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Report on
OPERATION "BACKFIRE"

VOLUME IV

Description of Equipments and Special Vehicles

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Report on Operation "BACKFIRE"

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Volume 4.

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Description of the STRABO CRANE . SECTION 1

1. The crane is used for lifting the rocket from the railway waggon on to the Vidalwagen and from the Vidalwagen on to the Meilerwagen. It is fully mobile.

2. Fig. 1 shows it in draught. It consists of a heavy horizontal girder which carries the hook and tackle and the electric motor. This girder is supported on two collapsible pillars. The pillars are of the scissor type and are identical, each has a raising and lowering handle and is supported by an axle with two jacks and two wheels. Compressed air brakes operate on two wheels.

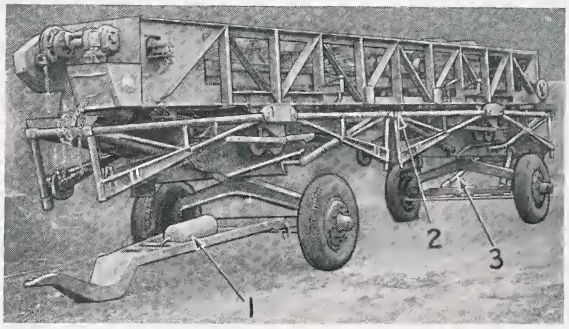


Fig. 1. Strabo Crane
1. Compressed air brake cylinder
2. Pillar securing bolt
3. Axle supporting stay

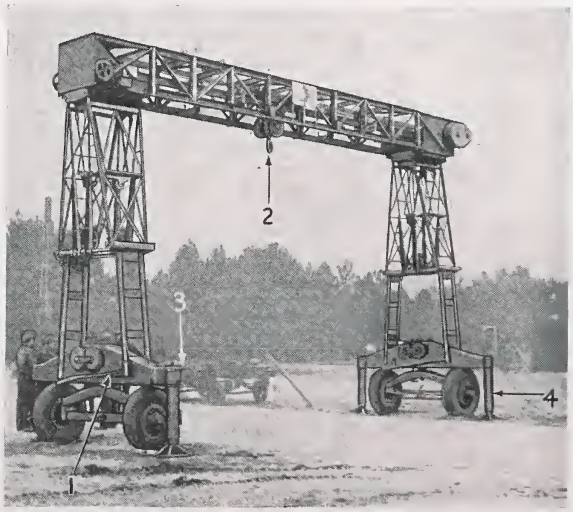


Fig. 2
1. Handle socket
2. Hook
3. " U " bolt
4. Jack

3. To bring the crane into action the pillars are disconnected and moved to the extremities of the girder. By lowering each pair of jacks in turn and taking the weight on the supporting struts, each axle is turned through 90°. The jacks are then lowered and by means of the handles the two parts of each pillar are drawn together and the girder is raised. When fully raised the pillars are locked (Fig. 2).

4. The electric motor is 220/380 v. 3 phase A.C., 15 KVA, and derives its power from a generator or the mains (Fig. 3). Alternative hand operation of the crane is supplied by an endless chain at each end of the girder, the one at the motor end being for moving the hook along the girder and the one at the other end being for raising and lowering it. The crane is capable of lifting a weight up to 16 tons.

5. *Technical Data* :—

Overall length (including trail)	37 ft.
Overall width	12 ft.
Maximum speed	30 m.p.h.
Ground clearance	1 ft. 5 ins.
Turning angle	45 degs.
Height when erected	20 ft. 6 ins.

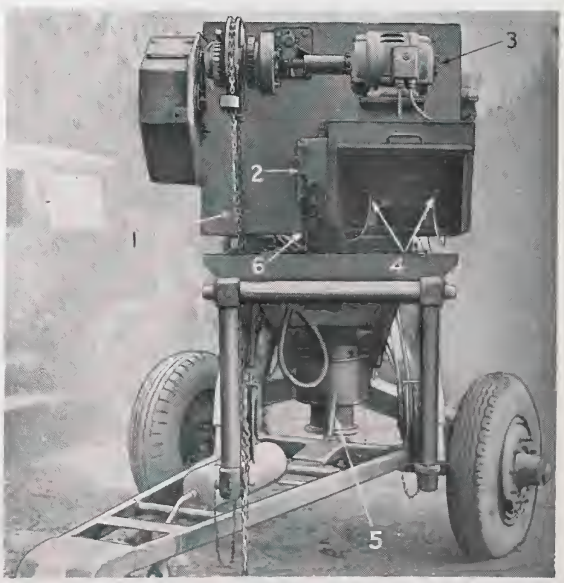


Fig. 3
1. Endless chain
2. Electric main switch
3. Electric motor
4. Raising and lowering chains (electric)
5. Jack pin
6. Power cable

Fig. 4

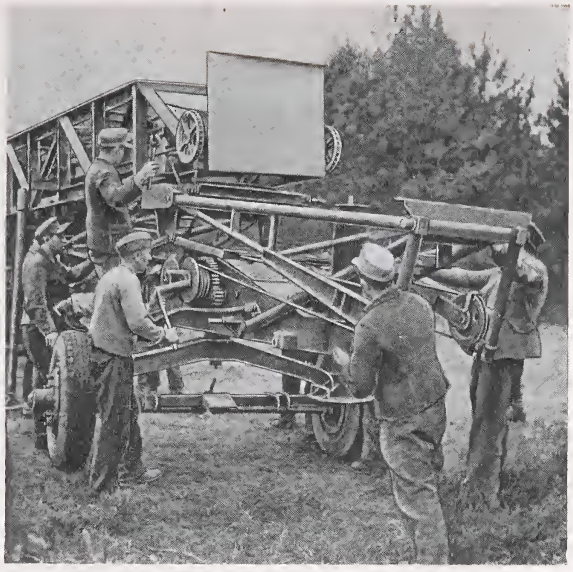


Fig. 5

Bringing the Strabo Crane IN and OUT of ACTION . . . SECTION 2

INTO ACTION

6. The towing vehicle is disconnected, the two pins securing the EDC to the front axle are taken out and the EDC is removed complete. The front jack pad is placed in position. The pins securing the rear axle stays to the girder are removed. The bolts securing the pillars to the centre of the girder are removed.

7. The handles used for raising the rear pillar are inserted and the pillar is raised until it is possible to place the two girder supporting struts in the rear brackets (Fig. 4). The pillar is then lowered until the weight is taken on the struts.

8. The four hinged bolts which secure the pillar to the girder are unscrewed and allowed to drop down. The rear pillar is then lowered about two inches until the pillar frame is clear of the circular recesses in the girder frame. The whole pillar is then pushed outwards along the girder (Fig. 5), raised and manœuvred until the four hinged bolts are under the four slots at the end of the girder.

Fig. 6

Fig. 7

9. The inside jack is lowered until it is clear of the girder and the axle and pillar are swung through 90° (Fig. 6). The four hinged bolts are then secured in the slots in the girder (Fig. 7). The other jack is lowered, the two U bolts are inserted in the tops of the jacks with lugs uppermost, and the two jacks are raised until the wheels are clear of the ground.

10. The handles used for raising the front pillar are inserted and the pillar raised until it is possible to remove the two girder supporting struts and place them in the front brackets.

11. The front pillar is then lowered until the weight is taken on the struts. It is moved to the extremity of the girder, the axle and pillar swung through 90° and the jacks lowered, all in the same way as for the rear pillar.

12. The endless chains for manual operation of the crane are taken from their box and fitted to the pulley wheels. The electric cable is connected from the generator or the mains to the crane motor.

13. Under the direction of the N.C.O. i/c, both pillars are raised (Fig. 8). The girder is raised and the girder supporting struts are removed. When it is fully raised (Fig. 9), the four pins which hold the two parts of each pillar together in the upright position are inserted. The raising handles are removed.

OUT OF ACTION

14. The hook is raised as far as it will go and is brought to the centre of the girder. The electric motor is disconnected.

15. The handles used for raising and lowering are inserted. The four pins which hold the two parts of each pillar together are removed. Under the direction of the N.C.O. i/c, both pillars are lowered until the girder is approximately 8 ft. from the ground (this allows for operation of the jacks).

16. The four U bolts are removed from the tops of the jacks. The jacks are then raised and all wheels are lowered to the ground.

17. The two girder supporting struts are placed in the front recesses and the pillars lowered further until the weight is taken on the struts.

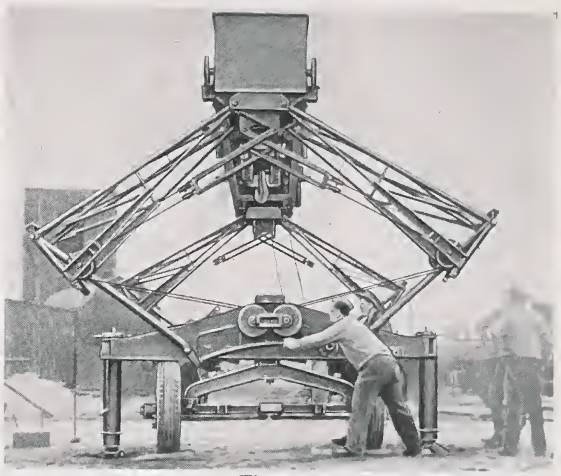


Fig. 8

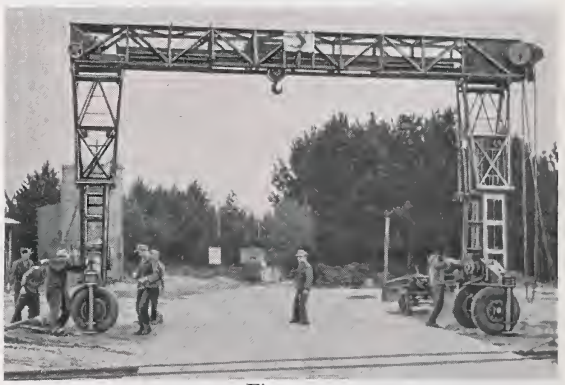


Fig. 9

18. The four hinged bolts which secure the front pillar to the girder are unscrewed and allowed to drop down. The jacks are raised to the first hole and secured by pins. The axle and pillar are turned through 90°.

19. The pillar is then lowered until the pillar frame is clear of the girder frame and the whole pillar is pushed inwards along the girder until the four hinged bolts come under the four inner recesses. The pillar is raised and the four hinged bolts are screwed up.

20. Both pillars are raised until the supporting struts can be removed and then lowered again until the front pillar can be secured to the centre of the girder. The front jacks are then raised to their highest position and secured by the pins. The endless chains are removed from the pulley wheels and placed in the chain boxes.

21. The rear pillar is now raised until the supporting struts can be inserted in the rear brackets and lowered until the weight is taken on the struts. The pillar is disengaged from the girder, swung through 90°, pushed inwards along the girder to the travelling position and secured, all in the same way as for the front pillar.

22. The two rear axle stays are secured to the girder, the front jack pad is removed, the EDC replaced and the towing vehicle connected up.

Description of the VIDALWAGEN. . SECTION 3

GENERAL

23. This trailer is used by the Fuel and Rocket Troop for transporting the rocket from the railhead to the Technical Troop's testing tent and by the Technical Troop for carrying out horizontal tests and for fitting the warhead (Fig. 10).

DESCRIPTION (Figs 11 and 12).

24. The chassis is of simple design consisting of two main tubular steel girders welded together at the front and 3 ft. 4 ins. apart at the rear with four tubular cross supports. It is carried on two axles.

25. The front axle has single wheels and a double transverse leaf spring. It supports the chassis on a ball and socket joint. Attached to the front axle is the EDC fitted with an overrun brake of the spring type, operating by a cable compressed air brakes on the two inner wheels of the rear axle. A pin is used to prevent the brake operating when backing.

26. The rear axle has double wheels and a double leaf spring. Fitted to it by two hinged bolts is a V-shaped spade which, when lowered, stops the trailer running back. When not required, it is held by a chain and spring secured to two hooks.

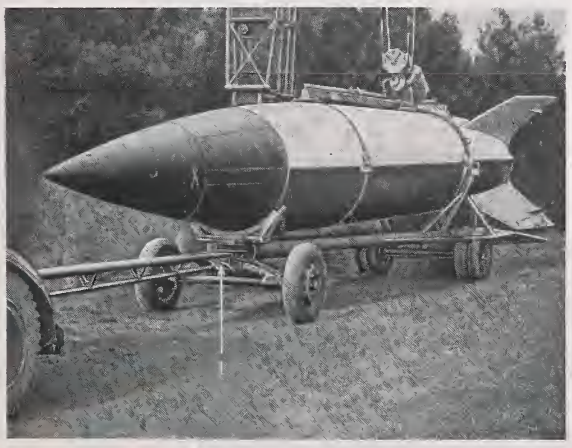


Fig. 10. Vidalwagen
1. Overrun brake pin

27. The chassis carries a small cradle in front and a large cradle at the rear to support the rocket. Both cradles have securing clamps which fit on the rocket lifting bands. Those on the front cradle are adjustable.

28. At approximately the centre of the chassis, a two-inch tubular frame extends outwards to a total width of 9 ft. 2 ins. and backwards to a length of 5 ft. 4 ins. beyond the rear of the chassis. This frame protects the fins of the rocket. A tool box is fitted on the left and a spare wheel on the right. Also attached to the main chassis is a rear towing eye.

DIMENSIONS

29.	Overall length	46 ft. 3 ins.
	Overall width	9 ft. 2 ins.
	Overall height (without rocket)	6 ft. 6 ins.
	(with rocket)	10 ft. 7 ins.
	Width of axle	7 ft.
	Turning angle	45 degs.

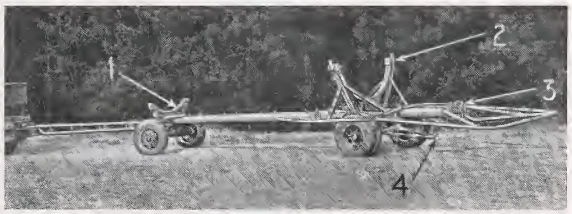


Fig. 11
1. Small cradle
2. Large cradle
3. Spade
4. Rear towing eye

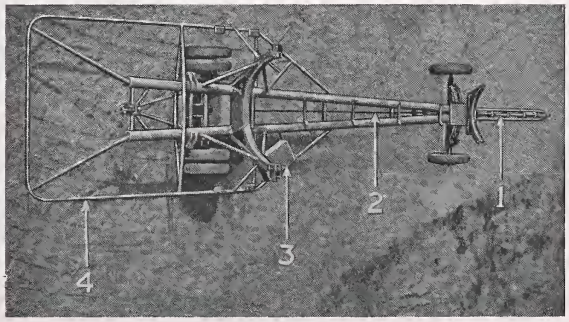


Fig. 12
1. Overrun brake
2. Brake shaft
3. Tool box
4. Protecting frame

Plate 1.

EXTERIOR VIEW OF ACCESSORIES, CABLES & TEST VEHICLE.

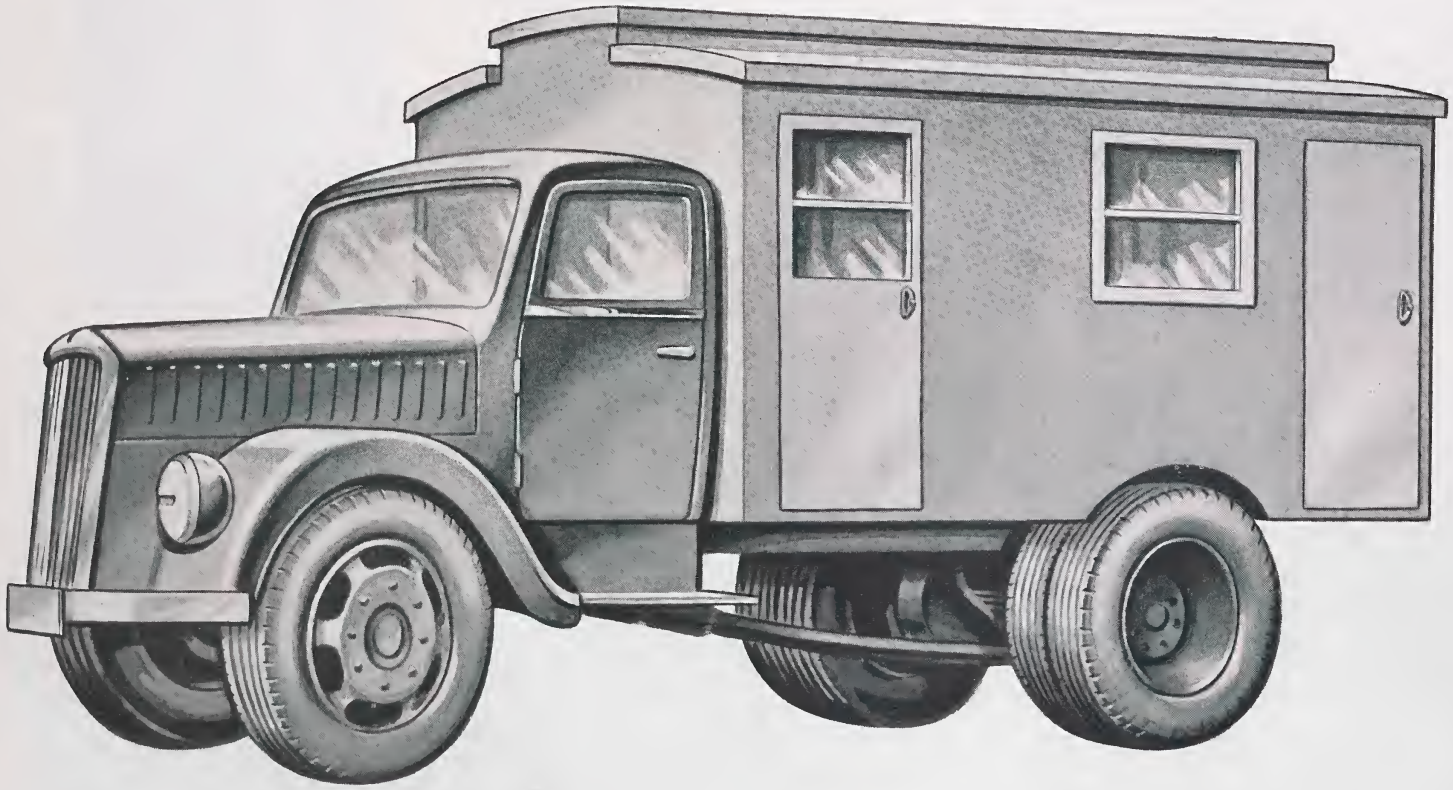
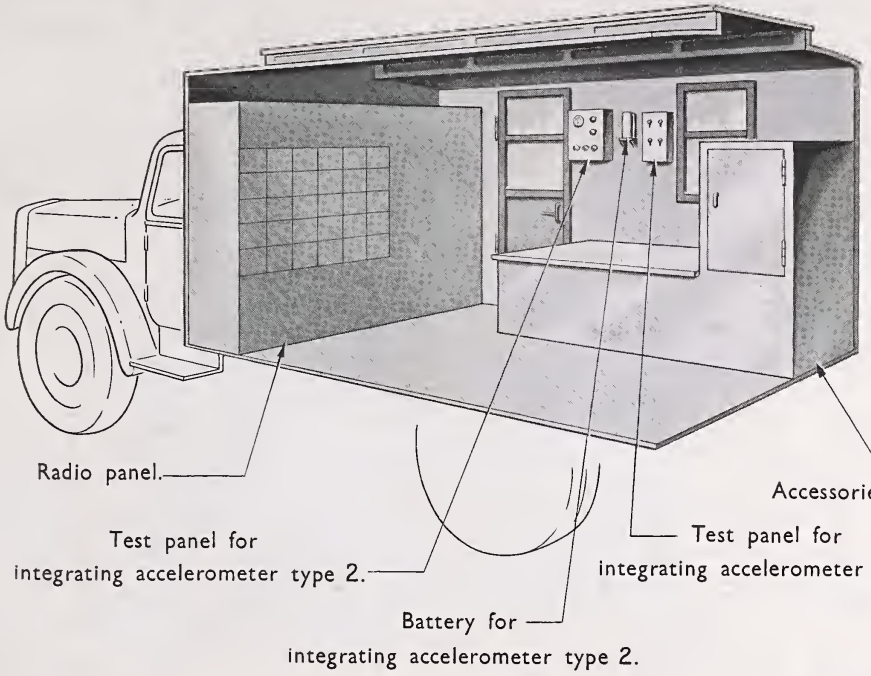


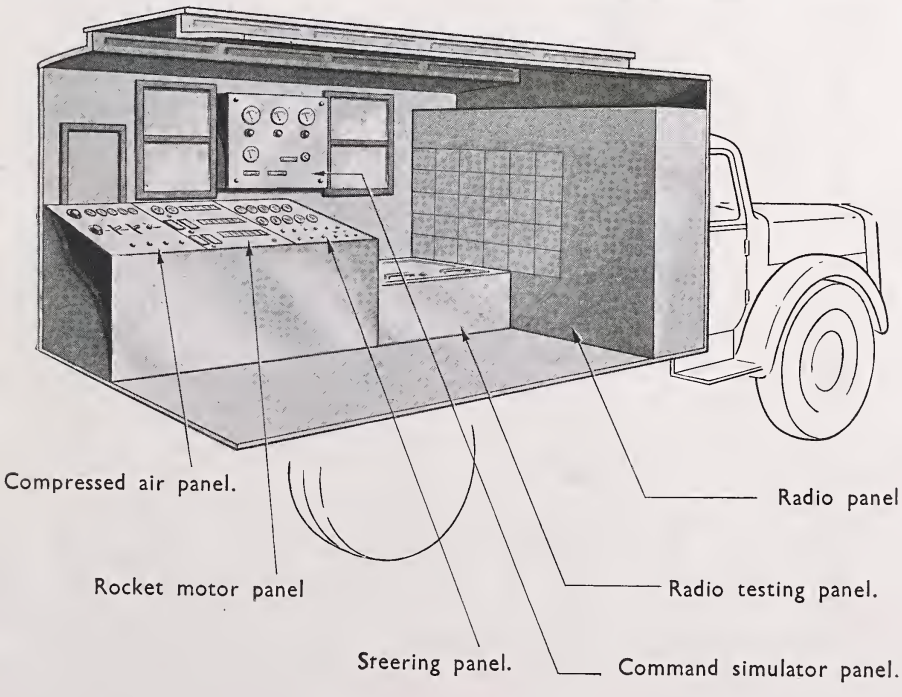
Plate 2

TEST VEHICLE.

INTERIOR VIEW RIGHT HAND SIDE.



INTERIOR VIEW LEFT HAND SIDE.



Description of the Technical Troop TEST VEHICLE (Pruefwagen) . . SECTION 4

GENERAL

30. The test vehicle is used by the Technical Troop for the horizontal tests. Together with accessories vehicle, it contains all the equipment necessary for testing the rocket.

31. It is a three-ton lorry with a caravan body. It has two doors, one at the side which opens into the accessories vehicle and one at the back which opens into the testing tent (Plate 1).

32. Looking into the caravan from the rear, on the left hand side (Plate 2) there are the four panels which are used during tests and which are described in Section 5, 6, 7 and 8. The compressed air, rocket motor and steering panels are built into a desk, the command simulator panel is above them on the wall. Beyond these panels there are two panels, one built into a desk and one on the far wall for testing radio equipment.

33. On the right-hand side (Plate 2) there are panels for testing integrating accelerometers, a chest for accessories and a cupboard for papers.

The Test Steering Panel (Steuerungspult) . . . . . SECTION 5

PLATE 3

34. This panel is in the test vehicle of the Technical Troop. It is very similar to the steering panel in the fire control vehicle described in Section 28.

35. At the bottom of the panel there are eight switches, as follows :

Steering switch	—switches on current to panel itself.
Meter switch	—interrupts current to ammeters and voltmeters. Used to check that meters are operating correctly.
Alternator switch	—switches on current for alternator 1 (control amplifier) and alternator 2 (gyros).
Servos on	—switch for switching on the servo motors which control vanes.
Alternator switch	—switches on current to alternator 3 (radio).
Take-off switch	—Operates the take-off switch.
Roll switch	—Used for simulating roll.
Gyro potentiometer switch	—switches on current to potentiometers of two gyros.

36. In the centre of the panel there is a two-way switch—" Run Backward " and " Run Forward " for testing the time sequence.

37. Above this switch there are two indicating lamps which light when precession and the gyro potentiometer current is correct.

38. Above these in the centre of the panel there is an alternator selector switch for selecting whichever alternator it is required to test. The voltage can then be read on the voltmeter above.

39. The voltmeter and ammeters on the left are for the pitch gyro potentiometer and those on the right, the roll and yaw gyro potentiometers. Press buttons D1, D2, E1 and E2, unbalance the current and thus simulate commands to the inner vanes.

40. On the right there is the time switch (S.S.W.) press button—used for zeroing the time switch during tests—and an indicating lamp which comes on when the time switch is not at zero.

41. The remaining lamps and switches on the right-hand side are used for wireless control.

Plate 3

TEST STEERING PANEL.

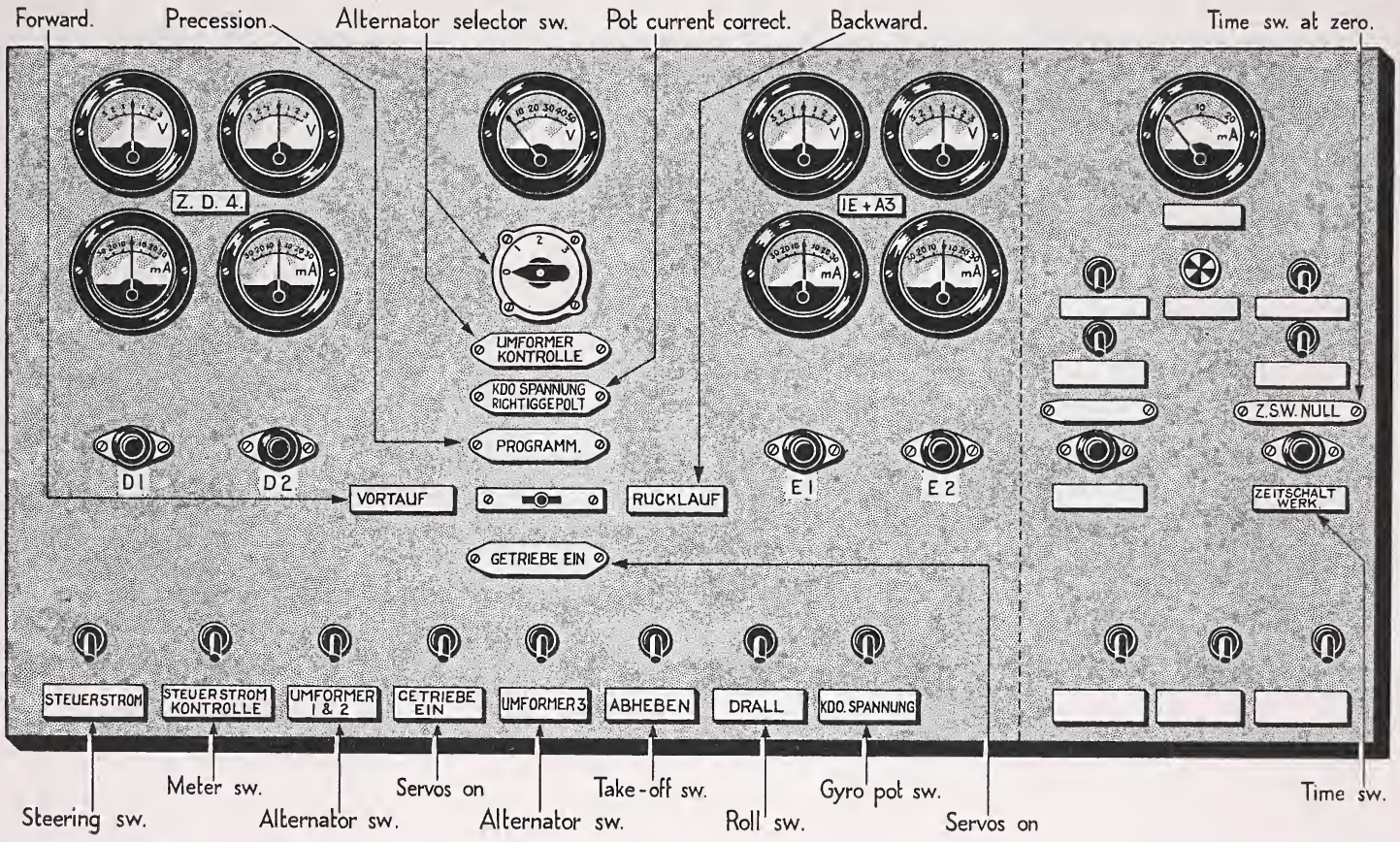
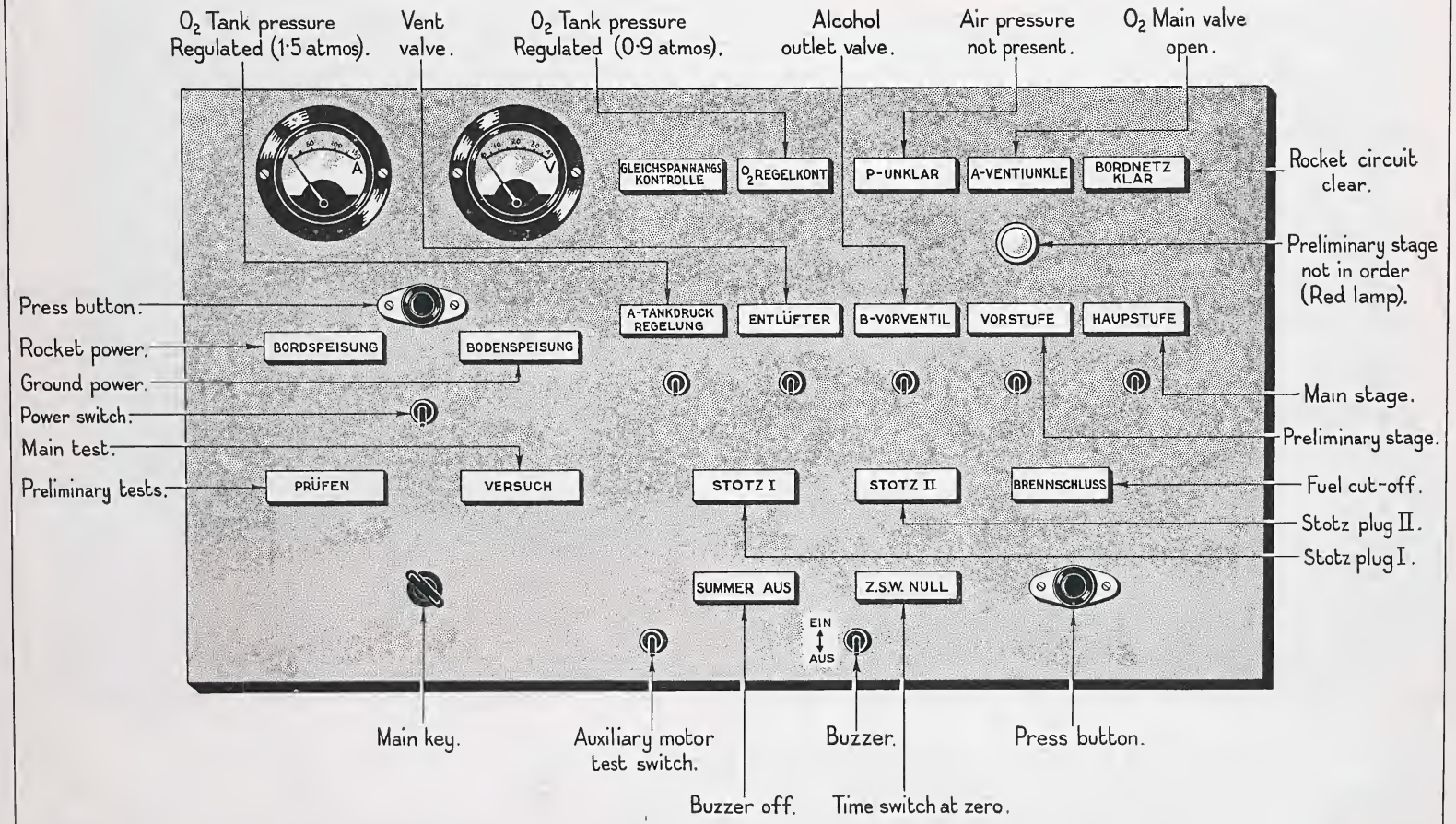


Plate 4

TEST ROCKET MOTOR PANEL.



The Test Rocket Motor Panel (Triebwerkspult) . . . . . SECTION 6

PLATE 4

42. This panel is in the test vehicle of the Technical Troop and has various switches and indicating lamps which are used for the horizontal tests.

43. At the base of the panel on the left is the keyhole for the main key. The main key when inserted can be turned either to preliminary tests or to main test.

44. Above this there is a power switch which can be turned either to ground power or to rocket-borne power.

45. Above this there is a press button used in conjunction with the voltmeter and ammeter.

46. At the base of the panel in the centre is the switch for initiating the rocket motor test.

47. To the right of this is a switch for switching the buzzer on or off. When this switch is on the buzzer will sound when a fault occurs. This draws attention to the fault. If it is then switched off, the indicating lamp " Buzzer off " will remain on as long as the fault persists.

48. At the base of the panel on the right is the press button for giving emergency fuel cut-off, and an indicating lamp which comes on when button is pressed.

49. The two Stotz plugs indicating lamps go out when the Stotz plugs are thrown off.

50. The five switches and indicating lamps on the centre of the panel are for the launching procedure, i.e., oxygen tank pressure regulated, hydrogen peroxide and sodium permanganate vent valves closed, alcohol outlet valve opened, preliminary stage on, main stage on.

51. Above these are indicating lamps which light up when a fault occurs. The " Rocket Circuit Clear " lamp is alight if the circuit is in order and goes out if it is not in order.

The Compressed Air Panel (Pneumatisches Pult) . . . . SECTION 7

PLATE 5

52. This panel is in the test vehicle of the Technical Troop and is used for controlling the entry of compressed air into the rocket and for testing the auxiliary motor unit.

53. At the base of the panel are four taps for filling and emptying the auxiliary motor air bottles and the compressed air system for operating valves. At the side are two further taps for filling or emptying other air bottles.

54. In the centre of the panel are two pressure reducers—one for the air operating valves system and one for the air operating the pressure operated contact. On the right is a three-way cock for pressurising or de-pressurising the rubid contact.

55. At the top of the panel there are five pressure gauges. The high pressure gauge is for measuring the air pressure on the air bottles. The remainder are for measuring the air pressure in the fuel tanks and rubid contact.

Plate 5

COMPRESSED AIR PANEL.

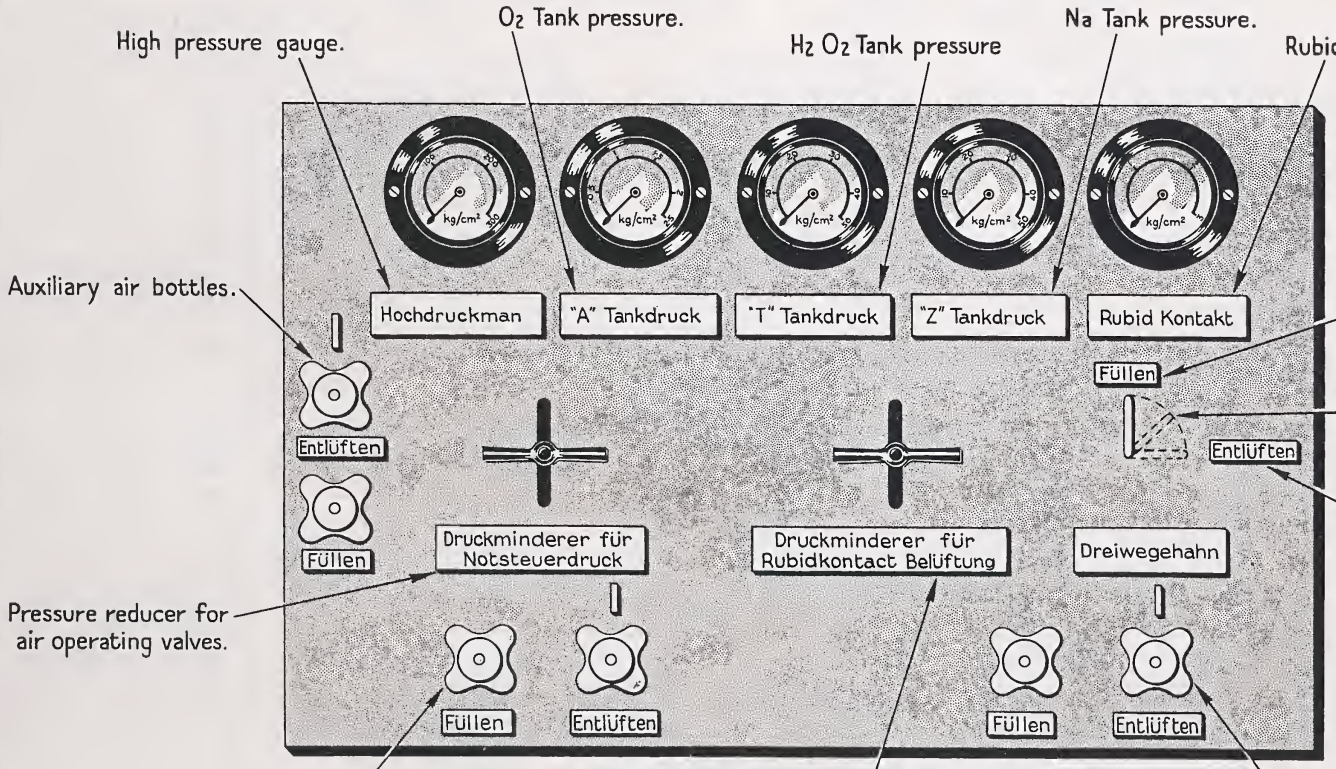
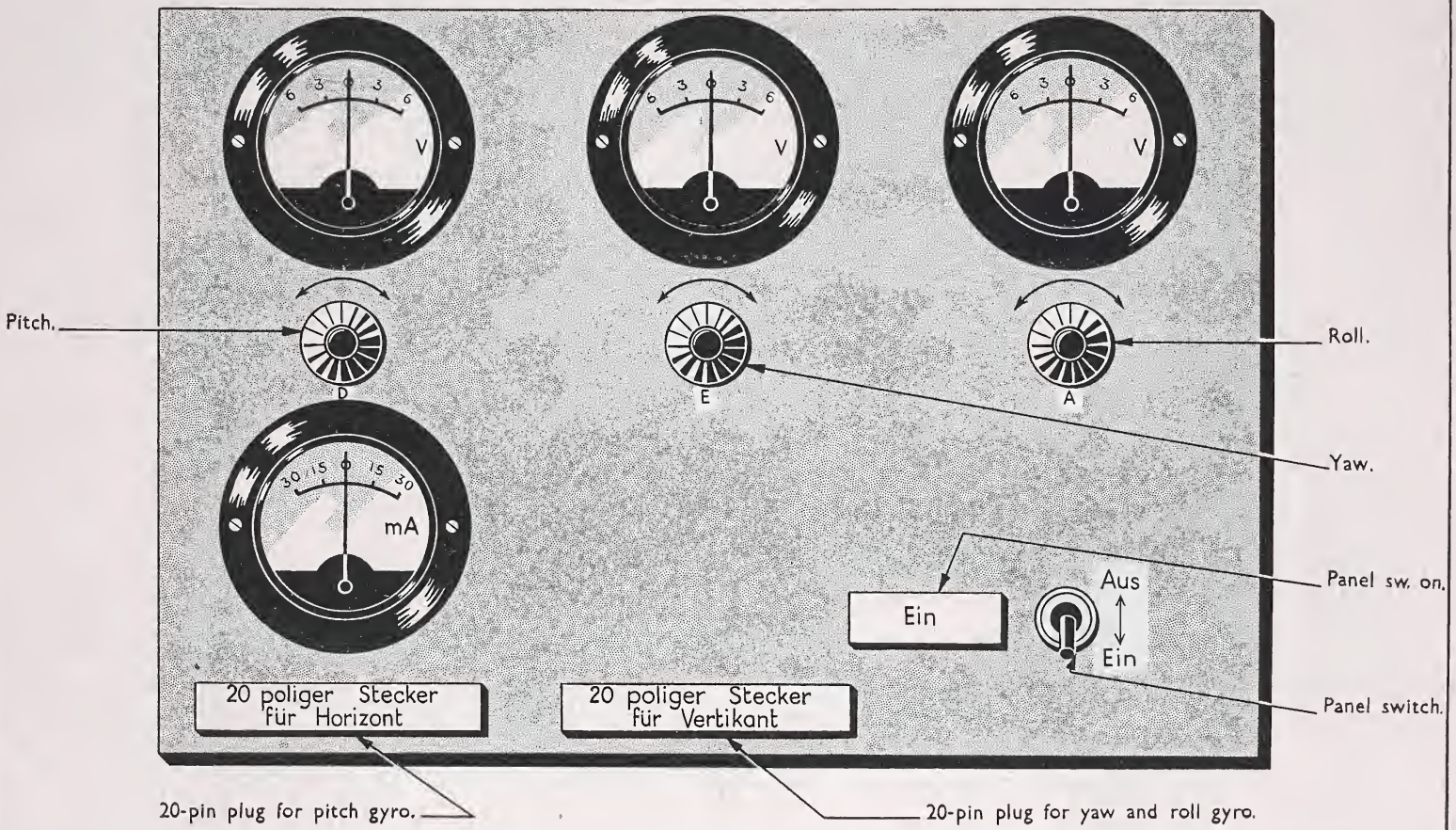


Plate 6

SIMULATOR PANEL.



The Command Simulator Panel (Fremdkommandotafel) . . . . SECTION 8

PLATE 6

56. This panel is in the test vehicle of the Technical Troop and is used to simulate gyroscopic signals, the gyros not being used during the tests. It is connected to the control amplifier (Mischgerast) by means of two plugs at the base of the panel on the left.

57. At the base of the panel on the right there is a panel switch and an indicating lamp which lights when the panel is switched on and the circuits are in order.

58. There are three buttons marked D (pitch), E (yaw) and A (roll). When these are turned, impulses are transmitted to the servos.

59. The three voltmeters indicate the strength of the impulse which is being transmitted to the control amplifier. The ammeter shows the current in the circuit.

The Lamp Box (Pruefkaestchen) . . . . . SECTION 9

FIG. 13

60. The lamp box is used during tests to indicate when certain control valves operate. It is connected up by breaking the auxiliary motor unit circuit and inserting the two 14-pin plugs.

61. It has four indicating lamps. When the lamps come on the valves indicated are open.

62. The lamp box also has a switch for operating the rubid contact.

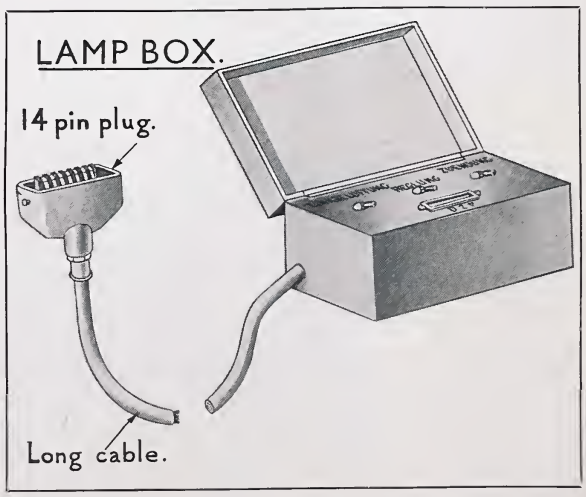


Fig. 13

TANKBELUFLUNG.	Oxygen tank pressurising.
REGLUNG.	Oxygen tank pressure regulator (1·5 atmos.).
ZUENDUNG	Igniter circuit closed.
D2r	Rubid contact closed.

The Switch Box (Schaltkaestchen)

63. The switch box is used during the launching sequence and fuel cut-off test to simulate launching procedure (no actual tank pressurising taking place).

64. It has three switches which simulate oxygen tank pressurising, oxygen tank pressure regulated and igniter circuit closed. Also an indicating lamp which lights up when the rubid contact functions.

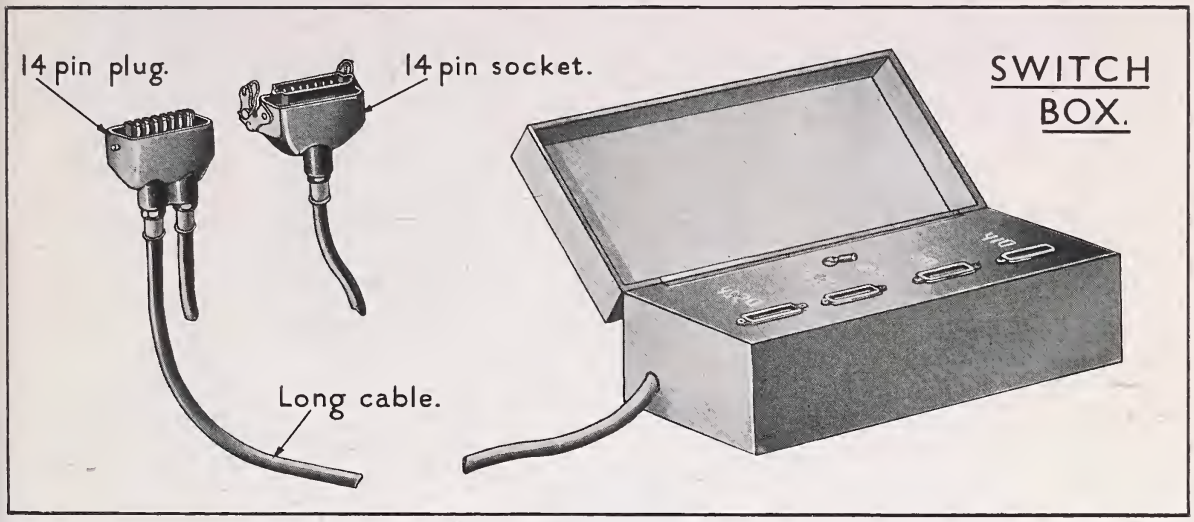


Fig. 14

D1h —Valve controlling H_2 O_2 and Na tank air release valves open.
Dh —Valve controlling H_2 O_2 and Na tank air pressurising valves open.
D8h —Valve controlling passage of H_2 O_2 to steam generator for 8 ton stage open.
D25h—Valve controlling passage of H_2 O_2 to steam generator for 25 ton stage open.
D2r —Switch controlling rubid contact.

The Rocket Steering Mechanism . . SECTION 10

GENERAL

65. An understanding of the functions performed by the steering mechanism and controls of the A-4 rocket is assisted by a comparison between the rocket at fuel cut-off and a shell at the moment it leaves a gun.

66. In order to hit a given target with a shell it is necessary :
(*a*) To fire it at the correct elevation for the range to the target.
(*b*) To fire it in the correct direction.
Similarly, with the rocket ; at fuel cut-off it must be at a certain elevation with respect to the horizontal and must have the correct orientation.

67. It is the function of the steering mechanism of the A-4 rocket to bring it to the required elevation and to direct it on to the correct path. It must do this before fuel cut-off, for control over the rocket is only exercised during burning.

STEERING MECHANISM

68. The mechanism which is used on the A-4 rocket to bring it to the correct elevation and orientation at fuel cut-off comprises eight control surfaces at the base of the rocket. Four of these control surfaces are carbon rudders which operate in the jet stream ; the remainder are outer vanes, attached to the stabilising fins, which operate in the atmosphere. The lay-out of these control surfaces is given diagramatically in Plate 7,

69. These surfaces exercise control over any tendency of the rocket to roll or yaw, and at the same time impart the required pitch in order to bring it to the correct elevation.

70. Control for line, in other words control over roll and yaw is exercised by carbon rudders 1 and 3 and outer vanes 1, 2, 3 and 4. The pitch of the rocket is governed by the movement of carbon rudders 2 and 4.

71. It will be seen from Plate 7 that outer vanes 1 and 3 are connected to their corresponding carbon rudders. On the other hand, outer vanes 2 and 4 work independently of their respective carbon rudders.

72. The carbon rudders and outer vanes are all operated by piston-type hydraulic servo motors. These servo motors are operated by electric motors which receive 27 volts D.C. from the rocket-borne batteries. The electric motor in each case drives a pump which forces oil in one of two directions, depending upon the direction of movement it is wished to impart to the vanes or rudders.

73. In addition, outer vanes 2 and 4 have their own electric motors which are controlled by potentiometers mounted behind the brackets or carbon rudders 1 and 3.

74. In all there are twelve potentiometers associated with the steering mechanism of the A-4 rocket. Four, known as

Plate 7

CONTROL SURFACES AND CONTROL MECHANISM

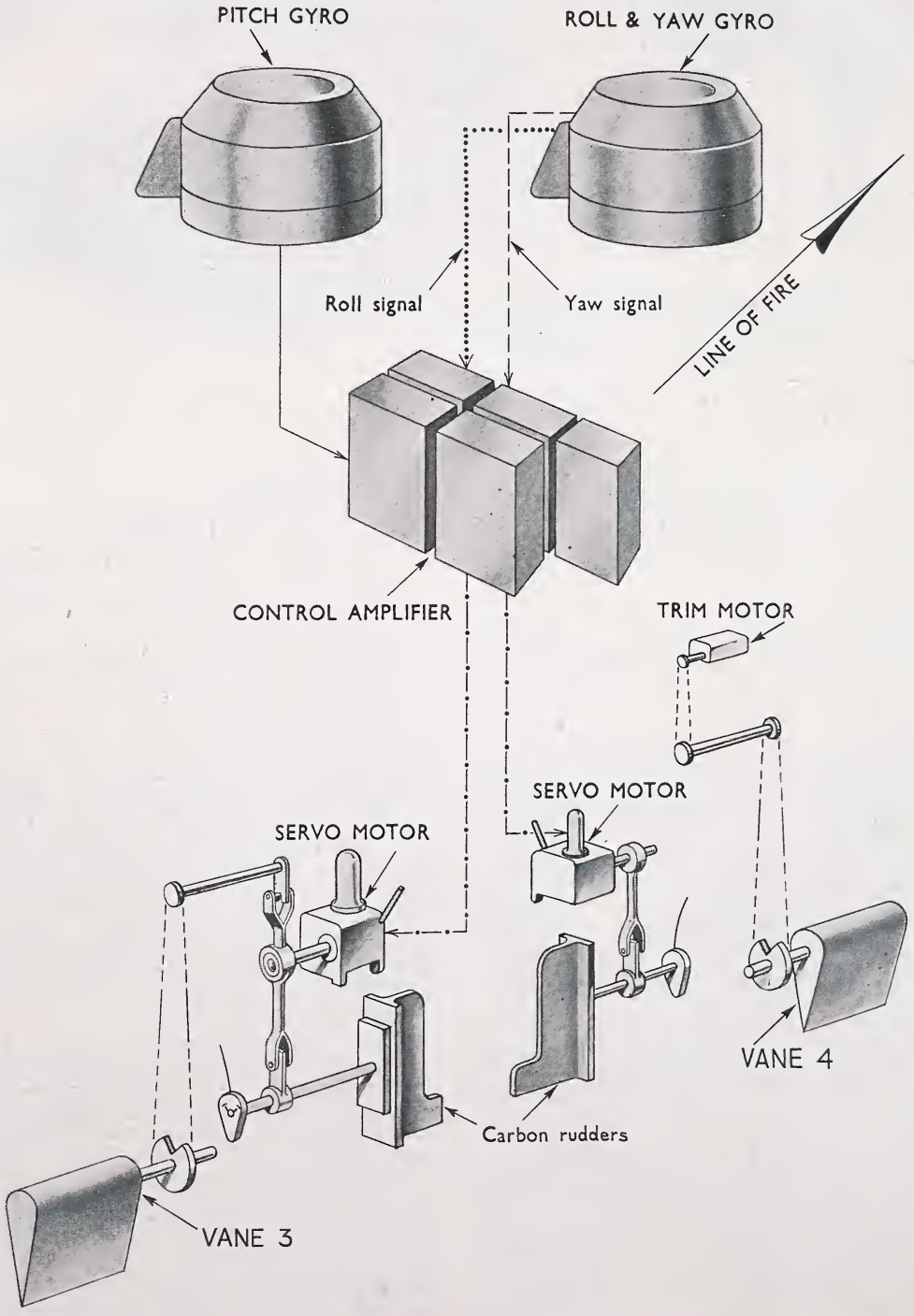
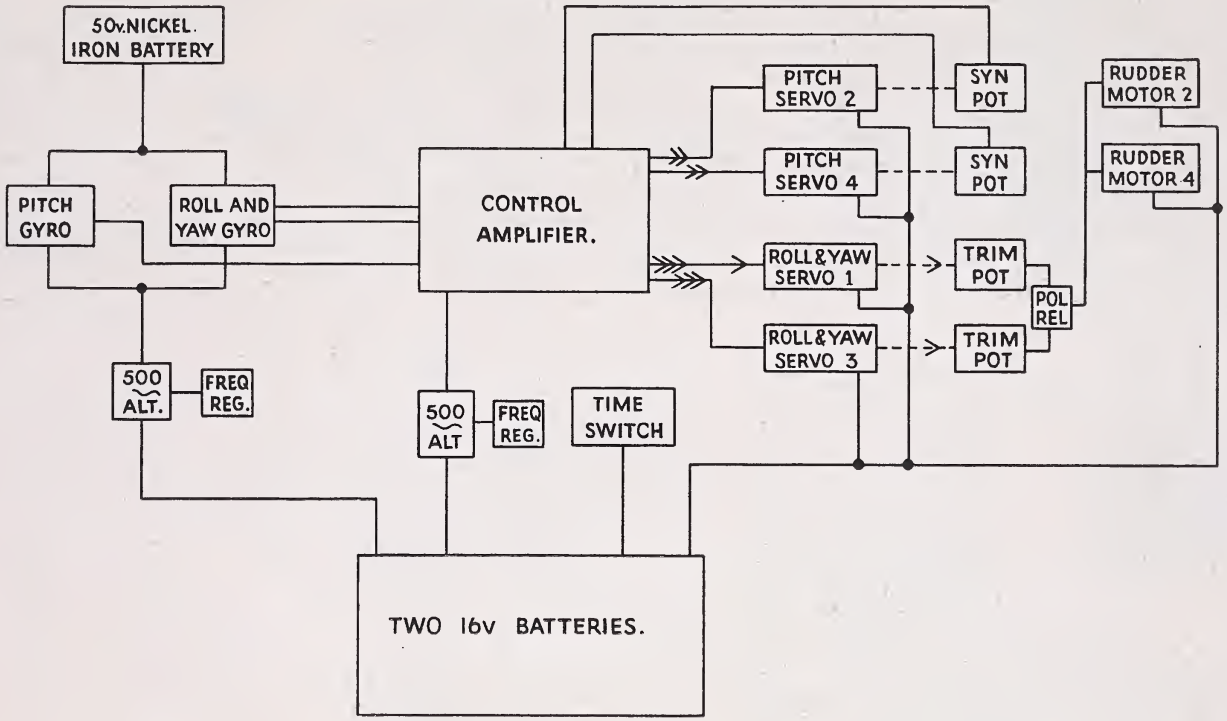


Plate 8

ROCKET A4 BLOCK SCHEMATIC OF FLIGHT CONTROLS.



internal potentiometers, are mounted on the servo motors. Their purpose is to enable the carbon rudder servo motors to be accurately zeroed during tests. The other eight potentiometers are mounted two behind each carbon rudder bracket. One of each pair is used to give an indication on the steering panel of the current in milliamps employed. The other is used :—

(*a*) With carbon rudders 2 and 4 to ensure their synchronisation ;

(*b*) With control surfaces 1 and 3 to determine when they are out of synchronisation.

CONTROL MECHANISM

75. The servo motors are controlled by signals which originate from the control compartment of the rocket. In this compartment there are two gyroscopes. One, known in German as the Horizont, is used for pitch control ; the other, known as the Vertikant, is used for the control of roll and yaw, i.e., direction. The schematic layout of these controls and their connection with the control surfaces previously described is shown in Plate 8.

76. A.C. current at 500 cycles for driving the two gyros is obtained from an alternator receiving power from two 16-volts batteries.

77. The Vertikant has a rotor which is disposed at launch with its axis horizontal and parallel to the pitching axis of the rocket. Any tendency of the rocket to roll or yaw will result in a signal being sent from the Vertikant gyro to the control amplifier. The current required for these signals is obtained from the 50-volt nickel-iron battery. In short, the function of the Vertikant gyro is to appreciate any movement of the rocket about its roll or yaw axis and send a signal which will be used to correct that movement.

78. The function of the Horizont gyro is to turn the rocket through an angle of 47° from the vertical before the end of burning. To do this, the gyro is made to precess. The precession of the gyro is governed, on a time basis, by a constant speed motor, a time switch or a " pecking " motor, according to the type of gyro in use. As the gyro precesses, a signal is sent, as before, to the control amplifier.

79. The purpose of the control amplifier is to amplify the signals received from the gyros, so that they will operate the servo motors in the base of the rocket.

ACTION—PITCH CONTROL

80. Precession of the Horizont gyro causes signals to be passed to the pitch servos which operate carbon rudders 2 and 4. The rudders move towards fin No. 1 which, it will be remembered, is pointing in the direction of the target when the rocket is on the launching table. This causes the rocket to tilt over in the direction of the target. The process of turning the rocket over on to its trajectory lasts for 45 ± 2 seconds. At the end of this period, the rocket will be at 47°, from the vertical or 43° from the horizontal. Servo motors 2 and 4 must remain in synchronism throughout. Should they not remain so the fact is at once appreciated by their synchronising potentiometers, which instantaneously bring them back into phase by means of signals sent through the control amplifier. (Plate 8.)

ACTION—CONTROL FOR LINE

81. Any tendency of the rocket to yaw results in a signal being received by servo motors 1 and 3. Correction of yaw will at once be made by moving all four vanes and rudders in the same direction, i.e., the control surfaces remain synchronised.

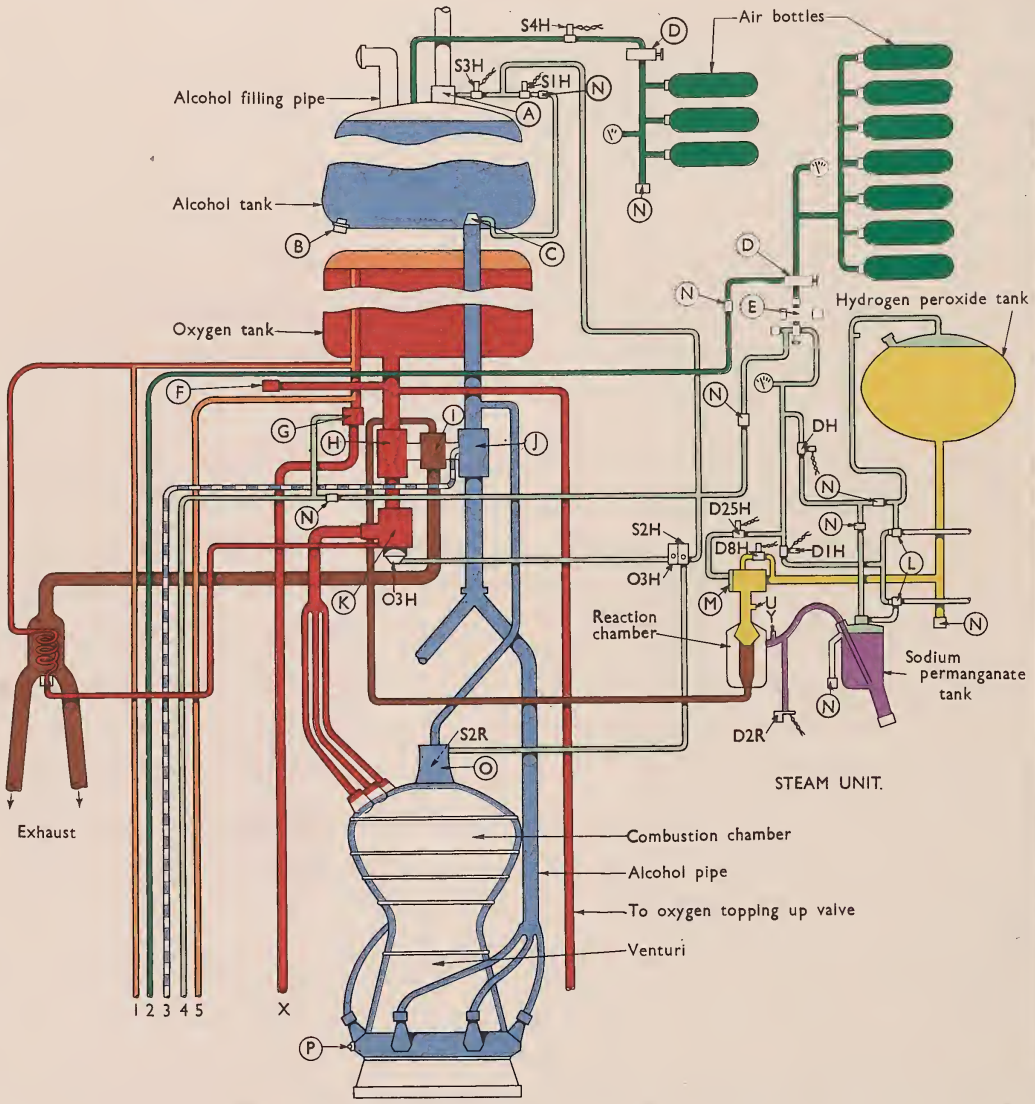
82. Should a roll signal be received from the Vertikant gyro, then carbon rudder 1 and outer vane 1 will move in one direction and carbon rudder 3 and outer vane 3 will move in the opposite direction. The trimming potentiometers will at once detect that the rudders are out of synchronism and by means of a polarised relay, operate the electric trim motors controlling outer vanes 2 and 4 and bring these vanes into play, thus introducing a measure of trimming in roll.

LEGEND.

- (A) Alcohol tank pressurising valve.
- (B) Alcohol defuelling valve.
- (C) First alcohol valve.
- (D) Stop valve.
- (E) Reducing valve.
- (F) Oxygen fuelling valve.
- (G) Oxygen tank pressurising valve.
- (H) Oxygen pump.
- (I) Turbine.
- (J) Alcohol pump.
- (K) Main oxygen valve.
- (L) Vent valve.
- (M) Main hydrogen peroxide valve.
- (N) Non-return valve.
- (O) Main alcohol valve.
- (P) Hand operated alcohol draining valve.

COLOUR KEY.

- Oxygen.
- Alcohol.
- Hydrogen peroxide.
- Sodium permanganate.
- High pressure air.
- Low pressure air.
- Steam.
- Oxygen tank pressurising.



Operation of the Rocket Motor and Auxiliary Motor Units . . . SECTION 11

GENERAL

83. This section describes the action of the rocket motor and auxiliary motor units from launch to fuel cut-off. Its object is to assist in an understanding of the rocket motor tests (Vol. 3) (Section 21 (B)) and the launching sequence and fuel cut-off test (Vol. 2) (Section 21 (E)).

FLOW OF FUELS TO COMBUSTION CHAMBER

84. The flow of oxygen and alcohol to the main combustion chamber, and of sodium permanganate and hydrogen peroxide to the auxiliary combustion chamber, is governed by a series of valves.

85. These valves are of two main types :
(*a*) electrically operated or solenoid valves
(*b*) pressure operated valves.

86. The solenoid valves are operated,
(*a*) from the propulsion panel in the control car (Feuerleitpanzer), the sequence of operation being governed by the relay box (Relaikasten), or
(*b*) by a contact activated by the operation of another valve,
or
(*c*) by the time switch and fuel cut-off mechanism in the rocket.

87. Electrical power for the operation of these valves, before the ground connector plugs (Stotz plugs) come away, is supplied by a generator. After the plugs come away, power is supplied by two 16-volt batteries on the rocket.

88. The pressure operated valves are actuated by compressed air. Some are held open when compressed air is applied ; others are held open when compressed air is released.

89. Until launch, compressed air for the operation of those valves is obtained from compressed air bottles on, or detached from, the Meilerwagen. In flight, the compressed air is supplied by compressed air bottles on the rocket. Compressed air for charging the rocket air bottles and operating the pressure valves before take off, passes from the Meilerwagen air bottles, through the valve box on the firing table and the five-way coupling, to the pipe numbered 2, Plate 9. This pipe distributes the compressed air to the rocket motor and auxiliary motor system.

90. The valves governing the flow of main fuels to the main combustion chamber are :
(*a*) The alcohol tank valve.
(*b*) The alcohol main valve.
(*c*) The oxygen main valve.

91. The alcohol tank valve is opened under air pressure, which is applied when its solenoid control valve (S1h) is operated.

92. The alcohol main valve is partially opened (5 mm.) when its electrically operated control valve (S2h) releases the air pressure in the pipe leading to it. The valve is fully opened under pressure of alcohol when the pump has started.

93. The oxygen main valve comprises in itself two valves. One opens when the control valve O3h releases air pressure during the preliminary stage. This valve, the preliminary stage valve, allows only a small flow of fuel to the burners. The other operates at main stage under the action of the pump against a spring and allows the maximum flow of fuel.

94. It will be seen from the diagram that the operation of S2h, and so the alcohol main valve, cannot occur until the contact O3r is made. This contact is operated by the oxygen main valve. Its purpose is to ensure liquid oxygen reaching the burners before alcohol.

95. Two valves control the supply of hydrogen peroxide to the auxiliary combustion chamber. They are known as the 8-ton and 25-ton valves. The former is a solenoid valve, the latter a pressure operated valve. The 25-ton valve opens under air pressure, applied when its control valve (D25h) is operated electrically. It will be seen from Plate 9 that the initial opening of the 8-ton and 25-ton valves cannot occur until sodium permanganate has reached the auxiliary combustion chamber and operated the rubid contact (D2r).

PRESSURISATION OF FUEL TANKS

96. Immediately the alcohol main valve has opened, during the preliminary stage, alcohol flows to the burners under pressure of the head of alcohol in the alcohol tank. Liquid oxygen, sodium permanganate, and hydrogen peroxide, however, are forced to their combustion chambers by the pressure of air previously built up in their respective tanks.

97. Pressurisation of the oxygen, sodium permanganate and hydrogen peroxide tanks comprises :
(*a*) closing of tank vent valve
(*b*) passing of compressed air into the tank

98. The oxygen tank vent valve is closed by releasing the compressed air in pipe 4. Release of compressed air is effected by the operation of the solenoid valve O1h in the valve box. Pressurisation of the tank to 1·5 atmos. is achieved by operating electrically the air inlet valve (N1h) in the

valve box. This allows air to pass via pipe 5 to the oxygen tank stack pipe. The pressure regulator in the valve box (N 10r and N 11r) is operated by the air pressure pipe 1, leading from the oxygen tank and maintains the pressure in the tank at between ·9 and 1·5 atmos. It does so by shutting off N1h electrically when the pressure exceeds 1·5 atmos. and re-opening it when it falls to ·9 atmos.

99. The sodium permanganate and hydrogen peroxide vent valves are closed when compressed air is applied to them. This is achieved by opening the valve D1h electrically. The flow of compressed air at 32 atmos. to the hydrogen peroxide and sodium permanganate tanks is governed by the operation of the solenoid valve Dh.

100. During the main stage, pressure is maintained in the alcohol and oxygen tanks to prevent them from collapsing and not to force fuel to the burners as was so with the oxygen tank during the preliminary stage.

101. Pressurisation of the oxygen tank is achieved by passing gaseous oxygen from the heat exchanger to the tank.

102. Pressurisation of the alcohol tank is achieved for the first 40 seconds of flight by an inrush of air through the pipe leading from the tank to the war-head. After 40 seconds the alcohol tank atmosphere pressurising valve is closed by the application of compressed air via the control valve (S3h) which is operated electrically by the time switch. At fuel cut-off pressurisation is again begun, this time by compressed air from the air bottles in the control compartment. For this purpose the alcohol tank compressed air pressurising valve (S4h) is opened electrically by the mechanism which effects fuel cut-off.

SEQUENCE OF EVENTS FROM LAUNCHING TO FUEL CUT-OFF

103. *Preliminary stage sequence*

Before this sequence is initiated, the following preparations will have been made :

(*a*) During launching.
Main key on rocket motor panel will be at " Fire."

(*b*) During Rocket Motor Tests.
Main key on rocket motor panel will be at " Test."
Test switch on rocket motor panel will be at " Rocket Motor Test " (Triebwerksversuch).
Igniter terminals on valve box will be shorted.

(*c*) During Launching Sequence and Fuel Cut-off Test.
Main key on rocket motor panel will be at " Fire."
Test switch on rocket motor panel will be at " Rocket Motor Test " (Triebwerksversuch).
Switch box will be plugged into valve box. Lamp box will be connected to auxiliary motor unit.

NOTE.—The following table is intended primarily to indicate the sequence of events in the rocket during *an actual launch*—Column 3. The purpose of Column 2 is to assist in tying up the sequence of events given in Column 3 with the drill at the rocket motor panel during launching.
Column 4 gives the test procedure for corresponding items in Column 3 where simulation is used.

(1) STAGE	(2) ACTION AT ROCKET MOTOR PANEL	(3) SEQUENCE OF EVENTS ON ROCKET AND VALVE BOX	(4) ACTION DURING TESTS (*b*) AND (*c*) REFERRED TO ABOVE
1	Preliminary stage button pressed.	Electrical circuits tested.	
2	Lamp indicating all circuits clear (Klar) comes on.		
3		Valve O1h on valve box operated. Air escapes down pipe 4 closing oxygen tank vent valve.	
4		Valve N1h on valve box opened. Air passes via pipe 5 to oxygen tank, thus pressurising it to 1·5 atmos.	(*c*) Tank pressurising switch and pressure regulating switch on switch box are switched on.
5	Lamp indicating oxygen tank pressurised (Beluftung) comes on.		
6		Simultaneously with Stage 3 valve O1h operates valve D1h in auxiliary motor unit. Compressed air passes to hydrogen peroxide and sodium permanganate vent valves and closes them.	(*b*) No action. (*c*) Lamp D1h comes on in the lamp box.

(1) STAGE	(2) ACTION AT ROCKET MOTOR PANEL	(3) SEQUENCE OF EVENTS ON ROCKET AND VALVE BOX	(4) ACTION DURING TESTS (*b*) AND (*c*) REFERRED TO ABOVE
7		Igniter is started and begins to spin when burning correctly. Spin of igniter breaks a contact thus causing Stage 8.	(*b*) Wire shorting igniter terminals removed. (*c*) Igniter switch on switch box is switched on.
8	Lamp indicating igniter started (Zundung) comes on.		
9		Alcohol outlet valve control valve (S1h) opened. Compressed air passes to alcohol outlet valve and opens it. Alcohol flows to walls of venturi.	This stage tested during flow of alcohol test (Section 21 (D)), Vol. 3.
10		Oxygen main valve control valve (O3h) opened thus releasing air pressure on oxygen preliminary stage valve which opens under pressure of oxygen. Oxygen flows to the roses in the venturi.	(*b*) Escape of compressed air through roses in venturi.
11		Contact O3r operated. This in turn causes alcohol main valve control valve (S2h) to open and release air pressure on alcohol main valve which opens 5 mm. under pressure of alcohol which flows to jets.	
12	Rocket-borne power lights up, ground power extinguished.	Changeover from ground to rocket-borne power.	
13		Ignition of alcohol and oxygen. Preliminary stage flame develops.	
14	Lamp indicating preliminary stage completed (Vorstufe) comes on.		

104. MAIN STAGE SEQUENCES

(1) STAGE	(2) ACTION AT ROCKET MOTOR PANEL	(2) SEQUENCE OF EVENTS ON ROCKET AND VALVE BOX	(4) ACTION DURING TESTS (*b*) AND (*c*) REFERRED TO ABOVE
15	Main stage button pressed (Hauptstufe).		
16		Ground connector (Stotz) plugs thrown off.	

(1) STAGE	(2) ACTION AT ROCKET MOTOR PANEL	(3) SEQUENCE OF EVENTS ON ROCKET AND VALVE BOX	(4) ACTION DURING TESTS (*b*) AND (*c*) REFERRED TO ABOVE
17		Valve Dh opened electrically by rocket-borne power allowing compressed air at 32 atmos. to pass to hydrogen peroxide and sodium permanganate tanks.	(*c*) Lamp indicating valve Dh lights up on lamp box.
18		Sodium permanganate forced under air pressure to auxiliary combustion chamber. Passage of sodium permanganate operates rubid contact (D2r).	(*c*) Rubid contact switches closed manually.
19		Rubid contact operates valve D8h (8-ton valve). Hydrogen peroxide flows to combustion chamber via 8-ton valve.	(*c*) Light D8h comes up on lamp box.
20		Rubid contact also operates 25-ton valve control valve (D25h) which opens to allow air pressure to pass to 25-ton valve and open it. Hydrogen peroxide passes to auxiliary combustion chamber via 25-ton valve.	Light D25h comes up on lamp box.
21		Steam generated in auxiliary combustion chamber drives the turbine which drives the pumps. Alcohol and oxygen pumped via their main valves now fully opened by increased pressure of fuel to the combustion chamber.	
22		Development of full thrust.	

105. SEQUENCE OF EVENTS IN FLIGHT

(1) STAGE	(2) ACTION AT ROCKET MOTOR PANEL	(3) SEQUENCE OF EVENTS ON THE ROCKET	(4) ACTION DURING TEST (*c*) REFERRED TO ABOVE
23		The rocket leaves the launching table. The take-off switch (Abhebekontakt) operates automatically and switches on the time switch (Zeitechaltwerk). The plug on the emergency fuel cut-off line (Not Brennschluss) pulls away from its socket in the base of fin No. 4. The oxygen tank pressuring pipe non-return valve closes. The non-return valve on the air bottle charging pipe closes. The non-return valve on the oxygen tank pressure regulating pipe closes.	(*c*) Take-off switch operated manually.

(1) STAGE	(2) ACTION AT ROCKET MOTOR PANEL	(3) SEQUENCE OF EVENTS ON THE ROCKET	(4) ACTION DURING TEST (*c*) REFERRED TO ABOVE
24		Pressurisation of oxygen tank by gaseous oxygen from heat exchanger begins. Tank is pressurised to 2·2 atmos., the oxygen vent valve safety valve acting as a pressure regulator. Pressurisation of alcohol tank by inrush of air through pipe in war-head.	
25		Commencement of precession 4 seconds after take-off.	(*c*) Checked by a stop watch.
26		40 seconds after take-off the alcohol tank atmosphere pressurising valve control valve (S3h) is opened electrically by the time switch. Compressed air closes the alcohol tank atmosphere pressurising valve.	(*c*) Audible click of valve closing after 40 seconds.
27		End of precession 47 to 51 seconds after take-off. Carbon rudders 2 and 4 move back back to zero position.	Checked by stop watch.
28		Fuel cut-off (Brennschluss) effected by integrating accelerometer or radio equipment. The stages in fuel cut-off are : (i) 25-ton valve control valve closed electrically causing 25-ton valve to close on resultant loss of air pressure. Flow of hydrogen peroxide to auxiliary combustion chamber reduced. Turbine speed reduced. Flow of alcohol and oxygen reduced. Thrust reduced from 25 tons to 8 tons. (ii) 8-ton valve closed, when correct velocity has been attained, through electrical operation of D8h. (iii) Dh closed electrically through the operation of a double relay in the distribution box (Hauptverteiler). Pressurisation of hydrogen peroxide and sodium permanganate tanks ceases. (iv) Oxygen and alcohol main valves closed by operation of their control valves O3h and S2h.	(*c*) Lamp marked D25h on the lamp box goes out. (*c*) Lamp D8h on lamp box goes out. (*c*) Indicating lamp Dh on lamp box goes out.

(1) STAGE	(2) ACTION AT ROCKET MOTOR PANEL	(3) SEQUENCE OF EVENTS ON THE ROCKET	(4) ACTION DURING TEST (*c*) REFERRED TO ABOVE
		(v) Alcohol outlet valve control valve (S1h) closed electrically by a double relay in the main distribution box.	
		(vi) Alcohol compressed air pressurising valve (S4h) opens and allows compressed air to pass to the alcohol tank.	(*c*) Compressed air heard to rush into the tank.
		(vii) Outer rudders return to zero position.	

The Integrating Accelerometer Type 2 SECTION 12

A. GENERAL DESCRIPTION

106. Fig. 15 shows the Integrating Accelerometer Type 2 (1a (2)). The function of the instrument is to cut off the fuel supply to the burners when the rocket has achieved the predetermined velocity calculated to carry it to the target. The instrument measures velocity by integrating the acceleration of the rocket with respect to time. (Velocity $v = \int a\ dt$, where a = acceleration.) Fuel cut-off is done in two stages. Thrust is first of all reduced to the 8-ton stage, and then after approximately 4·5 seconds fuel is shut off completely. The reason for it being done in two stages is to increase the accuracy of the fuel cut-off velocity.

107. The accelerometer consists of two main parts, the measuring unit and the electrolytic cell box. The former measures the acceleration of the rocket and passes an electric current proportional to this acceleration to the two electrolytic cells. The cells measure the total charge received by them and when predetermined amounts have been received these cells cause the two cut-off signals to be given, which reduce the thrust to eight tons and then to zero.

108. The accelerometer is fitted to a special bracket in control compartment No. 3 which contains the pitch, roll and yaw gyroscopes. (See Fig. 16.) Electrical connection is made by means of a 14-pole plug and socket.

DETAILS OF MEASURING PROCESS

109. Fig. 17 shows in broad outline the electrical circuits of the accelerometer. An arm, designed as a pendulum, is able to turn round a shaft standing perpendicular to the plane of the diagram and indicated in the centre between letters N and S. At the left hand end of this arm is a copper blade which moves in the air gap of the iron core of two coils (chokes). Movement of the copper blade downwards under the influence of the acceleration of the rocket changes the reactance of the coils. These chokes form part of an A.C. bridge together with the tapped primary of a transformer fed from the main supply circuit (40 v. 500 c/s). If there is no acceleration, the bridge is in equilibrium, and no A.C. voltage will be induced in the secondary coil of the transformer.

110. Under the influence of acceleration the copper blade will lower and an A.C. voltage will be produced which passes to the grid of the radio valve RO 3. This voltage is amplified and rectified by the full wave rectifier GL 2, which produces a D.C. proportional to the amplified A.C. This D.C. flows through a moving coil which is attached to the pendulum, in the magnetic field NS. The direction of the D.C. is chosen so that the motion of the coil opposes the motion caused by the acceleration. The pendulum then finds a balance point and the amount of current is proportional to the acceleration. This current flows to two electrolytic cells.

111. The electrolyte is hydrochloric acid and the electrodes are of polished silver. Prior to operation a measured film of silver chloride is deposited on the silver electrodes. When the rocket lifts from the table the relay contacts r2 connect the two cells to the circuit so that the current from the measuring unit flows through in such a way as to eliminate the deposit of silver chloride. Before launching the D.C. is sent through the cells in the reverse direction by relay contact r4 in order to deposit the required film. The quantity of current flowing before

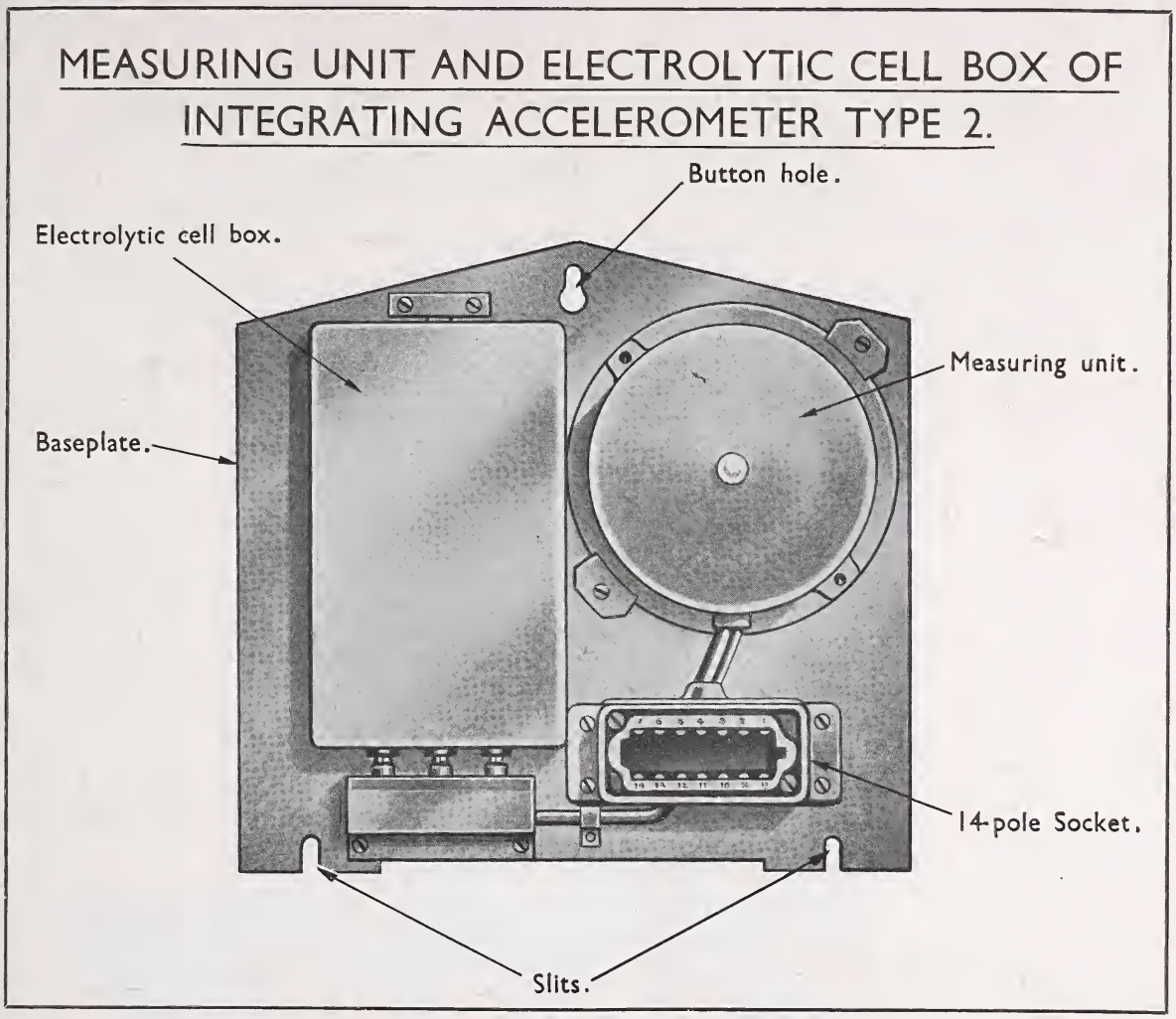


Fig. 15

launching is that due to gravity alone, and it is allowed to pass through cell 1 for time $t_1 = \frac{Vo}{g} - 7{\cdot}2$ seconds, and through cell 2 for time $t_2 = \frac{Vo}{g}$ seconds, where Vo is the desired fuel cut-off velocity. Thus, measured films of silver chloride are deposited on the polished silver electrodes. During operation the film is removed at a rate proportional to the acceleration of the rocket. When the velocity of the rocket $V = \int adt = k \int idt$ (where i is the current) reaches the value of approximately (Vo — 72) m/seconds, the deposit on coil 1 will be removed. This causes a sudden rise of voltage in this cell, and the current through valve RO 4 becomes sufficient to make the relay R8 respond. This relay causes the preliminary cut-off to the 8-ton stage and at the same time cell 1 is replaced by cell 2 in the grid circuit of RO 4. This cell was charged for a longer time and the deposit is removed some seconds later when a velocity Vo is reached by the rocket. The relay then responds a second time and energises the main fuel cut-out relay.

TESTING AND CHARGING THE ACCELEROMETER

112. For the purpose of testing and charging the accelerometer there is an integrating accelerometer test box situated to the right of the main testing panels in the fire control vehicle (Fig. 18). It consists of a stop watch which can be stopped magnetically and a series of switches, press button switches and indicator lamps. The unit is connected to the ground installations by a 14-pole plug. Before using the testing box the stop watch is wound up.

113. To test and charge the accelerometer, the supply current is switched on by the main switch. As soon as the alternator is switched on, bulbs IG 2 and either L or E will

CONTROL COMPARTMENT No 3 INTEGRATING ACCELEROMETER BRACKET.

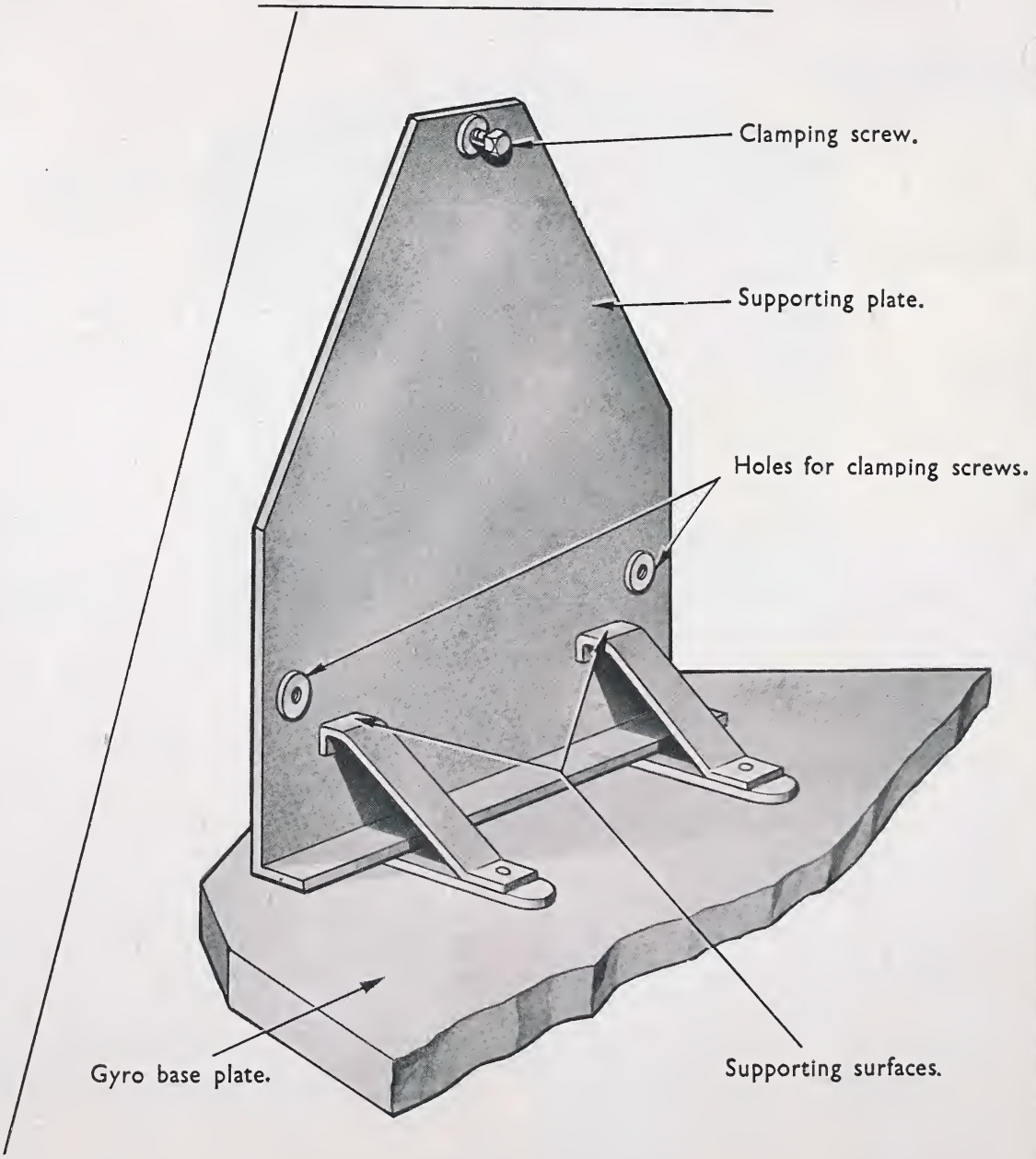


Fig. 16

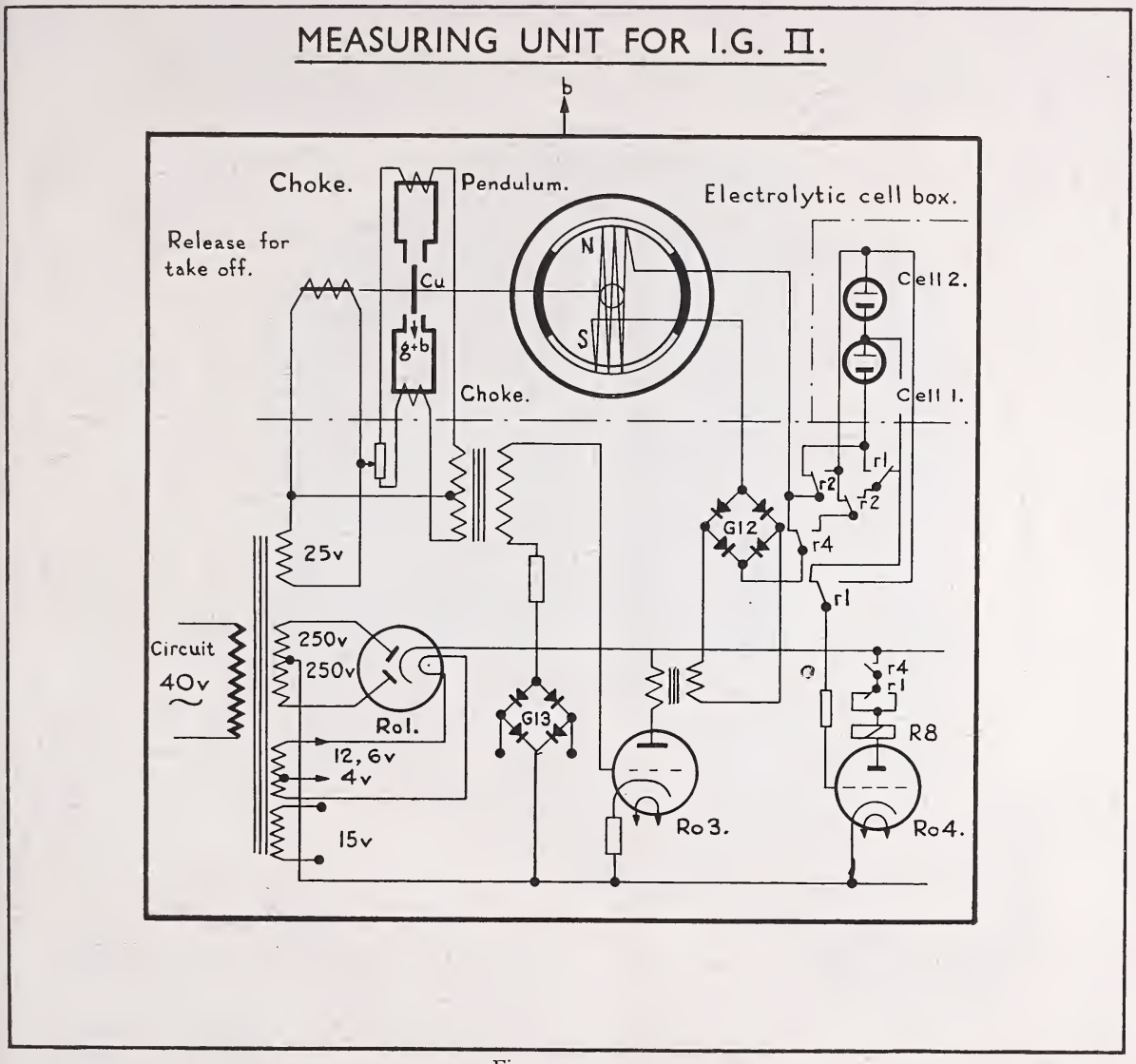


Fig. 17

light up, depending on the position of the changeover switch (1 or 2). About one minute after IG 2 lights up the test can be begun.

114. Set changeover switch to position 2 (discharge). Press button D1, the stop watch will start and the accelerometer will begin to discharge. Corresponding to the previous charge given to the accelerometer, the preliminary and main cut-off signals will be given and bulbs 1a and 1b light up. The stop watch will stop on the main signal. Bulb E should then light up.

115. Turn changeover switch to position 1 (charge). Bulbs 1a and 1b go out. Press D3 to zero the stop watch. Press D1, bulb E will go out and L light up. The accelerometer cell is now charging. After 7·2 seconds press D2, begin to charge cell 2. Bulb 1a will now light up. At the end of charging press D3. The stop watch will stop and bulb 1b will light up.

Discharge and charge can now be repeated or changeover to S for firing can be made. As soon as the changeover switch is turned bulbs 1a and 1b will go out.

THE INTEGRATING ACCELEROMETER TYPE 3 (I-GERART 1/3)

B. GENERAL DESCRIPTION

116. Fig. 19 shows the integrating accelerometer type 3. The function of this instrument is the same as that of integrating accelerometer type 2. It differs from the latter in that it integrates by entirely mechanical means.

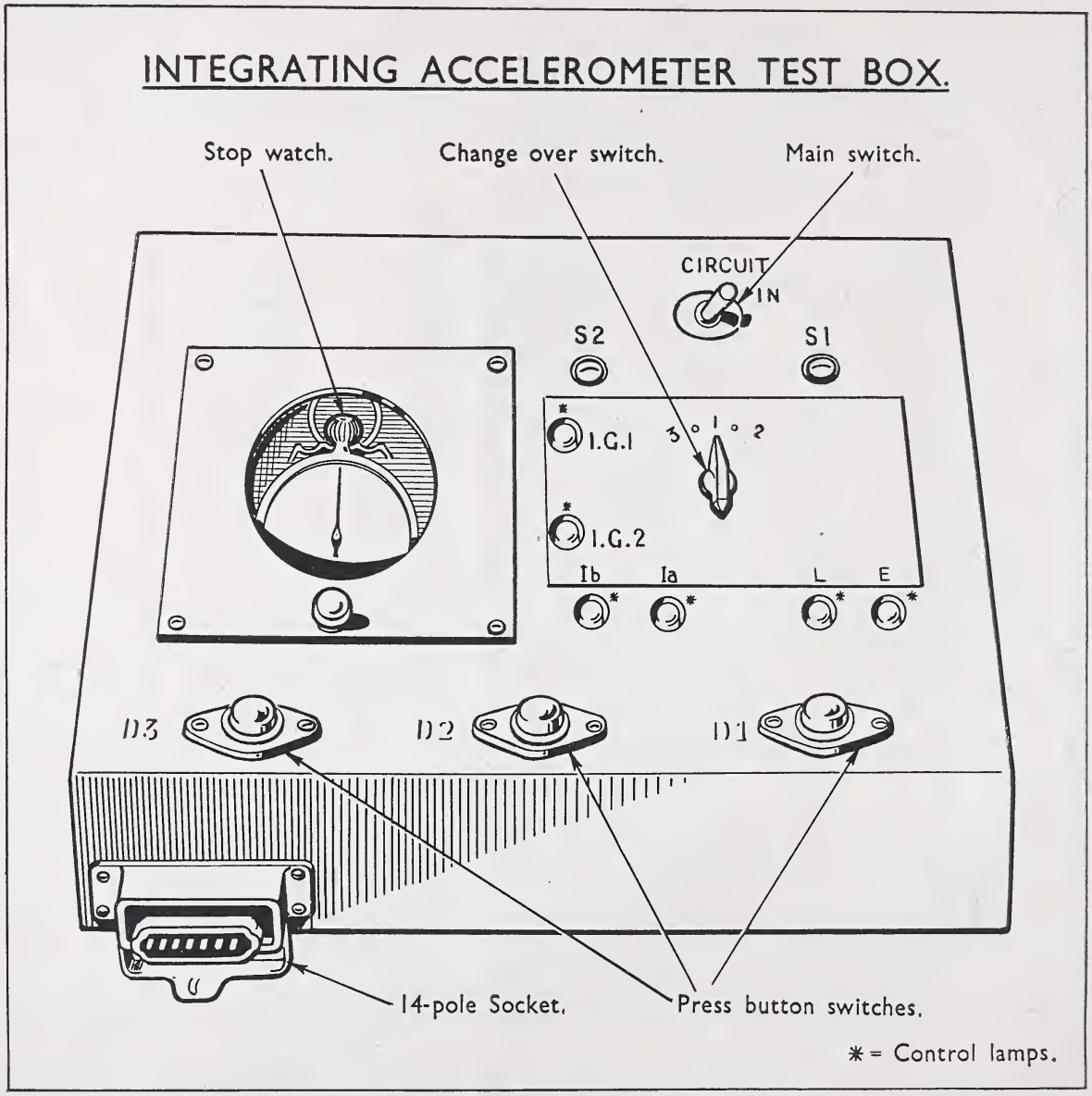


Fig. 18

117. The accelerometer is mounted on a base plate which clamps to the special bracket in control compartment No. 3 (see Fig. 16). A metal cover protects the instrument against dust. By means of two setting knobs the zero position of the gyro and the required velocity can be set. The setting scale can be observed through a small glass window. Electrical connection is by means of a 20-pole plug.

PRINCIPLE OF OPERATION (See Fig. 20)

118. A small gyro revolving at 30,000 revolutions per minute is suspended eccentrically on a gimble which revolves about the axis OC. During flight, the gyro is pulled down under the influence of gravity and of the acceleration of the rocket. This causes the gyro to precess and thereby to revolve about the axis AB. The angular velocity of this movement is proportional to the torque about the axis OC., i.e., to the total acceleration. The number of revolutions within a given time is proportional to the velocity of the rocket, and can be computed from the formulæ :—

$$a = \int_0^t a.dt. = c\int_0^t b.dt = c.v.$$

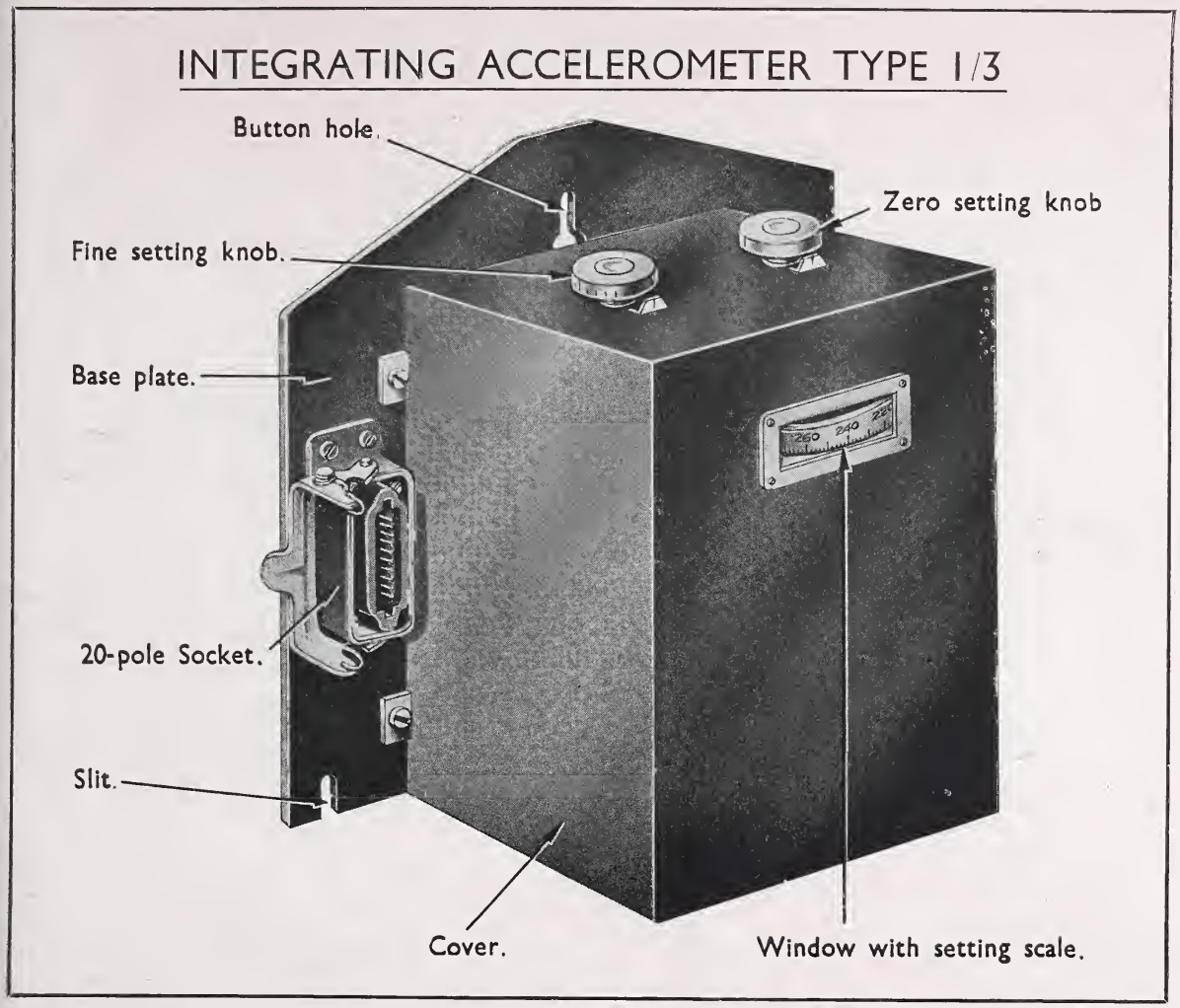


Fig. 19

119. By means of gears, the revolution of the gyro about the axle AB is transferred to a disc. This disc moves concentrically with a second disc which carries two electrical contacts and is adjustable in its position with respect to the first. If, during flight, the pre-act angle of revolution about the axis AB, and therefore the required velocity, has been obtained, the electrical contacts will close to give the two fuel cut-off signals, which reduce the thrust to eight tons and then to zero.

120. In order to eliminate the effect of friction of the axis AB, a special " erecting motor " is used to drive the shaft AB. If the gyro topples about the axis OC due to friction, contact is made which causes the erecting motor to accelerate the movement of the shaft AB, thereby raising the gyro. If the gyro should rise, the motor retards the motion of AB thereby causing it to fall again.

121. Before launch the gyro is held at zero by an arresting magnet which releases the gyro when the rocket leaves the table. By means of relays, the gyro can be brought to zero, so that tests can be performed from the fire control vehicle.

122. In setting the integrating accelerometer, allowances must be made for the acceleration due to gravity, as the component of this acceleration along the axis of the rocket is integrated together with the actual acceleration of the rocket. Thus, the apparent velocity is $v_s = v + \int_0^t g \cos P \, dt$ where P is the angle of pitch. It follows that errors in time to cut off due to variations in thrust performance and variations in the pitch programme will affect the accelerometer. Deviation of 2 degrees of the programme angle or of one second in time of burning from the normal causes errors of approximately 0·5 per cent. in the velocity at cut-off.

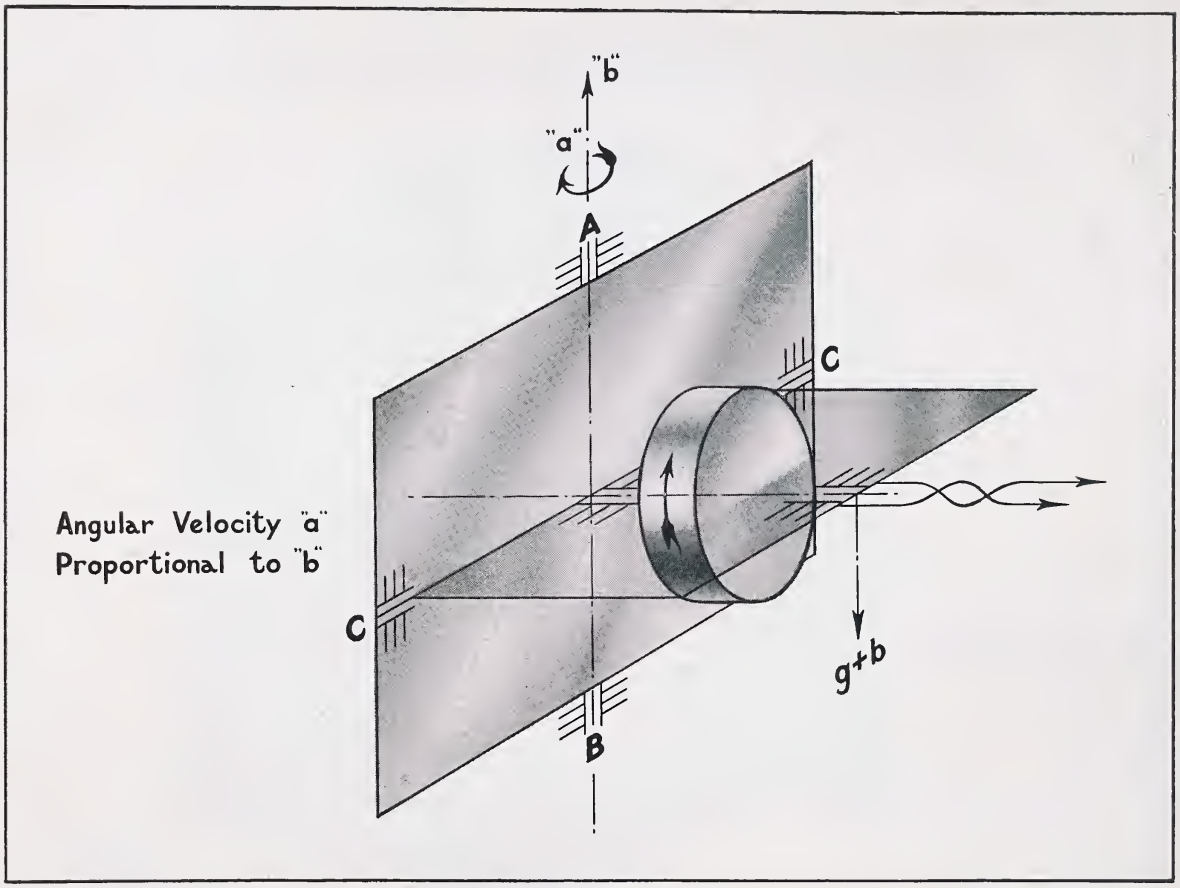


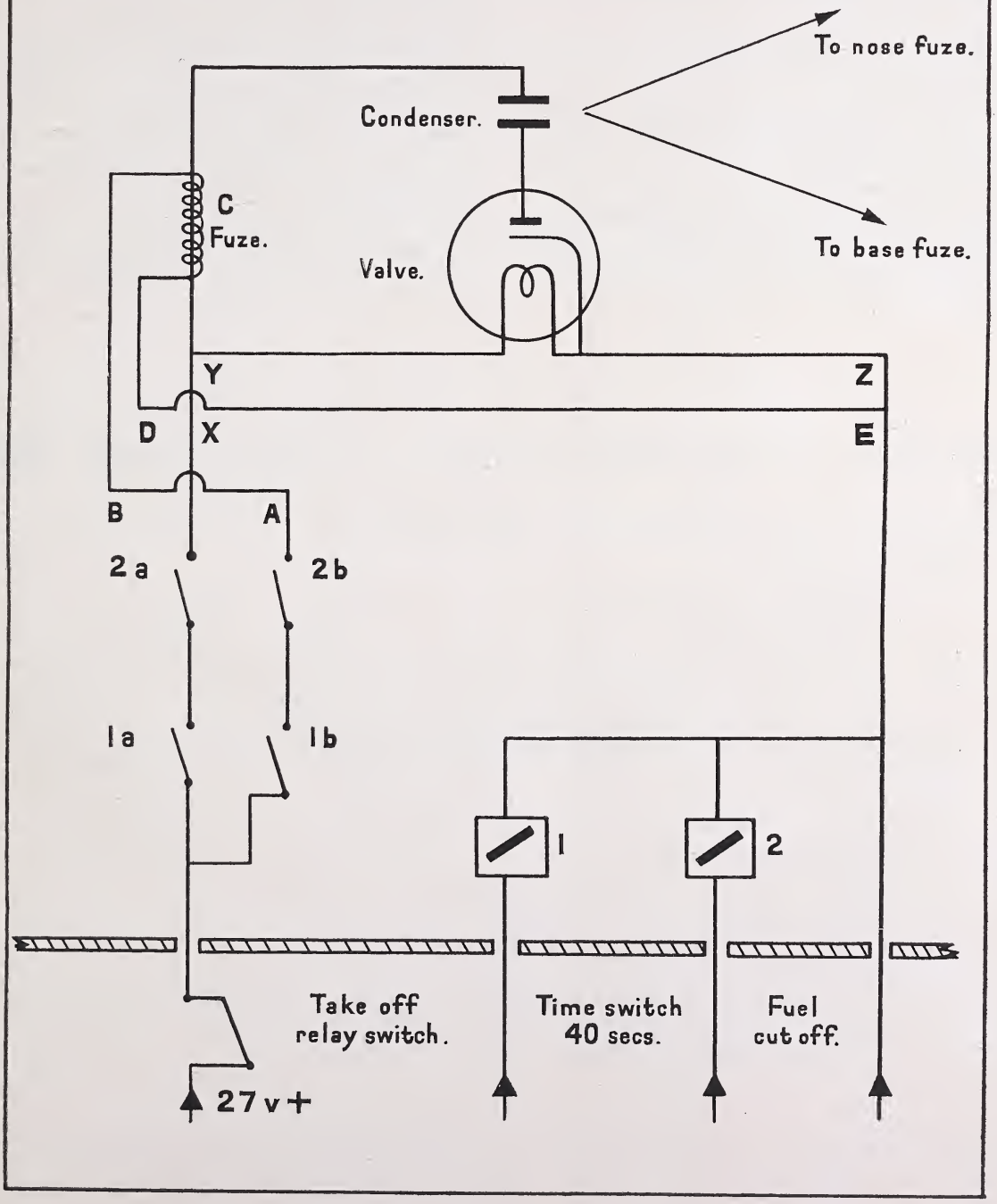
Fig. 20

TESTING THE INTEGRATING ACCELEROMETER

123. The accelerometer is tested by means of the integrating accelerometer test box. This instrument is also used to test integrating accelerometer type 2. It is situated in the firing control vehicle. The stop watch of the test box is first of all wound up and replaced in the stopping magnet. To test the accelerometer, switch on the supply current to the test box. Approximately one minute after switching on alternator No. 3, the bulb IG 1 and the bulb L will light up. Set the changeover switch to position 1. Push button D1 until bulb L goes out. The accelerometer and the stop watch will start. After the time set on the accelerometer, the preliminary cut-off signal will be given and the bulb 1a of the test box will light up. Approximately 7·2 seconds later the main cut-off signal will be given, the stop watch will stop, and bulb 1b will light up. Approximately five minutes after beginning the test, bulb L will light up again. This means that the accelerometer is standing at zero. Push the button D3 to bring the stop watch to zero. Another test can be made if desired or the changeover switch can be set to S ready for firing. By pushing D1, or by switching to position S, the bulbs 1a and 1b will go out.

Plate 10

THE FUZE ARMING UNIT.



The Fuze Arming Unit (Sterg) . . SECTION 13

GENERAL

124. The fuze arming unit arms the nose and base fuzes in the war-head approximately three minutes after take-off. It is in control compartment No. 3 and is connected to the low tension batteries.

OPERATION (PLATE 10)

125. The take-off switch (Abhebekontakt) closes the take-off relay switch.

126. After 40 seconds the time switch (ZSW) closes circuit 1 which in turn closes switch 1a. Switch 1b is already closed. See para. 128.

127. After fuel cut-off has taken place, circuit 2 is closed which in turn closes switches 2a and 2b. There is a resistance fuze at C and current will therefore flow along X—Y and through the valve. After approximately two minutes, the valve will be warm enough to allow current to flow from anode to cathode and then to the condenser which is charged. When the condenser is fully charged, current will flow to the nose fuze and base fuze and they will be armed.

128. A safety device is incorporated which prevents fuze arming should fuel cut-off take place in less than 40 seconds after take off. Switch 1b is already closed, the take-off relay switch operates as above and after fuel cut-off switches 2a and 2b will close, but since 40 seconds has not yet elapsed 1a will be open. The circuit will therefore be: 1b, 2b, A, B, C, D, E. The resistance fuze C will blow, thus breaking the circuit to the condenser and ensuring that the fuzes are not armed.

129. The fuze arming unit is tested during the main tests by connecting the plug carrying the contacts to circuit 1 and circuit 2. A test panel with indicating lamps which light as each stage is completed is used.

Technical Troop Test Report . . SECTION 14

TEST REPORT NO. 2

Start of Test	29 September, 1945	Time	18.45
Rocket No.	R 1/2	War-head	BB BL
		Weight	993 kg.

Pressure reducing valve adjustment (Launching pressure) 32·5 atmos.
Quantity of oxygen fuelled To overflow
Quantity of alcohol fuelled 4,430 litres

I. PROPULSION UNIT

(*a*) Venturi in order
(*b*) Turbine turning test (easy) Yes
(*c*) Safety cut-off Fitted
(*d*) Pressure reducing valve relaxed; electrical heating; present
(*e*) Oxygen tank pressurised to 1·5 atmos.
(*f*) Pressure operated Rubid contact operates at 1·5 atmos.
(*g*) Alcohol tank pressurised with 0·8 atmos.
(*h*) Hydrogen peroxide and sodium permanganate tanks in order Compressed air bottles in order.
(*i*) Additional compressed air bottles tested; bottles filled to 200 atmos.
(*j*) Five-way coupling in order

II. CONTROL

(*a*) Alternator I ..... 42 volts ; Alternator II ..... 41 volts ; Alternator III ..... volts.

(*b*) Pitch gyro. ..... Modified Roll and yaw. Control current reading ..... in order.

(*c*) Yaw and roll gyro ..... fr. 714/102185. Control current reading ..... in order.

(*d*) Electric time switch ..... in order. Programme ..... in order. Fuel cut-off after ..... 66·5 seconds.

(*e*) Steering control amplifier ..... m/amp. .....

III. ELECTRICAL SYSTEM AND WIRING

(*a*) Insulation resistance ..... 180,000 ohms. .....

(*b*) Aerial for emergency fuel cut-off ..... 5 ohms .....

(*c*) Wiring ..... in order. .....

(*d*) Honnet box tested ..... in order .....

IV. FAULTS FOUND AND JOBS TO BE DONE DURING TESTING.

Alternator II and regulator out of order and replaced .....

.....

.....

V. FINAL REPORT

Launching sequence and fuel cut-off test (G.D.V.) ..... Carried out in order .....

Rocket complete, flaps screwed down, covers on

Rocket is ready for launching .....

Completion of testing ..... 30 September, 1945 ..... 11.00 hours .....

.....

i/c Testing Station.

REMARKS BY LAUNCHING PLATOON

NOTE 1.—Under heading " Remarks by Launching Platoon," any faults which occur during preparation for action on the launching position, whether they can be put right on the spot or whether it necessitates returning the rocket to the Technical Troop, are entered by the Officer i/c Launching Platoon.

NOTE 2.—This paper is sent with others to Battery H.Q. immediately after each launch.

Description of the AIR COMPRESSOR (Luftverdichter) . . . . . SECTION 15

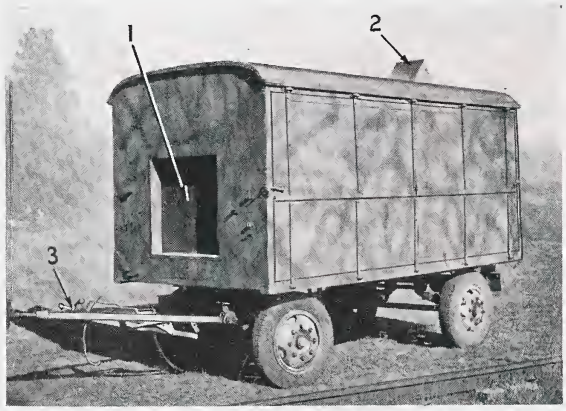


Fig. 21. Air compressor

1. Radiator 2. Exhaust 3. Overrun brake

GENERAL

130. The air compressor is used for filling the various air bottles which are used for testing and launching the rocket. It is a complete unit with Diesel engine, compressor and reservoir, and it is carried in a four-wheel trailer.

THE TRAILER (Fig. 21)

131. At the rear of the trailer there is an entrance door and stops. The sides have two hinged flaps, the bottom one of which can be let down and the top one raised and held by three steel supports. The front is cut away to receive the engine radiator. On the top there is an exhaust outlet which is closed down when travelling. The trail is fitted with an overrun brake operating on the two front wheels. A spare wheel is carried underneath the chassis. On the left rear is fitted the hand pump for filling the Diesel engine tank.

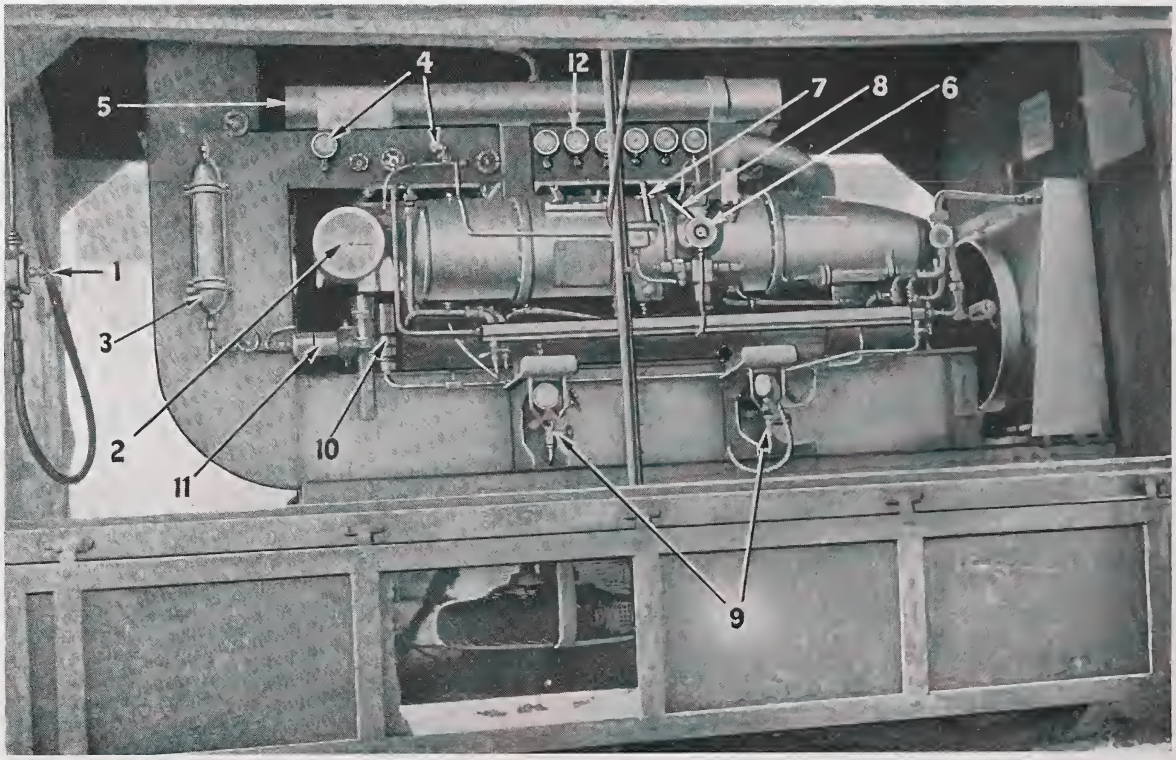


Fig. 22

1. Fuel pump
2. Air inlet
3. Dehydrator
4. Starting pressure gauges
5. Diesel tank
6. Starting handle
7. Starting lever
8. Fuel pump lever
9. Charging connections
10. Safety valve
11. Filter
12. Pressure gauges

THE COMPRESSOR (Figs. 22 and 23)

132. The complete compressor is carried inside the trailer. It is of the type used in submarines and is very compact. It is fixed to the floor by eight light bolts, there being hardly any vibration when the engine is running.

133. The Diesel engine is an integral part of the compressor. It obtains fuel from two 55-litre tanks mounted above the compressor and works two pistons which move laterally in one cylinder and form between them the fuel expansion chamber. The engine runs at 860 strokes per minute and is water cooled. When starting up the pistons are opened manually by a handle and a clutch holds the left-hand one open.

134. Each piston is connected by a large diameter connecting rod to two air compressing pistons, one inside the other but working in their own compression cylinders. The compressing pistons are of different sizes and, by passing air in turn from the largest to the smallest, compression takes place in four stages :—

No. 1 compression cylinder	...	1 to 4 atmos.
No. 2 compression cylinder	...	4 to 16 atmos.
No. 3 compression cylinder	...	16 to 75 atmos.
No. 4 compression cylinder	...	75 to 235 atmos.

Two decompressing valves are fitted to the forward end of the compressor and are used for starting.

AIR FLOW

135. Air is drawn through the large air inlet at the right rear and passes through non-return valves into No. 1 compression cylinder. From No. 1 it passes through a water-cooled jacket to No. 2. From No. 2 some of the air passes through a system of expansion pipes allowing it to expand to between 2 and 6 atmos. for driving the engine radiator cooling fan and for providing air for the Diesel engine. The remainder passes through a water cooling jacket to No. 3 and thence through a further water cooling jacket to No. 4. There are pressure gauges at each stage and also at the cooling fan.

136. After stage 4 the compressed air passes in turn through a mechanical cleaner and dehydrator (working on the condenser principle), a Silica Gel dehydrator (the Silica Gel is changed every eight running hours), a "Schuman" filter (which combines mechanical and chemical cleaning and dehydrating), then through a porous pot filter and finally to the five reservoir cylinders. Pressure gauges are fitted to the mechanical cleaner and to the reservoir cylinders. The mechanical cleaner is also fitted with an air escape valve.

137. A branch pipe from the final output to the reservoir cylinders leads to the starting reservoir cylinder which is mounted separately. 28 atmos. are required to start the compressor, but it must be kept charged at a pressure of over 50 atmos. in order that 28 atmos. may be maintained during the starting period. This starting reservoir cylinder also has its pressure gauge and a reducing valve.

138. Two charging pipes lead under the compressor from the storage cylinders to the right-hand side and are fitted with charging connections, pressure reducing valves and gauges.

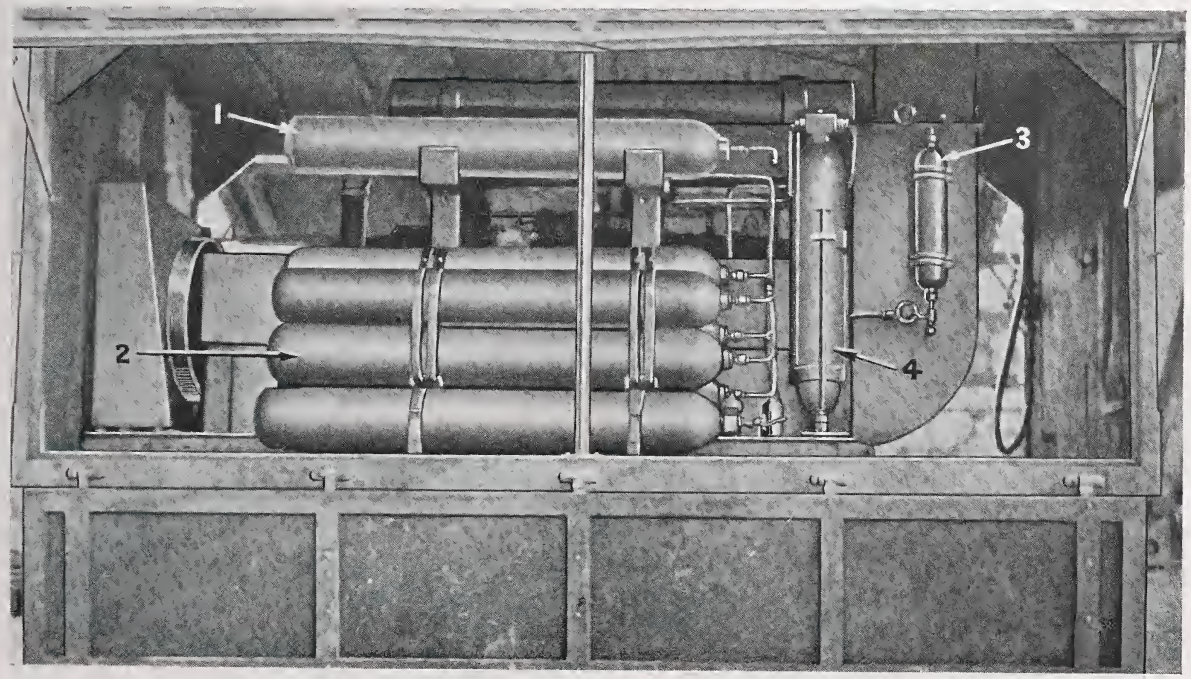


Fig. 23

1. Starting reservoir
2. Main reservoir
3. Filter (silica gel)
4. Dehydrator

139. Two safety valves are fitted. One operates at 235 atmos. The second operates at 250 atmos. and when it comes into operation it automatically shuts off the fuel supply to the Diesel engine and thus stops the compressor.

LUBRICATION

140. A pressurised oil distributor injects oil into the compression cylinders. This oil must be capable of withstanding great heat. Aircraft engine oil, with a flash point of 240 C., is used.

OPERATION

141. *To start up the compressor—*

(*a*) Open starting reservoir valve and ensure that pressure is 50 atmos. or more.
(*b*) Open reducing valve and check that the pressure is 28 atmos.
(*c*) Open the two decompressing valves.
(*d*) Open Diesel pistons manually by means of the handle, until the clutch, holding the left-hand piston, drops into position. Apply the clutch retaining catch.
(*e*) Remove the handle (this is very important).
(*f*) Close the two decompressing valves.
(*g*) Operate the fuel pump lever until fuel is heard passing to the Diesel engine.
(*h*) Operate the starting valve lever.
(*i*) Watch the stage 1 pressure gauge. When it reaches 5 atmos. the engine should start.
(*j*) Adjust the pressure to the radiator fan so that it is between 2 and 6 atmos. and the temperature is between 60 and 80 degrees C.

142. *To stop the compressor—*

(*a*) Close the fuel supply lever.
(*b*) Operate the valve on the mechanical cleaner and allow air to escape.

DIMENSIONS, ETC.

143.

Overall length with trail extended	...	10 ft.
Overall width	...	7 ft. 2 ins.
Overall height	...	9 ft. 6 ins.
Turning angle	...	45 degs.

Description of the Liquid Oxygen Road Tank Trailer (A-Stoff Anhaenger) . . SECTION 16

GENERAL (Fig. 24)

144. The liquid oxygen trailer is used for transporting liquid oxygen from rail head to the launching position where it is pumped direct from the trailer tank into the tank in the rocket.

145. It will hold 6,750 kilos. of oxygen, which, allowing for evaporation, is sufficient to fill one rocket.

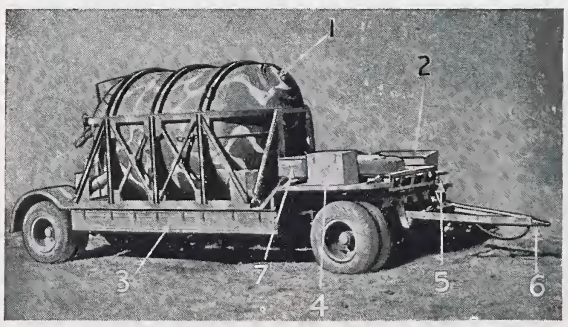


Fig. 24. Liquid oxygen road tank trailer

1. Manhole
2. Spares box
3. Hose compartment
4. Protective clothing box
5. Hand brake
6. Towing eye
7. 100 mm. hose box

THE INTERIOR (FIG. 25)

146. The inner tank, which contains the oxygen, is made of aluminium alloy and is divided into three compartments by two partitions. The partitions have one large hole to allow access for cleaning and six smaller ones. The purpose of the partitions is to strengthen the tank and to prevent the liquid surging during travelling, thus decreasing evaporation.

147. There are seven inlets and outlets on the inner tank and these are described in para. 151. There is a manhole at the front (Fig. 25). The space between the inner tank and the outer body is packed with Iperka asbestos wool compound which insulates the inner tank (Fig. 25).

THE EXTERIOR (FIGS. 24, 26 AND 27)

148. The tank is mounted on a four-wheel trailer with double wheels. In front there is a manhole to permit entry to the interior for cleaning. There are also a detachable engine draught connector, a hand brake operating on the rear wheels only, a spare wheel, a box containing the 100 mm. hose which is connected to the pump, a box containing protective clothing, a box containing spares, keys, bushes and 70 to 40 mm. hose reduction connection, and an electrical connection for lights.

149. At the rear there is a housing for the oxygen pump. a rear towing eye and an electrical connection for a rear light.

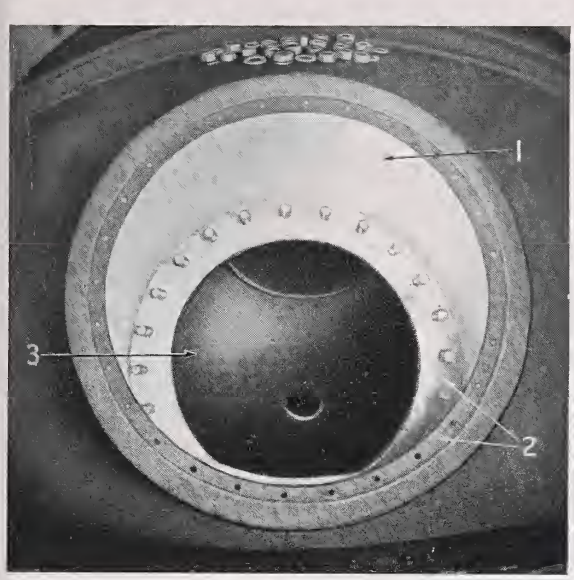


Fig. 25

1. Inner tank
2. Manholes
3. Partition

Fig. 26

1. Pump cover
2. Pump housing
3. Electric connection
4. Rear towing eye

150. On the right there is a compartment for housing 2 × 70 mm. and 1 × 40 mm. hoses. On the left there are two brackets for fixing the pump to the side of the trailer. Compressed air brakes are fitted to all four wheels and are operated via a flexible coupling from the towing vehicle.

151. The following valves and connections for filling and emptying hoses are fitted:

On the rear

(*a*) The main filling valve with 70 mm. hose connection.

(*b*) The gas pressure gauge measuring up to 3 kgs. per sq. cm. The maximum permissible pressure inside the tank is 1·5 kgs. per sq. cm.

(*c*) The liquid level gauge, with scale in kgs. up to 6,750.

(*d*) The gas release and overflow pipe, with main valve and auxiliary valve. The main valve is open when travelling as evaporation is then fairly high. It is also open when filling; the tank is full when the liquid overflows. The auxiliary valve is always open.

(*e*) Two safety valves.

On the right

(*f*) The outlet valve with 100 mm. connection for the hose leading to the pump. The pipe connecting this valve back to the tank includes a syphon, or air-lock; so that gas only will be in the pipe until such time as the liquid oxygen is being withdrawn.

(*g*) The air-lock release valve. It is sometimes necessary, when emptying, to turn this valve on, so putting the syphon out of action by giving a free passage of gas to the top of the tank. This raises the pressure over the liquid in the tank, and assists in pressurising the pump.

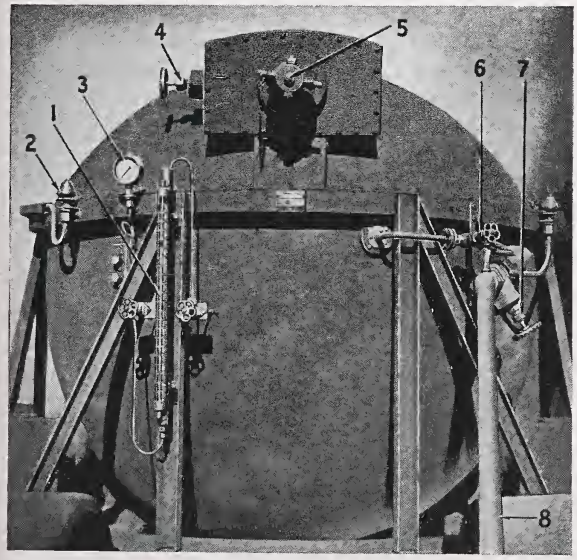


Fig. 27

1. Liquid level gauge
2. Safety valve
3. Pressure gauge
4. Main filling valve
5. Main filling connection
6. Auxiliary valve
7. Main valve
8. Gas release and overflow pipe

Description of the Oxygen Rail Tanker (A-Stoff Eisenbahnwagen) . . . SECTION 17

152. The oxygen rail tanker is used for conveying liquid oxygen from the factory to the rail head. It is a normal flat top freight car on which is mounted a tank with a capacity of 32,000 kilos (Fig. 28).

153. The tank, which is mounted on chain springs and brackets, is similar in construction to the road tank trailer (See Section 16). It has an outer protective shield and the space between the outer body and inner tank is filled with Iperka asbestos wool compound.

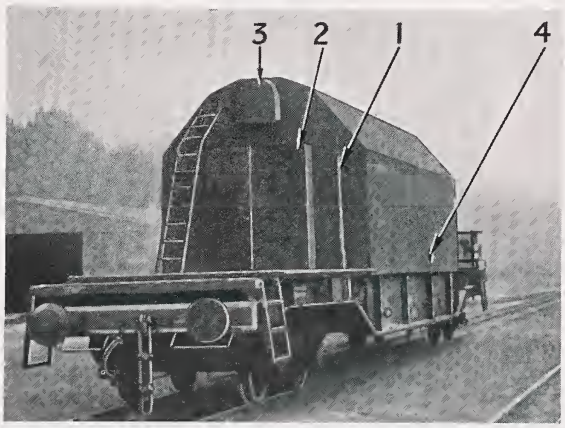


Fig. 28. Oxygen rail tanker
1. Gas vent and overflow pipe 2. Enclosed compartment
3. Filling connection cover 4. 70 mm. connection

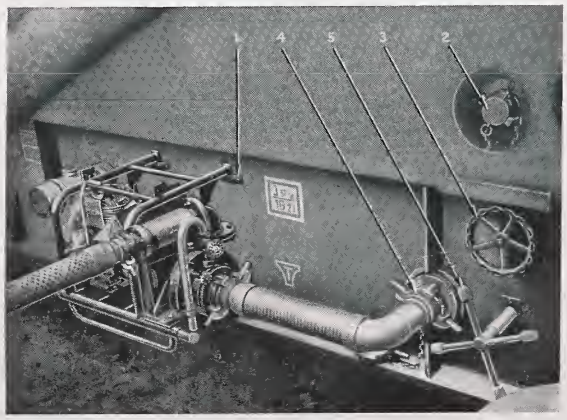


Fig. 29
1. Bracket 2. 70 mm. connection
3. Outlet valve 4. 100 mm. connection
5. Control handle

154. On one side of the tank there are four brackets for attaching the pump, an outlet valve and a 100 mm. outlet connection for the hose leading to the pump (Fig. 29). Above this outlet there is a 70 mm. inlet connection and valve. This leads through to the other side of the tank and by connecting the pump to the inlet is used when the road tank trailer, into which oxygen is being unloaded, can only be brought up on the other side of the rail tanker.

155. At one end of the tank there is a large vent pipe which is opened when filling the tank at the factory.

156. At the other end of the tank there is an enclosed compartment (Fig. 30) containing the following controls, gauges and accessories :

(*a*) A safety valve
(*b*) A gas escape valve
(*c*) A pressure gauge
(*d*) A 40 mm. inlet connection
(*e*) A liquid capacity gauge with shut-off valves
(*f*) The hose for connecting the pump to the 70 mm. inlet (see para. 154)
(*g*) A 40 mm. hose.

157. Above this compartment under a cover is a 70 mm. filling connection with cap (Fig. 28).

158. To the right of the compartment is a gas vent and overflow pipe leading to the under side of the car.

Fig. 30
1. Liquid level gauge 2. 40 mm. inlet
3. 100 mm. hose 4. Pressure gauge
5. Safety valve 6. Gas escape valve

Description of the OXYGEN Pump (A-Stoff Pumper) . . . . . SECTION 18

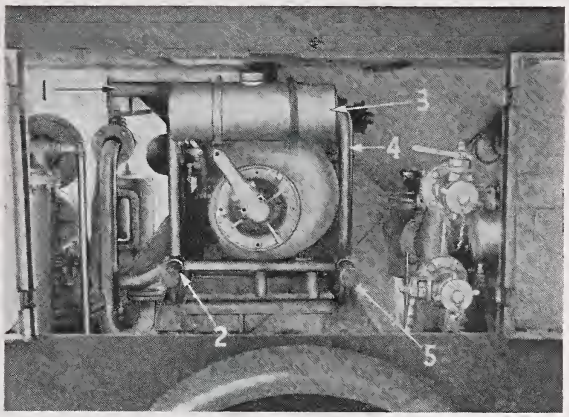


Fig. 31. Oxygen pump

1. Socket
2. Clamp
3. Petrol tank
4. Frame
5. Lifting handle

Fig. 32

1. 70 mm. outlet
2. Large gas escape valve
3. Small gas escape valve
4. 100 mm. connection

GENERAL

159. The oxygen pump is used for pumping liquid oxygen from the railway tank to the road tank and from the road tank to the rocket. The pump and engine are a complete unit fitted with a lifting frame and carried in the centre section of the alcohol pump trailer (Fig. 31) or on the rear of the oxygen tank trailer.

160. When pumping oxygen from the rail tanker to the road tanker, the pump is removed from the trailer by four men and attached to the side of the rail truck (Fig. 32) by means of two sockets in the carrying frame which fit over two projecting rods on the side of the truck. Two clips secure it in position. When pumping oxygen from the road tanker into the rocket, it is attached to the side of the road tanker in the same way (Fig. 33).

DESCRIPTION

161. The engine is a 300 cc. single cylinder IC engine of normal design burning a mixture of petrol and oil in the proportion 25 to 1. The air intake has a flexible pipe extension to carry it clear of the oxygen fumes. There is a decompressing tap on the cylinder head which is used during starting up and stopping and a hand throttle. The engine is connected by means of a clutch to a small rotary pump.

162. The pump inlet is at the side. It is connected by a 100 mm. flexible pipe to the outlet valve of the rail or road tanker. The pump outlet is at the top. This is a 70 mm. connection with no cut-off valve, and it is connected by a

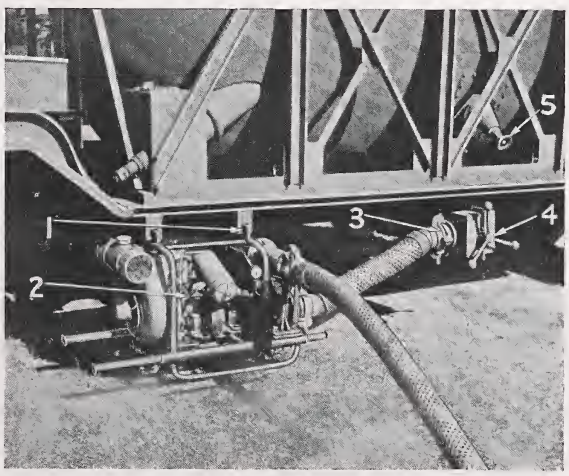


Fig. 33

1. Bracket
2. Motor
3. 100 mm. connection
4. Control handle
5. Air lock release valve

flexible pipe either to the road tanker inlet or to the intermediate pipe on the Meilerwagen.

163. There is a small gas release pipe with a cut-off valve which allows gas which accumulates in the pump to escape, but it is normally never used.

164. There is also a large gas escape pipe, and cut-off valve, leading from the pump inlet connection. This is opened during pre-cooling and closed as soon as the liquid oxygen flows out of it.

165. A pressure gauge shows the pump delivery pressure in kgs. per sq. cm. The normal pressure is between 1·5 and 2·2 kgs. per sq. cm. The pump is capable of filling the rocket in from 7 to 10 minutes.

TO START THE ENGINE

166. (*a*) Open the fuel cock.
(*b*) Prime the carburettor.
(*c*) Open the decompressing tap on the cylinder head.
(*d*) Turn the engine over three or four times.
(*e*) Close the decompressing tap.
(*f*) Turn the engine smartly.
(*g*) When the engine has started, allow it to idle until the pump clutch has been engaged.

TO STOP THE ENGINE

167. (*a*) Open the decompressing tap on the cylinder head.
(*b*) Close the fuel cock.

Description of the ALCOHOL Road Tanker (B-Stoff Strassenkesselwagen) . . SECTION 19

GENERAL

168. The alcohol tanker is used for transporting alcohol from the railhead to the launching position. It has a capacity of 2,900 litres. Two tankers are required to fill one rocket.

169. The tanker consists of four main parts :
(*a*) The chassis.
(*b*) The accessories compartment.
(*c*) The alcohol tank.
(*d*) The pump compartment containing a hand pump.

(*a*) THE CHASSIS (FIG. 34)

170. This is a three-ton truck on which are mounted the accessories compartment in the front, the alcohol tank in the middle and the pump compartment in the rear. The driver and spare driver travel in the cabin and assist in the fuelling procedure at the railhead and at the rocket.

Fig. 34. Alcohol road tanker

1. Metal cover
2. Pump compartment
3. Chassis
4. Accessories compartment

171. On each side of the chassis there are three tool compartments and at the rear there is a spare wheel.

172. Two curved cross sections support the tank and there are four adjustable brackets for securing it in position.

(*b*) THE ACCESSORIES COMPARTMENT

173. This contains hoses and accessories including a detachable ladder and the alcohol temperature gauge which is fixed to the front of the tank.

(*c*) THE ALCOHOL TANK

174. The tank is elliptical and has four lugs on which the chassis brackets engage.

175. There is a hinged cover on top which, when opened, exposes a manhole cover on which there are a filling inlet, an air vent with valve, a dip stick and a floating liquid level indicator (Fig. 35). At the bottom rear inside the pump compartment are the tank outlet and the capacity measuring gauge numbered every 500 litres from 0 to 3000 and also 3100 (Fig. 36).

176. The tank is enclosed in a light metal cover with four small access doors for tightening the tank securing brackets. A catwalk is fitted to the top of the tank for use when working.

(*d*) THE PUMP COMPARTMENT (FIG. 36)

177. The pump compartment contains the fuelling outlet, the cocks and the hand pump (Fig. 37).

178. The tank outlet leads to a four-way cock which has three fuel delivery positions marked A, B and C.

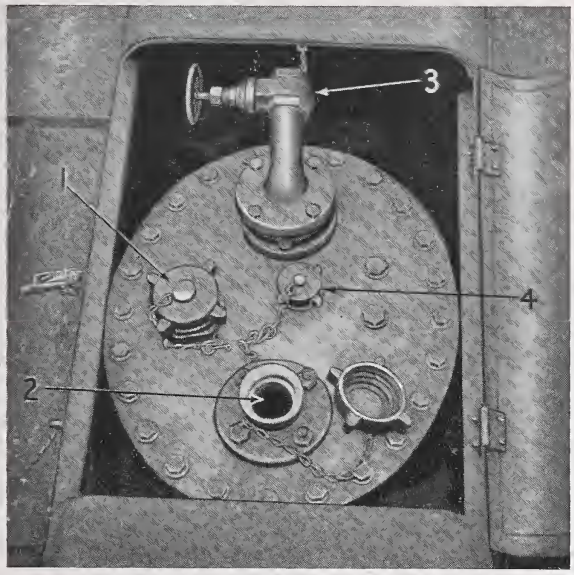


Fig. 35

1. Filling inlet
2. Indicator
3. Air vent
4. Dipstick

A (hand delivery). Liquid flows to the hand pump and via a shut-off cock to the pump outlet.

B (motor delivery). The shut-off cock is closed and liquid flows straight through to the pump outlet.

C (filling tanker by hand). Liquid flows via the pump outlet hand pump and shut-off cock into the tank. The pump handle is detachable and is carried in the pump compartment.

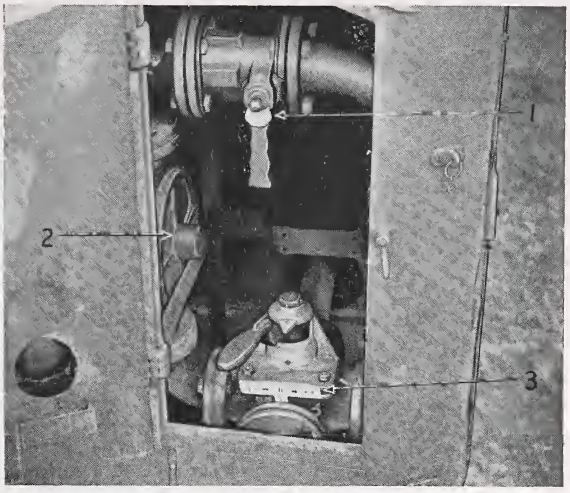


Fig. 36

1. Shut-off cock
2. Pump
3. Four-way cock

ALCOHOL Road Tanker (B-Stoff Eisenbahnwagen) . . . SECTION 20

179. The alcohol rail tanker (Fig. 38) is used for conveying alcohol from the factory to railhead. The tank contains 24,000 litres of alcohol and is enclosed in wooden protective shields. The interior is divided in two by a screen with holes in it. The purpose of the screen is to prevent the alcohol surging too much during transit.

180. At the top of the tank there is a cover under which there are : (Fig. 39)

(*a*) A manlid, used for access to the interior and for filling.

(*b*) A safety valve.

(*c*) A hand wheel for operating the outlet control valve. This valve is in the centre of the outlet pipe at the base of the tank (see para. 182) and when opened, allows alcohol to pass into the outlet pipe.

181. At one end of the tank there are two draining outlets with shut-off cocks.

182. The outlet pipe runs transversely through the base of the tank with the valve referred to in para. 180 in the middle. There is an outlet connection for a 60 mm. hose on each end of the pipe and a shut-off cock.

ALCOHOL PUMP ASSEMBLY.

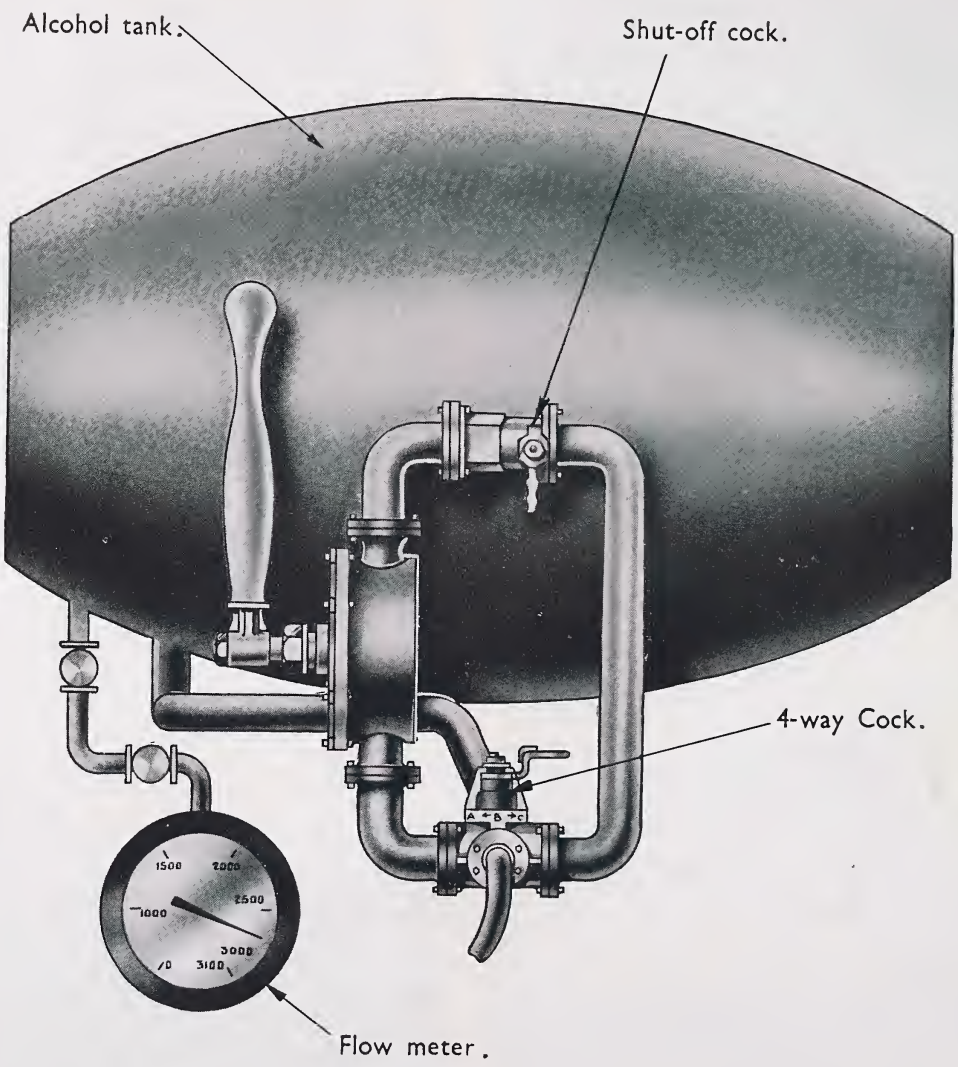


Fig. 37

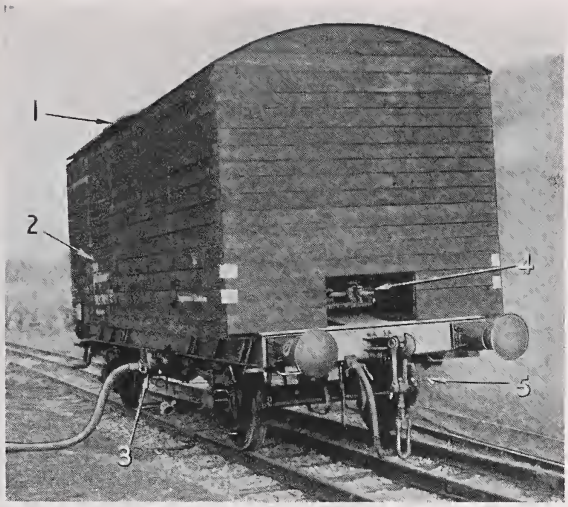


Fig. 38. Alcohol rail tanker

1. Hinged flap
2. Protective shield
3. 60 mm. outlet
4 & 5. Draining outlets

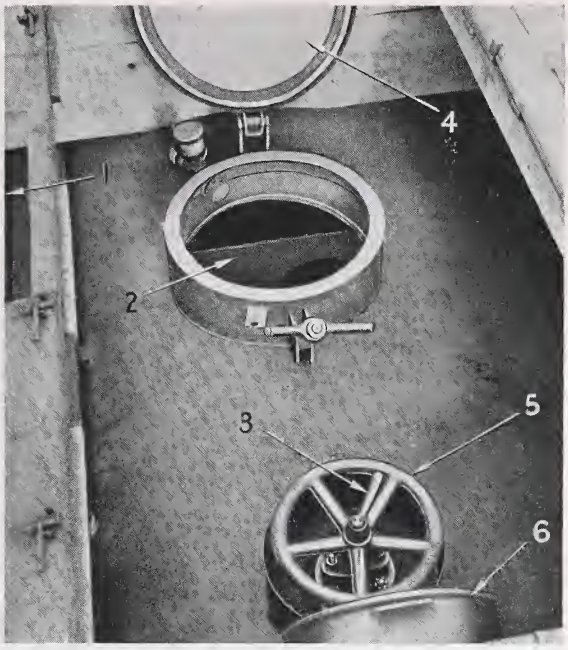


Fig. 39

1. Catwalk
2. Partition
3. Control valve lock
4. Manhole cover
5. Control valve
6. Cover

Description of the ALCOHOL Pump (B-Stoff Pumfe) . . . . . SECTION 21

GENERAL

183. The alcohol pump is carried in a two-wheel trailer (Fig. 40). The trailer has doors at the rear end on both sides. At the front is an engine draught connector and a support which folds underneath the trailer in the travelling position. It is towed by one of the alcohol waggons.

184. The pump and engine are bolted to the trailer and are permanent fixtures. They are arranged in two parts, with a space in the middle for housing the oxygen pump when travelling.

DESCRIPTION

185. At one end of the trailer is a 300 cc. single-cylinder IC engine of normal design burning a mixture of petrol and oil in proportion 25 to 1 (Fig. 41). It has an engine cut-off button and switch, so that pumping can be terminated as soon as the automatic cut-off gear (see para. 187 below) operates. A decompressing tap in the cylinder head is used when starting up and there is a hand throttle for controlling the speed.

186. The engine drives a rotary pump. Provision is made for simultaneous fuelling from two alcohol waggons (this is the normal procedure) and there are two 60 mm. inlet connections, with shut-off cocks on the left of the pump. Alcohol passes through a fine mesh filter into the pump and is expelled to a three-way cock, from which, according to the operation, it either :

(*a*) passes to an outlet connection and a corresponding shut-off cock ;
(*b*) (when fuelling the rocket) through the remainder of the system which is fitted to the other end of the trailer ;
(*c*) is shut off.

187. When fuelling the rocket, it passes on through an automatic de-gassing apparatus (Gasabsoheider), thence to an automatic shut-off gear, and then through a Siemens meter (Fig. 42). These last two pieces of apparatus are complementary. It is essential when fuelling the rocket that only the correct amount of alcohol is tanked ; the quantity required is therefore set on the shut-off gear.

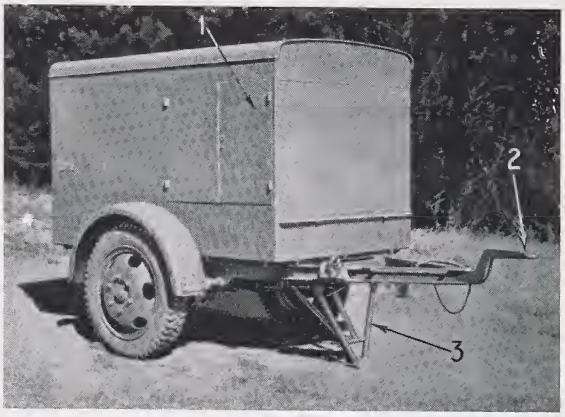


Fig. 40. Alcohol pump
1. Doors
2. Towing eye
3. Support

This quantity is measured by the Siemens meter which controls the automatic shut-off gear.

188. After passing through the meter the alcohol passes to a visual de-gassing apparatus (Gasensieger). Here it can be observed through a window and there is a release valve on top which can be opened to allow the escape of air. It then passes to a 60 mm. outlet with shut-off cock.

189. The connection from the pump to the intermediate pipe on the Meilerwagen is by means of a 70 mm. hose. A 70 to 60 mm. reducing connection is therefore required and this is fitted to the 60 mm. outlet.

190. Connecting hoses are stored in a compartment above the pump (Fig. 41).

191. The pump is capable of fuelling the rocket in from 12 to 18 minutes, according to the amount of alcohol required.

TO START THE ENGINE

192. (*a*) Open the fuel cock.
(*b*) Prime the carburettor.
(*c*) Open the decompressing tap on the cylinder head.
(*d*) Turn the engine over three or four times.
(*e*) Close the decompressing tap.
(*f*) Turn the engine smartly.

TO STOP THE ENGINE

193. (*a*) Press the engine cut-off button.
(*b*) Close the fuel cock.

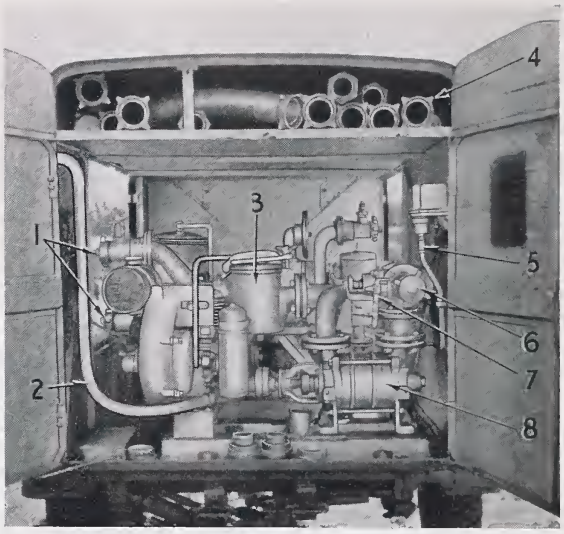


Fig. 41
1. Inlet connections
2. Exhaust
3. Filter
4. Hose compartment
5. Cut-off switch
6. Outlet connection
7. Shut-off cock
8. Rotary pump

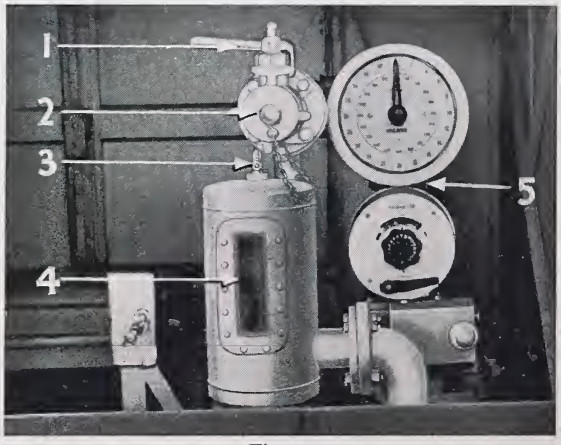


Fig. 42
1. Shut-off cock
2. Outlet connection
3. Air release cock
4. Visual degassing apparatus
5. Siemens meter

Description of the HYDROGEN PEROXIDE Road Tanker (T-Stoff Strassenkesselwagen) SECTION 22

GENERAL

194. The hydrogen peroxide road tanker is used for transporting hydrogen peroxide from railhead to the launching position. It has a capacity of 560 gallons, which is sufficient to fuel 16 rockets.

195. The road tanker (Fig. 43) consists of four main parts :
(*a*) The chassis.
(*b*) The accessories compartment and water tank.
(*c*) The hydrogen peroxide tank.
(*d*) The pump compartment containing mechanical and hand pumps.

(*a*) THE CHASSIS

196. This is a three-ton truck on which are mounted the accessories compartment in the front, the hydrogen peroxide tank in the middle and the pump compartment in the rear. The driver and spare driver travel in the cabin and they also carry out the hydrogen peroxide fuelling procedure at the rocket.

197. On the right-hand side of the chassis, below the accessories compartment, is fitted a hand pump with a 32 mm. hose connection (Fig. 44). This pump is used for pumping water from the water tank, through the hoses and tanks on the Meilerwagen in order to clean them after fuelling. A spare wheel is carried on a bracket at the rear of the chassis.

(*b*) THE ACCESSORIES COMPARTMENT

198. This is situated between the cab and the front wall of the tank and there is a small space of about half an inch between the two to allow for expansion of the hydrogen peroxide tank, this space being sealed by a rubber strip.

Fig. 43. Hydrogen peroxide road tanker
1. Accessories compartment and water tank
2. Hydrogen peroxide tank
3. Pump compartment
4. Chassis

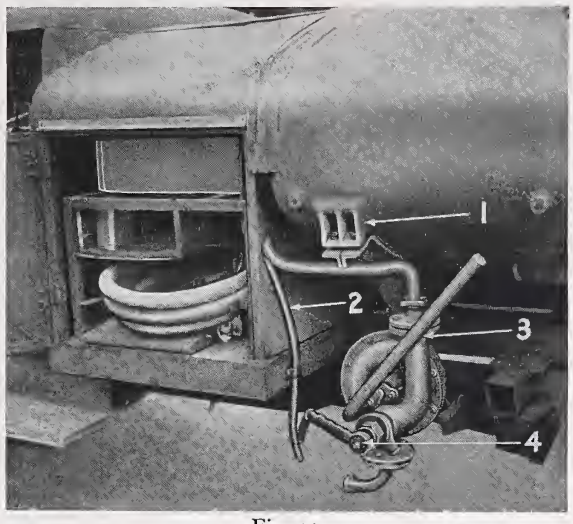


Fig. 44
1. Supporting brackets
2. Overflow (water)
3. Hand pump (water)
4. Three-way cock

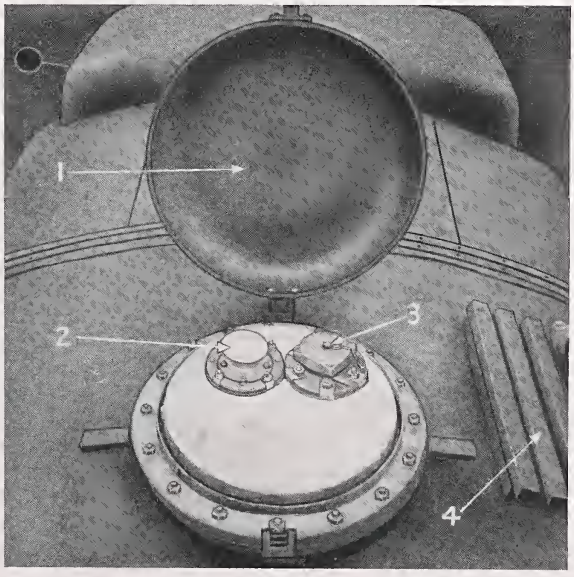


Fig. 45
1. Cover
2. Air vent
3. Filling connection
4. Catwalk

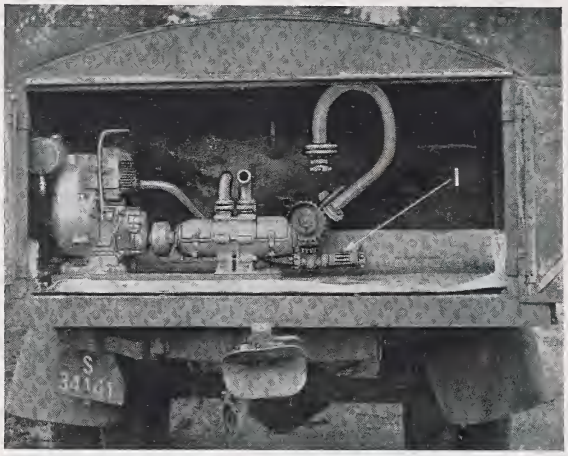


Fig. 46
1. Outlet pipe

199. The accessories compartment normally contains hoses for fuelling, protective clothing and tools. At the top of the compartment there is an 80 gallon water tank with an outlet connection and an overflow pipe.

(*c*) THE HYDROGEN PEROXIDE TANK

200. This is bolted in four places to supporting brackets on the chassis. It is made of aluminium and the interior is anodised for protection against corrosion.

On the top of the tank there is a hinged cover which, when lifted, exposes a filling connection with cap and an air escape vent (Fig. 45).

201. At the bottom rear of the tank in the pump compartment is a fuelling connection (Fig. 46) running to a three-way branch from which one pipe leads via a cut-off cock to a three-way stop cock (see para. 205). Another leads direct to an outlet pipe with stop cock. A third leads to a drain pipe which is normally closed with a plug.

202. At the top rear of the tank there is a relief pipe which is connected via a safety valve to the pumps. This is a safety device which enables fuel to be pumped back into the tank should pumping accidentally continue after the outlet cocks have been closed. Also at the top of the tank is an inspection window which shows the level of the liquid in the tank.

(*d*) THE PUMP COMPARTMENT (FIG. 47)

203. This is situated at the rear of the hydrogen peroxide tank and contains petrol driven (Plate 11) and hand operated (Plate 11) pumps for filling the hydrogen peroxide tank and for pumping hydrogen peroxide into the rocket.

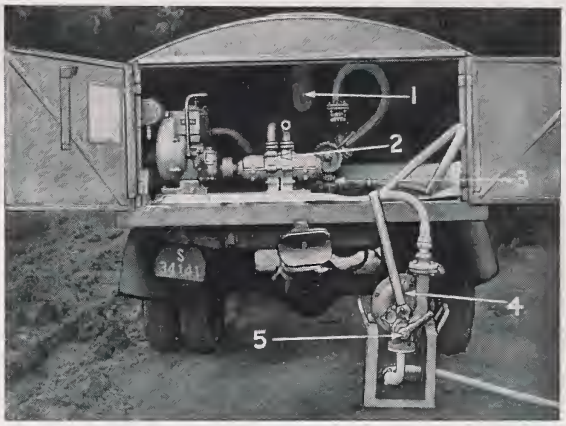


Fig. 47
1. Inspection window
2. Power driven rotary pump
3. Shut-off cock
4. Hand pump (peroxide)
5. Three-way cock

The pumps are bolted to an aluminium tray which protects the chassis from hydrogen peroxide and which has a drain hole in one corner.

204. The petrol driven pump has a greater pumping capacity than the hand pump, but it is not liked by the detachment as it tends to splash the liquid. In later models it was removed altogether.

205. The outlet from the hydrogen peroxide tank passes to a three-way cock (see para. 201). The positions of this cock are :

(*a*) through to the petrol driven and hand pumps
(*b*) out to atmosphere
(*c*) off

206. The hand pump is bolted to the left-hand side of the power pump, or if there is no power pump, to the aluminium tray, and is fitted with a three-way cock marked "V," "R" and "D."

"V" is the position used to pump hydrogen peroxide from the tanking vehicle into the measuring tank on the Meilerwagen.

"R" is used to pump back into the tank.

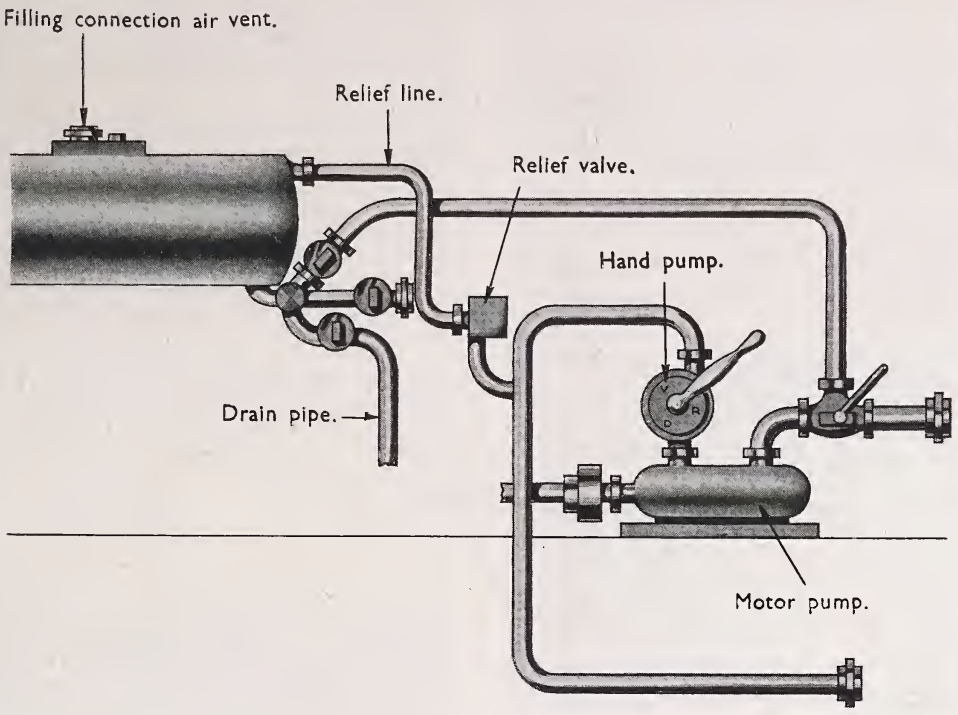
"D" cuts off the hand pump.

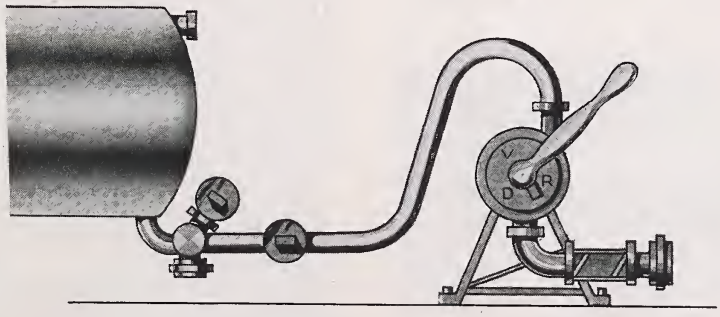
DIMENSIONS

Overall height	7 ft. 4 ins.
Overall width	7 ft.
Overall length	19 ft. 4 ins.
Tank capacity	560 gallons (2,100 litres).
Rate of pumping	Hand pump—21 gallons per minute.
	Power pump—26 gallons per minute.

Plate 11

HYDROGEN PEROXIDE ROAD TANKER PUMP.





Description of the HYDROGEN PEROXIDE Rail Tanker (T-Stoff Eisenbahnwagen) . SECTION 23

207. There are two types of hydrogen peroxide rail tanker. The original tanker consists of four separate tanks mounted in line on a flat top freight car. There is a space between each tank. Thus if one tank is damaged or catches fire, the remaining three may still be safe and intact.

208. Each tank has its own fuelling connection and cap at the top. This consists of a pipe running to the base of the tank with a connection at the top. Both filling and emptying are done through the same pipe. To empty the tank the pipe is connected by means of a hose to the road tanker hand pump and the three-way cock is set to "Pump Back." At the top of the tank there is also an air inlet and cap.

209. The capacity of the tanker is ten tons, each of the four tanks containing approximately $2\frac{1}{2}$ tons.

210. The later type of tanker is simpler in design and has a greater capacity. It consists of a single tank mounted on a freight car, with fuelling connection and air inlet as described above. It holds approximately 20 tons.

211. Hydrogen peroxide is distributed at about 85 per cent. concentration and has to be diluted when unloaded into the road tanker.

Description of the MEILERWAGEN SECTION 24

GENERAL

212. This trailer is used by the Launching Troop for transporting the rocket (Fig. 48) and for erecting it on the launching table (Fig. 49). It is also used as a platform for personnel working on the rocket when it is in the vertical position.

213. The trailer consists of four main parts :

(*a*) The chassis.
(*b*) The lift frame.
(*c*) The hydraulic lift.
(*d*) The camouflage cover.

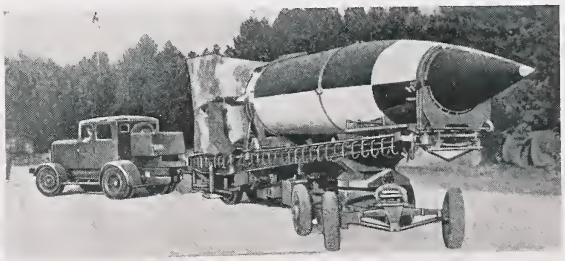


Fig. 48. The Meilerwagen

(*a*) THE CHASSIS (FIG. 50)

214. The chassis is carried on three axles. The front axle has two double wheels and a detachable trail with locking plate for driving in reverse. The two rear axles form a truck which is steered by means of a fork piece attached to a swivel stool. If the fork piece is disconnected the truck can be steered by means of a detachable bar (Fig. 51) carried on the right of the chassis.

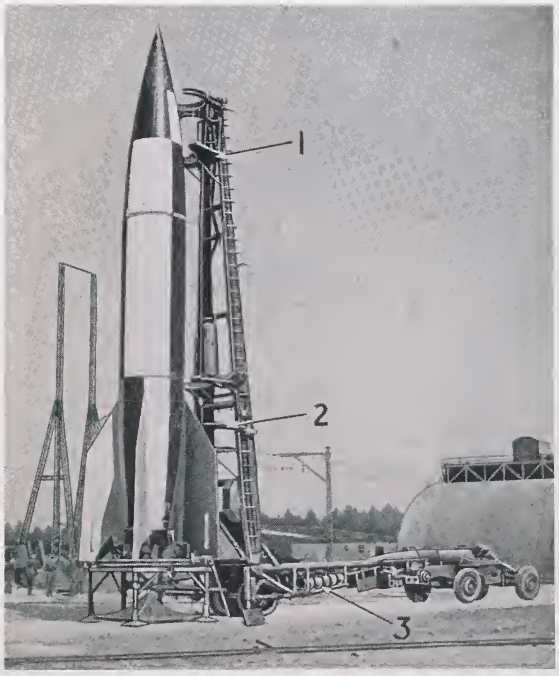


Fig. 49
1. Upper working platform 2. Lower working platform
3. Compressed air cylinder

215. The chassis consists of a heavy central tubular member which runs from the rear pillow block to a point about one-third of the way to the front axle where it forks into six smaller members, one a continuance of the central member, one below it and two on each side.

216. Compressed air brakes are fitted to the front and centre wheels and are operated from the towing vehicle. A hand brake fitted to the rear axle operates on the centre wheels only.

217. At the front end there are two guiding blades for holding the vehicle in the proper position with respect to the launching table when the rocket is being set on it after having been raised to the vertical position and a spirit level plane for levelling the trailer transversely.

218. Two girders (Fig. 52) with jacks and pads are swung out and help to support the movement caused by the overhang of the rocket when it is being raised to the vertical position but not yet set down on the launching table.

219. Also carried on the chassis are :

A spare wheel, a tool box, 10 compressed air cylinders (3,300 lbs. per sq. in.—six fixed and four removable) for charging air bottles in the rocket, two compressed air cylinders (60 lbs. per sq. in.) for operating the trailer brakes and a box containing carbon rudders for the rocket.

THE LIFT FRAME (FIG. 50)

220. Attached to the chassis by trunnions at the front or single axle end is the lift frame. This supports the rocket on the vehicle and is used for lifting it to the vertical position and lowering it to the launching table.

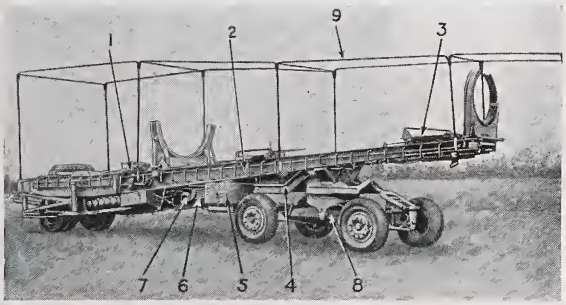


Fig. 50

1. Lower working platform
2. Lift frame
3. Upper working platform
4. Side platform
5. Petrol motor
6. The chassis
7. Petrol tank
8. Truck
9. Tubular steel frame

221. It consists of two main side girders of heavy tapered steel channel section with cross bracing both of tubular and channel form. It is rotated about the trunnions by the two pistons of the hydraulic lift which are attached by ball sockets near its base.

222. It carries two clamping collars for securing the rocket (Fig. 52). One is the full rocket diameter of 65 ins. and clamps the rocket between the propulsion unit and the tank bay. The other is of smaller diameter and fits around the rocket at the base of the war-head. Both clamps are opened by means of a lever running along the right side girder. They can be opened together or, by operating a changeover lever and using a ratchet bar, the top clamp can be opened independently. The large clamp also acts as a means of lowering the rocket on to the launching table. It is pivoted and can be raised or lowered by means of a lever which also runs along the right side girder.

223. Rungs are welded to the right side girder (Fig. 50) to form a permanent ladder by means of which the two platforms can be reached (there were originally three). These platforms, one half way up and one at the top, are folded out of the way during transport, but when the rocket is on the launching table and the trailer has been slightly withdrawn they may be swung into place by means of a handle and pulley wire (Fig. 49).

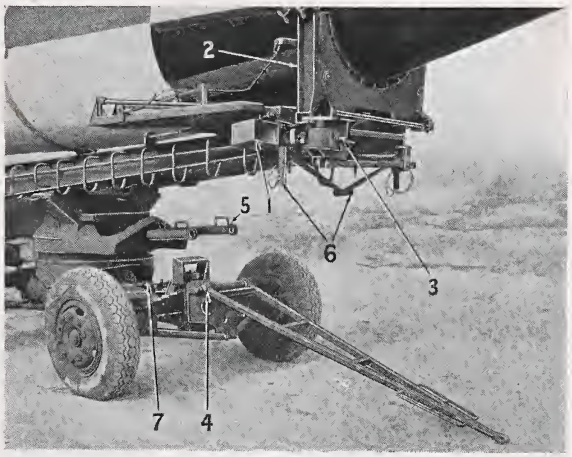


Fig. 51

1. Telephone box
2. Clamping collar
3. Ratchet shaft
4. Detachable bar
5. Fork
6. Steel support socket
7. Hand brake

224. The lift frame also carries a hydrogen peroxide tank (126 litres) with filling pipe and overflow tank and various other servicing facilities, including piping, valves and connections for filling the oxygen and alcohol tanks and electric outfits for power, light and telephone. On the left side girder is carried the cable mast belonging to the launching table.

THE HYDRAULIC LIFT (FIG. 53 AND 54).

225. This consists of two pressure cylinders with multiple extension pistons which nest together when in the lowered position. Oil for the hydraulic system is stored in a cylindrical tank on top of the chassis. A high pressure oil pump is driven by a petrol engine (or electric motor) and has three control valves operated by two control knobs and a large control hand wheel. One control valve determines the direction of flow of the oil for raising or lowering the lift frame ; another (actually two valves and operated by the large hand wheel) increases or decreases the oil pressure on the hydraulic pistons and thus controls the speed

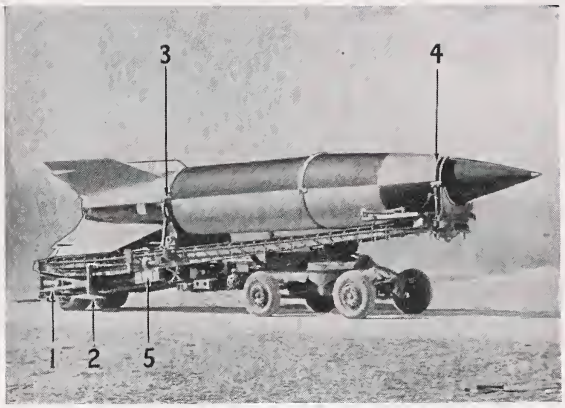


Fig. 52

1. Side girder
2. Jack
3. Lower clamping collar
4. Upper clamping collar
5. Tool box

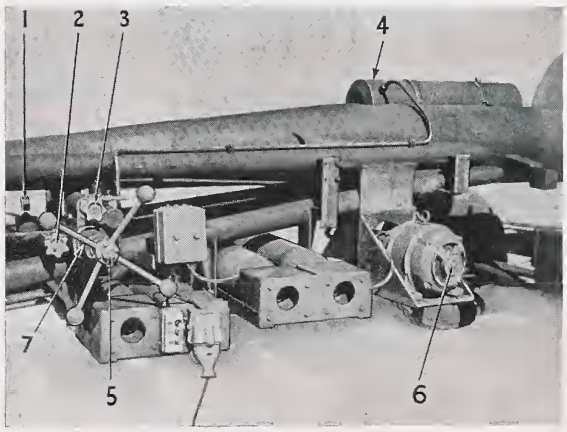


Fig. 53

1. Pressure gauge
2. Large piston control knob
3. Direction control knob
4. Oil storage tank
5. Pressure control handle
6. Electric motor for Operation "Backfire" only
7. Hydraulic control system

of raising or lowering and the third has a special function. It is necessary that the hydraulic pistons extend in the order 3, 2, 1, 4 (1 being the smallest and 4 the largest) when raising and in the reverse order when lowering. No. 4, having the greatest surface area, would extend first when raising if it were not withheld. When the third valve is closed piston No. 4 is prevented from extending.

226. The Plates 12 and 13 show the flow of oil. The two valves operated by the pressure control hand wheel are spring loaded. The top one will open against its spring if the oil pressure exceeds 125 atmos. and the bottom one if it exceeds 90 atmos. Suppose the lift frame is being raised. The sequence of events is as follows :

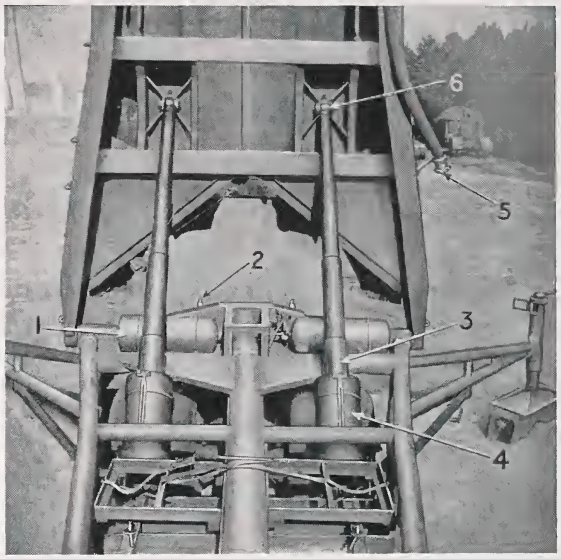


Fig. 54

1. Compressed air brake cylinder
2. Guide block
3. Large piston
4. Housing for pistons
5. Alcohol connection
6. Ball sockets

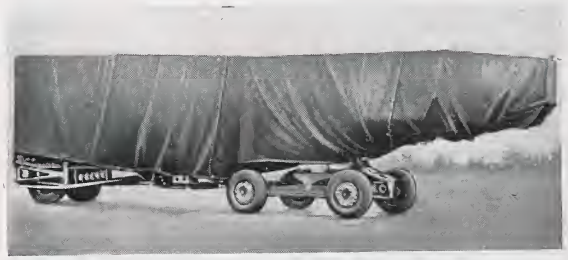


Fig. 55

(*a*) the direction control valve is set to the "Raise" position (i.e., open at the top) and the pressure control valves are opened and the large piston control valve is closed.

(*b*) The motor is started and oil is pumped via the direction control valve to the upper pressure control valve which, being open, allows oil to pass to the storage tank and no pressure is applied to the hydraulic pistons.

(*c*) The pressure control valves are then closed. Oil will flow through an annular groove surrounding the valve shaft to the hydraulic pistons and according to the amount the valves are closed (and the flow space back to the storage tank decreased) so the pressure on the pistons will increase.

(*d*) No. 4 piston, having the largest surface area, would tend to move first, but it is prevented from doing so by the oil which is locked on top of it, so No. 3 piston (the next largest) will extend, then No. 2 and then No. 1.

Plate 12

HYDRAULIC SYSTEM OF THE MEILERWAGEN.

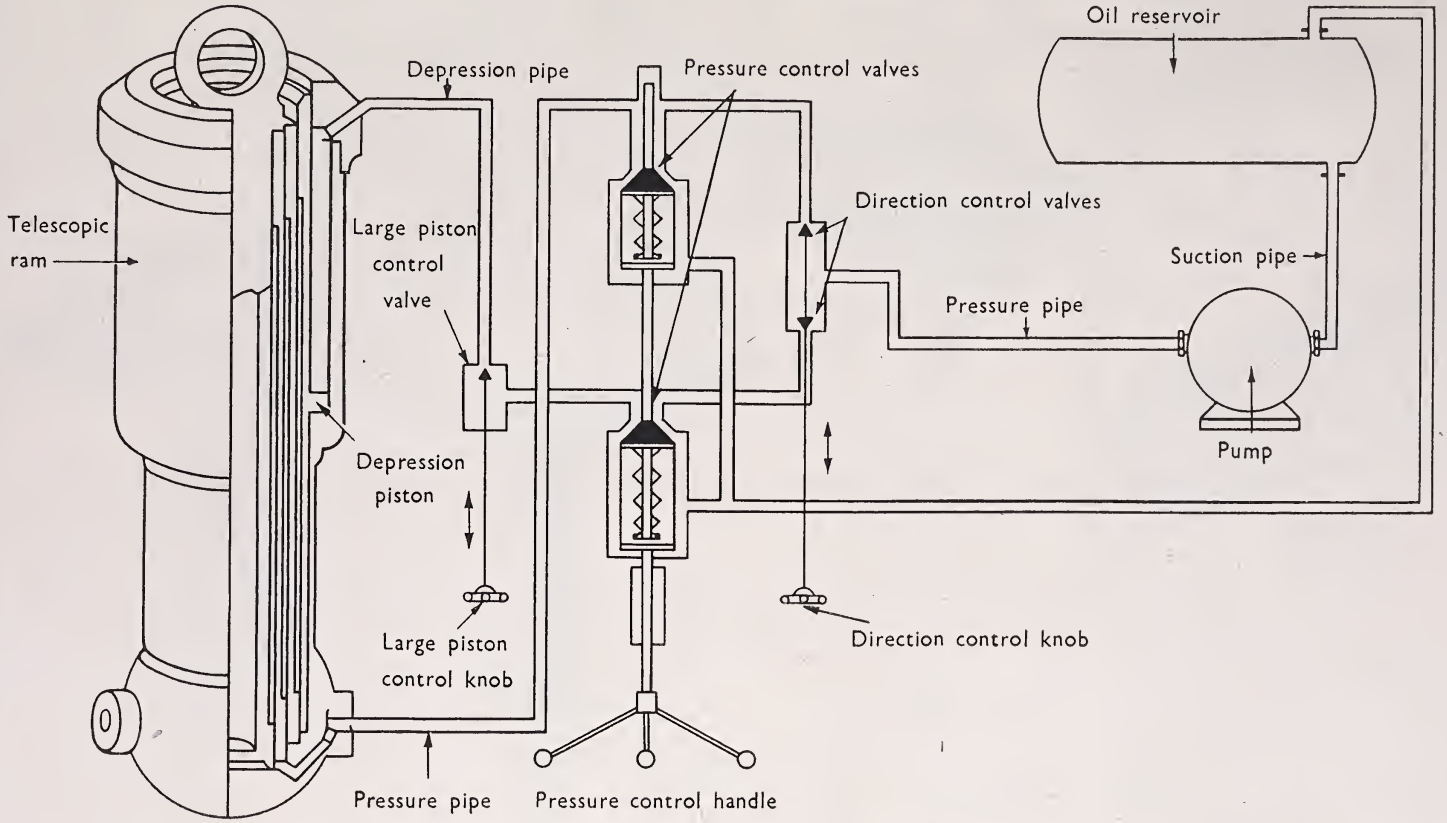
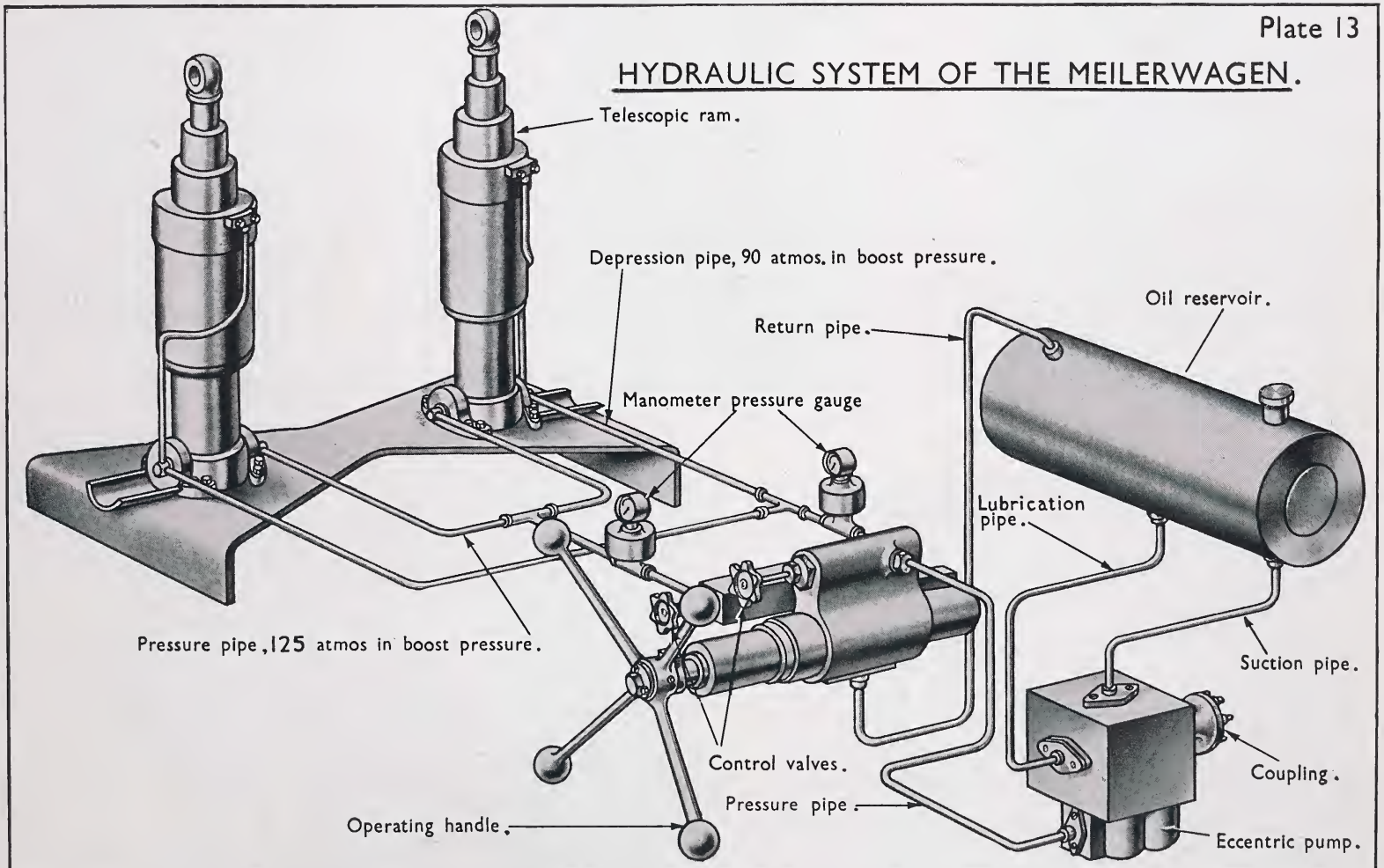


Plate 13

HYDRAULIC SYSTEM OF THE MEILERWAGEN.



THE CAMOUFLAGE COVER

227. Sockets are provided around the edge of the vehicle for mounting a pipe framework over the rocket as it rests in its clamps. The cover is made of canvas and the shape of the frame disguises the actual appearance of the rocket below as seen by air reconnaissance. The appearance is transformed to that of a large rectangular box (Fig. 55).

WEIGHTS, DIMENSIONS, ETC.

228. Total weight	Unloaded 24,900 lb. Loaded 34,100 lb.
Overall length with trail	Unloaded without camouflage frame—48 ft. 3 ins. Loaded with camouflage frame—54 ft. 8 ins.
Overall width	Unloaded without camouflage frame— 9 ft. 3 ins. Loaded with camouflage frame— 9 ft. 8 ins.
Overall height	Unloaded without camouflage frame— 9 ft. 9 ins. Loaded with camouflage frame—13 ft. 9 ins.
Turning angle	45 degs.
Turning radius	35 ft.
Ground clearance	1 ft. 2 ins.
Wheel base	Total—32 ft. 3 ins. Rear track—8 ft. 6 ins.
Track	Front axle—9 ft. 3 ins. Centre and rear axles—8 ft.
Tyre pressure	Front—92 lb. per square inch. Rear—72 lb. per square inch.
Normal speed	22 miles per hour.
Possible speed on good roads.	45 miles per hour.

Description of THE LAUNCHING TABLE and TRAILER (Abschusstisch) . . SECTION 25

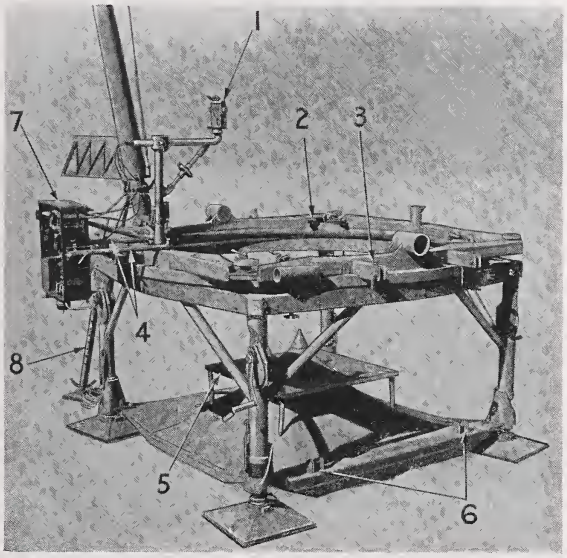


Fig. 56. Launching table

1. Five-way coupling
2. Socket for valve clamping bracket
3. Bracket for girder blade
4. Bracket for valve box
5. Working platform
6. Trailer brackets
7. Valve box
8. Cable mast support

GENERAL

229. The launching table supports the rocket in the vertical position and houses certain equipment for testing and launching. It is transportable and is carried on a two-wheel trailer.

230. The main parts are the table itself, the blast deflector, the cable mast, the valve box, the five-way coupling and the oxygen tank topping-up connection (Fig. 56).

THE TABLE (FIGS. 56 AND 57)

231. The rocket stands on four adjustable supporting plates on a turn-table mounted on a ball race. The turn-table can be traversed by means of a traversing handle, or by hand, if the traversing handle lever is set to the neutral position. It can be clamped by four screws underneath the turntable. Four jacks provide a means of raising, lowering and levelling the table. There are four hooks on the table legs which can be attached to the blast deflector.

THE BLAST DEFLECTOR

232. The blast deflector is of heavy steel plate in the shape of a pyramid, the sides being slightly concave. The four corners are bolted to sleeves which fit round the table legs. When the hooks on the table legs are secured to the sleeves, the blast deflector can be raised by means of the jacks. Two brackets and a leg on the blast deflector provide the means of attaching the launching table to the trailer in the travelling position (Fig. 58). The steel plate is cut away to form two hinged aprons to accommodate the wheels.

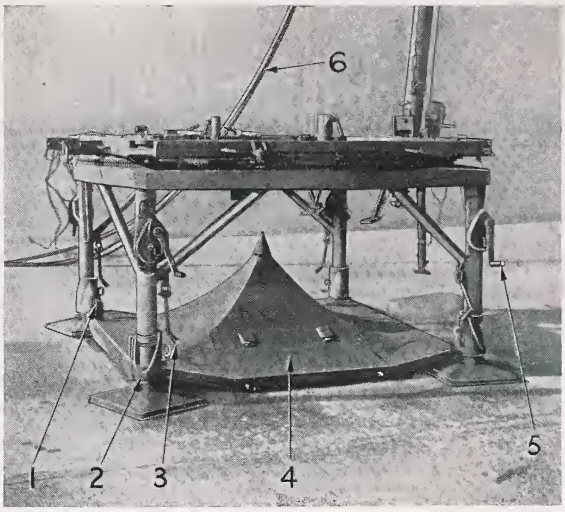


Fig. 57

1. Sleeve eye
2. Sleeve
3. Hook
4. Hinged panel of blast deflector
5. Jack handles
6. Cables

THE CABLE MAST (FIGS. 59 AND 60)

233. The cable mast fits into a socket on the turntable. It can be raised and lowered by means of a screw jack and ratchet. It has an adjustable supporting stay and a winch for raising and lowering the cables. When travelling, the mast is carried on the Meilerwagen.

THE VALVE BOX (FIG. 56)

234. The valve box is secured by clamps to two tubular supporting stays attached to the turntable. When travelling the valve box is removed and placed in another vehicle and the supporting stays are swung through 90°. The valve box contains electrical and compressed air connections and gauges for testing and firing the rocket. It is described in detail in Section 26.

THE FIVE-WAY COUPLING (FIG. 56)

235. This is an adjustable coupling which fits into a socket on the turntable at the rear of the valve box, and engages five connecting pipes at the base of the rocket. Four connections are to the valve box and one is a draining pipe from the alcohol pump in the socket. A spring-loaded protecting cover plate is in position when the coupling is not connected to the rocket. The coupling is raised or lowered by the hand wheel provided. When travelling it is carried on another vehicle.

THE OXYGEN TOPPING-UP CONNECTION

236. This is an adjustable connection which fits into a socket on the turntable. It receives the topping-up pipe on the rocket, and the oxygen filling pipe (40 mm.). There is also a compressed air pipe connection at its base for operating the filling valve.

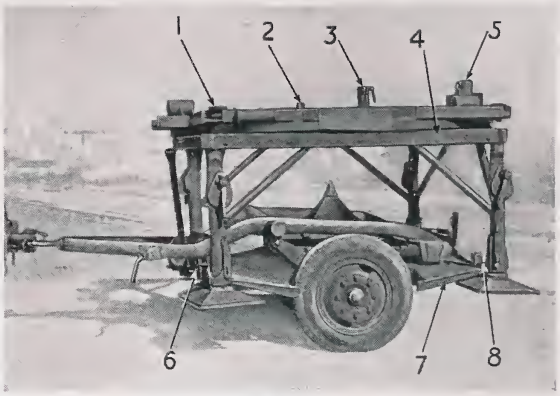


Fig. 58

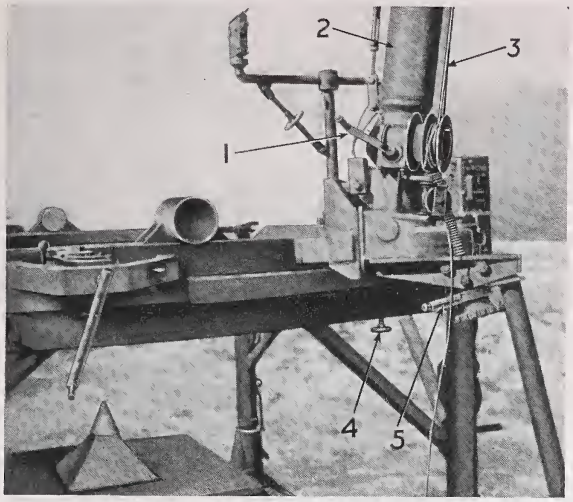
1. Adjustable plate
2. Oxygen topping up connection socket
3. Five-way coupling socket
4. Table
5. Cable mast socket
6. Trailer securing pin
7. Blast deflector
8. Trailer hooks

Fig. 59

THE TRAILER (FIGS. 58 AND 61)

237. The trailer is of simple tubular steel framework forming a trail at the front and two arms at the rear for engaging the brackets on the blast deflector. A jack is fitted to the trail. This supports the trailer when it is disconnected from the towing vehicle and also, by engaging the lug on the blast deflector, supplies a means of raising and lowering the launching table. A socket for engaging the lug on the blast deflector and a pin are used for securing

the table in the travelling position. The stub axles each have one leaf spring. No brakes are fitted.



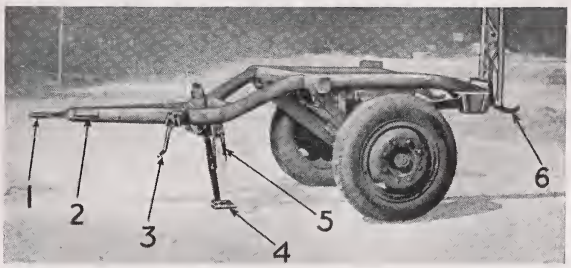


Fig. 61

1. Towing eye
2. Handle
3. Jack handle
4. Jack pad
5. Pin
6. Hooks

Fig. 60

1. Cable raising handle
2. Cable mast
3. Cable raising wire
4. Clamping screw
5. Mast raising ratchet

The VALVE BOX (Ventilkasten) . . . . . SECTION 26

(*See Fig.* 62 *and Section* 11, *Plate* 9)

GENERAL

238. The valve box provides a means of supplying air to the rocket at the required pressures during tests, fuelling and launching. It is mounted on the launching table by means of two brackets.

EXTERNAL CONNECTIONS

239. (*a*) *Oxygen tank air pressure regulating pipe* (*A-Tank-druckleitung*)
At the rear in the centre. The pipe comes from the five-way coupling.

(*b*) *Rocket air bottle charging pipe* (*Fuelleitung*)
At the rear on the left. Also from the five-way coupling.

(*c*) *Air pressure for operating valves pipe* (*Steuer-druckleitung*)
At the rear on the right. From the five-way coupling.

(*d*) *Oxygen tank pressurising pipe* (*A-Beluftungs-leitung*)
Right side. From the five-way coupling.

(*e*) *Air inlet pipe*
Left side at the top. The pipe comes from the air bottles on the Meilerwagen, or during launching, from a bottle laid on the ground.

EXTERNAL CONNECTIONS (*cont.*)

(*f*) *Igniter* (*Kundung*)
Three terminals on the left side under the air inlet.

(*g*) *Emergency fuel cut-off* (*Brennschluss*)
Two terminals on the left side in the middle.

(*h*) *Telephone to the fire control vehicle* (*Fernsprecher*)
Two terminals on the right side at the bottom.

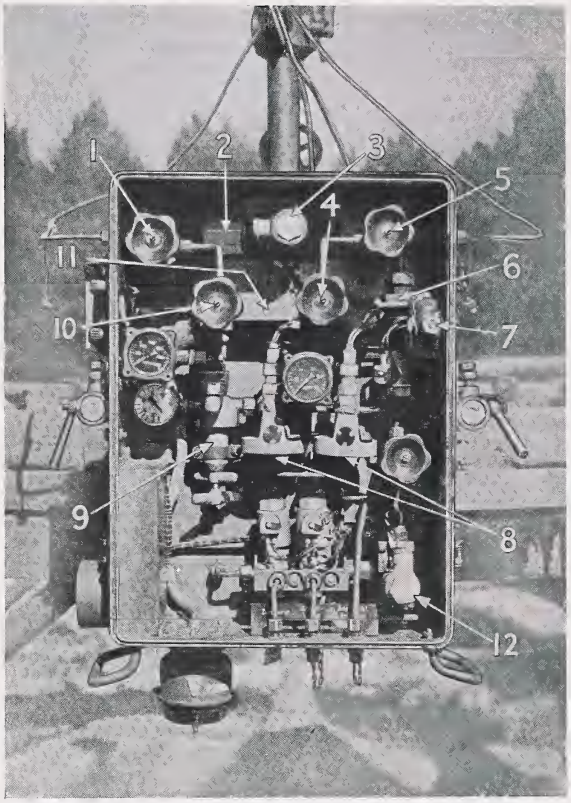
THE INTERIOR

240. A cover, which is always on and secured by four catches during launching, allows access to the interior which contains : a distributor, a pressure reducer, electric valves, three stop cocks, two release cocks and a 14-pin socket for attachment of the test switch box (See Section 9).

THE AIR FLOW

241. Compressed air at 200 atmos. comes in the inlet pipe, through a filter and an electric valve (N1h) to the distributor. From the distributor it goes in three directions :

(*a*) To the pressure reducer which reduces it to approximately 25 atmos. for operation of valves, through a hand stop cock (which is never used), past two electrical valves (which are not now used), through an electrical valve (D1h) through a hand stop cock and hand release cock to the " Air pressure for operating valves " pipe (Steuerdruckleitung).



AIR FLOW (*cont.*)

(*b*) Via hand stop cock and hand release cock to the " Rocket air bottle charging " pipe (Fuelleitung).
(*c*) Through an electrical valve (N1h) to the oxygen tank pressurising pipe (A-Beluftungsleitung).

242. The pressure regulator, which regulates the air pressure in the oxygen tank, controls the electric valve (N1h). It closes N1h at about 1·5 atmos and opens again when the air pressure drops to 0·9 atmos. and thus maintains the oxygen tank pressure at about 1·5 atmos.

243. The three gauges indicate high pressure (as it comes in), reduced pressure (as it goes out for operation of valves) and regulated pressure (for the oxygen tank).

Fig. 62. Valve box

1. Air release cock
2. Filter
3. Solenoid valve
4. Air inlet cock
5. Air release cock
6. Solenoid valve
7. 14-pin socket (plug in position)
8. Pressure regulator contacts
9. Pressure reducer
10. Air inlet cock
11. Distributor
12. Electric valve

Description of the FIRE CONTROL Vehicle (Feuerleitpanzer) . . . . . SECTION 27

GENERAL

244. The fire control vehicle is armoured as a protection against rocket blast. It is powered by a six-sylinder petrol driven engine developing 120 H.P. driving through two 14-inch tracks carried on eight-wheel bogies at each side.

245. It is driven into position with the rear towards the launching table and is normally dug in to the depth of its tracks (Fig. 63).

246. On the left-hand side at the forward end of the control compartment (see para. 257 below) there is a box with five sockets for telephone lines. On the same side at the rear there are two sockets for cable plugs, one for the power supply from the generator (27 and 220 volts) (Fig. 64) the other a 104 pin socket leading to the relay box in the generator vehicle.

247. On the right-hand side there is an entrance door and a tool box.

248. On both sides there are catches and fittings for accessories.

249. On top of the vehicle there is an observation manhole which can be closed before firing.

250. In the front there is the driver's compartment which is unarmoured.

251. At the rear there is a towing hook and brake connection (the fire control vehicle normally tows the launching table trailer) (Fig. 64).

252. The armoured portion of the vehicle is divided into the fire control compartment at the rear and the telephonist's compartment at the front.

Fig. 63. Fire control vehicle

THE FIRE CONTROL COMPARTMENT (FIG. 65).

253. In the fire control compartment there are three control panels which face the rear, i.e., face the launching table. On the left there is the rocket motor panel (described in Section 29) and on the right the steering panel (described in Section 28). The two operators sit on adjustable seats and can see the rocket through long oblong windows of special 2-inch glass.

254. Above these panels is the wireless panel, used for tests and control of the rocket during flight, including fuel cut-off. It is operated by the Officer i/c Launching Platoon.

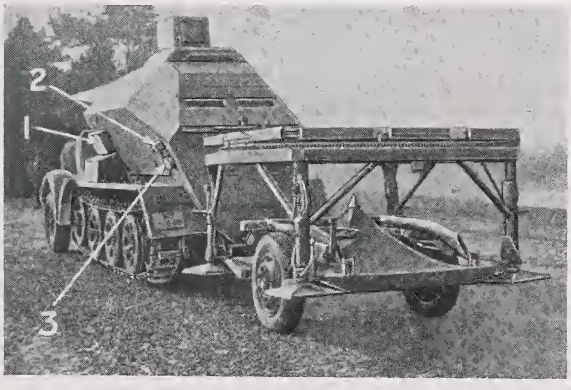


Fig. 64

1. Telephone box
2. Power supply plug
3. 104-pin socket

255. On the wall to the right of the steering panel, supported by four brackets, is the Integrating Accelerometer test box. This test box is used for testing and setting the Integrating Accelerometer. It is referred to in Section 12.

256. There are telephones under the rocket motor and steering panels for use of the steering and rocket motor panel operators and on the right-hand wall for use of the Officer i/c Launching Platoon. They are connected to the concentrator in the telephonist's compartment.

THE TELEPHONIST'S COMPARTMENT

257. The telephonist's compartment has a seat, a desk, a cupboard, various fittings for holding papers and a concentrator with 10 or 20 lines.

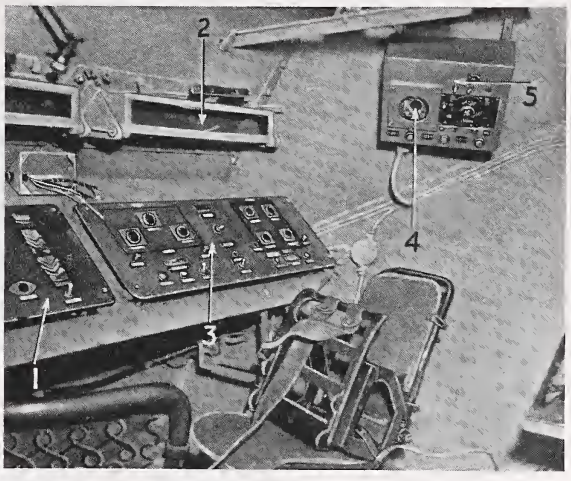


Fig. 65

1. Steering panel
2. Observation window
3. Rocket motor panel
4. Stop watch
5. Integrating accelerometer test box

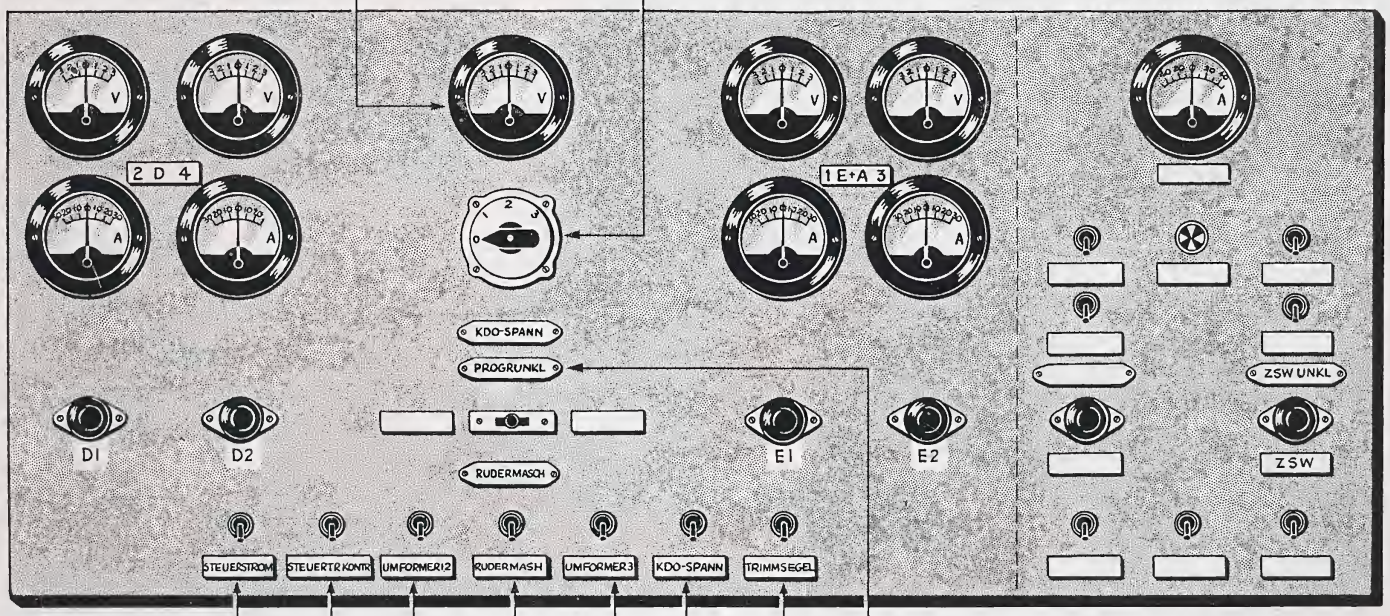
In the case of 10 lines, connections would be made as follows :—

1. Troop H.Q.
2. Upper Working Platform.
3. Launching Table.
4. Launching Position, general purpose.
5. Officer i/c Launching Platoon.
6. Steering Panel Operator.
7. Rocket Motor Panel Operator.
8. Generator Vehicle.
9. Fire Control Vehicle of No. 2 Launching Platoon.
10. Fire Control Vehicle of No. 3 Launching Platoon.

258. If wireless control is used, a 20-line concentrator is necessary. It is then also possible to have lines to the launching position car parks.

259. Battery H.Q. can be reached via Troop H.Q. and Fuel and Rocket and Technical Troops can be reached via Battery H.Q.

STEERING PANEL.



RADIO CONTROL PANEL.

The STEERING Panel (Steuerung Pult) . . . . . SECTION 28

260. This panel is in the fire control vehicle and is used for steering tests. It is illustrated in Plate 14.

261. At the bottom of the panel there are 7 switches as follows :—

Steering switch	—switches on current to panel itself.
Meter switch	—interrupts current to ammeters and voltmeters. Used to check that meters are operating correctly.
Alternator switch	—switches on current for alternator 1 (control amplifier) and alternator 2 (gyros).
Servo motor switch	—switches on current to servo motors which control vanes.
Radio alternator switch	—Switches on current to alternator 3 (radio).
Gyro potentiometer switch	—switches on current to potentiometers of two gyros.
Outer rudder motor switch	—switches on current for outer rudder motors.

262. Indicating lights below the switches light when the switch is on provided the mechanism is in order.

263. The two-way switch in the centre is not used.

264. Indicating lamp " Precession " comes on if there is a fault in the precession sequence.

265. The voltmeter switch for alternators 1, 2 and 3 selects whichever alternator it is required to test. The voltage can then be read on the voltmeter above.

266. The voltmeters and ammeters on the left are for the pitch gyro potentiometer, and those on the right the roll and yaw gyro potentiometers. Press buttons D1, D2, E1 and E2 unbalance the current and thus simulate commands to the carbon rudders.

267. On the right there is the time switch (ZSW) press button—used for zeroing the time switch during tests—and an indicating lamp which comes on when the time switch is not at zero.

268. The remaining lamps and switches on the right-hand side are used for wireless control.

The ROCKET MOTOR Panel (Triebwerk Pult) . . . . . SECTION 29

PLATE 15

269. This panel is in the fire control vehicle and is used for tests and launching.

270. At the top of the panel in the centre is the main key. It can be turned to two positions—test and fire. It controls the main test and launching circuits. When the panel is not in use the key is withdrawn.

271. On either side of the main key are a voltmeter and an ammeter for testing the D.C. current.

272. On the left of the panel there are various indicating lamps :

(*a*) Stotz I and II which are extinguished when the Stotz plugs are thrown off.
(*b*) Ground power and rocket-borne power which light up according to which source of power is being used.
(*c*) Oxygen tank pressure which lights up when the oxygen tank is being pressurised and is extinguished when the pressure is correct.
(*d*) Igniter Clear which is extinguished when the igniter circuit is broken, i.e., when ignition takes place.

273. On the right of the panel there are further indicating lamps which show when a fault occurs. There is a horn to call attention to it and a switch for turning it off. When the horn is switched off the indicating lamp " Horn off " will remain on as long as the fault persists.

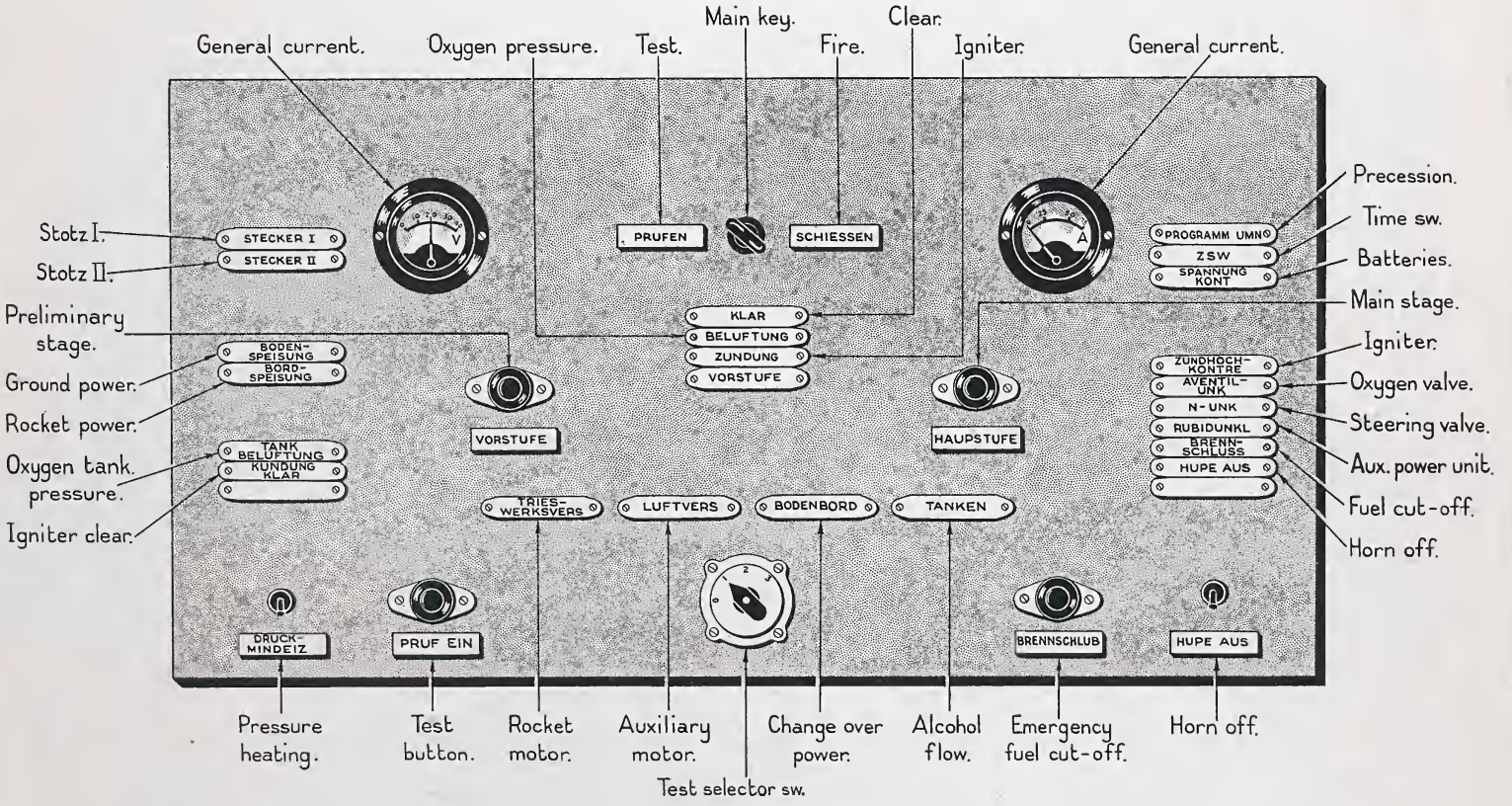
274. In the centre of the panel are the preliminary stage indicating lamps which come on in turn as the various events take place.

275. Also in the centre of the panel are the press buttons which initiate the preliminary and main stages.

276. At the base of the panel there is a test switch with four positions and a test button for initiating the test. The auxiliary motor test is not now done on the launching position.

278. On the right of the test switch is the emergency fuel cut-off button. As long as the rocket remains on the launching table the fuel supply can be cut off in an emergency by depressing this button.

ROCKET MOTOR PANEL.



Description of the HYDROGEN PEROXIDE Heater (T-Stoff Vorwaermenanhaenger SECTION 30

NOTE.—The photographs in this Section are of a mock-up heater which, in the absence of a real one, was used for Operation " Backfire." The real heater has a smaller trailer and is normally not fitted with a pump. A few models were fitted with a pump on top of the hydrogen peroxide container, but this pump was apparently never used.

GENERAL (FIG. 66).

279. The heater is used if the temperature is below 20°C. The reason for heating the hydrogen peroxide before it enters the rocket tank is that it delays freezing which may occur if the rocket remains fuelled with oxygen for any length of time. Interrogation has shown that the heater was in point of fact seldom used, even in winter. It was not liked, due to the danger of having any fire anywhere near hydrogen peroxide. The question of freezing rarely arose since the policy was always to launch the rocket as soon as possible after fuelling.

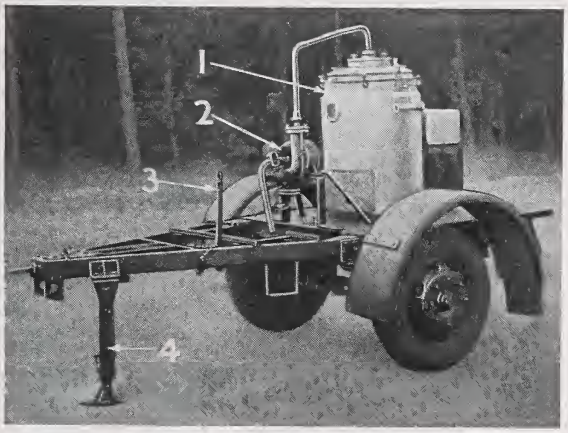


Fig. 66. Hydrogen peroxide heater

1. Heating jacket
2. Hand pump
3. Hand brake
4. Front supports

Fig. 67

280. The heater is mounted on a two-wheeled trailer and is towed by the hydrogen peroxide waggon (Fig. 67). It consists of three main parts :

(*a*) The heater blower.
(*b*) The heating jacket.
(*c*) The hydrogen peroxide container.

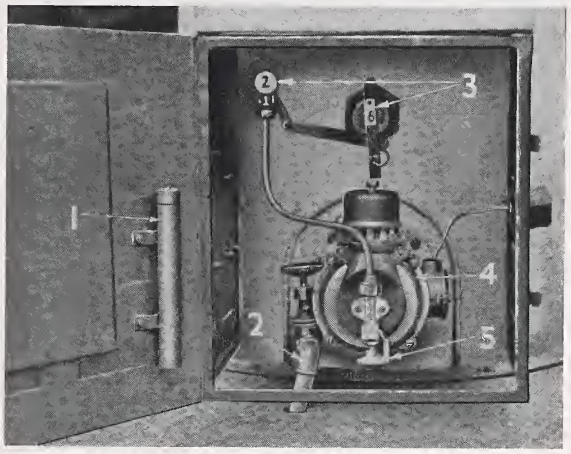


Fig. 68

1. Taper
2. Drain pipe
3. Thermostatic control
4. Electric blower
5. Control tap

THE HEATER BLOWER (FIG. 68)

281. The heater blower is mounted in a cupboard beside the heating jacket. It consists of an electric motor operated by a 220 volt supply obtained from the generator. The electric motor drives a fan. Alcohol, delivered from a saddle tank on top of the cupboard, is vaporised by the electric fan, and blown out through a jet (blow lamp principle). The alcohol feed is controlled by a thermostat so that the water temperature (see para. 283 below) does not exceed 40°C. A taper, soaked in alcohol, is kept in a container on the door of the cupboard and is used for lighting the jet. The flame from the jet passes through a 2-inch inlet at the base of the heating jacket.

THE HEATING JACKET (FIGS. 69 AND 70)

282. The heating jacket is a galvanised, double-walled cylinder. The 2-inch inlet at the base leads to a 6-inch pipe which divides into three and radiates heat to the hollow walls. This heats water inside the cylinder.

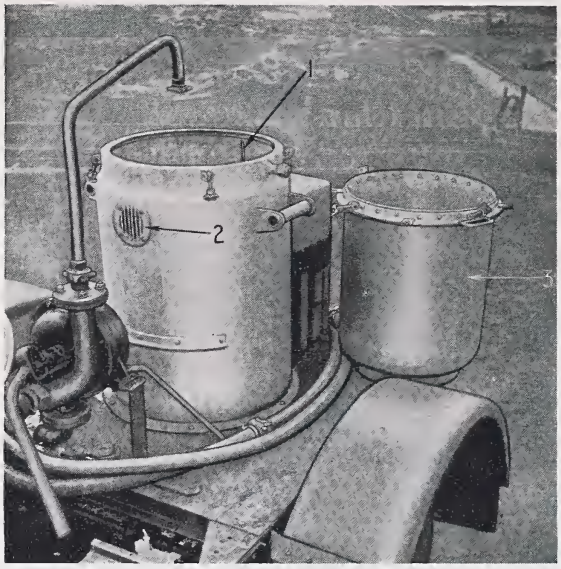


Fig. 69
1. Inspection window 2. Ventilator
3. Hydrogen peroxide container

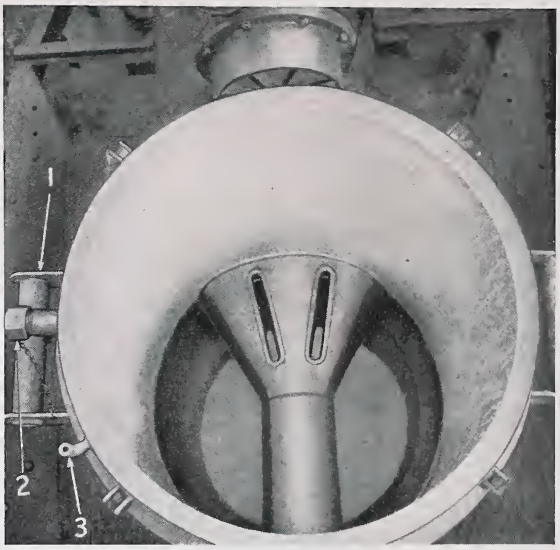


Fig. 70
1. Lifting handle 2. Filling pipe
3. Overflow pipe

283. To the heating jacket is fitted a 4-inch ventilator for allowing alcohol fumes to escape from the hollow walls, a water level inspection window, a recess for the thermostatic control, a $\frac{3}{4}$-inch filling pipe, a $\frac{1}{4}$-inch overflow pipe and a $\frac{1}{2}$-inch drain pipe and tap. The heater is bolted to the trailer and there are two handles for lifting it off and four tumbler bolts for securing the hydrogen peroxide container.

THE HYDROGEN PEROXIDE CONTAINER (FIG.69)

284. The container fits into the heating jacket and rests on a lip. It is secured in position by the four tumbler bolts on the heating jacket and has itself four tumbler bolts for securing its own lid. On the lid there is a small cover secured by two bolts.

285. There is a spring loaded gas escape valve on the lid and on the small cover there is a pipe which is used for both filling and emptying.

286. The container holds 150 litres of hydrogen peroxide. It is filled and emptied via a 32 mm. pipe by the hand pump on the hydrogen peroxide waggon.

Description of the HYDROGEN PEROXIDE Measuring Tank on the Meilerwagen (T-Stoff Messbehaelter) . . . . SECTION 31

GENERAL

287. The measuring tank holds 126 litres, which is the exact amount of hydrogen peroxide required for filling the tank on the rocket. It is permanently fixed to the lift frame of the Meilerwagen just above the lower working platform (Fig. 71). Hydrogen peroxide is pumped into it from the road tanker or heater trailer, and runs out of it into the rocket tank.

DESCRIPTION

288. The tank is made of aluminium alloy. It has a large inspection cover at the top which is kept screwed down.

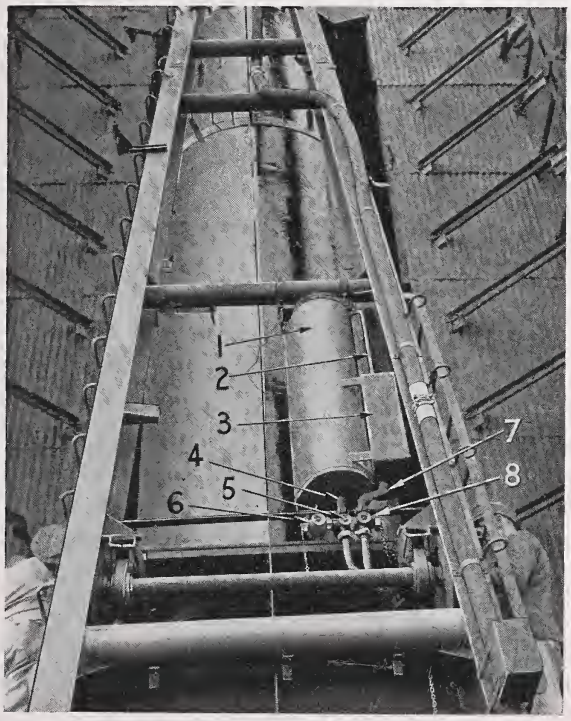


Fig. 71. Hydrogen peroxide measuring tank

1. Tank
2. Overflow pipe
3. Overflow tank
4. Inlet pipe
5. Three-way cock
6. Outlet cock
7. Overflow tank pipe
8. Overflow shut-off cock

Just below the top there is an inspection window with a mark on it, which indicates when the tank is filled to 126 litres, and an overflow pipe. At the base there is a pipe which serves both as an inlet and exit and leads to a three-way cock (Fig. 72).

289. The three-way cock can be set to " Fill or empty " (used when filling the measuring tank with hydrogen peroxide or when emptying rinsing water out of it), to " Tank " (used when emptying hydrogen peroxide from the measuring tank into the rocket tank) and to " Off." The " Tank " connection leading from the three-way cock to the rocket tank also has a shut-off cock.

290. The overflow pipe leads to an overflow tank, fixed to the side of the measuring tank. There is an outlet in the base of the overflow tank with a corresponding shut-off cock.

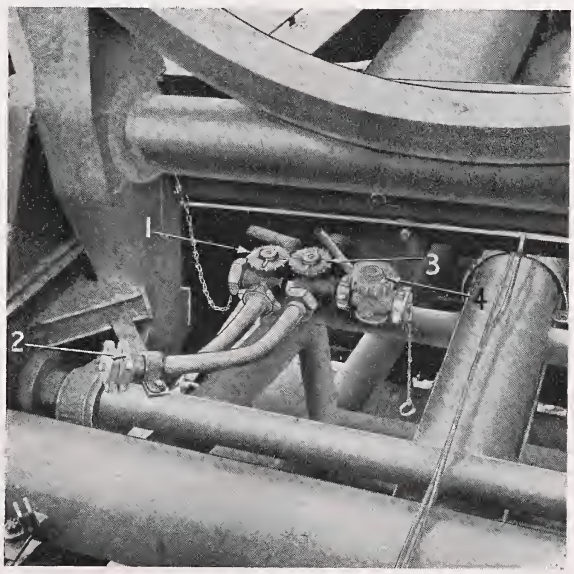


Fig. 72

1. Overflow shut-off cock
2. 32 mm. connection
3. Three-way cock
4. Outlet shut-off cock

Description of the HOT AIR Blower (Heissluftblaeser) . . . . . SECTION 32

GENERAL

291. The hot air blower is used to prevent the servo motors in the tail unit and the various valves and controls in the propulsion unit from freezing up after the oxygen tank has been filled. It is not normally used in hot weather if the rocket can be launched within an hour of fuelling.

292. It is portable and can be lifted by four men by means of four lifting handles. It is normally carried on the test vehicle and when standing on the ground it rests on two skids (Fig. 73).

DETAIL (FIG. 74)

293. The right section contains the engine. This is a single cylinder 2 H.P. 2-stroke IC engine burning a mixture of petrol and oil at a ratio of 25 to 1. It drives a petrol pump in the heater burner and an air blower.

294. The left section contains the heater burner in which a petrol jet is ignited by a sparking plug. It has an inlet and outlet ventilator. The outlet ventilator leads into the top of the centre section, which contains the blower.

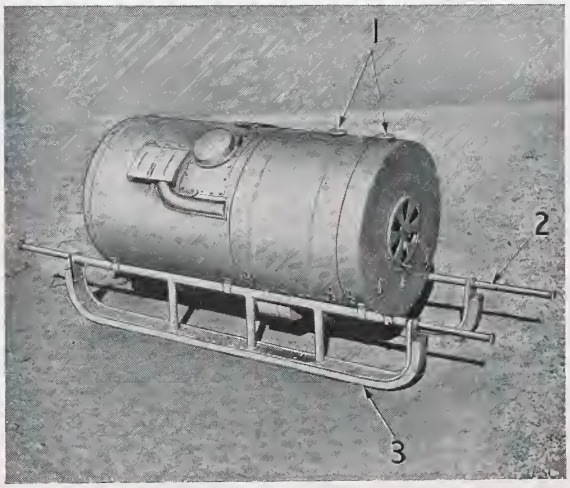


Fig. 73. Hot air blower
1. Filler caps 2. Lifting handle
3. Skid

295. The blower is a double fan. It drives hot air from the heater burner into a T-shaped pipe, to which are connected two flexible pipes. The ends of the flexible pipes are laid wherever heat is required, e.g., in the tail unit of the rocket (Fig. 75).

296. Behind the engine two tanks supply the mixture for the engine and the petrol for the heater burner. The mixture flows to the engine via the main control valve (see para. 297 below). The petrol flows to the pump and thence to the main control valve. It then passes through a thermal control valve (see para. 298 below) to the jet.

297. The main control valve has a three-position switch on the control panel. It is marked ZU (off), I and II. At position I the mixture only is allowed to flow. This position is used for starting the engine. At position II the petrol for the heater burner is allowed to flow. It is switched to this position after the engine has been running a few minutes.

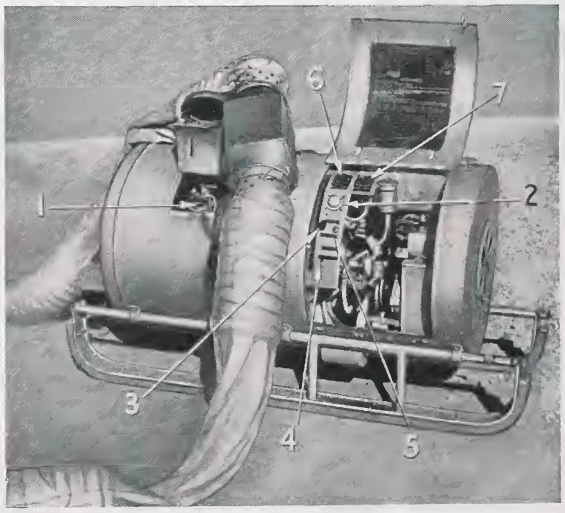


Fig. 74
1. Window
2. Thermal control screw
3. Auxiliary petrol pump knob
4. Main control valve
5. Ignition button
6. Air temperature gauge
7. Petrol pressure gauge

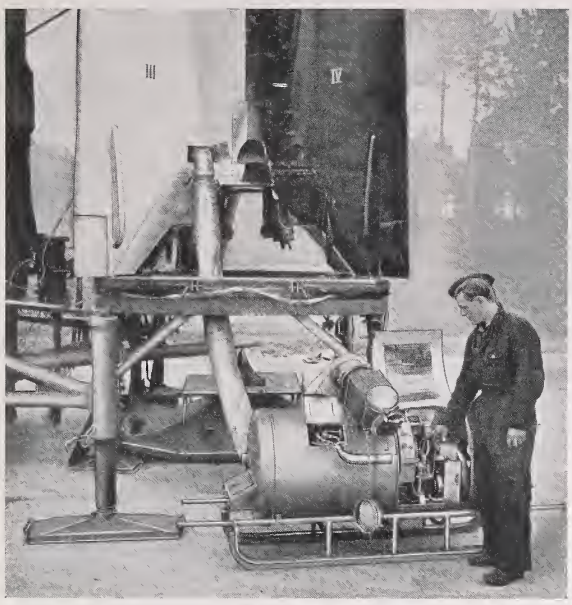


Fig. 75

298. The thermal control valve regulates the temperature of the hot air. It can be set to any temperature by means of a screw on the control panel. It will then keep the hot air at approximately that temperature by controlling the supply of petrol to the burner. A gauge on the control panel indicates the temperature of the air. A second gauge shows the pressure of the petrol at the jet.

299. Also provided on the control panel is a black knob which operates an auxiliary petrol pump. If, when starting up the heater burner, the jet becomes temporarily fouled, the knob on the control panel is pulled vigorously in and out, and petrol is forced through the jet. The flash in the heater burner when the petrol ignites can be seen through an inspection window. Next to this knob is a red button for arresting the ignition and stopping the engine.

OPERATION

To Start (*minimum temperature*—10° *Centigrade*)

(*a*) Open the lid.
(*b*) Ensure that both fuel tanks are full.
(*c*) Test for water at the drain cock.
(*d*) Set the main control valve lever to position I (Motor Fuel).
(*e*) Close air filter by putting lever marked "Z" to 12 o'clock.
(*f*) Prime the carburettor.
(*g*) Open carburettor lever quarter or half-way.
(*h*) Operate starting handle a few times, find the compression point, force the handle down and release.
(*i*) After starting slowly open the air filter and carburettor.
(*j*) Set the main control valve lever to position II (Heater Fuel).
(*k*) Observe through the window if the heater is functioning. If the fuel is not passing to the heater, operate the auxiliary pump knob by pulling vigorously in and out.

To Stop

(*a*) Set the main control valve lever to position I.
(*b*) After two minutes set the main control valve lever to ZU (off).
(*c*) Press the red button.

DIMENSIONS

300. Overall length (with lifting handles) — 7 ft.
Overall length (without lifting handles) — 5 ft. 3 in.
Overall height — 2 ft. 8 in.
Overall width — 2 ft. 2 in.

Description of THE MAGIRUS LADDER (Handlicher Feuerwehrleiter) . . SECTION 33

GENERAL

301. When the rocket is in the vertical position, this ladder is used for obtaining access to those parts which cannot be reached from the Meilerwagen lift arm.

It can be towed short distances on the launching position but is not sufficiently mobile to be towed any distance along roads (Fig. 76). It is therefore normally carried in a truck. It has a guide wheel and handle for use when manhandling and a hand operated brake which operates on the right wheel only.

DESCRIPTION (FIG. 77)

302. It is a three-section ladder, similar to a fire ladder, and is carried on a centrally mounted axle with two wooden wheels. When fully extended it is 56 ft. long and can be elevated to any angle.

303. It is pivoted at the centre and is elevated by operating two ratchets which turn a drum on to which is wound (or unwound) a steel web band attached to the bottom of the ladder. It is extended on the pulley and wire rope system by operating two handles at the base. Two adjustable jacks with pads support the front when it is brought into action.

304. On the left side there is a hand wheel for adjusting the ladder laterally when on uneven ground.

A plumbob and chart on the right-hand side show the angle of elevation and lateral tilt and indicate the safety length and weight for these angles.

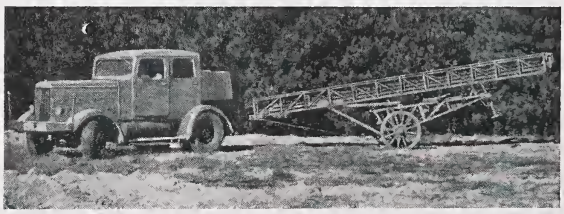


Fig. 76. The Magirus ladder

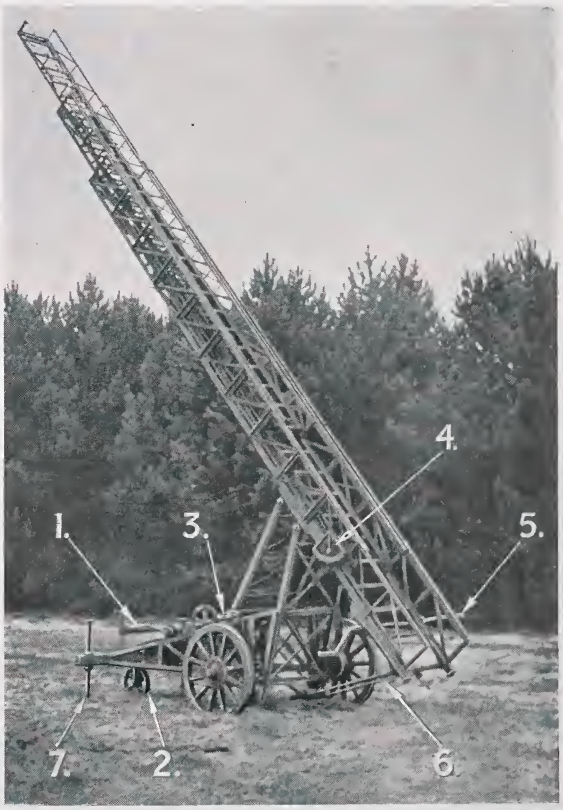


Fig. 77

1. Raising & lowering handle
2. Guide wheel
3. Lateral adjustment hand wheel
4. Plumbob
5. Extending handle
6. Steel web band
7. Supporting jacks

Description of the PYROTECHNIC IGNITER (Pyro-Zundung) . . . . . SECTION 34

GENERAL

305. The pyrotechnic igniter is supported on a stand (Fig. 78) which fits into the venturi so that the igniter itself is inside the combustion chamber. It is ignited by means of an electrical circuit which is closed when the oxygen tank has been pressurised and fuel is ready to pass into the combustion chamber. As soon as the fuel starts burning, the igniter and its stand are destroyed by the flame.

THE IGNITER STAND

306. The stand consists of two cardboard tubes 1·75 ins. in diameter and 2 ft. 6 ins. long, which are joined together by means of a wooden peg. The stand is supported at its base and in the combustion chamber by two wooden struts at right angles to each other. The bottom strut is secured by clips in the base of the venturi (Fig. 79). The top strut bears against the walls of the combustion chamber where it narrows to form the venturi.

307. At the top of the tube is a fuze head made of bakelite. In this are two fuzes connected to the valve box by means of electric leads. On the top of the fuze head is a supporting pin for the igniter. On ignition of the fuzes flame passes through two channels in the fuze head to the igniter. The fuze head also contains a magnesium strip which is broken when the igniter begins to revolve and breaks a circuit for the indicating lamp " Ignition " on the rocket motor panel.

THE IGNITER (FIG. 80)

308. The igniter is shaped like a swastika. It is made of plastic material and has four pyrotechnic charges with fuze trains in each. It is retained in position by two leaf springs.

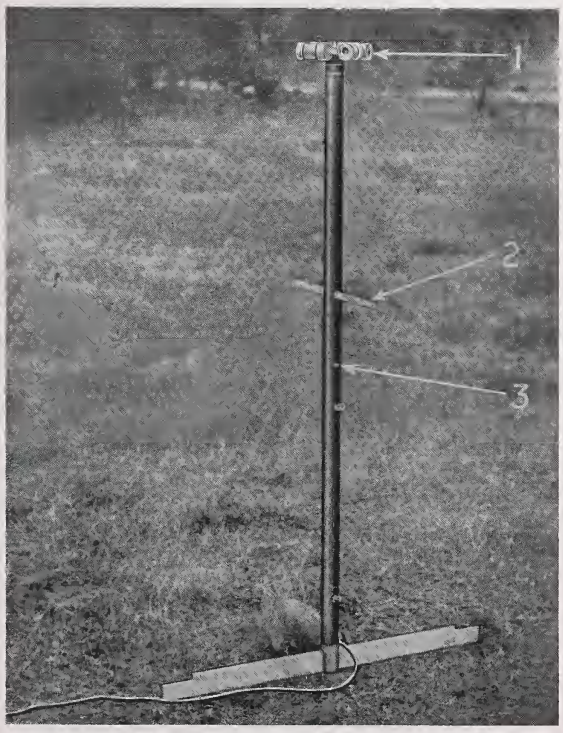


Fig. 78. Pyrotechnic igniter
1. Igniter 2. Top strut 3. Wooden peg

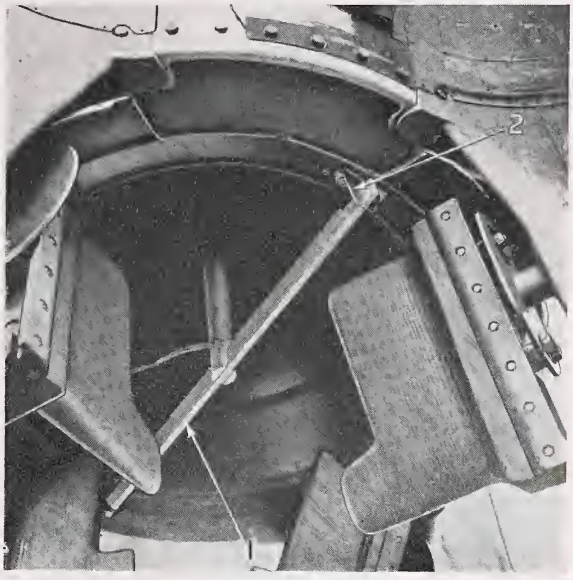


Fig. 79
1. Bottom strut 2. Clip

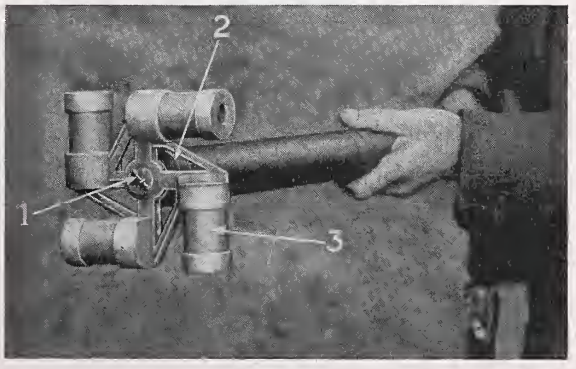


Fig. 80
1. Leaf spring 2. Fuze head 3. Pyrotechnic charge

Description of the DIRECTOR COLLIMATOR 12 Metres (Richtkreis Kollimator 12M) SECTION 35

GENERAL

309. The collimator is a twin optical instrument consisting of a director and a collimator.

310. As a director it is used to lay guns on the line of fire. As a collimator it is used as an aiming point to maintain the line of fire.

311. Director and collimator are joined mechanically but separated optically.

312. The magnification is five. The field of view is 130 metres at 1,000 metres.

313. It can be used in the same way as an ordinary director. In gunnery however, its main purpose is to lay the collimator in any given line.

314. As is nearly all directors the eyepiece is set at 45 degrees to the directing telescope.

315. Below the hinged rubber eyepiece cover is the focussing screw.

316. The object lens is protected against sun glare and rain by a movable cover hinged on the main body.

317. A lighting set is incorporated for night observation. This serves to illuminate the graticules and reading scales.

THE COLLIMATOR (PLATE 16)

318. A symbol graticule is set exactly at the focus of the collimator lens. This is the main feature of the collimator and it is protected by a frosted glass panel at the rear of the horizontal axis. It is illuminated by an adjustable mirror which deflects the light on to the graticule.

319. The object lens is protected by a cover hinged to the main body.

320. For night observations the mirror can be hinged right back and a lamp attached to illuminate the graticules.

THE BOTTOM PLATE (PLATE 16)

321. Graduated in hundreds of mils., this scale is intended for horizontal rough readings only. Final readings are read off from the graticule in the director telescope.

322. To release the bottom plate so as to allow it to revolve freely and independently of the collimator and director body, the locking screw is loosened.

323. When the locking screw is tightened the bottom plate can be turned slowly by the horizontal slow motion screw. The amount of slow motion is, however, limited.

THE TOP PLATE (PLATE 16)

324. This refers to the milled circular edge at the base of the collimator and director body.

325. A pointer is marked on the top plate against which is read the rough reading on the bottom plate.

326. To release the top plate in order to observe horizontal angles, the quick release button is pressed. No slow motion screw exists, nor is it necessary (see director readings and graticules below).

ELEVATION (PLATE 16)

327. The collimator and director body can turn in the vertical plane about the trunnion axis from a depression angle of 400 mils. to an elevation angle of 900 mils. This is done by means of the elevating screws.

328. As in the case of horizontal readings, there is a rough reading scale. The fine readings are read off the micrometer scale on the elevation screw.

LEVELLING (PLATE 16)

329. Three spirit bubbles are fitted on the magnetic compass housing: a circular bubble for use in rough levelling and two cross level bubbles for use in final levelling.

330. As in the theodolite, three footscrews are used for levelling which can be clamped by means of locking screws.

DIRECTOR READINGS AND GRATICULES (FIG. 81)

331. Horizontal readings are taken by means of the director. Rough readings can be set by means of the bottom plate and fine readings read from the graticule scale.

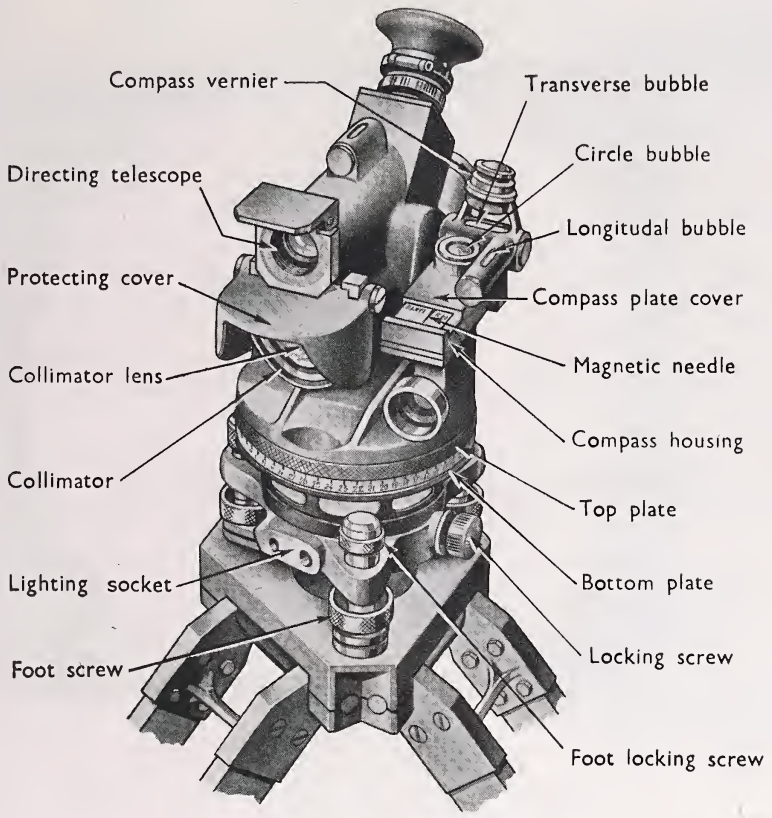
332. If the reading to the object is obtained from the left scale, i.e., between minus 40 mils. to 100 mils., then the number of hundreds indicated by the left figure in the "mask" are read off. If the reading is taken from the right scale, i.e., between 0 to + 60 mils., then the number of hundreds indicated by the right figure in the "mask" are read off.

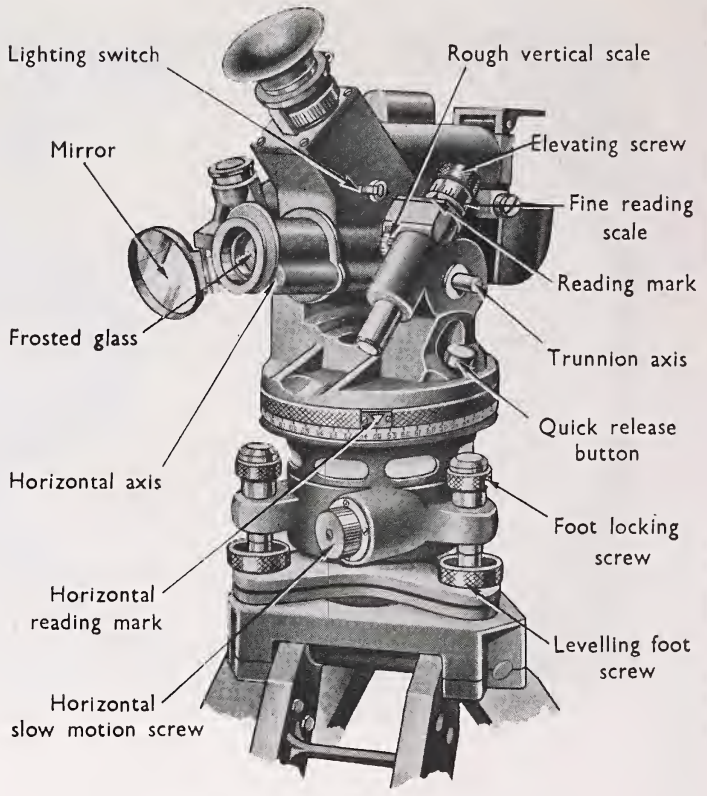
333. The graticule itself is graduated in one mil intervals. Interpolation is to about ·2 of a mil.

COLLIMATOR SYMBOL GRATICULE (FIGS 82 AND 83)

334. This graticule is divided by perpendicular lines into one hundred divisions. Each division is indicated by a symbol, none of which are duplicated.

DIRECTOR COLLIMATOR 12 METRES





DIRECTOR COLLIMATOR GRATICULE AND MASK.

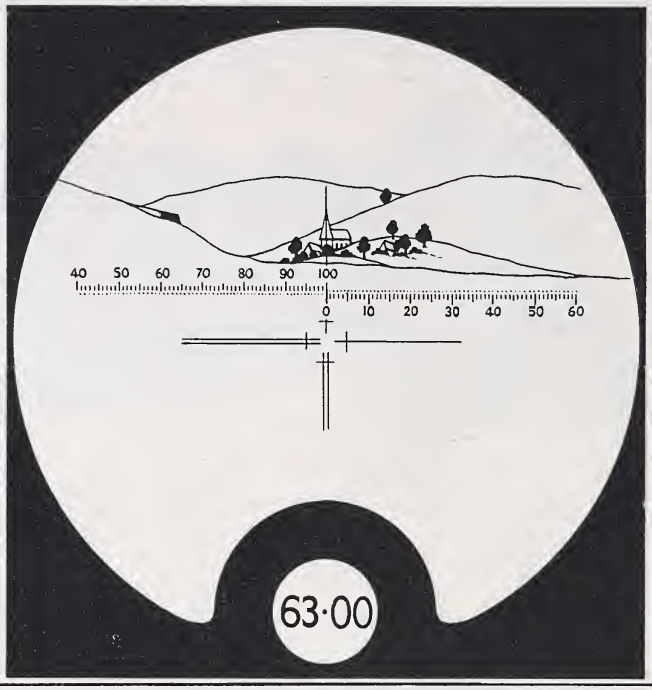


Fig. 81

DIRECTOR COLLIMATOR SYMBOLS AS OBSERVED THROUGH DIAL SIGHT.

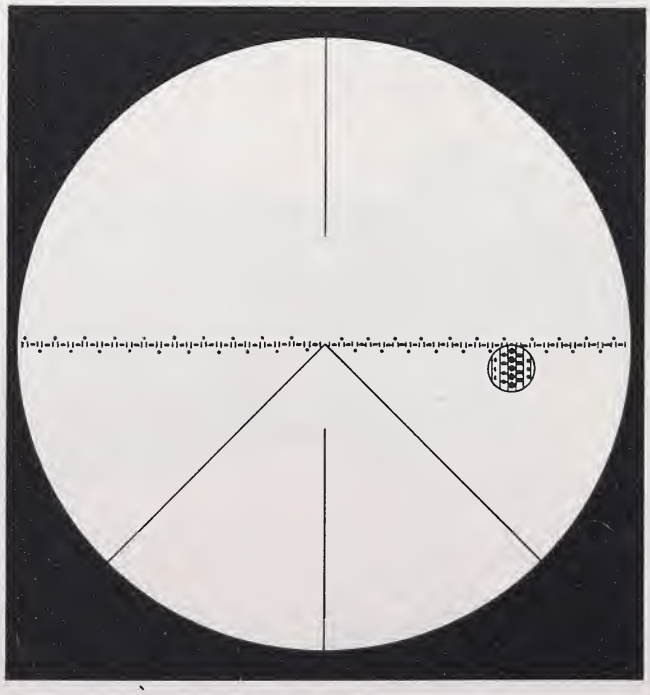


Fig. 82

DIRECTOR COLLIMATOR GRATICULE.

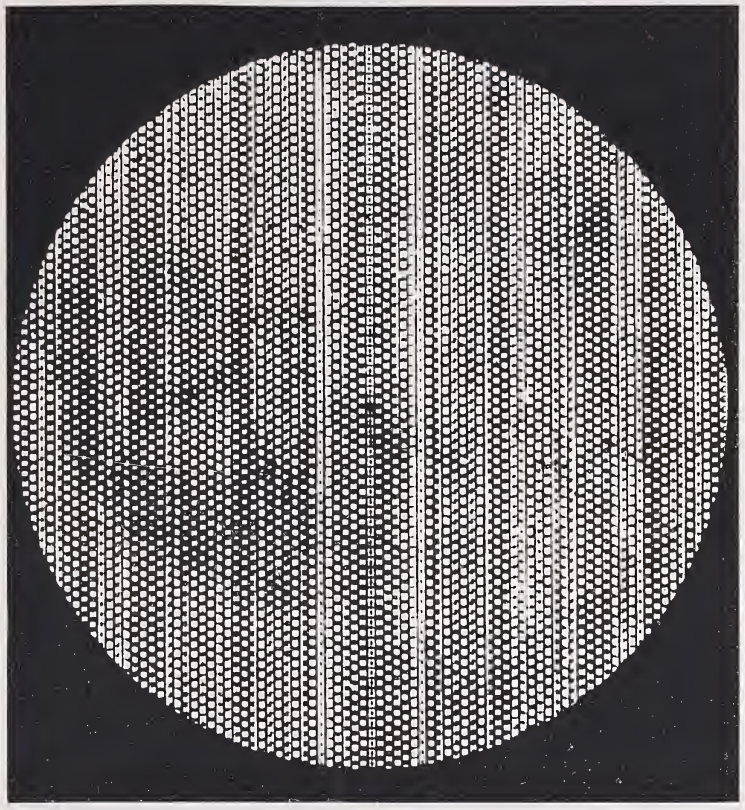


Fig. 83

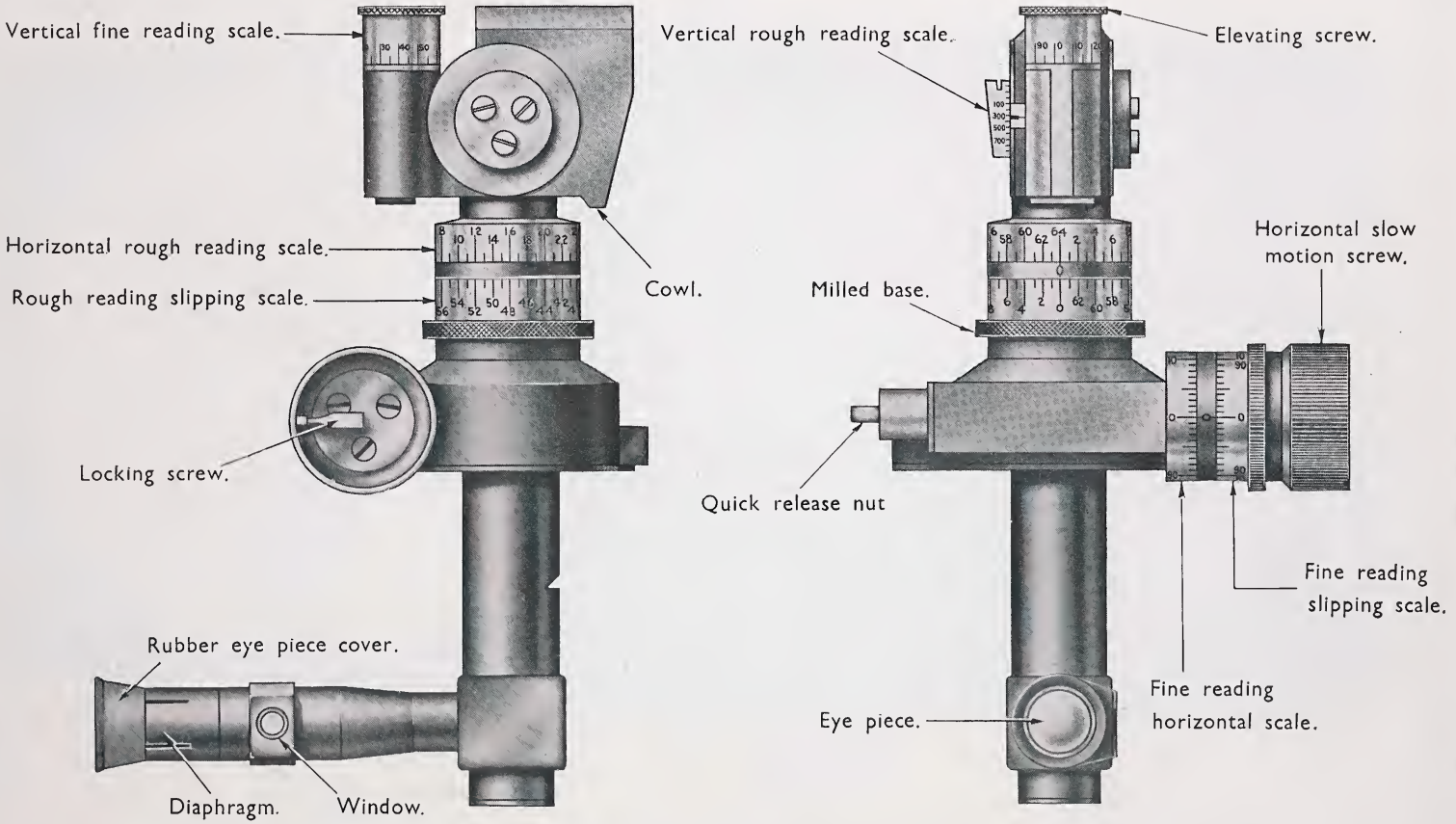
335. The graticule is set exactly at the focus of the collimator lens. Therefore, the symbols appear at infinity in a telescope (Dial Sight) observing into the collimator.

336. If, therefore, the telescope has a graticule corresponding to that of the collimator, the optical axis of both instruments can be made parallel by laying the telescope so that the symbols of the collimator seen through the telescope coincide with identical symbols of the telescope graticules.

337. This is true irrespective of any lateral displacement of the telescope up to about 120 mils, with respect to the collimator.

338. The collimator should be set up between 4 and 12 metres from the telescope. Three or four symbols are then visible through the telescope. At a distance of more than 12 metres a complete symbol cannot be observed.

THE GERMAN DIAL SIGHT.



Description of German DIAL SIGHT (Rundblickfernrohr) . . . . SECTION 36

PLATE 17

339. This dial sight is the same in principle as the British equivalent, with a slightly different reading system. It is fixed to a bracket which clamps on the rocket or on the launching table. This bracket carries the cross levelling bubbles. There are no levelling bubbles on the dial sight itself.

340. The cowl houses the prisms and object lens. These prisms are turned around a horizontal axis for elevation by means of the elevating screw. The elevating screw carries the fine reading scale graduated from minus 600 mils. to plus 600 mils. The rough reading vertical scale is fitted in the rear of the cowl. Made in one piece with the cowl revolving with it is the horizontal rough reading scale. This is graduated in one mil. intervals marked in black. The dividing line for independent movement of the object lens system is at the base of this scale.

341. At the base of the horizontal rough reading scale is a fixed ring. This ring does not revolve. It carries the pointer for the horizontal rough reading scale and the rough reading slipping scale. The slipping scale is freed by releasing the locking screw and turned by the fingers by means of the milled base.

342. Beneath the slipping scale and at right angles to the main column is the spindle on which are fixed the horizontal slow motion screw, the fine reading scale for horizontal readings and the fine reading slipping scale with a milled edge. Slipping scale graduations are in red. At the other end of the spindle is the quick release nut. When loosened this allows the cowl and horizontal rough reading scale to revolve freely, independent of the slow motion screw.

343. The eyepiece is at right angles to the main column. Fitted over the eyepiece is a diaphragm which can be removed when not required. The diaphragm is used to restrict the field of view when laying on the symbols of a collimator. A rubber eyepiece cover is fitted to the diaphragm. A small window is set in the side of the eyepiece through which a light can be directed to illuminate the graticules for night observations.

344. The arrangement of the graticules is different from that of the British dial sight. The apex formed by two diagonal graticules is used to lay on a reference object. In addition, there is also a horizontal strip of symboled graticule identical with that in the collimator and used in conjunction with the collimator for laying the rocket in the line of fire.

345. Both the horizontal reading scales and the slipping scales are graduated from zero to 6,400 mils. These scales are graduated in the reverse direction to one another. The British dial sight is the same except that the slipping scale readings increase in a clockwise direction instead of an anti-clockwise direction. The slipping scale is not used where the rocket is concerned.

A-4 Rocket Range Tables . . . SECTION 37

GENERAL

346. The following is a brief account of the contents of the range tables for A-4 rocket used by the Germans in operations.

CONTENTS OF THE RANGE TABLES.

347. The range tables consist of three main tables :

Table A. Gives the quantity of alcohol required for any given range.

Table B. Lists the value to be set on the integrating accelerater for any given range.

Table C. Gives the frequency required for radio controlled fuel cut-off (Brennschluss) for any given range.

STANDARDS ON WHICH THE RANGE TABLES ARE BASED

348. The range tables are compiled for the normal rocket and standard atmospheric conditions.

These are :

(*a*) Programm angle of 47°.
(*b*) Take-off weight of 12,650 kgs.
(*c*) Air density 1·22 kg. per cubic metre at height of launching position.
(*d*) Temperature of 10°C.
(*e*) Atmospheric pressure of 760 mm. of mercury.
(*f*) No wind.
(*g*) Control station situated 7 km. in rear of the launching point on the line target launching point produced (radio fuel-cut-off only).

349. Corrections are only made by field units for abnormal conditions in respect of the take-off weight. Any other variation in the standard conditions given above is ignored.

CORRECTIONS FOR ABNORMAL TAKE-OFF WEIGHT

350. Correction for abnormal take-off weight is made by adjusting the quantity of alcohol tanked. For this purpose Table A (see para. 347) has a subsidiary table called A2, which gives the adjustment to the true range which has to be made when using Table A in order to allow for abnormal take-off weight. Table A2 has two columns, viz. :—

Col. 1. True range in kms.

Col. 2. Kms. to be $\begin{matrix}\text{deducted from}\\ \text{added to}\end{matrix}$ true range for each 10 kgs. by which the take-off weight $\begin{matrix}\text{exceeds}\\ \text{is less}\end{matrix}$ than normal

351. The take-off weight is an aggregate of the following :

(*a*) Weight of rocket as received from the factory (given on rocket data sheet).
(*b*) Weight of warhead and filling.
(*c*) Weight of additional explosive charges (if fitted).
(*d*) Weight of fuzes.
(*e*) Weight of batteries.
(*f*) Weight of carbon rudders.
(*g*) Weight of oxygen (taking into account evaporation after fuelling).
(*h*) Weight of alcohol.

The weight of sodium permanganate and hydrogen peroxide is not included as this is assumed to be compensated for by the expenditure of oxygen and alcohol after ignition but before take-off.

CORRECTIONS FOR VARIATION IN INTEGRATING ACCELEROMETER PERFORMANCE

352. Table B referred to in para. 347 includes two tables which are designed Ba and Bb.

353. Table Ba is as follows :—

(1) Range in Kms.	(2) Value to be set on I.A. Scale.	(3) Theoretical time for testing.

354. Should the integrating accelerometer test result in a time differing from that in Col. 3 above, then a correction to the setting on the Integrating accelerometer has to be made. Table Bb gives the adjustments for any given time error revealed by the test. Table Bb takes the following form :

(1) Time error revealed during test.	(2) Correction to be made to the setting on I.A.

355. *Example*

Range to target = 240·3 kms.
Setting for I.A. = 103·1 (Table Ba Col. (2)).
Time error = −·8 secs. (difference between Table Ba Col. (3) and testing time).
Correction for −·8 time error = +4 (from Table Bb Col. (2)).
Setting for I.A. = 103·1 + 4 = 107·1.

War Establishment (Army) . . . SECTION 38

Source : German Officers employed on Operation "BACKFIRE" LAUNCHING TROOP of a German Motorised V-2 Rocket Regiment.

Serial No.	Grade of Appointment	Designation	Officers	Officials	N.C.O.s	Men	Rifles	Pistols (Machine Pistols)	M.G. 42 (Tripods)	M.T.	Armoured Vehicles	M/C's (Sidecars)	Trailers	Field Kitchens	Bicycles
a	b	c	d	e	f	g	h	i	k	l	m	n	o	p	q
1	—	*Launching Troop*													
2	—	*HQ Section*													
3	K	Troop Commander	1	—	—	—	—	(1)	—	—	—	—	—	—	—
4	Z	Troop Engineer	—	1	—	—	—	1	—	—	—	—	—	—	—
5	Z	Electrical Engineer	—	1	—	—	—	1	—	—	—	—	—	—	—
6	Z	Control Equipment Engineer	—	1	—	—	—	1	—	—	—	—	—	—	—
7	Z	Wireless Engineer	—	1	—	—	—	1	—	—	—	—	—	—	—
8	O	Artificer	—	—	1	—	—	1	—	—	—	—	—	—	—
9	G	Specialist N.C.O.	—	—	1	—	—	1	—	—	—	—	—	—	—
10	M	Motor Cyclist (D.R.)... ...	—	—	—	1	1	—	—	—	—	—	—	—	—
11	M	Drivers (Staff Cars) ...	—	—	—	2	2	—	—	—	—	—	—	—	—
12	—	Staff Car (Cross country, 4-seater)	—	—	—	—	—	—	—	1	—	—	—	—	—
13	—	Staff Car (Cross country 5-seater)	—	—	—	—	—	—	—	1	—	—	—	—	—
14	—	Medium Motor Cycle ...	—	—	—	—	—	—	—	—	—	1	—	—	—
15	—	Totals	1	4	2	3	3	6(1)	—	2	—	1	—	—	—
16	—	*Computing Section*													
17	G	Section Commander	—	—	1	—	1	—	—	—	—	—	—	—	—
18	M	Computers	—	—	—	2	2	—	—	—	—	—	—	—	—
19	M	Draughtsmen	—	—	—	2	2	—	—	—	—	—	—	—	—
20	M	Driver	—	—	—	1	1	—	—	—	—	—	—	—	—
21	—	Computation Lorry (3-ton) (closed)	—	—	—	—	—	—	—	1	—	—	—	—	—
22	—	Totals	—	—	1	5	6	—	—	1	—	—	—	—	—
23	—	1. *Launching Platoon*													
24	Z	Platoon Commander	1	—	—	—	—	(1)	—	—	—	—	—	—	—
25	O	2nd in command Platoon ...	—	—	1	—	—	(1)	—	—	—	—	—	—	—
26	M	Motor Cyclist (D.R.)... ...	—	—	—	1	1	—	—	—	—	—	—	—	—
27	M	Driver (Staff Cars)	—	—	—	1	1	—	—	—	—	—	—	—	—
28	M	Layers	—	—	—	3	3	—	—	—	—	—	—	—	—
29	—	Staff Car (Cross country, 4-seater)	—	—	—	—	—	—	—	1	—	—	—	—	—
30	—	Light Motor Cycle	—	—	—	—	—	—	—	—	—	1	—	—	—
31	—	Totals	1	—	1	5	5	(2)	—	1	—	1	—	—	—

LAUNCHING TROOP (*Contd.*)

Serial No.	Grade of Appointment	Designation	Officers	Officials	N.C.O.s	Men	Rifles	Pistols (Machine Pistols)	M.G. 42 (Tripods)	M.T.	Armoured Vehicles	M/C's (Sidecars)	Trailers	Field Kitchens	Bicycles
a	b	c	d	e	f	g	h	i	k	l	m	n	o	p	q
1	—	*Rocket Motor Section*													
2	G	Section Commander	—	—	1	—	1	—	—	—	—	—	—	—	—
3	M	Gunners	—	—	—	5	5	—	—	—	—	—	—	—	—
4	—	Totals	—	—	1	5	6	—	—	—	—	—	—	—	—
5	—	*Electrical Section*													
6	G	Section Commander	—	—	1	—	1	—	—	—	—	—	—	—	—
7	M	Gunners	—	—	—	6	6	—	—	—	—	—	—	—	—
8	—	Totals	—	—	1	6	7	—	—	—	—	—	—	—	—
9	—	*Power Supply Section*													
10	G	Section Commander	—	—	1	—	1	—	—	—	—	—	—	—	—
11	G	Switch Control N.C.O's ...	—	—	2	—	2	—	—	—	—	—	—	—	—
12	M	Gunners	—	—	—	2	2	—	—	—	—	—	—	—	—
13	—	Totals	—	—	3	2	5	—	—	—	—	—	—	—	—
14	—	*Truck Section*													
15	G	Section Commander	—	—	1	—	1	—	—	—	—	—	—	—	—
16	M	Gunners	—	—	—	6	6	—	—	—	—	—	—	—	—
17	—	Totals	—	—	1	6	7	—	—	—	—	—	—	—	—
18	M	Drivers	—	—	—	5	5	—	—	—	—	—	—	—	—
19	—	Steyertrucks (TCV)	—	—	—	—	—	—	—	1	—	—	—	—	—
20	—	Testing & Launching Truck	—	—	—	—	—	—	—	1	—	—	—	—	—
21	—	Generator Vehicle	—	—	—	—	—	—	—	1	—	—	—	—	—
22	—	Cable Trailer	—	—	—	—	—	—	—	—	—	—	1	—	—
23	—	Armoured Fire Control Vehicle	—	—	—	—	—	—	—	—	1	—	—	—	—
24	—	Launching Platform ...	—	—	—	—	—	—	—	—	—	—	1	—	—
25	—	Magirus Ladder	—	—	—	—	—	—	—	—	—	—	1	—	—
26	—	Heavy Rocket Lorry	—	—	—	—	—	—	—	1	—	—	—	—	—
27	—	Totals ...	—	—	—	5	5	—	—	4	1	—	3	—	—
28	—	*Composition* 1. *Launching Platoon*	1	—	7	29	35	(2)	—	5	1	1	3	—	—
29	—	2. *Launching Platoon* ... (as 1. Launching Platoon)	1	—	7	29	35	(2)	—	5	1	1	3	—	—

LAUNCHING TROOP (*Contd.*)

Serial No.	Grade of Appointment	Designation	Officers	Officials	N.C.O.s	Men	Rifles	Pistols (Machine Pistols)	M.G. 42 (Tripods)	M.T.	Armoured Vehicles	M/C's (Sidecars)	Trailers	Field Kitchens	Bicycles
a	b	c	d	e	f	g	h	i	k	l	m	n	o	p	q
1	—	3. *Launching Platoon*... ... (as 1. Launching Platoon)	1	—	7	29	35	(2)	—	5	1	1	3	—	—
2	—	*Rocket Supply and Accessories Column*													
3	O	Column Commander ...	—	—	1	—	—	(1)	—	—	—	—	—	—	—
4	G	Section Commanders ...	—	—	3	—	3	—	—	—	—	—	—	—	—
5	M	Meilerwagen Crew ... ... (Erection Gear Crew)	—	—	—	9	9	—	—	—	—	—	—	—	—
6	M	Motor Cyclist (D.R.) ...	—	—	—	1	1	—	—	—	—	—	—	—	—
7	M	Drivers	—	—	—	12	12	—	—	—	—	—	—	—	
8	M	Accumulator Orderly ...	—	—	—	1	1	—	—	—	—	—	—	—	—
9	M	Equipment Orderly	—	—	—	1	1	—	—	—	—	—	—	—	—
10	—	Staff Car (Cross country, 4-seater)	—	—	—	—	—	—	—	1	—	—	—	—	—
11	—	Motor Cycle (med.) ...	—	—	—	—	—	—	—	—	—	1	—	—	—
12	—	Caterpillar Tractors	—	—	—	—	—	—	—	3	—	—	—	—	—
13	—	Wheeled Tractors	—	—	—	—	—	—	—	6	—	—	—	—	—
14	—	Accumulator Lorry ...	—	—	—	—	—	—	—	1	—	—	—	—	—
15	—	Spare Parts Lorry	—	—	—	—	—	—	—	1	—	—	—	—	—
16	—	Cable Trailer	—	—	—	—	—	—	—	—	—	—	1	—	—
17	—	Compressor	—	—	—	—	—	—	—	—	—	—	1	—	—
18	—	Meilerwagen	—	—	—	—	—	—	—	—	—	—	9	—	—
19	M	Fire Fighter	—	—	—	1	—	—	—	—	—	—	—	—	—
20	M	Lorry Driver	—	—	—	1	—	—	—	—	—	—	—	—	—
21	—	Tanker (3,000 litre)	—	—	—	—	—	—	—	1	—	—	—	—	—
22	—	Fire Pump Trailer (1 axle)	—	—	—	—	—	—	—	—	—	—	1	—	—
23	—	Totals	—	—	4	26	27	(1)	—	13	—	1	12	—	—
24	—	*Telephone Section*													
25	G	Section Commander	1	—	1	—	1	—	—	—	—	—	—	—	—
26	M	Telephone Operators... ...	—	—	—	3	3	—	—	—	—	—	—	—	—
27	M	Motor Cyclist (also Telephone Operator)	—	—	—	1	1	—	—	—	—	—	—	—	—
28	—	Lorry—2-ton (closed) ...	—	—	—	—	—	—	—	1	—	—	—	—	—
29	—	Totals	1	—	1	4	5	—	—	1	—	—	—	—	—

LAUNCHING TROOP (*Contd.*)

Serial No.	Grade of Appointment	Designation	Officers	Officials	N.C.O.s	Men	Rifles	Pistols (Machine pistols)	M.G. 42 (Tripods)	M.T.	Armoured Vehicles	M/C's (Sidecars)	Trailers	Field Kitchens	Bicycles
a	b	c	d	e	f	g	h	i	k	l	m	n	o	p	q
1	—	*Light Telephone Construction Section*													
2	G	Section Commander ...	—	—	1	—	1	—	—	—	—	—	—	—	—
3	M	Signals Personnel	—	—	—	3	3	—	—	—	—	—	—	—	—
4	M	Driver (also Telephone Operator)	—	—	—	1	1	—	—	—	—	—	—	—	—
5	—	Lorry—2-ton (Open) ...	—	—	—	—	—	—	—	1	—	—	—	—	—
6	—	Totals	—	—	1	4	5	—	—	1	—	—	—	—	—
7	—	*M.T. Repair Section*													
8	G	Section Commander	—	—	1	—	1	—	—	—	—	—	—	—	—
9	M	Motor Mechanic	—	—	—	1	1	—	—	—	—	—	—	—	—
10	M	Driver Mechanic	—	—	—	2	2	—	—	—	—	—	—	—	—
11	—	Staff Car (Cross country, 4-seater)	—	—	—	—	—	—	—	1	—	—	—	—	—
12	—	Lorry—3-ton	—	—	—	—	—	—	—	1	—	—	—	—	—
13	—	Totals	—	—	1	3	4	—	—	2	—	—	—	—	—
14	—	*Supply Column*													
15	O	Warrant Officer	—	—	1	—	—	1	—	—	—	—	—	—	—
16	O	N.C.O. in charge M.T. ...	—	—	1	—	—	1	—	—	—	—	—	—	—
17	G	Accounts Clerk	—	—	1	—	—	1	—	—	—	—	—	—	—
18	G	Clerk (Grade 1)	—	—	1	—	—	1	—	—	—	—	—	—	—
19	G	Medical N.C.O.	—	—	1	—	—	—	—	—	—	—	—	—	—
20	G	Q.M. N.C.O. (Fourier) ...	—	—	1	—	—	1	—	—	—	—	—	—	—
21	G	Cook	—	—	1	—	—	1	—	—	—	—	—	—	—
22	G	Armourer N.C.O.	—	—	1	—	—	1	—	—	—	—	—	—	—
23	M	Clerk (Grade 2)	—	—	—	1	1	—	—	—	—	—	—	—	—
24	M	Assistant Cook	—	—	—	1	1	—	—	—	—	—	—	—	—
25	M	Tailor	—	—	—	1	1	—	—	—	—	—	—	—	—
26	M	Cobbler	—	—	—	1	1	—	—	—	—	—	—	—	—
27	M	Medical Orderly	—	—	—	1	—	—	—	—	—	—	—	—	—
28	M	Assistant Armourer	—	—	—	1	1	—	—	—	—	—	—	—	—
29	M	Petrol Orderly	—	—	—	1	1	—	—	—	—	—	—	—	—
30	M	Motor Cyclists (D.R.) ...	—	—	—	2	2	—	—	—	—	—	—	—	—
31	M	Drivers	—	—	—	5	5	—	—	—	—	—	—	—	—

LAUNCHING TROOP (*Contd.*)

Serial No.	Grade of Appointment	Designation	Officers	Officials	N.C.O.s	Men	Rifles	Pistols (Machine Pistols)	M.G. 42 (Tripods)	M.T.	Armoured Vehicles	M/C's (Sidecars)	Trailers	Field Kitchens	Bicycles
a	b	c	d	e	f	g	h	i	k	l	m	n	o	p	q
1	—	*Supply Column (Contd.)*													
2	—	Motor Cycle (Med.)	—	—	—	—	—	—	—	—	—	1	—	—	—
3	—	Motor Cycle (Heavy) with sidecar ... ... —	—	—	—	—	—	—	—	—	—	1(1)	—	—	
4	—	Staff Car (Cross country 4-seater)	—	—	—	—	—	—	—	1	—	—	—	—	—
5	—	Lorries—3-ton ... ... (for : Petrol, Rations, Field Kitchen, Office and Kit)	—	—	—	—	—	—	—	4	—	—	—	—	—
6	—	Field Kitchen Range (large)	—	—	—	—	—	—	—	—	—	—	—	1	—
7	—	Totals	—	—	8	14	13	7	—	5	—	2(1)	—	1	—
8	—	*Summary of Establishment for Launching Troop*													
9	—	*HQ. Section*	1	4	2	3	3	6(1)	—	2	—	1	—	—	—
10	—	Computing and Evaluating Section	—	—	1	5	6	—	—	1	—	—	—	—	—
11	—	1. Launching Platoon ...	1	—	7	29	35	(2)	—	5	1	1	3	—	—
12	—	2. Launching Platoon ...	1	—	7	29	35	(2)	—	5	1	1	3	—	—
13	—	3. Launching Platoon ...	1	—	7	29	35	(2)	—	5	1	1	3	—	—
14	—	Rocket Supply and Accessories Column	—	—	4	24	27	(1)	—	12	—	1	11	—	—
15	—	Telephone Section	—	—	1	4	5	—	—	1	—	—	—	—	—
16	—	Light Telephone Construction Section	—	—	1	4	5	—	—	1	—	—	—	—	—
17	—	M.T. Repair Section ...	—	—	1	3	4	—	—	2	—	—	—	—	—
18	—	Supply Column	—	—	8	14	13	7	—	5	—	2(1)	—	1	—
19	—	Totals	4	4	39	146	168	13(8)		40	3	7(1)	21	1	—

LEGEND :

K = Company Commander (Captain or Lieutenant)
Z = Platoon Commander (Lieutenant or Second Lieutenant)
O = Staff Sergeant (Oberfeldwebel) (Oberwachtmeister) or W.O. (Stavswachtmeister).
G = N.C.O. up to Sergeant (Wachmeister)
M = Men

Additional Explanation :

1 N.C.O. is to be detailed as anti-gas N.C.O.
7 G-appointments are Sergeant's appointments
10 Men are to be trained as stretcher bearers
3 Gas Detector and Decontamination Detachments are to be trained

TECHNICAL TROOP OF A GERMAN MOTORISED V-2 ROCKET REGIMENT

Serial No.	Grade of Appointment	Designation	Officers	Officials	N.C.O.s	Men	Rifles	Pistols (Machine Pistols)	M.G. 42 (Tripods)	M.T.	Armoured Vehicles	M/C's (Sidecars)	Trailers	Field Kitchens	Bicycles
a	b	c	d	e	f	g	h	i	k	l	m	n	o	p	q
1	—	*Technical Troop*													
2	—	*HQ. Section*													
3	K	Troop Commander (Ordnance Officer)	1	—	—	—	—	1	—	—	—	—	—	—	—
4	Z	Official of Advanced Technical Service (Elect. Eng.) ...	—	1	—	—	—	1	—	—	—	—	—	—	—
5	O	Artificer (Mech. Engineer) ...	—	—	1	—	—	(1)	—	—	—	—	—	—	—
6	G	Clerks	—	—	1	—	1		—	—	—	—	—	—	—
7	G	Draughtsmen	—	—	1	—	1	—	—	—	—	—	—	—	—
8	M	Clerks	—	—	—	1	1	—	—	—	—	—	—	—	—
9	M	Drivers (Staff Car)	—	—	—	2	—	2	—	—	—	—	—	—	—
10	M	Motor Cyclists (D.R.'s) ...	—	—	—	3	—	3	—	—	—	—	—	—	—
11	—	Staff Cars (Cross country —4-seater)	—	—	—	—	—	—	—	2	—	—	—	—	—
12	—	Medium motor cycles ...	—	—	—	—	—	—	—	—	—	3	—	—	—
13	—	Totals ...	1	1	3	6	3	7(1)	—	2	—	3	—	—	—
14	—	*Mot. Medium Telephone Section (12 km. cable length)*													
15	C	Section Commander (Telephone N.C.O.'s) ...	—	—	1	—	—	(1)	—	—	—	—	—	—	—
16	M	Telephone Operators ...	—	—	—	4	4	—	—	—	—	—	—	—	—
17	M	Drivers (Heavy Lorries) ...	—	—	—	1	—	1	—	—	—	—	—	—	—
18	—	Lorries, 3-ton (closed) ...	—	—	—	—	—	—	—	1	—	—	—	—	—
19	—	Totals	—	—	1	5	4	1(1)	—	1	—	—	—	—	—
20	—	1. *Platoon (Technical Platoon)*													
21	Z	Platoon Commander (Ordnance Officer) ...	1	—	—	—	—	1	—	—	—	—	—	—	—
22	O	Artificer (Mech. Engineer) and 2nd in command platoon	—	—	1	—	—	(1)	—	—	—	—	—	—	—
23	M	Drivers (Staff Cars)	—	—	—	1	—	1	—	—	—	—	—	—	—
24	M	Motor Cyclists (D.R.'s) ...	—	—	—	1	—	1	—	—	—	—	—	—	—
25	—	Staff Cars (Cross country 4-seater)	—	—	—	—	—	—	—	1	—	—	—	—	—
26	—	Heavy Motor Cycles with sidecar	—	—	—	—	—	—	—	—	—	1(1)	—	—	
27	—	Medium Motor Cycles ...	—	—	—	—	—	—	—	—	—	1	—	—	—
		Totals	1	—	1	2	—	3(1)	—	1	—	2(1)	—	—	—

TECHNICAL TROOP (*Contd.*)

Serial No.	Grade of Appointment	Designation	Officers	Officials	N.C.O.s	Men	Rifles	Pistols (Machine Pistols)	M.G. 42 (Tripods)	M.T.	Armoured vehicles	M/C's (sidecars)	Trailers	Field Kitchens	Bicycles
a	b	c	d	e	f	g	h	i	k	l	m	n	o	p	q
1	—	1. *Testing Section*													
2	O	Section Commander (Master Electrician)	—	—	1	—	—	(1)	—	—	—	—	—	—	—
3	G	Rocket Motor N.C.O. (Master Mechanic)	—	—	1	—	—	1	—	—	—	—	—	—	—
4	G	Control Equipment N.C.O. (Master Electrician) ...	—	—	1	—	—	1	—	—	—	—	—	—	—
5	G	N.C.O. for wireless and integrating accelerometer (Wireless and High Frequency Technician)	—	—	1	—	—	1	—	—	—	—	—	—	—
6	M	Rocket Motor Mechanics ...	—	—	—	4	4	—	—	—	—	—	—	—	—
7	M	Electricians for Rocket circuits	—	—	—	2	2	—	—	—	—	—	—	—	—
8	M	Electricians for control equipment	—	—	—	1	1	—	—	—	—	—	—	—	—
9	M	Wireless and high frequency technician for Wireless and Integrating Accelerometer	—	—	—	1	1	—	—	—	—	—	—	—	—
10	M	Power and Transformer Sets Orderly	—	—	—	1	1	—	—	—	—	—	—	—	—
11	M	Compressor Orderlies ...	—	—	—	1	1	—	—	—	—	—	—	—	—
12	M	Clerk	—	—	—	1	1	—	—	—	—	—	—	—	—
13	—	Totals ...	—	—	4	11	11	3(1)	—	—	—	—	—	—	—
14	—	2. *Testing Section* (Same as 1. Testing Section)	—	—	4	11	11	3(1)	—	—	—	—	—	—	—
15	—	*For 1 and 2 Testing Sections*													
16	M	Drivers (Lorries)	—	—	—	8	—	8	—	—	—	—	—	—	—
17	—	Medium Lorry 3-ton, Closed (Testing Lorry)	—	—	—	—	—	—	—	1	—	—	—	—	—
18	—	Medium Lorry 3-ton (Closed (Cable Lorry)	—	—	—	—	—	—	—	1	—	—	—	—	—
19	—	Medium Lorry 3-ton, Closed (Electrical Spare Parts Lorry)	—	—	—	—	—	—	—	1	—	—	—	—	—
20	—	Medium Lorry 3-ton, Closed For Troop carrying ...	—	—	—	—	—	—	—	1	—	—	—	—	—
21	—	Medium Lorry 3-ton, Closed (For tools)	—	—	—	—	—	—	—	1	—	—	—	—	—
22	—	Medium Lorry 6-ton, Open (For Test Equipment) ...	—	—	—	—	—	—	—	1	—	—	—	—	—

Serial No.	Grade of Appointment	Designation	Officers	Officials	N.C.O.s	Men	Rifles	Pistols (Machine Pistols)	M.G. 42 (Tripods)	M.T.	Armoured Vehicles	M/C's (Sidecars)	Trailers	Field Kitchens	Bicycles
a	b	c	d	e	f	g	h	i	k	l	m	n	o	p	q
1	—	*For Testing Sections 1 and 2* : (contd.).													
2	—	Wheeled Tractors, 100 H.P....	—	—	—	—	—	—	—	2	—	—	—	—	—
3	—	Heavy trailers, 2 axle, Air Compressor	—	—	—	—	—	—	—	—	—	—	2	—	—
4	—	Heavy trailer, 1 axle (Power Sets I 15 KVA.)	—	—	—	—	—	—	—	—	—	—	1	—	—
5	—	Heavy trailer, 1 axle Transformer 27 V.—100 amp.	—	—	—	—	—	—	—	—	—	—	1	—	—
6	—	Totals	—	—	—	8	—	8	—	8	—	—	4	—	—
7	—	*Repair & Tail Removal Section*													
8	O	Section Commander (Master armourer)	—	—	1	—	—	(1)	—	—	—	—	—	—	—
9	M	Drivers (Lorry)	—	—	—	3	—	3	—	—	—	—	—	—	—
10	—	Heavy Lorry, 5-ton, closed workshop lorry	—	—	—	—	—	—	—	1	—	—	—	—	—
11	—	Medium Lorry, 3-ton, closed mechanical spare parts lorry	—	—	—	—	—	—	—	1	—	—	—	—	—
12	—	Heavy lorry. 6-ton closed, for tools...	—	—	—	—	—	—	—	1	—	—	—	—	—
13	M	Carpenter	—	—	—	1	1	—	—	—	—	—	—	—	—
14	—	Totals	—	—	1	4	1	3(1)	—	3	—	—	—	—	—
15	—	1. *Sub-Section*													
16	G	Section Commander (Master Mechanic)	—	—	1	—	—	1	—	—	—	—	—	—	—
17	M	Turner	—	—	—	1	1	—	—	—	—	—	—	—	—
18	M	Mechanics	—	—	—	2	2	—	—	—	—	—	—	—	—
19	M	Oxy-acetylene Welder ...	—	—	—	1	1	—	—	—	—	—	—	—	—
20	M	Aluminium-Welder	—	—	—	1	1	—	—	—	—	—	—	—	—
21	M	Electrician	—	—	—	1	1	—	—	—	—	—	—	—	—
22	—	Totals	—	—	1	6	6	1	—	—	—	—	—	—	—
23	—	2 *Sub-Section* (as 1 Sub-section)	—	—	1	6	6	1	—	—	—	—	—	—	—
24	—	*Composition*	1	—	12	48	35	22	—	12	—	2	4	—	—
		1. *Platoon* (*Technical Platoon*)	—	—	—	—	—	(4)	—	—	—	(1)	—	—	—

TECHNICAL TROOP (*Contd.*)

Serial No.	Grade of Appointment	Designation	Officers	Officials	N.C.O.s	Men	Rifles	Pistols (Machine Pistols)	M.G. 42 (Tripods)	M.T.	Armoured Vehicles	M/C's (Sidecars)	Trailers	Field Kitchens	Bicycles
a	b	c	d	e	f	g	h	i	k	l	m	n	o	p	q
1	—	2. *Platoon* (*Transloading and Construction Platoon*)													
2	Z	Platoon Commander (Ordnance Officer)	1	—	—	—	—	1	—	—	—	—	—	—	—
3	O	Artificer (Mech. Engineer) ...	—	—	1	—	—	(1)	—	—	—	—	—	—	—
4	M	Clerk	—	—	—	1	1	—	—	—	—	—	—	—	—
5	M	Driver (Staff car)	—	—	—	1	—	1	—	—	—	—	—	—	—
6	M	Motor Cyclist (D.R.)... ...	—	—	—	1	—	1	—	—	—	—	—	—	—
7	—	Staff car (Cross country—4-seater)	—	—	—	—	—	—	—	1	—	—	—	—	—
8	—	Heavy M/C with sidecar ...	—	—	—	—	—	—	—	—	—	1(1)	—	—	—
9	—	Medium Motor Cycle ...	—	—	—	—	—	—	—	—	—	1	—	—	—
10	—	Totals	1	—	1	3	1	3(1)	—	1	—	2(1)	—	—	—
11	—	*Warhead Mounting Section*													
12	G	Section Commander	—	—	1	—	—	(1)	—	—	—	—	—	—	—
13	G	2nd in charge Section ...	—	—	1	—	—	1	—	—	—	—	—	—	—
14	M	Fitters for Warhead Mounting	—	—	—	8	8	—	—	—	—	—	—	—	—
15	M	Driver (Lorry)	—	—	—	1	—	1	—	—	—	—	—	—	—
16	M	Spare Driver	—	—	—	1	—	1	—	—	—	—	—	—	—
17	—	Heavy Lorry 6-ton for Warhead and Equipment Transport	—	—	—	—	—	—	—	1	—	—	—	—	—
18	—	Totals	—	—	2	10	8	3(1)	—	1	—	—	—	—	—
19	—	1. *Transloading Section* (*Railhead Transloading*)													
20	G	Section Commander ...	—	—	1	—	—	(1)	—	—	—	—	—	—	—
21	G	2nd in charge Section ...	—	—	1	—	—	1	—	—	—	—	—	—	—
22	M	Crane Driver	—	—	—	1	1	—	—	—	—	—	—	—	—
23	M	Crane Mechanic	—	—	—	1	1	—	—	—	—	—	—	—	—
24	M	Crane Crew ... ... (1 man also Spare Driver for lorry).	—	—	—	8	8	—	—	—	—	—	—	—	—
25	M	Drivers (for Lorry and wheeled tractor)	—	—	—	2	—	2	—	—	—	—	—	—	—
26	M	Spare Driver for wheeled tractor	—	—	—	1	—	1	—	—	—	—	—	—	—

TECHNICAL TROOP (*Contd.*)

Serial No.	Grade of Appointment	Designation	Officers	Officials	N.C.O.s	Men	Rifles	Pistols (Machine Pistols)	M.G. 42 (Tripods)	M.T.	Armoured Vehicles	M/C's (Sidecars)	Trailers	Field Kitchens	Bicycles
a	b	c	d	e	f	g	h	i	k	l	m	n	o	p	q
1	—	1. *Transloading Section (Railhead Transloading) (contd.)*													
2	—	Medium Lorry, 3-ton Open	—	—	—	—	—	—	—	1	—	—	—	—	—
3	—	Wheeled Tractor 100 h.p. ...	—	—	—	—	—	—	—	1	—	—	—	—	—
4	—	Special Trailer :— Strabo-Crane	—	—	—	—	—	—	—	—	—	—	1	—	—
5	—	Electric Power Set I, 220/380 V. 15 KVA	—	—	—	—	—	—	—	—	—	—	1	—	—
6	—	Totals	—	—	2	13	10	4(1)	—	2	—	—	2	—	—
7	—	2. *Transloading Section* (for transfer of rocket from Vidal-wagen to Meilerwagen) (as 1 sec. but Frame lorry 9/2 instead of Strabo)	—	—	2	13	10	4(1)	—	2	—	—	2	—	—
8	—	*Construction Section*													
9	O	Section Commander	—	—	1	—	—	(1)	—	—	—	—	—	—	—
10	G	Master miner	—	—	2	—	—	2	—	—	—	—	—	—	—
11	M	Construction Personnel (at same time M.G. crews) ...	—	—	—	16	13	3	—	—	—	—	—	—	—
12	—	L.M.G. (complete)	—	—	—	—	—	—	3	—	—	—	—	—	—
13	M	Motor Cyclist (D.R.)... ...	—	—	—	1	—	1	—	—	—	—	—	—	—
14	M	Driver (Lorry)	—	—	—	1	—	1	—	—	—	—	—	—	—
15	M	Spare Driver	—	—	—	1	—	1	—	—	—	—	—	—	—
16	—	Heavy Lorry, 6-ton	—	—	—	—	—	—	—	1	—	—	—	—	—
17	M	Driver (M/C) with sidecar ...	—	—	—	1	—	1	—	—	—	—	—	—	—
18	—	Medium M/C	—	—	—	—	—	—	—	—	—	1	—	—	—
19	—	Heavy M/C with sidecar ...	—	—	—	—	—	—	—	—	—	1(1)	—	—	—
20	—	Totals	—	—	3	20	13	9(1)	3	1	—	2(1)		—	—
21	—	*Accumulator Charging Section*													
22	O	Section Commander (Master Electrician)	—	—	1	—	—	(1)	—	—	—	—	—	—	—
23	M	Accumulator Orderlies (Electricians, 2 at the same time spare drivers for lorries) ...	—	—	—	6	6	—	—	—	—	—	—	—	—

TECHNICAL TROOP (*Contd.*)

Serial No.	Grade of Appointment	Designation	Officers	Officials	N.C.O.s	Men	Rifles	Pistols (Machine Pistols)	M.G. 42 (Tripods)	M.T.	Armoured Vehicles	M/C's (Sidecars)	Trailers	Field Kitchens	Bicycles
a	b	c	d	e	f	g	h	i	k	l	m	n	o	p	q
1	—	*Accumulator Charging Section (contd.)*													
2	M	Drivers (Lorry)	—	—	—	2	—	2	—	—	—	—	—	—	—
3	—	Medium Lorries, 4-5 ton, Closed, with heating ...	—	—	—	—	—	—	—	2	—	—	—	—	—
4	—	Special Trailer : Mobile charging plant	—	—	—	—	—	—	—	—	—	—	1	—	—
5	—	Totals	—	—	1	8	6	2(1)	—	2	—	—	1	—	—
6	—	*Composition 2. Platoon (Transloading and Construction Platoon)*	1	—	11	87	48	5(6)	3	9	—	4(2)	3	—	—
7	—	*M.T. Repair Section*													
8	O	N.C.O. in charge M.T. ...	—	—	1	—	—	(1)	—	—	—	—	—	—	—
9	G	M.T. N.C.O. (Master motor mechanic (at same time driver for staff car) ...	—	—	1	—	—	1	—	—	—	—	—	—	—
10	M	M.T. Mechanics (1 at the same time spare driver for lorry)	—	—	—	4	4	—	—	—	—	—	—	—	—
11	M	Petrol Orderly (also spare driver for lorry)	—	—	—	1	1	—	—	—	—	—	—	—	—
12	M	Drivers (Lorry)	—	—	—	2	—	2	—	—	—	—	—	—	—
13	—	Medium Lorry 3-ton, closed, Workshop Lorry ...	—	—	—	—	—	—	—	1	—	—	—	—	—
14	—	Medium Lorry, 3-ton, open, as tanker	—	—	—	—	—	—	—	1	—	—	—	—	—
15	—	Staff Car, (Cross country, 4-seater)	—	—	—	—	—	—	—	1	—	—	—	—	—
16	—	Totals	—	—	2	7	5	3(1)	—	3	—	—	—	—	—
17	—	*Supply Column*													
18	O	Warrant Officer	—	—	1	—	—	(1)	—	—	—	—	—	—	—
19	G	Accounts clerk	—	—	1	—	—	1	—	—	—	—	—	—	—
20	G	Equipment N.C.O.	—	—	1	—	—	1	—	—	—	—	—	—	—
21	G	Field Cook	—	—	1	—	—	1	—	—	—	—	—	—	—
22	G	Clerk (Grade 1)	—	—	1	—	—	1	—	—	—	—	—	—	—
23	G	Rations N.C.O.	—	—	1	—	—	1	—	—	—	—	—	—	—
24	G	Medical N.C.O.	—	—	1	—	—	—	—	—	—	—	—	—	—

TECHNICAL TROOP (*Contd.*)

Serial No.	Grade of Appointment	Designation	Officers	Officials	N.C.O.s	Men	Rifles	Pistols (Machine Pistols)	M.G. 42 (Tripods)	M.T.	Armoured Vehicles	M/C's (Sidecars)	Trailers	Field Kitchens	Bicycles
a	b	c	d	e	f	g	h	i	k	l	m	n	o	p	q
1	—	*Supply Column (contd.)*													
2	M	Clerks	—	—	—	2	2	—	—	—	—	—	—	—	—
3	M	Assistant Cook	—	—	—	1	1	—	—	—	—	—	—	—	—
4	M	Assistant Armourer	—	—	—	1	1	—	—	—	—	—	—	—	—
5	M	Tailor	—	—	—	1	1	—	—	—	—	—	—	—	—
6	M	Cobbler	—	—	—	1	1	—	—	—	—	—	—	—	—
7	M	Motor Cyclist (D.R.)... ...	—	—	—	1	—	1	—	—	—	—	—	—	—
8	M	Driver (Staff car)	—	—	—	1	—	1	—	—	—	—	—	—	—
9	M	Drivers (Lorry)	—	—	—	5	—	5	—	—	—	—	—	—	—
10	M	Cyclists (D.R.)	—	—	—	2	2	—	—	—	—	—	—	—	—
11	M	Medical Orderly	—	—	—	1	—	—	—	—	—	—	—	—	—
12	—	Medium Lorry—3-ton (closed) for Office	—	—	—	—	—	—	—	1	—	—	—	—	—
13	—	Medium Lorry—3-ton (closed) for weapons and equipment)	—	—	—	—	—	—	—	1	—	—	—	—	—
14	—	Medium Lorry—3-ton (closed) for clothing	—	—	—	—	—	—	—	1	—	—	—	—	—
15	—	Medium Lorry—3-ton (closed) for rations	—	—	—	—	—	—	—	1	—	—	—	—	—
16	—	Medium Lorry—3-ton (closed) for Field Kitchen ...	—	—	—	—	—	—	—	1	—	—	—	—	—
17	—	Staff Car (Cross country, 4-seater)	—	—	—	—	—	—	—	1	—	—	—	—	—
18	—	Medium Motor Cycle ...	—	—	—	—	—	—	—	—	—	1	—	—	—
19	—	Field Kitchen Range (Large)	—	—	—	—	—	—	—	—	—	—	—	1	—
20	—	Bicycles	—	—	—	—	—	—	—	—	—	—	—	—	2
21	—	Totals	—	—	7	16	8	12(1)	—	6	—	1	—	1	2
22	—	*Summary of Establishment for Technical Troop*													
23	—	HQ. Section	1	1	3	6	3	7(1)	—	2	—	3	—	—	—
24	—	Mot. Med. Telephone Section (12 km. Cable length) ...	—	—	1	5	4	1(1)	—	1	—	—	—	—	—
25	—	1 Platoon	1	—	12	48	35	22(4)	—	12	—	2(1)	4	—	—
26	—	2 Platoon	1	—	11	67	48	25(6)	3	9	—	4(2)	3	—	—
27	—	M.T. Repair Section ...	—	—	2	7	5	3(1)	—	3	—	—	—	—	—
28	—	Supply Column	—	—	7	16	8	12(1)	—	6	—	1	—	1	2
29	—	Grand Totals	3	1	36	149	103	70(14)	3	33	—	10(3)	7	1	2

LEGEND—K = Company Commander (Captain or Lieutenant)
Z = Platoon Commander (Lieutenant or Second Lieutenant)
O = Staff Sergeant (Oberfeldwebel) Oberwachmeister) or WO (Stabswachmeister)
G = N.C.O. up to Sergeant (Wachtmeister)
M = Men

Additional Note :— 7 G-Appointments are Sergeant's Appointments.
10 Men are to be trained as stretcher bearers ; in each platoon a Gas Detection and Decontamination Party must be trained.
1 N.C.O. is to be detailed as Anti-Gas N.C.O.

FUEL AND ROCKET TROOP OF A GERMAN MOTORISED V-2 ROCKET REGIMENT

Serial No	Grade of Appointment	Designation	Officers	Officials	N.C.O.s	Men	Rifles	Pistols (Machine Pistols)	M.G. 42 (Tripods)	M.T.	Armoured Vehicles	M/C's (Sidecars)	Trailers	Field Kitchens	Bicycles
a	b	c	d	e	f	g	h	i	k	l	m	n	o	p	q
1	—	*Fuel and Rocket Troop*													
2	—	*H.Q. Section*													
3	K	Troop Commander	1	—	—	—	—	1	—	—	—	—	—	—	—
4	Z	Troop Leader (for Liquid Oxygen, Alcohol and Hydrogen Peroxide)	1	—	—	—	—	1	—	—	—	—	—	—	—
5	M	Drivers (Staff Car) (N.C.O.)	—	—	—	2	2	—	—	—	—	—	—	—	—
6	G	Motor Cyclist (D.R.)... ...	—	—	1	—	—	(1)	—	—	—	—	—	—	—
7	M	Motor Cyclist (D.R.)... ...	—	—	—	1	—	(1)	—	—	—	—	—	—	—
8	G	Medical N.C.O.	—	—	1	—	—	—	—	—	—	—	—	—	—
9	—	Staff Cars (cross country 4-seater)	—	—	—	—	—	—	—	2	—	—	—	—	—
10	—	Medium Motor Cycles ...	—	—	—	—	—	—	—	—	—	2	—	—	—
11	—	Totals	2	—	2	3	2	2(2)	—	2	—	2	—	—	—
12	—	1. *Platoon (A-Stoff)* (Liquid Oxygen)													
13	O	Platoon Commander ...	—	—	1	—	—	1(1)	—	—	—	—	—	—	—
14	M	Driver (Staff) Car	—	—	—	1	1	—	—	—	—	—	—	—	—
15	M	Motor Cyclist (D.R.)... ...	—	—	—	1	—	(1)	—	—	—	—	—	—	—
16	—	Staff Car (cross country 4-seater)	—	—	—	—	—	—	—	1	—	—	—	—	—
17	—	Medium Motor Cycle ...	—	—	—	—	—	—	—	—	—	1	—	—	—
18		Totals	—	—	1	2	1	1(2)	—	1	—	1	—	—	—
19	—	1. *Section*													
20	—	Section Commander	—	—	1	—	1	—	—	—	—	—	—	—	—
21	M	Drivers for Tractors, 8-ton (also fuelling personnel)	—	—	—	4	4	—	—	—	—	—	—	—	—
22	M	Spare Drivers (also fuelling personnel) (one also machine gunner)	—	—	—	4	3	1	1	—	—	—	—	—	—
23	—	Tractors, 8-ton	—	—	—	—	—	—	—	4	—	—	—	—	—
24	—	Liquid Oxygen Trailers ... (6,000 Kg.)	—	—	—	—	—	—	—	—	—	—	5	—	—
25		Totals	—	—	1	8	8	1	1	4	—	—	5	—	—

FUEL AND ROCKET TROOP (*Contd.*)

Serial No.	Grade of Appointment	Designation	Officers	Officials	N.C.O.s	Men	Rifles	Pistols (Machine Pistols)	M.G. 42 (Tripods)	M.T.	Armoured Vehicles	M/C's (Sidecars)	Trailers	Field Kitchens	Bicycles
a	b	c	d	e	f	g	h	i	k	l	m	n	o	p	q
1	—	2. *Section* (as 1 Section but without MG.)	—	—	1	8	9	—	—	4	—	—	5	—	—
2	—	*Railhead Transloading Section.*													
3	G	Section Commander	—	—	1	—	1	—	—	—	—	—	—	—	—
4	M	Fuelling personnel (one also spare Driver for lorry) ...	—	—	—	4	4	—	—	—	—	—	—	—	—
5	—	Lorry 3-ton (for pumps and fuelling equipment) ...	—	—	—	—	—	—	—	1	—	—	—	—	—
6	—	Totals	—	—	1	4	5	—	—	1	—	—	—	1	—
7	—	*Composition* ... ... 1 *Platoon*	—	—	4	22	23	2(2)	1	10	—	1	10	—	—
8	—	2 *Platoon* (Alcohol & Hydrogen Peroxide)													
9	O	Platoon Commander	—	—	1	—	—	1(1)	—	—	—	—	—	—	—
10	M	Driver (Staff Car)	—	—	—	1	1	—	—	—	—	—	—	—	—
11	M	Motor Cyclist (D.R.)... ...	—	—	—	1	—	(1)	—	—	—	—	—	—	—
12	—	Staff Car (cross country 4-seater)	—	—	—	—	—	—	—	1	—	—	—	—	—
13	—	Medium Motor Cycle ...	—	—	—	—	—	—	—	—	—	1	—	—	—
14		Totals ...	—	—	1	2	1	1(2)	—	1	—	1	—	—	—
15	—	1 *Section*													
16	G	Section Commander (also spare driver)	—	—	1	—	1	—	—	—	—	—	—	—	—
17	M	Lorry Drivers (also fuelling personnel)	—	—	—	5	5	—	—	—	—	—	—	—	—
18	M	Spare Drivers (also fuelling personnel) (one also machine gunner)	—	—	—	4	3	1	1	—	—	—	—	—	—
19	—	Alcohol Tankers 3,500 litre ...	—	—	—	—	—	—	—	5	—	—	—	—	—
20	—	Pump trailer (1 axle) Type A.	—	—	—	—	—	—	—	—	—	—	1	—	—
21	—	Totals	—	—	1	9	9	1	1	5	—	—	1	—	—
22	—	2 *Section* ... ... (as 1 Sec. but with M.G.)	—	—	1	9	10	—	—	5	—	—	1	—	—

FUEL AND ROCKET TROOP (*Contd.*)

Serial No.	Grade of Appointment	Designation	Officers	Officials	N.C.O.s	Men	Rifles	Pistols (Machine Pistols)	M.G. 42 (Tripods)	M.T.	Armoured Vehicles.	M/C's (Sidecars)	Trailers	Field Kitchens	Bicycles
a	b	c	d	e	f	g	h	i	k	l	m	n	o	p	q
1	—	3. *Section*													
2	G	Section Commander (also spare driver)	—	—	1	—	1	—	—	—	—	—	—	—	—
3	M	Lorry Drivers (also fuelling personnel)	—	—	—	4	4	—	—	—	—	—	—	—	—
4	M	Spare drivers (also fuelling personnel)	—	—	—	3	3	—	—	—	—	—	—	—	—
5	—	Alcohol Tankers 3,500 litre ...	—	—	—	—	—	—	—	4	—	—	—	—	—
6	—	Pump trailers (1 axle) Type "A"	—	—	—	—	—	—	—	—	—	—	1	—	—
7		Totals	—	—	1	7	8	—	—	4	—	—	1	—	—
8	—	*Railhead transloading Section*													
9	G	Section Commander	—	—	1	—	1	—	—	—	—	—	—	—	—
10	M	Fuelling Personnel (one also lorry Driver)	—	—	—	3	3	—	—	—	—	—	—	—	—
11	—	Lorry for pumps and fuelling equipment, 3-ton	—	—	—	—	—	—	—	1	—	—	—	—	—
12	—	Totals	—	—	1	3	4	—	—	1	—	—	—	—	—
13	—	*Hydrogen Peroxide Section*													
14	M	Lorry Drivers (also fuelling personnel)	—	—	—	3	3	—	—	—	—	—	—	—	—
15	M	Spare Drivers (also fuelling personnel)	—	—	—	3	3	—	—	—	—	—	—	—	—
16	—	Hydrogen Peroxide Tankers, 2,100 litre	—	—	—	—	—	—	—	3	—	—	—	—	—
17	—	Preheater trailer (1 axle) ...	—	—	—	—	—	—	—	—	—	—	3	—	—
18	—	Totals	—	—	—	6	6	—	—	3	—	—	3	—	—
19	—	*Composition* ... *2. Platoon*	—	—	5	36	28	2(2)	1	19	—	1	6	—	—

FUEL AND ROCKET TROOP (*Contd.*)

Serial No.	Grade of Appointment	Designation	Officers	Officials	N.C.O.'s	Men	Rifles	Pistols (Machine Pistols)	M.G. 42 (Tripods)	M.T.	Armoured Vehicles.	M/C's (Sidecars)	Trailers	Field Kitchens.	Bicycles
a	b	c	d	e	f	g	h	i	k	l	m	n	o	p	q
1	—	3. *Platoon* (Rocket Transport)													
2	Z	Platoon Commander ...	1	—	—	—	—	1(1)	—	—	—	—	—	—	—
3	M	Driver (Staff Car)	—	—	—	1	1	—	—	—	—	—	—	—	—
4	M	Motor Cyclist (D.R.)... ...	—	—	—	1	—	(1)	—	—	—	—	—	—	—
5	—	Staff Car (cross country) 4-seater	—	—	—	—	—	—	—	1	—	—	—	—	—
6	—	Medium M/C.	—	—	—	—	—	—	—	—	—	1	—	—	—
7	—	Totals ...	1	—	—	2	1	1(2)	—	1	—	1	—	—	—
8	—	1. *Section*													
9	G	Section Commander (Also spare Driver)	—	—	1	—	1	—	—	—	—	—	—	—	—
10	—	Driver (for tractor, 6-ton) ...	—	—	—	4	4	—	—	—	—	—	—	—	—
11	M	Spare Drivers (one also Machine Gunner)	—	—	—	3	2	1	1	—	—	—	—	—	—
12	—	Tractors, 6-ton	—	—	—	—	—	—	—	4	—	—	—	—	—
13	—	Vidalwagen	—	—	—	—	—	—	—	—	—	—	8	—	—
14	—	Totals	—	—	1	7	7	1	1	4	—	—	8	—	—
15	—	2. *Section* (as 1 Section but without M.G.)	—	—	1	7	8	—	—	4	—	—	8	—	—
16	—	3. *Section* (as 1 Section but without M.G.)	—	—	1	7	8	—	—	4	—	—	8	—	—
17	M	Drivers (for lorries 8-ton) ...	—	—	—	2	2	—	—	—	—	—	—	—	—
18	M	Spare Drivers	—	—	—	2	2	—	—	—	—	—	—	—	—
19	—	Lorries, 9-ton (for war-head transport)	—	—	—	—	—	—	—	2	—	—	—	—	—
20	—	Totals	—	—	—	4	4	—	—	2	—	—	—	—	—
21	—	*Composition* ... ... 3. *Platoon*	1	—	3	27	28	2(2)	1	15	—	1	24	—	—

FUEL AND ROCKET TROOP (*Contd.*)

Serial No.	Grade of Appointment	Designation	Officers	Officials	N.C.O.s	Men	Rifles	Pistols (Machine Pistols)	M.G. 42 (Tripods)	M.T.	Armoured Vehicles	M/C's (Sidecars)	Trailers	Field Kitchens	Bicycles
a	b	c	d	e	f	g	h	i	k	l	m	n	o	p	q
1	—	*M.T. Repair Section*													
2	O	N.C.O. in charge M.T. ...	—	—	1	—	—	1	—	—	—	—	—	—	—
3	M	Driver (Staff Car)	—	—	—	1	1	—	—	—	—	—	—	—	—
4	G	M.T. N.C.O. (Kfz Wart I) (Master Motor Mechanic)	—	—	1	—	—	1	—	—	—	—	—	—	—
5	M	M.T. personnel (Kfz Wart II, III, IV) (motor mechanic, turner, welder, M.T. electrician) (one also Lorry Driver)	—	—	—	3	3	—	—	—	—	—	—	—	—
6	—	Staff Car (cross country, 4-seater)	—	—	—	—	—	—	—	1	—	—	—	—	—
7	—	Lorry 3-ton (for M.T. Workshop)	—	—	—	—	—	—	—	1	—	—	—	—	—
8	—	Trailer (1 axle) for spare parts	—	—	—	—	—	—	—	—	—	—	1	—	—
9	—	Totals	—	—	2	4	4	2	—	2	—	—	1	—	—
10	—	*Supply Column*													
11	O	Warrant Officer	—	—	1	—	—	1	—	—	—	—	—	—	—
12	G	Accounts Clerk	—	—	1	—	—	1	—	—	—	—	—	—	—
13	G	Weapons and Equipment N.C.O.	—	—	1	—	—	1	—	—	—	—	—	—	—
14	G	Armourer N.C.O.	—	—	1	—	—	1	—	—	—	—	—	—	—
15	M	Assistant Armourer	—	—	—	1	1	—	—	—	—	—	—	—	—
16	G	Clerk (Grade 1)	—	—	1	—	—	1	—	—	—	—	—	—	—
17	M	Clerk (Grade 2) (Draughtsman)	—	—	—	1	1	—	—	—	—	—	—	—	—
18	G	QM. N.C.O.	—	—	1	—	—	1	—	—	—	—	—	—	—
19	C	Field Cook	—	—	1	—	—	1	—	—	—	—	—	—	—
20	M	Assistant Cook	—	—	—	1	1	—	—	—	—	—	—	—	—
21	M	Petrol Orderly (also M.T. Clerk)	—	—	—	1	1	—	—	—	—	—	—	—	—
22	M	Drivers (for lorries, 3-ton) ...	—	—	—	4	4	—	—	—	—	—	—	—	—
23	M	Driver (Staff Car)	—	—	—	1	1	—	—	—	—	—	—	—	—
24	M	Motor Cyclist (D.R.)... ...	—	—	—	1	—	(1)	—	—	—	—	—	—	—
25	M	Tailor	—	—	—	1	1	—	—	—	—	—	—	—	—
26	M	Cobbler	—	—	—	1	1	—	—	—	—	—	—	—	—

FUEL AND ROCKET TROOP (*Contd.*)

Serial No.	Grade of Appointment	Designation	Officers	Officials	N.C.O.s	Men	Rifles	Pistols (Machine Pistols)	M.G. 42 (Tripods)	M.T.	Armoured Vehicles	M/C's (Sidecars)	Trailers	Field Kitchens	Bicycles
a	b	c	d	e	f	g	h	i	k	l	m	n	o	p	q
1	—	*Supply Column (contd.)*													
2	—	Staff Car (cross country 4-seater)	—	—	—	—	—	—	—	1	—	—	—	—	—
3	—	Motor Cycle (Med.)	—	—	—	—	—	—	—	—	—	1	—	—	—
4	—	Lorries—3-ton (for Fuel, Rations, Field Kitchen, Office and Kit)	—	—	—	—	—	—	—	4	—	—	—	—	—
5	—	Trailer (2 axle, 3-ton) (for Weapons, Ammunition, Equipment, Anti-gas Equipment, Signals Equipment)	—	—	—	—	—	—	—	—	—	—	1	—	—
6	—	Field Kitchen Range (Large)	—	—	—	—	—	—	—	—	—	—	—	1	—
7	—	Bicycles	—	—	—	—	—	—	—	—	—	—	—	—	3
8	—	Totals	—	—	7	12	11	7(1)	—	5	—	1	1	1	3
9	—	*Summary of Establishment for Fuel and Rocket Troop*													
10	—	HQ. Section	2	—	2	3	2	2(2)	—	2	—	2	—	—	—
11	—	1 Platoon	—	—	4	22	23	2(2)	1	10	—	1	10	—	—
12	—	2 Platoon	—	—	5	36	38	2(2)	1	19	—	1	6	—	—
13	—	3 Platoon	1	—	3	27	28	2(2)	1	15	—	1	24	—	—
14	—	Repair Section	—	—	2	4	4	2	—	2	—	—	1	—	—
15	—	Supply Column	—	—	7	12	11	7(1)	—	5	—	1	1	1	3
16	—	Totals	3	—	23	104	106	17(9)	3	53	—	6	42	1	3

LEGEND

K = Company Commander (Captain or Lieutenant)
Z = Platoon Commander (Lieutenant or Second Lieutenant)
O = Staff Sergeant (Oberfeldwebel) (Oberwachtmeister) or W.O. (Stabswachtmeister).
G = N.C.O. up to Sergeant (Wachtmeister)
M = Men

Additional Explanation

5 G-Appointments are Sergeant's Appointments.
10 Men are to be trained as Stretcher-bearers.
3 Gas Detector and Decontamination Sections are to be formed.
3 Men are Telephone Construction personnel.
One N.C.O. is to be detailed as Anti-gas N.C.O.