Chapter 7. Electrical system

Wiring and fuses

The electrical system is of the single-wire negative earth type. The vehicle basic wiring diagram is illustrated in Fig.7-1.

Most electrical circuits are powered when the ignition is switched on. Regardless the ignition switch position, the following functions are available: horn, stoplight, cigarette lighter, interior lamps, inspection lamp, hazard warning flashers, exterior lighting and main beam.

Most of the vehicle electrical circuits are protected by fuses, which are located beneath the facia, at the left-hand side of the steering column (Fig.7-2). There are no fuses for battery charging, ignition and engine start-up (starter and alternator) circuits, main/dipped beam relay. Extra fuses 11, 12, 14, 16 are provided in the additional fusebox to be used for alternative vehicle specifications.

Before renewing a blown fuse, isolate and remedy the cause. Before attempting to diagnose any electrical fault, refer to Table 7-1 to study the relevant wiring diagram protected by a failed fuse.

Table 7-1

Fuse-protected circuits

Fuse No	Circuit protected
1 (16 A)	Heater blower motor Headlight wiper relay (winding) and headlight wiper motors at all wiper positions, except initial Heated tailgate relay (winding) Tailgate wipe/wash motors Windscreen washer motor
2 (8 A)	Windscreen wiper relay and motor Direction indicators and indicators flasher relay (turn indication mode) Direction indicator warning light Tail lights (reversing lamp) Alternator winding (at engine start-up) and low battery warning light* Differential lockup warning light Relay and handbrake-on warning light Low brake fluid warning light Oil pressure warning light Coolant temperature gauge Low fuel gauge and fuel reserve warning light Tachometer
3 (8A)	Left-hand headlight (main beam) Main beam warning light
4 (8 A)	Right-hand headlight (main beam)
5 (8 A)	Left-hand headlight (dipped beam)
6 (8 A)	Right-hand headlight (main beam)
7 (8 A)	Left-hand front lamp (side marker light) Right-hand front lamp (side marker light) Number plate light Side marker warning light
8 (8A)	Right-hand rear lamp (side marker light) Left-hand rear lamp (side marker light) Instrument panel illumination Heater control illumination lamp Cigarette lighter illumination Switch illumination
9 (16A)	Direction indicators and indicators hazard relay (hazard flashers mode) Tailgate heating element and switch-on relay (contacts)
10 (16A)	Horn Inspection lamp socket Interior lamps Tail lights (stop lamp bulbs)
13 (8A)	Tail lights (fog lamps) Headlight wiper motors at start-up and when wiper arms pass initial position Headlight wiper relay (contacts) Headlight washer motor
15 (16A)	Cigarette lighter

** Pre-1996 vehicles were fitted with a voltmeter (protected by fuse No2) instead of the relevant warning light in the instrument cluster.*

In all wiring diagrams, covered by chapter «Electrical system», the letters are used to denote the respective colour code: the first letter stays for the wire colour code, while the second letter - for the tracer colour code (Table 7-2).

Table 7-2

Fuse colour codes

Letter	Colour
Б	*White*
Г	*Blue*
Ж	*Yellow*
З	*Green*
К	*Brown*
О	*Orange*
П	*Red*
Р	*Pink*
С	*Grey*
Ч	*Black*

WARNING. Always disconnect the battery negative lead when making repairs on the vehicles or its electrical system. When replacing fuses or checking wiring, never use fuses other than those specified for a particular vehicle model as it may damage current tracks in the fuse and relay box.

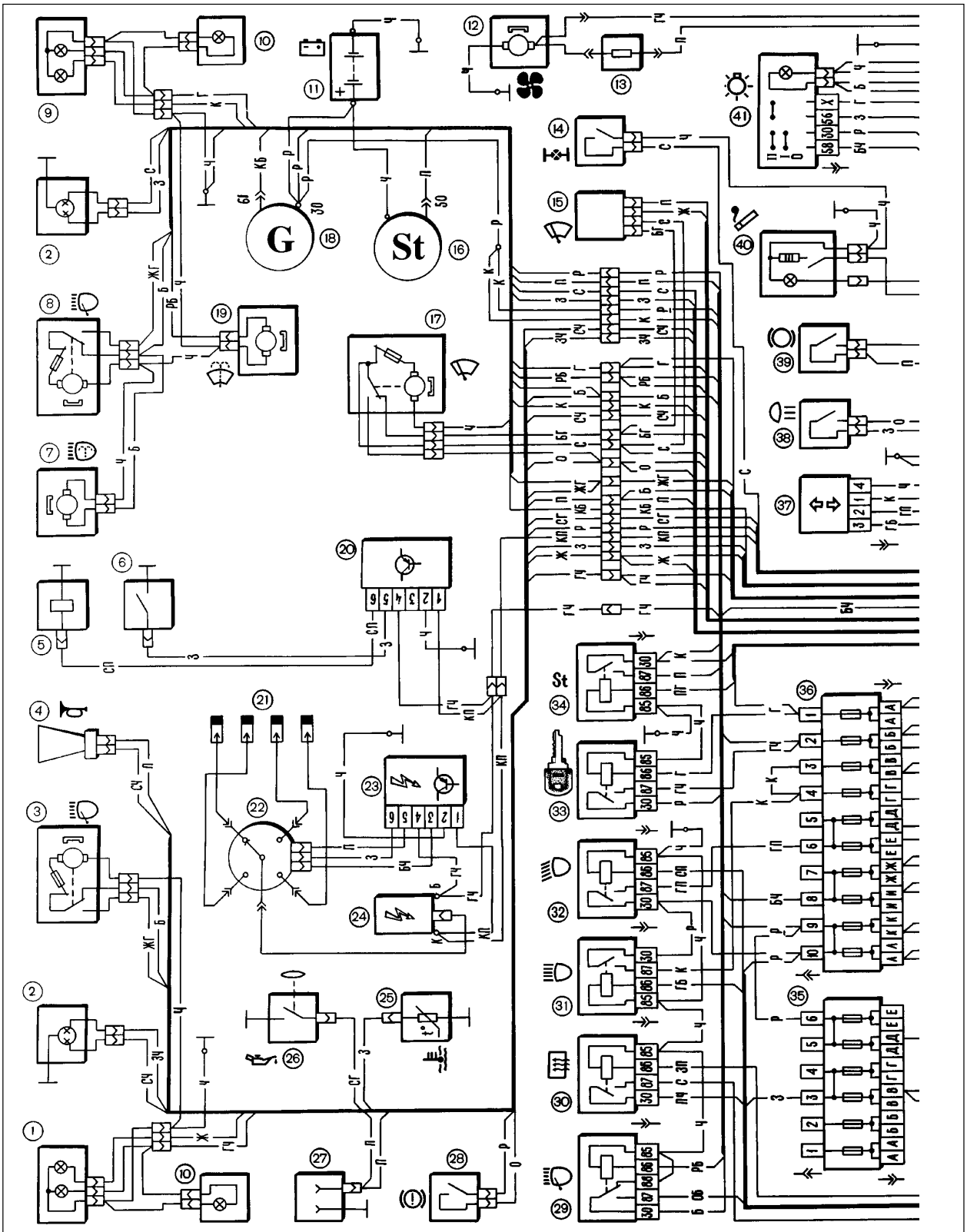
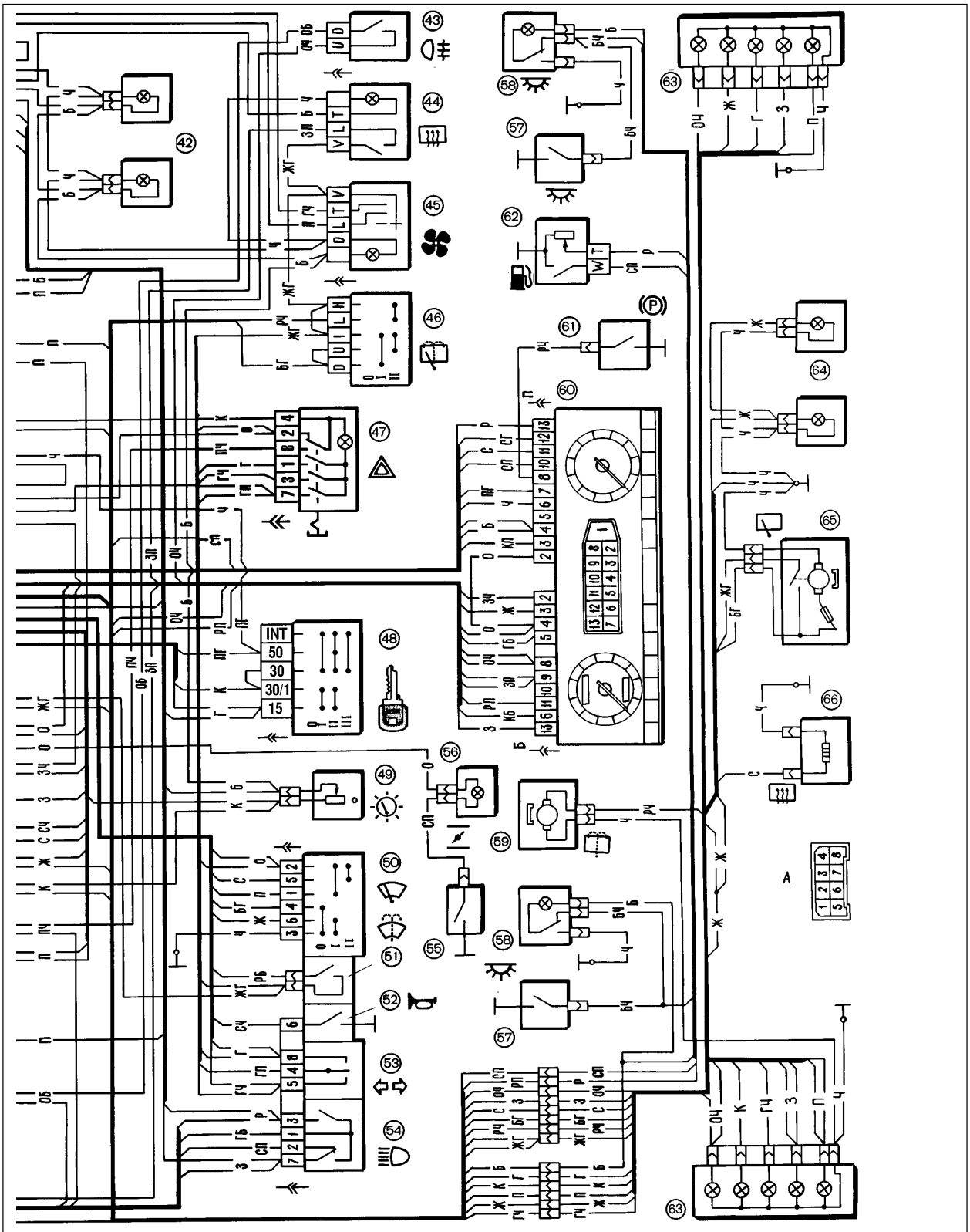


Fig.7-1. Electrical system of VAZ-21213 vehicle:

1 - left-hand front headlamp; 2 - headlights; 3 - left-hand headlamp wiper motor; 4 - horn; 5 - fuel cutoff solenoid; 6 - idle switch; 7 - headlight washer motor; 8 - right-hand headlight wiper motor; 9 - right-hand front headlamp; 10 - side repeaters; 11 - battery; 12 - heater motor; 13 - heater motor complimentary resistor; 14 - differential lockup warning light switch; 15 - windscreen wiper relay; 16 - starter motor; 17 - windscreen wiper motor; 18 - alternator; 19 - windscreen washer motor; 20 - fuel cutoff solenoid control unit; 21 - spark plugs; 22 - ignition distributor; 23 - spark control module; 24 - ignition coil; 25 - temperature gauge sender unit; 26 - oil pressure warning light sender; 27 - inspection lamp socket; 28 - brake fluid level warning light switch; 29 - headlight wipe/wash relay; 30 - rear window heating relay; 31 - main beam relay; 32 - dipped beam relay; 33 - ignition switch relay; 34 - starter motor relay; 35 - complimentary fuse box; 36 - main fuse box; 37 - indicators flasher relay; 38 - reversing light switch; 39



- stop light switch; 40 - cigarette lighter; 41 - exterior light switch; 42 - heater controls illumination; 43 - rear fog light switch; 44 - rear window heating switch; 45 - heater motor switch; 46 - rear window wipe/wash switch; 47 - hazard warning flasher switch; 48 - ignition switch; 49 - instrument lighting switch; 50 - windscreen wiper switch; 51 - switch, windscreen washer & headlamp wipe/wash; 52 - horn switch; 53 - direction indicator switch; 54 - headlight switch; 55 - choke warning light switch;
56 - choke warning light; 57 - door courtesy light switches; 58 - interior lights; 59 - rear window washer motor; 60 - instrument cluster; 61 - handbrake warning light switch; 62 - fuel level and fuel reserve gauge sender unit; 63 - rear lights; 64 - number plate light; 65 - rear window wiper motor; 66 - rear window heating element;
A - pin assignment in steering column combination switch connector

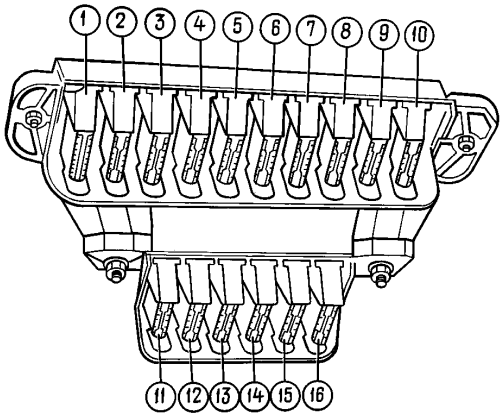


Fig.7-2. Fuses

Battery

Specification

Battery . . . . . 6CT-55A, maintenance-free
Maximum voltage,volt 12
Maximum capacity (at 20-hour discharge rate and initial electrolyte temperature of (27±2)°C, ampere-hour 55
20-hour discharge amps rate 2.75
Cold start amps rating (with running starter motor and electrolyte temperature of -18°C) 255

Fault diagnosis

Cause	Remedy
Battery discharge in operation	
1. Alternator drivebelt slipping	1. Adjust belt tension
2. Battery surface dirty	2. Clean battery surface
3. Damaged insulation in electrical equipment system (discharge rate exceeds 11 mA with loads disconnected)	3. Locate battery leak and remedy the situation
4. Too many accessories fitted by vehicle owner	4. Disconnect new electrical consumers
5. Alternator faulty	5. Check alternator
6. Electrolyte contaminated	6. Charge battery, drain electrolyte, flush, fill with new electrolyte and recharge battery
7. Short-circuits between plates	7. Renew battery
8. Electrolyte level below top plate edge	8. Restore electrolyte level
Electrolyte on battery cover	
1. Too high electrolyte level causing spillage	1. Replenish electrolyte as required
2. Electrolyte leaks through fractures in battery case	2. Replace battery
3. Electrolyte boiling due to excessive alternator voltage	3. Replace alternator
4. Electrolyte boiling through plate sulfation	4. Replace battery

Dry-storage battery - putting into operation

The vehicles are factory-fitted with ready-to-use batteries, i.e. batteries filled with electrolyte and fully charged.

Replacement batteries can be supplied dry, without electrolyte. In order to operate such battery, first remove any provisional plugs or masking tape. Then using a funnel (made of glass or acid-resistant plastic), slowly fill the battery with electrolyte (at 25°C) of 1.28 g/cm^3 for normal climates or 1.23 g/cm^3 for tropics. All procedures required to activate the battery should be performed at the ambient temperature of (25±10)°C.

Allow 20 minutes for the internal plates and separators to saturate well in electrolyte. Then check the battery voltage without loads.

The battery is ready for use when its voltage reading is at least 12.5 volts. At values below 12.5 volts but over 10.5 volts, the battery should be recharged to the output voltage which is specified by the manufacturer. The battery is rejected when the voltage is equal or below 10.5 volts.

The saturation of internal plates and separators normally results in a lower electrolyte level. Therefore, top up the battery with electrolyte of the original specific gravity before refitting it to the vehicle.

Always re-charge the battery after it is filled with electrolyte in the event:

- the battery will be initially operated in heavy duty conditions, in cold weather, at frequent engine starts, etc.;

- the battery has been stored for over 12 months from the date of manufacture.

Electrolyte level - checking

Electrolyte level in all battery cells must be maintained between the «MIN» «MAX» marks on the translucent battery case. Never try to use the battery with the electrolyte level below the «MIN» mark.

In the course of vehicle operation the electrolyte level gradually decreases due to water evaporation. Only distilled water should be used to top up the battery.

If spillage is suspected to be the cause for low electrolyte level, always add electrolyte of the same specific gravity as that remaining in the battery cell. When overfilled, remove excessive electrolyte using an ebony-tipped rubber bulb.

Battery charge level- checking

Always measure the battery charge with a hydrometer (areometer) during servicing or in the event of the battery failed in operation. At the same time measure the temperature in order to account for temperature correlation (Table 7-3) of hydrometer readings.

Table 7-3

Temperature correction values to hydrometer readings for measuring electrolyte density

Electrolyte temperature, °C	Correction value, g/cm^3
-40 to -26	-0.04
-25 to -11	-0.03
-10 to +4	-0.02
+5 to +19	-0.01
+20 to +30	0.00
+31 to +45	+0.01

With electrolyte temperatures over 30°C, the correction value is added to actual hydrometer readings. When electrolyte temperature is below 20°C, the correction value is subtracted. The correction value is not applied when electrolyte temperature is within 20 to 30°C.

Once you have measured the electrolyte specific gravity in each battery cell, determine the state of the battery charge using Table 7-4. Withdraw the battery from the vehicle for re-charging when it is discharged in excess of 25 percent in winter time or 50 percent in summer time.

When measuring electrolyte density, take care not to drip electrolyte on the battery cover, case, body or other parts. Electrolyte contains hazardous sulfuric acid which causes corrosion, current leaks, etc.

Do not measure the electrolyte specific gravity in the following cases to exclude wrong readings:

- when the electrolyte level is not as required;

- when electrolyte is too hot or too cold; the optimum temperature to measure electrolyte specific gravity is 15-27°C;

- immediately after the battery replenishment. Leave the battery for some time to let the electrolyte mix up; it may take up to several hours if the battery has been fully discharged;

- after a number of start-up attempts. It is advisable to wait until electrolyte in the battery cell is homogeneous in terms of density;

- when electrolyte is «boiling». Wait to see bubbles rising to the surface in the electrolyte, sampled with a hydrometer.

Battery charging

Remove the battery from the vehicle and clean it carefully, especially its top. Check the electrolyte level and replenish, if applicable.

The battery is recharged at a rate of 5.5 amperes with the caps undone. Charge the battery until intensive gas escape is observed and consistent voltage and electrolyte specific gravity is achieved within three hours. The electrolyte density of the charged battery at 25°C should be as shown in Table 7-4.

When recharging the battery, frequently check the electrolyte temperature to keep it below 40°C. When 40°C is reached, then either halve the charging current or stop recharging to cool the battery down to 27°C.

Stop charging the battery in case of intensive gas escape from the battery cells and when the last three measurements (taken hourly) show no changes in voltage and specific gravity.

If at the end of the recharging procedure the electrolyte specific gravity (after temperature correlation) differs from that specified, adjust it accordingly. In case of higher specific gravity, remove some electrolyte and top up distilled water, while in case of lower specific gravity - remove some amount of lower specific gravity electrolyte and add some higher specific gravity electrolyte (1.4 g/cm^3).

After the electrolyte specific gravity has been duly adjusted, continue to charge the battery further 30 minutes for better electrolyte mixing. Next disconnect the battery and after 30 minutes check the electrolyte level in all cells.

When electrolyte is below the level required, pour in electrolyte of the specific gravity which is recommended for that climate (Refer to Table 7-4). When electrolyte level is above that required, remove excessive amount using a rubber bulb.

Table 7-4

Electrolyte specific gravity at 25°C, g/cm^3

Climate (average January temperature, °C	Season	Fully discharged battery	Battery discharged by 25%	Battery discharged by 50%
Very cold (from -50 to -30)	Winter	1.30	1.26	1.22
	Summer	1.28	1.24	1.20
Cold (from -30 to -15)	All seasons	1.28	1.24	1.20
Moderate (from -15 to -8)	All seasons	1.28	1.24	1.20
Warm and damp (from 0 to +4)	All seasons	1.23	1.19	1.15
Hot and dry (from -15 to +4)	All seasons	1.23	1.19	1.15

Alternator

Specification

Maximum current output (at 13 volts and 5000 rpm), amp . . 55
Adjustable voltage range, volts . . . . . 14.1±0.5
Maximum rotor speed, rpm 13,000
Engine-to-alternator ratio 1:2.04

General description

The alternator of 37.3701 model is of AC, three-phase, clockwise rotation (when viewed from the drive end), with integral diode plate and voltage regulator.

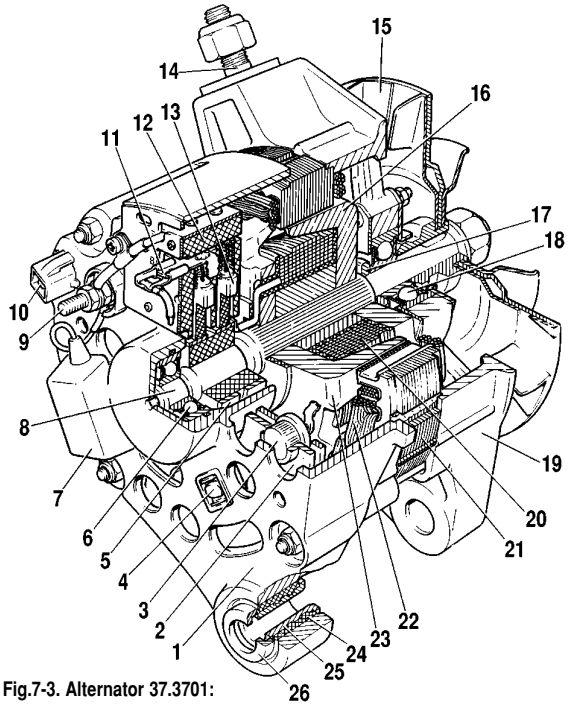


Fig.7-3. Alternator 37.3701:
1 - slip ring end housing; 2 - diode plate; 3 - diode; 4 - screw; 5 - slip ring; 6 - rear ballbearing; 7 - suppression condenser; 8 - rotor shaft; 9 - alternator terminal «30»; 10 - alternator terminal «61»; 11 - voltage regulator terminal «B»; 12 - voltage regulator; 13 - brush; 14 - alternator-to-belt tensioner lever securing pin; 15 - pulley and fan; 16 - rotor pole end; 17 - spacer; 18 - front ballbearing; 19 - drive-end housing; 20 - rotor winding; 21 - stator; 22 - stator winding; 23 - rotor pole end; 24 - buffer bush; 25 - bush; 26 - hold-down bush

Protective cover 4 is used for slip ring-end housing (Fig.7-11). The protective cover and air intake have several design alternatives.

Four bolts hold together stator 21 (Fig.7-3) and housings 1 and 19. Rotor shaft 8 runs in bearings 6 and 18 located in the housings. The rotor winding (field winding) is powered through the brushes and slip rings 5.

Three-phase alternative current, induced in the stator winding, is converted into direct current in diode plate 2 fitted to housing 1. Electronic voltage regulator 12 is integral with the brush holder and is also attached to housing 1.

The alternator wiring diagram is shown in Fig.7-4. When the ignition is switched on, the voltage for the alternator actuation is applied to the regulator terminal «B» (alternator terminal 61) via warning light 6 in instrument cluster 3. Once the engine is started, the current to the field winding is supplied from three supplementary diodes in the alternator diode plate.

The alternator operation is checked via warning light 6 in the instrument cluster. The light comes on when the ignition is switched on and goes out after the engine has been started, when the alternator is good. Bright or dim light of the warning lamp indicates faults.

Before 1995 an electronic voltmeter in the instrument cluster was used to control voltage in the vehicle electrical system. With correct voltage the voltmeter LED did not light up. In case of overvoltage the LED started flashing, while in case of undervoltage the LED stayed steadily.

Starting from 1996 an alternative voltage regulator and brush holder are used. Now the voltage regulator is located in the metal housing and is riveted to the brush holder (Fig.7-10, a), making a unit. The new voltage regulator has no terminal «Б», so voltage is supplied only to terminal «B». Both the earlier and new voltage regulators are similar and are interchangeable as a complete unit with the brush holder.

Some vehicles can be fitted with alternators made in Slovenia, Bulgaria or Germany. These alternators are interchangeable with the alternator of 37.3701 model as to specification and mounting sizes, though are slightly different in design. This chapter describes the alternator of 37.3701 model, preferably used in VAZ-21213 vehicles.

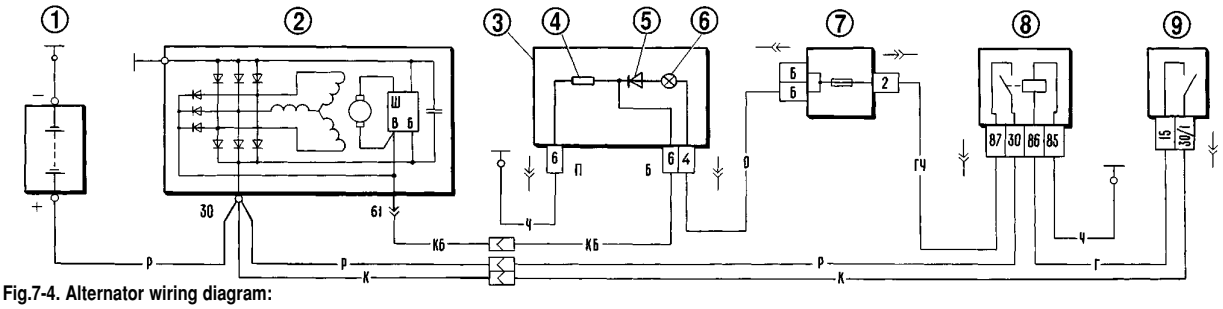


Fig.7-4. Alternator wiring diagram:
1 - battery; 2 - alternator; 3 - instrument cluster; 4 - resistor 51 Ohm, 5 W; 5 - diode; 6 - low battery charge warning light; 7 - fuse box; 8 - ignition relay; 9 - ignition switch

Fault diagnosis

Cause	Remedy
Warning light does not light up when ignition is switched on. Instruments inoperative	
1. Blown fuse 2 in fuse box	1. Renew fuse
2. Broken supply circuit in instrument cluster:	2. Carry out the following:
- no voltage between terminal «Б» of main fusebox and instrument cluster;	- check wire «О» and its connections between fuse boxes and instrument cluster;
- no voltage between ignition relay and fusebox unit	- check wire «ГЧ» and its connections between ignition relay and fusebox
3. Ignition switch or ignition relay faulty:	3. Carry out the following:
- faulty contact part or ignition relay;	- check and renew faulty contact part of ignition switch or ignition relay;
- no voltage between ignition switch and ignition relay;	- check wire «Г» and its connections between ignition switch and ignition relay;
- break or no contact in the ignition relay earth wire	- check wire «Ч» and its connections between ignition relay and earth
Warning light does not light up when ignition is switched on and does not stay on during engine operation. Instruments operate. Battery is discharged.	
1. Blown warning light bulb or loose holder-to-PCB contact	1. Renew failed bulb, bend holder contacts or replace bulb holder
2. Broken circuit between instrument cluster and alternator terminal 61	2. Check wire «КБ» and its connections between alternator and instrument cluster
3. Brushes worn or binding, slip ring oxidized	3. Renew brush holder with brushes, clean slip rings with fuel-moistened cloth
4. Voltage regulator damaged (break between «Ш» terminal and earth)	4. Renew voltage regulator
5. Lead from voltage regulator «В» terminal disconnected	5. Reconnect wire
6. Short-circuit in positive diodes	6. Renew diode plate
7. Field winding leads disconnected from slip rings	7. Solder pins or renew alternator rotor
8. No contact between voltage regulator terminals «В» and «Ш» and brush terminals (for pre-1996 alternators)	8. Clean voltage regulator terminals «В», «Ш» and brush output; bend voltage regulator pins
Warning light is bright or half bright with engine running. Battery is non-charged	
1. Alternator drivebelt slipping	1. Adjust belt tension
2. Voltage regulator damaged	2. Renew voltage regulator
3. Damaged diodes	3. Renew diode plate
4. Field winding diodes damaged	4. Renew diodes or diode plate
5. Stator winding broken, shorted or earthed	5. Replace alternator stator
Warning light is on with engine running. Battery is overcharged	
Voltage regulator damaged (short-circuit between terminal «Ш» and earth)	Renew voltage regulator
Alternator is noisy	
1. Loose alternator pulley nut	1. Tighten nut
2. Alternator bearings damaged	2. Renew rear bearing or front cover with bearing
3. Stator winding shorted internally or to housing (alternator howl)	3. Renew stator
4. Short-circuit in diode plate	4. Renew diode plate
5. Brush squeak	5. Clean brushes and slip rings with cotton cloth moistened in petrol

WARNING. Always earth the battery negative post to the bodyshell and connect the positive post to the alternator clip 30. If battery connections are erroneously reversed, the alternator diodes will be damaged by resulting high voltage.

Never operate the alternator with the battery disconnected since this causes overvoltage peaks at the alternator terminal 30 and can damage the voltage regulator or other electronic devices of the vehicle electrical system.

Never test the alternator for «spark» by earthing the alternator terminal 30 even for a short time. The diodes can be damaged by considerable current flow. Check the alternator operation using an ammeter or a voltmeter.

Never check the alternator diodes by applying voltage over 12 volts or using a megohmmeter, as its voltage is very high and can damage the diodes (by short-circuit).

Never check the vehicle wiring by a megohmmeter or a lamp powered in excess of 12 volts. If the check is really necessary, disconnect the leads from the alternator first.

Always use the test bench and disconnect the winding from the diodes when performing the high voltage check of alternator stator winding insulation resistance.

When welding the body units or components, remember to disconnect first the leads from all battery and alternator connectors.

Alternator - testing

Using tester

A tester helps determine whether the alternator is faulty or meets the specification. The carbon brushes of the unit tested should slide smoothly on the slip rings, which should always be clean.

Mount the alternator on the tester and connect as shown in Fig.7-5. Start the tester motor, using rheostat 4, set the alternator output voltage at 13 volts and raise the rotor speed to 5000 rpm. Run the alternator at this speed for at least 10 minutes and then measure the alternator output amperage. The reading for a sound alternator should not be below 55 amperes.

When the measured amperage is much lower, this is an indication of some fault in the stator or rotor windings or damaged diodes. If this is the case, very thorough diagnostics will have to be carried out in order to locate the fault.

The output voltage should be measured at rotor speed of 5000 rpm. Set rheostat 4 to test amperage of 15 amps and take the reading of the alternator output voltage to be within 14.1±0.5 volts at the ambient / alternator temperature of 25±10°C.

If the voltage reading falls outside the range specified, replace the complete voltage regulator with a new unit which is proved good. Then repeat the test procedure. Normal voltage indicates that the old regulator is faulty and must be renewed. If the fault persists, check the alternator windings and diodes.

Alternator - oscilloscope test

The oscilloscope offers an accurate and quick way to check the alternator and identify the fault through the output waveform.

To perform the check make the connections as shown in Fig.7-6. Disconnect the output lead common for three supplementary diodes from the voltage regulator terminal «B» and make sure the lead end does not touch the alternator housing. Connect the battery lead to the regulator terminal «B» via warning light 1. Now the field winding is only battery powered.

Start the tester motor and increase the rotor speed up to 1500-2000 rpm. Using switch 6, cut off the battery from the alternator terminal 30; while using rheostat 4, set the output current at 10 amperes.

Check the voltage across the alternator terminal 30. When the diodes and stator winding are sound, the output waveform is «saw-shaped» with uniform peaks (Refer to Fig.7-7, I). In case of a broken stator winding or shorted diodes, the waveform is quite different - the peaks are no longer uniform and there are very deep troughs (Fig.7-7, II и III).

Check to see the output waveform across the alternator terminal 30 is normal; next check voltage across the alternator terminal 61 or at the end of the lead disconnected from the voltage regulator terminal «B». These points are a common connection for three supplementary diodes (Fig.7-4), supplying current to the field winding during the alternator operation. The output waveform must have the same even saw-shaped pattern. An irregular waveform is an indication of damaged supplementary diodes.

Rotor field winding - testing

The field winding can be tested with the alternator in the vehicle. It is sufficient to remove the housing and voltage regulator/brush holder assembly.

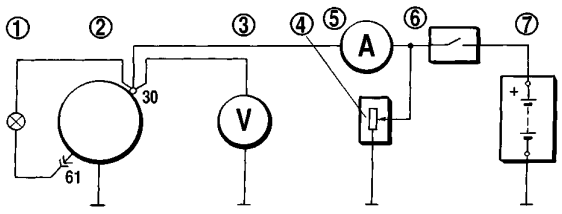


Fig.7-5. Wiring connections for diode plate test:
1 - warning light (12 v, 3 W); 2 - alternator; 3 - voltmeter; 4 - rheostat; 5 - amperemeter; 6 - switch; 7 - battery

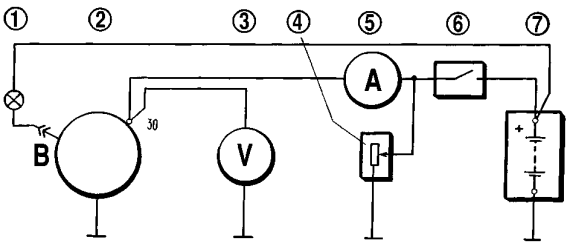


Fig.7-6. Alternator wiring connections for oscilloscope test:
1 - warning light (12 v, 3 W); 2 - alternator; 3 - voltmeter; 4 - rheostat; 5 - amperemeter; 6 - switch; 7 - battery

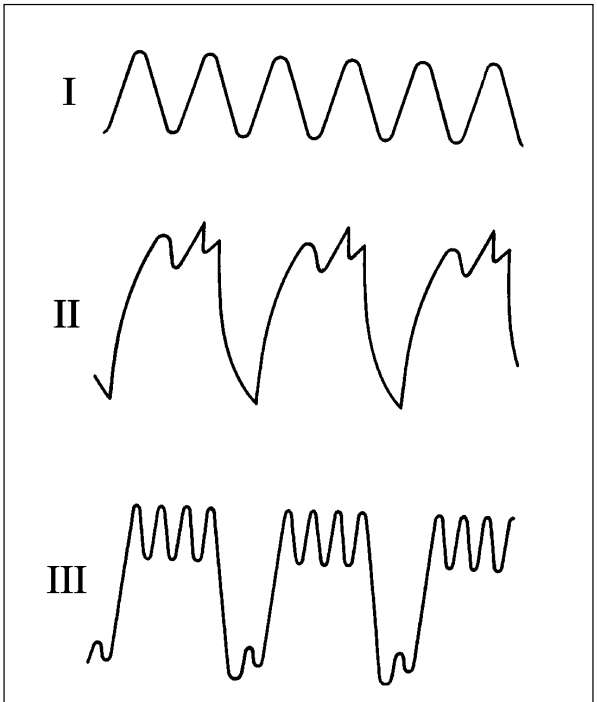


Fig.7-7. Alternator rectified waveform:
I - sound alternator; II - blown diode; III - diode circuit broken (stator winding)

When necessary, sand the slip rings with emery paper, then check the winding for continuity or earthing with an ohmmeter or a test bulb.

Stator - testing

The stator is tested separately after dismantling the alternator and disconnecting the winding from the diodes.

First test the stator winding for continuity or earthing using an ohmmeter or a test bulb and battery. The wire insulation should show no signs of overheating caused by short-circuit in the diode plate. Always renew the stator with a damaged winding.

Finally, using a special growler, check the stator winding for internal short-circuit.

Diodes - testing

A sound diode allows current only in one direction. A faulty diode can either prohibit the current flow (a broken circuit) or allow it in both directions (a short-circuit).

The complete diode plate must be renewed if any diode is found damaged.

The diode plate can be checked for a short-circuit with the alternator in the vehicle. For this disconnect leads from the battery and alternator and remove the slip ring end housing. Also the lead to the voltage regulator terminal «В» should be disconnected. In case of the alternator with an old voltage regulator do not forget to disconnect the voltage regulator terminal «Б» from the alternator terminal 30.

An ohmmeter or a test bulb (1-5 watt, 12 volts) and battery can be used as shown in Fig.7-8.

Note. *For easier diode fitting three diodes (marked red) make «positive» rectified voltage. These diodes are «plus» and are pressed within one diode plate connected to the alternator terminal 30. Three other diodes («minus», marked black) have «negative» rectified voltage to the housing. They are press-fitted to the other diode plate connected to earth.*

First make sure both positive and negative diodes are not shorted internally. For this connect the battery positive terminal through a test bulb to the alternator terminal 30, whilst the negative terminal - to the alternator housing (Fig.7-8, I). The illuminated bulb indicates shorted positive and negative diodes.

Short-circuit in the negative diodes can be detected by connecting the battery «plus» terminal through a test bulb to one of the diode plate securing bolts, while the «minus» to the alternator housing (Fig.7-8, II). The illuminated bulb is an indication of a short-circuit fault in one or more negative diodes. Note that in the latter case the bulb may come on as a result of stator winding being earthed to the alternator housing. However, this fault is much less frequent than short-circuits in the diodes.

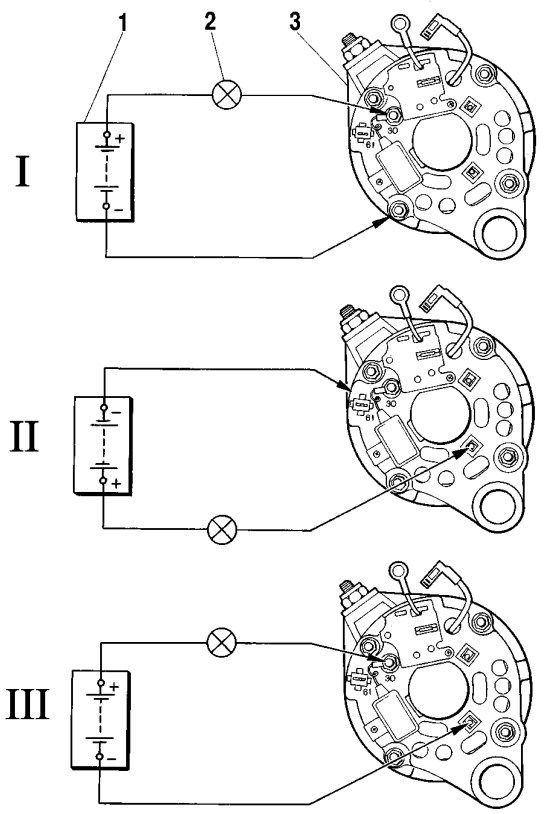


Fig.7-8. Diode check:
1 - battery; 2 - warning light; 3 - alternator; **I** - concurrent check of positive and negative diodes; **II** - check of negative diodes; **III** - check of positive diodes

Short-circuit in the positive diodes can be detected by connecting the battery «plus» terminal through a test bulb to the alternator terminal 30, while «minus» - to one of the diode plate securing bolts (Fig.7-8, III). The illuminated bulb advises about a short-circuit in one or more positive diodes.

Discontinuity in the diodes can be traced without dismantling the alternator either by means of an oscilloscope or a tester through a significant output current drop (20 to 30 percent) against the specification. If the alternator windings, supplementary diodes or voltage regulator are sound, whilst the diodes are not shorted, the cause of the output current drop is discontinuity in the diodes.

Supplementary diodes - testing

To check the supplementary diodes for short-circuit without removing and dismantling the alternator, make connections as shown in Fig.7-9. Similarly to the diode checking, disconnect the battery and alternator leads, remove the alternator housing, disconnect the lead to the voltage regulator terminal «В».

Connect the battery positive post through a test bulb (1-3 watt, 12 volts) to the alternator terminal 61, while the negative post - to one of the diode plate securing bolts.

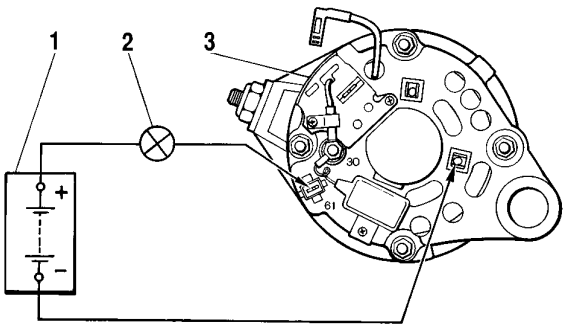


Fig.7-9. Checking the supplementary diodes:
1 - battery; 2 - warning light; 3 - alternator

An illuminated bulb advises about short-circuit in one or more supplementary diodes.

The damaged diode can be identified only after removing the diode plate and checking each diode.

Discontinuity in the supplementary diodes can be detected with an oscilloscope through distortions in the voltage waveform across terminal 61 and also by low voltage (below 14 volts) across terminal 61 at a medium rate of the alternator rotor.

Voltage regulator - testing

The function of the voltage regulator is to continuously adjust the field current flow to the alternator so that the alternator voltage is maintained within the preset range at various speed / load conditions of the alternator operation.

In-vehicle test. For this test you need a DC voltmeter with 15-30 volt scale and accuracy of at least 1.0 class.

Run the engine for 15 minutes at medium speeds with the headlights on, measure the voltage between the alternator terminal 30 and alternator earth. The reading should be within 13.6-14.6 volts.

When battery undercharge or overcharge becomes repetitive, while the adjustable voltage falls outside the specification, the voltage regulator must be renewed.

Off-vehicle test. For testing the voltage regulator, removed from the alternator, make the connections as shown in Fig.7-10. The pre-1996 voltage regulator should be tested complete with the brush holder (Fig.7-10, b), since at the same time you can detect a broken brush connection or a poor contact between the voltage regulator terminals and brush holder.

Connect a test lamp of 1-3 watt, 12 volts across the brush terminals. The terminals «В», «Б» (when available) and earth terminal should be connected first to the power supply of 12 volts and then to that of 15-16 volts.

With the sound voltage regulator, the lamp illuminates in the first case and goes out in the second case. If the lamp illuminates in both cases, there must be a break in the voltage regulator; when the bulb fails to light in both cases, the regulator circuit is broken or brush-to-regulator connection is loose (for pre-1996 alternators).

Capacitor - testing

The suppression capacitor is intended to protect the on-board electronic equipment against voltage surges in the ignition system along with suppression of radio interference.

A damaged capacitor or its loose fitting to the alternator (poor ground) is recognizable through increased radio interference with the engine running.

A simple way of testing the capacitor is to use a megohmmeter or a tester (scaled as 1-10 MOhm). In case of a sound capacitor, when its contacts are closed via the instrument, the needle should first deflect towards a lower resistance values and then gradually return to the initial position. The capacitance measured with a special device should be 2.2 microfarad ± 20%.

Alternator - overhaul

Alternatzor - dismantling

Clean the alternator and blow dry with compressed air. Release the clip to disconnect air intake 3 (Fig.7-11) from housing 4. Undo two screws 1 and nut from contact bolt extension 5,

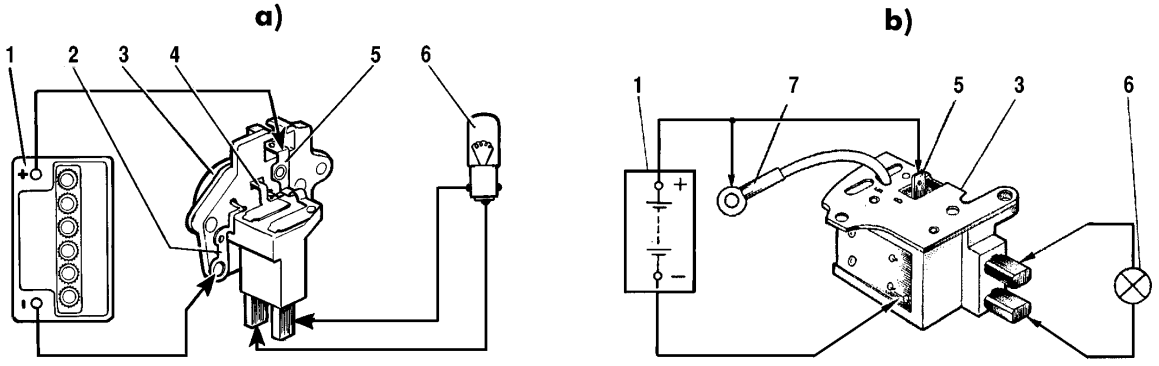


Fig.7-10. Checking the voltage regulator:
a - 1996-on voltage regulator; **b** - pre-1996 voltage regulator; 1 - battery; 2 - voltage regulator earth ; 3 - voltage regulator; 4 - voltage regulator terminal «Ш»; 5 - voltage regulator terminal «В»; 6 - warning light; 7 - voltage regulator terminal «Б»

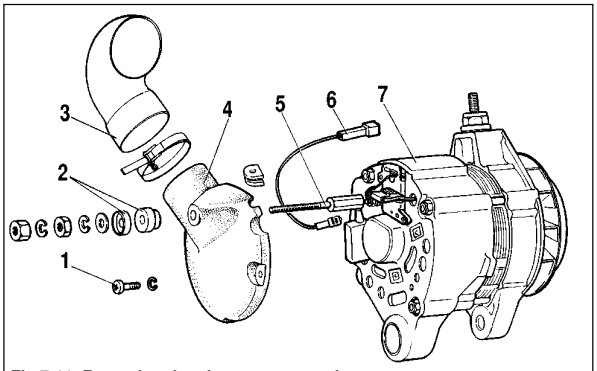


Fig.7-11. Removing the alternator protective case:
1 - securing screw; 2 - bushes; 3 - air intake; 4 - protective case; 5 - extension, alternator terminal 30; 6 - wire, alternator terminal 61; 7 - alternator

remove housing 4. Disconnect lead 6 from alternator terminal 61 and undo contact bolt extension 5.

Lock the alternator pulley with a tool from kit 67.7823.9504, undo the pulley retaining nut and press the pulley out using a puller.

Remove the pulley key and taper washer.

Tool kit 67.7823.9504 includes an ordinary picker and a grip. The grip consists of two steel half-rings, inserted into the pulley.

The half-rings are of the same cross-section area as the alternator drivebelt. At one end they are connected by means of the joint, at the other end they have levers to be compressed by hand when removing the pulley.

Disconnect the wire from the alternator terminal «B». Disconnect the voltage regulator and capacitor leads from alternator terminal 30, undo regulator 1 retaining screws (Fig.7-12) and withdraw it. In case of pre-1996 alternators to prevent damages to the brushes when removing the brush holder. Insert a screwdriver between regulator 2 housing and brush holder, then partly pull out the regulator from the alternator, leaving the brush holder in place. Next swing and withdraw the regulator complete with the brush holder from the alternator. Undo the retaining screw and remove suppression capacitor 20.

Undo clamp bolt 14 nuts, remove alternator housing 11 and rotor 8. Undo the bolt nuts, connecting diode ends to stator winding terminals, withdraw stator 7 from alternator housing 17.

Undo contact bolt 6 nut, disconnect the supplementary diode wire terminal from connector 3, remove diode plate 5.

Alternator - reassembly

The reassembly of the alternator is the reverse of the dismantling procedure.

In case of pre-1996 alternators (with detachable regulator / brush holder unit), in order to avoid damage to the brushes, before refitting the regulator complete with the brush holders, do not fully insert the brush holder into the regulator, it should be pushed in place only partly, then insert the assembly as such into the alternator. After the brush holder is refit into the alternator housing, press lightly the regulator into the alternator.

Out-of-concentricity for the holes in the alternator housings must not exceed 0.4 mm. Therefore during reassembly always insert a special gauge into these holes.

The taper spring washer of the pulley must be assembled with the convex side facing the nut. Tighten the pulley securing nut to a torque of 38.4-88 N•м (3.9-9.0 kgf•m)

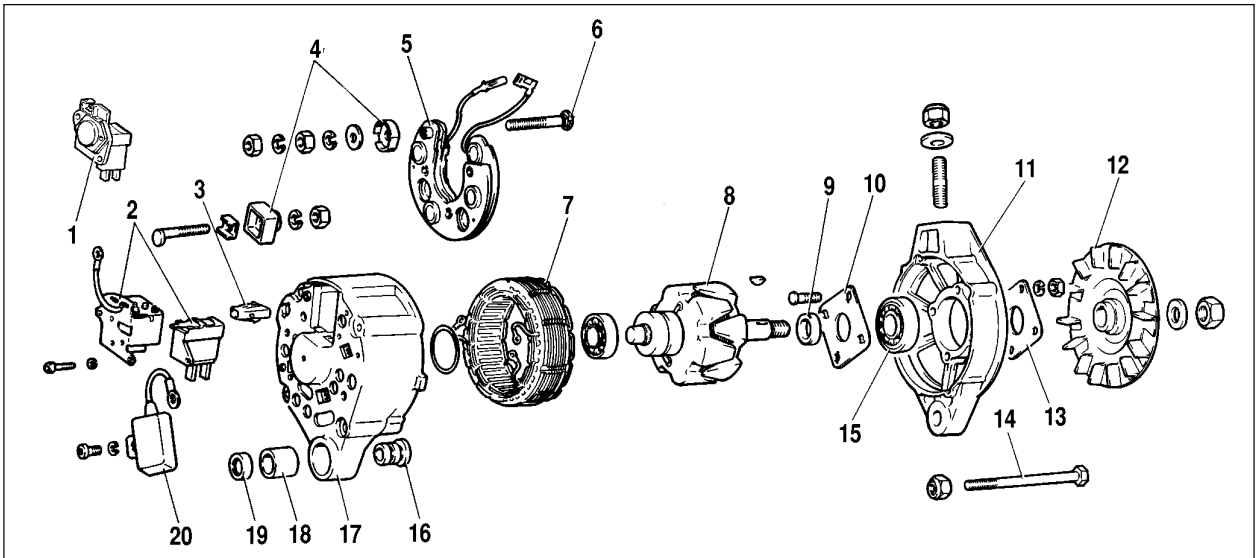


Fig.7-12. Alternator components:
1 - voltage regulator complete with brush holder, 1996-on alternators; 2 - voltage regulator and brush holder, pre-1996 alternators; 3 - supplementary diode connector; 4 - insulating bushes; 5 - diode plate; 6 - contact bolt; 7 - stator; 8 - rotor; 9 - spacer; 10 - inner washer for bearing attachment; 11 - drive end housing; 12 - pulley; 13 - outer washer for bearing attachment; 14 - clamp bolt; 15 - front rotor ball bearing; 16 - bush; 17 - slip ring end housing; 18 - buffer bush; 19 - hold-down bush; 20 - suppression capacitor

Brush holder - renewal

Always renew the complete unit if the regulator fails or brushes are worn or protrude from the holder to less than 5 mm.

In case of pre-1996 alternators, force the brush holder out of the voltage regulator housing by pressing the terminal «B». Avoid damaging the brushes, so remove and refit the regulator with the brush holder as described earlier in sections «Alternator - dismantling» and «Alternator - reassembly».

In case of 1996-on alternators with one-piece regulator/brush holder unit, renew the complete brush regulator/holder assembly.

Before refitting the voltage regulator with new brush holder, blow its locating place in the alternator clean from carbon dust and wipe off any oil contamination.

Rotor bearings - renewal

To remove a failed bearing from the drive-end housing, undo the nuts of screws holding the bearing retaining washers, remove the washers and screws, then press out the bearing on a hand press. Should the screw nuts fail to undo (the screw ends are bent-up), cut off the screw ends.

Refit the new bearing to the alternator housing only when the bore for the bearing is not deformed and its diameter is not over 42 mm. If the bore is bigger or deformed, renew the housing.

Using a press, drive in the bearing, then compress the bearing between two washers, held by the screws and nuts. Tighten the nuts and bend-up the screw ends. The slip ring rotor bearing is renewed together with the housing, since when the bearing is damaged, the recess in the housing is damaged too. The bearing is removed from the rotor using a puller; use a press tool to drive it into position.

Supplementary diodes - renewal

To replace a damaged diode, unsolder its pins, then carefully take the diode out from the plastic holder, taking care not to hit the diode plate. Clean the holder from epoxy, fit a new diode and solder it.

The colour-coded diode terminal must be re-soldered to the common output wire. After soldering, secure the diode to the holder with epoxy.

Starter motor

Specification

Maximum power, kW 1.3
Amperage at maximum power, not greater . . . . . .290±10
Amperage at 'brake-on', not greater 550
Amperage at idle without solenoid, not greater 60

General description

The starter motor is of pre-engaged type (35.3708 model), DC, with field coils, incorporating a double-winding solenoid.

Body 17 (Fig.7-13) houses four poles 18 with field windings, three of which are series and one is parallel. Covers 7 and 15 and starter housing 17 are held together by two bolts. The armature features a face-type commutator. The armature shaft runs in sintered shells 14, press fitted to cover 6 and 15.

The starter motor wiring diagram is shown in Fig.7-14. When the starter motor is switched on, the battery voltage is supplied through supplementary relay 4 (113.3747-10 model) to both solenoid windings (plunging winding II and holding winding I). The plunging winding shuts off when the solenoid contacts close.

Fault diagnosis

Cause	Remedy
At starter motor switch-on, armature fails to rotate, solenoid inoperative	
1. Battery defective or fully discharged	1. Charge or renew battery
2. Battery terminal posts and lead ends severely corroded; end loose	2. Clean battery posts and lead ends, tighten and apply a coat of petroleum jelly (Vaseline)
3. Solenoid faulty internally, earthed or broken	3. Renew solenoid
4. Starter motor relay defective	4. Clean relay contacts. Renew faulty relay
5. Starter relay winding power circuit open	5. Check wires and connections between ignition switch terminal 50 and relay terminal 86
6. Ignition switch contacts 30 and 50 fail to close	6. Renew ignition switch contact unit
7. Starter solenoid power leads broken	7. Check leads and connections: battery - starter cut-in relay - starter solenoid terminal 50
8. Stuck starter solenoid	8. Remove solenoid, check armature for smooth slide
No or slow armature rotation, solenoid inoperative	
1. Battery defective or fully discharged	1. Renew or charge battery
2. Battery posts and lead clamps severely corroded; ends loose	2. Clean battery posts and wire ends, tighten and apply a coat of petroleum jelly
3. Loose end of cable from power plant to body or between power plant to battery «minus» post	3. Tighten cable end fasteners
4. Solenoid terminal bolts oxidized or terminal bolt wire end retaining nuts loose	4. Clean terminal bolts, tighten lead retaining nuts
5. Commutator burnt, brushes sticking or worn	5. Clean commutator, renew brushes
6. Stator winding or armature broken or shorted	6. Renew stator or armature
7. Positive brush holder earthed	7. Eliminate shock-circuit or renew commutator end cover

Solenoid repetitive cutting in and out

1. Battery discharged	1. Recharge battery
2. Excessive voltage drop in solenoid power circuit caused by badly oxidized lead ends	2. Check leads and connections between battery and solenoid terminal 50
3. Solenoid holding winding broken or shorted	3. Renew solenoid

Starter motor armature rotates, flywheel inoperative

1. Overrun clutch slipping	1. Bench test starter motor, renew overrun clutch
2. Clutch operating lever broken or pivot shaft dropped	2. Renew lever or refit pivot shaft
3. One-way clutch guide ring or buffer spring broken	3. Renew clutch

Starter motor noisy

1. Starter motor retaining nuts loose or drive-end housing broken	1. Tighten retaining nuts or overhaul starter motor
2. Starter wrongly mounted	2. Check starter fitting
3. Bearing shells or armature shaft journals excessively worn	3. Renew starter motor
4. Stator pole loose (armature touches pole)	4. Tighten pole retaining screw
5. Pinion or ring gear teeth damaged	5. Renew drive or flywheel
6. Pinion fails to disengage ring gear:	6. Carry out the following:
- operating lever seized;	- renew operating lever;
- overrun clutch jams in mesh with armature shaft splines;	- clean and lubricate splines with motor oil;
- clutch or solenoid springs loose or broken;	- renew clutch or solenoid;
- clutch hub circlip lost;	- renew damaged components;
- solenoid armature sticking;	- renew solenoid or eliminate sticking
- ignition switch contact part faulty: pins 30 and 50 fail to open	- check correct contact closing at different key positions; renew faulty contact unit

Starter motor - bench testing

If the starter motor fails to operate effectively, check it using a tester. The wiring connections for the test are shown in Fig.7-15. The cross-sectional area of leads to power source, ammeter and starter solenoid terminal bolt should be at least 16 mm^2.

The starter motor test temperature should be (25±5)°C. The brushes must slide smoothly on the commutator.

Functional test. By closing switch 5 (Fig.7-15), operate the starter motor three times from a 12 volt source at different braking conditions, eg. at the braking moments of 2; 6 and 10 N•m (0.2; 0.6 and 1 kgf•m). The starter motor should be switched on for no longer than 5 seconds with minimum 5 second intervals in-between.

If the starter motor fails to turn the tester ring gear or produces unusual noise, dismantle the starter motor and examine its components.

Fully locked ring test. Lock the tester ring gear, operate the starter motor and measure the current, voltage and braking moment to be maximum 550 amps, 7.5 volts and at least 13.7 N•m (1.4 kgf•m) respectfully. Do not switch on the starter motor for over than 5 seconds.

When the braking moment is below, while the current is over the values specified, the likely reason is an internal short-circuit of the stator or armature winding or earthed winding.

When the braking moment and current are below the values specified, the possible cause is an oxidized or dirty commutator, severely worn brushes or weak springs, sticking brushes, loose stator winding terminals, eroded or burnt solenoid terminal bolts.

At fully locked condition, the starter armature must not turn; when otherwise the one-way clutch is faulty.

Dismantle the starter motor, replace or overhaul damaged components to remedy the situation.

No-load test. Disengage the tester ring gear from the starter motor pinion. Operate the starter motor, measure the current flow and armature shaft speed to be respectively maximum 60 amps and (5000±1000) rpm at 11.5-12 volts across the starter motor terminals.

If the amperage and drive shaft rpm readings differ from the values specified, the possible causes are likely to be the same as those for the test described above.

Solenoid test. Insert a shim of 12.8 mm between stop collar 21 (Fig.7-13) and pinion and operate the solenoid. The solenoid cut-in voltage, with the pinion resting against the shim, should not exceed 9 volts at ambient (20±5)°C. Any higher voltage indicates the solenoid or drive failure.

Starter motor relay. The relay cut-in voltage should not exceed 8 volts at (23±5)°C. When higher, it is an indication of a failed relay or drive.

Starter overhaul

Dismantling

Undo the nut on the lower solenoid terminal bolt and disconnect the stator winding lead. Undo the solenoid retaining nuts and remove the solenoid. Remove the end cap (Fig.7-16) from the pinion-end cover.

Unscrew and remove protective case 8. Recover lock ring 9, undo clamp bolts 12 and separate yoke 11 with housing 5 from housing 1 with armature 13.

Unscrew the brush holders from the stator winding leads, then separate the yoke from the commutator end housing. Extract springs 7 and brushes 6.

Undo the cotter pin and withdraw the lever and armature / actuator assembly, next disconnect the operating lever.

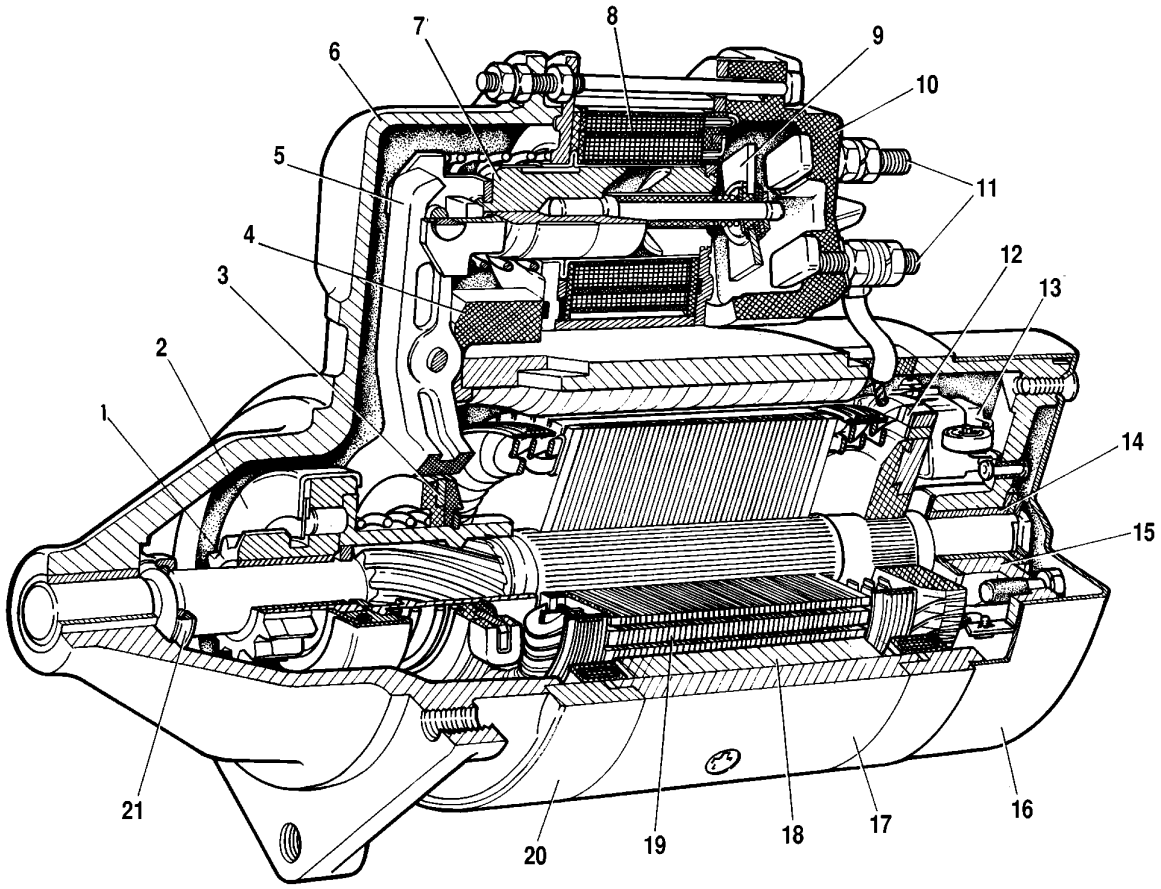


Fig.7-13. Starter motor (35.3708 model):
1 - pinion; 2 - overrun clutch; 3 - guide ring; 4 - rubber plug; 5 - operating lever; 6 - drive-end housing; 7 - relay armature; 8 - relay winding; 9 - contact plate; 10 - relay cover; 11 - terminal bolts; 12 - commutator; 13 - brush; 14 - armature shaft bush; 15 - commutator-end housing; 16 - end cover; 17 - housing; 18 - stator pole; 19 - armature; 20 - intermediate ring; 21 - stop collar

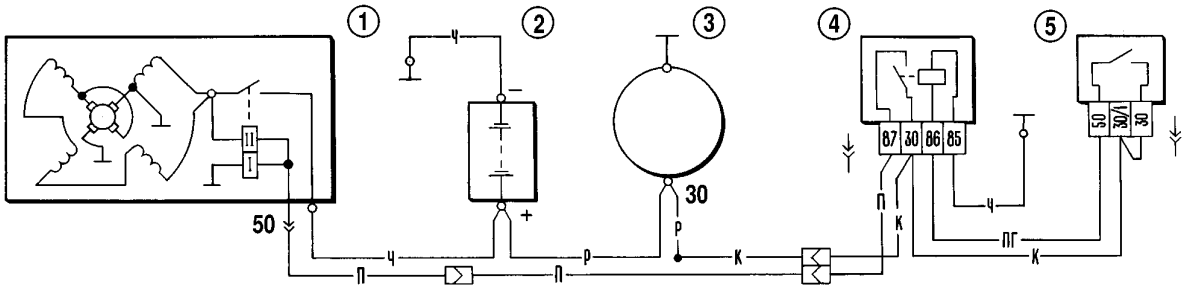


Fig.7-14. Starter wiring connections:
1 - starter motor; 2 - battery; 3 - alternator; 4 - starter cut-in relay; 5 - ignition switch

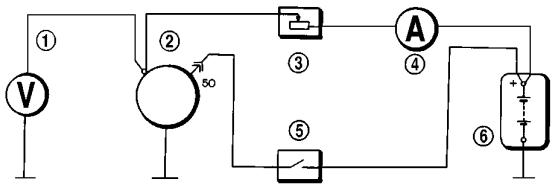


Fig.7-15. Wiring connections for starter motor testing:
1 - voltmeter with scale limit at least 15 v; 2 - starter motor; 3 - rheostat, 800 amps; 4 - amperemeter shunted to 1000 amps; 5 - switch; 6 - battery

To withdraw the actuator unit from the armature, retrieve the circlip from under stop collar 16. Dismantle the actuator unit after removing the lockwasher from the clutch hub.

To dismantle the solenoid, undo the clamp bolt nuts and unsolder the winding leads from terminal 50 and from the end which is secured at the bottom solenoid terminal bolt.

Once the starter motor has been dismantled, blow its parts with compressed air and wipe clean.

Components - inspection

Armature. Using a megohmmeter or a 220 v test lamp, check the armature for the earthed winding. The voltage through the test lamp is supplied to the commutator segments and armature core. An illuminated lamp is an indication of a commutator being shorted to earth. When using the megohmmeter, the reading should be at least 10 kOhms. Renew the earthed armature.

Using a specialized device, check for internal faults in the armature winding and commutator segments, check for loose connections where the winding wires are soldered to the commutator.

Inspect the commutator. When dirty or burnt, sand it with fine emery paper. Check the runout between the core and shaft journal. Renew the armature when the runout is over 0.08 mm.

Check the surfaces of splines and armature shaft journals. There should be no scuffs, scores or wear. In the event the shaft surface has yellow marks because of the pinion bush, remove the marks with the help of fine emery paper, since this can possibly cause a pinion jam in the shaft.

Actuator unit. The starter motor actuator unit should operate over the armature shaft smoothly, without jams. The pinion should turn on the armature shaft in the direction of the armature rotation at a maximum torque of 0.27 Н•м (2.8 kgf•cm).

The pinion is not supposed to turn in the reverse direction. If the teeth are scored, regrind them with a small-diameter fine abrasive disc.

When the drive-associated components are damaged or badly worn, renew the actuator assembly.

Stator. Using megohmmeter or a 220 v test lamp, check the stator winding is not earthed.

The test lamp voltage is supplied to the common winding terminal and starter housing. When the bulb is lit up or megohmmeter resistance reading is below 10 kOhm, or if the windings have evidence of overheating (blackened insulation), renew the housing complete with the windings.

Housings. Inspect the housings for cracks. If this is the case, replace the housings with new ones.

Examine the bushes. When they are worn, renew the complete housings or only the bushes. When the new bushes are pressed-in, ream them to 12.015+0.03 mm.

Make sure the brush holders are properly secured on the commutator end housing. The «positive» brush holders must not be earthed. The brushes should slide smoothly in the holder slots. Renew the brushes worn to 12 mm in height, but first run them in to the commutator.

Using the dynamometer, check the spring load at the brushes to be 9.8±0.98 N (1±0.1 kgf) for new brushes, renew the spring, when applicable.

Solenoid. Check the solenoid armature for smooth operation. Using ohmmeter, check the closing of the solenoid terminal bolts via a contact plate. When there is no contact, the solenoid should be dismantled and the terminal bolts to be sanded with fine emery paper or a superfine flat file.

You may turn the terminal bolts 180°C in case they are badly damaged at the contact point with the contact plate.

Reassembly

Assemble the starter motor in reversal of the dismantling procedure. Before reassembly lubricate the armature shaft splines and freewheel hub, pinion and housing bushes with motor oil. Lubricate drive guide ring with Litol-24 grease.

Protect the clamp bolt passing under the stator coils with an insulating plastic tube.

Select shim 10 thickness (Fig.7-16) to ensure maximum armature axial play of 0.5 mm. On reassembly, bench test the starter motor.

Ignition system

General description

The ignition system is breakerless. It comprises ignition distributor 5 (Fig.7-17), spark control module 3, ignition coils 4, spark plugs 6, ignition switch 1 with relay 2 (113.3747-10 model) and high-tension (HT) leads. The spark control module monitors the supply circuit of the ignition coil primary winding. Control pulses to the control module are generated by the Hall sensor housed in ignition distributor 6.

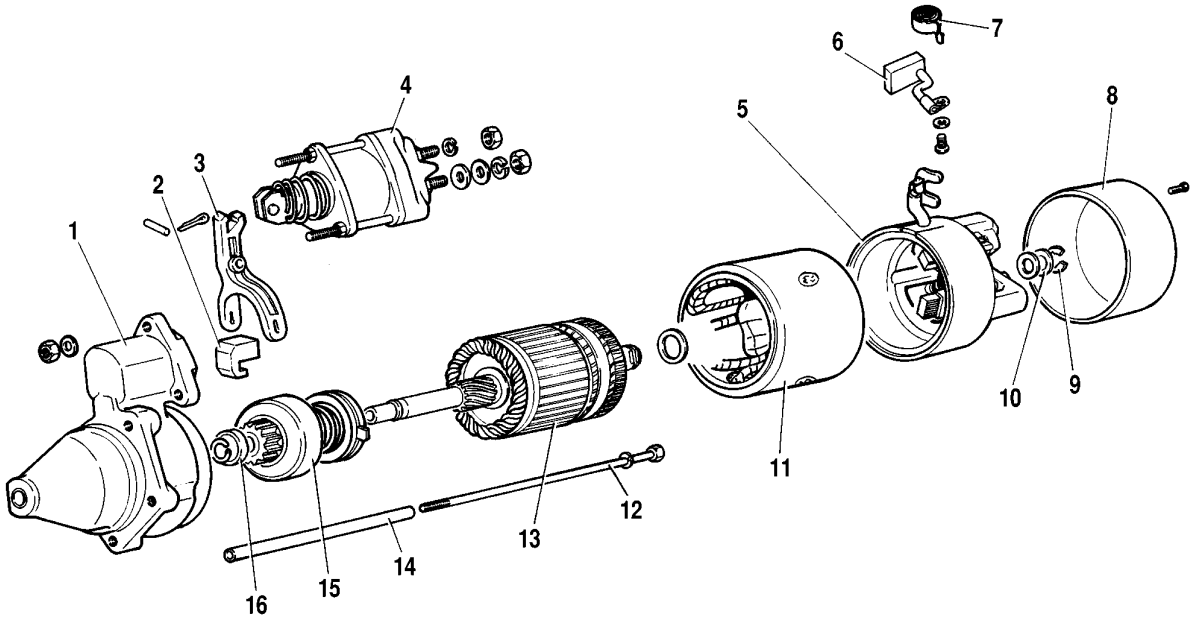


Fig.7-16. Exploded view of starter motor:
1 - drive end housing with intermediate ring; 2 - rubber plug; 3 - operating lever; 4 - solenoid; 5 - commutator end housing; 6 - brush; 7 - brush spring; 8 - protective case; 9 - stop ring; 10 - adjusting shim; 11 - yoke; 12 - clamp bolt; 13 - armature; 14 - insulating pipe; 15 - overrun clutch with pinion; 16 - stop collar

Ignition distributor is of 3810.3706 model, four-event sparking rate, non-shielded, with vacuum and centrifugal advance units, with built-in Hall sender.

Spark control module is of 3620.373 model, or 76.3734, or RT1903, or PZE4022, or K563.3747 model. The module processes the control output pulses from the Hall sender into current pulses for the ignition coil primary winding.

Ignition coil is of 8352.12, or 27.3705, or 027.3705, or 27.3705-01 model, oil-filled, sealed, open-loop magnetic circuit.

Spark plugs are of A17ДВРМ model, or A17ДВРМ1 model with suppressant chokes.

Ignition switch is of 2101-3704000-11 model, theft-deterrent.

Fault diagnosis

Cause	Remedy
Engine will not start	
1. Hall sender pulses fail to reach control module:	1. Carry out the following:
- broken circuit between sender and control module;	- check wiring and connections, renew damaged wires;
- Hall sensor faulty	- check Hall sensor using adapter and voltmeter; renew failed sensor
2. No pulses to primary winding:	2. Carry out the following:
- broken circuit between control module and solenoid or control module and ignition coil;	- check wires and connections; renew damaged wires;
- control module faulty;	- check control module with oscilloscope; renew faulty control module
- ignition switch or ignition relay failed	- check, renew faulty contact unit of ignition switch or ignition relay
3. No HT to spark plugs:	3. Carry out the following:
- HT lead ends loose, broken off or oxidized; leads dirty or insulation damaged;	- check and restore connections, clean or renew leads;
- carbon brush worn or damaged, or has no contact with rotor arm;	- check and when necessary renew carbon brush;
- tracking through cracks or burns in distributor cap or rotor, through damp or foul distributor cap inside;	- check, clean cap from moisture and carbon deposits, renew cap and rotor in case of cracks;
- distributor rotor resistor blown;	- renew resistor;
- ignition coil damaged	- renew ignition coil
4. Oily spark plugs or wrong electrode gap	4. Clean and regap spark plugs
5. Spark plug damaged (perished insulation)	5. Renew spark plugs
6. Wrong HT leads connection to distributor cap terminals	6. Reconnect leads as per firing order 1-3-4-2
7. Wrong ignition timing	7. Check and adjust ignition timing
Engine operates erratically or stalls at idle	
1. Ignition timing too advanced	1. Check, adjust ignition timing
2. Electrode gap excessive	2. Check, adjust electrode gap
Engine running unstable or irregular at high crankshaft speeds	
Weak weight springs in ignition distributor	Renew springs, run functional bench test of centrifugal unit

Engine gasps at all speeds

1. Ignition wires damaged, connections loose or lead ends oxidized	1. Examine leads and connections. Renew damaged leads
2. Electrodes worn or oily spark plugs, strong fouling; cracks in plug insulation	2. Examine plugs, regap spark plugs, renew damaged spark plugs
3. Carbon brush in ignition distributor worn or damaged	3. Renew carbon brush
4. Strong burning of central contact point on distributor rotor arm	4. Clean central contact
5. Cracks, fouling or burnings of rotor arm or distributor cap	5. Inspect, renew rotor or cap
6. Control module faulty - wrong waveform of ignition coil primary winding impulses	6. Check spark control module with oscilloscope, renew faulty control module

Engine lacking power or sluggish

1. Incorrect ignition timing	1. Check and adjust ignition timing
2. Jammed distributor weights, weak weight springs in ignition distributor	2. Examine and renew damaged parts
3. Spark control module faulty - wrong waveform of ignition coil primary winding pulses	3. Check spark control module with oscilloscope, renew faulty control module

WARNING. The vehicle is fitted with high energy transistorized ignition system with extended application of electronic components. Caution should be exercised to avoid personal injury or damage to electronics. Always observe the following rules.

Do not touch any ignition system parts (spark control module, coil or HT leads) when the engine is running.

Do not start the engine through a spark plug gap and do not check the ignition system through sparking between the ends of the spark plug leads and earth lead.

Do not route LT and HT ignition leads together within one wiring harness.

Always ensure the spark control unit is reliably earthed through the retaining dowels, or its trouble-free operation will be affected.

With ignition switched on, never disconnect the leads from the battery posts and never remove the connector from the spark control unit, since it may result in higher voltage to some components and damaged control module.

Ignition timing - adjustment

Refer to Attachment 3 for the advance angle BTDC at crankshaft speeds of 750-800 rpm.

To check the ignition timing there provided three marks - 1, 2 and 3 (Fig.7-18) on the timing cover and mark 4 in the crankshaft pulley, which corresponds to TDC of pistons No1 and No4 when aligned with mark 1 on the timing cover.

The ignition timing is best checked and adjusted by means of a stroboscopic timing light. Follow the procedure below:

- connect the timing light positive clamp to the battery positive post, earth terminal clamp to the battery negative post, connect the timing light terminal to No1 cylinder HT lead. Highlight in chalk timing mark 4 on the crankshaft pulley;

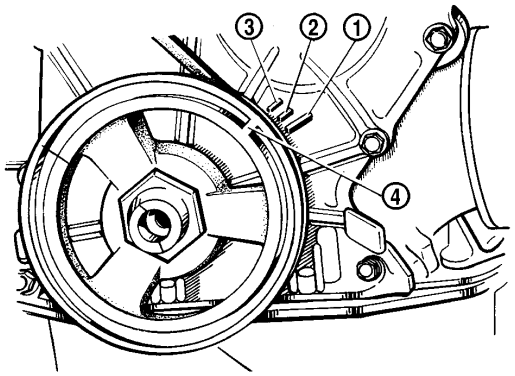


Fig.7-18. Ignition timing marks:
1 - TDC mark; 2 - 5°advance timing mark; 3 - 10° advance timing mark; 4 - TDC mark on crankshaft pulley

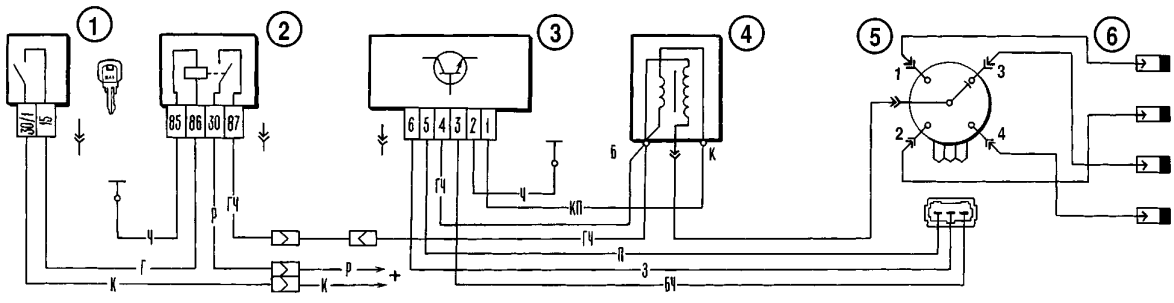


Fig.7 -17. Wiring diagram of ignition system:
1 - ignition switch; 2 - ignition solenoid; 3 - spark control unit; 4 - ignition coil; 5 - ignition distributor; 6 - spark plugs

- start the engine and point the flashing timing light at the timing mark on the pulley; when the ignition is correct, then at idling speed the TDC mark on the flywheel should be as outlined in Attachment 3.

To adjust the ignition timing, switch off the engine, slacken the nuts securing the ignition distributor and turn the latter to the angle desired (clockwise for advance and anticlockwise for retard when viewed from the distributor cap end). Tighten the nuts and recheck the ignition timing.

For easier ignition timing adjustment there provided the respective graduations and **(+)**/**(-)** marks on the distributor flange.

A graduation on the distributor flange corresponds to eight degrees (8°) of the crankshaft turn.

Another effective way for checking the ignition timing is to use an oscilloscope analyzer, when this tool is available.

Refit the distributor as following:

- turn the crankshaft to the position of compression beginning at No1 piston; then still turning the crankshaft, align mark 4 with mark 1;

- remove the distributor cap, turn the rotor arm so that its exterior contact faces the No1 piston contact on the distributor cap;

- holding the distributor driveshaft stationary, insert it to the cylinder block so that the axial line through the spring clamps is nearly parallel to the engine axial line;

- locate the distributor to the cylinder block, refit the distributor cap, reconnect the wiring, check and adjust timing ignition.

Ignition components - bench testing

Ignition distributor

The distributor of 3810.3706 model is shown in Fig.7-19.

Functional test. Mount the distributor on the tester intended for checking electrical devices. Connect it to a variable speed motor.

Connect the distributor terminals to the ignition coil, spark control module and battery of the tester similar to the wiring in the vehicle. Connect four terminals of the distributor cap to the spark box with adjustable gaps.

Set the spark gap to 5 mm, switch on the tester motor and operate the distributor driveshaft clockwise for some minutes at 2000 rpm. Increase the gap to 10 mm and check for internal discharges in the distributor. These can be recognized by specific sounds or weak or intermittent sparking in the tester spark box.

No noise should be produced by the ignition distributor at any driveshaft speed.

Automatic ignition advance control. Mount the ignition distributor on the tester and connect it to terminals 3, 5 and 6 of tester control module 1 (Fig.7-20). Connect control module terminal 4 to the tester «plus», while terminal 1 - to the tester «breaker» terminal. Set the spark gap to 7 mm.

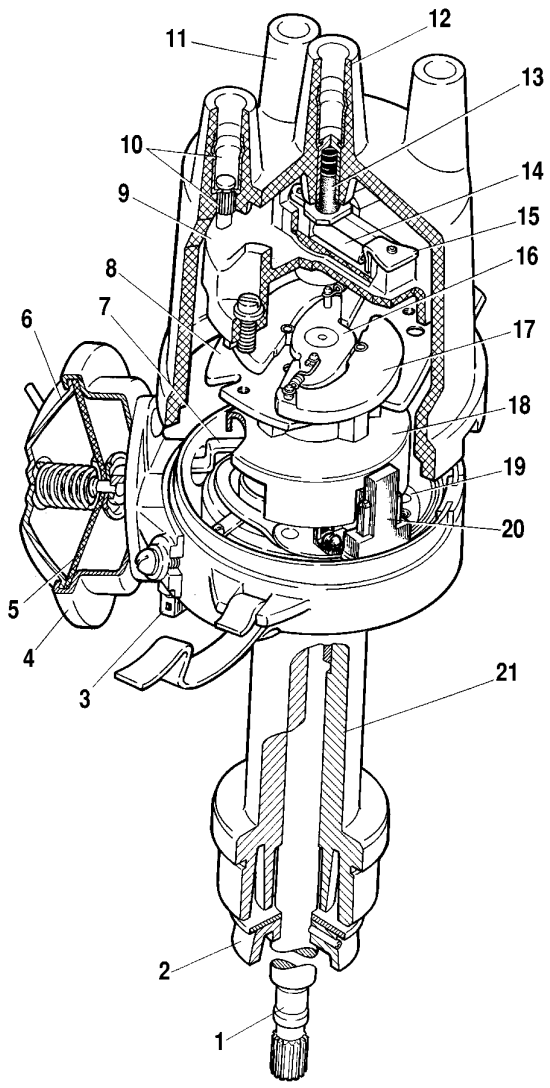


Fig.7-19. Ignition distributor (3810.3706 model):
1 - shaft; 2 - oil screen collar; 3 - connector; 4 - vacuum advance housing; 5 - diaphragm; 6 - vacuum advance cover; 7 - vacuum advance operating rod; 8 - bearing plate, centrifugal advance unit; 9 - ignition distributor rotor; 10 - side electrode and terminal; 11 - cover; 12 - centre electrode and terminal; 13 - centre electrode carbon brush; 14 - resistor; 15 - outside rotor contact breaker point; 16 - centrifugal advance unit plate; 17 - weight; 18 - screen; 19 - Hall sensor bearing plate; 20 - Hall sensor; 21 - ignition distributor body

Switch on the tester motor and operate the distributor shaft at 500-600 rpm. On the tester graduated disc note the angle at which one of the four sparkings occurs.

While increasing the speed in steps of 200-300 rpm and watching the disc, determine the advance angle with respect to the distributor shaft speed. Compare the resulting centrifugal advance pattern to that in Fig. 7-21.

When the pattern differs from that shown in Fig.7-21, it can be adjusted by bending the weight spring brackets of the centrifugal advance unit. Bend the thinner spring bracket for speeds

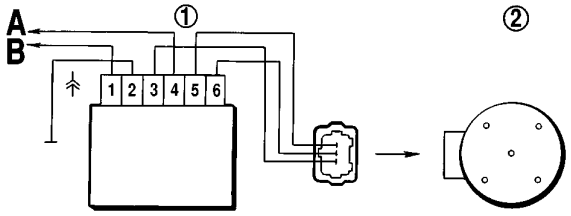


Fig.7-20. Checking the ignition distributor on the test bench:
1 - spark control module; 2 - ignition distributor; A - to test bench «plus» terminal; B - to test bench «breaker» terminal

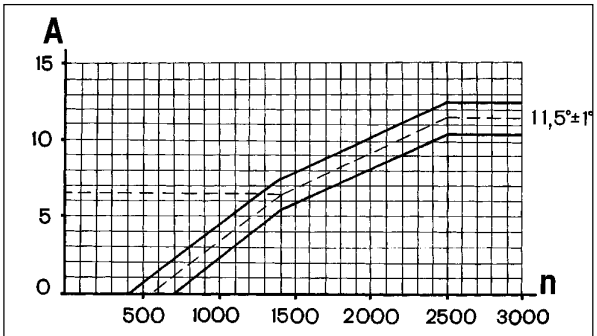


Fig.7-21. Centrifugal advance ignition distributor map:
A - advance timing, degrees; n - ignition distributor shaft speed, rpm

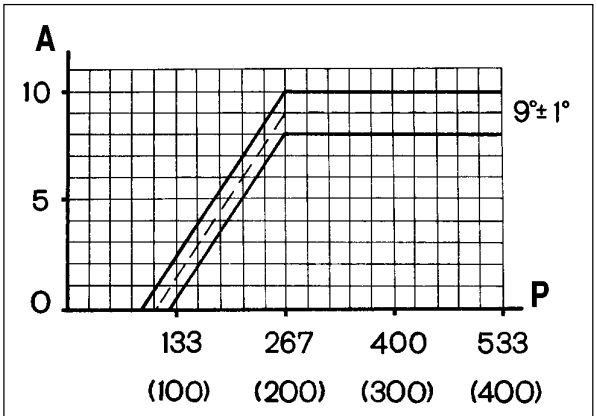


Fig.7-22. Ignition distributor vacuum advance map :
A - advance, degrees; P - vacuum gPa (mm Hg)

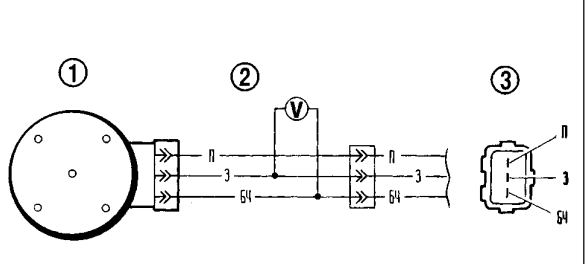


Fig.7-23. Wiring diagram for Hall sensor in-vehicle test:
1 - ignition distributor; 2 - adapter with voltmeter of at least 15 v scale and internal resistance of minimum 100 kOhm; 3 - view on ignition distributor connector

up to 1500 rpm or the thicker spring bracket for speeds over 1500 rpm. Increase the spring tension for a smaller angle (retard) or decrease the spring tension for a bigger angle (advance).

To obtain the vacuum advance pattern, connect the vacuum advance unit to the vacuum pump of the tester.

Operate the tester motor and run the distributor driveshaft at 1000 rpm. Watching the tester graduated disc, note the angle at which one of the four sparking events occurs.

Smoothly increase the vacuum through every 26.7 gPa (20 mm Hg) and make note of the advance angle with respect to the initial value. Compare the resulting advance pattern with that in Fig.7-22.

Note the Hall sensor mounting plate invariably returns to its original position after vacuum has been removed.

Hall sensor. The Hall sensor produces the output voltage if there is a steel vane in the air gap. The output is around zero volts when there is no vane in the gap.

With the distributor removed from the engine, the sensor can be tested as illustrated in Fig.7-24 at supply voltage of 8-14 volts.

While slowly rotating the distributor shaft, measure the output using a voltmeter. The voltage should change sharply between the low level (0.4 volt maximum) and the high level, which must be maximum 3 volts below the supply voltage.

The Hall sensor can be tested in the vehicle as shown in Fig.7-23. Adapter 2 and a voltmeter are connected across the distributor connector and wiring harness connector. Switch on the ignition and measure the sensor output with a voltmeter, while slowly rotating the crankshaft with a special tool. The output voltage readings should meet the specification.

Ignition coil

Check resistance of the winding and insulation.

For the ignition coil of 27.3705 model the resistance at 25°C should be 0.45±0.05 Ohm for the primary winding and 5±0.5 kOhm for the secondary winding. For the ignition coil of 8352.12 model the resistance of the primary winding is 0.42±0.05 Ohm, while that of the secondary winding is 5±1 kOhm.

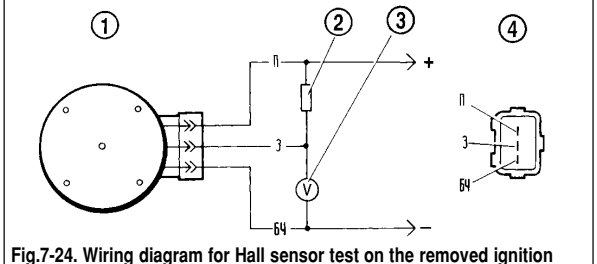


Fig.7-24. Wiring diagram for Hall sensor test on the removed ignition distributor:
1 - ignition distributor; 2 - 2kOhm resistor; 3 - voltmeter of minimum 15 v scale and minimum 100 kOhm internal resistance; 4 - view on the ignition distributor connector

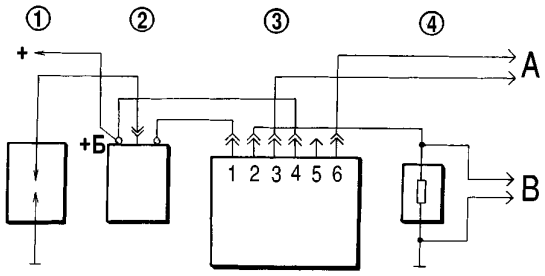


Fig.7-25. Checking the spark control module:
1 - spark gap; 2 - ignition coil; 3 - control module; 4 - 0.01 Ohm resistor (1%, at least 20 W); A - to square wave generator; B - to oscilloscope

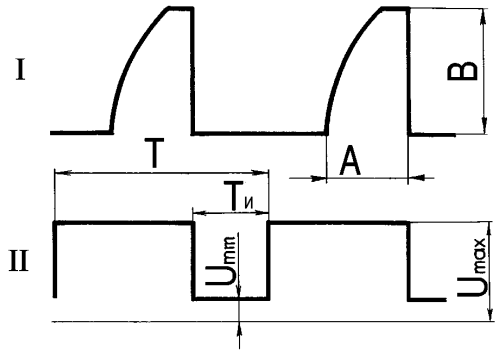


Fig.7-26. Displaying pulse waveform at the oscilloscope:
I - control module pulses; II - alternator pulses; A - dwell (current saturation time); B - maximum current; T - pulse period; Ти - pulse width

Resistance of the insulation to earth should be at least 50 MOhm.

Spark control module

The spark control module can be tested using an oscilloscope and square wave pulse generator connected as shown in Fig.7-25. The pulse generator resistance should be 100-500 Ohm. It is preferable to use a double-channel oscilloscope - the 1st channel is for the generator pulses, while the 2nd channel - for the control module pulses.

Square wave pulses, simulating those of the distributor sensor, are supplied to the module terminals 3 and 6. The pulse frequency should be within 3.33 - 233 Hz, while the duty cycle (period-to-pulse length ratio, T/Ти) should be set to 3. The maximum voltage (Umax) is 10 volts, the minimum voltage (Umin) should not exceed 0.4 volts (Fig.7-26, II). A sound control module should generate the pulses as shown in oscillogram I.

For 3620.3734 and 76.3734 modules at the supply voltage 13.5±0.5 volts, the current flow **(B)** should be from 7.5 to 8.5 amps. There is no standard dwell (current saturation) **(A)**.

For RT1903 module at the supply voltage of 13.5±0.2 volts and frequency of 25 Hz, the current flow is 7 to 8 amps, while the dwell is 5.5 to 11.5 milliseconds.

For PZE4022 module at the supply voltage of (14±0.3) volts and frequency 25 Hz, the current flow is 7.3-7.7 amps, while the dwell is not specified.

For K563.3747 module at the supply voltage of (13.5±0.5) volts and frequency 33.3 Hz, the current flow is 7.3-7.7 amps, while the dwell is not specified.

Any distortions in the pulse waveform can result in misfires or retarded ignition. The engine will tend to overheating and will not develop maximum power.

Spark plugs

If the spark plugs are foul or have deposits, then prior to testing clean them by means of a sand blasting machine and blow with compressed air. When the insulator nose is covered with light tan to greyish brown deposits, there is no need to clean them, as it is indicative that the mixture is correct and the engine is in good condition.

Once the plugs have been cleaned, examine them and set the correct spark gap. If the insulator is chipped, cracked or the side electrode weld is perished, renew the spark plug.

Check the spark plug gap (it is to be 0.7-0.8 mm) with a round wire feeler blade. It is not recommended to use a flat feeler blade since it is cannot account for erosion (cut-out) on the outer electrode which appears in course of operation. Bend, open or close, the outer (side) plug electrode only until the correct gap is achieved.

Leak test. Screw the plug into the seat on the tester and tighten it to a torque of 31.4-39.2 N•m (3.2-4 kgf•m). Build up the pressure of 2 MPa (20 kgf/cm^2) in the tester chamber.

Take an oil cup and place a few drops of oil or kerosine on the spark plug; the broken tightness is evident through the air bubbles between the insulator nose and metal plug body.

Electrical test. Insert the spark plug to the seat on the tester and tighten to the torque specified above. Adjust the gap between the spark box electrodes to 12 mm, which corresponds to 18 kvolts; afterwards, using a pump, build the pressure up to 0.6 MPa (6 kgf/cm^2).

Fit the end of the HT cable to the plug and apply HT pulses.

The spark plug is sound when a good spark is observed through the tester sight window. When sparking takes place between the spark box electrodes, decrease the pressure in the tester. Next recheck the pressure value when the spark jumps between the spark plug electrodes.

When sparking occurs at the pressure below 0.3 MPa (3 kgf/cm^2), the spark plug is defective.

Only a few sparks are allowed in the spark gap; when no sparking is observed either on the spark plug or in the spark gap, it is likely that the insulation is cracked and the central electrode arcs internally to earth. Always discard such spark plugs.

Ignition switch

Check the ignition switch contacts are closing properly at different key positions (Table 7-5) and theft-deterrent device is functional. The battery and alternator voltage is supplied to terminals 30 and 30/1. The vacant terminal «INT» is intended for radio/cassette player connection.

The steering lock pin moves out when the key is turned to position III «parking» and is then removed from the switch. The lock pin moves in after the ignition key is turned from position III «parking» to position 0 «ignition off». The key can only be removed from position III.

When inserting the contact part into the ignition switch housing, locate it so that terminals 15 and 30 are on the lock pin side (Fig.7-27), ensure the wider end of the contact part is well within the wider slot of the ignition switch housing.

Suppression components - testing

The following is used for interference suppression:

- 1 kOhm resistor in the distributor rotor arm;

- resistive HT cables of (2000±200) Ohm/m for red leads (ПВВП-8) or (2550±270) Ohm/m for blue leads (ПВППВ-40);

- 4-10 kOhm resistors in the spark plugs;

- 2.2 microfarad capacitor in the alternator.

The leads and resistors are checked with an ohmmeter. Refer to subsection «Alternator» for the capacitor checking procedure.

Lighting and signalling

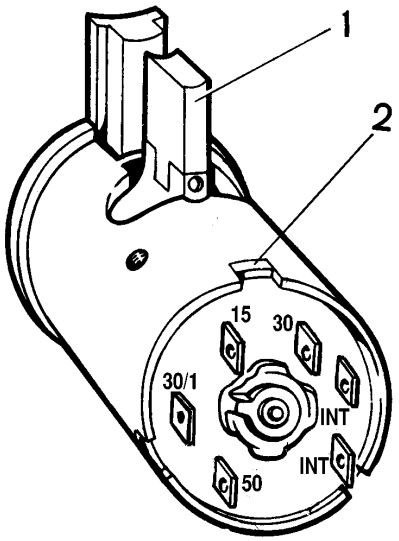


Fig.7-27. Ignition switch contact unit:
1 - lock pin; 2 - wider part of contact unit

Table 7-5

Circuits activated at different ignition switch positions

Position	Live contacts	Circuits activated
0 (Off)	**30 and 30/1**	–
I (Ignition)	**30-INT**	–
	30/1-15	Alternator field winding. Ignition system. Direction indicators. Instruments. Heater unit. Heated rear window. Wipers: windscreen, rear window, headlight .
II (Starter motor)	**30-INT**	–
	30/1-15	Refer to position **I**
	30-50	Starter motor
III (Parking)	**30-INT**	

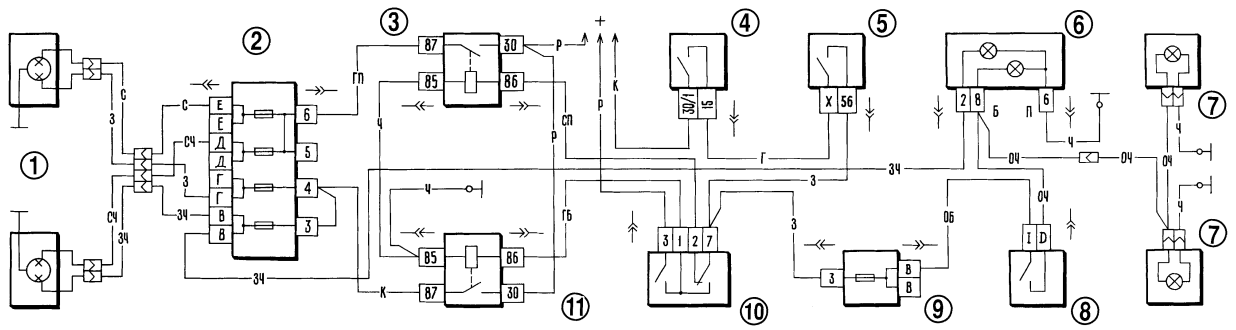


Fig.7-28. Wiring diagram for headlight and foglight:
1 - headlights; 2 - main fusebox; 3 - low beam relay; 4 - ignition switch; 5 - exterior light switch; 6 - warning lights: high beam (left) and fog lamp (right); 7 - rear fog light; 8 - fog light switch; 9 - complementary fusebox; 10 - headlight switch; 11 - high beam relay

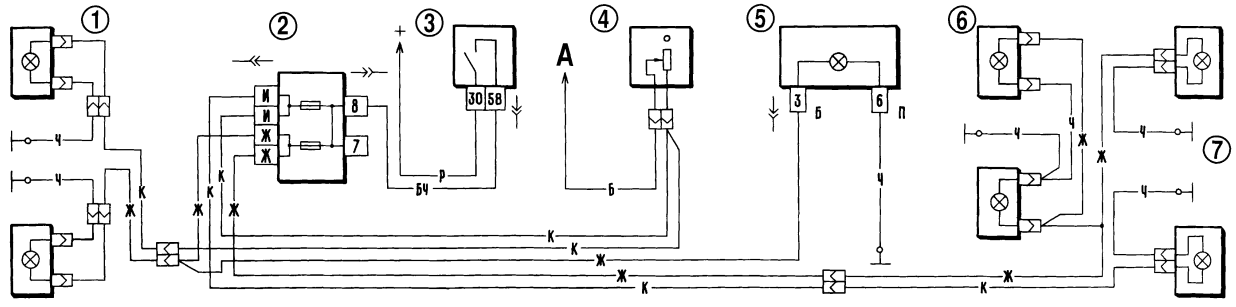


Fig.7-29. Wiring diagram for exterior lighting:
1 - sidelights in headlights; 2 - fusebox; 3 - exterior light switch; 4 - instrument illumination switch; 5 - exterior light warning lamp in instrument cluster; 6 - number plate lamp; 7 - sidelights in rear light units; A - to illumination lamps for instruments, switches and heater controls

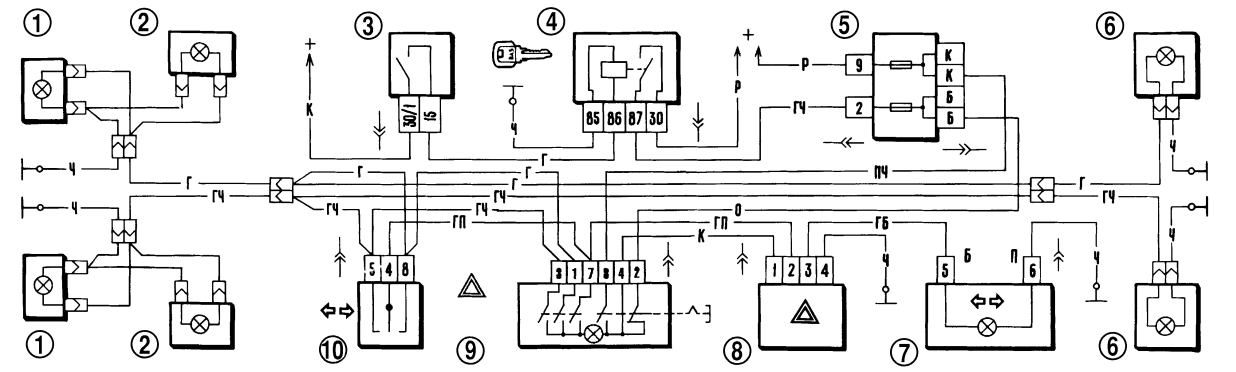


Fig.7-30. Wiring diagram for direction indicators and hazard flashers :
1 - direction indicators in headlights; 2 - side repeat indicators; 3 - ignition switch; 4 - ignition relay; 5 - fusebox; 6 - direction indicators in rear light cluster; 7 - direction indicators warning light in instrument cluster; 8 - indicators flasher relay; 9 - hazard warning flasher switch; 10 - direction indicators switch

General description

The headlight wiring diagram is shown in Fig.7-28.

High and low beam is operated through supplementary relays 3 and 11.

The control voltage to the relay winding is supplied from headlight combination switch 10 when external light push switch 5 is fully depressed.

Regardless the position of push switch 5, the high beam can be briefly switched on by pulling combination switch 10 for light signalling. By doing this, stalk switch 10 terminal is energized directly from the power source bypassing the ignition switch.

Some vehicles are fitted with the hydraulic headlight adjuster to align the headlight beam depending on the vehicle load.

The external light wiring diagram is shown in Fig.7-29.

The sidelights in the front and rear lights are operated by means of exterior light switch 3.

Number plate lamp 6, instruments and switch illumination lamps, sidelight warning lamp 5 are powered at the same time.

The wiring diagram for direction indicators/hazard warning flashers is shown in Fig.7-30.

The left-hand and right-hand direction indicators are operated with the help of steering column combination switch 10.

When operated, hazard flashing switch 9 activates all direction indicators.

Flashing is enabled by relay 8.Fault diagnosis

Cause	Remedy
Lights do not come on	
1. Fuses blown	
2. Bulb filament blown	
3. Switch or relay pins corroded	
4. Damaged leads, corroded ends of leads, loose lead connections	1. Renew fuses 2. Renew bulbs 3. Clean contacts 4. Check, renew damaged leads, clean wire ends
Brake light inoperative	
Brake light switch inoperative	
Failure to switch between low and high beam	Check with a test lamp, renew faulty switch
1. Corroded pins of combination switch	
2. High beam or low beam relay faulty	1. Renew 3- stalk switch 2. Check and renew relay
Steering column levers are inoperative	
1. Lever catch ball dropped	
2. Lever catch recesses damaged	1. Renew 3-stalk switch 2. Detto
Turn signal self-canceling device inoperative	
1. Cancelling mechanism seized	1. Renew 3-stalk switch
2. Combination switch guide ring shoulders worn or broken	2. Detto
Steering column levers fail to switch between the positions	
1. Lever catch balls jammed	1. Renew 3-stalk switch
2. Self-cancelling device seized	2. Detto
Turn signal warning light inoperative	
1. Bulb filament blown	1. Renew bulb
2. Indicators flasher relay faulty	2. Renew relay
Direction indicator warning light flashes at higher rate	
1. Direction indicator bulb blown, front or rear	1. Renew bulb
2. Indicators flasher relay faulty	2. Renew indicators flasher relay

Headlight - adjustment

The headlight beams should be adjusted so that the area in front of the vehicle is properly illuminated and the drivers of the oncoming traffic are not dazzled with the dipped beam.

The headlights are adjusted by means of screws 1 and 7 (Fig.7-31) which allow to alter vertical and horizontal settings of the reflector unit.

Headlight beam alignment is best carried out using optical beam setting equipment. If it is not available, the adjustment can be done using a screen.

A fully laden and equipped vehicle with a load of 735 N (75 kgf) to represent a driver should be positioned on level ground facing a flat wall or screen (plywood board of approx. 2x1 m or similar) at a distance of 5 meters with the vehicle centre line being normal to the screen. Before marking-off the screen, make sure that the tyre pressures are correct; next swing the vehicle to settle the springs and shock absorbers.

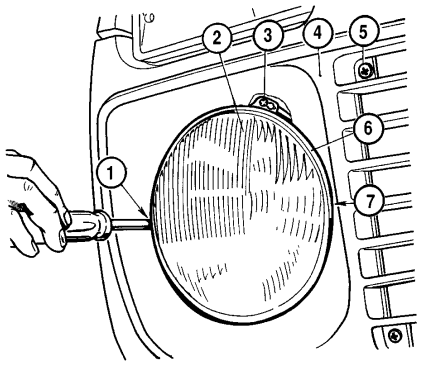


Fig.7-31. Headlight alignment:
1,7 - headlight beam adjustment screws; 2 - optical unit; 3 - retaining screw, optical unit rim; 4 - body front trim; 5 - trim retaining screw; 6 - optical unit rim

Three vertical lines should be drawn on the screen (Fig.7-32): centre line O and lines A and B through the reference points E corresponding to each headlamp center. These lines should run symmetrical to the centre line of the car. Draw line 1 at the height of 600 mm which is the distance to the centres from the ground and 75 mm below draw line 2 passing through the centres of the headlight beam patterns.

Make sure the facia-mounted switch of the headlamp aim adjustment system is in the position corresponding to the load of the driver only.

Switch on the lower beam. Using adjustment screws 1 and 7 (Fig.7-31), align the beams, first on the right-hand headlamp (while the other is covered with a piece of cardboard or dark cloth) and then on the left-hand headlamp (with the right-hand one screened).

To adjust the headlight beam in the vertical plane, turn screws 1 and 7 simultaneously in the same direction and to the same number of turns. The difference in turns between the screws (with the other screw intact) should not exceed 3 turns.

Horizontally the headlights are adjusted by means of screws 1 and 7, turned in opposite directions. If one screw is turned one turn clockwise, the other should be turned one turn anticlockwise.

Some vehicles can be fitted with the headlights without the hydraulic beam adjuster and have an alternatively mounted adjuster screws, when the horizontal adjuster screw is on the left, while that for vertical adjustment is fitted at the top.

If the headlights are correctly aligned, a cut-off at the top of the beam patterns must be at line 2 (Fig.7-32), while the intersection points of horizontal and angled lines should coincide with reference points E.

Bulb replacement

Headlight units. To replace a bulb:

- undo securing screws 5 and remove trim 4 (Fig.7-31);

- slacken screws 3 securing the headlight optical unit rim, turn the rim anti-clockwise to remove it;

- withdraw the headlight optical unit and renew a failed bulb;

- refit the optical unit so that the retaining lugs enter the recesses of the headlight inner rim.

Front lights. Undo two screws and remove the lens, then slightly depress the bulb and turn it anticlockwise to remove.

Direction indicator side repeater. To renew a failed bulb, first remove the holder complete with the bulb, working from the engine bay.

Interior lamp. To renew a blown bulb, gently pull the lens up. The lamp is held in the recess in the door centre pillar by two spring clips.

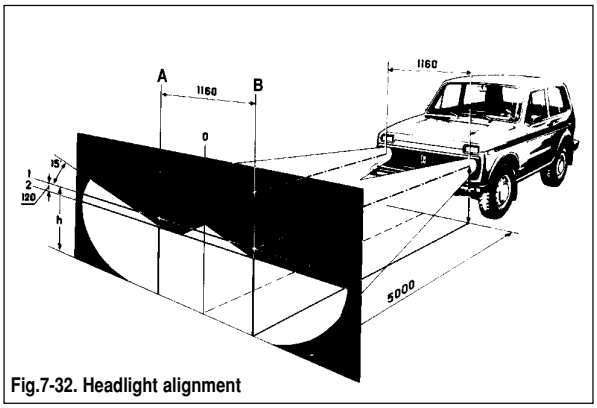


Fig.7-32. Headlight alignment

Rear light unit. To replace a failed bulb in the rear light unit, remove a plastic cap from the inside of the luggage compartment, disconnect the terminal connector, squeeze the retaining lugs and withdraw the base complete with the bulbs. Next depress the bulb, turn it anticlockwise and withdraw.

Number plate light. Undo the retaining screws, remove the light unit, detach the reflector lens and renew a blown bulb.

Hydraulic headlight adjuster

The hydraulic headlight adjuster system consists of the master cylinder, fitted to the instrument panel, working cylinders on the headlamps and connecting pipes. The cylinders and pipes are filled with non-freezing hydraulic fluid. The hydraulic adjuster is not serviceable and has to be renewed as a complete unit, together with the cylinders and pipes, in the event of a failure.

When the beam setting is disturbed and alignment by means of the adjustment screws on the headlight has failed, check the cylinders and pipes for leaks. Remove the working cylinders and check the rod travel to be (7±0.5) mm.

To replace a faulty headlamp adjuster, detach the pipe clips from the wiring clamps, remove the control knob from the master cylinder and undo the mounting nut. Detach the working cylinders from the headlight units and push them together with seals into the passenger compartment. Refit a new headlamp adjuster using the reversal of the removal procedure.

Steering column combination switch

The steering column switch is secured to the steering column support bracket with the help of the retaining strap.

Observe the following procedure when removing the steering column combination switch:

- remove the steering wheel;

- remove both steering column shrouds;

- remove the instrument cluster and disconnect the steering column switch wiring;

- release the retaining strap and withdraw the steering column switch.

Indicators flasher relay

Relay 8 (Fig.7-30) (231.3747 model) is intended for intermittent light signals both for direction indication and hazard flashing. It also allows to identify a failed bulb in the direction indicator. With good bulbs in the direction indication mode, the relay ensures flashing warning light 7. With a failed bulb in the direction indicators (blown bulb or broken bulb circuit), the direction indicator and relevant facia warning light start flashing faster.

The relay is secured under the facia by the bolt welded to the air intake wall. A faulty relay is not repairable and must be always replaced with a new relay.

The relay should ensure the direction indicators flashing at a rate of 90±30 cycles per minutes at 92 watt, ambient temperature of - 20 to +50°C and supply voltage between 10.8 and 15 volts.

Headlamp-on relay

The headlights are switched by means of relay 3 and 11 (Fig.7-28), model 113.3747-10, fitted below the instrument panel on the left. Similar relays are used to switch the rear window heating, headlight wipe/wash.

The relay cut-in voltage at (23±5)°C must not exceed 8 volts, the winding resistance should be (85±8.5) Ohms.

Horn

The vehicle is fitted with a horn of model 20.3721. The horn is located in the engine compartment behind the radiator grill.

The horn wiring diagram is shown in Fig.7-33.

When the volume is low or the horn emits harsh sound, adjust it using the adjustment screw on the horn body unit until a satisfactory sound is achieved.

In the event of the horn failure, inspect all connections and condition of the switch contacts.

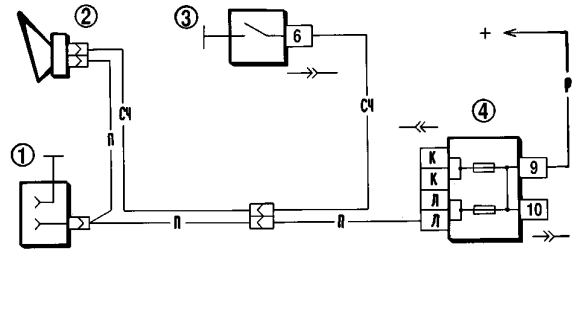


Fig.7-33. Horn wiring diagram:
1 - inspection lamp socket; 2 - horn; 3 - horn switch; 4 - fusebox

Windscreen wiper/washer

General description

The windscreen wipe/wash comprises motor, linkage and blades. The windscreen wipe/wash wiring diagram is shown in Fig.7-34.

There are two operating modes of the windscreen wiper: continuous operation and intermittent operation, ensured by a relay of PC-514 model.

A thermal bimetal fuse is provided to protect against the motor overheating in the event of the blades binding to the glass or resistance to sweep.

The washer pump is combined with the motor and is fitted to the washer fluid container in the engine compartment. The pump motor is operated by pulling up the right-hand lever of the steering column combination switch.

Fault diagnosis

Cause	Remedy
Inoperative wiper motor and bimetal fuse, non-blown fuse 2 in fuse and relay box	
1. Motor supply wires damaged, ends of wires in connectors corroded	1. Inspect and renew leads when found damaged. Clean wire ends
2. Wiper switch faulty	2. Renew 3-stalk switch
3. Motor brushes sticking, foul or burnt commutator	3. Inspect, eliminate wiper blades sticking or renew damaged components, clean commutator
4. Broken wires between motor brushes and connector	4. Check and when necessary solder wires
5. Bimetal thermal fuse damaged	5. Clean thermo-bimetal fuse contacts or renew it.
6. Motor armature winding lead broken	6. Renew armature or motor
Wiper motor inoperative, bimetal thermal fuse operative or fuse 2 in fuse box blown	
1. Wiper arms bent or conflict with bodywork	1. Examine, straighten wiper arms or renew windscreen wiper
2. Wiper blades stuck because of ice or snow	2. Detach blades from glass, taking care not to damage rubber
3. Foreign object in wiper mechanism	3. Check and remove foreign object if any
4. Short-circuit in motor armature winding	4. Renew motor or motor armature
Wiper motor fails to operate intermittently	
1. Wiper switch faulty	1. Renew 3-stalk switch
2. Wiper relay damaged: - break in relay winding; - shorted wires in contact part; - clearance between relay breaker contacts	2. Carry out the following: - renew relay; - remedy short-circuit; - eliminate clearance, renew relay when applicable

Continuous operation of wiper blades in intermittent mode

1. Wiper relay breaker winding blown	1. Renew wiper relay
2. Motor gear cam does not operate limit switch spring plate	2. Bend switch plate so cam can operate plate
3. Foul motor limit switch contacts	3. Clean limit switch contacts
4. Foul wiper relay breaker contacts	4. Clean breaker contacts or renew relay

Wiper stops in intermittent mode. Blades do not stop at park position

Motor limit switch contacts corroded or close incompletely	Clean switch contacts or bend limit switch plate

Blades inoperative with motor running

1. Motor gear teeth broken	1. Renew gear
2. Loose crank fitting to motor gear shaft	2. Check, tighten crank retaining nut in its end position

Windscreen wiper - removal and refitting

The repair of the wiper is basically restricted to straightening the deformed arms and rods or their renewal. A failed motor must be renewed. The overhaul of the motor is restricted to replacement of gears, cleaning of commutator and adjustment of limit switch. To remove the windscreen wiper:

- withdraw the blades complete with the arms, open the bonnet and disconnect the leads from the battery and wiper motor;

- undo the connector nuts and remove them together with washers and shims;

- undo the motor bracket retaining nut, withdraw the wiper.

When necessary, take the motor off the bracket and dismantle the linkage on the work bench.

Refitting is a reversal of the removal procedure.

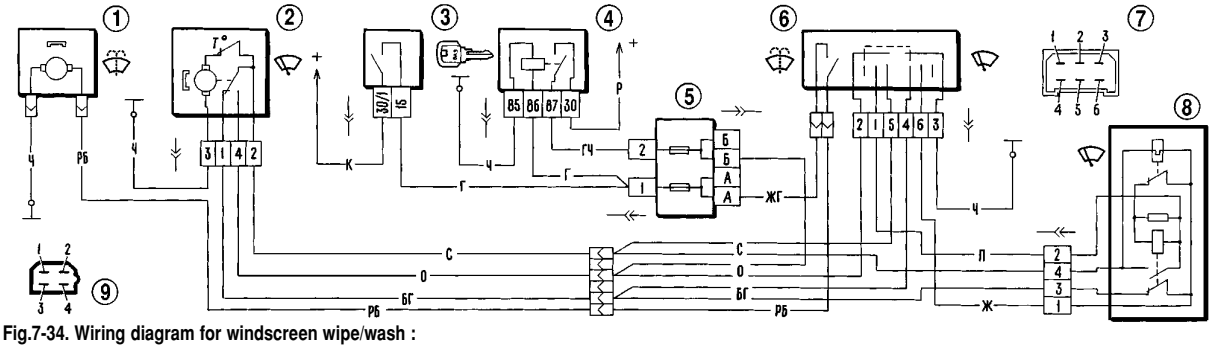


Fig.7-34. Wiring diagram for windscreen wipe/wash :
1 - windscreen washer motor; 2 - windscreen wiper motor; 3 - ignition switch; 4 - ignition relay; 5 - fusebox; 6 - windscreen wipe/wash switch; 7 - pin assignment of switch connector; 8 - windscreen wiper relay; 9 - pin assignment of wiper relay and motor connectors

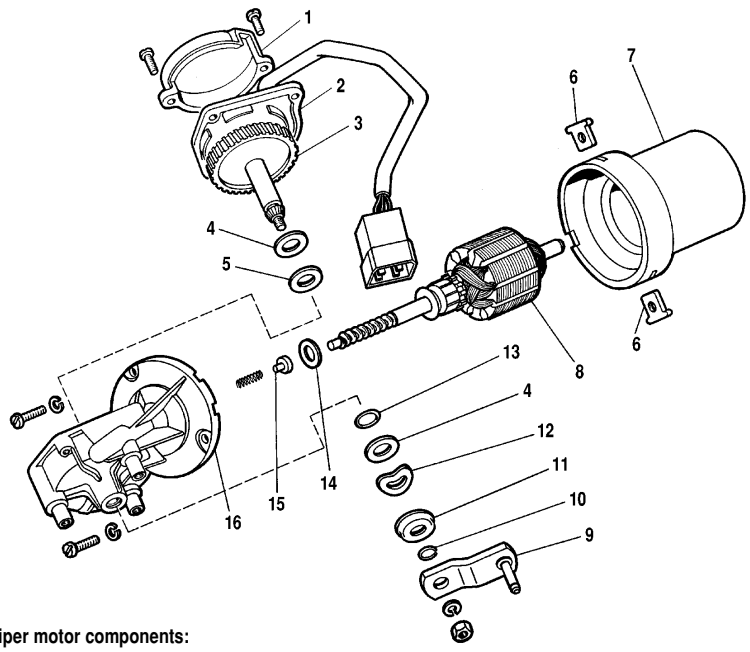


Fig.7-35. Windscreen wiper motor components:
1 - cover; 2 - panel; 3 - drive gear; 4 - steel washer; 5 - tekstolite washer; 6 - retainer; 7 - housing; 8 - armature; 9 - crank; 10 - circlip; 11 - protective cap; 12 - spring washer; 13 - sealing ring; 14 - shim; 15 - thrust washer; 16 - motor cover

Wiper motor - dismantling, reassembly and inspection

Commence to dismantle the motor by undoing cover 1 (Fig.7-35) retaining screws.

Remove the cover complete with plate 2. Next unscrew cover 16 from motor housing 7 and separate them. Extract armature 8 from the motor housing.

To remove motor gear 3, undo crank 9 retaining nut, retrieve the circlip from the spindle and withdraw the spindle complete with the gear and washers.

On completion blow the inside of the dismantled motor with compressed air to remove any carbon deposits; always inspect the brushes and commutator.

The brushes should slide freely without sticking in the brush holders, the springs should be good and sufficiently tense.

The commutator should be sanded with fine emery paper, then wiped with a cloth moistened in petroleum jelly.

If the commutator is badly burnt or worn, it is advisable to renew a complete motor.

Inspect the armature shaft ends for any traces of jamming. Sand them with fine emery paper, if applicable.

When reassembling, make sure the brushes are well clear off the commutator to prevent possible edge chipping or damage. Refit the armature into the motor housing with a particular care, avoiding hitting the magnets.

On completion, align the bearings by tapping the motor housing with a wooden mallet, then check the motor on the tester.

Wiper motor specification

Maximum operative drive spindle torque,* N•m (kgf•m) 2 (0.2)

*Consumption current **
at 1 N•m (0.1 kgf•m), not greater, amps 2.8
*Motor drive spindle speed**
at 1 N•m (0.1 kgf•m), at least, rpm 50

Starting torque of motor drive spindle,*
at least, N•m (kgf•m) 12 (1.2)

**** At 14 volts and ambient temperature of (25±10)°C, on a cold engine***

Windscreen wiper relay

The relay of PC-514 model is used for intermittent operation of the windscreen wiper. The relay is located beneath the instrument panel on the left-hand side and is attached to the body by means of two screws.

The relay must ensure 9 to 17 wiper cycles per minute at supply voltage of 10 volts and ambient temperatures of -20 to +50°C. The resistance of the electromagnet winding is (66±2) Ohm, while the breaker winding resistance is (23±1) Ohm.

When the wiper is activated for an intermittent operation (while the breaker bimetal plate is not warm enough), the wiper blades can make up to 4 continuous double sweeps.

Headlight wipe/wash

The headlight wipe/wash includes two (right-hand and left-hand) motors, arms and blades. The wiper arms and blades park at the bottom position. The motor unit is fitted with a thermal bimetal fuse for overload protection or 8 amps fuse in the motor yellow-black wire.

The headlight wipe motor unit is built as a complete unit, therefore it is not serviceable and is subject to renewal in case of failure.

The headlight washer pump motor is the same as that for the windscreen washer.

The wiring diagram for wipe/wash operation is shown in Fig.7-36. The headlight wipe/wash system is operated only with the headlights on by steering column lever 7, i.e. simultaneously with activation of the windscreen wipe/wash. Voltage is supplied to supplementary relay 3 winding, activating the relay. When the terminal «30» is powered through the exterior light switch (i.e. the headlights are on), voltage is supplied through the closed relay contacts to headlamp wipers 1 and to headlamp washer motor 2.

The headlamp wiper should operate at 45-60 rpm (double sweeps) at a load of 0.49 N•m (0.05 kgf•m), supply voltage of 12 volts, ambient temperature of (25±10)°C and maximum consumption current of 1.5 amperes.

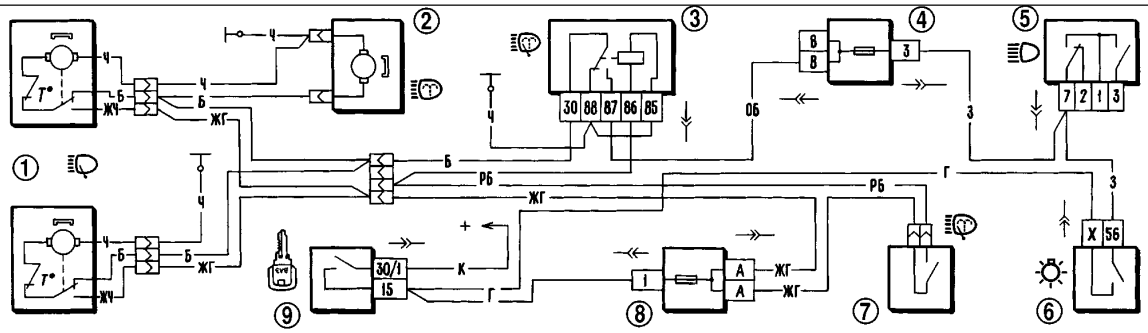


Fig.7-36. Wiring diagram for headlight wipe/wash:
1 - headlight wipers; 2 - headlight washer motor; 3 - headlight wipe/wash relay; 4 - complementary fusebox; 5 - headlight beam switch; 6 - external light switch; 7 - windscreen washer and headlight wipe/wash switch; 8 - fusebox; 9 - ignition switch

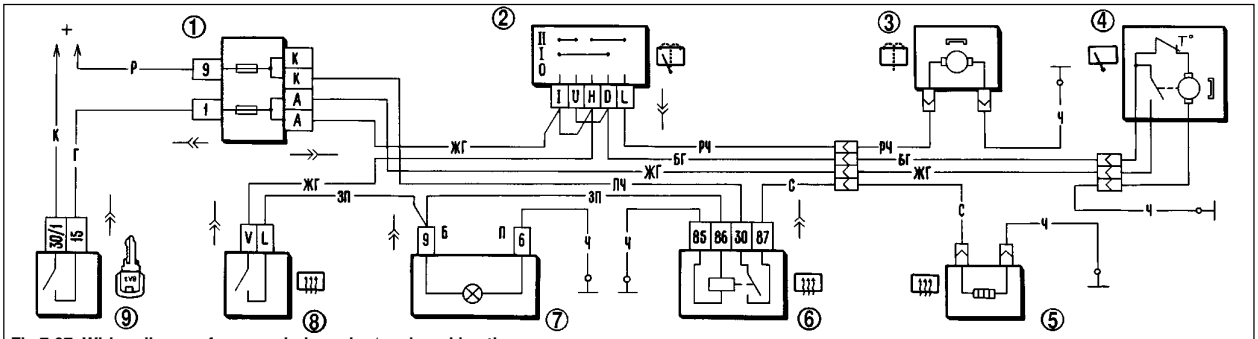


Fig.7-37. Wiring diagram for rear window wipe/wash and heating:
1 - fusebox; 2 - rear window wipe/wash switch; 3 - rear window washer motor; 4 - rear window wiper motor; 5 - rear window heating element; 6 - rear window heating relay; 7 -warning light of heated rear window; 8 - rear window heating switch; 9 - ignition switch

Rear window wipe/wash and heating, cigarette lighter

The rear window wiper includes a motor of 471.3730 model, arm and blade. The wiper arm and blade have a right-hand park position as viewed with the vehicle in forward motion. The motor has a thermal bimetal fuse for overload protection.

The washer motor integral with the pump is secured on the bracket to the left-hand bodyside panel.

The wiring diagram for rear window wipe/wash is shown in Fig.7-37. The wiper is activated by push-button 2 located at the left-hand side of the instrument panel. At the push-button middle position only the wiper is activated, while at a fully depressed push-button the rear window washer is operated too.

The motor design allows its dismantling to eliminate minor faults (commutator cleaning, etc.). Dismantling and reassembly methods are similar to those described earlier for the windscreen wiper motor.

The rear window wiper should operate at (50±5) rpm (double sweeps) at a load of 0.49 N•m (0.05 kgf•m), supply voltage of 14 volts, ambient temperature of (25±10)°C and maximum consumption current of 2 amperes.

The rear window heating is activated by switch 8 through supplementary relay 6 (113.3747-10 model), fitted at the left-hand side of the instrument panel. Refer to «Lighting and signalling» for details.

The cigarette lighter (11.3725 model) is provided with protection against extended operation (over 30 seconds) of the heating element by means of a fusible washer secured on the insulator at the rear of the cigarette lighter. When overheated the washer melts and closes the central lighter contact to earth. This results in a blown fuse No5 in the supplementary fuse box and disconnected cigarette lighter.

To restore the cigarette lighter operation, eliminate the cause of its lengthy operation, dismantle the cigarette lighter, remove the melted washer and fit a new safety washer.

Heater blower motor

It is a motor of МЭ-255 model, DC, on permanent magnets. The motor wiring diagram is shown in Fig.7-38.

For slower speeds there is supplemental resistor 4. The resistor is retained by two spring washers in the heater blower fan cowl. The resistance value is 1.5 Ohms at 20°C.

Always renew a faulty motor with a new one. The only repair possible is the commutator cleaning.

To dismantle the motor, undo the retaining screws to remove the cover. Then retrieve the lock washer from the armature shaft and withdraw the armature from the housing. The reassembly is carried out in the reverse order to the dismantling.

Inspect the motor in the way similar to that for the windscreen wiper motor.

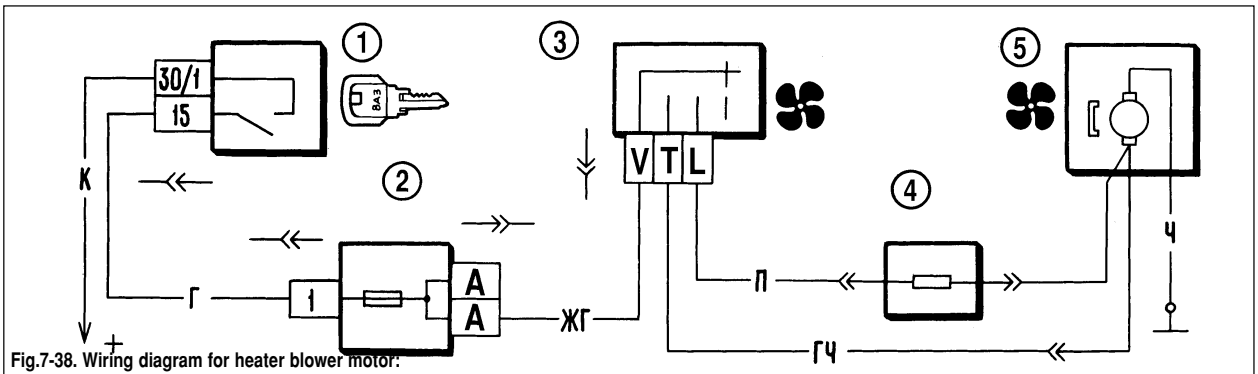


Fig.7-38. Wiring diagram for heater blower motor:
1 - ignition switch; 2 - fusebox; 3 - heater blower switch; 4 - supplemental resistor; 5 - heater blower motor

Blower motor specification

Shaft speed (with fan impeller load)

at 12 v and (25±10)°C, rpm . . . . . .3000±150

Consumption current at the load and

rpm as above, ampere, not greater 4.5

Fault diagnosis

Cause	Remedy
Motor does not operate	
1. Wires damaged or wire connections corroded	1. Check and restore connections. Renew damaged wiring
2. Blown fuse 1 (in fuse and relay box unit)	2. Renew blown fuse
3. Heater switch damaged - no voltage across switch terminals	3. Check switch, renew when applicable
4. Motor brushes stuck or worn, armature winding broken or commutator foul	4. Check motor, overhaul or renew as applicable
5. Armature winding shorted to earth - fuse blows at motor cut-in	5. Renew motor
Motor is restricted to one speed	
1. Wires damaged or wire connections corroded	1. Renew damaged wires, clean wire ends
2. Heater switch damaged	2. Renew switch
3. Supplemental resistor blown	3. Renew resistor
Slower motor armature rotation	
1. Dirty or corroded commutator, brushes worn	1. Clean commutator, renew brushes
2. Internal earthing in armature winding	2. Renew motor
3. Armature shaft seized in bearings	3. Dismantle motor, clean shaft journals

Instruments

General description

All gauges and warning lights are grouped within the instrument cluster. The instrument cluster includes a speedometer with trip counter, coolant temperature gauge, fuel gauge, tachometer, voltmeter with LED and 12 warning lights. In 1996 the voltmeter was replaced with the low battery warning light.

The instrument cluster is held to the dashboard by two nuts. The connections for instrument cluster are through the printed circuit board which is fitted to the back of the housing. The wiring diagram for the instrument cluster is shown in Fig.7-39 (pre-1996) and Fig.7-40 (1996-on).

The speedometer incorporates two trip recorders: total mileage odometer and trip counter. The trip counter can be reset to zero by pushing the reset knob in the instrument cluster. Reset the trip counter only on a stationary vehicle turning the knob clockwise.

WARNING. To avoid damage to the instrument cluster glass, never use solvents for its cleaning.

Fault diagnosis

Cause	Remedy
Temperature gauge or fuel gauge inoperative	
1. Gauge faulty	1. Renew gauge or instrument cluster
2. Sender unit faulty	2. Renew sender unit
3. Wires damaged or wire ends corroded	3. Check wiring, restore connections
Fuel gauge at zero with full tank	
Float stop set incorrectly (beyond resistor winding)	Bend stop 1-2 mm down
Fuel gauge needle moves erratically and frequently drops to zero	
1. Poor contact between sender resistance and current collector	1. Bend current collector
2. Sender resistor winding broken	2. Renew sender
Fuel reserve warning lamp stays on	
Sender lead earthed	Check, eliminate earthing
Warning light failure	
1. Bulb blown	1. Renew bulb
2. Warning light switch faulty	2. Renew switch
3. Wires broken, wire ends corroded	3. Renew damaged wires, clean wire ends
4. Poor bulb holder contact with PCB	4. Bend bulb holder contacts or renew bulb holder
Speedometer inoperative	
1. Loose speedometer cable ends retaining nuts	1. Check, tighten nuts
2. Cable broken	2. Renew cable
3. Speedometer mechanism damaged	3. Renew speedometer
Noise from speedometer cable	
1. Outer cable broken (dents, twists, etc.)	1. Renew cable
2. Cable routed with bending radius less than 100 mm	2. Route cable correctly

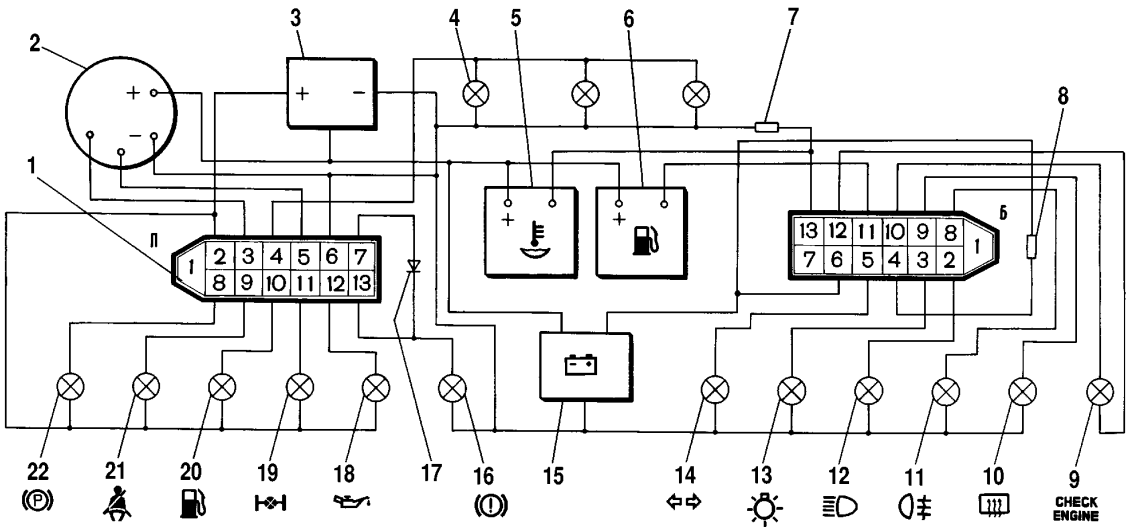


Fig.7-39. Wiring diagram for pre-1996 instrument cluster (rear view):
1 - wiring connector and pin assignment; 2 - tachometer; 3 - voltage stabilizer; 4 - instrument illumination lamp; 5 - coolant temperature gauge; 6 - fuel gauge; 7 - resistor, 470 Ohm, 0.25 W; 8 - resistor, 36 Ohm, 5 W; 9 - warning light, exhaust emission system; 10 - heated rear window warning light; 11 - foglamp warning light; 12 - high beam warning light; 13 - external light warning lamp; 14 - direction indicator warning light; 15 - voltmeter; 16 - low brake fluid warning light; 17 - diode IN4002; 18 - oil pressure warning light; 19 - differential lockup warning light; 20 - fuel reserve warning light; 21 - seat belt reminder; 22 - handbrake-on warning light

Instrument cluster - removal and refitting

The instrument cluster is removed as follows:

- disconnect the battery negative lead;

- undo the screws holding the facia, pull the bottom edge of the facia and release the top catches;

- undo the two securing nuts and withdraw the instrument cluster from the facia;

- disconnect the wiring and speedometer drive cable.

Refitting is the reversal of the removal procedure.

Take precautions not to loop or twist the cable which can result in the outer cable permanent set.

No sharp bends of the drive cable should be evident after refitting. The permitted drive cable bending radius is 100 mm as a maximum.

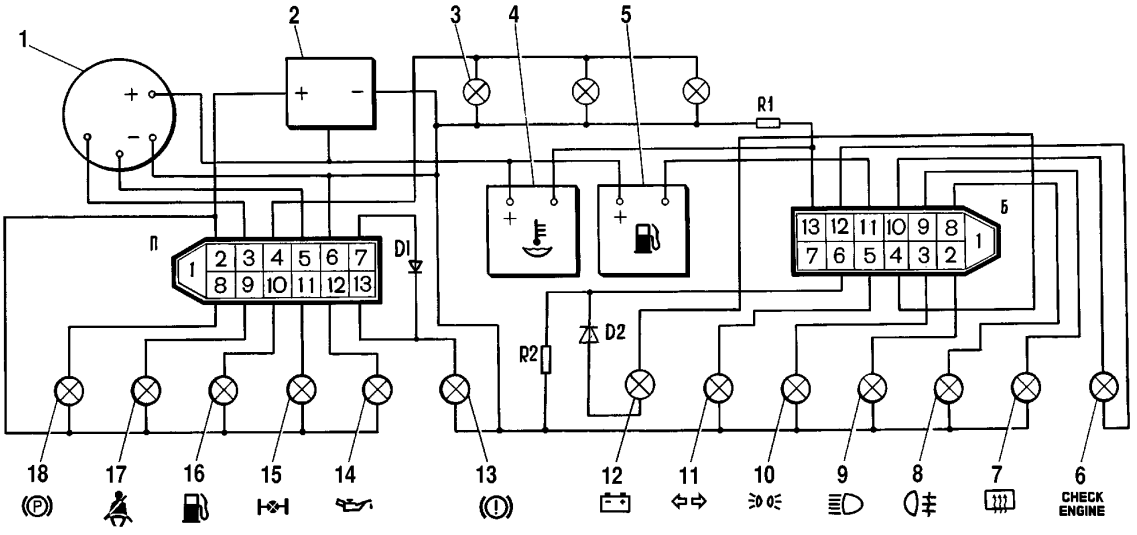


Fig.7-40. Wiring diagram for 1996-on instrument cluster (rear view):
1 - tachometer; 2 - voltage stabilizer; 3 - instrument illumination bulb; 4 - coolant temperature gauge; 5 - fuel gauge; 6 - warning light, exhaust emission system; 7 - heated rear window warning light; 8 - foglight warning lamp; 9 - high beam warning light; 10 - external light warning lamp; 11 - direction indicators warning light; 12 - voltmeter; 13 - low brake fluid warning light; 14 - low oil pressure warning light; 15 - differential lockup warning light; 16 - fuel reserve warning light; 17 - seat belt reminder; 18 - handbrake-on warning light; D1, D2 - diodes IN4002; R1 - resistor, 470 Ohm, 0.25 W; R2 - resistor, 51 Ohm, 5 W

Instrument cluster - dismantling and reassembly

Undo the trip counter knob by pulling it outward, then remove the surround and glass, having first released its bottom edge from the retaining spring wire. Undo the nuts holding the instruments to the PCB and withdraw the instruments.

Reassembly is the reverse of the dismantling procedure.

Instruments - fault diagnosis

Coolant temperature gauge

If the gauge needle constantly stays at the low end of scale, switch on the ignition, disconnect the lead from the gauge and connect its end to earth through a resistor of 20 - 50 Ohm.

If the needle swings, the gauge is faulty and must be renewed. If the needle does not move, remove the instrument cluster, and without disconnecting its wiring, pull out the red connector, then with the ignition switched on, earth terminal 13 (Fig.7-39) of the instrument cluster white connector through the 20-50 Ohm resistor. The needle swings if the gauge is sound but the wire between the sender and the instrument cluster is damaged. When the needle does not swing, renew the coolant temperature gauge or the complete instrument cluster.

When the needle stays in the red area, then with the ignition switched on, disconnect the sender wire. The sender is faulty if the needle returns to the low end of scale. If the needle remains in the red area, then either the lead is earthed or the gauge is damaged. The gauge can be checked through disconnecting the white terminal connector from the instrument cluster. With the ignition switched off, the needle should be at the low end of the scale.

Fuel gauge

The checking procedure for the fuel gauge is similar to the one described earlier.

If the needle stays at the low end of the scale and does not move when the pink wire is disconnected from the gauge and earthed, check the fuel gauge. To do this, remove the instrument cluster, disconnect the white wiring connector, then with the ignition switched on, earth terminal 11 of the instrument cluster white connector through a resistor of 20-50 Ohm. If the gauge is sound, the needle moves.

If the needle always stays at the high end of scale, check the gauge through disconnecting the instrument cluster white connector. If the gauge is sound, the needle returns to the low end of scale with the ignition switched on.

Instruments - checking

Coolant temperature gauge. The gauge is associated with a sender in the cylinder head. At 700 Ohm the needle should be at the low end of the scale, while at 77-89 Ohm it should stay at the beginning of the red area of scale.

Fuel gauge. The gauge is coupled with a sender in the fuel tank. The sender is used to operate the fuel reserve warning light when only 4 to 6 litres of petrol are left in the fuel tank.

The sender resistance of 238-262 Ohm corresponds to the «empty» reading, 59-71 Ohm - to the half filled tank reading (needle is in the middle of the scale), while 7-23 Ohm - to the «full» reading (mark 1).

Speedometer. Check the speedometer by rotating its drive shaft at various speeds. The speedometer specification is shown in Table 7-6.

Table 7-6

Speedometer checking data

Drive shaft speed, rpm	Speedometer reading, km/h
500	31-35
1000	62-66.5
1500	93-98
2000	124-130
2500	155-161.5

Tachometer. The tachometer measures the frequency of voltage pulses in the ignition primary circuit.

Check the speedometer on a tester unit which simulates the vehicle ignition system. Connect the tachometer to the tester circuitry as it done in the vehicle, set the primary circuit voltage to 14 volts and the spark gap in the tester to 7 mm. Turn the distributor shaft so that the tachometer needle reaches one of the main graduations of the scale. At this moment check the distributor shaft speed variation is within +250 to -70 rpm.

Voltmeter. The voltmeter was fitted to the vehicles before 1996, then it was replaced by the low battery warning light; refer to Fig.7-4 for the relevant wiring diagram.

Check the voltmeter by applying a known voltage. At voltage below (11.3±0.35) volts the voltmeter LED should light steadily. When the voltage is between (11.3±0.35) volts and (16±0.35) volts, the LED should not light. When the voltage is above (16±0.35) volts, the LED should flash. The voltmeter operates with a 5 second delay.

Switches and senders

Coolant temperature sender. The sender has an integrated thermal resistor which resistance alters depending on the coolant temperature. The sender specification is shown in Table 7-7.

Table 7-7

Coolant temperature sender specification

Temperature, °C	Supply voltage, volts	Resistance, Ohm
30	8	1350-1880
50	7.6	585-820
70	6.85	280-390
90	5.8	155-196
110	4.7	87-109

Low oil pressure warning light switch. The switch is fitted to the cylinder head. The switch contacts should close and open at 20-60 kPa (0.2-0.6 kgf/cm^2).

Fuel gauge sender. The sender unit is located in the fuel tank and is secured by nuts. The sender has an alternating Ni-Cr wire resistor. The resistor slide contact is operated by the float lever. Another slide contact, fitted to the shorter end of the lever, triggers the fuel reserve warning lamp, when only 4 to 4.6 litres of petrol are left in the tank.

The sender resistance should be (250±12) Ohm for an empty tank, (66±6) Ohm for a half filled tank and (20±3) Ohm for a full tank.

Handbrake-on warning lamp relay. The relay of PC-492 model is intended for intermittent light of the handbrake «on» warning lamp. It is fitted to the wires on the left-hand side beneath the instrument panel.

The number of the relay ons/offs per minute should be in the range of 60-120 at 10.8 to 15 volts within -40 to +40°C. The winding resistance is 26 Ohm.

The relay of PC-492 model is out of use starting from 1995, therefore when the handbrake is applied, the warning lamp lights steadily.

Carburettor solenoid - control Electronic control unit - testing

Sound electronic control unit 4 (Fig.7-41) should cut off solenoid 5 when the engine speed reaches 2100 rpm and operate it when the engine slows down to 1900 rpm, if the idle switch is earthed.

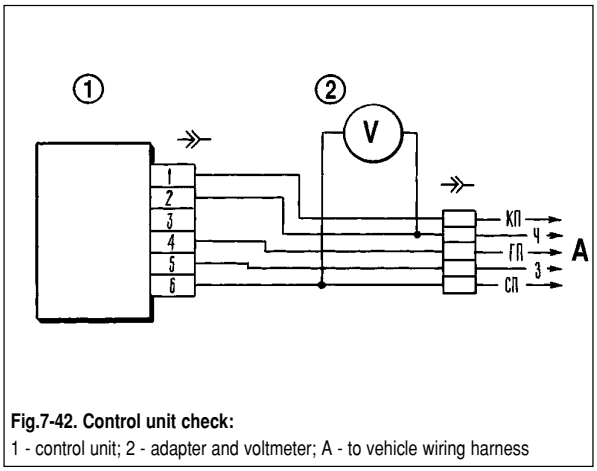


Fig.7-42. Control unit check:
1 - control unit; 2 - adapter and voltmeter; A - to vehicle wiring harness

Start testing the control unit with checking its correct wiring.

Check the control unit operation using a voltmeter (ranged 0-15 volts) in the following sequence:

- disconnect the green wire from the idle switch and earth the wire end;

- connect the voltmeter to the control unit using special connector 2 (Fig.7-42);

- start the engine and let it running, gradually increase the speed while observing the voltmeter readings: after start-up the voltmeter should read at least 10 volts with an instantaneous drop as low as 0.5 volts at the moment the solenoid shuts off;

- once the solenoid is shut off, gradually decrease the engine speed until the solenoid cuts in again - there should be an instant surge in voltage to 10 volts at least;

- run the engine at 2200-2300 rpm, disconnect the carburettor idle switch earth lead and then reconnect it. The solenoid should cut in when the earth wire is disconnected and cut off when the wire is reconnected to earth.

Note. *The control unit can be checked without a voltmeter by audible clicks the solenoid produces at cut-in or cut-off.*

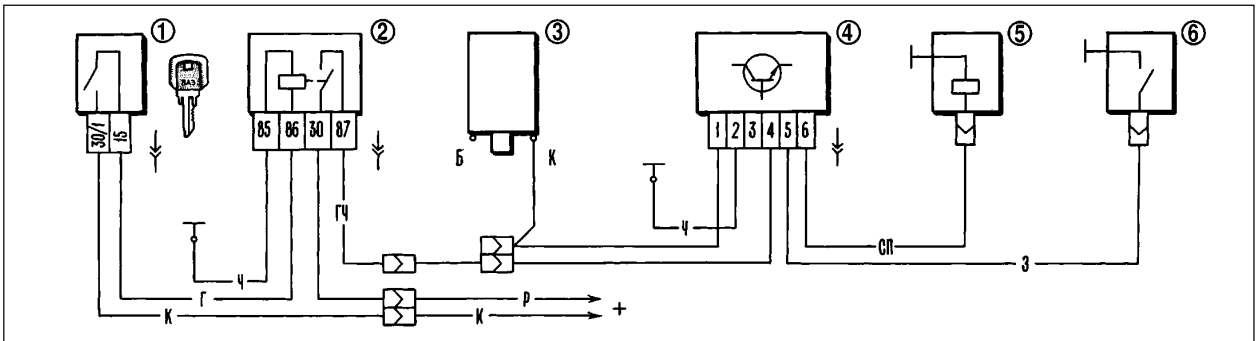


Fig.7-41. Fuel cutoff solenoid control system wiring diagram:
1 - ignition switch; 2 - ignition solenoid; 3 - ignition coil; 4 - control unit; 5 - fuel cutoff solenoid; 6 - idle switch