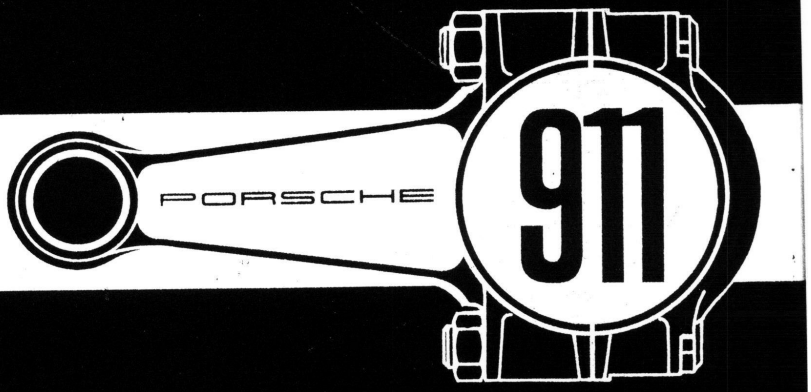
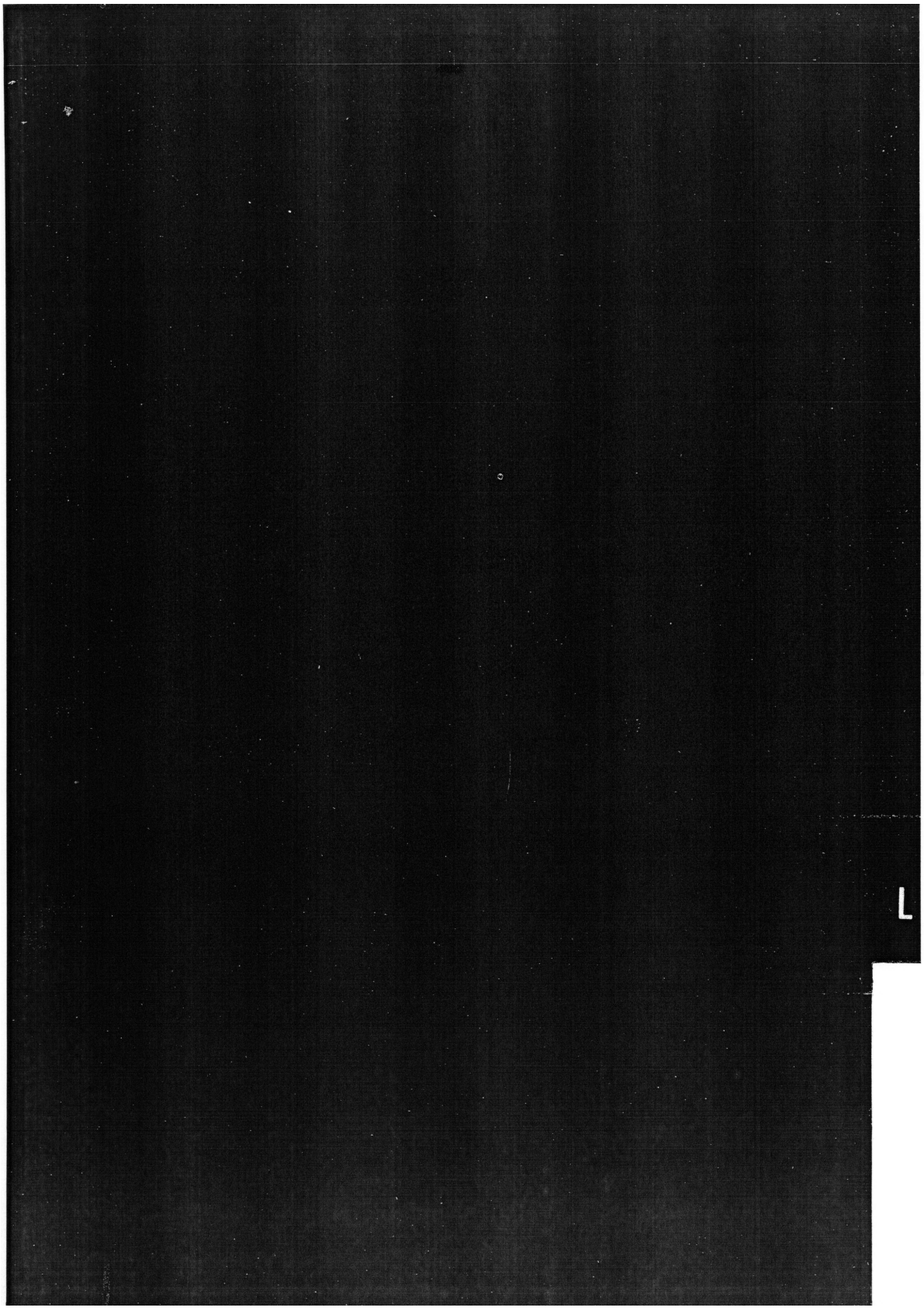
REPARATURLEITFADEN
WORKSHOP MANUAL
MANUEL DE RÉPARATION



VOLUME II

SECTIONS INDEX



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ALTERNATOR

A 12 volt, 500 watt alternator is utilized. The alternator charges the battery and supplies current to the electrical units of the car.

ENGINE STARTER

An 8/10 HP, solenoid-operated starter is utilized. The starter is controlled by the ignition/starter switch on the instrument panel.

BATTERY

The six-cell, 12 volt, 45 Ah battery is located within the luggage compartment under the front lid. The negative battery terminal is connected to the ground.

IGNITION SYSTEM

The ignition system is battery operated and includes a high tension coil as well as a distributor which is equipped with a centrifugal spark advance mechanism. The distributor is driven by a worm gear mounted on the crankshaft. The ignition current is switched on through the ignition switch on the instrument panel.

LIGHTING

The two headlamps are mounted in the front fenders and have high and low beams in each. Parking lights are accomodated in the front directional blinker housings. The parking lights and headlights are switched on through a switch on the instrument panel, next to the ignition switch. Instrument light brightness can be varied with the light switch knob by turning it to the desired position. Tail lights go on with headlights.

The headlights are dimmed with the blinker/dimmer/headlamp flasher switch located on the steering post below the steering wheel. A blue headlamp control light goes on in the tachometer dial when high beams are on.

The two tail lights are combined with stop lights and directional blinkers. Two small lamps illuminate the license plate in the back.

The stoplights are controlled through a switch mounted in the brake master cylinder and go on when the foot brake is depressed. The backup lights go on when reverse gear is engaged; the lamps are located in the tail lamp housing, the switch in the side of the transmission housing.

The interior lamps are located above the doors. The lamps can be turned on by tilting the entire lens. In the same manner, the lamps can be set for courtesy operating together with the opening doors.

The cigar lighter socket in the instrument panel can also be used for plugging in a hand lamp.

ELECTRICAL ACCESSORIES

The signal horns can be sounded through a horn button in the center of the steering wheel; the contact is made through a contact ring in the blinker/dimmer/flasher switch.

The directional blinkers and headlamp signal flasher can be actuated through switch lever in the steering post extension; the switch also controls the high and low headlamp beams. Operation of the directional blinkers is indicated by a green control light in the tachometer dial as well as through an audible ticking noise in unison with the flasher.

The windshield wipers and washers are actuated through a combination wiper/washer switch on the steering post. The fuses for the various accessories are located in the left part of the luggage compartment and are covered with a plastic top.

INSTRUMENTS

The speedometer and odometer are driven by a gear in the transmission by means of a cable drive. The tachometer is transistorized; electrical pulses emanating from the ignition system pass through a transistorized conventer and are fed into an electric counter in the tachometer unit.

The fuel level is indicated by means of a fuel gauge which is connected to an electrical sending unit in the fuel tank. In addition, the gauge has a low fuel warning light.

The oil temperature gauge and, in Type 911 S, the pressure gauge as well are electrically connected to their sending units in the crankcase.

Type 911 S also has an oil level gauge in the instrument panel.

NOTE

Repairs in the electrical system normally are confined to the replacement of worn or defective parts and the repair of the wiring system. In general, damaged wiring removed from the system should be replaced wire of same cross-section as shown in the wiring diagram. BOSCH components should be repaired by BOSCH service whenever possible.

CAUTION

To avoid shorting the circuit and minimize fire hazards due to electrical sparks, the battery ground strap should be removed from the battery prior to the initiation of any work in the electrical system.

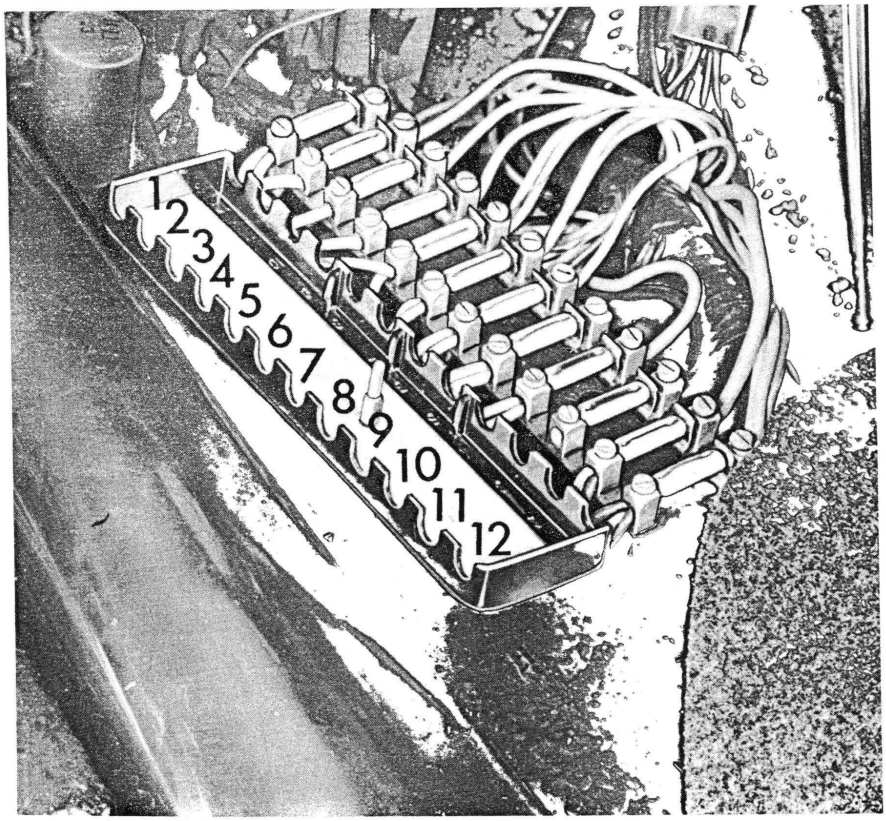


Fig. 1

1 High beam, left
2 High beam, right
High beam indicator
3 Low beam, left
4 Low beam, right
5 Parking lamp, left
6 Parking lamp, right
7 License plate lamp and luggage compartment lamp
8 Fog lamps
9 Windshield wipers and washer
10 Auxiliary combustion heater
11 Interior light, cigar lighter, electric clock
12 Stop lights, blinkers, backup light

BULB CHART

All bulbs 12 volts

Qty	Nomenclature	Wattage
2	Twin filiament headlamp bulbs	45/40 W
2	Sealed beam inserts (US made)	50/40 W
4	Cartridge bulbs for parking and license plate lamps	4 W
2	Cartridge bulbs for parking lamps (Italy)	3 W
4	Single filiament bulbs for directional blinkers	18 W
4	Single filiament bulbs for directional blinkers (Italy)	15 W
(6)	Single filiament bulbs for directional blinkers and backup lights (USA)	32 cp
(2)	Twin filiament bulbs for stop and tail lights (USA)	32/4 cp
2	Twin filiament bulbs for stop and tail lights	18/5 W
2	Single filiament bulbs for backup lights	25 W
2	Cartridge bulbs for interior lights	10 W
1	Single filiament bulb for luggage compartment light	5 W
16	Bulbs for instrument illumination and control lamps	2 W
(2)	Single filiament bulbs for parking lights (USA)	2 cp

General

The steadily growing application of electric power in motor vehicles required the use of generators of steadily growing capacity. This trend lead to the development of automotive AC generators, or alternators, which offer the following advantages: greater reliability, reduced maintenance, extended life, and improved efficiency due to power output over greater rpm ranges, including idling, which is advantageous in congested traffic environments.

Characteristics

The alternator in question is a 12-pole synchronous AC generator with an external field exciting source. The alternator has stationary windings and a rotating DC field coil. The rotating field coil receives the exciting voltage from a rectifier (Terminal D+/61) via the regulator and two brushes riding on slip rings. The stationary winding is directly connected to silicone rectifiers in a 3-phase circuit, while the DC voltage terminal B+ of the silicone rectifier is connected directly to the battery.

Owing to this arrangement, the charging current no longer flows through the regulator and its connections but directly to the battery. The connection between the alternator and regulator is by means of a three-fold wire loom so that the wires cannot be connected to the wrong terminals. The two-contact regulator limits the alternator voltage to 14 V. It is not necessary to limit the current since the current output curve rises to its maximum level and then stays flat up to the maximum rpm.
The direction of rotation of the alternator depends on the type of impeller used.
The alternator may be operated only when the battery and regulator are connected since otherwise the rectifier and regulator may become damaged.
The respective regulator must be ordered separately when ordering parts. Terminal D+/61 may be connected only to loads imposed by the regulator and generator charge indicator lamp.

The Diode

The diode is a semiconductor. Semiconductors allow electrons to flow in one direction only, blocking the flow in the other direction.

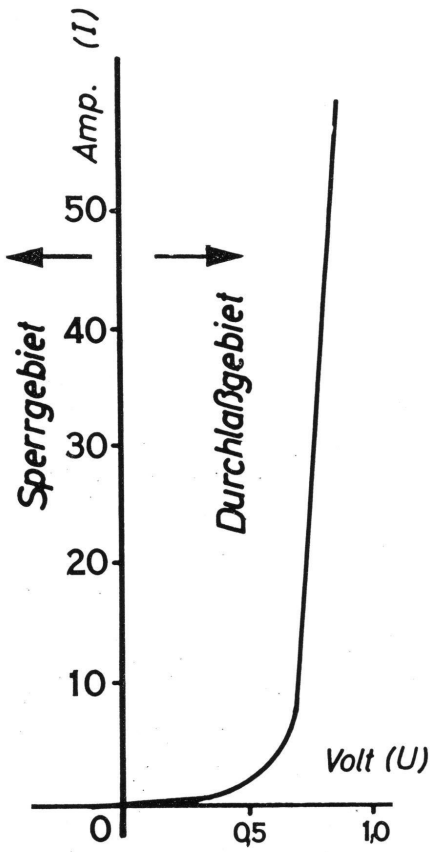


Fig. 2

This characteristic can be better understood when the atomic structure of germanium (Ge) can be grasped.
Germanium is an element of the 4th group in the periodic law. When purified, germanium is in the polycrystalline form. Each germanium atom is bonded to four neighboring atoms. Each germanium atom has 32 electrons; the four outer electrons reinforce the crystal lattice and, in pure germanium, can conduct electricity only when subjected to considerable electrical pressure.

By adding a small amount of impurities from an element in the 5th group of the periodic law, electrical conductivity is considerably increased.

In a five-electron atom, four electrons are grouped closely together within the lattice while the fifth remains free and assumes the role of a current carrier. Since the electrons are negatively charged, the conductor is called a negative conductor, or n-type.

If the germanium receives impurities from an element in the 3rd group, the lattice will have a deficiency of one electron. A free electron from nearby can, however, easily fill this free space but by so doing creates an electron deficiency or "hole" elsewhere. This occurence can be taken as an eternally transfering "hole". In such way, though, we have a positive conductor, or p-type.

A silicone germanium rectifier consists, in most part, of n and p atoms with a pn junction. This gives it alternating current rectifying characteristics. In this process, surplus electrons from the formerly neutral n-type germanium move into the neutral p-type germanium, so charging it negatively. Also, "holes" move from the p-type germanium into the n-type germanium. However, this diffusion ceases as soon as the n-type has a positive charge, and the p-type a negative charge. At this time, a space charge forms at the pn junction.

When the p-type germanium is given a positive charge and the n-type a negative charge, the space charge weakens and the diode functions as a conductor. When the diode polarity is reversed, it acts as an efficient resistor, having such strong space charge that the energy carriers are unable to pass through.

Single - Element Voltage Regulaor

Characteristic Features: Two-contact, single field regulator without a switch. The functions of the reverse current switch are carried out by diodes in the alternator. The regulator base has two mounting ears with holes for attachment bolts. The field coil end is connected to the negative brush. It is of constant voltage characteristics without a current limiter. Radio suppressors are built into the regulator. Radio suppression extends from FM to LW. It is equipped with three tab terminals of 6.3 mm width each (DF, D+, D-). The dust cover is rectangular.

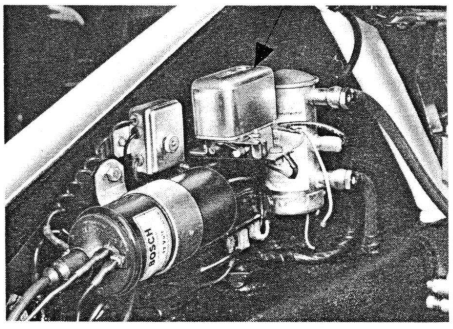


Fig. 3

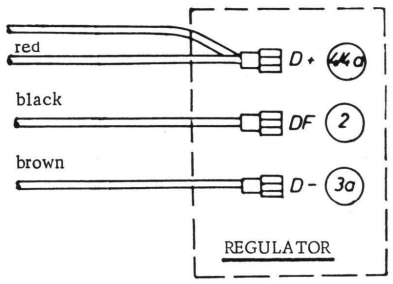


Fig. 4

Maintenance Requirements

The alternator is service free. However, the ball bearings and contact brushes should be checked and the ball bearings repacked with new grease in conjunction with engine overhauls, or at least once each year, whichever should first occur, using BOSCH ball bearing grease FT 1 v 33.

System Check

1. Switch the ignition on: the control lamp must light up.
   a. If the control lamp does not light up, then the bulb is defective or the wire connection broken.
   b. If the control lamp stays on when the ignition is switched off, one or several diodes conducts current against the direction of flow.
   Note: Disconnect the battery at once to prevent damage to the alternator and battery.

2. Start engine.
   If the control light does not go off despite increased engine speed, or when it lights up in certain rpm ranges, then one or several diodes may be defective.

Note:

Do not operate the alternator without connecting it to the battery.

Testing Alternator in Vehicle

Testing Instruments:	Voltmeter	0-20 V capacity
	Ammeter	0-60 A capacity
	Rheostat	500 W capacity

Testing Regulating Voltage

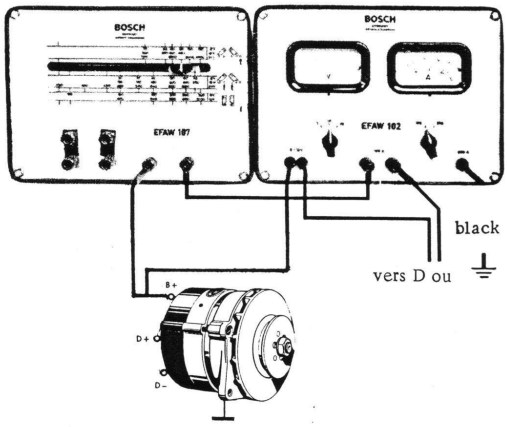


Fig. 5

Testing Procedure

Start engine and bring engine speed to 3000 rpm, keeping it steady. Adjust load current with rheostat and read voltage:

Load current:	28 - 30 Amps
Regulating volage:	13.5 - 14.5 volts

Note:

The test cables should not be removed or the load excessively reduced during the testing procedure. Considerable load variations may damage the diodes. The control lamp should not go on at any time during the test.

The alternator may also be tested with an ignition oscillograph. The test should be accomplished according to instructions of the unit's manufacturer.

Alternators should be repaired by BOSCH service or auto-electric shops since these will have the necessary equipment on hand.

REMOVING AND INSTALLING ALTERNATOR

Removal

1. Remove air intake silencer.

2. Remove upper shroud attaching bolts.

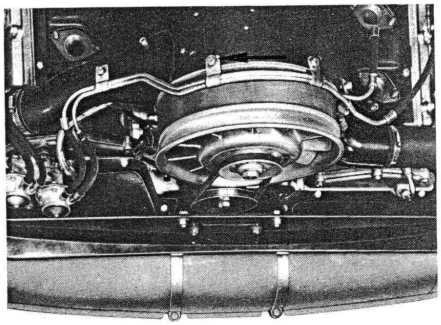


Fig. 6

3. Remove alternator pulley retaining nut (hold with special tool P 208) and take off the V-belt.

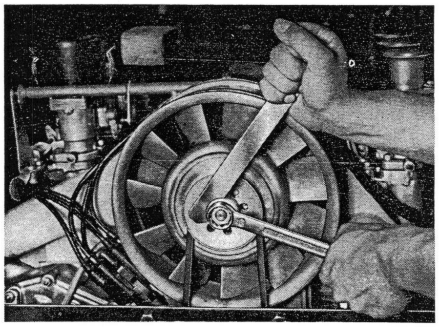


Fig. 7

4. Remove bolts from blower housing strap.

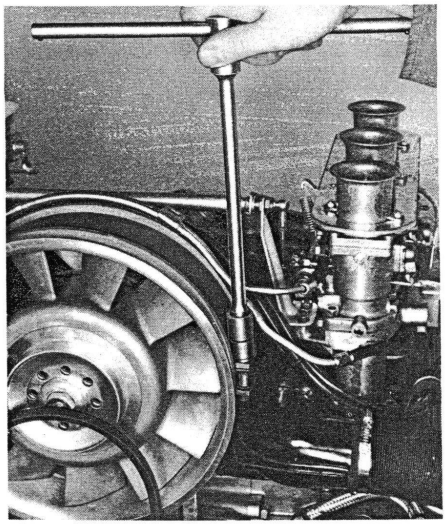


Fig. 8

5. Pull blower housing and alternator assembly towards the rear.

6. Detach wire connections from alternator.

Fig. 9

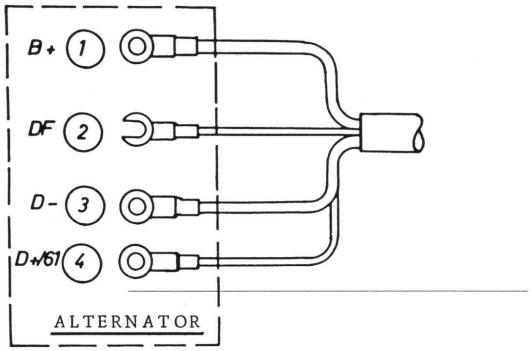
Installation

Install in reversed order of the before mentioned the following points:

1. Seat the blower housing in the dowel located in the crankcase.

2. Make sure that the blower housing is well seated in the crankcase.

3. Properly reconnect wires to the alternator.



Wiring color code:

Fig. 10

1	red / white
2	black
3	brown
4	red

4. Tighten alternator pulley nut to 29 ft-lb (4 mkp).

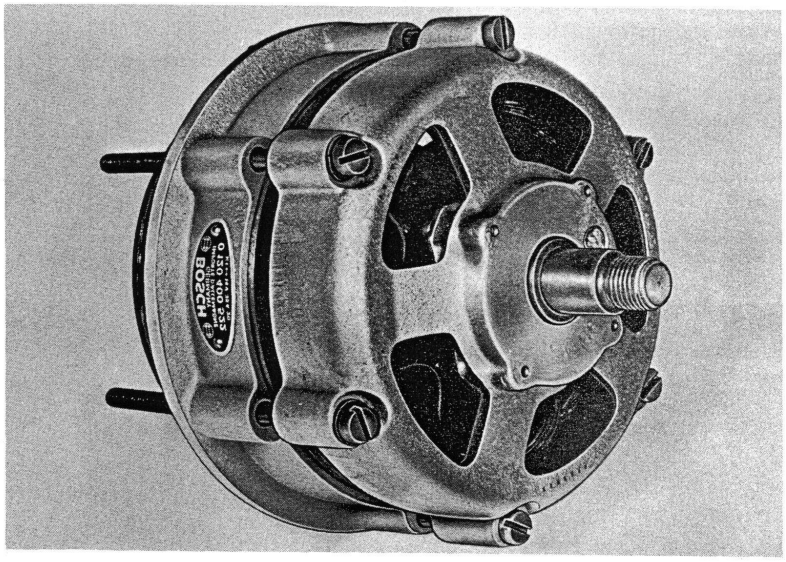


Fig. 11

Disassembling Alternator

Remove pulley retaining nut and take off pulley, hub, and key.
Mark location of the generator in the blower housing.

Remove retaining bolts from end frame and pull end frame away, together with the field rotor.

Unscrew brush plate assembly complete with brushes.

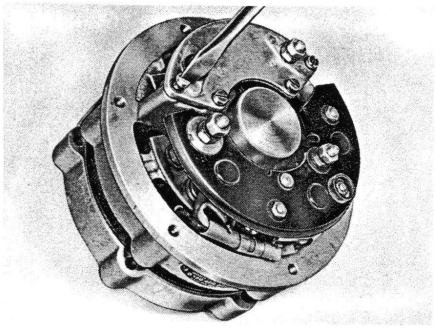


Fig. 12

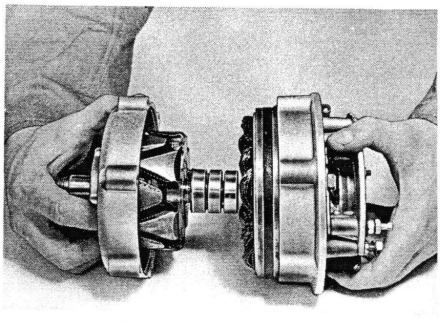


Fig. 13

Press field rotor out of the end frame on a shop press (hold rotor).

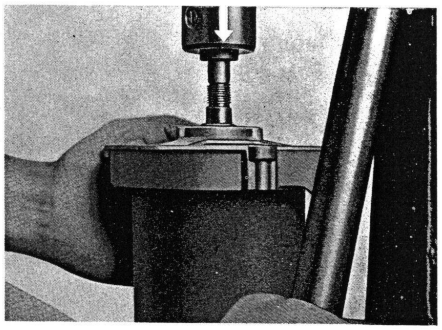


Fig. 14

Using a press and appropriate adapters, press ball bearing off shaft on the slip ring side. The ball bearing may also be removed with a claw puller. Remove ball bearing on the inner ring side; if not possible, the ball bearing must be replaced.

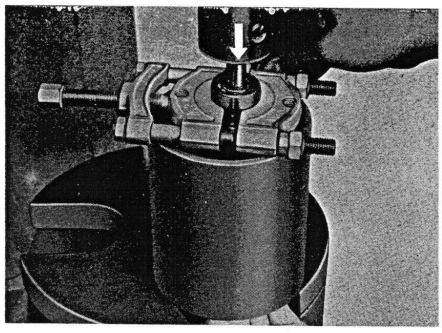


Fig. 15

Carefully open retaining clamps with a duckbill plier.

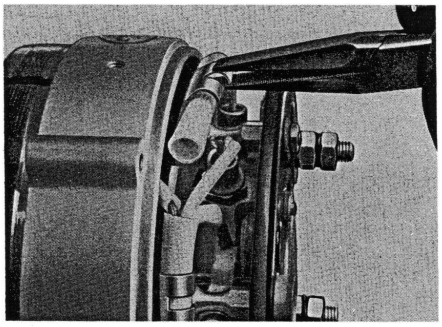


Fig. 16

Remove insulating conduit. Using a diagonal cutting plier, cut wires as close to the soldered joint as possible.

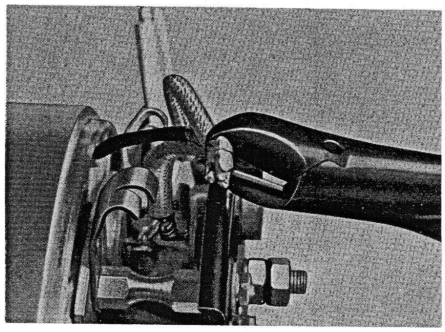


Fig. 17

Testing Diodes Prior to Further Disassembly

When using a test lamp (max. 24 V), the lamp must go on in the positive and exciter diodes when plus is connected to the terminal. When plus is connected to the housing, the lamp must not go on. In negative diodes, the lamp goes on when plus is connected to the housing. When the polarity is reversed, the lamp should not burn.
The diodes may also be tested with an ohmmeter in appropriate manner.
In good diodes, the resistance in the direction of flow is small (a few ohms), and it is great against the direction of flow (kilohm).

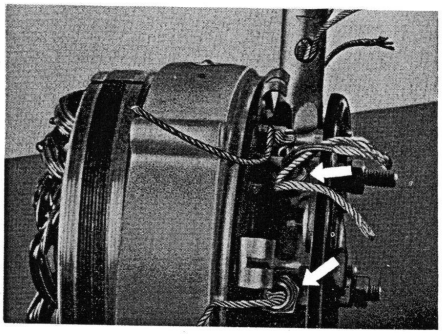


Fig. 19

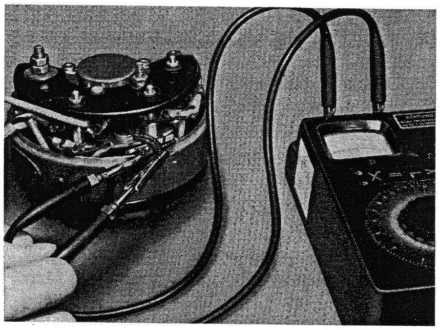


Fig. 18

If only the exicter diodes are defective, it will not be necessary to further disassemble the alternator. Remove the exciter diodes with a socket wrench.
Caution: Do not cant the socket wrench.

When one exciter diode has been damaged due to shortcircuiting, all three diodes must be replaced.

When rectifying diodes are defective, the frame on the slip ring side will have to be further disassembled.

When disassembling, particular care must be given to the insulating bushings under the plus diode carrier. To remove the minus diode carrier, remove threaded studs with a socket wrench.

When one rectifying diode has been damaged due to shortcircuiting, the three complementing diodes must be replaced as well.

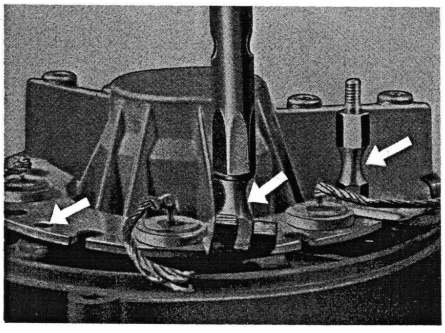


Fig. 20

Cleaning Parts

For cleaning, the alternator parts may be exposed to gasoline or cleaning solvents for a brief moment (no soaking).

Inspecting and Overhauling Individual Components

Test the stationary windings for shorting to the ground by using test probes EFA W 81 and 82. Test voltage: 40 V AC.

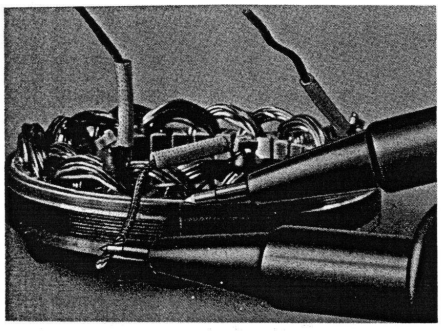


Fig. 21

Measure resistance in the stationary windings between the phase output terminals.

14 V alternator:
0.26 ohms + 10 %

Test the stationary windings for shorting within the coils by using test probes EFA W 90 or 95.

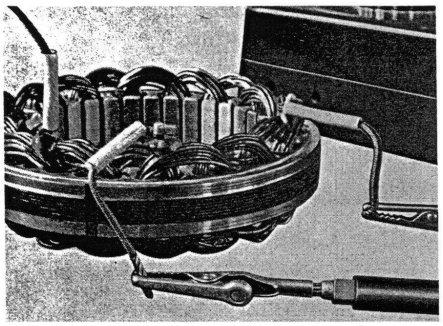


Fig. 22

Test rotating field coils for shorting to the ground. Test voltage: 40 V AC.

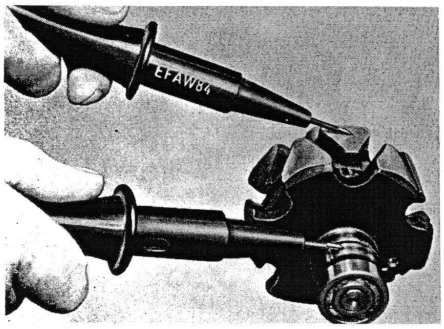


Fig. 23

Test resistance in rotating field coils with an ohmmeter.

14 V alternator: 4.0 ohms + 10 %

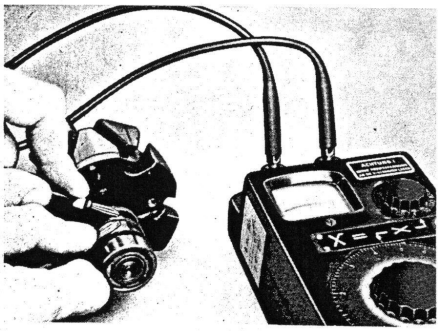


Fig. 24

Dress slip rings on a lathe; this process requires the use of tail stock support EFA W 75 or GDF 85 R 3.

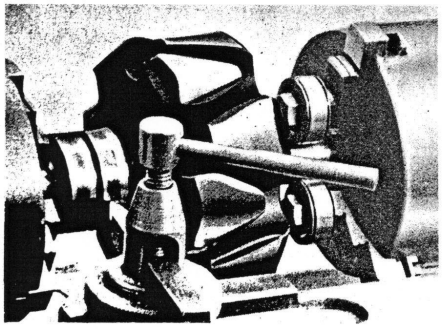


Fig. 25

After the dressing operation (turning), check slip rings for runout; max. permissible runout is .001" (0.03 mm). Minimum slip ring diameter is 1.24" (31.5 mm). Max. vertical runout of rotor is .002" (0.05 mm).

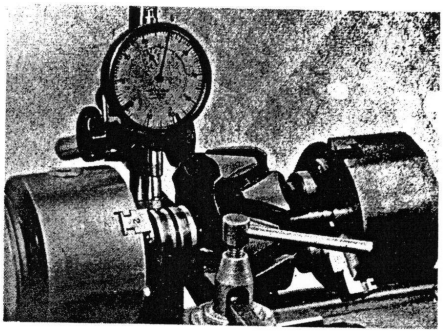


Fig. 26

Press output diodes out.

Locally manufacture the necessary tools (see Fig. 28 and 29).

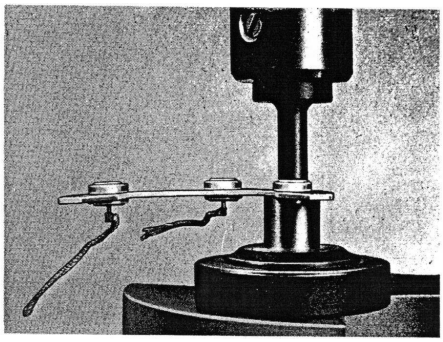
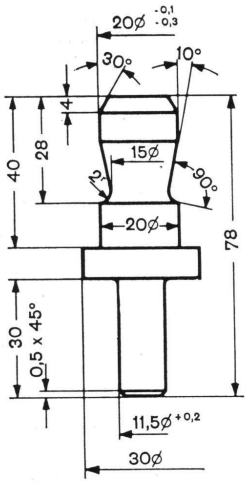


Fig. 27



Punch
(1 mm = . 03937")

Fig. 28

Calibrating the diode installation seat.
Locally manufacture the necessary tools.

(see Fig. 31 and 32)

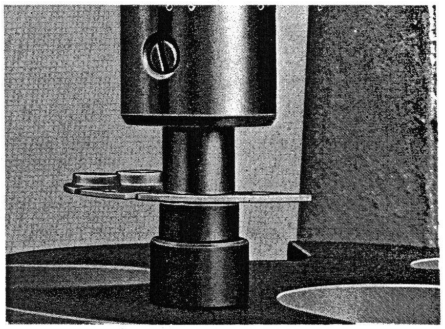
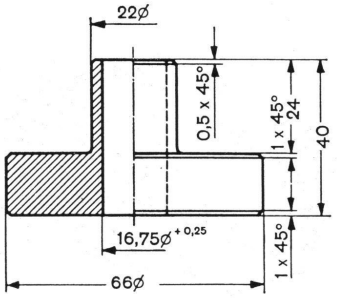
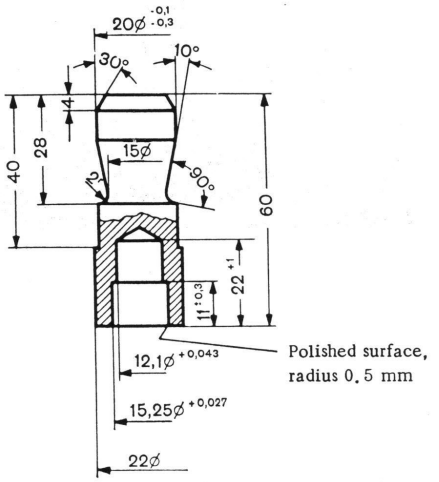


Fig. 30



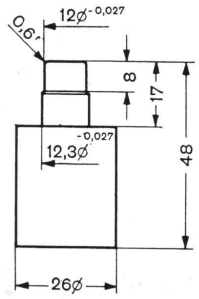
Die
(1 mm = . 03937")

Fig. 29



Socket
(Case harden to 0, 3 mm depth)
(1 mm = . 03937")

Fig. 31

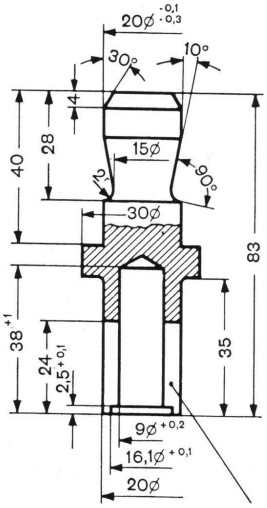


Guide stud
(Case harden to 0.3 mm depth)
(1 mm = .03937)

Fig. 32

Press the output diodes in, coating with silicone oil 01 63 v 2 prior to pressing. Locally manufacture installing tool according to the sketch.

(see Fig. 29 and 34)



4 mm wide groove

Installing punch

Fig. 34

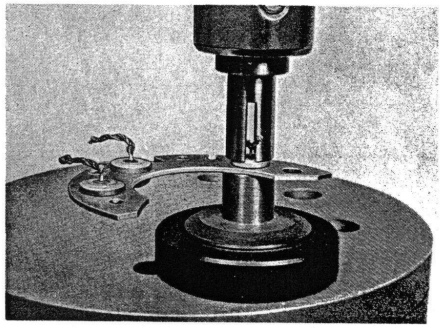


Fig. 33

Check diodes once they have been pressed in.

End Frame

Inspect ball bearings for wear and replace when necessary; in units with more than 60,000 miles of service the bearings should be replaced when the opportunity arises.

Coat one side of bearing with Ft 1 v 33 grease. Press ball bearing into the end frame with the closed side first, install retaining plate.

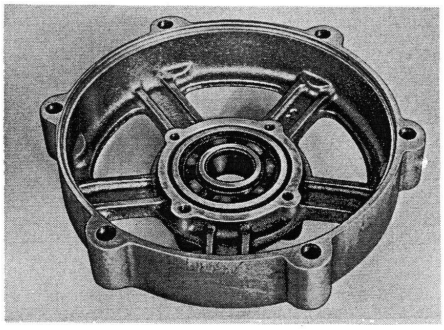


Fig. 35

Press ball bearing onto slip ring side of rotor using a hand press.
Use proper support for the rotor.

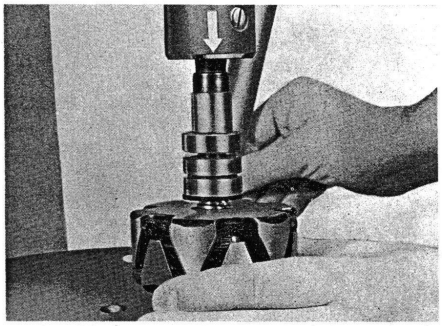


Fig. 36

Press pulley end ball bearing onto rotor with a press. Make sure that base support is clean to keep the dirt out of the bearing.

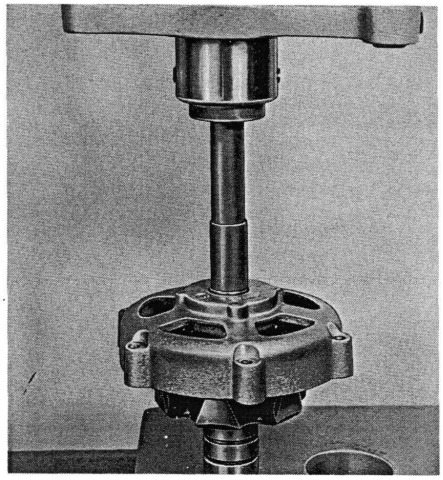


Fig. 37

Desolder brush terminals and withdraw brushes. Make sure that the solder (resin type only) does not sweat into the copper strand.

Minimum length of brush is .55" (14 mm)

After installation, check the brushes for freedom in their seats.

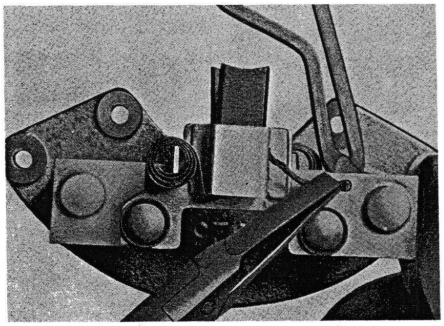


Fig. 38

Reassembling Alternator

Install minus diode carrier plate and fastening clips. Screw in threaded studs with shorter threads outwards. The left fastening clip is longer. Insert insulating washers and sleeves into proper places.

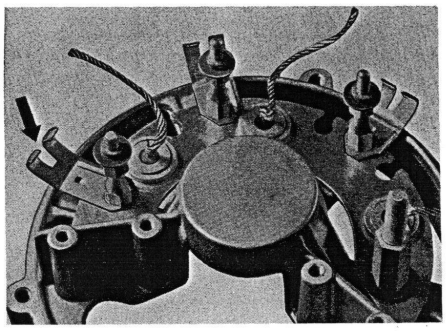


Fig. 39

Check connecting stud B+ for short circuiting to ground.
Test voltage: 40 V AC

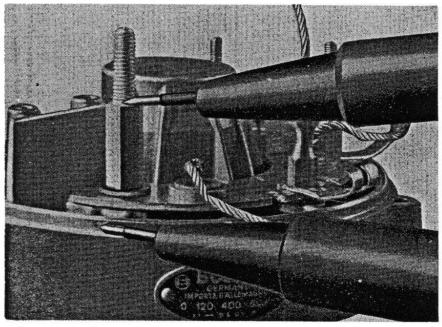


Fig. 40

Install plus diode carrier and insulating washers with spring rings. Across from the terminal D+/61, install insulating cap 1 120 502 000 instead of the insulating washers. Tighten hex nuts with open end wrench.

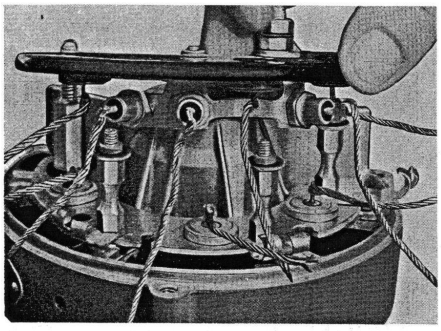


Fig. 41

Insert stator into the slip ring bearing. Bundle strands of the plus and minus diodes and slip a piece of insulating conduit over the strands. Slip insulating conduit over the wire of the exciter diode and winding connecting cable.

Hold the cable termonal ends together with adhesive tape, install metal ring at the end, and solder together.

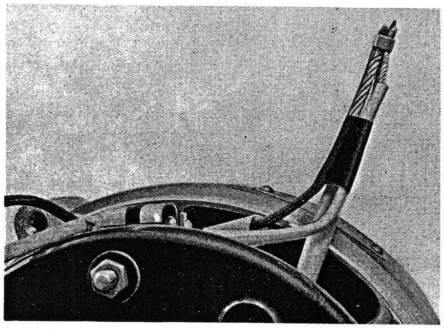


Fig. 42

After soldering, snip the excess wire beyond the ring off with diagonal cutters. Remove adhesive tape. Make sure that solder does not sweat into the strands farther than about 5/32" (4 mm). Install insulating conduit.

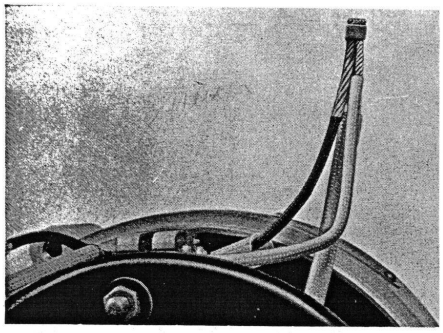


Fig. 43

Bend fastening clips with appropriate pliers.

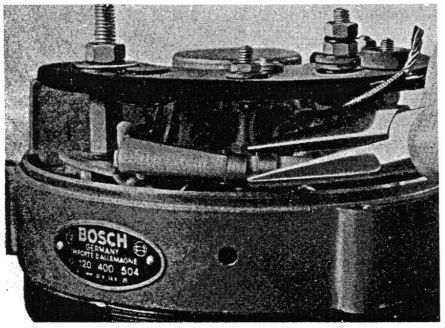


Fig. 44

The insulating conduit must extend up to the exciter diode. Do not tension diode connecting strands too tight. If the connecting strand of the exciter diode happens to rest improperly, lay the strand around the connecting tip so that the cable will not be pulled off.

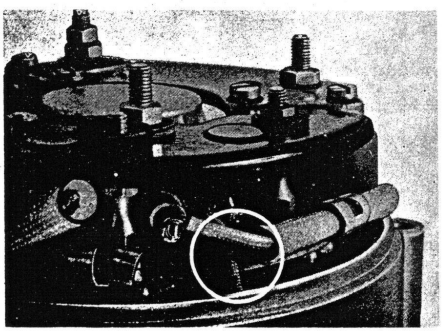


Fig. 45

The insulating conduits of the winding connecting terminals must extend beyond the edge of the minus diode carrier.

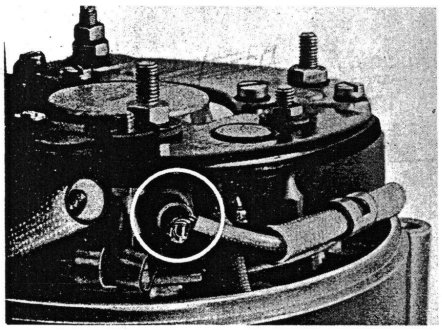


Fig. 46

The connections must be firmly seated in the fastening clips.
Make absolutely sure that an insulating space of at least 1/8" (3 mm) has been provided between the strands and the fastening clips and the alternator housing. The insulating conduit must extend at least 1/8" (3 mm) beyond the soldered joint.

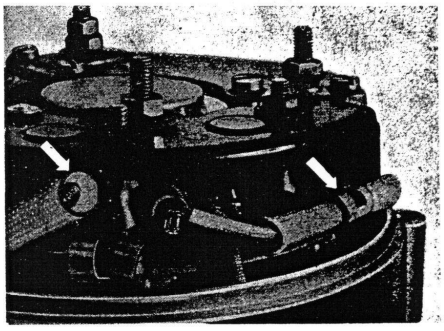


Fig. 47

Install rotor with end frame bearing.
Install brush carrier plate.
Upon installation, paint the newly installed plus diodes with chlorine caoutchouc lacquer Fl 87 v 1.

Slip ring runout	max. .001" (0.03 mm)
Rotor runout	max. .002" (0.05 mm)
Brush minimum length	.551" (14 mm)
Brush pressure	10.6 - 14.1 oz (300-400 p)
Slip ring minimum diameter	1.24" (31.5 mm)
Winding resistance	0.26 ohms + 10 %
Exciter resistance (rotor)	4.0 ohms + 10 % (formerly 3.5 ohms)
V-belt pulley tightening torque	29 lb-ft (4.0 mkp)
Exciter diode tightening torque	11.7-15.2 lb-in (13.5-17.5 cmkp)

General

The purpose of the starter is to start the engine. Type 911 and 912 cars are equipped with a starter of 0.8 HP rating, designed for 12 V systems.
The starter has a helical spline drive with a self-releasing pinion (BOSCH Type EB).

As in most cases, the starter is a DC motor. It provides a considerable amount of torque needed for turning the crankshaft at speeds needed for starting the engine and with enough force to overcome the initial resistance on the compression stroke.

To obtain the necessary torque from a starter and battery of proportionately acceptable size, the starter drives the starter ring on the flywheel with a small pinion. The gear teeth in the starter ring and starter pinion are beveled on one side to make engagement smoother.

Due to the high gear reduction ratio between the starter ring and pinion, the pinion cannot remain engaged with the starter ring longer than necessary since the armature would be forced to spin at excessively high revolutions. Therefore, the connection between the armature and starter ring must be automatically interrupted as soon as the engine has fired up. In the BOSCH helical spline starters the interruption is accomplished by means of an overrunning clutch situated between the pinion and armature. The clutch breaks the connection as soon as the engine speed becomes higher than that of the starter. A coupling, which rides on the helical spline shaft of the armature, is connected with the pinion through the overrunning clutch. Located on the coupling is an actuating sleeve which can slide back and forth. A fork-shaped end of the actuating lever is constantly engaged in the actuating sleeve. The actuating lever moves the locking ring forward. Balls located in the coupling bores are freed and the pinion is free to move towards the engagement phase. When moving forward, the pinion rotates on the helical splines. The application of thrust and rotation prompted the designation as helical spline starter.

Operation

When the starter/ignition key is switched on for starting, the starter solenoid is energized. The actuating lever pushes the actuating sleeve and the locking ring against the engagement ring; through this action, the engagement spring is tensioned.

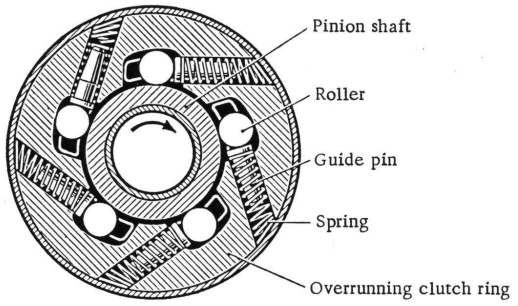
When the locking ring has moved forward by about 1/8" (2-3 mm), the balls located in the bores of the coupling are freed and can slide out of the shaft groove into the enlarged part of the locking ring. Thus the engagement components are freed and the fork begins to move the pinion; being mechanically connected to the helical splines, the pinion "bores" itself with a turning motion into the teeth in the starter ring on the flywheel.
At this time, the switch in the solenoid closes and, simultaneously, energizes the main field windings, causing the armature to turn. As the armature proceeds to turn, the effect of the helical splines further presses the pinion into the starter ring up to the point where the balls come to rest against the flanks of the helical spline portion on the armature shaft.

The actuating lever, also mechanically connected to the engagement components, is dragged along in the forward direction and tensions the disengagement spring located on the drag link of the solenoid switch. If, for instance, the pinion should be stuck due to gear tooth pressure in cases where the engine fails to fire up, the disengagement spring makes the solenoid plunger move back enough to open the switch contacts when the starter switch is released.

As a result, the starter is deenergized, gear tooth pressure ceases, and the pinion is drawn back through spring tension.

Normally, the pinion leaves the starter ring when the starter switch is released due to spring force exerted by the solenoid return spring which travels the distance allowed by the disengagement spring. This occurence is further supported by the fact that the overrun clutch breaks the torque transmitting connection between the pinion and armature shaft when the engine begins to turn faster than the armature. This also protects the armature from overspeeding.

Under the pressure of the engagement spring, the balls return into their groove in the shaft. The engagement spring decompresses further and pushes the locking ring over the balls. The brake disc is pressed against the brake pot of the armature and, at the same time, the balls in the coupling bores are pressed against the edge of the resting groove in the armature shaft. The decelerating armature is thus braked under the pressure of the engagement spring, further supported in this by the solenoid return spring.



Overrunning clutch

Fig. 48

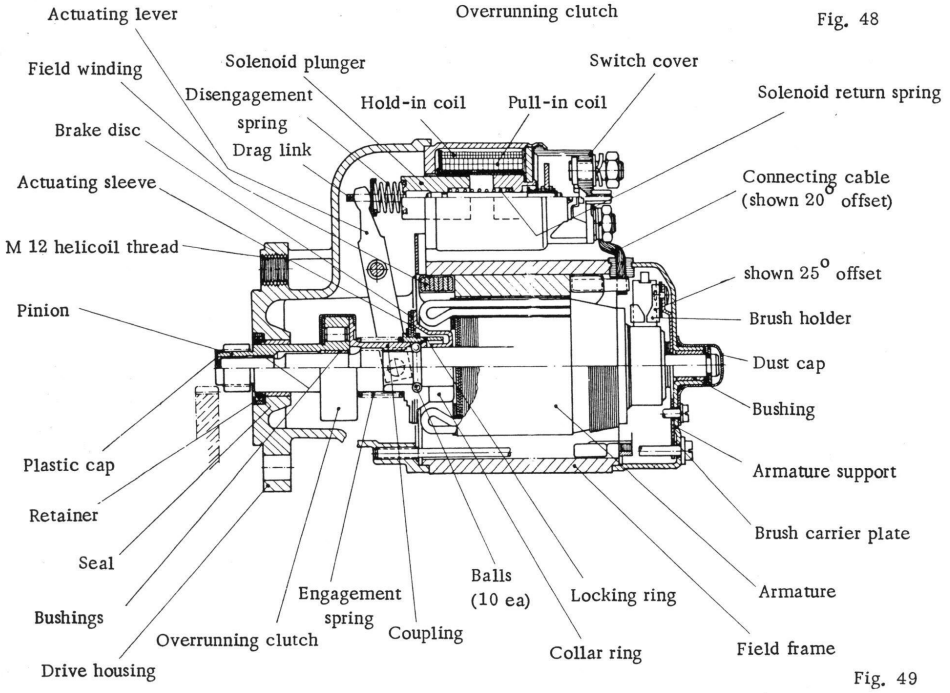


Fig. 49

REMOVING AND INSTALLING STARTER

2 LI

Removal

1. Disconnect battery ground strap.
2. Detach battery and generator cables from Terminal 30 at the starter.
3. Detach control wire (to ignition switch) from Terminal 50 at the starter.
4. Remove flanging bolts and take starter out.

When reinstalling, make sure that terminals are clean and properly tightened.

Note:

If the starter gear on the flywheel shows unusual traces of wear, the starter ring will have to be replaced.

Terminals:

1. Battery ground strap.
2. Generator and battery cables at the starter solenoid.
3. Control wire to ignition switch.

REMOVING AND INSTALLING STARTER SOLENOID

3 LI

Removal

1. Detach wire strand from solenoid.

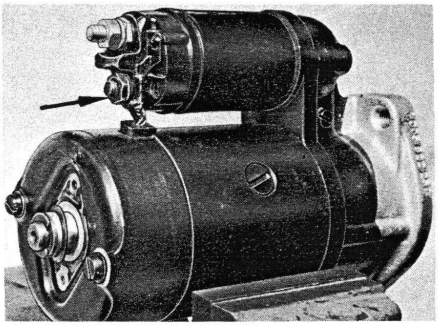


Fig. 50

2. Remove retaining bolts of solenoid from the drive housing.
3. Pull starter pinion out somewhat and withdraw solenoid switch.
   Defective solenoids should be replaced with new units. It is advisable to install a new solenoid when overhauling an engine.
   Do not attempt to readjust the solenoid.

Installation

Note the following at reassembly:

1. Hold the cable terminals when tightening the cable retaining nuts in the solenoid. Tighten the nuts moderately tight since it is possible to twist the solenoid switch contacts.

2. Pull the starter pinion forward so that the connecting end of the actuating lever moves closer to the solenoid mounting flange, and insert connecting end of solenoid plunger into the receptacle in the actuating lever.

3. When installing a new solenoid switch, adjust the connecting end of the solenoid plunger so that the distance from the hole center in the plunger clevis to the switch mounting flange is 1.276" $\pm$ .004" (32.4 $\pm$ 0.1 mm) when the plunger is in position.

Checking Starter Solenoid Switch

When the switch pulls up, travel of the solenoid plunger must be .394 $\pm$ .008" (10 $\pm$ 0.2 mm). Of that, .118" (3 mm) is engagement reserve.

4 LI CHECKING BRUSHES AND COMMUTATOR

1. Remove starter dust cover.

2. Brushes which completely disappear in the holders so that the connecting strand touches the holder are worn out and must be replaced with new ones of the same type; also, such brushes which have been soaked in grease or whose connecting strand is loose. When installing the brushes make sure that the connecting strands are free so as to prevent their binding in the holder. If one brush is used up, it is best to install a whole new set.

3. Check brush springs for tension. Slacked or annealed springs must be replaced.

4. If the commutator is oily or dirty, it can be cleaned with a clean cloth which is wrapped around a wooden stick and wetted in gasoline. Make sure that gasoline and dirt is kept out of the bearing.

5. If the commutator is scored or uneven, it should be redressed on a lathe.

5 LI DISASSEMBLING AND REASSEMBLING STARTER

Disassembly

1. Remove dust cover, lock ring, and spacers, watching the O-rings.
Detach connecting strand from the solenoid (see Fig. 51).

2. Remove solenoid retaining screws. Withdraw solenoid from drive housing, in the process unhooking the solenoid plunger from the actuating lever.
Remove through-bolts.
Remove commutator support.

3. Withdraw brushes from holders.
The plus-brushes are soldered to the winding, the minus-brushes to the brush holders. (see Fig. 52).

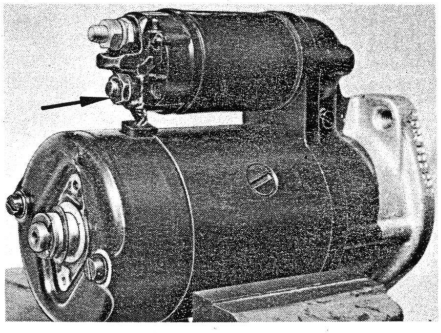


Fig. 51

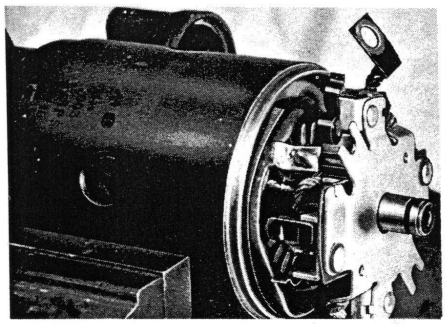


Fig. 52

4. Remove brush carrier plate, watch for the insulating washer and metal disc.

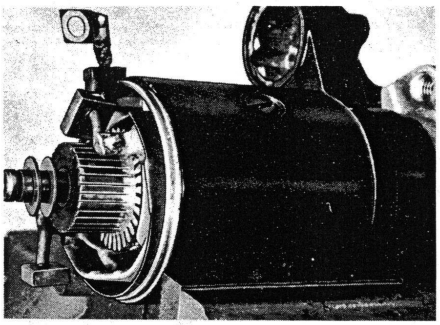


Fig. 53

5. Take field frame off drive housing, watch sealing rubber and metal plate.
Take out stud bolt from drive housing.

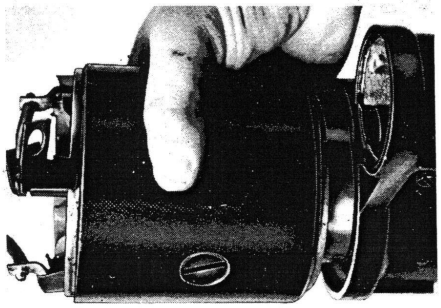


Fig. 54

6. Take armature and actuating lever out of the drive housing.

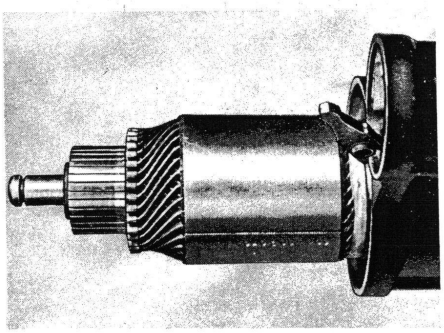


Fig. 55

7. Place armature in a vise.
Press actuating sleeve against the overrunning clutch and take it off the armature shaft, watching the locking balls.

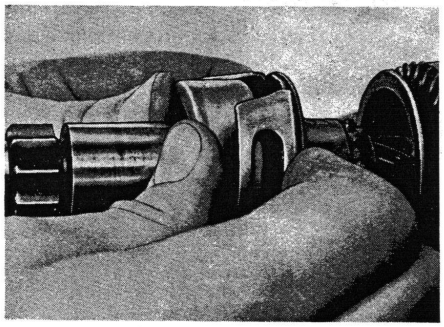


Fig. 56

Cleaning Components

1. Clean the parts in gasoline or "Tri" solvent and blow out with air.
2. Do not place the armature or overrunning clutch into the cleaning solvent.
3. Bearing bushings must be replaced.

Inspecting and Conditioning Parts

1. The mechanical engagement parts must slide freely on the armature shaft. The actuating lever and linkage must not rub or bind anywhere. Bent actuating levers must be replaced.

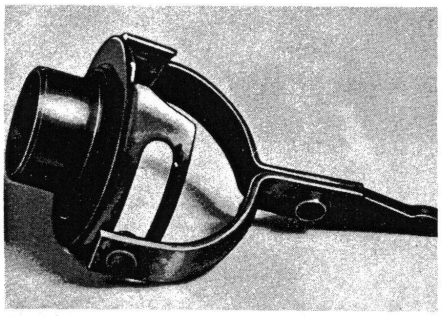


Fig. 57

2. Replace brake disc, if necessary.

3. Field coil:
   The field coil must not be scorched or the solder melted, nor be protruding beyond the pole shoes. Check the coil for continuity. Closely inspect connecting joints.

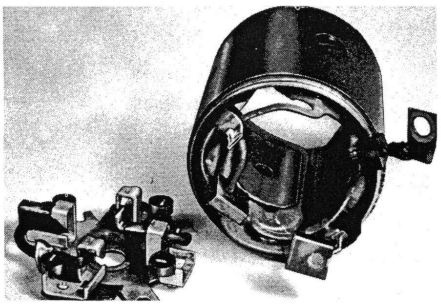


Fig. 58

4. Test brush carrier plate and field coil for shorting to the ground.
   Test voltage: 40 V AC.

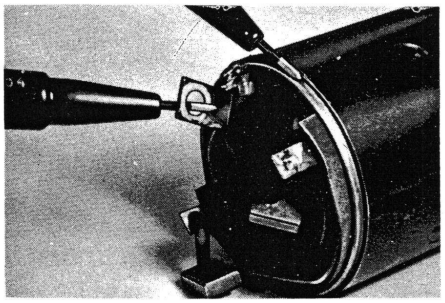


Fig. 59

5. Test armature for shorting to the ground.
   Test voltage: 40 V AC.

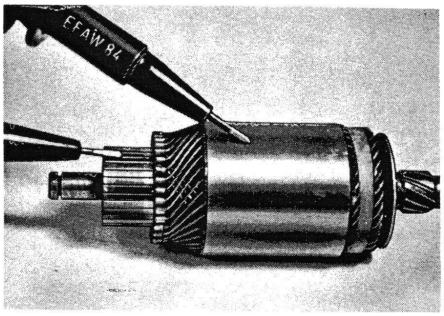


Fig. 60

A ground short will occur when the armature core comes in contact with the winding or when carbon dust has entered the assembly (direct or indirect short to the ground). The best method to test the armature is with a test lamp by connecting one lead to the metal core of the armature and the other to the commutator. The test lamp should not light.

6. Commutator:
   Max. permissible runout is .002" (0.05 mm).
   Min. diameter is 1.319" (33.5 mm).
   If necessary, remove insulating mica to a depth of about .031" (0.8 mm) with a commutator file; work with care around the segments and soldered points.

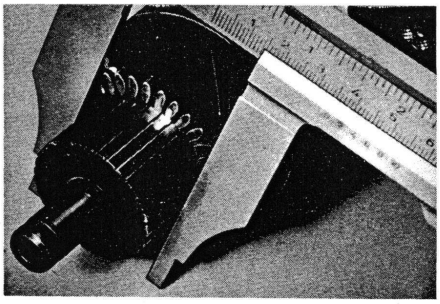


Fig. 61

7. The brushes must move freely in the holders.
   The brushes should not be dirty, broken, or desoldered.
   Replace brushes only in sets.

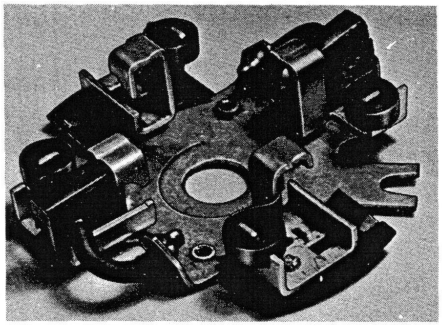


Fig. 62

8. Drive housing:
   Replace worn or unserviceable bearing bushings.
   The bushing must be flush on the inside.
   Use proper drivers for pressing the bushing in or out.
   Peen with care.

9. When replacing the metal bushing (sintered) and the sealing ring, replace the rivets with screws; peen screw ends.
   4 Fillister screws M 4 x 10
   4 Spring washers
   4 Nuts

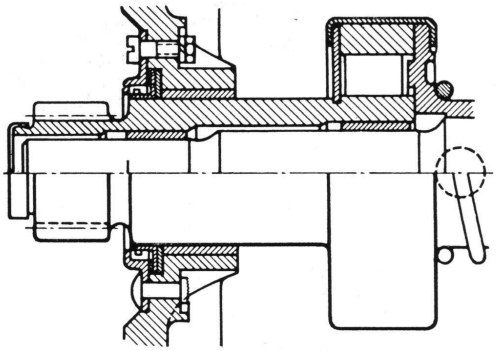


Fig. 63

10. Center the sealing ring with an aligning mandrel.

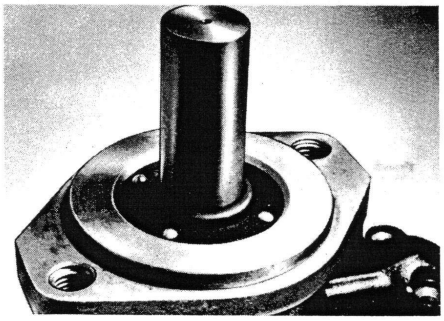


Fig. 64

Reassembling Starter

1. Place balls into locking ring with grease (such as Ft 2 v 3).

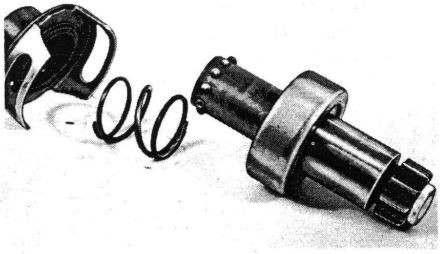


Fig. 65

2. Place armature into vice.
Push overrunning clutch with actuating sleeve and brake disc onto the armature shaft until the balls engage the groove in the shaft.

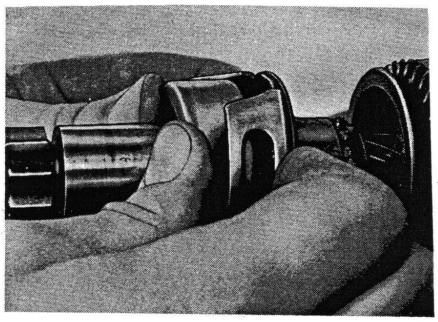


Fig. 66

3. Check if pinion and overrunning clutch are properly seated on the armature shaft.
The mechanical engagement parts must move freely on the armature when released.

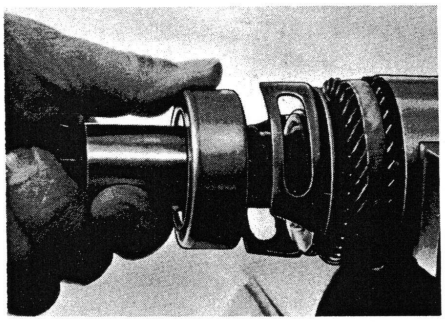


Fig. 67

4. Push armature together with the actuating lever into the drive housing.

5. Screw in pivot stud of actuating lever into drive housing. Tab of profiled rubber must seat in the cutout within the field frame.

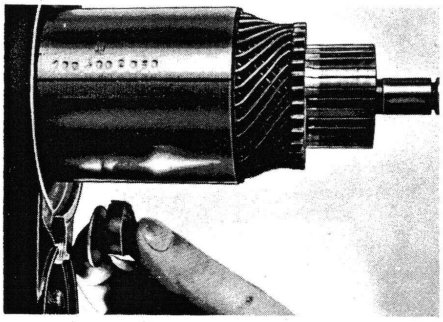


Fig. 68

6. Push the field frame over the armature.
Do not forget the steel shims and insultating washer on the commutator side.

7. Place the brush carrier plate onto the commutator shaft.
Brush pressure should be 40. 6 - 47. 6 oz. (1150 - 1350 p).
Note placement of the twist notch in the plate.

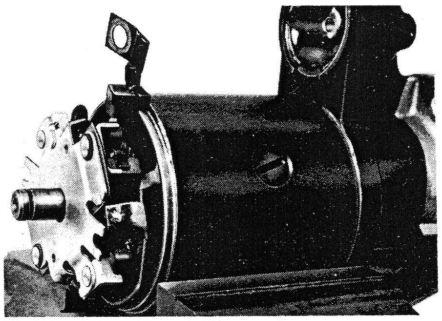


Fig. 69

8. Install dust cover.
   Make sure that rubber grommet for the connecting strand sits well. Ground connections between the brush carrier plate and cover, as well as between cover and housing, must be bare.

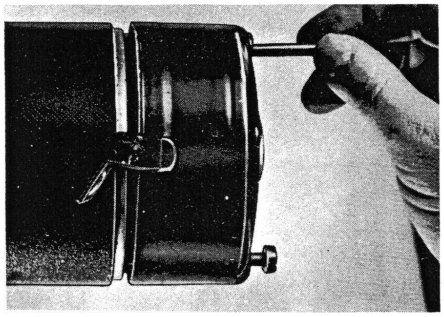


Fig. 70

9. Install spacer discs and lock ring.
   Axial play of armature should be .004 - .006" (0.1 - 0.15 mm).

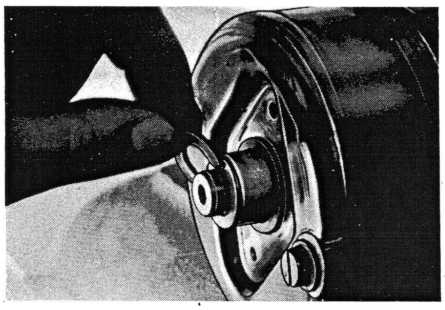


Fig. 71

10. Bolt cap of commutator bearing in place.
    Connect the solenoid plunger and bolt solenoid switch to drive housing.
    Connect terminal of winding to solenoid switch.

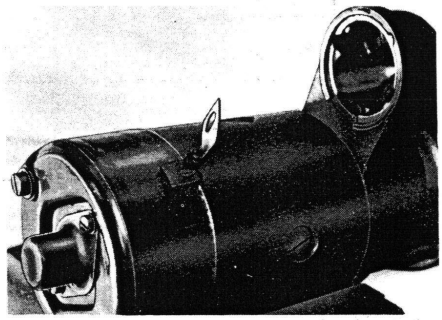


Fig. 72

TECHNICAL DATA

EB 12 V, 0.8 HP

Minimum voltage for solenoid actuation	7 volts
Specifications:	
Brush pressure	42.3 $^{+ 5.29 \text{ oz}}_{- 1.76 \text{ oz}}$ ($1200 ^{+ 150 \text{ p}}_{- 50 \text{ p}}$)
Armature axial play	.004 - .006" (0.10 - 0.15 mm)
Overrun torque of clutch	1.56 - 2.17 in-lb (1.8-2.5 kpcm)
Brake torque	3.04 - 4.34 in-lb (3.5-5.0 kpcm)

Lubricants

Lubrication prior to or during the reassembly.

Lubricants (BOSCH)	Lubricating Points	Dosage
Ft 2 v 3	Engagement Parts Coupling shaft, coil springs, locking ring, surfaces of the guide pan for the actuating lever pin, discs, and 10 greased balls.	Grease well
Ft 2 v 3	Armature Shaft Pinion running surface, helical spline shaft, commutator bearing	Grease lightly
Ol 1 v 13	Shaft Bushing Bushings in drive housing and commutator support	Oil well
Ft 2 v 3	Actuating Lever Pivot stud, studs in coupling	Grease lightly
Ft 2 v 3	Thrust Washers -on commutator side of armature	Grease lightly
Ft 2 v 3	Solenoid Switch Pivot, spring, spring pan at the actuating lever receptacle	Grease lightly

STARTER TROUBLE CHART

Symptom	Cause	Remedy
Starter does not turn when starter switch is actuated:	Switch the lights on for testing: a. Lights do not burn: Wire connecting or ground broken; dead battery. b. Lights burn but go dim or off when starter switch is turned on: Excessive resistance due to loose or corroded connections. c. Lights burn but slowly grow dim when starter is engaged: Low battery. d. Lights burn brightly. Jump-wire Terminal 30 with 50 at starter: starter runs. Connection 50 to starter switch broken; connection 30 to light switch broken; ignition/starter switch defective. e. Lights burn brightly, solenoid working Battery cable from Terminal 30 at the starter should be detached and connected to the contact bolt of the connecting strip -- starter runs. Solenoid contacts worn or dirty.	a. Check battery cables and connections. Check battery charge, recharge if necessary. b. Clean battery terminals and clamps. Make sure that electrical connections between battery, starter, and ground are adequate. c. Charge battery. d. Eliminate defect, replace defective parts. e. Replace solenoid.
Starter does not turn when battery cable is placed directly onto the contact bolt of the connecting strip; starter turns too slow or can't turn crankshaft:	a. The brushes are sticking. b. Worn brushes. c. Insufficient spring tension; brushes not making contact. d. Dirty commutator. e. Scored or scorched commutator. f. Defective armature or field coils.	a. Clean brushes and holders in the brush carrier. b. Replace brushes. c. Replace springs. d. Clean commutator. e. Overhaul starter. f. Overhaul starter.
Starter engages and pulls, but engine does not turn or turns only intermittently; pinion does not disengage:	a. Dead battery. b. Excessive resistance due to loose or corroded connections. c. Brushes are sticking. d. Worn out brushes. e. Dirty commutator. f. Scored or scorched commutator. g. Defective starter or field coils.	a. Charge battery. b. Clean battery terminals and clamps, tighten connections. c. Clean brushes and brush holders. d. Replace brushes. e. Clean the commutator. f. Overhaul starter. g. Overhaul starter.
Starter engages and pulls, but engine does not turn or turns only intermittently.	a. Defective pinion. b. Defective starter ring in flywheel.	a. Replace pinion. b. Dress starter ring, replace flywheel if necessary.
Pinion does not disengage:	a. Dirty or defective pinion or helical spline shaft. b. Defective solenoid switch.	a. Overhaul starter. b. Replace solenoid.

6 LI

BATTERY MAINTENANCE

General

The battery is a cushion and reservoir for the electrical energy in the vehicle.

Specific gravity of electrolyte:

The specific gravity of electrolyte can be determined with a hydrometer. The hydrometer float rises higher, the higher the specific gravity is. By reading a scale in the hydrometer, the specific gravity can be obtained in degrees Baume. Specific gravity increases proportionately with decreasing state of charge of the battery:

Dead battery.....18° Be = specific gravity of 1142

Half-charged battery.....27° Be = specific gravity of 1230

Fully charged battery.....32° Be = specific gravity of 1285

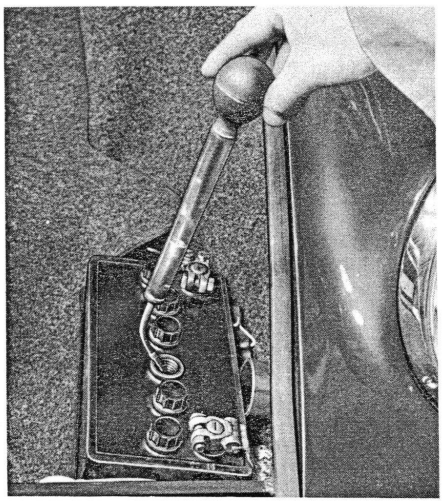


Fig. 73

Electrolyte Level

In course of operation, the electrolyte level drops due to evaporation and deterioration of water. Replenish only with distilled water since city water contains chemical contaminants, even if the water has been boiled first.
The electrolyte level should be about 1/2 - 3/4 inch (10-15 mm) above the upper edge of the plates.

Testing Battery Voltage

The battery can be tested with a cell tester, a voltmeter with a parallel wired resistance of 80 to 100 amps.
Each battery cell is tested individually by placing the pointed voltmeter probes onto the respective plus and minus poles of the given cell.

The voltage of a given cell must not drop below 1.6 volts during the test periods of 10-15 seconds each; if the voltage drops to less than 1.6 volts, then the given cell is defective or dead. Normal tension is 2 volts. The voltages of the invidual cells should not vary by more than 0.2 volts.

Battery Care

The battery must be firmly attached to the car. The battery terminals and wire clamps must be clean to keep the resistance low. The terminals should be greased with vaseline or corrosion preventing grease. Wire clamps which have corroded and cannot be lifted off the battery terminals must be handled with a special puller. Spilled electrolyte must be immediately neutralized with a soda solution to prevent damage to fabrics and painted surfaces.

Charging

It is a good practice to remove the battery at intervals of 3 to 4 months and discharge it to a cell voltage of 1.8 volts, then recharging it fully.
Normally, all batteries will discharge slowly at the rate of about 1 % per day.

Important

If the car is taken out of operation for prolonged periods of time, or if the battery is to be stored for such extended periods, it should be charged at four week intervals with a trickle of about 4 amps to prevent deterioration of the plates. In such cases the battery should be discharged prior to each third charging at a rate of 2 to 4 amps until the low limit of 1.75 volts per cell has been reached. After that, the battery should be fully recharged.

General

A 12 volt battery ignition is utilized. The battery current flows through a contact breaker which sends it on in the form of electrical pulses to the primary winding of the coil, inducing a high tension of about 20 kV in the secondary coil. This high voltage flows to the spark plugs in individual cylinders through an ignition distributor which is equipped with a centrifugal spark advance mechanism. Radio interference suppression is in accordance with VDE 0879, Part 1.

Coil Design

The primary and secondary coils are wound around an iron core which is built up of laminations to keep eddy currents down. The winding of the secondary coil starts at the iron core which is connected to the high tension ignition lead. The end of the secondary coil joins the beginning of the primary coil windings and both are connected to Terminal 15 of the coil. The coil is filled with oil to facilitate a better dissipation of heat.

Coil Operation

The operation of the coil is based on the transformer principle. The low voltage (12 V) but relatively high amperage (3 A) current flows from the battery through the primary coil and closed points to the ground. When the breaker points open, a high tension voltage of approx. 20 kV, with low amperage of a few mA, is induced in the secondary coil. This current flows to the spark plug where it crosses the electrode gap in the form of an electrical spark on the way to the ground of the car.

Wired in parallel with the distributor is a condenser whose function it is to greatly reduce breaker point arcing.

Condenser Operation

When the contact breaker points are closed, the current flows only through the primary winding in the ignition coil since the condenser acts as a strong resistor for the direct current. When the breaker points open, the primary windings induce a high tension voltage in the secondary coil. According to Lenz's law, however, an opposing induction forms simultaneously in the primary coil. Without the condenser, this opposing current would jump across the open breaker points in the form of an arc and quickly destroy these.

Ignition Coil

Defects in the ignition coil normally are difficult to diagnose without an electronic tester since in many cases the malfunction occurs in warm coils at high pulse frequency.

When such test instrument is not available for use, a superficial coil test can be made by pulling the high tension lead, which connects the coil with distributor, from the distributor cap and holding it about 9/32" (7 mm) away from ground of the car. When the engine is cranked by the starter, a spark must jump from the lead to the ground.

Ignition Distributor

The distributor controls the current flow to the individual spark plugs. The ignition timing advance at varying engine speeds is performed by a built-in centrifugal spark advance mechanism.

Distributor Design

The grey cast distributor housing is shaped like a pot. It accomodates the breaker point plate with point carrier and breaker points, the centrifugal spark advance mechanism, and the distributor rotor.

The supporting neck of the distributor housing is mounted in an orifice in the crankcase. The neck is hollow and accomodates the distributor drive shaft which is driven by a gear mounted on the crankshaft. The contact breaker plate supports the breaker arm and fixed breaker support. Each of the breaker components has a wolfram contact point brazed on. Contact breaker gap in open position should be .016" (0.4 mm) and is adjustable by means of an eccentric screw.
The actual distributor consists of the rotor atop the cam, and the distributor cover.

If engine malfunctions should be poining to troubles in the ignition system, the following checkout procedure should contribute to the determination as to whether the ignition is working properly, and if not, where the malfunction may be located. This procedure, however, is not intended to take place of a thorough analysis which can be accomplished only by specialized auto-electric shops, such as BOSCH SERVICE.

Engine does not fire when cranked:

1. Check high tension lead between coil and distributor for proper seating. Pull the lead out of the distributor cap and hold about 1/4" (5-7 mm) from car's ground; when the engine is cranked, electrical sparks should cross from the lead to the ground, which shows that the primary and secondary coil windings are in working order.
   If no sparks occur, do the following:

2. Connect a 12 volt test lamp between Terminal 1 at the distributor and the car's ground. Switch the ignition on and operate starter. If the test lamp goes on and off when the engine is cranked up, the primary coil winding is in working order.

3. If the test lamp should continue to burn while the engine is being cranked, check if the breaker point gap is too wide, or if grease, oil, dirt, or similar obstruction happens to be caught between the breaker points.

4. If the test lamp does not burn when the engine is being cranked, then the primary coil winding is interrupted or the points do not open fully. The test includes checking for loose cable connections, broken terminal ends, grounding distributor wire, and condition of the points. To make sure, a different ignition coil may be hooked up.

5. Remove distributor cap and check inside for condensation, corrosion, and electrical scorching. Check spark plug connectors for water condensation and current conductivity. Take the spark plugs out, check, and readjust electrode gap if necessary.

6. If the malfunction still has not been found, the ignition timing should be checked. If the timing is in order, then the malfunction is not in the ignition system and should be looked for in the fuel system.

8 LI ADJUSTING BREAKER POINTS

Adjust breaker points as follows:

1. Remove distributor cap and rotor.

2. Turn crankshaft through the crankshaft pulley until a cam lobe in the distributor fully lifts the breaker point arm.

3. Check breaker point gap with a feeler gauge; the gap should be not less than .010" (0.25 mm).

4. Check dwell angle with engine tester; dwell angle should be $38^{\circ} \pm 3^{\circ}$ ($63.5\% \pm 5\%$).

5. Dwell angle can be corrected by changing the breaker point gap.
   Loosen set screw in fixed contact support.
   Keep resetting the breaker gap until the dwell angle is correct.

6. Tighten set screw in fixed contact support.

Note:

Subsequent to the adjustment of the dwell angle, always check the ignition timing since changes in dwell angle adjustment affect the timing.

9 LI REPLACING BREAKER POINTS

The breaker points are subject to erosion and should, therefore, be replaced when pitting is in evidence.

Removal

1. Remove distributor cap and rotor.

2. Loosen nut of screw which secures the leaf spring of the breaker arm.

3. Remove lock ring from breaker arm pivot stud.

4. Pull breaker arm out.

5. Remove retaining screw from fixed contact support (anvil) and take the support out.

Reinstall in reversed order.

Breaker Point Care

Pitted points always should be replaced. Due to their high state of tuning, tuned engines are very sensitive to ignition malfunctions.

The rotor as well as the electrodes in the distributor cap are subject to erosion since the ignition sparks continuously cross between them when the engine is running. Malfunctions may occur when the insulating qualities of the distributor cap or rotor are impaired due to a small cracks through which the high tension voltage may be escaping to the ground.

A spring-loaded carbon contact in the distributor cap conducts the high tension voltage to the rotating rotor. From there, the current jumps across a .026" (0.7 mm) wide gap, in proper sequence, from the moving to the stationary electrodes.

The distributor cap must be well ventilated to prevent damage by the ozone created inside. The distributor cap should be kept clean, in and out, to keep creeping currents and arcing down.

AUTOMATIC IGNITION ADVANCE

The automatic ignition advance is effected by means of a centrifugal control device which is located in the distributor housing directly beneath the breaker plate and surrounding the distributor shaft.
Mounted on a plate which rides on the distributor shaft are two pivoting arms with weights of uneven size. The arms are pulled inward by springs. As the engine revolutions increase, centrifugal force pulls the weights outward, thus advancing the ignition timing by changing the position of the breaker cam in relation to the distributor shaft. Due to the uneven size of the weights, as well as the design of the mechanism, the desired timing advance curve is obtained.

ADJUSTING IGNITION TIMING

10 LI

Note:

Breaker point dwell angle must be checked and corrected, if necessary, before attempting to adjust the ignition timing.

Adjusting

Normal practice in high performance engines is to use a stroboscope when adjusting the ignition timing.

1. Hook up the engine tester connections to engine.

2. Stamped into the outer edge of the crankshaft pulley are three numerically identified notches, i. e., one for the TDC of Cylinder 1. and one each for 30^{o} and 35^{o} before TDC.

3. Adjust timing according to specifications shown in the table (see page L 40). Adjustment is possible by loosening the distributor clamping bolt at the distributor base and turning the distributor as required.

4. Retighten the clamping bolt at the distributor base without moving the distributor from the adjusted position.

SPECIFICATIONS FOR THE GIVEN DISTRIBUTORS

Type 2000 Engine with any Distributor (engine running without load)

Ignition Timing	
at 6000 rpm	30^{o} BTC
at 5000 rpm	21^{o} - 28^{o} BTC
at 2800 - 4200 rpm	17^{o} - 26^{o} BTC
at standstill	max. 5^{o} ATC

Type 2000 S Engine

Ignition Timing	
at 6000 rpm	30^{o} BTC
at 2000 - 4800 rpm	23^{o} - 29^{o} BTC
at standstill	min. 5^{o} BTC

A simple function test of the advance mechanism may be made by removing the distributor cap and twisting the rotor clockwise to stop, then releasing it; if the mechanism is free, the rotor will jump back into its original position.
An exact checkout of the timing advance curve is possible only with the use of a distributor tester or an electronic engine tester.
If the checkout is being made with the use of an engine tester, it will be necessary to further mark the crankshaft pulley. The pulley is 4.57" (116 mm) in diameter. The equivalent to the value of 5^{o} is .197" (5 mm) on the outer edge of the pulley and can be marked with the help of vernier calipers using the TDC (Z1) mark as a reference point.

IGNITION ADVANCE CURVE FOR BOSCH DISTRIBUTORS

TYPE 0 231 121 006 J FR 6 (R) WITHOUT SPEED GOVERNOR, AND
TYPE 0 231 159 001 J FDR 6 (R) WITH SPEED GOVERNOR
UP TO MANUFACTURE DATE CODE 609 FOR TYPE 2000 ENGINES

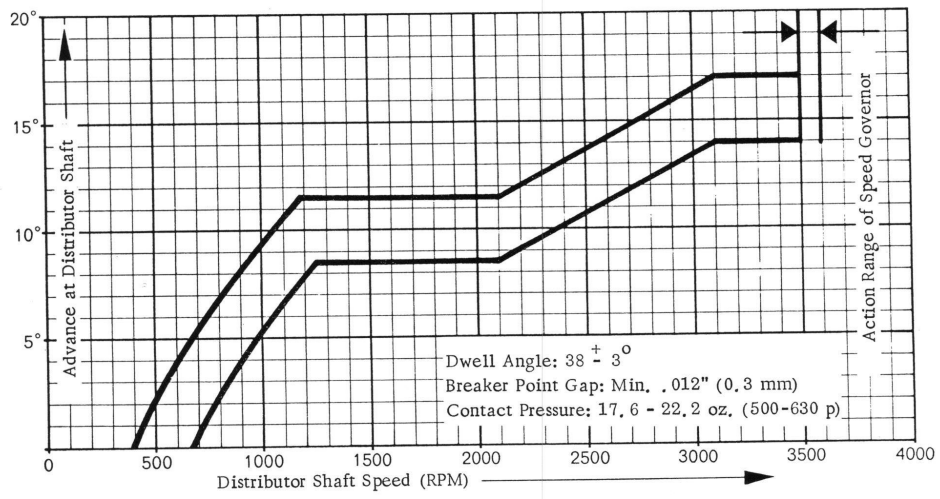


Fig. 74

IGNITION ADVANCE CURVE FOR BOSCH DISTRIBUTOR

TYPE 0 231 159 001 J FDR 6 (R) WITH SPEED GOVERNOR
FROM MANUFACTURE DATE CODE 609 FOR TYPE 2000 ENGINES

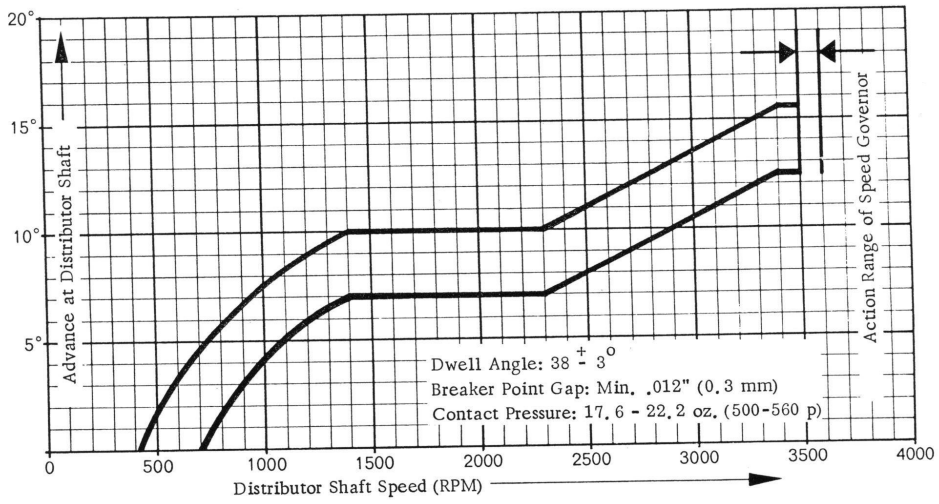


Fig. 75

IGNITION ADVANCE CURVE FOR BOSCH DISTRIBUTOR

TYPE 0 231 159 002 J FDR 6 (R) WITH YELLOW NOMENCLATURE PLATE
FOR TYPE 2000 S ENGINES

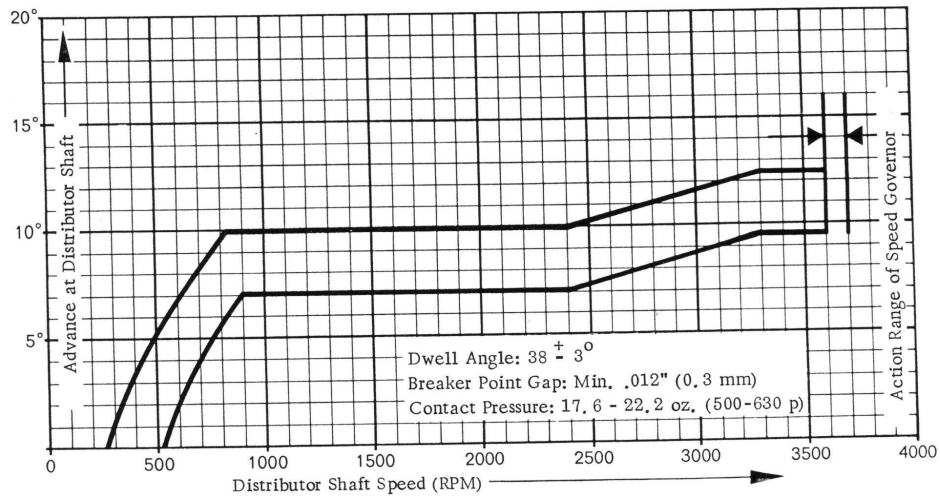


Fig. 75a

IGNITION TIMING DATA FOR ENGINES TYPE 2000 AND 2000 S

ENGINE TYPE	DISTRIBUTOR TYPE	IGNITION TIMING	BASIC SETTING		TECHNICAL REMARKS
2000	0231 121 006 without speed governor (no longer supplied as spare part.) 0231 159 001 with speed governor (replaces above listed distributor) Porsche Part Nr. 901. 602. 021. 02	30^{o} BTC at 6000 rpm engine without load, or 32^{o} BTC at 6000 rpm engine under load.	On TDC	These specifications are valid only as basic settings when installing the distributor or breaker points. In all cases, readjust timing with a stroboscope to obtain values shown to the left of this column.	Dwell Angle: 38 ± 3^{o} Breaker Point Gap: Min. .012" (0, 3 mm) Contact Pressure: 17. 6 - 22. 2 oz (500-630 p)
2000 S	0231 159 002 with speed governor Porsche Part Nr. 901. 602. 021. 50	30^{o} BTC at 6000 rpm engine under load or without load.	5^{o} BTC		Dwell Angle: 38 ± 3^{o} Breaker Point Gap: Min. .012" (0, 3 mm) Contact Pressure: 17. 6 - 22. 2 oz (500-630 p)

ADJUSTING CURVE OF IGNITION DISTRIBUTOR AS FROM MODEL 69

General

As from Model 69, the engines of type 911 E and 911 S were provided with modified ignition distributors. The timing for both engine types is adjusted to 30° BTDC at 6000 rpm. This value applies both, for engines under load and under no-load conditions.

Note!

The adjusting curve of the ignition distributor may be tested on test stand with normal battery ignition only.

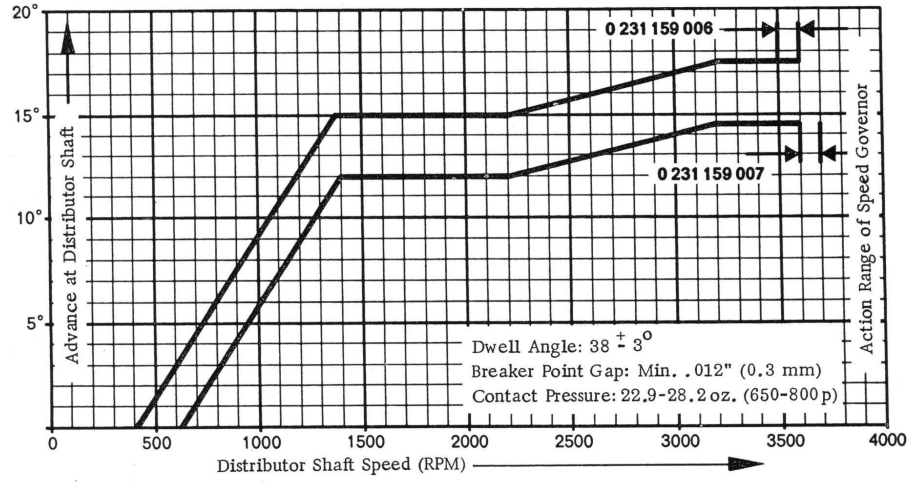
Test Values for Checking Adjusting Curve on Built-in Ignition Distributor

(Applicable to ignition distributors Type 0231 159 006 and 0 231 159 007)

Timing at:	6000 rpm	30° BTDC
	2800 - 4400 rpm	23° BTDC - 29° BTDC
	2000 rpm	10° BTDC - 18° BTDC
	1000 rpm	4° ABDC - 2° BTDC
	vehicle stopped	max. 4° ABDC

IGNITION ADVANCE CURVE FOR BOSCH DISTRIBUTORS

TYPE 0 231 159 006 (J FDR 6) FOR TYPE 911 E, 911 E-C ENGINES, AND
TYPE 0 231 159 007 (J FDR 6) FOR TYPE 911 S, 911 S-C ENGINES



SPARK PLUGS

General

Purpose of the spark plug is to conduct the high tension ignition current, without leakage, into the combustion chamber of the engine and initiate ignition of the compressed fuel/air mixture when the current crosses over the electrode gap.

Spark plug design features dictate the electrode gap required, which must be maintained accordingly in all spark plug types.
Spark plug types approved for use by Porsche are announced on a continuing basis by means of service bulletins made available to Porsche-authorized shops.

The approved spark plug types, as of March 1967, are as follows:

Type 2000 Engine

Manufacturer	Spark Plug Type	Electrode Gap
BOSCH	W 250 P 21	.012" (0.35 mm)
BOSCH	WG 265 T2 SP	.014" (0.40 mm)
BERU	260/14/3S	.018" (0.50 mm)
CHAMPION	N 6 Y	.019" (0.55 mm)

Performance-tuned Type 2000 Engines and Type 2000 S

Manufacturer	Spark Plug Type	Electrode Gap
BOSCH	W 265 P 21	.012" (0.35 mm)
BOSCH	WG 265 T2 SP	.014" (0.40 mm)
BERU	260/14/3S	.018" (0.50 mm)

Caution:

Use only Porsche-approved spark plug types.

Servicing and Testing

Remove the spark plugs at intervals of approx. 3,000 miles and check for proper appearance, electrode gap, and electrical functioning.
The spark plug appearance will be indicative of its condition as well as carburetion. Remember, however, that the spark plug inspection should be made after the engine has been brought to operating temperature under operating conditions, meaning that the engine must not be permitted to idle after the above prerequisites have been met.

CHECKING CONDENSER

12 LI

Symptoms of a defective condenser are, among other, poor power performance, poor starting, and high contact point erosion.
The condenser can be checked on an electronic engine tester; however, we suggest that the condenser be replaced whenever an assumption is made that it is defective.

REMOVING AND REINSTALLING IGNITION DISTRIBUTOR

See Engine Group (51 En).

HEADLAMPS

General

Both headlamps are mounted in the front fenders and are a combination of headlights with the asymmetric low beam, utilizing double filiament bulbs. Four-watt bulbs are used in the parking lamps. The double diliament bulb is located centrally in the headlamp reflector. Contrary to the old bulb system, the asymmetric lamps have bulbs with three-prong snapon connectors (same as sealed-beam connectors) onto which the cable connectors are slipped on. The bulb is held in place by means of a ring with a bayonet lock with three fastening tabs. The parking light bulb is situated below the headlamp bulb. The headlamp reflector can be moved vertically and horizontally to make headlamp beam adjustment possible.

Cars which are equipped for export to the USA are equipped with sealed-beam headlamps instead of the asymmetric-type headlamps with bulbs. However, the sealed-beams are not approved for use on public roads in various European countries; at time of this printing, the following countries prohibited the use of sealed-beam lights:

France

Holland

Italy

Sweden

Germany

In the sealed-beam headlamp, the double-filiament bulb is replaced by a sealed unit which encompasses the reflector, lamp lens, and the filiaments. When a filiament fails, the entire unit must be replaced. The sealed-beam unit cannot be installed into normal headlamp housings: installation is possible only through the use of special housings.

When driving a US-export car in Germany, or any of the above listed countries, the sealed beam unit must be replaced with the so-called "sealed-beam substitute" (SB-substitute). The SB-substitute has the same shape as the regular sealed beam unit but it consists of only the headlamp lens and reflector. In the center of the reflector an opening has been provided for the accomodation of a normal double-filiament bulb of the asymmetric type. When the car is returned to the USA, the substitutes must be replaced with regular sealed-beam units. The cable connector fits both, the sealed beam and the filiament bulb, whichever is used.

Description

The high beam effect at night conforms to the German traffic code; the high beam filiament is 45 watts, low beam 40 watts. The low beam light dispersion is asymmetrical, extending low-beam vision farther than that provided by the symmetric low beam, namely 130 to 160 feet (40-50 m). Despite this intensified low beam effect, approaching drivers are not flashed more than normally was the case with the symmetric beam. The low beam light intensity of the European system equals that of the sealed beam but does this with less blinding of the oncoming drivers. The dark/bright dispersion line of the light follows a horizontal plane to the left of the beam's center, rising at a 15^{o} angle to the right of it. The asymmetric light beam effect has been achieved by clipping one side of the shield below the low beam filiament and, also, providing an appropriate light outlet in the lamp lens with less beam dispersion in that area. Both headlamps are of equal light intensity and have identical means for adjustment.

Servicing

Make sure during all service operations that the reflectors are kept clean; avoid holding the unit by placing fingers onto the reflector, such as through the light bulb opening. Reflectors which have become dirty for any reason may not be wiped clean; dulled reflectors must be replaced.

The asymmetric beam effect can be eleminated when necessary, such as when driving through countries with left-hand traffic, by covering the taper-shaped light outlet in the lens with tape. This will prevent your blinding oncoming drivers.

REPLACING HEADLAMP BULB

13 LI

General

If the bulb blackens in an area due to tungsten evaporation, it should be replaced since its light intensity is no longer as high as originally intended.

Removal

1. Loosen Phillips screw in the lower center of the lamp rim and withdraw lamp assembly.
2. Withdraw cable connector, depress retaining ring and turn to the left (bayonet lock). Remove retainer and withdraw bulb.
3. Insert new bulb. Make sure that the aligning tab in the base of the bulb fits into the corresponding cutout in the reflector.
4. Position bulb retainer and turn to right while pressing the retainer down.
5. Slip cable connector onto tabs in bulb.
6. Install lamp unit and check lights for proper functioning.

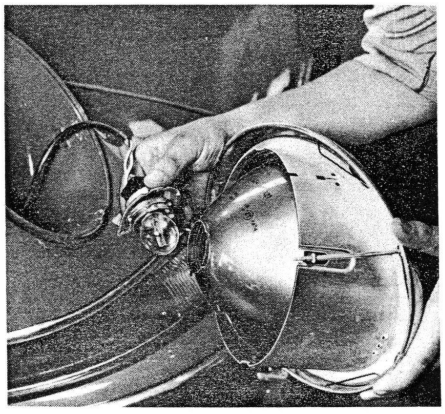


Fig. 76

Note:
Keep the bulb glass clean and free of grease. Hold the bulb only through a clean towel or soft paper since moisture carried on the bulb will evaporate from the bulb when in use and will deposit itself on the lamp reflector surface.

Note:
When changing the bulbs make sure that only the prescribed headlamp bulbs are used (brand-name items), avoiding the use of different makes or uneven wattage.

14 LI

REPLACING HEADLAMP LENS

1. Remove headlamp unit.
2. Remove bulb with retainer.
3. Unscrew reflector adjusting screws and remove reflector.
4. Using a screwdriver, remove lens retainers from rim.
5. Withdraw reflector support.
6. Take out lens or glass remnants.
7. Place rubber sealing ring onto new headlamp lens and place lens into the lamp rim so that the BOSCH inscription is upright, or the wedge-shaped asymmetric low beam outlet in the lens is on the left side when looking in the direction of travel.
8. Replace retaining ring with reflector, check if the sealing ring between the lens holder and retaining ring is well positioned.
9. Install retaining springs.
10. Adjust headlamps.

15 LI

ADJUSTING HEADLAMPS

Note:

The easiest way to adjust the headlamps exactly is with the aid of an optical adjuster by proceeding according to the manufacturers intructions.

If an adjuster is not at hand, the headlamps may be adjusted with the aid of a board. Headlamps with asymmetric low beam should be adjusted only on basis of the low beam projection. The reflector position can be reset with the two adjusting screws in the lamp rim.

Adjusting

1. Place the board perpendicular to the vehicle's axis at a distance of about 16.5 feet (5 m); the reference lines may, however, be painted on a wall as well.
2. Adjust the headlamps with proper tire pressure. Before proceeding, roll the car back and forth a few times to normalize the suspension attitude.
3. The height of the headlamp center should be determined in each car by measuring it from the floor level and then marking the board appropriately (Value "b").
4. Value "c" should be equal to 1 % of the distance between the board and the vehicle, i.g., at 198" (16.5') value "c" should be about 2" (at 5 m = 50 mm).
5. The horizontal headlamp spacing should be marked on the lower reference line of "c" by means of two crosses.

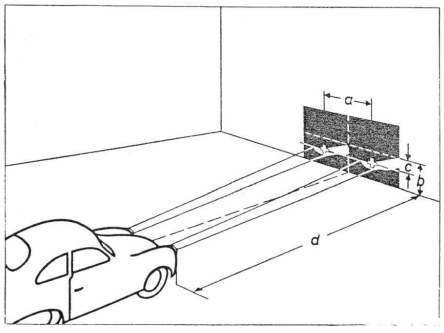


Fig. 77

6. Cover one headlamp while adjusting the other.

7. First adjust horizontally, bringing the kink in the dark/bright projection border onto the cross marked on the board.

8. In the vertical adjustment, the horizontal plane of the dark/bright projection must line up with the adjustment reference line, with the asymmetric sweep rising to the right from the center of the cross.

9. After adjusting the vertical setting, recheck the horizontal adjustment.

BOSCH Headlamp Adjusting Screws:

Vertical Adjustment b Upper screw:
turn right = lower
turn left = higher

Horizontal Adjustment a Lower screw:
turn right = beam to left
turn left = beam to right

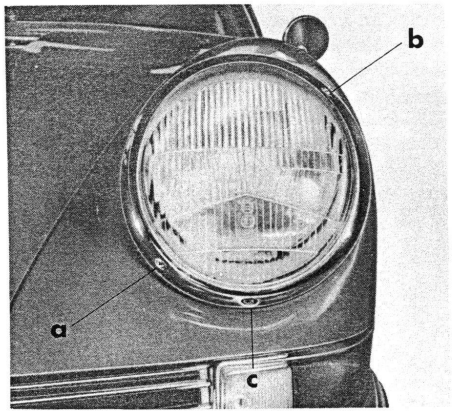


Fig. 77 a

16 LI

TESTING HEADLIGHT VOLTAGE

Procedure

1. Remove headlamp unit.

2. Connect a voltmeter to the two terminals (yellow and brown, or white and brown), and switch the headlights on.

3. The voltage reading must be 12 to 12.5 volts when the engine is running at approx. 2,000 rpm and the headlights are switched on.

4. If the above stated voltage is not in evidence, the following tests must be performed as shown below:
   a. Check battery terminals for proper attachment and/or oxydation.
   b. Check regulator connections for firm seating.
   c. Check slip-on connections in light switch wiring for firm seating.
   d. Check electrical conductivity at both ends of the fuse box, including the fuse for oxydation and firm seating.
   e. Check wire connections at the double-filiament bulb.

5. If the required voltage is still not obtained after the above procedure, check the voltage after installing a new bulb. Aged bulbs have weakened filiaments which can cause a voltage drop.

Should the required voltage still not be obtained, then the defect probably lies in the battery, generator, or voltage regulator.

DIRECTIONAL BLINKER SYSTEM
AND
COMBINED BLINKER, DIMMER, AND HEADLAMP FLASHER SWITCH

General

As already outlined, the blinker lamps are located below the headlamps at front, and together with the tail and stop lights at rear. The stop and tail lights use a common bulb for each side. The directional signals are actuated through the self-cancelling switch which is mounted on the steering post. The green blinker control lamps are accomodated within the tachometer dial. The blinker pulse switch is located in the luggage compartment under the mat next to the steering post support; the switch is held in place through a three-prong connector and can be easily slipped off when required. A magnetic switch interrupts the ground connection of the blinker control lamp whenever one of the blinker lamps should become inoperative to indicate this condition; this indication works, of course, only as long as the control lamp is in working order.
When replacing bulbs, make sure that proper type is used.

REMOVING AND INSTALLING COMBINED BLINKER, DIMMER, AND FLASHER SWITCH

17 LI

Removal

1. Remove steering wheel (see 14 St, 911 Workshop Manual).
2. Detach all wire connections from the combination switch.
3. Remove the two slotted screws from the horn contact ring, detach the wire, remove the ring.
4. Remove upper housing assembly retaining nuts (SW 8) and pull the assembly upward to remove. Lead wires and connectors through the hole which has been provided for that purpose.
5. Remove the three retaining screws which secure the combination switch and remove switch.

Install in reversed order of the above, making certain that the wires are connected properly.

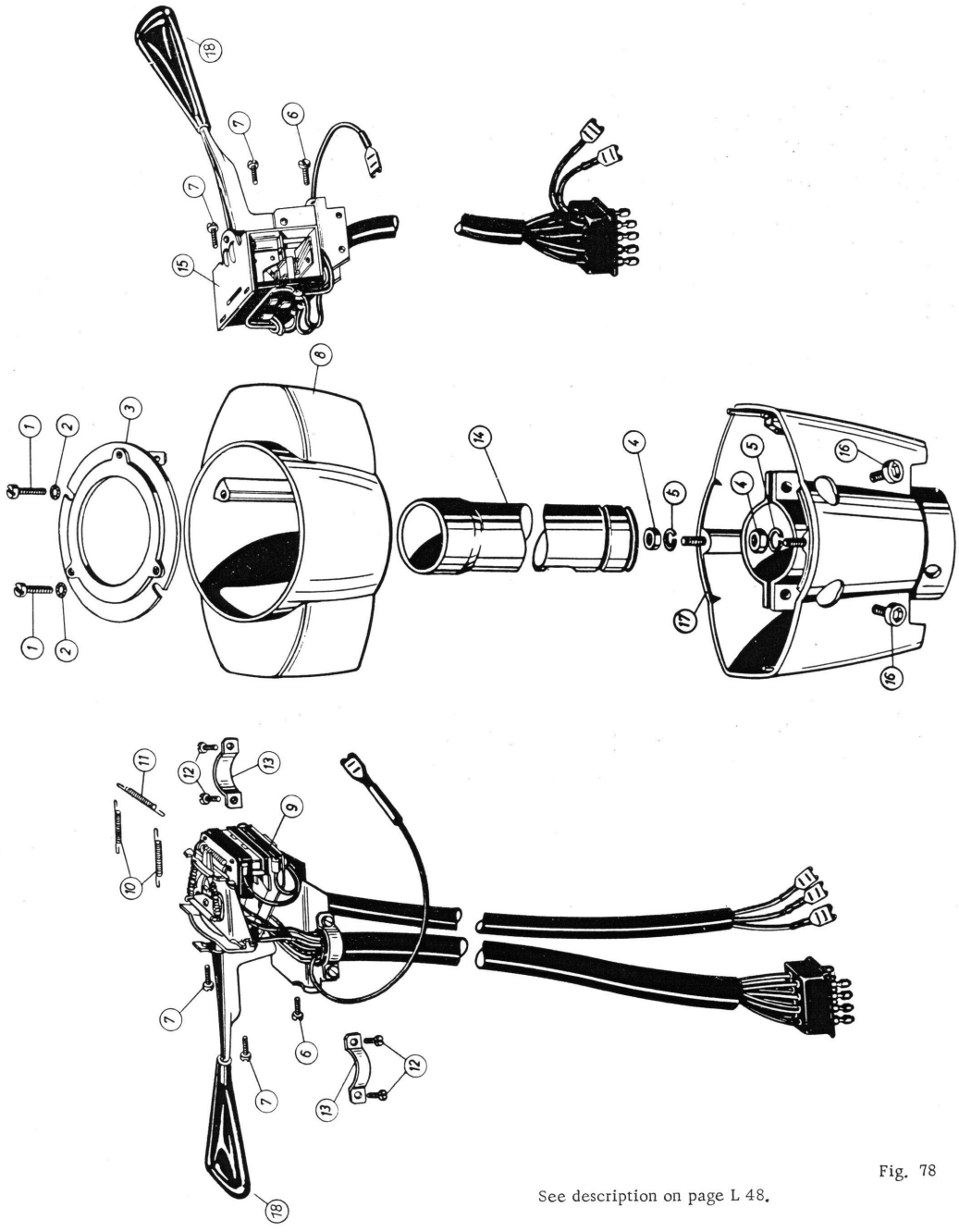


Fig. 78

See description on page L 48.

COMBINED BLINKER, DIMMER, AND HEADLAMP FLASHER SWITCH

1 ... Fillister screw
2 ... Serrated lock washer
3 ... Contact ring
4 ... Hex nut
5 ... Lock washer
6 ... Fillister screw
7 ... Round head countersunk screw
8 ... Upper housing assembly
9 ... Combination switch
10 ... Spring
11 ... Spring
12 ... Fillister screw
13 ... Clamp
14 ... Steering post extension
15 ... Wiper and washer switch
16 ... Allen bolt
17 ... Lower housing assembly
18 ... Lever knob

18 LI

REPLACING BLINKER SWITCH RETURN SPRING

1. Remove steering wheel (see 14 St, 911 Workshop Manual).
2. Remove slotted screws from horn contact ring, detach wire, remove ring.
3. Unhook return spring.
4. Install new spring.

REPLACING BLINKER, PARKING, BACKUP, AND STOP LIGHT BULBS

19 LI

1. Remove lamp unit retaining screws and remove unit.
2. Using a screwdriver, lift the plastic holder at the cut off corner and withdraw holder.
3. Push the bulb into the holder and turn to left (bayonet lock).
4. Remove bulb.
5. Install new bulb.
6. Fasten bulb by pushing into the holder and turning 90° to the right until the socket pins have engaged their seat.
7. Place holder into lamp unit and push lightly in so it snaps into place.
8. Install lamp unit and tighten slotted retaining screws.
9. Check lamp for proper functioning.

REPLACING FOG LAMP BULBS

20 LI

1. Remove slotted screws from retaining ring at lamp lens and withdraw lamp unit.
2. Pull lamp socket out of lamp unit (snap fit).
3. Push the bulb into the socket and turn to the left (bayonet lock).
4. Take old bulb out, insert new bulb.

Note:

Keep glass bulb clean and free of grease, handling it through soft paper or clean towel.

5. Push bulb into socket and turn to the right.
6. Push the socket into the lamp unit to firmly seat it.
7. Put the lamp unit back in place and tighten slotted retaining screws.
8. Check fog lamps for proper functioning.

REMOVING AND INSTALLING DOOR CONTACT SWITCH

21 LI

General

The door contact switch is accomodated within the forward door posts and controls the interior light when the latter is preset for automatic functioning. When the doors are opened, a contact is made through the switch in the door post and the interior light goes automatically on.

Removal

1. Remove rubber cap.
2. Unscrew contact switch with a 12 mm box wrench, detach wire.
3. Connect wire to new switch and reinstall.

Fig. 79

REPLACING BULB IN INTERIOR LAMP

22 LI

Gently press the lamp base out with a screwdriver, always applying force at the rear part of the base (as seen in direction of travel).

When installing new bulb, make sure that the bulb holding clamps are sufficiently tensioned to firmly hold the 10 W cartridge bulb in place.

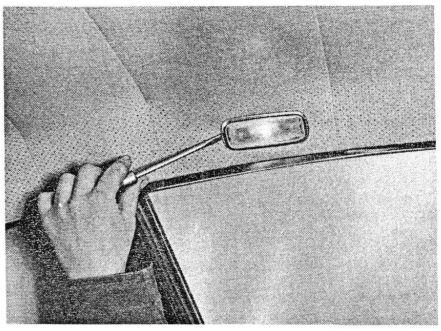


Fig. 80

REPLACING BULB IN LUGGAGE COMPARTMENT LAMP

23 LI

The luggage compartment lamp is located on the lower part of the lid. The lamp goes off automatically when the lid is closed.

1. Remove the glass lens.
2. Replace the 4 W cartridge bulb which is held in clamp contacts.

REPLACING LICENSE PLATE LAMP BULB

24 LI

1. Remove both screws which secure the license plate lamp assembly to the engine compartment lid and withdraw lamp assembly.
2. Replace bulb.
3. Reinstall in reversed order.

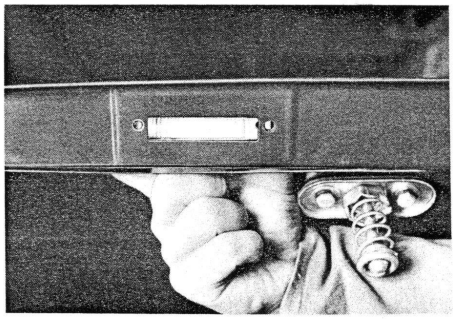


Fig. 81

General

The speedometer unit includes the odometer and trip mileage counter. A flex shaft connected to the transmission drives the unit. The speedometer indication is effected through the application of eddy currents. A disc-shaped magnet rotates within a closely-spaced aluminum shell. As the magnet rotates, induction currents are generated and create a turning force in the shell, the force being proportionate to the speed of the magnet. The shell is connected to the speedometer needle. Located on the axis of the indicator needle is a spiral spring which works against the force created by the induction currents, being matched to the electro-magnetic system. As the car moves and, thus, the driving flex shaft rotates, both forces maintain an equilibrium and the needle of the speedometer shows the given speed at which the vehicle is moving.

The odometer drive consists of a triple reduction gear. The odometer has a five-digit counter. The trip mileage counter can be reset to zero by means of a knob on the instrument panel.

REMOVING AND INSTALLING INSTRUMENTS

25 LI

Note:

Connecting terminals of all instruments are accessible from the luggage compartment upon removal of the carpeting.

1. Detach all cables from the instrument that is to be removed.
2. In the case of the speedometer, also remove the flex shaft knurled nut and withdraw flex shaft.
3. Remove small knurled nuts which secure the instrument, withdraw the retaining clamp, and take instrument out, with care, from within the passenger compartment.
4. Reinstall the new or repaired instrument in reversed order of the above.

REPLACING CONTROL LAMPS AND INSTRUMENT ILLUMINATION LAMPS

26 LI

1. Loosen luggage compartment mat retainers and pull mat forward.
2. Pull out the respective lamp socket from a given component.
3. Take bulb out of socket.
4. Install new bulb.

REMOVING AND INSTALLING FUEL GAUGE SENDER

27 LI

Removal

1. Fold luggage compartment mat back.
2. Withdraw multiple-pin socket.
3. Remove sender retaining bolts and withdraw sender unit.

When reinstalling, check the gasket for condition and proper seating.

REPLACING BACKUP LIGHT SWITCH

28 LI

General

The backup light switch is located on the transmission housing side. The switch is actuated through the respective positioning of the internal shift rod within the transmission when reverse gear is engaged, moving a contact pin and thus switching the backup light on.

Removal

1. Remove rubber cap.
2. Pull snap-on terminal connectors off.
3. Unscrew switch with an open end wrench (SW 22).

Reinstall in reversed order of the above making sure that the contacts are firmly seated and the rubber cap securely attached.

HEADLAMP FLASHER SIGNAL

The headlamp flasher signal is released by means of the combination switch on the steering post. The flasher relay switch is situated under the left floorboard.

The purpose of the flasher relay switch is to reduce the current load of the headlamps, i.e., routing the high current flow through heavy contacts in the flasher relay rather than through the switch on the steering post.

REPLACING FUSES

29 LI

The fuse box is located under the luggage compartment mat. The fuses can be easily removed by applying pressure against the retaining clamps. When a fuse burns out, the matter should be investigated to determine the cause rather than simply replacing the fuse.

We suggest that a small supply of fuses (8/15 amp and 25/40 amp) be always carried in the car.

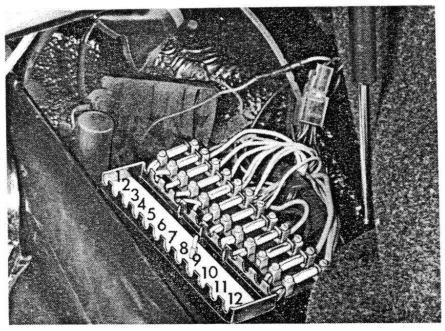


Fig. 82

REMOVING AND INSTALLING SIGNAL HORNS

30 LI

General

The signal horns are cushion-mounted under both front fenders.

1. Detach snap-on wire connectors.

2. Remove horn retaining nut and take horn out.

When reinstalling the horn, make sure that it does not make contact with the body.

General

The windshield wiper motor and actuating linkage are located just in front of the instrument units. The motor is controlled by a four-position wiper/ washer switch. The windshield wiper linkage joints are service free.

The windshield wiper blades should make an even contact with the windshield and move equally far on both sides.

31 LI REMOVING AND INSTALLING WIPER MOTOR WITH LINKAGE

Removal

1. Remove the forward ventilating case after removing the retaining clip and air duct.

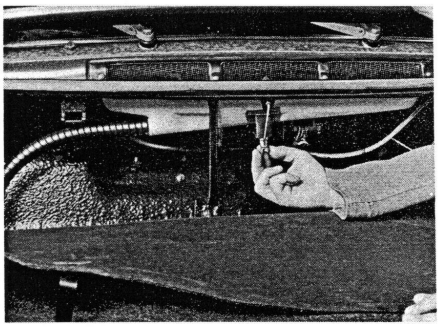


Fig. 83

4. Remove rubber discs located beneath the wiper arms and unscrew retaining hex nuts.

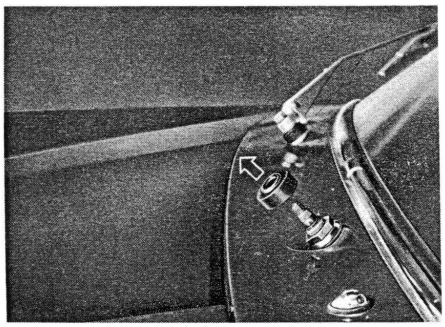


Fig. 84

2. Detach all (5) wire terminals from the wiper motor.

3. Remove wiper arms.

5. Withdraw wiper motor downward, together with linkage.

Check for proper placement of connecting wires and free movement of the wiper linkage when reassembling the wiper system.

The electrical windshield washer pump is located in the forward luggage compartment next to the windshield washer reservoir.

Removal

1. Remove both slotted screws which secure the reservoir.
2. Withdraw the reservoir.
3. Detach wires from pump.
4. Loosen plastic retaining straps from pump and pull the pump out.

Install in reversed order of the above.

Note:

Up to Chassis Serial Nr. 302 695, the windshield washer reservoir was installed into a recess along the side of the luggage compartment floor.
The windshield washer pump was installed in the right rear part of the luggage compartment (looking in the direction of travel) under the compartment mat.

Removing Reservoir

1. Pump the reservoir completely dry.
2. Remove cap and hose.
3. Remove reservoir by turning it.

Removing Windshield Washer Pump

1. Detach cables from pump.
2. Detach suction and pressure hoses from pump.
3. Loosen plastic retaining straps from pump and pull the pump out.

Install in reversed order of the above.

General

The car radio must perform well under relatively unfavorable conditions. On one side, the antenna input (signal strength) is very low due to the short antenna length; on the other side, the ignition system, generator, and windshield wiper motor are a more or less constant source of static or interference. For this reason it is of great importance that the vehicle is well freed of interference generators, especially in the case of FM reception. Loose ground connections, for one, are a common source of static noise. When installing a radio in the car, much care should be devoted to checking the ground connections. Normally, radio noise suppressors are selected by the set manufacturer and may be found in the radio accessory lists.

If a test drive should reveal that the radio reception still suffers from static or other interference, despite the installation of suppressors, the entire system should be rechecked, including all ground connections. If further corrections should be necessary, it is best to have the problem eliminated by soliciting the services of a radio shop which will have the necessary testing equipment on hand.

Note:

The maximum suppressor condenser capacity between the generator terminal D+ and ground is 3.0 mfd, and at the regulator terminal D+ it is 0.3 mfd, since otherwise the contacts will burn.

SUPPLEMENTS

GROUP **L**

LIGHTS AND ELECTRICAL SYSTEM

CONTENTS

Supplements to Group L: Electrical system

Operations:

General

Standard equipment in the 2000T vehicles equipped with the 2000T engine (901/03) is the 14 Volt, 490 Watt Motorola alternator.

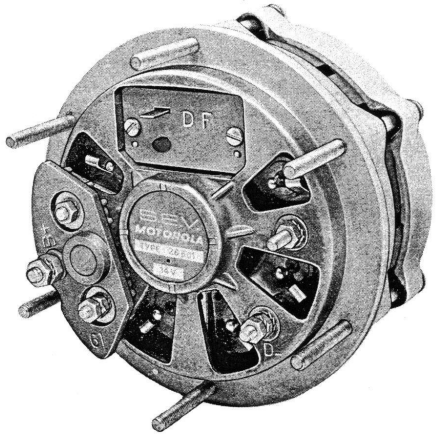


Fig. 1

The alternator consists of the following major components:

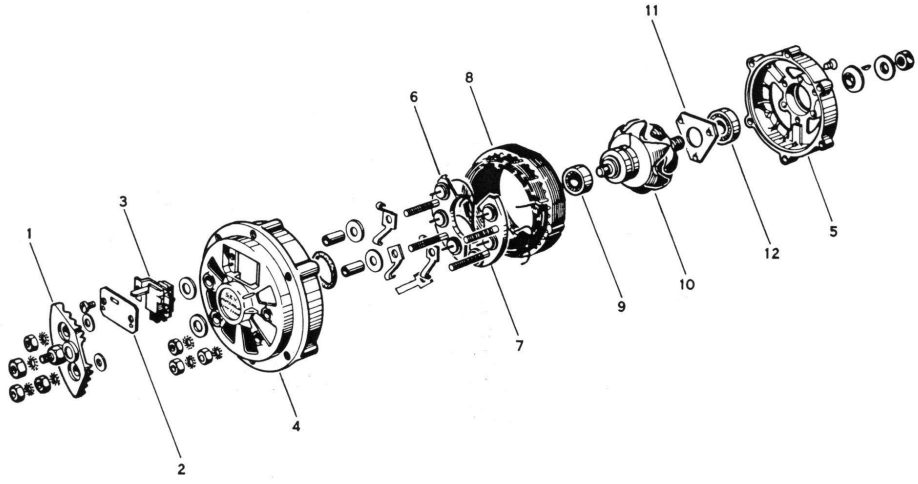


Fig. 2

1 Isolation diode heat sink
2 Brush cover plate
3 Brush holder
4 Rear housing, supporting bearing and rotor
5 Front housing, supporting bearing and rotor
6 Positive diode heat sink
7 Negative diode heat sink
8 Stator
9 Ball bearing
10 Rotor
11 Bearing cover plate
12 Ball bearing

Description

The electrical circuit of the alternator employs six silicon diodes in full wave rectifier circuit (three positive and three negative diodes). The diodes pass the current from the alternator to the battery or load but not in the reverse direction; therefore, the alternator does not employ a circuit breaker.

Contrary to the DC generator, the alternator is not self-exciting. When the ignition is switched on, the field exciting current reaches the alternator via the generator control lamp and voltage regulator. It is therefore always of importance that the generator control lamp is not burned out or of improper wattage.

Two brushes carry the field current to the rotor slip rings; this current is very weak (max. 2 amps) and contributes to the low wear factor of the brushes. The high DC output of the system needs not pass over the collector and brushes, thus rendering the alternator insensitive to rotational speeds (rpm).

The isolation diode protects the alternator against overloading and, in addition, permits the current to flow to the generator control lamp.

WIRING DIAGRAM FOR THE MOTOROLA ALTERNATOR

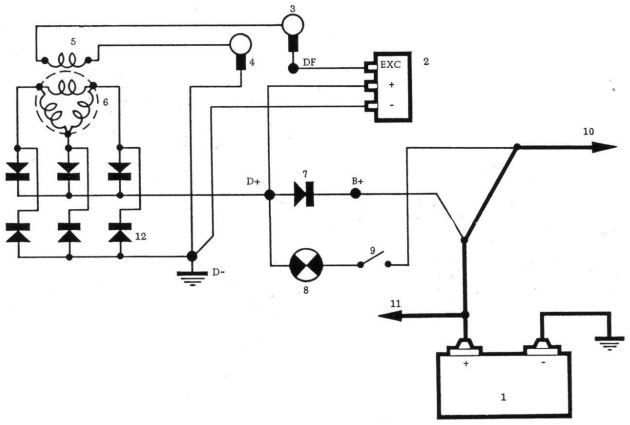


Fig. 3

1 Battery
2 Regulator
3 Slip rings
4 Brushes
5 Rotor
6 Stator
7 Isolation diode
8 Generator control lamp
9 Ignition/starter switch
10 To accessories
11 To starter
12 Diodes

Virtues of the Alternator:

1. The alternator is lighter and smaller than a DC generator of equivalent power output.

2. In comparison with the DC generator, the alternator can be subjected to higher rotational speed.

3. Power output of the alternator stretches over a greater rpm range. Alternator power cut-in rpm are lower than in today's DC generators, which ensures that charging current is produced at low speeds.

   This is of special advantage in city driving.

   The alternator power output curve is shown in the diagram below.

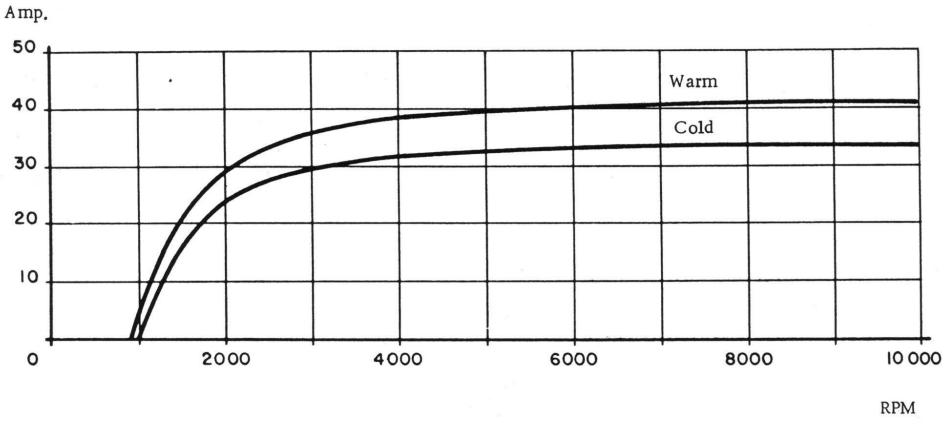


Fig. 4

CAUTION:

The following points must definitely be observed when working on the alternator:

1. The field exciter terminals (DF) of the alternator, regulator, and connecting wire must never touch ground.

2. In no case may the voltage regulator connections be mixed up.

3. The regulator and/or battery must not be disconnected when the alternator is in operation.

4. The battery must be disconnected prior to removal of the alternator.

5. The voltage regulator must never be put into operation without being connected to the ground terminal of the alternator.

6. The battery must be in good electrical condition and fully charged (check specific gravity of electrolyte) when testing the alternator.

7. When testing the alternator in car, the battery must be hooked into the car's electrical circuit.

8. The battery must be disconnected whenever arc welding is performed on the car.

9. When testing the alternator on a test stand, it is necessary to cool the alternator with a fan.

10. Heat will damage the diodes.
    If it is necessary to unsolder the diodes for the purpose of testing or repair, make absolutely certain that the applicable instructions are closely followed.

11. When charging the battery in car with an auxiliary battery charger, detach the battery positive and ground leads from the car's electrical circuit.

    The rectifier diodes and voltage regulator will be damaged whenever the polarity has been reversed through wrong reconnection.

ALTERNATOR MAINTENANCE

1. Alternator bearings need not be lubricated as both have an adequate supply of lubricant making these service-free.
2. V-belt tension must be maintained within required specifications.
3. The voltage regulator is service-free.

TESTING ALTERNATOR

1. V-belt Tension Check:
   The V-belt must deflect by about 10 mm (1/2") when pressed by thumb at a point between both V-belt pulleys.

2. Voltage Regulator Test:
   Cable terminals and connections at points connecting the alternator, voltage regulator, and battery must be in good electrical condition; they must never be connected to wrong points.

   Shown in the sketches below is the wire connection color code for points in the alternator and voltage regulator.

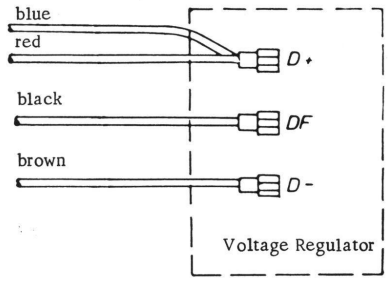


Fig. 5

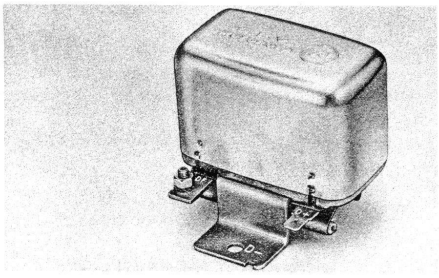


Fig. 6

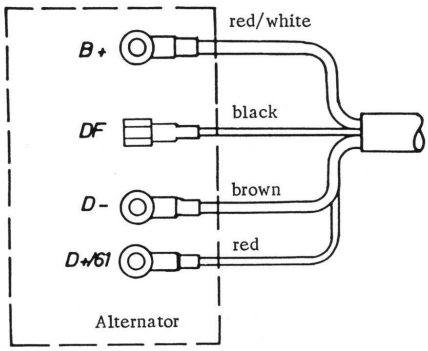


Fig. 7

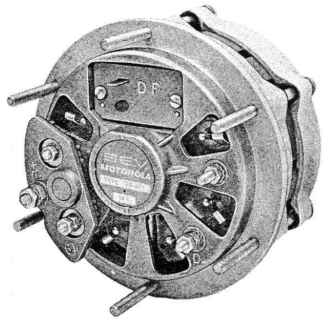


Fig. 8

3. Alternator Output Test:
   (Quick-test in installed condition)
   Run engine at 2500 ± 150 rpm. Load alternator with 28-30 amps (switch the appropriate accessories on, or adjust load control). At this time, voltage between terminals B+ and D- must be between 13.4 and 14.6 volts.

4. Brush Assembly Test:

a. Remove alternator (see page L 8).

b. Remove both retaining bolts from brush holder and remove it.

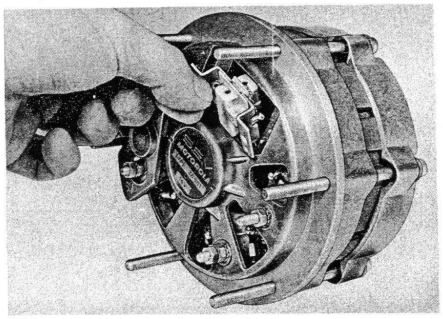


Fig. 9

c. To check the insulated brush for continuity, connect one ohmmeter probe to the insulated brush, and the other probe to the DF terminal.

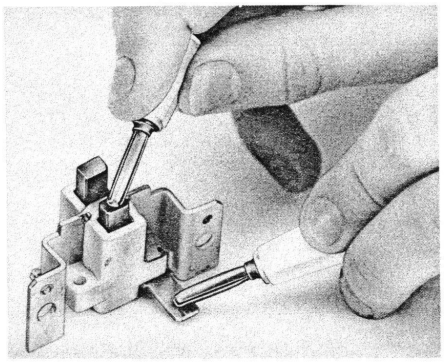


Fig. 10

d. To check the grounded brush for continuity, connect one ohmmeter probe to the grounded brush, and the other to the brush holder. In both tests (c and d, above), resistance should be zero even when the brushes are being moved in the process of taking the readings.

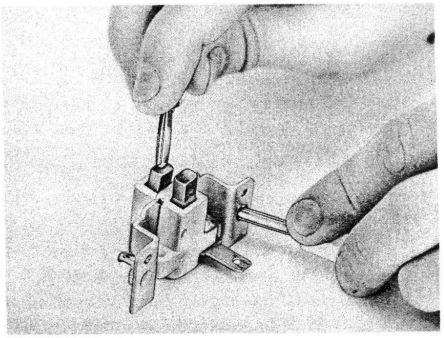


Fig. 11

e. To test brush isolation, connect one ohmmeter probe to one brush, and the other probe to the second brush. In this circuit, the resistance should be infinitely high with no current flowing through.

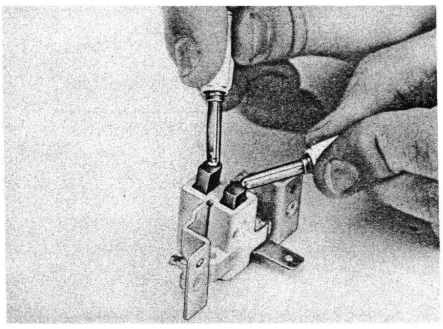


Fig. 12

5. Rotor Test:

a. To test the rotor for shorting to D-, connect one ohmmeter probe to D- and the other to one of the slip rings. Resistance should be infinitely high in this circuit.

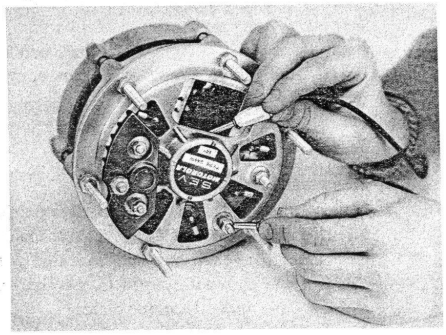


Fig. 13

b. To test the rotor coil for continuity, connect one ohmmeter probe to each slip ring. This circuit should have a resistance of 4.5 to 6.5 ohms.

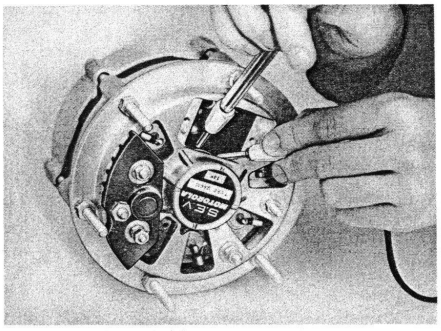


Fig. 14

Replace the rotor if the above readings cannot be obtained.

6. Isolation Diode Test:

a. To test the isolation diode heat sink for shorting to the ground, connect one ohmmeter probe to terminal D+61, and the other probe to terminal D-.

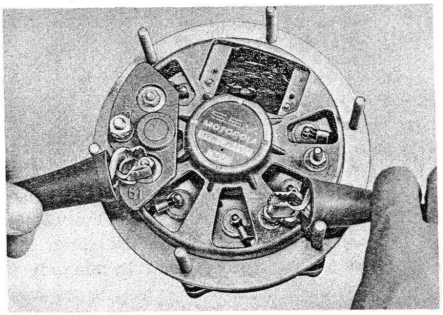


Fig. 15

When testing this circuit, resistance should be infinitely high in one direction, and less than 50 ohms in the other. If the readings differ from the above specifications, check diode heat sink insulation at the rear housing contact area.

b. To test the isolation diode, connect one ohmmeter probe to terminal B+, and the other to terminal D+61.

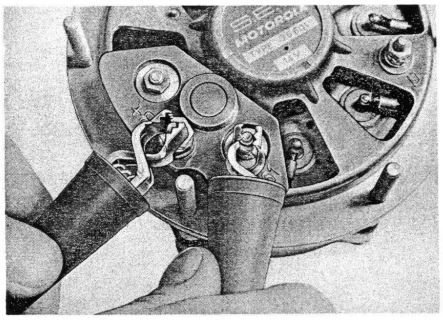


Fig. 16

After the first test, reverse the probes at terminal B+ and D+ 61. In one test the resistance must be infinitely high while in the other it must be less than 50 ohms. The diode assembly must be replaced when one diode is found to be defective. Ensure during installation of a new diode assembly that the heat sink insulation is in good order. Check for proper isolation upon installation of the diode assembly.

7. Rectifier Diode Test:

a. To test the negative diode, connect one ohmmeter probe to the negative diode terminal, and the other probe to terminal D-. After this test, reverse the probes. In one test the resistance must be infinitely high while in the other it must be less than 50 ohms. The diode assembly must be replaced when one diode is found to be defective.

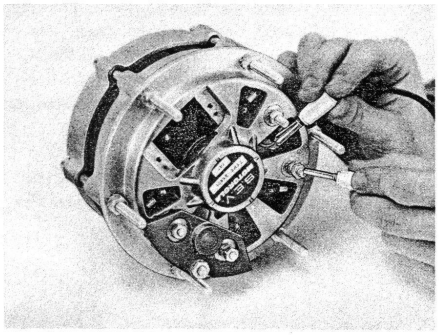


Fig. 17

b. The positive diodes are tested in the same manner. One ohmmeter probe is connected to the positive diode, and the other probe to terminal D+/61.

8. Stator Coil Test:

a. Visual Inspection:
When the stator coil develops a short circuit, a local hot spot is created in the defective area causing the insulation to burn. Such stator defects, therefore, can be readily recognized through visual inspection of the part.

b. Electrical Test:
If the alternator is hooked up in the electrical circuit, make sure that the heat sinks make no contact with each other or the stator plates. Connect one ohmmeter probe to one coil end, and the other probe to stator plates.

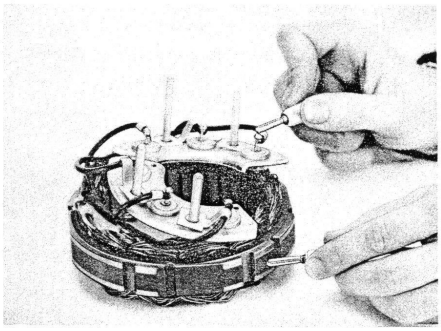


Fig. 18

In this circuit the resistance must be infinitely high. The test must be repeated at all coil ends. If improper resistance is found in any of the tests, replace the stator.

Disassembly

1. Remove alternator (see page L 8).

2. Remove brush assembly:

   a. Remove both brush assembly retaining screws.

   b. Withdraw cover plate and brush holder.

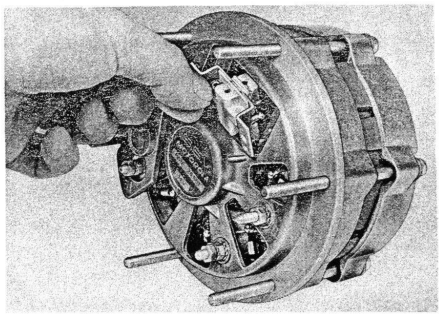


Fig. 19

3. Remove isolation diode assembly:

   a. Remove retaining nuts from both ends of diode heat sink.

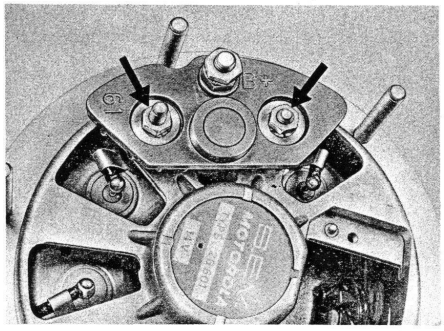


Fig. 20

   b. Remove diode assembly.

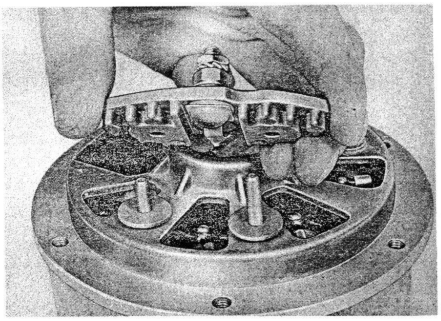


Fig. 21

4. Disassemble alternator:

   a. Remove the six nuts from alternator throughbolts.

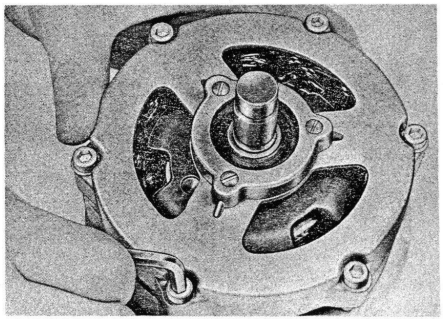


Fig. 22

b. Separate front housing with rotor from rear housing with stator.

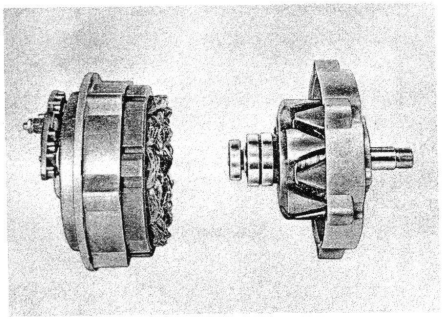


Fig. 23

c. Press rotor out of the front housing.

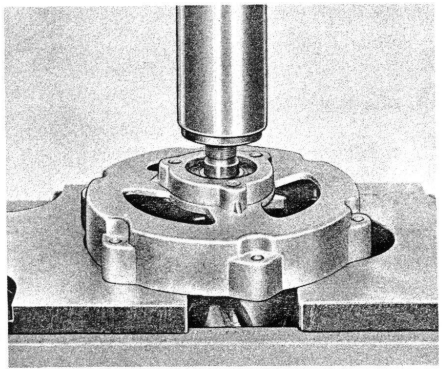


Fig. 24

d. Pull ball bearing off the rear end of the rotor shaft.

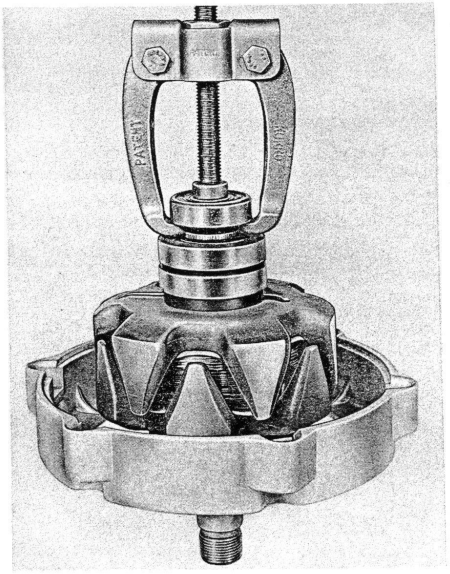


Fig. 25

e. Remove retaining screws from bearing cover in front housing.

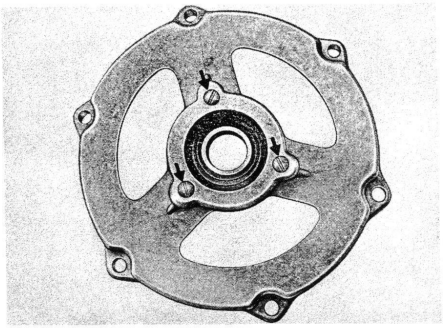


Fig. 26

f. Press ball bearing out of front housing.

5. Remove stator and diode assemblies:

   a. Remove diode assembly retaining nuts from rear housing.

   b. Withdraw stator together with diode assemblies.

   c. Mark diode leads (positive and negative diode leads).

   d. Unsolder leads from diodes. (Hold diode leads with pliers to protect diodes against damaging heat effects.)

Reassembly

Note the following points at reassembly:

1. Resolder stator leads to diodes:

   a. Note:
   Positive diodes have red markings, negative diodes have black markings. Make sure that these connections are not mixed up.

   b. Pull leads through holders and arrange properly prior to soldering so that they will not require bending into position once soldering has been completed.

   c. Protect diodes against damaging effects of heat when resoldering the stator leads to the diodes. This is accomplished through the use of pliers which act as a heat sink; that is, grasp the diode lead with the pliers when soldering. Also, use a hot soldering iron so that the solder flows quickly and the joint is fixed without loss of time.

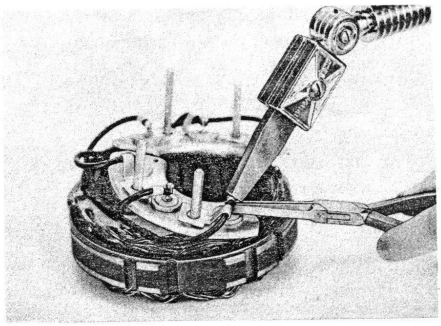


Fig. 27

2. Install stator, together with diode assemblies, in rear housing by noting the following points:

   a. Place an insulating washer and sleeve on each of the retaining bolts of the positive diode assembly.

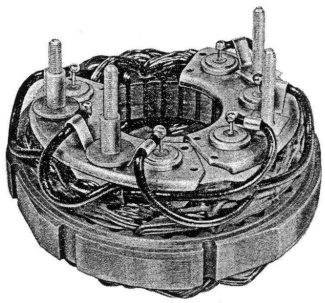


Fig. 28

b. Insert stator together with the diode assemblies into the rear housing. Place two insulating washers onto the retaining bolts of the positive diode assembly and fasten assembly. Make sure that stator leads are properly arranged.

3. Fasten rotor in front housing:

   a. Insert ball bearing in front housing, tighten bearing cover plate with three bolts, and secure bolts.

   b. Press rotor into front housing.

   c. Press other ball bearing onto rear end of rotor shaft all the way to stop.

4. Make sure during reassembly of alternator that the compensating bore in the rear housing is clear and the rubber O-ring in good condition.

   Join front housing with rotor and rear housing with stator, and evenly tighten the six through-bolts in a cross sequence.

5. Mount isolation diode assembly.

6. Mount brush assembly.

7. Install alternator (see page L 9).

ALTERNATOR TROUBLE CHART

Malfunction	Cause	Remedy
Alternator does not charge	a. Loose V-belt b. Generating circuit interrupted or shorted c. Defective voltage regulator d. Defective brushes e. Exciting current circuit interrupted f. Defective coil in rotor g. Grounded isolation diode assembly h. Defective isolation diode	a. Adjust V-belt tension b. Check connecting wires and terminals c. Replace voltage regulator d. Replace brushes e. Check wire terminals f. Replace rotor g. Check insulation of isolation diode assembly h. Replace isolation diode
Insufficient power output	a. Loose V-belt b. Poor terminal connections c. Defective voltage regulator d. Defective brushes e. Partly shorted rotor f. Defective or grounded rectifier diode g. Grounded stator	a. Adjust V-belt tension b. Check wire connections c. Replace voltage regulator d. Replace brushes e. Replace rotor f. Replace rectifier diode g. Replace stator
Excessive power output	a. Defective voltage regulator b. Poor connections between voltage regulator and alternator	a. Replace voltage regulator b. Check voltage regulator and alternator wire terminals
Noisy alternator	a. Excessively worn V-belt b. Loose V-belt pulley c. Defective ball bearing	a. Replace V-belt b. Torque V-belt pulley retaining nut to max. 4 mkp (29 ft-lb) c. Replace ball bearing

General

The Marelli S 112 AX distributor is being installed in Type 2000T (901/03) engines since the introduction of that production series.
The Marelli distributor can be easily distinguished from the Bosch distributors due to a different shape of housing and higher distributor cap.

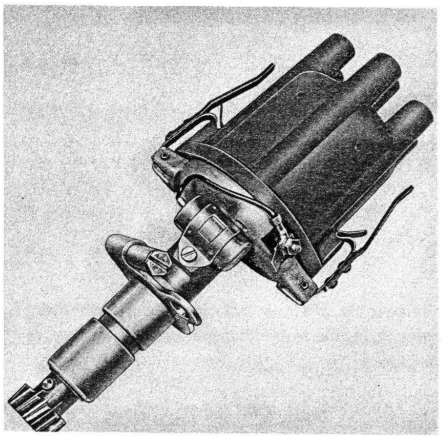


Fig. 1

The ignition advance mechanism is located above the breaker cam; it is covered by the rotor which is bolted to the cam weight base.

Adjusting Breaker Point Gap:

1. Remove distributor cap.
2. Remove retaining screws from rotor and take rotor off.

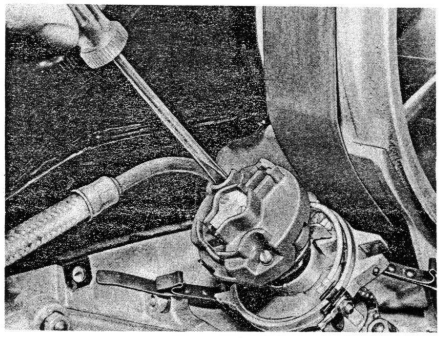


Fig. 2

3. Turn crankshaft through crankshaft pulley until a breaker cam has fully lifted the breaker arm.
4. Loosen the front retaining screw of the stationary contact plate with a screwdriver.
5. Adjust breaker point gap to 0.4 ± 0.03 mm (.016" ± .001") or dwell angle of $40^{\circ} \pm 3^{\circ}$.

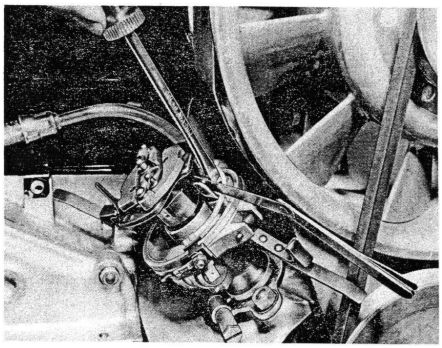


Fig. 3

6. Tighten the front retaining screw of the stationary contact plate with a screwdriver once the adjustment has been made.

Note:
Subsequent to the adjustment of the breaker point gap, always readjust the ignition timing. Changes in the breaker point gap or ignition dwell angle result in changed ignition timing.

Replacing Breaker Point Gap:

The breaker point arm and stationary plate can be replaced only as a unit since they are riveted together. It is necessary to remove the distributor when replacing the breaker point set.

1. Detach wire from terminal 1 in the distributor.
2. Remove distributor cap.
3. Remove retaining nut from clamp at the distributor base.

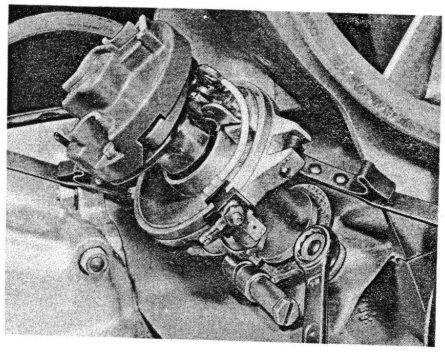


Fig. 4

4. Take distributor out.
5. Remove rotor retaining screws and take rotor off.
6. Replace breaker point set.

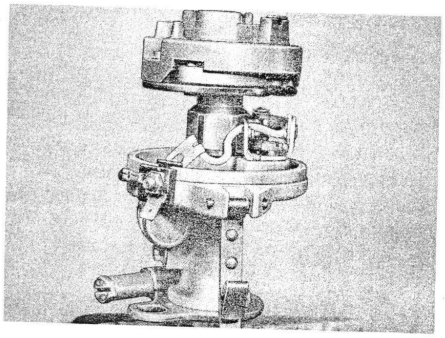


Fig. 5

7. Adjust breaker point gap or ignition dwell angle.
8. Install distributor in reversed order of the above.

Adjusting Ignition Timing:

Subsequent to the installation of the distributor, always check or readjust the ignition timing, as required.

1. Adjust breaker point gap or ignition dwell angle.
2. Accomplish basic ignition adjustment.
   The basic ignition adjustment in Type 2000T engines is made at TDC.
3. Bring engine to operating temperature.
4. Connect stroboscope according to manufacturer's instructions.
5. Allow engine to idle. Flash crankshaft pulley with the stroboscope, then increase rpm; at this time, the TDC mark (Z1) must move to left. When the 35° mark on the crankshaft pulley lines up with the mark in the blower housing while engine is running at 6000 rpm, the ignition timing is correctly set.
   This adjusting method may cause a change in the basic ignition setting; this deviation is, however, of no consequence.

Checking Distributor:

The following values apply when checking the ignition advance curve in installed distributors:

at standstill	max.	3° ATC
at 2000 rpm		15° - 19° BTC
at 3000 rpm		19° - 23° BTC
at 4000 rpm		24° - 28° BTC
at 5000 rpm		28° - 32° BTC
at 6000 rpm		35° BTC

The speed governor ignition cut-off point must be between 6400 and 6600 rpm in installed distributors.

Checking Distributor on Test Stand:

The ignition advance curve can be checked on a test stand with the aid of the ignition advance curve diagram.

When tested on the test stand, the speed governor ignition cut-off point is between 3250 and 3350 rpm, i.e., 100 rpm higher than in distributors installed in the car (less vibrations).

IGNITION ADVANCE CURVE FOR MARELLI DISTRIBUTOR

TYPE S 112 AX AND BX — FOR TYPE 2000 T AND 911 T-C ENGINES

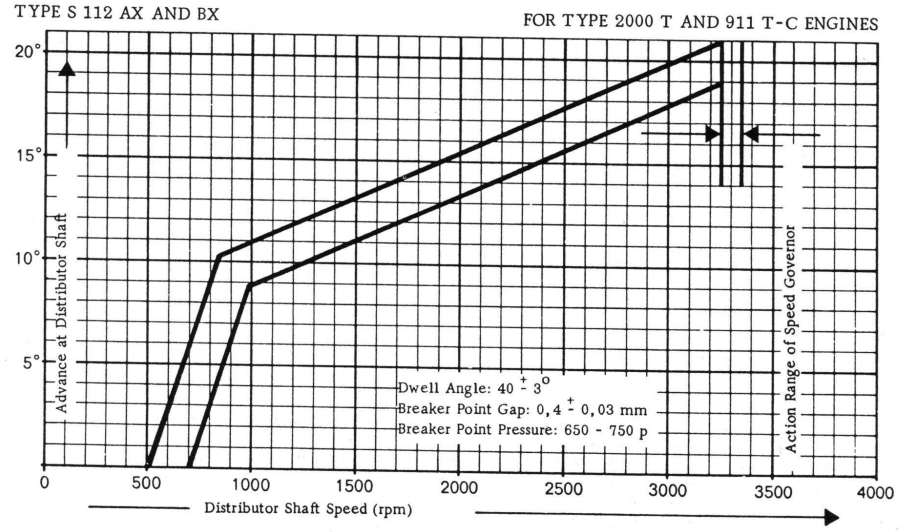


Fig. 6

ADJUSTING CURVE OF BOSCH IGNITION DISTRIBUTOR FOR 911 T

(From Model 70 on)

General

From April 1970 on, the engines of Type 911 T-C are optionally provided with Bosch ignition distributors. The firing point is set to 35° BTDC at 6000 rpm as before. This value applies for the engine under load and under no-load conditions.

Note!

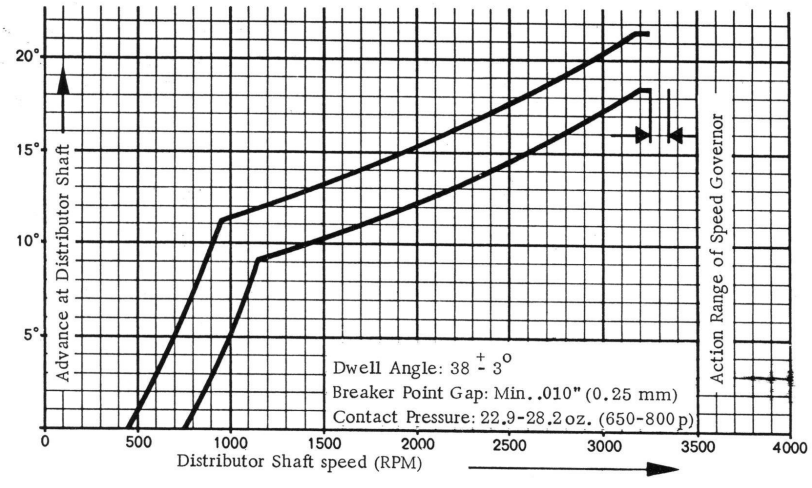
The adjusting curve of the ignition distributor may be tested on test stand with normal battery ignition only.

Test Values for Checking Adjusting Curve on Built-in Ignition Distributor

Firing point at:	6000 rpm	33° to 35° BTDC
	4600 rpm	27° to 29° BTDC
	3000 rpm	20° to 22° BTDC
Idling	900 ± 50 rpm	2° to 4° ATDC

IGNITION ADVANCE CURVE FOR BOSCH DISTRIBUTORS

TYPE 0 231 159 008 J FDR (R) FOR TYPE 911 T-C ENGINES



MODIFICATIONS TO ELECTRICAL SYSTEM FROM 69 MODEL ON

GENERAL

From the 69 model on the following modifications have been made to the electrical system of vehicle types 911 T, 911 E and 911 S.

GENERATOR

The output of the alternator is now 770 Watts.

BATTERIES

These vehicles are provided with two 12 Volt/36 Amp-hr batteries wired in parallel. The negative pole of both batteries goes to ground.

Warning:

When any work on the electrical system is done, both batteries must be disconnected. The batteries are housed in the right and left front wheel boxes and can be reached from the luggage compartment.

IGNITION

911 E and 911 S vehicles use a high tension battery/condenser ignition system developed by Bosch. The high tension ignition system is described on page SL 22.

LIGHTING

The lighting equipment has remained basically unaltered. Halogen headlights are standard equipment for export to all countries where they are allowed or demanded by law. Each headlight unit then contains an H 1 55 Watt halogen bulb for both high and low beams.

Vehicles for the USA are provided in addition with 4 side outline lights which are included in the front and rear turn indicator.

All vehicles are equipped as standard with emergency warning flashers except those intended for Italy.

The fuses are located in two fuse boxes in the front left of the luggage compartment next to the battery, and are protected by plastic covers.
The items of electrical equipment connected to each fuse are shown on the inside of the covers.

Fuse ratings

25/50 Amp. for window lifts, windshield wipers, emergency warning system
16/25 Amp. for cigarette lighter, stop light, sliding roof
8/15 Amp. for high and low headlight beams
5/ 9 Amp. for turn indicators, side lights, license plate lights

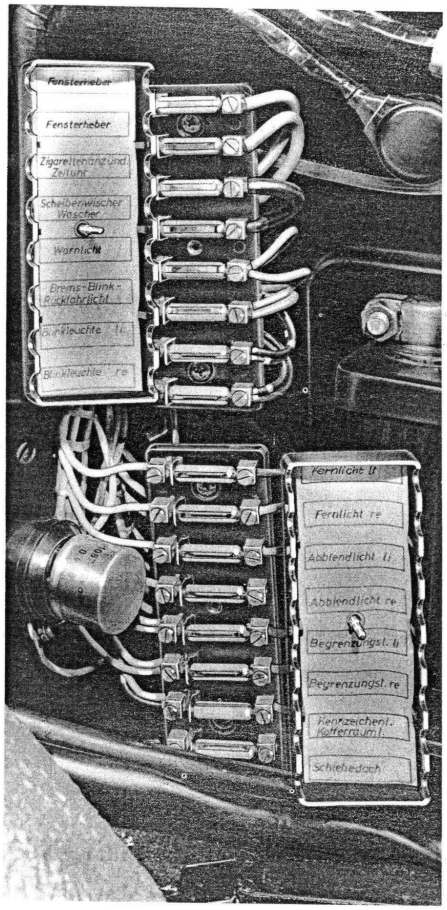


Fig. 1

SUMMARY OF BULBS
12 VOLT SYSTEM

Quantity			
4	Quartz-iodine bulbs for headlights	H 1	55 W
(2)	"Sealed-beam" headlight units (USA)		50/40 W
(2)	Double filament bulbs for headlight		45/40 W
2	Quartz-iodine bulbs for fog lights	H 3	55 W
(2)	Spherical bulbs for fog lights		35 W
4	Spherical bulbs for flashing turn indicators (Europe)		21 W
(4)	Double filament spherical bulbs for front turn indicators, stop lights and rear lights (USA)		32/4 cp
(2)	Spherical bulbs for rear flashing turn indicators (USA)		32 cp
4	Tubular bulbs for side lights and license plate lights (not USA)		4 W
(6)	Spherical bulbs for side lights and license plate lights (USA)		2 cp
2	Double filament spherical bulbs for stop and rear lights (Europe)		5 W
2	Spherical bulbs for reversing lights (Europe)		18 W
2	Spherical bulbs for reversing lights (USA)		15 cp
2	Festoon bulbs for interior light		10 W
2	Spherical bulbs for luggage compartment light		5 W
17	Indicator bulbs for instruments and telltales		2 W

IGNITION

General

Type 911 vehicles utilize a capacitive discharge (CDS) ignition system (Fig. 1).

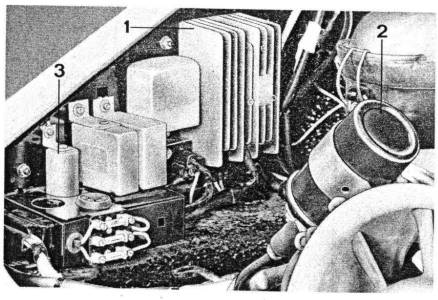


Fig. 1

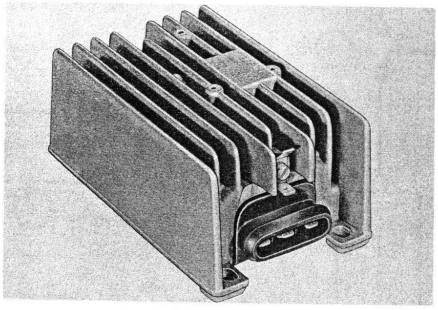


Fig. 2

1 CDS unit
2 Ignition voltage transformer
3 RPM sensor

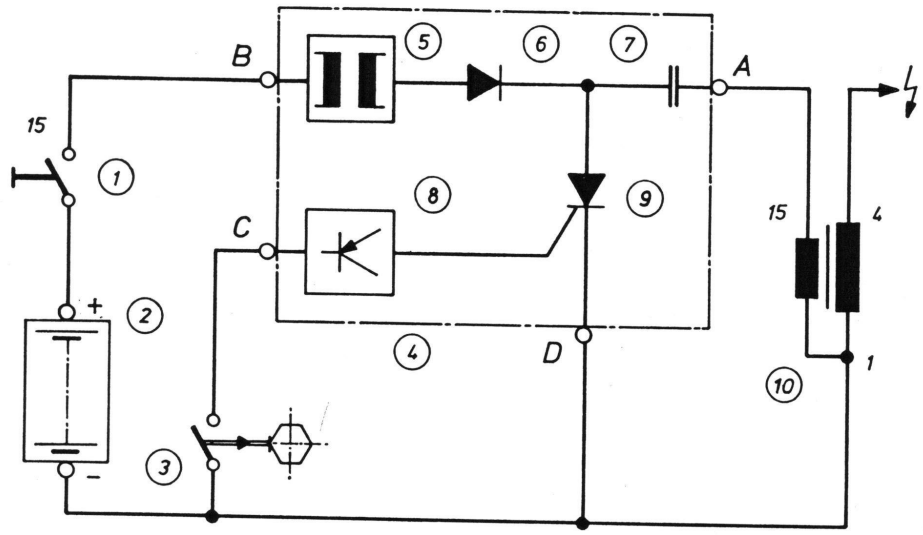
Advantages of this system, over the conventional induction coil system, are as follows:

1. Current leakage, such as through carbon or lead deposits is virtually eliminated.
2. Higher voltage available for cold starting.
3. No voltage drop at high engine speeds.
4. Practically no wear of breaker points.

The electronic components of the system are contained in the CDS unit. The light alloy housing of the CDS unit is provided with cooling fins to help dissipate heat generated by the system (Fig. 2). An ignition voltage transformer takes the place of the conventional induction coil. The transformer is similar in construction to a coil yet differs considerably. For example; resistance, voltage gain ratio and inductivity match the specific electrical characteristics of the CDS unit.

Principles of Operation

Wiring Schematic



1 Ignition switch
2 Battery
3 Breaker points
4 CDS unit
5 DC converter (amplifier)
6 Rectifier
7 Storage capacitor
8 Ignition trigger unit
9 Thyristor (load-sensitive switch)
10 Ignition voltage transformer

When the ignition is turned on, the DC converter steps up the battery voltage from 12 volts to 450 volts, charging the storage capacitor. This charging is brought about through periodic impulses at a frequency of approximately 3000 Hz; this produces a high pitch whistling sound in the DC converter.

When the breaker points open, the ignition trigger unit releases an impulse to the thyristor base. The thyristor becomes conductive. The charge in the storage capacitor then discharges through the thyristor and ignition voltage transformer. This causes a high voltage surge on the secondary side which is carried through the distributor to the spark plug. In the CDS, ignition voltage rise at the spark plug occurs much faster than in the induction coil ignition. As a result, current losses at the spark plugs are virtually eliminated.

The storage capacitor charges and discharges extremely fast, leaving sufficient time between any two firings, even at high engine speeds, to fully recharge the capacitor.

Furthermore, breaker point life is considerably increased since only very low currents are needed for controlling the thyristor. As a result, ignition timing remains in proper adjustment over a longer period of time.

Note

A thyristor is a semi-conductor which, when turned off, ceases to conduct current even in the normal direction of flow. It is not until the thyristor base receives another control impulse of a definite intensity and duration that the thyristor becomes conductive again. This condition then remains for as long as a current flows through the thyristor, even after the control impulse has lapsed. Thus the thyristor is an electronic switch responsive to extremely fast triggering action and not subject to wear.

Warning

Because of high voltage, do not touch leads of voltage transformer.

1. Shortly after removal, since it may still have a charge between terminal A and ground (This charge can not be released by grounding terminal A).
2. When operating the CDS unit without the voltage transformer on the distributor test bench.
3. When operating the CDS unit in the vehicle without the voltage transformer in cases where the storage capacitor is defective due to an inter-terminal short.

CDS Service Hints

To ensure personal safety and to prevent damage to the CDS unit observe the following when performing service operations:

1. Do not attach instruments or components such as a suppressor, test light, stroboscopic timing light etc., to terminal 15 since it carries 460 volts.

2. The ignition voltage transformer cannot be replaced with a conventional induction coil. It cannot be wired or tested as a coil.

3. Do not shut off engine by placing a jump wire or a tool between terminal 15 (ignition voltage transformer) and the ground.

4. Disconnect battery ground straps when working on CDS unit.

5. Make sure ignition is switched off before connecting or disconnecting wires. Make sure that the dust cover on terminal 15 is properly installed.

6. Batteries must be disconnected from the vehicle electrical system when being charged.

7. Do not start vehicles with the help of a battery quick charger.

8. Make sure batteries are correctly installed (batteries are maked "+" and "-").

Adjusting Breaker Points (see page L 36)

Adjust dwell to correct value at idle speed. Connect tachometer/dwell meter to terminal 1 on the distributor and ground (Fig. 3). Follow the instrument manufacturer's instructions.

Adjusting Ignition Timing (see page L 37)

Power for stroboscopic timing light can be taken only from the fuse box (Fig. 4). Refer to appropriate timing data for given engine.

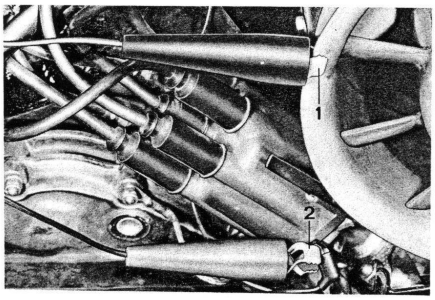


Fig. 3

1 Ground connection
2 Distributor Terminal 1

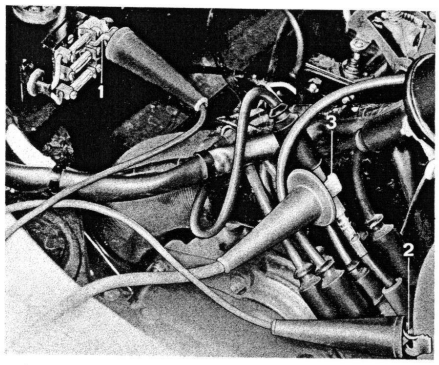


Fig. 4

1 Hot connection
2 Ground connection
3 Cylinder 1 tap

Checking Ignition System in Vehicle

1. Check breaker points and all electrical connections.

2. Switch the ignition on. The CDS unit should make a whistling sound. If no whistling sound can be heard remove the connector from the CDS unit and connect a voltmeter between terminal B (center terminal of connector) and ground. With the ignition turned on, it should be at least 11 volts. If the operating voltage is correct and the CDS unit does not make a whistling sound when connector is plugged in, the CDS unit must be replaced (see Fig. 5).

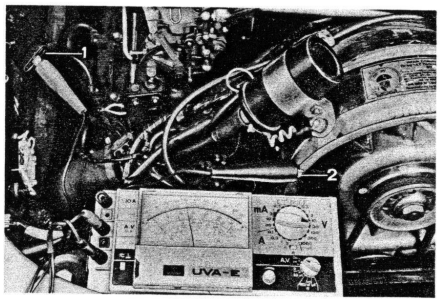


Fig. 5

1 Connector to CDS unit
2 Ground connection

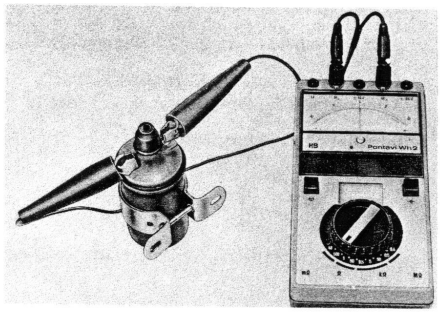


Fig. 6

3. If the whistling sound is audible, check if Terminal 4 has high voltage. To accomplish this, detach high tension lead from the ignition voltage transformer and connect a spark monitor, adjusting it to 10 mm spark gap; crank engine with starter. If there is no ignition spark or it occurs irregularly, complete tests according to Point 4 and 5.

Note

If the CDS ignition is tested without a spark monitor, it is possible that cross-arcing occurs in the secondary coil of the ignition voltage transformer.

4. The ignition voltage transformer can be tested only with an ohmmeter. Remove all connections from ignition voltage transformer. Measure the resistance in the primary coil between terminal 1 and 15. The value must be between 0.4 and 0.6 ohms. Measure the resistance in the secondary coil between terminals 1 and 4. This value should be 650 - 790 ohms (Fig. 6).

5. To check CDS unit current draw, connect an ammeter into wire 15 (from ignition switch) at the coupling. Disconnect wire at terminal 1 of the distributor to prevent a faulty reading. The CDS unit should be between 1.0 and 1.9 amps. If the current draw is not within this range, replace the CDS unit. Voltage at the unit between terminal B and ground must be at least 11 volts. This voltage can be measured by connecting an additional voltmeter between ammeter input (+ terminal) and ground.

   After completing the test, reconnect wire to terminal 1 of the distributor.

Fig. 7

1 Ammeter connections

A more extensive checkout of the CDS unit is not possible with the normally availably instruments.

6. The rpm sensor can be checked only with an ammeter. Resistance between terminal A and B must be 170 - 210 ohms, and between A and C 220 - 300 ohms.

CHANGING QUARTZ - IODINE HEADLIGHT BULBS

1. Remove the bottom Phillips head screw in the headlight rim and take out the headlight.

2. Pull away the cable from the flat pin plug of the defective bulb (high beam = lower bulb, low beam = upper bulb).
Press down the retaining clip and push it to one side.

3. Take out the bulb and insert the new bulb. Make sure that the bulb is correctly positioned.

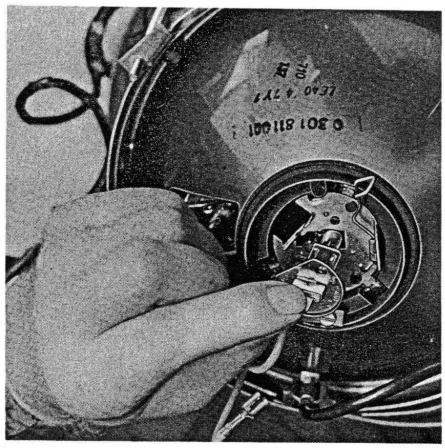


Fig. 4

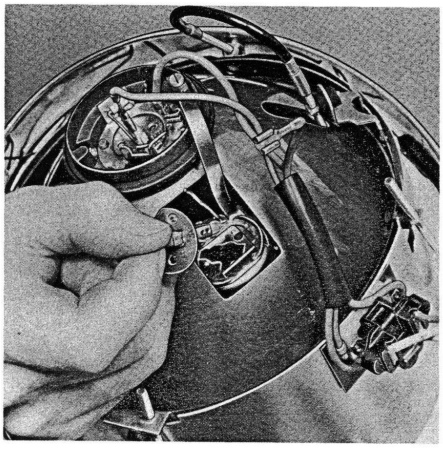


Fig. 3

Warning:
The bulb glass must be clean and free from grease. Handle bulbs only with a clean cloth or soft paper.

4. Re-attach the bulb retaining clip and push the cable back onto the flat pin plug.

5. Re-attach the headlight unit and tighten the Phillips head screws.

6. Check operation and beam setting of the headlights.

QUARTZ-IODINE HEADLIGHT LENSES - REMOVAL AND INSTALLATION

Removal

1. Take out the headlight.

2. Lift away the springs from the bezel.

3. Detach the adjusting screws for low beam (height and width) from the casing.

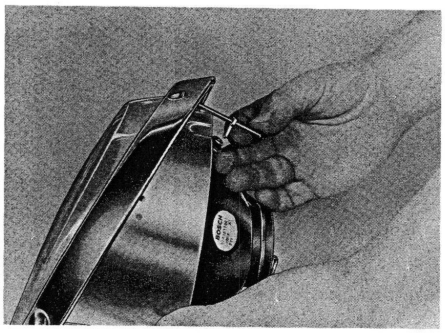


Fig. 5

4. Unscrew the adjusting screw for high beam width.

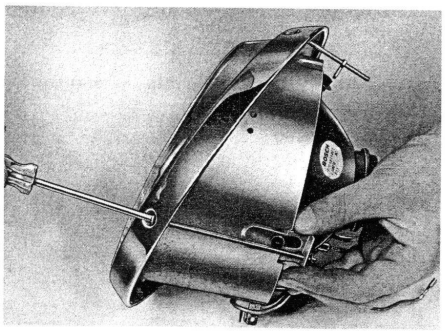


Fig. 6

5. Press the screws slightly to one side and lift off the housing.

Fig. 7

Installation

1. Take out the old lens and pull sealing ring on to new lens.

2. Align the lens to the center line of the screw hole (small mark).

3. Install the housing (to do this press the screws slightly to one side).

4. Partly screw up the adjusting screw for high beam width.

5. Secure the springs all round the lens.

Warning:
Retaining springs of various lengths are used in the headlight.
The longer retaining springs are used on the wider side of the headlight ring and the shorter springs on the narrow side. The bezel must not touch the retaining springs at the top (see picture).

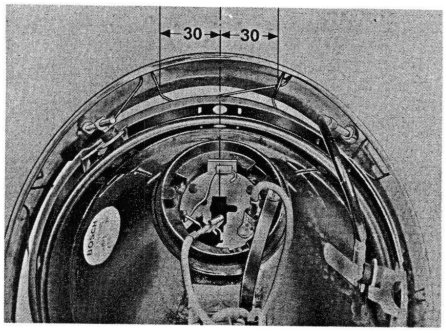


Fig. 8

6. Press in the low beam screws (long pointed screws).

7. Fully tighten the high beam width screw.

8. Install and align the headlight.

QUARTZ-IODINE HEADLIGHT BEZELS - REMOVAL AND INSTALLATION

Removal

1. Remove headlight.

2. Dismantle as described for replacing lens.

3. Core out the adjusting screw for main beam height (with flexible shaft) from its retaining rubber and the reflector hoop. Replace the bezel.

Installation

Attach the adjusting screws (main beam height) with retaining leather and reflector. Remaining assembly procedures as for replacing lens.

QUARTZ-IODINE HEADLIGHTS AND LOW BEAM - ADJUSTING

If the car is equipped with quartz-iodine headlights, the high and low beams are adjusted separately. The method of adjustment and the correct measurements and data are identical with those described under 15 LI.

The purpose of the adjusting screws is marked in each case on the headlight reflector (A = adjusting screw for low beam, F = adjusting screw for high beam).
By turning the appropriate adjusting screws clockwise or anti-clockwise, the headlight beam can be moved up and down or sideways as required.

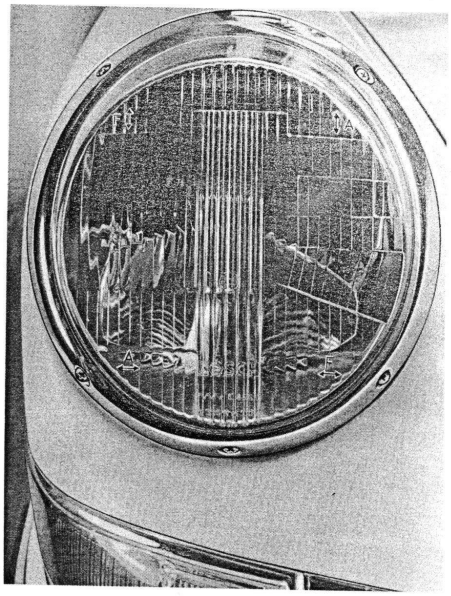


Fig. 9

TURN INDICATOR-LOW BEAM-HEADLIGHT FLASHER SWITCH OR WINDSHIELD WIPER-WASHER SWITCH - REMOVAL AND INSTALLATION

Removal

1. Disconnect batteries.

2. Remove steering wheel (see 14 ST).

3. Detach contact ring for horn.

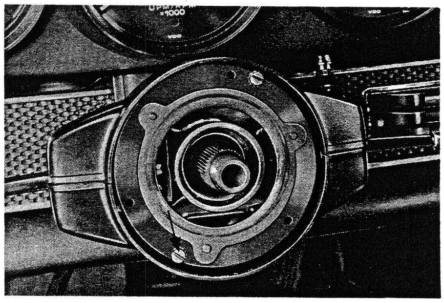


Fig. 10

4. Remove upper and lower parts of switch housing from the steering column outer tube.

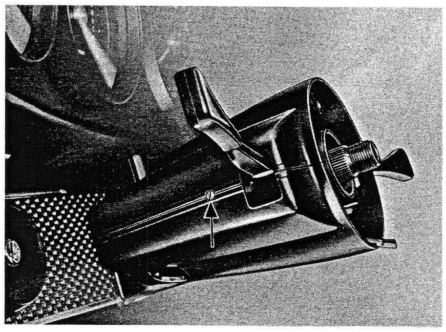


Fig. 11

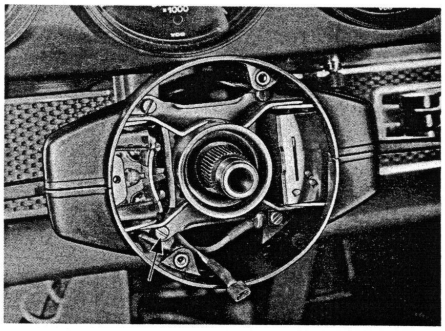


Fig. 12

5. Disconnect multi-pin plug and all other cable plugs.

6. Detach the indicator and headlight switch or wiper-washer switch as required from the steering column outer tube, and remove.

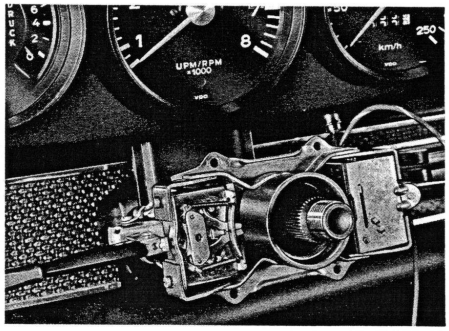


Fig. 13

Installation

When installing, the following should be noted.

Insert cable plugs at combined switch as described now:

Ignition/starter switch:

	Wiring color code
Terminal 30	red-white
Terminal 57a	grey

Light switch:

Terminal 56	yellow and white-black
Terminal 58L	grey-black
Terminal 58R	grey-red

Warning light switch:

Terminal L	black-white
Terminal R	black-green
Terminal 49a	black-white-green

LOCATION OF RELAY SWITCHES IN VEHICLE

1. Console - engine compartment, left side (Fig. 1)
2. Luggage compartment floor - left side in direction of travel (Fig. 2)
3. Luggage compartment - forward left side in direction of travel (Fig. 3)

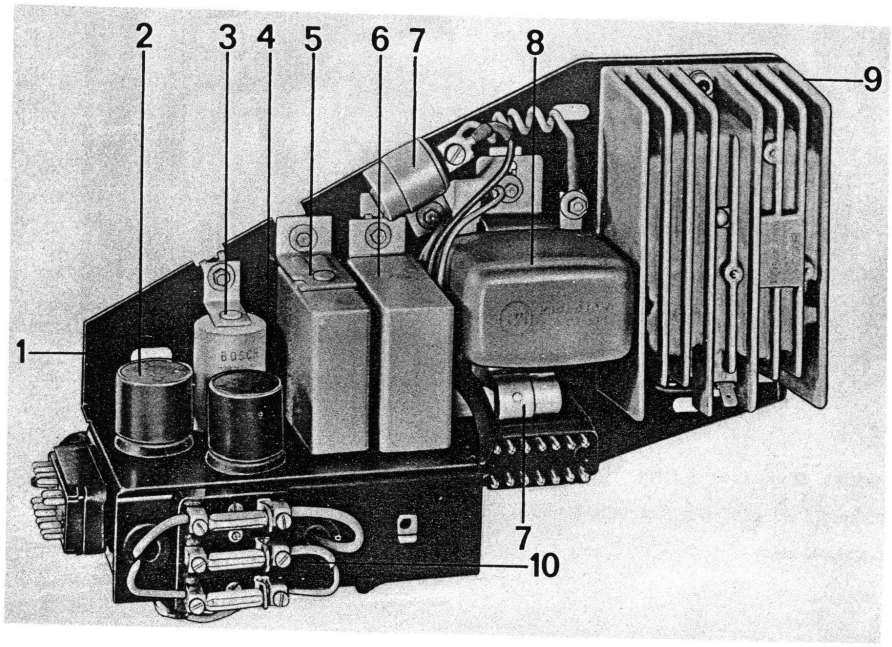


Fig. 1

1 Console

2 Relay switch for single-stage rear window defroster (not used with two-stage rear window defroster)

3 RPM sensor

4 Relay switch for start enrichment (not used in carburetor engines)

5 RPM transducer (not used in carburetor engines except 911 T USA-version)

6 Control relay for two-stage rear window defroster (not used with single-stage defroster)

7 Radio noise suppression

8 Regulator

9 Ignition trigger unit

10 Fuse box III

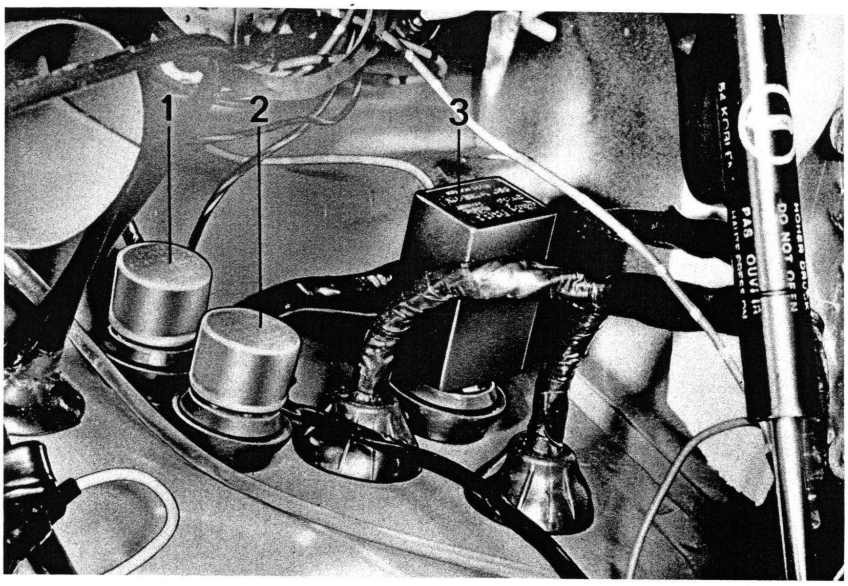


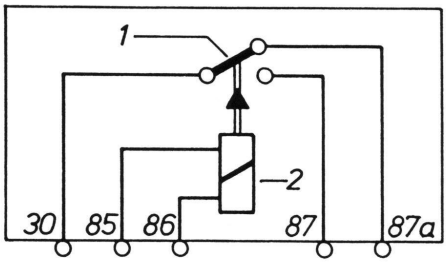
Fig. 2

1 Headlight dimmer switch relay

2 Windshield defogger relay (not valid for USA)

3 Turn signal relay

General



1 Switch contacts

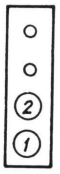
2 Coil

The relay is an electrically controlled switch. When the coil windings are energized (terminal 85 and 86) the electromagnetic force actuates the switch contacts. This interrupts the circuit from terminal 30 to terminal 87a. The circuit from terminal 30 to 87 is then completed. In this way it is possible to use low current (control current) for switching a main power circuit.

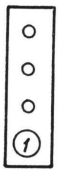
Location of standard relay switches (depending on equipment options):

Air conditioner
Auxiliary driving lights
Fog lights
Horn

Auxiliary driving lights/air conditioner
Fog lights/auxiliary driving lights
Horn



Fog lights/auxiliary driving lights/air conditioner
Horn



Horn

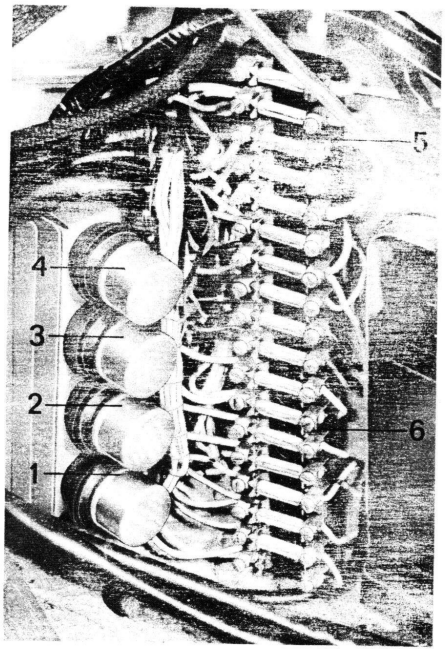
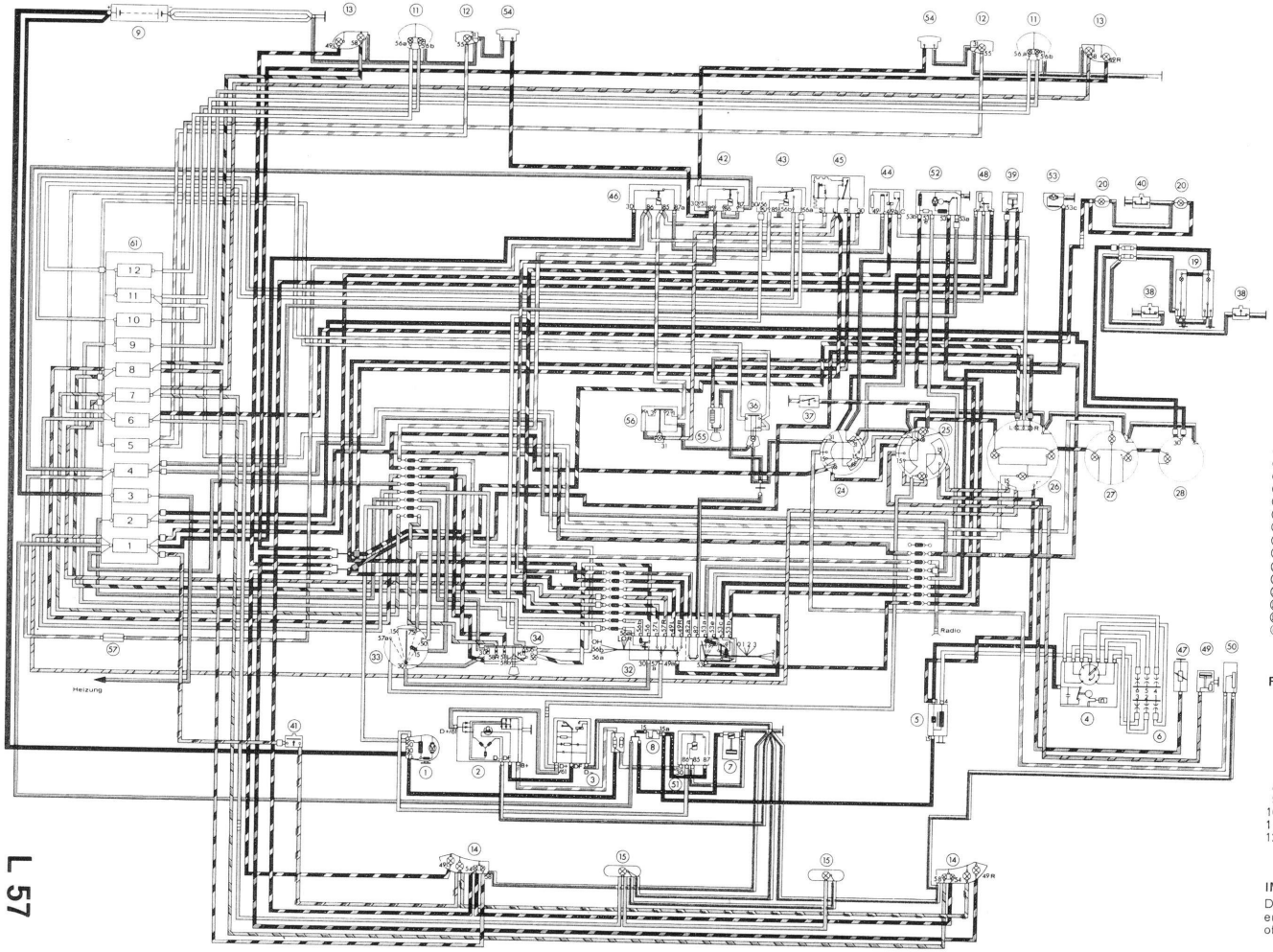


Fig. 3

1 - 4 Standard relay switches
5 Fuse box I
6 Fuse box II

Wiring Diagram Type 911



Key to wiring diagram

1. Starter motor
2. Alternator
3. Control box
4. Ignition distributor
5. Ignition coil
6. Spark plugs
7. Fuel pump
8. Resistor
9. Battery
11. Headlamps
12. Fog lamps
13. Blink/parking lights
14. Tail/stop/blink/back-up lights
15. License plate light
19. Interior light
20. Trunk light
24. Small combination instrument
25. Large combination instrument
26. Transistorized tachometer
27. Speedometer
28. Clock
32. Blink/dimmer/signal/wiper/washer switch with signal knob on steering wheel
33. Starter/ignition switch
34. Light switch
36. Fog lamp switch with control light
37. Handbrake control light switch
38. Door post contact switch
39. Brake light switch
40. Trunk light switch
41. Back-up light switch
42. Signal horn relay
43. Relay for light signal
44. Blink light unit
45. Control light unit
46. Control light relay
47. Oil temperature transmitter
48. Fuel tank unit
49. Oil pressure transmitter
50. Oil level transmitter
51. Resistor relay
52. Windshield wiper motor
53. Windshield washer pump
54. Signal horn
55. Cigarette lighter
56. Control light switch
57. Control light fuse
61. Fuse box

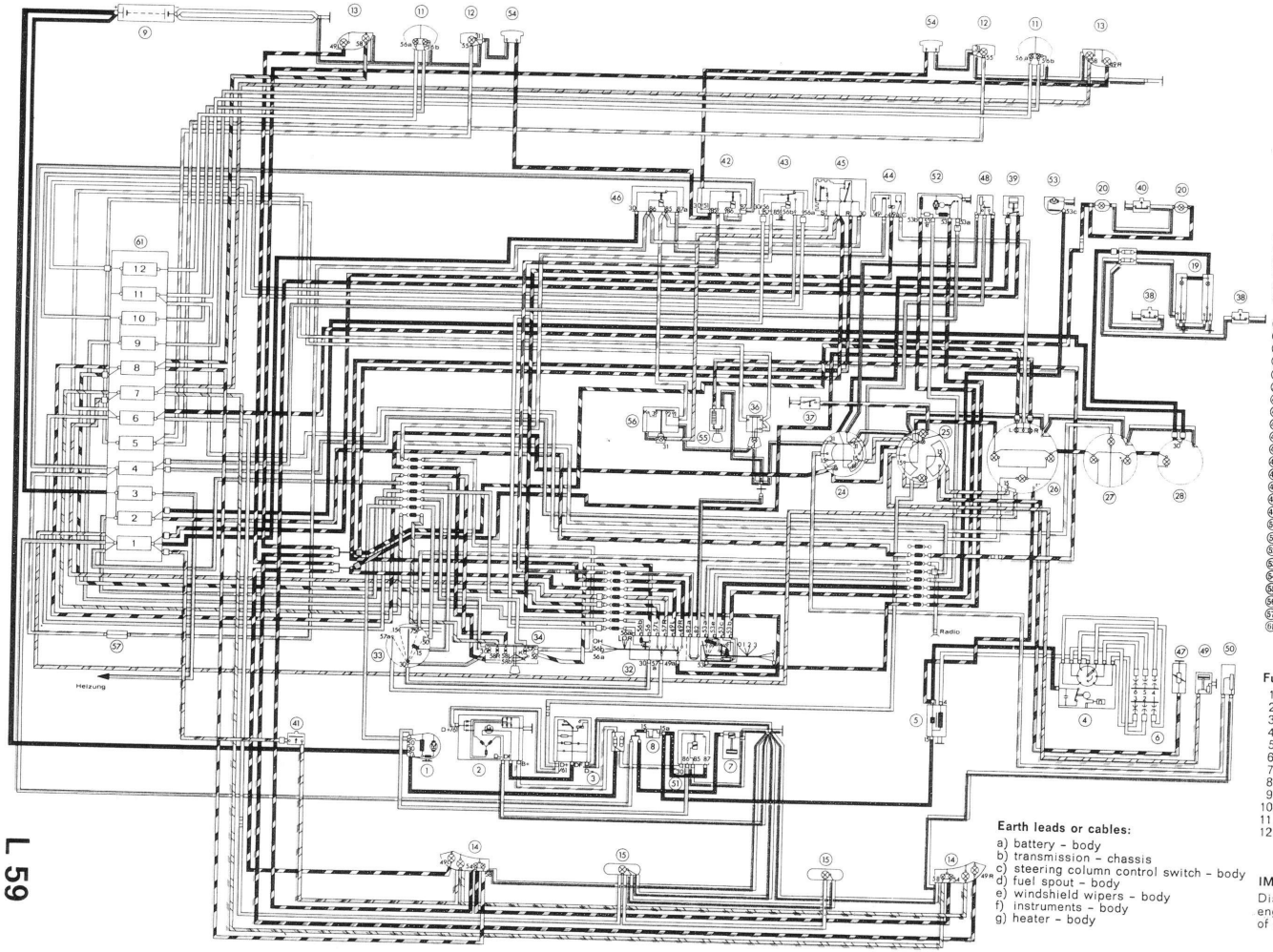
Fuses

1. Stop light, blinkers, back-up lights
2. Interior light, cigarette lighter, clock
3. Auxiliary heater
4. Windshield wipers and washer
5. Fog lamps
6. License plate light, trunk light
7. Parking light, RH
8. Parking light, LH
9. Low beam, RH
10. Low beam, LH
11. High beam, RH, high beam control light
12. High beam, LH

IMPORTANT

Disconnecting of battery with running engine results in immediate destruction of alternator.

Wiring Diagram Type 911 S



Key to wiring diagram

1. Starter motor
2. Alternator
3. Control box
4. Ignition distributor
5. Ignition coil
6. Spark plugs
7. Fuel pump
8. Resistor
9. Battery
11. Headlamps
12. Fog lamps
13. Blink/parking lights
14. Tail/stop/blink/back-up lights
15. License plate light
19. Interior light
20. Trunk light
24. Small combination instrument
25. Large combination instrument
26. Transistorized tachometer
27. Speedometer
28. Clock
32. Blink/dimmer/signal/wiper/washer switch with signal knob on steering wheel
33. Starter/ignition switch
34. Light switch
36. Fog lamp switch with control light
37. Handbrake control light switch
38. Door post contact switch
39. Brake light switch
40. Trunk light switch
41. Back-up light switch
42. Signal horn relay
43. Relay for light signal
44. Blink light unit
45. Control light unit
46. Control light relay
47. Oil temperature transmitter
48. Fuel tank unit
49. Oil pressure transmitter
50. Oil level transmitter
51. Resistor relay
52. Windshield wiper motor
53. Windshield washer pump
54. Signal horn
55. Cigarette lighter
56. Control light switch
57. Control light fuse
61. Fuse box

Fuses

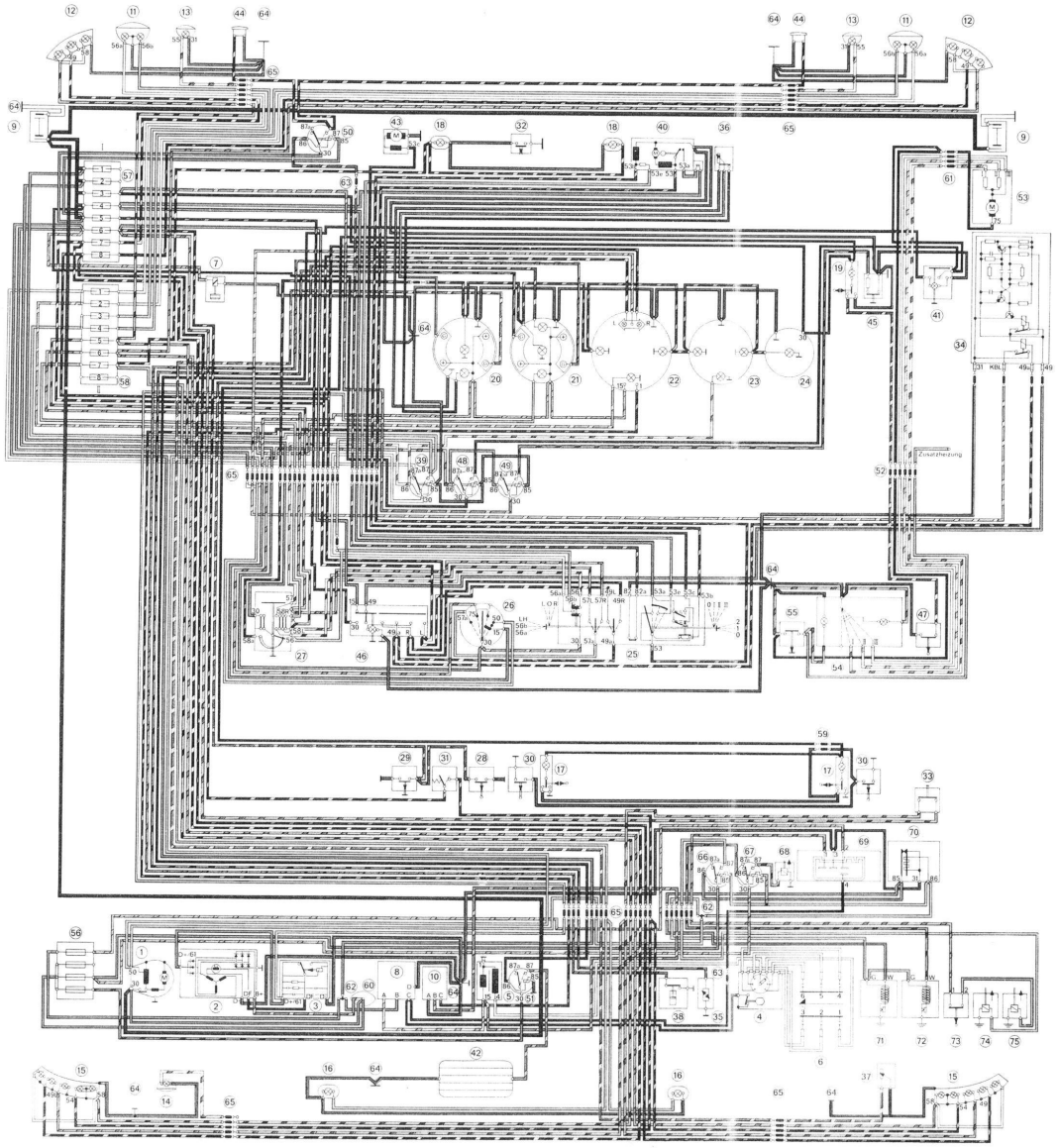
1. Stop light, blinkers, back-up lights
2. Interior light, cigarette lighter, clock
3. Auxiliary heater
4. Windshield wipers and washer
5. Fog lamps
6. License plate light, trunk light
7. Parking light, RH
8. Parking light, LH
9. Low beam, RH
10. Low beam, LH
11. High beam, RH, high beam control light
12. High beam, LH

Earth leads or cables:

a) battery - body
b) transmission - chassis
c) steering column control switch - body
d) fuel spout - body
e) windshield wipers - body
f) instruments - body
g) heater - body

IMPORTANT

Disconnecting of battery with running engine results in immediate destruction of alternator.



Wiring Diagram Type 911 E, 911 S

1 Starter
2 Generator
3 Regulator
4 Distributor
5 Ignition coil
6 Spark plugs
7 Fuel pump
8 CDS oscillator
9 Battery
10 Switching SCR
11 Headlamps
12 Blinker, parking and side marker lights (side marker USA only)
13 Fog lamps (special order)
14 Fog tail lamp (special order)
15 Tail, stop, blinker, backup and side marker lights (side marker USA only)
16 License plate lights
17 Interior light
18 Luggage compartment light
19 Glove compartment light
20 Small instrument cluster
21 Large instrument cluster
22 Transistorized tachometer
23 Speedometer
24 Electric clock
25 Blinker, dim, headlamp flasher, wiper, washer switch with horn button in steering wheel
26 Ignition/starter switch in steering column lock
27 Light switch
28 Brake failure warning switch (USA only)
29 Handbrake control lamp
30 Door contact switch
31 Stoplight switch
32 Luggage compartment light switch
33 Backup light switch
34 Blinker flasher
35 Oil temperature sender
36 Fuel gauge sender
37 Oil level sender
38 Diaphragm oil pressure sender
39 Headlamp flasher relay switch
40 Wiper motor
41 Rear window heating switch
42 Rear window heating circuit
43 Washer pump
44 Signal horn
45 Cigarette lighter
46 Emergency blinkers
47 Glove compartment light switch
48 Blower/heater relay switch
49 Cigarette lighter relay
50 Signal horn relay
51 Rear window heating relay switch
52 Multiple-pole connector
53 Blower motor
54 Blower and heater switch
55 Gasoline heater switch (special order)
56 Rear fuse box
57 Fuse box I
58 Fuse box II
59 Two-pole connector
60 Terminal bar
61 Multiple-pole connector
62 WECO-connector
63 Single-pole connector
64 Ground taps
65 Terminal connectors
66 Starting relay switch
67 Auxiliairy starting relay switch (standard)
68 Starting solenoid
69 RPM transducer
70 Time limit switch
71 Temperature switch (start)
72 Temperature switch (start assist)
73 Microswitch (throttle linkage)
74 Shut-off solenoid (start)
75 Shut-off solenoid (stop)

Fuses:

Fuse boxe I
1 (Electric window regulator)
2 (Electric window regulator)
3 Cigarette lighter, electric clock
4 Windshield wipers and washer
5 Hazard warning light
6 Stop light, blinkers backup lights
7 Blinker, LH
8 Blinker, RH

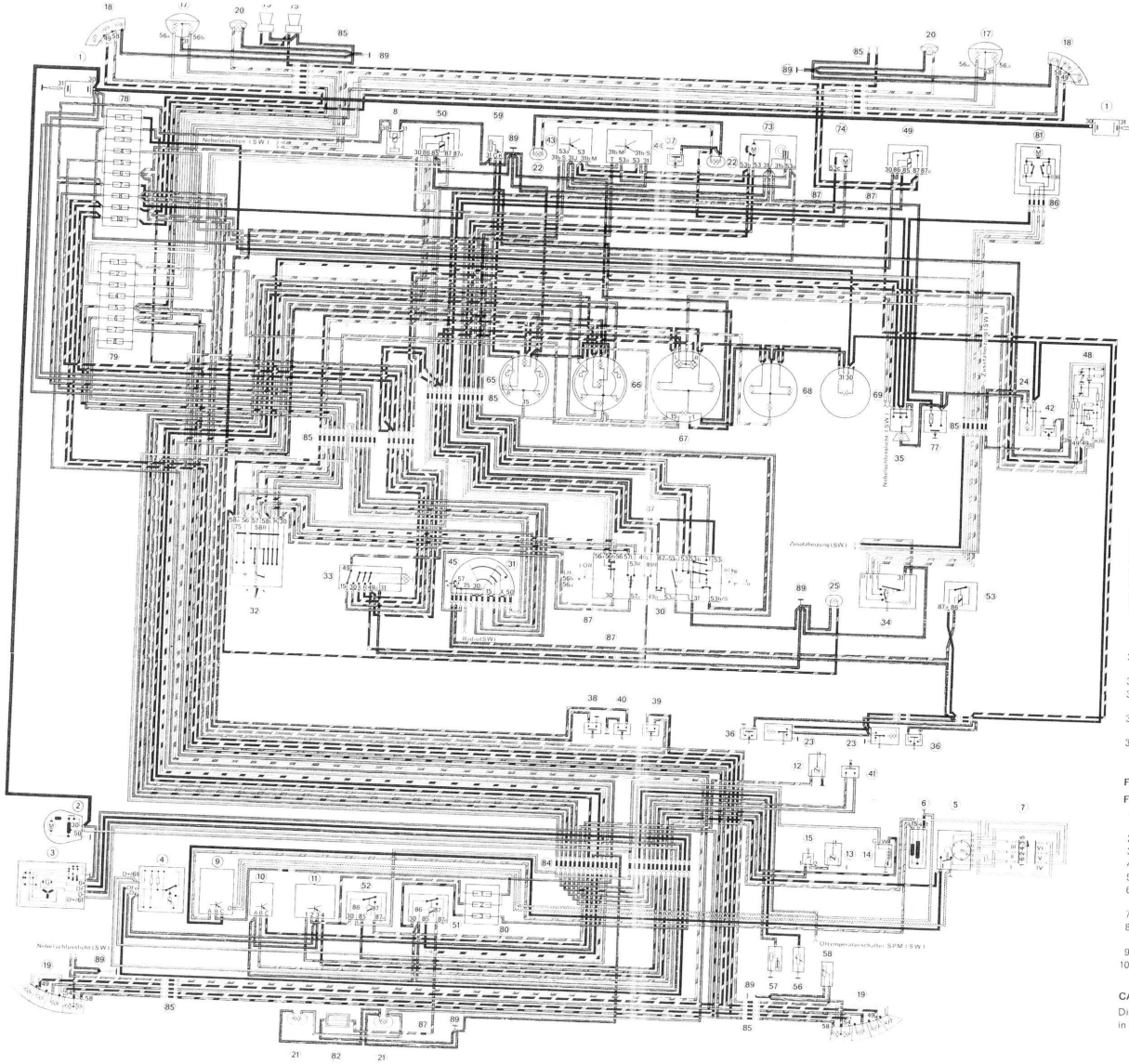
Fuse box II
1 High beam, LH
2 High beam, RH
3 Low beam, LH
4 Low beam, RH
5 Parking light, LH
6 Parking light, RH
7 License plate light, trunk light
8 (Sunroof)

Rear fuse box
Shut-off solenoid (start)
(Rear window wipers)
Shut-off solenoid (stop)
Rear window heating circuit

Earth leads or cables:
Battery-body
Transmission-chassis
Supporting plate-body
Fuel spout-body
Steering column control switch-body
Instruments-body

ATTENTION!
Disconnecting of battery with running engine results in immediate destruction of alternator.

Electric Wiring Diagram Type 911 T, 911 E, 911 S



1 Battery
2 Starter
3 Alternator
4 Governor
5 Ignition distributor
6 Ignition transformer
7 Spark plugs
8 Gasoline pump
9 BHKZ unit
10 Intermediate unit
11 Speed switch (only E and S)
12 Electromagnetic control valve
13 Lifting magnet (stop) (only E and S; on 911 T USA solenoid valve)
14 Temperature time switch
15 Microswitch (E and S only)
17 Headlamps
18 Blinker, clearance and side marker lamps (side marker lamps USA only)
19 Tail, brake, blinker, side marker and backup lamps (side marker lamps USA only)
20 Fog lamp (optional)
21 License plate lamp
22 Trunk lamp
23 Interior lamp
24 Glovebox lamp
25 Ashtray lamp
30 Blinker, dimming, headlamp flasher, wiper-washer switch with signal button in steering wheel
31 Steering ignition starter switch
32 Light switch
33 Warning light switch (not applicable in Italy)
34 Fan and separate heater switch
35 Rear window heater switch
36 Door contact switch
37 Switch for trunk room light
38 Hand brake contact
39 Brake light switch
40 Brake warning switch (USA only)
41 Backup light switch
42 Switch for glovebox ligh
43 Interval switch
44 Wiper follow-up switch
45 Buzzer contact (USA onl
48 Direction warning blinker indicator
49 Horn relay
50 Headlight flasher changeover relay
51 Rear window heater relay
52 Auxiliary starting relay
53 Buzzer (USA only)
56 Oil temperature indicator
57 Oil pressure indicator
58 Oil level indicator
59 Indicator for fuel gauge
65 Small combination instrument
66 Large combination instrument
67 Transistor revolution counter
68 Speedometer
69 Electric time clock
73 Wiper motor
74 Washer pump
75 Fanfare horn
77 Cigarette lighter
78 Fuse box I 10-pole
79 Fuse box II 8-pole
80 Fuse box III 3-pole
81 Fan motor
82 Heated pane
84 Plug connection 14-pole
85 Plug-connection 6-pole
86 Plug-connection 4-pole
87 Plug-connection 1-pole
89 Ground connection – body

FUSES:

Fusebox I

1 Interior light, time clock, trunk light
2 Warning light
3 (Window lifter)
4 Cigarette lighter
5 (Slide roof)
6 Windshield wiper, washer pump
7 Fresh air fan
8 Brake, blinker, backup lights
9 Blinker light front left
10 Blinker light front right

Fusebox II

1 High beam left
2 High beam right
3 Dimmer left
4 Dimmer right
5 Clearance light left
6 Clearance light right
7 License plate light
8 (Fog lights)

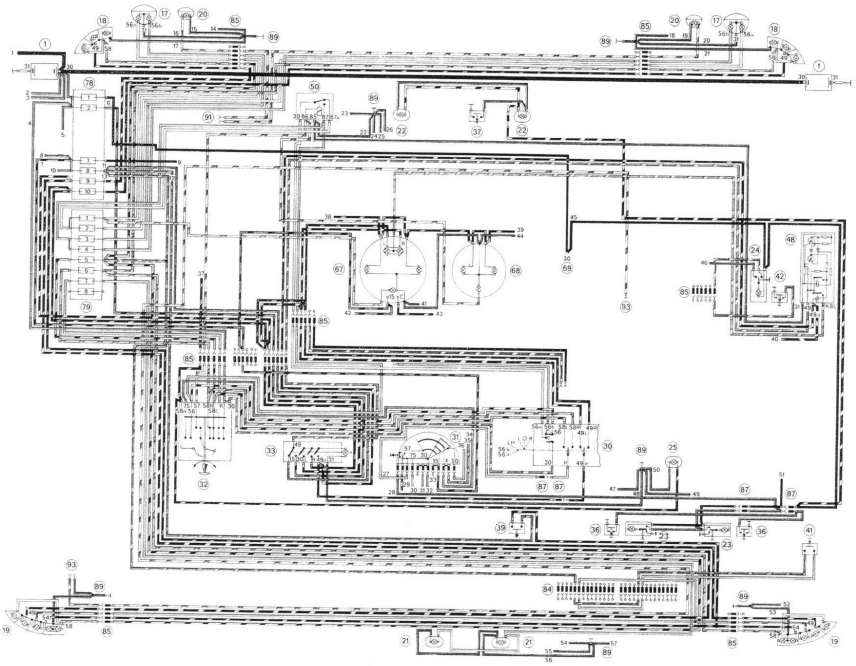
Fusebox III

1 (Sportomatic)
2 Stop magnet, solenoid valve, starting valve
3 Rear window heater

CAUTION!

Disconnection of battery with the engine running will result in immediate destruction of alternator.

Electric wiring diagram (Part I) Type 911 T, 911 E, 911 S, Model 71



1 Battery
17 Headlamps
18 Blinker, clearance and side marker lamps (side marker lamps USA only)
19 Tail, brake,blinker, side marker and backup lamps (side marker lamps USA only)
20 Fog lamps (optional)
21 License plate lamp
22 Trunk lamp
23 Interior lamp
24 Glovebox lamp
25 Ashtray lamp
30 Blinker, dimming, headlamp flasher, wiper-washer switch with signal button in steering wheel
31 Steering ignition starter switch
32 Light switch
33 Warning light switch (not applicable in Italy)
36 Door contact switch
37 Switch for trunk room light
39 Brake light switch
41 Backup light switch
42 Switch for glovebox light
48 Direction warning blinker indicator
50 Headlight flasher changeover relay
67 Transistor revolution counter
68 Speedometer
69 Electric time clock
78 Fuse box I 10-pole
79 Fuse box II 8-pole
84 Plug connection 14-pole
85 Plug connection 6-pole
87 Plug connection 1-pole
89 Ground connection - body
91 Switch for fog lamps (optional)
93 Fog tail light (optional)

FUSES:

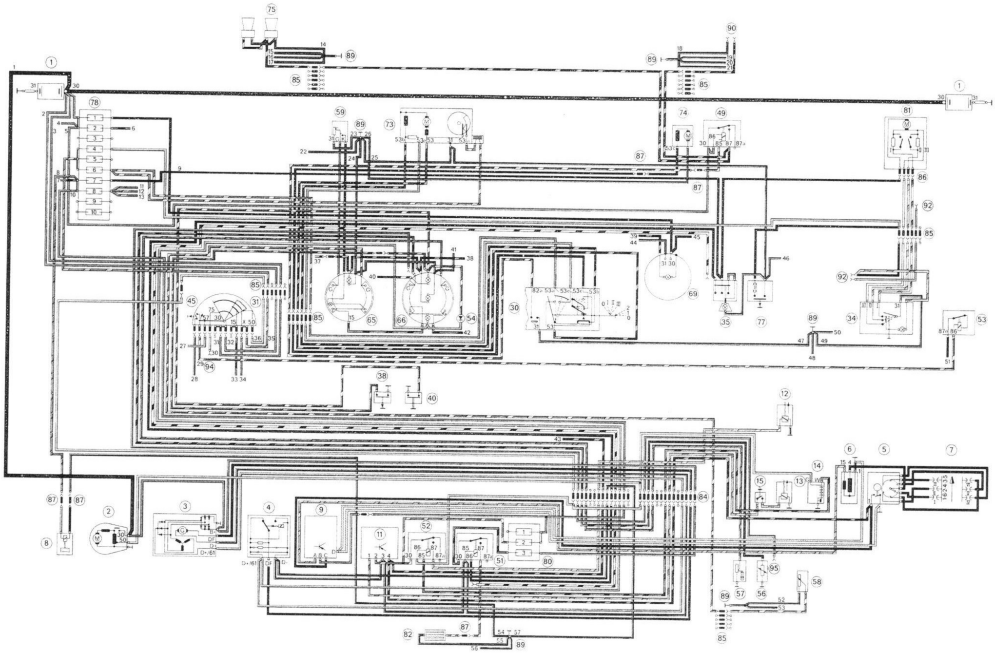
Fusebox I:
1 Interior light, time clock, trunk light
2 Warning light
7 Fresh air fan
8 Brake, blinker, backup lights
9 Blinker light front left
10 Blinker light front right

Fusebox II:
1 High beam left
2 High beam right
3 Dimmer left
4 Dimmer right
5 Clearance light left
6 Clearance light right
7 License plate light
8 (Fog lights)

CAUTION!

Disconnection of battery with the engine running will result in immediate destruction of alternator.

Electric wiring diagram (Part II) Type 911 T, 911 E, 911 S, Model 71



1 Battery
2 Starter
3 Alternator
4 Governor
5 Ignition distributor
6 Ignition transformer
7 Spark plugs
8 Gasoline pump
9 BHKZ unit
11 Speed switch (E, S and 911 T USA only)
12 Electromagnetic control valve (E and S only)
13 Lifting magnet (stop) (E and S only; on 911 T USA solenoid valve)
14 Temperature time switch
15 Microswitch (E, S and 911 T USA only)
30 Blinker, dimming, headlamp flasher, wiper-washer switch with signal button in steering wheel
31 Steering ignition starter switch
34 Fan and separate heater switch
35 Rear window heater switch
38 Hand brake contact
40 Brake warning switch (USA only)
45 Buzzer contact (USA only)
49 Horn relay
51 Rear window heater relay
52 Auxiliary starting relay (E and S only)
53 Buzzer (USA only)
54 Diode (USA only or optional)
56 Oil temperature indicator
57 Oil pressure indicator
58 Oil level indicator
59 Indicator for fuel gauge
65 Small combination instrument
66 Large combination instrument
69 Electric time clock
73 Wiper motor
74 Washer pump
75 Fanfare horn
77 Cigarette lighter
78 Fuse box I 10-pole
80 Fuse box III 3-pole
81 Fan motor
82 Heated pane
84 Plug connection 14-pole
85 Plug connection 6-pole
86 Plug connection 4-pole
87 Plug connection 1-pole
89 Ground connection – body
90 Extra fanfare horn (optional)
92 Separate heater (optional)
94 Radio (optional)
95 Oil temperature switch for SPM (optional)

FUSES:

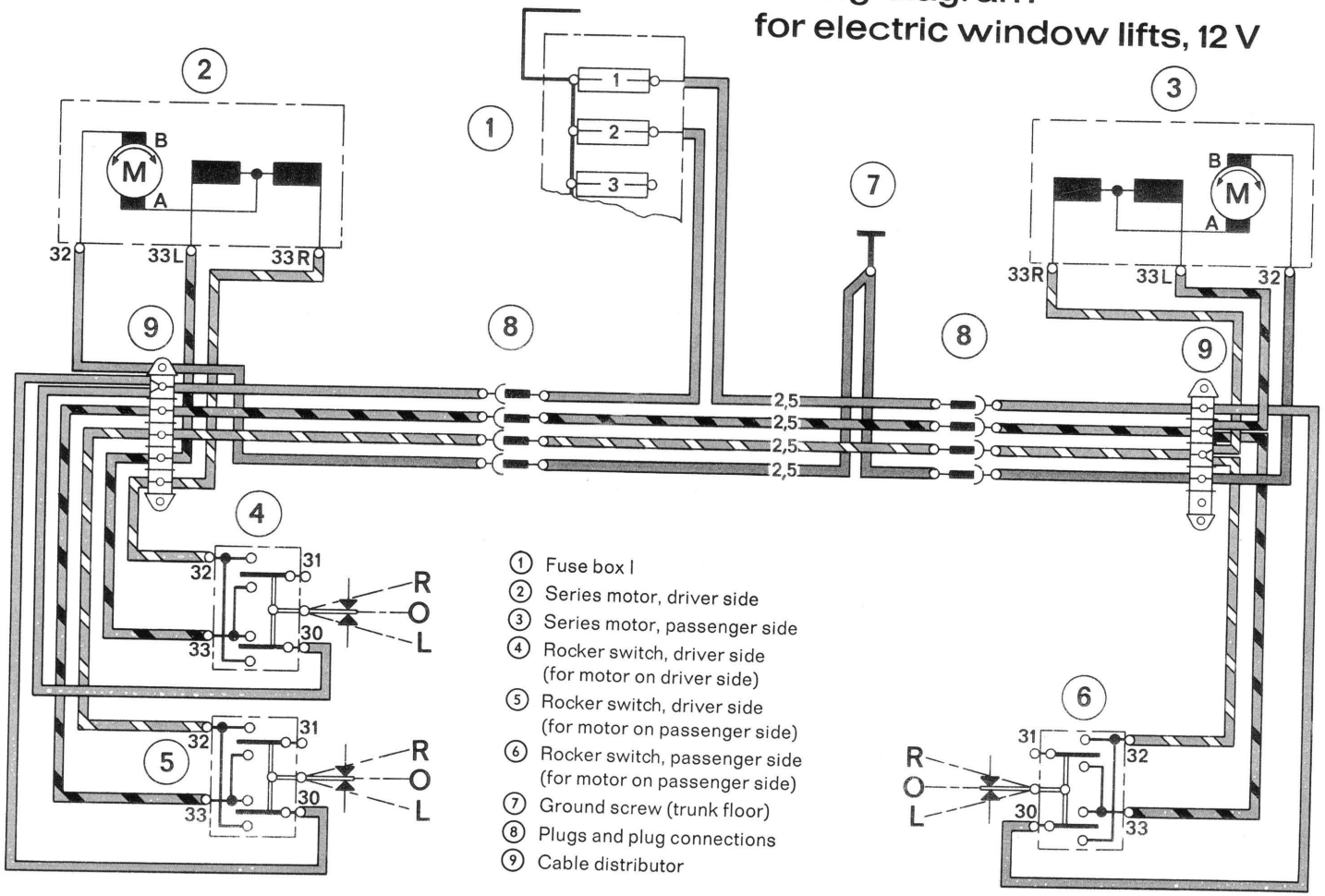
Fusebox I:
1 Interior light, time clock, trunk light
2 Warning light
3 (Window lifter)
4 Cigarette lighter
5 (Slide roof)
6 Windshield wiper, washer pump
7 Fresh air fan
8 Brake, blinker, backup lights
9 Blinker light front left
10 Blinker light front right

Fusebox II:
1 (Sportomatic)
2 Stop magnet, solenoid valve, starting valve
3 Rear window heater

CAUTION!

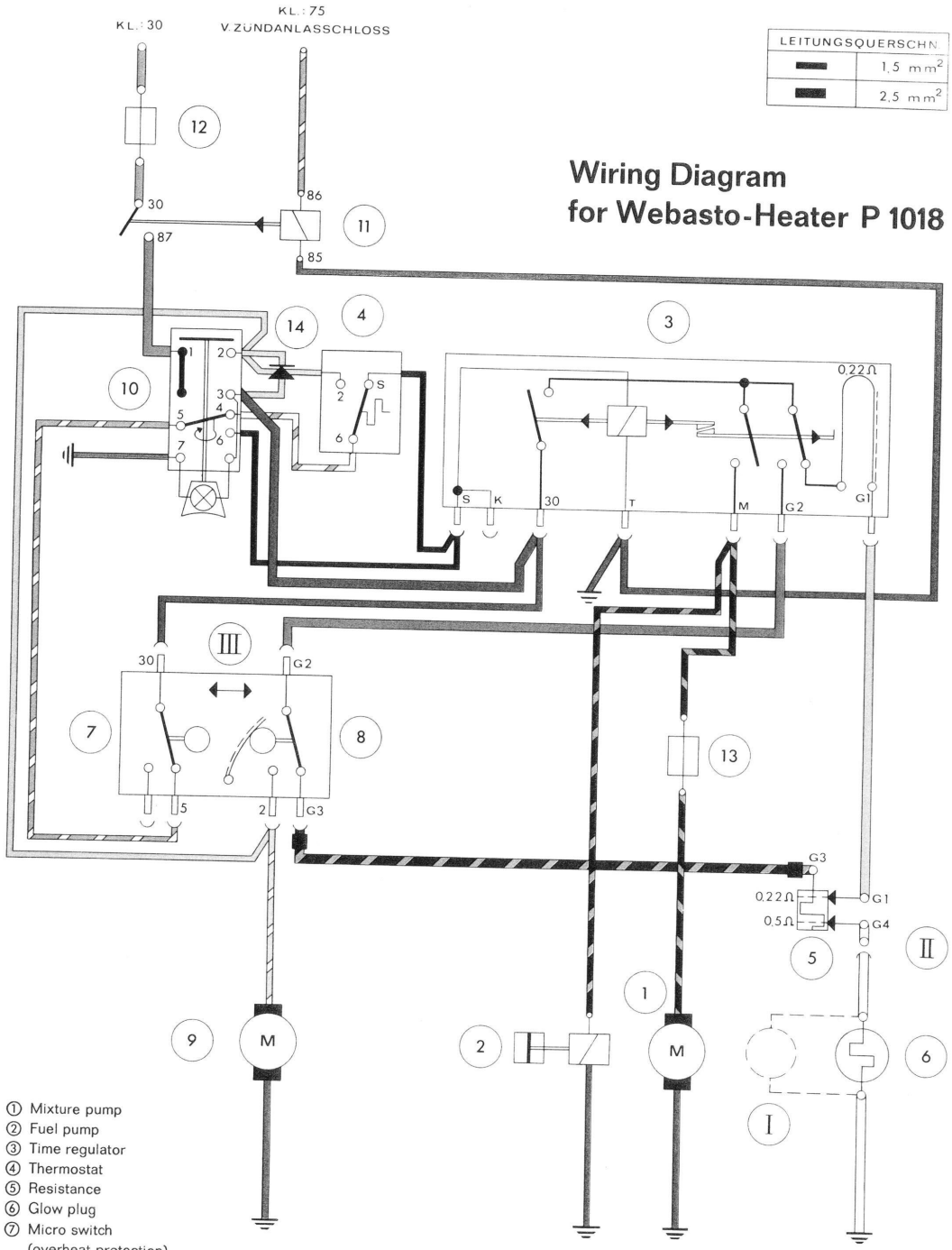
Disconnection of battery with the engine running will result in immediate destruction of alternator.

Wiring diagram for electric window lifts, 12 V



1. Fuse box I
2. Series motor, driver side
3. Series motor, passenger side
4. Rocker switch, driver side (for motor on driver side)
5. Rocker switch, driver side (for motor on passenger side)
6. Rocker switch, passenger side (for motor on passenger side)
7. Ground screw (trunk floor)
8. Plugs and plug connections
9. Cable distributor

Wiring Diagram for Webasto-Heater P 1018



① Mixture pump
② Fuel pump
③ Time regulator
④ Thermostat
⑤ Resistance
⑥ Glow plug
⑦ Micro switch (overheat protection)
⑧ Micro switch (glow plug control switch)
⑨ Blower motor
⑩ Control switch
⑪ Main contact relay
⑫ Fuse 3 25 A
⑬ Fuse 6 A quick
⑭ Blocking diode

(I) Check the glow plug voltage when mounting the heater resp. before the first operation of the heater. The voltage must be between 3,8 and 4,5 volts. This measurement can best be done at charged battery or at approx. 3000 R.P.M.

(II) Two different values of resistance! Mind proper cable colours when connecting (G1 yellow, G3 black-red). The ohm values are shown on the resistances.

(III) Wiring diagram stated on the inside of the cover.