

12 Engine Electrical Equipment

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320 i A

320 i

<u>Starter:</u>	Solenoid starter
Make	Bosch
Bosch No.	0 001 311 045
Type	GF (R) 12 V 1.0 HP (0.73 kW)
Direction of rotation	right
Max. speed	1300 rpm
No. of pinion teeth	9
Operating voltage	6 ... 12 V
Testing voltage	13 ± 0.26 V
Testing temperature	+ 20 (+ 68) °C (°F)
Max. efficiency	0.96 (1.3) kW (HP)
at current	210 A
at voltage	9.6 V
Max. torque	17.5 / 1.75 (13) Nm/kpm (ft lbs)
at current	380 A
at voltage	7.7 V
Max. short circuit current	380 A
at battery	56 1/2 charged Ah
<u>Solenoid</u>	
Current requirement of solenoid	
Engaging and holding winding	A 35
Holding winding	A 6

Model 320 i

320 i A

Alternator with Built-in Voltage Regulator

Make	Bosch
Bosch No.	0 120 489 608
Model	Bosch K 1 - 14 V alternator with vibration-proof mounting
Alternator voltage	14 V 55 A
Max. current	14
Max. efficiency	55
Charging begins at	770
2/3 current strength at	1000
Max. current strength at	2000
V-belt	6000
	9.5 x 850 (0.374 x 33.500) LA DIN 7753

Regulator

Make	Bosch
Bosch No.	0 192 052 004
Adjusting voltage	14.1 ± 0.2
Max. exciting current	4

Ignition Coil

Make	Bosch
Bosch No.	0 221 119 017 ¹⁾
Type	KW 12 V

1) Coil only in conjunction with series resistance of 0.9 ± 0.05 ohms.

Engine Electrical EquipmentSPECIFICATIONS

Model 320 i 320 i A

Continuation of Ignition Coil

Color of data plate Plate: red
Lettering: black

Mean watt consumption at 1000 rpm 20

Max. spark rate at 6 mm (0.24 in.) spark length 18,000

Starting spark length at 300 sparks/min. and 6 V 10 (0.394)

Operating spark length at 3600 sparks/minute 16 (0.630)

Spark Plugs

Threads M 14 x 1.25

Make Bosch
or

Type W 145 T 30

Electrode gap 0.6 ± 0.1 (0.024 + 0.004)

Distributor

Make Bosch

Type JFUD 4

Bosch No. 0 231 170 214

Vacuum control retarded

Contact breaker gap = 0.35 (0.014) static

Contact spring force = 5 ... 6.3/0.5 ... 0.63 (1.1 ... 1.4)

Dwell angle 0
59 ... 65
66 ... 72

Firing order

1 - 3 - 4 - 2 (cylinder number 1 - notch on distributor housing)

320 i

320 i A

Model

Distributor Rotor

Resistance of distributor rotor kOhm 5

Capacitor

Capacitance of capacitor uF 0.18 ... 0.22

Insulation resistance of capacitor ohm 200,000

Series resistance of capacitor ohm 0.01

Ignition Timing

Static ignition timing ¹⁾

- on cold engine -

3° BTDC

Dynamic ignition timing ²⁾ without vacuum ignition control on engine at operating temperature, both hoses disconnected

0° Crk. 25° BTDC at 2200 rpm (25° BTDC at 2400 rpm) ³⁾

Ignition Control

0° Crk.

For measurement with control angle tester without vacuum ignition control on engine at operating temperature. Stroboscope lamp must be aimed at TDC mark.

1000 rpm

1500 rpm

2000 rpm

2500 rpm

3000 rpm

4000 rpm

¹⁾

10° ... 15°

15° ... 24°

20° ... 27°

25° ... 31°

31° ... 38° (end)

1) This is only a reference value. Ignition timing adjustments must be dynamic.

2) Aim stroboscope at ball mark on flywheel (automatics: TDC = short pin, ignition timing = long pin).

3) California version.

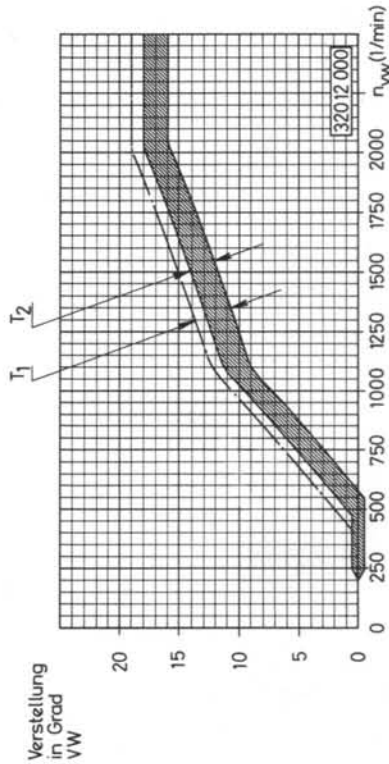
Engine Electrical Equipment

SPECIFICATIONS

Model	320 i	320 i A
Vacuum ignition control	Begins Torr	70 ... 100
	Ends Torr	170 ... 210
Control range	° Crk.	16

Centrifugal Ignition Control Curve

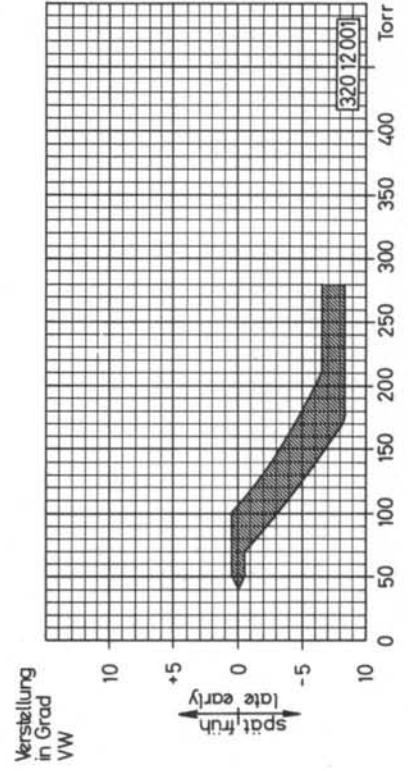
For measurements on distributor test bench:



Distributor Bosch No. 0 231 170 214

Control in degrees on distributor shaft
 Distributor shaft rpm
 T₁ = Tolerance range for run distributor
 T₂ = Tolerance range for new distributor
 VW = Distributor shaft

Vacuum Ignition Control Curve



Distributor Bosch No. 0 231 170 214

Control in degrees on distr. shaft
 Vacuum in Torr
 VW = Distributor shaft

Model

320 i

320 i A

Special Equipment

- Radio Shielding -

Shielded Capacitor for Alternator

	320 i	320 i A
Make	Bosch	Bremicker
Serial No.	0 290 800 036	4066
Testing voltage	150 V	200 ± 20 %
Capacitance	2.2 ± 20 % uF	2.2 ± 20 %

Shielded Capacitor for Ignition Coil

	320 i	320 i A
Make	Bosch	Bremicker
Serial No.	-	4074
Testing voltage	150 V	200 ± 20 %
Capacitance	2.2 ± 20 % uF	2.2 ± 20 %

Shielded Cap for Distributor

	320 i	320 i A
Make	Beru	Bremicker
Serial No.	0 310 920 031	10 284 C

Shielded Filter for Shielded Cap

	320 i	320 i A
Make	Beru	Bremicker
Serial No.	0 310 600 033	4085 C

Torque Specifications in Nm / kpm (ft. lbs.)

Alternator / pulley	35 ... 45 / 3.5 ... 4.5 (25 ... 32)	Spark plugs	25 ... 30 / 2.5 ... 3.0 (18 ... 21)
Temperature sensor	20 ... 25 / 2.0 ... 2.5 (14 ... 18)	Oil pressure switch	30 ... 35 / 3.0 ... 3.5 (21 ... 25)
Starter mounting screws	43 ... 48 / 4.3 ... 4.8 (31 ... 35)		

12 11 004 ADJUSTING IGNITION TIMING

A) Dwell Angle

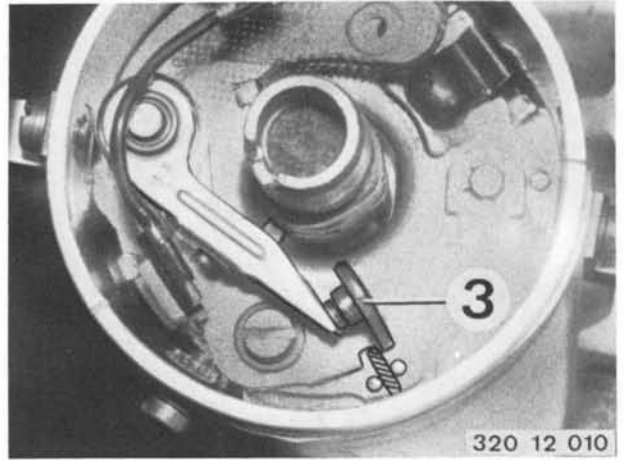
Exact ignition timing adjustments require that the contact breaker points be perfect and the dwell angle set correctly.

Remove distributor cap.

Connect dwell angle tester.

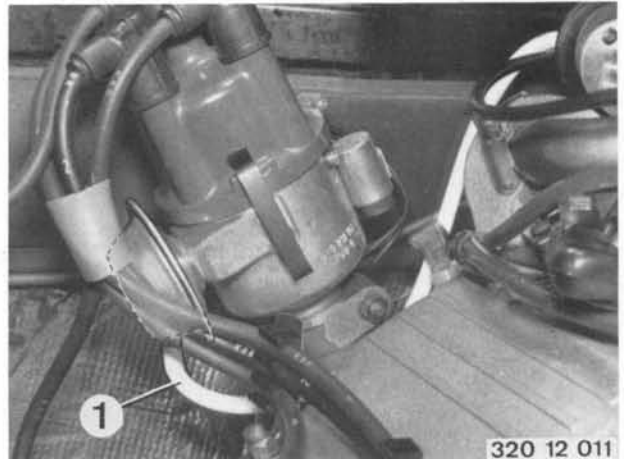
Start engine with starter.

By turning contact plate (3) set dwell angle to smallest value (59° ... 65°).



B) Ignition Timing

Detach vacuum hose (1) for retarded ignition control. Connect program tester - 11 00 005.



Turn off control angle gauge with thumbwheel (2).

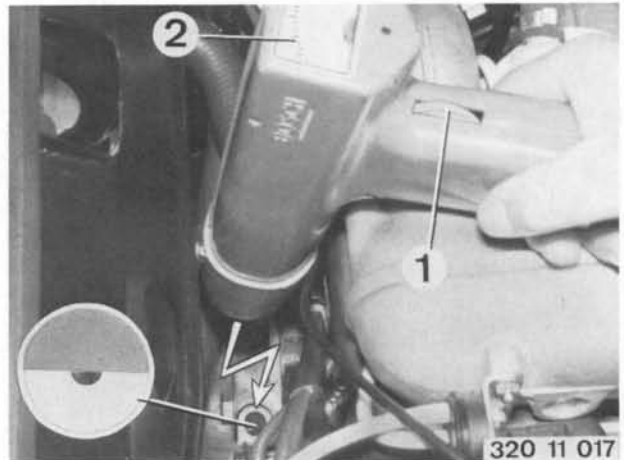
Aim stroboscope lamp at ball mark on flywheel.

Increase engine speed.

- 2200 rpm for 49 State Version

- 2400 rpm for California Version

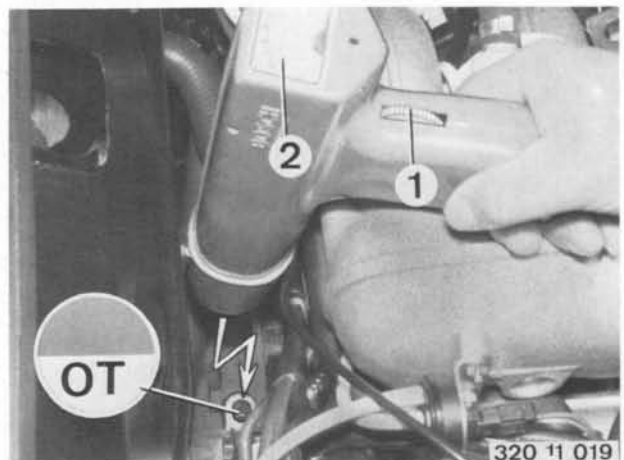
Loosen distributor and turn until centerline of ball is visible at edge of inspection hole.



Also check vacuum retarded ignition control.

Connect vacuum hose (1).

At about 1000 rpm TDC mark must be visible in inspection hole.



12 11 060 REMOVING AND INSTALLING DISTRIBUTOR

Remove distributor cap.
Remove dust cap.
Disconnect wire at terminal 1.
Set piston of cylinder 1 at TDC, i.e. notch in distributor arm aligns with notch in distributor housing.
Loosen clamping screw. Pull out distributor.

Installation Note! Turn distributor rotor counter-clockwise from notch in distributor housing by about 3.5 cm (1.378 in.) (A).
Guide distributor drive into camshaft drive.

Adjust ignition timing - 12 11 004.

TDC position of piston:
Indicator point aligned with notch in pulley.

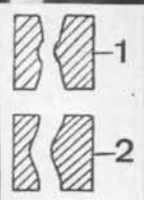
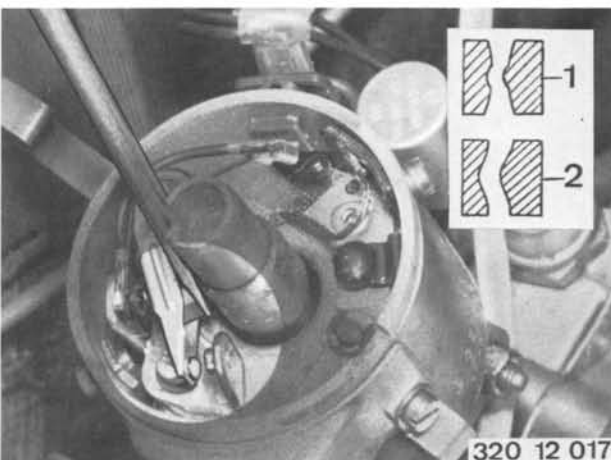
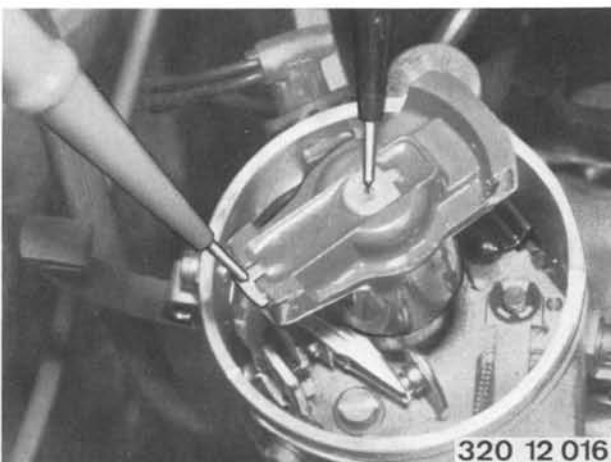
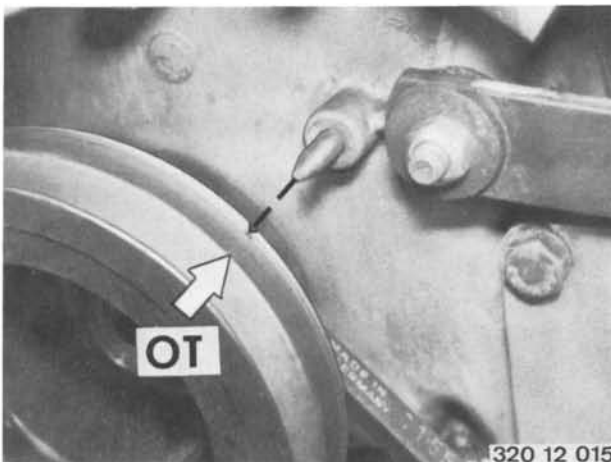
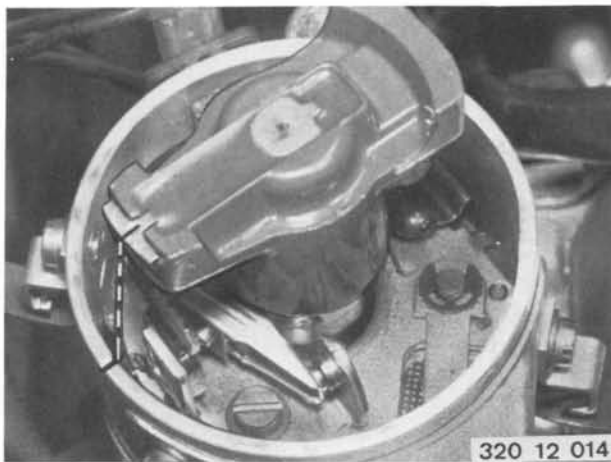
12 11 109 CHECKING DISTRIBUTOR ROTOR

Check resistance of distributor rotor.
Resistance of shielded distributor rotor is 5,000 ohms.

12 11 141 REPLACING CONTACT BREAKER POINTS

Inspect surface condition of points visually.

- 1 Good
- 2 Shot, must be replaced

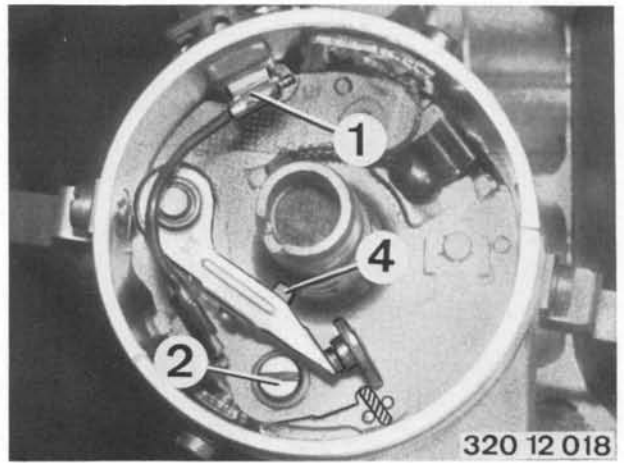


Disconnect flat male plug (1).
Loosen screw (2).
Remove contact breaker points.

Installation Note! New points must be cleaned of grease.

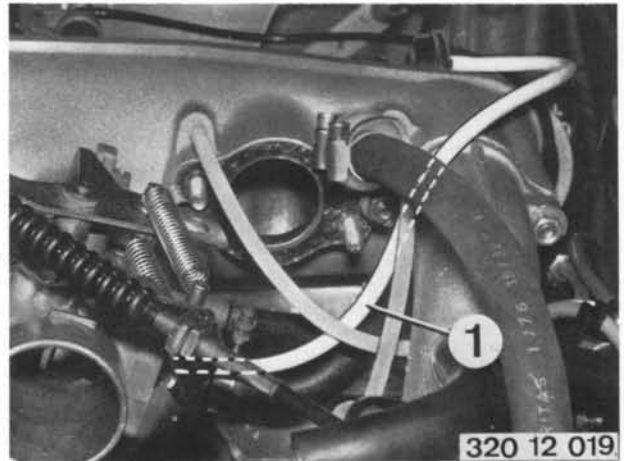
Lubricate cam and lead (4) on breaker arm with Bosch Ft 1 v 4 grease.

Adjust ignition timing and dwell angle - 12 11 004.

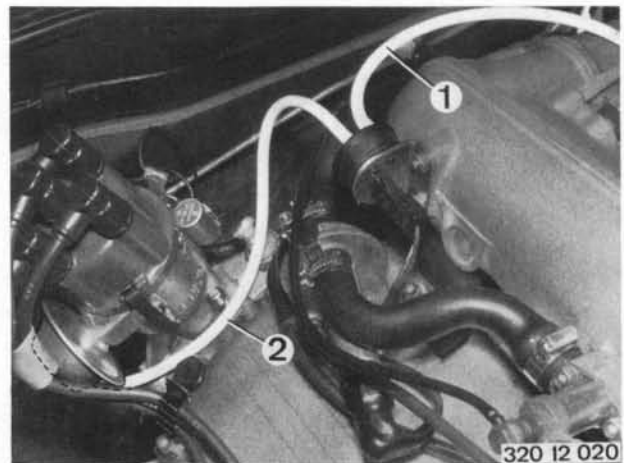


12 11 191 REPLACING DISTRIBUTOR VACUUM LINE

Replace vacuum line (1) running from throttle housing to timing valve.



Replace vacuum line (2) from timing valve to distributor.



TROUBLESHOOTING DISTRIBUTOR

Condition	Cause ¹⁾	Correction
Engine will not start or stops	Points burnt or dirty	Replace points
Engine runs erratically and misfires	Stray current in distributor cap	Clean or replace distributor cap
Engine misfires in partial throttle range	Shielded resistor in distributor rotor defective	Replace distributor rotor
Engine power output drops	Dwell angle incorrect Contact gap of all cams is not equal Uneven cam wear	Adjust dwell angle Replace distributor
Engine misfires - backfiring noise	Contact breaker plate for vacuum ignition control worn	Replace distributor
Engine will not accelerate	No centrifugal ignition control - cams seized or rusted to shaft	Service distributor cams on shaft (lubricate), replace distributor if necessary
Engine starts, but dies	Break or short circuit in capacitor	Replace capacitor
Engine misfires - excessive fuel consumption	Ignition cable defective Plug connectors defective Shielded resistors defective	Replace ignition cable Replace plug connectors Replace shielded resistors

1) Determine with BMW program tester - 11 00 005.

12 31 009 CHECKING ALTERNATOR AND REGULATOR

See Program Test for testing procedures - 11 00 005.

12 31 020 REMOVING AND INSTALLING ALTERNATOR

Caution! Only disconnect wire between battery and alternator when engine is stopped.
Disconnect battery's plus and minus cables, if battery is charged in car with a charger.
When arc welding connect ground terminals of welding equipment directly to car's part to be welded.
Disconnect minus cable at battery.

Detach wires at alternator.

Color Codes: black/red B +
blue D +
brown ground

Remove mounting screw (1) on tensioning bar.
Loosen upper suspension (2) and lift out alternator.

Installation Note! V-belt should give by 5 to 10 mm or 0.197 to 0.394 in..

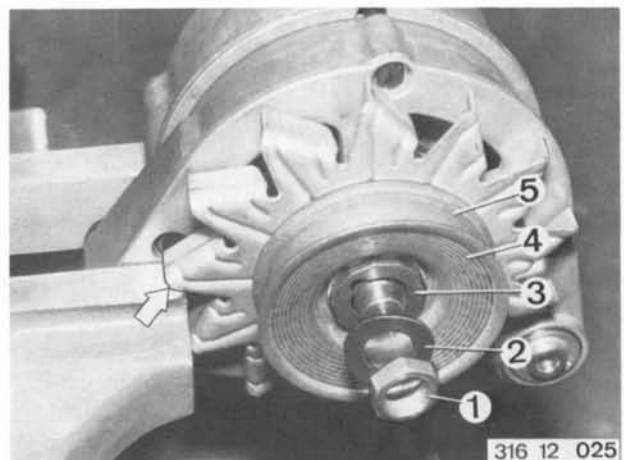
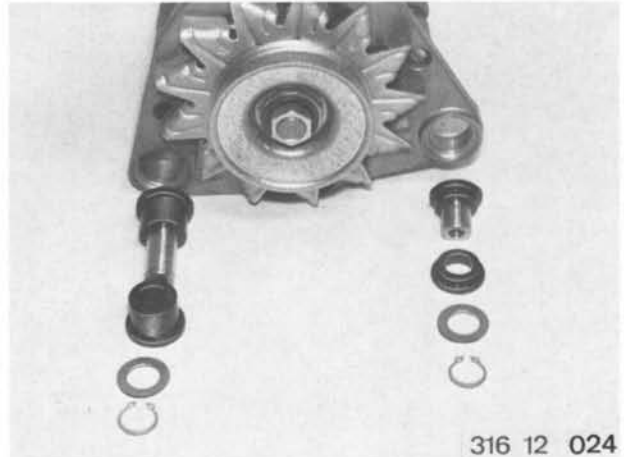
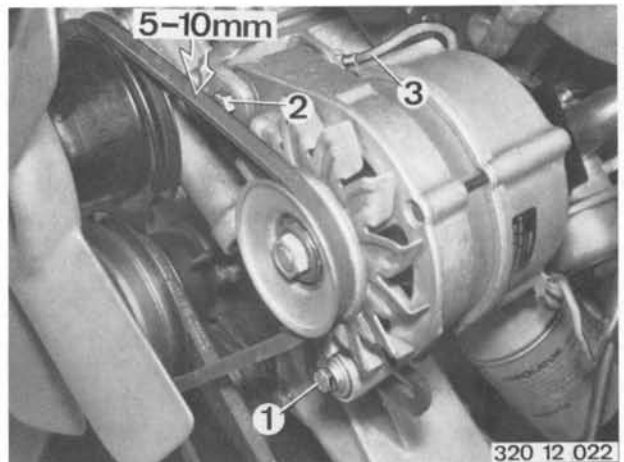
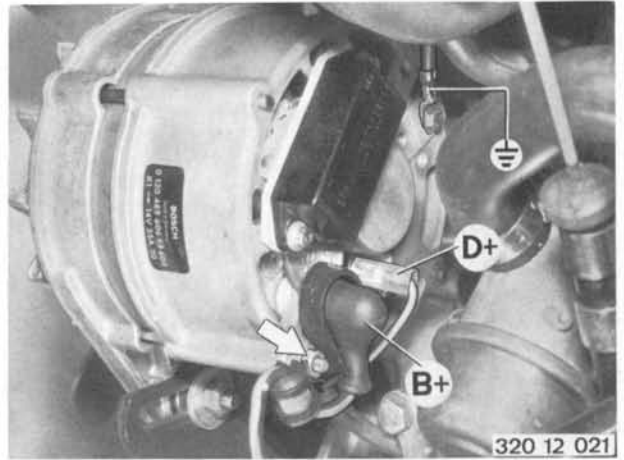
Secure ground wire (3) at upper suspension.

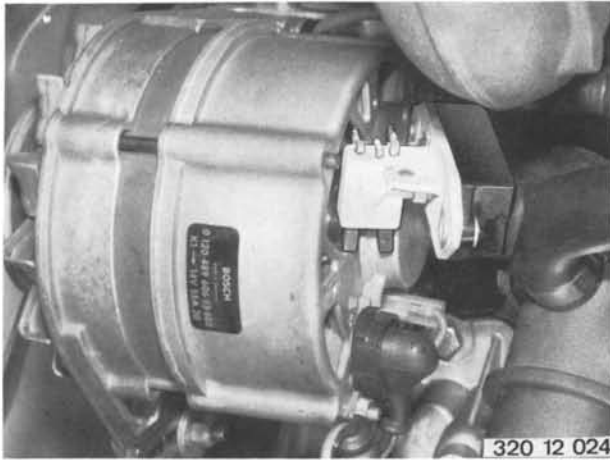
Check bearing bushings, replace if necessary.

12 31 101 REPLACING PULLEY/FAN WHEEL

Remove alternator - 12 31 020.
Block and remove fan wheel.

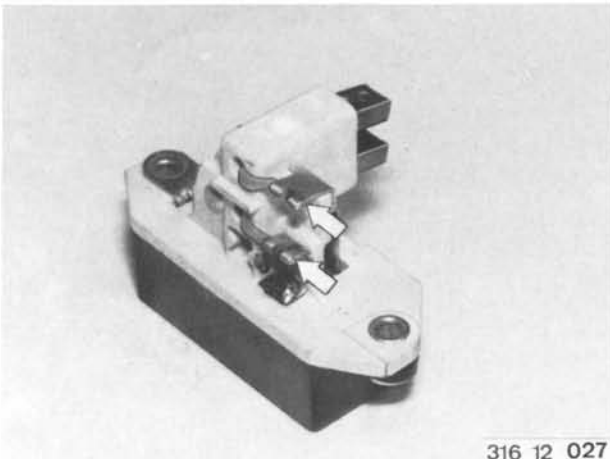
Installation Note! Nut (1), corrugated washer (2), plain washer (3), pulley (4 and 5) and fan wheel (6).





12 31 201 REPLACING CARBON BRUSHES

Take off regulator and remove carbon brush holder.

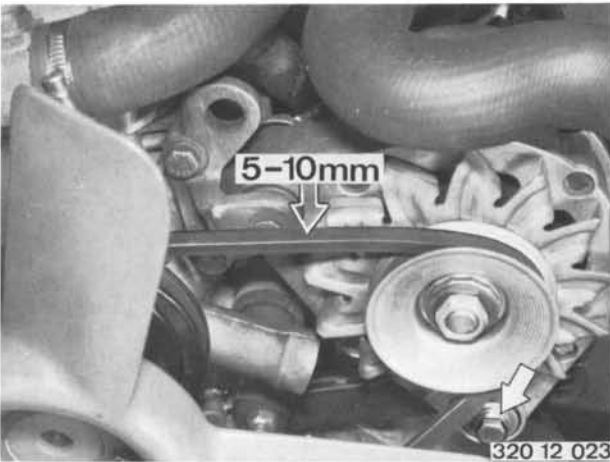


Unsolder old and solder new carbon brushes.

Caution!

Don't allow solder to run down strands of copper wire.

If regulator unit is replaced, only use regulator, Bosch No. 019 20 52 004.

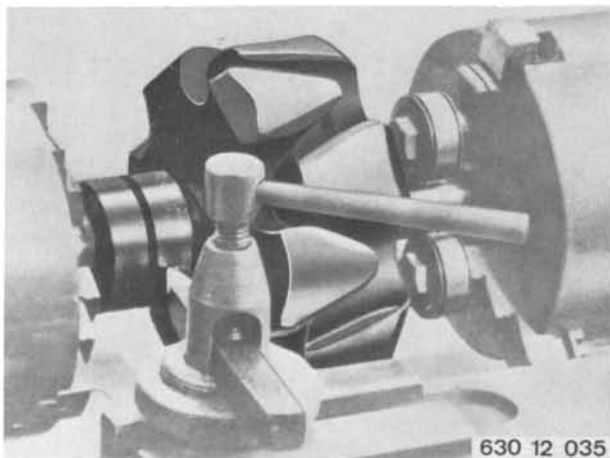


12 31 301 REPLACING V-BELT

Loosen alternator at tensioning bar and upper mounting.

Remove v-belt¹⁾.

Installation Note! V-belt must give by 5 ... 10 mm or 0.197 ... 0.394 inch.



12 31 569 FINE GRINDING SLIP RINGS

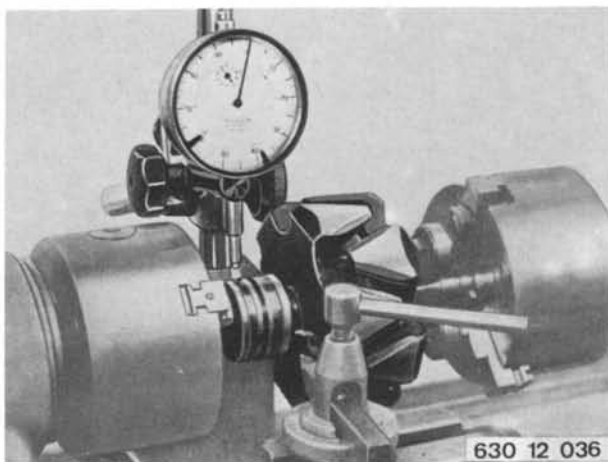
Tailstock spindle EFAW 75 or GDF 85 R 3 is required to fine grind the slip rings.

Only remove enough material to smooth scored surfaces.

Caution! Minimum slip ring diameter is 31.5 mm or 1.240 inch.

1) See Specifications

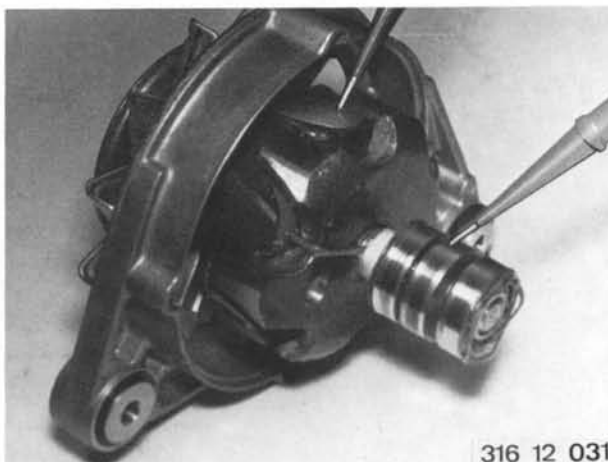
Check slip rings for out-of-true after grinding.
Max. permissible runout is 0.03 mm (0.0012 in.).
Polish and clean slip rings with compressed air.



630 12 036

12 31 571 REPLACING ROTOR

Check rotor coil and slip rings for ground.
Test lamp (12 volts) should not come on.



316 12 031

Check rotor coil for short circuit in coil.
Check resistance of exciter coil from slip ring to
slip ring with ohmmeter.
Test value: $4.0 \pm 10\%$ ohm.

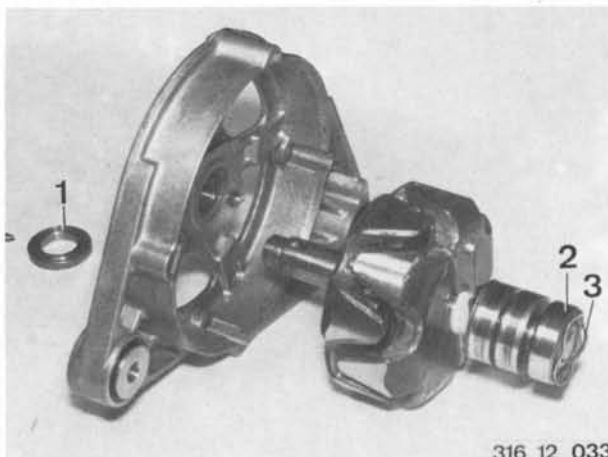


316 12 032

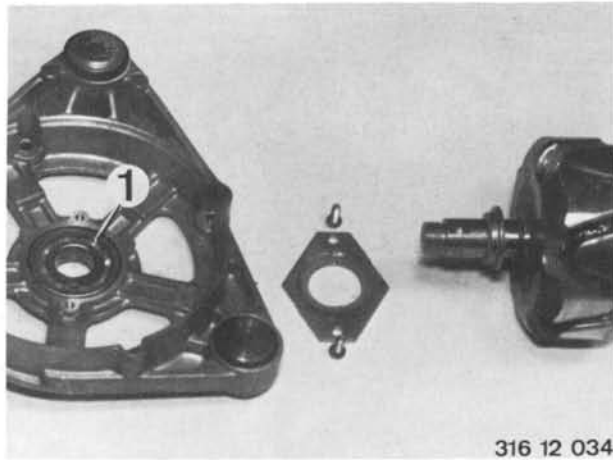
Remove pulley and fan wheel - 12 31 101.
Lift out key.
Remove regulator and bearing plate.
Press rotor out of bearing plate.

Installation Note! Collar of washer (1) faces
grooved ball bearing. Pull grooved ball bearing (2)
off of rotor.

Installation Note! Lubricate grooved ball bearing
with Ft 1 v 34.
Open bearing end faces housing.
Place corrugated washer (3) in housing before grooved
ball bearing.



316 12 033

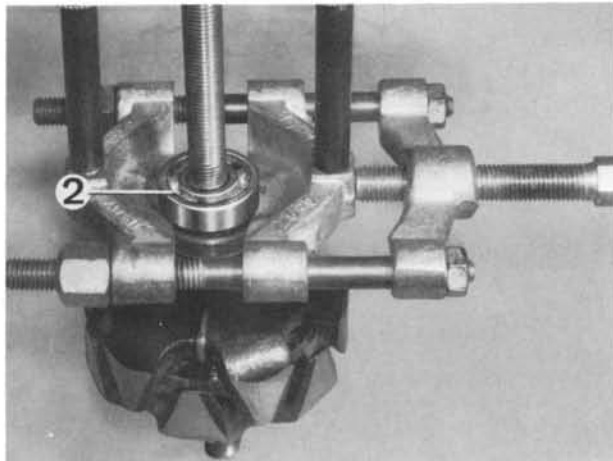


316 12 034

12 31 581 REPLACING BOTH GROOVED BALL BEARINGS

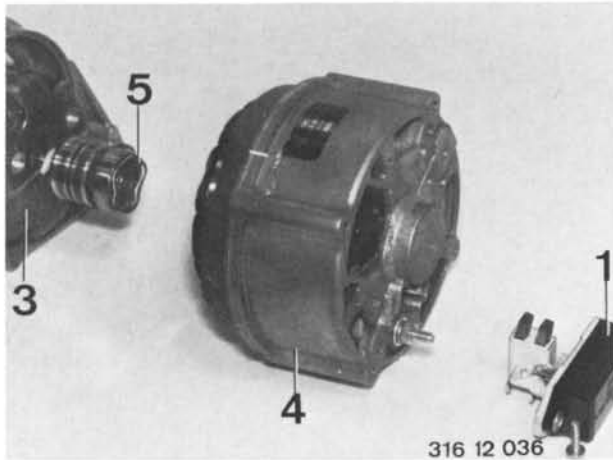
Remove rotor - 12 31 571.
 Remove holder.
 Press grooved ball bearing (1) out of bearing plate.

Installation Note! Lubricate grooved ball bearing with Ft 1 v 34.
 Open end of bearing faces rotor.



Pull grooved ball bearing (2) off of rotor.

Installation Note! Only use C 3 bearings.
 Lubricate grooved ball bearing with Ft v 34.
 Open end of bearing faces rotor.
 Place corrugated washer in housing before grooved ball bearing.



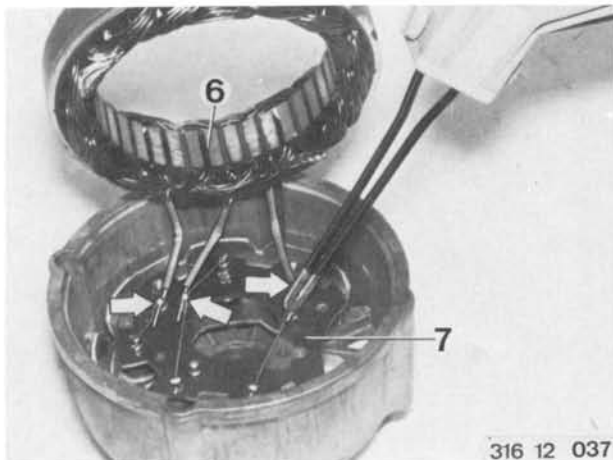
316 12 036

12 31 691 REPLACING DIODE PLATE

Remove carbon brush holder (1).
 Mark position of housing to slip ring bearing.
 Take housing with rotor (3) off of slip ring bearing.

Installation Note! Stick corrugated washer (5) in front of grooved ball bearing with Ft 1 v 34 grease.

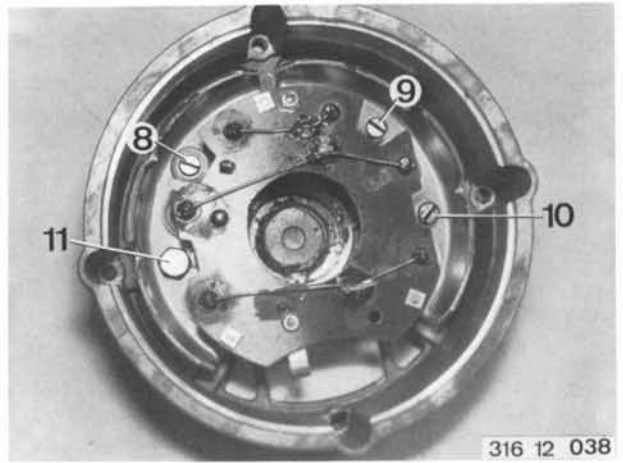
Unsolder stator coil (6) at diode plate (7).



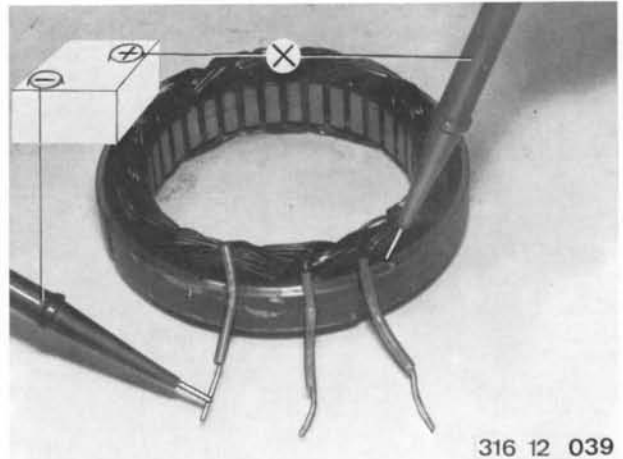
316 12 037

Loosen screws (8 ... 10) on slip ring bearing.
Take nut off of screw (11).
Remove diode plate.

Installation Note! Nut, lockwasher, plain washer,
insulators, insulator sleeve, plain washer.



Check stator coil for ground.
Stator coil is good as long as test lamp does not
come on.



Check stator coil for short circuit in coil.
Check resistance between two phases with ohmmeter.
Hold test probes against coil ends alternately.
Test value: 45 A alternator - 0.2 + 10 % ohm.



12 32 001 REPLACING VOLTAGE REGULATOR

For testing with program tester see page 11-00/6.

Proceed as follows, if program tester is not available.

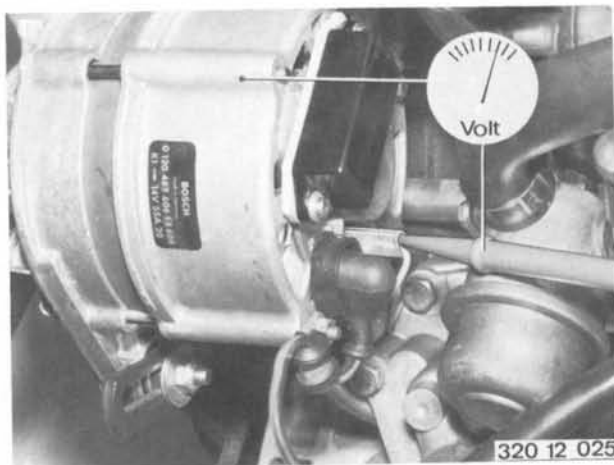
A) Battery voltage must be good.

Connect voltmeter between B + and ground.

Reading must be 13.5 ... 14.6 volts at 2000 rpm.

Regulator is defective when reading is higher than 14.6 volts.

If voltmeter shows no reading when engine is stopped or running, carbon brushes could be too short or regulator has a break.



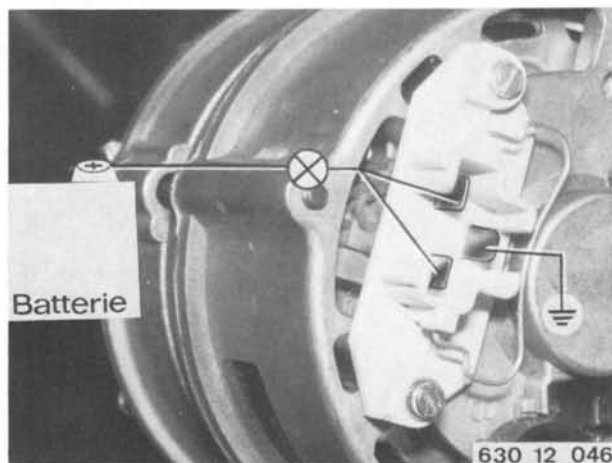
B) Remove voltage regulator and install carbon brush holder, Bosch No. 1 194 336 006.

Connect D + with DF.

Connect test lamp to battery + and bridging cable between D + and DF.

1. Alternator is good, if lamp comes on bright with engine stopped and goes out with engine running.

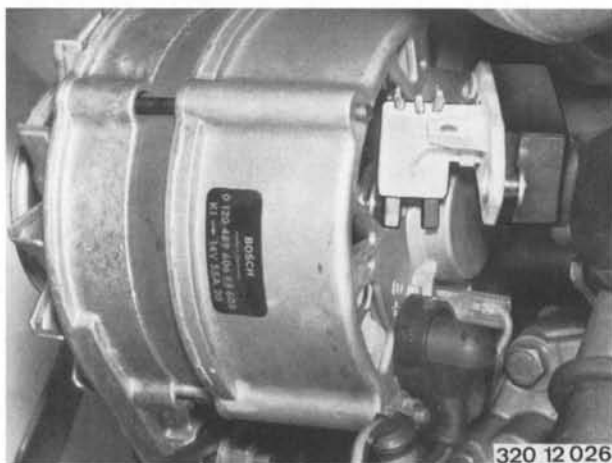
2. If lamp glows, stator coil or diodes are defect.



Voltage regulator can only be replaced together with carbon brush holder.

Remove voltage regulator.

Installation Note! Only use Bosch regulators, No. 019 20 52 004.



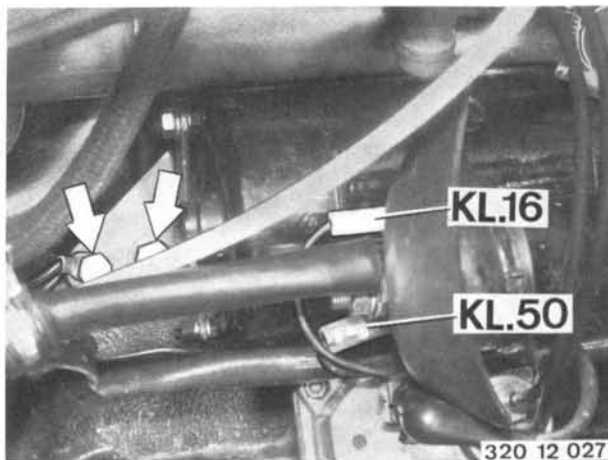
TROUBLESHOOTING ALTERNATOR

Condition	Cause	Correction
Alternator noise	Ball bearings shot V-belt damaged Pulley loose	Replace ball bearings - 12 31 581 Replace v-belt - 12 31 301 Tighten mounting nut
Indicator lamp on at half brightness with engine running	V-belt loose Poor contact at wire connectors Regulator defective Carbon brushes worn Rectifier diode defective or ground Stator ground Rotor partially grounded	Tighten v-belt - 12 31 581 Check wire connectors and wires Replace regulator - 12 32 001 Replace carbon brushes - 12 31 191 Replace rectifier diode - 12 31 691 Replace stator - 12 31 691 Replace rotor - 12 31 571
Severe battery gas	Poor contact between regulator and alternator Regulator defective	Check wire connections on regulator and alternator Replace regulator - 12 32 001
Indicator lamp on at half or full brightness with engine running	V-belt loose Regulator damaged Break or short circuit in supply wires Carbon brushes worn Rotor coil defective Exciter circuit broken Diodes or diode carrier defective Wire D + /61 grounded	Tighten v-belt - 12 31 301 Replace regulator - 12 32 001 Check wire connections and wires Replace carbon brushes - 12 31 191 Replace rotor - 12 31 571 Check wire connections Check diodes or diode carrier, replace if necessary - 12 31 691 Eliminate short circuit or replace wire
Indicator lamp not on with engine stopped Ignition turned on	Indicator lamp defective Wire 61 has break Battery dead Battery defective Cable loose or damaged Regulator defective One plus diode in alternator has short circuit Carbon brushes worn Oxide deposits on slip rings, rotor coil has break	Install 4 watt indicator lamp Eliminate break Charge battery Replace battery Replace cable or tighten connections Replace regulator - 12 32 001 Disconnect charge wire immediately, otherwise battery will discharge; repair alternator Replace carbon brushes - 12 31 191 Repair alternator

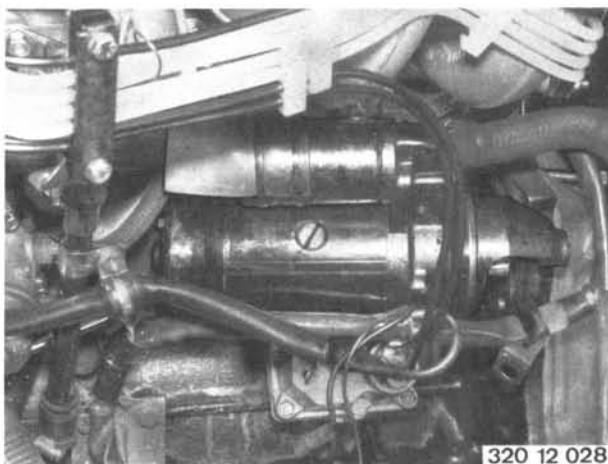
12 41 020 REMOVING AND INSTALLING STARTER

Take intake cowl off of mixture control unit.
Detach minus cable at battery.
Disconnect wire at solenoid and minus wire at support bracket.
Detach support bracket at engine block.

Installation Note! Wire Colors: black/red Term. 16
black Term. 50

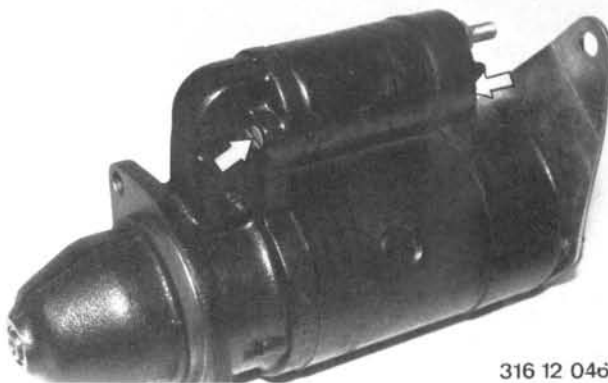


Detach starter at crankcase/transmission and lift off with support bracket.



12 41 041 REPLACING SOLENOID

Remove starter - 12 41 020.
Take solenoid off of drive bearing.



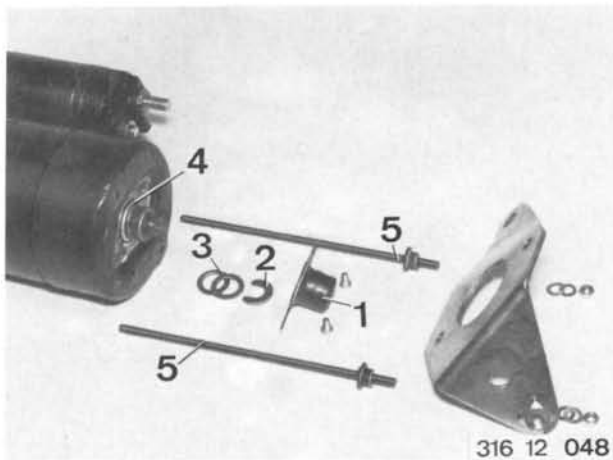
Disengage solenoid at operating lever.



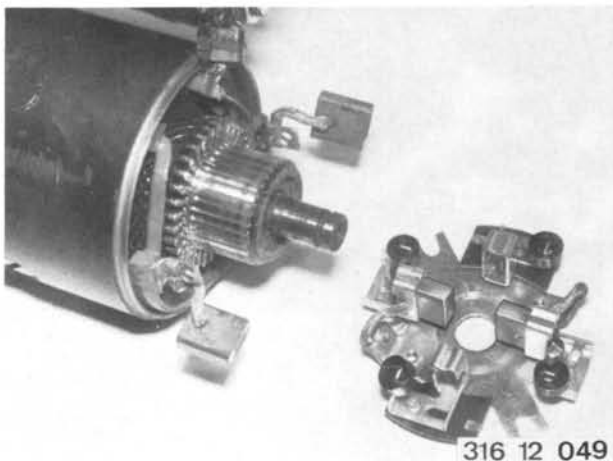
12 41 551 REPLACING CARBON BRUSHES

- Starter Removed -

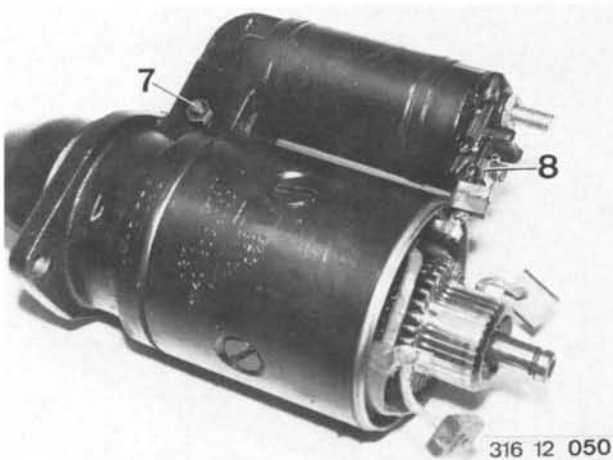
Remove support bracket and dust cap (1).
Remove lockwasher (2), shims (3) and gasket (4).
Loosen pole housing screws (5).
Pull off cap (6).



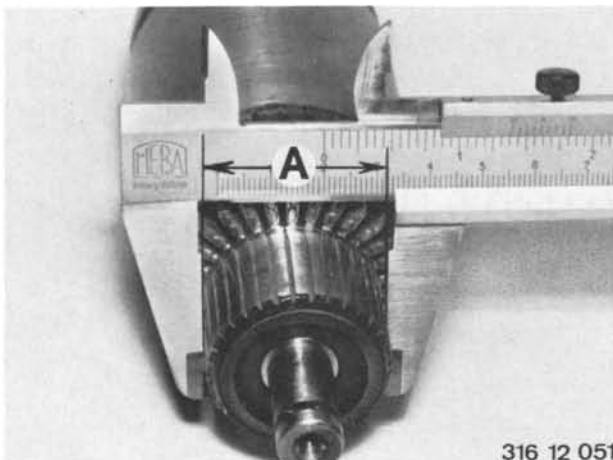
Lift out plus brushes and remove carbon brush plate.
Unsolder old and solder new carbon brushes to exciter coil and carbon brush holding plate.



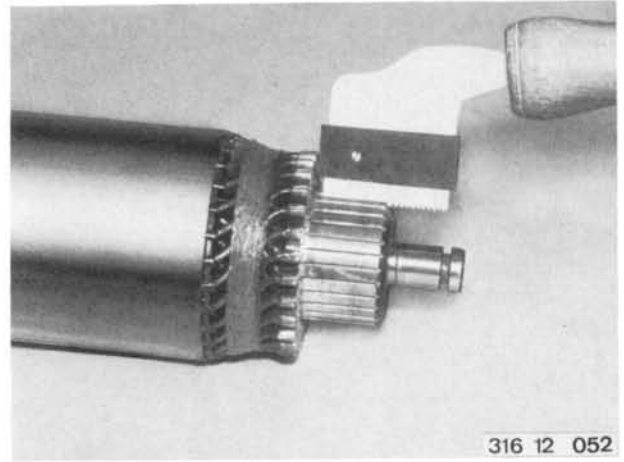
Check commutator and armature coil.
Loosen screw (7) and nut (8).
Remove armature.



Fine grind commutator.
Only remove enough material to smooth scored surfaces.
Don't grind commutator diameter (A) to less than 33 mm (1.299 inch).



Undercut commutator plates.
Insulation must be 0.5 mm (0.020 in.) deeper than surface of plates.

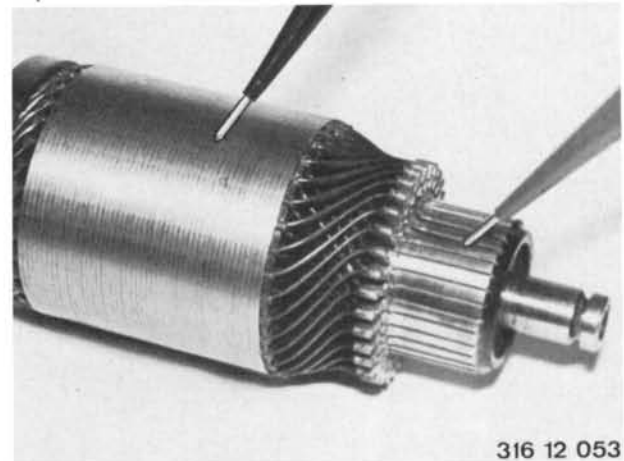


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12 41 602 OVERHAULING STARTER

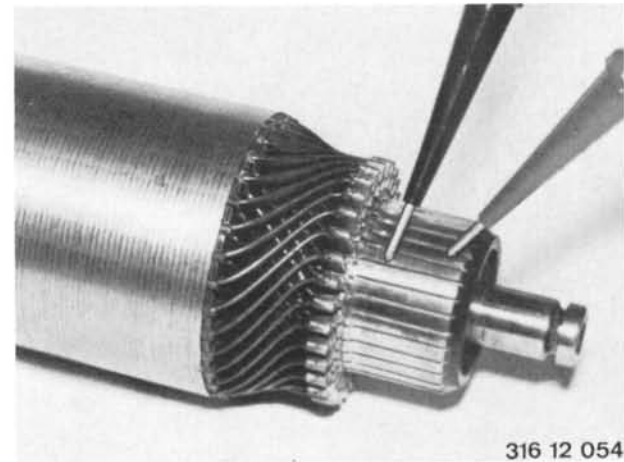
- Starter Removed -

Check armature and field coil with 220 volt test lamp.
Apply test probes to commutator and packet of plates.
Lamp comes on when there is a ground, replace armature.



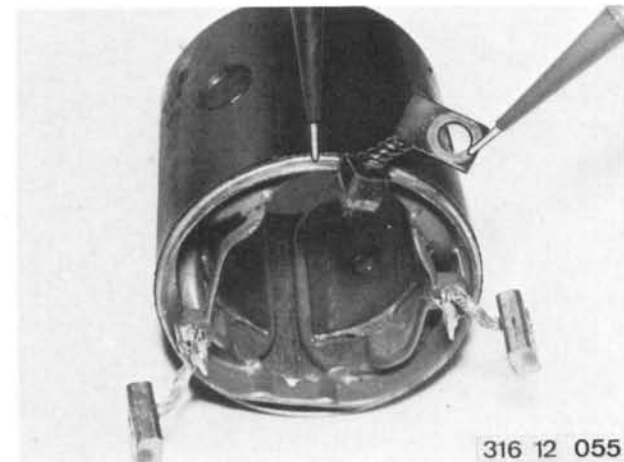
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Connect ammeter (60 ampere measuring range) in circuit and apply probes to commutator briefly from plate to plate.
Testing voltage 2 ... 4 volts.
Gauge deflection must be equal between the individual plates.
Serious deviations indicate a break.
Replace armature having a break.

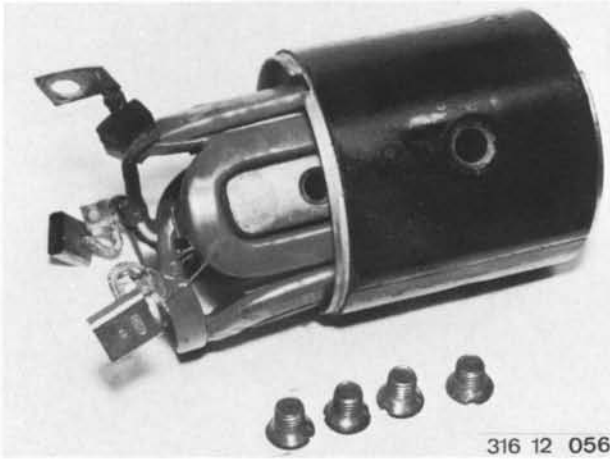


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Check exciter coil for ground.
Visual inspection.
Replace burnt or damaged coils.

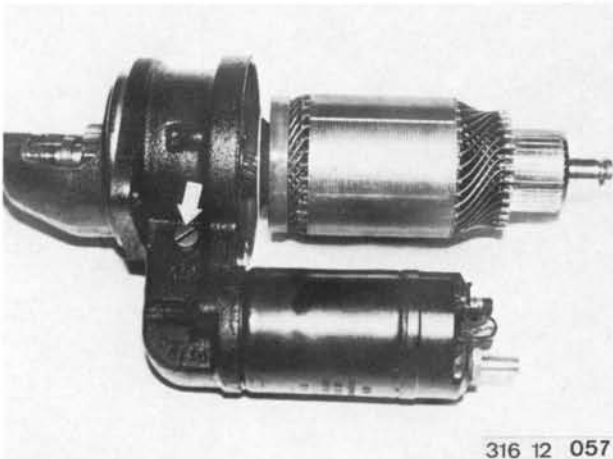


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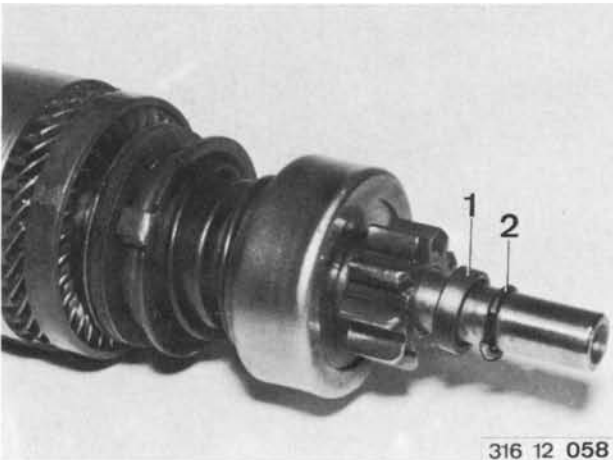


Mark pole shoes so that they will be reinstalled in the same position.
Loosen 4 pole screws.
Take pole shoes and exciter coil out of carbon brush housing.

Installation Note! Align pole shoes to be exactly parallel with longitudinal axis before finally tightening pole screws.



Proceed as follows, if starter gears are defective.
Loosen operating lever pivot screw.
Pull out armature with operating lever.



Press back thrust ring (1).
Remove circlip (2).
Pull off starter gears.

Installation Note! Coat coarse threads and engaging ring with Bosch Ft 2 v 3 silicone grease.
Pull thrust ring over circlip.

TROUBLESHOOTING STARTER

Condition	Cause	Correction
Starter motor does not turn when operating ignition switch	Turn on lights:	
	a) Lights not on, battery dead, break in circuit	a) Check battery voltage, check wire connections
	b) Lights on, but grow dim when operating starter; battery dead	b) Charge battery
	c) Lights on, but go out as soon as starter is operated; corroded battery terminals or body ground connection	c) Clean battery terminals and body ground connection
	d) Lights normal. Bridge starter terminals 50 and 30 - starter turns. Ignition switch defective or break in supply line.	d) Replace ignition switch. Eliminate break.
Starter motor does not turn when wire from battery + is held directly on terminal 30	e) Lights normal. Solenoid engages, but starter does not turn. Bridge battery + and terminal 30 with an appropriate cable. Starter turns. Contacts of solenoid dirty or burnt.	e) Replace solenoid
Starter motor does not turn when wire from battery + is held directly on terminal 30	a) Carbon brushes too short	a) Replace carbon brushes
	b) Carbon brushes stuck	b) Service carbon brushes
	c) Carbon brush spring force too low	c) Replace springs
Starter motor turns too slow and cannot turn engine	a) Battery voltage insufficient	a) Charge battery
	b) Battery terminals loose, corroded	b) Clean pole heads and terminals
	c) Solenoid defective	c) Replace solenoid
	d) Wire connections loose	d) Tighten wire connections
	e) Commutator dirty	e) Clean commutator
	f) Armature or exciter coil defective	f) Repair starter
Starter motor turns at high speed, but engine does not turn or turns erratically	a) Drive pinion defective	a) Replace drive pinion
	b) Gear ring defective	b) Replace gear ring
	c) Drive pinion not engaging, coarse threads dirty or damaged	c) Repair starter
Drive pinion not engaging, starter motor turns at high speed without driving engine	a) Drive pinion extremely dirty	a) Clean drive pinion bearings
	b) Solenoid spring defective	b) Replace solenoid
	c) Flywheel gear teeth seriously damaged	c) Replace gear ring
Drive pinion engages, but starter motor turns without driving engine	a) Drive pinion roller one-way clutch slips	a) Replace drive pinion