Section VII
ELECTRICAL EQUIPMENT

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GENERAL

The electrical equipment is of the single-wire ground-return type with the negative terminals of the power sources and consumers connected to "ground" which functions as the second wire.

The majority of the circuits are actuated by the ignition switch. The supply circuits of the horns, cigarette lighter, stoplight, interior lamps, distress light switch (at distress mode) and inspection lamp socket are constantly energized, irrespective of the position of the ignition key.

The electrical equipment of the car is protected by fuses (Fig. 7-1) located under the instrument panel, left of the steering column. The battery charging circuit, headlight lower and upper beam relays, ignition and starting circuits are not protected by fuses.

Fuses 11, 13, 14, 15 (Fig. 7-1) installed in the auxiliary fuse unit are vacant.

If a fuse is blown, first identify and eliminate the cause of the trouble, then replace the fuse. To trace down the faulty spot, refer to the table of fuse-protected circuits (Table 7-1) to find which particular fuse protects the given circuit.

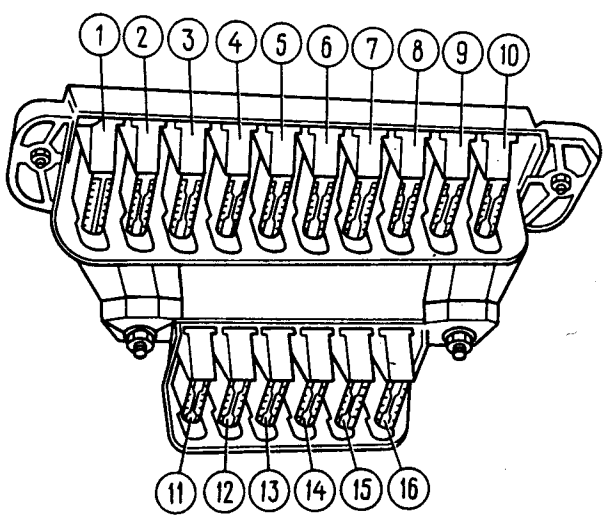


Fig. 7-1. Fuses

Table 7-1

Fuse-Protected Circuits

Fuse No. (Fig. 7-1)	Circuit
1(16A)	Interior lamps. Horns. Inspection lamp socket. Cigarette lighter. Stoplight lamps
2(8A)	Windshield wiper and its relay. Heater motor. Windshield washer motor. Headlight wiper and washer relay (with headlight wiper and washer switch button not pressed on). Headlight wiper motors in all positions of wiper blade, except initial position
3 (8A)	L.H. headlight (upper beam) and its warning lamp
4 (8A)	R.H. headlight (upper beam)
5 (8A)	L.H. headlight (lower beam)
6 (8A)	R.H. headlight (lower beam)
7 (8A)	L.H. side light (marker light). Marker light warning lamp. R.H. tail light (marker light). R.H. number plate light
8 (8A)	R.H. side light (marker light). L.H. number plate light. Cigarette lighter lamp. L.H. tail light (marker light). Instrument lamps
9 (8A)	Oil pressure gauge and warning lamp. Coolant temperature gauge. Fuel level gauge with low fuel level warning lamp. Parking brake warning lamp. Brake fluid low level warning lamp. Direction indicators and warning lamp. Carburettor choke valve warning lamp. Battery no-charge warning lamp. Carburettor shutoff valve. Tachometer. Tail lights (backing light). Differential lock warning lamp

Cont'd

Fuse No. (Fig. 7-1)	Circuit
10 (8A)	Voltage regulator. Alternator field winding
12 (8A)	Headlight wiper and washer (with control button depressed). Headlight washer motor. Headlight wiper motors at starting and when wiper blades pass through initial position.
16 (8A)	Distress light switch and direction indicators at distress mode

The wiring diagram of the car is shown in Fig. 7-2.

In all the diagrams of the "Electrical Equipment" Section the colour of the wires is denoted by letters, the first letter standing for the colour of the wire, while the second one denotes the colour of the wire tracer (Table 7-2).

Table 7-2

Wire Colour Code

Letter	Colour	Letter	Colour
Б	White	О	Amber
Г	Blue	Р	Pink
Ж	Yellow	С	Gray
З	Green	Ф	Violet
К	Brown	Ч	Black
П	Red		

STORAGE BATTERY

Specifications

Type 6СТ-55П
Rated voltage, V 12
Rated capacity at 20-h discharge rate and at 25 °C of electrolyte at beginning of discharge, A.h 55
Discharge current at 20-h discharge rate, A 2.75
Discharge current at starting, at electrolyte temperature of minus 18 °C, A 255

TROUBLE SHOOTING

Cont'd

Cause	Remedy
Rapid Discharge in Service	
1. Slipping of alternator drive belt	1. Adjust belt tension
2. Alternator faulty	2. Check alternator
3. Damaged insulation in car electrical system (discharge current higher than 1 mA with consumers disconnected)	3. Find leaky point and correct defect
4. Short-circuiting of cell plates	4. Replace battery
5. Connection of new loads by car owner in excess of permissible limits	5. Remove new loads
6. Electrolyte contaminated by foreign matter	6. Drain electrolyte, wash and charge battery
7. Battery surface very dirty	7. Clean battery surface
8. Electrolyte level dropped below upper edge of plates	8. Restore normal electrolyte level
Battery Surface Wetted with Electrolyte	
1. Battery overfilled, electrolyte splashes out	1. Adjust normal electrolyte level
2. Electrolyte seeping through cracks in battery case	2. Replace battery
3. Violent gassing of electrolyte caused by excessively high alternator voltage	3. Check connection of voltage regulator body to ground and connectio of its wires; adjust or replace voltage regulat
4. "Boiling" of electrolyte caused by sulphation of plates	4. Replace battery

ACTIVATION OF DRY-CHARGED BATTERY

The cars shipped from the Plant are fitted with storage batteries filled with the electrolyte and charged.

Spare batteries are delivered in a dry-charge state, without the electrolyte. To get the battery ready for use remove the filler plugs and, dependi on the battery design, remove the plug seals or cu off the vent projections. Then fill the battery wi the electrolyte at 15-25 °C.

The specific gravity of the poured-in electrolyte (corrected to 25 °C) should be 1.27 - 1.29 g/cm^3 for temperate climates and 1.22 - 1.24 g/cm^3 for tropics.

Let the plates and separators impregnate with the electrolyte for two hours, then check the battery no-load voltage and the specific gravity of the electrolyte.

The specific gravity of the electrolyte drops omewhat due to interaction with the active aterial of the plates. If the specific gravity as dropped by not more than 0.03 g/cm^3 and the attery voltage is higher than 12 V, the battery hould be considered ready for use. If the voltage s from 10 to 12 V and the specific gravity has ropped by more than 0.03 g/cm^3, charge the batery with a 2-3 A current for 24 h. If the voltage remains lower than 12 V after charging, the attery should be discarded.

After the separators and plates have been oaked with the electrolyte, the electrolyte level ill drop inevitably. Therefore, prior to instaling the battery on the car, bring the electrolyte evel to the normal value by adding the electrolyte f the same specific gravity as that at the begining of filling.

In the course of charging check the electroyte temperature periodically to prevent its rising bov) °C. If the temperature reaches 40 °C, educe the charging current by 50 % or stop charging until the battery cools down to 27 °C.

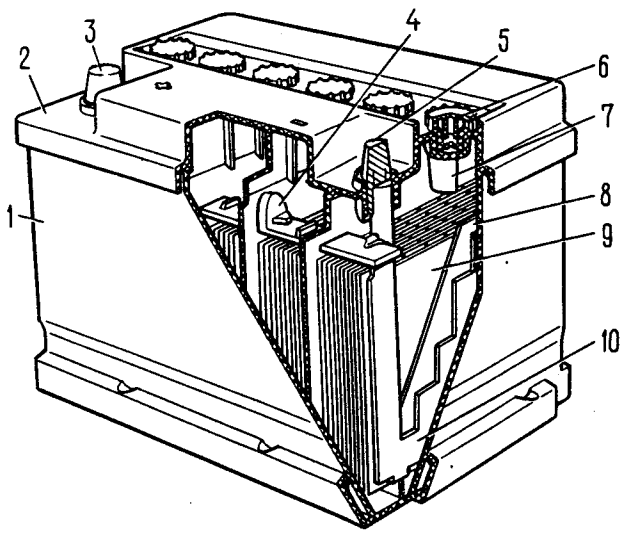
Stop charging when violent gassing begins in ll the cells and when the voltage and specific ravity remain constant in the course of two or hree last hours of charging.

Having filled the battery charge it as a andatory requirement in the following cases:

- if the battery has been out of use for 24 h after filling;
- if the initial service conditions are severe (cold weather, frequent applications of the starter, etc.);
- if the battery has been in storage for more than 6 months after the date of manufacture.

CHECKING ELECTROLYTE LEVEL

The electrolyte level should be 5-10 mm above the er edge of the separators or the baffle plate and should not rise above the lower edge of indicator 7 (Fig. 7-3).



In the course of service the electrolyte level drops gradually due to evaporation of water component of the electrolyte. To restore the normal level add distilled water only.

If it is known for certain that the electrolyte level has dropped due to splashing out, top up the battery with the electrolyte of the same specific gravity as that of the electrolyte remaining in the cells.

If the level is higher than necessary, remove the surplus quantity using a rubber bulb with an ebonite tip.

CHECKING STATE OF CHARGE

To check the state of charge, measure the specific gravity of the electrolyte (Table 7-3) with a hydrometer.

If the battery is discharged to 50 % and over, remove it from the car and have it charged.

When measuring the specific gravity see that drops of the electrolyte do not fall from the pipette on the surface of the battery, car body and other parts: the electrolyte contains sulphuric acid which causes corrosion, current leaks, etc.

Table 7-3

State of Battery Charge VS Specific Gravity of Electrolyte

State of charge, %	Specific gravity at 25 °C, g/cm^3	
	Temperate climate	Tropical climate
100	1.27±0.01	1.23±0.01
50	1.20	1.15
0	1.13	1.10

The specific gravity of the electrolyte depends on its temperature. It changes by 0.01 g/cm^3 approximately per 15 °C. Therefore, if the temperature of the electrolyte is higher or lower than 25 °C, make temperature corrections by adding or abstracting the following values from the hydrometer readings:

Electrolyte temperature, °C	+40	+25	+10	-5	-20
Correction	+0.01	0	-0.01	-0.02	-0.03

To avoid errors do not measure the specific gravity when:

- electrolyte level is other than normal;

Fig. 7-3. Storage Battery. Sectionalized: 1 - battery case; 2 - cover; 3 - positive pole terminal; 4 - cell connector; 5 - negative pole terminal; 6 - plug; 7 - electrolyte level indicator; 8 - separator; 9 - positive plate; 10 - negative plate

- electrolyte is either too hot or too cold; its optimum temperature for measurement is 15-25 °C;

- the cells have just been topped up with distilled water; allow the electrolyte to mix up well; with a discharged battery a delay of a few hours may even become necessary;

- the starter has just been operated several times; wait until the specific gravity in the cells becomes equalized;

- electrolyte is gassing; wait until the bubbles in the hydrometer syringe come up to the surface of the electrolyte.

If the specific gravity of the electrolyte is too low (under 1.22 g/cm^3) and the battery is overheated in service (more than 10 °C above the ambient temperature), or else if the specific gravity of the electrolyte in separate battery cells differs by more than 0.2 g/cm^3, charge the battery with a 2-3 A current during 24 h. If the battery voltage is below 12 V after charging, the battery must be discarded.

If the specific gravity of the electrolyte is too high (1.3 g/cm^3 and higher), bring it to the normal value as described below.

CHARGING BATTERY

Remove the battery from the car, clean it thoroughly, particularly on the top, and check the electrolyte level.

Charge the battery with a 5.5 A current for several hours until the cell voltage and the specific gravity of the electrolyte remain constant.

At the end of charge the specific gravity of the electrolyte may sometimes be other than normal If so, adjust it to the required value.

If the specific gravity is too high, remove some electrolyte from the cells, add some distilled water, wait until the electrolyte gets mixed and measure the specific gravity again.

If the specific gravity is lower than normal, remove some electrolyte from the cells and add the electrolyte of a higher specific gravity (1.40 g/cm^3).

ALTERNATOR

Specifications

Rated voltage, V	12
Sense of rotation	R.H. (viewed from drive end)
Maximum output current at 14 V and rotor speed of 5000 min^{-1}, A	42
Maximum rotor speed, min^{-1}	13000
Engine-to-generator gear ratio	1: 2.04

A sectional view of the alternator is shown in Fig. 7-4 and its connections, in Fig. 7-5.

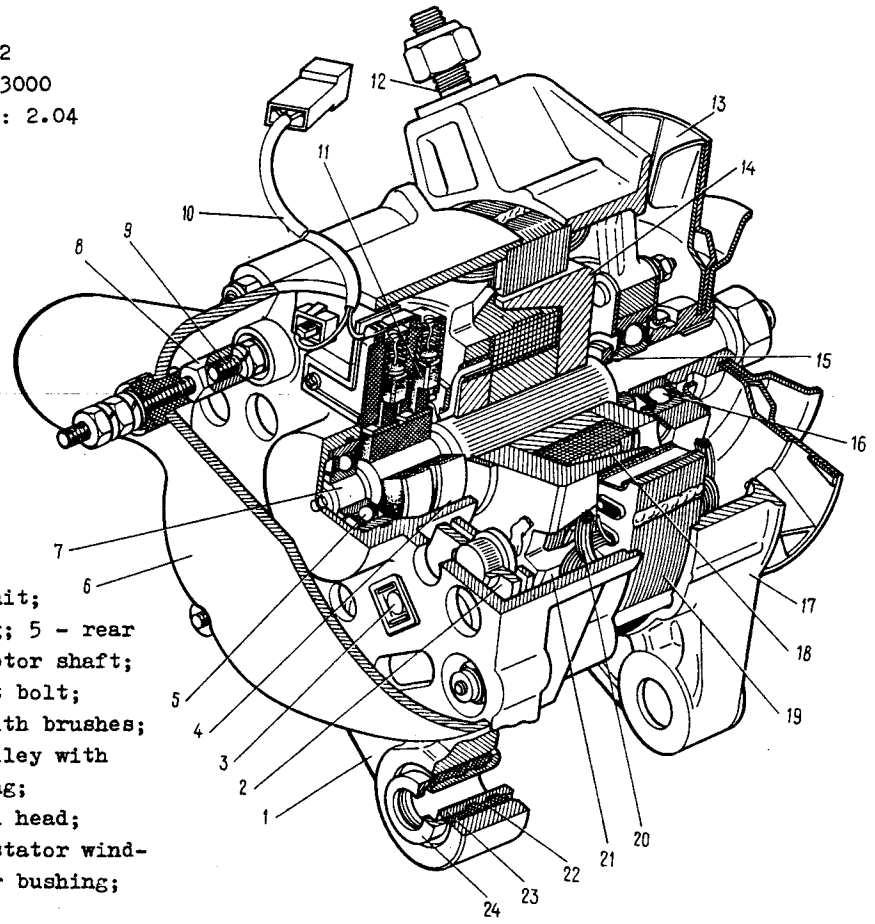


Fig. 7-4. Alternator Г-221:
1 - slip ring end head; 2 - rectifier unit; 3 - rectifier unit screw; 4 - slip ring; 5 - rear ball bearing; 6 - guard housing; 7 - rotor shaft; 8 - contact bolt extension; 9 - contact bolt; 10 - wire harness; 11 - brush holder with brushes; 12 - alternator-to-brace stud; 13 - pulley with fan; 14 - rotor pole piece; 15 - bushing; 16 - front ball bearing; 17 - drive end head; 18 - rotor winding; 19 - stator; 20 - stator winding; 21 - rotor pole piece; 22 - buffer bushing; 23 - bushing; 24 - holddown bushing

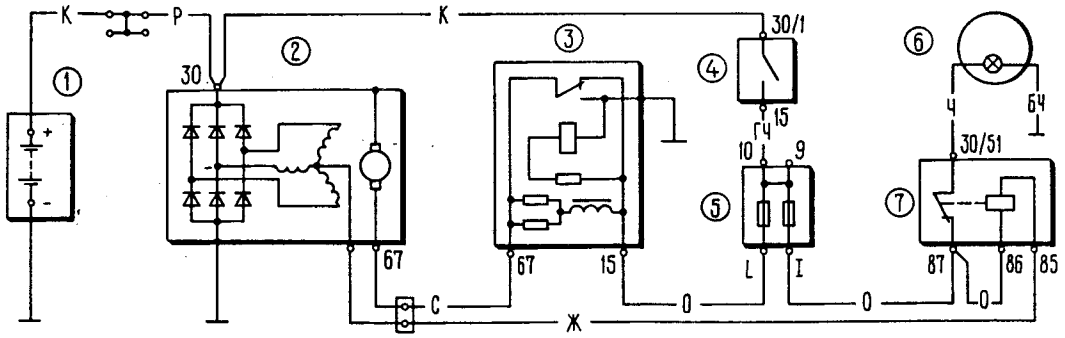


Fig. 7-5. Alternator Connections:
1 - storage battery; 2 - alternator; 3 - voltage regulator; 4 - ignition switch; 5 - fuse unit; 6 -battery no-charge warning lamp; 7 - battery no-charge warning lamp relay

TROUBLE SHOOTING

Cont'd

Cause	Remedy
No-Charge Warning Lamp Constantly Alight or Flashes Up Periodically on Moving Car	
1. Alternator belt slipping	1. Adjust belt tension
2. Open-circuit fault between "85" terminal of no-charge warning lamp relay and centre of alternator star	2. Check and restore connection
3. No-charge warning lamp relay damaged or out of adjustment	3. Check, adjust or replace relay
4. Open-circuit fault in field winding supply circuit	4. Restore connection
5. Voltage regulator de[illegible]ed or maladjusted	5. Clean contacts, adjust or replace regulator
6. Alternator brushes worn or jammed; slip rings oxidized	6. Replace brush holder with brushes; wipe slip rings with gasoline-soaked rag
7. Open-circuit fault or ground fault in alternator field winding	7. Connect winding ends to slip rings or replace rotor
8. One or more positive polarity rectifiers short-circuited	8. Replace rectifier unit
9. Open-circuit fault in one or more alternator rectifiers	9. Replace rectifier unit
10. Open-circuit fault between "86" and "87" terminals of no-charge warning lamp relay	10. Restore connection
11. Open-circuit fault or short circuit in stator winding	11. Replace stator
No-Charge Warning Lamp Fails to Light Up After Turning On Ignition Switch	
1. Lamp filament burnt out	1. Replace lamp
2. No-charge warning lamp relay damaged or maladjusted	2. Clean contacts, adjust or replace relay
3. Open-circuit fault between "87" terminal of no-charge warning lamp relay and terminal "1" of fuse unit	3. Restore connection
4. Short-circuits in one or more negative polarity rectifiers	4. Replace rectifier unit
5. Ground fault of stator winding	5. Replace stator
Alternator Working, Battery Undercharged	
1. Alternator belt slack: slipping at high speed and under load	1. Adjust belt tension
2. Wire clamps loose on alternator and battery; battery terminals oxidized; wires damaged	2. Clean battery terminals of oxides, tighten clamps, replace damaged wires
3. Battery faulty	3. Replace battery
4. Voltage regulator maladjusted or damaged	4. Clean contacts, adjust or replace voltage regulator
Battery Overcharged	
1. Poor contact between "ground" and voltage regulator body	1. Restore contact
2. Voltage regulator maladjusted or damaged	2. Adjust or replace voltage regulator
3. Battery faulty	3. Replace battery

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Cause	Remedy
Alternator Noisy	
1. Loosening of alternator pulley nut	1. Tighten up nut
2. Alternator bearings damaged	2. Replace bearings
3. Shorted turns of stator winding (humming of alternator)	3. Replace stator
4. Squeaking of brushes	4. Wipe brushes and slip rings with cotton cloth soaked in gasoline

Caution

1. The "minus" terminal of the storage battery should always be connected to "ground" and its "plus" terminal, to alternator terminal "30". An accidental wrong connection of the battery terminals will immediately cause an overcurrent through the alternator rectifiers, thus ruining them.

2. Do not work the alternator with the loads disconnected from terminal "30" (particularly with the storage battery disconnected). This causes a dangerous voltage rise and may damage the rectifiers.

3. Never check the functioning of the alternator "for spark", i.e. by connecting alternator terminal "30" with "ground" or terminal "67" even for a short time. This creates a very large current in the rectifiers and damages them. The alternator must be checked only with an ammeter and a voltmeter.

4. Do not check the charging circuits with a megger or a 36 V lamp. If such a check is required, first disconnect the wires from the alternator and voltage regulator.

5. The strength of stator insulation should be checked by a high-voltage current only on a test stand, first disconnecting the phase windings from the rectifiers.

6. Do not confuse the wire connected to alternator terminal "67" with the one connected to the star neutral point (unmarked terminal). A wrong connection will make fuse 10 (Fig. 7-1) blow and damage the voltage regulator contacts.

7. If some welding work is to be performed on the car body, disconnect the wires from all the alternator and battery terminals.

8. Under no circumstances should the alternator rectifiers be checked in a circuit supplied from a 110 or 220 V A.C. source even if there in a signal neon lamp; neither should they be checked with a megger since its voltage is too high for the rectifiers. In these cases the rectifier will be broken down (short-circuited).

CHECK TESTS

On-Car Test

If the battery no-charge warning lamp is alight when the engine is running, the fault of the alternator can be identified approximately as follows:

- pull out the carburettor choke knob a little to bring the engine idle speed to 1000-1500 min^{-1};
- disconnect the wire from the battery "minus" terminal for a short time. If the engine stalls, this is an indication that the alternator is faulty and all the loads are supplied from the storage battery.

Stand Test

The stand test is intended to check the condition of the alternator and to ascertain whether its performance agrees with the rated characteristics. Guard housing 6 (Fig. 7-4) of the alternator under test should be removed, the brushes should be well bedded on the slip rings and the slip rings should be perfectly clean.

Mount the alternator on the stand and make connections as shown in Fig. 7-6. Start the stand motor, adjust alternator output voltage to 14 V by rheostat 4 and accelerate the rotor to 5000 min^{-1}. Work the alternator at this speed for at least two minutes and then measure the output current. In a serviceable alternator it should be not under 44 A.

If the output current is smaller, this should be traced to some fault in the stator and rotor windings, to damaged rectifiers or wear of the slip rings and brushes. In this case the windings and rectifiers should be thoroughly checked to identify the faulty spot.

If some fault of the rectifiers is suspected, measure the output current on a warm alternator. This check helps to discover more accurately the faulty condition of the rectifiers by a sharp reduction of the output current at the rise of the alternator temperature. To warm up the machine, wor it for at least 15 minutes at a rotor speed of 5000 min^{-1} and at 14 V across the alternator output terminals. Then measure the output current. On a warmed-up alternator it should be not lower than 42 A.

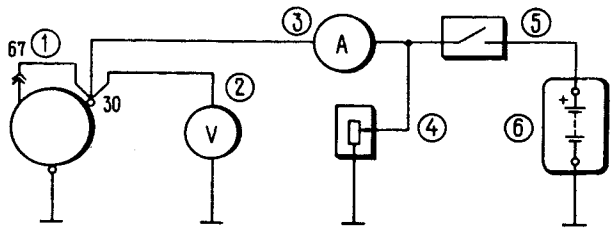


Fig. 7-6. Alternator Test Stand Hookup:
1 - alternator; 2 - voltmeter; 3 - switch;
4 - rheostat; 5 - storage battery; 6 - ammeter

Oscilloscope Test

The oscilloscope makes it possible to check the alternator accurately and quickly and determine the nature of the trouble by the shape of the rectified voltage curve.

For conducting this test, run the alternator rotor at 1500 - 2000 min^{-1}, supplying the field winding from the storage battery but disconnecting the battery from terminal "30".

If the rectifiers and the stator winding are in order, the rectified voltage curve will be of a saw-like pattern with uniform teeth (Fig. 7-7). If there is an open-circuit fault in the stator winding, an open-circuit or a short-circuit fault in the rectifiers, the shape of the curve changes radically: the teeth become nonuniform with deep valleys between them (Fig. 7-7, II and III).

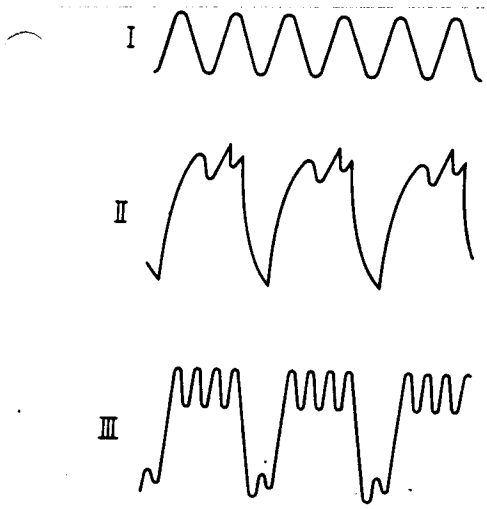


Fig. 7-7. Alternator Rectified Diodes Voltage Curve:
I - alternator serviceable; II - rectifier diode breakdown; III - open circuit fault in rectifier diode

Rotor Field Winding Test

The condition of the winding and the standard of brush-to-slip ring contact can be checked on the stand without disassembling the alternator, by measuring the resistance between terminal "67" and the alternator "ground".

If there are no shorted turns in the winding and the brushes are well seated, the winding resistance should be $(4.4^{+0.3}_{-0.2})$ Ω at 20 °C. In the course of the test ensure a reliable contact between the rotor slip rings and the conductors connected thereto.

Stator Test

The stator should be tested separately after disassembling the alternator and disconnecting the stator winding terminals from the rectifiers.

The first thing to do is to check the stator winding for open circuits and ground faults with an ohmmeter or a test lamp and a storage battery.

The insulation of the winding conductors should bear no signs of overheating caused by a short circuit in the rectifiers. Replace the stator if its winding is damaged in this manner.

Finally, check the stator winding for shorted turns with a growler.

Rectifiers Test

A sound rectifier passes current in one direction only. A faulty one may either pass no current at all (open circuit) or pass it in both directions (short circuit).

If one of the rectifiers is damaged, the entire rectifier unit has to be replaced.

The rectifiers can be checked for shorts without removing the alternator from the car, but first disconnecting the wires from the storage

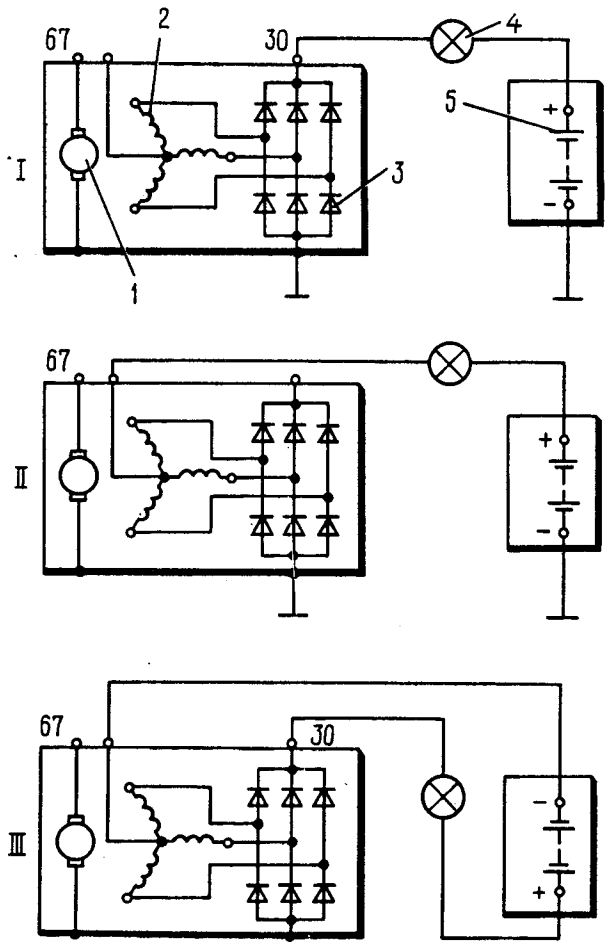


Fig. 7-8. Rectifier Diode Test Hookups:
I - simultaneous test of positive and negative-polarity diodes; II - negative-polarity diode test; III - positive-polarity diode test;
1 - alternator rotor; 2 - stator winding;
3 - rectifier diodes; 4 - signal lamp; 5 - storage battery

battery and alternator. Make the test with an ohmmeter or a 25-40 W test lamp and a storage battery as shown in Fig. 7-8.

Note. To simplify the fastening of the rectifier unit parts, three rectifiers have rectified voltage with the "plus" sign on the body. These are positive rectifiers which are pressed into one plate of the rectifier unit. The other three rectifiers are negative ones and the rectified voltage on their body has the "minus" sign. They are pressed into the other plate of the rectifier unit.

First check for simultaneous shorts in both the positive and negative rectifiers. For this purpose connect the battery "plus" across a lamp to alternator terminal "30" and its "minus", to the alternator frame (Fig. 7-8, I). If the lamp lights up, it means that both the negative and positive rectifiers are shorted.

The negative rectifiers can be tested for shorts by connecting the battery "plus" through a lamp with the terminal of the stator winding neutral wire and its "minus", with the alternator frame (Fig. 7-8, II).

If the lamp is alight, this is an evidence of a short circuit in one or more negative rectifiers.

It should be borne in mind that in this case the lamp may be caused to light due to shorting of the stator winding turns to the alternator frame. However, this fault is by far less frequent than short-circuiting of the rectifiers.

To check the positive rectifiers for shorts, connect the battery "plus" through a lamp with alternator terminal "30" and its "minus" with the terminal of the stator winding neutral wire (Fig. 7-8, III). Lighting up of the lamp will indicate a short circuit in one or more positive rectifiers.

An open-circuit in the rectifiers can be discovered without disassembling the alternator only by an indirect method on a stand, judging by a considerable reduction (by 20 - 30 %) of the output current as compared with the rated value. If the alternator windings are in order and the rectifiers are not short-circuited, the cause of the low current output lies in an open-circuit fault in the rectifiers.

ALTERNATOR REPAIRS

Disassembly

Remove the nuts from contact bolt extension 21 (Fig. 7-9), turn off the fastening screws and remove guard housing 19 with the hose. Disconnect wire harness 22.

Turn off the screws and remove brush holder 2 with brushes.

Unscrew the nuts of through bolts 14 and remove alternator drive end head 11 complete with the rotor.

Clamp the rotor in a vice, unscrew the pulley nut and, using remover tool 02.7823.9504, take the pulley off the rotor shaft. Withdraw the Woodruff key from the shaft slot and remove end head 11.

Turn off the nuts of the screws which connect the rectifier ends with the stator winding terminals, pull the neutral wire plug from connector 4 and withdraw stator 8 from slip ring end head 16.

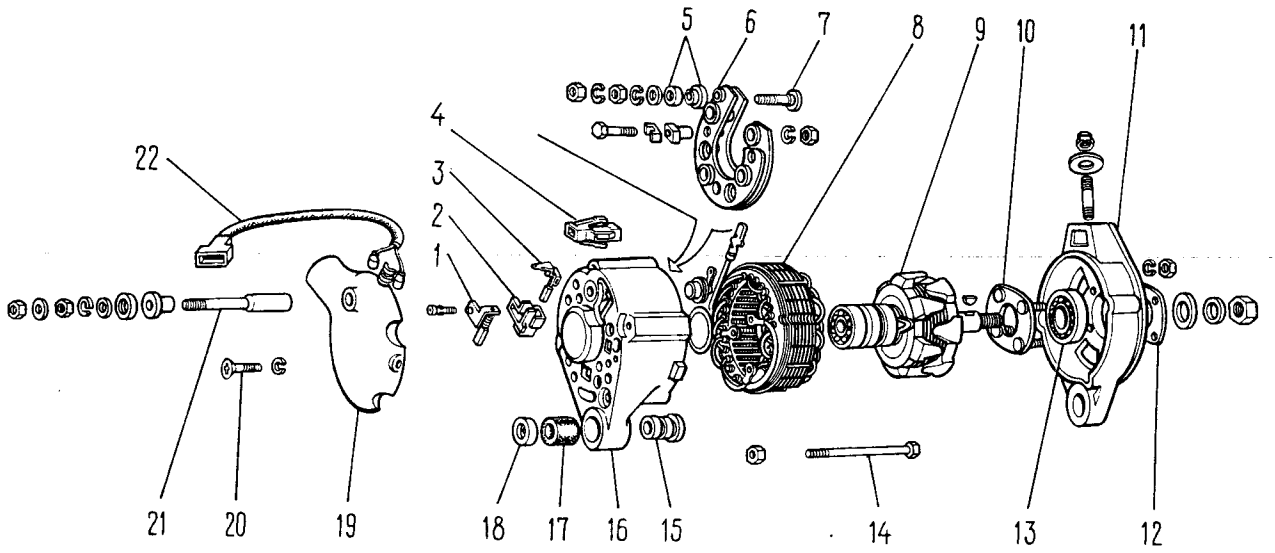


Fig. 7-9. Alternator Parts:
1 - "negative" brush; 2 - brush holder; 3 - "positive" brush; 4 - neutral wire connector; 5 - insulating bushings; 6 - rectifier unit; 7 - contact bolt; 8 - stator; 9 - rotor; 10 - bearing inner fastening washer; 11 - drive end head; 12 - bearing outer fastening washer; 13 - rotor bearing; 14 - through bolt; 15 - holddown bushing; 16 - slip ring end head; 17 - buffer bushing; 18 - bushing; 19 - guard housing; 20 - housing screw; 21 - contact bolt extension; 22 - wire harness

Turn off the nut of contact bolt 7 and remove rectifier unit 6.

Assembly

To assemble the alternator, reverse the disassembly operations. Axial misalignment of the holes in the alternator end head lugs should not exceed 0.4 mm. Therefore, insert a special gauge into these holes at assembly.

The convex side of the tapered spring washer of the pulley should be in contact with the nut. Tighten the pulley nut with a torque of 38.2 - 61.7 N.m (3.9 - 6.3 kgf.m).

Replacement of Brush Holder

If the brushes are worn and protrude by less than 5 mm from the holder, replace the latter complete with the brushes.

Prior to installing the brush holder, blow out the carbon dust and wipe away the oil mixed with carbon dust.

Replacement of Rotor Bearing in Drive End Head

To remove the faulty bearing from the end head, turn off the nuts of the screws that hold together the bearing washers, remove the washers with the screws and force out the bearing on a hand-operated press. If the ends of the screws are lock-punched and the nuts refuse to come off, file off the ends of the screws.

A new bearing may be installed into the alternator end head only if the bore for it is not distorted and its diameter does not exceed 42 mm. If it is larger or the bore is distorted, replace the end head by a new one.

Force the bearing into the end head on a press and then clamp it between two washers which are held together by screws with nuts. After tightening the nuts, lock-punch the ends of the screws.

VOLTAGE REGULATOR

A general view of the voltage regulator appears in Fig. 7-10 and its electrical connections, in Fig. 7-11.

Caution

1. Do not confuse the wires connected to terminals "15" and "67". In case of a wrong connection of the wires the voltage regulator will become inoperative and the upper contacts will be constantly closed. The alternator output voltage will rise high, thus resulting in violent gassing of the electrolyte in the storage battery and in damage to the consumers. Besides, the contacts will get stuck and the voltage regulator will have to be replaced.

2. Do not connect the radio noise suppressor capacitors to the circuit between terminals "67" of the regulator and alternator. This will disturb normal functioning of the contacts and they will be rapidly ruined.

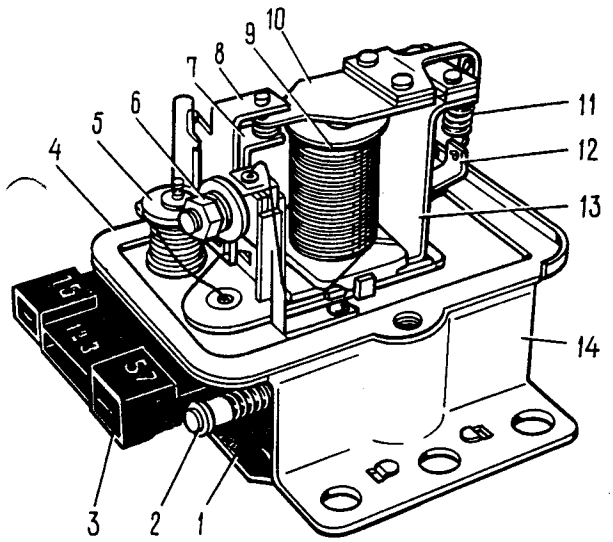


Fig. 7-10. Voltage Regulator PP-380:
1 - protective plate; 2 - series resistor; 3 - lower gasket with sockets for "15" and "67" plugs; 4 - cover gakset; 5 - choke; 6 - bracket fastening nut; 7 - lower contact bracket; 8 - upper contact bracket; 9 - regulator winding; 10 - armature; 11 - armature spring; 12 - spring bracket; 13 - yoke; 14 - base

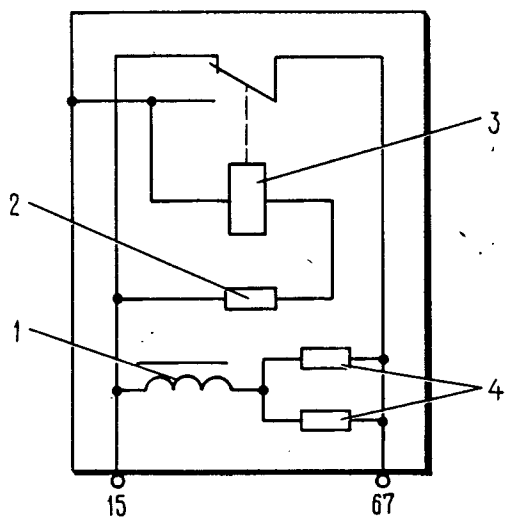


Fig. 7-11. Voltage Regulator Circuit Diagram:
1 - choke; 2 - thermal-compensating resistor; 3 - regulator winding; 4 - series resistors

3. Do not connect additional consumers to the alternator field winding supply circuit as this will raise the alternator voltage excessively.

4. Do not check the regulator by shorting its terminals "15" and "67". This will raise the alternator voltage and may damage the rectifier unit.

5. Do not remove the regulator cover unless urgently necessary so as to avoid disturbing the tightness of the seal. Moisture and various foreign particles penetrating under the cover cause soiling, burning of contacts and interfere with the normal functioning of the regulator. For this reason all the materials of which the regulator is made are checked for absence of gassing; when replacing the gasket, see that the new one is made of polyurethane as prescribed in the regulator design.

6. Keep the regulator always clean and protect it against chance blows that may disturb its setting.

See that the regulator body and "ground" are reliably connected by the fastening screws since inadequate connection steps up the alternator voltage above the specified limit.

Stand Checks and Adjustment. Reference Data

Regulated voltage at regulator and ambient temperature of 50±3 °C, V:

2nd stage ..... 14.2±0.3

1st stage, lower than that of the 2nd stage by not more than 0.7

Resistance between terminal "15" and "ground", Ω ..... 27.7±2

Resistance between terminals "15" and "67" with contacts open, Ω ..... 5.65±0.3

Armature-to-core air gap, mm ..... 1.4±0.07

2nd stage contact gap, mm ..... 0.45±0.1

The regulator should be checked and adjusted on a stand which is equipped with a generator, storage battery, thermostat and an electric motor capable of varying the rotation speed within a wide range. The regulator with the cover closed should be mounted on the stand with its connector plugs down.

A diagram of the stand hookup is illustrated in Fig. 7-12. Pay particular attention to the reliability of connections seeing that their contact resistance should not be higher than that specified in Table 7-4.

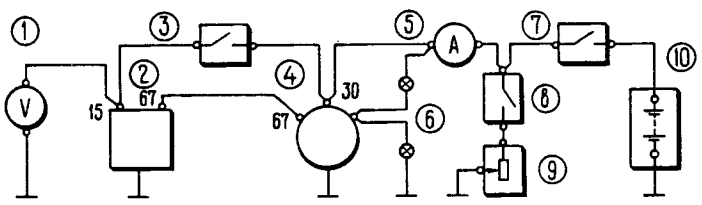


Fig. 7-12. Voltage Regulator Test Stand Hookup: 1 - voltmeter, 15 V scale, accuracy class not under 0.5; 2 - voltage regulator; 3 - master switch; 4 - generator; 5 - ammeter, scale up to 50 A; 6 - signal lamps, 3 W, 12 V; 7 - storage battery switch; 8 - rheostat switch; 9 - rheostat 5 - 30 A, 15 V; 10 - storage battery

Table 7-4

Maximum Ohmic Resistance of Connections

Connections	Resistance, Ω
Generator "30" - battery "plus"	0.005
Generator "ground" - battery "minus"	0.001
Generator "30" - regulator "15"	0.02
Generator "67" - regulator "67"	0.02
Generator "ground" - regulator "ground"	0.02

The wires leading from switch 3 should be connected directly to generator "30" terminal and regulator "15" terminal and the regulator "ground" should be directly connected to generator "ground". All connecting wires should be as short as possible. If tray wiring is used (wires laid in pipes or trays), the trays should be made of a nonmagnetic material.

During stand tests do not operate the regulator with the battery disconnected since this may damage the regulator contacts.

Signal lamps 6 indicating the condition of the generator should light with equal brightness with the generator running.

Before the check warm the regulator in a thermostat for 15-18 min at (50±3) °C, supplying a 12-13 V current to the regulator winding. This voltage is set by rheostat 9 with switches 3, 7, 8 turned ON and the generator inoperative.

Carry out the checks and adjustments immediately after warm-up.

2nd stage tests. Run the generator rotor at 5000 min^{-1}. Set the generator load current to 2-12 A with rheostat 9. Check the generator voltage which must be (14.2±0.3) V. If it is different, stop the generator, disconnect the storage battery, remove the regulator cover and, bending bracket 12 (Fig. 7-10) weaken spring 11 (if the voltage is too high) or increase its tension (if the voltage is too low). Replace the regulator cover and recheck the 2nd stage voltage.

After adjustment of the 2nd stage, check the 1st stage immediately.

1st stage tests. At a rotor speed of 5000 min^{-1}, set a load current to 25-35 A with rheostat 9 (Fig. 7-12). The voltage should be by not more than 0.7 V below the value obtained during the 2nd stage adjustment.

Note. While checking the 1st and 2nd stages see that the adjusted voltage is steady, without sharp fluctuations.

If the voltage fails to fall within these limits, stop the generator, disconnect the storage battery, remove the regulator cover, loosen nut 6 (Fig. 7-10) and shift bracket 8 through 0.1 - 0.2 mm.

If the voltage is high, shift the bracket down and vice versa. Simultaneously shift bracket 7 so as to retain a clearance of (0.45±0.1) mm between the 2nd stage contacts. Meanwhile see that the axes of the 1st and 2nd stage contacts are aligned. The armature contact should not go beyond the outline of the contacts on the brackets.

Tighten nut 6, put the cover in place, recheck the 1st and 2nd stages of the regulator and, if necessary, repeat the adjusting operations.

Upon completion of adjustment clean the regulator cover carefully and install it on the hot regulator to bring the absorption of moisture down to a minimum.

Trouble Shooting

If the storage battery is overcharged systematically on the car, check the voltage regulator without removing it under the following conditions:

- the storage battery should be fully charged;
- all the consumers, except for the storage battery and ignition system, should be disconnected;
- the engine speed should be 2500-3000 min^{-1}.

Measure the voltage across the battery terminals with a voltmeter. If it does not exceed 14.5 V, the regulator may be considered serviceable. If it is higher, connect the regulator body to the car body by a separate conductor and check the voltage again.

If the voltage in the second case is again too high, the voltage regulator is faulty and must be adjusted or replaced. If the voltage is normal, the cause of battery overcharging lies in poor connection of the regulator body with "ground".

The defects of the voltage regulator can be identified by checking its internal parts.

The causes of defects may be as follows:

1. An open-circuit fault in thermal-compensating resistor 2 (Fig. 7-11) or in the regulator winding; in this case the voltage cannot be regulated and rises excessively. This defect can be discovered by measuring the resistance between terminal "15" and the "ground" (base) with an ohmmeter.

2. An open-circuit fault in the winding of the choke or in series resistor 4; in this case voltage is unsteady and fluctuates sharply.

This defect can be identified by checking the electric resistance between terminals "15" and "67" with the contacts of both the 1st and 2nd stages open.

3. Soiling, burning or oxidation of 1st and 2nd stage contacts when the regulated voltage is unsteady.

This defect may be caused by oil, gasoline, and water penetrating into the regulator and soiling the contacts, or by a short circuit in the circuit of terminal "67" or else in the alternator field winding. Foreign matter may penetrate into the regulator due to incorrect installation or damage of the sealing gasket between the regulator cover and base, also when the gasket is made of a material other than that recommended by the manufacturers and fails to ensure adequate tightness or liberates volatile substances.

If the contacts are found damaged, it is good practice to check the circuits for shorts, for correct connections of the wires and to check the condition of the alternator.

REPAIRS

The regulator should be repaired as an exception only; as a rule, it must be replaced. Described below are some of the permitted regulator repair operations.

Replacing the cover and gasket. When installing a new cover see that both the cover and its gasket are perfectly clean and the gasket occupies a correct position. After installation draw up the screws all the way.

If dirt is detected inside the regulator body, clean the regulator contacts and other parts.

Soldering the faulty connections. Solder the connections with a neutral flux in a small amount and take care not to overheat the insulation. After soldering remove the surplus flux since the remaining flux will evaporate under the effect of heat liberated by the operating regulator and soil the contacts.

Cleaning the contacts. To clean the contacts take off the armature spring and, loosening nut 6 (Fig. 7-10), lift somewhat 1st stage stationary contact bracket 8.

Using a flat barette file dress neatly the contacts, removing the burnt matter and oxides throughout the contact surface. The file should be perfectly dry, washed in clean alcohol, gasoline or, even better, in trichloroethylene. The craters on the contacts caused by burning must be dressed with a clean pointed steel tool. Remove the silver chippings from the regulator body, blowing it with dry clean air.

Put the armature spring back in position.

Moving the bracket of the 1st stage stationary contact adjust the armature-to-core gap to (1.4±0.07) mm, ensuring proper touching of the contacts.

Moving the bracket of the 2nd stage stationary

contact, adjust the gap between the 2nd stage contacts to (0.45±0.1) mm, ensuring proper touching of the contacts. Tighten nut 6.

Put in place the gasket and cover, then check the regulator on the stand and adjust it, if necessary.

Cleaning the voltage regulator. If some foreign matter gets inside the regulator, after cleaning the contacts wash the regulator with alcohol or clean gasoline (solvent) before checks and adjustments, then dry it (without the cover) in an oven at 120 °C for 2 hours. Check the regulator on the stand and adjust it, if necessary.

BATTERY NO-CHARGE WARNING LAMP RELAY

The relay, Type PC-702, switches on the warning lamp on the instrument panel when the alternator voltage becomes too low for charging the storage battery. The relay is installed in the engine compartment, on the upper part of the R.H. wheel mudguard.

When the alternator is in operation, the relay winding is supplied with the rectified phase voltage of the alternator. This voltage is approximately a half of the alternator voltage. If the voltage between alternator terminal "30" and "ground" is 13.8 - 14.5 V, the rectified phase voltage is 5 - 7 V.

The relay contacts close the supply circuit of warning lamp 6 (Fig. 7-5). When the ignition switch is turned on but the engine and alternator are still inoperative, the relay contacts pass the current from the storage battery and the lamp is alight.

After engine starting and on the moving car the lamp should go off because the rectified phase voltage should attract the relay armature to the core, thus opening the relay contacts.

If the warning lamp fails to go off after engine starting and on the move, this may be caused by some fault in the alternator or regulator or in the relay proper (an open-circuit fault in the winding, etc.).

Reference Data

Contact-opening voltage*, V	5.3±0.4
Contact-closing voltage*, V	0.2 - 1.5
Winding resistance at 20 °C, Ω	29^{+2}

* At (25±5) °C

STARTER

Specifications

Rated voltage, V	12
Rated power, kW	1.3
Current drain at maximum power, max, A	260
Locked-torque current drain, max, A	500
Current drain at no-load, max, A	35 (60*)

* For starter 35.3708

The design of the starter appears in Fig. 7-13 and its circuit diagram, in Fig. 7-14. The circuit diagram shows the starter with two windings in the solenoid switch installed on some cars since 1983. Before 1983 the starter with one-winding solenoid switch was used.

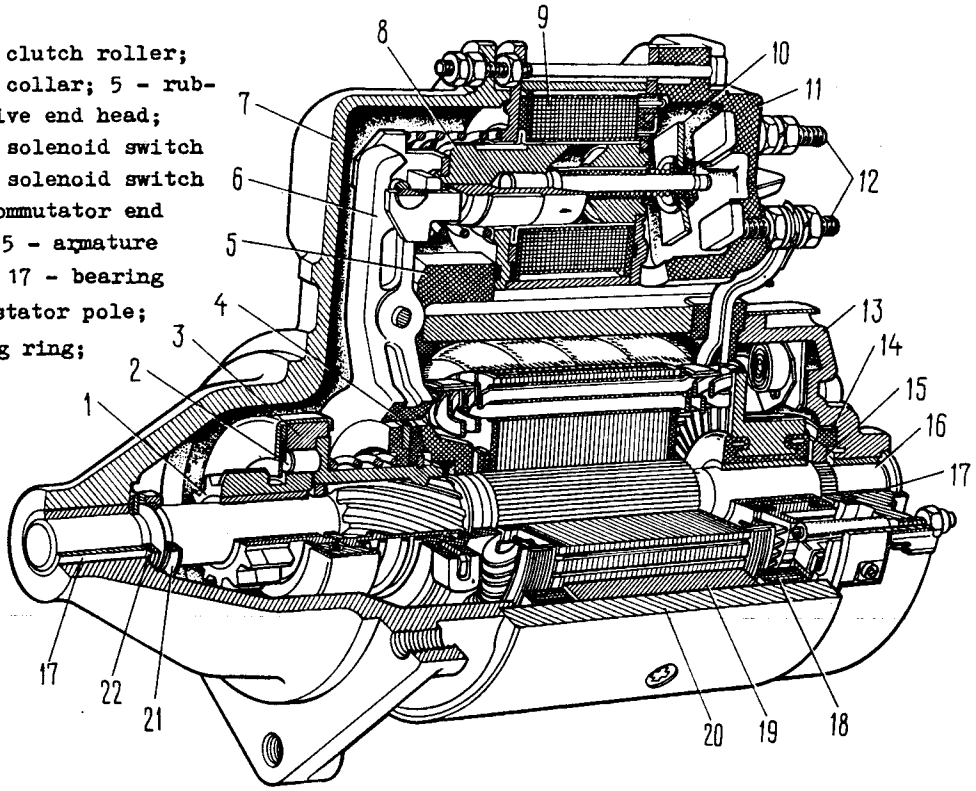
Since 1986 some cars are furnished with the starter type 35.3708 with an end commutator, three series and one shunt windings.

TROUBLE SHOOTING

Cont'd

Cause	Remedy
With Starter Switched on its Armature Stands Still, Solenoid Switch Fails	
1. Storage battery faulty or completely run down	1. Charge or replace battery
2. Heavy oxidation of battery terminals and wire clamps; loosening of wire clamps	2. Clean battery terminals and wire clamps, coat with petrolatum and tighten
3. Shorted turns, ground fault or open-circuit fault in solenoid switch winding	3. Replace solenoid switch
4. Wire terminal disconnected from solenoid switch terminal "50" or from ignition switch	4. Restore connection
5. Faulty ignition switch contact unit: contacts "30" and "50" fail to close	5. Replace ignition switch contact unit
6. Jamming of solenoid switch armature	6. Remove solenoid switch, check armature for freedom of movement
With Starter Switched on, Its Armature Rotates Slowly or Not At All, Solenoid Switch Operates	
1. Storage battery faulty or discharged	1. Charge or replace battery

Fig. 7-13. Starter CT-221:
1 - drive pinion; 2 - overrunning clutch roller; 3 - overrunning clutch; 4 - guide collar; 5 - rubber plug; 6 - shift lever; 7 - drive end head; 8 - solenoid switch armature; 9 - solenoid switch winding; 10 - contact plate; 11 - solenoid switch cover; 12 - contact bolts; 13 - commutator end head; 14 - end head brake disc; 15 - armature shaft brake disc; 16 - armature; 17 - bearing bush; 18 - stator winding; 19 - stator pole; 20 - starter frame; 21 - limiting ring; 22 - adjusting ring



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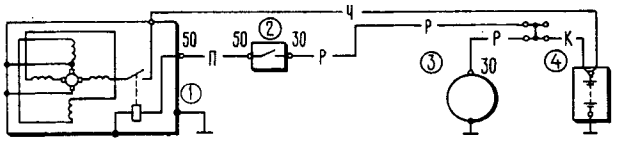

Fig. 7-14. Starter Circuit Diagram:
1 - starter; 2 - ignition switch; 3 - alternator; 4 - storage battery

Cont'd

Cause	Remedy
Battery terminals and wire clamps oxidized; wire clamps loose	2. Clean battery terminals and wire clamps, coat with petrolatum and tighten securely
3. Solenoid switch contact bolts oxidized	3. Dress contact bolts
4. Wire tip nuts loose on solenoid switch contact bolts	4. Tighten nuts
5. Burning of commutator, jamming or wear of brushes	5. Dress commutator, replace brushes
6. Open-circuit fault in stator or armature winding	6. Replace stator coils or armature
7. Shorting of commutator bars, turn-to-turn shorts in armature or stator windings, or ground fault	7. Replace faulty parts
8. Ground fault of positive brush holder	8. Eliminate ground fault or replace commutator end head

With Starter Switched on its Armature Rotates, but Flywheel Stands Still

1. Overrunning clutch slipping	1. Check starter on stand, replace clutch
2. Clutch shift lever broken or its shaft has slipped out	2. Replace lever or put in place its shaft
3. Breaking of clutch carrier ring or buffer spring	3. Replace clutch

Abnormal Noise of Starter During Armature Rotation

1. Excessive wear of bearing bushes or armature shaft bushes	1. Replace armature bushes
2. Starter fastenings loose or drive end head broken	2. Tighten bolts or repair starter
3. Starter fastened out of true	3. Check starter mounting
4. Loosening of stator pole (armature rubs against pole)	4. Tighten pole screw
5. Damaged teeth of starter pinion or flywheel ring gear	5. Replace starter pinion or flywheel

Cont'd

Cause	Remedy
6. Pinion fails to disengage from flywheel:	
(a) jamming of shift lever	(a) replace lever
(b) clutch seized on armature shaft splines	(b) clean splines and coat them with engine oil
(c) clutch or solenoid switch springs weak or broken	(c) replace clutch or solenoid switch
(d) lockring has come off clutch hub	(d) replace faulty parts
(e) solenoid switch armature seized due to overheating	(e) replace solenoid switch
(f) faulty ignition switch contact unit: contacts "30" and "50" fail to open	(f) check for correct contacting in various positions of ignition key; replace faulty contact unit

Stand Tests

The efficiency of the starter can be determined by checking its electrical and mechanical characteristics on a stand.

A hookup for checking the starter on the stand is shown in Fig. 7-15. The cross-section of the wires leading to the power source, ammeter and to the contact bolt of the starter solenoid switch should be not less than 16 mm^2.

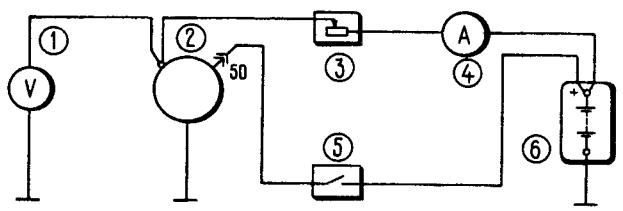

Fig. 7-15. Starter Test Stand Hookup:
1 - voltmeter, scale not under 15 V; 2 - starter; 3 - rheostat, 800 A; 4 - ammeter with 1000 A shunt; 5 - switch; 6 - storage battery

The starter should be supplied from a fully charged battery 6CT-55П or from a special source of power whose voltage drop curve under load corresponds to that of the battery.

The temperature during the tests should be (25±5) °C and the brushes must be well seated on the commutator.

Performance Test

Closing switch 5 and using a 12 V power source, apply the starter four times with different brake torques, e.g. 1.96 - 2.35; 5.4 - 6.45; 8.8 - 10.6; 11.3 - 12.3 N.m (0.2 - 0.24; 0.55 - 0.66; 0.9 - 1.08; and 1.15 - 1.25 kgf.m). Each time the starter should be applied for not longer than 5 s with at least 5-s intervals between successive applications.

If the starter fails to rotate the stand ring gear or is noisy in operation, disassemble it and examine its parts.

Locked-Torque Test

Lock the stand ring gear, switch on the starter and measure the current, voltage and torque which should not be over 500 A and 6.5 V, and not under 13.7 N.m (1.4 kgf.m), respectively. Apply the starter for not longer than 5 s.

If the torque is lower and the current is higher than the above-specified values, this may be probably caused by shorted turns or ground fault of the stator and armature windings.

If the brake torque and current drain are lower than specified above, the cause may be oxidation and soiling of the commutator, heavy wear of brushes or weakening of their springs, jamming of brushes in the holders, loose terminals of the stator winding, oxidation or burning of the solenoid switch contact bolts.

With the pinion locked, the starter armature should not rotate. If it does, the overrunning clutch is at fault.

To remedy the defects disassemble the starter and replace or repair the damaged parts.

No-Load Test

Disengage the ring gear of the stand from the starter pinion. Switch on the starter and measure the current drain and the armature speed which should be, respectively, not over 35 A (60 A for the starter 35.3708) and (5000^{+500}_{-800}) min^{-1} at 11.5 - 12 V across the starter terminals.

If the current drain and the armature speed go beyond the above-indicated limits, the causes may be the same as those in the previous test.

Solenoid Switch Test

Place a gasket, 12.8 mm thick, between limiting ring 21 (Fig. 7-13) and the pinion and energize the solenoid switch. In a single-winding solenoid switch check the current drain which should not exceed 23 A. In a two-winding solenoid switch check the cut-in voltage which should not exceed 9 V at an ambient temperature of (20±5) °C.

Mechanical Test

Using a dynamometer check the brush spring tension which should be (9.8±0.98) N [(1±0.1) kgf] for new brushes. If the brushes are worn to a length of 12 mm, replace the brushes and seat them well on the commutator.

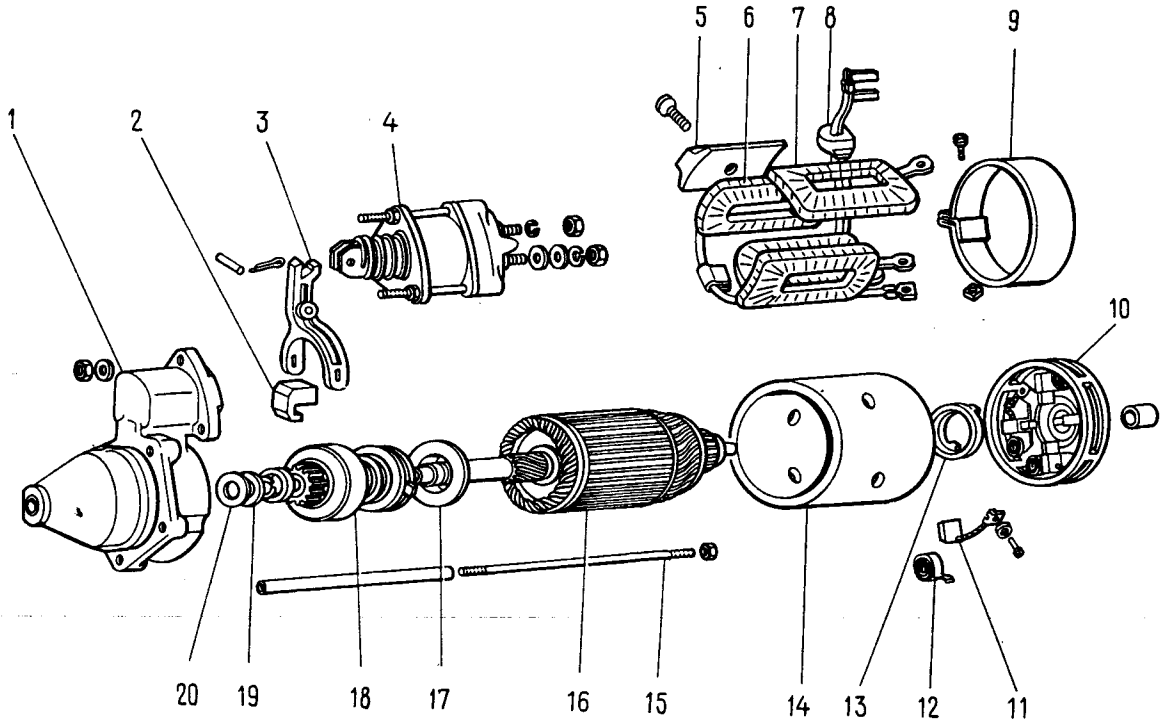

Fig. 7-16. Starter Parts:
1 - drive end head; 2 - rubber plug; 3 - shift lever; 4 - solenoid switch; 5 - stator pole; 6 - stator series winding; 7 - stator shunt winding; 8 - rubber plug; 9 - cover band; 10 - commutator end head; 11 - brush; 12 - brush spring; 13 - end head brake disc; 14 - frame; 15 - through stud; 16 - armature; 17 - pinion stop; 18 - overrunning clutch with drive pinion; 19 - thrust washer; 20 - adjusting washer

The end play of the armature shaft should be from 0.07 to 0.7 mm. If it fails to fall within these limits, disassemble the starter and select the required thickness and number of adjusting washers 20 (Fig. 7-16).

The starter drive should move freely along the splined shaft without perceptible jamming and be pulled from the working to the initial position by the return spring of the switch armature.

When the drive pinion is turned in the normal direction of the armature, the latter should stay still. The torque required for turning the pinion relative to the armature shaft should not exceed 27.4 N.cm (2.8 kgf.cm).

REPAIRS

Defects and damage of the starter should be eliminated by replacing the faulty parts. The only permissible repair operation is turning the commutator on a lathe.

Disassembly

Unscrew the nut on the lower contact bolt of the solenoid switch and disconnect the stator winding. Unscrew the solenoid switch fastening nuts and remove the switch.

Loosen the screw of the cover band on commutator end head 10 and remove cover band 9 with its gasket. Remove the brush terminal screws and take off the brushes. In the starter 35.3708 remove the lockwasher from the rear end of the shaft.

Unscrew the nuts of through studs 15, screw out the latter and remove drive end head 1 complete with armature 16.

Detach the commutator end head from the frame. Remove rubber plug 2 of the lever from the drive end head, uncotter and pull out the shaft of starter shift lever 3, take the lever and the armature from the end head.

To remove the starter drive from the armature, take the lockring from under limiting ring 21 (Fig. 7-13). The drive can be disassembled after removing the lockwasher from the clutch hub.

After disassembly blow the parts with compressed air and wipe them clean.

Inspection and Repairs

Armature. Using a megger or a 220 V test lamp check the armature winding for ground faults.

The voltage is fed through the lamp to the commutator bars and the armature core. If the lamp is alight it means that either the armature winding or the commutator bars are shorted to the ground. When a megger is used, it should read a resistance of not less than 10 kΩ. The armature with a ground fault should be replaced.

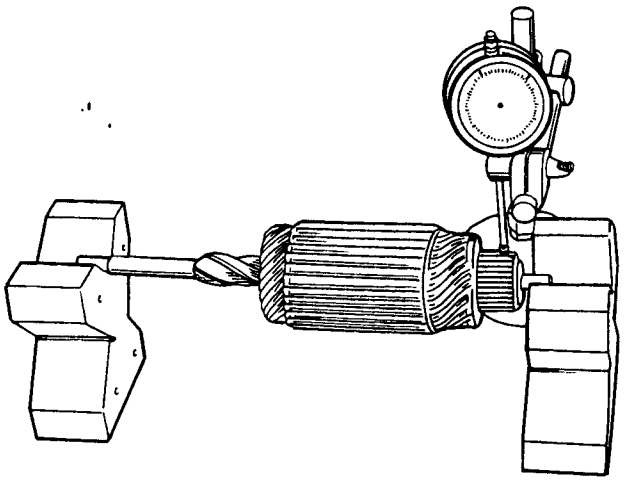

Fig. 7-17. Checking Commutator Runout

Using a special tester check for short circuits between the armature winding sections or commutator bars and for opens at the points where the ends of the winding sections are soldered to the commutator bars.

Examine the working surface of the commutator and check it for runout relative to the shaft journals (Fig. 7-17). If the commutator is soiled or burnt, dress it with fine abrasive cloth. If the surface is heavily damaged or its runout exceeds 0.06 mm, turn the commutator on a lathe, taking care to remove as little metal as possible. The minimum diameter to which the commutator may be turned is 36 mm. After turning grind the commutator with fine abrasive cloth.

Check the core for runout relative to the shaft journals. Replace the armature if the runout exceeds 0.08 mm.

Examine the surfaces of the armature shaft splines and journals. They should be free of scores, nicks and wear. If the shaft surface bears yellow deposit from the pinion bush, remove it with fine abrasive cloth since it may cause jamming of the pinion on the shaft.

Starter drive. The pinion teeth should be free of considerable wear. If the engaging portion of the teeth is nicked, grind the teeth with a fine small-diameter grinding stone. The pinion should rotate easily relative to the clutch hub but only in the direction of armature rotation at engine starting.

If the parts of the starter drive are damaged or considerably worn, replace the drive by a new one.

Stator. Using a megger or a 220 V test lamp, check the stator winding for ground faults. The voltage is fed through the lamp to the common terminal of the winding and to the starter frame. If the lamp lights or the megger reading is under 10 kΩ, also if the winding shows signs of overheating (darkened insulation), replace the winding.

To replace the stator winding coils take off the poles by turning out the pole screws with a power screwdriver. Prior to removing the poles, match-mark both the frame and the poles so as to return them to their initial position.

It is recommended that the winding be heated to 50 °C approximately before installation so as to make it flexible and facilitate its fitting on the poles. Fasten the poles by tightening their screws as far as they will go in order to retain the initial air gap between the armature and the poles (0.38 mm, measured with a feeler gauge).

After assembly check the inside diameter between the poles; it must be 67.80 - 67.97 mm. Besides, using a plug gauge of 67.66 mm diameter, check the concentricity of the frame and the poles. Being touched to the inside surface of the frame, the gauge should go in and turn freely between the poles. If this requirement is not satisfied, it means that the starter was improperly assembled and must again be stripped down and reassembled.

Machining of the poles is by no means permissible.

End heads. Examine the end heads for cracks. Replace them, if cracked. Inspect the end head bushes. If they are worn, replace either the end head assemblies or the bushes alone. After press-fitting ream out the new bushes to a diameter of $12.015^{+0.015}$ mm. Before replacing the bush in the commutator end head, take out the blank plug; having pressed-in the bush, reinstall the blank plug and lock-punch it at three points.

Check to see that the brush holders are reliably secured on the commutator end head. The positive brush holders should have no ground faults. The brushes must be free to move in their holders. The brushes worn down to a length of 12 mm should be replaced by new ones and carefully bedded on the commutator.

Using a dynamometer check the brush spring pressure; for new brushes it should be (9.8 ± 0.98) N $[(1 \pm 0.1)$ kgf$]$. If necessary, replace the springs by new ones.

Solenoid switch. Check the switch armature for freedom of movement. Using an ohmmeter check the contact bolts for reliable contact with the contact plate. If the contact is poor, disassemble the switch and dress the contact bolts with fine abrasive cloth or a flat barette file. If the contact bolts are seriously damaged at the point where they touch upon the contact plate, turn them through 180°.

Assembly

Before assembling the starter, coat the helical splines of the armature shaft and overrunning clutch hub with engine oil М-10ГИ. Lubricate the bushes of both end heads as well as the pinion with engine oil; coat the carrier ring of the drive with Литол-24 grease.

Before assembly check end play of the armature shaft, first assembling the end heads, frame and armature and tightening the nuts of the through studs. The armature can be assembled without the drive; end head 1 (Fig. 7-16) can be assembled without the lever. End play of the shaft should be within 0.07-0.7 mm. It can be changed by selecting the required number or thickness of adjusting washer 20.

In the starter 35.3708 the adjusting washers are installed at both sides of commutator end head 10.

Having installed the appropriate number of adjusting washers, assemble the starter by reversing the disassembly operations.

Check the assembled starter on a stand.

IGNITION SYSTEM

A circuit diagram of the ignition system is given in Fig. 7-18.

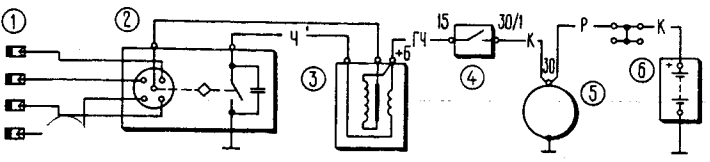

Fig. 7-18. Ignition System Circuit Diagram: 1 - spark plugs; 2 - ignition distributor; 3 - ignition coil; 4 - ignition switch; 5 - alternator; 6 - storage battery

TROUBLE SHOOTING

Cause	Remedy
Engine Fails to Start	
1. Current does not pass through breaker contacts:	
(a) breaker contacts dirty, oxidized or stuck; bulges and craters on contacts due to erosion; excessively large contact gap or weakening of contact spring	(a) dress contacts and adjust contact gap; replace contact unit if spring is weak
(b) L.T. wire tips loose or oxidized; wires broken or shorted to "ground"	(b) inspect wires and connections, replace damaged wires
(c) ignition switch faulty; contacts "15" and "30/1" fail to close	(c) examine switch and, if necessary, replace switch or its contact unit
(d) breakdown of capacitor (short circuit)	(d) replace capacitor
(e) open-circuit fault in ignition coil primary winding	(e) replace coil
2. Breaker contacts fail to open:	
(a) breaker point gap out of adjustment	(a) adjust
(b) heavy wear of breaker arm rubbing block or bushing	(b) replace contact unit
3. No H.T. supply to spark plugs:	
(a) H.T. wire tips loose, broken or oxidized; wires badly soiled or their insulation damaged	(a) inspect and restore connections, clean or replace wires
(b) carbon brush worn, damaged or jammed in distributor cap	(b) inspect distributor cap and replace, if necessary
(c) current leaks through cracks or burnt holes in distributor cap, through carbon deposits or moisture on inside surface of cap	(c) examine cap, remove moisture and carbon deposits; replace cap, if cracked
(d) current leaks through cracks or burnt holes in distributor rotor	(d) examine rotor and replace, if necessary
(e) burnt resistor in distributor rotor	(e) replace resistor
(f) open-circuit or ground fault in ignition coil secondary winding	(f) replace coil
4. H.T. wires confused in distributor cap towers	4. Check and connect wires according to engine firing order (1-3-4-2)
5. Wrong spark plug gap or oiling of spark plugs	5. Clean spark plugs and adjust spark gap
6. Spark plugs damaged (cracked insulator)	6. Replace spark plugs by new ones

Cont'd

Cause	Remedy
7. Wrong ignition timing	7. Check and adjust ignition timing
Engine Runs Unsteadily or Stalls When Idling	
1. Ignition too early	1. Check and adjust ignition timing
2. Excessively large spark plug gap	2. Check and adjust spark plug gap
3. Breaker contact gap too small	3. Check and adjust contact gap
4. Burnt resistor in distributor rotor	4. Replace resistor
Engine Runs Unsteadily at High Speeds	
1. Weakening of breaker arm spring	1. Replace breaker contact unit
2. Breaker contact gap too large	2. Check and adjust contact gap
3. Weak springs of centrifugal spark timer flyweights	3. Replace springs, check centrifugal spark timer on stand
Engine Missing at All Speeds	
1. Faulty ignition wires. Loose wire fastenings or oxidation of wire tips	1. Inspect wires and connections. Replace damaged wires
2. Breaker contacts dirty, oxidized, stuck or displaced	2. Dress contacts and adjust contact gap
3. Reduced capacity or punctured capacitor	3. Check capacitor and replace, if necessary
4. Wear or damage of carbon brush in distributor cap, weakening of its spring	4. Replace distributor cap
5. Badly burnt central contact in distributor rotor	5. Dress central contact
6. Cracks, dirt or burns of distributor rotor or cap	6. Inspect and replace rotor or cap
7. Excessive runout of distributor shaft, heavy wear of shaft bushing	7. Replace ignition distributor
8. Wear or oiling of spark plug electrodes; heavy carbonization; cracked spark plug insulator	8. Examine spark plugs, decarbonize them, adjust spark gap, replace faulty spark plug
Lack of Power and Poor Pickup	
1. Wrong ignition timing	1. Check and adjust
2. Jamming of spark timer flyweights or weakening of their springs	2. Inspect and replace damaged parts
3. Heavy wear of breaker arm bushing	3. Check and replace breaker contact unit

IGNITION TIMING

To check ignition timing there are three marks 1, 2, and 3 (Fig. 7-19) on the valve gear cover and mark 4 on the crankshaft pulley; when mark 4 is aligned with mark 3 on the cover, this indicates the TDC of the pistons in No.1 and No. 4 cylinders.

Ignition timing can be checked and adjusted with a strobe light in the following order:

- set the eccentric of the ignition distributor octane selector to zero (if the P-125B distributor is installed on the engine);
- connect strobe light terminal "+" with ignition coil terminal "+B" and connect the "ground" clamp with the minus terminal of the storage battery;
- insert an adapter for the strobe light between the spark plug of No. 1 cylinder and its wire and make a chalk mark to render mark 4 more conspicuous on the crankshaft pulley;
- start the engine and direct the flashing light of the stroboscope at the mark on the pulley; if ignition timing is correct, mark 4 seen on the pulley will be in line with mark 2 on the valve gear cover when the engine is idling.

To adjust ignition timing stop the engine, loosen the distributor fastening nut and turn the distributor through a required angle. To increase or decrease the ignition advance angle, turn the distributor body counter-clockwise or clockwise, respectively. Then recheck the ignition timing.

If a diagnostic stand with an oscilloscope is available, it can also be used for an easy check of ignition timing, following the instructions for the stand.

If the ignition distributor has been removed from the engine, put it back in place as follows:

- remove the distributor cap, check the breaker point gap and adjust it, if necessary;
- turn the crankshaft until a compression stroke begins in No. 1 cylinder and, continuing to turn the crankshaft, align mark 4 with mark 2;

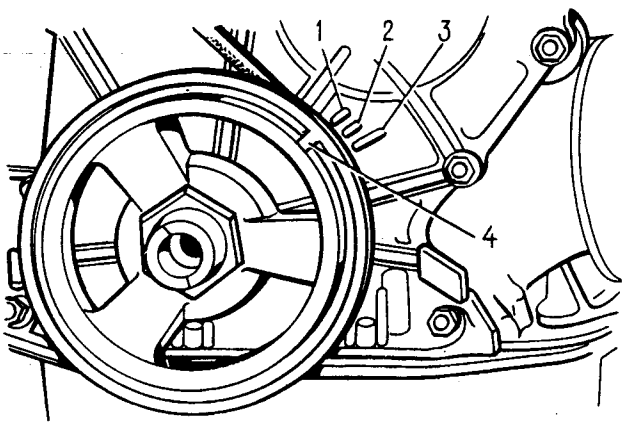

Fig. 7-19. Ignition Timing Marks:
1 - 10° spark advance mark; 2 - 5° spark advance mark; 3 - 0° advance mark; 4 - TDC mark on crankshaft pulley

- turn the rotor to a position in which its outer contact faces the contact of No. 1 cylinder on the distributor cap;

- holding the distributor shaft against turning, insert it into the socket on the cylinder block so that the axis passing through the spring clips be parallel to the engine axis;

- secure the distributor on the cylinder block, install the cap, connect the wires, check and adjust the ignition timing.

Checking and Adjustment of Breaker Point Gap

To check the breaker point gap:

- set the gearshift lever to neutral and apply the parking brake;

- turning the engine crankshaft, bring the breaker cam to a position in which the breaker contacts are completely open;

- measure the gap with a feeler gauge. If the gap not within 0.35 and 0.45 mm limits, loosen screws 21 (Fig. 7-21) of the breaker bracket, insert the blade of a screwdriver into slot 22 and turn the breaker bracket as required. After adjustment tighten screws 21 all the way home.

STAND TESTS OF IGNITION UNITS

Ignition Distributor

Caution

Before 1980 the car engines were fitted with type P-125B ignition distributors (Fig. 7-20).

From 1980, the car engines fitted with carburettor 2107-1107010-20 are furnished with type 30.3706-02 ignition distributors with a vacuum spark timer (Fig. 7-21).

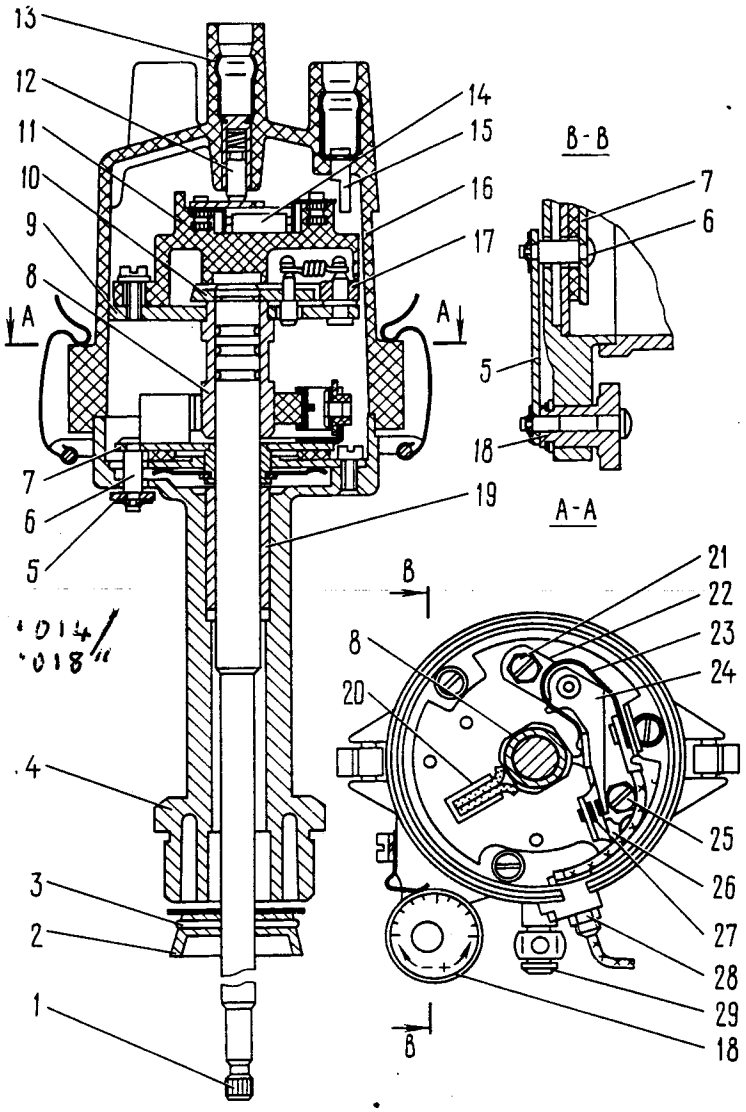

Fig. 7-20. Ignition Distributor P-125B:
1 - shaft; 2 - oil-deflecting sleeve; 3 - spiral stud; 4 - body; 5 - link; 6 - axle; 7 - breaker movable plate; 8 - breaker cam; 9 - driven plate; 10 - driving plate; 11 - rotor; 12 - central carbon electrode; 13 - central electrode terminal; 14 - resistor; 15 - side electrode; 16 - cap; 17 - flyweight; 18 - octane selector eccentric; 19 - shaft bushing; 20 - wick; 21, 25 - breaker contact bracket screws; 22 - breaker contact bracket; 23 - arm spring; 24 - breaker arm; 26 - bracket adjusting slot; 27 - breaker contact points; 28 - L.T. wire terminal nut; 29 - shaft oiler

Prior to mounting the ignition distributor on the stand, examine the breaker contacts, see that the breaker arm with the movable contact is not jammed on its shaft and measure the contact pressure which should be 4.9 - 5.88 N (500 - 600 gf).

Check the rubbing block of the breaker arm for wear; if it is worn, set the required gap between the breaker contact points. If the arm is jammed on its shaft or its spring is weak, replace the contact group.

If the breaker contacts are soiled, stuck or eroded, dress them with a barette file. Never use abrasive cloth or other abrasives for this purpose.

After dressing wipe the breaker contacts with chamois leather soaked in gasoline. Then pull off the breaker arm to allow gasoline to evaporate and wipe the contacts once more with dry chamois leather. The chamois leather may be substituted by any other material which leaves no lints on the contacts.

The contacts should touch each other throughout their surface. If they are not in full contact, adjust the position of the fixed contact by bending the bracket support. It is not permitted to bend the breaker arm with the movable contact.

Wipe the distributor cap to remove any dirt and oil.

Lifting the distributor cap a little, check to see whether the rotor contact faces the electrode of the cap at the moment of opening of the breaker contacts.

CONTACT BREAKER SET
LUCAS DSB 8 G1 C 0394 803

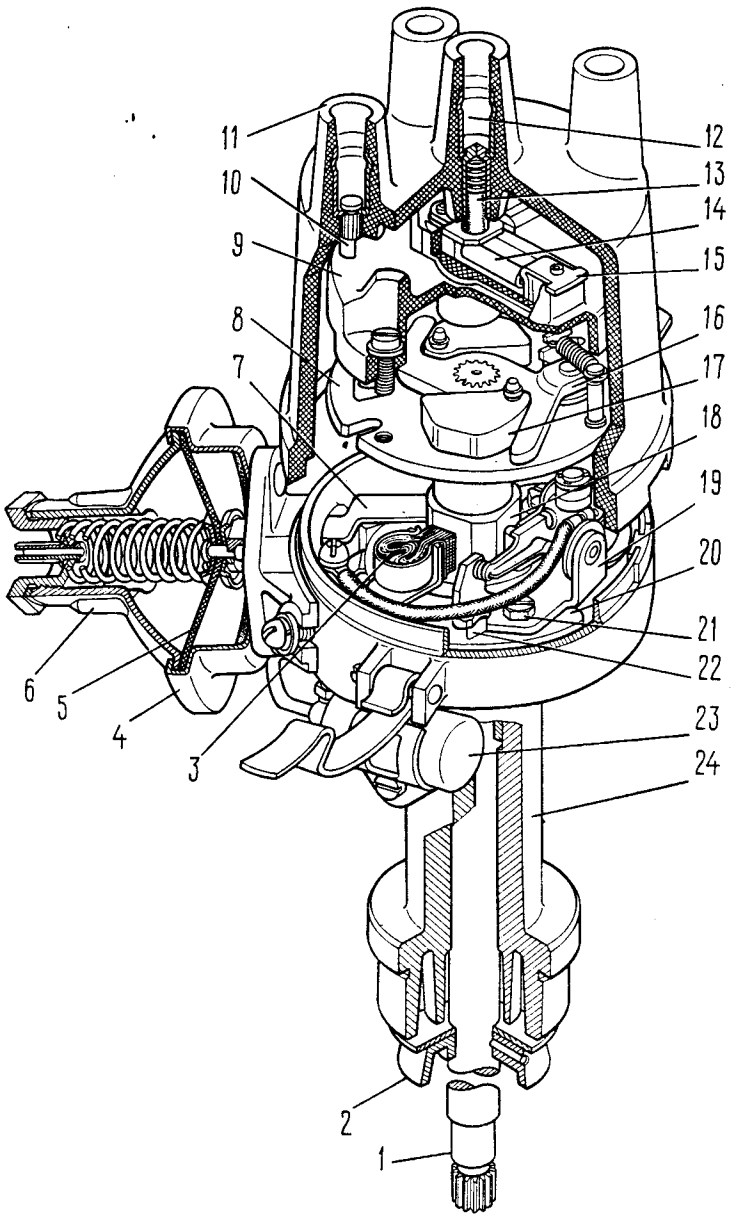

Fig. 7-21. Ignition Distributor 30.3706-02:
1 - shaft; 2 - oil deflecting sleeve; 3 - wick; 4 - vacuum spark timer body; 5 - membrane; 6 - vacuum spark timer cap; 7 - vacuum spark timer link; 8 - centrifugal spark timer supporting plate; 9 - distributor rotor; 10 - side electrode with terminal; 11 - cap; 12 - central electrode with terminal; 13 - central electrode carbon; 14 - resistor; 15 - rotor outer contact; 16 - centrifugal spark timer plate; 17 - flyweight; 18 - breaker cam; 19 - contact group; 20 - breaker movable plate; 21 - contact group screw; 22 - slot; 23 - capacitor; 24 - ignition distributor body

Performance check. Mount the distributor on the test stand and connect it to a variable-speed motor.

Make necessary connections with the ignition coil and storage battery; connect four terminals of the distributor cap with four adjustable spark gaps of the stand.

Set a 5-mm electrode clearance in the spark gaps, start the stand motor and rotate the distributor shaft a few minutes in the clockwise direction at 2000 min^{-1}. Then increase the electrode clearance to 10 mm and look for internal discharges in the distributor. Internal discharges can be noticed either by sound or by weak and missing sparks in the stand spark gaps.

The operating distributor should make no noise at any engine speed.

Measuring the automatic spark advance. Mount the distributor on the stand and connect it in compliance with the stand instructions.

Start the stand motor and rotate the distributor shaft at 150 - 200* min^{-1}. Watching the graduated disc, note the degrees at which one of the four spark occurs.

Increasing the motor speed and taking the readings each time after raising the speed by 200 - 300 min^{-1}, determine the degrees of the spark advance angle relative to the initial setting at various distributor shaft speeds. Compare the obtained curve with that shown in Fig. 7-22.

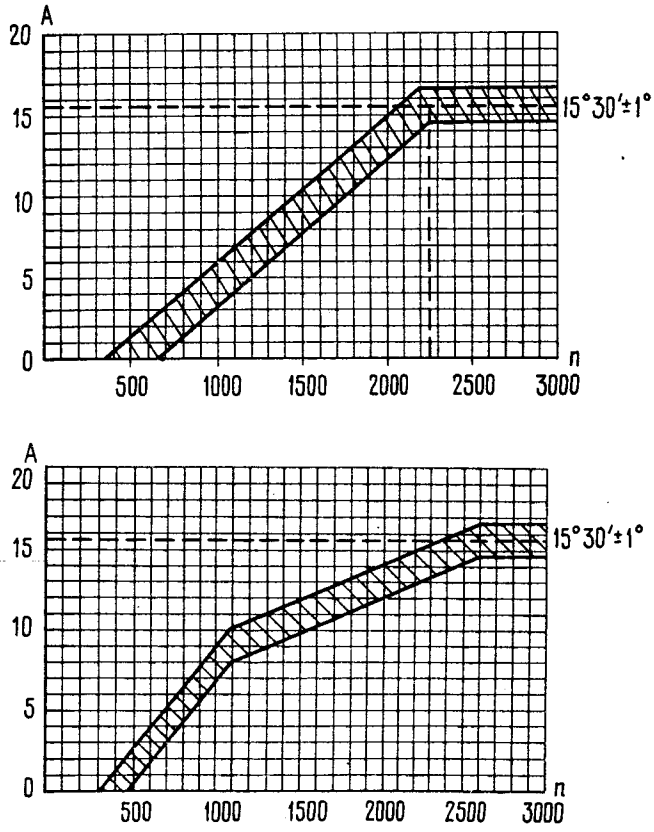

Fig. 7-22. Centrifugal Spark Timer Curve:
a - ignition distributor P-125B; b - ignition distributor 30.3706-02; A - spark advance angle, deg.; n - distributor shaft speed, min^{-1}

* 300 - 400 min^{-1} for ignition distributor P-125B.

Checking the dwell angle.

Turn on the stand motor and accelerate the distributor shaft to 1000 min^{-1}.

Measure the dwell angle on the lighted portions of the scale; the angle should be $(55\pm3)^{\circ}$.

Having checked the dwell angle, check the angles between the contact-opening moments in the cylinders relative to No. 1 cylinder (asynchronism); these angles should not differ by more than $\pm1^{\circ}$ from the nominal values.

Measuring vacuum spark timer response. Connect the vacuum spark timer of the ignition distributor with the vacuum pump of the stand by a hose.

Turn on the stand motor and rotate the distributor shaft at a speed of 1000 min^{-1}. Watching the graduated disc, set an arbitrary "zero" at which a spark occurs in any cylinder.

Increasing the vacuum gradually, note the number of spark advance degrees every 26.7 GPa (20 mm Hg) comparing it with the initial value. Compare the obtained curve with that shown in Fig. 7-23.

Adjust the timer curve by selecting the required number of adjusting washers inserted between the timer spring and plug.

See that the breaker movable plate returns readily to the initial position after the vacuum has been relieved.

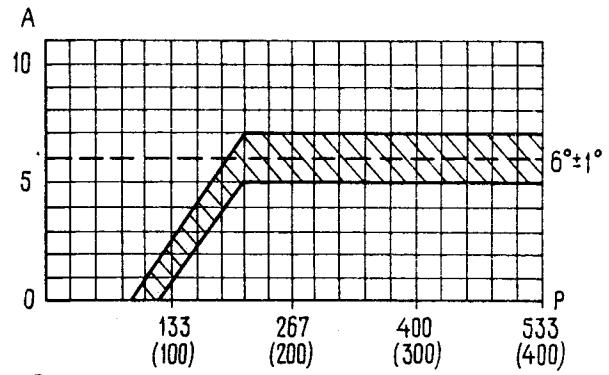

Fig. 7-23. Vacuum Spark Timer Curve of Ignition Distributor 30.3706-02:
A - spark advance angle, deg.; P - vacuum, GPa (mm Hg)

Checking the insulation resistance. The resistance of insulation between various terminals and "ground" at (25 ± 5) °C checked with a megger should be not less than 10 MΩ. Measure the resistance between the breaker L.T. terminal and "ground" with the breaker contacts open.

Checking the capacitor. The capacity measured within a frequency range of 50 - 1000 Hz should be from 0.20 to 0.25 μF.

Ignition Coil

To check the ignition coil, make the following tests:

The ohmic resistance of the primary winding at 20 °C should be 3.07 - 3.5 Ω and that of the secondary winding, 5400 - 9200 Ω.

Insulation to "ground". The coil should withstand 1500 V, 50 Hz A.C. applied during one minute between the end of the primary winding and the body without discharges.

The resistance of insulation to "ground" should be equal to, or higher than, 50 MΩ.

Spark Plugs

If sparks are missing in one or more cylinders, take care to examine the spark plugs.

Before the test clean the carbonized or fouled spark plugs by sand- and airblasting on a special installation.

If carbon deposits are light-brown in colour, they may be left in place since they may appear in a sound engine and do not interfere with normal functioning of the ignition system.

After cleaning examine the spark plugs and adjust the electrode gap. Replace the spark plug, if the insulator is chipped or cracked or the weld of the side electrode is damaged.

The gap between the spark plug electrodes (0.5 - 0.6 mm) should be checked with a round wire feeler gauge included into the driver's tool kit. Do not check the gap with a flat feeler gauge since this measurement will not include the crater on the side electrode that develops in the course of spark plug operation. Adjust the gap by bending the side electrode only. The central electrode must not be bent as this may damage the ceramic insulator.

Tightness test. Screw the spark plug into the corresponding socket of the stand and build up a pressure of 2 MPa (20 kgf/cm^2) in the stand chamber.

Apply a few drops of oil or kerosene to the spark plug; in case of poor tightness bubbles will appear, usually between the insulator and the metal body of the spark plug.

Electric test. Adjust the electrode gap to 0.6 mm, screw the spark plug into the stand socket and tighten to a torque of 30.67 - 39 N.m (3.13 - 3.99 kgf.m) with a torque-indicating wrench; pressure-tightness is ensured by an elastic gasket of the socket union. Set a 12 mm clearance in the spark gaps (which corresponds to a voltage of 18 kV) and build up a pressure of 0.6 MPa (6 kgf/cm^2) with a pump.

Fit the tip of a H.T. wire on the spark plug and press the switch button.

The following conditions may be observed:

1. A good hot spark jumps across the spark plug electrodes as seen through the stand eyepiece. In this case the spark plug is considered to be good.

2. Sparking takes place in the spark gaps. If so, reduce the pressure and note the value at

which the spark plug starts producing sparks. If this occurs at a pressure of 0.5 MPa (5 kgf/cm^2), the spark plug is considered sound; if it occurs at a pressure of 0.4 MPa (4 kgf/cm^2) and lower, the spark plug is defective and must be discarded.

There may be several sparks on the spark gap; if there are no sparks both in the spark plug and spark gap, the fault lies probably with a cracked spark plug insulator so that the discharge takes place inside, between "ground" and the electrode. Such a spark plug is considered faulty.

Ignition Switch

The ignition switch should be checked for proper functioning of the antitheft device and for correct closing of contacts in various positions of the key (Table 7-5). The voltage is fed from the battery and alternator to contacts "30" and "30/1". A vacant additional plug "INT" is intended for connecting a radio receiver.

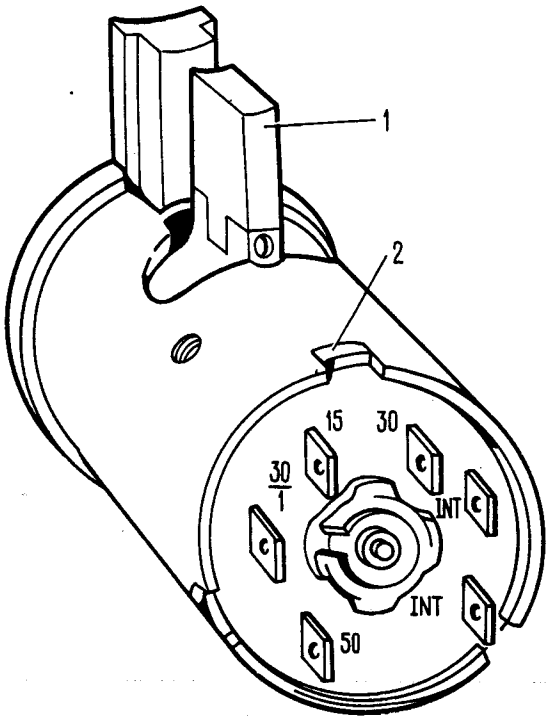

Fig. 7-24. Ignition Switch Contact Group: 1 - locking bar; 2 - wide lug

The locking bar of the antitheft device should extend when the key is turned to the PARKING (СТОЯНКА) position and removed from the lock; it should be retracted when the key is turned from the PARKING (СТОЯНКА) to the OFF (ВЫКЛЮЧЕНО) position.

When installing the contact unit into the switch body, arrange the unit so that terminals "15" and "30" are located at the locking bar side (Fig. 7-24) in which case the wide lug of the contact unit will snap into the wide slot of the switch body.

Checking Radio Noise Suppressors

The radio noise suppressors include the H.T. wires with a distributed resistance of (2000±200) Ω/m and a suppressor resistor in the distributor rotor, rated for 5000-6000 Ω. The condition of these elements can be checked with an ohmmeter.

Table 7-5

Circuits Energized in Various Positions of Key

Key position	Energized contacts	Energized circuits
OFF (ВЫКЛЮЧЕНО)	30 and 30/1	-
III PARKING (СТОЯНКА)	30-INT	External lighting, windshield wiper, heater
	30/1	-
I IGNITION (ЗАЖИГАНИЕ)	30-INT	External lighting, windshield wiper, heater
	30/1 - 15	Ignition system, alternator field, instruments, direction indicators
II STARTER (СТАРТЕР)	30-INT	External lighting, windshield wiper, heater
	30/1 - 15	Ignition system alternator field, instruments, direction indicators
	30 - 50	Starter

LIGHTING AND LIGHT SIGNALLING SYSTEM

The external lighting circuit diagram is shown in Fig. 7-25 and the headlight circuit diagram, in Fig. 7-26.

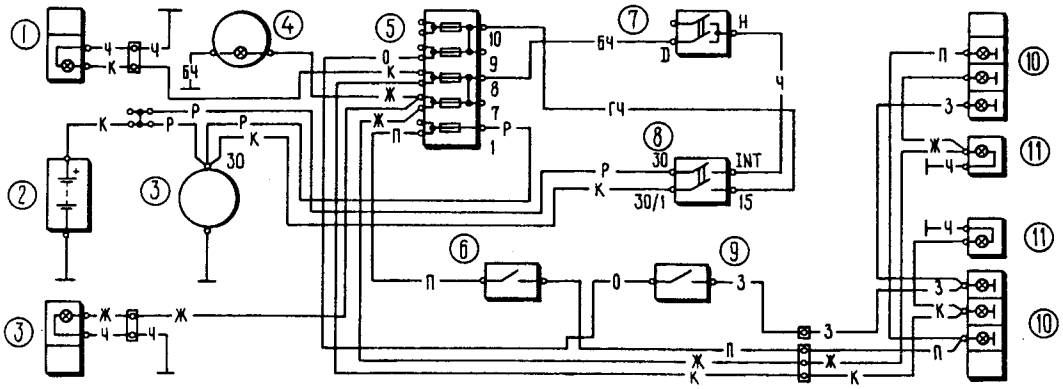

Fig. 7-25. External Lighting Circuit Diagram:
1 - side light; 2 - storage battery; 3 - alternator; 4 - external lighting warning lamp; 5 - fuse unit; 6 - stoplight switch; 7 - external lighting switch; 8 - ignition switch; 9 - backing light switch; 10 - tail light; 11 - number plate light

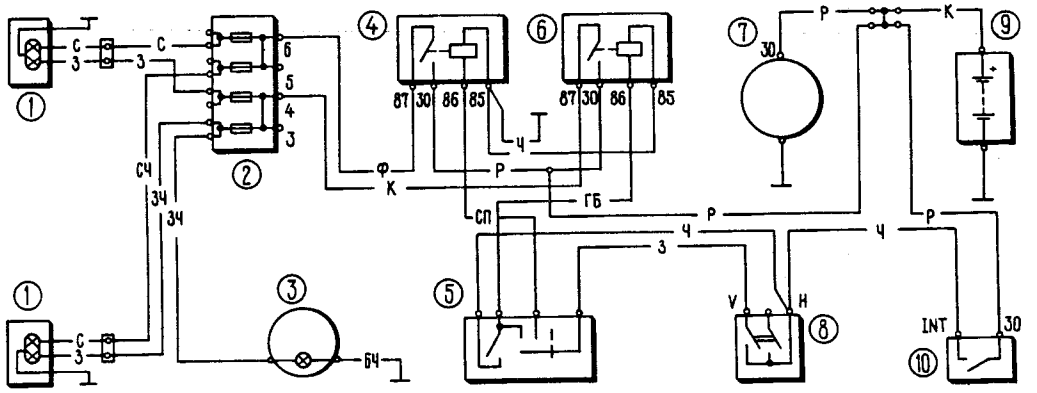

Fig. 7-26. Headlight Circuit Diagram:
1 - headlight; 2 - fuse unit; 3 - headlight upper beam warning lamp in speedometer; 4 - headlight lower beam relay; 5 - headlight beam switch; 6 - headlight upper beam relay; 7 - alternator; 8 - external lighting switch; 9 - storage battery; 10 - ignition switch

TROUBLE SHOOTING

Cont'd

Cause	Remedy
Some Bulbs Inoperative	
1. Fuses blown out	1. Check and replace fuses
2. Bulb filaments burnt out	2. Replace bulbs
3. Wires damaged, their tips oxidized or connections loosened	3. Inspect, replace damaged wires, clean tips
Stoplight Inoperative	
Stoplight switch faulty	Check with test lamp, replace faulty switch
Headlight Lower and Upper Beams Cannot be Changed Over	
1. Defective headlight relay	1. Adjust or replace relay
2. Oxidation of switch contacts	2. Replace three-lever switch
Direction Indicator and Headlight Switch Levers Fail to be Fixed in Position	
1. Lever lock ball has snapped out	1. Replace three-lever switch
2. Damaged sockets of lever locks	2. Replace three-lever switch
Direction Indicators Fail to Switch Off Automatically on Completion of Turn	
1. Jamming of direction indicator lever return mechanism	1. Replace three-lever switch
2. Lugs of direction indicator switch carrier ring worn or broken	2. Replace three-lever switch
Direction Indicator and Headlight Switch Levers Fail to Function	
1. Jamming of lever lock balls	1. Replace three-lever switch

Cont'd

Cause	Remedy
2. Jamming of direction indicator lever return mechanism	2. Replace three-lever switch
Direction Indicator Warning Lamp Inoperative	
1. Bulb filament burnt out	1. Replace bulb
2. Direction indicator and distress light flasher unit faulty	2. Replace flasher unit
After Turning on Direction Indicator Warning Lamp is Constantly Alight (Fails to Blink)	
1. Bulb of front or rear direction indicator burnt out	1. Replace bulb
2. Direction indicator and distress light flasher unit faulty	2. Replace flasher unit

HEADLIGHTS

Replacement of Bulb

To replace the bulb:

- remove decorative facing 4 (Fig. 7-27) on the front end of the body by turning out screws 5;
- loosen headlight moulding screws 3, turn the moulding counter-clockwise and take it off;
- take out the light unit and replace the bulb.

Put the light unit back in position so that its lugs enter the sockets of the headlight inner rim.

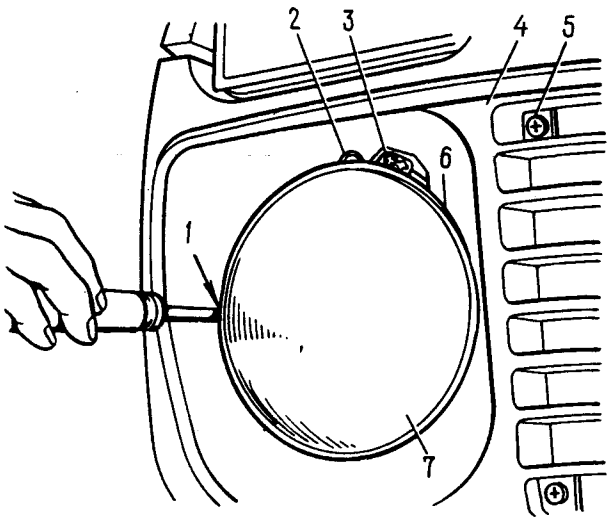

Fig. 7-27. Headlight Aiming:
1 - horizontal adjustment screw; 2 - vertical adjustment screw; 3 - headlight moulding screw; 4 - body front decorative facing; 5 - facing screw; 6 - headlight moulding; 7 - light unit

Headlight Aiming

The headlights should be aimed so as to ensure efficient illumination of the road ahead without dazzling the drivers of the oncoming vehicles by the lower beam. The headlights are aimed by rotating screws 1 and 2 which turn the light unit in the vertical and horizontal planes.

The best practice is to aim the headlights with the aid of portable optical apparatuses. However, if they are not available, this work can be done with the aid of a makeshift screen.

Place a fully primed and equipped car with a 750 N (75 kgf) load on the driver's seat on a level horizontal ground, 5 m away from a smooth wall or some sort of a screen (a sheet of plywood measuring 2x1 m, etc.) so that the car fore-and-aft line (axis) is square to the screen. Before marking out the screen make sure that the car tyres are properly inflated, then swing the car by pushing it from one of its sides to allow the suspension springs to settle.

Mark the screen as shown in Fig. 7-28, drawing an axial vertical line 0 and vertical lines A and B passing through the points which correspond to the headlight centres. These lines should be symmetrical with the fore-and-aft line of the car. Draw line 1 at the height of the headlight centres above the floor and line 2 of the headlight hot spots at a distance of 120 mm below line 1.

Turn on the lower beam. Cover first the L.H., then the R.H. headlight with a piece of cardboard or dark cloth and adjust the light beams with screws 1 and 2 (Fig. 7-27). The upper boundary of the hot spots of well-aimed headlights should coincide with line 2 (Fig. 7-28) while the points of intersection of the horizontal and inclined portions of the hot spots, with lines A and B.

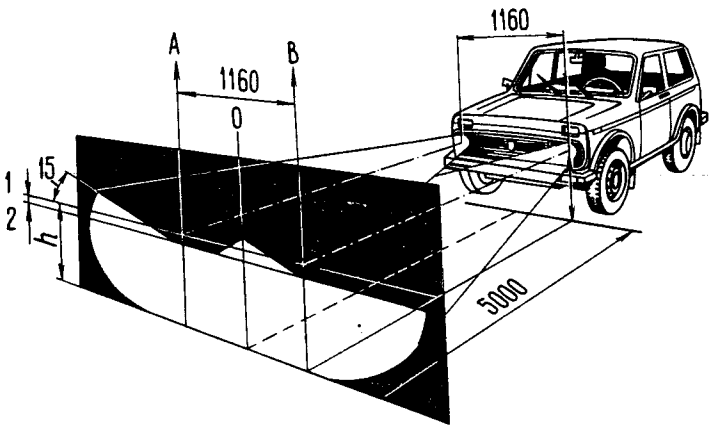

Fig. 7-28. Headlight Aiming Diagram

HEADLIGHT RELAY

Reference Data

Relay cut-in voltage at (23±5) °C, V, maximum 8
Winding resistance at 20 °C, Ω ..... 85±5

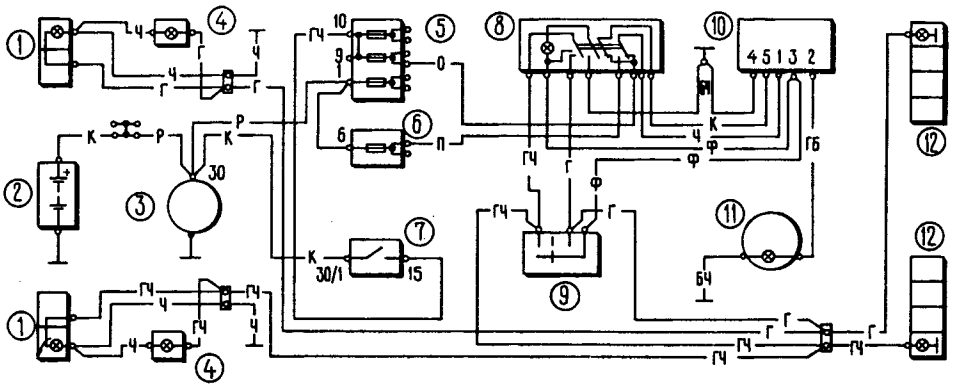

Fig. 7-29. Distress Light and Direction Indicator Circuit Diagram:
1 - side lights; 2 - storage battery; 3 - alternator; 4 - side direction indicators; 5 - main fuse unit; 6 - additional fuse unit; 7 - ignition switch; 8 - distress light switch; 9 - direction indicator switch; 10 - distress light and direction indicator flasher unit; 11 - direction indicator warning lamp in speedometer; 12 - tail lights

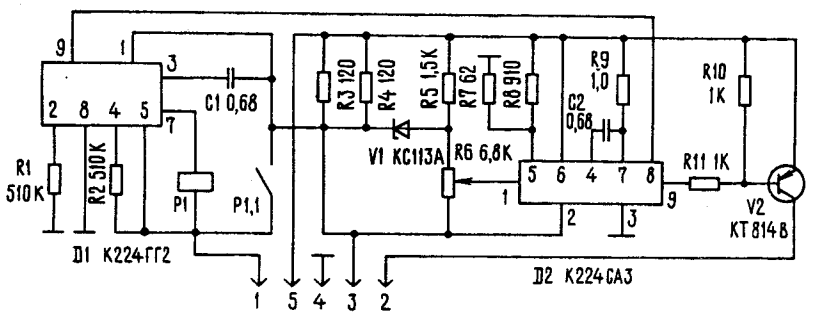

Fig. 7-30. Distress Light and Direction Indicator Flasher Unit Circuit Diagram

The lower and upper beams of the headlights are turned on by identical relays, Type 111.3747. They are installed, together with the headlight wiper and washer relays, under the instrument panel behind the fuse unit.

THREE-LEVER SWITCH

The switch is held by a clamp on the steering shaft bracket.

To remove the switch:

- take off the steering wheel;
- remove the two halves of the steering shaft casing;
- take off the instrument panel and disconnect the switch wires from the wire harness of the car;
- loosen the fastening clamp and take off the switch.

DISTRESS LIGHT AND DIRECTION INDICATOR FLASHER UNIT

Flasher unit 10 (Fig. 7-29) provides for the blinking light of direction indicators both when indicating the turns and giving distress signals, also for checking the condition of the direction indicator bulbs. If these bulbs are sound, warning lamp 11 will be blinking. If the bulbs are faulty (burnt or inoperative because of an open-circuit fault in their supply circuit), the flasher unit will ensure constant light of the warning lamp.

The flasher unit is fastened under the instrument panel on a bolt welded to the wall of the air intake box. A defective flasher unit is not subject to repairs and must be replaced by a new one.

The flasher unit makes the direction indicator bulbs blink at a frequency of 90±30 cycles per minute under a rated load of 92 W, ambient temperature from minus 20 to plus 50 °C and voltage of 10.8 to 15 V.

A circuit diagram of the flasher unit is given in Fig. 7-30.

The car is fitted with two horns (Fig. 7-31): high-tone and low-tone ones. They are bracketed to the radiator L.H. shield in the engine compartment.

The horn connection diagram is shown in Fig. 7-32.

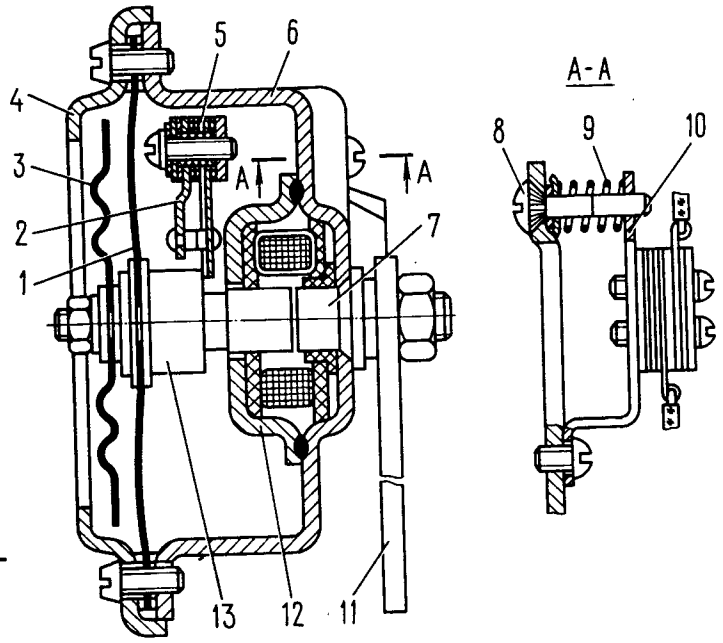

Fig. 7-31. Horn:
1 - membrane; 2 - stationary contact holder; 3 - diffuser; 4 - ring; 5 - movable contact plate; 6 - body; 7 - core; 8 - adjusting screw; 9 - adjusting screw spring; 10 - bridge; 11 - horn fastening plate; 12 - yoke; 13 - armature

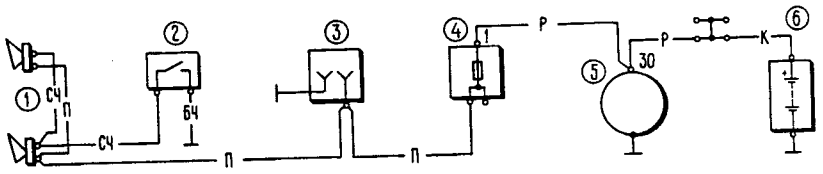

Fig. 7-32. Horn Connection Diagram:
1 - horns; 2 - horn switch; 3 - inspection lamp socket; 4 - fuse unit; 5 - alternator; 6 - storage battery

TROUBLE SHOOTING

Faulty operation of the horns can be caused by a defective or jamming switch and by a defective horn.

To identify the trouble examine the wire connections and the switch contacts. Clean the contacts, if necessary. The faulty switch or horn should be replaced by a new one.

If the sound becomes weak or hoarse, adjust the horn by turning screw 8 in or out (Fig. 7-31) until a loud and clear sound is obtained.

If adjustment fails to eliminate hoarseness or the horn produces intermittent sound, disassemble it and clean the breaker contacts.

When assembling the horn take care to install the previously removed gasket between horn membrane 1 and body 6 so as to retain a clearance of (0.4±0.05) mm between the armature and the core.

WINDSHIELD WIPER

Cont'd

TROUBLE SHOOTING

Cause	Remedy
Wiper Motor Inoperative, Fuse Intact	
1. Damaged motor supply wires, oxidized wire tips	1. Inspect wires, replace damaged ones, clean tips
2. Damaged wiper switch	2. Replace three-lever switch
3. Jamming of motor brushes, heavy oxidation of commutator	3. Inspect, eliminate jamming of brushes or replace faulty parts; dress commutator
4. Breaking of motor leads	4. Inspect and solder up, if necessary
5. Open-circuit fault in motor armature winding	5. Replace armature or motor

Cont'd

Cause	Remedy
Wiper Motor Inoperative, Fuse Blown Out	
1. Short circuit in motor armature	1. Replace motor or armature
2. Wiper arms distorted and brush against car body	2. Inspect, straighten arms or replace wiper
3. Wiper blades frozen to windshield	3. Pull wiper blades off windshield
4. Foreign object in wiper mechanism	4. Inspect, remove foreign object
Wiper Motor Fails to Function at Intermittent Mode	
1. Wiper switch damaged	1. Replace three-lever switch
2. Wiper relay damaged:	
(a) open-circuit fault in relay winding	(a) replace relay
(b) shorted wires on contact bracket	(b) eliminate short circuit
(c) clearance developed between relay breaker contacts	(c) eliminate clearance; replace relay, if necessary
Wiper Motor Fails to Stop at Intermittent Mode	
1. Burnt wiper relay breaker winding	1. Replace relay
2. Cam of motor reduction unit gear fails to force off limit switch sp. ; plate	2. Bend switch plate so that cam can force it off
3. Burning of motor limit switch contacts	3. Dress switch contacts
4. Burning of wiper relay breaker contacts	4. Remedy defect, dress breaker contacts or replace relay

Cont'd

Cause	Remedy
Wiper Motor Stops at Intermittent Mode. Blades Fail to Park in Initial Position	
Oxidation or poor closing of limit switch contacts in motor	Clean switch contacts or bend limit switch plate
Wiper Motor Operating, Blades Stay Still	
1. Broken teeth of motor reduction unit gear	1. Replace gear
2. Loosening of crank on reduction unit gear shaft	2. Inspect, tighten crank nut

REPAIRS

The circuit diagram of the windshield wiper is given in Fig. 7-33. Some of the windshield wipers are furnished with a thermobimetallic cut-out to protect the motor from overloads.

The repairs of the windshield wiper are confined basically to straightening the distorted components of the leverage or replacing them with new ones. A faulty motor should also be replaced by a new one. The only permissible repair operations on the electric motor are replacing the reduction unit gear, the armature and cleaning the commutator.

Removal and Installation

The windshield wiper is removed from the engine compartment as follows:

- remove the blades with the arms;
- disconnect the wires from the storage battery and wiper motor;
- unscrew the nuts of the arm pivots with the locating bushings;
- unscrew the nuts of the motor bracket and take off the motor complete with the leverage.

Put the motor on a work bench and remove the leverage.

To install, reverse the removal operations.

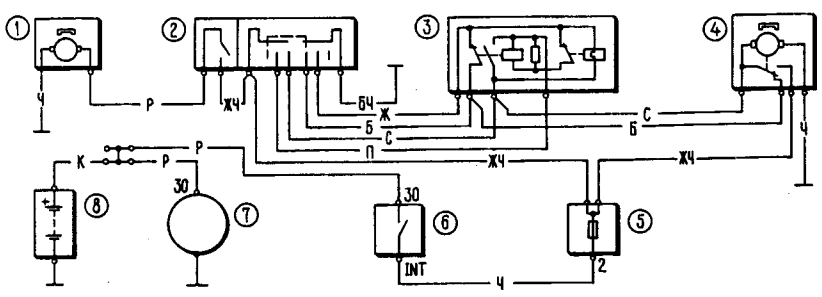

Fig. 7-33. Windshield Wiper and Washer Circuit Diagram:
1 - windshield washer motor; 2 - windshield wiper relay; 3 - windshield wiper and washer switch; 4 - windshield wiper motor; 5 - fuse unit; 6 - ignition switch; 7 - alternator; 8 - storage battery

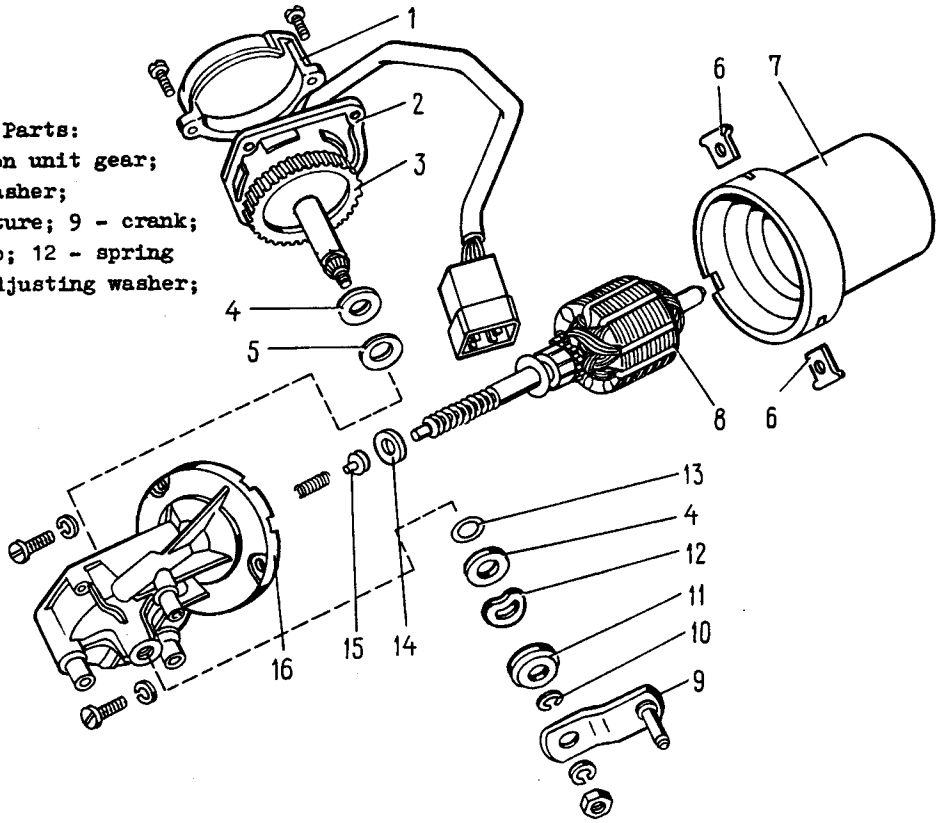

Fig. 7-34. Windshield Wiper Motor Parts:
1 - cover; 2 - panel; 3 - reduction unit gear; 4 - steel washer; 5 - textolite washer; 6 - retainer; 7 - frame; 8 - armature; 9 - crank; 10 - lockring; 11 - protective cap; 12 - spring washer; 13 - sealing ring; 14 - adjusting washer; 15 - spring seat; 16 - end head

Disassembly, Assembly and Inspection of Windshield Wiper Motor

Reference Data

Maximum effective torque on reduction unit shaft*, N.m (kgf.m)	2 (0.2)
Current drain* at a torque of 1 N.m (0.1 kgf.m), maximum, A	2.8
Reduction unit shaft speed* at a torque of 1 N.m (0.1 kgf.m), minimum, min^{-1}	50
Starting torque on reduction unit shaft*, minimum, N.m (kgf.m)	12 (1.2)

* At 14 V and (25±10) °C in cold state.

The МЭ-241 motor (Fig. 7-34) is a D.C. permanent-magnet excitation machine made integral with a worm reduction unit.

To disassemble the motor turn out the screws of reduction unit cover 1 and take off the cover together with panel 2. Then turn out the screws which hold end head 16 to motor frame 7 and detach the end head. Take out motor armature 8.

To remove reduction unit gear 3 unscrew the nut of crank 9, take the lockring off the shaft and take the shaft complete with the gear and washers out of the frame.

After disassembly blow the motor inside spaces with compressed air to remove carbon dust; then examine the brushes and the commutator.

The brushes should be free to move in the holders and the brush springs should be intact and sufficiently resilient. Clean the commutator with fine glass cloth, then wipe it with a clean rag lightly coated with petrolatum. If the commutator is heavily burnt or worn, the best practice is to replace the armature.

Look for the signs of binding on the armature shaft journals. If necessary, clean them with fine abrasive cloth.

During assembly pull the brushes away from the commutator to avoid breakage and damaging their edges. Insert the armature into the frame with particular care without bumping the armature against the pole pieces so as not to break them.

WINDSHIELD WIPER RELAY

Reference Data

Number of operations per minute at 10-14 V and a temperature from minus 20 to plus 50 °C	9-17
Electromagnet winding resistance, Ω	66±2
Breaker winding resistance, Ω	23±1

The PC-514 relay ensures intermittent operation of the windshield wiper. It is installed under the instrument panel at the left-hand side and is held to the car body by two screws.

At the first moment after switching on the wiper for intermittent operation (while the bimetallic plate of the breaker has not yet become heated) the wiper blades may make up to four double strokes in succession.

HEADLIGHT WIPER

The headlight wiper circuit diagram is shown in Fig. 7-35.

The headlight wiper motor is enclosed in one housing with the reduction unit. The motor is not to be disassembled and should be discarded, when faulty.

Motor Reference Data

Rated voltage, V	12
Current drain* at a torque of 1 N.m (0.1 kgf.m), not over, A	1.5
Number of double shaft strokes per minute* at a torque of 1 N.m (0.1 kgf.m)	50±5
Swinging angle of output shaft	65°±1°30'

* At 12 V and (25±10) °C

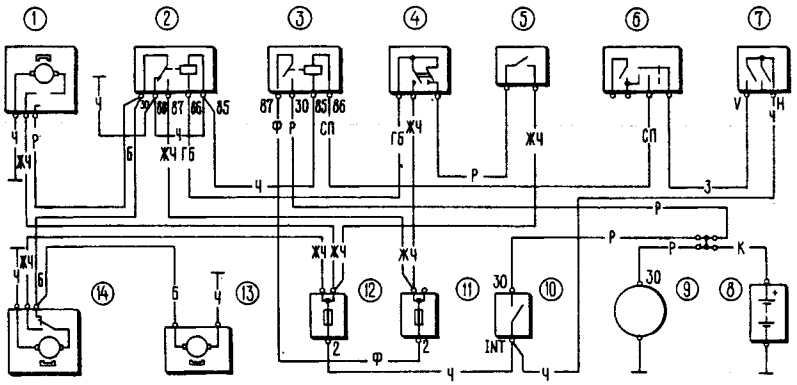

Fig. 7-35. Headlight Wiper and Washer Connection Diagram:
1 - headlight wiper R.H. motor; 2 - headlight wiper and washer relay; 3 - headlight lower beam relay; 4 - headlight wiper and washer switch; 5 - windshield washer switch; 6 - headlight beam switch; 7 - external lighting switch; 8 - storage battery; 9 - alternator; 10 - ignition switch; 11 - additional fuse unit; 12 - main fuse unit; 13 - headlight washer motor; 14 - headlight wiper L.H. motor

HEATER MOTOR

TROUBLE SHOOTING

Cont'd

Cause	Remedy
Motor Inoperative	
1. Wires damaged or connections oxidized	1. Inspect and restore connections. Replace damaged wires
2. Heater switch damaged. No voltage on switch output terminals	2. Examine switch. Replace, if necessary
3. Jamming or wear of motor brushes. Open circuit in armature winding or oxidation of commutator	3. Check motor, repair or replace
4. Ground fault in armature winding. Fuse burns out when motor is turned on	4. Replace motor
Motor Armature Rotates Slowly	
1. Commutator soiled or oxidized	1. Clean commutator
2. Shorted turns in armature winding	2. Replace motor
3. Armature shaft jammed in bearings	3. Disassemble motor, clean shaft journals

REPAIRS

Reference Data

Rated voltage, V	12
Rated power, W	20
Speed of armature shaft with impeller at rated power, min^{-1}	3000±150
Current drain at rated power, not over, A	4.5
Low speed of armature shaft with impeller, min^{-1}	2200±150
Current drain at 2200 min^{-1} of armature shaft, not over, A	2.7

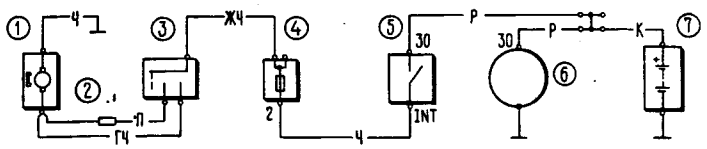

Fig. 7-36. Heater Motor Connection Diagram:
1 - heater motor; 2 - series resistor; 3 - heater switch; 4 - fuse unit; 5 - ignition switch; 6 - alternator; 7 - storage battery

The МЭ-255 motor is a D.C. permanent-magnet excitation machine. The heater motor connection diagram is given in Fig. 7-36.

When series resistor 2 is cut into the motor supply circuit, the armature shaft rotates at a low speed. The resistor is secured by two spring washers in the heater fan shroud. The resistor is rated for 1.5 Ω at 20 °C.

As a rule the faulty motor should be replaced. The only permissible repair operation is cleaning the commutator.

To disassemble the motor turn off the screws of end head 6 (Fig. 7-37) and remove the latter. Then remove lockwasher 1 from the armature shaft and take armature 4 out of the frame. To assemble reverse the disassembly operations.

Inspection of the heater motor is similar to that prescribed for the windshield wiper motor.

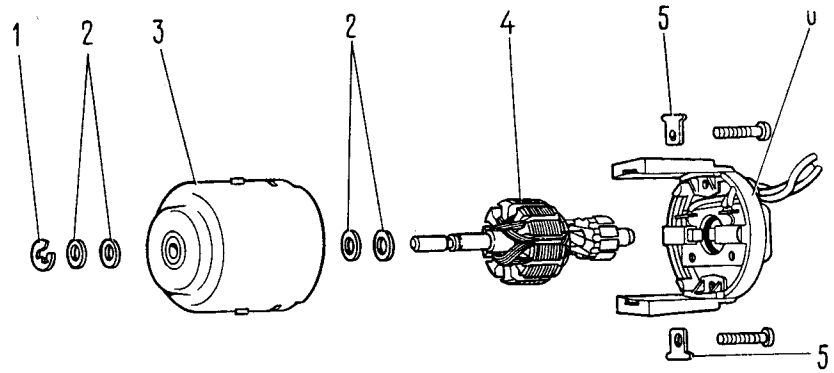

Fig. 7-37. Heater Motor Parts:
1 - lockwasher; 2 - washer; 3 - frame; 4 - armature; 5 - retainer; 6 - end head

INSTRUMENTS

TROUBLE SHOOTING

Cause	Remedy
Instrument Fuse Blows Out Repeatedly	
Breakdown of instrument-protecting diode	Replace damaged diode
Coolant Temperature Gauge Pointer Stays Constantly at Beginning of Scale	
1. Gauge faulty	1. Replace
2. Transmitter faulty	2. Replace
3. Wires damaged or wire tips oxidized	3. Examine wires, restore connections
Coolant Temperature Gauge Pointer Stays Constantly in Red Zone	
1. Gauge faulty	1. Replace
2. Transmitter faulty	2. Replace
3. Transmitter wire shorted to "ground"	3. Check, eliminate ground fault

Cont'd

Cause	Remedy
Fuel Level Gauge Pointer Stays Constantly at "0" Division	
1. Gauge faulty	1. Replace
2. Wires damaged or wire tips oxidized	2. Examine wires, restore connections
3. Transmitter faulty:	
(a) transmitter flexible bus torn off	(a) solder bus or replace transmitter
(b) open-circuit fault in resistor winding	(b) replace transmitter
(c) poor contact of resistor sliding contact	(c) provide reliable contact
(d) leaky float	(d) replace float

Cont'd

Cause	Remedy
Fuel Level Gauge Pointer Stays Constantly at "4/4" Division	
1. Gauge faulty	1. Replace
2. Transmitter flexible bus shorted to fuel suction pipe	2. Bend off bus
3. Transmitter wire shorted to "ground"	3. Check, eliminate ground fault
Fuel Level Gauge Pointer Returns to "0" Division when Tank is Full	
Wrong installation of float travel stop (end of resistor winding)	Bend stop 1-2 mm down
Fuel Level Gauge Pointer Jumps and Falls Frequently to "0" Division	
1. Poor contact between transmitter resistor and slider	1. Bend slider
2. Open circuit fault in transmitter resistor winding	2. Replace transmitter
Low Fuel Warning Lamp Constantly Alight	
1. Flexible bus touches upon fuel suction pipe	1. Bend off bus
2. Transmitter wire shorted to "ground"	2. Check, eliminate ground fault
Low Fuel Warning Lamp Fails to Light Up	
1. Bulb burnt out	1. Replace bulb
2. Transmitter contacts oxidized	2. Clean contacts
3. Transmitter contacts fail to close	3. Bend transmitter sliding contact
4. Broken wire	4. Replace damaged wire
Oil Pressure Warning Lamp Fails to Light Up After Turning On Ignition Switch	
1. Bulb burnt out	1. Replace
2. Transmitter faulty	2. Replace
3. Wires broken or wire tips oxidized	3. Check, replace damaged wires, clean tips
Oil Pressure Warning Lamp Constantly Alight or Goes Off at High Engine Speeds	
1. Transmitter faulty	1. Replace
2. Oil pressure too low	2. See Chapter "Engine"
Parking Brake Warning Lamp Fails to Blink (Constantly Alight)	
Open circuit in flasher unit winding (between "-" and "+" terminals)	Replace flasher unit

Cont'd

Cause	Remedy
Parking Brake Warning Lamp Fails to Light Up	
1. Bulb burnt out	1. Replace
2. Flasher unit contacts oxidized or clearance has formed between contact points	2. Remove flasher unit cover, clean contacts and eliminate clearance between them
3. Warning lamp switch faulty	3. Replace switch
Speedometer Fails to Operate	
1. Loosening of nuts which fasten cable ends to speedometer or its drive	1. Check and tighten nuts
2. Breaking of speedometer drive cable	2. Replace cable
3. Speedometer mechanism damaged	3. Replace speedometer
Speedometer Drive Cable Noisy	
1. Speedometer cable casing distorted (dented, bent, etc.)	1. Replace cable
2. Bending radiuses of speedometer cable smaller than 100 mm	2. Check and correct cable installation

Removal of Instrument Board

To remove the instrument board from the instrument panel for replacing a faulty instrument or a blown out bulb, force off clamps 3 (Fig. 7-38)

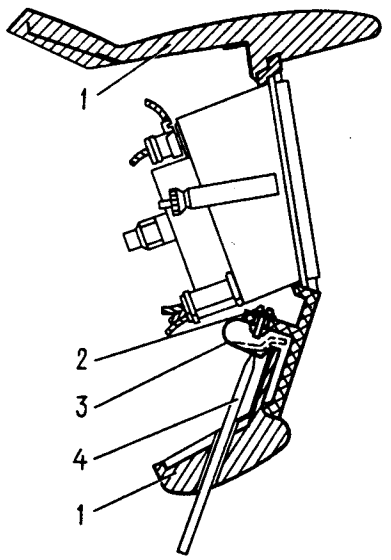

Fig. 7-38. Removing Instrument Board:
1 - instrument panel; 2 - instrument board;
3 - clamp; 4 - broach

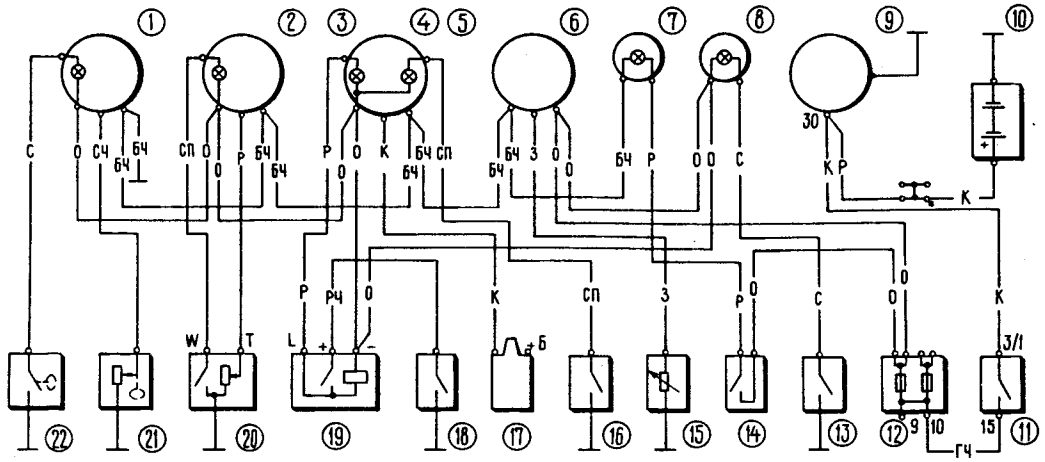

Fig. 7-39. Instrument Circuit Diagram:
1 - oil pressure gauge with low pressure warning lamp; 2 - fuel level gauge with low fuel level warning lamp; 3 - parking brake warning lamp; 4 - tachometer; 5 - carburettor choke valve warning lamp; 6 - coolant temperature gauge; 7 - brake fluid low level warning lamp; 8 - differential lock warning lamp; 9 - alternator; 10 - storage battery; 11 - ignition switch; 12 - fuse unit; 13 - differential lock warning lamp switch; 14 - brake fluid low level transmitter; 15 - coolant temperature gauge transmitter; 16 - carburettor choke valve warning lamp switch; 17 - ignition coil; 18 - parking brake warning lamp switch; 19 - parking brake warning lamp flasher unit; 20 - fuel level and low fuel level transmitter; 21 - oil pressure gauge transmitter; 22 - oil pressure warning lamp transmitter

with broach 4 through special holes in the lower part of the instrument panel, disconnect the plug connectors and detach the cable from the speedometer.

Caution

When removing the instrument board take a note of the manner in which the speedometer cable has been laid; when installing the instrument board position the cable in the previous place to avoid bends with radiuses smaller than 100 mm.

The instrument illumination and warning lamps are removed from their holders complete with the sockets.

Methods of Trouble Shooting

The instrument circuit diagram is shown in Fig. 7-39. The circuit diagrams of the battery no-charge warning lamp, marker light, upper beam warning lamps and direction indicator warning lamp are given earlier in Figs 7-5, 7-25, 7-26 and 7-29.

Coolant Temperature Gauge

If the gauge pointer stays constantly at the beginning of the scale, turn on the ignition switch, disconnect the wire from the gauge transmitter and touch the end of the wire to "ground.

If the pointer deflects, it means that the transmitter is faulty and has to be replaced. If the pointer does not deflect, remove the instrument board, turn on the ignition switch and touch the gauge terminal "V" to "ground". In this case deflection of the pointer will indicate that the instrument is in order, but the wire between the gauge and its transmitter is faulty. If the pointer stays still, replace the instrument.

If the gauge pointer stays constantly in the red zone, turn on the ignition switch and disconnect the wire from the transmitter. If the transmitter is faulty, the pointer will return to division "50".

If the pointer stays in the red zone, it means that either the wire is shorted to "ground" or the instrument is damaged. The condition of the gauge can be checked by disconnecting the green wire leading from the gauge to the transmitter. With the ignition switch turned on the pointer should return to "50" division.

Fuel Level Gauge

The checking procedure is the same as described above. It should be borne in mind that terminal "W" of the gauge transmitter is connected to the wire leading to the low fuel warning lamp, while the wire leading to the gauge proper is connected to terminal "T".

If the gauge pointer stays constantly at the beginning of the scale and does not deflect when the wire disconnected from transmitter terminal "T" is touched to "ground", it is necessary to check the gauge. For this purpose remove the instrument board, turn on the ignition switch and connect terminal "S" of the gauge to "ground". If

the gauge is sound, its pointer will deflect to the end of the scale.

If the gauge pointer is constantly opposite the 4/4 division, the condition of the gauge can be checked by disconnecting from it the pink wire leading to terminal "T" of the transmitter. In this case the pointer of the sound gauge should settle opposite division "0", when the ignition switch is turned on.

Oil Pressure Gauge

The checking procedure is the same as described above. When looking for a trouble, connect terminal "HN" of the gauge to "ground" or disconnect from it the grey wire with black tracer leading to the transmitter.

INSTRUMENT CHECKS

Coolant Temperature Gauge

The gauge УК-193 operates in conjunction with the transmitter ТМ-106. With the transmitter resistance ranging from 640 to 1320 Ω the pointer should stay at the beginning of the scale, at a resistance of 77-89 Ω it should be at the beginning of the red zone, while at a resistance of 40-50 Ω it should move to the end of the red zone of the scale.

Fuel Level Gauge

The gauge УБ-193 operates in conjunction with transmitter БМ-168 installed in the fuel tank. This transmitter is also used to switch on the low fuel warning lamp when 5.3-6.5 l of gasoline remains in the tank.

With the transmitter resistance ranging from 285 to 335 Ω, the pointer should stay at the beginning of the scale, at 100-135 Ω it should be i he middle of the scale and at 7-25 Ω, at the end of the scale.

Oil Pressure Gauge

The gauge УК-194 incorporates a low oil pressure warning lamp turned on by transmitter ММ-120.

The gauge works jointly with a ММ-393А transmitter which changes the resistance of the electrical circuit depending on changes of oil pressure in the engine lubricating system. At a transmitter resistance of 285-335 Ω the gauge pointer is at the beginning of the scale, at 100-135 Ω, in the middle of the scale and at 0-25 Ω, at the end of the scale.

Tachometer

The electronic tachometer ТХ-193 installed on the car operates by measuring the frequency of voltage pulses in the primary circuit of the engine ignition system.

The tachometer should be checked on a stand simulating the engine ignition system. Connect the tachometer to the stand circuitry in the same manner as on the car, set a voltage of 14 V in the primary circuit and a 7-mm clearance in the stand spark gap. Rotate the ignition distributor shaft at a speed at which the tachometer pointer moves to one of the scale divisions. At this instant check to see that the distributor shaft speed is within the limits specified in Table 7-6.

Table 7-6

Tachometer Check Data

Scale divisions, min^{-1}	Distributor shaft speed, min^{-1}
1000	440-550
2000	875-1050
3000	1350-1525
4000	1850-2025
5000	2350-2500
6000	2900-3000
7000	3350-3500
8000	3800-4200

Speedometer

The speedometer СП-193 consists of a pointer-type speed indicator showing the road speed in kilometers per hour, an odometer and a trip counter.

The trip counter can be reset to zero by rotating counter-clockwise the knob on the instrument board.

To avoid damaging the counter do not reset it on the moving car.

To check the speedometer, compare its readings with those of a reference speedometer. The speedometer check data are given in Table 7-7.

Table 7-7

Speedometer Check Data

Drive cable speed, min^{-1}	Speedometer readings, km/h
500	31-35
1000	62-66.5
1500	93-98
2000	124-130
2500	155-161.5

CHECKING INSTRUMENT TRANSMITTERS

Fuel Level Transmitter

The БМ-168 transmitter is fastened by screws in the fuel tank.

The transmitter comprises a variable resistor of nichrome wire. The resistor slider is controlled by a lever with a float. The short end of this lever also carries a movable contact which switches on the low fuel warning lamp when 4 - 6.5 l of gasoline remains in the tank.

With the empty tank the transmitter resistance should be 315 - 345 Ω; it should be 108 - 128 Ω with a half-full tank and 7 Ω or less when the tank is full.

Coolant Temperature Transmitter

The TM-106 transmitter is screwed into the cylinder head at the L.H. side of the engine.

The transmitter comprises a thermal resistor whose electric resistance varies with the temperature of coolant. The transmitter check data are given below in Table 7-8.

Table 7-8

Coolant Temperature Transmitter Check Data

Temperature, °C	Supply voltage, V	Transmitter resistance, Ω
30	8.00	1350-1880
50	7.60	585-820
70	6.85	280-390
90	5.80	155-196
110	4.70	87-109

Oil Pressure Transmitter

The MM-393A transmitter converts pressure in the engine lubricating system into electric resistance. It is installed on the L.H. side of the cylinder block. The transmitter check data are given in Table 7-9.

Table 7-9

Check Data

Pressure, MPa (kgf/cm^2)	Transmitter resistance, Ω
0 0	290-320
0.4 (4)	103-133
0.6 (6)	55-80
0.8 (8)	0-15

Oil Pressure Warning Lamp Transmitter

The MM-120 transmitter is installed on the L.H. side of the cylinder block.

The transmitter contacts should close and open at a pressure of 20 and 60 kPa (0.2 and 0.6 kgf/cm^2) respectively.

Parking Brake Warning Lamp Flasher Unit

The PC-492 flasher unit ensures the blinking light of the parking brake warning lamp. It is suspended from wires behind the instrument board.

The number of closing and opening cycles per minute at a voltage of 10.8-15 V and a temperature from minus 40 to plus 40 °C should range from 60 to 120. The resistance of the flasher unit winding is 26 Ω.