

8. MOTOR

The electric motor used to drive the vehicle is coupled to the clutch and transmission in the same manner as the gasoline engine that it replaces. The motor is of a type known as a separately excited DC traction motor and has a maximum output of 8 kilowatts (24 horsepower) as installed in this vehicle.

The term “separately excited means that power inputs to the armature windings and field windings are separated. The armature is connected directly to the battery pack; the field is also connected to the battery pack but separately through the controller. It is this field circuit that enables us to control the speed of the motor.

Electricity flowing through the field circuit creates a magnetic field which influences the speed of the armature. When the flow of electricity is at its highest, the magnetic field is strongest; and it exerts the greatest force on the armature causing it to “idle” at its base speed of approximately 1800 RPM. As the flow of electricity in the field circuit is decreased, the magnetic field weakens allowing the armature to speed up.

Pressing or releasing the accelerator pedal signals the controller to vary the field strength accordingly and allows us to accelerate and decelerate the motor.

An important feature made possible by this type of motor and controller is called regenerative braking. It enables us to capture some of the energy used in slowing the vehicle and return it to the battery pack.

Releasing the accelerator pedal causes maximum field strength. When the vehicle is moving and motor speed is above 1800 RPM, this high field strength will act to slow the armature to “idle” speed. However, the forward motion of the vehicle will be driving the armature above “idle” speed, the result being that the motor will now act as a generator. The electricity being generated is returned to the battery pack, and the energy absorbed in driving the generator (motor) assists in slowing the vehicle.

To protect the motor against overheating, two temperature sensors are mounted inside the case. These sensors activate the temperature warning light, switch the cooling blower to high speed when necessary, and signal the controller to reduce power when the motor is in danger.

At the rear of the motor is a tachometer generator unit that senses the rotational speed of the armature.

MOTOR PROBLEM DIAGNOSIS

<u>Symptom</u>	<u>Probable Cause</u>	<u>Remedy</u>
Motor will not start	Vehicle battery charger plugged in to AC line. Improper starting procedure.	Disconnect charger plug from vehicle socket. Depress clutch pedal fully, and on sedan models, be sure both seat belts are fastened.
	Main fuse at battery pack inoperative.	Replace main fuse.
	Battery pack state of charge too low.	Check and recharge battery pack as necessary.
	Accessory battery state of charge too low.	Check and recharge accessory battery as necessary.
	Cables from motor to controller not properly connected.	Correct improper cable connections. Refer to wiring diagram. Section 13.
	Poor connections between batteries or from battery pack to controller.*	Correct poor connections. Pay particular attention to the battery interconnects; they must be clean and cable ends must be making full contact with battery posts.
	Malfunction in controller or wiring.	Perform controller problem diagnosis procedure; repair as necessary.
Motor overheats	Motor overheated	Allow motor to cool
	Cooling blower air delivery duct disconnected.	Reconnect air delivery duct.
	Cooling blower inoperative or not switching to high speed.	Refer to cooling system problem diagnosis; repair as necessary.
Brushes arcing	Brushes worn out.	Replace brushes.
	Brush support ring out of position.	Reposition brush support ring to align brush neutral lines (see Fig. 8-26), and tighten bolts.
	Short circuit in armature windings.	Replace armature or motor assembly.

MOTOR PROBLEM DIAGNOSIS (cont'd)

<u>Symptom</u>	<u>Probable Cause</u>	<u>Remedy</u>
Motor noisy. (brushes are not arcing)	Bearings worn out.	Replace bearings.
Motor will not 'idle' at 1800 RPM or will not accelerate from idle.	Accelerator pedal or cable binding or disconnected.	Repair pedal or cable as necessary.
	Malfunction in controller or wiring.	Perform controller problem diagnosis procedure; repair as necessary.
Poor performance.	Battery pack state of charge too low.	Check and recharge battery pack as necessary.
	Poor connections at battery posts.*	Correct poor connections; they must be clean and the cable ends must be making full contact with the battery post.

* Poor connections reveal their presence by overheating. Inspect carefully any cable connection that appears warmer than its counterparts. CAUTION: Under conditions of high current demand, a poor connection can become extremely hot, even to the point of melting the cable end and/or battery post.

MOTOR REPAIR

CAUTION: Before attempting any repair or maintenance on the electrical system, always disconnect all electrical supply, 12 volt and 108 volt DC and the 110 volt AC charging cord.

The motor is virtually maintenance free, with the exception of periodic brush inspection and replacement.

Should the motor require more extensive repairs, it will be necessary to remove the motor and transaxle unit as an assembly (Fig. 8-1).

Motor Removal and Installation

- Disconnect all electrical sources. 108 V, 12 V, and AC.
- Refer to the directions in Section 6 for controller removal.
- Disconnect tachometer wiring at harness plug near instrumentation box (Fig. 8-2).
- Disconnect temperature sensor wiring (Fig. 8-3).
- Disconnect clutch cable.
- Disconnect back up light wiring (Fig. 8-4).
- Disconnect shift linkage.
- Remove bolts from left and right constant velocity joints and disconnect shafts (Fig. 8-6), support shafts as high as possible to provide clearance when motor/transaxle unit is lowered.
- Attach chain hoist to lifting ring on rotor top mount plate (Fig. 8-6).
- Remove bolt holding right motor mount to chassis (Fig. 8-7).
- Remove bolts holding front motor mount to front bulkhead (Fig 8-8).
- Remove nuts holding rear motor mounting plate to vehicle underbody (2) and to mount (1).
- Remove bolt from left motor mount insulator and frame bracket (Fig. 8-9).
- Disconnect chassis ground cable at left motor mount to transaxle housing bolt (Fig. 8-10).
- Lower motor/transaxle unit to floor and disconnect hoist.
- Move vehicle backwards until it clears the motor/transaxle assembly. Be careful to lift the vehicle if necessary so as not to damage the horn or the front air dam.
- To reinstall this motor/transaxle unit, reverse the above procedure.

Motor/Transaxle Disassembly

- Remove rear housing end cover (Fig. 8-11).
- Remove bolts attaching transaxle to motor and separate the transaxle from the motor adaptor.
NOTE: To facilitate the separation or attachment of the transaxle to the motor, it is suggested that the unit be arranged upright on the rear motor housing (Fig. 8-12). However, it must not be left in this position for any length of time as lubricant could leak from the transaxle and contaminate the clutch assembly.
- Remove flywheel to clutch plate attaching bolts and lift off flywheel and clutch friction disc.
- Remove release plate retaining ring and lift off release plate.
- Remove bolts retaining pressure plate to motor drive hub.
NOTE: Inspection of the clutch assembly should be carried out in accordance with procedures published in the official Volkswagen service manuals.

Motor Disassembly

- Remove motor drive hub retaining bolt (Fig. 8-13) and remove drive hub from shaft.
NOTE: If hub is tight on the shaft (Fig. 8-14), it may be necessary to use a puller to aid in withdrawing it.
- Remove bolts from drive end housing (4) and remove housing and end play washers (Fig. 8-15).
- Install four 12 x 55 mm bolts in the motor mount bosses (Fig. 8-16). This will support the motor when it is on its side for rear housing and armature removal.
- Lay the motor down so that it stands on the bolts installed in the mount bosses. Remove the motor rear cover (Fig. 8-17).
- Observe the depth of the brushes and springs in the holders; if the spring is immersed in the holder, the brushes will need to be replaced. Refer to Section 12 - Maintenance for brush replacement procedures.
NOTE: Brushes should always be replaced at the 30,000 mile maintenance service.
- Roll the brush tension springs back (Fig. 8-18) and withdraw brushes approximately one inch from holders (Fig. 8-19). Release the tension springs and the brushes will be held in that position. Disconnect main leads from brush holder (Fig. 8-20). Disconnect tachometer lead wires (3) from terminal strip and remove terminal strip (Fig. 8-21).
- Remove bolts holding tachometer generator cover (4) (Fig. 8-22) and remove cover. Loosen the allen set screw in the armature shaft and withdraw the tachometer rotor (Fig. 8-23).
NOTE: Store this rotor where it will not come in contact with magnetically conductive material.

Motor Disassembly (cont'd)

- Mark rear housing and field case to facilitate alignment during reassembly (Fig. 8-24).
- Remove bolts holding rear housing (4) to field case and remove housing.
NOTE: These bolts are slightly shorter than those that retain the front covet. Care should be taken not to interchange them during reassembly.
- Do not loosen the brush holder support ring bolts (Fig. 8-25, [marked with asterisk*]). The neutral lines of the brushes have been preset and marked (Fig. 8-26) at the factory and should not be tampered with.
NOTE: It may be necessary to tap the rear housing lightly to loosen it from the field case. Always use a block of wood (Fig. 8-27) to prevent damage to the aluminum housing.
- The armature may now be withdrawn using care not to damage the commutator or the windings of the field and armature.
- Inspect the commutator for wear. If the area of brush contact is .008 (.2 mm) or more lower than the unworn surface of the commutator (Fig. 8-28), it will require machining. Following machining, run out of the commutator must not exceed .0008" (.02mm) (Fig. 8-29).
- Inspect the bearings for roughness or lubricant leakage. If either condition is present, the bearings must be replaced.
- Using a suitable puller, remove the bearing from the armature shaft (Fig. 8-30). Be sure to protect the end of the armature shaft from being damaged by the forcing screw of the puller.
- The new bearing may be driven onto the shaft using a suitable bearing driver (Fig. 8-31).
- To assemble the motor, reverse the above procedure.
NOTE: When reinstalling the brushes, be sure that the retaining clips are securely locked in place.
- If the commutator is severely burned and/or there are damaged armature or field windings, it is recommended that the motor be returned to the manufacturer for service.

MOTOR SPECIFICATIONS

Type:	Separately excited, DC traction
Model No.:	Siemens 1GV1
Max. Armature Voltage:	180 V
Max. Speed:	6700 RPM
Speed to Damage: 8370 RPM	8370 RPM
Rated Power Output:	17 KW (23 HP) @ 130 V and 150 A
Maximum Power Output:	33.5 KW (45 HP) @ 130 V and 320 A
Rated Power Output: (as installed)	12 KW (16 HP) @ 108 V and 150 amps
Maximum Power Output: (as installed)	18 KW (24 HP) @ 95 V and 300 amps
Field Current:	10 amps maximum; 1 amp minimum
Field Resistance:	10 Ω
Field Inductance:	1.5 H
Armature Current:	300 amps max. operating; 400 amps max. at overload shutdown
Armature Resistance:	0.045 Ω
Armature Inductance:	0.8 mH
Armature Endplay:	.015" - .050" (.4— 1.2 mm)

COOLING

Cooling air is supplied to the main propulsion motor by a squirrel cage fan driven by a 12 VDC motor. The fan and motor assembly are mounted in the right front of the engine compartment.

The fan has normal and high speed modes depending on the cooling requirement of the traction motor. A temperature sensor mounted inside the traction motor activates the blower relay at 165°F (75°C) to switch the fan to the high speed mode.

Cooling System Problem Diagnosis

Cooling blower inoperative. (ignition key on)

NOTE: Perform these tests in sequence, continue only as far as necessary to diagnose the malfunction.

1. Verify that the 12 volt battery is charged and that the connections are clean and tight. Also, check the battery ground connection to the chassis. CAUTION: If it is necessary to charge the battery, be sure that there are no fumes from the charging process in the motor compartment before continuing with the diagnosis.
2. Verify that the cooling blower motor is properly grounded.
3. Disconnect the harness plug J19/P19 at the blower motor. (Refer to wiring diagrams in Section 13 for connector numbers.) Connect a jumper wire (14GA) from the positive terminal of the 12 volt battery to the P19 connector. If the blower fails to operate, replace it. However, if it operates with the jumper wire connected, the problem is not in the blower motor. Continue with the test sequence.
4. Remove the jumper wire from the P19 connector and reconnect J19/P19. Disconnect plugs J24 and J25 from the blower relay. Connect the jumper wire from the battery positive terminal first to J24 and then to J25. If the blower does not operate when the jumper is connected to J24 or J25, the wiring from these plugs to the J19/P19 connector is faulty. If the blower operates when connected to J24 but not when connected to J25, the blower resistor or its wiring is faulty. If the blower operates at full speed with the jumper connected to J24 and approximately half speed when it is connected to J25, continue with the test sequence.
5. Reconnect plug J24 to terminal #87a on the blower relay and plug J25 to terminal #87. Disconnect plug J16 from terminal #30 on the blower relay. Connect the jumper wire from the battery to terminal #30 on the blower relay. The blower should now operate at approximately half speed. If not, replace the blower relay.
6. To test the high speed circuit of the blower relay, first verify that continuity exists between terminal #86 (plug J23) on the relay and chassis ground. Leave the jumper wire connected from the positive terminal of the 12 volt battery to terminal #30 on the blower relay. Remove plug J15 from terminal #85 on the blower relay and connect another jumper wire from the 12 volt battery positive terminal to terminal #85. The blower should now operate at full speed. If not, replace the blower relay.

7. Disconnect both jumper wires and reconnect all the plugs to the blower relay. You have now verified that the cooling blower, the blower resistor, the blower relay and the interconnecting wiring are functional. If the blower remains inoperative with the ignition key on, it will be necessary to perform additional testing at the instrument/fuse module. Refer to Section 13 for Instructions in the installation of the diagnostic aids at the instrument/fuse module.
8. With the diagnostic aids installed and the multimeter set to the DC volts function, perform the following tests. As a reference, first test and record the voltage at the 12 volt battery.

9.

<u>+ Red Probe</u>	<u>- Black Probe</u>	<u>Meter Reading</u>	<u>Conclusion</u>
Positive terminal of 12 volt battery.	Test Socket J4-9	Same as 12 volt battery	OK. Proceed to Test #10.
		Less than 12 volt battery	Faulty connection between J4-9 connector and chassis ground.

10.

<u>+ Red Probe</u>	<u>- Black Probe</u>	<u>Meter Reading</u>	<u>Conclusion</u>
Test socket J13-8	Test Socket J4-9	Same as 12 volt battery	OK. Proceed to Test #11.
		Less than 12 volt battery	Faulty connection between 12 volt battery positive terminal and J13-8 connector.

11. (Ignition key on)

<u>+ Red Probe</u>	<u>- Black Probe</u>	<u>Meter Reading</u>	<u>Conclusion</u>
Test socket J13-3	Test Socket J4-9	Same as 12 volt battery	OK. Proceed to Test #12.
		Less than 12 volt battery	Faulty connection between J13-3 and ant terminal G7 on VW fuse panel. -OR- No power at terminal G7 on VW fuse panel. Refer to VW service manual to diagnose.

12. (Ignition key on)

<u>+ Red Probe</u>	<u>- Black Probe</u>	<u>Meter Reading</u>	<u>Conclusion</u>
Test socket J13-7	Test Socket J4-9	Same as 12 volt battery	Faulty connection between connector J13-7 and connector J16
		Less than 12 volt battery	Remove instrument/fuse module cover, Check 20 amp fuse, fuse holder, printed circuit board and wiring.

Cooling blower does not switch to high-speed when propulsion motor temperature exceeds 165°F (75°C). (Blower operates correctly at approximately half speed below 165°F (15°C))

13. (Ignition key on) (Turn temperature simulator control knob slowly counter-clockwise)

<u>+ Red Probe</u>	<u>- Black Probe</u>	<u>Meter Reading</u>	<u>Conclusion</u>
Test socket J4-7	Test Socket J4-5	Increasing as knob is turned	OK, proceed to test #14
		No increase as knob is turned	Faulty connection between J1-13 and J4-5 or between J1-5 and J4-7. Repair as necessary.

14. (Ignition key on) (Turn temperature simulator control knob counter-clockwise past the red test socket)

<u>+ Red Probe</u>	<u>- Black Probe</u>	<u>Meter Reading</u>	<u>Conclusion</u>
Test socket J13-6	Test Socket J4-9	Same as 12 volt battery	OK, proceed to test #15
		Less than 12 volt battery	Problem in instrument/fuse module. See Section 7 for replacement instructions.

15. (Ignition key on) (Turn temperature simulator control knob counter-clockwise past the red test socket)

<u>+ Red Probe</u>	<u>- Black Probe</u>	<u>Meter Reading</u>	<u>Conclusion</u>
Connector J15 at blower relay	Test Socket J4-9	Same as 12 volt battery	Replace blower relay
		Less than 12 volt battery	Faulty connection between J13-6 and J15. Repair as necessary.

Cooling System Specifications

Blower:

Voltage: 12 volts DC

Amps: 9.9 amps

Air flow: 250 CFM (7.0 m³/min.)

Low Speed Resistor:

Resistance: .25 ohms

Wattage: 25 watts

Cooling Blower Removal/Installation

1. Remove air delivery duct from cooling blower.
2. Disconnect J19/P19 connector and blower motor ground wire.
3. Loosen screws that clamp mount around blower motor and slide blower assembly out of clamp.
4. Install new blower assembly, tighten mount screws and reconnect ground wire and J19/P19 connector.
5. Reinstall air delivery duct.

Tachometer Generator Replacement

1. Loosen the clamp holding the motor housing end cover in place and remove the cover (Fig. 8-14).
2. Remove the motor cooling bower duct.
3. Remove the motor rear cover (Fig. 8-20).
4. Disconnect the tachometer generator leads from the terminal block on the side of the motor housing.
5. Remove the bolts holding the tachometer generator to the rear of the motor (Fig. 8-25).
6. If the rotor is damaged, it will be necessary to loosen the set screw (Fig. 8-26) in order to remove it.
7. To reinstall, reverse the above procedure.

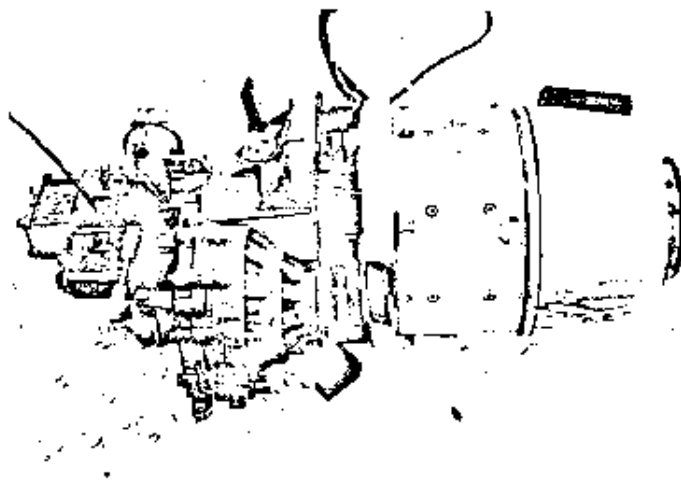


FIG. 8-1



FIG. 8-2



FIG. 8-3



FIG. 8-4

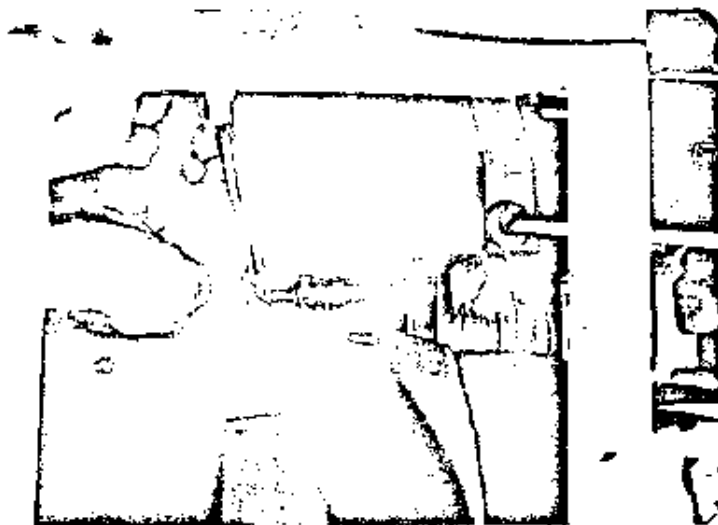


FIG. 8-5



FIG. 8-6

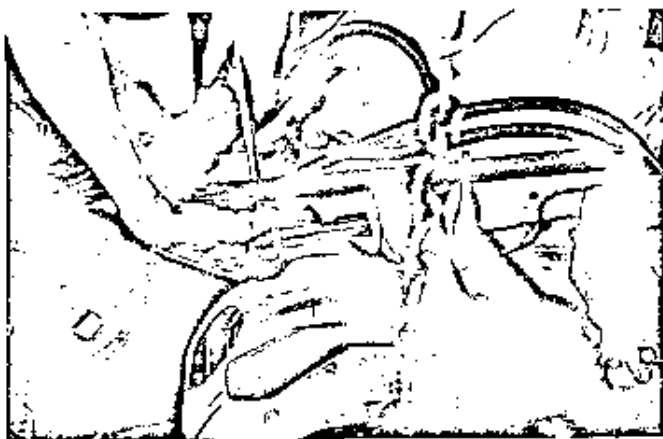


FIG. 8-7

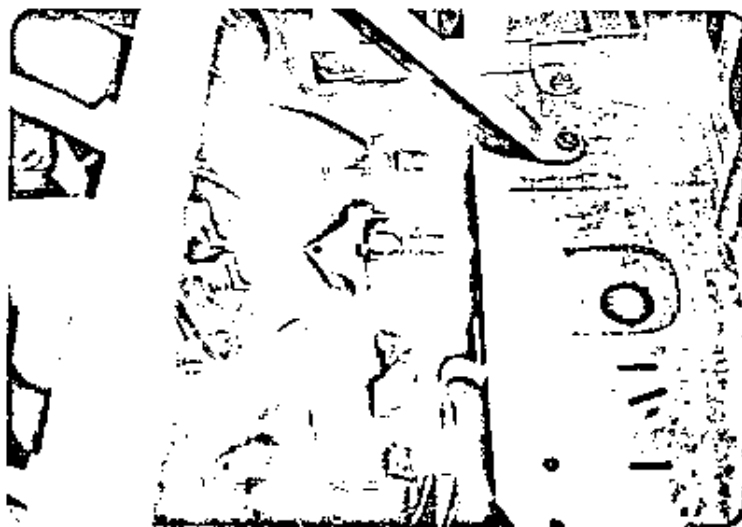


FIG. 8-8



FIG. 8-9



FIG. 8-10



FIG. 8-11

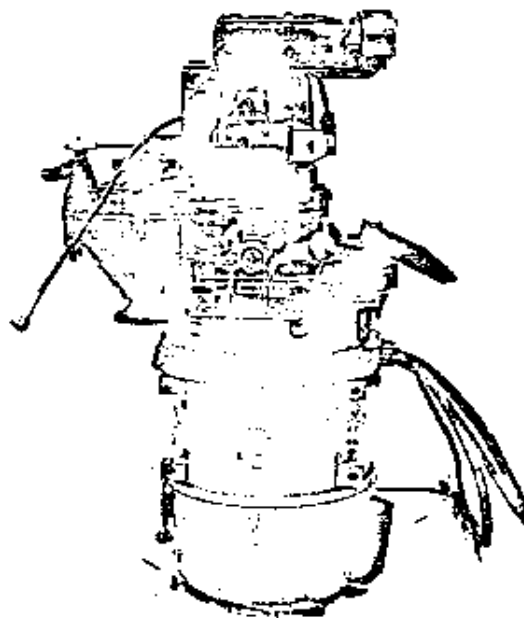


FIG. 8-12

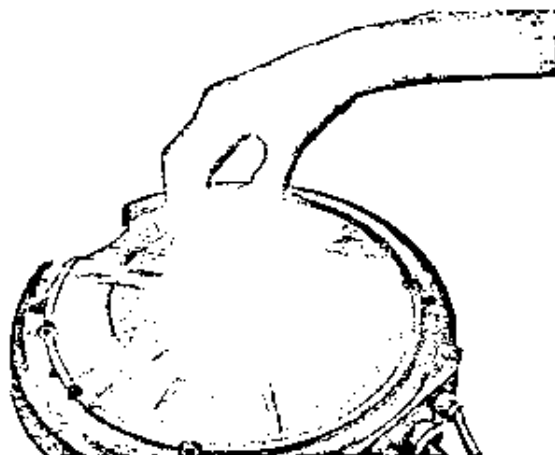


FIG. 8-13

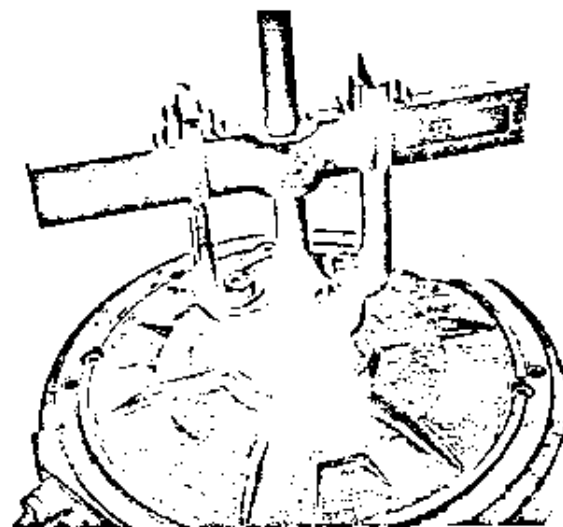


FIG. 8-14

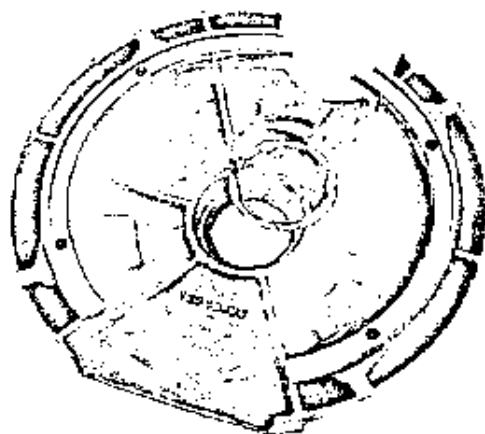


FIG. 8-15

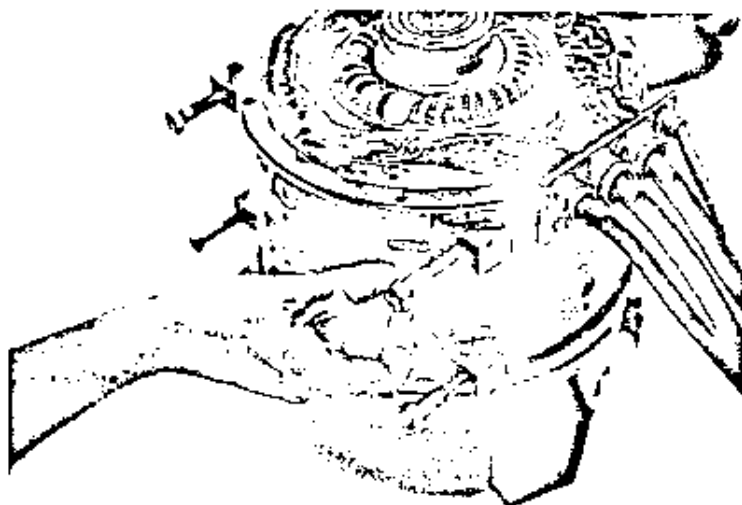


FIG. 8-16

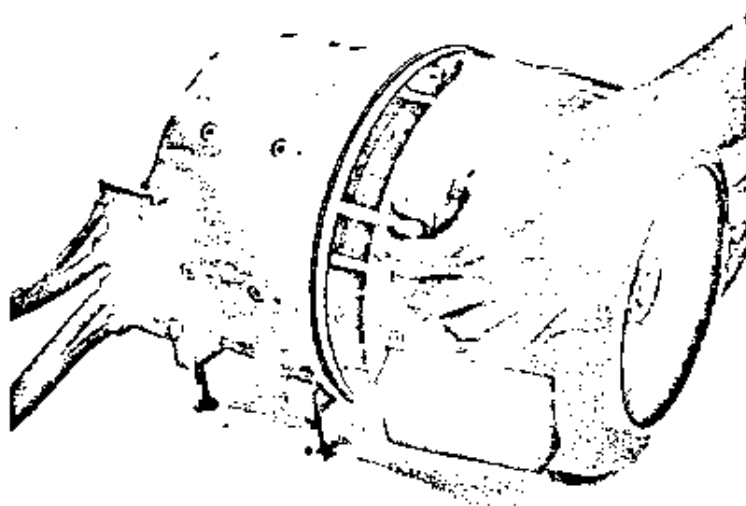


FIG. 8-17



FIG. 8-18

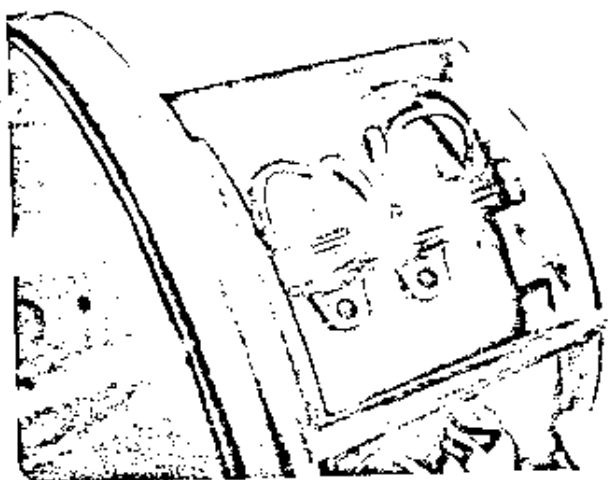


FIG. 8-19

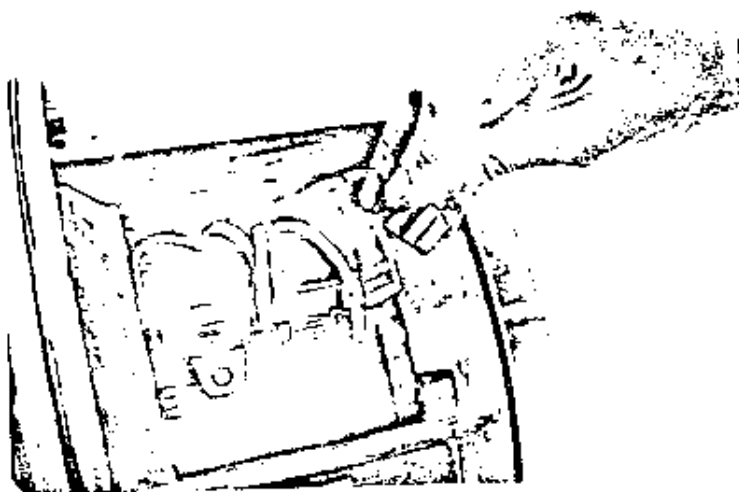


FIG. 8-20

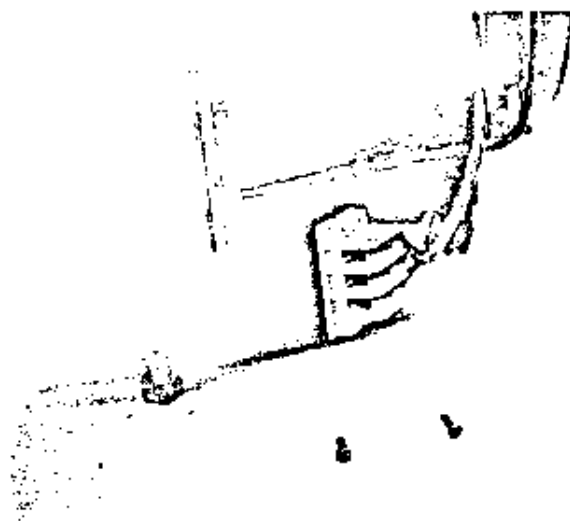


FIG. 8-21

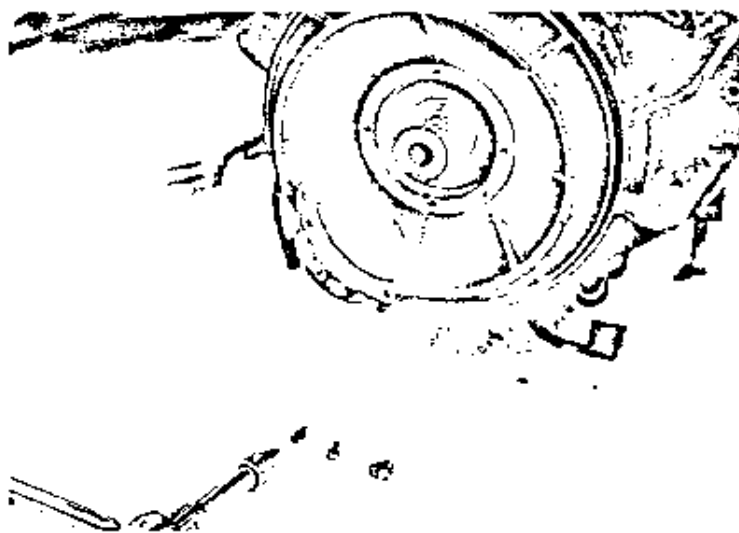


FIG. 8-22

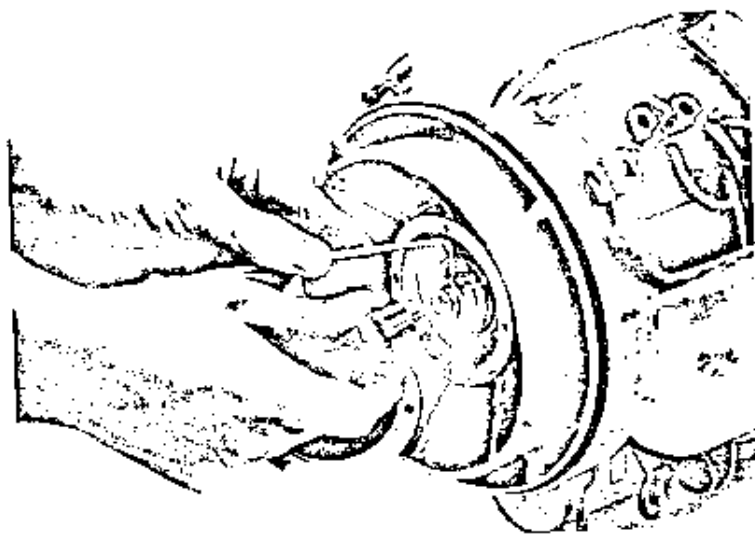


FIG. 8-23

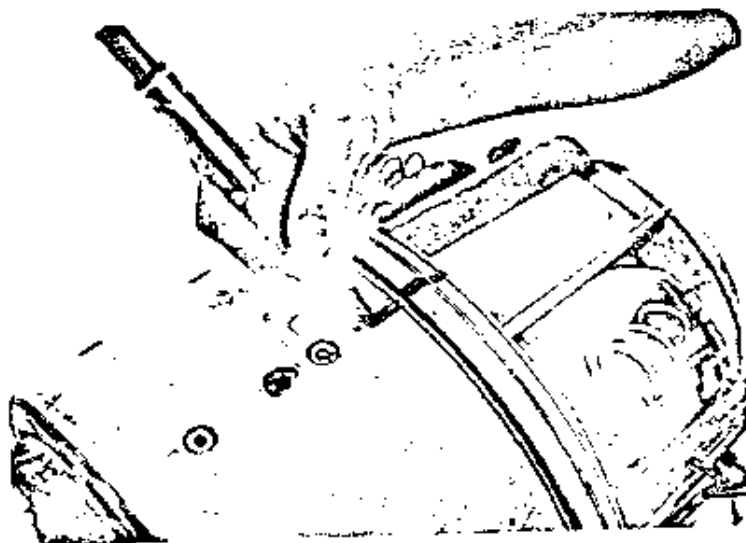


FIG. 8-24

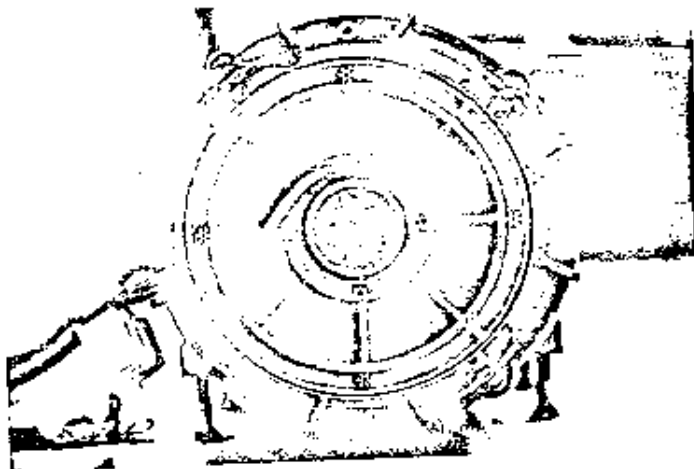


FIG. 8-25

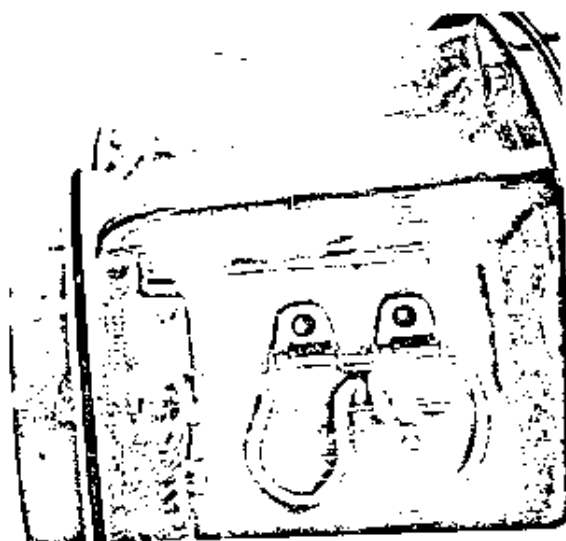


FIG. 8-26

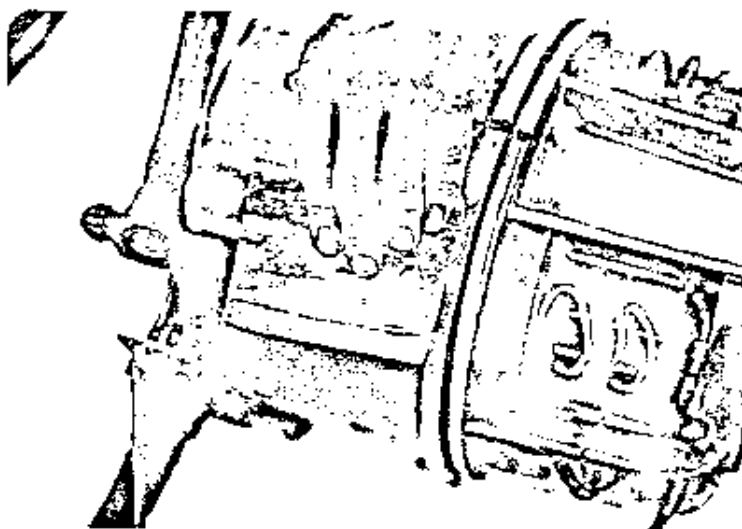


FIG. 8-27

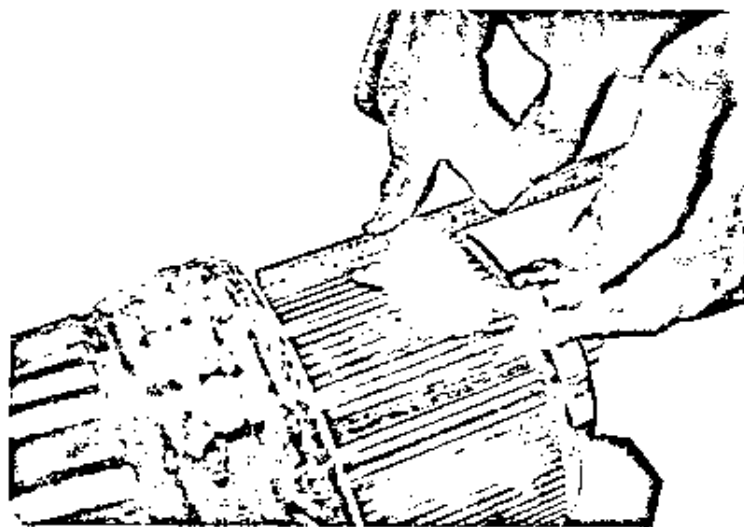


FIG. 8-28

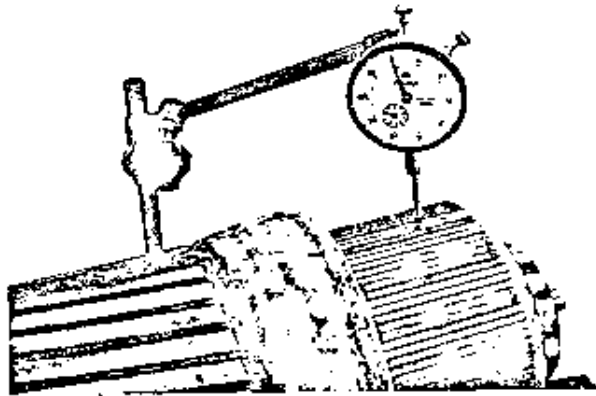


FIG. 8-29

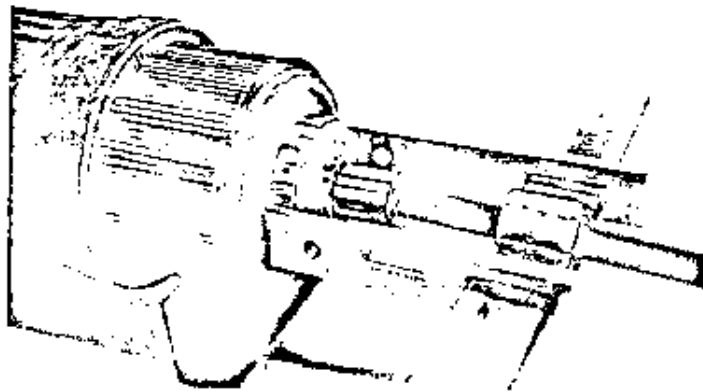


FIG. 8-30

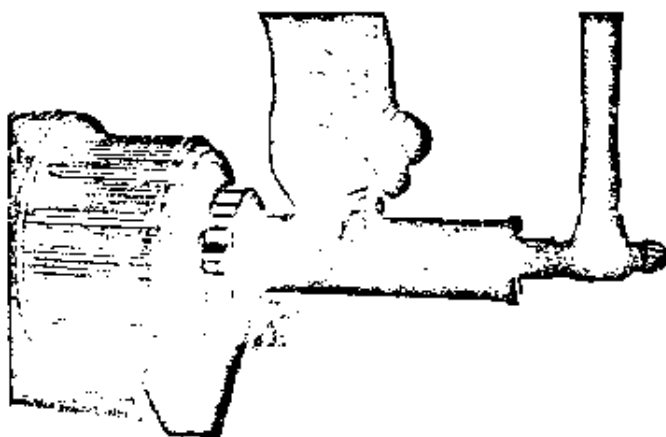


FIG. 8-31