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PART ONE—INTRODUCTION

Section I GENERAL

1. SCOPE.

a. These instructions are published for the information and guidance of the personnel to whom this equipment is assigned. They contain information on the operation and maintenance of the German Volkswagen as well as descriptions of the major units and their functions in relation to the other components of the vehicle.

b. This manual has the following arrangement.

(1) Part One, Introduction, contains description and data.

(2) Part Two, Operating Instructions, contains instructions for the operation of the vehicle, with description and location of the controls and instruments.

(3) Part Three, Maintenance Instructions, contains information needed for the performance of the scheduled lubrication and preventive maintenance services, and instructions for maintenance operations which can ordinarily be performed by using organizations (first and second echelons).

(4) The Appendix contains instructions for shipment and limited storage, and a list of references which may provide helpful information concerning operation or maintenance.

c. The operations described in this manual are based on the availability of necessary parts, accessories, and tools. Conditions will arise in which the items referred to in the manual are not available since they cannot be requisitioned through usual channels. In these cases, individual initiative must be resorted to when repairs are required.

2. RECORDS.

a. Forms and records which may be provided for use in performing prescribed operations are listed below with brief explanations of each. In case of Volkswagen use of these forms will be governed by tactical situation and extent to which vehicle is employed.

(1) STANDARD FORM NO. 25, DRIVER'S REPORT—ACCIDENT, MOTOR TRANSPORTATION. One copy of this form should be kept with the vehicle at all times. In case of an accident resulting in injury or property damage, it should be filled out by the driver on the spot, or as promptly as practical thereafter.

(2) WAR DEPARTMENT FORM NO. 48, DRIVER'S TRIP TICKET AND PREVENTIVE MAINTENANCE SERVICE RECORD. This form, prop-

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erly executed, is furnished to the driver when his vehicle is dispatched on non-tactical missions. The driver and the official user of the vehicle complete, in detail, appropriate parts of this form. These forms need not be issued for vehicles in convoy or on tactical missions. The reverse side of this form contains the driver's daily and weekly preventive maintenance service reminder schedule.

(3) W.D., A.G.O. FORM NO. 6, DUTY ROSTER. This form, slightly modified, is used for scheduling and maintaining a record of vehicle maintenance operations. It may be used for lubrication records.

(4) W.D., A.G.O. FORM NO. 461 PREVENTIVE MAINTENANCE SERVICE AND TECHNICAL INSPECTION WORK SHEET FOR WHEELED AND HALF-TRACK VEHICLES. This form is used for all 1,000-mile (monthly) and 5,000-mile (semiannual) maintenance services and all technical inspections performed on wheeled or half-track vehicles.

Section II**DESCRIPTION AND DATA****3. DESCRIPTION.**

a. **General.** The Volkswagen is a four-wheeled, rubber-tired, rear axle drive personnel carrier and reconnaissance car, comparable in purpose and size to the American $\frac{1}{4}$ -ton 4x4 truck. No propeller shaft, as such, is used; the engine, transmission, and differential comprise a unit structure which is secured to the floor at the extreme rear end of the vehicle. Access to the engine is provided by a hinged door at the rear of the body. The vehicle has no frame. Instead, a base stamping comprising the floor of the vehicle is ribbed and provided with a central tunnel to give desired stiffness, to form the foundation of the vehicle. The main fuel tank is located under the front body panel on the right-hand side of the vehicle. The spare tire is carried on top of the front body panel.

b. **Engine.** The engine is an air-cooled, four-cylinder, four-cycle, horizontally-opposed type. Intake and exhaust valves are located in the cylinder head and are operated by conventional rocker arms and push rods.

c. **Transmission.** The transmission is the selective, sliding-gear type. Four speeds forward and one reverse are available. Differing from American vehicles, no direct drive is used. The fourth speed forward is an overdrive, having a ratio of 0.80 to 1. A detailed description of the transmission is contained in section XX.

DESCRIPTION AND DATA

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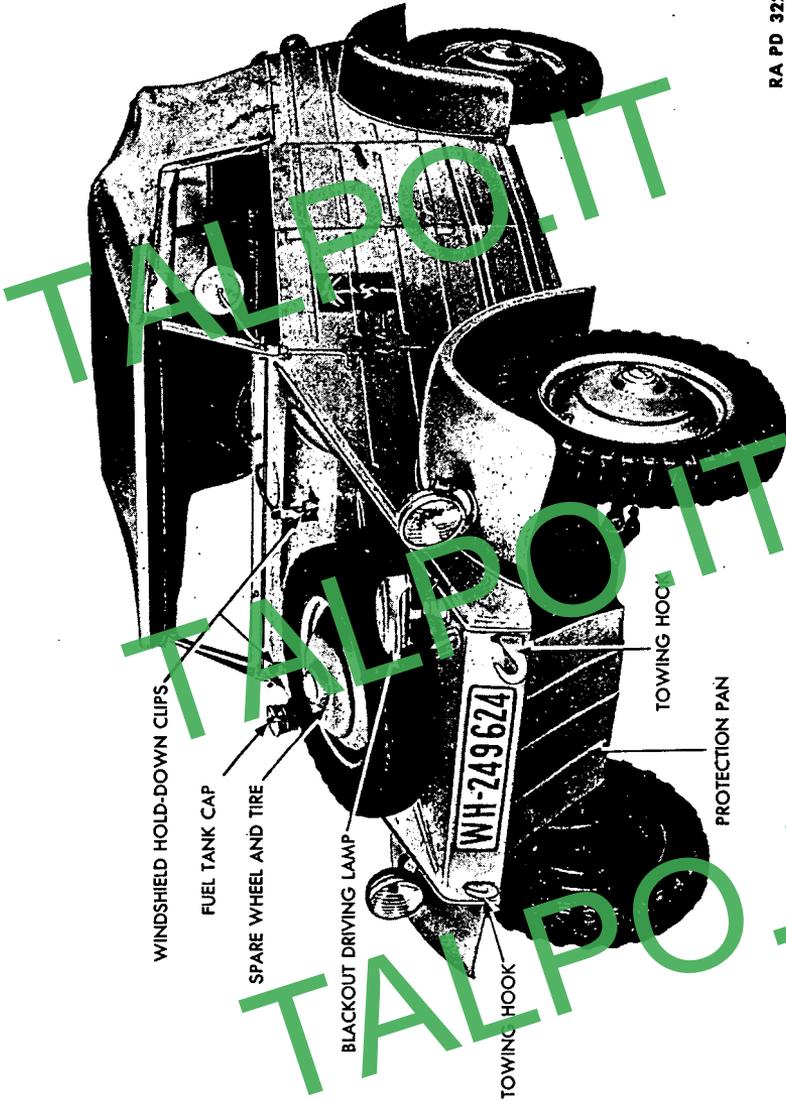


Figure 1—Volkswagen—Left Front View

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RA PD 322083



Figure 2—Volkswagen—Left Rear View

DESCRIPTION AND DATA

d. **Differential.** A positive locking differential is used in place of spider gears. Whenever excessive friction is built up, the differential locks, thereby transmitting torque equally to the two driving wheels. A detailed description of the differential is contained in section XX.

e. **Suspension.** All wheels are independently sprung. The two front wheels are sprung on pairs of torsion rods mounted transversely on the vehicle, with the wheel kingpins being supported on a parallelogram linkage. The two rear wheels are stabilized laterally from the differential housing, and oscillate vertically about centers of the universal joints which are attached to the sides of the differential housing. Suspension of the rear wheels is by torsion arms attached to each end of a torsion rod mounted transversely on the vehicle.

f. **Steering Gear.** Steering wheel and steering mechanism are of the conventional type commonly used in American vehicles.

g. **Braking System.** Service brakes operate on all four wheels. These are mechanical brakes, actuated by cables attached to the foot brake pedal. The parking brake, through the same system of cables, also operates the service brakes on all four wheels.

4. TABULATED DATA.

a. Vehicle Specifications	Metric	U. S.
Wheel base	2,400 mm	7 ft 10½ in.
Length, overall	3,740 mm	12 ft 3¼ in.
Width, overall	1,600 mm	5 ft 5 in.
Height (top up)	1,650 mm	5 ft 3 in.
Height (top down)	1,111 mm	3 ft 8 in.
Tire size		5.25-16
Tire air pressure (front)	1.4 atmospheres	20.5 lb
Tire air pressure (rear)	1.8 atmospheres	26.5 lb
Tread (front)	1,356 mm	53.39 in.
Tread (rear)	1,360 mm	53.54 in.
Crew	4	
Weight (empty)	725 kg	1,598 lb
Weight (loaded)	1,160 kg	2,557 lb
Net load	435 kg	957 lb
Ground clearance	290 mm	11.4 in.
Foot brake works on		4 wheels
Hand brake works on		4 wheels
Wheels		Disk
Type of rims		Drop center
Front wheel toe-in	3-6 mm	⅛-¼ in.
Camber		2½ deg
Caster		5 deg

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b. Performance.

	Metric	U. S.
Minimum speed	3 kmph	1.8 mph
Maximum speed	80 kmph	49.7 mph
Climbing ability in loose sand		40 pct.
Climbing ability on the road		45 pct.
Fording depth (without wetting engine)	450 mm	17.7 in.
Operating radius	400-450 km	250-280 miles

c. Capacities.

Main gas tank	30 liters	7.925 gal
Normal fuel consumption	8 liters per 100 kilometers	30 mpg (approx)
Transmission and differential for lubricant change	2.5 liters	2.6 qt
For filling after overhaul	3.0 liters	3.1 qt
Engine		
For oil change	2.5 liters	2.6 qt
For filling after overhaul	3.0 liters	3.1 qt
Steering mechanism	0.25 liters	$\frac{1}{2}$ pt

5. CONVERSION TABLE.

Metric to U. S.	U. S. to Metric
1 millimeter equals .0394 inches	1 inch equals 25.4 millimeters
1 liter equals 0.264 gallons	1 gallon equals 3.785 liters
1 kilogram equals 2.205 pounds	1 pound equals 0.454 kilograms
1 kilometer equals 0.621 miles	1 mile equals 1.609 kilometers

Section III

TOOLS, PARTS, AND ACCESSORIES

6. TOOLS.

a. All maintenance operations listed in this manual can be performed with standard tools available to the first and second echelon maintenance organizations. Open-end and socket wrenches used must be in $\frac{1}{64}$ -inch sizes to properly fit the metric scale of bolt and nut sizes.

7. PARTS AND ACCESSORIES.

a. Since this materiel is of German manufacture, replacement of various units with corresponding units of American manufacture is limited to minor parts which can be adapted for use on this vehicle by

TOOLS, PARTS, AND ACCESSORIES

improvising mounting facilities. Examples of such replacement units headlights, coil, wiring, and some of the instruments in the instrument panel. Otherwise, parts replacement will have to be handled by cannibalization.

b. Many vehicles will be found from which the tools and equipment have been removed, lost, or damaged. These may be replaced by cannibalization or by requisition of comparable American equipment through usual channels. Below is a suggested list of American equipment which will be found valuable and useful for proper operation and maintenance of the vehicle. This list is for information only and is not to be used as a basis for requisition.

Tools and Equipment	Federal Stock No.
Ax, chopping, single-bit.....	41-A-1277
Extinguisher, fire.....	58-E-202
Gage, tire pressure.....	8-G-615
Gun, lubr., hand-type.....	41-G-1330-60
Oiler, straight spout, 1/2-pt.....	13-O-1530
Pliers, combination, slip joint, 6-in.....	41-P-1650
Pump, tire, w/chuck.....	8-P-1000
Screwdriver, common, 6-in.....	41-S-1104
Shovel, D-handle, rd. pt.....	41-S-1170
Wrench, adjustable, automobile type, 11-in.....	41-W-448
Wrench, adjustable, crescent type, 8-in.....	41-W-486

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- A—HORN BUTTON
- B—WINDSHIELD WIPER
- C—FUSE BOX
- D—AMMETER
- E—OIL PRESSURE GAGE
- F—SPEEDOMETER
- G—BRIGHT LIGHT INDICATOR
- H—DIRECTION SIGNAL INDICATOR
- J—FUSE BOX
- K—DIRECTION SIGNAL SWITCH
- L—SPOTLIGHT
- M—FUEL COCK
- N—MULTIPLE SWITCH
- P—LIGHT SWITCH
- Q—GEARSHIFT LEVER
- R—IGNITION KEY
- S—DASHBOARD LIGHT SWITCH
- T—DOUBLE LAMP SOCKET
- U—CRANKING MOTOR BUTTON
- V—CLUTCH
- W—EMERGENCY BRAKE
- X—ACCELERATOR
- Y—BRAKE PEDAL
- Z—CLUTCH PEDAL
- AA—FRONT LIGHT SWITCH

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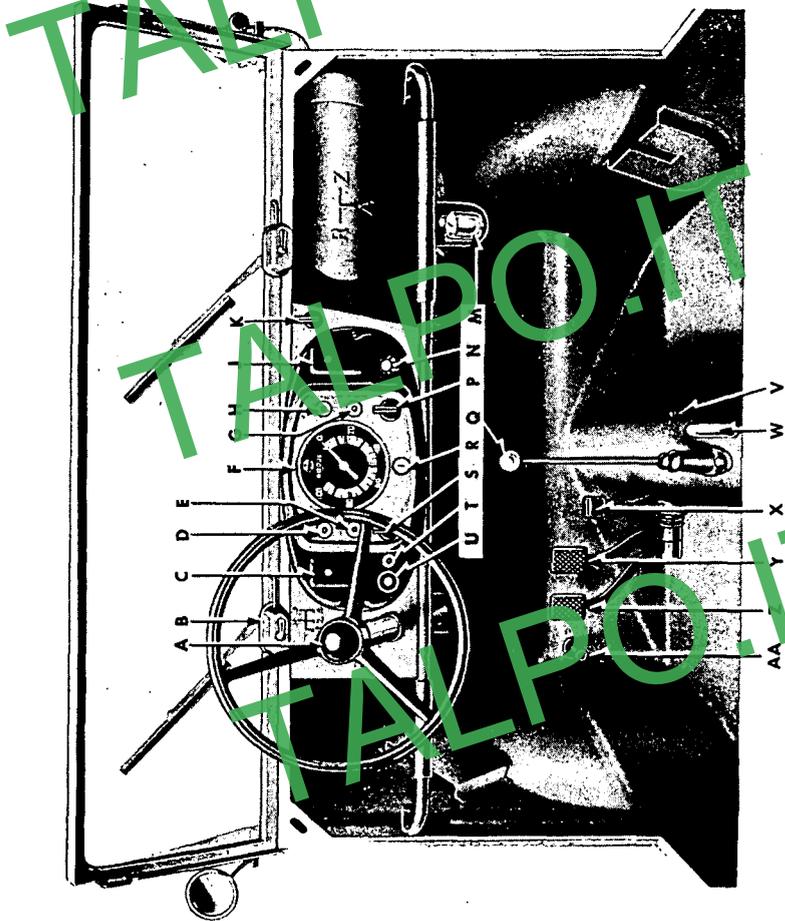


Figure 3—Instrument Panel, Brake, and Shift Levers

PART TWO—OPERATING INSTRUCTIONS

Section IV

CONTROLS AND INSTRUMENTS

8. CONTROLS.

a. **Ignition Switch.** The ignition switch is located at the lower center of the instrument panel. A key is furnished to operate the switch. When the key is inserted and turned, the switch serves to close electrical circuits between the battery and ignition coil, direction indicator light, oil pressure light, and dash light switch. All the other circuits are opened and closed by their respective switches.

b. **Horn Button.** The horn button is located in the hub of the steering wheel. When the button is depressed, it closes the circuit between the source of electrical power and the horn, and thus actuates the horn.

c. **Cranking Motor Button.** The cranking motor button is located on the extreme lower left side of the instrument panel. When the cranking motor button is depressed, it closes the electrical circuit between the cranking motor and battery. The cranking motor routes and, through a series of gears, rotates the engine crankshaft.

d. **Fuse Boxes.** Two rectangular fuse boxes, one at each end, are located on the instrument panel. Most of the electrical circuits in the vehicle pass through one, or the other, of these boxes. In the event a circuit is shorted or overloaded, the fuse burns out. This opens the circuit and prevents damage to any item of equipment, or injury to personnel.

e. **Trouble Lamp Socket.** This socket provides an electrical outlet in which a corded lamp may be plugged, thus providing portable illumination. The socket is located just to the right of the cranking motor button.

f. **Dash Light Switch.** The dash light switch is located on the instrument panel to the right of the trouble lamp socket. When turned on, it closes the circuit between the source of electrical power and the dash light, thus turning on the dash light.

g. **Light Switch.** The light switch is located on the instrument panel just beneath the bright light indicator. When the light switch is turned on it operates the service headlights and service tail and stop light.

h. **Multiple Switch.** The multiple switch is located just to the right of the light switch. The multiple switch has three positions: one

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"OFF"; one to turn on the blackout driving light and the blackout tail and stop light; and one to close the circuit to the headlight switch.

i. **Direction Signal Switch.** The direction signal switch is located at the extreme right-hand top side of the instrument panel. It controls the two direction signals located on the outer ends of the windshield. When the switch is turned to the left, the left direction signal is extended, and when the switch is turned to the right, the right direction signal is extended. "OFF" position of the switch is vertical.

j. **Fuel Cock.** The fuel cock is located at the fuel strainer beneath the fuel tank. Closing the cock shuts off the flow of fuel from the fuel tank to the carburetor on the engine.

k. **Foot Dimmer Switch.** The foot dimmer switch, located on the upward slope of the floor and convenient to the driver's left foot, is used to control the output of the front headlights. Stepping down on the switch operates it.

l. **Clutch Pedal.** The clutch pedal, mounted on a horizontal shaft extending outward from the tunnel in the center of the vehicle, extends upward to a position convenient to the driver's left foot. Depressing the pedal serves to disengage the clutch and thus interrupt the flow of power from the engine to the transmission and driving rear axles. The clutch pedal must be depressed in order to shift gears.

m. **Brake Pedal.** The brake pedal, located just to the right of the clutch pedal, is connected to the mechanical brakes on each wheel through a system of cables. Depressing the brake pedal pulls the cables, which in turn expands the brake shoes within the wheel drums, and slows, or stops the vehicle, depending on the amount of pressure exerted.

n. **Accelerator.** The accelerator is located just to the right of the brake pedal. In its released position, the accelerator is adjusted so that the engine will run at idling speed. Depressing the accelerator increases the speed of the engine.

o. **Choke.** The choke is mounted to the right of the gearshift lever on the tunnel extending through the center of the vehicle. Pulling out the choke enriches the mixture of gasoline and air being fed from the carburetor into the engine, and thus aids in starting a cold engine.

p. **Gearshift Lever.** The gearshift lever, convenient to the driver's right hand, is mounted on the tunnel extending through the center of the vehicle. The lever may be shifted into any of six positions.

CONTROLS AND INSTRUMENTS

Five of these are power positions, and one position is neutral. The purpose of the gearshift lever is to provide a means of selecting the proper transmission gear ratio to suit driving conditions.

q. Parking Brake. In its release position the parking brake lever rests in a horizontal position on the tunnel extending through the center of the vehicle. Pulling up on the parking brake lever operates the same cables as are operated by the service foot brakes, and thus slows or stops the vehicle, depending on the pressure exerted on the brake lever. A toothed segment on which the lever end of the parking brake is mounted engages a latch on the side of the parking brake lever, providing a means of locking the lever at any position along its arc of travel. This latch is released from the segment by depressing a button on the top of the parking brake lever.

9. INSTRUMENTS.

a. Oil Pressure Gage. The oil pressure gage is the lower warning light on the left-hand side of the instrument panel. The light glows green when the ignition is switched on, and is extinguished as soon as the engine is running. If the light glows again after the engine is warmed and running, it indicates the oil pressure has dropped below the safety margin.

b. Ammeter. The ammeter is the top warning light on the left-hand side of the instrument panel. The light glows red when the ignition is turned on, and is extinguished as soon as the engine is running above its idling speed. If the light should glow while the engine is running above idling speed, it indicates that the generator is not charging, and signifies trouble in the generating circuit.

c. Speedometer. The speedometer, located in the center of the instrument panel, is graduated in 20 kilometer calibrations from 0 to 100 kilometers. The speedometer indicates the speed at which the vehicle is traveling. A speedometer drive, used to turn speedometer gears, passes through the left front axle and is secured to the left front wheel bearing dust cap.

d. Direction Signal Indicator Light. The direction signal indicator light is a warning light located at the top right side of the instrument panel. When the direction signal switch is turned on, operating either the left or right direction signal, the light flashes on, warning the driver that one of the direction signals is extended. When the switch is turned off, retracting the direction signal, the light flashes off.

e. Bright Light Indicator. This is a warning light located just beneath the direction signal indicator light. When the bright lights are turned on, this indicator light flashes on, and remains on as long as the bright lights are in use.

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Section V

OPERATION UNDER ORDINARY CONDITIONS

10. STARTING THE ENGINE.

a. **Before-operation Service.** Perform the services in paragraph 21 before attempting to start the engine.

b. **Starting Procedure.** Turn fuel cock counterclockwise to open. Place gear-shift lever in neutral. Insert ignition key in switch and turn to right, so that ammeter warning light glows red. Depress clutch pedal and pull out choke. Press cranking motor button. Release cranking motor button as soon as the engine starts and push choke half way in. Permit the engine to run at low speed for two or three minutes to warm up with the choke half-way out. Push the choke all the way in as soon as the engine runs smoothly. If the engine fails to start with the first attempt, repeat the procedure. Do not hold the cranking motor button depressed continuously, for more than ten seconds at a time. Should the engine fail to start after numerous attempts, the carburetor may be flooded. In this circumstance, push the choke all the way in, depress the accelerator, and again attempt to start the engine. If the engine still will not start, refer to the section on trouble shooting (par. 27).

11. DRIVING THE VEHICLE.

a. **Placing Vehicle in Motion.** Release parking brake lever. With the engine warmed up and running smoothly, depress clutch pedal and shift into first gear. Depress accelerator pedal slightly, and slowly, and smoothly, release the clutch pedal. As soon as the speed of the vehicle reaches approximately ten miles per hour (17 kilometers per hour), depress clutch pedal, release the accelerator pedal, and shift into second gear. Continue this procedure until the highest possible gear is reached which will enable the vehicle to move smoothly at the desired speed. On a level road, the following speeds should not be exceeded in the designated gears.

Gear	Speed
1st	10.5 miles (17 kms.) per hour
2nd	19.2 miles (31 kms.) per hour
3rd	31.5 miles (51 kms.) per hour
4th	49.6 miles (80 kms.) per hour
Reverse	5.5 miles (9 kms.) per hour

b. **Stopping the Vehicle.** Remove foot from accelerator pedal and apply service brakes, depressing the clutch when the vehicle has slowed down to approximately five miles per hour. With the clutch depressed, move the gearshift lever into neutral. If the halt

OPERATIONS UNDER UNUSUAL CONDITIONS

is of temporary duration and the engine is to remain running, apply the parking brake to hold the vehicle. When parking the vehicle on a grade, apply the parking brake, shift the transmission into first gear, or reverse, and turn the front wheels toward the side of the road.

c. **Stopping the Engine.** With gearshift lever in neutral and the parking brake applied, turn off the ignition switch and remove the key. Turn the fuel cock clockwise to shut off the flow of fuel from the fuel tank.

12. TOWING THE VEHICLE

a. **Towing to Start the Vehicle.** This method of starting the engine can be used where the power from the battery is insufficient. Two riveted hooks are provided on the front of the vehicle for cable attachment. Preliminary inspection of the vehicle must take place before any towing action is allowed (par. 21). The towing vehicle must effect a gradual start to avoid any undue strain and must be driven in first gear during the entire towing operation. High speed is unnecessary. The fuel cock and the ignition switch of the towed vehicle must be turned to the "ON" position, the clutch pedal must be fully depressed, the gearshift lever placed in the third position, and the choke lever pulled all the way out. Release the parking brake. The signal can now be given to the towing vehicle to start. When normal speed has been reached, release the clutch pedal gradually until the driving action takes place in the engine. Then depress the clutch pedal immediately and push the choke button in part way. Keep the engine going by joint action of the accelerator and choke, until it is warm enough to make the choke action unnecessary.

b. **Towing Disabled Vehicle.** Two hooks are bolted in place on the rear of the vehicle identical with those on the front, for cable attachment when the vehicle is disabled. Under normal conditions the vehicle can be towed from the front, but where damage is apparent in the transmission or rear axle, the vehicle can be hoisted clear of the ground by the rear hooks, and towed on its front wheels.

OPERATIONS UNDER UNUSUAL CONDITIONS

13. COLD WEATHER OPERATIONS.

a. **Purpose.** Just as in the case of any comparable American equipment, operation of the Volkswagen in subzero temperatures pre-

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sents problems that demand special precautions. If poor performance and total functional failures are to be avoided, extra careful servicing by both operation and maintenance personnel must be maintained.

b. Gasoline.

(1) **TYPE.** Winter grade of gasoline is designed to reduce cold weather starting difficulties. The winter grade of fuel supplied for American vehicles should always be used for cold weather operations.

(2) **STORAGE AND HANDLING.** Due to condensation of moisture from the air, water will accumulate in tanks, drums, and containers. At low temperatures, this water will form ice crystals that will clog fuel lines and carburetor jets unless the following precautions are taken:

(a) Strain the fuel through filter paper or any other type of strainer that will prevent the passage of water. Gasoline flowing over a surface generates static electricity that will result in a spark unless means are provided to ground the electricity. Always provide a metallic contact between the container and the vehicle tank.

(b) Keep storage tank full, if possible. The more fuel there is in the tank, the smaller will be the volume of air from which moisture can be condensed.

(c) Add 1 quart of grade 3 denatured alcohol to the fuel storage tank at start of winter season, and 1 pint per month thereafter. This will reduce the hazard of ice formation in the fuel.

(d) Be sure that all containers are thoroughly clean and free from rust before storing fuel in them.

(e) If possible, after filling or moving a container, allow the fuel to settle 24 hours before filling vehicle tank from it.

(f) Keep all closures of containers tight to prevent snow, ice, dirt, and other foreign matter from entering.

(g) Wipe all snow or ice from dispensing equipment and from around fuel tank fill cap before removing cap to refuel vehicles.

c. Keeping Crankcase Oil Fluid. Several methods for keeping crankcase oil sufficiently fluid for proper lubrication are listed below. Preference should be given to the different methods in the order listed, according to the facilities available.

(1) Keep the vehicle in a heated inclosure when it is not being operated.

(2) When the engine is stopped, drain the crankcase oil while it is still hot and store in a warm place until the vehicle is to be operated again. If warm storage is not available, heat the oil before reinstalling. Do not get the oil too hot. Tag the vehicle in the driver's compartment to warn personnel that the crankcase is empty.

OPERATIONS UNDER UNUSUAL CONDITIONS

(3) Dilute the crankcase oil, using gasoline or Diesel fuel with preference given to gasoline. Fill the crankcase with SAE 30 engine oil and add 1½ pints of gasoline or grade X Diesel fuel. Run engine 5 to 10 minutes to mix the oil and the diluent thoroughly. Stop the engine and note that the level of the oil is above the normal "FULL" mark on the oil gage. This level should be marked on the gage for reference. After the vehicle has been operated 4 hours or more at operating temperature, redilute the oil if the vehicle is to be left standing unprotected for 5 hours or more. This can be accomplished by adding oil to the "FULL" mark, then adding gasoline or Diesel fuel to the dilution mark made on the gage for reference purposes. The presence of a large percentage of diluent will increase oil consumption and the oil level must be checked frequently.

(4) If the vehicle must be kept out-of-doors and if the crankcase cannot be drained, cover the engine with a tarpaulin. About three hours before the engine is to be started, place fire pots under the tarpaulin. A Van Prag, Primus-type, or other type blow torch, and ordinary kerosene lanterns may be used. With due consideration for the fire hazard involved, the flame may be applied directly to the oil pan.

d. Lubrication.

(1) **TRANSMISSION AND DIFFERENTIAL.** SAE 30 universal gear lubricant is suitable for use in temperatures as low as -20°F. If consistent temperatures below 0°F is anticipated, drain the oil from the cases while warm and refill with SAE 75 universal gear lubricant which is suitable for operation at all temperatures below +32°F. If SAE 75 universal gear lubricant is not available, drain the transmission and differential and refill with SAE 80 universal gear lubricant diluted with 1 pint of gasoline. After engine has been warmed up, engage clutch and maintain engine speed at fast idle for 5 minutes until gears can be engaged. Put transmission in first gear, and drive vehicle for 100 yards, being careful not to stall engine. This will heat gear lubricant to the point when normal operation can be expected.

(2) **STEERING GEAR AND REDUCTION GEAR HOUSINGS.** Drain, if possible, or use suction to remove as much lubricant as possible. Refill with SAE 75 universal gear lubricant, or, if not available, use SAE 80 universal gear lubricant, diluted with ¼ pint of gasoline per housing.

(3) **WHEEL BEARINGS.** When temperatures consistently below +32°F are anticipated, repack the wheel bearings with general purpose grease No. 0. Follow procedure outlined in paragraph 19.

(4) **OTHER LUBRICATION POINTS.** For cold weather servicing of the air cleaner, distributor, and oilcan points, refer to paragraph 19.

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e. Electrical Systems.

(1) **GENERATOR AND CRANKING MOTOR.** Check the brushes, commutators, and bearings. See that the commutators are clean. The large surges of current which occur when starting a cold engine require good contact between brushes and commutators. Be sure that no heavy grease or dirt has been left on the cranking motor throw-out mechanism. Heavy grease or dirt may keep the gears from being meshed or cause them to remain in mesh after the engine starts running thus ruining the cranking motor.

(2) **WIRING.** Check, clean and tighten all connections, especially the battery terminals. Make sure that no short circuits are present.

(3) **COIL.** Check coil for proper functioning by noting quality of the spark.

(4) **DISTRIBUTOR.** Clean thoroughly, and clean or replace points. Check the points frequently. In cold weather, slightly pitted points may prevent engine from starting.

(5) **SPARK PLUGS.** Clean and adjust or replace, if necessary. If it is difficult to make the engine fire, reduce the gap 0.002 inch less than that recommended in paragraph 79. This will make ignition effective at the reduced voltages likely to prevail.

(6) **TIMING.** Check carefully (par 45). Make certain that the spark is not unduly advanced or retarded.

(7) **BATTERIES.**

(a) The efficiency of the 6-volt battery decreases sharply with decreasing temperatures, and becomes practically nil at -40°F . Do not try to start the engine with the battery when it has been chilled to temperatures below -30°F until battery has been heated, unless a warm slave battery is available. See that the battery is always fully charged, with the hydrometer reading between 1.275 and 1.300. A fully discharged battery will freeze and rupture at $+5^{\circ}\text{F}$.

(b) Do not add water to a battery when it has been exposed to sub-zero temperatures unless the battery is to be recharged immediately. If water is added and the battery not put on charge, the layer of water will stay at the top and freeze before it has a chance to mix with the acid.

(8) **LIGHTS.** Inspect the lights carefully. Check for short circuits and presence of moisture around sockets.

(9) **ICE ON ELECTRICAL EQUIPMENT.** Before every start, see that the spark plugs, wiring, or other electrical equipment, is free from ice.

f. **Fuel System.** Carburetors and fuel pumps, which give no appreciable trouble at normal temperatures, may not operate satisfactorily at low temperatures. Check valves and diaphragms for proper operation. Faulty fuel pumps or carburetors should be cor-

OPERATIONS UNDER UNUSUAL CONDITIONS

rected or replaced. Remove and clean fuel screens daily. Drain fuel tank frequently to remove water and sediment. Prepare and maintain air cleaners as described in paragraph 19.

g. Chassis.

(1) Brake bands, particularly on new vehicles, have a tendency to bind when they are very cold. Always have a blow torch handy to warm up these parts if they bind when an attempt is made to move the vehicle. Parking the vehicle with the brake released will eliminate most of the binding. Under these circumstances, be sure to block the wheels or otherwise prevent movement of the vehicle.

(2) Inspect the vehicle frequently. Shock resistance of metals, or resistance against breaking, is greatly reduced at extremely low temperatures. Operation of vehicles on hard, frozen ground causes strain and jarring which will result in screws breaking or nuts jarring loose.

14. DUSTY CONDITIONS AND HOT WEATHER.

a. Dusty Conditions. When operating under dusty conditions, trouble caused by sand-laden air may be expected unless extra precautions are taken. Clean oil strainer, fuel strainer and sediment bowl frequently. In particularly sandy areas it may be necessary to service the air cleaner every 4 hours or often. When filling gasoline and oil tanks, use cloth over filler openings to prevent dirt and dust from entering.

b. Hot Weather.

(1) **GENERAL.** Since the engine in the Volkswagen is air cooled, high temperatures in the vicinity of operation will be reflected in an increased engine temperature. Keep a close check on the oil level and the viscosity of the lubricant. Examine the fan belt to be sure it is operating the fan at normal speed. See that the cylinder baffles are in place, and that the fan housing is properly connected to provide adequate air circulation around the cylinders.

(2) BATTERY CARE.

(a) **Water Level.** In torrid zones, check cell water level daily, and replenish, if necessary, with pure distilled water. If this is not available, any water fit to drink may be used. However, continuous use of water with high mineral content will eventually cause damage to the battery and should be avoided.

(b) **Specific Gravity.** Batteries operating in torrid climates should have a weaker electrolyte than for temperature climates. Instead of 1.300 gravity, the electrolyte should be adjusted to around 1.210 to 1.230 for a fully charged battery. This will prolong the life of the

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negative plates and separators. Under this condition, a battery should be recharged at about 1.160. Where freezing conditions do not prevail, there is no danger with hydrometer readings from 1.230 to 1.075.

(c) *Self-discharge.* A battery will self-discharge at a greater rate at high temperatures if standing for long periods. This must be taken into consideration when operating in torrid zones. If necessary to park for several days, remove the battery and store in a cool place.

15. DRIVING UP OR DOWN STEEP GRADES.

a. When driving up a long steep grade, shift the transmission to a lower gear when vehicle speed begins to decrease, to permit driving the vehicle at the desired rate with the least strain on engine and drive mechanism. When driving down a steep grade, shift into a lower transmission gear so that the engine will help in slowing the vehicle down, and reduce the necessity for continuous, or severe, application of the brakes.

16. DESERT OPERATION.

a. Operation under extremely sandy conditions will necessitate more frequent cleaning of the oil-bath air cleaner. Operating under such variable weather conditions also calls for a more frequent check of the oil in the crankcase.

17. SNOW, MUD, OR LOOSE SAND OPERATION.

a. Operation of the vehicle under precarious, slippery, or unfirm road conditions necessitates the use of chains on rear wheels. This will prevent damage to the differential gear with its self-locking device. The positive locking differential transmits power equally to the two driving wheels. Thus the vehicle can be extricated as long as one of the driving wheels has firm ground underneath it. When starting the vehicle in loose sand, snow, or mud, engage the clutch pedal slowly so that the wheels will not spin. Spinning the wheels causes the vehicle to mire itself more deeply. Do not attempt to "jump" the vehicle out of a muddy or sandy situation by racing the engine and suddenly engaging the clutch.

PART THREE—MAINTENANCE INSTRUCTIONS

Section VII

LUBRICATION

18. GENERAL LUBRICATION INSTRUCTIONS.

a. Figure 4 prescribes lubrication maintenance for the Volkswagen.

b. These lubrication instructions are binding for all echelons of maintenance and there should be no deviations.

c. Service intervals specified in figure 4 are for normal operating conditions. Reduce these intervals under extreme conditions such as excessively high or low temperatures, prolonged periods of high speed, continued operation in sand or dust, immersion in water, or exposure to moisture, any one of which may quickly destroy the protective qualities of the lubricant and require servicing in order to prevent malfunctioning or damage to the materiel.

d. Lubricants are prescribed in the "Key" in accordance with three temperature ranges; above $+32^{\circ}\text{F}$, $+32^{\circ}\text{F}$ to 0°F , and below 0°F . Determine the time to change grades of lubricant by maintaining a close check on operation of the vehicle during the approach to change-over periods. Be particularly observant when starting the engine. Sluggish starting is an indication of thickened lubricants and the signal to change to grades prescribed for the next lower temperature range. Ordinarily, it will be necessary to change grades of lubricants *only when temperatures are consistently in the next higher or lower range, unless malfunctioning occurs sooner due to lubricants being too thin or too heavy.*

19. DETAILED LUBRICATION INSTRUCTIONS.

a. **Lubrication Equipment.** Be sure to clean lubrication equipment both before and after use. Operate lubricating guns carefully and in such manner as to insure a proper distribution of the lubricant.

b. **Points of Application.** Lubrication fittings, grease cups, oilers, and oilholes are readily identified on the vehicle. Be sure to wipe each lubricator and the surrounding surface clean before lubricant is applied. If lubrication fitting valves stick and prevent the entrance of lubricant, remove the fitting and determine the cause. Replace broken or damaged lubricators. If lubricator cannot be replaced immediately, cover hole as a temporary expedient with tape to prevent the entrance of dirt. If oil lines become clogged, disassemble the line and remove the obstruction. Where relief valves are provided, apply new lubricant until the old lubricant is forced from the vent.

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