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Report on
OPERATION "BACKFIRE"

VOLUME III
Field Procedure

Prepared for Printing by the Ministry of Supply

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Preface . .

SCOPE OF THE VOLUME

1. This volume describes in outline the organisation and deployment of a German Motorised V-2 Rocket Regiment and in detail the field procedure for unloading, preparing and launching A-4 rockets, without the assistance of wireless control. It is an account of how the Germans *did* it and not of how they *would* do it now or in the future.

ACCURACY OF THE INFORMATION

2. The information has been collected (a) by preparation and launchings during operation " BACKFIRE," (b) by interrogation of personnel who took part in operations during the war, (c) by staging various scenes as realistically as possible, and (d) by examination of what written instructions were available.

3. The Germans who took part in (a), (b) and (c) above were a mixture of soldiers and technicians, a certain number of the latter always having been included in V-2 regiments. They came from various units. Drill appears to have varied in small details between batteries and often in large details from the written instructions which they said they rarely received and never exactly followed. This is understandable in view of the novelty of the weapon.

TERMINOLOGY

4. A literal translation of some of the German terms employed does not make sense. On the other hand, it may be difficult to make a sensible translation concise. For instance, the term Fremdkommandotafel (literally translated " Enemy Command Table ") is, in fact, a " panel on which there are switches for simulating gyroscopic signals during horizontal tests." At first, therefore, common sense names were used, and owing to lack of time for correction it has been necessary to adhere to them although in some cases better translations have since come to hand.

5. For ease of reference when using German equipment, German names, and in some cases German words of command, are also given throughout the volume.

SEQUENCE

6. After a description of the rocket—an understanding of which is essential in order to follow the drill—and a brief description of the organisation and deployment of a V-2 regiment—which must be read in order to follow the procedure—the volume covers each step in unloading, preparing and launching rockets in the order in which it was done in the field.

7. It is suggested, however, that Sections 14 and 21, which describe the horizontal and vertical tests, should be read last. This is because they form a section apart and are more easily understood when the remainder of the procedure has been grasped.

8. Volume 4 contains descriptions of all the equipment and special vehicles employed. They are intended to contain sufficient detail to enable it to be understood what a man is doing when he turns a certain knob, and they should be referred to as directed throughout the procedure.

Description of the German Long Range Rocket A-4 . . SECTION 1

INTRODUCTION

9. The object of this description of the German long range rocket A-4 is to assist in an understanding of the procedure for handling, transportation, setting up and fuelling which follow. More detailed descriptions of the rocket motor unit, the auxiliary motor unit and the steering mechanism, required for an understanding of the various tests carried out on the rocket before firing, will be found in Volume 4.

PRINCIPAL COMPONENTS (PLATE 1)

10. The long range rocket is a liquid fuel rocket designed to carry a payload of one ton a distance of 300 kms (200 miles). Its overall length is 46 ft. 1 in. and its maximum diameter 5 ft. 5 in.

11. The rocket is made up of the following main components :—

(a) The ballistic nose and warhead.
(b) The control compartment.
(c) The centre section or fuel tank bay.
(d) The auxiliary motor unit and fuel pumps.
(e) The rocket motor and venturi.
(f) The tail unit and thrust ring.

12. The weight of the projectile without the warhead is approximately 2.8 tons. The warhead weighs 2,190 lbs., giving a total weight of approximately 4 tons without fuel. When fuelled, the rocket weighs a little over 12 tons.

THE BALLISTIC NOSE AND WARHEAD

13. The warhead is a sharply pointed cone 5 ft. 7 ins. long. The side casing is of mild steel plate, which is braced internally by struts. At the rear end the casing is welded to a steel ring to which is also welded a circular end plate with a central hole for filling. About 3 ft. from the nose there is a hole leading to an internal pipe which runs through the warhead and the control compartment to the top of the alcohol tank for the purpose of pressurising this tank for the first 40 seconds of flight of the projectile.

14. Two diametrically opposite slinging points are provided in the side casing of the warhead and there are two more in the end plate itself. The warhead is attached to the control compartment by means of bolts and this junction forms one of the two transport joints of the rocket when on the Meilerwagen.

15. A central exploder tube, with electrical fuzes at its forward and rear ends, runs through the warhead. Each fuze has two inertia switches so positioned that they operate whatever the angle of impact. In addition, the nose fuze has a nose switch mounted on a steel tube which projects beyond the nose housing.

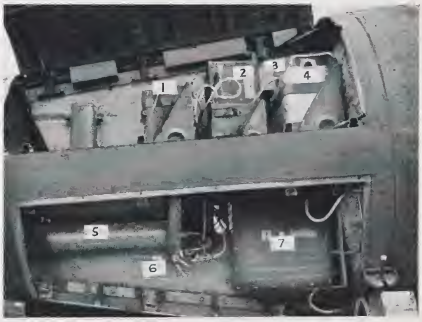


Fig. 1. Control Compartments 1 & 4

1. Ortler
2. 16v Batteries
3. Emergency fuel cut-off
4. Honef
5. Compressed air bottles
6. High pressure valve
7. Leitstrahl

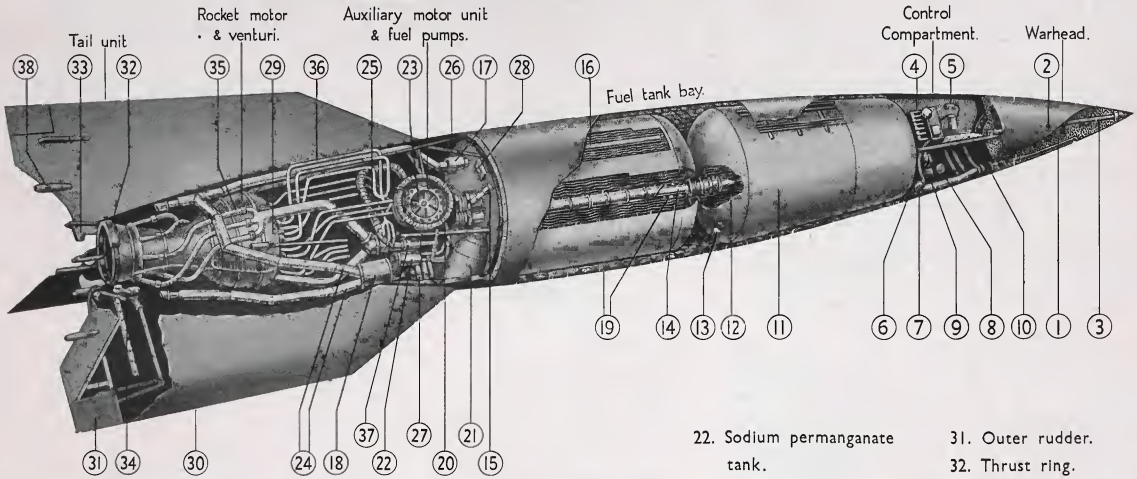
THE CONTROL COMPARTMENT (Plate 2 and Figs. 1, 2, 3, 4, 5 and 6).

16. The control compartment is situated immediately in rear of the warhead. It is a truncated cone, 4 ft. 7½ ins. long, divided into four equal sections by radial plywood sheets. Relative to the plane of any two of the stabilising fins of the rocket, the plywood sheets are oriented at 45°.

17. From Plate 2 it will be seen that the four compartments can be distinguished by the number of the corresponding

GERMAN LONG-RANGE A-4 ROCKET.

Plate I.



1. Alcohol tank pressurising pipe.
2. Slinging point.
3. Central exploder tube.
4. Main distribution box & ground control plug
5. Alternator & regulator.
6. Time switch.
7. Alcohol fuelling inlet.
8. Air pressure gauge & hand control cock.
9. Automatic pilot.
10. Control amplifier.
11. Alcohol tank.
12. Outlet valve.
13. Drainage valve.
14. Alcohol delivery pipe.
15. Oxygen fuelling inlet.
16. Stack pipe.
17. Oxygen tank vent valve.
18. Heat exchanger unit.
19. Glass wool.
20. Turbine.
21. Hydrogen peroxide tank.
22. Sodium permanganate tank.
23. Oxygen & alcohol pumps.
24. Turbine exhausts.
25. Oxygen main valve.
26. Braced steel frame.
27. Compressed air bottles.
28. Distribution box.
29. Combustion chamber.
30. Stabilising fin.
31. Outer rudder.
32. Thrust ring.
33. Carbon rudder.
34. Servo motor.
35. Alcohol feed pipes.
36. Oxygen feed pipes.
37. Auxiliary combustion chamber.
38. Aerial supports.

COMPARTMENT	EQUIPMENT	FUNCTION
1	Radio equipment for velocity measurement (Ortler or Verdoppler).	Used to determine point of fuel cut-off when fuel cut-off is radio controlled from the ground.
	Radio equipment for receiving fuel cut-off signal (Honef or Kommandoempsfaenger).	Also only installed when fuel cut-off is radio controlled from the ground.
	Emergency fuel cut-off equipment (Not-Brennschluss).	Enables fuel supply to be cut off in an emergency. Operated by ground control up to the moment the rocket leaves the table.
	Two 16 v. batteries. (Bordbatterie).	Main electrical D.C. supply for operation of gyros, control amplifier, solenoid valves, etc.
2	Main electrical distribution box (Hauptverteiler) and distribution box safety switch (Bordautomat).	
	Ground connector plug sockets (Stotz Stecker).	Plug sockets for ground power supply and connections between the fire control vehicle (Feuerleitpanzer) and the rocket.
3	Fuze arming unit (Sterg)	Arms fuzes in warhead approximately 2 minutes after take off.
	Automatic pilot comprising two gyros, one for roll and yaw (Vertikant), the other for pitch (Horizont), mounted on base plate (Richtgeberplatte).	Control of line and pitch of the rocket.
	Integrating accelerometer (I-Geraet).	Automatic fuel cut-off equipment. Alternative to radio equipment for fuel cut-off listed under Compartment 1.
	Time switch (Zeitschaltwerk)	Governs sequence of events after take-off on a time basis.
	Control amplifier (Mischgeraet).	Amplifies signals received from gyros so that they will operate servo motors and rudder motors which control moveable vanes and rudders in tail unit.
	One 50 v. H.T. nickel iron battery (Kommandogeberbatterie).	Supplies current for gyro signals.
	Alternator with regulator (Umformer mit Regler). Alcohol fuel tank inlet	Supplies A.C. three phase supply at 500 cycles per second to gyros. D.C. supply received from two 16 v. batteries. Alcohol fuelling.
	Alcohol tank pressurising pipe.	For pressurising alcohol tank from atmosphere for first 40 seconds of flight.
	Hand operated stop cock and pressure gauge (Handabsperrventil und manometer).	For filling and testing pressure in alcohol tank pressurising bottles.
4	Receiver for radio control for line (Leitstrahl).	
	Three compressed air bottles (Zusatzbeluftung).	Pressurising alcohol tank after fuel cut-off.
	Three alternators with regulators.	A.C. three phase supply, 500 cycles for control amplifier and radio equipment (when installed).
	High pressure valve (Hochdruckventil).	Safety valve for three compressed air bottles.

fin. This method of notation is used in table on opposite page which lists the main components of the control compartment and briefly indicates their several functions.

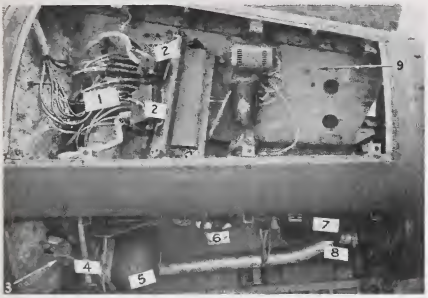


Fig. 2. Control Compartments 2 & 3

1. Main electrical distribution box
2. Ground connector plug sockets
3. Alcohol fuel tank inlet
4. Base plate
5. Automatic pilot
6. Alternator
7. Control amplifier
8. Alcohol tank pressurising pipe
9. Plywood sheet

Fig. 3. Main electrical distribution box

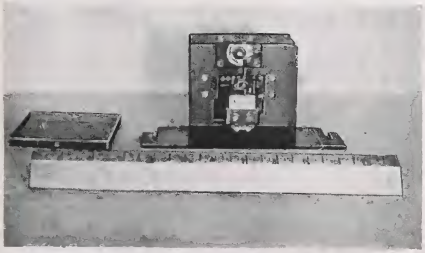


Fig. 4. Emergency fuel cut-off equipment

18. Compartments 1 and 3 (Plate 2) are each provided with two hinged panels held together by four fasteners. This permits easy access to the automatic pilot and alcohol tank inlet and the radio equipment, the hand operated stop cock for filling the alcohol tank pressurising bottles and the pressure gauge for reading the pressure in these bottles. For insertion of the ground connector plugs in compartment 2, a spring-loaded hatch is provided in the main panel. There is also a hatch for access to the main distribution box safety switch which is located in compartment 2.

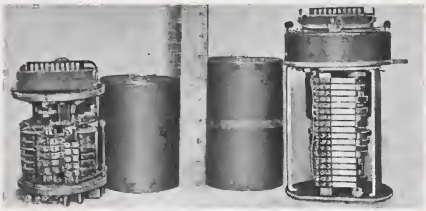


Fig. 5. Time switch

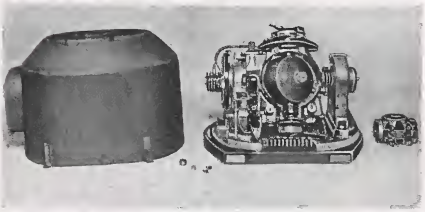


Fig. 6. Gyroscope

CENTRE SECTION OR FUEL TANK BAY

19. The centre section is 20 ft. $3\frac{1}{2}$ ins. long and houses the alcohol and oxygen tanks, the former being forward of the latter. The shell structure around the tanks is constructed in two halves and is made of steel reinforced by longitudinal and circumferential stringers.

20. The alcohol tank is constructed from light alloy sheet and is tapered towards the forward end of the rocket. The top of the tank is fitted with an inspection cover, a fuelling inlet, and an electrically operated pressure valve on the pipe running through the control compartment and the warhead. At the base of the tank is a pressure operated outlet valve (Fig. 7) and a drainage valve. The outlet valve leads via bellows (Fig. 8) to allow for expansion and contracting, to a delivery pipe which runs through the oxygen tank to the alcohol pump. Access to the alcohol drainage valve is by means of a hatch in the side of the shell between fins 2 and 3 (Plate 2).

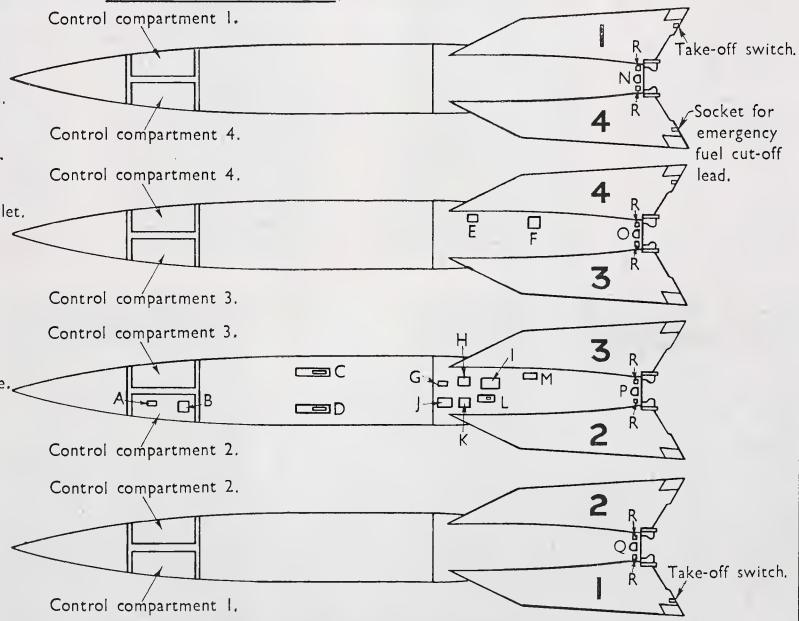
21. The capacity of the alcohol tank is approximately 9,200 lbs. by weight or 183 cu. ft.

Plate 2

A-4 ROCKET — POSITION OF HATCHES.

(CONTROL COMPARTMENTS)

A. Hatch for distribution box safety switch.
B. Spring hatch for Stotz plugs.
C. Hatch for alcohol drainage.
D. Hatch for leads for alcohol outlet valve.
E. Hatch for turbine centrifugal switch.
F. Hatch for alcohol main valve.
G. Hatch for hydrogen peroxide fuelling inlet.
H. Hatch for pressure reducing valve and auxiliary motor unit.
I. Hatch for hydrogen peroxide drainage and vent.
J. Hatch for oxygen fuelling inlet.
K. Hatch for sodium permanganate fuelling inlet.
L. Hatch for sodium permanganate vent.
M. Hatch for sodium permanganate drainage.
N. Cowling for oxygen topping up valve.
O. Turbine exhaust cowling.
P. Cowling for five-way coupling.
Q. Cowling for oxygen tank overflow and turbine exhaust.
R Hatches for Servo potentiometers.



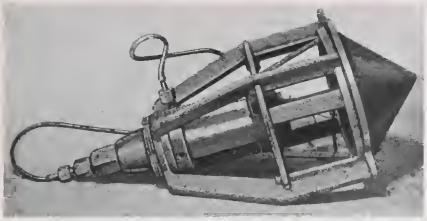


Fig. 7. Alcohol outlet valve

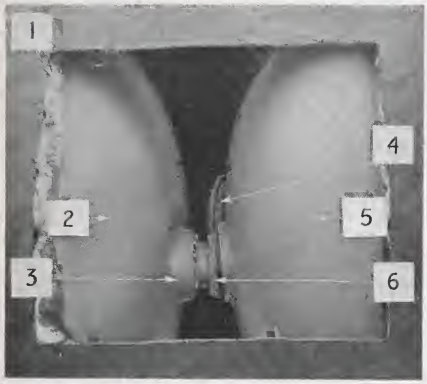


Fig. 8. Fuel tanks showing bellows

1. Glass wool
2. Alcohol tank
3. Alcohol outlet
4. Oxygen tank manhole cover
5. Oxygen tank
6. Bellows

22. The oxygen tank is also constructed from light alloy sheet. The tank is filled by means of a fuelling connection with a hand operated valve fitted to the tank outlet. An internal stack pipe which reaches to the top of the tank leads via a valve to a vent on the tail unit of the rocket. This pipe allows for venting of the tank during fuelling. A connection from the base of the stack pipe to the heat exchanger unit (Fig. 9) allows pressurisation by oxygen gas during flight. Access to the oxygen fuelling inlet is by means of a panel in the shell structure of the tail unit (Plate 2).

23. The capacity of the oxygen tank is approximately 12,200 lbs. by weight or 170 cu. ft.

24. The tanks and the alcohol pipe running through the oxygen tank are heavily lagged with glass wool (Fig. 8).

THE AUXILIARY MOTOR UNIT AND FUEL PUMP

25. The purpose of the auxiliary motor unit (Fig. 10) is to provide steam for the turbine which drives the alcohol and

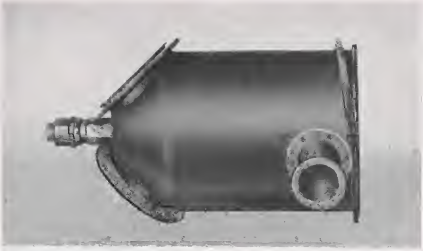


Fig. 9. Heat exchanger unit

oxygen pumps (Fig. 11) supplying fuel to the main combustion chamber of the rocket. The steam for the turbine is generated by the reaction of concentrated hydrogen peroxide and a catalyst, sodium permanganate. The fuels are stored in tanks (Fig. 10) which are filled through hatches in the main tail unit of the rocket (Plate 2). The hydrogen peroxide tank has a capacity of 379 lbs. or 126 litres. The sodium permanganate tank has a capacity of 29 lbs. or 11 litres. Provision is made for the drainage of these tanks, if, for any reason, fuel has to be removed from the rocket. Steam produced from the auxiliary combustion chamber drives the turbine to which are connected the alcohol and oxygen pumps.

26. Exhaust from the turbine is led via the heat exchanger into the rear of the rocket, where it escapes through cowlings in the tail unit. The heat exchanger vaporises some of the liquid oxygen, which is then used for pressurising the oxygen tank.

27. Oxygen is pumped from the oxygen tank through the oxygen main valve and subsequently by 18 pipes to 18 roses (Fig. 12) in the main combustion chamber (Fig. 13).

28. Alcohol is pumped via two pipes, each subsequently becoming three, to the base of the venturi, whence it passes between the walls of the venturi, for cooling purposes, to the jets (Fig. 12) in the combustion chamber.

29. The complete auxiliary motor unit, together with the turbine and pumps, is mounted on a braced steel framework bolted to the rear of the tank bay. This framework also supports seven compressed air bottles which pressurise the sodium permanganate and hydrogen peroxide tanks and operate various valves which control the flow of fuels.

30. An auxiliary electrical distribution box is fitted at the base of the oxygen tank.

THE ROCKET MOTOR AND VENTURI (Fig. 14)

31. The combustion chamber and venturi constitute one welded steel assembly. The combustion chamber has 18 open-ended cups facing rearwards.

32. The oxygen is fed to the roses direct from the oxygen main valve (Fig. 15). Alcohol, pumped to the base of the venturi, travels between the walls of the venturi to the

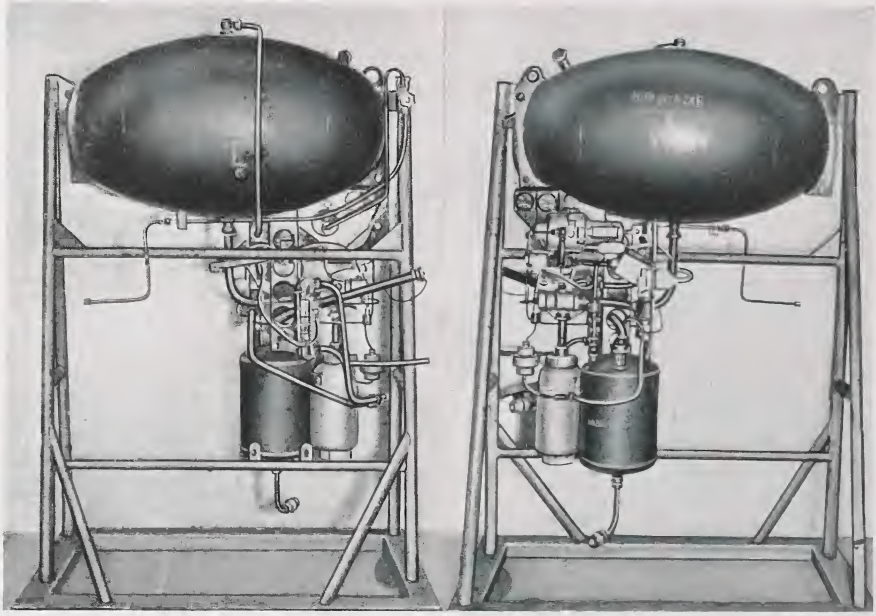


Fig. 10. Auxiliary motor unit

alcohol main valve (Fig. 16) which operates under pressure to allow alcohol to pass to the jets in the burners.

33. The venturi has rows of film coolant holes spaced throughout its length. These allow alcohol to pass to the inner surface of the venturi for additional cooling purposes.

THE TAIL UNIT AND THRUST RING (Fig. 17)

34. The tail unit is that part of the shell structure which encloses the rocket motor and auxiliary motor units. The tail unit does not transmit thrust loads; it acts as a fairing for the motor units and a support for the stabilising fins and the thrust ring at the base of the rocket. At its forward end the tail unit is supported by a circular rolled steel angle frame. This frame is bolted to the rear of the tank bay forming the second transport joint for the complete rocket.

35. The four stabilising fins are fixed at right angles to one another. Two are in the same plane as the plane of rotation of the turbine rotor; they are numbered 1 and 3 (Plate 2) and are aligned on to the target immediately prior to launching. Fins 2 and 4 are at right angles to the plane of rotation of the turbine rotor and are consequently at right angles to the plane of the trajectory when the rocket is in flight. At the rear end of each fin is an outer vane.

36. The tail unit has numerous hatches (Plate 2) which are used for fuelling and give access to various valves, servo motors and potentiometers. At the base of the rocket, between fins 2 and 3 there is a 5-way coupling which forms the connection between the rocket and the valve box. The 5-way coupling is protected by a cowling. Between fins 1 and 2 and 3 and 4, respectively, are vents for the exhaust from the steam turbine. The cowling between fins 1 and 2 contains a valve which may be used for topping up the oxygen tank if there has been undue wastage since main fuelling was completed. In the base of fin 4 is a socket for the emergency fuel cut-off line, whilst fin 1 is fitted with a spring-loaded take-off switch (Abhebekontakt).

37. The thrust ring at the base of the tail unit is a cast light alloy channel ring which mounts the four supports and brackets for the carbon rudders (Fig. 18). These carbon rudders, together with the four outer vanes on the fins, are used for controlling the rocket in flight up to the fuel cut-off point. The vanes and rudders are actuated by hydraulic servo motors (Fig. 19), mounted inside the tail unit on the thrust ring. Two of the carbon rudders, together with their corresponding outer vanes (1 and 3) which are geared to them, control the rocket for line and counteract any tendency of the rocket to roll or yaw. Any such tendency is detected by the roll and yaw gyro which operates

the servo units through the control amplifier in the control compartment and the potentiometers on the thrust ring. The remaining two carbon rudders control the pitch (Program) of the rocket as directed by the pitch gyro. These latter rudders are not connected with their corresponding outer vanes (2 and 4) which assist control surfaces 1 and 3 correcting roll. A more detailed account of the steering mechanism is given in Section 10 of Volume 4.

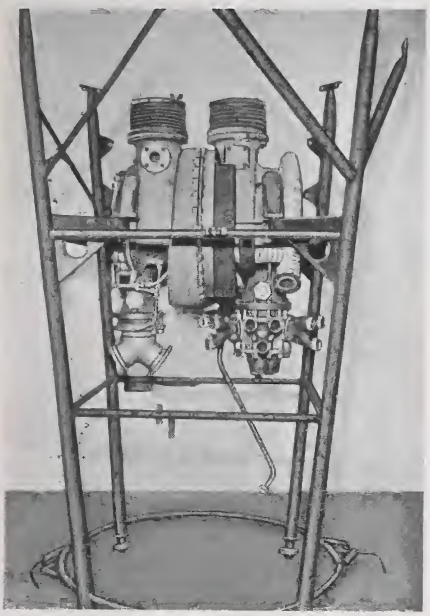


Fig. 11. Turbine, alcohol pump and oxygen pump

Fig. 12. Oxygen rose and alcohol jets

Fig. 13. Main combustion chamber

Fig. 14. Rocket motor and Venturi

Fig. 15. Oxygen main valve

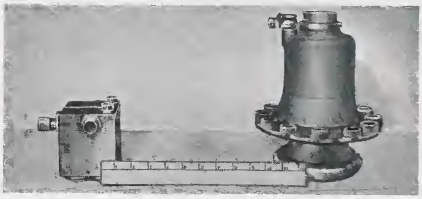


Fig. 16. Alcohol main valve and alcohol and oxygen main valve control valve

Fig. 18. Carbon rudder

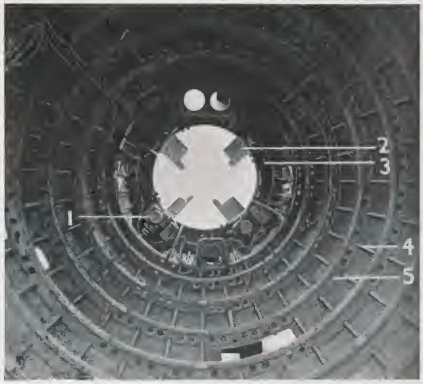


Fig. 17. Tail unit

1. Servo motor
2. Carbon vane
3. Thrust ring
4. Longitudinal stringer
5. Circumferential stringer

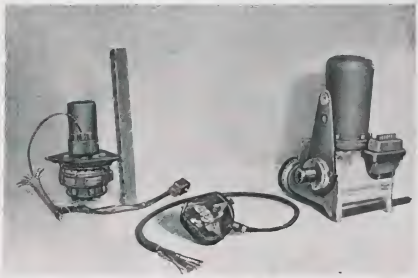


Fig. 19. Trim motor and Servo motor

Performance of the German Long Range Rocket A-4 . . SECTION 2

THE TRAJECTORY (Plate 3)

38. The trajectory of the A-4 rocket may be divided into two parts :
(*a*) from launch until fuel cut-off,
(*b*) from fuel cut-off until fall of shot.

During the period before fuel cut-off, the flight of the rocket is controlled ; after fuel cut-off the rocket is uncontrolled.

39. When the rocket leaves the launching table, it first climbs vertically for 4 seconds. It is then made to pitch in the direction of the target in accordance with a predetermined programme, which is put into effect by a time switch. The pitch programme lasts for approximately 43 seconds and at the end of this time the rocket is at an inclination of 47° to the vertical. Thereafter, until fuel cut-off, which is approximately 65 seconds after launching, depending on the range to the target, the rocket is held at constant inclination and the trajectory is almost straight. After fuel cut-off, the rocket follows the normal parabolic trajectory of a free projectile attaining a maximum height of the order of 70 to 80 kms.

40. The initial acceleration of the rocket relative to the ground is 1g. The acceleration increases during burning as the weight of the rocket and the resistance of the atmosphere decrease, until it is approximately 5g. at fuel cut-off. Air resistance, encountered as the projectile descends into the atmosphere again, causes retardation. The maximum velocity attainable by the rocket is 5,000 ft. per second, falling to a terminal velocity of 2,500 ft. per second.

41. The three axes of the rocket (pitch, roll and yaw) are controlled gyroscopically during burning. It is the purpose of these controls, together with the thrust of the rocket motor, to bring the rocket to a predetermined point in space, so that it has a predetermined orientation and velocity. When this point is reached, fuel supply to the rocket motor is shut off (Brennschluss) and control over the flight path is relinquished. Thereafter, the behaviour of the projectile is similar to that of a normal shell, the velocity attained at fuel cut-off being comparable with muzzle velocity.

42. The trajectory up to fuel cut-off is assumed to be constant for all rockets. To fire at a given range, it is therefore only necessary to calculate the required velocity at fuel cut-off and to set the integrating accelerometer or sequence switch (or radio fuel cut-off devices) accordingly. The setting values can be read from range tables. The rocket, as used by the Germans, was fired entirely according to range tables.

43. Corrections are made to both line of fire and range to allow for the effect of the rotation of the earth. These corrections vary according to latitude, range of employment and direction of the line of fire. For example, for a range of 500 kms. (200 miles) and line of fire due north at latitude 54°, the line correction is of the order of 54 mins. left and the range correction approximately ± 2 kms. These corrections can be read direct from the range tables. No corrections are made either for meteorological conditions or for variation between rockets. Variation in thrust performance is already allowed for in the rocket as a result of factory tests.

RANGE CAPABILITIES OF A-4

44. With methyl alcohol and no fuel cut-off (i.e., all fuel is consumed), the mean range achieved by the rocket is 295 kms. (183 miles) with a so-called 100 per cent. zone of ± 35 kms. Thus, although it is possible to reach a range of 330 kms. (205 miles), it is not in fact advisable to engage targets at ranges exceeding 260 kms (162 miles) which is the maximum effective operational range when methyl alcohol is employed. At ranges greater than 260 kms. (162 miles), an increasing proportion of rounds will exhaust their stocks of fuel before attaining the velocity required to take them to the target. The minimum operational range is 80 kms. (50 miles), and this is governed by the limitations of the time switch which prohibits fuel cut-off before 45 seconds burning.

THE EFFECTIVENESS AND ACCURACY OF A-4

45. Rounds set up for firing may suffer one of three fates :
(*a*) They may fail to take off due to some technical fault.
(*b*) They may rise but fail to behave normally, also due to some technical failure.
(*c*) They may behave as expected and fall in the vicinity of the target.

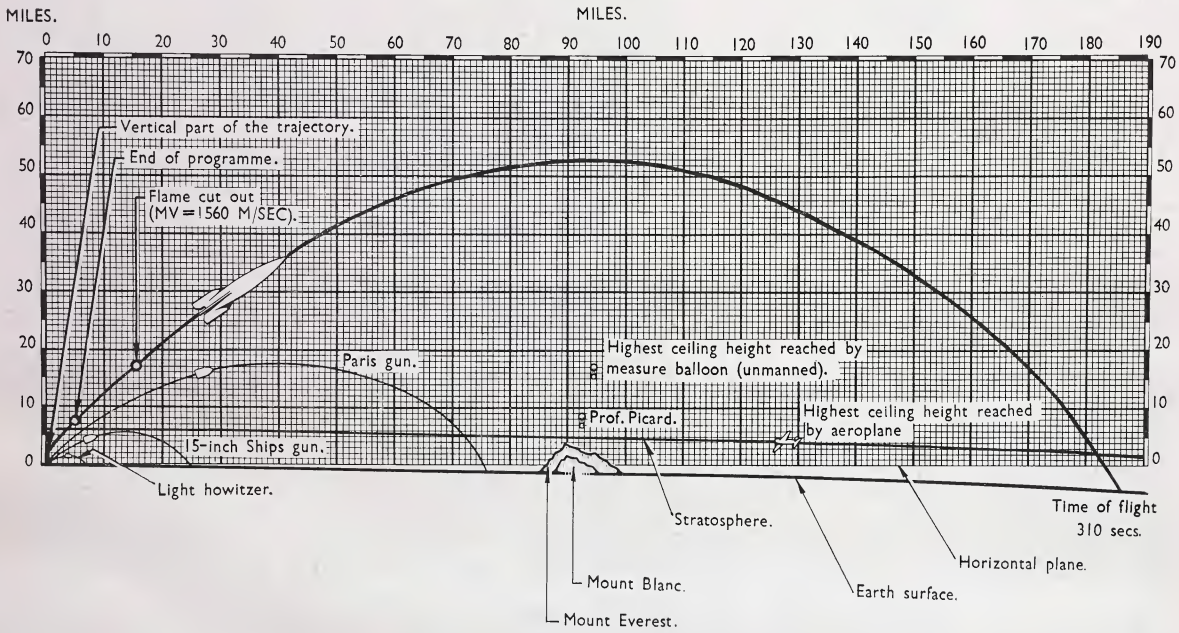
During the bombardment of Antwerp by the Germans, from December 1944 to March 1945, the proportion of rounds falling into these three categories was 17 per cent., 18 per cent. and 65 per cent., respectively.

46. Of the 65 per cent. which behaved normally, the scatter of the fall of shot about the mean point of impact (MPI) varies according to the method of control employed. The following table indicates the accuracy achieved with the varying forms of control during operations against ANTWERP at a range of 200 kms.

TYPE OF CONTROL		MEAN DEVIATION (KMS.)	
Range Mechanical	*Line* Mechanical	*Range* 3·4 ± 0·2	*Line* 4·6 ± 0·3
Mechanical	Radio	2·9 ± 0·3	0·4 ± 0·1
Radio	Radio	6·7 ± 0·8	0·4 ± 0·1

TRAJECTORY OF THE ROCKET (RANGE 300 KM-185 MILES).

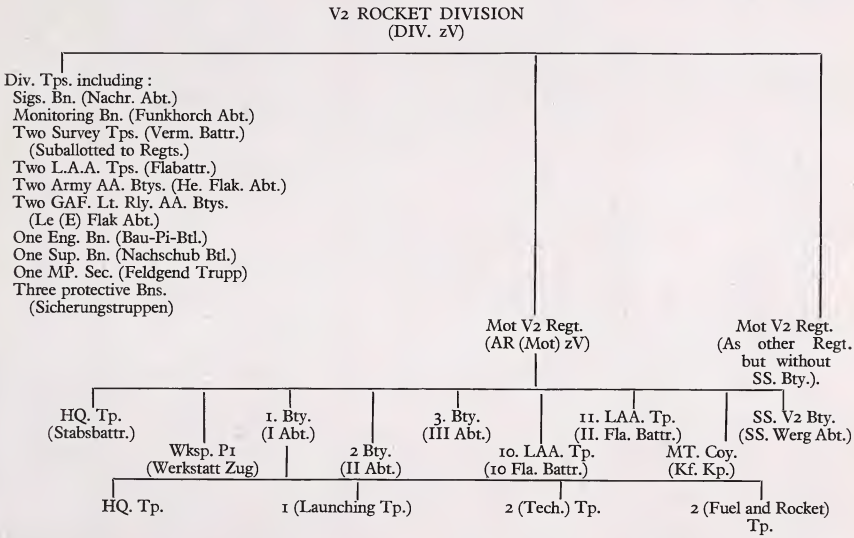
Plate 3



Field Organisation and Establishments SECTION 3

GENERAL

47. The organisation as it existed in the West in March, 1945, was broadly as follows :



THE REGIMENT

48. The Regiment commanded by a Lieut.-Col. (Oberst lt) consists of a Headquarters, various Troops as detailed below and three batteries.

THE HEADQUARTERS TROOP (GRUPPE FUEHRER)

49. In this Troop there are a Headquarters Section, a Signals Platoon which is responsible for inter-battery and Regimental Headquarters communications, a Medical Section, a Salvage Section and Supply Column for Regimental Headquarters.

THE WORKSHOP PLATOON (WERKSTATT ZUG)

50. The Workshop Platoon carries out repairs on MT vehicles and special vehicles.

TWO LAA TPS (FLAKBATTERIEN)

51. These troops are armed with quadruple 20 mms. and allotted to the batteries for the protection of launching positions and vulnerable points.

THE MT COMPANY (KRAFTFAHRKOMPANIE)

52. The MT. Company is responsible for the transport of fuel (other than rocket fuels) and oils.

(It will be noted that one Regt. had a fourth battery under command. Except that it was made up of SS personnel and contained an AA Troop, it was similar to the other batteries).

THE BATTERY (ABTEILUNG)

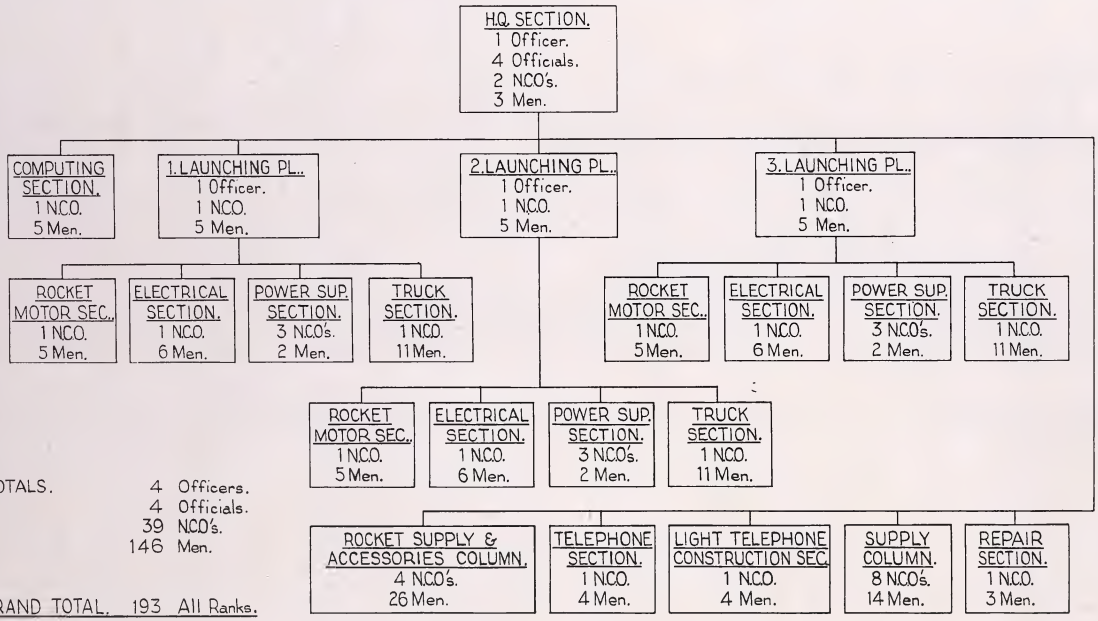
53. The Battery consists of a Headquarters, a Headquarters Troop, a Launching Troop, a Technical Troop and a Fuel and Rocket Troop.

THE HEADQUARTERS TROOP (GRUPPE FUEHRER)

54. The Headquarters Troop contains a Headquarters Section, a Signals Platoon for communications within the battery, a Survey Detachment, a Medical Section, a Weapons Maintenance Section, a Light MT Repair Platoon, a Supply Column for Headquarters supplies and a Battery Rations Section which deals with accounts.

Plate 4

ORGANIZATION OF GERMAN LONG RANGE ROCKET LAUNCHING TROOP, APRIL 1945.



TOTALS. 4 Officers.
4 Officials.
39 N.C.O's.
146 Men.

GRAND TOTAL. 193 All Ranks.

THE LAUNCHING TROOP (SCHIESSENDE BATTERIE) (Plate 4)

55. The Launching Troop is responsible for preparation for action and launching the rocket.

56. It consists of a Headquarters Section, a Computing Section, a Rocket Supply and Accessories Column, a Telephone Section, a Light Telephone Construction Section, a Supply Column, a Repair Section and three Launching Platoons, one launching site to each platoon.

THE HEADQUARTERS SECTION (GRUPPE FUEHRER)

57. The Headquarters Section consists of a Troop Commander, usually a Captain, and four engineers (Ingenieur) usually Lieuts. or 2/Lieuts. These engineers are experts in various branches of the rocket. There is a Troop Engineer who understands the whole rocket and particularly the rocket motor, a Control Engineer who specialises in the steering unit, an Electrical Engineer and a Wireless Engineer.

THE COMPUTING SECTION (RECHEN-UND-AUSWERTETRUPP)

58. The Computing Section make all calculations connected with the line of fire and range.

THE ROCKET SUPPLY AND ACCESSORIES COLUMN (NACHSCHUB-UND ZUHEHOER-STAFFEL)

59. The Rocket Supply and Accessories Column with 9 Meilerwagens for transporting the rocket, take over the rocket and accessories from the Technical Troop at the transloading point and deliver them to the Launching Platoons. They also work the compressor and provide the fire services.

THE TELEPHONE SECTION AND LIGHT TELEPHONE CONSTRUCTION SECTION (FERNSPRECHBETRIEBSTRUPP UND LEICHTE FERNSPRECHBAUTRUPP)

60. The Telephone Section and the Light Telephone Construction Section are responsible for the layout and maintenance of telephone communications within the troop.

THE SUPPLY COLUMN (TROSS)

61. This Column is responsible for all non-technical supplies.

THE REPAIR SECTION (J. TRUPP)

62. The Repair Section carry out minor repairs to equipment within the Launching Troop.

THE LAUNCHING PLATOON (SCHIESSZUG)

63. Each Launching Platoon has a Headquarters Section, a Rocket Motor Section, an Electrical Section, a Power Supply Section and a Truck Section.

THE HEADQUARTERS SECTION (GRUPPE FUEHRER)

64. The Headquarters Section of the Launching Platoon consists of the Platoon Commander (Lt.), the second in charge (N.C.O.) and three layers who are responsible for laying the rockets in the correct line of fire.

THE ROCKET MOTOR SECTION (TRIEBWERK-STRUPP)

65. The Rocket Motor Section prepare and test the rocket motor prior to launching.

THE ELECTRICAL SECTION (ELEKTROTRUPP)

66. The Electrical Section prepare and test the apparatus in the control compartments and the steering mechanism.

THE POWER SUPPLY SECTION (ENERGIEVER-SORSUNGSTRUPP)

67. The Power Supply Section are responsible for the generator, two N.C.O.'s from this section operate the rocket motor and steering panels in the fire control vehicle.

THE TRUCK SECTION (WAGENTRUPP)

68. The Truck Section operate the Meilerwagen on the launching position. They are responsible for the erection of the rocket on the launching table and they assist in fuelling. They move all special vehicles (fire control vehicle, generator vehicle, etc.)

THE TECHNICAL TROOP (TECHNISCHE-BATTERIE) (Plate 5)

69. The Technical Troop has a Headquarters Section, No. 1 Platoon (Testing), No. 2 Platoon (Transloading and Construction), a Motorised Telephone Section, an MT Repair Echelon and a Supply Column.

THE HEADQUARTERS SECTION (GRUPPE FUEHRER)

70. The Headquarters Section consists of a Troop Commander who is a technical expert, a second in charge who is an engineer, various clerks, a draughtsman and DR's, etc.

THE MOTORISED MEDIUM TELEPHONE SECTION (MITTL FERNSPRECHTRUPP (MOT))

71. This section is responsible for telephone communications within the Technical Troop.

THE MT REPAIR ECHELON (KFZ-J-STAFFEL)

72. This section carries out major repairs on MT vehicles for the battery.

THE SUPPLY COLUMN (TROSS)

73. This column is responsible for rations, clothing and all non-technical stores for the Technical Troop.

NO. 1 PLATOON (1 ZUG) OF THE TECHNICAL TROOP

74. No. 1 Platoon has an officer in charge, a Headquarters Section, two Testing Sections and a Repair and Tail Removal Section.

THE TWO TESTING SECTIONS (PRUEFTRUPP)

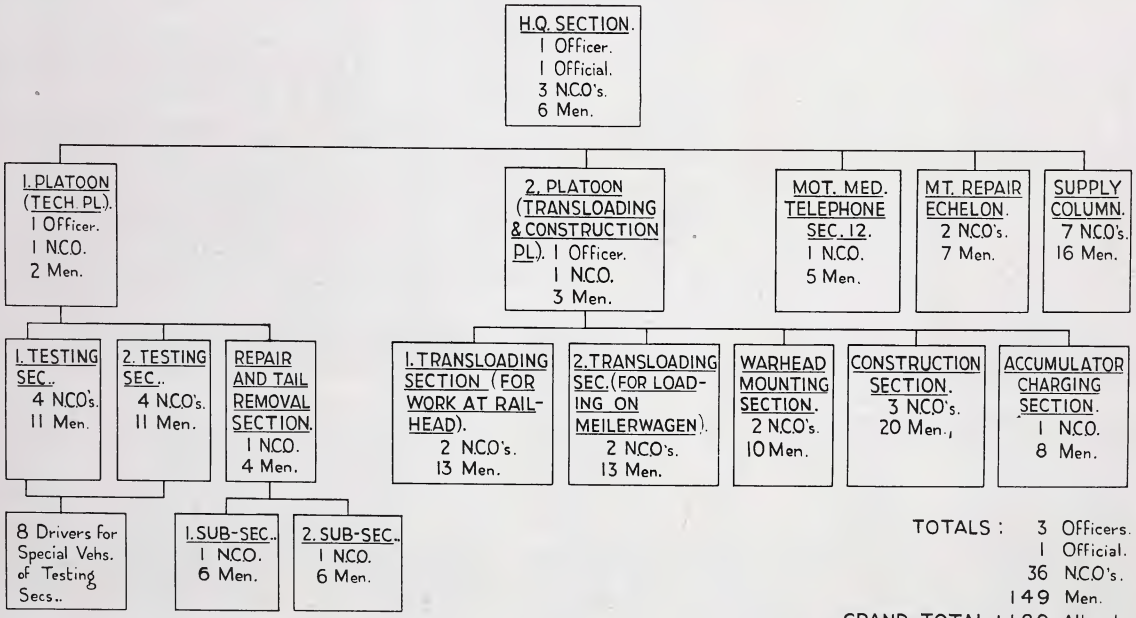
75. These sections are identical. The personnel are responsible for testing the rocket in the horizontal position. The sections work in shifts.

THE REPAIR AND TAIL REMOVAL SECTION (J-u. HECKABZUGTRUPP)

76. This section carries out minor repairs which can be done without sending the rocket to base workshops or back to the factory. It has two sub-sections which work in shifts.

Plate 5

ORGANIZATION OF GERMAN LONG RANGE ROCKET TECHNICAL TROOP, APRIL 1945.



TOTALS : 3 Officers.
1 Official.
36 N.C.O's.
149 Men.

GRAND TOTAL : 189 All ranks.

NO. 2 PLATOON (2 ZUG) OF THE TECHNICAL TROOP

77. No. 2 Platoon, with an officer in charge, consists of Nos. 1 and 2 Transloading Sections, a Warhead Mounting Section, a Construction Section and an Accumulator Charging Section.

NO. 1 TRANSLOADING SECTION (UMSCHLAG-TRUPP)

78. This section work at the railhead and assist in unloading rockets.

NO. 2 TRANSLOADING SECTION (UMSCHLAG-TRUPP)

79. This section work at the troop transloading point and assist in transloading the rocket from the Testing Troop's Trailer (Vidalwagen) on to the Meilerwagen.

THE WARHEAD MOUNTING SECTION (SPITZENMONTAGETRUPP)

80. This section fits warheads to fully tested rockets before they are sent to the transloading point.

THE CONSTRUCTION SECTION (BAUTRUPP)

81. This section is mainly concerned with road construction and building within the Technical Troop.

THE ACCUMULATOR CHARGING SECTION (SAMMLER-LADE-STATION)

82. This section charges all batteries and accumulators for rockets and for MT.

THE FUEL AND ROCKET TROOP (TRIEBSTOFF-u. GERAET BATTERIE) (Plate 6)

83. The Fuel and Rocket Troop has a Headquarters Section, a Repair Section, a Supply Column and three Platoons.

THE HEADQUARTERS SECTION (GRUPPE FUEHRER)

84. The Headquarters Section consists of a Troop Commander (Lt.) a second in charge (N.C.O.), DRs, etc.

THE REPAIR SECTION (J-TRUPP)

85. This section carries out minor repairs within the Troop.

THE SUPPLY COLUMN (TROSS)

86. This column is responsible for all non-technical supplies.

NO. 1 PLATOON (LIQUID OXYGEN) (A-STOFF)

87. The Liquid Oxygen Platoon has three sections. Nos. 1 and 2 Sections each have five road tank trailers and transport oxygen from the railhead to the launching positions. No. 3 Section remains at the railhead for unloading and checking.

NO. 2 PLATOON (ALCOHOL AND HYDROGEN PEROXIDE) (B UND T STOFF)

88. No. 2 Platoon has five sections. Nos. 1, 2 (five road tankers each) and No. 3 Section (four road tankers), transport alcohol from the railhead to the launching positions. The fourth section remains at the railhead for unloading and checking. The fifth section is the hydrogen peroxide section. It unloads and transports hydrogen peroxide in three road tankers.

NO. 3 PLATOON (ROCKET TRANSPORT) (GERAET)

89. This Platoon has three sections. Nos. 1 and 2 Sections, with eight Vidalwagens each, transport the rocket from railhead to the Technical Troop. No. 3 Section, with two 8-ton lorries, unloads warheads and sodium permanganate (Z-Stoff) at railhead and transports them to the Technical Troop.

THE OFFICIAL WAR ESTABLISHMENT OF 1 JAN., 1945

90. The WE outlined above and given in detail in Section 38, Volume 4, is unofficial, but it was evolved as a result of experience in the field. It has been put together by interrogation of personnel who took part in the operations.

91. The official WE was first published in January, 1945, but was modified by the troops in actual operations. It differs in small details and in the following main points:

THE LAUNCHING TROOP

(*a*) The Supply and Accessories Column forms part of each Launching Troop. The Officer i/c Launching Troop is therefore responsible for the rocket from the moment it leaves the transloading point (whereas in the unofficial WE he is relieved of this responsibility and only has to concentrate on launching).

(*b*) The layers are part of the Computing Section. (In the unofficial WE they are part of the Launching Platoon and therefore remain on the position).

THE TECHNICAL TROOP

(*c*) A considerable reduction in personnel caused by the initial limitation of launching operations which was an inevitable consequence of supply difficulties.

(*d*) There is only one testing Section (instead of two working in shifts).

(*e*) The Railway Transloading Section forms part of the Fuel and Rocket Troop.

THE FUEL AND ROCKET TROOP

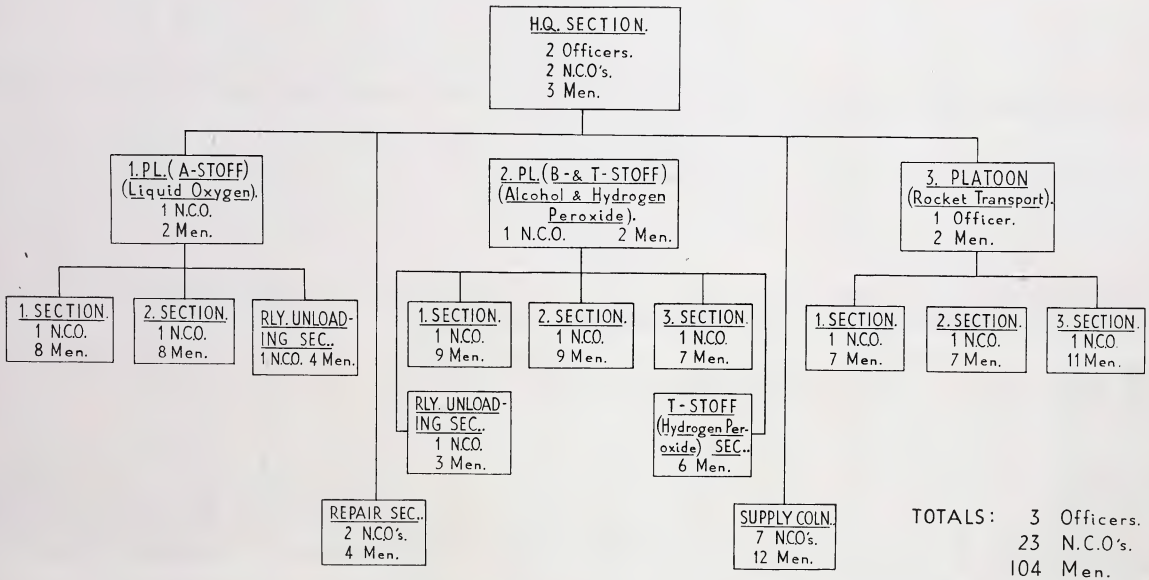
(*f*) Eight oxygen tankers (instead of ten in the unofficial WE).

(*g*) Two hydrogen peroxide tankers (instead of three in the unofficial WE).

(*h*) Oxygen, alcohol and hydrogen peroxide all carried by one platoon (instead of two as in the unofficial WE).

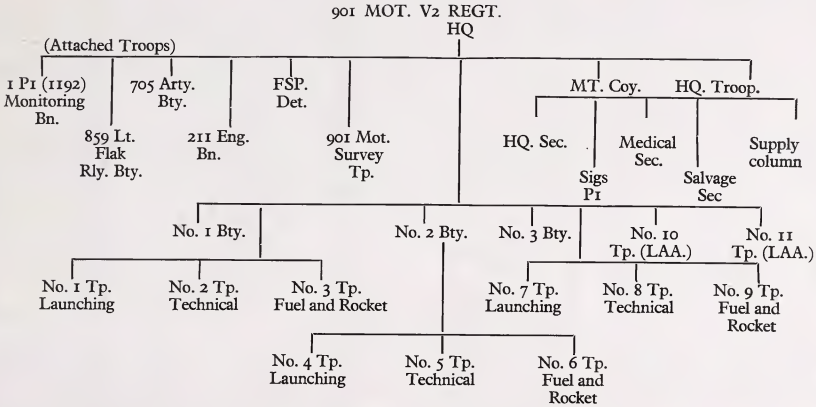
Plate 6

ORGANIZATION OF GERMAN FUEL AND ROCKET TROOP, APRIL 1945.



TOTALS: 3 Officers.
23 N.C.O's.
104 Men.
GRAND TOTAL: 130 All Ranks.

Deployment . . . . . SECTION 4



92. The layout of 901 V-2 Regiment in the Hachenburg Area as it was in March, 1945, is given in Plate 7.

93. It is a good layout in country well suited for the purpose, and will serve to illustrate various points in the deployment of a V-2 regiment.

94. The make up of the regiment and its attached Troops was as above.

REGIMENTAL HEADQUARTERS

95. Headquarters 901 Mot V-2 Regiment is at Maxsain. This is right in the centre of the area conveniently placed between a main road and the railway.

HEADQUARTERS TROOP

96. To the east of Regimental Headquarters is the Headquarters Troop and the Motor Pool of the Troop, also the Survey Troop.

BATTERY HEADQUARTERS

97. No. 1 Battery Headquarters is at Holler, in the south, No. 2 Battery Headquarters at Marienberg, in the north-east, and No. 3 Battery Headquarters at Altdtadt in the north-west. These are all near the railway unloading points and within three miles or less of the launching positions.

LAUNCHING TROOPS.

98. No. 1 Launching Troop Headquarters is at Oberlbert, in the south, No. 4 Launching Troop Headquarters is near Norken, in the north east, and No. 7 Launching Troop is at Gehlert, in the north-west. These are all within one mile or less of the launching positions.

99. Launching Troops should be dispersed within the Regiment in order to avoid road congestion, to make enemy air reconnaissance difficult and to reduce losses during raids.

100. Launching Platoons should be dispersed within the Troop in order to avoid them being in each other's way when launching and to minimise losses of personnel and material from misfires. The best distance apart is about 1 kilometre.

101. The launching points of No. 7 Launching Troop are in line roughly at right angles to the line of fire. In the case of No. 4 Troop this was not possible owing to the country. The third position was therefore put well behind the other two. The launching points of No. 1 Troop are approximately in the line of fire. This was possibly due to the intention to launch with wireless beam.

102. In selecting a launching position, the following points are borne in mind :

(*a*) It should be near the railway in order to preserve fuel and vehicles and more particularly to avoid delay in bringing up the rocket.
(*b*) It should be near a metalled road in order to minimise road building and maintenance, and preferably on a metalled road in order to avoid having to make a launching platform.
(*c*) Cover is very important, both from the point of view of avoiding easy air reconnaissance and also as a screen against the wind. Pine woods are preferred.

103. If no natural hard platform for the launching table is available, one has to be built. This is best done by placing steel sleepers across wooden ones. A platform about 7m. × 8 m. is required and hard standing in addition for the fuelling vehicles.

TECHNICAL TROOPS

104. No. 2 Technical Troop is at Hohrgrenshausen, in the south. No. 8 Technical Troop is at Alpenrod, in the north. No. 5 Technical Troop had not yet been formed. The plan at one time was to have one Technical Troop to each two Launching Troops, but in operations this was found to be inadequate.

105. In selecting an area for the deployment of a Technical Troop (for the layout of the Technical Troops see Section 11, Plate 11) the following points are borne in mind :
(*a*) The Testing Area must be on a road leading from the rocket unloading station to the launching position.
(*b*) It must be well camouflaged, because there are several tents and parking grounds within the Troop—a wood is used whenever possible.
(*c*) There must be good roads.
(*d*) If possible there should be electricity available from the mains.

106. It will be seen that the Testing Area of No. 2 Troop is well placed between the rocket unloading station at Ransbach and the launching position. The Testing Area of No. 8 Troop is not marked because it is within the Technical Troop area, which again is well placed, being the centre of the triangle rocket unloading station, No. 4 Troop Launching Position, and No. 7 Troop Launching Position.

FUEL AND ROCKET TROOPS

107. No. 3 Fuel and Rocket Troop is at Dernbach, in the south, No. 6 at Langenbach, in the north-east, and No. 9 at Merklebach, in the north-west.

108. No. 6 Troop was standing by, Nos. 4 and 7 Launching Troops both being serviced by No. 9 Fuel and Rocket Troop.

109. The Fuel and Rocket Troop layout consists of billets and parking grounds. It is essential :
(*a*) that routes should be synchronised so that there is no congestion between alcohol, oxygen, hydrogen peroxide and rocket transport.
(*b*) that parking grounds for oxygen, alcohol and hydrogen peroxide and Vidalwagens should be dispersed and near the routes. This usually means building by-pass roads.

RAILWAY UNLOADING STATIONS

110. Separate stations for alcohol, oxygen, hydrogen peroxide and rockets are favoured ; also separate stations for each battery and alternative stations in case the main ones are put out of action. This is ideal and not always possible. No alternative stations are marked on the map, but it is understood that they eventually existed.

111. Station layouts are dealt with in detail in Sections 6, 7, 8 and 9.

PROTECTION

112. Attached to the regiment is one battery of LAA mounted on railway wagons—859 Lt. Flak Rly. Bty. This consists of 3 mixed troops each of 12 guns (20mm. and 37mm.) and they are deployed for the protection of the railway unloading stations. The Headquarters is at Montabaur, in the south.

113. The regiment contains two troops (Nos. 10 and 11) of LAA for protection of the launching position and vulnerable points. These troops are armed with nine quadruple 20mms. each.

114. At one time each battery also had one platoon of motorised infantry and one platoon of motorised anti-tank for protection against possible air landings, but these were later required for the front.

115. At the beginning of 1944 it was proposed to use smoke for hiding the approach of the rocket to the launching position, but this never materialised.

116. One detachment of Field Security Police is used to seal the approaches to the launching positions. Their Headquarters is at Quirnbach.

117. At one time dummy positions were discussed but never materialised. A shiny rocket was made which emitted flame. This was to give agents and aircraft the impression that a faulty launch had been made.

118. One platoon of 1192 Monitoring Bn. is attached and is deployed at Ruscheid, in the west. This platoon passes "spoof" launching signals. Such launching signals could be tied in with dummy launches.

ENGINEERS

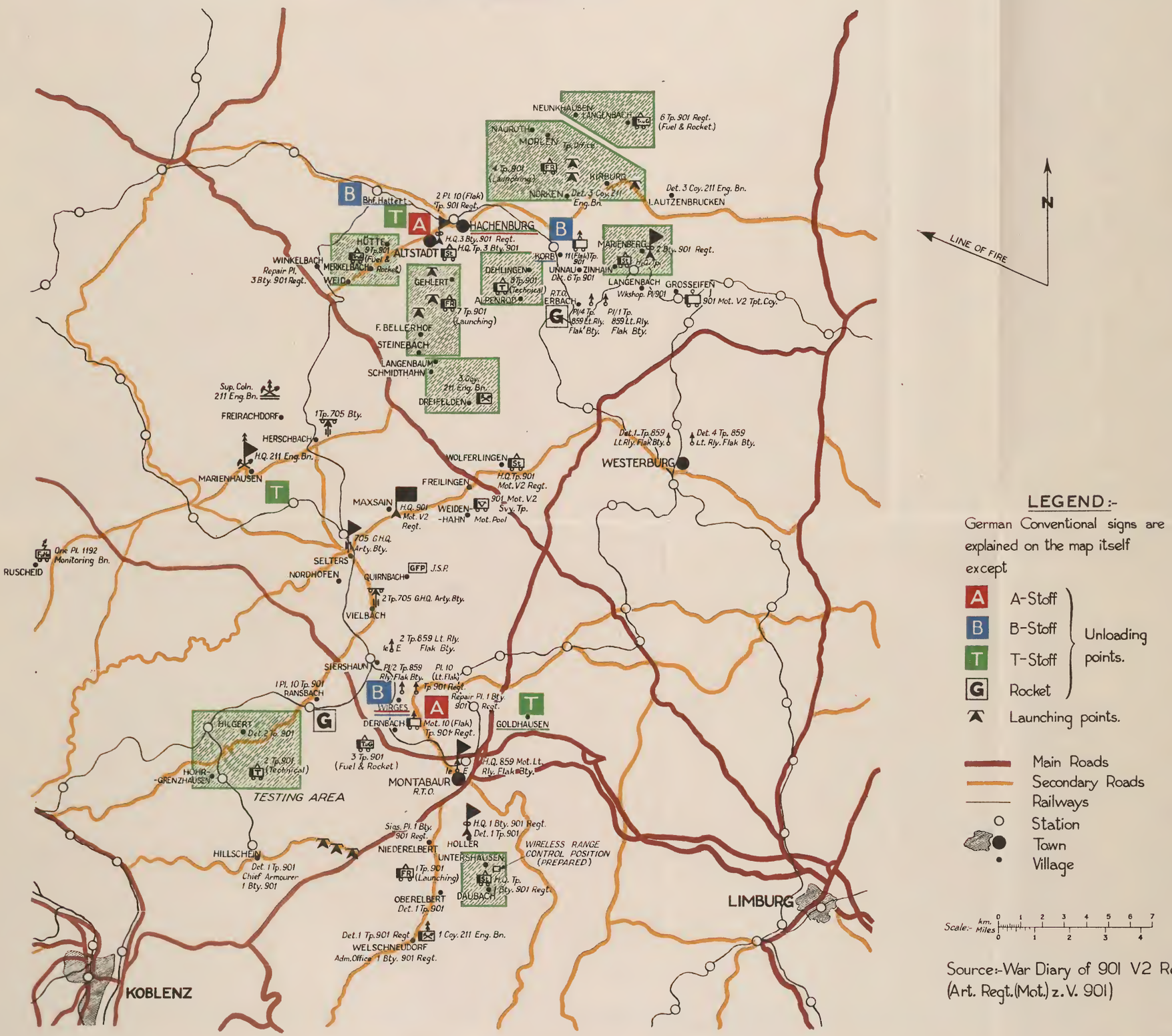
119. 211 Engineer Bn. Headquarters is at Marienhausen, in the west. No. 1 Company is deployed at Welschnendorf, in the south, and No. 3 Company at Dreifeldon, in the north-west. One detachment of No. 3 Company is at Lautzenbrucken, in the north-east.

120. The engineers are engaged on making and repairing launching positions, roads and parking grounds. They have been allotted on the basis of one company to No. 1 Battery, 2 detachments to No. 3 Battery and 1 detachment to No. 2 Battery.

TELEPHONE COMMUNICATIONS

121. Telephone communications are normal. A Battery, Troop and Railway Station Layout is given in Section

DISPOSITION OF GERMAN V2 REGIMENT & ATTACHED TROOPS IN AREA HACHENBURG
11 FEB. - 18 MAR. 1945



Source:-War Diary of 901 V2 Regt. (Art. Regt. (Mot.) z.V. 901)

5, Fig. 20. Wireless communication is only available between regimental and Battery Headquarters.

WIRELESS CONTROL

122. It was intended that when equipment was available No. 1 Battery should launch with wireless beam and range control (fuel cut-off) and No. 2 Battery with wireless range control (fuel cut-off). No. 3 Battery was intended to launch exclusively rockets with automatic fuel cut-off. The requisite detachments (remote flight control platoons) would have been allotted to the respective Batteries. One position was prepared near Holler, in the south, but never used.

FUELS OTHER THAN ROCKET FUELS

123. 901 Mot. V-2 Tpt. Coy. is deployed at Grosselfen, in the east, on the railway and near the largest concentration area. This company supplies fuels for M.T.

15 CM. POWDER ROCKETS (HOCHDRUCKPUMPE)

124. 705 Arty. Battery is attached to 901 Regt. and the Headquarters is at Maxsain. The launching positions are at Herschbach and Viebach.

At this time the battery was being converted to 10-cm. guns.

Part 4

Layout of Fuel and Rocket Troop . . SECTION 5

GENERAL LAYOUT (Plate 8)

125. The four fuels used in the rocket are normally unloaded at four separate railway stations. In Plate 8, which illustrates the layout of No. 9 Troop of 901 V-2 Regt. in the Westerwald, the alcohol and oxygen unloading stations are shown at the top of the map and the hydrogen peroxide unloading station at the bottom of the map. Sodium permanganate is unloaded at the rocket unloading station which can be seen on the right of the map.

126. Alternative fuelling stations are prepared in case the main stations are put out of action by enemy activity. These are further south and are not shown.

127. As near as possible to these stations are the No. 1 Platoon (oxygen), No. 2 Platoon (alcohol and hydrogen peroxide) and No. 3 Platoon (rocket transport) Headquarters and parking grounds.

PARKING GROUNDS (Plate 9)

128. Important points to consider in selecting parking grounds are :
(*a*) concealment from the air ;
(*b*) proximity to good roads

129. It will be noted in Plate 9 that all the parking grounds in the Westerwald were in pine forests and on either side of metalled roads.

SIGNAL COMMUNICATIONS

130. Fig. 20 shows a diagrammatical layout of the telephone communications of a Fuel and Rocket Troop.

131. Field lines are laid from the Fuel and Rocket Troop Headquarters to Battery Headquarters and to the three main fuelling stations.

132. Battery Headquarters is connected by field lines to the Technical Troop Headquarters and the Launching Troop Headquarters.

133. Technical Troop Headquarters has a field line to the rocket unloading station and the Launching Troop Headquarters has field lines to its three launching points.

THE PATH OF THE FUELLING COLUMNS (Plate 8)

134. The main points to consider when selecting routes for the fuelling vehicles are :
(*a*) concealment from the air ;
(*b*) roads with a good surface ;
(*c*) avoidance of congestion.

135. It will be seen that empty alcohol tankers are driven from the alcohol parking ground to the alcohol fuelling station. When full, they return to the parking ground. When ordered to proceed (see Section 10, para. 191), they drive to the launching positions (two tankers for each launching position) and remain under cover in the neigh-

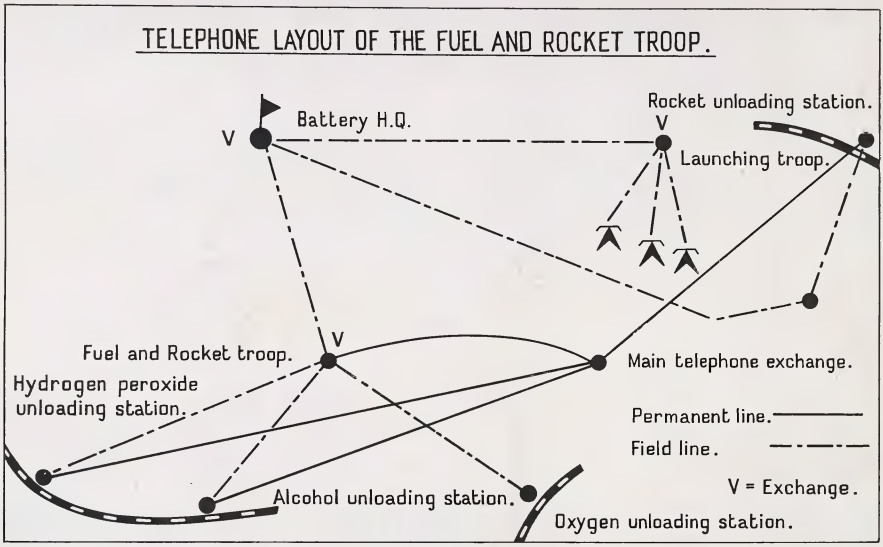


Fig. 20

bourhood (see Section 10, Fig. 39) until called for by the Officer i/c Launching Platoon. When rocket fuelling is completed, they return via the other route to the alcohol parking ground where they remain until required for refuelling at the fuelling station.

136. Empty oxygen tank trailers are towed from the oxygen parking ground, to the oxygen fuelling station and when full they return to the parking ground. When ordered, they proceed along the route indicated in Plate 9 to the launching positions (one tank trailer for each launching position) and remain under cover (see Section 10, Fig. 39) until called for by Officer i/c Launching Platoon. When rocket fuelling is completed they return along the other route as indicated to the parking ground where they remain until required for refuelling.

137. Empty hydrogen peroxide tankers are driven from the alcohol parking ground to the fuelling station. When full, they are driven back to the parking ground. When required they proceed to the launching positions (one tanker to each launching position) and remain under cover until called for by the Officer i/c Launching Platoon. When fuelling is completed they return to their covered position by the launching position. There is sufficient hydrogen peroxide in one tanker to fill 16 rockets, the tanker therefore remains by the launching position until empty or until no further rockets are to be launched from that position. The tanker then returns by the same route to the parking ground.

THE PATH OF THE ROCKET TRANSPORT COLUMN (Plate 8)

138. Empty Vidalwagens are towed from the Vidalwagen parking ground (No. 3 Platoon at Merkelbach) along the route marked in Plate 8 to the rocket unloading station.

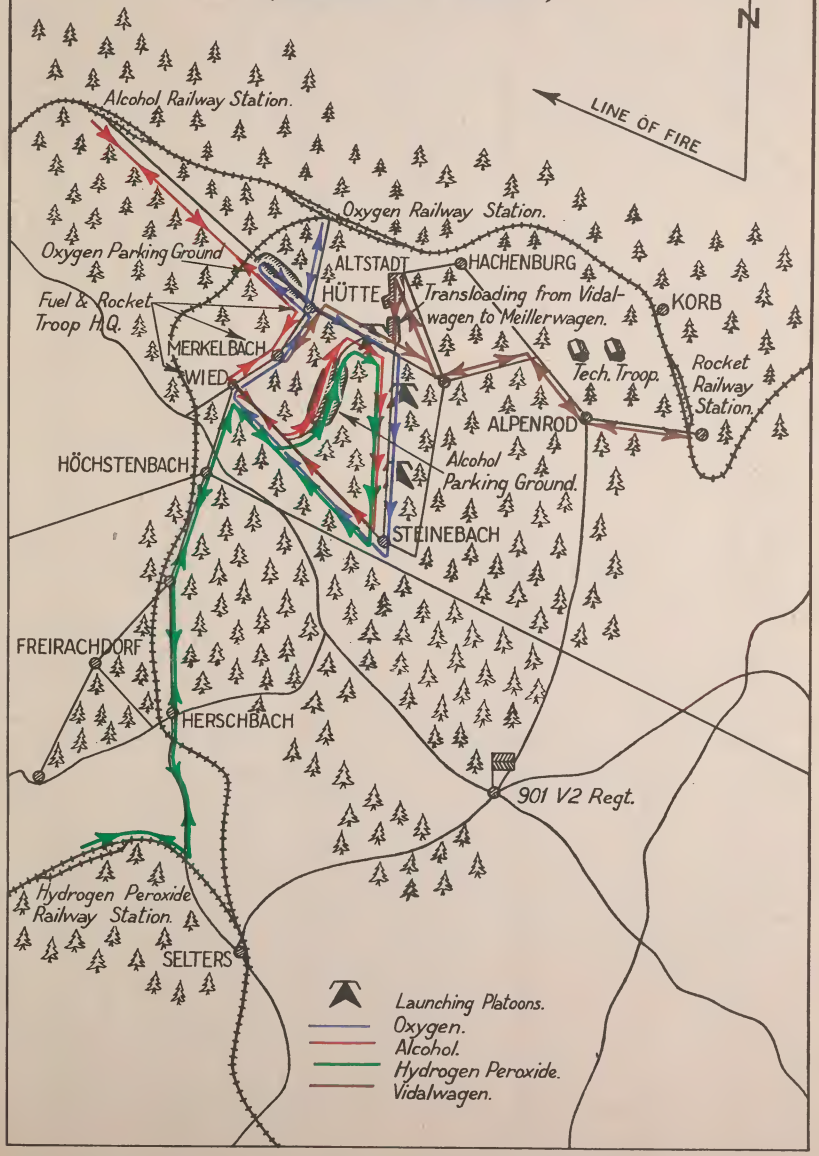
139. The rockets on the Vidalwagen leave the rocket unloading station and are driven and handed over to the Technical Troop (see Section 11). After that the Fuel and Rocket Troop do no further work in transporting the rockets, but to complete the picture it will be seen in Plate 8 that the rockets pass through the Technical Troop, on to the Troop Transloading Point, where they are handed over to the Launching Troop. They then go on, one to each launching platoon, and remain under cover in the launching position area until called for by the Officer i/c Launching Platoon.

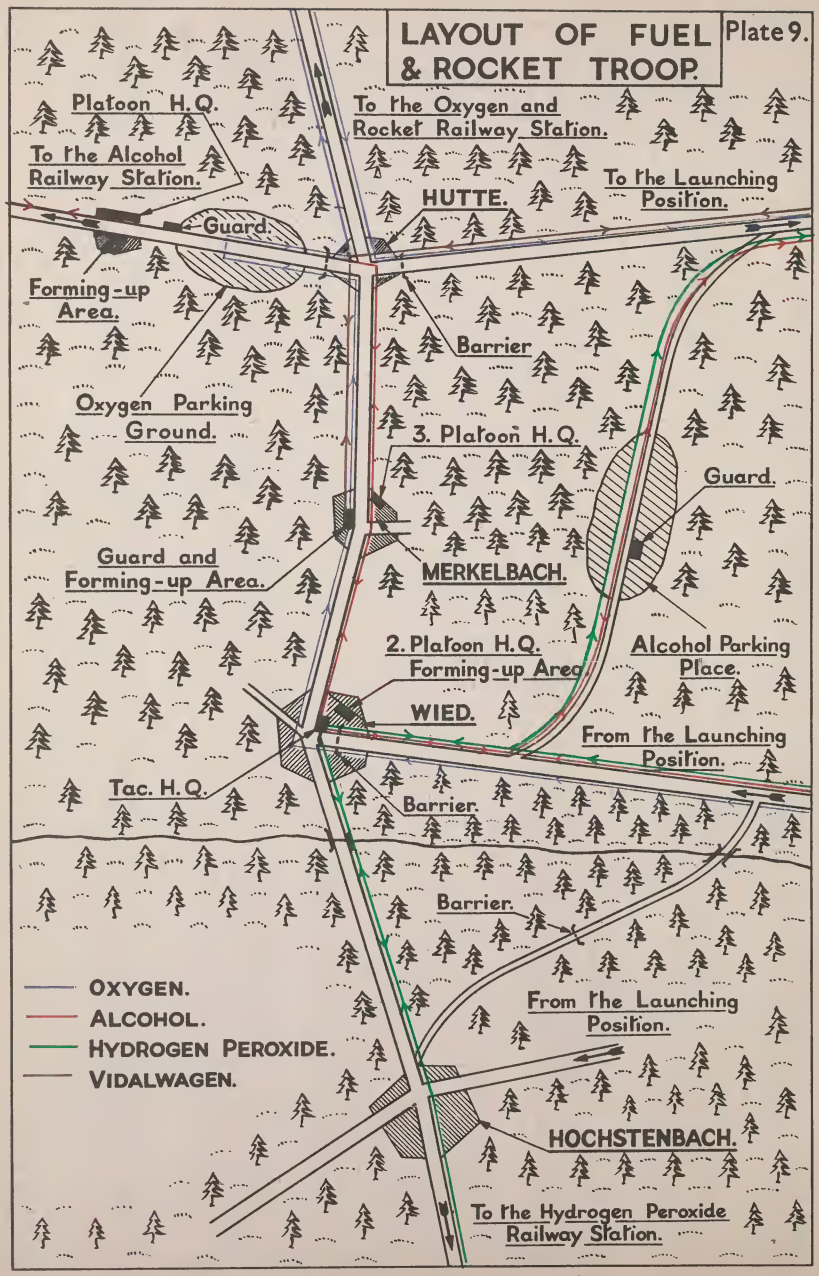
140. The empty Vidalwagens are towed from the Transloading Point back along the same route to No. 3 Platoon parking ground.

Plate 8.

AREA HACHENBURG (WESTERWALD)

(GENERAL - LAYOUT)




LAYOUT OF FUEL & ROCKET TROOP.
Plate 9.
Platoon H.Q.
To the Alcohol Railway Station.
Guard.
Forming-up Area.
Oxygen Parking Ground.
To the Oxygen and Rocket Railway Station.
HUTTE.
To the Launching Position.
Barrier
3. Platoon H.Q.
Guard.
MERKELBACH.
Guard and Forming-up Area.
2. Platoon H.Q. Forming-up Area
Alcohol Parking Place.
WIED.
From the Launching Position.
Tac. H.Q.
Barrier.
Barrier.
From the Launching Position.
HOCHSTENBACH.
To the Hydrogen Peroxide Railway Station.
OXYGEN.
ALCOHOL.
HYDROGEN PEROXIDE.
VIDALWAGEN.

No. 3 Platoon (Rocket Transport) of the Fuel and Rocket Troop.

One Transloading Section of the Technical Troop.

THE RAILWAY STATION (Fig. 21)

141. In selecting or laying out a railway station for unloading rockets it is important that there should be a circular road so that heavy lorries and rocket trailers can drive in, pick up their loads and drive out again without having to turn round. It is convenient if rocket trailers can drive in alternately from different directions and when selecting a position for the Strabo crane, this should be borne in mind.

142. One Strabo crane is kept at the station and is set up by the Technical Troop over the railway line in such a position that when the rocket train drives under it there will be a clearance of about 6 ins. from the railway trucks on the far side (Fig. 22). This will allow room for a heavy lorry or Vidalwagen to drive in under the Strabo crane alongside the waggon (Fig. 23). For the setting up of the Strabo crane, see Section 2, Volume 4.

143. When the Strabo crane is first set up, i.e., at the beginning of an operation, a report of completion will be given to the headquarters of the Technical Troop; no subsequent report need be given unless anything goes wrong with the crane.

THE TECHNICAL TROOP AT RAILHEAD

144. One Transloading Section consisting of 2 N.C.O.s and 13 men of the Technical Troop remain at the railway station while rockets are being unloaded. Besides setting up the Strabo crane and assisting in unloading, they are mainly responsible for inspecting rockets as they arrive and reporting to the Officer i/c Launching Troop any damage which rockets may have sustained during transit. This procedure prevents badly damaged rockets being sent to the Technical Troop and having immediately to be sent back again. In other words, the Technical Troop Commander has his own representatives on the spot.

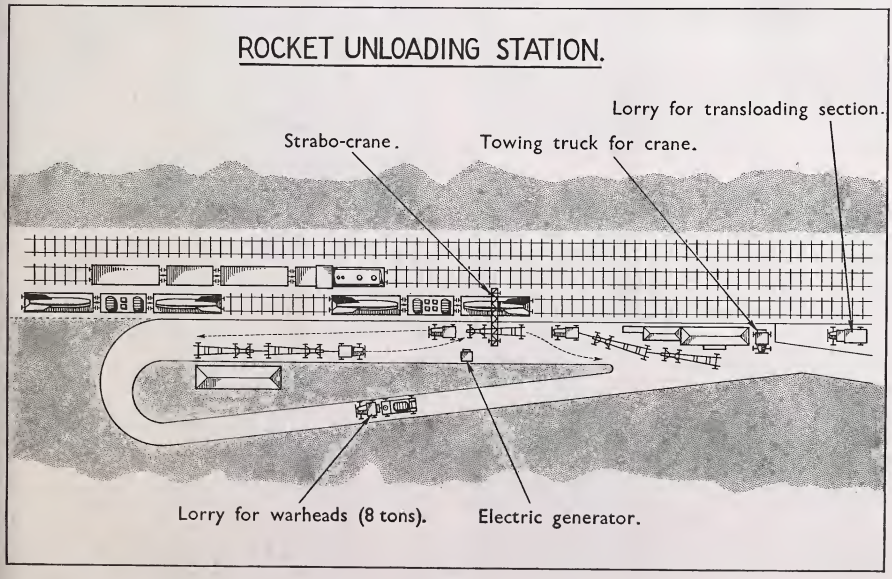


Fig. 21

Fig. 22

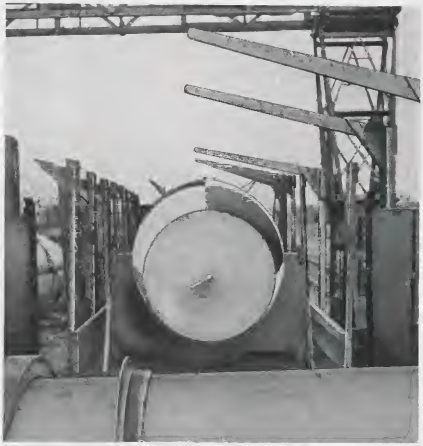


Fig. 24

Fig. 26

Fig. 23

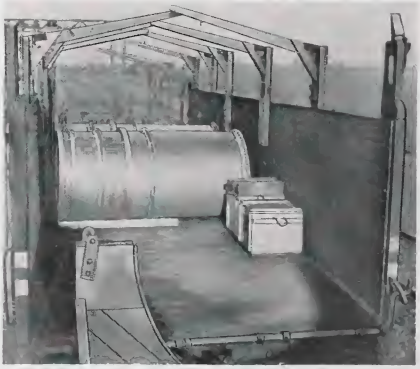


Fig. 25

THE ROCKET TRAIN

145. The rocket train is made up of sections, each section consisting of three waggons (Fig. 22). Two waggons carry rockets lying on pillow supporting blocks (Fig. 24). The rockets are without warheads. Another waggon carries the two warheads and in addition, two sodium permanganate containers and two boxes, each box containing four carbon rudders (Fig. 25). The warhead waggon travels between the two rocket waggons and the rockets are loaded nose to nose with the control compartments overhanging the warhead waggon. Camouflage covers are in position over the top of the railway waggons.

MEETING THE TRAIN

146. The train is met by the Railway Transport Officer, the Regimental Quartermaster, the Battery Quartermaster and representatives from the Technical Troop and the Fuel and Rocket Troop. They check the contents of the train with the transport vouchers; they allot rockets to the Technical Troops and they inform the headquarters of

the Fuel and Rocket Troop the numbers of Vidalwagens required and times for unloading. As soon as the train arrives, the Technical Troop commence removing the camouflage covers from the waggons.

UNLOADING

147. The train is moved into position so that the Strabo crane is over the first warhead waggon (Fig. 26). The first heavy lorry moves into position beside the warhead waggon and unloading commences. The warheads are carried in special containers which have three eyes for the attachment of a 3-point lifting sling. The railway waggon doors are opened and the crane block is lowered until the sling can be hooked on to the warhead container. The warhead is lifted and when it is clear of the waggon (Fig. 26) it is moved over by the Strabo crane through the waggon doors to a position where it can be lowered into the waiting lorry.

148. The sodium permanganate containers and the boxes containing the carbon rudders are removed by hand and placed on the heavy lorry which drives off to the Technical Troop, unloads and returns to the railhead.

149. The train is then moved until the Strabo crane is over the first rocket waggon. No. 1 rocket trailer moves into position alongside the railway waggon.

150. The block of the Strabo crane is lowered, the special lifting bracket is hooked on, the block is raised, moved into position over the rocket and again lowered. The four shackles on the lifting bracket are secured to the front and rear lifting straps on the rocket. A drag rope is secured to the front or tail (Fig. 27)

151. The rocket is lifted clear of the pillow supporting blocks. The waggon is disconnected from the remainder of the train and pulled forward to clear the rocket (Fig. 28). The drag rope is manned by four men to prevent the rocket swinging (Fig. 27). The block is then moved into position over the rocket trailer and the rocket is lowered on to the supporting arms and secured by clamps (Fig. 27). The trailer is then towed away to the Technical Troop parking ground (see Section 11, para. 199).

152. The train is then moved so that the second rocket waggon is underneath the Strabo crane. No. 2 rocket trailer then moves into position from the opposite direction. The rocket is unloaded and the trailer is towed away.

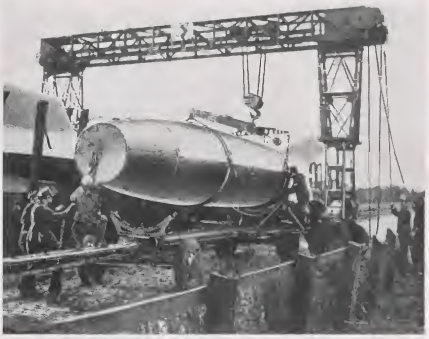


Fig. 27

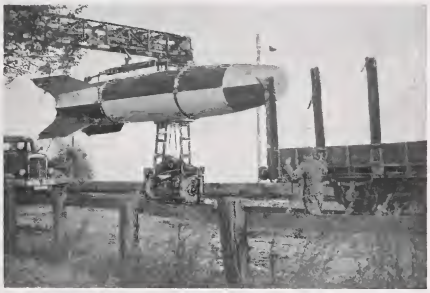


Fig. 28

153. This procedure of unloading first the warhead waggon and then the two rocket waggons is repeated until the train is clear. Unloading completed is then reported to the headquarters of the Technical Troop and the headquarters of the Fuel and Rocket Troop for the further information of the headquarters of the Launching Troop.

N.o 2 Platoon (Alcohol) of Fuel and Rocket Troop

THE ALCOHOL TRAIN

154. One railway tank contains 22,000 litres of alcohol. One battery launching six to nine rockets a day will require four rail tankers daily. A train normally consists of 15 rail tankers and trains come in every third day.

LAYOUT AT THE STATION (Fig. 29)

155. At the alcohol unloading station all that is required is a wide siding. Two rail tankers are normally unloaded at the same time, one pump being used for each rail tanker and one or two road tankers to each pump. It is not quicker to connect two road tankers to one pump because the rate of delivery is governed by the 60 mm. hose between the pump and the rail tankers.

156. The pump used is the same as that used for fuelling the rocket (see Section 21, Vol. 4) less the de-gassing apparatus, the Siemens meter and the automatic cut-off. When the road tankers are full they move off and others come up. When the rail tankers are empty the train is moved along as required and further rail tankers are connected up to the pump.

MEETING THE TRAIN

157. The Transport Officer, Regimental Quartermaster, Battery Quartermaster and a representative from the Fuel and Rocket Troop meet the train, check the waggons with the transport vouchers and allot waggon numbers. No. 2 Platoon of the Fuel and Rocket Troop (14 alcohol waggons) are sent for and their time of arrival is reported to the headquarters of the Fuel and Rocket Troop for further information of the headquarters of the Launching Troop.

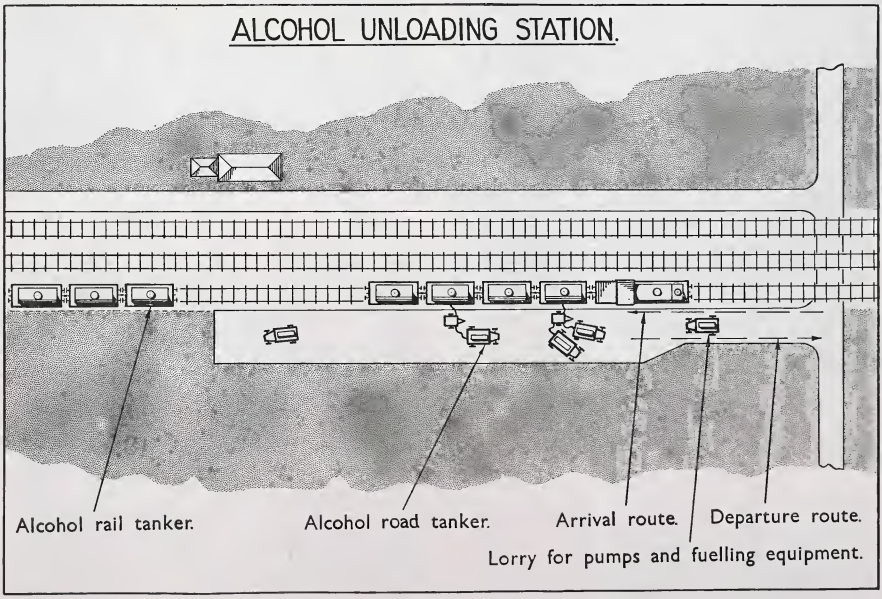


Fig. 29

Fig. 30

PROCEDURE FOR UNLOADING

158. Two pumps are brought opposite the outlets of two rail tankers. The 60 mm. hoses are taken from the pump trailers and the rail tanker outlet is connected to one of the pump inlets (Fig. 30)

159. The road tankers are then driven up. If it is intended to use two road tankers for one pump the special connecting piece with one inlet and two outlets is taken from the accessories compartment in the road tanker and fitted to the pump outlet.

160. The 70 mm. hoses are taken from the road tankers and the pump outlets are connected to the road tanker inlet.

161. The outlet shut-off cocks on the rail tankers and the inlet and outlet shut-off cocks on the pumps are opened The pump operators start the pump motors and alcohol is pumped from the rail tankers into the road tankers. The capacity gauges on the road tankers are watched and a man with a dipstick also checks the level of the alcohol in the tanks (Fig. 31).

DEPARTURE OF ROAD TANKERS

162. When there is sufficient alcohol in the road tanker, the pump is stopped, the shut-off cock on the pump outlet is closed, the 70 mm. hose is disconnected from the pump outlet and lifted until all alcohol remaining in the hose is drained into the road tanker. The hoses are then disconnected from the road tanker. Water is added and stirring effected by connecting the fuel outlet via the pump to the fuel inlet and operating the pump. The specific gravity is tested and should be approximately .086, depending on the temperature (75 per cent. concentration of alcohol by weight), and they depart to No. 2 Platoon

Fig. 31

parking ground. Their departure is reported to the headquarters of the Fuel and Rocket Troop for further information of the headquarters of the Launching Troop.

163. Further road tankers then come up and are connected to the pumps and the same procedure follows until the rail tankers are empty.

164. The 60 mm. hoses are then disconnected from the rail tankers and the train is moved so that the next two rail tankers come opposite the pumps.

165. This procedure continues until all road tankers are full.

166. The quantity unloaded into the road tankers and the quantity remaining in the rail tankers is then calculated and reported to the headquarters of the Fuel and Rocket Troop for the information of the Q Department.

167. Further unloading is arranged as empty road tankers become available. As long as there is alcohol in the train, alcohol tankers will not remain empty at the parking ground.

Procedure at Liquid Oxygen Unloading Station . . . . . SECTION 8

No. 1 Platoon (Oxygen) of Fuel and Rocket Troop

THE LIQUID OXYGEN TRAIN

168. A rail tanker holds 27,000 kilos of liquid oxygen. (For description of rail tanker see Section 17, Vol. 4). One battery launching six to nine rockets a day will require two rail tankers of oxygen per day. A train normally consists of four rail tankers, and trains come in every other day.

LAYOUT AT THE STATION (Fig. 32)

169. When laying out or choosing an oxygen unloading station, it is important that there should be a roundabout in order that road tank trailers can be towed up, filled and towed straight away again without having to turn round.

170. A good layout is shown in Fig. 32. It will be seen that the road tank trailers are towed in along one road to the train. Two road tank trailers can be filled at once from two separate rail tankers. When the road tank trailers are full they move off and two more come up and so on. When the two rail tankers are empty, the train moves along and the next two are emptied.

MEETING THE TRAIN

171. The Transport Officer, Regimental Quartermaster, Battery Quartermaster and a representative from the Fuel and Rocket Troop meet the train, check the waggons with the transport vouchers and allot waggon numbers. Oxygen tank trailers are sent for and come up and their time of arrival is reported to the headquarters of the Fuel and Rocket Troop for further information of the headquarters of the Launching Troop.

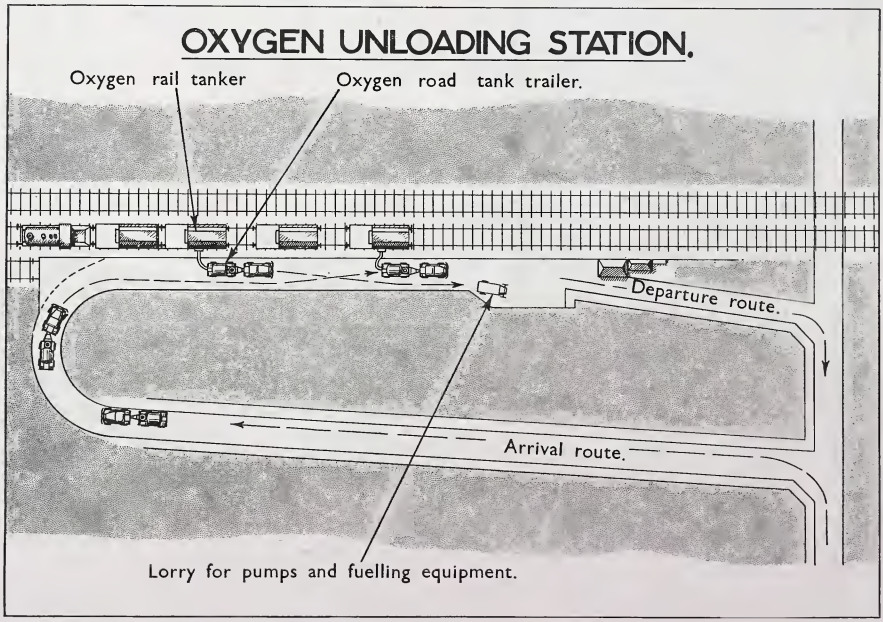


Fig. 32

Fig. 33

PROCEDURE FOR UNLOADING

172. Road tank trailers 1 and 2 are towed into position as in Fig. 32. (For description of the road tank trailer and pump see Sections 16 and 18, Vol. 4.) They must be as close as possible to the rail tank main outlet (Fig. 33). The vehicles halt and the detachments dismount.

173. The cover is removed from the pump and placed clear. Four men remove the pump from the rear of the road tank trailer and attach it on the brackets at the side of the rail tanker (Fig. 34).

174. The rail tank outlet and road tank trailer inlet covers are removed. The 100 mm. hose is taken from its compartment on the road tank trailer and is connected to the rail tanker outlet and pump inlet (Fig. 34).

175. The 70 mm. hose is taken from its compartment on the road tank trailer and connected to the pump outlet and the road tank trailer inlet (Fig. 35).

176. The vent valve on the rail tanker and the inlet and vent valves on the road tank trailer are opened and the pump motor is started up but the clutch is not engaged.

Fig. 36

Fig. 34

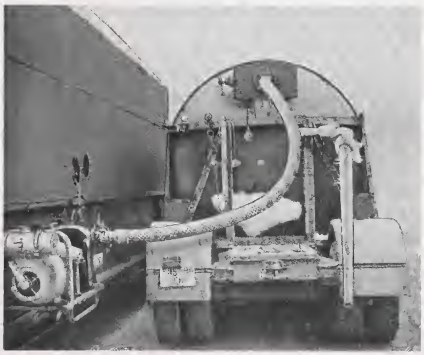


Fig. 35

The rail tanker outlet and control valves and the cut-off valve on the pump gas escape are then opened. Oxygen gas is allowed to pass through the whole system to cool it thoroughly.

177. After about five minutes, the system will be thoroughly cooled and pumping can commence. The pump clutch is engaged and the throttle adjusted to give a delivery pressure of 1.5 kgs. per sq. cm.

178. When the road tank trailer is full, as indicated by oxygen flowing from the vent pipe, the pump clutch is disengaged and the outlet valve on the rail tanker closed. The inlet valve on the road tank trailer is closed. Without loss of time, all hoses are disconnected to prevent bursting through the oxygen warming up. The hoses are then stowed in their travelling compartments.

ALTERNATIVE PROCEDURE

179. It may not always be possible to bring the road tank trailer into position on the rail tanker main outlet side. Such a case is illustrated in Fig. 32. It will then be necessary to connect the 70 mm. outlet of the pump to the transverse pipe which leads from one side of the rail tanker to the other (Fig. 36). The road tank trailer is then brought into position close to the other side of this pipe and a 70 mm. hose is connected between the pipe and the road tank trailer inlet. Pumping may then go on in the normal manner (Fig. 37).

DEPARTURE OF ROAD TANK TRAILERS

180. Road tank trailers Nos. 1 and 2, being full, drive away to No. 1 platoon parking ground and their departure is reported to the headquarters of the Fuel and Rocket Troop for the further information of the headquarters of the Launching Troop.

181. Road tank trailers Nos. 3 and 4 then come up and the procedure is repeated until the train has been emptied. No. 1 Platoon of the Fuel and Rocket Troop then leaves.

Fig. 37

182. The quantity of oxygen tanked is compared with the quantity loaded as per the transport vouchers and the loss due to evaporation during transit is reported to the headquarters of the Fuel and Rocket Troop.

Procedure at Hydrogen Peroxide Railhead SECTION 9

HYDROGEN PEROXIDE SECTION OF NO. 2 PLATOON OF FUEL AND ROCKET TROOP

THE HYDROGEN PEROXIDE TRAIN

183. There is normally only one hydrogen peroxide tank in a train, but there are two kinds of railway tank (see Section 23, Vol. 4). One holds 20 tons of liquid, the other has four special tanks each holding $2\frac{1}{2}$ tons.

LAYOUT AT THE STATION (Fig. 38)

184. All that is required is a siding large enough for one hydrogen peroxide road tanker to turn around. It is only possible to load one road tanker at a time. The pump used is normally the ordinary hand pump in the rear of the tanker (see Section 22, Vol. 4).

MEETING THE TRAIN

185. The Transport Officer, Regimental Quartermaster, Battery Quartermaster, and a representative from the Fuel and Rocket Troop meet the train and check the transport vouchers. The hydrogen peroxide section of No. 2 Platoon of the Fuel and Rocket Troop are sent for. The three tankers are driven to the station. It is important that the water tanks should be full. Their time of arrival is reported to the headquarters of the Fuel and Rocket Troop for further information of the headquarters of the Launching Troop.

PROCEDURE FOR UNLOADING

186. The driver and assistant driver put on their protective clothing. They connect the outlet on the top of the rail tanker to the inlet of the pump and the outlet of the pump to the inlet at the top of the road tanker. The 3-way cock is set to "Pump Back," and hydrogen peroxide is pumped into the road tanker.

187. The required specific gravity is 1·34. Taking into account the atmospheric temperature of the day and using

the chart illustrated in Plate 10, water is added to the hydrogen peroxide until the specific gravity is closely around 1·34 Stirring is obtained by using the pump to circulate from the outlet to the inlet connections.

188. When the road tanker is full at this concentration, the hoses are connected to the water pump and water is pumped through to clean them.

189. The full tanker drives to No. 2 Platoon parking ground, refills its water tank and remains until called for by the launching platoons. The second road tanker takes its place and then the third. When all three road tankers are full, a report is made to the headquarters of the Fuel and Rocket Troop for further information of the headquarters of the Launching Troop.

190. The rail tanker remains at railhead until empty.

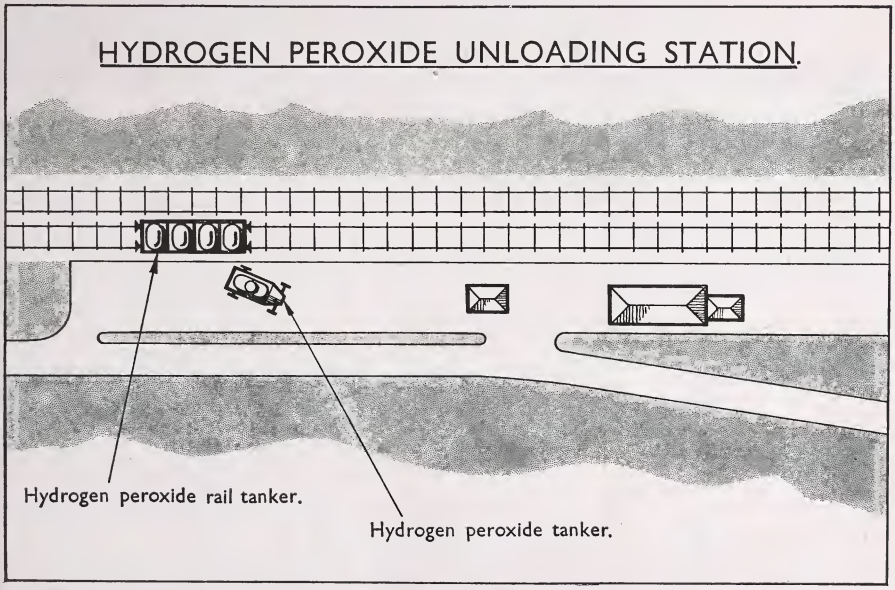
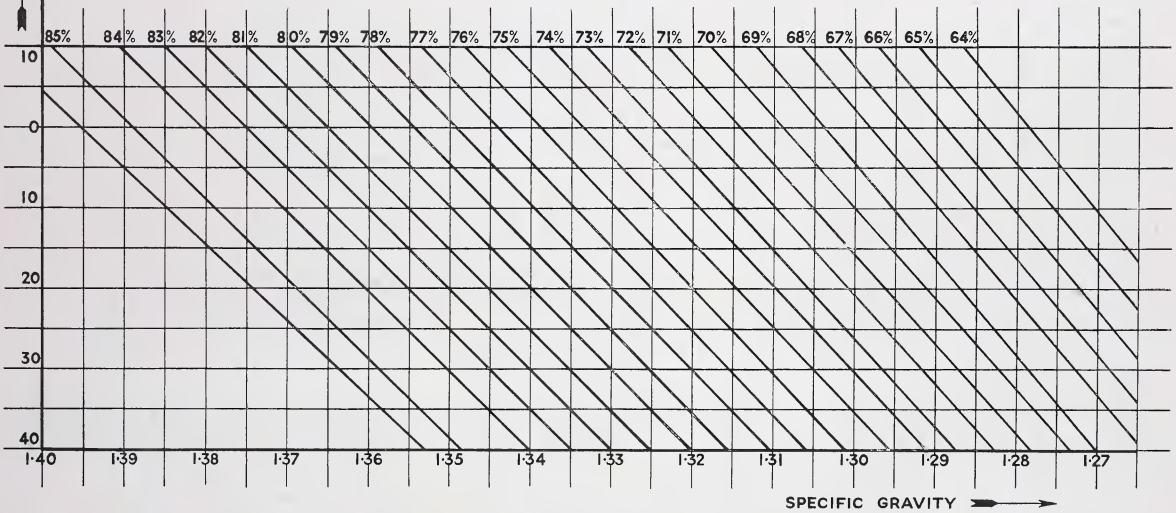


Fig. 38

Plate 10

HYDROGEN PEROXIDE SPECIFIC GRAVITY/CONCENTRATION/TEMPERATURE/CHART.



191. The alcohol and hydrogen peroxide road tankers and the oxygen road tank trailers are full and are waiting at their parking grounds. The order comes through from headquarters Launching Troop that the tankers are to move to the three launching positions.

192. The headquarters Fuel and Rocket Troop arrange for three oxygen road tank trailers to move off, followed by six alcohol tankers and three hydrogen peroxide tankers. They drive to their parking grounds under cover and in the neighbourhood of the launching positions, two alcohol road tankers, one oxygen road tank trailer and one hydrogen peroxide road tanker to each launching position (Figs. 39 and 40).

193. They report their time of arrival to the headquarters Launching Troop and to the Officers i/c Launching Positions and they wait until ordered to come up for fuelling the rocket.

Fig. 39

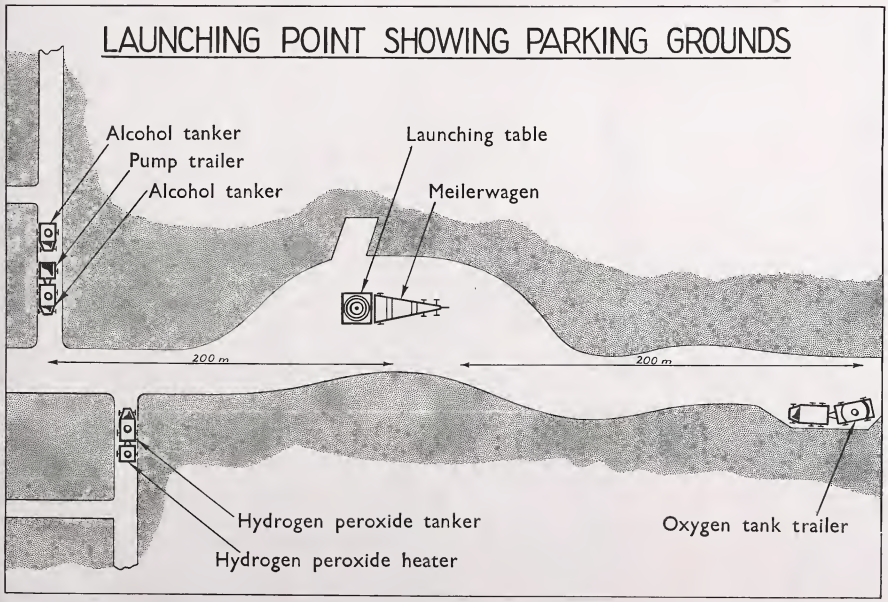


Fig. 40

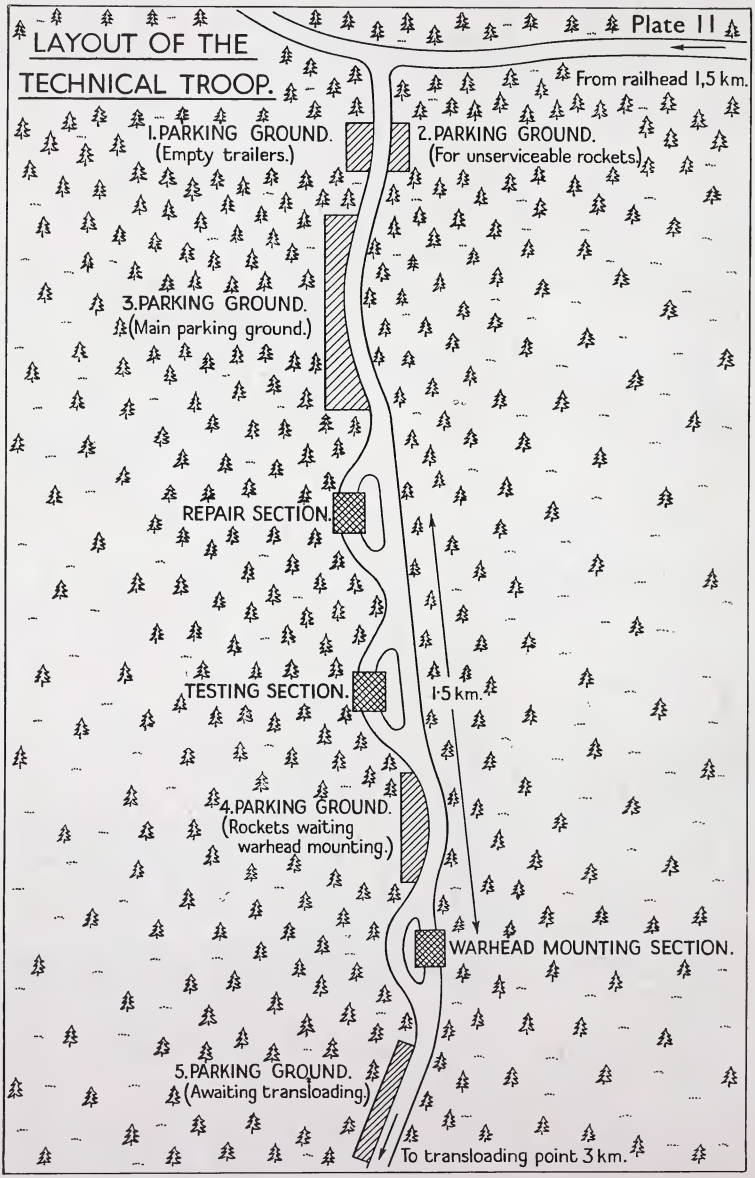


Plate 11
LAYOUT OF THE TECHNICAL TROOP.
From railhead 1,5 km.
1. PARKING GROUND.
(Empty trailers.)
2. PARKING GROUND.
(For unserviceable rockets.)
3. PARKING GROUND.
(Main parking ground.)
REPAIR SECTION.
TESTING SECTION.
1·5 km.
4. PARKING GROUND.
(Rockets waiting warhead mounting.)
WARHEAD MOUNTING SECTION.
5. PARKING GROUND.
(Awaiting transloading.)
To transloading point 3 km.

The General Layout of the Technical Troop . . . SECTION 11

194. The Technical Troop is deployed somewhere between the railhead and the launching position. It is an advantage if the Technical Troop is as near as possible to the Launching Troop in order that rockets can be delivered quickly and in good order with as little risk as possible of damage by travelling, weather or enemy air action.

195. The two most important points to consider in selecting an area for deployment are :—

(*a*) good roads
(*b*) concealment from the air

196 The layout in Plate 11 illustrates a deployment in the Westerwald district in what the Technical Troop commander described as a " Wundervolle Wald " (wonderful forest). Its only disadvantage was that it was 3 kms. from the launching position. An ideal layout would be with the warhead mounting point about 1 km. from the launching position.

197. A road runs through a forest. It must have a reasonably hard surface and be wide enough to accommodate a Vidalwagen. At convenient intervals along the road, three semicircular by-pass roads are cut for the testing tent, the repair tent and the warhead mounting tent. These three tents (described in Sections 12, 13 and 14) are placed on the by-pass roads so that the Vidalwagen drives in at one end of the tent and out of the other.

198. The length of this particular layout is 1½ kms. The size of the forest may not always allow a straight through layout such as this, but it is essential that a rocket can drive in at one end, through the various sections and out at the other end without the inconvenience of having to turn round.

199. It will be seen that the rocket on the Vidalwagen is towed from the railhead, via parking ground 2 (Abstellplatz) (unserviceable rockets) to parking ground 3 (main parking ground). The size of the latter depends on the number of rockets which are likely to be waiting at any one time. In the Westerwald there were sometimes as many as 50 rockets awaiting testing.

200. The towing vehicle which belongs to the Rocket Transport Platoon of the Fuel and Rocket Troop leaves the trailer at the parking ground and returns to the railhead for another rocket. The Technical Troop has its own towing vehicles for moving rockets within the Troop area and as far as the Technical and Launching Troop transloading point.

201. The rocket is then towed to the Testing Section (Prueftrupp) (see Section 13). If it passes its test, it goes on from there to parking ground 4.

202. From parking ground 4, it goes on to the Warhead Mounting Section (Spitzenmontage Trupp) (see Section 15). When the warhead has been fitted, it is moved on to parking ground 5, where it waits until called forward by the Launching Troop to the Technical and Launching Troop transloading point.

203. From the transloading point, the empty trailer is towed back to parking ground 1, where it waits until collected by the Fuel and Rocket Troop for return to the railhead to collect another rocket.

204. If the rocket does not pass its test, it goes back to the Repair Section (J-Trupp), from there it might go forward again to the testing tent or else back to parking ground 2.

205. When a number of unserviceable rockets have accumulated at parking ground 2 and a train is available to take them back to the factory, the Fuel and Rocket Troop collect them for loading.

The Repair and Tail Removal Section SECTION 12

THE REPAIR AND TAIL REMOVAL SECTION AND SUB-SECTIONS OF NO. 1 PLATOON

LAYOUT

206. This section has a tent large enough to contain the rocket on its trailer and to allow work to go on around it, including the withdrawal of the tail unit.

207. The repair section vehicle is outside the tent. It contains a small lathe, an electric drill, a bench and vice and various drawers and cupboards for tools.

208. When removing the tail unit, the tail-removing trailer is used. This is placed under the tail unit and can be jacked up to take the weight.

DUTIES

209. If the horizontal tests (see Section 14) are not satisfactory and repairs are necessary which are likely to take some time, the rocket is removed from the testing section and taken to the repair section. Very often the tail unit has to be removed so that work can proceed on the rocket motor and auxiliary motor unit.

210. The repair section does minor repairs such as changing a valve or servo motor or mending a fin. For major repairs the rocket is taken to the field workshop (Feldspeicher) or sent back to the factory.

The Testing Section . . . . SECTION 13

NOS. 1 AND 2 TESTING SECTIONS (WORKING IN SHIFTS) OF NO. 1 PLATOON OF THE TECHNICAL TROOP

LAYOUT

211. The Testing Section is laid out as in Fig. 41. The tent is approximately 18 m. long and 7 m. wide. The two ends roll up, thus allowing the rocket on its trailer to be towed in at one end and out at the other.

212. The test vehicle is backed against the right wall of the tent so that it is opposite the rocket tail unit. A flap in the tent allows direct access. The test vehicle is described in Section 4, Vol. 4, and contains testing equipment including the steering panel (described in Section 5, Vol. 4), the rocket motor panel (described in Section 6, Vol. 4), the compressed air panel (described in Section 7, Vol. 4) and the command simulator panel (described in Section 8, Vol. 4).

213. The accessories vehicle is backed against the side of the test vehicle. Doors provide access from one vehicle to the other. This vehicle contains the remainder of the testing equipment. It has chests of drawers and cupboards and is also the office of the Officer i/c the Technical Troop.

214. The generator trailer (Fig. 42) is placed as far away from the test vehicle as the cable will allow. It provides 220 volts, 3 phase A.C.

215. The transformer trailer (Fig. 43) is placed near the generator. It provides 27 volts D.C.

216. The cable vehicle is backed against the left side of the test tent, also opposite the rocket tail unit. It contains all cables rolled on drums, for connecting the generator, transformer, test vehicle and rocket.

DUTIES

217. The rocket is tested before it leaves the factory, but there is sometimes a considerable delay before it is launched and weather and transit may affect its performance. It is therefore tested twice more, once by the Technical Troop in the horizontal position and once by the Launching Troop in the vertical position.

218. The tests carried out by the Technical Troop are extremely thorough and are detailed in Section 14. If all goes well they normally take about 3 hours.

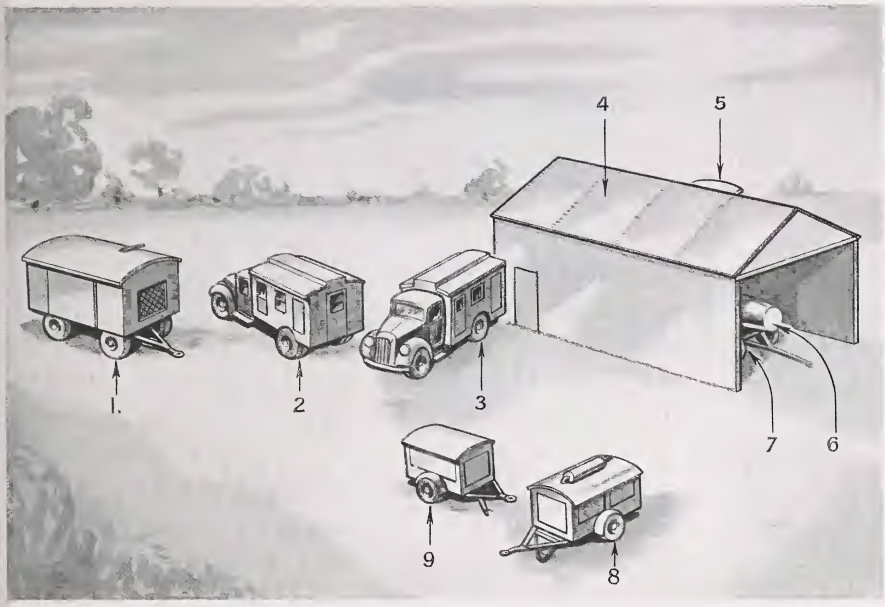
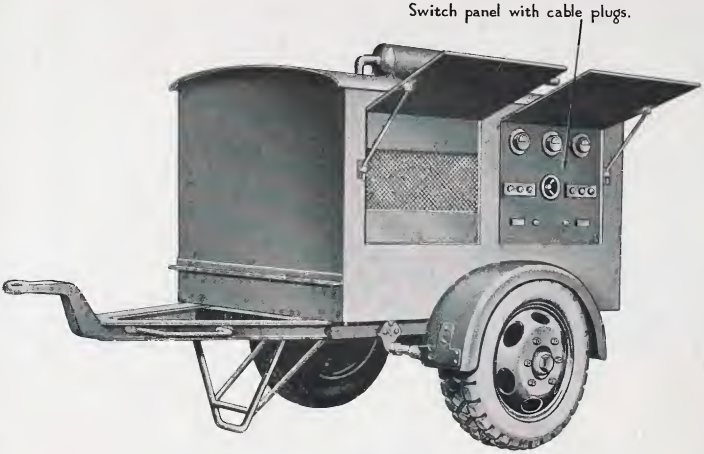


Fig. 41

LAYOUT OF TESTING SECTION

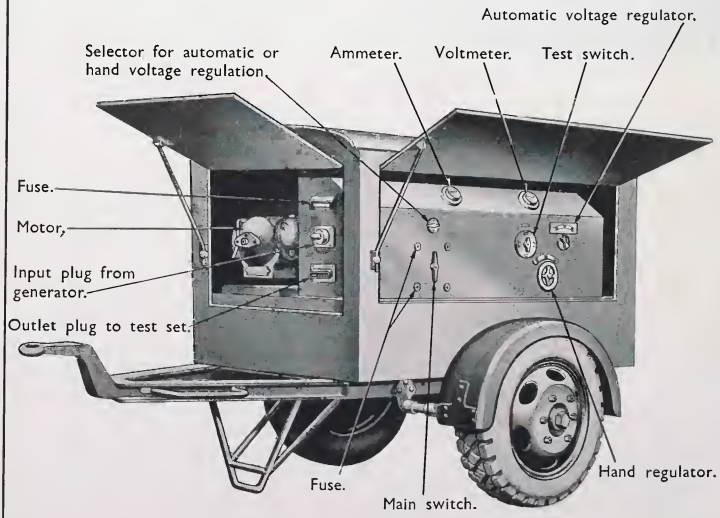
1. Compressor
2. Accessories vehicle
3. Test vehicle
4. Test tent
5. Cable vehicle
6. Rocket without warhead
7. Vidalwagen (Rocket trailer)
8. 15-KVA, 220 V. Generator
9. 220 V. A.C., 27 V. D.C. Transformer



15 KVA. PETROL ELECTRIC GENERATOR.

(GENERATOR TRAILER)

Fig. 42



ROTARY CONVERTER.

(TRANSFORMER TRAILER)

Fig. 43

Nos. 1 and 2 Testing Sections (working in shifts) of No. 1 Platoon of the Technical Troop

219. Whilst the rocket is in the horizontal position in the test tent, it is tested for the second time. The tests cover :—

A. Testing the insulation of the Stotz Plugs.
B. Testing the steering mechanism and controls.
C. Testing the rocket motor.
D. Testing the auxiliary motor.
E. Testing the alcohol tank pressurising system.
F. Testing the changeover from ground to rocket-borne power.
G. Testing the complete procedure during launching and up to fuel cut-off.

GENERAL PREPARATION FOR TESTS

220. The body cover is withdrawn sufficiently to allow all doors and hatches to the control compartments to be opened. The tail cover is removed complete. All doors and hatches in the control compartment and rocket motor are opened. The take-off switch (Abhebekontakt) is depressed and clamped.

221. The air compressor is started up and the air bottles in the compressor filled. The compressor is connected to the test vehicle (Pruefwagen).

222. The steam turbine is tested for free running by turning it over by hand.

223. The pipes on the 5-way coupling on the rocket which from left to right are (See Section 11, Vol. 4, Plate 9) :—

(1) Oxygen tank air pressure regulating pipe (A-Tankdruckleitung) ;
(2) Rocket air bottle charging pipe (Pressluft-Fuelleitung) ;
(3) Alcohol pump drainage pipe (B-Leckleitung) ;
(4) Air pressure for operating valves pipe (Steuerdruckleitung) ;
(5) Oxygen tank pressurising pipe (A-Beluftungsleitung),

must, with the exception of (3) be screwed to the corresponding connections on the base of the compressed air panel in the test vehicle.

224. Pressure pipes from the hydrogen peroxide and sodium permanganate tanks and from the pressure operated contact are connected to the base of the compressed air panel.

225. One of the cooling jets in the combustion chamber is removed and a pipe, with a pressure gauge, screwed in.

226. The cable between the generator and transformer, and the power and control cables from the transformer to the test vehicle, are connected (Fig. 44).

227. The ground connector (Stotz) plug cables are laid out and connected to the test vehicle.

228. The generator is started and the transformer switched on.

A. INSULATION TEST

229. An ohmmeter is used to test the resistance between the pins of the cable plugs and the rocket. The minimum resistance values must be as follows :—

(*a*) Through pins 11/1—100,000 ohms.
Through pins 11/18—300,000 ohms.
Through pins 1/7, 9, 12, 13, 15, 20, 22, 24, 26, 57, 58, 59, 62—100,000 ohms.
(*b*) Between pins 11/1 and 1/7, 20, 22, 24, 26, 40 and 11/57, 59, 61—100,000 ohms.
(*c*) Between pins 1/7 and 11/57, 59—100,000 ohms.
(*d*) Between pins 1/40 and 1/20, 22, 24, 26—100,000 ohms.

230. If any of the above tests fail, the rocket is sent to the repair and tail removal section (see Section 12).

CONNECTING UP THE ROCKET AND GENERAL PREPARATION FOR TESTS (*CONTD.*)

231. Rocket Motor Panel Operator. Inserts main key and turns it to " Test " (Pruefen). Indicating lamps " Test " (Pruefen) and " DC Current on " (Gleichspannung Kontrolle) light up.

232. Stotz plugs I and II are plugged in. Indicating lamps " Stotz Plug I " (Stotz I) and " Stotz Plug II " (Stotz II) light up.

233. The power switch is turned to " Ground Power." Indicating lamps " Ground Power " (Bodenspeisung), " Rocket Circuit Clear " (Bordnetz Klar) on the rocket motor panel and " Time Switch at Zero " (Zeitschaltwerk null) on the steering panel, light up.

If the indicating lamp " Time Switch at Zero " does not light up, the press button " Time Switch (Zeitschaltwerk ein) must be operated for 15 seconds. The time switch will then go through a complete sequence and after 90 seconds, come back to zero. Indicating lamp " Time switch at Zero " will then light up.

234. As long as the air pressure for operating valves is not switched on, indicating lamp " Oxygen Main Valve Open " (A-Ventil Unkl) and " Compressed air not present " (P Unkl) will light up and the buzzer will sound. This can be switched off by operating the switch " Buzzer off " (Summer aus). Indicating lamp " Buzzer off " will then light up.

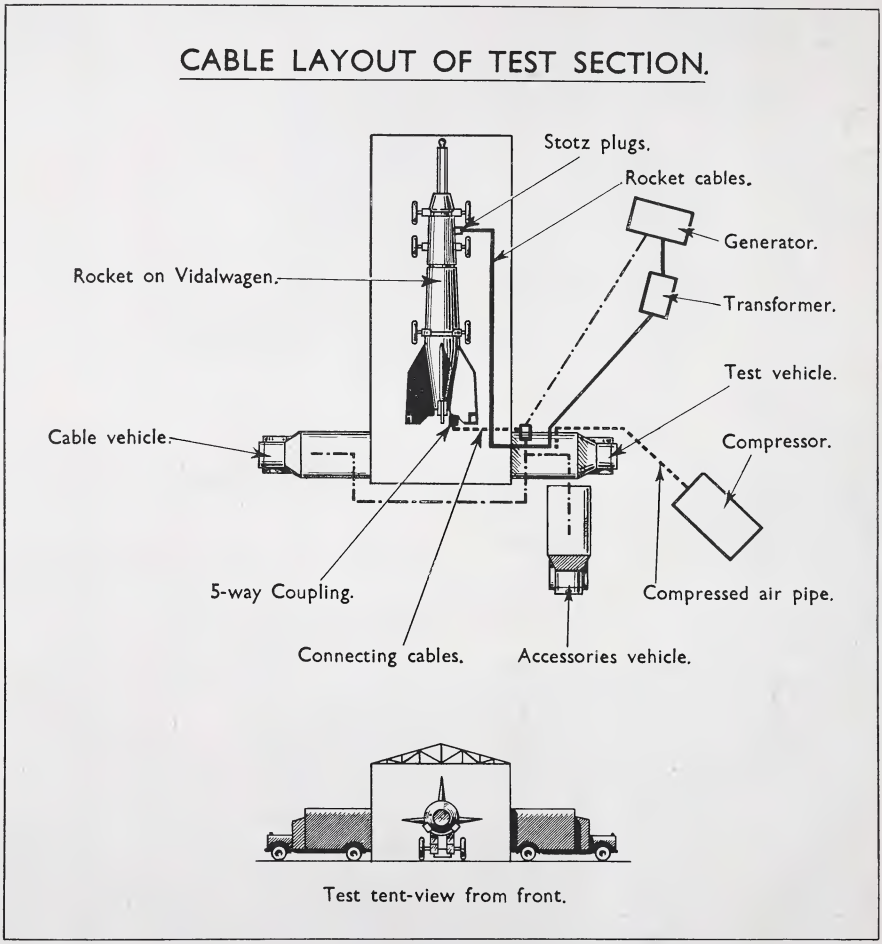


Fig. 44

B. STEERING TESTS

(For description of steering mechanism of the A-4 rocket see Section 10, Vol. 4).

TO TEST THE PRECESSION MOTOR (PROGRAMM)

235. *Steering Panel Operator*

Turns precession switch to " Run Forward " (Vorlauf). The precession motor can be heard running in the pitch gyro. After four seconds, indicating lamp " Precession " (Programm) lights up.

After about 1 minute, he turns the precession switch to " Run Back " (Rueklauf) until the " Precession " indicating lamp goes out.

TO CONNECT THE COMMAND SIMULATOR PANEL TO THE CONTROL AMPLIFIER

236. The plugs are withdrawn from the gyro and connected to the cables to the command simulator panel in the test vehicle. A third cable from the command simulator panel is connected to the control amplifier.

237. *Command Simulator Panel Operator*

Switches on panel switch and by turning the knobs marked D, E and A brings the pitch, yaw and roll voltmeters to zero.

238. *Steering Panel Operator*

Switches on alternators 1 and 2 (Umformer 1 und 2) and allows the gyros to run for approximately 10 minutes. He turns the alternator selector switch (Umformer Kontr.) to I and to II. The voltmeter must read $\begin{cases} 40 + 2{\cdot}5 \\ -3{\cdot}5 \end{cases}$ volts in each case.

239. *Steering Panel Operator*

Switches on the motor switch. The four ammeters should read exactly zero, the servo potentiometers having been adjusted in the final factory tests. But if there are small deviations no adjustment is made to the servo potentiometers whilst the rocket is in the horizontal position. This will be done by the Launching Troop during the main vertical tests (see Section 21, para. 390).

TO TEST THE CONTROL AMPLIFIER (MISCHGERART).

240. *Command Simulator Panel Operator*

(*a*) Turns knob D to left (left impulse). The control current ammeters of the pitch axis (D-Achse) (rudders 2 and 4) on the steering panel show a large reading to the left and then return to a small reading.

(*b*) Turns knob D to the right (right impulse). The control current ammeters show a large reading to the right and return again to a small reading.

(*c*) Brings the pitch voltmeter on the command simulator panel back to zero by turning knob D.

(*d*) Turns knob E to the left. The control current ammeters of the yaw axis (E-Achse) (rudders 1 and 3) on the steering panel show a large reading to the left and return immediately to a small reading.

(*e*) Turns knob E to the right (right impulse). The control current ammeters show a large reading to the right and return again to a small reading.

(*f*) Brings the yaw voltmeter on the command simulator panel back to zero by turning the knob E.

(*g*) Turns knob A to the left (simulating a roll to the left). The control current ammeters of the roll axis (A-Achse) (vanes 1 and 3) on the steering panel show large opposite readings, the left ammeter to the right and the right ammeter to the left and return immediately to small readings.

(*h*) Turns knob A to the right (simulating a roll to the right). The control current ammeters again move in opposite directions, the left ammeter to the left and the right ammeter to the right.

(*i*) Brings the roll voltmeter to zero by turning knob A.

241. *Command Simulator Panel Operator*

(*a*) Turns knob D to the left until the pitch voltmeter on the command simulator panel reads 6 volts. The control current ammeters of the pitch axis on the steering panel must show a left reading corresponding to the average value which is given in the makers' handbook.

(*b*) He repeats (*a*) above but giving a right impulse of 6 volts.

(*c*) He brings the pitch voltmeter to zero.

(*d*) The procedure as in (*a*), (*b*) and (*c*) is repeated for the yaw axis (E-Achse).

(*e*) The procedure as in (*a*), (*b*) and (*c*) is repeated for the roll axis (A-Achse).

TO TEST THE SERVO MOTORS

242. *Control Panel Operator*

Switches on the servo motors (Getriebe ein). The indicating lamp " Servo Motors on " (Getriebe ein) lights up.

243. *Steering Panel Operator*

Presses knob DI (left impulse) and carbon rudders 2 and 4 move towards fin 1. The pitch voltmeters show a left reading, the rudders move as far as the brake contacts and the control current ammeters oscillate. If the oscillation does not stop and should the reading of one of the control ammeters go down, the brake contact must be re-set.

244.. As the rudders move, a man holds them to make sure that they are moving with normal force.

245. *Steering Panel Operator*

Presses button D2, rudders 2 and 4 move towards fin 3 and the voltmeters show a right reading as in para. 243 above.

246. Procedure as in paras. 243 and 244 above is repeated with buttons E1 and E2 (yaw axis).

247. *Command Simulator Panel Operator*

Turns knob A to the left (left roll), rudder 1 turns towards fin 2 and rudder 3 turns towards fin 4. The left roll voltmeter on the steering panel (rudder 1) swings to the right, the right voltmeter (vane 3) swings to the left. The control current ammeters swing in the same direction.

248. *Command Simulator Panel Operator*

Turns knob A to the right (right roll) rudder, 1 turns towards fin 4, rudder 3 towards fin 2. The left roll voltmeter (rudder 1) on the steering panel swings to the left, the right voltmeter (rudder 3) swings to the right. Control current ammeters swing in the same direction.

249. *Command Simulator Panel Operator*

Turns knob A until the voltmeter on the command simulator panel is at zero.

SYNCHRONISATION OF RUDDERS 2 AND 4 (PITCH)

250. *Steering Panel Operator*

Switches off the servo motors (Getriebe). Rudder 2 is moved by hand towards fin 1 and rudder 4 towards fin 3

The control current ammeters of the pitch axis swing in opposite directions.

251. *Steering Panel Operator*

Switches on the servo motors. Rudders 2 and 4 move back to the zero position. The ammeter readings return to zero.

252. The procedure as in paras. 250 and 251 above is repeated but rudder 2 is moved towards fin 3 and rudder 4 towards fin 1.

C. ROCKET MOTOR TEST

(For description of rocket motor of A-4 rocket see Section 11, Vol. 4)

PRESSURE TEST

253. The compressor is switched on.

Compressed Air Panel Operator

Opens the air bottle charging valve (Feulleitung) by turning the knob marked "Fill" (Fuellen) on the compressed air panel. The air bottles in the rocket motor unit are charged to 100 atmos read off the high pressure gauge in the rocket. The stop-cock on the non-return valve to the bottles must be closed by hand and the pressure reducer must be closed.

254. *Compressed Air Panel Operator*

Closes the charging valve and opens the air outlet valve by turning the knob marked "Empty" (Entlueften). This releases air from the charging pipe. The pressure must not drop below 90 atmos in 10 mins.

255. *Compressed Air Panel Operator*

Opens the inlet to the pipe supplying compressed air for operating valves (Steuerdruck) by turning the knob marked "Fill" (Fuellen). Compressed air closes the oxygen and alcohol main valves. Indicating lamp "Oxygen Main Valve Open" (A-Ventil Unkl) goes out.

256. *Compressed Air Panel Operator*

Closes the inlet to the pipe supplying compressed air for operating the valves and opens the air outlet valve by turning the knob marked "Empty" (Entlueften). This releases air and is a test of the non-return valve in the inlet pipe. If there is a prolonged escape of air it shows there is a leak in the system.

257. The stop-cock on the non-return valve is then opened by hand. Air passes through the filter to the pressure reducer (adjusted to 30 atmos) and to the auxiliary motor unit. The low pressure system is tested for leaks. The reading on the high pressure gauge goes down slightly. Indicating lamp "Compressed Air Not Present" (P-Unkl) goes out.

258. The indicating lamp "Buzzer off" (Summer aus) goes out.

259. *Compressed Air Panel Operator*

Closes the air outlet valve by turning the knob marked "Empty" and opens the inlet to the pipe supplying pressure for operating valves by turning the knob marked "Fill."

GENERAL ROCKET MOTOR TEST

260. *Rocket Motor Panel Operator*

Closes the oxygen tank vent valve (Entlueften). Indicating lamp "Vent Valve" lights up. The ammeter should read 1 amp.

261. *Rocket Motor Panel Operator*

Switches on the alcohol tank outlet valve (Brennstoff Vorventil). Indicating lamp "Alcohol tank outlet Valve" lights up. The working of this valve can be felt with the palm of the hand on one of the stabilising fins. The ammeter should read about 1 amp.

262. *Rocket Motor Panel Operator*

Switches on the preliminary stage (Vorstufe). Indicating lamp "Preliminary Stage" lights up and the oxygen main valve opens first and then the alcohol main valve. The working of the relay operating these valves and the opening of the valves themselves can be felt by placing a hand on the rocket.

The ammeter should read about 3·5 amps.

If the alcohol main valve does not open within 0·8 sec. after the oxygen main valve has opened, the indicating lamp "Preliminary Stage" (Vorstufe) does not light up. The indicating lamp "Preliminary Stage out of Order" (Vorstufe Unkl) lights up instead and the buzzer sounds.

263. *Rocket Motor Panel Operator*

Immediately opens the vent valve, closes the alcohol tank outlet valve and switches off preliminary stage. The corresponding indicating lamps go out.

PRESSURISING OXYGEN TANK

264. *Rocket Motor Panel Operator*

Closes the vent valve (Entlueften). Indicating lamp "Vent Valve" lights up. The ammeter should read about 1 amp.

265. *Rocket Motor Panel Operator*

Switches on "Oxygen Tank Pressure Regulator" (A-Tankdruck Regelung). Indicating lamp "Oxygen Tank Pressure Regulator" lights up. After a pressure of 1 atmos has been reached, "Oxygen Tank Pressure Regulator" is switched off for a moment to make sure that no pipes are leaking. When 1·5 atmos has been reached, the pressure regulator functions and indicating lamp "Oxygen Tank Pressure Regulator" goes out.

266. *Rocket Motor Panel Operator*

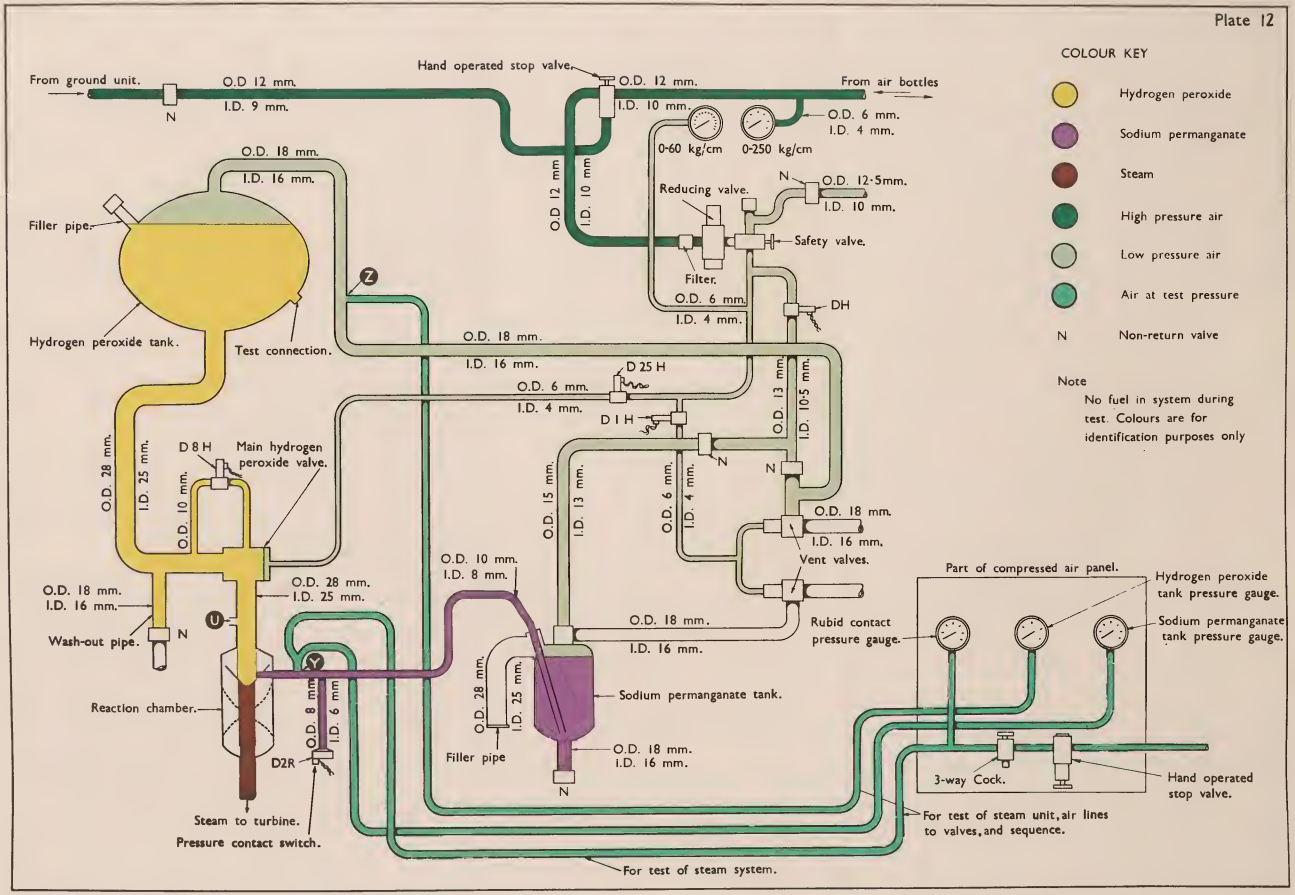
Switches off "Oxygen Tank Pressure Regulator" and opens the vent valve. Indicating lamp "Vent Valve" goes out, air is realeased from the tank with a rush.

D. AUXILIARY MOTOR TEST

PREPARATIONS (Plate 12)

267. The connection between the sodium permanganate tank and auxiliary combustion chamber is removed and the sodium permanganate pressure gauge in the compressed air panel is connected.

268. The connection between the rubid contact and the auxiliary combustion chamber is disconnected and the rubid contact is connected to the pressure gauge in the pressure panel.


From ground unit.
O.D 12 mm.
I.D. 9 mm.
N
Hand operated stop valve.
O.D. 12 mm.
I.D. 10 mm.
From air bottles
O.D. 6 mm.
I.D. 4 mm.
0-60 kg/cm
0-250 kg/cm
O.D. 12 mm
I.D. 10 mm
O.D. 18 mm.
I.D. 16 mm.
Filler pipe.
Hydrogen peroxide tank.
Test connection.
Z
Reducing valve.
N
O.D. 12·5mm.
I.D. 10 mm.
Safety valve.
Filter.
O.D. 6 mm.
I.D. 4 mm.
DH
O.D. 18 mm.
I.D. 16 mm.
D 25 H
O.D. 6 mm.
I.D. 4 mm.
D 1 H
O.D. 13 mm.
I.D. 10·5 mm.
N
N
O.D. 28 mm.
I.D. 25 mm.
D 8 H
O.D. 10 mm.
Main hydrogen peroxide valve.
O.D. 15 mm.
I.D. 13 mm.
O.D. 6 mm.
I.D. 4 mm.
O.D. 18 mm.
I.D. 16 mm.
Vent valves.
O.D. 10 mm.
I.D. 8 mm.
O.D. 18 mm.
I.D. 16 mm.
O.D. 28 mm.
I.D. 25 mm.
U
N
Wash-out pipe.
O.D. 18 mm.
I.D. 16 mm.
Rubid contact pressure gauge.
Y
Reaction chamber.
O.D. 8 mm.
I.D. 6 mm.
D2R
O.D. 28 mm.
I.D. 25 mm.
Filler pipe
Sodium permanganate tank.
O.D. 18 mm.
I.D. 16 mm.
N
Steam to turbine.
Pressure contact switch.
Part of compressed air panel.
Hydrogen peroxide tank pressure gauge.
Sodium permanganate tank pressure gauge.
3-way Cock.
Hand operated stop valve.
For test of steam unit, air lines to valves, and sequence.
For test of steam system.
COLOUR KEY
Hydrogen peroxide
Sodium permanganate
Steam
High pressure air
Low pressure air
Air at test pressure
N Non-return valve
Note
No fuel in system during test. Colours are for identification purposes only

269. The cap of the outlet in the side of the hydrogen peroxide pressurising pipe is removed and a pipe to the pressure gauge in the air pressure panel is connected.

270. The cap of the outlet in the side of the pipe connecting the 25-ton valve to the auxiliary combustion chamber is removed.

AUXILIARY MOTOR TEST

271. *Compressed Air Panel Operator*

Closes the inlet to the air pressure pipe for controlling valves by turning the knob marked " Fill " (Fuellen) and releases air pressure in the pipe by turning the knob marked " Empty " (Entlueften) in order to test the operation of the non-return valve in the pipe leading to the air bottles.

272. The locking device on the non-return valve is released and air is allowed to escape until the pressure in the air bottles is 50 atmos.

273. The rubid contact air pressure reducer on the compressed air panel is adjusted until the rubid contact pressure gauge reads 2·5 atmos.

274. *Rocket Motor Panel Operator*

Switches on the auxiliary motor test switch. The indicating lamp " Vent valve " (Entlueften) lights up. The ammeter reading for the vent valve should be about 1 amp. The hydrogen peroxide and sodium permanganate tank vent valves close. The tank air inlet valves open. Compressed air passes into the tanks.

275. The pressure gauges on the compressed air panel for the sodium permanganate and hydrogen peroxide tanks should read about 10 atmos. By listening for any escape of air, the tanks and valves are checked for leakage.

276. *Compressed Air Panel Operator*

Turns the 3-way cock to " Fill " (Fuellen). The rubid contact is pressurised. The pressure read on the pressure gauge on the air pressure panel should be between 1·5 and 2·3 atmos. The indicating lamp " Main Stage " (Hauptstufe) on the rocket motor panel lights up. The ammeter for the main stage valve should read about 4 amps. The 8 and 25-ton valves then open quickly one after the other and some air is released from the hydrogen peroxide tank through the outlet in the side of the pipe between the 25-ton valve and the auxiliary combustion chamber. This can be heard.

277. *Rocket Motor Panel Operator*

Immediately the 25-ton valve has opened, presses the fuel cut-off (Brennschluss) button, because compressed air passes through the auxiliary combustion chamber to the turbine and drives it, and the oxygen pump will be damaged because there is no oxygen to lubricate it. The indicating lamp " Fuel cut-off " (Brennschluss) lights and indicating lamp " Main Stage " (Hauptstufe) goes out. The ammeter reading for the main stage goes back to about 3 amps. The 25-ton valve closes.

278. *Rocket Motor Panel Operator*

After 3 seconds withdraws the main key (Schluessel). The indicating lamps " Fuel cut-off " and " Vent valve " go out. The ammeter reading for main stage and vent valve goes back to zero. The 8-ton valve and high pressure valve close, the vent valve opens. The compressed air in the sodium permanganate tank and what is left in the hydrogen peroxide tank is released through the vent valve.

279. *Compressed Air Panel Operator*

Turns the 3-way cock to " Empty " (Entlueften).

Rocket Motor Panel Operator

Switches off the auxiliary motor test switch.

E. TO TEST THE ALCOHOL TANK PRESSURISING SYSTEM

280. *Steering Panel Operator*

Switches on the take-off switch (Abhebekontakt). The indicating lamp " Time Switch Zero " (Z.S.W. Null) goes out. He presses the time switch button and keeps it pressed.

281. *Rocket Motor Panel Operator*

Opens the alcohol outlet valve (B-Vorventil). The indicating lamp " Alcohol outlet Valve " lights up.

282. After 40 secs. the alcohol tank pressurising valve closes.

283. *Steering Panel Operator*

Releases the time switch button and the time switch mechanism stops.

284. The alcohol air tank pressuring valve opens (during actual launching this does not take place until after fuel cut-off). Air from the compressed air bottles passes into the alcohol tank and through the alcohol pipes as far as the alcohol main valve. The tank pipes and cooling jets must be tested for leaks and the pressure gauge connected to one of the cooling jets in the combustion chamber is read. The 5-way coupling is withdrawn for a moment and the alcohol pump drainage pipe is inspected to see whether there is a leak from the alcohol pump.

285. *Steering Panel Operator*

Switches off the take-off switch. The time switch runs back to zero, the alcohol tank pressurising valve opens and compressed air is released.

286. *Rocket Motor Panel Operator*

Closes the alcohol tank outlet valve and indicating lamp " Alcohol Tank Outlet Valve " goes out.

F. TO TEST THE CHANGEOVER FROM GROUND TO ROCKET-BORNE POWER

287. The main distribution box safety switch (Bordautomat) is switched on.

288. *Rocket Motor Panel Operator*

Switches on the power changeover switch. The indicating lamp " Ground Power " goes out. The indicating lamp " Rocket-borne Power " comes on. The voltmeter should read at least 30 volts.

289. *Rocket Motor Panel Operator*

Switches off the power changeover switch. The indicating lamp " Rocket-borne Power " goes out and the indicating lamp " Ground Power " comes on.

290. The main distribution box safety switch is switched off.

G. LAUNCHING PROCEDURE AS FAR AS FUEL CUT-OFF TEST

291. This test, called in German Generaldurchschaltversuch or G.D.V. is normally carried out three times :—

(*a*) Using the time switch (Z.S.W.) to give fuel cut-off.
(*b*) With emergency fuel cut-off (Not Brennschluss).
(*c*) With Integrating Accelerometer (I-Geraet) fuel cut-off.

(If wireless control is used it would be carried out with wireless controlled fuel cut-off.)

(*a*) WITH TIME SWITCH (Z.S.W.) FUEL CUT-OFF

292. The lamp box (Lampenkaestchen) (for description see Section 9, Vol. 4), is plugged into the auxiliary motor unit. This indicates when various electrical control valves operate.

293. The main distribution box safety switch (Bordautomat) is switched on.

294. *Rocket Motor Panel Operator*

Switches to " Ground Power " (Bodenspei sung). The indicating lamps " Ground Power Supply," " Rocket Circuit Clear " (Bordnetz Klar) and " Time Switch at Zero " (Z.S.W. Null) should be on.

295. *Rocket Motor Panel Operator*

Turns the main key to " Launching Test " (Versuch). The indicating lamp " Test " (Pruefen) goes out and the indicating lamp " Launching Test " comes on.

296. *Steering Panel Operator*

Switches on " Alternators 1 and 2 " (Umformer 1 and 2) and waits until the ammeters are stationary at zero and the voltage on each alternator is between 41 and 42. This is tested by means of the alternator selector switch. He then switches on steering switch (Steuerstrom aus), motor switch (Steuerstrom Kontrolle), gyro potentiometer switch (KDO Spannung) and servo motors (Getriebe ein).

297. *Command Simulator Panel Operator*

Switches on the panel switch. He turns button A sharply to the right. Carbon rudder 1 should turn towards fin 4, carbon rudder 3 towards fin 2 (i.e., a roll is simulated. This will be corrected after take off is simulated (see para. 302)).

298. *Rocket Motor Panel Operator*

Closes the vent valve (Entluefter). The indicating lamp " Vent Valve " on the rocket motor panel and also D1h in the lamp box light up. (D1h controls the hydrogen peroxide and sodium permanganate tank vent valves).

299. *Rocket Motor Panel Operator*

Opens the alcohol outlet valve (B-Vorventil). The indicating lamps " Alcohol outlet Valve " and " Rocket-borne power supply " light up. The indicating lamp " Ground Power " goes out. The opening of the outlet valve can be felt by laying the palm of the hand on one of the stabilising fins.

300. *Rocket Motor Panel Operator*

Switches on the " Preliminary Stage " (Vorstufe) switch. The preliminary stage valve in the oxygen main valve opens. 0·8 sec. after (at the latest) the alcohol main valve opens as far as the preliminary stage. The indicating lamp " Preliminary Stage " lights up. Should the indicating lamp " Preliminary Stage not in order " (Vorstufe Unklar) light up, the test must not be proceeded with and everything must be switched back.

301. *Rocket Motor Panel Operator*

Switches on the " Main Stage " (Hauptstufe) switch. Stotz plugs I and II are released and taken off. The indicating lamp Dh on the lamp box lights (Dh controls the air pressurising valves in the hydrogen peroxide and sodium permanganate tanks).

The pressure operated contact switch on the lamp box is switched on. This shorts the rubid contact, and the 8-ton (D8h) and 25-ton (D25h) control valve indicating lamps on the lamp box come on. (The 8-ton and 25-ton valves themselves do not open.)

302. The take-off switch (Abhebekontakt) under fin 1 is released and the subsequent sequence of events is timed with a stop watch. 4 secs. after take-off, carbon rudders 2 and 4 move towards fin 1 into the precession (Programm) position.

Outer vane 2 moves towards fin 1 and outer vane 4 towards fin 3 (correction for roll, see para. 297).

303. 40 secs. after take-off the alcohol tank pressurising valve (Stauerdruckventil) closes. This can be heard.

304. 48 secs. after take-off, precession finishes. Carbon rudders 2 and 4 move back to the zero position.

305. After fuel cut-off (between 60 and 70 secs. after take-off according to the setting of the time switch) indicating lamp D25h, D8h and Dh all go out together.

Alternators 1 and 2, the servo motors and the time switch remain on.

The compressed air valve for pressurising the alcohol tank opens. This can be heard.

306. The main distribution box safety switch (Bordautomat) is switched off. Indicating lamp D1h goes out. The compressed air valve on the alcohol tank closes, the atmosphere pressurising valve opens and air is released from the alcohol tank.

307. All switches on the rocket motor and steering panels are switched back. The time switch runs back to zero.

(*b*) WITH EMERGENCY FUEL CUT-OFF (NOT BRENNSCHLUSS)

308. The Stotz plugs are replaced. The procedure as in paras. 291-301 inclusive is carried out.

309. *Rocket Motor Panel Operator*

Presses the button " Fuel cut-off " (Brennschluss).

310. Indicating lamps D25h, D8h and Dh on the lamp box go out.
The oxygen and alcohol main valves close.
The alcohol tank outlet valve closes.
Alternators 1 and 2 and the time switch remain on.

311. The main distribution box safety switch is switched off. All switches on the rocket motor and steering panels are switched off. The time switch runs back to zero.

(c) WITH INTEGRATING ACCELEROMETER (I-GERAET) FUEL CUT-OFF

312. The Stotz plugs are replaced. The procedure as in paras. 291-304 inclusive is carried out, with the addition that alternator 3 is switched on in para. 296.

313. After the time to which the Integrating Accelerometer has been set has elapsed, fuel cut-off commences.

314. The Integrating Accelerometer gives the preliminary signal (Vorkommando). The indicating lamp D25h on the lamp box goes out.

315. After about 3 secs. the accelerometer gives the main signal (Hauptkommando). The indicating lamps D8h and Dh go out. The alternators and servo motors remain on.

316. Outer vanes 2 and 4 move to the zero position. The oxygen and alcohol main valves close. The compressed air valve for pressurising the alcohol tank opens.

317. The main distribution box safety switch (Bordautomat) is switched off. Indicating lamp D1h goes out. The compressed air valve on the alcohol tank closes, the atmosphere pressurising valve opens and air is released from the alcohol tank.

318. All switches on the rocket motor and steering panels are switched back. The time switch runs back to zero.

THE FUZE ARMING UNIT TEST BOX
(For description of the fuze arming unit see Section 13, Vol. 4).

319. If the fuze arming unit (Sterg) test box is used, it is connected to the fuze arming unit lead.

320. When the take-off switch is released the indicating lamp A (take-off) lights up. 40 secs. after take-off the indicating lamp St. (Alcohol tank atmosphere pressurising valve closed) lights up. After fuel cut-off the indicating lamp B (fuel cut-off) lights up.

DISCONNECTING THE ROCKET FROM THE TEST VEHICLE

321. All the cables from the rocket to the test vehicle are disconnected.

322. The special connections made in paras. 269 to 271 are removed and the pipes which were disconnected are replaced. The cap in the side of the pipe connecting the 25-ton valve to the auxiliary combustion chamber is replaced.

323. All the hatches on the rocket are closed and the covers are replaced.

324. The rocket is then towed to the Warhead Mounting Section.

The Warhead Mounting Section (Spitzenmontage Trupp) . . . SECTION 15

WARHEAD MOUNTING SECTION OF NO. 2 PLATOON

LAYOUT

325. The Warhead Mounting crane (Montage Bock) which normally improvised, is set up in a tent on a by-pass road (see Section 11, para. 197) in such a position that the rocket on the Vidalwagen can be driven into the tent, have the warhead mounted and drive straight through and out the other side.

326. The crane is illustrated in Plate 13. It has two pulley blocks to which are attached two slings which fit round the warhead container against its ribs. The pulley blocks are raised and lowered by hand.

PROCEDURE

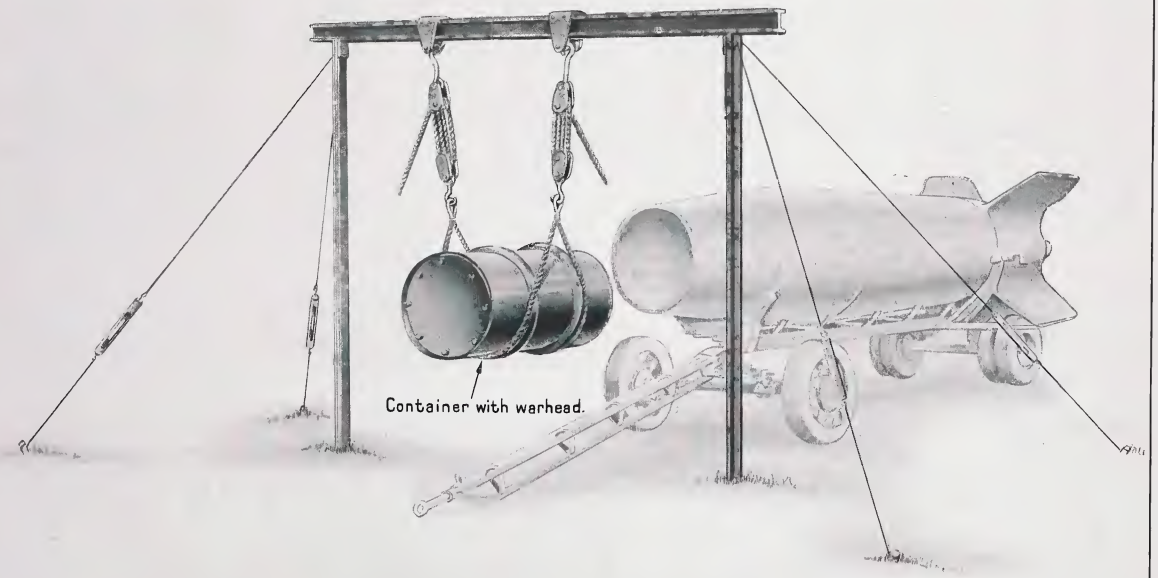
327. The rocket on the trailer is towed into the tent. The towing vehicle is disconnected and drives on.

328. The metal cover on the control compartment on the front of the rocket (Fig. 24) is removed and the canvas body cover is drawn back sufficiently to allow the control compartment doors to be opened.

329. The warhead in its container is rolled up and the two slings are fitted. The base cover of the container is removed and the warhead securing sleeve loosened by unscrewing the tommy bar.

Plate 13

WARHEAD MOUNTING CRANE.



The warhead will project 5 cms. from the base of the container (Fig. 45).

330. The container is then lifted by means of the crane and the rocket trailer is man-handled forward until the front of the control compartment is touching the base of the warhead (Fig. 46).

Fig. 45

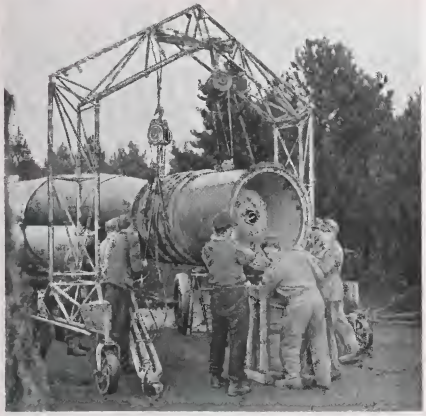


Fig. 46

Fig. 47

331. The warhead is manœuvred by means of the pulley blocks until the two positioning studs on the rocket engage with the two sockets in the base of the warhead (Fig. 45). When in this position, the front end of the container is supported by a wooden table (Fig. 46).

332. The twenty warhead-securing studs are inserted and tightened in the order 3 o'clock, 9 o'clock, 12 o'clock and then laterally in both directions from 12 o'clock downwards. The tommy bar of the sleeve securing the warhead to the container is removed by withdrawing its two bolts and sliding them clear.

The weight of the container is then taken by the crane (Fig. 47).

333. The wooden platform is removed and the crane blocks lowered. As the centre of gravity of the empty container is considerably forward of the slings, the container will tip over and fall to the ground. The sleeve which secured the warhead in the container is unscrewed and removed.

334. The nose fuze (Spitzezusnde) and gaine (Zuendladung) are inserted; the exploder tube is filled with an intermediary; the base fuze (Bedebsuende) and gaine are inserted, the fuze arming unit (Sterg) is inserted and the base fuze is connected to the fuze arming unit.

335. The control compartments are then closed and the top cover replaced. The towing vehicle is reconnected and the Vidalwagen is towed out of the tent to the parking ground (see Section 11, para. 202).

Procedure at the Technical and the Launching Troop Transloading Point SECTION 16

No. 2 Section of No. 2 Platoon of the Technical Troop.
Rocket Supply and Accessories Columns of the Launching Troop.

THE TRANSLOADING POINT

336. The transloading point is on a road under cover, somewhere between the Technical Troop position and the launching position.

It is most conveniently situated as near as possible to the warhead mounting point of the Technical Troop, but this is not always practicable. Plate 8 shows it on the road running up to No. 3 launching position.

ERECTION OF THE STRABO CRANE

337. The Strabo crane is halted on the road; the towing vehicle is disconnected and is driven into a suitable position for winching. The winch cable is run out and attached to the rear axle of the Strabo crane. A drag rope is attached to the engine draught connector (EDC) and is used to bring the crane into position across the road (Fig. 48). The crane is then brought into action as per Section 2, Vol. 4. It remains in action as long as the transloading point is being used.

TRANSLOADING

338. The Vidalwagen is driven under the Strabo crane. The Meilerwagen is backed in from the opposite direction and brought alongside the Vidalwagen (Fig. 49). The centre clamping bolt brackets of each trailer must be in line because no forward movement of the crane is possible.

339. The lifting bracket (Fig. 50) is attached to the rocket. The clamps on the Vidalwagen are undone, the clamps on the Meilerwagen are opened and two guide ropes are attached to the carbon rudder brackets.

Fig. 48

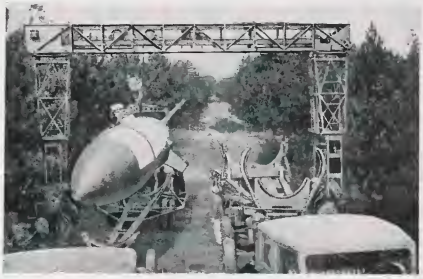


Fig. 49

Fig. 50

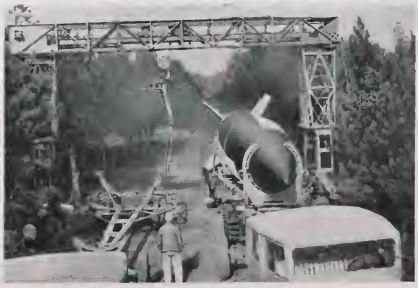


Fig. 51

340. The crane pulley block is lowered and attached to the lifting bracket. The rocket is raised. The pulley block is driven across into position above the Meilerwagen. The rocket is lowered and guided by means of the two ropes; the lifting bracket is undone and raised by means of the crane; the centre retaining bolts are shut and secured and the retaining clamps are closed over the rocket (Fig. 51).

HANDING OVER

341. The N.C.O. i/c Technical Section hands over to the N.C.O. i/c Rocket Supply and Accessories Column of the Launching Platoon the factory data papers, the test report (see Section 14, Vol. 4) and the following accessories:

one igniter and stand,
one box containing four carbon rudders,
one 50-volt nickel iron battery.
two 16-volt lead acid batteries,
one sodium permanganate container.

342. The rocket and accessories are then taken by the Rocket Supply and Accessories Column of the Launching Platoon to the launching position, where they wait under cover until called for by the Officer i/c Launching Platoon.

Part 6

Launching Troop Procedure . . . SECTION 17

PREPARATION OF THE LAUNCHING POSITION (Plate 14)

GENERAL

343. For the selection of the launching position see Section 4.

Before the rocket is brought up, the position selected must be prepared and surveyed. The following vehicles and equipment are brought up and positioned:

(*a*) The fire control vehicle (Feuerleitpanzer)
(*b*) The generator vehicle.
(*c*) The compressor
(*d*) The Magirus ladder
(*e*) The cable trailer (Kabeltrommelanhaenger).
Cables are laid out and connected up.

SURVEY

344. This is done by a survey detachment which is attached to Regimental Headquarters.

345. A bearing picket consisting of a peg with a nail on it is driven into the ground about 12 yards from the proposed position of the launching table. This bearing picket is used for the collimator during the final laying of the rocket on the line of fire.

346. An aiming point and two or three reference objects (ROs) are selected. The ROs are marked on trees by means of a cross with a nail in the centre or else on the ground by means of a peg and a nail.

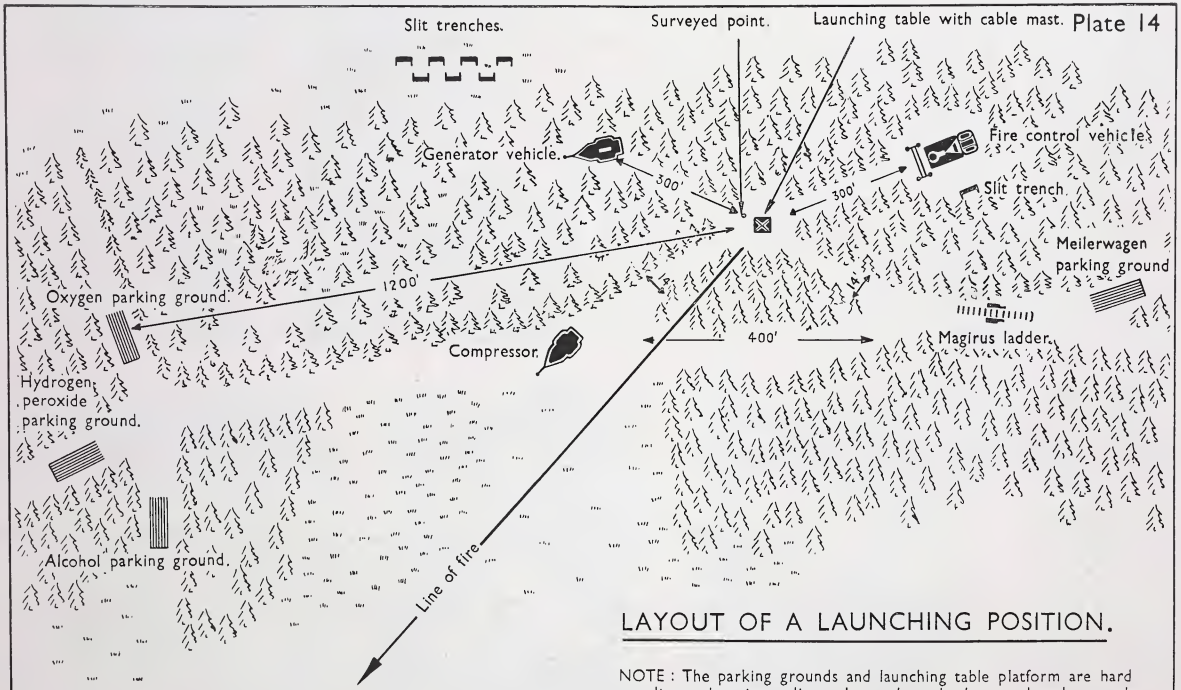
Fig. 52

347. In order to simplify the procedure for laying the rocket on the line of fire, a special bearing picket card is prepared. On this card, bearings to the aiming point and the ROs are calculated on the assumption that the line of fire is on a bearing of 3,200 mils. from the bearing picket. The collimator is oriented with the aid of this card so that when it is laid on a bearing of 3,200 mils. it is automatically laid on the line of fire.

SETTING UP THE LAUNCHING TABLE

348. The launching table is towed behind the fire control vehicle on to the launching position and halts at the required point (Fig. 52).

Plate 14



LAYOUT OF A LAUNCHING POSITION.

NOTE : The parking grounds and launching table platform are hard standing, otherwise ordinary lanes through the wood and a rough circular road well covered by overhanging trees.

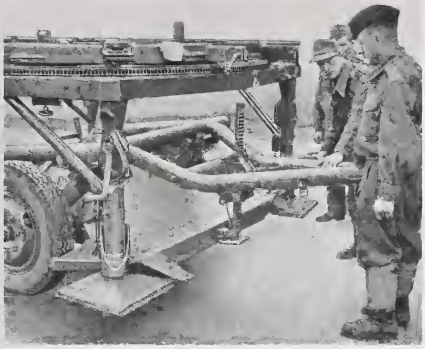


Fig. 53

349. Two men support the trail whilst another disconnects the trail from the towing vehicle. The towing vehicle drives on. The trail is lowered to the ground.

350. The trailer jack is lowered to the ground and the weight of the blast deflector is taken on it. The pin securing the blast deflector to the trailer can then be removed.

351. By means of the launching table front jacks, the front of the blast deflector is raised. The trailer jack is then raised and this allows the blast deflector and trail to come apart (Fig. 53).

352. By means of the launching table rear jacks, the rear of the blast deflector is now raised to its highest position (Fig. 54). At the same time, by means of the launching table front jacks, the front of the blast deflector is lowered to the ground, the hooks on the front legs are released from the blast deflector sleeves and the front of the launching table can now be raised (Fig. 41).

353. The trailer arms are cleared from the two brackets at the rear of the blast deflector and the trailer is wheeled clear of the launching table (Fig. 54). It is then withdrawn from the launching position.

354. By means of the launching table rear jacks the rear of the blast deflector is lowered to the ground and the hooks on the table legs disconnected from the blast deflector sleeves. The two aprons are folded down and secured (Fig. 55).

355. The table is roughly levelled by means of the jacks. The turntable is unclamped, traversed through 180° and reclamped. The four adjustable supporting plates are screwed up to about half way.

THE FIRE CONTROL VEHICLE AND THE GENERATOR VEHICLE

356. The fire control vehicle is driven to a suitable

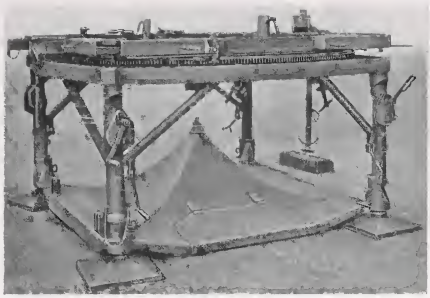


Fig. 54

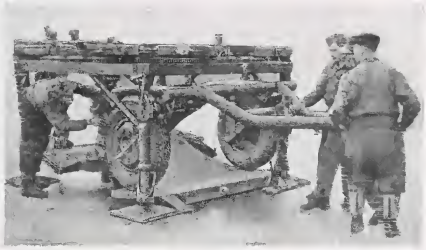


Fig. 55

position about 100 yards from the launching table behind the line of fire and with its rear facing the launching table. It is normally dug in to the depth of its tracks. The generator vehicle is placed on one side of the fire control vehicle as far away as cables will allow and again about 100 yards from the launching table (Plate 14).

THE CABLE LAYOUT

357. Cables between the fire control vehicle, the relay box on the generator and the launching table are laid out and connected up as in Fig. 56. The cables are normally hung on trees or, if this is not possible, suspended on posts driven into the ground, in order to protect them from damp, spilled fuel and fire.

THE COMPRESSOR AND THE MAGIRUS LADDER

358. The compressor is towed to any suitable position about 30 yards from the launching table. The Magirus ladder is unloaded from its truck (Plate 14).

THE SLIT TRENCHES

359. A slit trench is dug next to the fire control vehicle for use of the steering and rocket motor engineers. Further slit trenches for the whole platoon, each to hold two men, are dug between 150 and 200 yards from the launching table behind the line of fire (Plate 14).

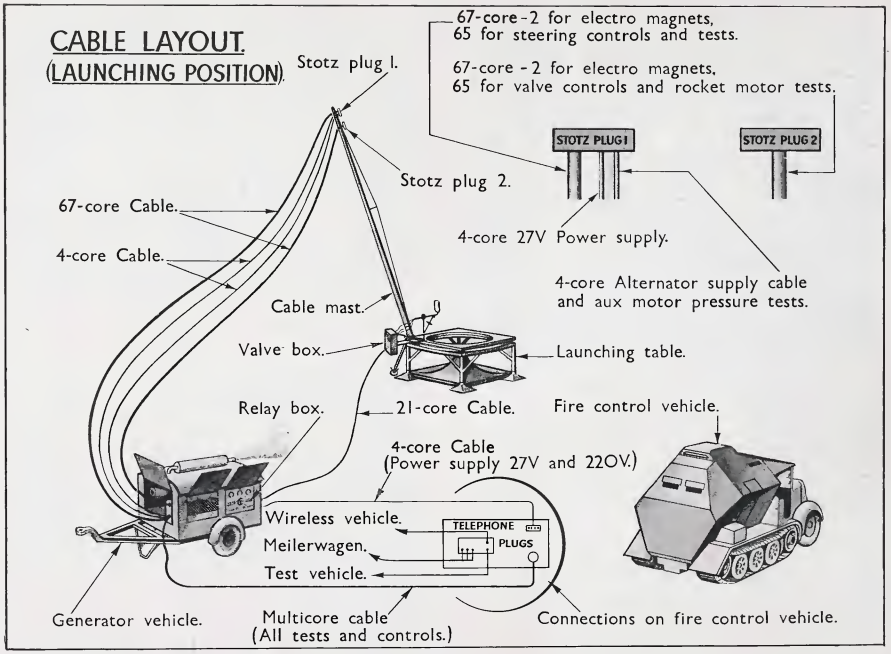


Fig. 56

PARKING GROUNDS

360. Parking grounds are prepared. The number varies according to the locality. An ideal layout would have four parking grounds, one each for the oxygen tank trailer, the hydrogen peroxide tanker, the two alcohol tankers and the three Meilerwagens. In addition to the rocket being launched, there are normally two further rockets waiting on Meilerwagens. These parking grounds are about 200 yards from the launching table.

TELEPHONE LAYOUT

361. Telephone lines are laid from the concentrator in the fire control vehicle to the following points :—

(*a*) Troop Headquarters.
(*b*) The launching table (two lines).
(*c*) A general purpose telephone placed somewhere on the launching position.
(*d*) The generator vehicle.
(*e*) Two lines to the fire control vehicles of adjacent launching platoons.

362. Battery Headquarters can be reached via Troop Headquarters, and Fuel and Rocket and Technical Troop Headquarters can be reached via Battery Headquarters.

Erecting the Rocket on the Launching Table . . . SECTION 18

TRUCK SECTION.
SUPPLY AND ACCESSORIES COLUMN OF LAUNCHING PLATOON.

DRIVING ON TO THE LAUNCHING POSITION

363. The Meilerwagen with the rocket in position (Fig. 57) is towed to a distance of about 50 ft. from the launching table and handed over by the Supply and Accessories Column to the Truck Section.

Fig. 57

364. The towing vehicle is disconnected and driven and reversed to a position approximately two yards on the other side of the launching table. The winch cable is run out, passed under the launching table and attached to the EDC of the Meilerwagen.

PREPARATION OF THE ROCKET IN THE HORIZONTAL POSITION

365. The tail cover is removed, folded up and put on one side (Fig. 58). The cases protecting fins are removed

Fig. 58

(Fig. 59). The body cover is undone and the upper clamping collar is opened by means of the ratchet. The auxiliary working platform is then placed in position over the nose of the rocket so that it lies flat on top of the rocket and the upper clamping collar is again closed (Fig. 60).

Fig. 59

Fig. 60

366. The two low tension lead acid batteries (Bordtatterien) and the high tension nickel iron battery (Kommandogebebatterie), together with the alcohol filling connection, tools and accessories, are placed in a container which is hung on the pulley strut at the top of the ladder (Fig. 61). The cable mast and the removable working platforms are taken off the Meilerwegen. The removable

Fig. 61

Fig. 62

Fig. 63

Fig. 64

Fig. 65

working platforms are placed in position on the lift frame and the side girders are swung outwards into the action position (Fig. 62).

WINCHING THE MEILERWAGEN TO THE LAUNCHING TABLE

367. The N.C.O. i c Truck Section stands at the launching table and gives directions to four men who operate the EDC and to one man who operates the hand brake. The Meilerwagen is winched up to the launching table (Fig. 63).

The two guide blades on the Meilerwagen must engage with the two brackets on the launching table (Fig. 64). It is sometimes necessary, if they do not engage, to move the launching table bodily by means of levers (Fig. 65).

RAISING THE LIFT FRAME AND ROCKET TO THE VERTICAL POSITION

368. Before the rocket is raised, the front of the Meilerwagen must be levelled transversely. The weight is taken on the side girder jacks, a spirit level is placed on the bracket provided and the jacks are operated until the bubble is central.

369. The hydraulic pump operator now takes post at his controls. He must have considerable experience in raising and lowering the lift frame. (For description of the hydraulic mechanism and controls see Section 24, Vol. 4).

Fig. 66

Fig. 67

He proceeds as follows (Figs. 66, 67, 68 and 69) :—

(*a*) He turns the direction control knob fully anti-clockwise to " Raise " (Heben).

(*b*) He ensures that the large piston control knob is turned fully clockwise.

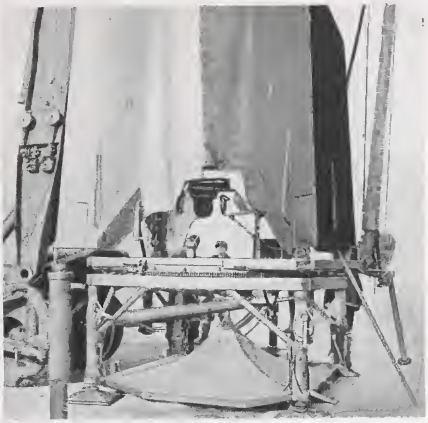


Fig. 68

Fig. 69

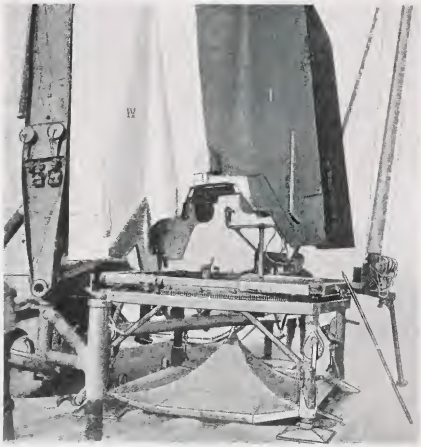


Fig. 70

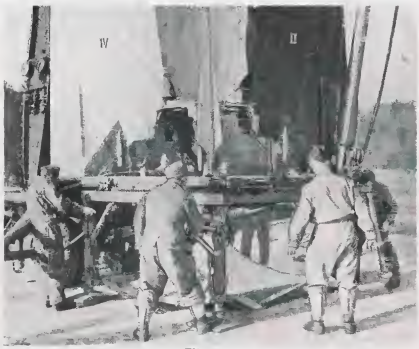


Fig. 71

(*c*) He starts the hydraulic pump motor.
(*d*) He turns the pressure control handle in a clockwise direction.
(*e*) When the two smaller pistons are fully extended and the smallest piston half way out, he turns the pressure control handle two or three turns in an anti-clockwise direction according to speed.
(*f*) He turns the large piston control knob anti-clockwise.
(*g*) He turns the pressure control handle anti-clockwise.
(*h*) As the lift frame reaches the perpendicular he decreases speed again, by turning the pressure control handle almost fully anti-clockwise.
(*i*) When the lift frame is perpendicular as seen by the plumbob pointing directly downwards, he turns the pressure control handle fully anti-clockwise and the large piston control knob fully clockwise.

Fig. 72

LOWERING THE ROCKET ON TO THE LAUNCHING TABLE

370. The rocket is now suspended above the launching table (Fig. 70). A further slight adjustment to the position of the launching table may now be necessary in order to bring the adjustable supporting plates directly under the bearing surfaces on the fins of the rocket. This can be done by means of hand levers.

371. The launching table is then raised by means of the jacks and the adjustable supporting plates are turned until all four are just touching the fin bearing surfaces (Fig. 71). The centre clamping collar is lowered by means of the right hand ratchet at the base of the lift frame so that all the weight of the rocket rests on the launching table.

Fig. 73

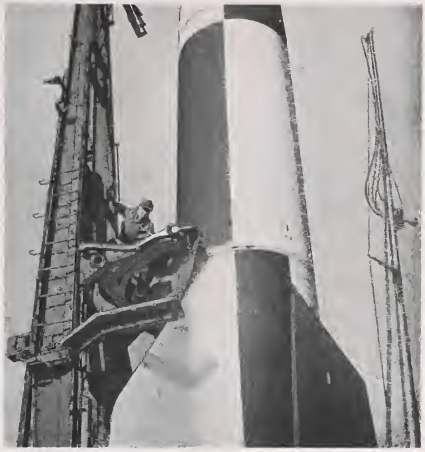


Fig. 74

Fig. 75

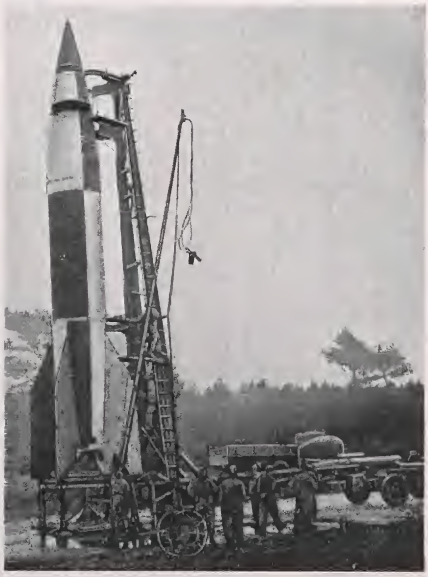


Fig. 76

372. Two men climb to the centre clamping collar and release the strap (Fig. 72). The side bolts (Bolzen) securing the rocket are withdrawn by operating the left hand ratchet at the base of the lift frame. One man climbs to the upper clamping collar and opens it with the ratchet bar (Fig. 73). As the upper clamping collar is opened, the body cover will fall down. It is removed (Fig. 74), folded up and put on one side.

373. The hydraulic pump operator takes post at his controls and the lift frame is lowered until the upper and centre clamping collars are clear of the rocket. The weight is taken off the side girders by raising the jacks and the trailer is man-handled 90 cms. as measured by a rod that length, from the launching table. The weight is again taken on the side girders (this is done whenever possible in order to relieve the trailer springs).

374. The rocket is then traversed through 90° to bring the fuelling connections opposite the working platforms. The upper and lower working platforms are then dropped into position using the handle provided. The hydraulic pump operator takes post at his controls and again raises the lift frame until it is perpendicular, care being taken to see that the working platforms do not foul the rocket. During this operation it may be again necessary to adjust the level of this trailer by means of the side girders.

375. One man climbs to the upper working platform and places the safety chains in position. Two men attach the valve box to the launching table. The cable mast, if not previously in position, is placed in its socket (Fig. 75), the cables are attached to it and it is raised by means of the screw jack and ratchet (Fig. 76).

Ensuring that the Rocket is Vertical SECTION 19

Laying Section and Truck Section

376. It is important that the rocket should be perfectly vertical when it is launched and for this purpose two collimators are used. (For description of the collimator see Section 35, Vol. 4). Nos. 2 and 3 of the Laying Section set up their collimators facing two sides of the launching table (Fig. 77). The collimators should be about 90 yards

Fig. 78

Fig. 77

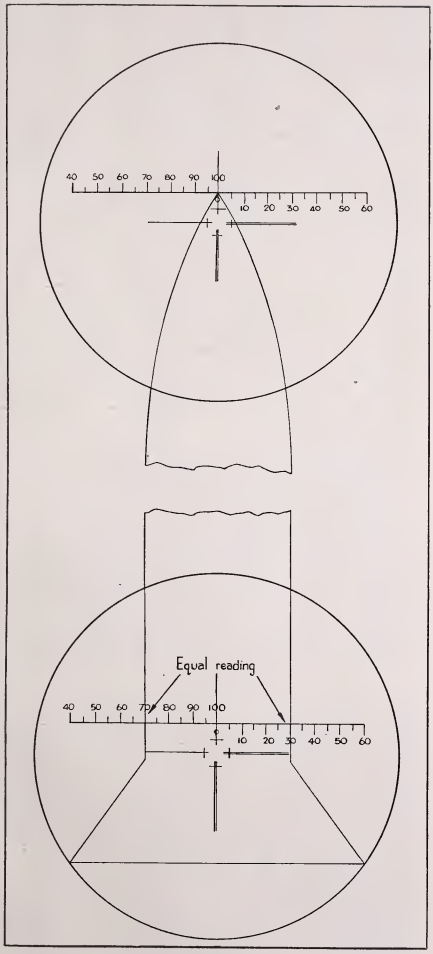


Fig. 79

from the launching table, at right angles to each other and accurately levelled. The N.C.O. i/c Laying Section stands by the launching table and gives directions to the N.C.O. i/c Truck Section. Four men of the Truck Section man the jacks of the launching table.

377. No. 2 lays his collimator on the rocket so that the horizontal graticule is on a level with the top of the fins (Fig. 78). He traverses until, left and right of the vertical graticule, an even number of divisions of the interval scale cover the rocket (Fig. 79). He then elevates until the horizontal graticule is laid on the nose of the rocket and makes signals to the N.C.O. to bring the nose of the rocket on to the vertical graticule.

378. The N.C.O. i/c Laying Section gives the necessary instructions to the N.C.O. i/c Truck Section, who orders the jack numbers to elevate or depress until the rocket is vertical as seen by No. 2.

379. The same procedure is carried out by No. 3 of the Laying Section. Then a further adjustment may be necessary from No. 2 and so on until the rocket is vertical from both directions.

N.C.O. i/c Laying Section.
Reports to the Officer i/c Launching Section: ROCKET IS VERTICAL.

Note.—By night the same procedure is carried out using torches.

Opening Rocket Hatches, Connecting the Electrical Cables and Pneumatic Leads to the Rocket . . . . . SECTION 20

ROCKET MOTOR SECTION
ELECTRICAL SECTION
FIRE CONTROL SECTION

380. *The Electrical Section*

(*a*) Lay out the telephone lines between the fire control vehicle, the launching table and the upper working platform. They test the lines.

(*b*) Plug in the 21-core cable into the base socket on the valve box.

(*c*) Plug in the emergency fuel cut-off (Not Brennschluss) line into the socket in the base of fin No. 4 and connect it to the fuel cut-off terminals in the side of the valve box.

(*d*) Place the take-off switch (Abhebekontakt) bracket under fin No. 1 and raise the bracket until the switch is depressed.

(*e*) Open the four internal potentiometer inspection hatches.

Fig. 80

(*f*) Remove the four carbon rudders from their travelling boxes and secure three of them to their brackets (Fig. 80). Any one rudder is left off to allow access to the combustion chamber. When the work outlined in para. 381(*d*) below has been completed, the fourth rudder is also secured.

(*g*) Open the hatch to control compartment No. 2 and plug in the two Stotz plugs.

(*h*) Open the panels of control compartment No. 3 (Fig. 81). Test the pressure of the alcohol tank pressurising bottles (200 atmos). Remove the springs which clamp the gyros during travelling. Check the seating of the gyro by means of a clinometer (Fig. 82). Insert the high tension nickel iron battery (Kommandogebe-batterie) and connect it up. Connect up the fuze arming unit (Sterg) to the base fuze (Bodenzuender) and to the fuze arming power unit (Glasttungzur-schenstueck).

(*i*) Open the panels of control compartment No. 1. Insert the two low tension lead acid batteries (Bord-batterien) and connect them up.

381. *The Rocket Motor Section*

(*a*) Prepare the 5-way coupling on the launching table (Fig. 83), the pipes from the 5-way coupling are from left to right:

(1) Oxygen tank air pressure regulating pipe (A-Tankdruckleitung).
(2) Rocket air bottle charging pipe (Pressluft-Fuelleitung).
(3) Alcohol pump drainage pipe (B-Leckleitung).
(4) Air pressure for operating valves pipe (Steuerdruckleitung).
(5) Oxygen tank pressurising pipe (A-Beluftungsleitung).

These pipes, with the exception of (3), must be screwed to the corresponding connections in the valve box.

(*b*) Connect the air compressor and the valve box to the air bottles on the Meilerwagen. The air compressor operator starts up the compressor.

(*c*) Remove the hatch covers to the oxygen fuelling inlet, the hydrogen peroxide fuelling inlet, the sodium permanganate fuelling inlet and the auxiliary motor unit.

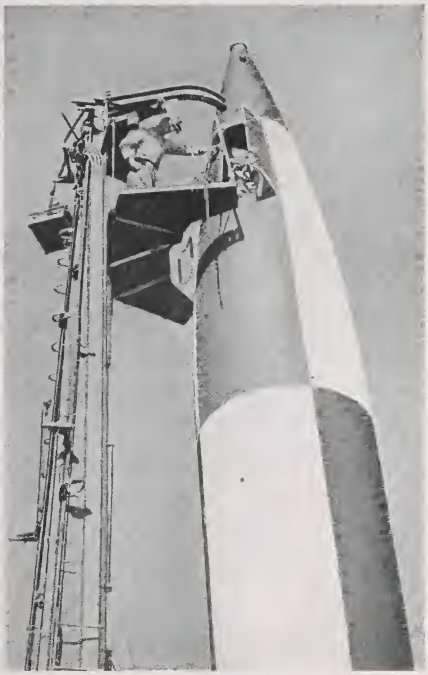


Fig. 81

Fig. 84

Fig. 82

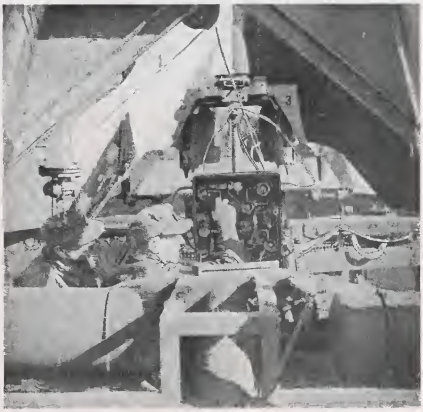


Fig. 83

Connect the pressure gauge, required for testing the reduced pressure in the auxiliary motor unit (Fig. 84). Disconnect the 14-pin plugs from the auxiliary motor unit and plug in the indicating lamp box required for the main tests. Open the pressure gauge valve and the high pressure valve in the auxiliary motor.

(*d*) Place the wooden working platform on top of the blast deflector. Place the ladder for examining the interior of the combustion chamber in position on the wooden working platform. Remove the protecting covers from the fuel jets in the combustion chamber (Fig. 85). See that the jets are free from dirt and grease and insert the cardboard cups around the jets (Fig. 86). When this has been done the ladder is removed.

(*e*) Remove the portable ladder from the Meilerwagen and place it in position so that the cover of the inspection manhole in the tail unit (Heckmannloch) can be removed. Remove the inspection manhole cover.

Fig. 85

Fig. 86

Main Tests . . . . . SECTION 21

ROCKET MOTOR SECTION, FIRE CONTROL SECTION, ELECTRICAL SECTION
STEERING ENGINEER, ROCKET MOTOR ENGINEER, ELECTRICAL ENGINEER

382. Whilst the rocket is in the vertical position it is tested for the third time. The tests are extremely thorough and cover:

A. Testing the steering mechanisms and controls.
B. Testing the rocket motor.
C. Testing the changeover from ground to rocket-borne power.
D. Testing the walls of the venturi and combustion chamber for leaks.
E. Testing the complete sequence during launching and up to fuel cut-off.

383. At the commencement of the tests the Officer i/c. Launching Platoon orders the tanking vehicles to come up to the launching position and whilst the tests are going on all preparations for tanking are made (see Section 22).

A. STEERING TESTS (STEUERUNGVERSUCH)

(For description of the steering panel and steering mechanism see Section 10 and 28, Vol. 4).

384. *N.C.O. i/c Electrical Section*
Orders: INSERT MAIN KEY AND SWITCH TO TEST.
Rocket Motor Panel Operator
Inserts the main key (Schluessel) in the rocket motor panel and turns it anti-clockwise to "Test" (Pruefen). He reports: MAIN KEY INSERTED AND SWITCHED TO TEST.

TO TEST THE MOTORS OF OUTER VANES 2 AND 4

385. *N.C.O. i/c Electrical Section*
Orders: SWITCH ON OUTER VANE MOTORS (TRIMMSEGELN).
Steering Panel Operator.
Switches on the vane motor switch (Trimmsegel) and reports: OUTER VANE MOTORS SWITCHED ON.

386. *N.C.O. i/c Electrical Section.*
Releases manually the take-off switch (Abhebekontakt). The carbon rudder No. 3 is moved to the zero position: the outer vane No. 1 is moved first to the left and then to the right. The outer vane Nos. 2 and 4 should move in the same direction. He closes the take-off switch when the outer vanes are at their zero position He orders: SWITCH OFF VANE MOTORS.

Steering Panel Operator
Switches off outer vane motors and reports: OUTER VANE MOTORS SWITCHED OFF.

TO SWITCH ON THE GYROS AND TO TEST IF THEY ARE RUNNING AT APPROXIMATELY THE RIGHT SPEED

387. *N.C.O. i/c Electrical Section*
Orders: SWITCH ON STEERING SWITCH (STEUERSTROM), METER SWITCH (STEUERSTROM UNTER-BRECHE) and ALTERNATOR SWITCH (UMFORMER 1 UND 2).

Steering Panel Operator

Switches on all three switches and reports: STEERING SWITCH, METER SWITCH AND ALTERNATOR SWITCH, ON.

388. When the gyros have been running for approximately 10 minutes they will have taken up their zero position. But for the purpose of the test it is sufficient if the voltages on the gyro and control amplifier alternators are equal. This is tested by setting the alternator selector switch to positions 1 and 2 and noting the voltage on the alternator voltmeter. It should be about 42 volts in each case.

TO ZERO THE SERVO MOTORS BY MEANS OF THE INTERNAL POTENTIOMETERS

389. *N.C.O. i/c Electrical Section*

Orders: SWITCH ON SERVO MOTORS (RUDERMASCHINEN).

Steering Panel Operator

Switches on servo motors and reports: SERVO MOTORS SWITCHED ON.

390. The internal rudder potentiometers 1 and 3 are adjusted until the rudders are stationary in the zero position. This procedure is repeated with internal potentiometers 2 and 4.

Steering Panel Operator

Checks milliammeters on the steering panel to see whether the current in the servo mechanisms are nil. The maximum permissible current is 3 m/amps.

TO TEST THE SERVO MOTORS

391. *N.C.O. i/c Electrical Section*

Orders: SWITCH ON GYRO POTENTIOMETER SWITCH (KDO SPANNUNG). UNBALANCE STEERING CONTROL CURRENT (STOERKOMMANDO) IN E PLANE (VANES 1 AND 3) TO LEFT AND TO RIGHT. (This has the effect of simulating commands from the horizontal gyro).

Steering Panel Operator

Switches on gyro potentiometer switch and presses, in turn, push button E1 (left) and E2 (right)—(command simulators)—and observes the E plane voltmeter and milliameters which should show approximately equal deflections for both rudders in both directions.

N.C.O. i/c Electrical Section

Checks manually the turning movement of the internal rudders. He does this by trying to hold the rudders stationary. The current shown in the milliammeters should increase proportionately to the resistance applied.

392. *N.C.O. i/c Electrical Section*

Orders: UNBALANCE STEERING CONTROL CURRENT IN D PLANE (RUDDERS 2 AND 4) TO LEFT AND TO RIGHT (To simulate commands from the vertical gyro).

Steering Panel Operator

Repeats the procedure as in para. 390 above, but using push bottons D1 and D2.

TO TEST THE SYNCHRONISATION OF CARBON RUDDERS 2 AND 4 (PITCH).

393. *N.C.O. i/c Electrical Section*

Orders: SWITCH OFF SERVO MOTORS (RUDERMASCHINEN).

Steering Panel Operator

Switches off servo motors and reports: SERVO MOTORS SWITCHED OFF.

N.C.O. i/c Electrical Section

Moves by hand the D rudders (2 and 4) in opposite directions and orders: SWITCH ON SERVO MOTORS.

Steering Panel Operator

Switches on the servo motors and reports: SERVO MOTORS SWITCHED ON.

N.C.O. i/c Electrical Section

Observes if the D rudders move into the zero position.

394. The procedure as in para. 393 above is repeated but the D rudders are set in the opposite sense.

TO TEST THE MOVEMENT OF THE CARBON RUDDERS AND OUTER VANES TO COUNTERACT ROLL

395. The take-off switch is released and the launching table is rotated clockwise. Carbon rudders 1 and 3 should take up positions for counteracting roll. Outer vanes 1, 2, 3 and 4 should move with carbon rudders 1 and 3. The launching table is rotated in an anti-clockwise direction. All rudders and vanes should return to their zero positions.

The time sequence is returned to zero by pressing the time switch (Z.S.W.) on the steering panel. The take-off switch is reclamped.

TO TEST PRECESSION

396. *N.C.O. i/c Electrical Section*

Releases manually the take-off switch (Abhebekontakt). 4 secs. after the switch has operated the D rudders should deflect towards fin No. 1 with sufficient force not to be retainable by hand. He orders: SWITCH OFF SERVO MOTORS.

Steering Panel Operator

Switches off servo motors and reports: SERVO MOTORS SWITCHED OFF. He returns the time sequence to zero by pressing the time switch button (Z.S.W.) on the steering panel.

The take-off switch is reclamped.

397. *N.C.O. i/c Electrical Section*

Reports to Officer i/c Launching Platoon: STEERING CONTROL ASSEMBLY IN ORDER (STEUERUNG KLAR).

B. ROCKET MOTOR TEST (TRIEBWERKSVERSUCH).

(For description of rocket motor unit and auxiliary motor unit, the rocket motor panel and the valve box see Sections 11, 26 and 29 of Volume 4).

TO FILL THE AIR BOTTLES ON THE MEILERWAGEN

398. The air bottles on the Meilerwagen are opened in turn and filled from the air compressor. The pressure in each air bottle must be 200 atmos. This is read either on the air pressure gauge in the valve box or on the gauge in the air compressor. Throughout the tests the compressor is kept running as required and the air bottles are kept full.

TO TEST THE VALVE BOX AND THE NON-RETURN VALVE IN THE CHARGING PIPE FOR LEAKAGE OF COMPRESSED AIR

399. One man opens the first air bottle on the Meilerwagen.

Valve Box Operator

Opens the rocket air bottle charging valve (Pressluft-Fuelleitung). Air passes audibly through the distributor

in the valve box through the whole system and into the compressed air bottles in the rocket motor unit. He then closes the charging valve and opens the air release valve in the valve box. Air streams out and the non-return valve in the charging pipe immediately closes. If there is a prolonged exit of air, it indicates that there is a lock in the system or that the non-return valve in the charging pipe is not operating correctly.

TO FILL THE AIR BOTTLES IN THE ROCKET MOTOR UNIT

400. *Valve Box Operator*

Closes the air release valve in the valve box and opens the air bottle charging valve. A man watches the high pressure gauge in the auxiliary motor. Filling continues until a pressure of 200 atmos is reached. He adjusts the pressure reducer to give 25·5 atmos. The pressure reducer in the auxiliary motor unit is adjusted to give 32·5 atmos.

TO TEST THE FUNCTIONING OF THE ROCKET MOTOR DURING THE PRELIMINARY STAGE (VORSTUFE)

401. On the rocket motor panel in the fire control vehicle the main key (Schluessel) is already in and switched to test (Pruefen). Indicating lamps Stotz plugs 1 and 2 (Stecker 1 und 2) should be alight. The battery indicating lamp (Spannungkont) should be on, showing that the electrical circuit is clear; and all "unclear" indicating lamps on the panel should be out. On the valve box, the two igniter terminals are shorted out with a piece of wire. (This is equivalent to the igniter being in position and connected up).

N.C.O. i/c Rocket Motor Section

Orders: COMMENCE ROCKET MOTOR TEST. TURN TEST SWITCH TO ROCKET MOTOR TEST (TRIEBWERKS-VERSUCH)

402. *Rocket Motor Panel Operator*

Switches test switch to Rocket Motor Test (Triebwerks-such) and presses the test button (Prufein).

N.C.O. i/c Rocket Motor Section

Orders: SWITCH THROUGH AS FAR AS MAIN STAGE (DURCHSCHALTET).

Rocket Motor Panel Operator

Presses the preliminary stage button (Vorstufe) and reports: SWITCHED THROUGH AS FAR AS MAIN STAGE (IST DURCHGESCHALTET).

The indicating lamp "Clear" (Klar) in the centre of the rocket motor panel lights up. The indicating lamps "Oxygen Tank Pressure" (Tank Beluftung) and "Igniter Clear" (Eusdung Klar) on the left-hand side of the rocket motor panel light up. The oxygen tank vent valve is closed, the electrical air inlet valve in the valve box is opened and air passes into the tank until a pressure of 1·5 atmos. has been reached. The automatic air pressure regulator in the valve box will maintain the air pressure at 1·5 atmos.

403. As soon as a pressure of 1·5 atmos. has been reached the indicating lamp "Oxygen Tank Pressure" on the left-hand side of the panel will go out and the indicating lamp "Oxygen Pressure" (Beluftung) in the centre of the panel will come on.

Rocket Motor Panel Operator

Reports: OXYGEN PRESSURE CLEAR (BELUFTUNG KLAR).

404. The wire shorting the igniter terminals in the valve box is then disconnected (this is equivalent to ignition having taken place). The indicating lamp "Ignition Clear" on the left-hand side of the panel will then go out and the indicating lamp "Ignition" (Zundung) in the centre of the panel will come on.

Rock Motor Panel Operator

Reports: IGNITION CLEAR (ZUNDUNG KLAR).

405. When ignition is clear, the main valve control circuit is closed and the oxygen main valve (first) and the alcohol main valve (second) are opened as far as the preliminary stage. The indicating light "Preliminary Stage" (Vorstufe) in the centre of the panel will come on. The compressed air will pass with a rush through the oxygen main valves to atmosphere.

Rocket Motor Panel Operator

Reports: PRELIMINARY STAGE CLEAR (BELUFTUNG KLAR).

406. *N.C.O. i/c Rocket Motor Section*

Orders: SWITCH BACK (ZURUCKSCHALTEN).

Rocket Motor Panel Operator

Withdraws the main key and reports: SWITCHED BACK (ZURUCKGESCHALTET).

C. CHANGEOVER FROM GROUND TO ROCKET-BORNE POWER TEST (BODENBORD)

407. *N.C.O. i/c. Rocket Motor Section*

Orders: TEST CHANGEOVER FROM GROUND TO ROCKET-BORNE POWER SUPPLY. SWITCH ON MAIN DISTRIBUTION BOX SAFETY SWITCH (BORDAUTOMAT).

408. *Steering Panel Operator*

Switches on alternators 1 and 2 (Umformer 1 und 2) and servo motors (Rudermaschinen). Indicating lamps "Alternators 1 and 2" and "Servo Motors" on the steering panel must be on.

A man on the upper working platform switches on the safety switch.

409. *Rocket Motor Panel Operator*

All "Unclear" lamps on the rocket motor panel must be out. He presses in the main key and turns it to "Test." He turns the test switch to "Changeover Power" (Bodenbord) and presses the test button. The indicating lamp "Ground Power" (Bodenspeisung) on the left hand side of the rocket motor panel should go out and "Rocket Power" (Bordspeisung) should light up. The voltmeter on the left hand side of the panel should show at least 30 volts. The indicating lamp "Changeover Power" (Bodenbord) should come on. Indicating lamps "Alternators 1 and 2" and "Servo Motors" must remain on.

410. *N.C.O. i/c Rocket Motor Section*

Orders: SWITCH BACK (ZURUCKSCHALTEN). SWITCH OFF MAIN DISTRIBUTION BOX SAFETY SWITCH (BORDAUTOMAT AUS).

Rocket Motor Panel Operator

Pulls out the main key.

The man on the upper working platform switches off the main distribution box safety switch.

D. FLOW OF ALCOHOL TEST (TANKEN)

411. *This has to be done after* 1,000 *litres of alcohol have been tanked* (see Section 25, para. 463). A leak in the combustion chamber will result in vapour forming and when the igniter is lit an explosion may take place which will eject it.

412. *N.C.O. i/c Rocket Motor Section*
Orders : TEST THE FLOW OF ALCOHOL (TANKEN PRUEFEN).

413. *Rocket Motor Panel Operator*
Presses in the main key and turns the test switch to " Test Alcohol Flow " (Tanken). He presses the test button. The indicating lamp " Alcohol Flow " (Tanken) should light up.

This operates the electrical valve controlling the alcohol tank outlet valve (Vorventil). Alcohol passes through the alcohol pump to the walls of the venturi and combustion chamber as far as the alcohol main valve.

414. A man listens at the inspection manhole to the flow of alcohol (Fig. 87). Another man watches to see that no alcohol drips out of the venturi. A possible cause of leak is through the cooling jets around the inside of the venturi. If one of these is leaking, it must be changed.

415. *N.C.O. i/c Rocket Motor Section*
If there is no leakage, orders : SWITCH BACK (ZURUCKSCHALTEN).

Rocket Motor Panel Operator
Turns the test switch back to Rocket Motor Test (Triebwerksversuch) and withdraws the main key.

E. LAUNCHING SEQUENCE AND FUEL CUT-OFF TEST (GENERALDURCHSCHALTVERSUCH)

(For description of lamp box and switch box see Section 9, Vol. 5).

416. *N.C.O. i/c Rocket Section*
Reports : ALL READY FOR MAIN TEST (FERTIG ZUM G.D.V.).

PREPARATION FOR THE TEST

417. On the rocket motor panel all the lamps on the right-hand side except " Batteries " (Spannungskont) must be out. On the left hand side Stotz plugs 1 and 2 (Stecker 1 und 2) lamps must be on and also " Ground Power " (Bodenspeisung).

On the rocket the switch box is plugged into the valve box and the main distribution box safety switch is switched on (Fig. 88).

Rocket Motor Panel Operator
Reports : CLEAR (KLAR).

418. On the steering panel the steering (Steuerstrom), meter (Steuerstr. Kontr), alternators 1 and 2 (Umformer 1 und 2), servo motors (Rudermaschinen) and gyro pot (KDO Spann) switches must be on and indicator lamps alight.

Steering Panel Operator
Reports : CLEAR (KLAR).

TO TEST THE PRELIMINARY STAGE SEQUENCE (VORSTUFE)

419. *N.C.O. i/c Rocket Motor Section*
Orders : TURN MAIN KEY TO SHOOTING POSITION (SCHLUESSEL AUF SCHIESSEN).

Rocket Motor Panel Operator
Inserts the main key and turns to the shooting position and reports : KEY IS TURNED TO SHOOTING POSITION (SCHLUESSEL STEHT AUF SCHIESSEN). The indicating lamp " Clear " (Klar) should come on.

Fig. 87

Fig. 88

420. *N.C.O. i/c Rocket Motor Section*

Orders: SWITCH THROUGH AS FAR AS MAIN STAGE (DURCHSCHALTEN).

Rocket Motor Panel Operator

Presses preliminary stage button (Vorstufe) and reports: SWITCHED THROUGH AS FAR AS MAIN STAGE (IST DURCHGESCHALTET).

When the button is pressed the preliminary stage is started .

421. *N.C.O. i/c Rocket Motor Section*

Switches on the tank pressurising switch (Tank Beluftung), the pressure regulating switch (Luftreglung) and the igniter switch (Zundung) on the switch box (Fig. 89). The sequence of the oxygen tank being pressurised followed by the igniter being switched on is simulated and indicator lamps "Oxygen Pressure" and "Igniter" will light up on the rocket motor panel. No report is made.

The N.C.O. i/c Rocket Motor Section will see the lamp D1h, indicating that the hydrogen peroxide and sodium permanganate tank vent valves are closed, come on in the lamp box.

422. As soon as the igniter is switched on, the main valve control circuit is closed and the oxygen main valve (first) and the alcohol main valve (second) are opened as far as the preliminary stage, and the changeover from ground to rocket-borne power takes place. The indicating lamp on the rocket motor panel "Ground Power" (Boden Speisung) will go out and "Rocket Power" (Bord Speisung) will light up. The indicating lamp "Preliminary Stage" (Vorstufe) will then light up.

TO TEST THE MAIN STAGE SEQUENCE (HAUPTSTUFE)

423. *N.C.O. i/c Rocket Motor Section*

Orders: PRESS MAIN STAGE BUTTON (HAUPTSTUFE).

When this button is pressed the two Stotz plugs are thrown off. The N.C.O. i/c. Rocket Motor Section will see lamp Dh, indicating that the hydrogen peroxide and sodium permanganate tank pressurising valve has opened, come on in the lamp box.

424. *N.C.O. i/c Rocket Motor Section*

Switches on the rubid contact switch on the lamp box (Fig. 90). He will see lamp D2r on the switch box, indicating that the rubid contact has operated, and lamps D8h and D25h on the lamp box, indicating that the 8-and 25-ton valves have been opened, come on.

TO TEST PRECESSION (PROGRAMM), ALCOHOL TANK PRESSURISING AND FUEL CUT-OFF (BRENNSCHLUSS)

425. *N.C.O. i/c Rocket Motor Section*

Orders: OPERATE TAKE-OFF SWITCH (LASSEN ABHEBEKONTAKT FALLEN).

A man standing beside the take-off switch lets it fall and this starts the time sequence.

426. *N.C.O. i/c. Rocket Motor Section*

Checks with a stop watch the commencement of precession (Programm). Carbon rudders 2 and 4 should move sharply towards Fin No. 1 into the precession position after 4 secs. A man holds the rudders to check that they are moving with sufficient force. (He should not be able to stop them moving).

427. *N.C.O. i/c Rocket Motor Section*

Also checks the closing of the alcohol tank atmosphere pressurising valve. This should close with an audible click after 40 seconds. He checks the end of precession which should occur after 47 to 51 secs. according to range. Carbon rudders 2 and 4 should move back to their zero position.

Fig. 89

Fig. 90

428. *N.C.O. i/c Rocket Motor Section*

Also checks the fuel cut-off point (Brennschluss). This should occur after whatever time it has been decided that fuel cut-off should take place.

The 25-ton valve is closed and indicating lamp D25h goes out. Then the hydrogen peroxide and sodium permanganate tank pressurising valve is closed. Indicating lamp Dh goes out. The 8-ton valve then closes and indicating lamp D8h goes out. The oxygen and alcohol main valves close.

Alternators 1 and 2, the carbon rudder servo motors and the gyro potentiometers are switched off and the corresponding indicating lamps will got out on the steering panel.

429. *N.C.O. i/c Rocket Motor Section*

Finally checks that the alcohol tank is pressurised after fuel cut-off. Compressed air is heard to rush into the alcohol tank. (This is to stop the tank collapsing due to atmospheric pressure).

430. During the sequence of the tests, if anything is not in order the corresponding lamp will light up on the right-hand side of the rocket motor panel.

431. *N.C.O. i/c Rocket Motor Section*

Orders: SWITCH OFF MAIN DISTRIBUTION BOX SAFETY SWITCH.

SWITCH OFF MAIN KEY (BORDAUTOMAT AUS. ZURUCKSCHALTEN).

A man on the upper working platform replaces the Stotz plugs and switches off the safety switch. The rocket panel operator turns the main key and pulls it up. They report: DISTRIBUTION BOX SAFETY SWITCH OFF (BORDAUTOMAT AUS) AND MAIN KEY SWITCHED OFF (ZURUCKGESCHALTET).

Indicating lamp D1h on the lamp box goes out.

The alcohol tank atmosphere pressurising valve is opened and allows air to escape from the alcohol tank.

The Steering Panel Operator switches off all switches. The servo motors (Rudermaschinen) are switched on from time to time during fuelling to stop them freezing up.

432. The take-off switch is again raised and secured. The securing screws of the internal rudders are checked. The bolts securing the warhead are tightened up. The voltage of the low tension and high tension batteries is checked with a voltmeter and if they are below 16 and 50 volts they are replaced.

433. *N.C.O. i/c Rocket Motor Section*

Reports to Officer i/c Launching Platoon: MAIN TESTS SATISFACTORY.

Preparation for Fuelling . . . SECTION 22

ROCKET MOTOR SECTION, FUEL COLUMN, OXYGEN SECTION, ALCOHOL SECTION, HYDROGEN PEROXIDE SECTION

434. Preparation for fuelling can begin during the main tests. The officer i/c the Launching Platoon orders: BRING UP THE FUELLING VEHICLES. The N.C.O. i/c the Fuel Column supervises the bringing up of the fuelling vehicles and equipment, which are positioned as in Plate 15 and Figs. 91 and 92. It is important that:—

(*a*) The oxygen trailer is placed so that the tank outlet is towards the rocket.

(*b*) The alcohol tankers are placed so that the lengths of hose between the tankers and pump on the one hand and the pump and the rocket on the other are as short as possible.

(*c*) The hydrogen peroxide tanker is so placed that the lengths of hose between it and the Meilerwagen are as short as possible.

435. When all vehicles are in position, the Officer i/c Launching Platoon orders: CONNECT.

The connections as far as the rocket are made by the Fuel and Rocket Sections. The connections to the rocket are made by the Rocket Motor Section.

ALCOHOL

436. The pump operator opens all the doors of the pump trailer.

437. The two drivers fetch the 60 mm. hoses from the alcohol tankers and connect the tanker outlets to the alcohol pump inlets (Fig. 93).

438. Three men fetch the 70 mm. hose from one of the alcohol tankers and connect the pump outlet to the intermediate pipe on the Meilerwagen (Fig. 94). Another man screws on the alcohol tank fuelling connection on the rocket and connects the intermediate pipe on the Meilerwagen to the alcohol tank fuelling connection.

439. *N.C.O. i/c Alcohol Section*

Reports to the N.C.O. i/c Fuel Column: ALCOHOL CONNECTIONS COMPLETED.

440. The N.C.O. i/c Fuel Column inspects all the connections.

441. The Launching Troop Engineer, taking into account the range to the target and the time of burning to the fuel cut-off point (Brennschluss), will have previously worked out the exact quantity of alcohol which it is required to tank. The quantity will include 70 litres which will be left in the hoses when the automatic cut-off gear on the alcohol pump operates.

442. The N.C.O. i/c Fuel Column ascertains from the Launching Troop Engineer what this quantity is and orders it to the N.C.O. i/c Alcohol Section.

Fig. 91

Fig. 92

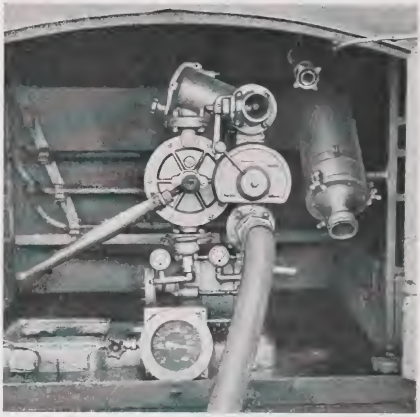


Fig. 93

Fig. 94

OXYGEN

443. The Oxygen Section put on their protective clothing.

444. Four men remove the oxygen pump from the trailer and attach it to the side of the oxygen tanker.

445. The pump operator ensures that the pump clutch is disengaged.

446. Two men remove the 100 mm. hose from the box on the oxygen trailer and connect the trailer tank outlet to the pump inlet.

447. One man screws on the oxygen fuelling connection

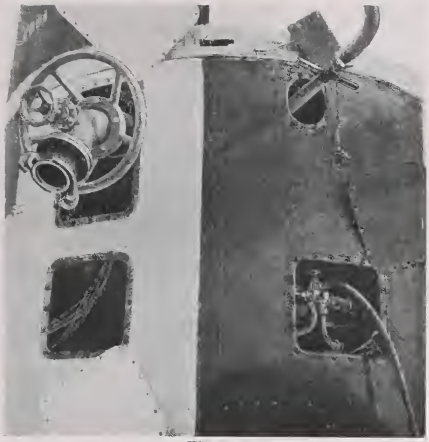


Fig. 95

Fig. 97

Fig. 96

Fig. 98

to the oxygen tank on the rocket (Fig. 95). He connects a short hose from the intermediate pipe on the Meilerwagen to the fuelling connection on the rocket (Fig. 96). Two men obtain the 70 mm. hose from the trailer and connect the pump outlet to the intermediate pipe on the Meilerwagen. The oxygen overflow is connected to the oxygen vent pipe (Fig. 97).

448. *N.C.O. i/c Oxygen Section*

Reports to the N.C.O. i/c Fuel Column: OXYGEN CONNECTIONS COMPLETED.

449. The N.C.O. i/c Fuel Column then inspects all the connections.

HYDROGEN PEROXIDE

450. The driver and spare driver of the hydrogen peroxide tank put on their protective clothing.

451. They obtain the 32 mm. hose from the hydrogen peroxide tanker and connect the pump outlet on the tanker to the intermediate pipe on the Meilerwagen (Fig. 98). One man fits the fuelling coupling to the rocket tank and connects the outlet of the measuring tank on the Meilerwagen to the fuelling coupling of the rocket tank (Fig. 99). A bucket is filled from the water tank in the hydrogen peroxide tanker and placed on the lower working platform.

Plate 15

LAUNCHING POINT DURING FUELLING.

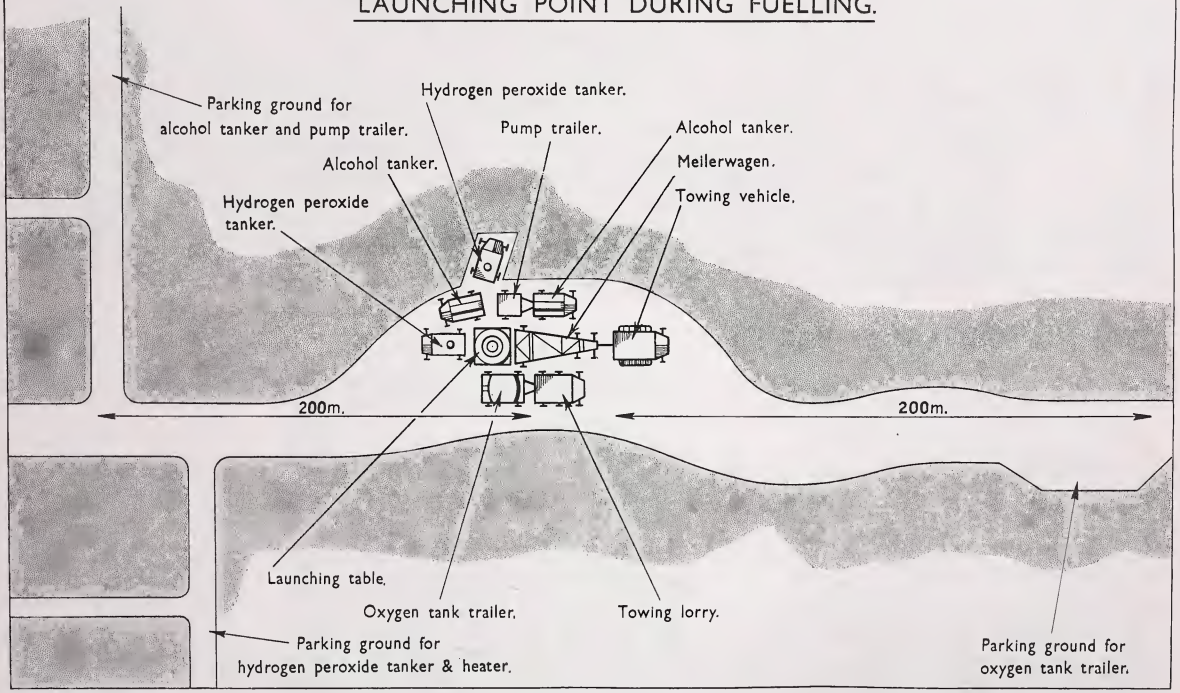


Fig. 99

Fig. 100

452. If the temperature is below 20°C the hydrogen peroxide must be heated before it is tanked. For this purpose the hydrogen peroxide heating trailer (T-Stoff Vorwaermenhaenger) is used (see Section 30, Vol. 4).

453. The driver reports to the N.C.O. i/c Fuel Column: HYDROGEN PEROXIDE CONNECTIONS COMPLETED.

454. The N.C.O. i/c Fuel Column inspects the connections.

SODIUM PERMANGANATE

455. One man places a sodium permanganate container inside the electrical heater and stands beside it and every now and then shakes it to circulate the heat (Fig. 100). If the electrical heater fails, a little alcohol and a piece of paper is placed in a bucket. This, when lit, provides a good fire and the sodium permanganate container is placed on the bucket. This method is quicker than the electrical one.

Fuelling the Rocket . . . . SECTION 23

ROCKET MOTOR SECTION, FUEL COLUMN, OXYGEN SECTION, ALCOHOL SECTION, HYDROGEN PEROXIDE SECTION

456. As soon as the main tests have been completed, the N.C.O. i/c Fuel Column orders alcohol fuelling to begin.

Oxygen pre-cooling begins after 1,000 litres of alcohol have been tanked. Hydrogen peroxide fuelling begins approximately 5 minutes after oxygen fuelling has begun. Sodium permanganate fuelling is left until last.

ALCOHOL

457. The shut-off cocks on the alcohol tanker outlets are opened and the three-way cocks on the alcohol tanker pumps are set to "Hand Pump."

458. The trailer pump operator closes the shut-off cock on the pump outlet. He opens the cocks on the two pump inlets. He sets the three-way cock to "Gasanzeiger," the position which allows alcohol to pass through the complete pump system. He opens the gas escape valve on the visual de-gassing apparatus (Gasatzeiger).

459. The hand pumps on the alcohol tankers are operated in order to drive alcohol through the system and clear it of air. As soon as alcohol flows from the gas escape valve on the visual de-gassing apparatus, the valve is closed.

460. The N.C.O. i/c Alcohol Section sets the quantity of alcohol it is required to pump on the Siemens meter (Fig. 101). He sets the automatic cut-off gear by pulling out the control lever.

461. The pump operator starts up the engine and opens the shut-off cock on the pump outlet. Alcohol is pumped into the rocket tank.

462. When the Siemens meter shows that 1,000 litres have been pumped, the report is made: 1,000 LITRES IN ALCOHOL TANK.

463. *Officer i/c Launching Platoon.*

Orders: TEST FLOW OF ALCOHOL (TANKEN PRUEFEN).

The combustion chamber is tested for leaks as described in Section 21, para. 410.

464. When the correct amount of alcohol has been tanked the automatic cut-off operates. The N.C.O. i/c Alcohol Section standing beside the Siemens meter reports that it has operated and the pump operator stops the engine by pressing the engine cut-off switch.

465. The pump shut-off cock on the pump outlet is closed, the Siemens meter set back to zero and the three-way cock on the pump in the alcohol tanker is set to " Return."

466. The shut-off cock on the alcohol pump outlet is opened, the hand pumps operated and any alcohol that remains in the hoses pumped back into the alcohol tankers.

Fig. 101

Fig. 102

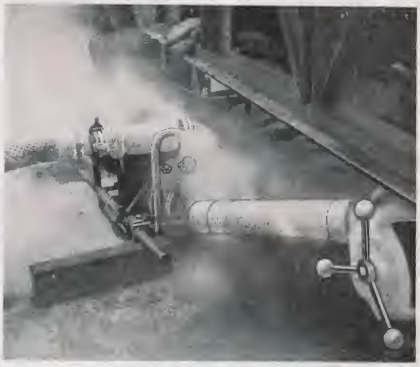


Fig. 103

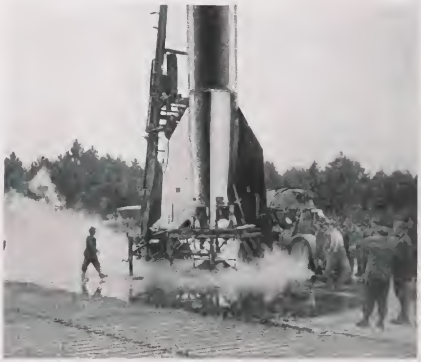


Fig. 104

467. The shut-off cocks on the tanker outlets are closed, the hoses from the tankers to the pump are disconnected and stowed in the tankers. The hose from the pump to the Meilerwagen is disconnected and stowed in the pump trailer. All pipes must have their caps screwed on.

OXYGEN

468. Before oxygen fuelling commences it is necessary to cool the pump, connecting hoses and the oxygen tank in the rocket gradually. For this reason, when 1,000 litres of alcohol have been tanked, the N.C.O. i/c Alcohol Section reports the fact to the N.C.O. i/c Oxygen Section, who orders : COMMENCE PRE-COOLING (VORKUEHLEN).

469. The oxygen pump motor is started, but the pump is not clutched in. The outlet valve of the oxygen tank trailer is slightly opened. The inlet valve on the oxygen

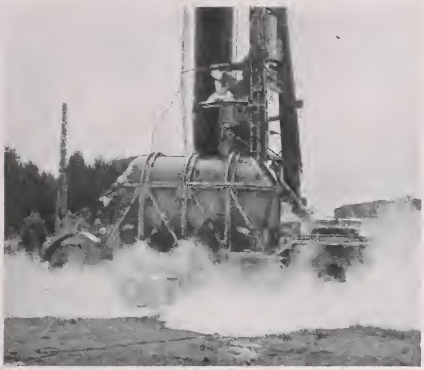


Fig. 105

Fig. 106

tank in the rocket is opened by turning the handwheel on the connecting piece. Oxygen gas flows through the pump and hoses and into the oxygen tank in the rocket and out of the overflow pipe. The N.C.O. i/c watches the oxygen gas escape pipe on the oxygen tank and notes when pre-cooling commences.

470. After pre-cooling has been going on for about five minutes, the N.C.O. i/c Oxygen Section will order: COMMENCE PUMPING OXYGEN.

471. The main valve on the tank trailer is fully opened. The pump operator lets in the pump clutch (Fig. 102). He adjusts the speed of the engine until a delivery pressure of 1·5 atmospheres is reached. The pump will take a little time to build up pressure. As soon as the liquid oxygen commences to be pumped, gas will cease to escape from the overflow pipe in the tank trailer. Oxygen tanking takes from eight to eleven minutes (Figs. 103, 104 and 105).

472. As soon as the oxygen tank is full, liquid oxygen will flow from the gas escape pipe on the rocket. The N.C.O. i/c Fuel Column orders: STOP PUMPING OXYGEN.

473. The main valve of the oxygen tank trailer is closed. The pump operator declutches the pump and stops the engine.

474. The inlet valve on the oxygen tank on the rocket is closed by turning the handwheel on the connecting piece. The gas escape valve on the pump is opened. Using a mallet, the 70 mm. hose is disconnected from the fuelling connecting piece. Any oxygen which is in the hose will flow back to the pump and out of the gas escape valve to atmosphere. The connecting piece is removed from the oxygen tank inlet.

475. The 100 mm. hose is disconnected. The hoses are housed in the oxygen tank trailer. The pump is housed in the pump trailer. The oxygen tank trailer and pump trailer are driven away.

HYDROGEN PEROXIDE

476. Hydrogen peroxide must be handled with great care due to its inflammable properties. A bucket of water must always be readily available and pipes and connections must be closely watched for leaks.

477. The three-way cock on the measuring tank is set to "Fill or Empty." The shut-off cocks on the overflow tank and on the connection leading from the three-way cock to the rocket tank are closed.

478. The shut-off cock on the outlet of the hydrogen peroxide tanker is opened, the hand pump is set to "Delivery" and hydrogen peroxide is pumped from the tanker into the measuring tank (Fig. 106). (For the procedure if it is necessary to use the hydrogen peroxide heater, see Section 30, Vol. 4).

Fig. 107

Fig. 108

Fig. 109

479. When the liquid reaches the mark on the measuring tank inspection window, showing that 126 litres have been tanked, the man at the measuring tank orders: HALT. The three-way cock on the measuring tank is closed.

480. The shut-off cock on the outlet of the hydrogen peroxide tanker is closed and reported: CLOSED.

481. Some hydrogen peroxide will have overflowed from the measuring tank to the overflow tank. This must be pumped back. The man at the measuring tank opens the shut-off cock on the overflow tank and orders: PUMP BACK.

482. The pump is set to "Return," the shut-off cock on the outlet of the tanker is opened and hydrogen peroxide is pumped back. The man at the measuring tank looks through the inspection window of the overflow tank until all the overflow liquid has been pumped back. The hose between the tanker and the Meilerwagen is then raised so that the last few drops can be pumped back.

483. The hose is then disconnected from the hydrogen peroxide pump and secured to the water pump.

484. The N.C.O. i/c Fuel Column then orders the hydrogen peroxide to be tanked into the rocket. The three-way cock is set to "Tank" and the cut-off cock on the connection leading from the three-way cock to the rocket tank opened and hydrogen peroxide gravitates into the rocket tank. The hydrogen peroxide is observed through the inspection window (Fig. 107) on the fuelling connection and when it ceases to flow the fact is reported to the N.C.O. i/c Fuel Column.

485. One man disconnects the hose from the fuelling connection and places the open end in the bucket of water. He sets the three-way cock to "Fill or Empty," closes the overflow tank shut-off cock and the shut-off cock on the connection leading from the 3-way cock to the rocket tank. He orders: PUMP WATER.

486. The shut-off cock on the water pump is opened and water is pumped into the measuring tank. The man at the measuring tank watches through the inspection window and when the water is above the mark on the glass he orders: HALT. He then sets the three-way cock to "Tank" and opens for a moment the shut-off cock on the connection leading from the three-way cock to the rocket in order to rinse out the connection. The rinse water is caught in the bucket.

487. The shut-off cock on the water pump is closed and the hose is disconnected from the pump. A hole is dug in the ground and the rinse water is allowed to flow into the hole.

488. The man at the measuring tank opens the shut-off cock on the overflow and sets the three-way cock to "Fill or Empty" in order to allow the rinse water from the measuring and overflow tanks to run into the "safety hole."

489. The fuelling connection is removed and the cover on to the inlet to the rocket tank secured. The hose from the three-way cock to the rocket, the fuelling connection and the bucket of water are lowered by means of a rope from the lower working platform.

490. The hose from the measuring tank to the waggon is disconnected and stowed in the tanker. The tanker then drives away.

SODIUM PERMANGANATE

491. One man carries the sodium permanganate container from the heater to the launching table, attaches it to a rope and it is hauled up on to the lower working platform (Fig. 108).

492. A man on the lower working platform unscrews the cap from the sodium permanganate tank inlet and places a funnel in position. The sodium permanganate is poured into the funnel until the tank is full (Fig. 109).

493. The funnel is withdrawn and the cap replaced on the tank inlet. The funnel is placed in the bucket of water and the sodium permanganate container and the bucket of water lowered by means of a rope to the ground.

Closing of Hatches and Lowering of Meilerwagen Lift Frame . . . SECTION 24

ROCKET MOTOR SECTION, ELECTRICAL SECTION, TRUCK SECTION, FIRE CONTROL SECTION

494. *Rocket Motor Section*

(*a*) Remove the oxygen overflow pipe and place it on the lorry.
(*b*) Start up the hot air blower (Heissluftblaeser) and insert the flexible pipes into the tail unit (Fig. 110).
(*c*) Make a final adjustment to the air pressure reducer to give 32·5 atmos. Close the pressure gauge valve and remove the pressure gauge and connection.
(*d*) Withdraw the indicating lamp box plugs and reconnect the 14-point plugs in the auxiliary motor.
(*e*) Screw on the hatch covers to the oxygen fuelling inlet, the hydrogen peroxide fuelling inlet, the sodium permanganate fuelling inlet and the auxiliary motor.
(*f*) Lower any tools or accessories which remain on the lower working platform to the ground.
(*g*) Screw on the cover of the inspection manhole in the tail unit. Remove the portable ladder and place it on the Meilerwagen.
(*h*) Report: LOWER WORKING PLATFORM READY.

495. *Electrical Section.*

(*a*) *N.C.O. i/c Electrical Section.*
Orders: ARM THE WARHEAD (GERAETSCHAERFEN).
Connect the fuze arming unit to the low tension battery and to the take-off switch by inserting and locking the four-pin plug. Open the cut-off valve on the alcohol tank compressed air pressurising pipe allowing compressed air to pass as far as the compressed air inlet valve.
(*b*) Report: ROCKET ARMED, ALCOHOL PRESSURISING SUPPLY ON.
(*c*) *N.C.O. i/c Electrical Section*
Orders: INSERT MAIN KEY.
Rocket Motor Panel Operator
Inserts main key and reports: MAIN KEY INSERTED.
(*d*) The steering panel operator, on his own initiative, switches on the servo motor switch. The servo motors are run from time to time after fuelling has been completed in order to maintain the working temperature of the oil.
(*e*) *N.C.O. i/c Electrical Section.*
Orders: CLOSE HATCHES, REMOVE AUXILIARY WORKING PLATFORM, REMOVE NOSE FUZE PROTECTING CAP.
(*f*) Arrange the Stotz plug cable so that the possibility of the Stotz plugs not being thrown off during launching is minimised.
(*g*) Switch on the main distribution box safety switch (Bordautomat).
(*h*) Remove the protecting cap from the nose fuse.
(*i*) Close all hatches and panels to the control compartments.
(*j*) Report: ALL HATCHES CLOSED; UPPER WORKING PLATFORM READY.

496. *N.C.O. i/c Rocket Motor Section and N.C.O. i/c Electrical Section*
Report to Officer i/c Launching Platoon: UPPER AND LOWER PLATFORMS READY, ALL DOORS AND HATCHES CLOSED.

497. *Officer i/c Launching Platoon*
Orders: LOWER LIFT FRAME OF MEILERWAGEN.

The hydraulic pump operator takes post at his controls, starts up the engine and lowers the lift frame to the travelling position. (For this procedure see Section 32, para. 559). It is the privilege of the man on the upper working platform to come down with the lift frame bringing tools and accessories with him.

498. All tools and accessories are placed in the lorry.

Fig. 110

Fig. 111

Fig. 112

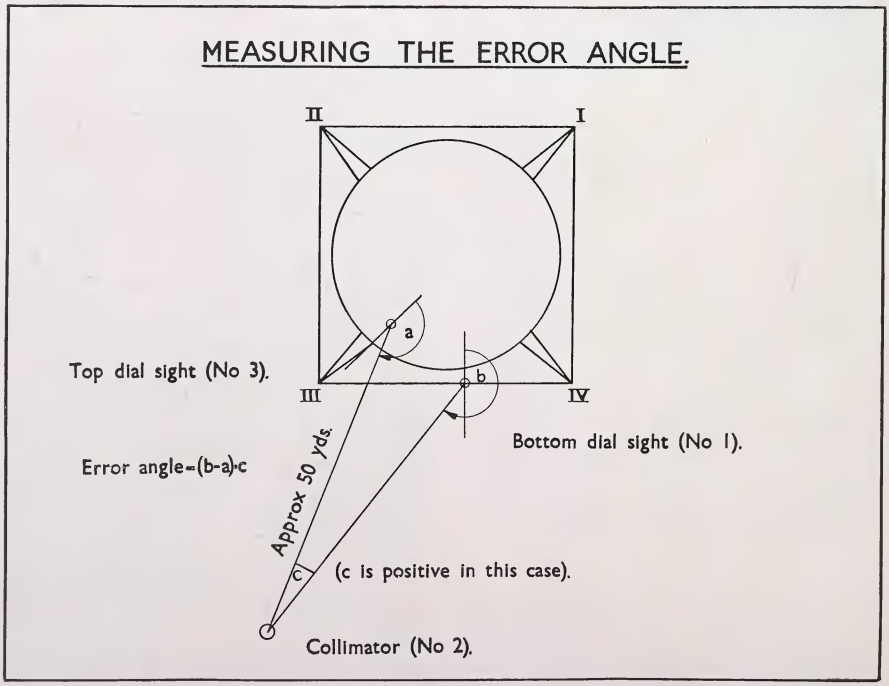


Fig. 113

ROCKET MOTOR SECTION
LAYING SECTION.

GENERAL

499. Fundamentally it is necessary to ensure that the axis of the roll and yaw gyroscope lies along the line of fire. On the edge of the base plate in the control compartment mounting the gyroscopes is a special plate with two machined flanges set so that the plane of the flanges contains the axis of the roll and yaw gyroscope, which is mounted on the base plate. To this special plate can be attached a bracket and a dial sight (Fig. 111).

500. At this stage in preparation for launching it is not feasible to use the dial sight mounted in the control compartment. A dial sight mounted either on the launching table (Fig. 112) or else on a bracket, which can be slung from the shafts of carbon rudders 1 and 3, is used. This dial sight may not, however, be parallel to the dial sight in the control compartment, and the error angle (Fehlewinkel) must first of all be determined. This will have been done previously, whilst the Meilerwagen was still available, and the procedure is as follows :

FINDING THE ERROR ANGLE (Fig. 113)

501. No. 2 of the Laying Section sets up a collimator approximately 50 yards from the rocket in the direction of fin No. 3 (Fig. 115). No. 1 sets up a dial sight on the launching table or on the bracket suspended beneath vanes 1 and 3.

502. No. 3 sets up a dial sight on the special plate in the control compartment. The instruments are levelled.

503. Nos. 1 and 3 direct their dial sight telescopes so that the vertical graticule bisects the object lens of the colli-

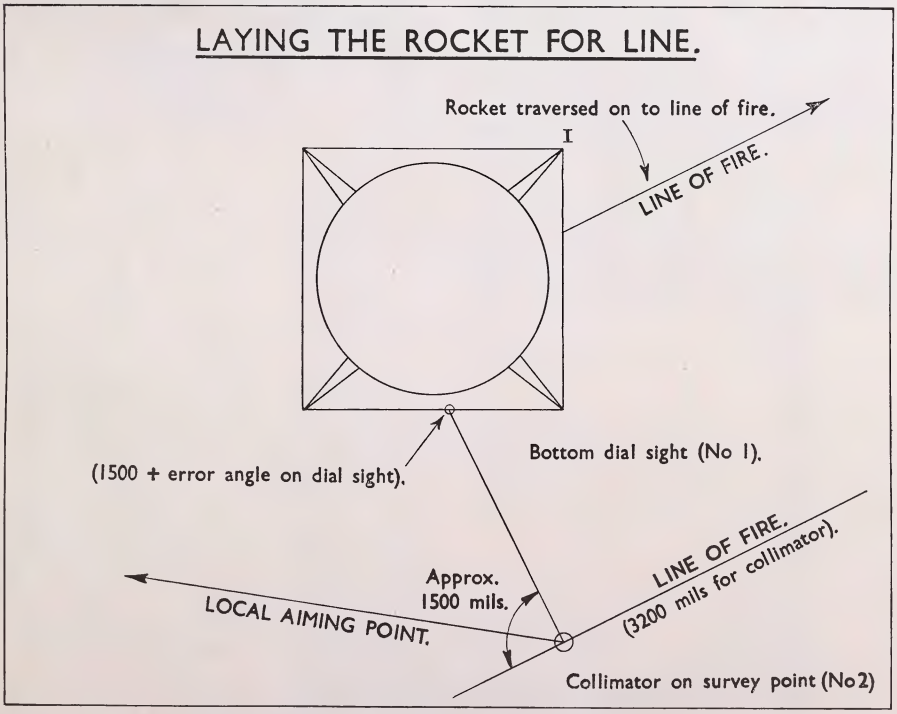


Fig. 114

Fig. 115

mator. Each reads the scale reading and these are written down by No. 1.

504. No. 2 directs his collimator on to No. 3's dial sight (at the top of the rocket) setting the vertical graticule of the collimator across the centre of the red collar of the dial sight. He depresses the telescope of the collimator and notes the scale reading (in the internal scale of the instrument) corresponding to the centre of the red collar on No. 1's dial sight (to the left —ve, to the right +ve). No. 1 notes this angle.

505. The error angle is then calculated as follows :

If the top dial sight reading	=	a (positive)
bottom dial sight reading	=	b (positive)
collimator angle	=	c (positive or negative)
The error angle	=	(b—a)—c

Fig. 116

The error angle (+ or —) so obtained is written by No. 1 on No. 4 fin of the rocket.

LAYING THE ROCKET ON THE LINE OF FIRE (Fig. 114).

506. No. 2 sets up a collimator on the survey point (Fig. 116). This is done accurately with a plumb line. Using the surveyed R.O.'s around the launching position, he orients the collimator so that 3,200 mils (180) is in the line of fire (Fig. 117). He does this with data given on a specially prepared bearing picket card.

507. Under the orders of No. 1 (operating the dial sight at the base) the rocket is turned roughly into the line of fire.

508. No. 2 lays the collimator (which moves in 100 mil clicks) so that the dial sight at the base of the rocket is as near the centre of the field of view as possible, reads the hundreds of the scale and calls the reading to No. 1. No. 1 sets this angle, + or — the error angle, on the dial sight at the base of the rocket.

509. No. 1 orders the rocket to be turned until the corresponding graticule readings of the dial sight and collimator (both seen by him through the dial sight telescope) are coincident (Fig. 118). When this is done, the rocket is on the line of fire.

510. *N.C.O. i/c Laying Section*

Reports to Officer i/c Launching Platoon : ROCKET ON LINE OF FIRE (GERAET AUF SCHUSSRICHTUNG).

FIELD OF VIEW OF COLLIMATOR TELESCOPE.

NOTE : The internal scale is in mils. Hundreds of mils are shown in the circle at the bottom.

Bearing to church steeple is 0000 mils. (6400 mils).

Bearing to point X is 6347 5 mils.

Bearing to point Y is 0045 mils.

Fig. 117

FIELD OF VIEW OF DIAL SIGHT AT BASE OF ROCKET DURING LAYING OF ROCKET IN LINE OF FIRE.

NOTE : Internal scale of dial sight and patch of collimator scale. The rocket is turned until the symbols of the two scales coincide as shown.

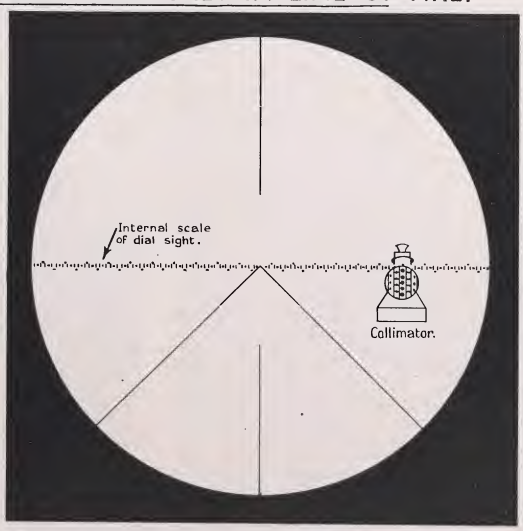


Fig. 118

Placing the Igniter in Position and Withdrawing the Meilerwagen . . SECTION 26

TRUCK SECTION, ROCKET MOTOR SECTION, ELECTRICAL SECTION, FIRE CONTROL SECTION

511. *Electrical Section*

(*a*) As soon as the rocket has been laid on the line of fire, place the pyrotechnic igniter in position (Figs. 119, 120, 121). For description and procedure see Section 34, Vol. 4.

(*b*) Place the carbon rudder clamps (Fig. 105) in position on the launching table ready to clamp the rudders after the final steering test.

512. *Rocket Motor Section*

Bring up the extending ladder (Handleicherfeuerwehrleiter) and set it up. One man climbs to the joint between the rocket motor unit and tank bay and tightens the securing bolts (Fig. 122).

513. *Truck Section*

(*a*) Fold the Meilerwagen side girders into the travelling position.

(*b*) Remove the auxiliary working platform and tool basket from the lift frame.

(*c*) Remove the wooden working platform from the blast deflector.

(*d*) Stow the tarpaulin covers, the carbon rudder travelling box, the sodium permanganate containers, the auxiliary working platform, the nose fuze cover, the tool basket and the wooden working platform, either on the Meilerwagen or in the lorry.

(*e*) Disconnect the pipe line from the fixed air bottles on the Meilerwagen, lay out the moveable air bottles in a position chosen by the N.C.O., connect the pipe line to the bottles, open one bottle and check the rising pressure on the gauge in the valve box (the minimum pressure required is 190 atmos.).

(*f*) *N.C.O. i/c Truck Section*
Orders : WITHDRAW MEILERWAGEN.
Manhandle the Meilerwagen far enough away from the launching table to allow the towing vehicle to be hooked on. Tow the Meilerwagen away from the launching position. Three men from the Truck Section and three men from the Electrical Section accompanying it.

(*g*) Lower the cable mast by means of the ratchet until the wire is taut and ensure that the cables are in direct line with the Stotz plugs.

(*h*) Bury those parts of the cables which are near the launching table in order to stop them being burned.

(*i*) Turn the hot air blower off, remove the flexible pipes, close it up and place it in the lorry.

Fig. 119

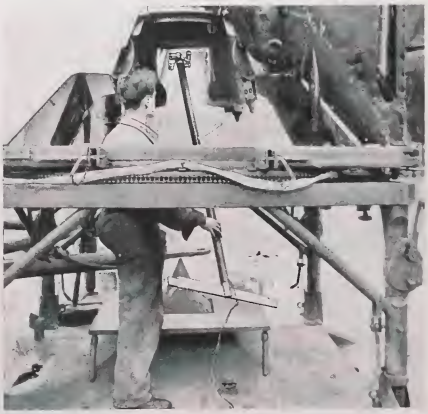


Fig. 120

Fig. 121

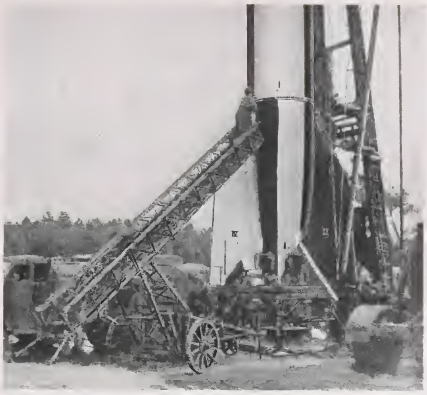


Fig. 122

Final Steering Tests . . . . SECTION 27

TRUCK SECTION, ROCKET MOTOR SECTION, ELECTRICAL SECTION, FIRE CONTROL SECTION.

TO SWITCH ON THE GYROS

514. *N.C.O. i/c Electrical Section*

Orders: SWITCH ON STEERING SWITCH (STEUERSTROM), METER SWITCH (STEUERSTROM UNTER-BRECHE) AND ALTERNATOR SWITCH (UMFORMER 1 UND 2).

Steering Panel Operator

Switches on all three switches and reports: STEERING SWITCH, METER SWITCH AND ALTERNATOR SWITCH ON.

515. The gyros will not be switched off again. By the time the rocket is launched they will be running at their correct speed. For the purpose of the final test, it is again sufficient for the voltages on each alternator to be equal. This is tested by setting the alternator switch to positions 1 and 2 and noting the voltage on the voltmeter,which should be about 42 volts in each case.

TO ZERO THE SERVO MOTORS BY MEANS OF THE INTERNAL POTENTIOMETERS

516. *N.C.O. i/c Electrical Section*

Orders: ZERO RUDDERS IN E PLANE

The potentiometers of rudders 1 and 3 are adjusted until the rudders are stationary in the zero position.

This procedure is repeated with internal potentiometers 2 and 4.

Steering Panel Operator

Checks milliammeters on the steering panel to see whether the currents in the servos are nil. The maximum permissible current is 3 milliamps.

517. As soon as the internal potentiometers have been zeroed, the four potentiometer inspection hatches are screwed on.

TO TEST THE SERVO MOTORS

518. *N.C.O. i/c Electrical Section*

Orders: SWITCH ON GYRO POTENTIOMETER SWITCH (KDO SPANNUNG), UNBALANCE STEERING CONTROL CURRENT (STOERKOMMANDO) IN E PLANE TO LEFT AND TO RIGHT.

Steering Panel Operator

Switches on gyro potentiometer switch and presses in turn push button E1 (left) and E2 (right) and observes the E plane voltmeter and milliammeters which should show approximately equal deflections for both rudders in both directions.

N.C.O. i/c Electrical Section

Checks manually the turning movement of the internal rudders. He does this by trying to hold the rudders stationary. The current shown in the milliammeters should increase proportionately to the resistance applied.

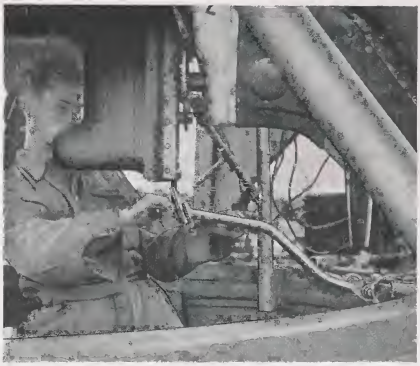


Fig. 123

519. *N.C.O. i/c Electrical Section*

Orders : UNBALANCE STEERING CONTROL CURRENT IN D PLANE TO LEFT AND TO RIGHT.

Steering Panel Operator

Repeats the procedure as in para. 518 above, but using push buttons D1 and D2.

TO TEST THE SYNCHRONISATION OF CARBON RUDDERS 2 AND 4

520. *N.C.O. i/c Electrical Section*

Orders : SWITCH OFF SERVO MOTORS.

Steering Panel Operator

Switches off servo motors and reports : SERVO MOTORS SWITCHED OFF.

N.C.O. i/c Electrical Section

Moves by hand the D rudders in opposite directions and orders : SWITCH ON SERVO MOTORS.

Steering Panel Operator

Switches on servo motors and reports : SERVO MOTORS SWITCHED ON.

N.C.O. i/c Electrical Section

Observes if the D rudders move into the zero position.

Fig. 124

521. The procedure as in para. 520 above is repeated but setting the D rudders in the opposite sense.

TO CLAMP THE INTERNAL VANES PRIOR TO LAUNCHING

522. *N.C.O. i/c Electrical Section*

Orders : SWITCH OFF METER SWITCH

Steering Panel Operator

Switches off meter switch and reports : METER SWITCH OFF.

N.C.O. i/c Electrical Section

Orders : CLAMP RUDDERS. Internal rudders are clamped in the launching position (Figs. 123 and 124).

N.C.O. i/c Electrical Section

Orders : SWITCH ON METER SWITCH.

Steering Panel Operator

Switches on meter switch. He checks the voltmeters to see whether the rudders are in the zero position. He reports : RUDDERS IN ZERO POSITION.

Clearing the Launching Position . . SECTION 28

TRUCK SECTION, ROCKET MOTOR SECTION, ELECTRICAL SECTION, FIRE CONTROL SECTION

523. The N.C.O. i/c Electrical Section connects the igniter leads to the terminals on the side of the valve box.

524. The valve of the first air bottle is closed and the second one is opened. The N.C.O. i/c Rocket Motor Section checks the air pressure on the gauge in the valve box (190 atmos.). He closes the oxygen tank vent valve and opens the air release valve in the valve box. The cover is then placed on the valve box.

525. *N.C.O. i/c Rocket Motor Section and N.C.O. i/c Electrical Section*
Report to Officer i/c Launching Platoon: ROCKET MOTOR AND ELECTRICAL ASSEMBLY ARE IN ORDER.

526. *Officer i/c Launching Platoon*
Orders: CLEAR LAUNCHING POSITION (RAUMEN).

527. Two men from the Rocket Motor Section remove the extending ladder clear of the position.

528. All tools and accessories are placed in the lorry which is driven away.

529. All personnel other than the two panel operators and telephonist in the fire control vehicle take cover in the slit trenches.

530. The Officer i/c Launching Platoon remains on the launching position and takes a last look round to see that everything is in order (Fig. 125). He then walks slowly to the fire control vehicle.

Fig. 125

Launching the Rocket . . . . SECTION 29

OFFICER I/C LAUNCHING PLATOON
TWO PANEL OPERATORS.

531. *Officer i/c Launching Platoon*
Reports to Battery Operations Room: ROCKET NO. . . . READY FOR LAUNCHING. LAUNCHING POSITION CLEARED.
Battery Commander
Orders: LAUNCH, when he is satisfied that there are no enemy aircraft in the vicinity. The Operations Room reports the air situation every 20 seconds.

532. *Officer i/c Launching Platoon*
IS STEERING PANEL READY? (STEUERUNG KLAR?)
Steering Panel Operator
Reports: STEERING PANEL READY (IST KLAR)
Officer i/c Launching Platoon
IS ROCKET MOTOR PANEL READY? (TRIEBWERK KLAR?)
Rocket Motor Panel Operator
Reports: ROCKET MOTOR PANEL IS READY (IST KLAR). He is also on the telephone to the Battery Operations Room and reports: NO ENEMY AIRCRAFT IN THE VICINITY (LUFTLAGE KLAR).

533. *Officer i/c Launching Platoon.*
Orders: TURN MAIN KEY TO FIRE (SCHLUESSEL AUF SCHIESSEN).
Rocket Motor Panel Operator
Turns key to fire and reports: KEY TURNED TO FIRE (SCHLUESSEL STEHT AUF SCHIESSEN).

534. *Officer i/c Launching Platoon*

Orders: SWITCH THROUGH AS FAR AS MAIN STAGE (DURCHSCHALTEN).

Steering Panel Operator

Reports: NO AIRCRAFT IN THE VICINITY (LUFTLAGE KLAR)

Rocket Motor Panel Operator

Presses preliminary stage button (Vorstufe). The switch through as far as main stage follows automatically. Oxygen tank pressurising takes about 15 seconds. He reports: SWITCHED THROUGH AS FAR AS MAIN STAGE. Then reports: TANK PRESSURISING LAMP LIGHTS. IGNITER LAMP LIGHTS. PRELIMINARY STAGE ON. (IST DURCHGESCHALTET. BELUFTUNG KLAR. ZUNDING KLAR. VORSTUFE KLAR).

535. Rocket Motor Panel Operator also notes the change-over from ground to rocket-borne power supply when the rocket-borne power supply indicating lamp (Bordspeisung) lights and the ground power supply indicating lamp (Bodenspeisung) goes out. This takes place just before the igniter lamp lights.

536. *Officer i/c Launching Platoon*

Allows the preliminary stage to go on. He watches the flame develop (Fig. 126) and based on experience he decides when the moment is right to switch on the main stage. This is usually after about four seconds. He orders: PRESS MAIN STAGE BUTTON (HAUPTSTUFE).

Rocket Motor Panel Operator

Presses main stage button and reports: MAIN STAGE BUTTON PRESSED (HAUPTSTUFE IST GEGEBEN).

When he sees the indicating lamps "Stotz Plugs 1 and 2" (Stecker 1 und 2) go out, he reports: STOTZ PLUGS HAVE BEEN THROWN OFF (STECKER 1 UND 2 GEFALLEN).

Fig. 128

Fig. 126

Fig. 127

Fig. 129

537. *Officer i/c Launching Platoon*
Observes that the Stotz plugs have been thrown off. He watches the development of the main stage.

538. The rocket remains for a moment on the launching table. The turbine can be heard roaring. The flame grows rapidly as full thrust develops. The rocket rises slowly and steadily from the launching table (Fig. 127). It gradually gathers speed (Fig. 128). After four seconds it turns over in the direction of the target (Fig. 129) and accelerates rapidly (Fig. 130).

Fig. 130

539. The officer i/c Launching Platoon looks through the top of the fire control vehicle. With a stop watch he times the beginning of precession (i.e., when the rocket turns over in the direction of the target) and the time to fuel cut-off point (Brennschluss). Provided the rocket is visible this can be clearly seen because the smoke trail will cease abruptly. If the rocket is invisible the time can be taken to the point where the noise ceases and an allowance made for the speed of sound.

Record of Launching and Preparation for Subsequent Launching . . . SECTION 30

TRUCK SECTION, ROCKET MOTOR SECTION, ELECTRICAL SECTION, FIRE CONTROL SECTION

540. *Officer i/c Launching Platoon*
Orders: SWITCH OFF (ZURUECKSCHALTEN).
Rocket Motor and Steering Panel Operators
Switch off all switches and report: SWITCHED OFF (IST ZURUECKGESCHALTET).

541. *Officer i/c Launching Platoon*
Notes: (as an example)

Rocket No. 21234.	*Time of Launching* 0724 *hours.*
IGNITION	—Normal (early) (late).
PRELIMINARY STAGE	—Normal (slow) (too much oxygen—flame too bright).
MAIN STAGE	—Normal (Stotz plugs thrown off late) (too much oxygen—white flame) (too much alcohol—red flame).
TAKE OFF	—Normal (unsteady) (slow) (quick) (rocket swung from side to side).
PRECESSION	—Normal (early) (late) (invisible due to clouds).
FUEL CUT-OFF	—59·3 seconds (heard after 172 seconds).
LAUNCHING POSITION	—407—all in order.

542. If the launching is normal, the launching table and fittings will not be damaged. Experience has shown that if the launching table and accessories are properly maintained they can be used 30 or 40 times.

543. *Officer i/c Launching Platoon*
Orders: BRING UP MEILERWAGEN WITH ROCKET.

544. *N.C.O. i/c Truck Section*
Orders: RAISE CABLE MAST TO VERTICAL POSITION.

545. The cable mast is raised by means of the ratchet. The launching table is traversed so that the valve box is to the left when the Meilerwagen comes up. The air bottle valve is closed. Everything is ready to prepare and launch another rocket.

ROCKET MOTOR SECTION, FUEL COLUMN, OXYGEN SECTION, ALCOHOL SECTION, HYDROGEN PEROXIDE SECTION

546. In certain circumstances it may be necessary to empty the fuel tanks on the rocket. The procedure is as follows :

ALCOHOL

547. The 40 mm. hose is connected by means of a special coupling to the drainage outlet of the alcohol tank on the rocket (Fig. 131) and either :

(*a*) to the centre connection on the 70 mm. intermediate pipe on the Meilerwagen or

(*b*) direct to the alcohol tanker filling inlet.

In the case of (*a*), a 70 mm. hose is connected from the intermediate pipe on the Meilerwagen to the tanker filling inlet.

548. The cock on the tank draining coupling is opened and alcohol gravitates into the tanker. When the tanker is full, as seen from the gauge, the cock on the draining coupling is closed. The hose is then connected to the second tanker and the same procedure is repeated.

Fig. 131

OXYGEN

549. The fuelling connection is fitted to the oxygen tank inlet on the rocket oxygen tank. It is also connected to the intermediate pipe on the Meilerwagen intermediate pipe and to the inlet valve (top connection) of the oxygen tank trailer (Fig. 132).

550. The valve on the fuelling connection is opened and oxygen gravitates into the tank trailer.

HYDROGEN PEROXIDE

551. *To Empty Fuel from the Rocket Tank*

The 32 mm. filling hose is connected from the hydrogen peroxide tanker inlet to the pump and from the pump to the draining outlet on the tank in the rocket.

552. The pump is set to " return," the shut-off cock on the tanker inlet is opened and hydrogen peroxide is pumped back into the tanker. The hose is thoroughly drained by lifting it up.

553. *To Rinse out the Rocket Tank and Hose*

The shut-off cocks on the tanker inlet and rocket tank outlet are closed, the hose is removed and connected from the fuelling inlet on the rocket tank to the water pump. The shut-off cock on the fuelling inlet on the rocket tank is opened and water pumped through until the system is full.

554. The shut-off cock on the fuelling inlet is closed, the hose disconnected and connected to the draining outlet of the tank. The other end is disconnected from the water pump. The shut-off cock on the draining outlet is then opened and rinse water is allowed to drain out into a hole in the ground.

SODIUM PERMANGANATE

555. The sodium permanganate container with funnel is placed under the rocket tank outlet. The outlet cover is removed and sodium permanganate gravitates into the container.

Fig. 132

Removing the Rocket from the Launching Table . . . . SECTION 32

556. Occasions may arise when it is necessary to remove the rocket from the launching table. Before doing this the valve box and the oxygen topping up connection must be removed. The cable mast may stay in position.

557. The launching table is rotated to bring the brackets in line with the guiding blades on the Meilerwagen. At the same time the working platforms are raised to the travelling position and the centre clamping collar is raised in order to ensure that it will have sufficient travel for lowering the rocket on to the launching table when it is next erected.

558. The Meilerwagen is manhandled so that the guiding blades engage with the two brackets on the launching table. The weight of the Meilerwagen is taken on the girder jacks and it is levelled transversely, using the spirit level.

559. One man climbs to the top of the ladder and partially closes the upper clamping collar so that it encircles but does not grip the rocket. Two men climb to the centre clamping collar. The launching table jacks are then manned and the launching table is raised until the bolts in the centre clamping collar can engage. They are then engaged, using the ratchet. The upper clamping collar is tightened and the strap of the centre clamping collar is passed around the rocket and secured. The launching table is lowered clear of the rocket.

560. The hydraulic pump operator now takes post and he proceeds to lower the lift frame as follows :—

(*a*) He starts the pump motor.
(*b*) He turns the direction control knob fully clockwise to " Lower " (Senken).
(*c*) He turns the large piston control knob anti-clockwise.
(*d*) He turns the pressure control handwheel in a clockwise direction and controls the speed.
(*e*) When the large piston is fully home he turns the pressure control handwheel fully anti-clockwise.
(*f*) He turns the large piston control knob fully clockwise.
(*g*) He turns the pressure control handwheel in a clockwise direction and controls the speed.
(*h*) As the lift frame reaches the horizontal he turns the pressure control valve anti-clockwise to decrease speed, finally turning it fully anti-clockwise when the lift frame is horizontal.
(*i*) He stops the motor.

561. The two removable side platforms are stowed in the travelling position, the jacks are raised and the Meilerwagen is manhandled well clear of the platform.

562. The side girders are then swung into the travelling position, the fork piece replaced in position and, if it is required to remove the rocket and Meilerwagen from the launching position, the towing vehicle is hooked up.

To bring the Launching Table out of Action . . . . . SECTION 33

563. The turntable is traversed to the travelling position, i.e., with the cable mast socket to the rear. If there are any fittings left on the launching table, such as the cable mast or valve box, they are removed. The two aprons on the blast deflector are raised.

564. The rear jacks are lowered until the hooks on the rear table legs can be engaged in the blast deflector. The rear of the blast deflector is then raised by means of the jacks.

565. The front jacks are raised until the front of the table is high enough to allow the trailer to be wheeled into position. The trailer arms are engaged in the two brackets on the rear of the blast deflector.

566. The front jacks are lowered and the hooks in the front legs are engaged in the blast deflector sleeves. The front of the blast deflector is then raised until the base of the trailer jack can be engaged in the lug on the blast deflector.

567. The trailer jack is then screwed up and the trail is drawn down until the pin securing the blast deflector to the trailer can be inserted. All four launching table jacks are screwed up to the fully-housed position.

568. Two men support the trail and under the direction of the N.C.O. i/c the trailer is hooked on to the towing vehicle.