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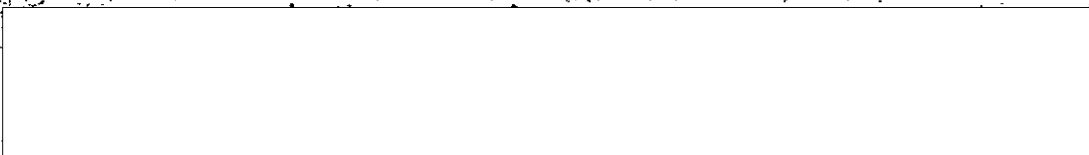
COUNTRY USSR

DCI 1969

SUBJECT Soviet Manuals on the MAZ-537 Truck and Its Modifications

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1. The following English-language manuals on the MAZ-537 truck and its modifications (MAZ-537A, MAZ-537G, and MAZ-537D) have been deposited in the CIA Document and Pictorial Services Division:

a. Automobile MAZ-537 and Its Modifications - Description and Operating Instructions, as of 1 January 1966, 336 pages.

b. Supplementary Notes to Technical Description, Operating and Maintenance Instructions of the MAZ-537 Automobile and Its Modifications, 44 pages.

c. Delivery List 537-BK (list of spare parts, tools, and accessories), 21 pages.

2. Field Dissemination: None.

Distribution of Attachments:

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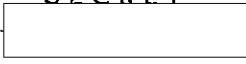
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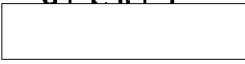
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# AUTOMOBILE MA3-537 AND ITS MODIFICATIONS

## Description and Operating Instructions

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The present book is a Manufacturer's manual on operation and maintenance of the MA3-537 automobile and its modifications.

The Manual contains description of the automobile design as well as information pertaining to operation of units and assemblies, peculiarities of operation and preventive maintenance.

Preliminary Materials for the Manual have been prepared by a group of designers of the automobile Manufacturing Plant.

The Manual has been compiled in conformity with the technical documents as of January 1, 1966.

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Автомобиль М43-537  
 и его модификация  
 Техническое описание и инструкция  
 по эксплуатации  
 (на английском языке)  
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## C A U T I O N

Only drivers who are well acquainted with and have passed examinations on the design, operating and driving instructions of the automobiles should be admitted to operate the automobile.

During operation of the automobile the driver should take into consideration the followings:

1. Normal and trouble-free operation of the automobile units is ensured only by the use of fuel, oils and other service materials specified in the present Manual.

2. Before each starting of the engine it is necessary to build up the pressure in the lubricating system of the engine of at least  $3.0 \text{ kgf/cm}^2$ , using an electric oil priming pump.

Do not operate the electric oil priming pump for more than one minute.

3. To prevent overfilling of the right-hand tank when draining fuel, always start operation employing the right-hand tank and only after the fuel in this tank is used up, change over to the left-hand tank.

4. Bear in mind that the engine is equipped with a device automatically cutting off delivery of fuel when the pressure in the engine lubricating system drops below  $2.5 \text{ kgf/cm}^2$ . The device is installed on the fuel injection pump and sealed.

5. At ambient temperatures below  $+5^\circ\text{C}$  the engine cooling system should be filled with antifreeze 40 or 65 according to State Standard (GOST) 159-52.

6. Do not add liquid into the engine cooling system, with the boiler overheated, to prevent it from damage.

7. At ambient temperatures below  $+5^\circ\text{C}$ , warm up the engine, using the preheater.

To reduce the time required for warming up the engine by the preheater, the radiators should be disconnected from the cooling system with the help of a thermostat box shutter (the shutter rod should be pushed downward as far as it will go).

8. Do not start the engine after it has been warmed up, with the preheater switched on, to prevent damage of the cooling system and preheater.

9. To prevent overheating of the engine during operation the radiators should be connected to the cooling system after the engine gets warmed. The radiator cut-out shutter located on the thermostat box should be kept open, with the shutter rod pulled upwards as far as it will go.

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10. Prior to starting the engine after prolonged standstill at ambient temperatures below  $-15^{\circ}\text{C}$ , when lubricant in the automobile units is thick, it is necessary to disconnect the transmission from the engine, using a lever located in the engine compartment. To disconnect the transmission from the engine, set the lever to the forward position (when looking forward).

After starting and warming up, stop the engine and set the lever to the rearward position to couple the transmission with the engine.

11. Do not service the engine systems and other units in the engine compartment, with the engine running, to prevent injuries since the cardan shafts and belts of the fans and compressor drives in the engine compartment are open for access.

12. It is strictly forbidden to use the emergency shutdown device for ordinary stopping of the engine. During operation of the engine the gate valves should be completely open.

Remember! When employing the engine emergency shut-down device the control knob should be kept in the extreme position until the engine stalls completely.

13. When the engine runs at cruising speed, the readings of the instruments should be the following:

(a) oil pressure in the main oil line of the engine - within 5.0 to 10.0  $\text{kgf/cm}^2$  (at idle running - at least 2.5  $\text{kgf/cm}^2$ );

(b) engine outlet oil temperature - not over  $+110^{\circ}\text{C}$ .

(c) engine outlet coolant temperature - not over  $+105^{\circ}\text{C}$ .

When the oil pressure drops or the outlet temperature of oil or coolant sharply rises, stop the engine, find out the causes and eliminate them.

14. It is forbidden to stop the engine at the temperature of coolant over  $+70^{\circ}\text{C}$  except for the cases listed in item 13.

15. It is forbidden to pour boiling water into the cooling system of the cold engine and cold coolant into the cooling system of the warmed-up engine.

16. When washing the automobile it is forbidden to direct a stream of water onto ports of the air cleaners and spark arresters as during starting of the engine water may penetrate into the engine cylinders and the engine may be brought out of order, as well as onto the starter, generator and flywheel housing ports (if no breathers are installed in the housing ports).

17. The pressure of working fluid in the torque converter should be within the limits of 3-4  $\text{kgf/cm}^2$ , in the planetary gearbox boosters - of 9-13  $\text{kgf/cm}^2$  and in the hydraulic transmission lubricating system - of 1-1.5  $\text{kgf/cm}^2$ .

The temperature of oil at the torque converter outlet should not exceed  $+125^{\circ}\text{C}$  and in the planetary gearbox  $+95^{\circ}\text{C}$ .

18. When driving the automobile, shifting of gears in the planetary gearbox from high to low gear should be carried out in succession; from the third to the second, from the second to the first and then to the neutral position.

It is forbidden to shift from the third to the first gear or to the neutral position.

Shifting of the reverse gear should be performed only after the automobile stops. Non-observance of these requirements may result in breakdown; the speeds of automobile movement in different gears must correspond to the speed ranges specified on page 254.

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19. When driving on hard-surface roads and dry trafficbound earthen roads, the direct-drive gear should be engaged in the transfer case.

To prevent overloading of the torque converter and over-heating of oil in the hydraulic transmission when driving the automobile under heavy road conditions, the low gear should be engaged in the transfer case.

The neutral position is used only when operating the winch or taking off power at halt.

20. Shifting of gears in the transfer case should be carried out at the pressure of air in the brake system at least  $5.65 \text{ kgf/cm}^2$ , with the automobile at halt and the engine shut down. The time during which the engine is stopped, should not exceed one minute. Do not try to place the automobile in motion with the transfer case pilot lamp on the instrument panel lighting.

If at the normal pressure of air in the brake system the transfer case pilot lamp on the instrument panel lights up, it indicates that no gear is engaged in the transfer case. Engage the transfer case for which purpose set the cock handle into a required gear position.

If the air pressure in the brake system drops below  $5.65 \text{ kgf/cm}^2$ , start the engine, build up the rated pressure of air in the system, stop the engine and engage the required gear in the transfer case.

21. The transfer case differential may be interlocked for a short period and only under heavy road conditions. The differential interlock mechanism should be engaged only with the automobile at halt and the engine stopped.

After negotiating a section of a heavy road the differential should be unlocked, otherwise heavy overloads will be imposed on the transmission parts and premature wear of the tyres caused.

22. When the pressure in the compressor lubricating system drops below  $0.6 \text{ kgf/cm}^2$ , the emergency pressure pilot lamp on the instrument panel lights up. In this case, stop the engine, find out and eliminate the cause of pressure drop.

23. It is forbidden to start motion when the air pressure in the brake system is less than  $5.65 \text{ kgf/cm}^2$ .

24. To observe the safety rules, inflate the tyres only after all the nuts of the pressure ring securing the tyre on the wheel rim are reliably tightened and the wheel is installed on the hub and securely fastened.

The spare wheel tyre should be inflated to the pressure of  $2.2 \text{ kgf/cm}^2$  without installing it on the hub, first having checked the pressure ring for reliable attachment (all the nuts attaching the pressure ring should be tightened until the pressure ring thrusts against the wheel rim).

It is forbidden to inflate the spare wheel tyre in excess of  $2.2 \text{ kgf/cm}^2$ . When handling the spare wheel, observe the safety measures, considering that it is in an inflated state.

It is forbidden to mount and demount tyres in the inflated state.

25. It is prohibited to leave the battery switch in the ON position after operation of the automobile.

26. It is prohibited to cut in the battery switch and the starter button during slave charging.

27. Upon reception of an automobile from the Manufacturing Plant in summer place the gasket disconnecting the preheater from the thermostat box into the position SUMMER (LETO) as the Manufacturing Plant delivers automobiles with the gasket installed in the position WINTER (ZIMA) regardless of the season.

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Shut off the cab heater cut-in cock and drain coolant from it.

28. When transporting readily inflammable materials it is forbidden to sharply change the engine speed.

~~29. When the automobile is out of operation for a period of up to 30 days, to prevent corrosion in the inner spaces of the planetary gearbox, every 15 days carry out the operations prescribed in the recommendations of item 2 of the Section "Preparation of Automobile for Storage" (Appendix 4).~~

30. It is forbidden to use any compressed gases for starting the diesel engine except for the air.

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Chapter IGENERAL DESIGN OF AUTOMOBILE AND SPECIFICATIONSI. PURPOSE AND GENERAL DESIGN OF AUTOMOBILE

The MA3-537 automobile and its modifications MA3-537A, MA3-537T, MA3-537H are cross-country four-axle truck tractors with all driving axles.

The automobiles are designed to tow semitrailers (trailers) on hard-surface roads:

- MA3-537 - fifth wheel truck tractor, intended for towing a semitrailer with a total weight of up to 65 tons.
- MA3-537A - ballast truck tractor with a winch, intended for towing a trailer with a total weight of up to 75 tons.
- MA3-537T - fifth wheel truck tractor with a winch, intended for towing a semitrailer with a total weight of up to 68 tons.
- MA3-537H - fifth wheel truck tractor with a generator plant, intended for towing a semitrailer with a total weight of up to 65 tons.

It is permissible to drive the loaded automobile train on improved earthen roads whose upgrades and downgrades do not exceed the State Standards adopted for improved roads; in this case the speed of automobile should not exceed 20-25 km/hr. The road surface should possess a high carrying ability and withstand a total weight of the automobile train without noticeable dipping of its wheels into the ground.

The basic automobile model is MA3-537 equipped with a fifth wheel assembly.

The main components of the automobile are the following: power plant, power train, running gear, steering system, brake system, cab, body and special equipment.

II. SPECIFICATIONS

Parameters	MA3-537	MA3-537T	MA3-537H	MA3-537A
1	2	3	4	5
<u>1. General Data</u>				
Net weight of automobile, t	21.6±2.5%	22.3±2.5%	23±2.5%	22.5±2.5%
Weight of towed completely loaded semitrailer (trailer), t	65	68	65	75
Weight of completely loaded automobile	87	90	88	98

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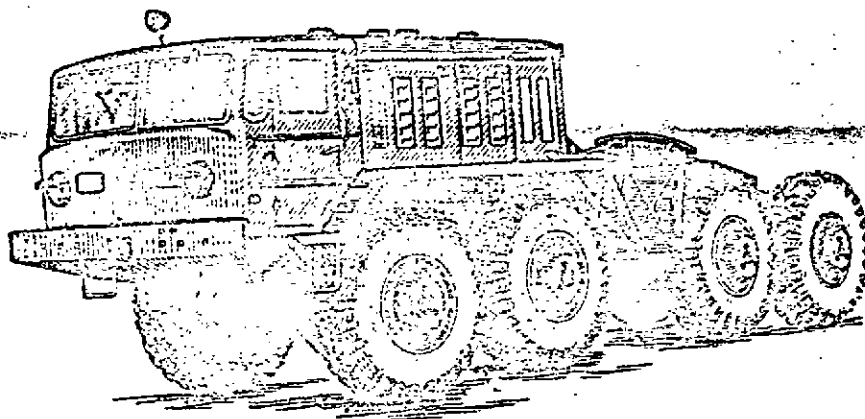


FIG. 1. GENERAL VIEW OF M43-57 TRUCK TRACTOR

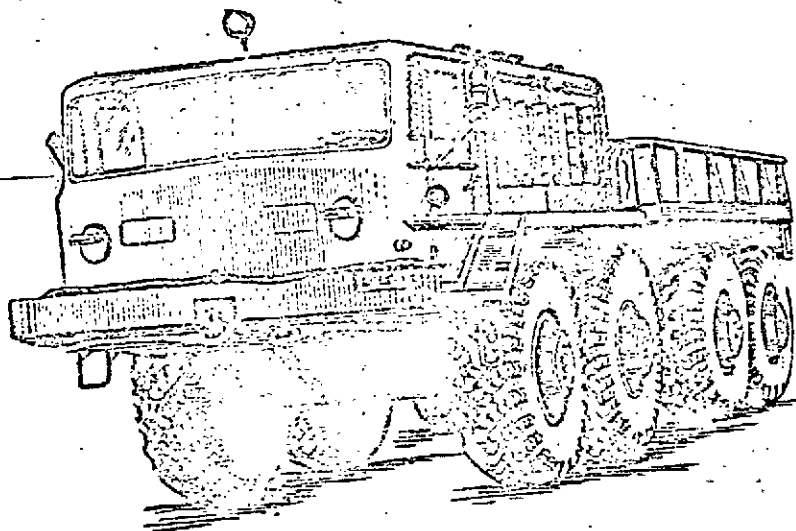


FIG. 2. GENERAL VIEW OF M43-57A TRUCK TRACTOR

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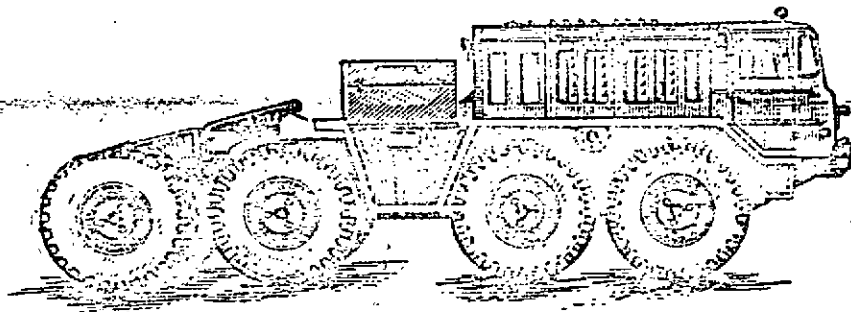


FIG. 3. GENERAL VIEW OF M43-537.1 TRUCK TRACTOR

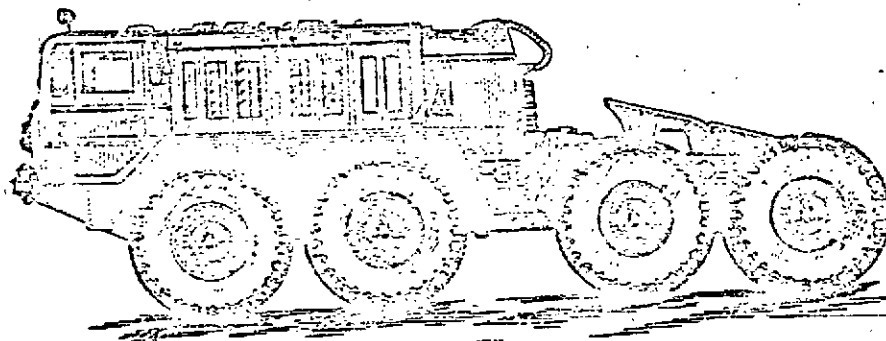


FIG. 4. GENERAL VIEW OF M43-537.1 TRUCK TRACTOR

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1	2	3	4	5
obile train (approximately), t				
Load capacity of trailer (semitrailer), t	50	(for semitrailer)		60
Load on fifth wheel assembly (in body), t	25	27	25	15
Distribution of load on axles <sup>1)</sup> :				
two front axles, t	<u>13.03</u> 17.07	<u>14.32</u> 17.9	<u>14.73</u> 17.73	<u>13.79</u> 14.89
two rear axles, t	<u>7.97</u> 28.72	<u>7.98</u> 31.4	<u>8.27</u> 30.07	<u>8.71</u> 22.61
Angle of approach, deg.		38		
Angle of departure, deg.		52		
Minimum width of road passageway at turning of automobile train, m		9.5		
Number of automobile axles (driving ones included)		4		
Number of steerable axles		Two, front		
Overall dimensions of automobile (approximately), mm:				
length		8960		9130
width		2885		
height (w/o load) <sup>2)</sup>		<u>2880</u> 3100		
Tread (distance between centres of wheels), mm		2200		
Wheel base (distance between extreme axles), mm		6050		
Distance between front (rear) axles, mm		1700		
Distance from ground to bedplate of fifth wheel assembly (w/o load), mm		1925		

- 1) In the numerator - without load on the fifth wheel assembly, in the denominator - with load on the fifth wheel assembly.  
 2) In the numerator - as by the cab, in the denominator - as by the spot light.

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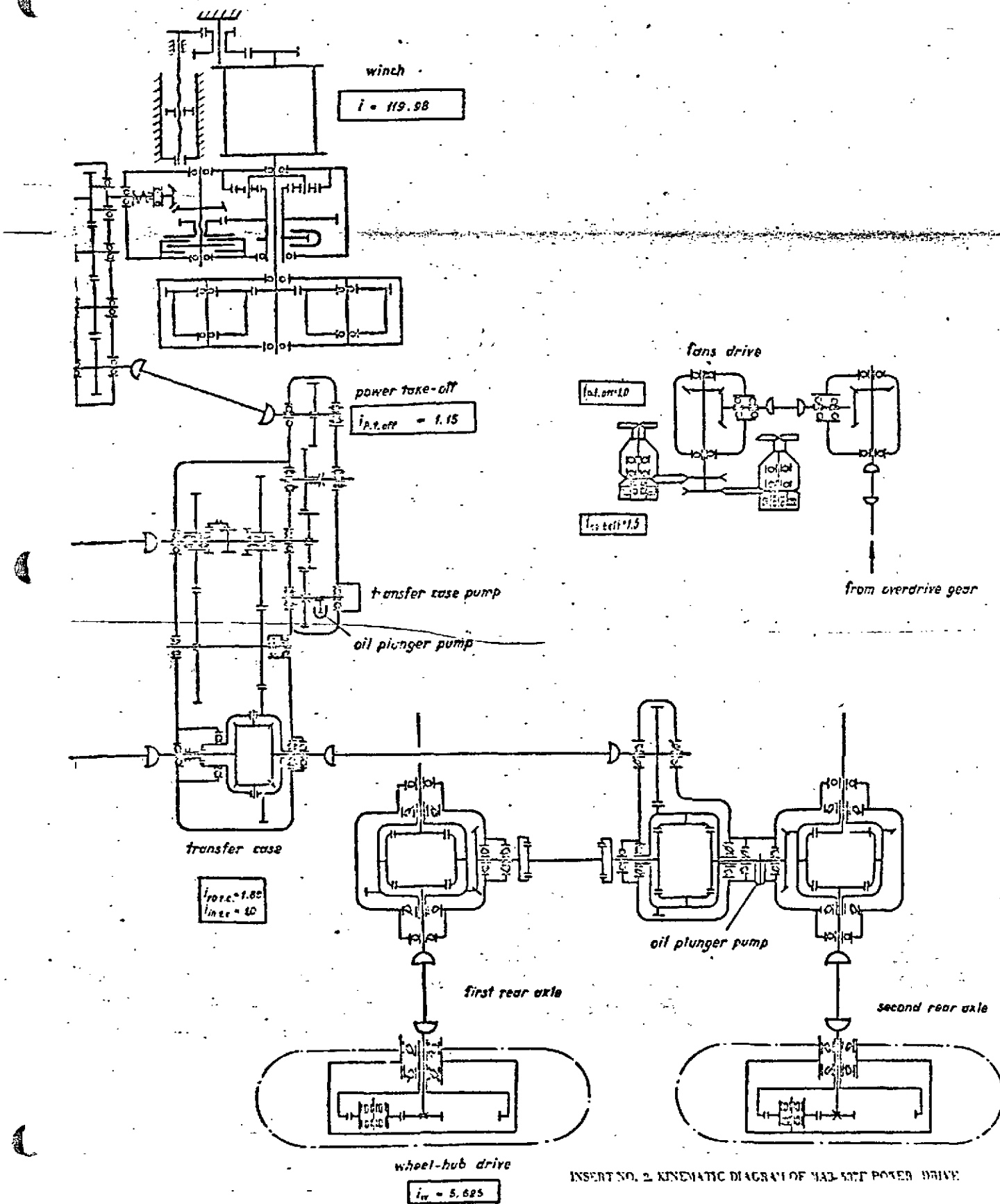
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INSERT NO. 2 KINEMATIC DIAGRAM OF M43-5MT POWER DRIVE

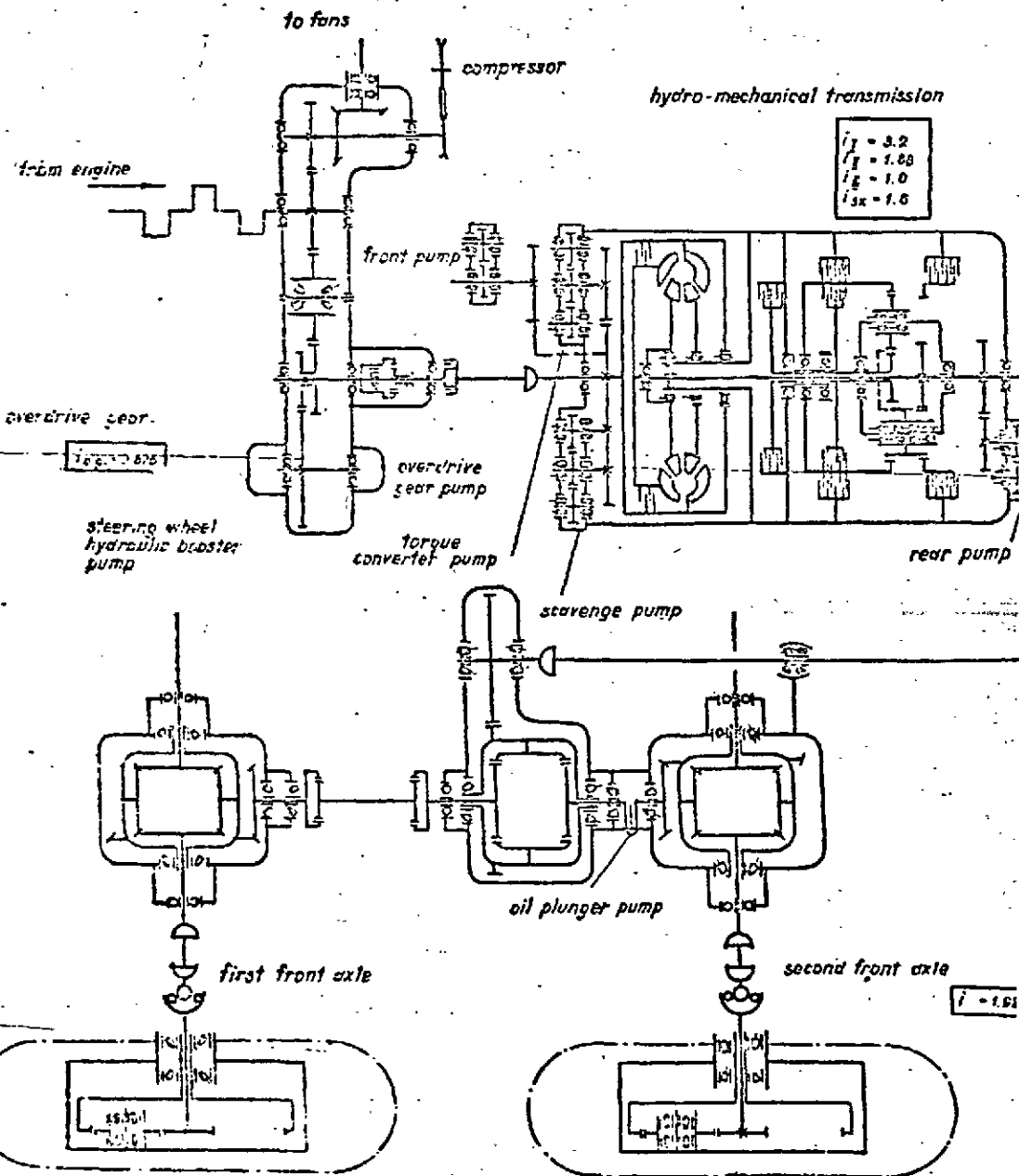
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1	2	3	4	5
Minimum turning radius (to each side) on outer front wheel, m		15.5		
Road clearance (fully loaded), up to suspension brackets, mm		500		
Crew of automobile		2		
Number of seats in cab		4		
Tyres		24-ply 18.00-24, type H-170		
<b>2. Speed of Movement</b>				
Maximum speed, km/hr		60		
Maximum permissible speed of movement with trailer (semitrailer) on hard-surface roads (fully loaded), km/hr	55	55	55	50
Average rated speed on hard-surface roads (fully-loaded), km/hr		25-30		
<b>3. Performance Data</b>				
Rated fuel consumption for 100 km run with full load, lit <sup>1)</sup>		125		
Cruising range at rated fuel consumption with full load, km		650		
Minimum braking length with semitrailer on horizontal highway from speed of 30 km/hr to complete stop, m		15		
Oil-to-fuel consumption rate, per cent		5		
<b>4. Negotiable Obstacles</b>				
Maximum grade ascending ability on hard-surface roads with fully-loaded trailer (semitrailer), deg		8		

1) The specified fuel consumption is valid for a run-in automobile moving in the third gear with the interlocked torque converter on a dry even hard-surface road at a continuous speed of 35 to 40 km/hr.

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1	2	3	4	5
<b>6. Power Plant</b>				
<b>Engine</b>				
Type	Four-stroke, high-speed, liquid-cooled airless-injection diesel engine			
Model	M12A-525			
Sense of crankshaft rotation	Clockwise (as viewed from accessory drive side)			
Number of cylinders	12			
Arrangement of cylinders	V-shaped			
Total displacement, lit	38.8			
Compression ratio	14-15			
Numbering of cylinders	From accessory drive to flywheel casing			
Firing order	1 L.H. - 6 R.H. - 5 L.H. - 2 R.H. - 3 L.H. - 4 R.H. - 6 L.H. - 1 R.H. - 2 L.H. - 5 R.H. - 4 L.H. - 3 R.H. <sup>1)</sup>			
Rated (continuous) power taken off flywheel at 75% load of charging generator, with no resistance at intake and exhaust and with no losses for fans drive under normal atmospheric conditions (temperature +20°C, atmospheric pressure 760 mm of mercury and relative humidity 70%), H.P.	525			
Crankshaft speed, r.p.m.:				
rated speed	2100			
maximum idle speed	2300			
minimum stable idle speed, maximum	500			
speed corresponding to maximum torque	1200-1400			
Maximum torque, kg-m	220±10 per cent			
Dry weight of engine delivered from engine Manufacturing Plant, kg	1550			

1) L.H. - left-hand cylinder bank; R.H. - right-hand cylinder bank as viewed from the accessory drive side

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1	2	3	4	5
Parking brake	On dry ground it should hold empty automobile in place on up-grades and downgrades of up to 15°			
Fording depth (on hard ground), m:				
(a) with open check holes of engine circulation and fuel feed pumps		1		
(b) with closed check holes		1.3		
		5. Capacities (lit)		
Engine cooling system with preheater boiler		100		
Engine lubricating system		90		
Fuel tanks (two)		420 each		
Compressor crankcase		1.0		
Overdrive gear housing		7.5		
Fans drive reduction gear housing		0.2 each		
Hydraulic transmission (torque converter, planetary gearbox and tank)		105		
Transfer case with auxiliary oil pan		14		
Power take-off unit housing		2.5		
Intermediate reduction unit housing		8 each		
Final reduction unit housing		5 each		
Wheel-hub drive case		5 each		
Steering gear case		3		
Steering gear tank		45		
Master brake cylinder		2		
Shock absorber		1.15		
Constant-velocity universal joint, kg		2		

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1	2	3	4	5
Specific consumption at rated power, gr/h.p./hr: fuel oil, maximum		180 <sup>+55</sup> -10%		9
<u>Fuel System</u>				
Fuel used	See Section "Service Materials"			
Number of fuel tanks	2			
Manual fuel priming pump	Vane, double-acting, type PH1A			
Primary filter	Screen type			
Fuel feed pump	Rotary, type EHK-12TK.			
Secondary filter	Felt with cardboard or caprone spacers			
Fuel injection pump	Monoblock, plunger, with corrector and device for automatic shut-down of engine in case oil pressure in main oil line drops below 2.5 kgf/cm <sup>2</sup> , type HE-10			
Engine governor	Variable speed, in one unit with fuel injection pump			
Injector	Closed, with slotted filter.			
Fuel injection pressure, kgf/cm <sup>2</sup>	210+10			
<u>Air Feed System</u>				
Air cleaners	Two, combination type, two-stage, first stage with automatic ejection of dust, second stage - wire mesh, oil-wetted cleaning elements			
Engine emergency shut-down device	Two gate valves in cast aluminium bodies with control cable running from cab			
<u>Exhaust System</u>				
Manifolds	Aluminium, cast with jacket connected into engine cooling system			
Exhaust pipes	Cast iron branch pipe with asbestos insulation, stamped of sheet steel			
Spark arrestors	Inertia type with ejector trap and device for suction of dust from air cleaners			
<u>Lubricating System</u>				
Type	Circulation, under pressure, with dry crankcase			
Oil used	See Section "Service Materials"			
Oil tank	With circulation tank, foam reducer, coils for heating of oil and sump			
Oil pump	Gear type, three-section (one delivery section, two suction sections)			
Oil filter	Fine, wire mesh, slotted, with replaceable cardboard filtering element			
Oil coolers	Fin-and-tube type			
Oil priming pump	Gear type with preheated body, electrically driven, type M3H-2			

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1	2	3	4	5
Oil pressure in main oil line after oil filter, $\text{kgf/cm}^2$ :				
at cruising speed	6-10.	At air ambient temperatures below $+5^\circ\text{C}$ it is permitted to build up pressure up to $12 \text{ kgf/cm}^2$		
at minimum stable idling speed, minimum	2.5			
Temperature of oil at engine outlet, $^\circ\text{C}$ :				
recommended	80-90			
maximum	110			
<u>Cooling System</u>				
Type	Liquid, sealed, with forced circulation of coolant			
Liquid used for cooling	See Section "Service Materials"			
Circulation pump	Centrifugal			
Radiators	Fin-and-tube, three-path			
Fans	Axial flow			
Drive to fans	From overdrive gear by means of bevel reduction gears, cardan shafts and V-belts			
Temperature of coolant at engine outlet, $^\circ\text{C}$ :				
recommended	80-90			
maximum	105			
<u>Preheating System</u>				
Preheater	Liquid, with forced circulation of coolant, type HXK-600			
Method of coolant preheating	In preheater, by burning fuel atomized from injector			
Heating capacity, Cal/hr	60000	5000		
Liquid capacity of boiler, lit	10			
Fuel used	Diesel fuel (same as for engine)			
Ignition of fuel	From glow spark			
Injector	Centrifugal type with stack filter			
Pressure built up by fuel pump during operation, $\text{kgf/cm}^2$	4-7			
Reduction gear drive	<u>From electric motor</u>			
Fuel consumption, kg/hr, maximum	9			

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1	2	3	4	5
Temperature of burnt gases, °C		500-750		
Time from beginning of engine preheating to its starting at temperature of -40°C, min, maximum		30		
Power source	Automobile storage batteries			
	<u>Starting System</u>			
Main	By electric starter			
Auxiliary	By compressed air			
Air pressure in completely charged bottles, kgf/cm <sup>2</sup>		125-150		
Minimum air pressure required for engine starting, kgf/cm <sup>2</sup>				
in summer		60		
in winter when engine is warmed up by pre-heater		75		
	<u>7. Power Train</u>			
Damper coupling of overdrive gear with engine	Elastic spring-type coupling with friction elements			
Installation	Fastened to engine flywheel			
	<u>Overdrive Gear</u>			
Type	Single row, three-shaft reduction gear with cylindrical spiral gears			
Gear ratio of hydraulic transmission drive		0.875		
Installation	Fastened to engine flywheel casing			
Lubrication	Combination: forced (by pump) and by splashing			
Disengagement of overdrive gear from transmission	By means of lever			
	<u>Hydraulic Transmission</u>			
Torque converter	Single stage, combination type, with changing over for operation as fluid coupling and with interlocking of pump and turbine wheels			

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1	2	3	4	5
Overrunning clutches of torque converter stators	Roller type, with cams on outer race			
Torque converter interlocking friction clutch	Single-disc, hydraulically operated			
Torque converter interlocking control	Button, through electro-hydraulic valve			
Gearbox	Planetary type, three-speed			
Number of gears	Three gears forward and one gear reverse			
Gear ratio:				
first gear		3.2		
second gear		1.8		
third gear		1.0		
reverse gear		1.6		
Gearbox friction clutches	Multidisc for each gear, driving discs are steel with metal-ceramic surface, driven discs are steel			
Friction clutch control	Hydraulic, through control-valve mechanism			
Hydraulic transmission pumps	Front-torque converter and suction pumps of dual, gear type; rear - of two-gear type			
Smooth engagement mechanism	Plunger type, installed on first and reverse gears			
Cooling of working fluid in hydraulic transmission	Two fin-and-tube coolers with forced circulation of fluid			
Oil pressure, kgf/cm <sup>2</sup> :				
torque converter		3-4		
gearbox friction clutch boosters		9-13		
hydraulic transmission lubricating system		1-1.5		
Maximum oil temperature, °C				
torque converter		125		
gearbox		95		
	<u>Transfer Case</u>			
Type	Double-row, three-shaft reduction gear with cylindrical spiral gears and interlocking differential			
Number of gears	Two gears			
Gear ratio:				
low gear		1.88		
direct-drive gear		1.0		

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1	2	3	4	5
Differential	Bevel, symmetrical, on lower shaft			
Transfer case	Pneumatic, by control cock installed on steering wheel column or through manual repeater control linkage			
control	Combination: forced (by pump) and splashing			
Lubrication				
	<u>Power Take-Off Unit</u>			
Type	Gear reduction unit with spur gears on transfer case			
Gear ratio	1.15			
Engagement of power	By lever from driver's cab			
take-off unit				
Lubrication	Forced (by pump) and by splashing			
	<u>Driving Axle</u>			
Axle drive	Pair of bevel spiral gears			
Gear ratio	1.92			
Auxiliary drive of	Pair of spur gears with interaxle differential			
intermediate reduction				
units				
Gear ratio	1.0			
Interwheel diffe-				
rentials:				
in front reduction	Bevel, symmetrical, with high-friction elements			
units				
in rear reduction	Self-locking, of overrunning clutch type			
units				
Interaxle dif-	Self-locking, of overrunning clutch type			
ferentials in inter-				
mediate reduction				
units				
Lubrication	Forced (by plunger pump) and by splashing			
Wheel-hub drive	Planetary type, with spur gears in each wheel			
Gear ratio	5.625			
	<u>Propeller Shafts</u>			
Torque converter	Double-joint type:			
propeller shaft	front joint with rubber bushes and rear joint with centre crosses on needle bearings			
	Double-joint type, with centre crosses on needle bearings and sliding bearings			
Power train pro-	Double-joint type, with centre crosses on needle bearings; auxiliary link-constant velocity universal joint			
peller shafts				
Wheel-hub drive	Double-joint type, with centre crosses on needle bearings			
propeller shafts:				
front				
rear				
	<u>8. Turning Gear</u>			
Wheel hub	Cast, steel			
Wheel rim	Steel, welded, with removable side rings; outer split ring composed of three sections			

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1	2	3	4	5
Attachment of tyre on rim	By nuts and studs through pressure ring			
Attachment of wheel on hub	By nuts and studs through clamps			
Tyres		18.00-24		
Number of plies		24		
Tyre pressure, kgf/cm <sup>2</sup>		4.5		
Front suspension	Independent (individual) with arm and torsion bars arranged longitudinally			
Number of torsion bars	Two per each front wheel			
Rear suspension	Rocker type, springless			
Wheel guiding unit	Two forked-type arms, forming four-link assembly of trapezoid type			
Attachment of arms to frame	On bronze bushings, on support tubes			
Attachment of arms to wheel support	On bronze bushings			
Suspension shock absorbers (two)	Hydraulic telescopic type, double-acting			
Installation of shock absorbers	On each wheel of front axle			
Frame	Folded and riveted, with stamped-welded, tubular welded and stamped cross members along entire length			
Upper side members	Channel section, of steel sheets			
Frame sills	Z-shaped section, inclined, of steel sheets			
Rear and front towing gears	With double damping			
Fifth wheel assembly, mm	Double-joint type; with semiautomatic lock			
Diameter of fifth wheel bedplate, mm	1010			
Lateral and longitudinal swing angle of fifth wheel (from horizontal position), deg	15			
<b>9. Steering System</b>				
Steering mechanism	Worm, rack, sector with circulating balls			
Gear ratio	26.9			
Hydraulic booster	Piston type, double-acting			
Hydraulic booster oil tank	Welded with filler and intake filters			
Effort applied to hydraulic booster rod (at extension) at 23-	3500			

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1	2	3	4	5
<p>Maximum pressure in hydraulic booster, kgf</p> <p>Hydraulic booster distributor control</p> <p>Steering system pump</p> <p>Pump drive</p> <p>Pressure of working fluid in hydraulic system, kgf/cm<sup>2</sup></p> <p>Transmission of efforts from steering wheel and hydraulic booster to steerable wheels</p> <p>Adjustment of steerable wheels:</p> <p>  camber, deg</p> <p>  toe-in (on diameter of 1080 mm), mm</p> <p>Type</p> <p>Wheel brakes</p> <p>Brake control</p> <p>Diameter of brake drum, mm</p> <p>Width of brake shoe lining, mm</p> <p>Compressor</p> <p>Compressor drive</p> <p>Lubrication</p> <p>Air working pressure in brake system, maintained by pressure regulator, kgf/cm<sup>2</sup></p> <p>Pressure regulator</p> <p>Safety valve</p> <p>Brake valve</p> <p>Master brake cylinder (two)</p> <p>Diameter of fluid cylinder, mm</p> <p>Working fluid pressure built up by master brake cylinder at air pressure of</p>	<p>From steering wheel through steering mechanism and pitman arm</p> <p>Gear, type HL-46</p> <p>From overdrive gear.</p> <p>70</p> <p>Through drag links, linkage and steering arms</p> <p>1</p> <p>10-14</p> <p><u>10. Brake System</u></p> <p>Single pipelines</p> <p>Shoe type, acting on all wheels</p> <p>Air-hydraulic, from brake pedal in driver's cab</p> <p>500</p> <p>140</p> <p>Single stage, two-cylinder with water cooling</p> <p>From overdrive gear through V-shaped belts</p> <p>Combination: forced (by pump) and by splashing</p> <p>5.65-7.35</p> <p>Double-ball, valve mechanism with spring</p> <p>Ball type with spring</p> <p>Combination, piston type, provides simultaneous operation of automobile and semitrailer wheel brakes</p> <p>Hydraulic, piston type with pneumatic booster</p> <p>65</p> <p>120</p>			

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1	2	3	4	5
5 kgf/cm <sup>2</sup> in air line, kgf/cm <sup>2</sup>				
Wheel brake cylinder		Piston type, single-acting		
Diameter of piston, mm		65		
Air bottles		Two, 43 lit capacity each		
Air take-off cock		Plug type		
Cut-out cock		Plug type		
Coupling head		For coupling semitrailer brake system		
Parking brake		Band type, installed on transfer case		
Drum diameter, mm		410		
Width of brake band friction lining, mm		100		
Brake control		Mechanical, by lever from driver's cab		
		<u>11. Cab</u>		
Cab		Metal, two-door, closed, four-seat, heated type, with hatches in cab roof and rear wall for access to front section of engine		
Windshields (two)		Triplex, on butaphol base		
Seats		Extreme seats-single, middle one for two persons, driver's seat - adjustable in length		
Doors		With locks and window raisers		
Door glasses		Triplex, on butaphol base		
Cab equipment		Controls and instruments, air-liquid heater fed from engine cooling system, sun visors, windshield wipers, driver's fan, ventilation hatches, locker for small articles, pocket for papers, luggage compartment, two fire-extinguishers, attachment places for: first-aid chest, portable water tanks, self-contained heater 015-B		
Body		Mounted on MA3-537A automobiles only		
		Metal, welded, with hinged tail gate		
		<u>12. Electrical Equipment</u>		
Electric system		Single-wire; double-wire: one receptacle and commander's lamp		
Wiring to generator, tachometer, generator regulator, speedometer and electromagnetic couplings		Shielded		
Rated voltage in electric system, V		24		

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1	2	3	4	5
	<u>Power Sources</u>			
Storage batteries	4, starter, acid, type 12CT-70			
Connection of storage batteries	Parallel			
Voltage of single storage battery, V		24		
Capacity of single storage battery, Ah		70		
Total capacity, Ah		280		
Generator:	Type I-731, shunt			
output, W		1500		
rated voltage, V		28		
Generator regulator	Type PPT-24M			
	<u>Power Consumers</u>			
Electric starter:	Type CT710, series			
power, H.P.		15		
rated voltage, V		24		
Contactors	Type TEC-601AT			
Oil priming pump	Type MB-1			
motor:				
output, W		500		
rated voltage, V		24		
Engine preheater	Type MBH-3H			
motor:				
output, W		380±20		
rated voltage, V		24		
Preheater electromagnetic valve	Type MKT-4			
Cab heater motor:	Type M3-233			
output, W		25		
rated voltage, V		24		
Electric horn	Type C-58			
Electromagnetic couplings of fans		3		
Torque converter		2		
interlocking mechanism coils				
Turn indicator breaker relay	Type PC-401			
Headlights	2, type 6H111-II			
Rear licence plate lamp	Type 6H11B-B			
Cab dome lamp	Type HR2-B			
Inspection lamp	Type CH-1			

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1	2	3	4	5
Bulbs of headlights and spot light	Two-contact, A 28-60 28-40			
Bulbs of side lamps	Two-contact, A 28-32 28-4			
Bulbs of rear licence plate lamp, cab dome lamp and hood lamp	Single-contact, A 28-3			
Bulbs of stop light and inspection lamp	Single-contact, A 28-21			
Bulbs of instrument panel illuminating lamp, passenger lamp and pilot lamps	Single-contact, A 28-1			
<u>Auxiliary Equipment</u>				
Storage battery switch	Type BE-404			
Starter button	Type EX-322			
Master light switch	Type H305			
Foot dimmer switch	Type H-59			
Switches of fans electromagnetic couplings	Type H45-12			
Blackout selector switch	Type H29-B			
Stop light switch	Type EX-13			
Switches of cab heater motor, dome light and instrument panel illuminating lamps, passenger lamp, spot light and turn indicator switch	Type H20-12			
Preheater glow plug switch	Type EX-317			
Preheater change-over switch	Type HMB-45			
Electromagnetic valve switch	Type B-45H			
Electric horn and torque converter interlocking buttons	Type KY-1			
Inspection lamp receptacle	Type 47-K			

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1	2	3	4	5
Semitrailer power receptacle	Type NC-300			
Pneumatic horn	Type C-40B			
Pneumatic horn switch	Type BK-40A			
Windshield wiper switch	2			
Oil priming pump switch	Type BK-50			
	<u>Instruments</u>			
Voltmeter	Type BA-240			
Speedometer	Electric, type CH-110 with sending unit M3-302			
Tachometer	Type T3-3M			
Hourmeter	Type 5634N-4			
Temperature gauges: engine cooling and lubricating systems, oil in gearbox	Remote, electric Type T73-4BT			
oil in torque converter	Type T73-4B			
Cooling system pilot lamp sending unit	Type MN7			
Pressure gauges: engine lubricating system, torque converter, gearbox and air system	Remote, electric Type TCM-15			
Hydraulic transmission lubricating system	Type 32M7-3			
Engine air starting lubricating system pressure gauge	Type MT-60			
Compressor lubricating system pressure sending unit	Type MM102			
Circuit breakers	Thermobimetal, button type for 20A NP2-E, for 10A NP310, and NP3 for 30A			
Clock	Type ABPM, mechanical			
Winch				
Type				
	13. <u>Auxiliary Equipment</u>			
	- Friction (with two traction rollers), consists of reduction gear with safety coupling, stop brake, drum with friction clutch, wire rope winding device with gear-type drive and wire rope pay-out indicator			

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1	2	3	4	5
Reduction gear drive		Propeller shaft from power take-off unit		-
Working length of wire rope, m	-	100		-
Maximum pull on wire rope, t	-	15		-
Heater				
Type of heater		Self - contained		
Fuel used		Gasoline, State Standard (ГОСТ) 2084-54		
Fuel consumption, lit/hr		0.25		
Rated voltage in electric circuits, V		24		
Power consump- tion, W		24		
Capacity, Gal/hr		1500		
Ventilation (breathing) system		Connection of inner spaces of unit housings with the atmo- sphere by means of brass and copper pipelines to maintain at- mospheric pressure in units		

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## Chapter II

### POWER PLANT

The power plant of the automobile comprises the engine and its accessory systems: fuel, air feed, lubricating, cooling, preheating, starting and exhaust.

Parts and units of the systems are mounted both directly on and outside the engine.

#### ENGINE D12A

The automobile is powered by a M12A-525 engine. The engine is a V-shaped, 12-cylinder, four-stroke, water-cooled, high-speed airless injection diesel engine.

The crankshaft rotates clockwise as viewed from the accessory drive side.

The general view of the engine completely equipped with the accessories before installation on the automobile is shown in Fig.5.

The engine is installed on the automobile frame and attached at three points, providing normal operation of the automobile in case of possible warpage of the frame.

The front bearing point of the engine is cylindrical surface of the front support body by which the engine is installed on a beam.

Each end of the beam is bolted to brackets which are provided with rubber pads secured to the frame.

Rear supports of the engine are two brackets mounted on the flywheel casing. Each bracket is bolted to brackets which are provided with rubber pads riveted to the frame.

#### Crank Gear

The crank gear serves to convert thermal energy of fuel into mechanical work. It consists of a crankcase, cylinder blocks, crankshaft with a flywheel and a piston and connecting rod assembly.

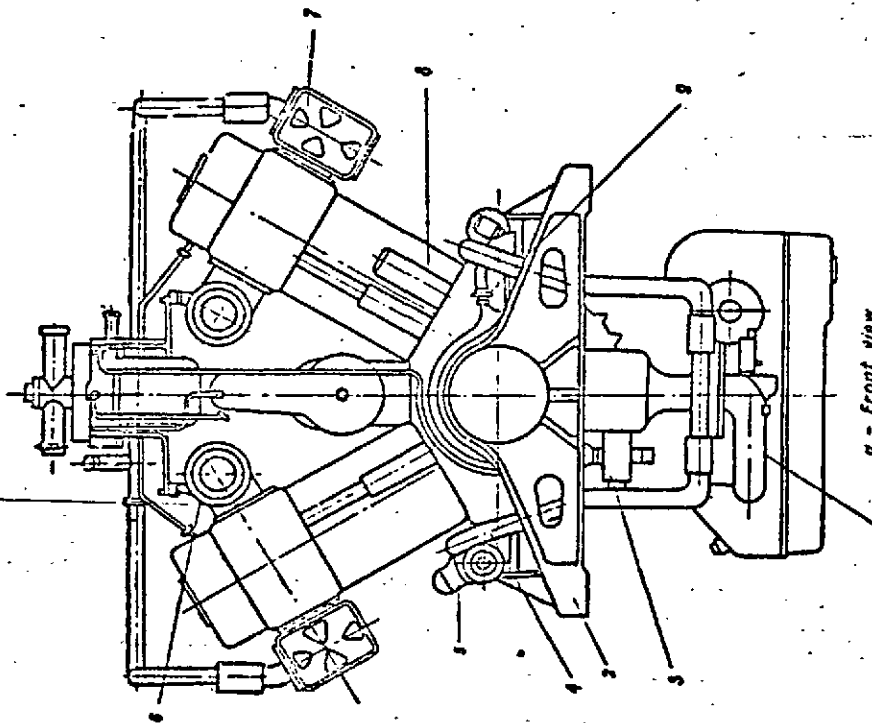
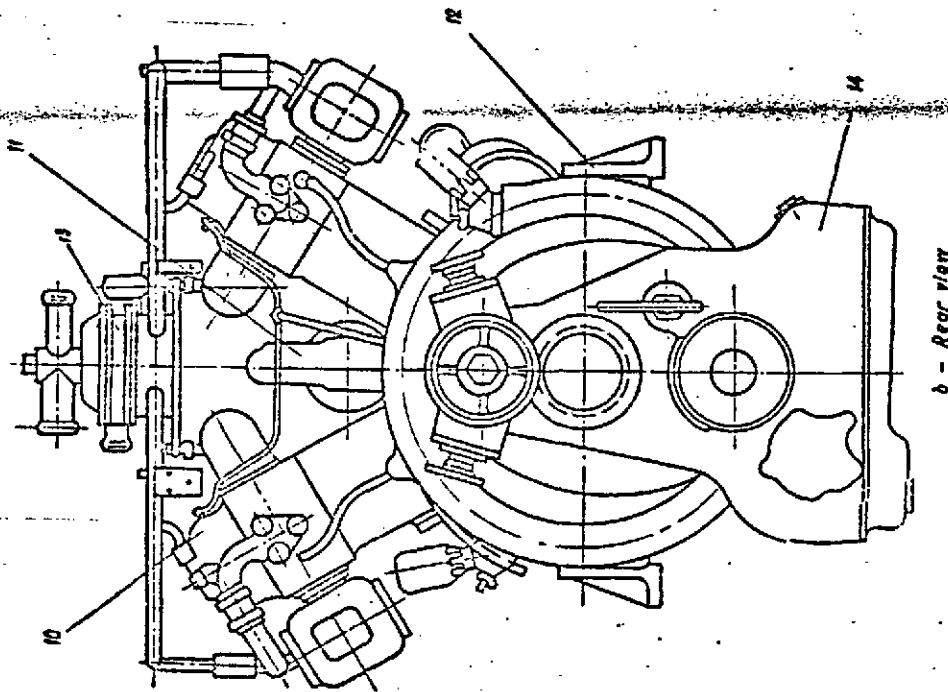
The crankcase (Fig.6) is a base for mounting all parts and units of the engine and is composed of two halves: upper and lower. Crankcase upper half 4 serves as a supporting one. Its partitions are provided with seven seats to receive main bearing shells 11 in which the crankshaft rotates.

Bearing caps (suspensions) 10 are attached to the crankcase upper half by studs. The split shells are made of steel (lined with lead bronze) or steel-aluminium (of bimetall band).

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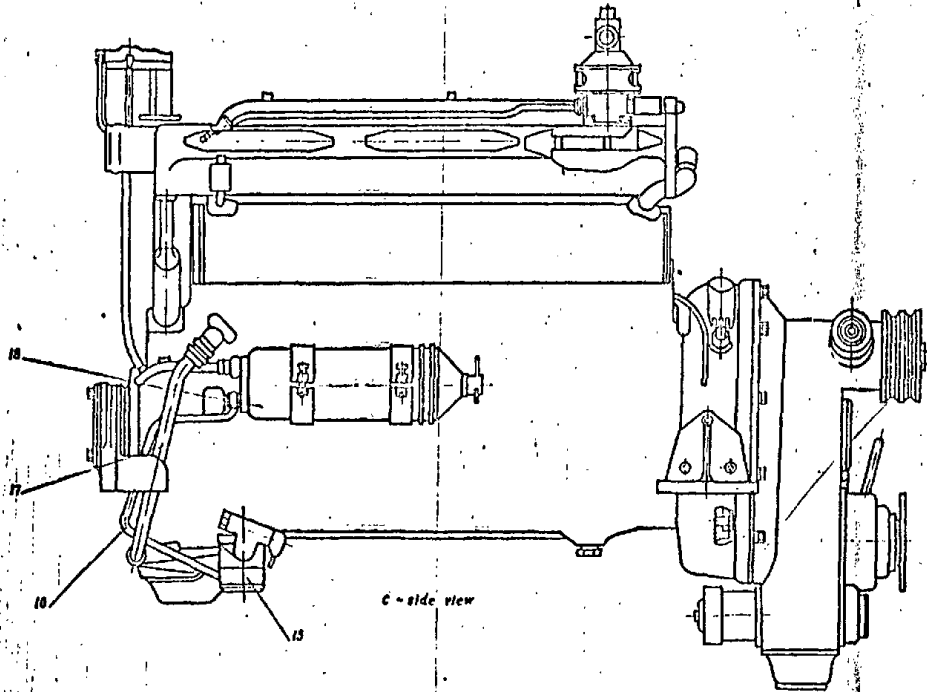


FIG. 5. ENGINE BEFORE INSTALLATION ON CHASSIS

- 1 - circulation pump; 2 - front engine support; 3 - fuel feed pump; 4 - pipe for delivery of coolant to left-hand cylinder block; 5 - generator; 6 - exhaust manifold; 7 - water-cooled exhaust manifold; 8 - engine crankcase breather; 9 - union for delivery of oil to main oil line; 10 - cylinder head cover; 11 - secondary fuel filter; 12 - engine support rear bracket; 13 - thermostat box; 14 - overdrive gear; 15 - oil pump; 16 - pipe running from oil pump to oil filter; 17 - pipe for delivery of coolant to right-hand cylinder block; 18 - oil filter

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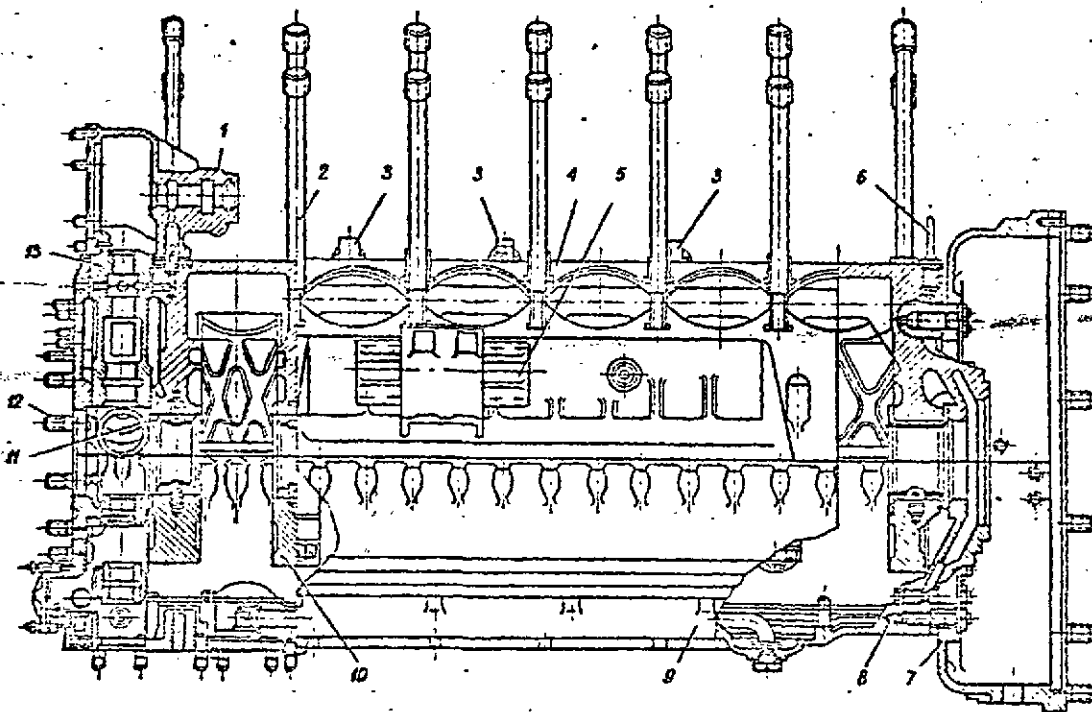


FIG. 6. ENGINE CRANKCASE.

1 - fuel injection pump drive body; 2 - hold-down stud; 3 - brackets for installation of fuel injection pump; 4 - crankcase upper half; 5 - bracket for attaching oil filter; 6 - eye ring; 7 - flywheel casing; 8 - pipe for drawing oil from crankcase's parking; 9 - crankcase lower half; 10 - bearing cap (suspension); 11 - shell; 12 - stud for attaching front support body; 13 - upper vertical shaft bearing

To improve working-in of the steel shells lined with lead bronze a lead layer, 0.02 mm thick, is plated on their working surface.

One of the shells (the seventh) which is installed first from the flywheel side, serves as a thrust one. It has shoulders which are also lined with lead bronze. These shoulders take up axial thrust of the crankshaft and limit the crankshaft end play.

Top inclined surfaces of the crankcase arranged at an angle of  $60^\circ$  serve for installation of cylinder blocks which are fastened to the crankcase by fourteen hold-down studs 2.

Each inclined surface is provided with six ports to receive lower portions of the cylinder liners projecting out of the cylinder block.

Crankcase end faces are machined and provided with studs. One of the end faces has bored holes for accommodation of the accessory drive bearings and drilled passages for delivery of oil to them.

This end face of the crankcase mounts a body of the front support installed onto the cylindrical portion of which is the front beam serving as an engine support. Flywheel casing 7 is fastened to the opposite end face of the crankcase. The casing is provided with two supports for attaching the engine to the frame.

The crankcase upper half sides mount bracket 5 for attaching the oil filter and lugs for fastening the charging generator and starter. Besides, the top horizontal machined surface carries three brackets 3 for installation of a fuel injection pump and body 2 of its drive.

Machining of the end faces in crankcase lower half 9 as well as boring of the holes along the engine crankshaft axis are accomplished in assembly with the crankcase upper half.

The crankcase lower half carries oil, circulation (of the cooling system) and fuel feed pumps and parts of their drives.

The flywheel casing has a port for installation of a timing pointer used to read degrees of the crank-angle when adjusting the valve-timing and the setting of the fuel injection pump and air distributor.

To prevent dirt from getting inside the flywheel casing, the inspection ports are fitted with breathers.

After the engine is timed at the Manufacturing Plant and the timing pointer is secured on the casing, a mark is made against the pointer on a port side opposite to the side on which the timing pointer is attached.

All engine adjustments involving setting of the crankshaft in a definite position should be performed only after the timing pointer is lined up with the above mark.

The cylinder block (Fig. 7) and pistons form chambers in which the heat of burned fuel is converted into mechanical work.

Each cylinder block consists of a cylinder jacket, six steel liners and a cylinder head.

Cylinder jacket 7 has six bores to receive cylinder liners 6. Coolant circulates through the space formed between the cylinder liners and jacket walls. Fourteen holes made on the lower side surface of the cylinder jacket are used to check leakage of the coolant and oil from wells of the hold-down studs.

Shoulders made on the upper part of the cylinder liners fit into corresponding recesses of the cylinder jacket and seal the water space at the top of the cylinder liners, thus preventing penetration of coolant from the jacket to the outside.

At the bottom the cylinder liner is sealed by rubber rings.

Cylinder head 10 is cast of aluminium alloy. Six cylindrical bores and piston crowns form combustion chambers. Each combustion chamber is connected through passages with intake ports on one side of the cylinder head and with exhaust ports on its opposite side. Steel valve seats are press-fitted and calked into the places where the passages enter the combustion chamber. Cast iron guide bushings of the valves are press-fitted into the holes bored coaxially with the seats. A stepped hole for installation of an injector is bored against the centre of the combustion chamber.

The top surface of the cylinder head accommodating the camshafts and valve actuating mechanism is closed by cover 8.

The tachometer generator secured on the end face of the right-hand cylinder head cover is driven by a plug with a tail piece, screwed into the intake camshaft.

The joint between the cylinder head and cylinder liner shoulders is sealed by aluminium gasket 5 and that between the cylinder head and cover - by paronite gasket 9.

Intake and water-cooled exhaust manifolds are attached to the cylinder head by studs.

The left-hand and right-hand cylinder block assemblies are not interchangeable. The cylinder heads are also not interchangeable.

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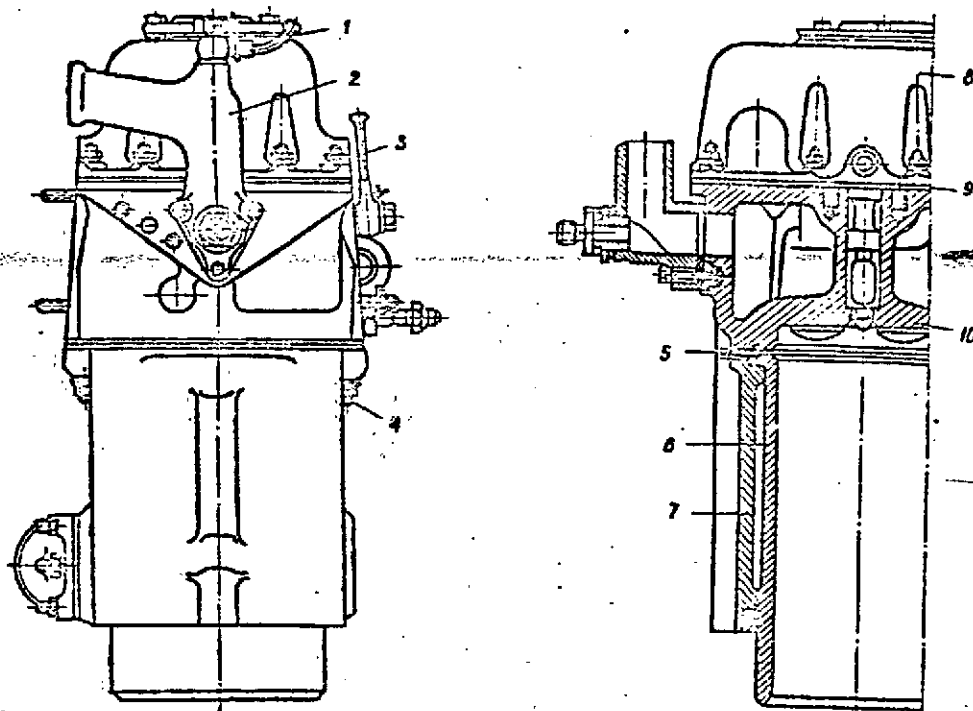


FIG. 7. CYLINDER BLOCK

1 and 3 - steam outlet pipes; 2 - coolant outlet branch pipe; 4 - coupling stud; 5 - Jermaluminum gasket; 6 - cylinder liner; 7 - cylinder jacket; 8 - cylinder head cover; 9 - paronite gasket; 10 - cylinder head

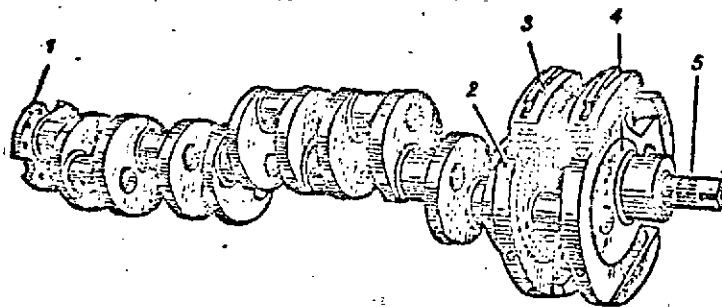


FIG. 8. CRANKSHAFT

1 - Dange; 2 - carrier; 3 - balance weight; 4 - web; 5 - tail piece



The crankshaft is forged of alloy steel, and has six throws arranged at an angle of  $120^\circ$  to each other (Fig. 8). The crankshaft is provided with six crankpins and seven main journals joined by webs.

The crankshaft journals are hollow and are connected with each other through web drillings intended for passage of oil. In the journal spaces the oil is additionally cleaned by separation. The journal spaces are closed by caps which are tied up by bolts.

Press-fitted into the first main journal is hollow tail piece 5 with splines fitted upon which is a bevel gear actuating the accessory drive. A smooth ground end of the tail piece matches up with a unit supplying oil into the crankshaft and secured on the front support body.

The end of the last seventh main journal carries flange 1 to which the flywheel is attached. A ring gear intended for meshing with the starter pinion during starting of the engine is press-fitted on the flywheel.

The flywheel outer rim is provided with divisions denoting degrees, and marks (the order of their arrangement is in the direction of flywheel rotation):

TMT - top dead centre in first and sixth cylinders of left-hand cylinder

INA block; corresponds to  $0^\circ$ ;

TEX - end of exhaust from first or sixth cylinder of left-hand cylinder

INA block; corresponds to  $20^\circ$ ;

BCSM - complete opening of air port delivering air into first or sixth cylinder of left-hand cylinder block; corresponds to  $27^\circ$ ;

BCSH - complete opening of air port delivering air into first or sixth cylinder of right-hand cylinder block; corresponds to  $87^\circ$ ;

HNA - beginning of exhaust from first or sixth cylinder of left-hand cylinder block; corresponds to  $132^\circ$ ;

TMT - bottom dead centre in first and sixth cylinders of left-hand cylinder

INA block; corresponds to  $180^\circ$ ;

KAC - end of intake in first or sixth cylinder of left-hand cylinder block;

INA corresponds to  $228^\circ$ ;

HIC - beginning of intake in first or sixth cylinder of left-hand cylinder

INA block; corresponds to  $340^\circ$ .

An arrow indicating the sense of crankshaft rotation is made on the flywheel rim. The flywheel has threaded holes for fitting and attachment of the overdrive gear damper coupling. The first two webs of the crankshaft are fitted with a vibration damper of the balance type intended to decrease the torsion angle of the crankshaft and to reduce stresses caused by torsional vibrations.

The vibration damper consists of two carriers 2 fitted with interference on webs 4 and having three lugs each to which six balance weights 3 are attached by pins. For attachment to the carrier the balance weight is provided with two blind holes which are closed at the open side by threaded plugs.

Connecting Rod and Piston Assembly (Fig. 9). The connecting rods are made of alloy steel and provided with shanks of I-section. Connecting rods whose big ends rest on crankpins of the crankshaft are called master connecting rods while connecting rods whose big ends are attached to lugs on the big ends of the master connecting rods by pins are called articulated connecting rods.

Piston pins 5 slip in bronze bushes 7 which are press-fitted into the small ends of the master (8) and articulated (9) connecting rods. The master connecting rod big end is a split type. Its ribbed cap 13 is attached to the connecting rod by two taper

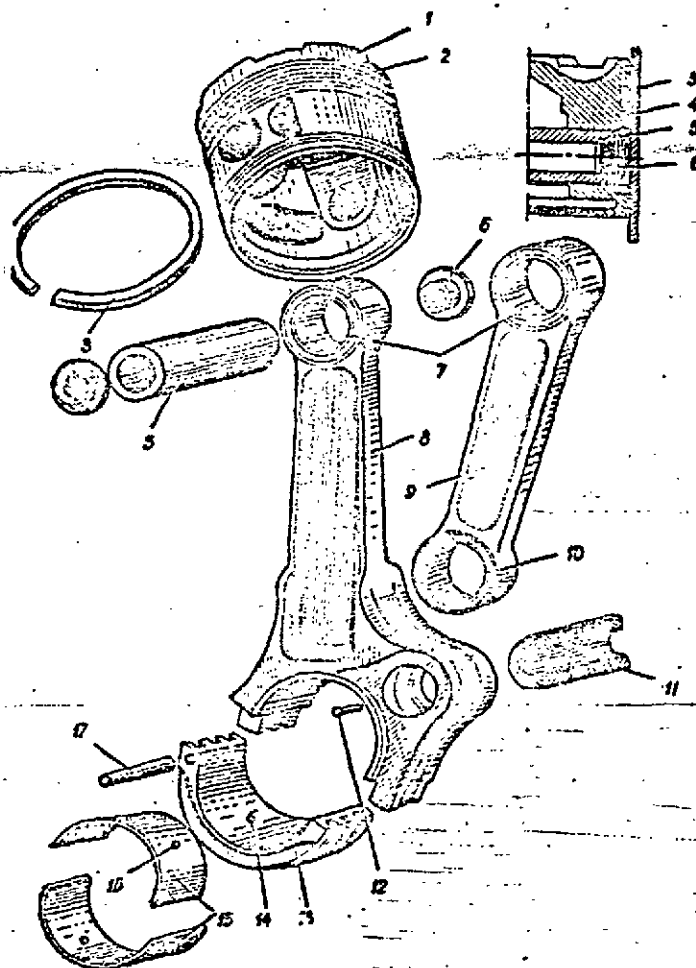


FIG. 9. PISTON AND CONNECTING ROD ASSEMBLY

1 - piston; 2 - piston ring grooves; 3 - cylindrical piston ring; 4 - taper-face piston ring;  
 5 - piston pin; 6 - piston pin cap; 7 - connecting rod small end bush; 8 - master connecting rod;  
 9 - articulated connecting rod; 10 - articulated connecting rod big end bush;  
 11 - articulated connecting rod attachment pin; 12 - locating pin; 13 - master connecting end lag end cap;  
 14 - shell locating pin; 15 - shell; 16 - hole for delivery of oil to articulated connecting rod pin;  
 17 - taper pin

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pins 17 which are driven into holes of the combs of the connecting rod big end and its cap.

Split shells 15 lined with lead bronze or made of steel-aluminium band are clamped in a bore of the big end. They slip on the crankshaft crankpin.

The articulated connecting rod is attached to the master connecting rod by pin 11 fitted into the lugs of the master connecting rod big end. Pin 11 is locked by locating pin 12. Bronze bush 10 is press-fitted into the articulated connecting rod big end.

Pistons 1 are drop-forged of aluminium alloy.

The top face of the piston crown is shaped to ensure better preparation of a mixture.

The piston is provided with two bosses to receive hollow case hardened piston pin 5 which is held from axial displacement by cap 6 made of aluminium alloy. Five piston grooves 2 are fitted with two cylindrical steel compression rings 3 plated with porous chromium and with three taper cast iron oil control rings 4.

#### Accessory Drive

Rotation of the crankshaft is transmitted to the engine mechanisms and systems from a bevel gear fitted on the splines of the crankshaft tail piece, in accordance with the diagram given in Fig.10. The gear is meshed with:

- bevel gears of the charging generator drive inclined shaft and upper vertical shaft, thus driving the mechanisms mounted on the crankcase upper half;
- bevel gear of the lower vertical shaft, thus driving the mechanisms mounted on the crankcase lower half.

The upper vertical shaft transfers rotation of the crankshaft to the two inclined shafts of the camshafts drive and also to the air distributor and fuel injection pump drive.

The upper vertical shaft rotates in a bearing installed in the hole on the horizontal surface of the crankcase upper half.

The lower vertical shaft is made integral with the upper bevel gear. At the bottom the shaft has rectangular splines by means of which it is engaged with a spur gear. The spur gear the slot of which receives the cam of the circulation pump drives the pump. By its teeth the spur gear rotates idle gears of the oil and fuel feed pumps drive.

The lower vertical shaft rotates in a bronze bushing press-fitted into the crankcase lower half.

The bevel gear which is press-fitted into the inner hole of the fuel feed pump drive spur gear and locked by a pin, is in mesh with the bevel gear attached to the fuel feed pump rotor.

The oil pump drive idle gear rotates on a ball bearing secured on the axle in the crankcase lower half.

The fuel feed pump drive idle gear rotates in a bushing press-fitted into the partition of the crankcase lower half.

The inclined shafts of the camshafts drive are not arranged in the plane of symmetry of the cylinder blocks but are displaced parallel to them towards the fuel injection pump drive body. The inclined shafts rotate in aluminium alloy bearings which are fitted in the holes bored in the crankcase upper half, and in bronze bushings which are press-fitted into the boxes attached to the cylinder heads. The bearings and bushings are lubricated with oil delivered through the pipelines and drillings in the crankcase and bearings.

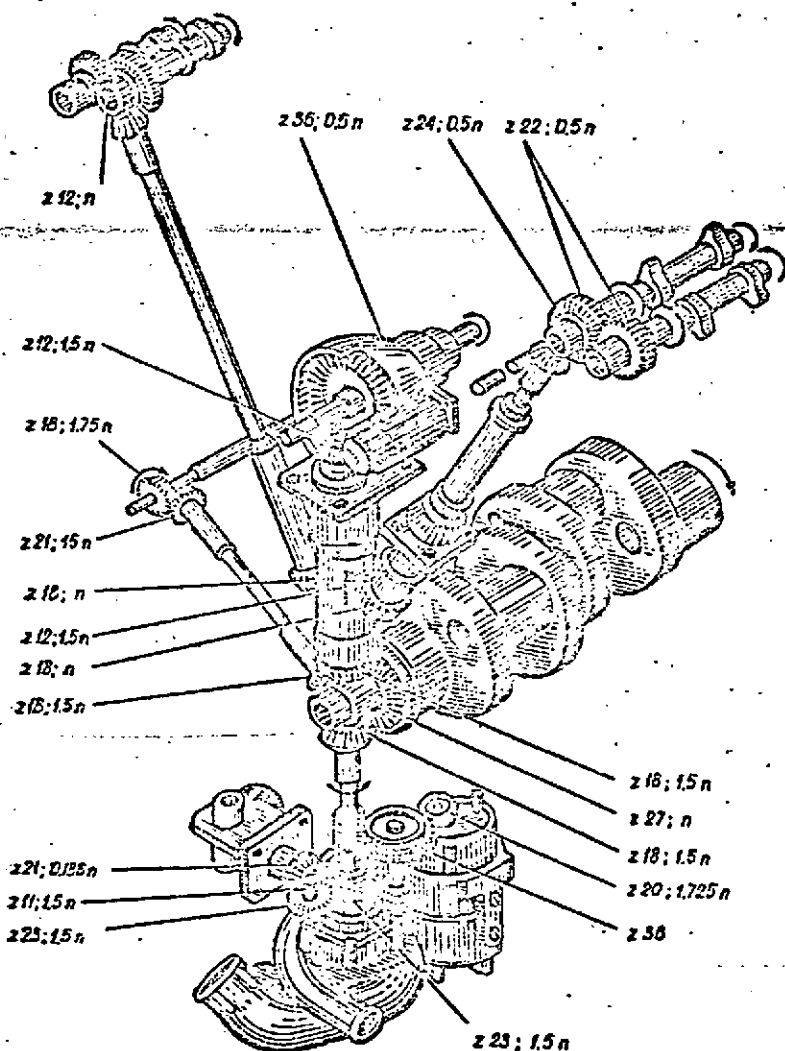


FIG. 10, ENGINE ACCESSORY DRIVE DIAGRAM  
 In the diagram letter "z" and the figure indicates the number of gear teeth; letter "n" and the figure denotes the crankshaft-to-shaft speed ratio; directions of shaft rotation are indicated by arrows

Oil flowing out of the bearings drains into the crankcase lower half.  
The meshing of the bevel gears is adjusted by means of adjusting rings having different thickness.

#### Valve Timing Gear

The valve timing gear is intended to provide correlated operation of the engine cylinders in conformity with the firing order and the working cycle.

The engine working cycle is graphically illustrated in the valve timing diagram (Fig.11).

The diagram shows:

beginning of intake stroke (beginning of opening of intake valves)  $20 \pm 3^\circ$  before the TDC on exhaust stroke;

end of intake stroke (end of closing of intake valves)  $48 \pm 3^\circ$  after the EDC on compression stroke;

beginning of exhaust stroke (beginning of opening of exhaust valves)  $48 \pm 3^\circ$  before the EDC on expansion stroke (working stroke);

end of exhaust stroke (end of closing of exhaust valves)  $20 \pm 3^\circ$  after the TDC on intake stroke.

Duration of the intake and exhaust strokes is  $248 \pm 6^\circ$  of the crank angle.

The engine firing order: 1.L.H., 6R.H., 5L.H., 2R.H., 3L.H., 4R.H., 6L.H., 1R.H., 2L.H., 5R.H., 4L.H., 3R.H. (L.H. - left-hand cylinder block; R.H. - right-hand cylinder block).

Sequence of operation of the fuel injection pump plungers: 2,11,10,3,6,7,12,1,4,9,8,5.

The valve timing gear comprises a valve-actuating mechanism, camshafts, fuel injection pump drive and air distributor drive.

The fuel injection pump and air starter drives and also the procedure for checking and adjusting their setting will be dealt with below at the description of these units.

Valve-Actuating Mechanism. Each cylinder is equipped with two exhaust and two intake valves (Fig.12). The cams of the camshafts act directly on the ground top surface of tappet discs 1 screwed into the valves.

The clearances between the tappet discs and cam lobes and, consequently, the valve timing are adjusted by screwing in or out the tappet discs.

Closing of each valve is accomplished by two coaxially arranged springs 5 and 6. The springs press the teeth of spring retainer 2 of the tappet disc which is fitted on the flats of the valve, against the teeth of the tappet disc, thereby preventing it from turning relative to the valve and, consequently, from spontaneous disturbance of the timing.

Exhaust valves 3 are made of heat-resisting steel and have a smaller diameter of the head than the intake valves. Intake valves 4, tappet discs and spring retainers are made of high-quality steel.

The camshafts (Fig.13) rotate in seven bearings installed on the cylinder head. Intake camshaft 1 is located at the fuel injection pump side.

Shaft 11 is an exhaust one. The camshafts are made hollow of carbon steel. Each camshaft is provided with seven journals and twelve cams. The camshaft inner space serves for delivery of oil to the bearings and tappet discs. For this purpose each journal and each cam are provided with radial holes. The holes are so arranged on the cams that oil gets on the tappet disc before the cam comes in contact with it.

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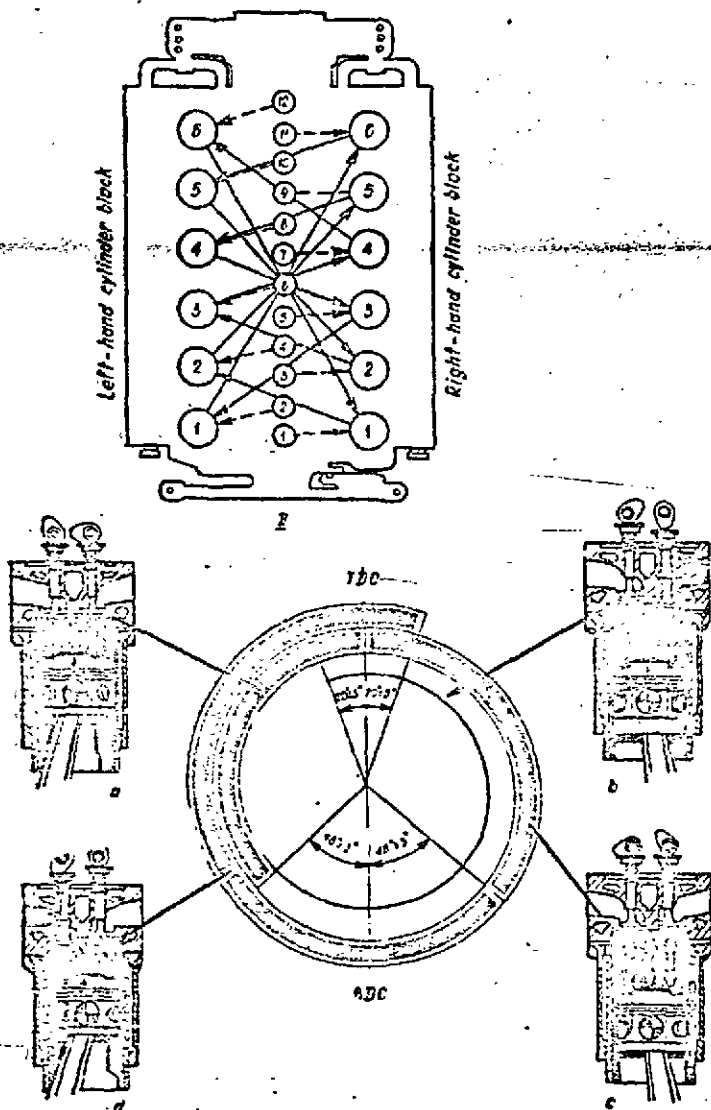


FIG. 11. VALVETIMING DIAGRAM

I - valve timing diagram  
 II - engine firing order (solid arrows) and sequence of operation of fuel injection pump sections (dotted arrows)  
 a - compression; b - intake; c - expansion; d - exhaust

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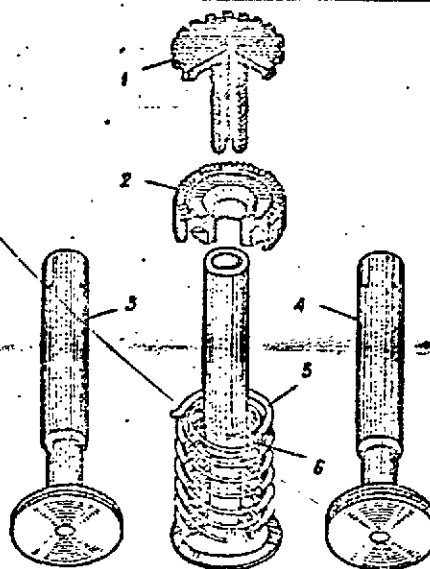


FIG. 12. VALVES

- 1 - tappet die; 2 - spring retainer; 3 - exhaust valve;
- 4 - intake valve; 5 - outer spring; 6 - inner spring

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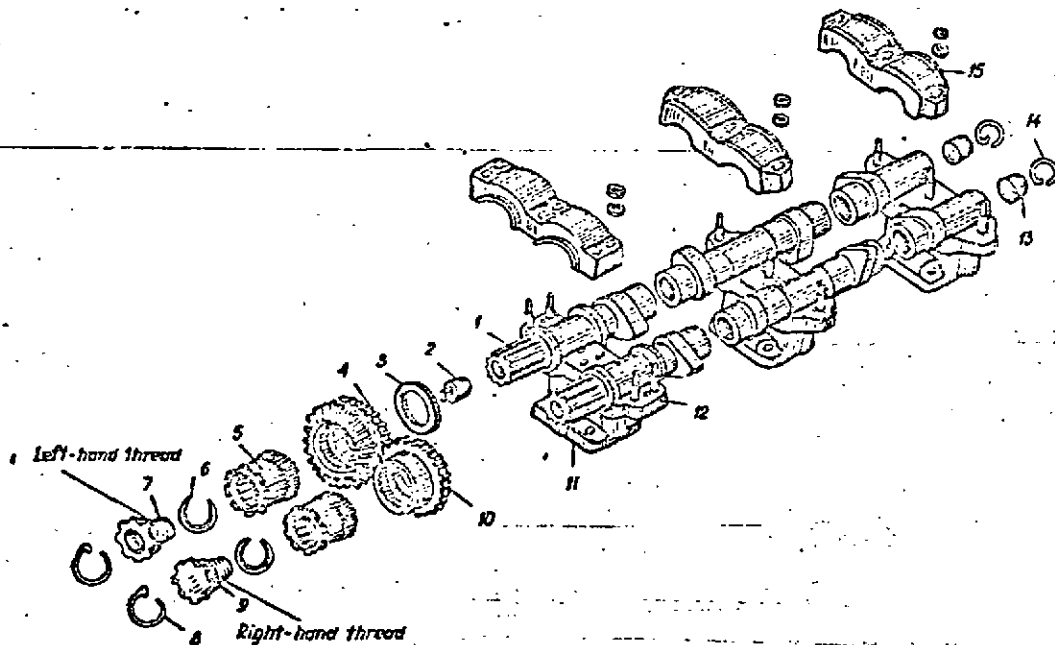


FIG. 13. CAMSHAFTS

- 1 - intake camshaft; 2 - plug with tail piece; 3 - adjusting ring;
- 4 - intake camshaft cluster gear; 5 - adjusting bushing; 6 - snap ring;
- 7 and 9 - shaped bolts; 8 - spring lock; 10 - exhaust camshaft gear;
- 11 - exhaust camshaft; 12 - front bearing base; 13 - plug;
- 14 - lock ring; 15 - bearing cap

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During operation of the engine the intake camshafts rotate clockwise and the exhaust camshafts - counter-clockwise.

All the cams are similar in shape. The cams are arranged in pairs in six planes and in such a manner that, when the camshafts rotate, the cams press on the tappet discs in accordance with the firing order of each cylinder block: 1,5,3,6,2,4.

The front end of each camshaft is provided with a thrust collar, a short cylindrical section and 10 external rectangular splines. The front and rear ends of each shaft are threaded from the inside. The front ends of the intake camshafts have a left-hand thread and those of the exhaust camshafts - a right-hand thread. The rear ends of the camshafts have a right-hand thread. The thread serves for screwing in steel plugs 13. When screwed in, the plugs are stopped by split spring lock rings 14 which fit in special grooves.

Steel plug 2 with a tail piece is screwed into the front end face of the right-hand cylinder block intake camshaft; the plug is provided with a drilled hole for passage of oil. The plug tail piece serves for connection with the electric tachometer generator shaft and for its driving.

Fitted on the cylindrical section of the intake camshaft front end are: adjusting ring 3 used for adjusting the clearance in the pair of bevel gears, and a cluster gear made integral of a spur and a bevel gears 4. Spur gear 10 is put on the cylindrical section of the exhaust camshaft front end. These gears are provided with internal triangular splines. For convenience of valve timing adjustment forty-one splines are made on each gear.

The gears are connected with the camshafts by means of steel adjusting bushing 5 having forty-one external triangular and ten internal rectangular splines each.

The adjusting bushings are loosely attached to shaped bolts 7 and 9 by snap rings 6.

For disconnecting the adjusting bushings from the bolts the adjusting bushings are provided with radial holes permitting the snap rings to be fitted.

The bolts are screwed into the front end faces of the camshafts and stopped relative to the adjusting bushings by spring locks 8.

The loose joint of the adjusting bushings with the bolts makes it possible to engage the adjusting bushings with or disengage them from the gears and camshafts by turning the bolts in the shaft thread.

The spur gears are intermeshed while the bevel gear is engaged with the camshaft drive inclined shaft gear.

#### Checking and Adjusting Valve Timing on Engine

Checking of the valve timing is carried out during maintenance after 2,000 hours of the engine operation and comes down to preliminary checking of the clearances between the cam lobes and tappet discs of the camshafts and, if necessary, to their adjustment. The clearance should be equal to  $2.34 \pm 0.1$  mm.

The valve timing should be checked and adjusted each time the cylinder heads are installed or parts of the timing gear and accessory drive are replaced during overhaul and repair of the engine.

To adjust the valve timing, proceed as follows:

- see that the timing pointer on the flywheel casing is correctly set; if necessary, align the timing pointer with the mark on the casing port;
- remove the electric tachometer generator together with its drive;
- take off the covers of the cylinder heads;
- prepare the engine for cranking by hand;



- adjust the clearances between the cam lobes and tappet discs within the specified limits, using the fork, pliers and a feeler gauge provided in the SPTA set;

- adjust the valve timing, starting from the first cylinder of the left-hand cylinder block in the following way:

(a) using the timing pointer on the flywheel casing and the graduated rim of the flywheel, set the crankshaft to the position corresponding to  $40-50^\circ$  before the TDC in the first cylinder of the left-hand cylinder block on the exhaust stroke (the exhaust valves are open) by rotating it clockwise;

(b) rotate the crankshaft until the intake cams start opening the valves in the first cylinder of the left-hand cylinder block.

The beginning of the valve opening is determined by biting of a plate, 0.03-0.04 mm thick but not over 0.05 mm thick, (foil, feeler gauge). Before opening of the valve the plate placed between the cam and the tappet disc can be freely shifted. The beginning of the valve opening can also be determined by turning it with the help of the tappet disc. When closed the valve will not turn.

Determine the beginning of opening of the intake valves in the first cylinder of the left-hand cylinder block by the graduated rim of the flywheel. In case the beginning of opening of the intake valves does not conform to the valve timing diagram (Fig. 11), it is necessary to set the crankshaft to the position corresponding to  $20 \pm 3^\circ$  before the TDC in the first cylinder of the left-hand cylinder block on the exhaust stroke (the exhaust valves are open), remove the adjusting bushing of the intake camshaft (the bolt attaching the bushing has a left-hand thread), bring the cams of the left-hand cylinder block first cylinder to the beginning of opening of the valves by striking them with a lead or copper hammer.

Set the adjusting bushing back home, having selected such a position at which the splines on the bushing freely engage the splines on the camshaft and the gear.

Recheck the beginning of opening of the intake valves.

When the results are satisfactory, tighten up the bolt and secure it with spring lock 8 (Fig. 13);

(c) press the tappet disc of the exhaust valve of this cylinder and insert a foil plate, not more than 0.05 mm thick, between the cam and the tappet disc.

Rotating the crankshaft clockwise and applying an effort to withdraw the plate, determine the end of closing of the exhaust valves in the first cylinder of the left-hand cylinder block.

The end of the valve closing can also be determined by turning it with the help of the tappet disc. Non-conformity of the end of closing of the exhaust valves with the above diagram is eliminated in the same manner as the non-conformity of the beginning of opening of the intake valves. The thread on the bolt attaching the adjusting bushing is right-hand;

(d) rotating the crankshaft clockwise, determine the beginning of opening of the intake valves in the sixth cylinder of the right-hand cylinder block (by the graduated rim of the flywheel -  $40 \pm 3^\circ$ ) and the end of closing of the exhaust valves in the same cylinder ( $80 \pm 3^\circ$ ).

The non-conformity of opening and closing of the valves in the sixth cylinder of the right-hand cylinder block is eliminated in the same manner as in the first cylinder of the left-hand cylinder block;

(e) during two revolutions of the crankshaft determine in succession the beginning of opening and the end of closing of the intake and exhaust valves in the first

cylinder of the left-hand cylinder block and in the sixth cylinder of the right-hand cylinder block which must correspond to the following divisions on the flywheel rim<sup>1)</sup>.

First revolution of the crankshaft:

- beginning of opening of intake valves in first cylinder of left-hand cylinder block  $340^{\circ}$ ; ( $20^{\circ}$  before the TDC);
- end of closing of exhaust valves in first cylinder of left-hand cylinder block  $20^{\circ}$ ;
- beginning of opening of intake valves in sixth cylinder of right-hand cylinder block  $40^{\circ}$ ;
- end of closing of exhaust valves in sixth cylinder of right-hand cylinder block  $80^{\circ}$ ;
- end of closing of intake valves in first cylinder of left-hand cylinder block  $228^{\circ}$ ;
- end of closing of intake valves in sixth cylinder of right-hand cylinder block  $288^{\circ}$ .

Second revolution of the crankshaft:

- beginning of opening of exhaust valves in first cylinder of left-hand cylinder block  $132^{\circ}$ ;
- beginning of opening of exhaust valves in sixth cylinder of right-hand cylinder block  $192^{\circ}$ ;

(f) check the valve timing in all the engine cylinders.

Deviations from the valve timing allowance ( $\pm 3^{\circ}$ ) should be corrected by adjusting the clearance between the cam lobes and tappet discs.

If the valve timing cannot be set within the clearance of  $2.34 \pm 0.1$  mm, it is permitted to decrease the clearance in separate valves to 2.1 mm to obtain the timing within the allowance;

(g) put down the adjustment data into the engine Service Log.

Install the cylinder head covers and the electric tachometer generator with its drive.

When checking and adjusting the valve timing, bear in mind that:

- after overhaul or repair of the engine, before installing the cylinder heads, the camshafts should be preliminarily placed as is shown in Fig.1A to prevent the pistons from striking against the open valves. Wrong positions of the camshafts are corrected as instructed in Subitems "b" and "o";

- shift in advance angles of the two adjacent cylinders in accordance with the firing order is equal to  $60^{\circ}$  of the crank angle;

- when adjusting the valve timing by resetting the camshaft and the adjusting bushing the earlier opening of the valve causes its earlier closing by the same number of degrees. The duration of the timed cycle will not change;

- for cranking the engine by hand during adjustment of the valve timing or processing of the engine the automobile is furnished with a special device provided in the SPTA set.

The device is a conventional single-acting ratchet mechanism which is attached to the flange of the left-hand fans drive overdrive gear shaft.

1) The allowance of  $\pm 3^{\circ}$  is omitted

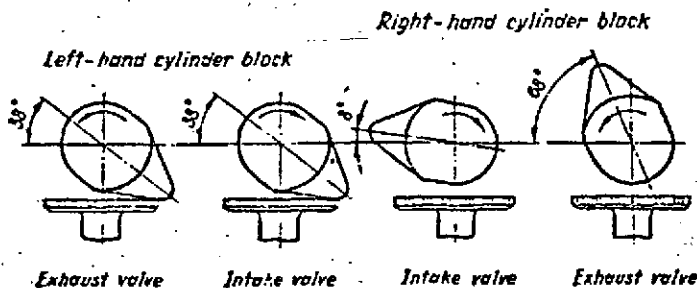


FIG. 14. ARRANGEMENT OF CAMSHAFT CAMS, WITH PISTON OF FIRST CYLINDER OF LEFT-HAND CYLINDER BLOCK IN THE EXHAUST STROKE (AS VIEWED FROM THE ACCESSORY DRIVE END)

For installing the device proceed as follows:

- loosen the bolts which attach the flanges of the overdrive gear output shaft and left-hand fans drive cardan shaft;
  - install the device on the flange of the overdrive gear output shaft and secure it by bolts which has been removed when disconnecting the fans cardan shaft flange;
  - disengage the overdrive gear from the automobile power train;
  - insert a mounting iron (from the SPTA set) from above into the device hole.
- If necessary, the device hole can be brought to a required position by pressing out the ratchet pawl;
- upon completion of the necessary operations involving the engine cranking, remove the device, install the fans drive cardan shaft and engage the overdrive gear with the automobile transmission.

#### ENGINE FUEL SYSTEM

##### Purpose and Design of Fuel System

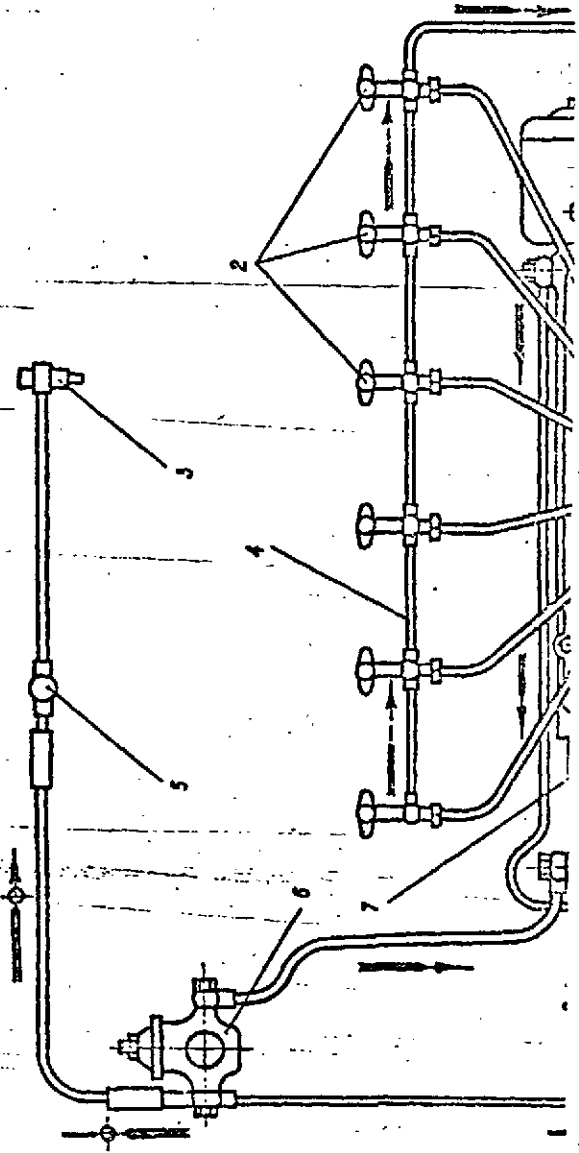
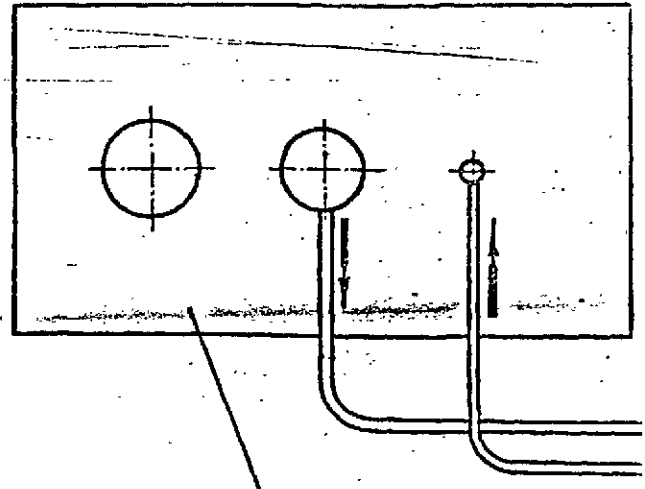
The fuel system is intended:

- to deliver fuel from the tanks to the fuel injection pump;
- to clean fuel of foreign particles;
- to uniformly distribute fuel among the cylinders and to inject it into the cylinders at definite moments with regard to the crank angle;
- to atomize fuel in the combustion chambers for better preparation of combustible mixture;
- to adjust the amount of fuel delivered into the engine depending on its operation.

The main components of the fuel system mounted on the engine are the following: fuel feed pump (Fig.15), secondary fuel filter, fuel injection pump with drive coupling and engine governor, twelve injectors, low and high pressure pipes. Located outside the engine are: fuel tanks, fuel distributing cock, manual fuel priming pump, primary fuel filter, drain tank and fuel feed control linkage.

Note. For convenience of mounting and demounting the pipelines of the fuel system their ends are painted yellow.

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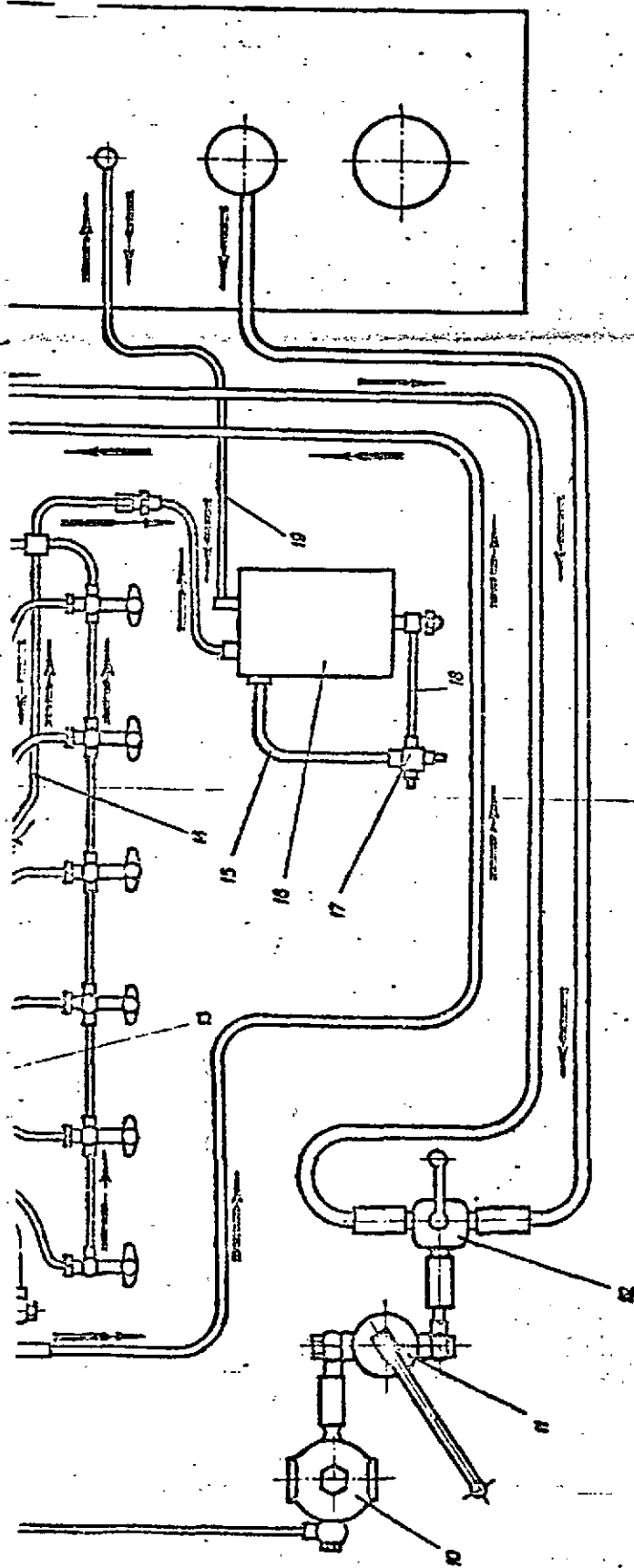


FIG. 15. FUEL SYSTEM DIAGRAM

1 - fuel tanks; 2 - diesel engine injectors; 3 - starting preheater injector; 4 - pipe for draining fuel from diesel engine injector bodies; 5 - starting pre-water fuel pump; 6 - fuel feed pump IIR-12TK; 7 - engine automatic shutdown device which cuts off delivery of fuel to fuel injection pump in case of drop of oil pressure in main oil line; 8 - secondary fuel filter; 9 - valve for automatic release of air from pump IIR-10 and secondary fuel filter; 10 - primary fuel filter; 11 - manual fuel priming pump PMA-1A (wobble type); 12 - fuel distributing cock; 13 - fuel injection pump IIR-10; 14 - pipe for draining fuel from housing of pump IIR-10; 15 - tank drain pipe; 16 - tank for fuel draining from injector bodies and pump IIR-10; 17 - drain tank cut-off valve; 18 - tank drain pipe; 19 - tank vent pipe

SYMBOLS:

- fuel flow from tanks to fuel injection pump, with engine running and fuel system primed by means of manual fuel priming pump
- air and fuel flow from diesel engine fuel injection pump and filter to right-hand tank, with engine running (system for continuous removal of air)
- air flow at washing of drain tank and space of diesel engine fuel injection pump housing through left-hand fuel tank
- delivery of fuel for starting preheater
- flow of fuel draining from injector bodies and fuel injection pump of diesel engine to drain tank, with diesel engine running

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When the engine is running, fuel from the tank which is cut in, is drawn by the BK-12K fuel feed pump of the engine via the fuel distributing cock, manual fuel priming pump and primary fuel filter, and delivered, under a pressure of 0.6-0.8 kgf/cm<sup>2</sup>, to the secondary fuel filter where it is cleaned of solid mechanical impurities. From the filter the fuel is conducted to the fuel injection pump. The fuel injection pump delivers metered portions of fuel to the injectors of the cylinders through the high pressure pipelines according to the firing order. The injectors spray and deliver fuel into the combustion chambers of the engine cylinders.

Fuel leaking through untight joints of the pump plunger pairs into the pump housing as well as fuel leaking through a clearance between the needle and injector spray tip drains along drain pipes into the drain tank.

During operation of the engine the air trapped in the system is continuously discharged through a non-return valve mounted on the fuel injection pump, and a connector with a metering orifice installed in the secondary fuel filter, and together with some fuel is delivered into the right-hand fuel tank.

When the fuel system is primed with the help of the manual fuel priming pump to remove air or to fill the system with fuel, the fuel from the tank which is cut in, is drawn by the manual pump and conducted through the primary fuel filter and the BK-12K fuel feed pump to the secondary fuel filter. From the secondary fuel filter the fuel with air is forced through the connector with the metering orifice to drain to the fuel tank. When the engine is out of operation, i.e. when no pressure is built up in the lubricating system the fuel is prevented from flowing to the fuel injection pump by the valve of the engine emergency shut-down device. Therefore, to bleed air from the fuel injection pump during priming, it is necessary to build up pressure in the lubricating system with the help of the oil priming pump, thereby admitting fuel to the fuel injection pump. While passing through the pump and non-return valve the fuel together with the air will drain into the tank.

The rotary-type fuel feed pump serves for delivery of fuel at a pressure of 0.6-0.8 kgf/cm<sup>2</sup> to the fuel injection pump through the secondary fuel filter when the engine is running.

The pump (Fig.16) consists of the following main parts: body 2 with cover 1, rotor sleeve 19, rotor 20, floating pin 21, four vanes 22, reducing valve 13 and by-pass valve 12.

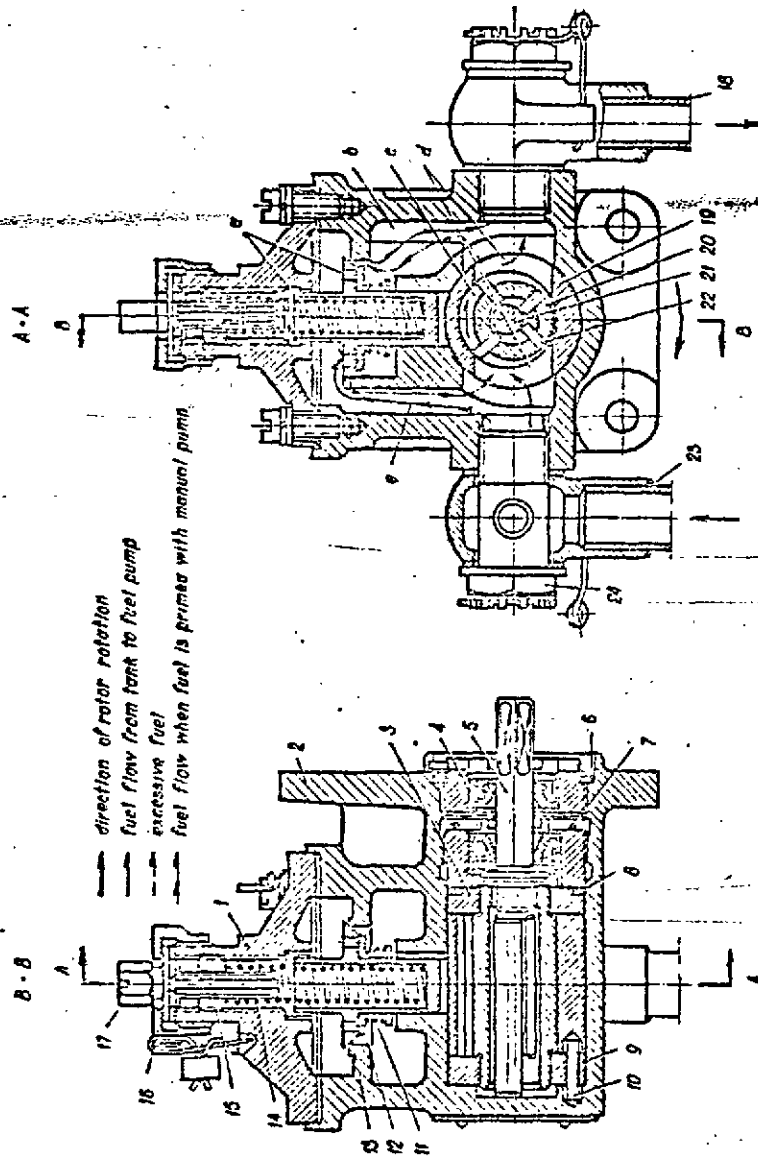
Cylindrical hole "c" is arranged in rotor sleeve eccentrically relative to the external cylindrical surface of the sleeve. On the sides the sleeve is provided with fuel inlet and outlet holes "d". The sleeve is press-fitted into body 2 with interference and locked by pin 10.

Rotor 20 is installed eccentrically relative to the sleeve hole in bearings 3 and 9. The rotor is provided with four slots loosely fitted into which are vanes 22 resting on one side on pin 21 and on the other - on the internal surface of sleeve 19. Removable tail piece 5 attached to the rotor transmits rotation to the rotor from the engine drive.

The valve unit comprises two valves: reducing 13 and by-pass 12. The reducing valve accommodates spring 14. One end of the spring rests on the valve bottom and the other - on adjusting screw 15. The valve is pressed to the seat by the spring, thus separating the suction and delivery chambers in the pump body. The valve disc is provided with eight holes "a".

By-pass valve 12 pressed to the reducing valve by spring 11 covers holes "a".

The tension of spring 14 is adjusted by turning adjusting stem 17 which is connected to screw 15 by a square tail-piece. The adjusting stem is locked by union nut 16.



direction of rotor rotation  
 fuel flow from tank to fuel pump  
 excessive fuel  
 fuel flow when fuel is primed with manual pump

FIG. 16. RIN-127K FUEL FEED PUMP

1 - body cover; 2 - pump body; 3 and 9 - O-rings; 4 and 7 - feather-type rubber collar; 5 - rotor tail piece; 6 and 8 - rubber clugs; 10 - plug; 11 - bypass valve spring; 12 - bypass valve; 13 - recharging valve; 14 - recharging valve spring; 15 - adjusting screw; 16 - union nut; 17 - adjusting screw; 18 - pipe for delivery of fuel from pump (link to fuel filter); 19 - rotor sleeve; 20 - rotor; 21 - rotor flange pin; 22 - rotor vane; 23 - pipe for delivery of fuel to pump (link); 24 - rotor on recharging valve for inspection of fuel of manual priming; 25 - delivery chamber; 26 - square in rotor sleeve; 27 - inlet and outlet holes in rotor sleeve; 28 - suction chamber

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Fuel is delivered to the BHK-12TK pump through pipe 23. The pipe is attached to the pump body by connector 24. Delivery of fuel from the pump to the fuel filter is accomplished through pipe 18.

The pump packing preventing fuel from leaking through clearances between the parts is ensured by rubber ring 8 and frame-type rubber collar 7. The crankcase oil is prevented from leaking through the pump drive by rubber rings 6 and collar 4.

The pump body is provided with taper threaded plug 1 (Fig.17) screwed into the body.

Check hole "a" of plug 1 is used to check the condition of the packings: collar 7 (Fig.16) and ring 8 which prevent leakage of fuel from the pump, and of the packings: collar 4 and ring 6 preventing crankcase oil from leaking.

Pump rotor 20 with four vanes 22, floating pin 21 and sleeve 19 forms a rotary mechanism with four working spaces (between each pair of the adjacent vanes). When the rotor is rotating the volumes of the working spaces periodically vary: when passing by the inlet hole they are increased, and when passing by the outlet hole decreased. Vacuum is produced in the increased volumes and fuel from the tank is drawn through pipe 23. From the decreased volumes the fuel is displaced and forced out along pipe 18 to the fuel filter.

The pump capacity exceeds the fuel consumption. As a result, excessive pressure is built up in delivery chamber "b". To limit the excessive pressure a provision is made for reducing valve 13. Under the action of excessive pressure the valve compresses spring 14, opens and by-passes excessive fuel delivered by the pump back into pump suction chamber "a".

When the fuel system is being filled before starting of the engine, fuel is delivered into the system via the BHK-12TK pump with the help of the manual fuel priming pump. The fuel delivered into suction chamber "a" by the manual pump fills the space above reducing valve 13 past the rotary mechanism, passes through holes "a", compresses spring 11 and opens by-pass valve 12, comes into delivery chamber "b" and flows further along pipe 18 through the fuel filter to the fuel injection pump.

The direction of fuel flow depending on the operating conditions of the pump is shown by arrows in Fig.15.

The rotor rotates anti-clockwise as viewed from the drive side.

The secondary fuel filter serves for cleaning fuel of mechanical admixtures.

The filter is introduced into the line connecting the BHK-12TK fuel feed pump with the fuel injection pump.

The fuel filter consists of the following main parts: casing 9 (Fig.18), filtering element 15, cover 2, non-return valve 1 for automatic removal of air, clamping bolt 12.

Fuel from the fuel feed pump is delivered to the filter through non-filtered fuel chamber 17 and fills the space of casing 9.

Filtering element 15 installed in the casing consists of sets of cardboard or caprone spacers 1 and 3 (Fig.19) and felt discs 2 assembled on the filter screen.

Under the pressure built up by the fuel feed pump fuel from the casing passes through slots "a" into spaces "b" of inlet spacers 1, penetrates through felt discs 2 into spaces "c" of outlet spacers 3 and flows through slots "d" of these spacers, silk bag 8 (Fig.18) and screen 7 into filtered fuel chamber 3.

Non-filtered fuel is prevented from getting into the filtered fuel chamber by oil seal 10 pressed to nut 13 and clamping bolt 12 by spring 11, and by pressure plate 14. At the top the sealing is effected by packing plate 16 pressed to felt ring 21 which is fitted in a groove of filter cover 2.



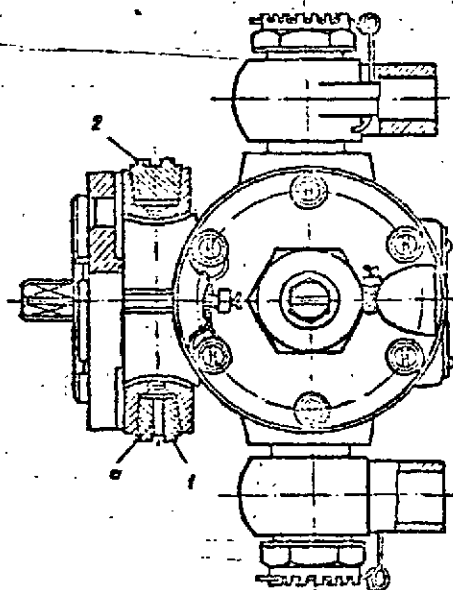


FIG. 17. CHECK HOLES OF DIS-LETA PUMP PACKINGS.  
1 - plug; 2 - manufacturer's access plug; a - check hole

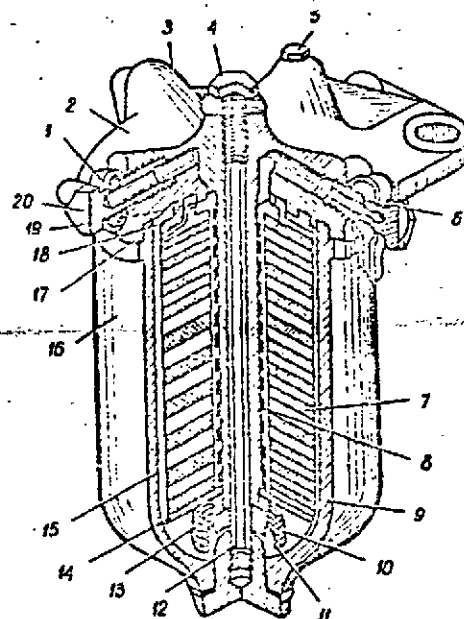


FIG. 18. SECONDARY FUEL FILTER  
1 - non-return valve of common system for continuous removal of air from pump and filter; 2 - filter cover; 3 - filtered fuel chamber; 4 - clamping bolt nut; 5 - air release plug; 6 - filtered fuel outlet passage; 7 - filter metal screen; 8 - will bag; 9 - filter casing; 10 - oil seal; 11 - spring; 12 - clamping bolt; 13 - nut; 14 - pressure plate; 15 - filtering element; 16 - packing plate; 17 - non-filtered fuel chamber; 18 - packing gasket; 19 - felt ring; 20 - connector with metering orifice for continuous removal of air during engine operation

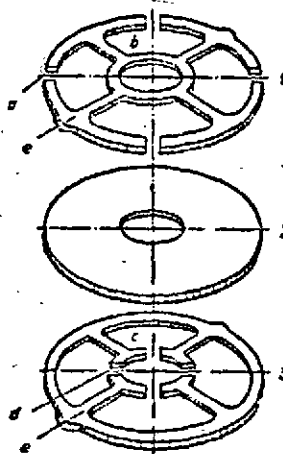


FIG. 19. PARTS OF FILTERING ELEMENT  
1 - inlet spacer; 2 - felt filtering disc;  
3 - outlet spacer; a, d - slots; b,  
c - space; e - lug

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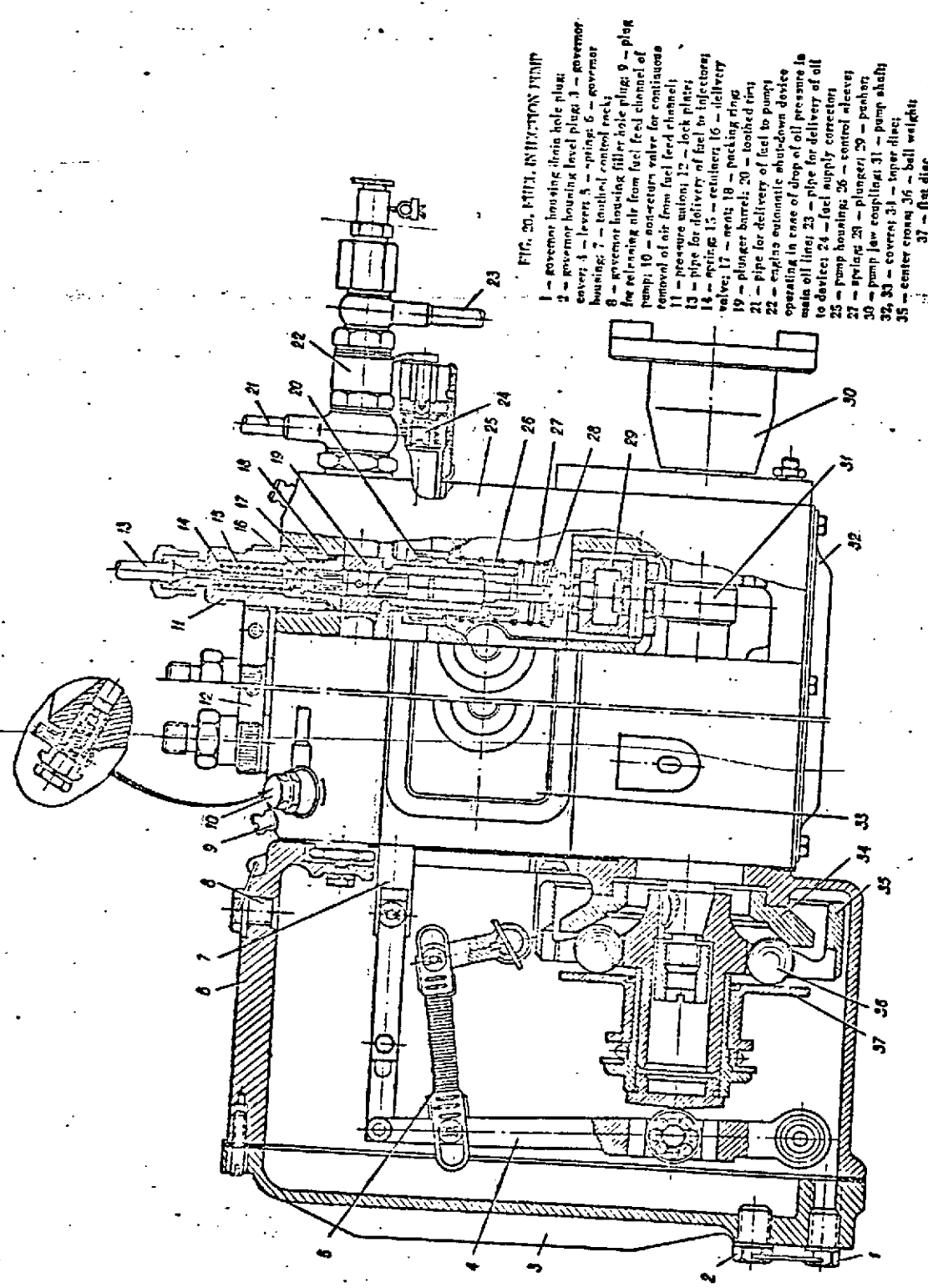


FIG. 20. FUEL INJECTION PUMP

- 1 - governor housing filler hole plug;
- 2 - governor housing level plug;
- 3 - governor lever;
- 4 - lever;
- 5 - spring;
- 6 - governor housing;
- 7 - control rack;
- 8 - governor housing filler hole plug;
- 9 - plug for releasing air from fuel feed channel of pump;
- 10 - nonreturn valve for continuous removal of air from fuel feed channel;
- 11 - pressure nut;
- 12 - lock plate;
- 13 - pipe for delivery of fuel to injectors;
- 14 - spring;
- 15 - retainer;
- 16 - delivery valve;
- 17 - nut;
- 18 - packing ring;
- 19 - plunger barrel;
- 20 - toothed rim;
- 21 - pipe for delivery of fuel to pump;
- 22 - engine automatic shut-down device operating in case of drop of oil pressure in main oil line;
- 23 - pipe for delivery of oil to devices;
- 24 - fuel supply corrector;
- 25 - pump housing;
- 26 - control sleeve;
- 27 - spring;
- 28 - plunger;
- 29 - pump jaw coupling;
- 31 - pump shaft;
- 32, 33 - cover;
- 34 - taper fit;
- 35 - center crown;
- 36 - ball weight;
- 37 - flat disc.

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Filtered fuel from chamber 3 flows through passage 6 in the filter cover, along the pipeline to the fuel injection pump.

Air getting into the fuel filter together with fuel accumulates in filtered fuel chamber 3 where from it is continuously removed together with some fuel through the connector with the metering orifice and branch pipe into the right-hand fuel tank during operation of the engine.

The hole closed by plug 5 is used to remove air from the non-filtered fuel chamber of the secondary fuel filter after replacement of the elements.

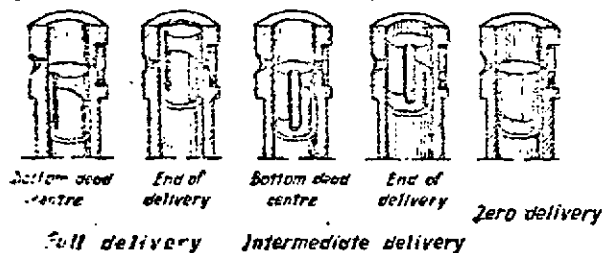
The fuel injection pump (Fig. 20) serves to deliver strictly metered portions of fuel (depending on engine load) under high pressure to the injectors according to the firing order.

The pump pairs (plungers and barrels) are located in a common housing cast of aluminum alloy. The camshaft with twelve cams causes the upward movement of the plungers through pushers with rollers.

The pump camshaft is driven from the accessory drive through a coupling with a textolite washer and is supported in two ball bearings (on the ends) and five sliding bearings.

The downward movement of the plungers and pushers is produced by the springs which press the plungers through the discs to the pusher bolts, and the pushers - to the pump shaft cams.

The delivery of fuel begins after the edge of the plunger top face covers the ports in the barrel on its upward stroke.



The delivery of the fuel ceases as soon as the cut-off helix on the plunger uncovers the barrel port (Fig. 21).

The amount of delivered fuel depends on the position of the plunger relative to the barrel. Thus, the volumetric control and, consequently that of the engine power is effected by rotating the plunger.

Turning of the plungers is accomplished by common toothed control

rack 7 (Fig. 20) meshed with twelve toothed rims 20. The toothed-rims are secured on control sleeves which are centered by the external surfaces of the plunger barrels.

The control sleeves have rectangular slots which receive rectangular projections provided on plunger journals.

The delivery of equal amounts of fuel by different plungers is achieved by the adjustment performed at the Manufacturing Plant.

The adjustment is carried out by turning the control sleeves together with the plungers. The permissible variation in the delivery of fuel by the pump plungers should not exceed 10 per cent.

Fuel delivered by the plunger passes through a delivery valve, located above the plunger pair, into the injection pipe conducting the fuel to the injector.

The parts of the fuel injection pump are made with utmost precision.

The precision pairs: plunger with barrel and delivery valve with seat are finished in assembly. Therefore, the fuel injection pump is sensitive to clogging and requires especially thorough filtration of fuel. The pump is lubricated by oil filled into its housing.

The engine speed governor is of a mechanical centrifugal, variable speed, direct-acting type.

The governor is designed:

- to limit the engine speed;
- to maintain stable operation of the engine at minimum idle speed;
- to maintain the preset speed of the engine within the entire range of loads from idle running to rated power.

The governor is attached to the face of the fuel injection pump and makes up with it a single unit.

Ball weights of the governor are arranged in slots of the centre cross which is secured on the tapered end of the fuel injection pump camshaft by a key.

At the pump side the balls thrust against a tapered disc which is fitted in a recess of the governor housing. At the opposite side the balls rest against a flat disc which can freely rotate and slide together with the sleeve axially along the centre cross tail piece.

Axial displacement of the flat disc caused by the centrifugal force of the balls, with the speed increasing, is transmitted through a thrust ball bearing, flat stop and roller to the governor lever. Turning the lever around its stationary axle causes extension of the two governor springs and movement of the pump control rack towards the decreased delivery of fuel by the plungers.

The governor is splash-lubricated for which purpose the housing is filled with oil used for lubrication of the engine.

The governor is provided with three plugs used for filling oil, checking the oil level and draining oil.

The fuel supply corrector is intended to increase the quantity of fuel delivered into the cylinders at the maximum torque, thus improving the adaptability of the engine to overcome increased loads.

The fuel supply corrector is attached to the face of the fuel injection pump, and is a control rack stop provided with a rigid spring permitting slight additional shifting of the rack towards the increase of fuel delivery only in case when the engine is overloaded with the resultant drop of its speed. The maximum delivery of fuel is determined by a position of the fuel supply corrector.

The fuel injection pump drive coupling serves for connection of the pump shaft with the shaft of the engine accessory drive and permits mutual rearrangement of these shafts when setting or adjusting the injection advance angle.

The design of the fuel injection pump drive coupling is illustrated in Fig. 22.

The injector (Fig. 23) serves for delivery of fuel under high pressure into the engine cylinder in a finely atomized state, and uniform distribution of fuel over the entire volume of the combustion chamber.

The engine is equipped with injectors of a closed type. The injector spring tension provides a pressure of beginning of the fuel delivery equal to  $210 \text{ kgf/cm}^2$ .

Spring 4 located in the upper part of body 5 rests with its lower end on the retainer pressed on injector rod 6 and with the upper end - on adjusting bolt 1 through support washer 3. The bolt is secured by lock nut 2. The rod passes through the central hole of the body.

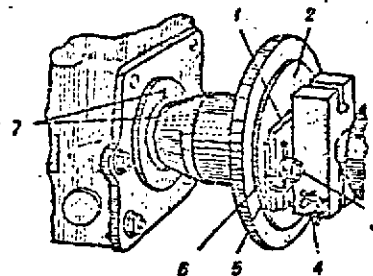


FIG. 22. FUEL INJECTION PUMP DRIVE COUPLING

1 - flange; 2 - cam disc; 3 - bolt;  
4 - clamping bolt; 5 - mark on flange;  
6 - mark on cam disc; 7 - marks on ball bearing housing and pump jaw coupling

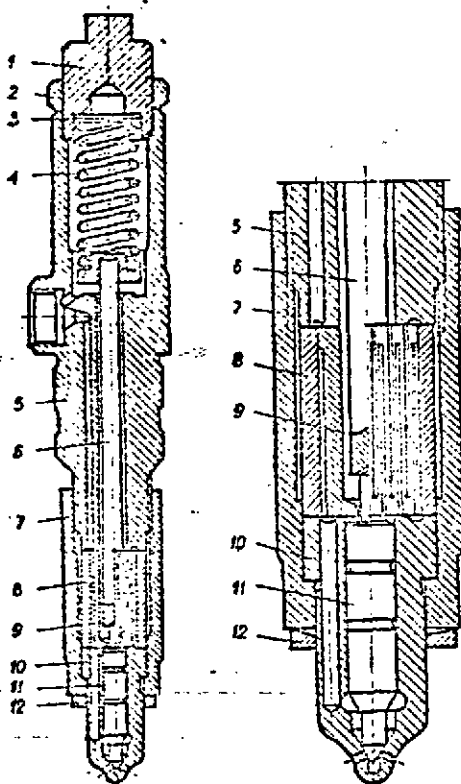


FIG. 23. INJECTOR

1 - adjusting bolt; 2 - lock nut; 3 - support washer;  
 4 - spring; 5 - injector body; 6 - rod; 7 - spray tip nut;  
 8 - slotted filter outer bushing; 9 - slotted filter inner  
 bushing; 10 - spray tip; 11 - spray tip needle; 12 - pack-  
 ing ring

The bottom face of the injector is thoroughly finished. Pitted to it is the face of a slotted filter. The body face is provided with a circular groove connected with the union delivering fuel to the injector through a longitudinal channel.

The slotted filter serves to prevent the spray tip orifices from clogging and the spray tip needle from sticking.

The filter is composed of two steel bushings fitted into each other with a clearance of 0.02 to 0.04 mm.

The end faces of the bushings are machined in assembly, therefore the filter bushings should be used only in sets.

The external cylindrical surface of inner bushing 9 is provided with longitudinal grooves alternately leading to the end faces. This bushing is provided with a central hole to pass the injector rod. Outer bushing 8 is smooth.

The filter is installed between the bottom face of the injector body and the face of the spray tip body.

The injector spray tip is pressed against the end face of the slotted filter by nut 7. The spray tip face has a circular groove; a similar groove is provided on the injector body.

Needle 11 with two cones at the bottom is arranged inside the inner hole of spray tip 10. The smaller cone covers the spray orifices connecting the spray tip inner space with the combustion chamber.

Fuel flows under the larger cone through passages communicating with the circular groove on the spray tip end face. The needle and spray tip are lapped and finished in assembly. They are a precision pair of parts.

Injector rod 6 rests on the needle pin. With the help of the spring the injector rod presses to the spray tip seat the needle which covers the spray orifices.

Fuel delivered by the pump through the passage in the injector body comes to the end face of the slotted filter, passes into the grooves leading to its top face, is filtered in the slits between the bushings and flows to the spray tip along the grooves leading to the bottom face of the filter.

The fuel coming out of the filter grooves passes into the circular groove on the spray tip end face and runs through the passages in its body under the needle larger cone.

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When the specified pressure of fuel is obtained the spray tip needle goes up. With the needle rising, the fuel is injected into the combustion chamber through seven orifices of the spray tip (0.25 mm in dia. each).

When the plunger stops delivering fuel the needle actuated by the spring goes down sharply cutting off the injection.

The fuel injected into the engine cylinder under high pressure is finely atomized and mixed with air, forming a readily inflammable combustible mixture.

#### Fuel Drain Tank

Fuel leaking through untight joints of the fuel injection pump plunger pairs and through the clearance between the needle and spray tip of the injector flows along a common drain pipe to a special tank located on the left-hand side of the automobile (on the attaching gusset of the engine fuel tanks).

The tank is connected to the left-hand fuel tank by means of a drain pipe.

The drain pipe running from the injectors and the fuel injection pump to the drain tank should be laid so as to provide inclination necessary to drain fuel into the fuel tank and to ensure continuous communication of the fuel injection pump inner space with the atmosphere (through the left-hand fuel tank).

During operation it is necessary to prevent the above section of the drain pipeline from deflection in the vertical plane which otherwise may result in local fuel retention blocking the communication of the HK-10 fuel injection pump with the atmosphere.

To drain fuel from the tank, open the drain cock located in the tank bottom. After complete drainage of fuel, turn the valve in the cock.

#### Fuel Tanks

Two fuel tanks are attached to the bracket by straps in the rear section of the engine compartment. Each tank is provided with a fuel intake extended upward, sump with a drain cock and a filler neck. Each of the tanks is fitted with a dipstick for measuring the fuel level.

The internal surface of the tank is treated with bakelite for protection against corrosion. No welding operations are allowed on the tank treated with bakelite. Besides, when handling the tank do not strike it or drop. The tank is provided with three hatches for inspection and flushing.

The partitions provided inside the tank serve to add to the strength of the tank and to decrease surging of fuel during movement of the automobile.

The fuel distributing cock serves for cutting in any of the fuel tanks into the engine fuel system. The cock is of a four-way plug type. One hole of the cock is plugged. The handle position indicates the tank which is cut in. The cock design is illustrated in Fig. 24.

The cock is installed in the engine compartment on the rear wall of the driver's cab. The cock handle is extended inside the cab. The handle positions corresponding to cutting in (cutting out) of any of the tanks are given in the instruction plate located under the cock-handle.

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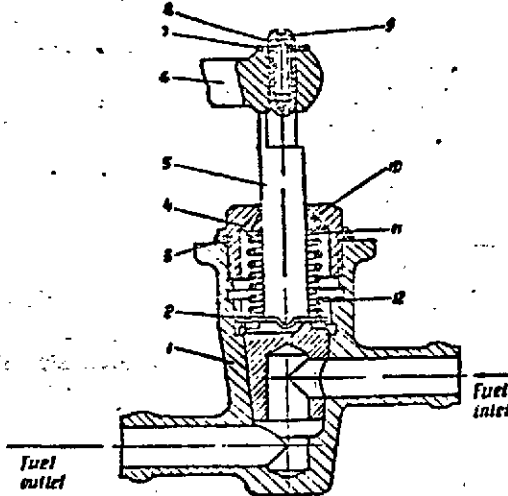


FIG. 24. FUEL DISTRIBUTING COCK

- 1 - cock body; 2 - cock latch; 3 - packing ring; 4 - oil seal;  
 5 - cock stem; 6 - handle; 7 - washer; 8 - spring washer; 9 - handle  
 screw; 10 - nut; 11 - washer; 12 - spring.

The vane and valve bodies divide the working chamber of the pump into four spaces: I, II, III, IV whose volumes vary during movement of the vane.

Spaces I-III and II-IV are interconnected by circular channels in the cylindrical portion of the vane.

When turning the pump handle clockwise the filled volume of spaces II-IV decreases, the right-hand inlet valve gets closed, and fuel from space II and also through the circular channel from space IV, having lifted the upper delivery valve, flows to the primary fuel filter through the pipeline. At the same time the volume of spaces I-III increases; under the action of vacuum produced in them the left-hand inlet valve opens and the upper delivery valve closes. Fuel fills spaces I-III. When the handle is moved counter-clockwise, the reverse processes take place in the spaces.

The pump capacity at the suction head of 1 m and at 100 double complete strokes of the handle is 12 lit/min. The angle of handle travel is up to 100°.

To prevent rise of pressure in the fuel system in excess of 2 kgf/cm<sup>2</sup> and damage of the DNM-12TK fuel feed pump oil seals, the handle travel of the PMA-1A, pump when it is installed on the automobile, is limited to 30°. The stops which limit the handle travel are a pump attaching nut and a recess in which the handle is arranged.

The pump handle is installed on the shaft so that at the extreme positions limited by the stops the handle will be short of the extreme positions on the pump (without the stops) by an angle of 8-15° which is ensured by resetting the handle on the shaft splines.

When the pump is used it is prohibited to apply considerable efforts to the handle to prevent damage of the pump.

The pump is installed in the engine compartment on the rear wall of the driver's cab. The pump handle is extended inside the cab.

The primary fuel filter is used for preliminary cleaning of fuel of mechanical impurities before its delivery to the fuel feed pump.

The filter (Fig. 26) consists of bowl 4 with a stud and an instruction plate for cleaning and servicing of the filter glued to it, bowl cover 6, screen filtering sections 1, 2 and 3, spring 13.

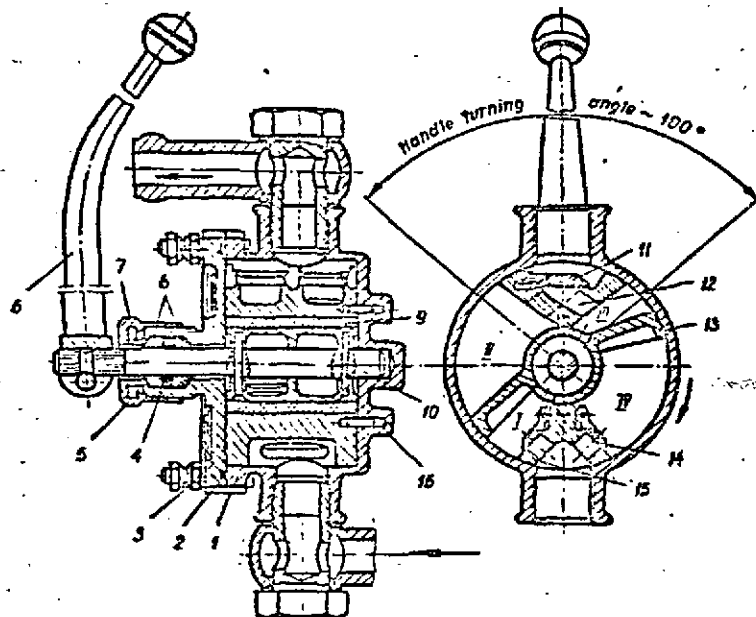


FIG. 25. MANUAL FUEL PRIMING PUMP

- 1 - pump body; 2 - packing ring; 3 - pump cover; 4 - oil-seal; 5 - nut; 6 - handle;
- 7 - pressure ring; 8 - gasket; 9 - gasket; 10 - shaft; 11 - delivery valve;
- 12 - delivery valve body; 13 - valve; 14 - inlet valve; 15 - inlet valve body;
- 16 - pin; I, II, III, IV - spaces

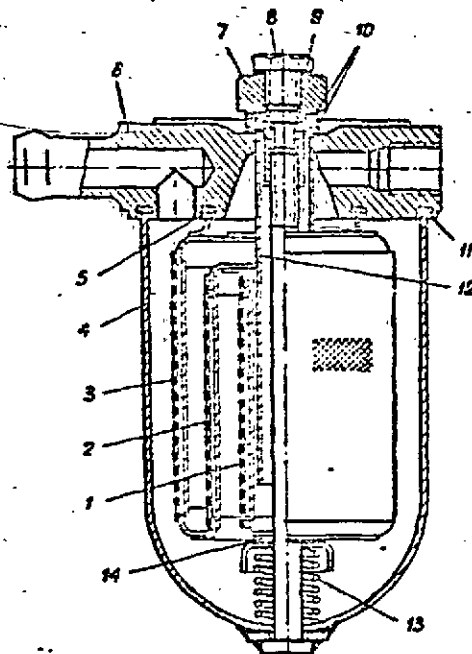


FIG. 26. PRIMARY FUEL FILTER

- 1, 2 - filtering sections; 3 - filter bowl; 4, 11 - packing rings; 6 - bowl cover; 7 - nut; 8 - plug; 9 - gaskets;
- 10 - fibre rings; 12 - central tube; 13 - spring;
- 14 - packing ring

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Nut 7 screwed on the stud presses the cover through fibre rings 10 against the filter bowl.

Packing gaskets 5 and 11 preventing leakage of fuel outside and also from the non-filtered fuel chamber to the clean fuel chamber are placed between the housing and the cover and between the outer filtering section and the cover. Fuel is delivered into the chamber between the bowl wall and filtering sections, forced through the sections and conducted along the outlet pipeline to the fuel feed pump.

The filter is mounted on the cab rear wall in the engine compartment.

The fuel feed control linkage is intended to change the quantity of fuel delivered by the fuel injection pump into the engine cylinders. The control linkage (Fig.27) consists of a foot accelerator pedal and a system of levers, shafts and rods.

Accelerator pedal 7 is hinged to the cab floor in front of the driver's seat to the right. The travel of the pedal is conveyed through the system of levers and rods to the lever on the engine speed governor.

Hand control handle 5 arranged on the cab front panel under the instrument panel to the right of the driver is used to set the engine at constant speed. The hand control linkage mechanism is of an eccentric type. The required delivery of fuel is set by turning the handle with the eccentric and simultaneously depressing the pedal. The handle with the eccentric and the foot accelerator pedal are so joined with each other that when the handle is set into a definite position the foot pedal can be used only to increase the delivery of fuel. Travel of the pedal in the direction of the decreased delivery of fuel is limited by a cylindrical surface of the eccentric.

The handle with the eccentric is held in a definite position by an elastic friction washer which is pressed against the eccentric by nuts through a shaped washer.

The maximum speed set by the hand control is limited by a stop on the bracket and the maximum speed set by the foot control - by accelerator pedal stop 6.

Holes in the inclined floor of the cab are sealed by protective boots 9 which are put on the rods of the hand control and accelerator pedal respectively and attached to them and also to the flanges on the inclined floor by clamping rings.

#### Maintenance of Engine Fuel System

To ensure normal operation of the engine fuel system, carry out all the operations prescribed in the table of the Section "Preventive Maintenance of Automobile".

#### Washing of Primary Fuel Filter

To wash the primary fuel filter proceed as follows:

- unscrew nut 7 (Fig.26) of the clamping stud, remove filter bowl 4 with the filtering sections;
- take out filtering sections 3, 2, 1 and wash them in diesel fuel;
- wash the filter bowl in diesel fuel;
- install the filtering sections and the filter bowl;
- check packing rings 5 and 9 in cover 6 for condition and turn in nut 7, having inspected at the same time fibre rings 10 of the central tube (12) flange.

#### Washing of Secondary Fuel Filter

To wash the secondary fuel filter proceed as follows:

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25X1

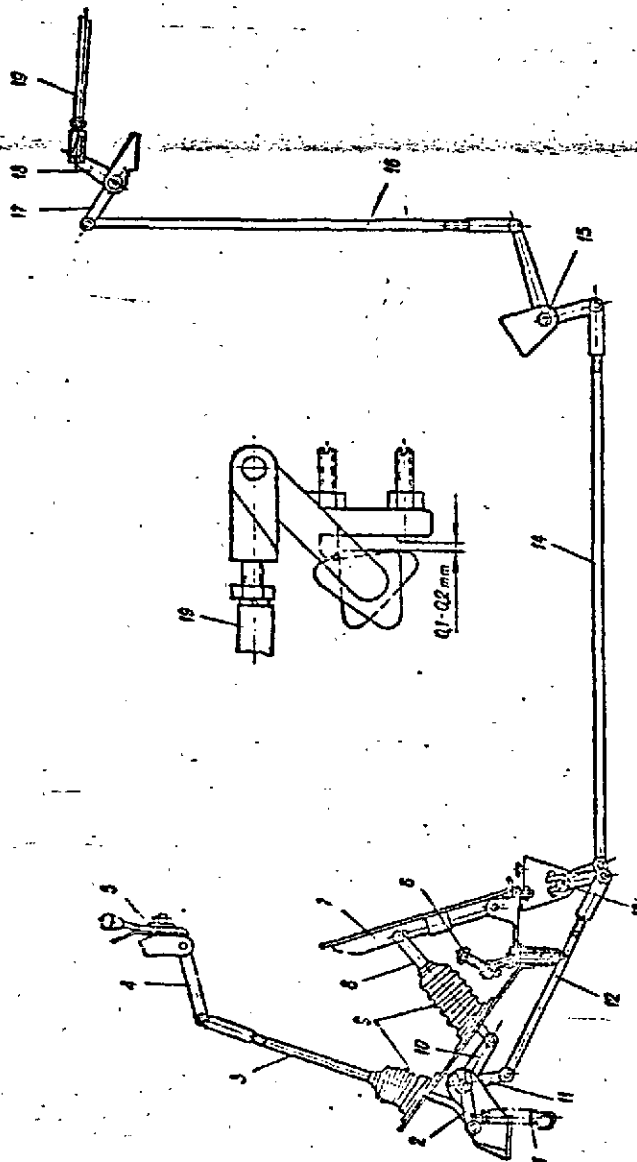


FIG. 27. FEED CONTROL LINKAGE

- 1 - pullback spring; 2 - hand control lever; 3 - hand control rod; 4 - hand control lever; 5 - hand control handles
- 6 - accelerator pedal stop; 7 - accelerator pedal; 8 - pedal rod; 9 - protective boot; 10 - pedal lever; 11 - front shaft lever; 12 - front rod; 13 - front accelerator shaft; 14 - middle rod; 15 - middle accelerator shaft; 16 - rear rod; 17 - upper lever; 18 - upper small lever; 19 - rod to engine governor

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25X1

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25X1

25X1

- unscrew clamping bolt nut 4 (Fig.18) and take off the casing with the filter-  
ing element;
- remove the filtering element, oil seal and oil seal spring from the casing,  
wash the casing with diesel fuel;
- clean the filtering element of dirt and wash it in the assembled state with  
diesel fuel;
- disassemble the filtering element, having unscrewed the nut and removed the  
pressure plate, cardboard (or caprone) spacers and felt discs; the silk bag should  
not be taken off;
- wash each felt disc with two portions of diesel fuel and then squeeze them  
out by placing each 3-4 pieces between two discs in a vice;
- wash the cardboard (caprone) spacers with diesel fuel;
- place on the filter screen in succession: inlet spacer, felt disc, outlet  
spacer, etc. until the filtering element is completely assembled; in this case lugs  
"e" (Fig.19) located on the outside diameter of the inlet and outlet spacers should  
be arranged in one plane (placing the spacers during assembly in any other order  
results in reduction of the element filtering surface);
- put the pressure plate on the filtering element and turn in the nut (when as-  
sembling the filtering element, place the felt discs in the same manner as they  
were arranged before disassembly, the disc side mating with the inlet spacer is more  
dark);

Note. If the assembled filtering element after washing is insufficiently clamped  
by the plate and nut, it is necessary to add one felt disc and one spacer  
in accordance with the assembly order described above, having taken them  
from the SPTA set.

- place the spring, oil seal and the assembled filtering element (with the nut  
facing the oil seal) into the casing;
- check to see that the packing ring is fitted into the cover groove, place the  
cover on the casing and turn the nut onto the clamping bolt (a packing ring should be  
set under the nut);

~~having pressed the button of the air release valve, fill the filter-casing  
with fuel, using the manual fuel priming pump and bleed the air.~~

#### Checking and Adjusting Fuel Injection Advance Angle

1. By marks on the cam disc and the drive coupling flange.

The actual position of marks 6 and 5 (Fig.22) on fuel injection pump drive  
coupling flange 1 and cam disc 2 is recorded in the engine Service Log. The entry  
is made in the Service Log after adjustment; the recorded positions of the marks cor-  
respond to a fuel injection advance angle set for the given engine at the Manufactur-  
ing Plant.

If after checking the fuel injection advance angle on the engine it is found  
out that the positions of the marks on the flange and the cam disc do not correspond  
to those recorded in the Service Log, unlock and loosen bolts 3 attaching the drive  
coupling flange to the cam disc. Turn the fuel injection pump camshaft to reset the  
advance angle.

Turning the pump camshaft through one division of the jaw coupling causes the  
advance angle to change within  $6^\circ$  degrees of the crank angle. The middle division  
corresponds to  $12^\circ$ . To increase the advance angle the camshaft should be turned in  
the direction of rotation and to decrease it - in the reverse direction.

After the fuel injection advance angle has been reset, tighten bolts 3 attach-  
ing the drive coupling flange to the cam disc as far as they will go and lock them.

34

bleed the air from the fuel system. For this purpose, building  
up a pressure not more than  $3\text{kg/cm}^2$  by the oil priming pump,  
prime fuel using the manual fuel priming pump within 1-2 min.

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25X1

SECRET

25X1

25X1

2. By marks on the jaw coupling and ball bearing housing (in case the fuel injection pump is removed and replaced).

To reset the fuel injection advance angle, proceed as follows:

- rotating the crankshaft clockwise bring the piston of the first cylinder of the left-hand cylinder block to the TDC at the beginning of the expansion stroke (all valves are closed);
- turn the crankshaft counter-clockwise through 50-60°;
- rotate the crankshaft clockwise until marks 7 on the jaw coupling and ball bearing housing coincide; the coincidence of the marks corresponds to the beginning of fuel delivery by the second plunger of the fuel injection pump into the first cylinder of the left-hand cylinder block.

Determine the angle corresponding to this position of the pump by the graduated rim of the flywheel, if the delivery of fuel occurs untimely, set the required angle as follows:

- (a) rotating the crankshaft clockwise, bring the piston of the first cylinder of the left-hand cylinder block by the graduated rim of the flywheel to the position corresponding to the fuel injection advance angle specified in the Service Log;
- (b) unlock and loosen two bolts 3 attaching the drive coupling flange to the cam disc;
- (c) turn the pump camshaft so that marks 7 on the jaw coupling and the ball bearing housing coincide and tighten up the bolts;
- (d) check the fuel injection advance angle and lock the bolts.

#### Replacement of Oil in Engine Speed Governor Housing

Oil in the governor housing should be replaced twice a year when changing over to a corresponding period of operation.

When changing over to winter operation the governor housing should be filled with a mixture containing 50 per cent of oil MT-16n and 50 per cent of diesel fuel E2 and E4. When changing over to summer operation the governor housing should be filled with oil MT-16n.

To replace oil in the governor housing, proceed as follows:

- unscrew the filler and drain plugs (Fig.20) and drain the oil;
- turn in drain hole plug 1 and unscrew level plug 2;
- fill oil into the governor housing up to the level plug;
- screw in the filler and level plugs;
- lock the plugs.

#### Washing of Fuel Injection Pump

To increase the serviceability of the fuel injection pump, wash the pump inner space with heated oil used for lubrication of the engine; for this purpose proceed as follows:

- unscrew the filler hole plug on the fuel injection pump housing;
- disconnect the drain pipeline from the drain tank and stop it with a wooden plug;
- fill 6-7 lit of preliminarily dehydrated oil heated to a temperature of 110-120°C;
- after 5-10 minutes drain oil from the pump into a special container, having removed the wooden plug from the drain pipeline;
- connect the drain pipeline to the automobile drain tank;

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- screw the plug into the filler hole on the fuel injection pump housing.

Note. During filling, slight amounts of oil together with air and water vapours can be thrown out through the filler hole of the pump housing.

#### Adjustment of Fuel Feed Control Linkage

If normal operation of the fuel feed control linkage is disturbed, check it and adjust.

The control linkage should ensure complete cutting-off of fuel delivery into the engine and also its maximum delivery.

Adjustment of the fuel feed control linkage is carried out in the following order:

- connect rod 19 (Fig.27) to the engine speed governor lever and upper small lever 18;
- set the governor lever to the fuel delivery cut-off position;
- connect rear rod 16 to upper lever 17 so that the angle between the lever axis and the horizontal plane amounts to approximately  $17^{\circ}$ ;
- if rear rod 16 rubs against any object when the governor lever is turned to the maximum fuel delivery position it is necessary to adjust the rod length to eliminate the rubbing;
- connect rod 3 to manual control levers 2 and 4 (with the manual control handle turned to the extreme left-hand position), set spring 1 and adjust the length of rod 3 to obtain the spring tension after installation of rods 12 and 14, required to return the control linkage to the initial position corresponding to the complete cutting-off of fuel delivery;
- install pedal rod 8, adjust its length so that with the fuel delivery cut off the pedal should be inclined at an angle of  $63\pm 3^{\circ}$  to the horizontal panel of the cab floor and put on protective boots 9;
- depress the pedal until the lever thrusts against the adjusting screw on the engine speed governor;
- screw out accelerator pedal stop 6 until it touches the pedal, then rotate it additionally through  $1/6$  of a turn to obtain a clearance of 0.1-0.2 mm between the lever and adjusting screw on the engine speed governor;
- lock the pedal stop with a nut;
- turn the hand control handle to the extreme right-hand position, leaving it short of the travel stop by 1-3 mm; at the same time adjust the length of rod 3 so that with the pedal depressed to the stop, lever 4 thrusts with its spherical surface against the cylindrical surface of the eccentric;
- adjust tightening of the hand control friction washer so that with the pedal depressed the handle with the eccentric is freely turned by hand without considerable efforts and left in any position fixed, with the pedal released.

Properly adjusted fuel feed control linkage should ensure complete shut-down of the engine, when the pedal is released and the hand control disengaged, while with the pedal depressed to the stop, the engine speed should be not less than 2,150 r.p.m.

**REMEMBER!** It is forbidden to tear off the seal from the adjusting screws of the governor lever and to carry out the adjustment, using the adjusting screws of the governor lever.

#### Checking Operation of Injectors

If necessary, operation of injectors is checked with the help of a special tester or a reference injector, for which purpose a spare injector taken from the SPTA set can be used if it has not been installed on the engine.

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Checking of the injectors in a repair shop is performed by specially trained personnel.

Removal of the injectors for checking is carried out with the help of a device, furnished with the engine, through hatches of the cylinder head covers or by a fitter's screw-driver when the covers are removed.

The injector to be tested and the reference injector are attached by means of a tee-piece to one of the engine fuel injection pump sections.

Having set the maximum delivery of fuel by the pump and rotating the crankshaft, make a number of fuel injections through the injectors.

If the spring is properly tightened the injection of fuel by both injectors should be performed simultaneously and with equal intensity.

If the injector under test fails to inject fuel, it means that the needle lifting pressure in the injector is too high which may frequently be caused by jamming of the needle in the spray tip in the closed position.

Rotate the adjusting bolt on the injector under test to obtain a position at which the injection from both injectors is similar and take place simultaneously.

The quality of fuel atomization is checked by observing the jets injected from the spray tip orifices when the fuel is primed through the injector.

In case of normal injection of fuel the fuel jets should be in a finely atomized mist state, have a sharp and distinct cut-off with a specific sound and no dripping of fuel should be detected on the spray tip end before and after the injection.

When defects in operation of the injector are detected the injector should be disassembled and the defects corrected.

Checking of the injectors is performed with the help of a special tester. This tester should be installed in repair shops and repair bases.

The tester is one section of the fuel injection pump operated manually to move the plunger.

For checking fuel pressure before the beginning of injection the tester may be equipped with a pressure gauge according to State Standard (ГОСТ) 8625-57 rated at a pressure 400 kgf/cm<sup>2</sup> with thread M20x1.5 (the pressure gauge is not furnished with the tester).

When no pressure gauge is available the check is performed with the help of a reference injector; in this case the injector under test and the reference injector are connected to the tester instead of the engine fuel injection pump section.

#### ENGINE AIR FEED SYSTEM

##### Purpose and Design of Air Feed System

The air feed system is designed to clean air of dust and to distribute it among the engine cylinders.

The air feed system comprises: two air cleaners, intake manifolds, two dust ejectors, pipes and engine emergency shut-down device.

Under the action of vacuum produced by the pistons during operation of the engine air is drawn through side slots of the cyclones into the air cleaners. In the cyclones the air is cleaned of coarse dust particles which are carried with a portion of air into the dust collector.

The main flow of air partially cleaned of dust is additionally filtered in the second stage consisting of wire-mesh and directed into the intake manifolds and further into the cylinders. The dust getting into the dust collector is automatically removed along special pipes with the help of ejectors and discharged together with exhaust gases outside.

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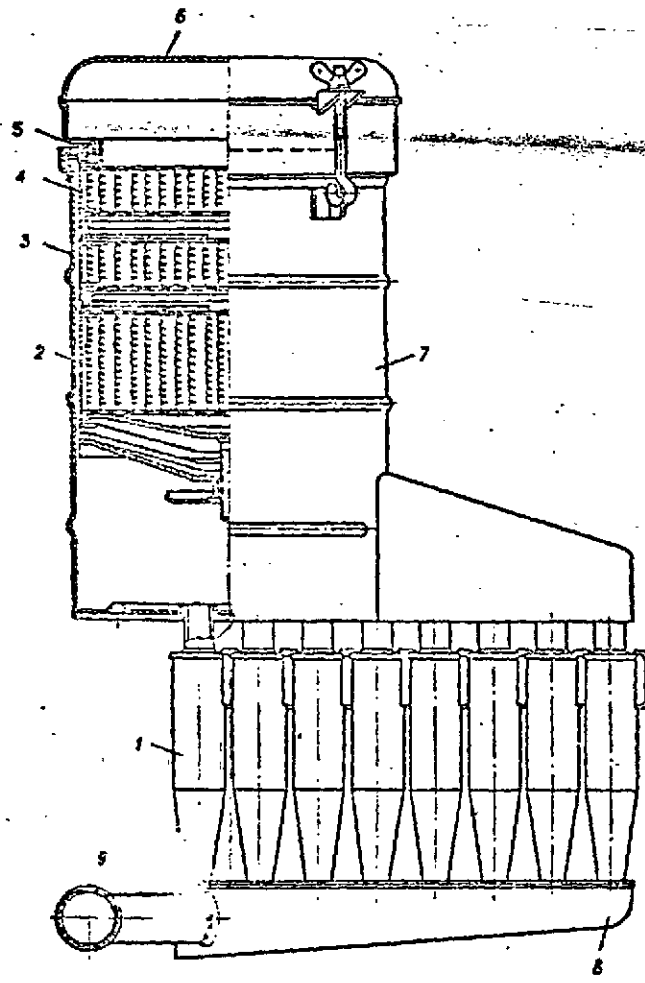


FIG. 23. AIR CLEANER

- 1 - air cleaner first stage
- 2, 3 - air cleaner second stage elements
- 4 - packing ring
- 5 - packing ring
- 6 - head
- 7 - air cleaner housing
- 8 - dust collector
- 9 - ejector pipe branch

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To prevent breakdown in case the engine starts racing the engine is stopped by means of the engine emergency shut-down device which comprises gate valves preventing admission of air into the engine cylinders.

#### Air Cleaners

The air cleaners are a combination, two stage type. Each air cleaner is connected to the corresponding intake manifold of the engine. Coarse cleaning of air of dust is accomplished in the first stage and final cleaning - in the second stage.

The inertia-type first stage of the air cleaner (cyclones) provides rotary motion of the air flow and changes its direction; the second stage of the air cleaner consists of three flat round elements packed with wire-mesh of different density and wetted with oil.

For normal operation of the air cleaner first stage the surface of the cyclones should be clean having no traces of oil and fuel. Therefore, the internal surface of the cyclones should be cleaned, washed and dried, whenever necessary.

The dust ejector is installed in the spark arrester housing of each cylinder block and connected to the air cleaner dust collector by a pipeline.

The air cleaner design is shown in Fig.28. The air cleaners are mounted on the cab rear wall in the engine compartment.

#### Engine Emergency Shut-Down Device

The engine emergency shut-down device is intended to stop the engine by cutting off delivery of air into the intake manifolds in case the engine starts racing or when the engine cannot be shut down by means of the fuel feed control linkage.

The operation diagram of the engine emergency shut-down device is shown in Fig.29.

The engine emergency shut-down device comprises the following main parts: two gate valves 3, rod 4 with spring 6 and cable 7.

The gate valves are fitted on shafts in special bodies installed in the intake pipelines between the air cleaners and the engine intake manifolds.

The gate valves are provided with stops to limit their travel in the open position.

Levers of the shafts of both gate valves are interconnected by a rod adjustable in length, permitting to obtain simultaneous closing of both gate valves. The connecting rod and, consequently, the gate valves are shifted by means of engine emergency shut-down device control cable 7. Pulling out control cable knob 8, arranged on the cab rear wall all the way out causes the gate valves to turn until they thrust against the body, thus closing the air passage. Spring 6 returns the gate valves to the open position.

The engine emergency shut-down device should be used in emergency cases only.

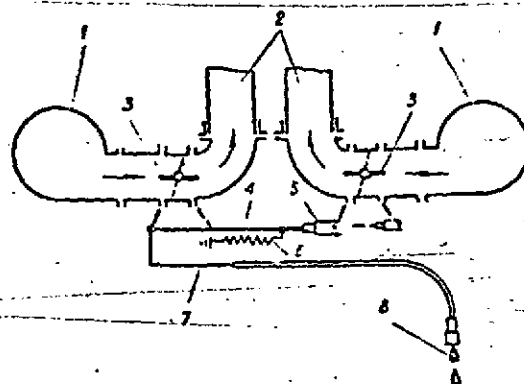


FIG. 29. OPERATION DIAGRAM OF ENGINE EMERGENCY SHUT-DOWN DEVICE

1 - air cleaners; 2 - engine intake manifolds; 3 - engine emergency shut-down device gate valve; 4 - gate valve connecting rod; 5 - connecting rod fork; 6 - return spring; 7 - engine emergency shut-down device control cable; 8 - engine emergency shut-down device control cable knob

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Maintenance of Engine Air Feed System

When servicing the engine air feed system, carry out all the operations prescribed in the Section "Preventive Maintenance of Automobile".

When checking operation of the engine emergency shut-down device, with the engine not operating, pull the engine emergency shut-down control knob all the way out several times; seizing and other defects detected should be eliminated.

To adjust the gate valves of the engine shut-down device for simultaneous closing, proceed as follows:

- disconnect the left-hand gate valve, having removed the pin from the hole of the connecting rod 4 (Fig. 29) fork;
- pull control knob 8 all the way out, i.e. close the through passage area by the right-hand gate valve;
- shift the left-hand gate valve lever to the extreme right-hand position, i.e. close the left-hand gate valve;
- adjust the length of rod 4 with the help of fork 5 until the pin freely enters the hole of rod 4 and the left-hand gate valve lever;
- connect rod 4 with the left-hand gate valve lever, insert the pin and lock it;
- start the engine, warm it up and close the gate valves at the maximum idle speed. If the gate valves are properly adjusted, the engine should stall after not more than 30 sec.

To preserve the adjustment it is necessary to inspect and tighten the attachment of a rigid brace connecting the bodies of the left-hand and right-hand gate valves of the engine emergency shut-down device.

EXHAUST SYSTEMPurpose and Design of Exhaust System

The exhaust system serves to discharge burnt gases into the atmosphere. It comprises cast-water-cooled manifolds, intermediate exhaust pipes and spark arresters.

The manifold cooling jacket is connected in series with the engine cooling system. Cooling liquid from the engine cylinder head jacket runs into the manifold jacket, thus cooling down the exhaust gases.

The heat-insulated intermediate exhaust pipe is attached with one end to the pipe branches of the exhaust manifold and with the other end to the branch pipe of the spark arrester. Both joints of the intermediate exhaust pipe are sealed by an asbestos cord and allow some warping within certain limits when the exhaust system is being installed on the chassis frame.

The spark arrester branch pipe makes up a single solid unit with the spark arrester housing and has a rectangular section at the place where it enters the spark arrester housing.

The spark arrester (Fig. 30) consists of housing 3, inner tube 1 with a diffuser, ejector pipe 4 leading to the air cleaner.

A bottom is welded to one end of the spark arrester housing while the other end is fitted with an inner tube flange. The surface of the inner tube is provided with drilled holes for outlet of exhaust gases. Welded to the inside of the spark arrester housing is a trough and a spark baffle.

The housing bottom is provided with plug 5 for draining condensate.

During operation of the engine the exhaust gases getting into the spark arrester move along the contour of the housing under the action of inertia forces and run outside through the inner tube holes and diffuser. Heavier unburnt particles

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of the exhaust gases (sparks) are thrown by the exhaust gas flow to the periphery of the housing and carried through the trough inside to the spark arrester branch pipe. Sparks and other heavy particles remain in the spark arrester housing until they completely burn out.

Rarefaction is formed in the diffuser due to the reduction of the passage area. This rarefaction is conveyed through the ejector tube and pipeline to the first stage of the air cleaner where from the dust getting into the rarefaction chamber is discharged together with exhaust gases into the atmosphere. The spark arrester is attached on the fender bracket. To exclude the effect of relative deformation of the fender and the engine the spark arrester is mounted on spring supports.

The position of the spark arresters and exhaust pipes is adjusted by shifting the bolts in slots of the brackets along the automobile axis. The positioning of the spark arresters in height, lengthwise and crosswise directions is adjusted by placing gaskets between the upper springs and the bracket.

The clearance between the flanges of the spark arresters and exhaust pipes is taken up by adjusting shims.

Each adjusting shim is followed by a packing gasket. When the clearance between the flanges is taken up the bolts should be tightened up as far as they will go.

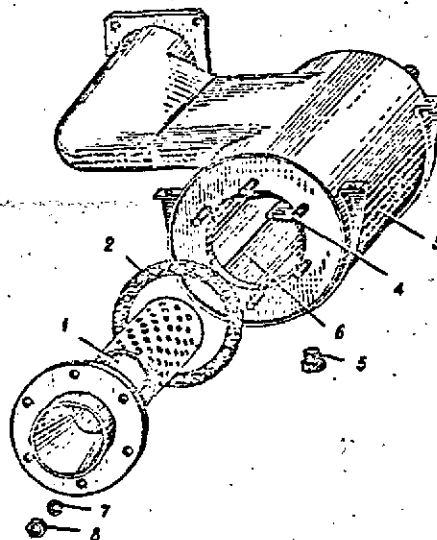


FIG. 30. SPARK ARRESTER

1 - inner tube with a diffuser; 2 - gasket; 3 - housing; 4 - ejector pipe; 5 - drain hole plug; 6 - trough; 7 - washer; 8 - nut

#### Maintenance of Exhaust System

When servicing the exhaust system carry out all the operations prescribed in the Section "Preventive Maintenance of Automobile".

#### ENGINE LUBRICATING SYSTEM

##### Purpose and Design of Lubricating System

During operation of the engine its friction parts are continuously lubricated with oil. Oil separates one friction surface from the other and thus reduces friction losses, decreases heating and wear of the friction parts and ensures dissipation of heat generated due to friction. Some parts are lubricated with oil under the pressure built up by the oil pump while the others are lubricated with finely sprayed oil forced from clearances in the bearings.

The lubricating system comprises the following engine parts and units: oil pump, oil filter, external oil pipelines, channels and holes for passage of oil in the crankcase, crankshaft, accessory drive bearings, connecting rod ends, camshafts and other parts, intake pipes and oil sumps of the crankcase, pressure gauge and temperature gauge.

Mounted outside the engine and included in the lubricating system are: oil coolers, oil tank, oil priming pump and pipelines.

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Note. For convenience of mounting and demounting the pipelines of the engine lubricating system their ends are painted brown.  
The lubricating system diagram is shown in Fig.31.

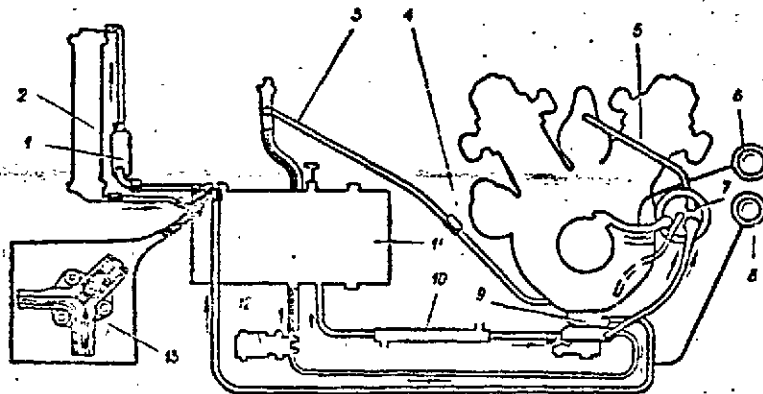


FIG. 31. ENGINE LUBRICATING SYSTEM DIAGRAM

1 - auxiliary oil cooler; 2 - main oil cooler; 3, 4 - oil tank breather pipes; 5 - delivery of oil from filter to engine automatic shut-down device operating at drop of oil pressure in main oil line; 6 - pressure gauge; 7 - filter; 8 - temperature gauge; 9 - oil pump; 10 - main oil line; 11 - oil tank; 12 - oil priming pump; 13 - oil bypass valve

Before each starting of the engine, oil from oil tank 11 is delivered by oil priming pump 12 to the union of the engine oil pump delivery section, oil filter 7 and then through the central oil delivery pipe to the engine crank gear and simultaneously to pressure gauge 6 of the lubricating system.

During operation of the engine oil from the oil tank, is delivered under the action of rarefaction produced by the delivery section to oil pump 9 and then is forced to oil filter 7.

To prevent oil from flowing back to the oil tank through the oil priming pump, the pipeline running from the oil priming pump to the engine is equipped with a non-return valve permitting oil to flow in the direction from the oil priming pump.

Having passed through the slotted cleaning section of the oil filter the main portion of oil is fed through the oil pipeline to the central oil delivery pipe while the remaining oil after being cleaned in the cardboard element of the filter drains to the engine crankcase lower half.

From the central oil delivery pipe the oil is delivered for lubrication of the crank gear, accessory drive, timing gear and engine units.

Used oil drains into the oil ramps of the engine crankcase lower half where from it is delivered by two sections of the pump to oil coolers 1 and 2 and then to oil tank 11.

If the pressure in the pipeline running to the oil cooler reaches 3.0-4.0 kgf/cm<sup>2</sup>, ~~bypass~~ <sup>reducing</sup> valve 13 overcomes the spring effort, opens, and some oil flows directly into the tank past the oil coolers; as a result the heating of oil is intensified and the service life of the oil cooler is extended.

Pressure in the main oil line of the engine lubricating system is controlled by pressure gauge 6 arranged on the instrument panel in the driver's cab.

The sending unit of the pressure gauge is installed after the oil filter.

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The outlet temperature of engine oil is controlled by temperature gauge 8 arranged on the instrument panel. The sending unit of the temperature gauge is installed on the body of the oil pump suction section in the line running to the oil cooler.

The suction sections of the oil pump deliver into the tank oil together with some air and exhaust gases getting inside the crankcase during operation of the engine. To prevent considerable increase of pressure in the tank the latter communicates with the engine crankcase through a drain pipe.

The oil pump (Fig. 32) is designed to deliver oil, under pressure, to the friction parts of the engine and to deliver oil from the engine oil sumps through the oil cooler to the oil tank.

The pump is provided with three sections: two suction and one delivery. The suction sections ensure reliable pumping of oil from the engine crankcase even during prolonged movement of the automobile on upgrades and downgrades. The delivery section supplies oil through the oil filter to the engine.

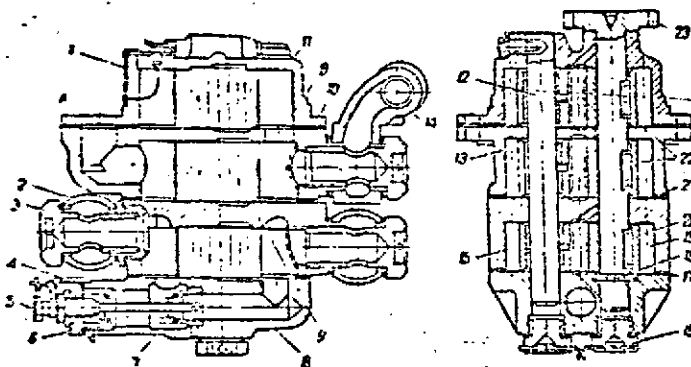


FIG. 32. OIL PUMP

1 - screen; 2 - elbows; 3 - connector; 4 - reducing valve plate lock; 5 - reducing valve stem; 6 - reducing valve body; 7 - reducing valve; 8 - cover; 9 - delivery section body; 10 - lower scavenge section body; 11 - upper scavenge section body; 12 - driven gear axle; 13 - driven gears of scavenge sections; 14 - space for delivery of oil to system; 15 - delivery section driven gear; 16 - plug; 17, 21 - gaskets; 18 - lock ring; 19 - delivery section driving gear; 20 - key; 22 - driving gears of scavenge sections; 23 - driving shaft with gear; A - suction hole of lower scavenge section; B - hole connecting pressure chambers of scavenge sections

Each pump section consists of a pair of cylindrical gears enclosed in a separate body.

Upper suction section body 11 is provided on the top with a hole closed by screen 1. The hole serves for connection of the suction chamber with the front oil sump of the engine.

Hole "B" located against the pressure chamber in the lower suction section body serves for passage of oil from the pressure chamber of the upper suction section to the pressure chamber of the lower suction section. The rear oil sump 13 is connected to the suction chamber of the lower suction section by means of a pipe.

Connectors 3 attaching oil pipeline elbows 2 are screwed into the delivery and suction sections for inlet and outlet of oil. A steel threaded fitting is screwed into the hole of the delivery section at the side of oil delivery from the tank.

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Cover 8 is provided with channels for by-passing some oil from the pressure chamber to the suction chamber through reducing valve 7 to prevent excessive rise of oil pressure.

The cover boss in which the reducing valve is installed has a hole receiving a steel press-fitted seat, a small recess accommodating the reducing valve, and a thread for screwing in reducing valve body 6.

Paper packing gaskets 17 and 21 are placed between the mating surfaces of the bodies.

When the reducing valve is screwed into the cover, the valve disc thrusts against the seat face, and is pressed by a spring, thus disconnecting the pressure and suction chambers of the delivery section.

Bronze bushings which are press-fitted into driven gears 13 and 15 are lubricated with oil passing through holes drilled between the teeth of the gears.

The gears of the suction sections are higher than those of the delivery section as they must ensure delivery of foamy oil containing air and gases from the crankcase.

The oil pump is centered in a bore of the engine crankcase lower half by a head provided on the body, located by a cylindrical pin press-fitted into the crankcase flange and attached to the latter by six studs.

The joint between the crankcase flange and the pump is sealed by a paronite gasket.

When the driving shaft of the pump is rotating the upper suction section gears draw oil from the front oil sump through a hole closed by the screen and deliver it to the pressure chamber common for both suction sections.

The lower suction section gears draw oil along a pipe laid on the bottom of the crankcase lower half and through a body channel from the rear oil sump and also from the crankcase packing space, and deliver it to the opposite side into the pressure chamber.

From the pressure chamber of the lower suction section the oil delivered by both sections is fed to the oil cooler through a pipe.

The delivery section gears draw oil from the oil tank and supply it into the pressure chamber and further through the oil filter to the engine.

The reducing valve spring is adjusted for a pressure of  $8.5 \text{ kgf/cm}^2$ . If the pressure in the pressure chamber reaches this value, the valve disc moves off its seat under the oil pressure and some oil overflows from the pressure chamber into the suction chamber, thus reducing the pressure in the pressure chamber.

The pressure at which the valve starts opening depends on the spring tension which can be adjusted by screwing in or out stem 5. After the reducing valve spring is adjusted for a required pressure, the valve is sealed.

It is forbidden to disturb the adjustment made at the Manufacturing Plant.

The oil filter (Fig. 33) is intended to clean oil delivered into the engine lubricating system.

The filter comprises a slotted cleaning section and a cardboard filtering element.

The central hole on the housing bottom is fitted with tubular rod 4 having two radial holes on its ends for inlet and outlet of oil passing through (slotted) cleaning section 7. Soldered inside this tubular rod is tube 5 delivering out oil that has passed through cardboard fine-cleaning element 8.

The tubular rod is fitted in succession with a perforated casing accommodating the replaceable cardboard fine-cleaning element, the slotted cleaning section and cover 10.

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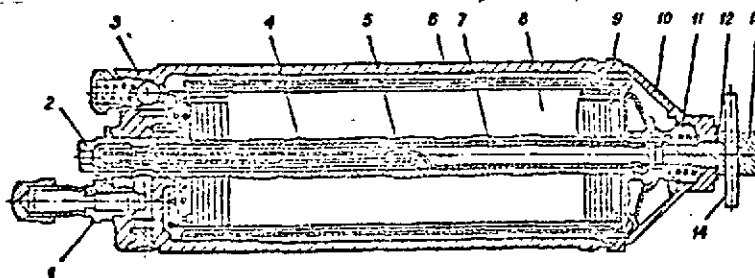
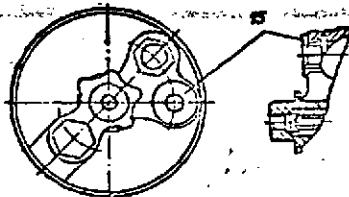


FIG. 33. OIL FILTER

1 - inlet union; 2 - union; 3 - by-pass valve;  
 4 - central tubular rod; 5 - tube; 6 - filter housing; 7 - coarse (slotted) cleaning section;  
 8 - cardboard filtering element; 9 - rubber ring;  
 10 - cover; 11 - spring; 12 - copper ring;  
 13 - bolt; 14 - coarse (slotted) cleaning section handle; 15 - union of delivery pipeline running from oil pump delivery section



All filter parts are tied up by tubular rod bolt 13 placed under which is copper packing ring 12.

The slotted cleaning section is stamped. Its cylindrical surface has corrugations wound on which is a shaped band.

While forced through the slots formed by the band turns the oil is cleaned, the clean oil is conducted through corrugation cavities into the inner space of the tubular rod and delivered through the pipeline to the engine.

Mechanical impurities are retained on the external surface of the slotted cleaning section.

The replaceable cardboard fine-cleaning element is composed of cardboard discs and radial gaskets assembled on steel rods. The discs and gaskets are alternately placed and clamped between two cardboard plates. Grooves made on the radial gaskets are intended to deliver filtered oil to the central hole provided in each disc and each gasket.

These holes form an oil supply passage. After fine cleaning, oil is conducted through the inner tube of the tubular rod to the crankcase. The assembled replaceable cardboard filtering element is inserted into the perforated casing and clamped between two steel plates.

At one end the steel plate is fitted with a spring that exerts pressure on the steel plate compressing the cardboard discs and radial gaskets. After the replaceable cardboard filtering element is installed into the perforated casing the latter is closed by a steel bottom secured by three cotter pins.

The bottom of filter housing 6 is fitted with by-pass valve 3 which by-passes oil past the filtering sections in case they are heavily clogged or if the engine operates with cold oil.

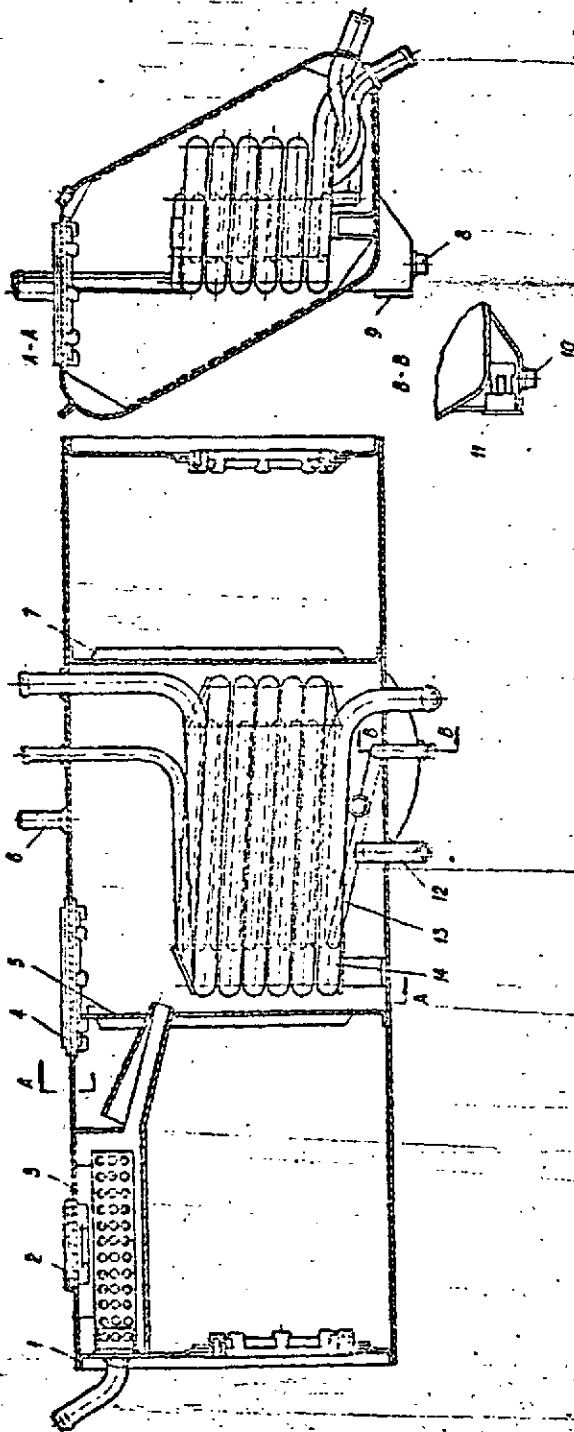
The oil tank (Fig.34) is installed on the right-hand side of the automobile frame behind the cab.

Oil tank body 1 is provided with two partitions 5 and 7 dividing it into three sections.

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1-11, 11, OIL TANK

1 - oil tank body; 2 - reducing valve flange; 3 - four valve assembly; 4 - oil tank flange; 5, 7 - partitions; 6 - oil dipstick; 8 - pump plug; 9 - drain hole plug; 10 - oil tank pump; 11 - drain flange with valve body; 12 - oil intake pipes; 13, 11 - coils

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Foam reducer 3 is placed in the engine oil drain line in the first section of the oil tank.

Coils 13 and 14 are introduced into the cooling system and used to heat oil in a cold season when the preheater is employed.

Oil from the oil tank is drawn into the engine through oil intake pipe 12.

The oil level in the tank is measured by means of oil dipstick 6. The upper mark on the oil dipstick indicates the maximum quantity of oil in the tank and the lower mark - the minimum permissible amount at which the tank is to be refilled.

When measuring the oil level, do not screw the dipstick into the tank.

Oil is filled into the tank through a filler neck and drained through a special spring-loaded drain valve, and a plug of the tank sump.

To drain oil from the tank, unscrew the drain hole plug and screw in a drain hose with a special tip.

The hose tip pin lifts the ball making it possible to drain oil from the tank.

The oil leftovers are removed from the sump by unscrewing plug 8.

Oil Coolers. To cool down the oil leaving the engine, the automobile is equipped with two oil coolers: main and auxiliary (Fig.31).

The auxiliary oil cooler is placed into the lubricating system in series with the main oil cooler. All oil delivered by the pump is forced through the auxiliary oil cooler and then through the main oil cooler.

Both oil coolers are of a fin-and-tube type. The main oil cooler is of a three-path design while the auxiliary one is of a one-path design.

The main part of the oil cooler is a core formed by tubes and fins intersecting with and soldered to each other. At the top and bottom the cooler core is provided with tanks.

Oil is conducted through the core tubes which are cooled by air flow from the fan.

The air forced through the cooler by the fan removes heat from the tubes and fins soldered to them and dissipates it into the atmosphere.

The main oil cooler of the automobile engine is made in a single unit with the left-hand radiator of the cooling system. The oil cooler section is separated from the radiator of the cooling system by a partition.

The auxiliary oil cooler is installed in front of the main cooler.

The oil priming pump (Fig.35) is designed to build up oil pressure in the main oil line before each starting of the engine to prevent melting of the bearings during starting due to the lack of oil.

The oil priming pump is an electrically-driven, gear type with a water jacket in the body.

Pump cover 8 is provided with two threaded holes for attaching inlet and outlet pipelines. The cover is fastened to the pump body by four bolts, two of which are fitted ones.

Pump body 4 has inlet 9 and outlet 1 branch pipes for delivery of coolant intended to warm up oil in the space of the pump body.

The pump is located under the oil tank and attached to the frame.

The electric motor of the oil priming pump is powered from the automobile storage batteries.

The oil priming pump is controlled by means of a switch from the driver's cab.

While rotating, the gears pick up oil and deliver it to the union of the engine oil pump delivery section and then through the pipeline to the oil filter where from the clean oil is pressure-fed through the central oil delivery pipe to the engine crank gear.

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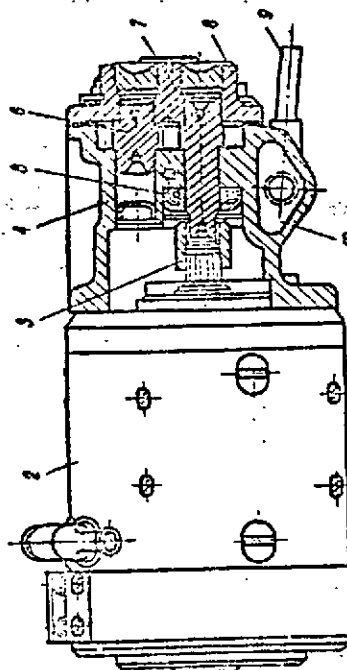
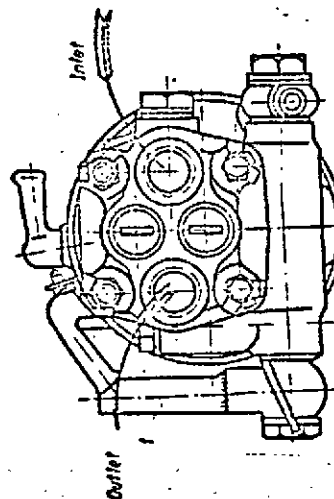


FIG. 35. VV1.2 DIE. PUMPING UNIT  
 1 - coolant outlet branch pipe; 2 - electric motor; 3 - toothed coupling; 4 - pump body; 5 - oil seal; 6 - driving gear; 7 - coolant inlet branch pipe; 8 - pump cover; 9 - bearing space; 10 - outlet



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When resistance in the main oil line exceeds  $12 \text{ kgf/cm}^2$ , the by-pass valve opens and by-passes oil from the delivery stage to the suction stage.

The oil priming pump jacket is introduced into the common engine cooling system and in winter, when the preheater is operating, is heated by the coolant.

Device for Automatic Shut-Down of Engine at Drop of Oil Pressure in Main Oil Line

To prevent possible breakdown caused by sudden drop of oil pressure or absence of oil in the system the engine is equipped with a device for automatic shut-down.

The device provides for durability of the bearing shells as it permits starting of the engine only after the oil pressure of at least  $2.5 \text{ kgf/cm}^2$  is built up in the main oil line.

The introduction of the device does not take off the responsibility from the driver for engine breakdowns caused by drop of oil pressure. Take into consideration that the device stops the engine at an oil pressure below  $2.5 \text{ kgf/cm}^2$  while reliable operation of the engine is ensured at an oil pressure of at least  $6 \text{ kgf/cm}^2$ . The device protects the engine from breakdown only in case the oil pressure suddenly and sharply drops.

Body 4 (Fig. 36) is screwed into a threaded fitting of the fuel injection pump channel and clamps the elbow of fuel delivery pipe 3.

The body has two radial holes "A" through which its inner space communicates with the fuel delivery pipe elbow.

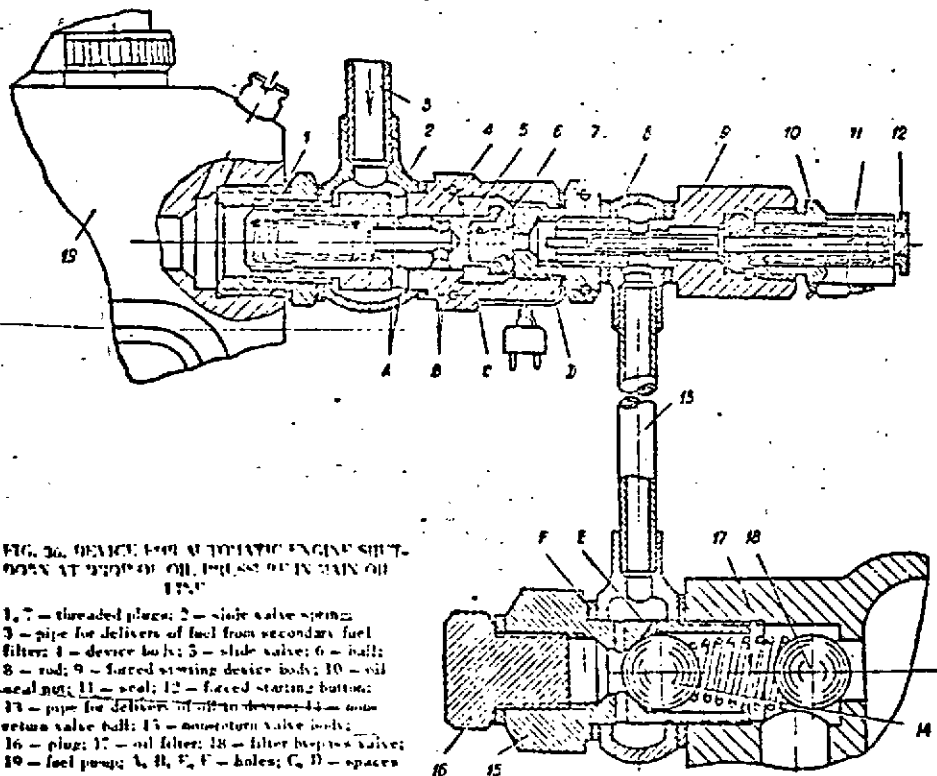


FIG. 36. DEVICE FOR AUTOMATIC ENGINE SHUT-DOWN AT DROP OF OIL PRESSURE IN MAIN OIL LINE

- 1, 7 - threaded plugs; 2 - slide valve spring;  
 3 - pipe for delivery of fuel from secondary fuel filter; 4 - device body; 5 - slide valve; 6 - ball;  
 8 - rod; 9 - forced starting device body; 10 - oil seal nut; 11 - seal; 12 - forced starting bottom;  
 13 - pipe for delivery of oil to device; 14 - non-return valve ball; 15 - non-return valve body;  
 16 - plug; 17 - oil filter; 18 - filter bypass valve;  
 19 - fuel pump; A, B, E, F - holes; C, D - spaces

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Arranged in the body space is cylindrical slide valve 5. Threaded plug 1 screwed into the body serves as a retainer of slide valve spring 2.

Slide valve 5 is tightly fitted to the body inner space and is free to move inside it. It has a central space and two radial holes "B" communicating with it.

On one end face the slide valve is provided with a ground thrust bead and a seat to receive spring-loaded ball 6.

Forced starting device body 9 screwed into threaded plug 7 clamps the elbow of pipe 13 for delivery of oil to the device. The elbow communicates with the device space through two radial holes in body 9.

Body 9 accommodates rod 8 with button 12 secured on its end.

To prevent seeping of oil along the rod, body 9 is fitted with a rubber oil seal clamped by nut 10.

The rod is pressed out to the extreme right position by a spring.

The part of the spring projecting from the oil seal nut is protected with the safety cap made of aluminium foil. The rod is sealed with seal 11.

Threaded plug 7 is screwed into body 4, secured with wire and sealed. Space "T" of the device is connected with the engine main oil line through pipe 13.

Under pressure produced by the oil pump or oil priming pump oil is delivered into the engine main oil line through the oil filter.

Through hole "A" oil is delivered also into pipe 13 and fills space "T". Under pressure of oil in space "T" slide valve ball 6 compresses this spring, opens the hole and by-passes oil into space "B". Oil actuates slide valve 5 and compressing spring 2 shifts it into the extreme left-hand position.

Hole "A" of device body 4 and hole "B" of slide valve 5 are aligned. Fuel from pipe 3 is supplied into fuel pump channel through the slide valve channel.

Oil is prevented from getting into the fuel line due to the fact that slide valve 5 is pressed with its ground, thrust bead to the lug of the device body.

Fuel is prevented from getting into the lubricating system when the engine is inoperative by slide valve ball 6 with spring.

When the oil pressure in the main oil line drops below  $2.5 \text{ kgf/cm}^2$ , slide valve 5 actuated by spring 2 moves to the extreme right-hand position and covers hole "A" of the device body, thereby cutting off the delivery of fuel to the pump, as a result the engine stalls.

In case of extreme necessity to start the engine at an oil pressure in the main oil line below  $2.5 \text{ kgf/cm}^2$  a provision is made for forced starting button 12.

For forced starting of the engine press button 12. In this case rod 8 presses ball 6, shifts slide valve 5 to the extreme left-hand position, aligns holes "A" and "B" and fuel is admitted into the pump.

When the button is pressed, the protective shield is deformed and seal 11 is torn off.

In case of necessity to operate at low pressure of oil button 12 should be kept pressed during the entire period of engine operation.

Each forced starting and operation at low pressure adversely affect the engine condition.

Therefore, the forced starting button should be used only in exceptional emergency cases. Each forced starting should be recorded in the Service Log.

After seal 11 is torn off from the device, the Manufacturing Plant bears no responsibility for the engine condition.

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Maintenance of Engine Lubricating System

Proper and timely lubrication of the friction surfaces of parts considerably decreases wear and ensures reliable prolonged operation of the engine.

When servicing the engine lubricating system, carry out all the operations prescribed in the table of the Section "Preventive Maintenance of Automobiles".

During operation of the engine observe readings of the oil pressure and temperature gauges.

The pressure of oil in the lubricating system of a warmed-up engine at cruising speed should be within 6.0-10.0 kgf/cm<sup>2</sup> and at idle running - not below 2.5 kgf/cm<sup>2</sup>. When the oil pressure in the lubricating system at cruising speed drops below 5 kgf/cm<sup>2</sup>, immediately stop the engine and eliminate the trouble.

The normal temperature of oil leaving the engine should be 80-90°C and the maximum permissible temperature - 110°C.

Changing of Oil

To change the oil in the engine lubricating system proceed as follows:

- drain oil from the tank, engine crankcase and oil filter housing;
- fill 30 litres of fresh oil into the tank;
- start the engine and run it for 3-5 minutes to wash the lubricating system and to fill the engine channels and pipelines with oil;
- drain oil from the tank;
- fill fresh oil into the tank up to mark "H" on the oil dipstick.

Washing of Oil Filter

To wash the oil filter (Fig.33) or to replace the cardboard filtering element, proceed as follows:

- place a container for draining oil under oil filter cover 10;
- unscrew bolt 13 attaching the cover to housing 6, remove the cover and drain oil from the filter;
- remove slotted cleaning section 7 and fine-cleaning element 8 from the housing;
- wash the oil filter housing in diesel fuel;
- remove the cotter pins attaching the rear cover of the perforated casing, take out the cover, spring, pressure washer with an oil seal and the replaceable cardboard filtering element;
- wash the slotted cleaning section in diesel fuel by means of a hair brush and blow through with compressed air;
- flush the perforated casing in diesel fuel and blow through with compressed air;
- fit into the perforated casing a new filtering element, the pressure washer, spring, rear cover and secure the cover by cotter pins. The element should be installed in such a manner so that the projecting ends of the clamping rods should fit in the recesses of the steel plates.

Note. During storage of the replaceable filtering elements the cardboard, of which the discs and gaskets are made, may shrink due to which the length of the element reduces. Therefore, the elements in which the discs and gaskets on the rods are loosely fitted, should additionally be completed with discs and gaskets furnished with the filtering element. The discs and gaskets should be placed in sets (the set is composed of one disc and one gasket). When additional sets are placed in the filtering element the gaskets should be arranged with their radial grooves facing the same side as the grooves on the gaskets of which the filtering element is assembled.

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using the oil priming pump, build up a pressure of at least 3 kgf/cm<sup>2</sup> and crank the engine by means of the starter 3-4 times without fuel feed within 3 sec."

To set the discs and gaskets, remove the two spring locks and cardboard disc, place one or two sets of the filtering discs and gaskets and install the cardboard disc.

To fit the locks on the rods, compress the discs and gaskets of the filtering element with an effort of approximately 40 kg (in this case, the height of the element with the cardboard discs should be 348±1 mm) and then fit the locks.

Place the spring and rear cover and, compressing the spring, fit the filtering element into the perforated casing until the holes receiving the cotter pins are aligned, insert the cotter pins and spread out the ends.

- install the assembled fine-cleaning section in the filter housing; turn it when putting on the rod;
- install the washed slotted cleaning section into the housing; during installation, it also should be turned;
- place the filter cover on the housing so that the bead of the filter housing enters a circular recess on the cover and then, turn in the rod bolt;
- ~~using the oil priming pump, build up a pressure of at least 3 kgf/cm<sup>2</sup> and crank the engine by means of the starter several times without fuel feed.~~

It is not permitted to start the engine when the filtering element is not installed in the oil filter.

#### ENGINE COOLING SYSTEM

##### Design of Cooling System

The engine cooling system is a liquid forced circulation type. The cooling system is sealed, i.e. it communicates with the atmosphere only when the vacuum and pressure relief valve is open in case the pressure in the cooling system exceeds a certain surplus pressure or drops below the atmospheric pressure.

The cooling system ensures transfer of heat to the radiator by the coolant continuously circulating through the cylinder jackets, cylinder heads and exhaust manifold jackets. After being cooled down in the radiator, the coolant returns to the engine.

The cooling system comprises the following units and parts: circulation pump which continuously forces the coolant to circulate through the cooling system, external pipelines and inner spaces of the cylinder jackets and cylinder heads. Mounted outside the engine are radiators with vacuum and pressure relief valves, thermostat box and fans for forcing air through the radiators.

Note. For convenience of mounting and demounting the pipelines of the engine cooling system their ends are painted green.

The engine temperature is controlled by temperature gauges whose sending units are installed at the outlet of the coolant from the right-hand and left-hand cylinder heads.

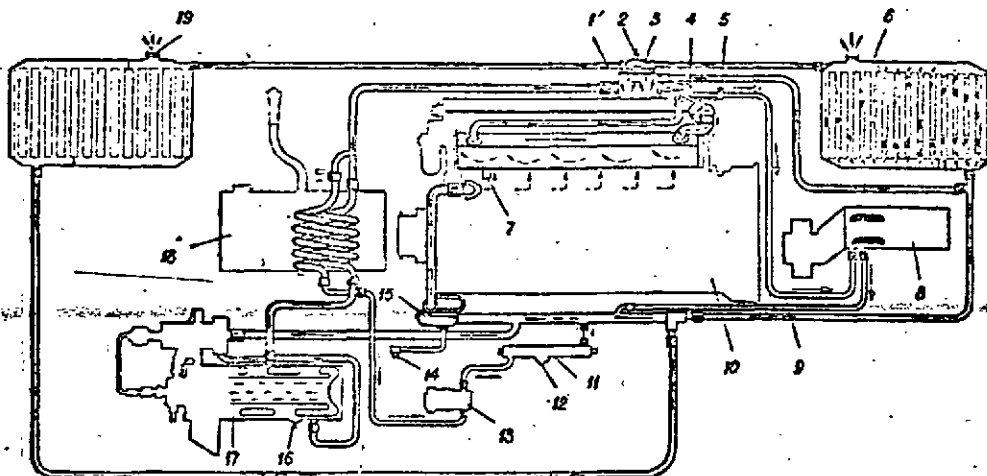
Connected to the cooling system are: a preheater for preheating the engine before starting in winter, cab heater, oil priming pump jacket, compressor jacket and a main oil line jacket for warming of oil before starting the engine in winter.

To drain the coolant from the system a provision is made for drain cocks installed on the circulation pump, cab heater, preheater body, left-hand and right-hand exhaust manifolds, and a drain plug on a water-heated pipe of the main oil line. When the coolant is drained, the radiator cap should be removed. For complete removal of the coolant from the system, crank the engine with the help of a starter without fuel feed.

The coolant is forced to circulate through the system by circulation pump 15 (Fig. 37). From the outlet branch pipes of the circulation pump the coolant is directed through delivery pipes to the bottom part of the jackets of the left-hand and

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- > — flow of coolant during operation of preheater
- - -> — flow of coolant during normal operation of engine.
- > — flow of coolant along smaller circuit
- > — flow of coolant through cab water heater
- - -> — steam flow

FIG. 37. ENGINE COOLING SYSTEM DIAGRAM

1 - preheater cut-out gasket; 2 - radiators cut-out shutter; 3 - thermostat box; 4 - steam outlet pipe; 5 - cab heater cut-out cock; 6 - radiator; 7 - exhaust manifold jacket drain cock; 8 - cab heater; 9 - cab heater drain cock; 10 - engine; 11 - main oil line; 12 - drain plug on main oil line heating pipe; 13 - oil priming pump; 14 - circulation pump drain cock; 15 - circulation pump; 16 - preheater drain cock; 17 - preheater; 18 - engine oil tank; 19 - radiator relief valve

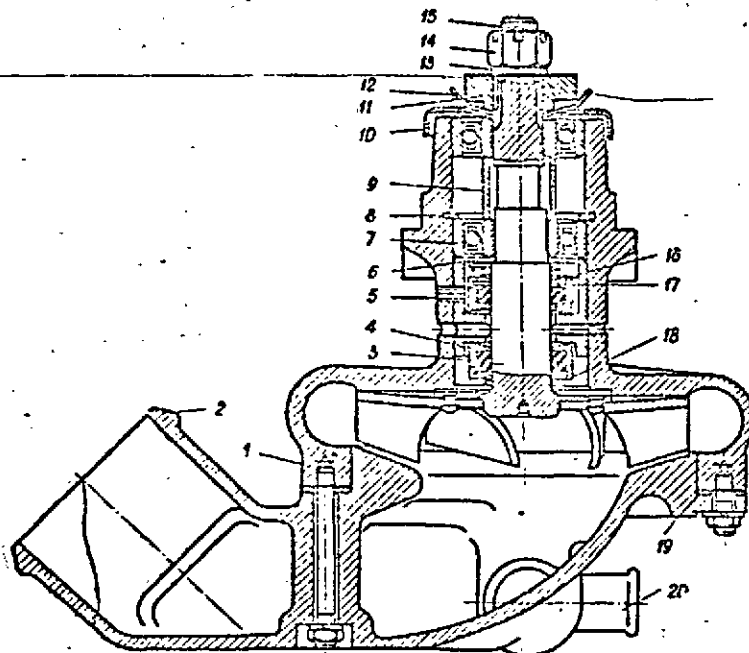


FIG. 38. CIRCULATION PUMP

1 - body; 2 - bell; 3 - shaft with impeller; 4 - packing washer; 5 - rubber ring; 6 - driving washer; 7 - ball bearing; 8 - lock ring; 9 - distance sleeve; 10 - oil slinger washer; 11 - driving cam; 12 - spring washer; 13 - washer; 14 - nut; 15 - cotter pin; 16 - spacer; 17, 18 - springs; 19 - gasket; 20 - drain branch pipe

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right-hand cylinder blocks where it passes through the inner spaces of the cylinder block jackets flushing the cylinder liners. From the cylinder block jackets the coolant flows through overflow tubes into the cylinder head jackets flushing the combustion chambers, injector sleeves and exhaust channels of the cylinder heads. From the cylinder heads the coolant is conducted through branch pipes to the jackets of the cast water-cooled exhaust manifolds, reducing the temperature of engine exhaust gases. From the manifolds the liquid runs into thermostat box 3 and then into upper tanks of radiators 6. Having passed through the radiator cores, the coolant from the lower tanks returns to the circulation pump.

If the coolant leaves the cooling jackets of the manifolds insufficiently heated (below  $+70^{\circ}\text{C}$ ) the thermostats automatically cut off the radiators, and the coolant from the thermostat box is delivered to the circulation pump through a by-pass pipe by-passing the radiators.

If the coolant temperature exceeds  $+70^{\circ}\text{C}$  the thermostats open and the coolant is conducted through the larger circulation circuit (through the radiators); in this case the coolant is not fed through the by-pass pipe.

To prevent formation of steam bounds which may cause overheating of the cylinder head walls, the cylinder head of each cylinder block is equipped with a steam outlet union. The thermostat box to which the steam is conducted is connected with the steam outlet unions by means of pipes. From the thermostat box the steam with hot water passes to the upper tanks of the radiators wherefrom excessive steam is released into the atmosphere through the vacuum and pressure relief valve.

The circulation pump is a centrifugal type. The head of the coolant is built up by the vanes of a rapidly rotating pump impeller. The main parts of the pump are the following: body 1 (Fig.38), bell 2, shaft 3 with impeller, two ball bearings 7, and packings.

Body 1 is provided with branch pipes through which the coolant is forced to the engine cylinder blocks. A square flange with a centering bead and holes for studs attaching the pump to the crankcase lower half flange is located above the branch pipes.

Two ball bearings 7 and antifriction cast iron spacer 16 are press-fitted inside the body. The spacer faces, precisely finished and ground, serve as friction surfaces of the packing parts. The spacer is provided with two check holes drilled in assembly with the body (for checking the packing condition).

The body inside is made in the shape of a volute.

Bell 2 is attached to the pump body and provided with a branch pipe for delivery of coolant to the impeller centre, and drain branch pipe 20. A pipe with a cock for draining the coolant from the system is connected to the drain branch pipe.

The upper portion of shaft 3 has a thread and splines to receive driving cam 11; below the splines there are journals for the bearings and a ground surface upon which the packing is put on.

The lower end of the shaft is fitted with a flange riveted to which is a forged stainless steel impeller. The shaft flange has a hole to receive a lug of packing spring 18.

The shaft and impeller are machined and balanced in assembly. It is not permitted to replace the impeller without additional balancing of the unit. The impeller is provided with six working vanes. Leaking of the coolant and oil is prevented by the packings consisting of washers 4, rubber rings 5, support washers, springs 17, 18 and driving washer 6.

Washer 4 is made of rod textolite or fibre-filled material and has a friction surface tapered by  $1.5^{\circ}$ . The washer is provided with a hole to pass the shaft and

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a groove to receive the rubber ring. The washer face has a slot for receiving the spring lug. The working surface of the washer is ground to the spacer face to obtain a band 1.5-3.0 mm wide. The cone on this surface is provided for better working-in. To relieve the rubber rings of friction the packing springs are provided with two lugs one of which enters a hole on the flange of shaft 3 or a slot of driving washer 6 and the other fits in a slot of washer 4.

### Radiators

The automobile is equipped with two connected-in-parallel radiators which are mounted on beams through rubber pads. One of them is installed at the rear of the left-hand radiator block together with the engine oil cooler and the other - at the front of the right-hand radiator block together with hydro-mechanical transmission coolers. Both radiators are similar in design, therefore given below is the description of one of them.

The radiator consists of two supports, a core, upper and lower tanks and a cap with a vacuum and pressure relief valve.

The radiator core consists of flat oval brass tubes and cooling fins soldered to them due to which the core has an enlarged cooling area for dissipation of heat. The core is bolted to the upper and lower tanks.

To add to the cooling efficiency the radiators are made of a three-path design.

From the thermostat box the coolant flows to the upper tanks through a pipe, passes through the radiator core tubes where it is cooled down by air forced through by the fans. From the lower cooling tanks of the radiators the coolant is conducted through a pipe to the circulation pump.

Radiator relief valve. The air space of the radiator upper tank communicates with the atmosphere through the vacuum and pressure relief valve installed in the filler neck. The valve design is shown in Fig.39.

The vacuum and pressure relief valve consists of pressure relief valve 1 with spring 3 and vacuum relief valve 8 with spring 2.

The vacuum relief valve opens when the pressure in the upper tank drops below the atmospheric pressure by 0.08-0.13 kgf/cm<sup>2</sup>.

The pressure relief valve spring is adjusted for an excessive pressure of 0.75-0.9 kgf/cm<sup>2</sup> in the radiator upper tank, thus ensuring normal operation of the cooling system until the coolant temperature reaches 105°C (without throw of water from the radiator).

The thermostat box serves for automatic control of a coolant temperature and speeding-up of the engine warming after starting.

The thermostat box (Fig.40) consists of the following main parts: housing 7 with tank 11, inlet and outlet branch pipes connected with the cooling system pipelines, two thermostat bellows 3 and radiators cut-out shutter 10.

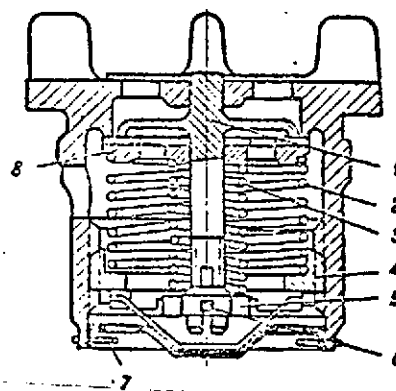


FIG. 39. RADIATOR RELIEF VALVE AND CAP

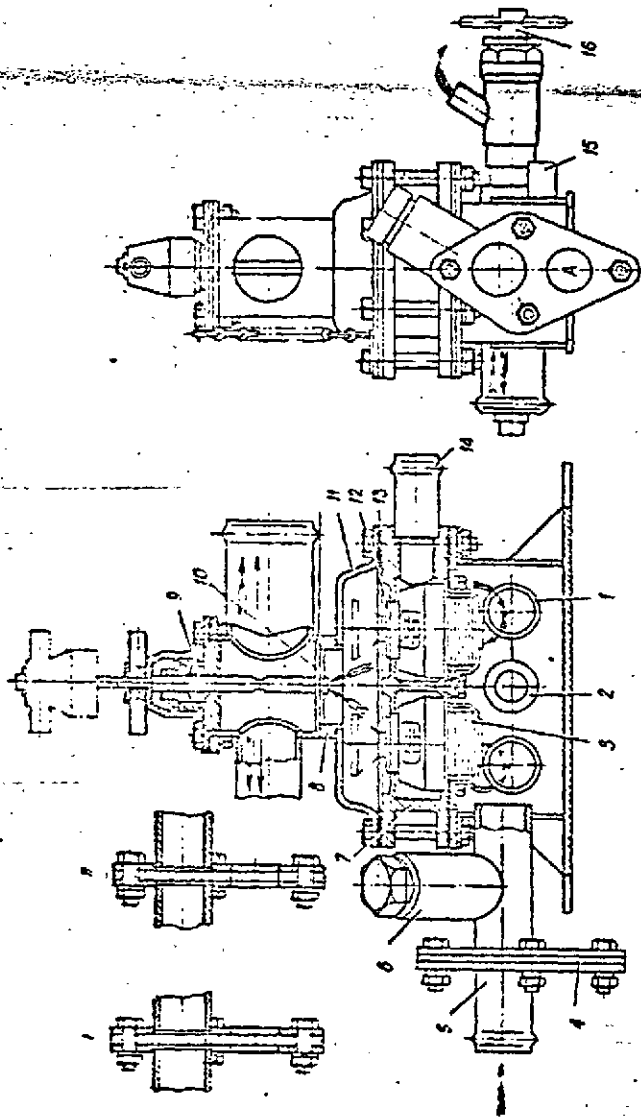
1 - pressure relief valve; 2 - vacuum relief valve spring; 3 - pressure relief valve spring; 4 - vacuum relief valve spring nut; 5 - pressure relief valve spring nut; 6 - pressure relief valve out lock; 7 - seal wire; 8 - vacuum relief valve

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Flow of hot coolant from preheater (with engine out of operation)  
 Flow of coolant from engine (with engine running)  
 Flow of steam from engine

FIG. 10. THERMOSTAT 10X

1 - branch pipe for connecting water-cooled exhaust manifold of engine by outlet pipes; 2 - boss with hole for installation of coolant temperature pilot lamp reading unit; 3 - thermostat bellows; 4 - solid gasket for cutting out preheater from cooling system; 5 - branch pipe for connection with preheater; 6 - auxiliary filler neck for pouring hot water into cooling system; 7 - thermostat box housing; 8 - branch pipe for delivery of coolant to radiators and compressor; 9 - shut-off valve; 10 - radiators cut-out shifter; 11 - tank; 12 - thermostat valve; 13 - gasket; 14 - bypass pipe connection; 15 - steam outlet valve; 16 - cut heater exhaust rack; 1 - "Water" (Auss) position of gasket II - "Steamer" (Dross) position of gasket

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Thermostat box housing 7 accommodates two thermostat bellows 3 with valves 12. At the top the box housing is closed by tank 11 with branch pipe 8 to which the pipelines running to the radiators are connected.

Four branch pipes are welded to the housing: two branch pipes 1 for delivery of hot coolant from the cylinder head jackets of the right-hand and left-hand cylinder blocks, branch pipe 5 for delivery of coolant from the preheater, and branch pipe 14 which connects the housing with the by-pass pipe running to the engine circulation pump.

Auxiliary filler neck 6 for pouring hot coolant into the engine is welded into branch pipe 5 connected with the preheater. The thermostat box housing is provided with two steam outlet unions 15 delivering steam from the cylinder heads, boss 2 with a threaded hole for installation of the coolant temperature pilot lamp sending unit, and a union for installation of cab heater cut-out cock 16.

The thermostat box housing accommodates two thermostats of a double-acting, by-pass type.

The thermostat is an automatic valve operating on the principle that the length of the corrugated bellows filled with highly volatile liquid changes under the action of coolant temperature variation. When the temperature of coolant increases, the pressure inside the bellows rises and the bellows expands; when the temperature decreases, the pressure inside the bellows reduces and the bellows contracts due to its own elasticity.

Contraction or expansion of the thermostat bellows causes the valve rigidly joined to it to be moved.

Hot coolant from the cylinder block jacket flows through branch pipes 1 into the thermostat box housing. In this case, both corrugated bellows 3 are flushed with coolant. If the coolant temperature does not exceed 70°C, the thermostat valves are closed. With the valves closed, the radiators are cut off from the cooling system and the coolant circulates through connection 14 along the by-pass pipe to the circulation pump and then returns to the engine water jacket. As a result the engine quickly warms up because coolant by-passes the radiator. When the engine outlet temperature of coolant exceeds 70°C, the bellows act on the valves. In this case the lower portion of the valves covers the passage of coolant to the by-pass pipe while the upper portion of the valve is lifted opening the passage of coolant to branch pipe 8 wherefrom coolant is conducted through the pipelines to the radiators.

When the engine is warmed up with the help of the preheater the radiators are cut off from the cooling system by special shutter 10 mounted in branch pipe 8 of the thermostat box.

When the shutter is lifted the radiators are connected into the cooling system; with the shutter lowered, the radiators are disconnected. In the latter case the coolant flows through branch pipe 5 to the thermostat box and through branch pipe 1 passes to the engine, then to the circulation pump and again returns to the preheater.

The fans are intended to produce an air flow cooling the liquid in the radiators of the cooling system (Fig. 41).

The air flow is created by four axial fans 12: two per each radiator block. The fans are installed in shroud 2 on common beam 3 and attached to flange 14 (Fig. 42) keyed to shaft 15. The other end of the shaft is jointed to fan drive pulley 4.

The left-hand and right-hand fan pulleys are arranged symmetrically and are similar in design.

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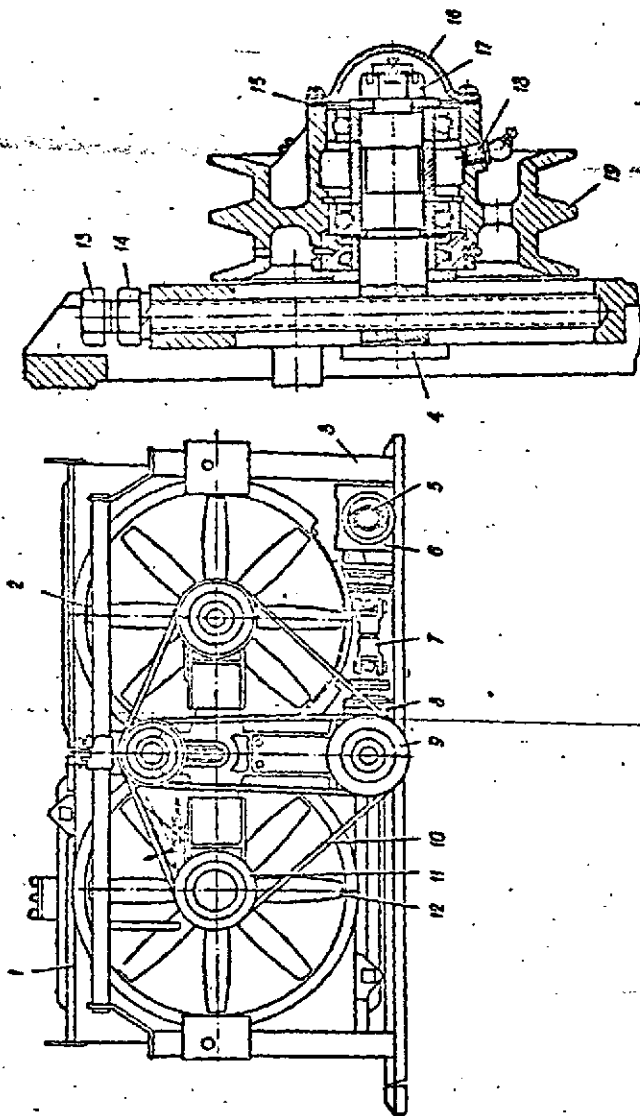


FIG. 11. RIGHT AND LEFT TOP FANS AND THEIR DRIVE

12 - fan, 13 - adjusting bolt, 14 - adjusting bolt nut, 15 - gasket  
 16 - pulley cover, 17 - belt tensioner axle nut, 18 - lubrication fitting  
 19 - tensioner

Note: Shown to the right is the tensioner pulley sectional view

1 - shaft, 2 - shroud, 3 - radiator support, 4 - belt tensioner roller  
 5 - rear reduction gear drive casing shaft, 6 - rear wheel reduction gear  
 7 - front reduction gear drive casing shaft, 8 - front wheel reduction gear  
 9 - driving pulley, 10 - shaft, 11 - fan drive electromagnetic coupling

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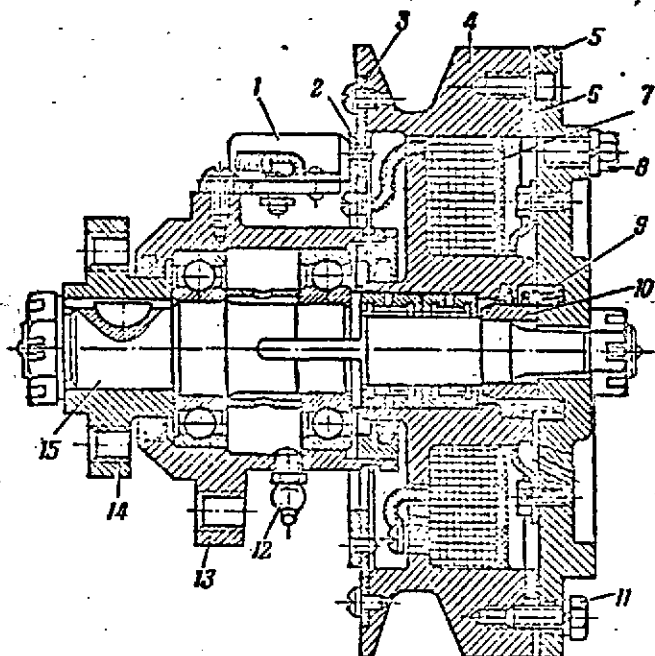


FIG. 42. FAN DRIVE ELECTRO-MAGNET COUPLING

- 1 - brush; 2 - current collector ring;
- 3 - insulation (textolite) washer;
- 4 - magnetic circuit (pulley);
- 5 - armature; 6 - friction ring;
- 7 - coil; 8 - lock bolt (position of bolts when coupling is unlocked);
- 9 - spring; 10 - bushing; 11 - lock bolt (position of bolts when coupling is locked up);
- 12 - lubrication fitting; 13 - body; 14 - flange;
- 15 - shaft

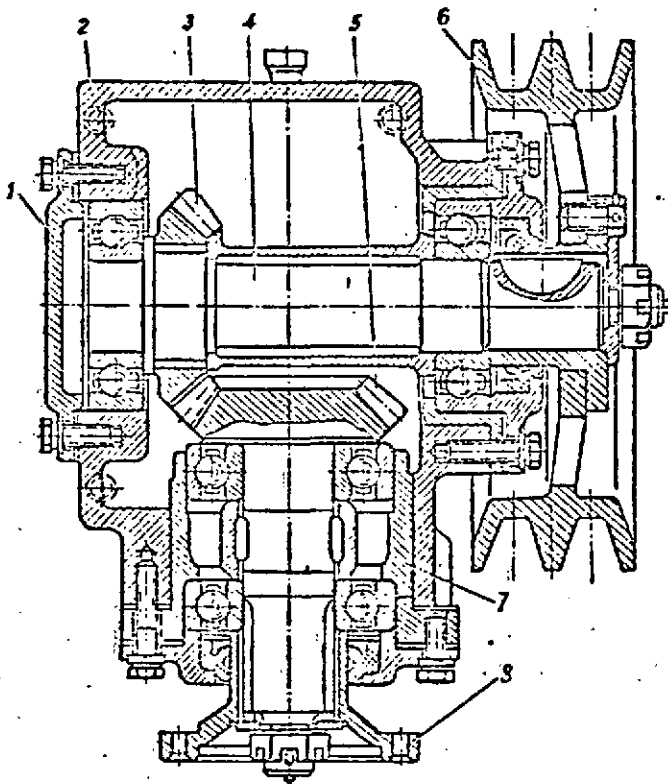


FIG. 43. FAN DRIVE REDUCTION GEAR

- 1 - fan drive case cover; 2 - reduction gear case; 3 - driven gear; 4 - driven shaft;
- 5 - driving gear; 6 - pulley;
- 7 - bearing sleeve; 8 - driving flange

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The fan drive is of a combination type (cardan shafts and belts) and comprises the following main units and parts (Fig.41): front 8 and rear 6 bevel reduction gears, cardan shafts 7 and 5 of the front and rear reduction gears drive, driving pulley 9, tensioner 19, driven pulleys 11 with electromagnetic couplings. The fan drive is actuated by the overdrive gear through cardan shaft 5.

The front fan drive reduction gear (Fig.43) consists of two bevel gears: driving 5 and driven 3. The driving gear is installed on two ball bearings in sleeve 7 of case 2. The driven gear is fitted on the splines of driven shaft 4 which rotates on two bearings.

Flange 8 which is fitted on the splines of the driving gear shank is attached to the cardan shaft flange. Driven pulley 6 is keyed to the driven shaft end.

Instead of the pulley the driven shaft of the rear reduction gear (as differed from the front reduction gear) mounts a flange attaching the cardan shaft of the front reduction gear drive.

The reduction gear case is filled with lubricant through a hole for an adapter of the breather located in the crankcase upper half to the level of the lower level hole.

For convenience of filling, use a hose furnished in the SPTA set, having put it on the breather adapter, but first unscrew the breather.

Draining of the lubricant is accomplished through a hole provided in the crankcase lower half.

The level and drain holes are stopped by plugs.

The electromagnetic couplings (Fig.42) provide for forced connection or disconnection of the fans.

Shaft 15 is installed on two ball bearings in electromagnetic coupling body 13.

The body flange is bolted to the bracket which, in its turn, is mounted on a cross piece. The cross piece is attached with its external portion to the reduction gear case and at the top - to the beam by means of a brace.

Flange 14 for attaching the fan impeller is keyed to the front end of the shaft; fitted on the splines of the shaft rear end is armature 5.

Pulley 4 (magnetic circuit) is supported on the shaft by two needle bearings and during operation of the engine is rotated by the driving belt.

Insulation (textolite) washer 3 with current collector ring 2 riveted to it is attached to the pulley; brush 1 is continuously pressed against the collector ring.

The current collector ring is connected to electromagnetic coil 7 by a conductor.

Split friction (cast iron) ring 6 is placed between the pulley and the armature. The ring thickness is selected so as to obtain a clearance of 1-0.2 mm between the pulley and the armature, with the electromagnetic coil connected.

The friction ring can wear off with resultant decrease of the clearance between the pulley and the armature. When the clearance becomes less than 0.2 mm, the ring should be replaced with a new one.

Because of its elasticity the friction ring tightly fits in a pulley groove.

Spring 9 constantly pressing out the pulley from the armature is installed on bushing 10 between the pulley and the armature. Steel washers are placed at the spring ends to prevent wear of the friction surfaces.

The coupling is provided with three felt seals to prevent leakage of lubricant from the bearings. An oil slinger ring placed before the friction ring prevents lubricant from getting on it (which causes slippage and heavy wear of the ring).

The coupling body is fitted with a lubrication fitting for lubrication of the coupling bearings.

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The electromagnetic couplings are electrically controlled by means of a switch arranged in the driver's cab.

When the switch (on the instrument panel) is set to the ON (ВКЛЮЧЕНО) position, pulley 4 (magnetic circuit) is drawn to armature 5 (driven element) under the action of the electromagnetic force produced by the electric current in coil 7, overcoming the resistance of spring 9.

In this case the pulley and armature rotate as one unit, driving the fan impeller due to the friction which arises between the armature and the friction ring.

With the switch in the OFF (ВЫКЛЮЧЕНО) position, the magnetic field is not produced, pulley 4 (magnetic circuit) is disconnected from armature 5 and is rotated idle by the driving pulley; in this case the fan impeller rotates at a low speed (from zero to 500 r.p.m.).

#### Maintenance of Cooling System

For normal operation of the cooling system, carry out all the operations prescribed in the table of the Section "Preventive Maintenance of Automobiles".

#### Filling of Cooling System

In summer (at ambient air temperature above  $+5^{\circ}\text{C}$ ) the cooling system should be filled with water and in winter (at temperature below  $+5^{\circ}\text{C}$ ) with antifreeze.

It is forbidden to remove the radiator cap at a coolant temperature of  $100^{\circ}$  or above. When adding coolant, first reduce the temperature of  $75-80^{\circ}\text{C}$ .

The level of coolant should be 20-25 mm above the radiator core tubes when water is filled, or 10-15 mm above the radiator core tubes when antifreeze is poured.

During operation of the engine, observe readings of the coolant temperature gauges. The normal temperature of coolant is  $80-90^{\circ}\text{C}$  and the maximum permissible (for short time) -  $105^{\circ}\text{C}$ .

When draining the coolant from the cooling system simultaneously open all the drain cocks located on the circulation pump, water-cooled exhaust manifolds, pipeline delivering coolant from the thermostat box to the cab heater, engine preheater, and also unscrew the plug on the water-heated pipe of the main oil line and remove the radiator caps.

#### Adjustment of Fan Belt Tension

Bear in mind that the fan belts are intensively extended during the initial period of their service (approximately during 1,500-2,000 km of run), and then the extension of the belts practically ceases. Therefore, during the initial period, check the condition and tension of the belts with particular care. After 1,500-2,000 km of the run the belt tension should be adjusted in separate cases only (when required).

The fan belt should be deflected within 18-25 mm by an effort of 10 kg applied to the middle of a branch of the most tight belt between the fan hub and the tensioner.

To adjust the belt tension, proceed as follows:

- turn out the screws and remove cover 16 (Fig.41) of the tensioner body with the gasket;
- remove the lubricant, unlock and loosen nut 17 attaching the tensioner axle;
- loosen lock nut 14 and adjust the belt tension (as judged by the most tight belt) by rotating adjusting bolt 13;

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- tighten up and lock nut 17 attaching the tensioner axle;
- pack tensioner body cover 16 with lubricant, grade JTB(1-13), reinstall it with the gasket and tighten up the attaching screws;
- holding adjusting bolt 13 from turning, tighten up lock nut 14.

#### Locking-up and Unlocking of Electromagnetic Coupling

When changing over to summer operation, lock up the fan drive electromagnetic coupling, and when changing over to winter operation - unlock it.

An exception is made for the rear coupling which should be kept locked up during the entire period of the automobile service (regardless of the season).

The electromagnetic coupling is also locked up when the electric equipment is out of order.

To lock up the electromagnetic coupling, proceed as follows:

- unscrew lock bolts 8 (Fig.42) from the threaded bosses of armature 5 and screw them into pulley 4 through holes in the armature without removal of the spring washers;
- turn out the attaching screws and disconnect brush 1 with the body; wrap the brush wire lug with an insulation tape and place the removed brush with the body into the SPTA set.

To unlock the electromagnetic coupling, proceed as follows:

- take the brush with the body from the SPTA set, connect the wire to it and turn in the attaching screw;
- reinstall the brush with the body and turn in the attaching screw;
- unscrew the lock bolts from the pulley and screw them into the threaded bosses of the armature without removal of the spring washers;
- cut in the fan drive electromagnetic coupling switch and check the clearance between the armature and the pulley.

With the fan drive electromagnetic coupling connected, the clearance between the armature and the pulley should be: normal - 0.8-1.0 mm, minimum permissible - 0.2 mm;

- if the clearance between the armature and the pulley is less than the minimum permissible, replace friction ring 6;
- cut out the electromagnetic coupling switch.

To replace friction ring 6, proceed as follows:

- unlock and remove the armature attaching nut;
- remove the armature and take out the worn friction ring, fit a new ring;
- reinstall the armature, screw on and lock the attaching nut.

During operation of the automobile at ambient air temperatures below  $-25^{\circ}\text{C}$  it is permitted to unlock the electromagnetic coupling, if the temperature of oil in the hydraulic transmission lubrication line is less than  $0^{\circ}\text{C}$ .

In this case the torque converter temperature should be controlled by periodically switching on and off the electromagnetic coupling.

#### Washing of Cooling System

In case of necessity (every 15,000-18,000 km of run) the cooling system should be washed and cleaned of scale.

The scale is removed by washing the cooling system with scale solvent, neutralizer (sludge removing) and passivating solution in succession.

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The scale solvent is a 4% hydrochloric acid solution inhibited by a formaldehyde-ammonia mixture. It is intended to soften and dissolve the scale already formed in the engine cooling system.

For preparation of the solution it is necessary to fill a clean metal or glass tightly closing container with small portions of the following components (with continuous stirring): 0.335 lit of 40% formaldehyde and 0.215 lit of 25% ammonia (the industry produces formaldehyde and ammonia in the given concentrations). Fill another clean metal container with 10 lit of water, 0.5 lit of the formaldehyde-ammonia mixture and 0.4 lit of the commercial hydrochloric acid, in succession.

Close the container and mix the content by shaking. The prepared solution can be stored and used, when required.

The neutralizer (sludge removing solution) is a 1.5% solution of trisodium phosphate added with potassium hydroxide and sodium nitrate. It is intended to remove undissolved scale and oil contamination from the cooling system and to neutralize leftovers of the hydrochloric acid.

For preparation of the solution it is necessary to fill a clean metal or glass container with 10 lit of water and to add 150 gr of ground commercial trisodium phosphate, 20 gr of potassium hydroxide and 25 gr of commercial sodium nitrate.

The container should be shaken up until the deposited matter dissolves. This done, the solution is ready for use. Possible formation of thin flaky deposit caused by hard salts of used water should not be taken into consideration.

The passivating solution is a 0.5% solution of potassium bichromate. It is intended to make the internal metal surfaces of the cooling system parts corrosion-resistant after acid treatment.

For preparation of the solution it is necessary to fill a clean container with 10 lit of water and to dissolve 50 gr of ground commercial potassium bichromate in it. The storage period of the solution is not limited.

Washing of the cooling system should be carried out as follows:

1. Fill the engine cooling system with the scale solvent. Start the engine and run it at low idle speed to ensure circulation and heating of the solvent to a temperature of +80°C. In 10 minutes after the above temperature is reached, drain the solvent.

Note. If oily contaminants are present in the cooling system, it is recommended to wash the cooling system preliminarily with the sludge removing solution in the above order with the only exception - the solution should be drained immediately after the temperature of +80°C is reached.

2. Wash the cooling system with the scale solvent again, keeping the latter at this time in the cooling system of the engine heated to a temperature of +80°C for 15 minutes.

In case of heavy scale formation the system may be washed for the third time, keeping the solution in the system for 25 minutes.

3. With the scale solvent still draining, conduct clean water through the cooling system to remove easily-washable sludges and leftovers of the acid solution. Flush the system until the outgoing water becomes transparent

4. Fill the cooling system with the neutralizer. Start the engine and run it at low idling speed until the neutralizer is heated to a temperature of +80°C. In 10 minutes after the above temperature is reached, drain the solution, flush the cooling system with water until the outgoing water becomes transparent but for not less than 5 minutes.

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5. Fill the cooling system with the passivating solution and wash it as prescribed in item 4. During the summer period of operation the passivating solution may be left in the cooling system.

Engine Troubles and Remedies

Trouble	Cause	Remedy
1	2	3
Engine fails to start or starts with difficulty	<p>1. No fuel is delivered to fuel injection pump:</p> <p>(a) Fuel distributing cock is closed</p> <p>(b) No fuel in tanks</p> <p>(c) Engine fuel feed pump fails to operate</p> <p>(d) Low oil pressure in main oil line of lubricating system, with fuel pipeline cut out by engine shut-down device</p> <p>(e) Air in engine fuel system</p> <p>(f) Fuel pipeline or primary fuel filter or secondary fuel filter is clogged</p> <p>(g) Frozen or jammed control rack of fuel injection pump</p> <p>(h) Slide valve of engine automatic shut-down device prevents admission of fuel</p> <p>2. Engine is insufficiently warmed up at low ambient temperature</p> <p>3. Crankshaft slowly rotates at starting:</p> <p>(a) Discharged storage batteries</p> <p>(b) Loose wires</p> <p>(c) Poor contact of starter brushes with com-</p>	<p>Open cock</p> <p>Fill tanks with fuel</p> <p>Replace fuel feed pump</p> <p>Using oil priming pump, build up pressure in lubricating system of at least 2.5-3 kgf/cm<sup>2</sup></p> <p>Prime fuel system with the help of manual pump, having switched on M3H-2 pump</p> <p>Pump M3H-2 should be kept switched on for not more than 3 minutes with intervals for motor cooling after each minute</p> <p>See that pipeline delivers fuel, and wash filter</p> <p>Warm up pump, having filled its housing with hot oil</p> <p>Press button 12 (Fig.36)</p> <p>Warm up engine by means of preheater</p> <p>Start engine by compressed air. Recharge storage batteries</p> <p>Tighten up terminals</p> <p>Clean commutator</p>

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1	2	3
<p>Engine starts but after first revolutions stalls</p>	<p>mutator due to contamination or burning</p> <p>4. When starting engine by compressed air, crankshaft fails to rotate:</p> <p>(a) Incorrect adjustment of air distributor after disassembly</p> <p>(b) Leaky valves</p> <p>(c) Incorrect adjustment of valve timing after disassembly, incorrect adjustment of fuel injection advance angle</p> <p>5. Closed gate valves of engine emergency shut-down device</p> <p>6. Injectors fail to deliver atomized fuel into cylinders</p> <p>1. No pressure in lubricating system main oil line</p> <p>2. Air in engine fuel system</p> <p>3. Fuel feed pump fails to deliver fuel</p>	<p>Adjust air distributor</p> <p>Send engine for repair</p> <p>Adjust valve timing.</p> <p>Adjust fuel injection advance angle</p> <p>Open gate valves</p> <p>Check unions of injection pipes running to injector bodies for tightness. Check injectors for atomization</p> <p>Replace pressure gauge.</p> <p>Remove oil header from oil tank and wash screen.</p> <p>Unscrew oil pump reducing valve, wash in diesel fuel, eliminate jamming and install in place</p> <p>Prime fuel system with the help of manual pump, having switched on pump M3H-2. Pump M3H-2 should be kept switched on for NOT MORE than 3 minutes with intervals for motor cooling after each minute</p> <p>Unscrew connection of pipelines running from tank to pump and see that fuel is fed from tank. Unscrew connection of pipelines running from pump to filters, and rotating crankshaft, check to see that pump delivers fuel; if no fuel is delivered, replace pump</p>

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1	2	3
<p>Oil pressure gauge does not register sufficient pressure</p>	<p>4. Manual fuel priming pump does not pass fuel due to jammed or frozen valves</p> <p>5. Incomplete opening of fuel distributing cock</p> <p>6. Usage of summer grades of fuel in winter operation</p> <p>1. Insufficient quantity of oil in tank</p> <p>2. Air inleakage through connections of oil pipelines; oil pressure gauge pointer sharply fluctuates</p> <p>3. Usage of oil grades not recommended by manufacturer</p> <p>4. Clogged oil filter</p> <p>5. Faulty oil pressure gauge</p> <p>6. Clogged or seized reducing valve of oil pump</p> <p>7. Weak spring of reducing valve</p> <p>8. Worn bronze bushing of central oil delivery pipe</p> <p>9. Increased clearances in crankshaft main and connecting rod bearings</p> <p>10. Unheated oil in oil tank</p> <p>11. Clogged screen of oil header in oil tank</p> <p>Air in oil pipeline running from oil tank to pump K3B-2</p>	<p>Remove pump and correct jammed valves</p> <p>Open cock</p> <p>Change fuel</p> <p>Top up engine oil tank</p> <p>Check connections of oil pipelines running from tank to pump for airtightness and eliminate inleakage</p> <p>Change oil</p> <p>Wash filter</p> <p>Replace oil pressure gauge</p> <p>Unscrew reducing valve, not disturbing seal, and wash it in diesel fuel, eliminate seizing and reinstall</p> <p>Adjust oil pressure in main oil line for 6.0-10.0 kgf/cm<sup>2</sup> at 1,500 r.p.m. without removal of pump from engine</p> <p>Send engine for repair to grind bushing along face or to replace it in case of its considerable wear</p> <p>When oil pressure in main oil line drops below 5 kgf/cm<sup>2</sup> at crankshaft speed of 1,500 r.p.m., send engine for repair</p> <p>Warm up oil with the help of starting preheater or fill tank with hot oil</p> <p>Remove oil header, wash screen</p> <p>Slightly turn out union of oil pipeline running to pump K3B-2 and cut in switch but-</p>
<p>Oil priming pump fails to build up pressure</p>		

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1	2	3
<p>Leakage of exhaust gases</p>	<p>Clogged oil header in oil tank Oil temperature is above +70°C</p> <p>1. Leakage of exhaust gases between cylinder head and manifold flanges 2. Leakage of exhaust gases at the joint between cylinder head and cylinder jacket</p> <p>Loose hold-down studs attaching cylinder block or damaged gasket between cylinder head and cylinder jacket. Oil leaks and gas jets felt at place of leakage</p> <p>3. Leakage of gases through exhaust pipe flanges</p> <p>4. Throw of unburnt particles (sparks) from spark arrester</p>	<p>tion of KDH-2 pump, bleed air until oil without air appears Remove oil header, wash oil header screen Let oil cool down (It is prohibited to stop engine at coolant temperature above +70°C) Tighten up nuts attaching manifold flanges to cylinder head Tighten up cylinder head attaching bolts or replace gasket between cylinder head and cylinder jacket. For tightening, use wrench with tubular extension bar, 1.0 m long Tighten up studs uniformly: each time turning nuts for not more than one edge; tighten up studs starting from the middle of cylinder head alternately towards first and sixth cylinders Tighten up bolts; if necessary, replace gasket Clean spark arrester</p>
<p>Engine fails to develop full power</p>	<p>1. Disturbed adjustment of rods conveying motion from pedal or fuel feed control lever to lever on fuel injection pump 2. Faulty fuel injection pump Find out fault as follows: (a) With engine running at minimum speed, disconnect pipes delivering fuel to injectors in turn from fuel injection pump. If no fuel is delivered from pressure union, it indicates that this section is at fault (seized plunger,</p>	<p>Adjust rods so that with accelerator pedal depressed completely, engine develops idle speed of at least 2,200 r.p.m. Replace damaged parts. If they are not available in SPTA set, replace fuel injection pump</p>

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1	2	3
	<p>broken plunger spring, etc.)</p> <p>(b) With engine not operating, disconnect injection pipes from fuel injection pump, build up pressure in fuel system with the help of manual fuel priming pump and, rotating crankshaft, see that fuel injection pump sections deliver fuel. If fuel continuously flows from any of the unions it means that either delivery valve is clogged or delivery valve spring is broken or delivery valve-seat pair is at fault</p> <p>3. Faulty injectors.</p> <p>To detect faulty injector, proceed as follows:</p> <ul style="list-style-type: none"> <li>- set 800-900 r.p.m. at idle running;</li> <li>- disconnect all injectors of cylinder block in which faulty injector is suspected. Disconnection of injectors is carried out by partial loosening of pressure nuts attaching injection pipes to fuel injection pump unions until fuel starts sprinkling from under loosened nut. Absence of fuel sprinkling means that fuel injection pump section is at fault (seized plunger, broken plunger spring); detect faulty injector by connecting and disconnecting injectors in turn. When serviceable injector is connected,</li> </ul>	<p>Wash delivery valve.</p> <p>If this does not help, replace delivery valve. Defective delivery valves and their springs can be replaced without removal of fuel injection pump from engine</p> <p>Replace detected faulty injectors</p>

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	<p>stream of hot burned gases is thrown outside from exhaust pipe; temperature of these gases considerably exceeds temperature of air stream discharged from exhaust pipe when injectors are disconnected (to be checked by hand at exhaust pipe outlet). Connection of faulty injector causes no change at the exhaust</p> <p>4. Insufficient amount of fuel is delivered to fuel injection pump due to clogging of fuel filters</p> <p>5. Disturbed fuel injection advance angle. Loose bolts of fuel injection pump drive coupling. Indication of insufficient advance angle:</p> <ul style="list-style-type: none"> <li>- black smoke at the exhaust; indication of excessive advance angle:</li> <li>- knocks in cylinders, intensifying at decrease of engine speed</li> </ul>	<p>Wash fuel filters</p> <p>Check fuel injection pump for proper installation and set the angle recorded in Service Log. Tighten up coupling bolts</p>
	<p>6. Clogged air cleaners</p> <p>7. Insufficient compression:</p> <ul style="list-style-type: none"> <li>(a) Heavy wear or carbonization of piston rings. Misfiring in cylinders at low speeds and rise of pressure in crankcase (smoke and leakage of oil from breather);</li> <li>(b) Disturbed valve timing;</li> <li>(c) Untight fitting of valves to seats</li> </ul> <p>8. Cold engine, loaded without preliminary warming. Knocks in cylinders; black smoke at the exhaust;</p>	<p>Wash air cleaners</p> <p>Send engine for repair (replace rings)</p> <p>Adjust valve timing</p> <p>Send engine for repair. Lap valves to seats</p> <p>Remove load and warm up engine</p>

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1	2	3
<p>Black smoke at the exhaust under all service conditions</p>	<p>1. Faulty injectors:            (a) intense oil leaks from injectors;            (b) seized or stuck spray tip needle;            (c) poor atomization of fuel, clogged spray tip orifices. When faulty injector is disconnected, engine smoking ceases</p> <p>2. Clogged air cleaners</p> <p>3. Disturbed valve timing</p> <p>4. Decreased fuel injection advance angle</p> <p>5. Insufficient compression</p>	<p>Replace detected faulty injectors</p> <p>Wash air cleaners            Adjust valve timing</p> <p>Set fuel injection advance angle recorded in Service Log</p> <p>Send engine for repair. Check condition of piston rings and fitting of valves to their seats.            Eliminate defects</p>
<p>White smoke at low speed</p>	<p>Engine is not warmed up</p>	<p>Warm up engine by decreasing intensity of coolant and oil cooling (Switch off fans)</p>
<p>Engine knocks</p>	<p>Knocks in all cylinders:            (a) Increased fuel injection advance angle. Knocks intensify when changing over to low speeds            (b) Engine is loaded without preliminary warming            (c) Thick carbon deposit on walls of combustion chambers and crowns of pistons; sparks from exhaust pipe            (d) Knocks in separate cylinders. Non-uniform delivery of fuel by separate sections of pump</p>	<p>Set fuel injection advance angle recorded in Service Log</p> <p>Remove load. Warm up engine</p> <p>Remove carbon deposit, protecting at the same time piston crowns and combustion chamber surface from damage</p> <p>Send pump to repair shop for adjustment</p>
<p>Engine runs unsteady</p>	<p>1. Sharp fluctuations of engine speed:            (a) Non-uniform delivery of fuel by pump sections</p>	<p>When engine speed fluctuates in excess of 50 r.p.m., send fuel injection pump to repair shop for adjustment            Send pump to repair shop for adjustment</p>

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1	2	3
	<p>(b) Insufficient or excessive oil in governor housing or too viscous oil</p> <p>2. Misfiring in separate cylinders (to be determined by ear). Seizing of injector needle or plunger in barrel</p>	<p>Check oil level and bring it up to level plug.</p> <p>Replace oil with less viscous one</p> <p>Replace injectors. Send pump for repair</p>
<p>Engine is racing</p>	<p>Engine speed exceeds maximum permissible limit. Faulty governor or fuel injection pump or jammed control rack</p>	<p>Immediately stop engine by means of air gate valves of engine emergency shut-down device, first having loaded it, if possible. Send fuel injection pump for repair shop</p>
<p>High engine outlet temperature of coolant (above 105°C) and oil (above 110°C)</p>	<p>1. Cooling system is filled incompletely or is leaky</p>	<p>Add coolant. Eliminate leakage</p>
	<p>2. Coolant does not circulate through system - damaged shaft or impeller of circulation pump</p> <p>3. Temperature gauge reads incorrectly</p> <p>4. Slipping of fan belts</p> <p>5. Fans are switched off</p> <p>6. Pipeline or steam outlet pipes are clogged</p>	<p>Replace faulty pump</p> <p>Replace faulty temperature gauge</p> <p>Find out cause and eliminate it</p> <p>Switch on fans</p> <p>Wash cooling system</p>
<p>High engine outlet temperature of oil (above 110°C)</p>	<p>1. Insufficient amount of oil in lubricating system</p>	<p>Top up tank</p>
	<p>2. Temperature gauge reads incorrectly</p> <p>3. Unsatisfactory quality of oil (to be determined by physico-chemical analysis)</p> <p>4. Oil cooler fan is switched off</p> <p>5. Faulty oil by-pass valve 13 (Fig. 31)</p> <p>6. Oil tank heating system is connected during summer period</p>	<p>Replace faulty temperature gauge</p> <p>Change oil</p> <p>Switch on fan</p> <p>Check valve condition and adjustment</p> <p>Disconnect heating system by shutter located at thermostat box</p>
	<p>7. Fans electromagnetic coupling is at fault</p>	<p>Eliminate fault or unlock coupling</p>

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1	2	3
Leakage of coolant, fuel and oil	<p>E. Radiator honeycomb clogged from outside</p> <p>1. Leakage of coolant from check holes of cylinder jackets and at the joint between cylinder heads and cylinder jackets.</p> <p>Engine overheats. Slight fusing of by-pass tubes sealing rubber rings</p> <p>2. Presence of coolant in oil</p> <p>(a) damaged sealing of liners in cylinder jacket (most often in the result of overheating)</p> <p>(b) leakage of coolant through oil tank coils</p> <p>3. Leakage of oil from check holes of cylinders. Damaged support surface of hold-down stud washer or broken hold-down stud</p> <p>4. Penetration of fuel into engine lubricating system. Oil level in tank remains constant or increases:</p> <p>(a) leakage of fuel from union delivering fuel to injector as a result of wear of sealing cone</p> <p>(b) damaged packing of EHX-12TE fuel feed pump shaft</p> <p>(c) penetration of fuel through leaky ball in slide valve of device for stopping engine at pressure drop in main oil line</p> <p>5. Leakage of coolant or oil through check holes of circulation pump. Disturbed pump packing</p>	<p>Wash radiator</p> <p>Replace defective sealing rubber rings</p> <p>Send engine for repair</p> <p>Replace oil tank. Flush lubricating system and fill with fresh oil</p> <p>Send engine for repair</p> <p>Replace injection pipe. Check unions in injector bodies for tightening</p> <p>Replace pump or shaft packing</p> <p>Replace device stopping engine at pressure drop in main oil line</p> <p>Dripping of coolant is permitted (not more than 5 drops per minute during operation)</p> <p>Leakage of oil is not permitted</p> <p>Grind working surface of packing washers on plate. If</p>

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1	2	3
<p>Leakage of oil or coolant through radiator or oil cooler tubes</p> <p>When using engine emergency shut-down device, engine fails to be shut down or produces backshots in spark arrestor</p>	<p>5. Leakage of coolant along rod of radiators cut-out shutter in thermostat box</p> <p>High oil pressure or high temperature in system</p> <p>Non-synchronous closing of gate valves</p> <p>Inleakage of air through gasket between engine emergency shut-down device housing and connecting elbow</p> <p>Inleakage of air at the joint of connecting elbow and intake manifold</p> <p>Inleakage of air through gasket at the joint of intake manifold and engine cylinder head</p>	<p>coolant penetrates through circulation pump packings to engine crankcase, flush lubricating system and replace oil after elimination of leakage through pump packings</p> <p>Tighten rod oil seal. If it has been tightened completely, replace seal</p> <p>Remove radiator or oil cooler. Plug defective tubes at each end with solder</p> <p>Adjust gate valves</p> <p>Tighten up nuts attaching engine emergency shut-down device</p> <p>1. Tighten up clamps attaching connecting branch pipe to intake manifold</p> <p>2. Tighten up nuts attaching connecting elbow with branch pipe</p> <p>Tighten up nuts attaching intake manifold to cylinder head</p>

**ENGINE STARTING SYSTEM**

The automobile is provided with two starting systems: electric and air-operated. Both systems operate independently of each other. When the main electric system is used, the engine is started with the help of a starter (section "Electrical Equipment").

The air starting system is auxiliary and is used to start the engine when the starter is out of order.

Design of Air Starting System

The air starting system (Fig.44) consists of two compressed air bottles, a reducing valve, air line pressure gauge, air distributor and 12 starting valves arranged in the engine cylinder heads.

Note. For convenience of mounting and demounting the engine starting system pipelines their ends are painted blue.

Union 7 which is installed on pipeline 6 between the bottles and closed by a threaded plug, is designed for charging the bottles with compressed air. The union can be connected to an external source of compressed air for starting the engine.

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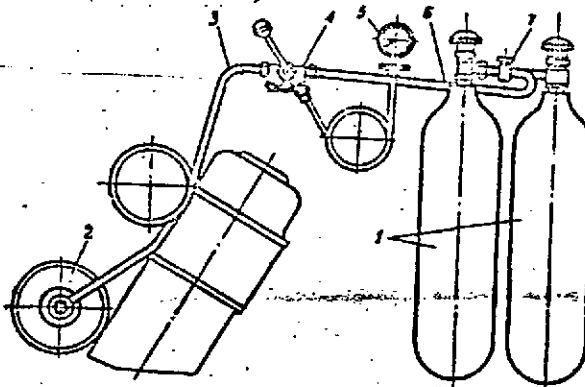


FIG. 44. AIR STARTING SYSTEM

1 - compressed air bottles; 2 - air distributor; 3 - pipeline running from reducing valve to air distributor; 4 - reducing valve; 5 - pressure gauge; 6 - pipeline running from compressed air bottles to reducing valve; 7 - pipe union for charging bottles with compressed air

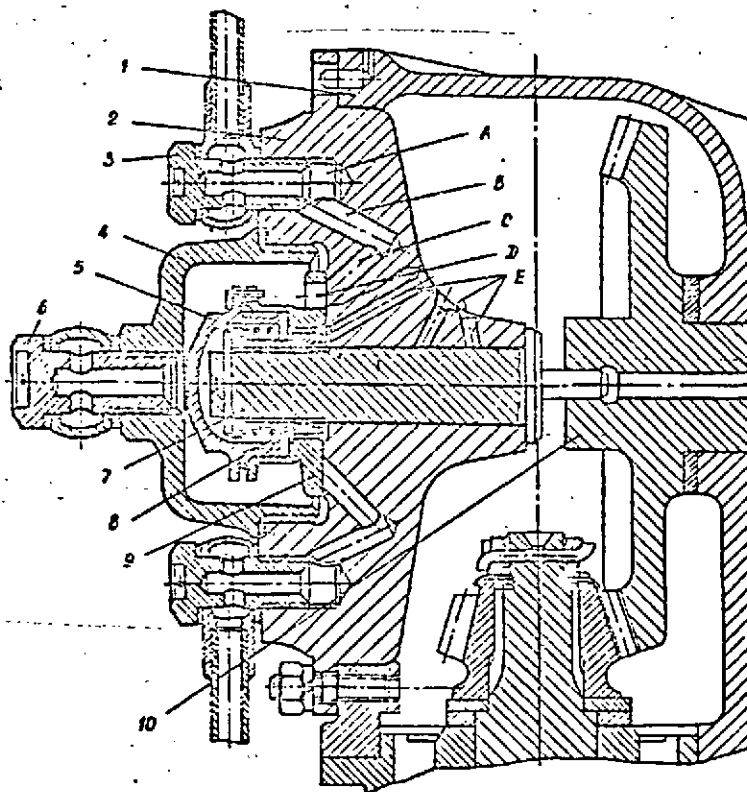


FIG. 45. AIR DISTRIBUTOR

1 - fuel injection pump drive casing; 2 - air distributor body; 3, 6 - connector; 4 - cup; 5 - cover; 7 - air distributor shaft; 8 - splined coupling; 9 - distributing disc; 10 - fuel injection pump drive gear; A, B, C - drillings; D - oval hole in distributing disc; E - oil inlet drilling

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The compressed air bottles are mounted in the engine compartment on the cab rear wall. The capacity of each bottle is 10 lit. Air pressure in the bottles should not exceed 150 kgf/cm<sup>2</sup>. Both bottles are connected to reducing valve 4 by a pipeline.

The reducing valve serves to adjust the pressure of air delivered through the air distributor to the engine cylinders. The pressure of air fed to the air distributor should not be higher than 90 kgf/cm<sup>2</sup> as read by the pressure gauge and can be achieved by incomplete opening of the reducing valve.

The reducing valve and pressure gauge are mounted in the cab on the rear wall.

Compressed air from the bottle is delivered through the reducing valve to the air distributor wherefrom at the beginning of the expansion stroke it is alternately supplied according to the firing order to the starting valves installed in the cylinder heads and further into the cylinders where acting on the pistons the air drives the crankshaft.

The air distributor (Fig.45) is attached to fuel injection pump drive casing 1 in the front part of the engine.

Air distributor shaft 7 is rotated by fuel injection pump drive gear 10. The direction of rotation of the air distributor shaft is counter-clockwise as viewed from the air delivery side.

Air distributor body 2 is stamped of aluminium alloy. Its external face is machined and has 12 threaded holes "A" screwed into which are connectors 3 of the pipes delivering air to the cylinders.

A hole for shaft 7 and twelve oblique drillings "C" communicating with drillings "A" through oblique drillings are arranged in the centre.

Air distributor cap 4 provided with a packing aluminium gasket is screwed into the central threaded hole.

The front end of shaft 7 has triangular splines and a hole to receive a pin shaft coupling 8 designed for precise installation of distributing disc 9 during adjustment is fitted on the splines.

The coupling has 30 internal and 36 external splines; distributing disc 9 is fitted on the external splines.

Shaft 7 has a tail piece entering a slot of fuel injection pump drive gear 10. Oval hole "D" for passage of air is made on the working surface of the distributing disc.

The disc is pressed against the body surface by a spring. The disc space is closed by cover 5 which is screwed in and locked. An aluminium gasket is placed under the cover.

Connector 6 is screwed into distributor cap 4 for connection of the pipe delivering air from the bottle.

When the engine is started, compressed air from the bottle is conducted through the connector into the space between the cap and distributing disc.

As, with the crankshaft in any position, the oval hole coincides with one or two holes in the body, compressed air flows through the starting valves to one or simultaneously to two cylinders. The crankshaft and, consequently, the distributing disc start to rotate.

During rotation of the distributing disc oval hole "D" matching with oblique drillings "C" in the air distributor body alternately passes air to the engine cylinders according to the firing order. After the engine starts to operate, the delivery of compressed air to the air distributor is cut off by closing the reducing valve.

The air distributor shaft and distributing disc rotate during operation of the engine.

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The holes in the body begin to open  $6\frac{1}{2}^{\circ}$  of the crank angle before the TDC on the compression stroke.

The duration of air delivery into the cylinder is  $11\frac{1}{2}^{\circ}$  of the crank angle.

#### Maintenance of Air Starting System

When servicing the air starting system, carry out all the operations prescribed in the Section "Preventive Maintenance of Automobile".

The minimum air pressure in the bottles, at which reliable starting of the engine is ensured, should be at least  $60 \text{ kgf/cm}^2$  in summer and  $75 \text{ kgf/cm}^2$  in winter.

#### Adjustment of Air Distributor

To adjust the delivery of starting air into the cylinders, proceed as follows:

- bring the piston in the first cylinder of the left-hand cylinder block by the graduated rim of the flywheel to the position corresponding to  $27^{\circ}$  after the TDC on the expansion stroke (rotating the crankshaft clockwise);
- take off cap 4 and cover 5 from the air distributor and remove the pin, washer, spring and coupling 8;
- set distributing disc 9 so that the front edge of its hole "D" (in the direction of rotation) matches with the edge of drilling "C" delivering air into the first cylinder of the left-hand cylinder block, this drilling should be completely open; when doing so, take up the clearance towards the side opposite to the direction of rotation;
- select such a position of the coupling at which it gets in mesh with the splines of the shaft and disc without rotation of the latter;
- turn the crankshaft counter-clockwise through  $30-40^{\circ}$ , then turn the flywheel in the direction of rotation to the initial position and check the distributing disc for proper setting;
- reinstall all the parts.

#### Probable Troubles and Remedies of Air Starting System

Trouble	Cause	Remedy
1	2	3
Engine fails to be started by compressed air	1. Insufficient air pressure in bottles 2. Sticking of starting valves 3. Leakage of air through crack in pipelines or through un-tight connections 4. Untight fitting of mating surfaces of air distributor body and distributing disc	Charge bottles with air  Unscrew valve, eliminate fault or replace valve Check connections for leakage, replace defective pipelines or repair  Grind surfaces of mating parts or replace

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ENGINE PREHEATING SYSTEMPurpose and Design of Preheating System

To ensure reliable starting of the engine in the winter period of operation (at ambient air temperatures below +5°C) the automobile is provided with an engine preheating system.

The preheating system comprises a preheater (Fig.37), coils for preheating oil in the engine oil tank, pipelines.

The preheating system is connected to the cooling system by means of gasket 1 installed, with the side having a hole, between the flanges of branch pipe 5 (Fig.40) of the thermostat box and a pipe running from the coils which heat oil in the engine oil tank. The position of the gasket in the flanges of the branch pipes is checked through inspection hole A. When the inspection hole is covered by the gasket, the preheating system is cut in.

Coolant heated by the preheater (when it operates) is forced by a preheater circulation pump through the oil tank coils and conducted to the thermostat box. From the thermostat box the coolant is delivered through the pipelines to the exhaust manifold jackets, then to the cylinder head and cylinder block jackets, and at last through the engine circulation pump to the lower pipe of the cooling system wherefrom it returns to the preheater.

When the heated coolant circulates through the above closed circuit, oil in the oil tank, the cylinder heads, cylinder blocks and the entire bulk of the engine become warm, thereby creating favourable conditions for starting of the engine, and reliable lubrication of the friction surfaces during starting of the cold engine.

The oil priming pump jacket and the main oil line jacket are connected in parallel with the preheating system, due to which the oil line from the tank to the engine oil pump becomes heated before the engine is started.

The preheater is designed to heat the engine before its starting at ambient air temperatures below +5°C. It is located under the cab on the right-hand side member of the frame.

The preheater consists of the following main units:

- preheater boiler;
- burner;
- pump unit composed of electric motor, blower, circulation and fuel pumps;
- injectors;
- electromagnetic fuel valve;
- glow plug;
- preheater control board.

The preheater boiler (Fig.46) is a single-path, solid unit made of four cylinders. The first and second cylinders form an outer jacket. The space between the second and third cylinders forms return gas duct 10. The inner jacket is formed between the third and fourth cylinders. The space inside the fourth cylinder is a combustion chamber or a "fire tube".

To provide for reliable circulation of heated coolant the second and third cylinders are connected with each other through holes connecting the inner and outer coolant jackets.

The boiler is made of stainless steel.

Coolant from circulation pump 4 is delivered, under pressure, to the boiler through pipe 11 and conducted through the inner and outer jackets.

The preheater burner with tangential delivery of air consists of outer cylinder 1A welded to which are a flange attaching the chamber, and a chamber cover. Primary

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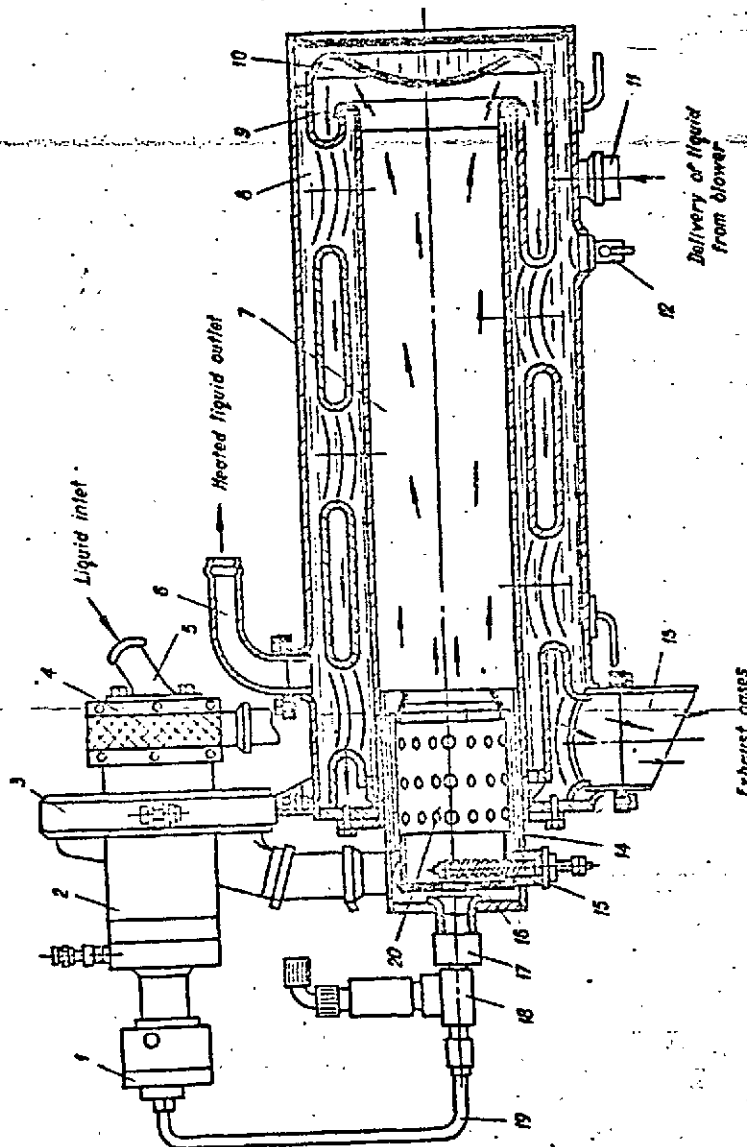


FIG. 66. PHE/HEATFR

- 1 - generator fuel pump; 2 - electric motor; 3 - blower; 4 - circulation pump; 5 - circulation pump inlet branch pipe; 6 - hot coolant outlet branch pipe; 7 - cylindrical combustion chamber; 8 - outer jacket; 9 - inner jacket; 10 - gas duct; 11 - branch pipe for delivery of water to boiler; 12 - drain cock; 13 - exhaust branch pipe; 14 - combustion chamber outer cylinder; 15 - glow plug; 16 - outlet; 17 - injector; 18 - electromagnetic valve; 19 - fuel pipe; 20 - circulation chamber inner cylinder

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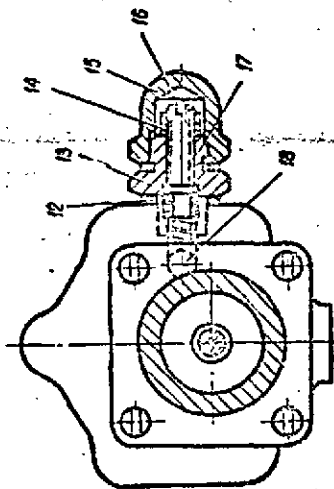
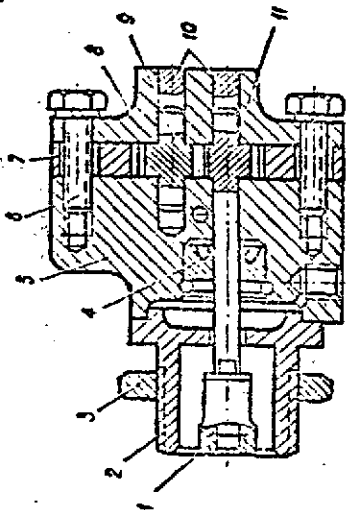


FIG. 48. FUEL PUMP  
 1 - coupling 2 - adapters 3 - nut; 4 - oil seal; 5 - pump body; 6 - bolt; 7 - spacer; 8 - cover; 9 - driven shaft; 10 - plate; 11 - driving shaft; 12 - packing; 13 - spring; 14 - lock nut; 15 - union nut; 16 - adjusting screws; 17 - union; 18 - bell

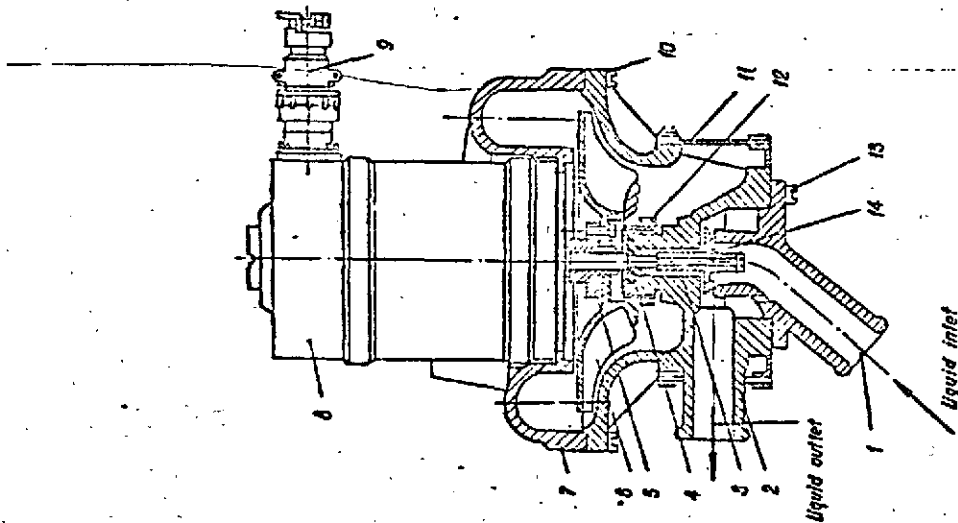


FIG. 47. MIXER  
 1 - branch pipe; 2 - body; 3 - driving shaft; 4 - oil seal; 5 - hub; 6 - impeller; 7 - volute; 8 - electric motor; 9 - plug connector; 10 - screw; 11 - screw; 12 - nut; 13 - screw; 14 - circulation pump impeller

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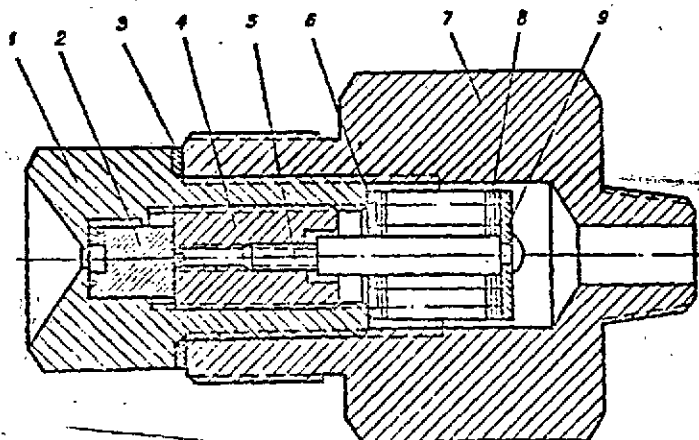


FIG. 49. FUEL INJECTOR

- 1 - injector body; 2 - chamber; 3 - gasket; 4 - screen; 5 - cover stem; 6 - end plate;
- 7 - injector union; 8 - filter plate; 9 - filter cover

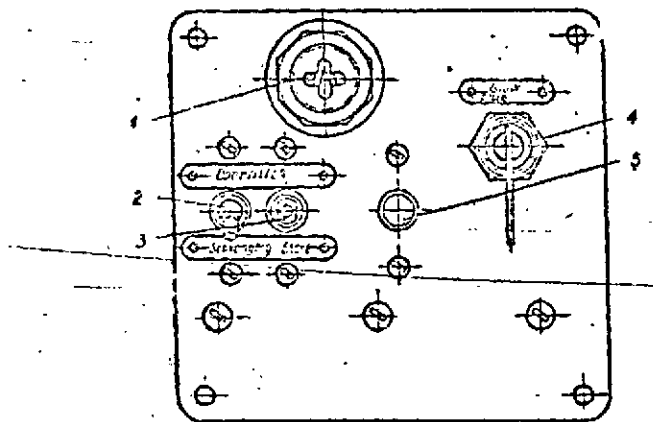


FIG. 50. PREINJECTION CONTROL BOARD

- 1 - pilot coil; 2 - electromagnetic valve switch; 3 - electric motor selector switch; 4 - glow plug switch;
- 5 - safety fuse

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air swirler 16 is installed between the cover and combustion chamber inner cylinder 20. The inner cylinder of the burner is provided with three rows of holes for delivery of secondary air to the combustion chamber.

The preheater pump unit consists of an air blower and a circulation pump, installed in a common housing (Fig.47), and a gear-type fuel pump (Fig.48). The pump unit is driven by the electric motor.

The air blower and circulation pump are attached to the motor frame at the side of the longer end of the shaft, while the gear-type fuel pump is screwed into the motor cover at the commutator side. The fuel pump adapter is fitted with a pipe for discharge of fuel leaking through the oil seals. Fuel consumption is controlled by means of a fuel pump reducing valve.

Leakage of fuel (not more than 30 cm<sup>3</sup> per hour) from the drain hole of the pipe is allowed.

The preheater injector (Fig.49) is screwed into a union which, in its turn, is screwed into the front cover of the burner.

The fuel pipeline running to the preheater pump is connected to the engine primary fuel filter or to the intake union of the engine fuel feed pump.

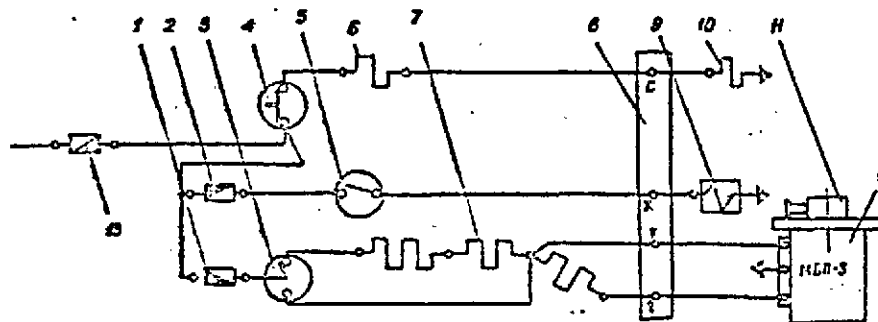


FIG. 51. PREHEATER CONNECTION DIAGRAM

1 - circuit breaker MP-25; 2 - safety block with 2A fuse link; 3 - switch MBL-45; 4 - switch; 5 - switch G.A.; 6 - reference coil; 7 - resistor panel; 8 - junction block; 9 - electromagnetic valves; 10 - glow plug; 11 - blower; 12 - electric motor; 13 - safety block with fuse link MB-6D

The preheater is provided with a manual remote control effected from the preheater control board (Fig.50) mounted on the instrument panel in the driver's cab. The connection diagram of the preheater control board is shown in Fig.51.

#### Operation of Preheater

1. Before starting the preheater, check to see that the automobile is equipped with serviceable fire extinguishers.
2. Open the front inclined plate of the frame.
3. Bear in mind that oily places or leakage of fuel in the preheater, careless handling as well as possible deficiencies may cause fire.
4. During operation of the preheater the driver should not leave the automobile. In case of fire, immediately close the fuel distributing cock installed on the cab rear wall, switch off the preheater and begin extinguishing the fire.

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5. Starting and operation of the preheater are allowed only if the cooling system is completely filled.

(a) Starting

To start the preheater, proceed as follows:

- see that the tank is filled with fuel, start the motor by setting the electric motor switch to the OPERATION (PABOTA) position (Fig.50) for 10-15 sec. The electromagnetic valve switch should be kept in the SCAVENGE (HPOBYB) position;
- turn switch lever 4 to the left to cut in the glow plug and hold it in this position for 30-40 sec.

As a result pilot coil 1 on the panel, connected in series with the glow plug, should glow bright red;

- set electromagnetic valve switch 2 from the SCAVENGE (HPOBYB) to OPERATION (PABOTA) position, and motor selector switch 3 to the START (BYCK) position;
- if noise of flame is heard in the preheater boiler, release plug switch lever 4 and set switch 3 to the OPERATION (PABOTA) position (at temperatures below  $-20^{\circ}\text{C}$ ).

When the ambient air temperature is above  $-20^{\circ}\text{C}$ , it is permitted to set switch 3 to the OPERATION (PABOTA) position omitting the START (BYCK) position.

In emergency cases when the preheater motor fails to develop the necessary starting speed (severe frost, jamming of the fuel pump, discharged storage batteries, it is permitted to switch on the motor for 1-2 sec to the OPERATION (PABOTA) duty with subsequent changing over to the START (BYCK) duty, and after the flame noise is heard, to change over to the OPERATION (PABOTA) duty;

- if no specific noise of flame is heard, set switch 3 into the neutral position, electric valve switch 2 into the SCAVENGE (HPOBYB) position and repeat the preheater starting.

If the preheater fails to start, check to see that fuel is available in the fuel pump, for this purpose unscrew the fuel pipe; when fuel starts flowing out, screw in the pipe and restart the preheater.

If the preheater fails to start again, check atomization of fuel in the combustion chamber, and heating of the glow plug (See "Troubles and Remedies of Preheater").

It is prohibited to start the preheater immediately after its stopping or to repeat starting after 2-3 failures without preliminary scavenging for 5-7 minutes.

(b) Operation

During operation of the preheater the gear pump driven by the motor draws fuel through the pipelines and delivers it along the pipe to the electromagnetic valve (Fig.52).

When the valve is open, the fuel is forced under pressure through the injector into the combustion chamber. The fuel is mixed with air delivered by the blower and at the moment of starting is ignited by the glow plug. Then, the glow plug is switched off and the burning is maintained automatically. While burning off, the fuel heats the heat exchanger walls through which the heat is transferred to the coolant forced by the circulation pump into the boiler.

The optimum delivery of fuel into the combustion chamber during operation is characterized by a uniform angle of burning and bluish incandescence of the burnt gases at the preheater outlet.

Periodical throw of flame tongues, up to 100 mm long, is permitted.

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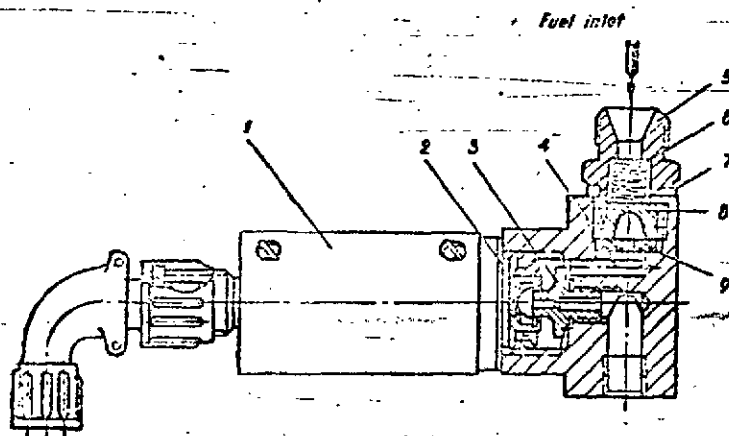


FIG. 52. ELECTROMAGNETIC VALVE

1 - valve; 2 - valve gasket; 3 - valve union; 4 - valve body; 5 - filter body;  
6 - main filter spring; 7 - injector gasket; 8 - injector filter; 9 - preheater  
horn pump valve gasket

As the gear pair (Fig. 48) wears off the fuel consumption is adjusted by means of a screw of the gear pump reducing valve. To increase the quantity of fuel delivered through the injector into the preheater, unscrew union nut 15 and turn screw 16 to the right until traces of flame are seen at the exhaust branch pipe of the preheater.

### (c) Stopping

To stop the preheater, proceed as follows:

- set electromagnetic valve switch 2 (Fig. 50) to the SCAVENGE (ИПОДВ) position to cut off the delivery of fuel to the combustion chamber.

After 1-2 minutes of the motor operation without burning of fuel (w/o noise of flame) switch off the motor by setting switch 3 to the neutral position.

Scavenging of the preheater combustion chamber and gas duct is carried out to remove remaining products of combustion and to prevent possible explosion of gases at subsequent starting.

### Maintenance of Preheating System

For reliable operation of the preheating system carry out all the operations prescribed in the Section "Preventive Maintenance of Automobile".

### Probable Troubles and Remedies of Preheating System

Trouble	Cause	Remedy
1	2	3
Preheater fails to operate - no delivery of fuel	(a) Clogged filter of electromagnetic valve	(a) Remove, wash and clean filter with compressed air or replace

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1.	2	3
	<p>(b) Electromagnetic valve fails to open (no click is heard when switch is set to OPERATION (PAWOTA) position</p> <p>(c) Clogged injector delivering fuel into combustion chamber</p> <p>(d) Air contained in fuel line</p> <p>(e) Electric motor fails to operate</p>	<p>(b) Check wire lugs on terminals for tightening, fuse link HP-2A and circuit breaker EJ-20 for condition; if necessary, replace connection of wire with valve plug connector; if necessary, disassemble and solder wire; check storage batteries and recharge, if necessary</p> <p>(c) Remove and disassemble injector, clean orifice in chamber and central hole in body, wash in gasoline or clean fuel, blow with compressed air, check injector for atomization without screwing it into burner. Metal objects should not be used for cleaning injector orifices</p> <p>(d) Unscrew fuel pipe, release air and turn in pipe as soon as fuel starts flowing from pump</p> <p>(e) Ring out motor circuit with the help of lamp, press down button of circuit breaker HP-2B on control board, check wire tags on terminals for tightening, check storage batteries for condition and recharge, if necessary</p>
<p>Glow plug fails to operate</p>	<p>(f) Electric motor does not operate at starting speed</p> <p>(a) Poor contact of glow plug wire lugs</p> <p>(b) Burnt pilot coil on control panel</p> <p>(c) Burnt glow plug coil</p> <p>(d) Insufficient heating of glow plug coil</p>	<p>(f) Check circuit, tightening of wire lugs on terminals; check storage batteries for condition and recharge, if necessary</p> <p>(a) Check wire lugs on terminals for proper tightening</p> <p>(b) Replace coil</p> <p>(c) Replace glow plug</p> <p>(d) Check wire lugs on terminals for tightening and storage batteries for condition, recharge, if necessary</p>

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1	2	3
Preheater smokes	<p>(a) Low speed of electric motor</p> <p>(b) Injector fails to spray</p> <p>(c) Exhaust branch pipe or air intake screen of blower clogged with dirt</p> <p>(d) Scale formation in combustion chamber</p>	<p>(a) Recharge storage batteries</p> <p>(b) Disassemble, check for atomisation, clean, wash and blow with compressed air</p> <p>(c) Clean of dirt</p> <p>(d) Disassemble, remove scale, wash and blow with compressed air</p>
Low temperature of burnt gases (prolonged heating of engine)	<p>(a) Insufficient fuel consumption: clogged valve filter and injector, leaky pipelines</p> <p>(b) Burnt 0.16 ohm resistor on control board panel</p>	<p>(a) Wash filter, injector tighten pipeline connections</p> <p>(b) Replace resistor, having wound nichrome wire X20H30, 124 mm long, dia. 1 mm</p>
Overheating of pre-heater during operation	<p>(a) Circulation pump fails to operate</p> <p>(b) Air locks in system</p>	<p>Check to see whether pre-heater motor operates. If the motor is in order, disassemble pump unit, eliminate trouble</p> <p>(b) Check level of coolant in radiator; add coolant, drain 2-3 litres of coolant through preheater drain cock</p>

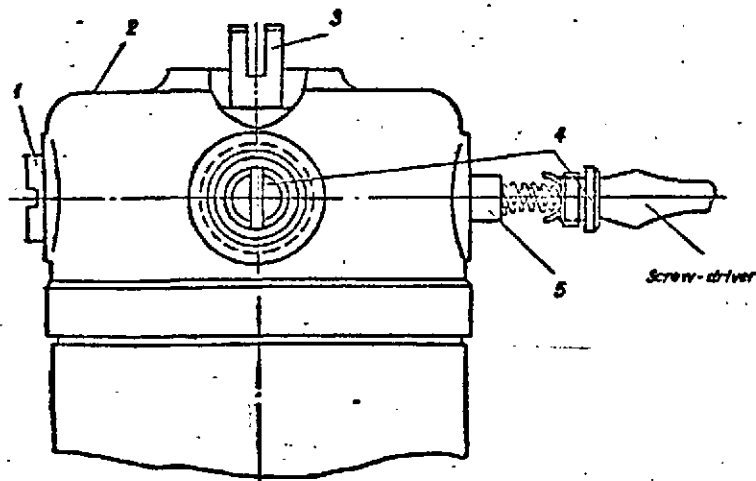


FIG. 51. REPLACEMENT OF PREHEATER MOTOR COMMUTATOR BRUSHES

1 - plug; 2 - electric motor; 3 - coupling; 4 - plug-brush; 5 - brush

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1	2	3
	(c) Preheater is disconnected from engine cooling system	Check position of preheater cut-in gasket

Note. If the commutator brushes are worn, replace them. For this purpose: unlock motor plugs 1 (Fig.53), unscrew plug brushes 4 and take out the brushes, clean the commutator of dust with the help of a cloth soaked in alcohol, install new brushes, screw in the plugs and lock them

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**Chapter III****HYDRO-MECHANICAL TRANSMISSION****PURPOSE AND DESIGN OF HYDRO-MECHANICAL TRANSMISSION**

The hydro-mechanical transmission is designed:

- to change the tractive effort applied to the driving wheels and to change the automobile speed depending upon the road conditions;
- to provide reverse movement of the automobile without changing the sense of the engine crankshaft rotation;
- to disconnect the engine from the power train when the engine is started, or is running at halts.

The tractive effort applied to the driving wheels and the automobile speed on different roads are varied by stepless automatic change in gear ratios in the torque converter (hydraulically) and also by selecting the gears in the planetary gearbox (mechanically).

The hydro-mechanical transmission is driven from the overdrive gear propeller shaft and is installed on the automobile frame on rubber pads.

The hydro-mechanical transmission mounted on the automobile is a single assembly consisting of the following main units:

- torque converter;
- planetary gearbox;
- hydraulic system units.

The general view of the hydro-mechanical transmission is shown in Fig.54.

**TORQUE CONVERTER**

The torque converter is designed for automatic stepless (smooth) change of the engine torque within the specified limits depending on varying road conditions.

The torque converter contributes to extended service life of the engine and transmission, decreases engine torsional vibrations and cushions shocks transmitted from the driving wheels to the engine, and also excludes the possibility of engine stopping in case of overload.

The torque converter is a hydraulic drive in which the power from the driving shaft is transmitted to the driven shaft by means of fluid.

**Torque Converter Design**

The torque converter consists of the following main elements: pump wheel, turbine wheel, two stators, two overrunning clutches and torque converter lock-up friction clutch.

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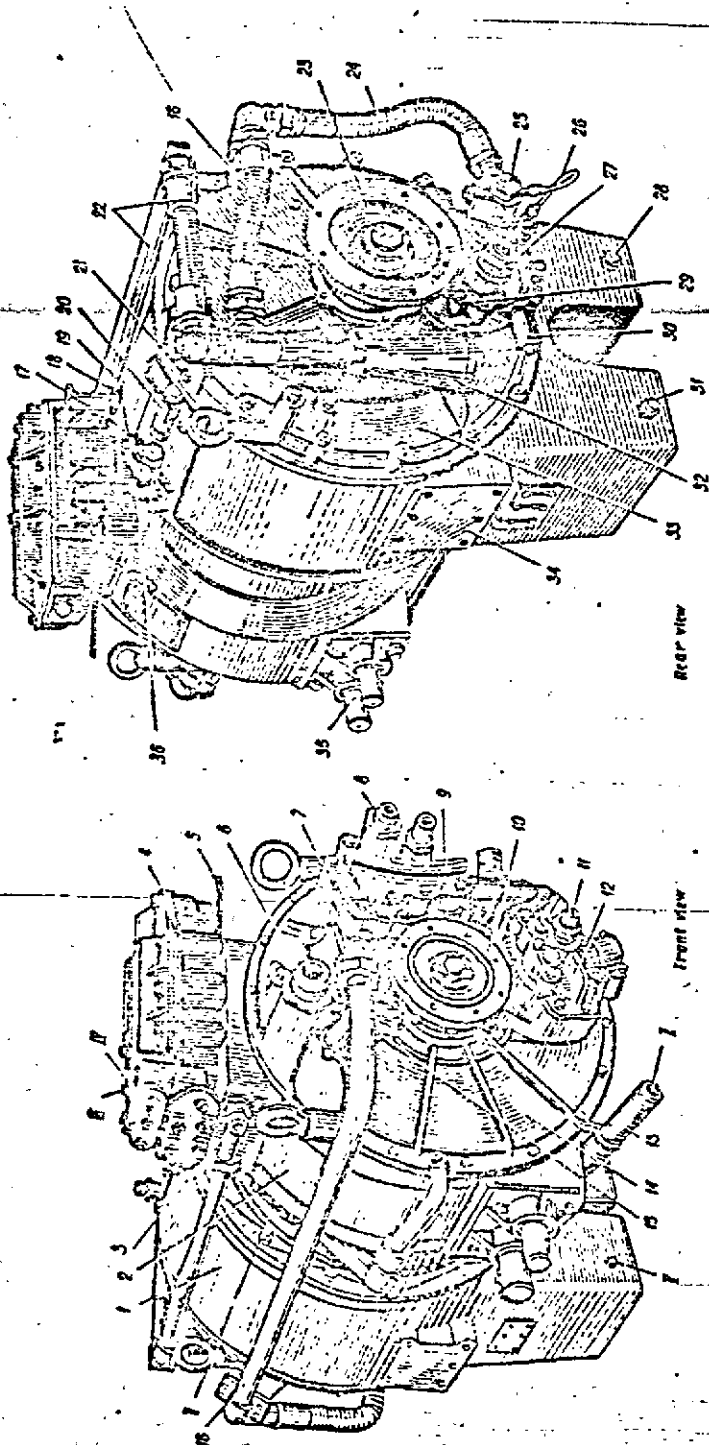


FIG. 51. GENERAL VIEW OF HYDRO-MECHANICAL TRANSMISSION

1 - planetary gear set; 2 - torque converter housing; 3 - union of drain pipeline connecting control unit with tank; 4 - hydro-mechanical transmission control unit; 5 - control unit lever; 6 - union of suction pipeline connecting tank with front pump; 7 - eye ring; 8 - union of suction pipeline entering from oil cooling; 9 - torque converter pump; 10 - hydraulic transmission driving shaft flange; 11 - union of pipeline connecting front torque converter housing to torque converter encoder; 12 - pipeline running from torque converter; 13 - pipeline running from torque converter housing to torque converter encoder; 14 - torque converter lock-up mechanism; 15 - screw; 16 - eye ring; 17 - torque converter front cover; 18 - first gear channel plug; 19 - union of pipeline running from hydraulic cyclone filter to torque converter front cover; 20 - first gear channel plug; 21 - pipeline running from hydraulic cyclone filter to torque converter front cover; 22 - pipeline running from hydraulic cyclone filter to torque converter front cover; 23 - hydraulic transmission driven shaft flange; 24 - planetary gear set; 25 - rear pump non-return valve; 26 - rear pump non-return valve; 27 - rear pump cut-out valve; 28 - union of suction pipeline running from tank to rear pump; 29 - joint for installation of elbow for obtaining from front tank; 30 - hydraulic transmission rear pump; 31 - rear pump cut-out valve; 32 - magnetic ball plug; 33 - hydraulic cyclone filter; 34 - planetary gear set cover; 35 - plate for attachment of hydraulic transmission support brackets; 36 - hydraulic transmission front support bracket; 37 - reverse gear smooth engagement mechanism.

Points for connection of sensing units:  
 I - torque converter temperature gauge sensing unit; II - torque converter pressure gauge sensing unit; III - rear low pressure gauge sensing unit; IV - lubricating system pressure gauge sensing unit; V - gearbox temperature gauge sensing unit.

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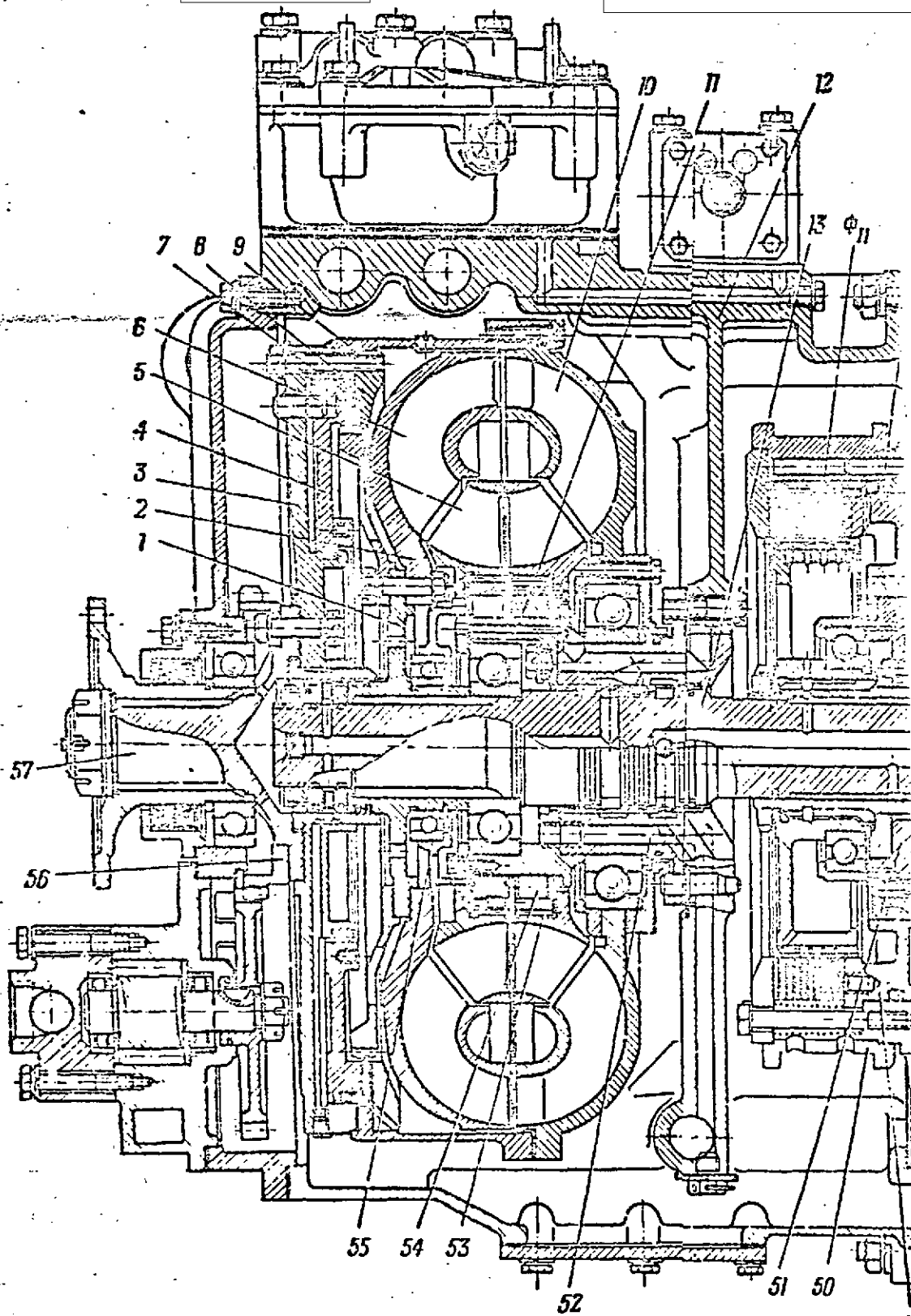


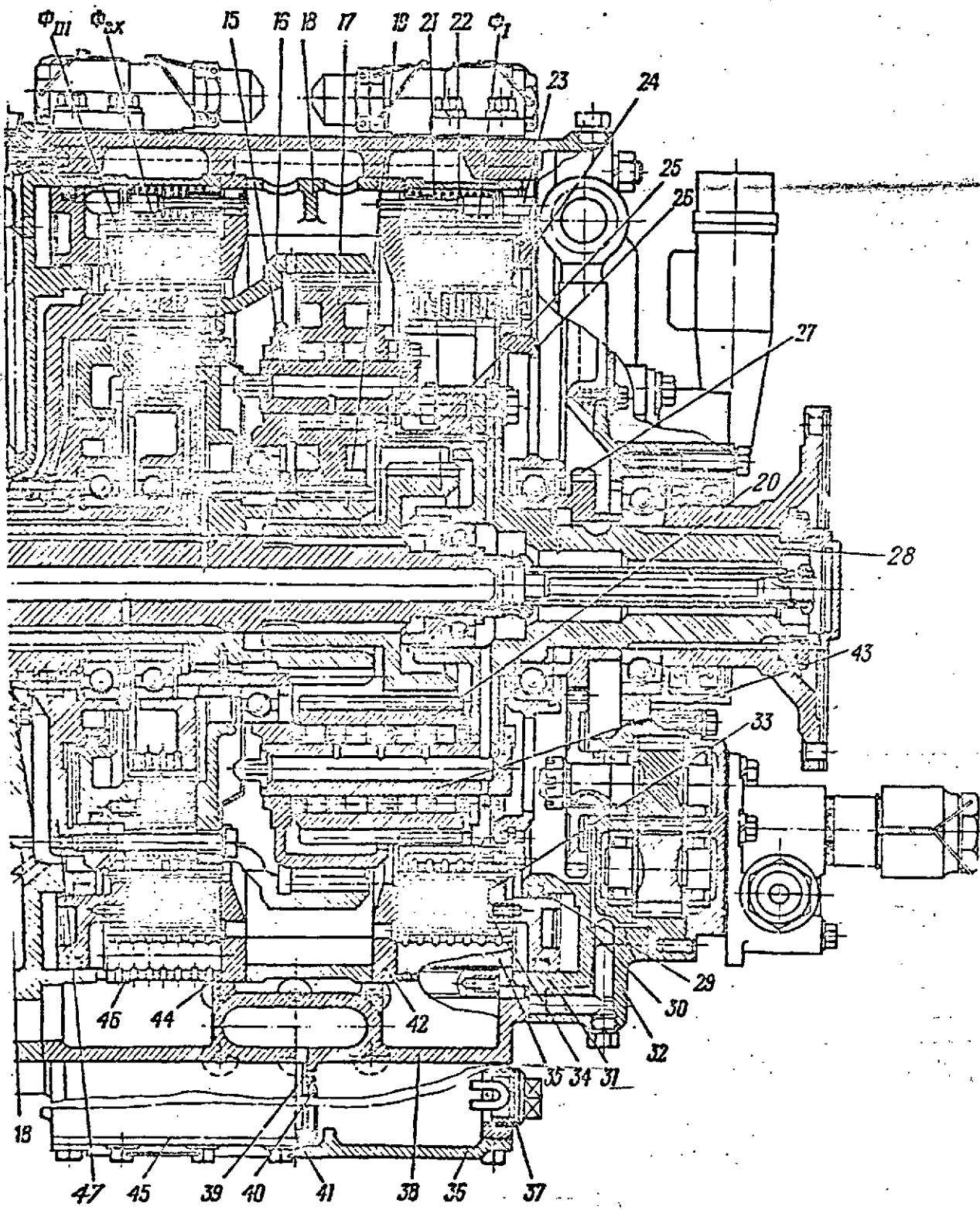
FIG. 5  
 1 - turbine wheel; hub; 2 - torque converter lock-up friction clutch hub; 3 - lock-up friction clutch housing; 4 - piston; 5 - stators; 6 - turbine wheel; 7 - torque converter lock-up friction clutch disc; 8 - torque converter lock-up friction clutch disc; 9 - torque converter casing; 10 - pump wheel; 11 - overrunning clutch; 12 - torque converter housing; 13 - turbine shaft; 14 - reverse speed friction clutch; 15 - first planetary set crown gear; 17 - first planetary set crown gear; 18 - first planetary set crown gear; 19 - first planetary set crown gear; 20 - first planetary set crown gear; 21 - first planetary set crown gear; 22 - first planetary set crown gear; 23 - first planetary set crown gear; 24 - first planetary set crown gear; 25 - first planetary set crown gear; 26 - first planetary set crown gear; 27 - first planetary set crown gear; 28 - first planetary set crown gear; 29 - first planetary set crown gear; 30 - first planetary set crown gear; 31 - first planetary set crown gear; 32 - first planetary set crown gear; 33 - first planetary set crown gear; 34 - first planetary set crown gear; 35 - first planetary set crown gear; 36 - first planetary set crown gear; 37 - first planetary set crown gear; 38 - first planetary set crown gear; 39 - first planetary set crown gear; 40 - first planetary set crown gear; 41 - first planetary set crown gear; 42 - first planetary set crown gear; 43 - first planetary set crown gear; 44 - first planetary set crown gear; 45 - first planetary set crown gear; 46 - first planetary set crown gear; 47 - first planetary set crown gear; 48 - first planetary set crown gear; 49 - first planetary set crown gear; 50 - first planetary set crown gear; 51 - first planetary set crown gear; 52 - first planetary set crown gear; 53 - first planetary set crown gear; 54 - first planetary set crown gear; 55 - first planetary set crown gear; 56 - first planetary set crown gear; 57 - first planetary set crown gear.

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HYDRO-MECHANICAL TRANSMISSION

- 15 - driven shaft
- 16 - first speed friction clutch cover
- 17 - first speed friction clutch piston
- 18 - planetary gearbox rear cover
- 19 - first speed friction clutch driving plate
- 20 - first speed friction clutch driven plate
- 21 - first gear toothed rim
- 22 - lower cover
- 23 - magnetic drain plug
- 24 - planetary gear case
- 25 - oil header body
- 26 - screen
- 27 - oil header handle
- 28 - first speed friction clutch cover
- 29 - planetary gear case
- 30 - first speed friction clutch piston
- 31 - planetary gearbox rear cover
- 32 - first speed friction clutch driving plate
- 33 - first speed friction clutch driven plate
- 34 - first gear toothed rim
- 35 - lower cover
- 36 - magnetic drain plug
- 37 - planetary gear case
- 38 - oil header body
- 39 - screen
- 40 - oil header handle
- 41 - first speed friction clutch cover
- 42 - planetary gear case
- 43 - planetary gear case
- 44 - reverse speed friction clutch cover
- 45 - planetary gear case
- 46 - planetary gear case
- 47 - planetary gear case

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Pump wheel 10 (Fig. 55) is a driving member of the torque converter. The pump wheel is connected with driving shaft 57 through casing 9 and lock-up friction clutch housing 3. The wheel is driven from the engine through the overdrive gear. The pump wheel is provided with vanes evenly spaced along the circumference. The vane shape imparts the flow of working fluid a certain speed and a required direction.

Turbine wheel 6 is a driven member of the torque converter and is rotated by the flow of working fluid created by the pump wheel. The turbine wheel is provided with evenly spaced vanes the shape of which provides for maximum utilization of the fluid flow directed by the pump wheel to the turbine wheel.

When leaving the turbine wheel, the flow of working fluid changes its direction and flows in the direction reverse to the pump wheel rotation.

The turbine wheel is coupled through hub 1 with turbine (driven) shaft 13 which, at the same time, is the driving shaft of the planetary gearbox.

Stators 5 provide for multiplication of the torque applied to the turbine shaft due to the action of the stator vanes on the flow of working fluid leaving the turbine wheel.

The stators are provided with vanes evenly spaced along the circumference. Due to the vane shape the flow of working fluid leaving the turbine wheel changes its direction and flows in the same direction as the pump and turbine wheels rotate.

Each of the stators is connected with stationary housing 12 of the torque converter through an overrunning clutch.

The overrunning clutches are a roller type. The overrunning clutches allow the stators to rotate in the direction of rotation of the pump and turbine wheels but prevent them from rotating in the reverse direction. Each clutch is provided with outer race 53 whose inner surface has wedge slots, rollers 54 and springs pressing the rollers to the wedging surface of the outer race slots. Inner race 11 is common for both clutches and is bolted to stator hub 52 which is attached, in its turn, to the torque converter housing.

The outer races of the overrunning clutches are attached to the stators by means of screws and splines.

The overrunning clutch design is shown in Fig. 56.

The torque converter lock-up friction clutch consists of friction clutch housing 3 (Fig. 55) with a packing ring, piston 4 with a sealing ring, driven metal-ceramic disc 7, friction clutch hub 2 rigidly jointed to turbine shaft 13, and thrust disc 8.

Hydraulic transmission pump drive gear 56 and driving shaft 57 are attached to the friction clutch housing.

The friction clutch is operated hydraulically.

When the friction clutch is engaged, the oil pressure in the booster exceeds the pressure of oil in the torque converter space and causes the friction clutch piston to move. While moving, the

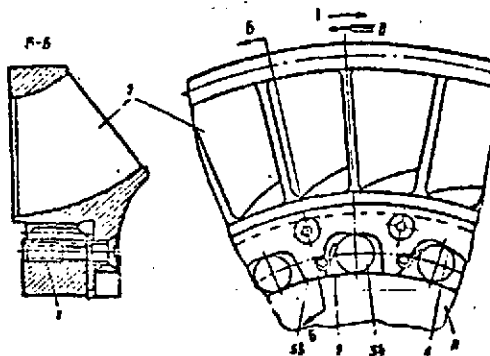


FIG. 56. STATOR AND OVERRUNNING CLUTCH

1 - screw attaching outer race to stator; 2 - spring; 5, 11, 53 and 54 - see Fig. 55. A - outer race wedging surface; I - direction in which stator can rotate (overrunning clutch is unlocked); II - direction in which stator can not rotate (overrunning clutch is locked)

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friction clutch piston presses the driven disc against the thrust disc which is attached to the pump wheel; as a result the turbine and pump wheels become rigidly interconnected, thus providing direct transmission of the engine power to the planetary gearbox.

The friction clutch is disengaged when the pressure in the friction clutch space is relieved due to the pressure of oil in the torque converter space; in this case, the rigid connection of the pump and turbine wheel is eliminated.

Friction clutch housing 3, casing 9 and pump wheel 10 form a sealed space which is always filled with working fluid (oil) kept under pressure during operation of the torque converter.

#### Operation of Torque Converter

The torque converter can be used to perform three duties: torque multiplication, functioning as a fluid coupling and operation in a locked-up state. Description of the torque converter operating principles at different duties is given below.

#### Torque Multiplication Duty

(a) During the first stage of the torque converter operation both stators are stationary and ensure the greatest difference of torque between the driving and driven shafts. The stators are stationary because oil leaving the turbine strikes the stator vanes causing them to rotate in a direction opposing rotation of the pump and turbine wheels. The stators are mounted on the overrunning clutches which prevent the stators from rotating in this direction. The stators turn the flow of oil leaving the turbine wheel in the direction of the pump wheel rotation. Such a direction of the oil flow reduces loss of power when the oil re-enters the pump, and, at the same time, the flow reaction on the stator side acts on the turbine wheel and increases the torque applied to the output shaft.

(b) During the second stage of the torque converter operation the primary (front) stator freely rotates in the flow of working liquid. The primary stator begins to freely rotate as soon as the load applied to the turbine shaft is reduced. As a result, the turbine wheel speed increases and the oil leaving the turbine wheel acts on the vanes of the primary stator so that its locking-up on the overrunning clutch ceases and the stator begins to freely rotate in the flow of working fluid in the direction of the turbine wheel rotation. The torque multiplication ratio decreases, the speed of the turbine wheel rotation increases and the slipping of the torque converter decreases.

The torque multiplication duty is used when placing the vehicle in motion, accelerating, movement on poor roads, towing heavy trailers, negotiating upgrades and obstacles.

#### Fluid Coupling Duty

When the secondary (rear) stator also begins to freely rotate in the flow of working fluid, the torque converter functions as a fluid coupling. It means that the speed of the turbine wheel rotation practically differs still less from the speed of the pump wheel rotation, and the torques applied to the driving and driven shafts are equal to each other.

The torque converter automatically changes over to functioning as a fluid coupling in case the road conditions require no increase of the torque applied to

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the turbine shaft. But as soon as the turbine wheel slows down due to increasing load on the turbine shaft, the stators at first one and then the other, are wedged on the overrunning clutches, the torque multiplication operation begins and the slipping of the torque converter increases.

#### Locked-Up State Duty

Even when the torque converter functions as a fluid coupling there is a certain loss of power due to slipping of the turbine wheel relative to the pump wheel. To avoid this loss of power caused by the slipping, the turbine and pump wheels are rigidly locked up by means of the lock-up friction clutch. With the lock-up friction clutch engaged, the pump and turbine wheels are interlocked and rotate at the same speed, and the power is transmitted mechanically. The torque converter should be locked up only after it begins to act as a fluid coupling. Locking-up of the torque converter is accomplished compulsorily when the automobile moves on good roads.

The torque converter should be locked up when driving the automobile in the second gear at a speed exceeding 25 km/hr or in the third gear at a speed exceeding 45 km/hr (in high gear in the transfer case).

### PLANETARY GEARBOX

#### Design of Planetary Gearbox

The planetary gearbox serves as an addition to the torque converter for changing the torque ranges.

The torque converter together with the planetary gearbox and hydraulic control system ensure smooth variation and a necessary range of the torque applied to the driving wheels in different gears, and also the possibility of engine operation with full utilization of its power under various driving conditions.

The kinematic diagram of the planetary gearbox is shown in Fig. 57.

The planetary gearbox has three speeds forward and one reverse.

Planetary Sets. Conversion of the torque in the planetary gearbox is accomplished in two planetary sets. Each planetary set consists of a sun gear, crown gear and three planet pinions.

The first planetary set comprises sun gear 19 (Fig. 55), crown gear 16 and three planet pinions 17.

Sun gear 19 of the first planetary set is made integral with the countershaft. A direct-drive friction clutch hub is press-fitted on the countershaft

spline having a greater diameter, while an intermediate-drive friction clutch hub is fitted on the tail piece splines.

Crown gear 16 serves, at the same time, as a cover of the direct-drive friction clutch (2III) and is attached to friction clutch housing 47.

The second planetary set comprises sun gear 21, crown gear 24 and three long planet pinions 20 which are in constant mesh with the planet pinions of the first set.

Sun gear 21 of the second planetary set is a driving gear of the planetary gearbox. After the torque converter is coupled with the gearbox, gear 21 is secured on turbine shaft 13.

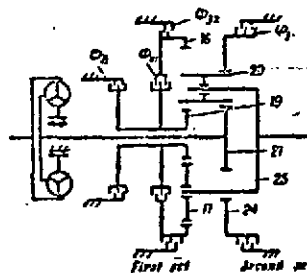


FIG. 57. KINEMATIC DIAGRAM OF PLANETARY GEARBOX (SEE FIG. 55) FOR REFERENCE NUMBERS AND DESIGNATIONS

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Crown gear 24 is attached to support 26 by means of plates. Support 26 is mounted on a bearing of hydraulic transmission driven shaft 28.

The fourth element of the planetary set is carrier 25 which is common for both planetary sets. Hydraulic transmission driven shaft 28 is attached to it by six fitted bolts.

Short axles 15 of the first planetary set planet pinions and long axles 43 of the second planetary set planet pinions are mounted in the carrier. The axles are kept from turning by plates which are attached by two bolts each.

The planet pinion axles are made hollow and are provided with holes for delivery of lubricant to the planet pinion bearings.

The plugs of the planet pinion axles have metering orifices for lubrication of the reverse-speed friction clutch (63X).

The surface of the planet pinion inner diameter serves as an outer race of the bearing, and the planet pinion axle - as an inner race.

The planet pinions of the first and second planetary sets are installed on special roller bearings.

Each planet pinion with the axle and bearings is a separate set, and in case of disassembly the complete set should be preserved.

Control Friction Clutches. Shifting of the gears is accomplished by alternately locking the elements of the planetary sets by means of control friction clutches. Each gear is engaged by applying only one of the four friction clutches, with the others kept released.

All the friction clutches operate in oil.

The friction clutches of the first (61), second (611) and reverse (63X) speed are stationary while the third speed friction clutch (6111) is a rotary type.

The friction clutches are hydraulically operated.

All the friction clutches are similar in design and consist of the following main parts: friction clutch housing, piston, driving and driven discs, hub, rim and return springs.

As an example, we shall consider the design and operation of the first speed friction clutch.

The friction clutch (61) is similar in design with friction clutch (63X) and their parts are identical.

Planetary gearbox rear cover 32 serves as a housing of the first speed friction clutch. The friction clutch housing and piston 30 form a space called a friction clutch booster. The friction clutch booster is sealed by oil-resistant rubber rings 29 and 31 one of which is fitted into a piston groove and the other - into a groove of the friction clutch housing.

The first speed booster is connected with the control unit through channels made in torque converter housing 12, intermediate housing 48, gear case 38 and rear cover 32.

The boosters of all the other speeds are also connected with the control unit through channels.

The first and reverse-speed friction clutches are provided with 15 discs each; seven of them are driving and eight discs are driven. In all the friction clutches the driving and driven discs are placed alternately, with the driven steel disc placed first from the piston side.

Driving discs 33 of the friction clutch with internal teeth are fitted on the external splines of crown gear 24 which is a friction clutch hub. The steel driving discs are covered with metal-ceramic friction linings having spiral and radial

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grooves contributing to rapid removal of oil from the disc surface when the friction clutches are engaged, and to reduction of their slippage time.

The driving discs are made by caking metal-ceramic linings with a steel disc. The metal-ceramic linings are made of copper-base powders.

The metal-ceramic composition provides for high wear resistance, high friction coefficient in oil and anticoring when the metal-ceramic surface rubs against the steel surface.

Steel driven discs 34 with external teeth are installed on the internal splines of first gear toothed rim 35. The rim is stationary and is attached to planetary gear case 38 by a key of the rectangular section.

The planetary gear case is provided with two diametrically arranged notches for keys.

Notches for keys are also provided on the first (35) and reverse (46) gear rims, first (42) and reverse (44) gear friction clutch covers and spacing cylinder 18.

In the first and reverse gears the key takes up the reactive moment from the friction clutch rims and transmits it to the case.

When friction clutch (I) is engaged, the working fluid is delivered, under pressure, to the friction clutch booster and causes the piston to move. While moving, the piston compresses the stack of discs; as a result the crown gear stops, ensuring engagement of the first gear. When the stack of discs gets compressed the piston simultaneously compresses through push rods 23 springs 22 which return the piston to the initial position after disengagement of the friction clutch.

Second speed friction clutch (II) is provided with 11 discs five of which have metal-ceramic surfaces and the others are made of steel.

Piston 49 of the second speed friction clutch is mounted in intermediate housing 48; attached to the latter is second gear toothed rim 50 and support 51 of the third speed friction clutch housing bearing.

The intermediate housing also accommodates reverse speed friction clutch piston 14.

The pressure is conveyed to the second speed friction clutch booster through channels in the intermediate housing and torque converter housing.

Third speed friction clutch (III) is fitted with nine discs four of which have a metal-ceramic surface and the other five are made of steel.

The oil delivery line from stationary support 51 of the third speed friction clutch housing bearing to direct-drive friction clutch rotating housing 47 in which the piston is installed, is sealed by cast iron rings with a stepped lock.

The bushings, which accommodate the sealing cast iron rings, are plated with porous chrome.

Due to channeled pores filled with oil, the porous chrome layer improves working-in of the sealing cast iron rings and also extends the service life of both the rings and the bushings.

The planetary gear case mounts first- and reverse-speed smooth engagement mechanisms.

Rear pump drive gear 27 is keyed to driven shaft 28, and the rear pump is mounted on the rear cover.

Two oil headers of the suction pump are installed in two compartments of the planetary gear case lower half.

The oil header consists of body 39, screen 40 and handle 41.

The lower compartments of the case are closed by cover 36 through gasket 45. The compartments are provided with two drain holes one of which is closed by mag-

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netic plug 37 and the other receives a foam outlet hose running from the hydraulic transmission oil tank.

#### Lubrication of Planetary Gearbox

Lubrication of the planetary gearbox is a forced, pressure type. The planetary gearbox lubricating system is a component of the common hydraulic system of the hydromechanical transmission.

Lubricant is forced through channels in the torque converter housing into the inner space of the hydraulic transmission turbine and driven shafts. From the inner space of the turbine and driven shafts the lubricant is conducted through channels to the planet pinion rollers, gears and other rotating parts.

The oil delivered to the rotating parts is forced by the action of the centrifugal forces to flow through drilled passages provided in the turbine and driven shafts for lubrication of the bearings and friction clutches.

The splined parts mounting the driven and driving discs of the clutches, have special holes ensuring free passage of oil through the friction clutches.

The oil delivered to the friction clutches contributes to efficient dissipation of heat, preventing the friction clutch discs from warping. While flowing, the oil also cleans the friction clutches of wear products.

#### Operation of Planetary Gearbox in Different Gears

##### In First Gear

When the first gear is engaged, friction clutch CI (Fig.58) locks crown gear 24 (Fig.55). Only the second planetary set operates under load. Sun gear 21 is a driving element and carrier 25 - a driven one. The carrier rotates in the same direction as the sun gear but at a decreased speed. In the first gear the maximum increase of the torque is obtained in the gearbox.

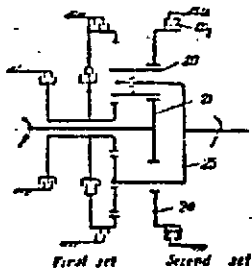


FIG. 58. OPERATION OF PLANETARY GEARBOX IN FIRST GEAR (SEE FIG. 55 FOR REFERENCE NUMBERS AND DESIGNATIONS)

the carrier which rotates in the same direction as the sun gear but at a higher speed than in case when the first gear is engaged.

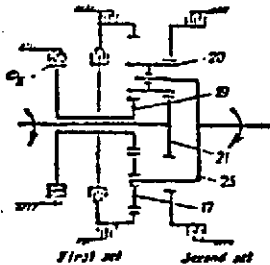


FIG. 59. OPERATION OF PLANETARY GEARBOX IN SECOND GEAR (SEE FIG. 55 FOR REFERENCE NUMBERS AND DESIGNATIONS)

When the second (intermediate) gear is engaged friction clutch CII (Fig.59) locks sun gear 19 (Fig.55). Gears 19,21, 17 and 20 of both planetary sets operate under load. The driving element is sun gear 21 and the driven one -

In the second gear the torque is increased in the gearbox but to a smaller extent than when the first gear is engaged.

##### In Third Gear

When the third (direct drive) gear is shifted in, rotating friction clutch CIII (Fig.60) locks up sun gear 19 and crown gear 16 (Fig.55) with each other; as a result, short planet pinion 17 and second planetary set long planet pinion 20 which is in constant mesh with it are prevented from rotation. Hence, the first and second planetary sets are interlocked and the entire planetary gearset rotates

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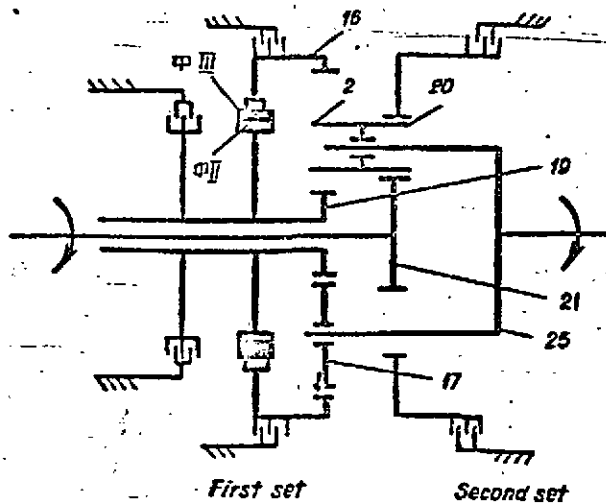


FIG. 60. OPERATION OF PLANETARY GEARBOX IN THIRD GEAR (SEE FIG. 55 FOR REFERENCE NUMBERS AND DESIGNATIONS)

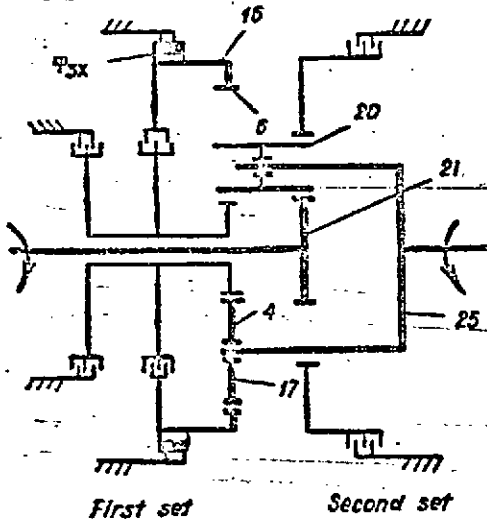


FIG. 61. OPERATION OF PLANETARY GEARBOX IN REVERSE GEAR (SEE FIG. 55 FOR REFERENCE NUMBERS AND DESIGNATIONS)

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as one unit at a speed of the driving shaft. In this case the torque is not increased in the planetary gearbox.

#### In Reverse Gear

When the reverse gear is engaged, friction clutch 63X (Fig.61) blocks crown gear 16 (Fig.55). Gears 21,17,20 and 16 of both planetary sets operate under load. Sun gear 21 is driving element and the carrier is a driven one. In the reverse the carrier rotates in the direction reverse to rotation of the driving shaft.

#### In Neutral

In neutral all friction clutches in the planetary gearbox are released and none of the planetary sets is locked up; as a result, no reactive element tending to increase the torque is available. In the neutral the planetary gearbox disconnects the engine from the automobile transmission.

When placing the vehicle in motion or changing over from one gear to another the speeds of the driving and driven elements of the hydraulic transmission become equal due to slippage in the gearbox friction clutches, and also due to relative slipping of the torque converter pump and turbine wheels.

### HYDRAULIC SYSTEM OF HYDRO-MECHANICAL TRANSMISSION

The transmission hydraulic system is intended:

- to shift gears in the planetary gearbox;
- to lock up the torque converter;
- to build up pressure in the four friction clutches of the gearbox and in the torque converter lock-up friction clutch;
- to fill the torque converter space with working fluid (to prepare it for working condition) and to provide for circulation of fluid which removes heat;
- to provide lubrication of the transmission working parts and removal of heat generated during operation;
- to smoothly engage the planetary gearbox friction clutches and the torque converter lock-up friction clutch.

#### Hydraulic System Diagram

The hydro-mechanical transmission hydraulic system diagram is presented in Fig.62.

The hydro-mechanical transmission hydraulic system comprises main oil line I, torque converter feed line II; hydro-mechanical transmission lubrication line III, oil suction line IV, rear pump line V and torque converter locking-up system.

Main oil line I delivers oil to selector valve II which shifts the speed gears. The selector valve is connected through a system of levers and rods with the gearshift lever mounted on the steering column in the driver's cab.

When the driver sets the gearshift lever to this or that position, the selector valve admits oil from the main oil line to the booster of a corresponding speed friction clutch, connecting all the other boosters with the drain line.

The oil pressure required for engagement of the friction clutches is maintained by hydraulic master control valve 15 which discharges oil into the drain line when the pressure exceeds the specified limit. The spring of the master control valve is adjusted for maintaining the oil pressure within 9-13 kgf/cm<sup>2</sup>.

Oil is supplied to the main oil line by front oil pump 2 which draws oil from tank 4 through a screened oil header and delivers it to "hydraulic cyclone" filter 23. In the filter the oil is cleaned and conducted to control unit 13.

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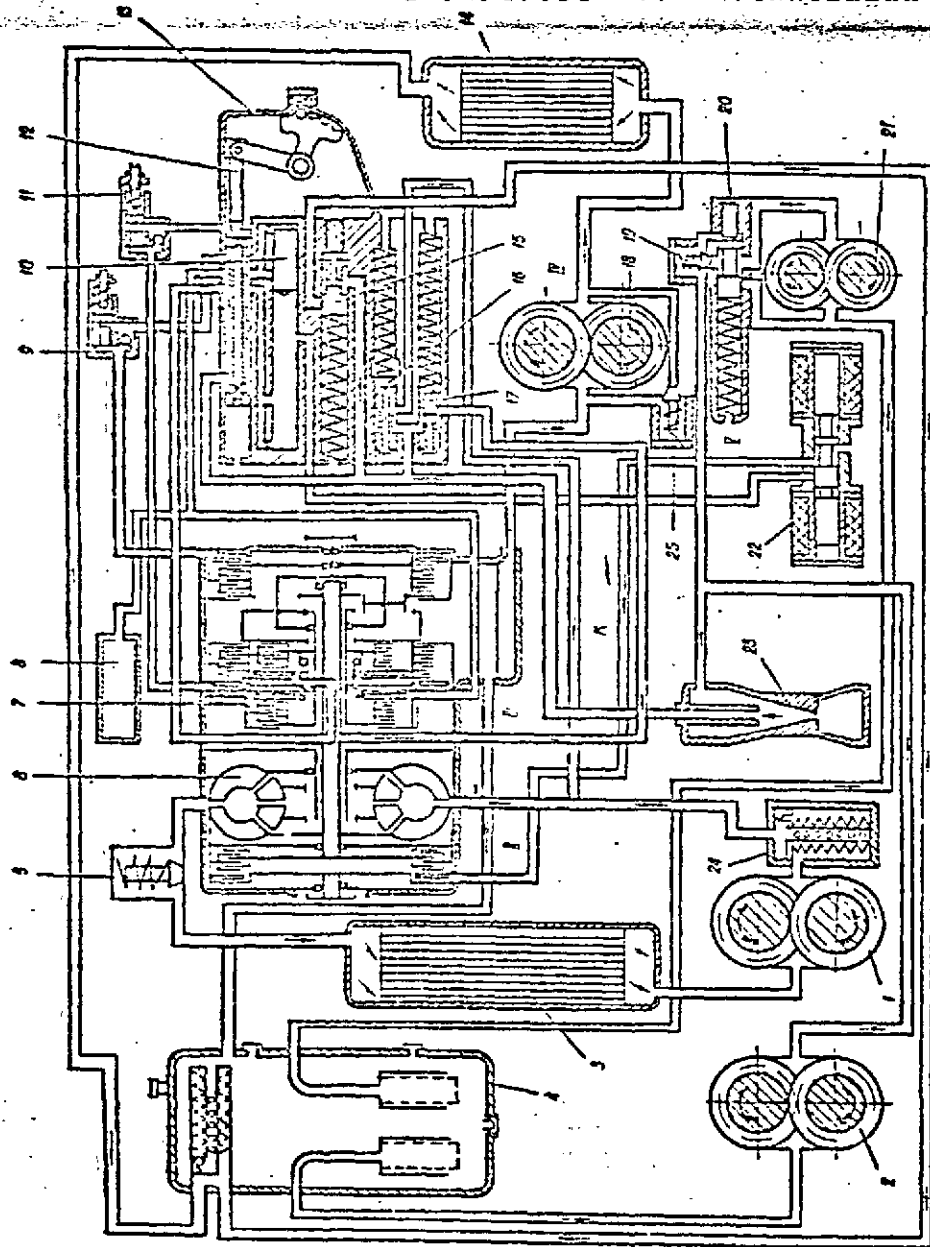
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FIG. 65. HYDRO-MECHANICAL TRANSMISSION HYDRAULIC SYSTEM DIAGRAM

- 1 - torque converter pump; 2 - front pump; 3 - torque converter cooler; 4 - oil tank; 5 - safety valve; 6 - torque converter; 7 - planetary gears; 8 - vertical gear damper; 9 - first speed smooth engagement mechanism; 10 - position slide valve; 11 - reverse gear smooth engage mechanism; 12 - relief valve; 13 - hydro-mechanical transmission control unit; 14 - planetary gearbox cooler; 15 - hydraulic master control valve; 16 - torque converter control valve; 17 - lubrication control valve; 18 - suction pump; 19 - rear pump nonreturn valve; 20 - rear pump return control valve; 21 - rear pump; 22 - torque converter lockup mechanism; 23 - hydraulic cylinder filter; 24 - oil filter; 25 - suction pump nonreturn valve; 1 - main oil line; II - torque converter feed line; III - hydraulic transmission lubrication line; IV - oil suction line; V - rear pump line; K - torque converter auxiliary feed channel



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Torque converter feed line II is a closed circuit connected into which in series are torque converter pump 1, torque converter 6, cooler 3, torque converter filter 24 and safety valve 5.

During operation of the torque converter the temperature of oil sharply rises due to relative slippage of the pump and turbine wheels; as a result the temperature conditions may become worse.

To eliminate the heat the oil is forced by the torque converter pump through the oil cooler, thus maintaining the operating temperature within 90-125°C.

To prevent damage of the torque converter cooler in case of a pressure rise at the inlet, a safety valve (Fig.63) is placed into the feed line between the torque converter and oil cooler, with its spring adjusted for a pressure of 4-4.6 kgf/cm<sup>2</sup>.

Leakage of oil from the torque converter feed line through packing rings, pump bearings, etc. is inevitable and is compensated by delivery of oil to the feed line through channel E.

The specified oil pressure in the torque converter feed line is maintained by a torque converter control valve whose spring is adjusted for a pressure of 3-4 kgf/cm<sup>2</sup>.

Operation of the control valve is schematically shown in Fig.64.

At the moment of engine starting when no pressure is built up in the torque converter feed line, the control valve is positioned as shown in Fig.64 (position I). When the pressure in channel "b" rises above the specified limit, the control valve overcomes the spring effort, moves to the right and covers delivery channel "a" (position II).

When the torque converter is locked up, the pressure in the feed line may rise due to additional pressure produced by the lock-up piston in the circulation circuit. To prevent excessive rise of the pressure the torque converter control valve is provided with a special journal having holes. When the pressure increases at the moment of locking-up, the control valve is moved until the drain journal aligns with a groove made in the body. Some oil drains through the holes into the groove and the pressure drops to the specified limit (position III).

Hydro-mechanical transmission lubrication line III is intended for lubrication of the friction surfaces of the parts and removal of heat in due time to ensure reliable operation and extended service life of the hydro-mechanical transmission.

Oil is fed under pressure into the line and conducted through a system of channels in the hydro-mechanical transmission to all lubrication points.

The specified pressure in the line is maintained by lubrication control valve 17 (Fig.62) which is introduced into the delivery line. The control valve spring is adjusted for a pressure of 1.0-1.5 kgf/cm<sup>2</sup>.

Suction line IV delivers oil from the sump of the hydraulic transmission, ensuring operation of the latter under "dry" housing conditions. Suction pump 18 draws oil from the sump and delivers it to oil cooler 14. The cooled oil is directed to the tank filter and then into tank 4. This system maintains the normal temperature conditions of the planetary gearbox corresponding to an oil temperature of 60-95°C.

The suction line is provided with a pressure limit valve. The valve prevents any damage of the planetary gearbox cooler in case of a pressure rise in the suction line, when the accelerator pedal is sharply depressed at the moment of engine starting.

The pressure limit valve is installed in the suction pump cover.

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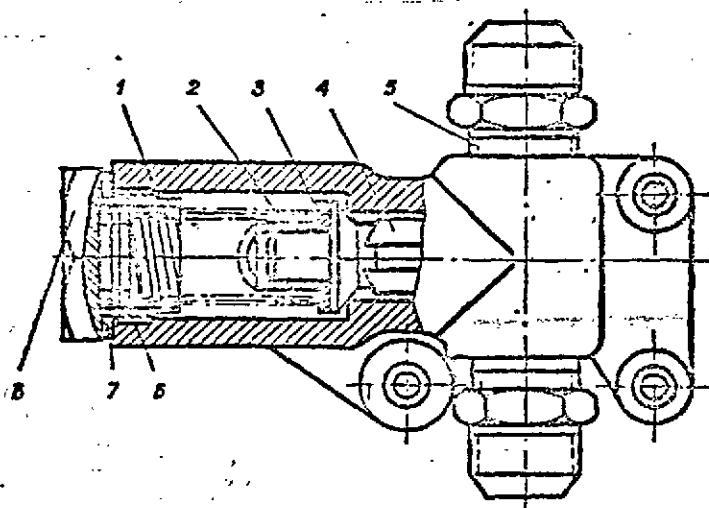


FIG. 63. TORQUE CONVERTER COOLER SAFETY VALVE

1 - safety valve body; 2 - spring; 3 - bushing; 4 - valve; 5 - unions; 6 - washer; 7 - gasket; 8 - bolt

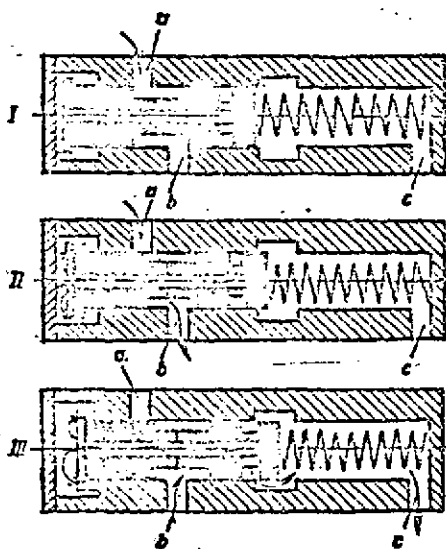


FIG. 64. OPERATION OF TORQUE CONVERTER CONTROL VALVE

I - position of control valve at the moment of engine starting; II - position of control valve during normal operation of the transmission; III - position of control valve at the moment the torque converter is locked up

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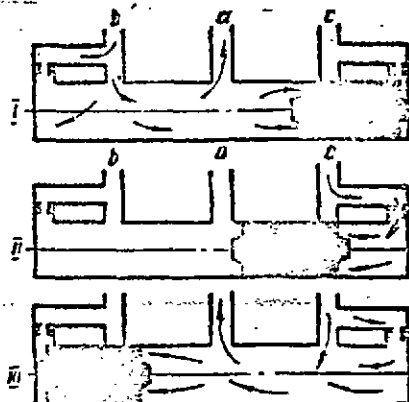


FIG. 65. OPERATION OF PENDULUM SLIDE VALVE

I - position of slide valve with third gear engaged; II - intermediate position of slide valve when changing over from the third to the second gear; III - position of slide valve with second gear engaged

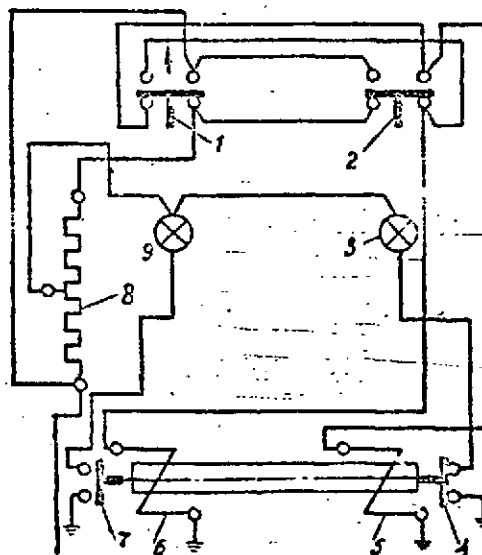


FIG. 66. TORQUE CONVERTER LOCK-UP MECHANISM CONNECTION DIAGRAM

1 - locking button; 2 - unlocking button; 3 - unlocking pilot lamp; 4 - unlocking contact assembly; 5 - unlocking coil; 6 - locking coil; 7 - locking contact assembly; 8 - resistor; 9 - locking pilot lamp

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Rear pump line V is intended to supply oil to the hydromechanical transmission when the engine is started by towing with another automobile. Rear pump 21 feeding oil into the line is driven by the automobile wheels through transmission units. Oil delivered by the rear pump flows to the main oil line through cut-out control valve 20 and non-return valve 19.

After the engine is started, front pump 2 begins to operate. The pressure in the main oil line rises and control valve 20 connects the delivery line of the rear pump with the suction line. In this case, non-return valve 19 closes and the rear oil pump becomes disconnected from the main line.

The torque converter locking-up system consists of a pendulum slide valve and lock-up mechanism.

Pendulum slide valve 10 permits the gears to be engaged, with the torque converter locked up. At the moment of shifting, the pendulum slide valve automatically unlocks the torque converter for 2-3 sec and then locks it up again.

The slide valve is arranged in a central channel of the control unit.

Operation of the pendulum slide valve is schematically shown in Fig.65.

Two channels connected with the second speed run into the slide valve space on the right side, one of them communicating with the slide valve space through jet (channel "c").

On the left side the slide valve space receives two channels similar in design but connected with the third speed (channel "b").

The line delivering working fluid to the torque converter lock-up mechanism (channel "a") starts from the centre of the slide valve space.

When the third gear is engaged the slide valve is brought to the extreme right position (I). With the torque converter locked up the position of the slide valve remains the same.

When changing over from the third to the second gear, with the torque converter locked up, the lock-up friction clutch is released simultaneously with disengagement of the third speed friction clutch since the line delivering working fluid to lock-up mechanism becomes connected with the drain channel.

At the same time when the second speed friction clutch is engaged the working fluid is delivered, under pressure, through the jet to the pendulum slide valve (position II).

It takes 2-3 sec for the working fluid to pass through the jet and to shift the pendulum slide valve to the extreme left position, thus having connected the torque converter lock-up mechanism line again (position III).

When changing over from the second to the third gear, the pendulum slide valve operates in the same manner but this time it is moved to the extreme right position.

Lock-up mechanism 22 (Fig.62) is designed for engagement of the torque converter friction clutch.

The lock-up mechanism is of an electromagnetic type. Its housing accommodates a slide valve and electromagnetic coils mounted at each end of the slide valve, and connected to the automobile electric system.

The torque converter connection diagram is shown in Fig.66.

To lock up the torque converter the driver should press locking button 1.

When button 1 is pressed, 5A "cut-in" current flows to locking coil 6. It passes along the parallel circuits: through the closed upper contacts of button 1 and through resistor 8, closed lower contacts of button 2 and closed upper contacts of button 1.

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Under the action of electromagnetic force of the "cut-in" current the lock-up mechanism slide valve moves to the left, thus connecting the main line with the lock-up friction clutch booster. At the same time locking pilot lamp 9 is switched on through contact assembly 7.

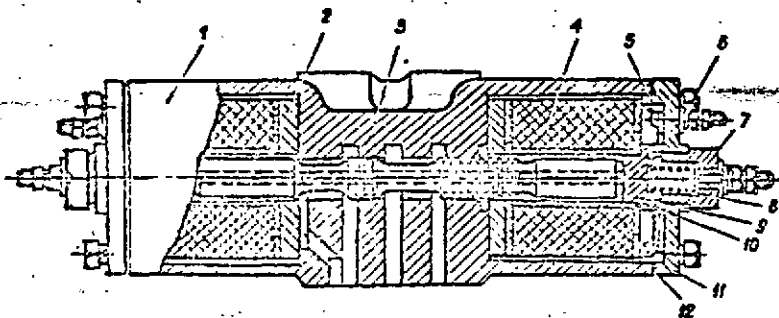


FIG. 67. TORQUE CONVERTER LOCK-UP MECHANISM

1 - lock-up mechanism housing; 2 - shield; 3 - slide valve; 4 - locking coil; 5 - insulation bushing; 6 - intermediate washer; 7 - locking contact; 8 - contact spring; 9 - limiter; 10 - insulation ring; 11 - cover; 12 - gasket

When the driver releases button 1, 1 A "hold-on" current flows to locking coil 4. It passes through resistor 8 and the closed lower contacts of button 2. The electromagnetic force of the hold-on current holds the lock-up mechanism slide valve in place.

To unlock the torque converter it is necessary to press unlocking button 2. When the button is pressed the current flows through the closed contacts of button 2 to coil 5 and causes the slide valve to move to the right position; as a result the main line is disconnected, and the lock-up friction clutch booster is connected with the drain hole. At the same time unlocking pilot lamp 9 is switched on through contact assembly 7.

The design and operation of the torque converter lock-up mechanism are shown in Figs 67 and 68.

#### Hydro-Mechanical Transmission Cooling System

The cooling system of the hydro-mechanical transmission is intended to maintain the normal temperature of all units of the hydro-mechanical transmission under any driving conditions.

The system (Fig. 12) consists of two independent lines: torque converter cooling line and planetary gearbox cooling line.

Gear pumps which force the oil to circulate through the system are introduced into both lines.

The air oil coolers of the torque converter cooling system are mounted on the chassis at the right-hand side of the engine and made as a single block with the right-hand section of the engine water radiator. The planetary gearbox section of the oil cooler is located in the middle of the radiator block and the torque converter section - at the rear of the block.

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Air forced by the fan through the coolers removes heat from the tubes along which the hot oil flows, and from the fins soldered to them, and dissipates it into the atmosphere, thus cooling down the radiators.

The torque converter cooling line is a closed oil circulation circuit: gear pump 1 - filter 24 - torque converter - safety valve 5 - torque converter cooler 3 - gear pump 1.

The planetary gearbox cooling line consists of suction pump 18 and planetary gearbox cooler 14. The suction pump draws used oil from the planetary gear case and delivers it through the cooler and filter to hydro-mechanical transmission oil tank 4.

The cooling system maintains normal temperature conditions corresponding to oil temperatures: in the torque converter - 90-125°C, in the planetary gearbox - 60-95°C.

#### Hydro-Mechanical Transmission Pumps

The pumps of the hydro-mechanical transmission are intended to deliver working fluid (oil) to the torque converter and planetary gearbox during their operation. The front pump, torque converter pump and suction pump are located on the front cover of the torque converter and driven from the gear installed on the hydro-mechanical transmission input shaft. The rear pump is located on the rear cover of the planetary gearbox and driven from the gear installed on the output shaft of the hydro-mechanical transmission.

The torque converter pump (Fig.69) serves to force working fluid through the torque converter to remove heat generated during its operation and to build up excessive pressure in the torque converter, ensuring steady transmission of power under all operating conditions of the torque converter.

Driving gear 7 and two driven gears 5 are installed on roller bearings 12 in pump body 3 and cover 1. Drive gear 6 is secured on the driving gear shank by key 9 and locked by nut 10 and cotter pin 11.

To decrease internal leaks in the pump, two steel ground end gaskets 4 are placed between the gears and the body at one side and between the gears and the cover at the other.

To prevent external leakage from the pump liner gasket 2 is set between the cover and the body, and packing cast iron ring 8 is fitted on pump drive gear 6.

The pump cover is centered on the body by means of two pins and attached to it by bolts and spring washers.

The inlet and outlet holes are made on the pump cover.

During assembly it is necessary to match holes "a", 8 mm in dia, in end gaskets 4 with milled notches in body 3 and a hole in cover 1 as shown in Fig.70.

The front pump is designed to deliver working fluid to the boosters of the planetary gearbox when the gears are shifted in, to lubricate the friction surfaces of the parts and to replenish leaking fluid in the line serviced by the torque converter pump.

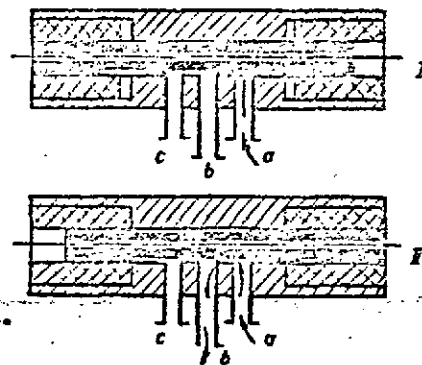


FIG. 69. OPERATION OF LOCK-UP MECHANISM

Position I - torque converter is unlocked;  
Position II - torque converter is locked up  
a - main pressure delivery channel; b - channel for delivery of main pressure to torque converter lock-up booster; c - drain channel

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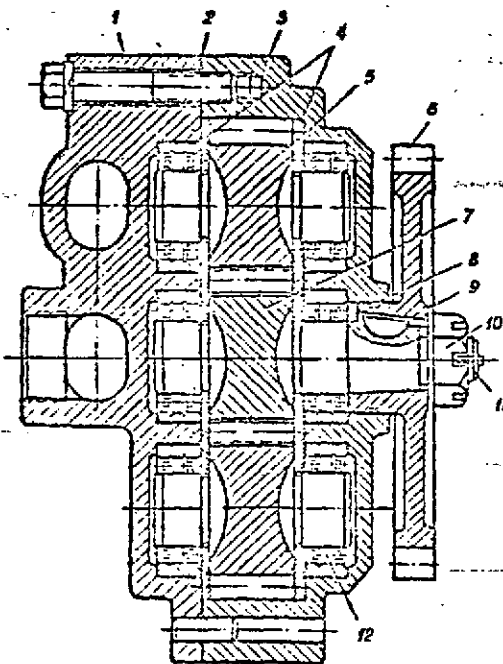


FIG. 69. TORQUE CONVERTER PUMP

- 1 - pump cover; 2 - pocket (liner); 3 - pump body; 4 - gaskets (steel); 5 - driven gear; 6 - drive gear; 7 - driving gear;
- 8 - packing ring; 9 - key; 10 - nut; 11 - cotter pin; 12 - bearing

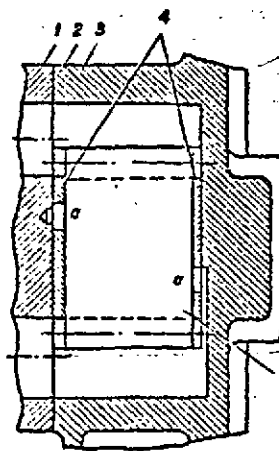


FIG. 70. ALIGNMENT OF HOLES IN GASKETS, BODY AND COVER DURING ASSEMBLY OF TORQUE CONVERTER (SEE FIG. 69 FOR REFERENCE NUMBERS)

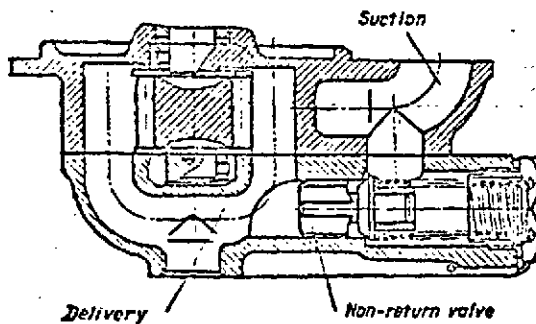


FIG. 21. SUCTION PUMP WITH NON-RETURN VALVE

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The front pump is interchangeable with the torque converter pump. The suction pump (Fig.71) serves to deliver working fluid from the lower half of the planetary gear case to the oil tank.

The design of the suction pump is similar with that of the torque converter pump. The difference consists in that the inlet hole is made in the pump body and the outlet hole - in the pump cover. Besides, the pump cover accommodates a non-return valve limiting oil pressure in the line running from the suction pump to the cooler.

The rear pump (Fig.72) is intended to deliver working fluid to the hydro-mechanical transmission and to lubricate it during towing of the automobile. Driving gear 3 and driven gear 9 are installed on roller bearings 2 in body 1 and cover 4. Drive gear 14 is secured on the driving gear shank by key 11 and locked by nut 12 and cotter pin 13.

To decrease internal leaks in the pump two steel ground gaskets 8 are placed between the gears and the body at one side and between the gears and the cover at the other.

During assembly of the rear pump it is necessary to match holes, 8 mm in dia, provided in end gaskets 8 with milled notches in body 1 and a hole in cover 4 in the same manner as it was done for the torque converter pump.

To prevent external leakage from the pump liner gasket 7 is set between the cover and the body and packing cast iron ring 10 is fitted on the hub of pump drive gear 14.

Cover 4 is centered on the pump body by two pins and attached to it by bolts and spring washers.

rear pump cut-out valve 6 is installed on the pump cover through cardboard gasket 5.

The rear pump is attached to the rear cover of the planetary gearbox by bolts and spring washers. The inlet and outlet holes are made in the body of the rear pump cut-out valve.

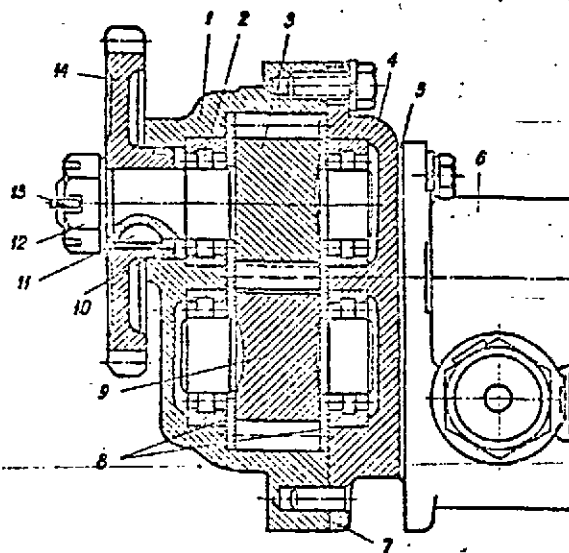


FIG. 72. HYDRAULIC TRANSMISSION REAR PUMP

1 - pump body; 2 - bearing; 3 - driving gear; 4 - pump cover;  
5 - gasket (cardboard); 6 - rear pump cut-out valve; 7 - gasket  
(liner); 8 - gaskets (steel); 9 - driven gear; 10 - packing ring;  
11 - key; 12 - nut; 13 - cotter pin; 14 - drive gear

#### Hydraulic Cyclone Filter

The hydro-mechanical transmission hydraulic system is provided with an inertia-type hydraulic cyclone filter (Fig.73) placed in the line between the pumps and the control unit. It is intended to clean oil circulating in the hydraulic system of mechanical impurities.

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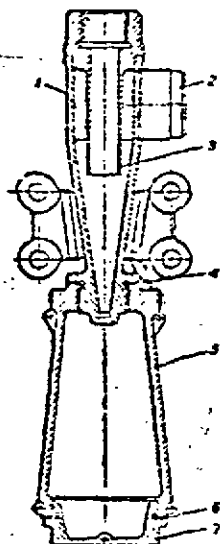


FIG. 73. HYDRAULIC  
CYCLONE FILTER

1 - filter body; 2 - inlet  
branch pipe; 3 - outlet  
branch pipe; 4, 6 - gaskets;  
5 - container; 7 - container  
cover

Oil is forced by the front and rear pumps through inlet branch pipe 2 into cyclone filter body 1 tangentially to the internal surface of the body. Under the action of centrifugal forces mechanical particles are thrown out to the wall of the hydraulic cyclone filter body and helically sliding along the smooth surface settle in container 5. The oil leaves the hydraulic cyclone filter through outlet branch pipe 3 and flows to the control unit.

From below the container is closed by threaded cover 7, gasket 6 is placed between the container and cover.

#### Smooth Engagement Mechanism and Air Damper

##### Purpose and Design of Mechanism

For smooth placing of the automobile in motion and also for shockless shifting of the gears the hydro-mechanical transmission is equipped with special smooth engagement mechanisms. They are introduced in series with the lines connecting the hydro-mechanical transmission control unit with the boosters of the first and reverse speed friction clutches. Air damper 8 (Fig. 62) is connected in parallel with the second speed line.

The first and reverse speed smooth engagement mechanisms are similar in design and differ only in bodies. The mechanism design is shown in Fig. 74.

##### Operation of Smooth Engagement Mechanism

When the first or reverse gear is shifted in, oil enters space "A" (Figs 74 and 75), presses ball 1 against the seat and covers the hole connecting spaces "A" and "B". As a result, the oil from space "A" passes through holes of valve 2 into space "B" and then into a booster of the gear to be shifted-in (position I).

When the pressure in space "B" rises up to 1 kgf/cm<sup>2</sup>, valve 2 is forced to move until it thrusts against screw 5, and the fluid from space A flows into space "B" through a throttle flat on the valve. As a result, the pressure in the booster of the gear to be engaged increases smoothly (position II).

When the gear is disengaged, space A is connected with a drain line and the oil from space "B" rapidly drains from the friction clutch booster, having pressed out the ball (position III).

##### Adjustment of Smooth Engagement Mechanism

After installation on the automobile the smooth engagement mechanism is adjusted by means of screw 5 (Fig. 74) which is fixed in a definite position by lock nut 4. In case the required values cannot be obtained by turning the adjusting screw, it is permitted to place washers under the valve spring.

When the screw is turned out, the valve travels through a longer distance to the stop, thereby decreasing the flat passage area through which the oil is passed. Due to throttling of oil through a metering passage area, the pressure in the friction clutch booster rises smoothly.

The less the screw is turned out, the greater is the flat passage area and, consequently, the more rapid and rigid is the engagement of the clutch.

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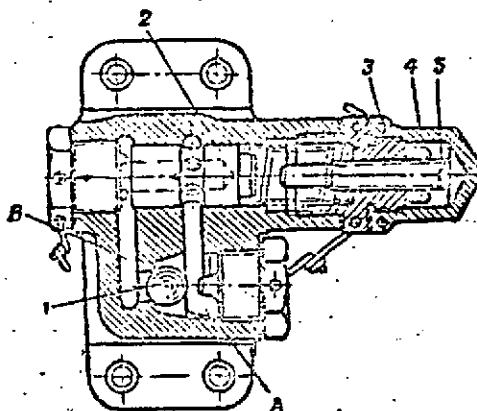


FIG. 74. SMOOTH ENGAGEMENT MECHANISM

1 - ball; 2 - valve; 3 - cap; 4 - lock nut;  
5 - adjusting screw; A, B - spaces

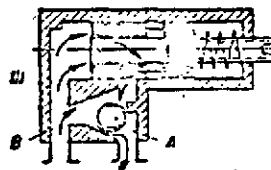
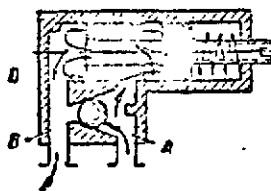
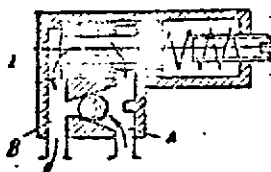


FIG. 75. OPERATION DIAGRAM  
OF SMOOTH ENGAGEMENT  
MECHANISM (SEE FIG. 74 FOR  
REFERENCE NUMBERS)

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The adjustment of the smooth engagement mechanisms is checked on an even horizontal hard-surface road at an engine speed of 550 r.p.m. and at a temperature of oil in the planetary gearbox of not below 20°C.

When the gearshift lever on the steering column is brought from the neutral to the first or reverse speed position, the pressure should increase to 10 kgf/cm<sup>2</sup> within 3 sec. The time of the pressure rise is controlled by pressure gauges installed in channels of the first and reverse speed boosters (the arrangement of the channel plugs is shown in Fig.5t).

The more accurate method of checking the smooth starting comes down to the following: when the gearshift lever on the steering column is brought from the neutral to the first or reverse speed position, acceleration of the automobile without load, when placing it in motion, should not exceed the following values: in the first gear - 0.6 m/sec<sup>2</sup> and in the reverse gear - 0.5 m/sec<sup>2</sup>. The acceleration test is carried out with the help of an accelerometer.

After adjustment screw 5 is locked with lock nut 4 and cap 3 - with a safety wire (Fig.7A).

#### Air Damper

The air damper which is placed in parallel with the second speed line is a cylindrical vessel installed vertically on the bracket of the hydro-mechanical transmission control unit.

When the second gear is shifted in, the oil is delivered into the friction clutch booster and the working space of the damper simultaneously. Due to compression of the air contained in the damper the pressure in the friction clutch booster rises more smoothly. The time required for engagement of the second gear is not adjusted.

#### Hydro-Mechanical Transmission Control Unit

##### Purpose and Design of Control Unit

The control unit consists of two parts - body 3 and cover 1 (Fig.76). The control unit body accommodates hydraulic drive master control valve 5, pendulum slide valve 10 and a shifting device consisting of control linkage lever 4, lever 13 and selector valve 11. When the gearshift lever located on the steering column is turned, control linkage lever 4, connected to selector valve 11 by means of lever 13, is also turned through a system of rods and links. Lock-ball 12 provides matching of the selector valve inlet channel with the first, second, third and reverse speed channels made in body 3.

Spring 7 of hydraulic master control valve 5 is fitted in guide bushing 6 which is installed between the bushing of the hydraulic master control valve and side cover 9. Adjustment of spring 7 is carried out by changing the number of adjusting washers 8 placed into guide bushings 6.

The control unit cover 1 accommodates torque converter control valve 14 with spring 15 and lubrication control valve 18 with spring 17. Both springs are adjusted by changing the number of adjusting washers 16. Control valves 14 and 18 are constantly pressed against upper side cover 19 by the springs. To separate the oil channels provided in cover 1 from those made in control unit body 3 intermediate cover 2 is installed between them.

The adjustment of the control unit is carried out at the Manufacturing Plant and it is prohibited to disturb it or disassemble the control unit without a cause. Only in exceptional cases when the unit trouble cause is found out for cer-

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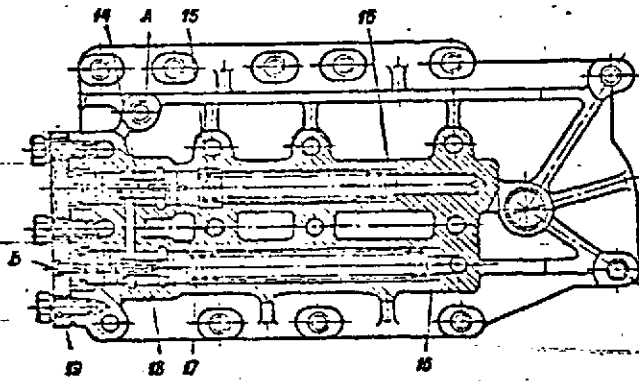
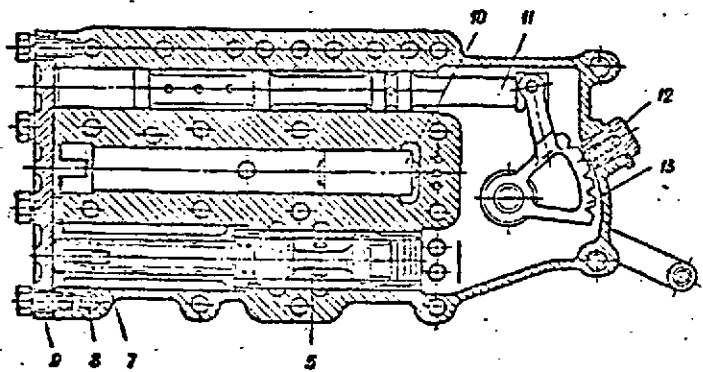
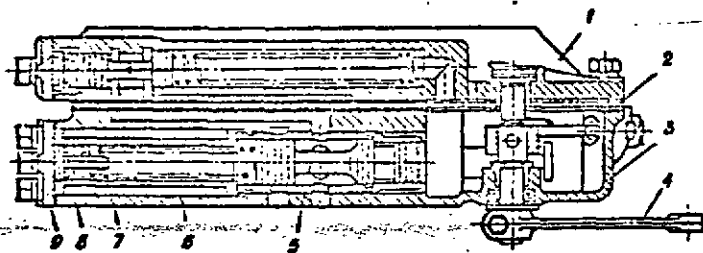


FIG. 76. HYDRAULIC TRANSMISSION CONTROL UNIT

- 1 - control unit cover; 2 - intermediate cover; 3 - control unit body; 4 - control linkage lever; 5 - hydraulic master control valve; 6 - guide bushing; 7 - hydraulic master control valve spring; 8 - adjusting washer; 9 - side cover; 10 - pendulum slide valves; 11 - selector valve; 12 - selector valve lever; 13 - torque converter control valve; 14 - torque converter control valve; 15 - torque converter control valve spring; 16 - adjusting washers; 17 - lubrication control valve sprays; 18 - lubrication control valve; 19 - upper side cover; A - threaded hole for sending unit of gear/clutch boosters pressure gauge; B - threaded hole for sending unit of lubricating system pressure gauge

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tain (jamming of any control valve, settling of spring, broken gasket), it is permitted to remove a faulty control valve, to wash and blow it with compressed air, and reinstall, not changing the number of adjusting washers under it. In case the spring of any control valve has settled, it is permitted to place additional washers under the control valve. During disassembly of the control unit it is necessary to observe cleanliness to prevent dust and dirt from getting on the control valves.

In case the control unit is removed from and then reinstalled in the torque converter housing, the bolts attaching the control unit should be tightened evenly to prevent leakage of oil during operation and also to avoid deformation of the control unit body which may result in jamming of the control valves.

#### Adjustment of Planetary Gearbox Control Linkage

In case the positions of the gearshift lever on the steering column and the fixed positions of the control linkage lever on the control unit installed on the planetary gearbox get out of adjustment, proceed as follows:

- disconnect the rod fork from the control unit lever on the planetary gearbox;
- set the control unit lever to any of the extreme positions;
- return the control unit lever to the centre position counting clicks of the lock ball (the centre position of the lever corresponds to the first gear engaged in the planetary gearbox);
- set the gearshift lever on the steering column into the first speed position too;
- see that the axes of the rods and levers are properly positioned relative to each other;
- the axes of the rods should be perpendicular to the axes of the control levers, special attention should be paid to the position of a double-arm lever installed on the internal side of the left-hand side member;
- using the threaded ends, adjust the control linkage and lock it by nuts;
- connect the rod fork with the control lever on the hydro-mechanical transmission control unit;
- drive the automobile to make sure that the control linkage is properly adjusted.

#### Hydro-Mechanical Transmission Oil Tank

The oil tank of the hydro-mechanical transmission is mounted on the right-hand side of the automobile frame. Screened header 7 of the front oil pump is attached to the front wall of tank body 1 (Fig.77) and screened header 10 of the rear oil pump - to the rear wall of the tank. Filters of both oil headers are identical. The oil filter is mounted on the front wall of the tank at the top.

The oil filter consists of the following components: filter casing 2, filtering element 3 and filter cover 5 with by-pass valve 4. Tubular centre rod 3 (Fig.78) carries a stack of filter sections 6 (frame-type brass screens) clamped on the rod by a nut.

The filter cover has two holes through which oil from the suction pump and control unit drains into the tank. When the pressure in the filter rises due to clogging of the filtering element, the by-pass valve opens and by-passes oil through the inner space of the centre rod to the tank past the filtering element. Two plugs 9 (Fig.77) for checking oil level in the tank are installed on the external vertical wall of the tank. The tank bottom is provided with two magnetic plugs 8 through which oil is drained from the tank.

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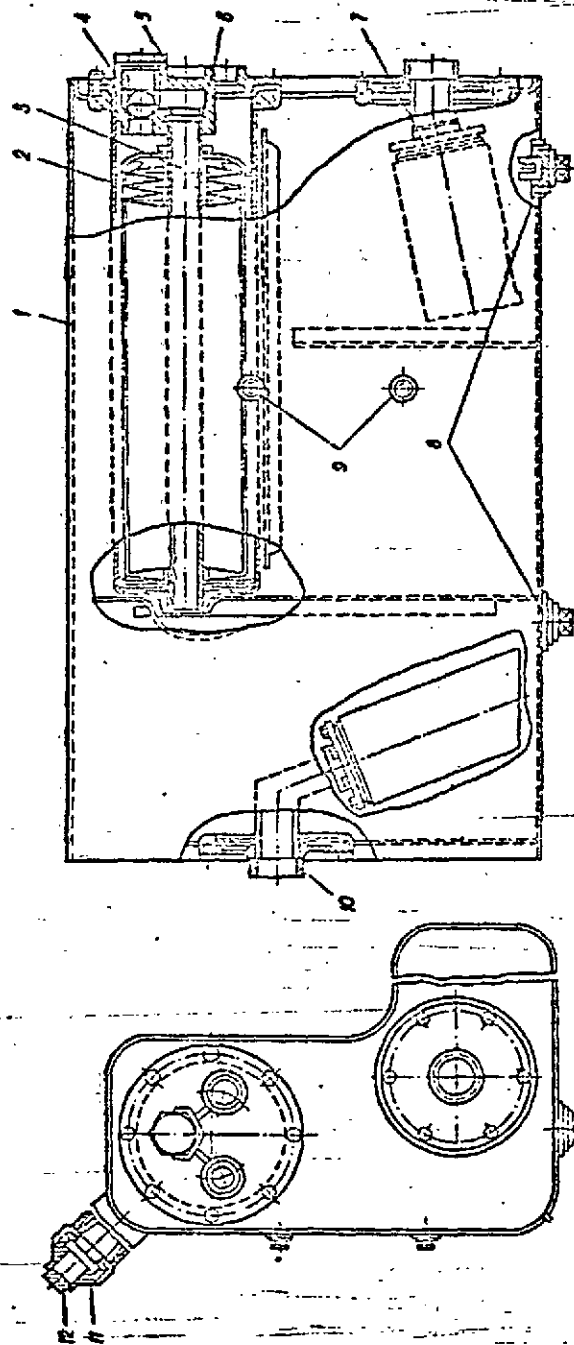


FIG. 72 HYDROMECHANICAL TRANSMISSION OIL TANK

1 - oil tank body 2 - filter housing 3 - filter element assembly 4 - bypass valve 5 - filter cover 6 - rubber stop 7 - float pump oil head 8 - magnetic drain plug 9 - check hole 10 - reat pump oil head 11 - filter neck 12 - filler neck plug

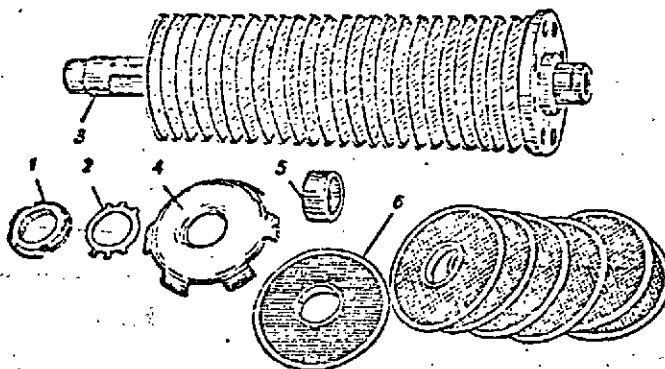


FIG. 78. HYDRO-MECHANICAL TRANSMISSION TANK FILTER PARTS

1 - nut; 2 - lock washer; 3 - centre rod; 4 - deflector; 5 - distance bushing; 6 - filtering sections

The torque converter oil filter (Fig.79) is installed on the bracket mounting the fuel tanks (at the rear, on the right-hand side).

The filter is connected in series with the torque converter feed line. Oil from the torque converter pump flows to the filter casing, passes through the filtering elements and comes to a channel running to the torque converter.

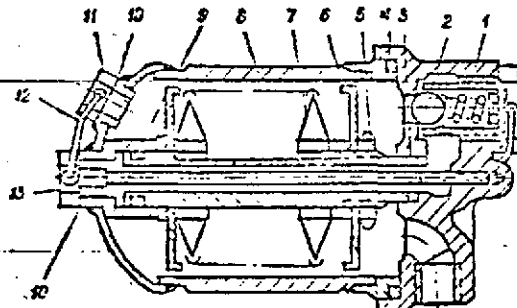


FIG. 79. TORQUE CONVERTER OIL FILTER

1 - filter cover; 2 - bypass valve; 3, 4 - packing rings;  
5 - filter centre rod; 6 - filtering element; 7 - filtering element section; 8 - filter casing; 9 - packing ring; 10 - gasket;  
11 - plug; 12 - cotter pin; 13 - bolt

The oil filter consists of the following components: casing 8, filtering element 6, cover 1 with bypass valve 2. Tubular centre rod 5 carries a stack of filtering sections 7 (frame-type brass screens) clamped on the rod by a nut. All filter parts are secured by centre bolt 13 (Fig.79).

#### Maintenance of Hydro-Mechanical Transmission

When servicing the hydro-mechanical transmission, carry out all the operations of maintenance No.1 and No.2 prescribed in the Section "Preventive Maintenance of Automobile".

To clean magnetic plugs 8 (Fig.77) of the planetary gearbox and hydro-mechanical transmission tank, blow them with compressed air.

When driving the automobile, observe readings of the oil pressure and temperature gauges of the hydraulic transmission.

The oil pressure should be as follows:

- in hydraulic transmission boosters - 9-13 kgf/cm<sup>2</sup>;
- in torque converter - 3-4 kgf/cm<sup>2</sup>;
- in lubricating system of hydraulic transmission - 1.0-1.5 kgf/cm<sup>2</sup>.

The temperature of oil in the torque converter should be the following:

- recommended 70-115°C;
- permissible 40-125°C.

The temperature of oil in the planetary gearbox should be within 20-95°C.

If the temperature exceeds the above limits when moving on earthen roads or continuous upgrades with heavy semi-trailers, shift to a lower gear in the gearbox or transfer case in due time.

#### Washing of Hydraulic Cyclone Filter

To clean container 5 (Fig.73) of the hydraulic cyclone filter, proceed as follows:

- disconnect it from body 1 and unscrew container cover 7;
- wash the container and cover in diesel fuel;
- screw in the cover and turn the container on the filter body, having checked gaskets 4 and 5 for condition.

When a great amount of aluminium chips or metal-ceramic dust is detected in the container, remove the hydraulic transmission for repair.

#### Washing of Tank Filter

To wash the filter of the hydro-mechanical transmission tank, proceed as follows:

- disconnect the drain oil pipelines from the unions of cover 5 (Fig.77);
- unscrew the bolts attaching the cover and remove the oil filter cover; when doing so, take care not to damage the cardboard gasket of the cover;
- screw a special puller, which facilitates removal of the filtering element, on the threaded end of filter centre rod 3 until it thrusts against the nut;
- slightly swinging the puller, extract the filtering element from the filter casing;
- secure the filtering element in a vice, bend out the tab of lock washer 2 (Fig.78) and unscrew nut 1 clamping filtering element sections 6;
- remove the sections from filter centre rod 3 and wash the parts of the filtering element in diesel fuel, blow the washed sections and the centre rod of the filter with compressed air (sections of the filtering element with broken screens should be replaced);
- put sections 6 on filter centre rod 3, reinstall in succession: distance bushing 5, deflector 4, lock washer 2, screw in nut 1 and bend one of the lock washer tabs into a nut slot;
- install the assembled filtering element in the filter casing; during installation, it is permitted to slightly strike the centre rod end face through a wooden block;
- set the filter cover in place and tighten up the attaching bolts; when installing the cover, check rubber ring 6 (Fig.77) in the cover and the packing gasket under the cover flange for condition; if necessary, replace them;
- connect the drain oil pipelines to the unions of the filter cover.

Washing of Torque Converter Filter

To wash the torque converter filter, proceed as follows:

- remove cotter pin 12 (Fig.79);
- unscrew plug 11 and drain oil from the filter;
- unscrew bolt 13 and take out casing 8 complete with filtering element 6; extract filtering element 6 from the filter casing;
- secure the filtering element in a vice and unscrew nut 5 (Fig.80) clamping filtering element sections 3;

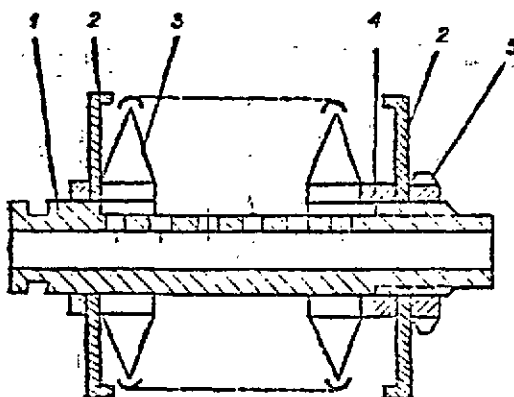


FIG. 80. FILTERING ELEMENT

1 - centre rod; 2 - guide disc; 3 - sections; 4 - distance bushings;  
5 - nut

- remove sections 3 from centre rod 1 and wash the parts of the filtering element in diesel fuel. Blow the washed sections and the centre rod with compressed air (sections of the filtering element with broken screen should be replaced);
- put guide disc 2, then sections 3 on centre rod 1, set in place in succession: distance bushing 4, disc 2 and screw in nut 5;
- install the assembled filtering element in the filter casing; when doing so, check rubber ring 9 (Fig.79) for condition and replace, if necessary;
- install filter casing 8 complete with filtering element 6 in place, first having checked rubber rings 3 and 4 for condition (if necessary, replace);
- put gasket 10 on bolt 13 and screw in the latter;
- put gasket 10 on plug 11, screw in the latter and lock.

In this case, filter casing 8 should be installed so that drain plug 11 faces outside from the automobile axis.

Filling and Replacement of Working Fluid

The hydraulic transmission of the automobile is filled with a mixture composed of spindle oil, grade AV and oil, grade MT-16n.

The mixture is prepared by mechanical mixing of seven volumetric parts of spindle oil, grade AV and three volumetric parts of oil, grade MT-16n and thorough agitation of the mixture. The temperature of mixed oils should be 10-20°C.

The prepared mixture should be stored in a clean container. Sediment should be periodically discarded from the container.

When replacing the working fluid, proceed as follows:

- drain fluid from the hydraulic transmission tank, planetary gearbox case, torque converter and torque converter filter. For draining oil from the torque converter, do the following: remove the hatch cover located in the upper part of the torque converter housing to the right from the engine side, disconnect the overdrive gear from the hydraulic transmission, and, turning driving shaft 57 (Fig.55), successively position two drain plugs on torque converter casing 9 against the open hatch and unscrew them. With one of the drain holes in the hatch centre, turn the input shaft through 1/8 turn counter-clockwise, as viewed from the engine side.

Page 134, lines 12-16 from bottom.

→ Instead of the text " The hydraulic transmission...by 10-20°C" insert as follows: "The hydraulic transmission of the automobile is filled with a mixture of spindle oil, grade AY State Standard /ГОСТ/ 1642-50, oil, grade MT-16H State Standard /ГОСТ/ 6360-58 and anticorrosion additive, grade AKOP-1/CTI 36-13 15-64/ The oil mixture is prepared by mechanical mixture of seven volumetric parts of oil, grade AY, and three volumetric parts of oil, grade MT-16H, through agitation of the mixture. The temperature of mixed oil should be not less than 10-12°C.

The additive AKOP-1, heated up to 60°C, is being gradually added into the oil mixture heated up to the same temperature and is intensively agitated.

The quantity of the additive primed is 10% of the oil mixture portion. The mixture obtained should be homogeneous in colour, without sediment and clots. The mixture is considered to be prepared if there are no black streaks in the oil stream."

As a result, the diametrically arranged hole will be positioned at the bottom part of the torque converter, thus ensuring complete draining of the working fluid to the planetary gearbox case. Drainage of the working fluid outside as well drainage from the planetary gearbox is accomplished through plug 37.

After the working fluid drains off, screw in the drain plugs and close the hatch.

During replacement of oil in the hydraulic transmission it is necessary also to wash the filters, oil headers of the front, rear and suction pumps as well as to clean the magnetic plugs;

- fill the hydraulic transmission tank with fresh fluid up to the upper plug;
- start the engine and run it for 3-5 minutes at 600-800 r.p.m.;
- stop the engine and after 5-10 minutes add fluid into the hydraulic transmission tank up to the lower edge of the upper check hole.

Note: It is permissible to drive the automobile when the fluid level in the hydraulic transmission tank is between the lower and upper check holes.

When filling the hydraulic transmission with working fluid, strictly observe the following requirements:

- oil should be filled from clean containers and only through a screen placed in the tank neck to prevent dirt and sand from getting into the hydraulic transmission;
- the tank filler neck and plug before filling should be thoroughly cleaned of dirt;
- take care to prevent water from getting into the fluid. It is strictly prohibited to fill the hydraulic transmission with fluid if the latter contains water;
- when replacing the working fluid in the hydraulic transmission in a cold season, it is recommended to heat the fluid to a temperature of not below +20°C before pouring it into the tank.

#### Washing of Oil Headers of Front, Rear and Suction Pumps

To wash the oil headers of the front and rear pumps, proceed as follows:

- drain oil from the tank;
- disconnect the oil pipeline from the union of the oil header flange;
- unscrew the bolts attaching the oil header flange to the tank and remove the oil header;
- unscrew the bolts attaching the oil header casing, wash the parts of the oil header in diesel fuel and dry them;
- assemble the oil header, install in the tank and screw in the attaching bolts; when doing so, check the packing cardboard gasket under the flange for condition and replace, if necessary;
- connect the oil pipeline to the union of the oil header flange.

To wash the oil headers of the suction pump, proceed as follows:

- drain oil from the case;
- remove lower covers 36 (Fig.55) of the planetary gear case;
- throw out handles 41 and take out the oil headers;
- remove screens 40 from oil header bodies 39, wash them in diesel fuel and blow with compressed air;
- assemble the oil headers and reinstall. When installing the oil headers, it is permitted to strike them slightly with a wooden hammer;
- set the lower covers in place and screw in the attaching bolts; when doing so, check the packing gaskets for condition and replace, if necessary.

Troubles and Remedies of Hydro-Mechanical Transmission

Trouble	Cause	Remedy
1	2	3
No oil pressure in entire hydraulic system	<p>1. Low oil level in tank of hydromechanical transmission</p> <p>2. Oil header of front oil pump is clogged and oil is not drawn into system</p> <p>3. Jamming of hydraulic master control valve in open position</p> <p>4. Damaged front oil pump</p> <p>5. Mechanical damage of transmission proper (broken packing ring, open pits in pipeline, etc.)</p> <p>6. Unscrewed or loose ground wire</p>	<p>Add oil to upper level plug</p> <p>Clean oil header of front oil pump</p> <p>Remove lower side cover of control unit; using mandrel, remove master control valve and wash. After washing it should freely slide in body</p> <p>Replace or repair oil pump</p> <p>Hydro-mechanical transmission is subject to repair</p>
No oil pressure in lubrication line	<p>1. Jamming of lubrication control valve in open position</p> <p>2. Faulty sending unit of lubricating system pressure gauge</p> <p>3. Broken packing cast iron ring in planetary gearbox</p> <p>Settling of spring</p>	<p>Tighten up wire attachment</p> <p>Remove upper side cover of control unit; using mandrel, remove control valve and wash</p> <p>Replace sending unit</p> <p>Transmission is subject to repair</p>
Low pressure in lubrication line	<p>Settling of spring</p>	<p>Remove upper side cover of control unit and adjust lubrication control valve spring by means of shims. If adjustment limits are used up and pressure fails to rise, replace control valve spring</p>
No oil pressure in torque converter feed line	<p>1. Jamming of torque converter control valve in closed position</p>	<p>Remove upper side cover of control unit and, using mandrel, remove control valve and wash</p>

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1	2	3
<p>Low oil pressure in torque converter feed line</p> <p>High oil pressure in torque converter feed line</p> <p>Low oil pressure in main oil line</p>	<p>2. Faulty sending unit of torque converter oil pressure gauge</p> <p>3. Damaged packing ring of torque converter lock-up friction clutch</p> <p>Settling of spring</p> <p>Jamming of torque converter control valve in open position</p> <p>1. Jamming of hydraulic master control valve in open position</p> <p>2. Settling of spring</p>	<p>Replace sending unit</p> <p>Hydro-mechanical transmission is subject to repair</p> <p>Remove upper side cover of control unit and adjust torque converter control valve spring by means of shims. If adjustment limits are used up and pressure fails to increase, replace control valve spring.</p> <p>Remove upper side cover of control unit and, using mandrel, remove control valve and wash</p> <p>Remove lower side cover of control unit and, using mandrel, extract control valve and wash</p> <p>Remove lower side cover of control unit and adjust hydraulic master control valve spring by means of shims. If adjustment limits are used up and pressure fails to increase, replace master control valve spring</p>
<p>High oil pressure in main oil line</p> <p>High oil pressure in lubricating line</p> <p>Hydro-mechanical transmission fails to operate in all gears</p>	<p>1. Jamming of hydraulic master control valve in closed position</p> <p>2. Jet of hydraulic master control valve in clogged</p> <p>Jamming of lubrication control valve in open position</p> <p>1. Low pressure of oil in boosters due to which friction clutch slips</p> <p>2. No oil pressure in torque converter feed line</p>	<p>Remove lower side cover of control unit and, using mandrel, extract master control valve and wash</p> <p>Remove master control valve and clean jet</p> <p>Remove upper side cover of control unit and, using mandrel, remove control valve and wash</p> <p>Remove lower side cover of control unit and, using mandrel, take out hydraulic master control valve and wash</p> <p>Remove upper side cover of control unit and, using mandrel, take out torque</p>

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1	2	3
<p>Intensive fluctuations of oil pressure in hydraulic system</p> <p>With gearshift lever in neutral, hydro-mechanical transmission operates in first or pulls forward but fails to operate in second, third and reverse gears</p> <p>With gearshift lever in neutral, hydro-mechanical transmission operates in second gear or pulls forward but fails to operate in first, third and reverse gears</p>	<p>3. One of rods is disconnected or gearbox control linkage is out of adjustment</p> <p>4. Oil is delivered to boosters of two speed gears simultaneously</p> <p>5. Mechanical damage of hydromechanical transmission</p> <p>1. Low level of oil in tank, leakage of air through suction pipeline of pumps</p> <p>2. Jet of lubrication control valve or torque converter control valve is unscrewed</p> <p>3. Water in oil of hydro-mechanical transmission</p> <p>1. Gearbox control unit linkage is out of adjustment</p> <p>2. Mechanical damage of first speed friction clutch</p> <p>1. Gearbox control unit linkage is out of adjustment</p>	<p>converter control valve and wash</p> <p>Check connections of rods and see that gearshift lever position corresponds to positions of lever on gearbox control unit</p> <p>Check and, if necessary, adjust system of gearbox control linkage. If control linkage of gearbox control unit is adjusted correctly, the cause of simultaneous engagement of two friction clutches is damage of gasket in control unit. If so, replace gasket</p> <p>Hydro-mechanical transmission is subject to repair</p> <p>Add oil into tank up to upper level plug</p> <p>Remove upper side cover, take out control valve and screw in jet</p> <p>Drain oil and refill hydraulic system with fresh oil</p> <p>Adjust control linkage of gearbox control unit</p> <p>Hydro-mechanical transmission is subject to repair</p> <p>Adjust control linkage of gearbox control unit</p>

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1	2	3
<p>With gearshift lever in neutral, hydro-mechanical transmission operates in third gear or pulls forward, but fails to operate in first, second and reverse gears</p>	<p>2. Mechanical damage of second speed friction clutch 1. Gearbox control unit linkage is out of adjustment</p>	<p>Hydro-mechanical transmission is subject to repair Adjust control linkage of gearbox control unit</p>
<p>With gearshift lever in neutral, hydro-mechanical transmission operates in reverse gear or pulls backward but fails to operate in first, second and third gears</p>	<p>2. Mechanical damage of third speed friction clutch 1. Gearbox control unit linkage is out of adjustment</p>	<p>Hydro-mechanical transmission is subject to repair Adjust control linkage of gearbox control unit</p>
<p>Hydro-mechanical transmission is overfilled with oil</p> <p>With first and reverse gear engaged, automobile fails to start from rest for prolonged time or starts with long delay</p> <p>Leaky oil cooler</p>	<p>2. Mechanical damage of reverse speed friction clutch 1. Oil headers of suction pump are clogged 2. Damaged suction pump 1. Reverse and first speed smooth engagement mechanisms are out of adjustment</p>	<p>Hydro-mechanical transmission is subject to repair Clean oil headers of suction pump Replace or repair suction pump Adjust reverse and first speed smooth engagement mechanisms</p>
	<p>High temperature of oil and high pressure in system</p>	<p>Remove oil cooler. Solder up leaky places</p>

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## Chapter IV

### MECHANICAL TRANSMISSION

The mechanical transmission consists of the following main units:

- damper coupling;
- overdrive gear;
- transfer case;
- transmission propeller shafts;
- driving axles.

#### DAMPER COUPLING

The damper coupling (Fig.82) serves to protect the overdrive gear and the torque converter drive propeller shaft against loads caused by torsional vibrations arising due to irregular rotation of the engine crankshaft.

The damper coupling consists of outer 8 and inner 6 discs. Six friction linings 1 are secured to the outer disc by brass rivets 3. Six cast iron shoes 2, which are attached to the inner disc, are continuously pressed against the friction linings by springs 7.

Movement of the discs relative to each other is caused by compression of springs 4 fitted on blocks 5. The compression of these springs is completed when the blocks come in contact.

The damper coupling is attached to the engine flywheel by twelve bolts which are locked by plates and a safety wire. The sequence of tightening the bolts is shown in Fig.81.

#### OVERDRIVE GEAR

##### Purpose and Design of Overdrive Gear

The overdrive gear is designed to increase the speed after the engine to provide conditions necessary for combined operation of the engine and torque converter.

The overdrive gear (Fig.83) is a reduction unit with cylindrical spiral gears. The overdrive gear housing is bolted to the engine flywheel casing.

Mounted inside housing 1 are primary shaft 5, countershaft 6 and lower shaft 15 and also upper shaft 4 for driving the fans and compressor, and shaft 12 for driving steering gear booster pump 14 and overdrive gear oil pump 9. All the shafts except for the countershaft rotate on ball bearings. The countershaft is stationary. The

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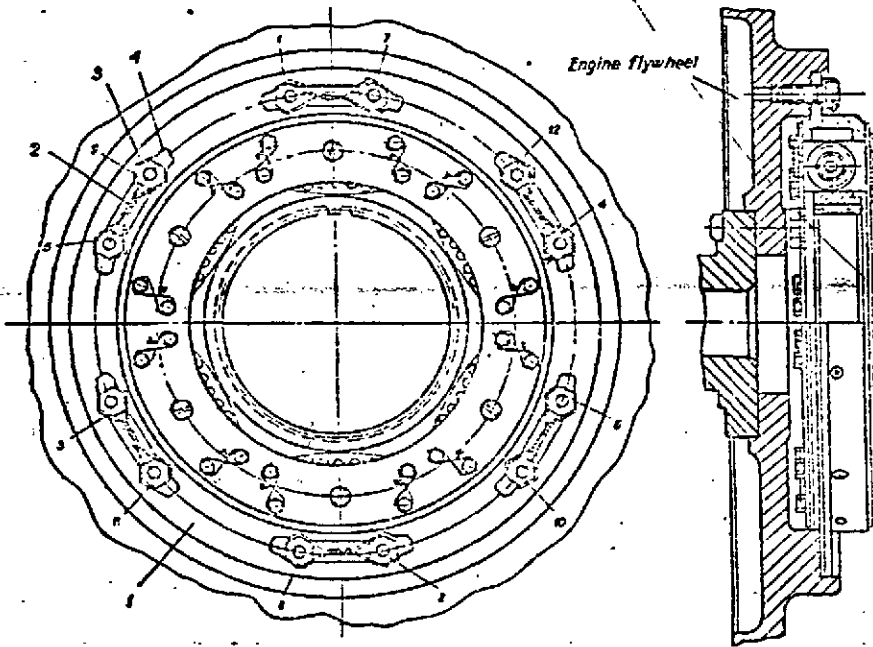


FIG. 21. INSTALLATION OF DAMPER COUPLING  
 1 - damper coupling; 2 - center pin; 3 - bolt; 4 - lock plate

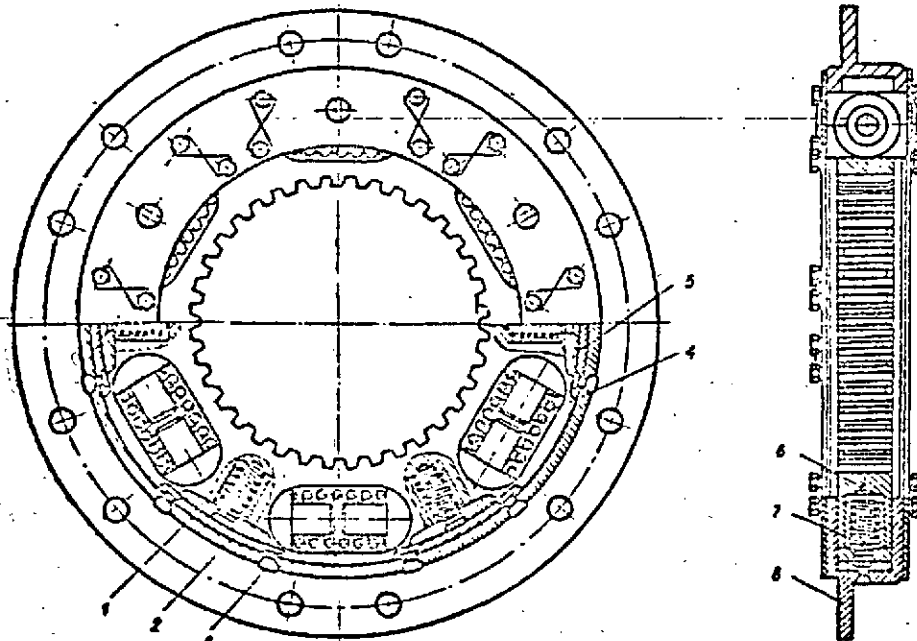
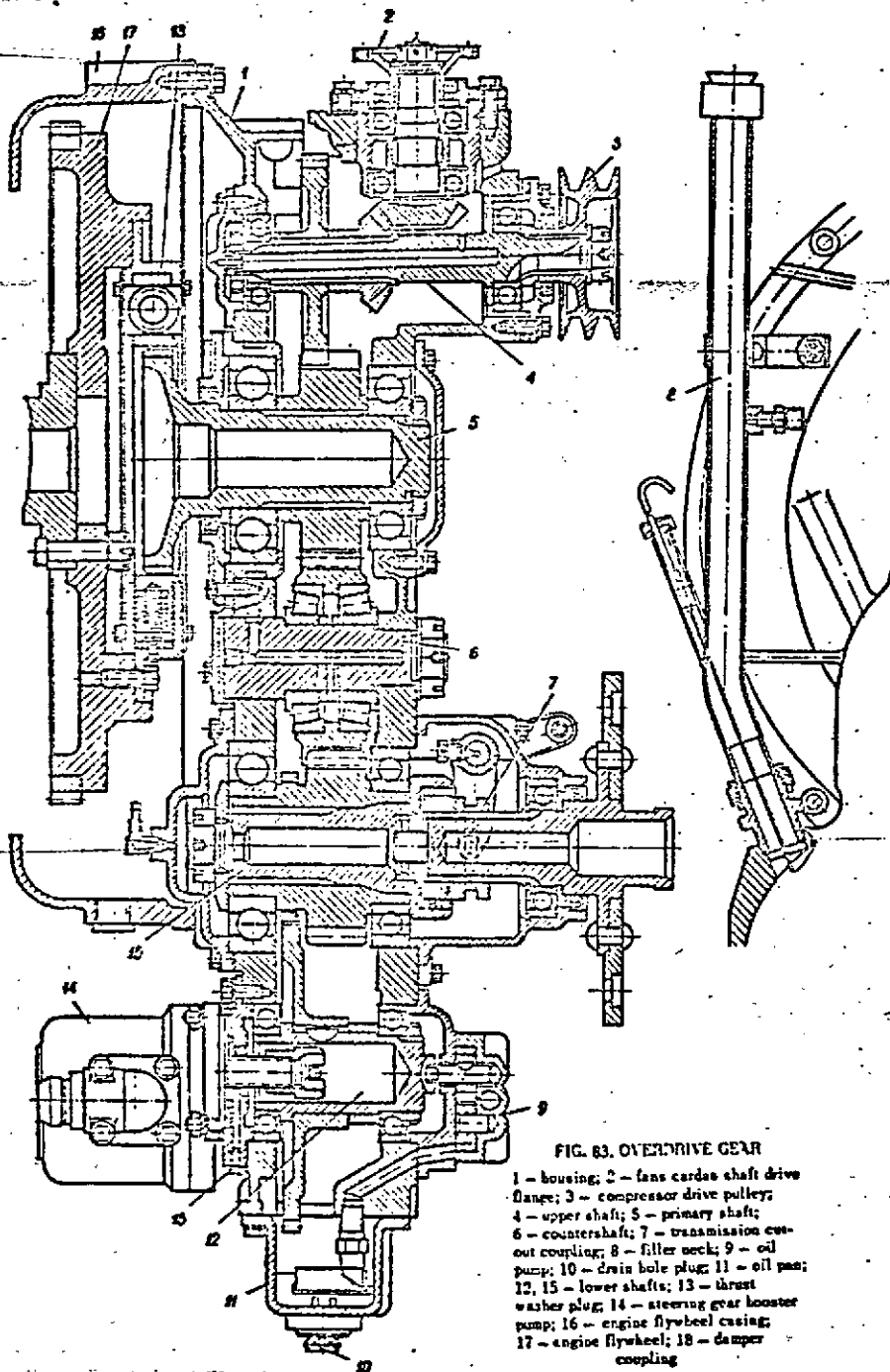


FIG. 22. DAMPER COUPLING  
 1 - Inertia lining; 2 - cast iron shoe; 3 - aluminum rivet; 4 - blocks spring; 5 - damper block; 6 - inner disc; 7 - lining spring; 8 - outer disc.

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**FIG. 83. OVERDRIVE GEAR**  
 1 - housing; 2 - fans cardax shaft drive flange; 3 - compressor drive pulley; 4 - upper shaft; 5 - primary shaft; 6 - countershaft; 7 - transmission cut-out coupling; 8 - filler neck; 9 - oil pump; 10 - drain hole plug; 11 - oil pan; 12, 15 - lower shafts; 13 - thrust washer plug; 14 - steering gear hooster pump; 16 - engine flywheel casing; 17 - engine flywheel; 18 - damper coupling

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gear fitted on it rotates on taper bearings. The upper shaft drives flanges 2 of the fans drive cardan shaft through bevel gears, one flange:

- for the right-hand fan drive and the other,

- for the left-hand fan drive. The tail piece of shaft 4 carries a compressor drive pulley.

The overdrive gear primary shaft is coupled with the engine crankshaft through the damper coupling.

Lubrication of the overdrive gear parts is a forced type and is accomplished by pump 9. Lubricant is delivered to the main parts of the overdrive gear through a system of drilled channels in the housing and shafts. Some parts are splash-lubricated by oil trickling down and picked up by the gear from oil pan 11.

A screened oil header of the pump is installed in the oil pan. The overdrive gear is filled with oil through a filler neck up to the upper mark on the oil dipstick.

For draining oil the oil pan is provided with a hole closed by plug 10.

To facilitate starting of the engine in winter when the oil in the hydraulic transmission is thick and offers additional resistance to cranking of the engine, the hydraulic transmission is disconnected from the overdrive gear by coupling 7 which is fixed in extreme positions by a ball lock. The coupling control lever is located on the engine flywheel casing.

To disconnect the overdrive gear from the transmission it is necessary to shift the lever handle forward, when looking ahead. After starting and warming up, stop the engine and return the lever to the transmission cut-in position. With the engine running (in case the transmission or the running gear is out of order) disconnection of the overdrive gear from the transmission also provides for operation of the brakes and steering gear when the automobile is towed. The filler neck of the overdrive gear is accessible from the engine compartment.

#### Maintenance of Overdrive Gear

When servicing the overdrive gear, carry out all the operations prescribed in Maintenance No.1 and No.2 in accordance with the table of the Section "Preventive Maintenance of Automobile".

#### TRANSFER CASE

##### Design and Purpose of Transfer Case

The transfer case serves to transmit the torque from the planetary gearbox to the bogies of the automobile driving axles through two output shafts.

The transfer case is attached to the automobile frame by means of two brackets with rubber rings, and a torque reaction rod. The transfer case is a two-speed (low and direct drive), three-shaft reduction unit with cylindrical spiral gears. The transfer case shafts are mounted in cast housing 11 (Fig.84) with removable cover 14, and supported by ball and roller bearings.

Gears of upper shaft 10 rotate on rollers and have splines. Gearshift coupling 12 is fitted on the splines of the upper shaft. The coupling is shifted by fork 13 which is actuated by a pneumatic gear shifter.

The rear end of upper primary shaft 10 is fitted with gear 15 driving the power take-off unit.

Lower shaft 4 of the transfer case mounts bevel differential 2 providing differential connection between the front and rear bogies through corresponding output shafts.

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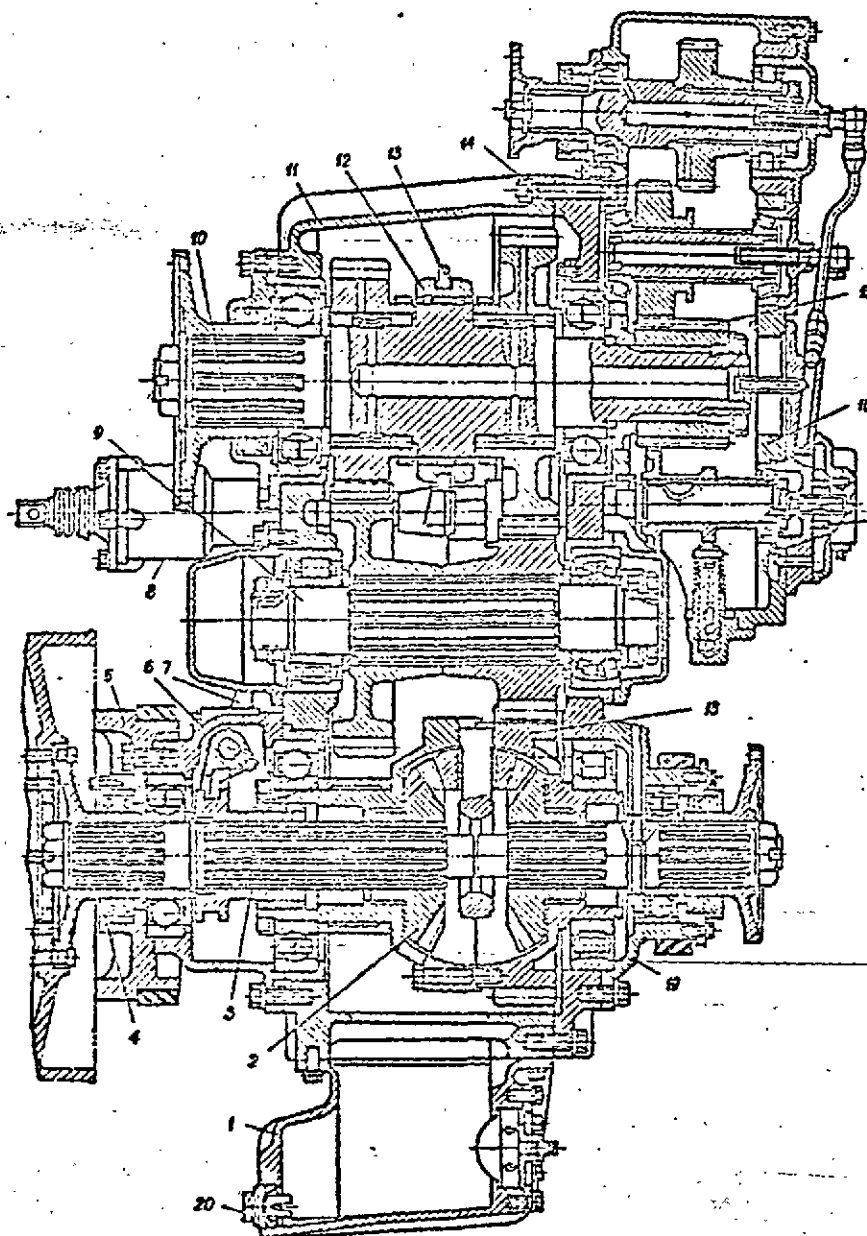


FIG. 84. TRANSFER CASE

- 1 - oil pan; 2 - differential; 3 - differential lock-up coupling; 4 - lower shaft; 5 - parking brake support; 6 - front axle drive housing; 7 - fork lever; 8 - pneumatic gear shifter; 9 - countershaft; 10 - primary shaft; 11 - transfer case housing; 12 - gearshift coupling; 13 - fork; 14 - housing carrier; 15 - power take-off drive gear; 16 - power take-off housing; 17 - oil pump; 18 - differential gear; 19 - rear cover; 20 - magnetic drain plug.

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When the differential is unlocked the transfer case ensures transmission of equal torques (at different rotation speeds of the lower shaft output ends), which depend on road condition and tyre inflation, to the front and rear bogies of the driving axles.

When the differential is locked up, both ends of the lower shaft rotate as one unit at a speed of differential driven gear 18.

Locking-up of the differential is accomplished by shifting coupling 3 until it is engaged with the differential carrier by means of involute splines. Shifting of the coupling is controlled by a lock-up pneumatic switch mounted on the right-hand side of the transfer case.

Parking brake support 5, attached to front axle drive housing 6 serves at the same time as a support for mounting the transfer case on the frame. Rear axle drive cover 19 is a second support of the transfer case.

Lubrication of the upper shaft gear rollers is a forced type and is accomplished by gear-type oil pump 17, mounted on the power take-off unit, through drilled passages in the cover of the power take-off housing and the transfer case upper shaft. Oil is drawn by the pump from the oil pan of the transfer case through a screen filter. The pump also delivers oil for lubrication of the differential through a special pipe connected to rear cover 19 and drilled channels of the lower shaft.

The gears and bearings of the transfer case are lubricated by oil trickling down after lubrication of the rollers and gears of the upper shaft and also by splashing oil contained in the housing.

#### Transfer Case Control

The transfer case is air-controlled. The control mechanism includes a control cock, pneumatic gear shifter, differential lock-up pneumatic switch and pipelines.

The control cock (Fig. 85) is intended to provide admission and discharge of compressed air to and from the gear shifter and transfer case differential lock-up switch. It is mounted on the left-hand side of the steering column.

Cock body 6 has a number of air inlet ports leading to the lower polished surface of the body. On the top and bottom the body is closed by covers 2 and 8 attached to the body by screws. Rubber gasket 4 is placed under the lower cover. The bottom part of the body accommodates distributing grooved washer 3 which is pressed against the body by spring 1. The washer is ground to the bottom part of the body and installed in only one definite position on cock handle stem 9 by means of a pin and a groove on the washer. Also fitted in a definite position are locking washer 7 on the stem edges between the body and upper cover, and the cock handle - on the stem end. The locking

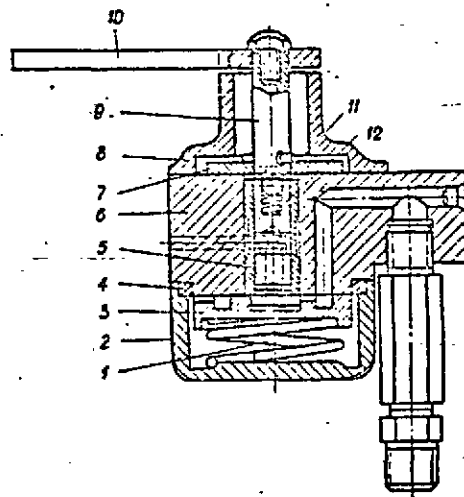


FIG. 85. CONTROL COCK

1 - spring; 2 - lower cover; 3 - distributing washer; 4 - rubber gasket; 5 - bushing; 6 - cock body; 7 - locking washer; 8 - upper cover; 9 - stem; 10 - cock handle; 11 - lock ball; 12 - lock ball spring

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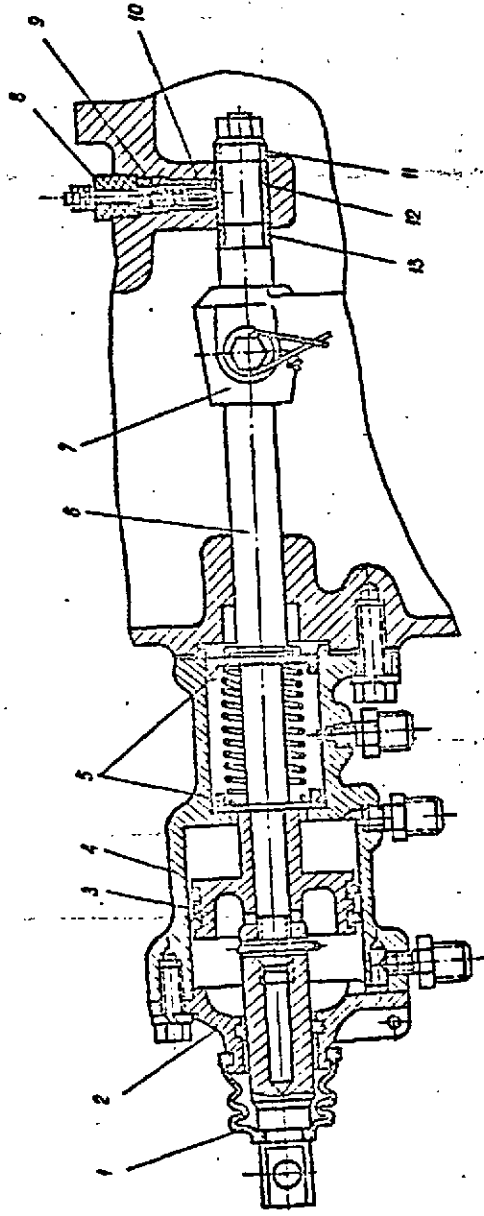


FIG. 16. PNEUMATIC GEAR SHIFTER  
 1 - bolts; 2 - bolt covers; 3 - piston with packing rings; 4 - body; 5 - piston; 6 - rod; 7 - fork; 8 - contact bushing; 9 - insulating contact and ring of pneumatic gear shifter rod; 10 - contact bushing; 11 - contact bushing; 12 - insulating contact bushing; 13 - insulating contact bushing.

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washer has four holes corresponding to four positions of the cock handle and receiving lock ball 11 which is arranged together with spring 12 in a body hole.

The air pipelines running from the brake system air bottles, transfer gear shifter and differential lock-up switch are connected to the cock.

When the cock handle is turned to different positions, the distributing washer is turned too and its grooves interconnect these or those holes, thus providing for delivery of compressed air from the brake system air bottles to the gear shifter or differential lock-up switch.

The cock handle can be set into four positions:

B - direct drive (high) gear is engaged;

O - neutral;

H - low gear is engaged;

H - Ex. - low gear is engaged and transfer case differential is locked up.

The pneumatic gear shifter (Fig.86) is mounted on the transfer case at the front.

Gear shifter body 4 accommodates piston 3 with packing rings. The piston is secured to rod 6 which is jointed to the gearshift fork. The rod is also fitted with pistons 5 of the gear shifter neutral position with inner and outer packing rings, and a distance spring. The gear shifter body is closed by cover 2. Protective boot 1 is put on the cover and the free end of the rod extension.

Irrespective of the cock handle position, compressed air is always delivered into the space between the neutral position pistons. In the neutral position the compressed air delivered into the space between the neutral position pistons causes the pistons to move apart setting rod 6 and piston 3 to the middle position. As a result, rod 6 (Fig.86) shifts fork 13 (Fig.84) and coupling 12 also to the neutral position.

When the cock handle is set to the direct drive position, space "A" (Fig.86) communicates with the atmosphere and compressed air is delivered into space "B" causing the piston with the rod to move to the left, thus engaging the direct drive gear in the transfer case. In this case shifting of the piston is accomplished due to

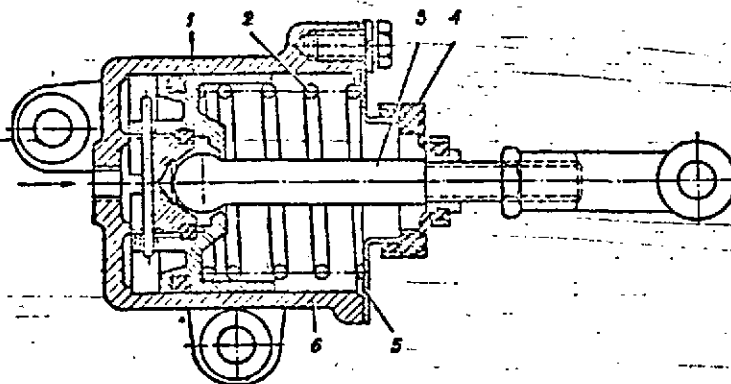


FIG. 87. DIFFERENTIAL LOCK-UP PNEUMATIC SWITCH

1 - switch piston; 2 - piston return spring; 3 - switch rod; 4 - rubber boot; 5 - body cover; 6 - switch body

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a difference of the forces arising in space "B" and in the space between the neutral position pistons.

When the cock handle is set into the low gear position space "B" communicates with the atmosphere and compressed air is delivered into space A, causing the piston with the rod to move to the right (forward, as viewed in the direction of movement), thus providing engagement of the low gear in the transfer case.

The differential lock-up pneumatic switch (Fig.87) consists of body 6 accommodating piston 1 with packing rings, return spring 2, body cover 5, rod 3 and protective boot 4. The differential lock-up switch is mounted on the right-hand side of the transfer case. When the handle of the transfer control cock is set to position "H-B" (transfer case differential is locked, low-gear is engaged), compressed air is delivered into the body of the differential lock-up switch, causing the piston with the rod to move to the right (forward, if locking ahead). While moving, the rod acts on lever 7 of the fork (Fig.84) which shifts coupling 3 until it gets engaged with the differential carrier. When the differential is locked up, both ends of the lower shaft rotate as one unit at a speed of differential gear 18. When the differential is unlocked, piston 1 (Fig.87) of the differential lock-up switch is returned to the initial position by spring 2.

#### Transfer Gearshift Manual Repeating Control Linkage

The manual control linkage is intended to shift in gears in the transfer case only in case when the pneumatic gear shifter or the control cock are faulty.

The manual control lever (Fig.88) is located on the right-hand side member of the frame at the transfer case.

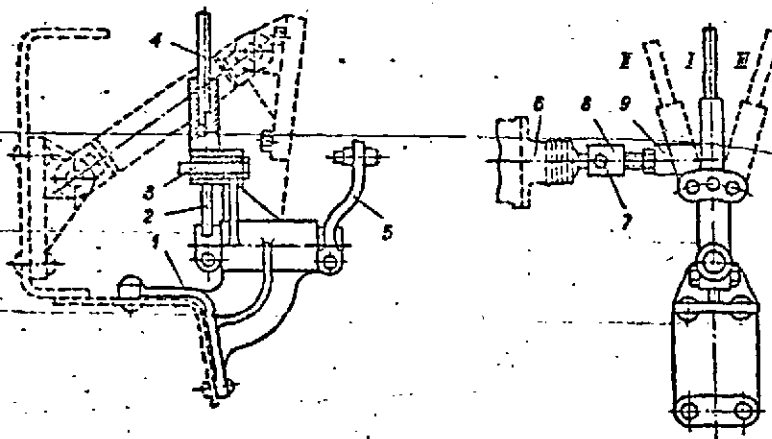


FIG. 88. TRANSFER GEARSHIFT MANUAL (REPEATING) CONTROL LINKAGE

1 - bracket; 2 - lever; 3 - quick-removable pin; 4 - tommy bar; 5 - control linkage lever;  
6 - boot; 7 - pin; 8 - fork; 9 - connecting fork; I - neutral position; II - direct drive positions;  
III - low gear position

To shift in the transfer gears by means of the manual control linkage, proceed as follows:

- take out pin 3;
- connect fork 8 with the pneumatic gear shifter rod by means of pin 7 (when doing so, to avoid damage of the pneumatic gear shifter it is strictly forbidden to turn the projecting end of its rod);

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- insert tommy bar 4, having taken it from the driver's tool set, into the hole from the end face of lever 2;
- shift in the required gear by operating the tommy bar; the low gear is engaged by shifting the tommy bar forward, as viewed forward, (position III), the direct-drive gear - by shifting it backward (position II), and the neutral position is obtained by setting the handle bar into the middle position (position I);
- insert pin 3 into the aligned holes of lever 2 and bracket 1.

After the faults in the transfer case air system are corrected, proceed as follows:

- disconnect fork 8 from the pneumatic gear shifter rod;
- insert pin 7 into the ear of fork 8 and lock it;
- tie up fork 8 to linkage lever 5 by a wire.

#### Contact Device of Transfer Case Pilot Lamp

The contact device is mounted on rod 6 of the gearshift fork (Fig.86). When the transfer case is in neutral, contact 10 touches contact bushing 12 of the gearshift rod, and the pilot lamp is lighting, indicating that no gear is engaged in the transfer case.

When rod 6 is moved until contact 10 touches insulating ring 11 (low gear) or insulating ring 13 (direct drive gear), the electric circuit is open and the pilot lamp does not light, indicating that one of the gears in the transfer case is engaged.

#### Operation of Transfer Case

When the automobile is in operation, one of the gears in the transfer case should be constantly engaged. The neutral position is used only when the winch is operated or the reserve power is taken off at halts. In general, during operation of the automobile the direct drive gear is engaged in the transfer case. The low gear is shifted in only when moving under hard conditions and also when towing heavy trailers. If necessary, the low gear is engaged with the differential locked up. After a difficult stretch of the road is negotiated the differential should be obligatorily unlocked.

Initial engagement of the gears and their subsequent reshifting in the transfer case should be carried out only when the air pressure in the air system is at least  $5.65 \text{ kgf/cm}^2$  with the planetary gearbox in neutral, the automobile stopped and the engine shut down. Engagement of this or that gear is checked by a pilot lamp located on the instrument panel. When any of the gears is engaged, the pilot lamp should go out. If it does not occur, with the cock handle turned to a required position, set the cock handle into the neutral position, shift in the first gear in the planetary gearbox and start the engine to turn the primary shaft of the transfer case. This done, disengage the gear in the planetary gearbox and again shift in the required gear in the transfer case. Attempts to start the automobile, with the neutral position pilot lamp lighting and the handle set to the engagement position, may result in damage of the toothed coupling and gears of the mainshaft. The differential may be locked up only when the automobile is at rest; attempts to lock up the differential in motion may cause damage of the lock-up mechanism.

#### Maintenance of Transfer Case

For normal operation of the transfer case carry out all the operations prescribed in preventive maintenance No.1 and No.2 in accordance with the table of the

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Section "Preventive Maintenance of Automobile". When changing oil in the transfer case, clean magnetic plug 20 (Fig.84) which closes the drain hole in the transfer case, with compressed air and wash the oil pan with kerosene.

The transfer case is filled with oil through a filler neck provided on the left-hand side of the transfer case and closed by a plug, up to the level hole which is located on the rear cover of the transfer case and closed by plug 5 (Fig.89).

Oil from the transfer case is drained through a drain hole closed by magnetic plug 20 (Fig.84).

To check the oil pumps for operation it is necessary to shift the transfer case in neutral and to disconnect pipe 1 connecting oil pump 4 with the transfer case differential, and also pipe 2, connecting plunger pump 3 with the power take-off countershaft (Fig.89).

With the engine running and the second gear in the planetary gearbox engaged, a stream of clean oil should flow out of pipes 1 and 2. If air bubbles are present, eliminate inleakage of air.

In case no lubricant is delivered, and also after a prolonged inoperative period (in excess of one month) it is necessary to fill the gear pump with 200 cu.cm of oil through filler pipe.

Operation of the oil pumps (gear-type 4 and plunger-type 3) should be checked at an engine speed of 1000-1200 r.p.m., with the direct-drive gear engaged in the hydro-mechanical transmission.

#### POWER TAKE-OFF UNIT

##### Purpose and Design of Power Take-Off Unit

The power take-off unit (Fig.90) is mounted on the transfer case and serves for power take-off.

Installed inside power take-off housing 2 are drive shaft 4 with drive gear 3, countershaft 7 with gear 6, and pumps drive shaft 9 with gear 8.

The drive shaft rotates in two bearings: ball bearing and cylindrical roller bearing.

Gear 3 is fitted on the splines of the drive shaft. Drive flange 5 is installed on the splines of the drive shaft output end.

The countershaft rotates in two tapered bearings. A sliding idler gear fitted on the shaft splines is in constant mesh with the gear of the transfer case primary shaft. When shifting in the power take-off, the gear is engaged by fork 12 secured on rod 11. The fork rod is fixed in two positions by a ball lock.

The pumps drive shaft rotates in two bearings: ball bearing and cylindrical roller bearing. Gear 8 is attached to the pumps drive shaft by means of a Woodruff key and is in constant mesh with the gear of the transfer case primary shaft.

The end face of shaft 9 is provided with a notch receiving a shank of the driving gear of gear-type oil pump 1.

Plunger pump 14 which is driven by an eccentric made integral with gear 8 of the pumps drive shaft is also mounted on the power take-off unit.

The lubricating system of the power take-off unit is a combination type and is common with the lubricating system of the transfer case.

The gear pump ensures forced lubrication of the transfer case primary shaft and parts.

The gear pump also delivers oil to the parts of power take-off drive shaft 4.

Plunger pump 14 ensures forced lubrication of the bearings of power take-off countershaft 7. Lubricant from the plunger pump is conducted to the countershaft through a pipe.

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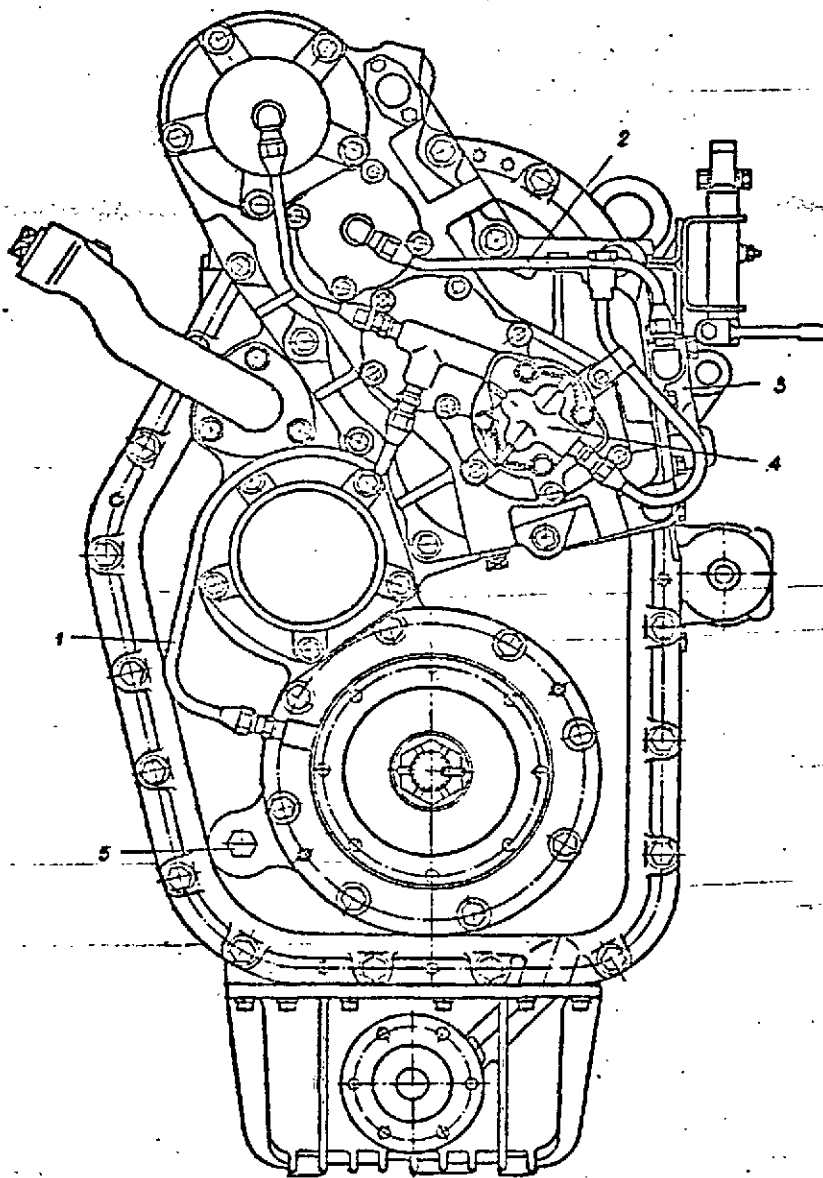


FIG. 69. TRANSFER CASE (REAR VIEW)

1 - oil pipeline running from gear - type pump to transfer case differential; 2 - oil pipeline running from plunger pump to power take-off unit counterball; 3 - plunger pump; 4 - gear-type pump; 5 - check hole plug

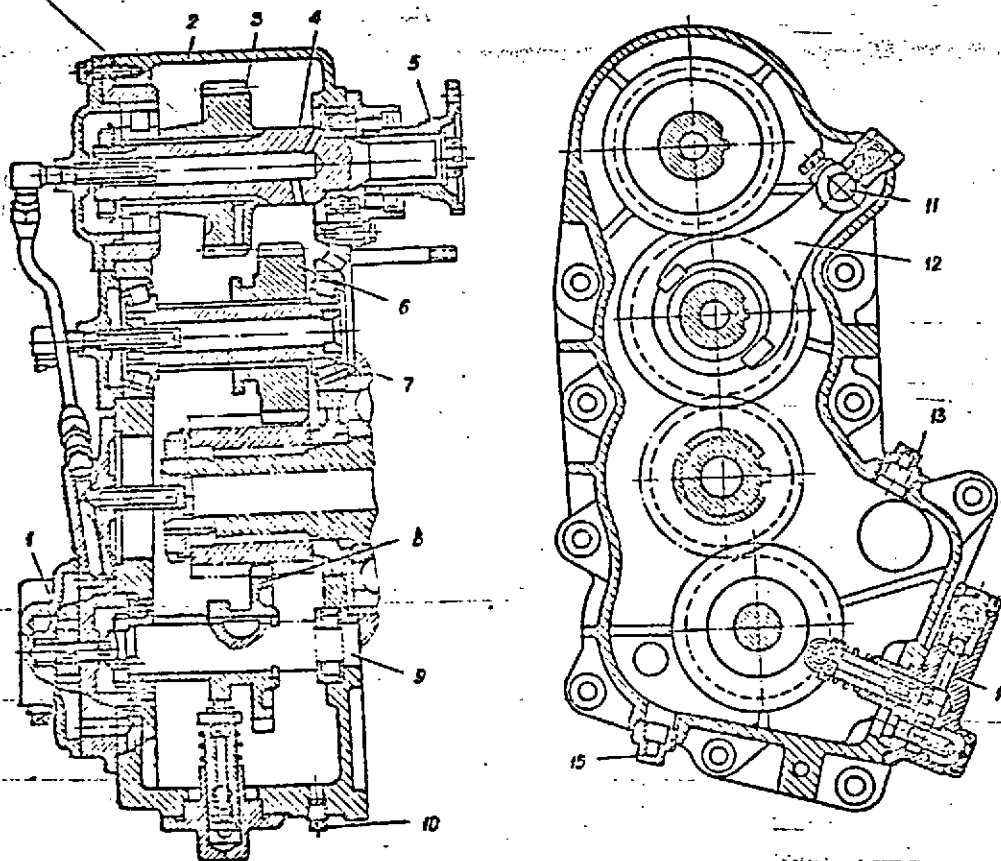


FIG. 90. POWER TAKEOFF UNIT

- 1 - gear-type pump; 2 - housing; 3 - drive gear; 4 - drive shaft; 5 - flange; 6 - countershaft gear; 7 - counter shaft; 8 - pumps drive shaft gear; 9 - pumps drive shaft; 10 - level hole plug; 11 - gear shifting rod; 12 - shifting fork; 13 - filler hole plug; 14 - plunger pump; 15 - drain hole plug

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All other friction parts of the power take off unit and transfer case are lubricated by splashing and also with oil trickling down.

Oil in the power take-off housing is maintained at a definite level. Excessive lubricant drains through a drilled hole of the housing to the transfer case.

The power take-off housing has three holes: for filling, draining and checking the oil level; the holes are closed by plugs 13, 15 and 10.

The inner spaces of the power take-off unit and transfer case communicate with a common ventilation system through a pipeline, as a result the atmospheric pressure is maintained in the housings. The pipeline of the ventilation system is connected to an elbow installed on the housing at the side of a free end of the gearshift fork rod.

#### Operation of Power Take-Off Unit

The power take-off unit is intended to supply up to 140 h.p. at an engine speed of 1,700-1,800 r.p.m.

At halts the power take-off is allowed within the limits from 100 to 140 h.p. To prevent excessive wear of the engine during its operation at low loads it is prohibited to take off power less than 100 h.p.

The power take-off operation cycle should not exceed 1-1.5 hours. As a rule, the power should be taken off in the third gear engaged in the planetary gearbox, and with the torque converter locked up.

Engagement of the power take-off unit should be carried out only after complete stoppage of the automobile and the engine, at a pressure of at least 3 kgf/cm<sup>2</sup> in the air feed system and with the planetary gearbox in neutral.

To engage the power take-off unit, proceed as follows:

- set the transfer control cock handle into the neutral position;
- set the power take-off unit control lever to the rearward position, first having removed the latch ring;
- start the engine;
- set the planetary gearbox gearshift lever into the first gear position.

When a power unit is driven by the power take-off unit, the gears in the planetary gearbox should be engaged starting from the first and to the third gear in turn. When the required speed of the generator is achieved, lock up the torque converter.

To disengage the power take-off unit, proceed as follows: unlock the torque converter; shift the planetary gearbox gearshift lever to the neutral position; shut down the engine; set the power take-off control lever into the neutral position and fix it by the latch ring.

In motion it is permitted to supply power up to 30 h.p. In this case one of the gears in the transfer case should be shifted in. The power take-off unit should be engaged at halts when the automobile is still stationary.

If during operation of the power take-off unit its housing is intensively heated (above 110°C), discontinue the operation upon termination of the operation cycle and see that oil is delivered by the gear pump.

For checking unscrew the nut attaching the pipe to the union through 1.5-2 turns. If oil leaks through the joint it indicates that the pressure is being built up by the pump. If no lubricant is fed, it is necessary to fill the gear pump with 200 cu.cm of oil.

#### TRANSMISSION PROPELLER SHAFTS

The propeller shafts transmit the torque from the overdrive gear to the bogies of the automobile driving axles through the hydro-mechanical transmission.

The torque converter propeller shaft (Fig. 91) consists of two universal joints.

The rear universal joint (to the torque converter) is of a conventional design with a centre cross on needle bearings.

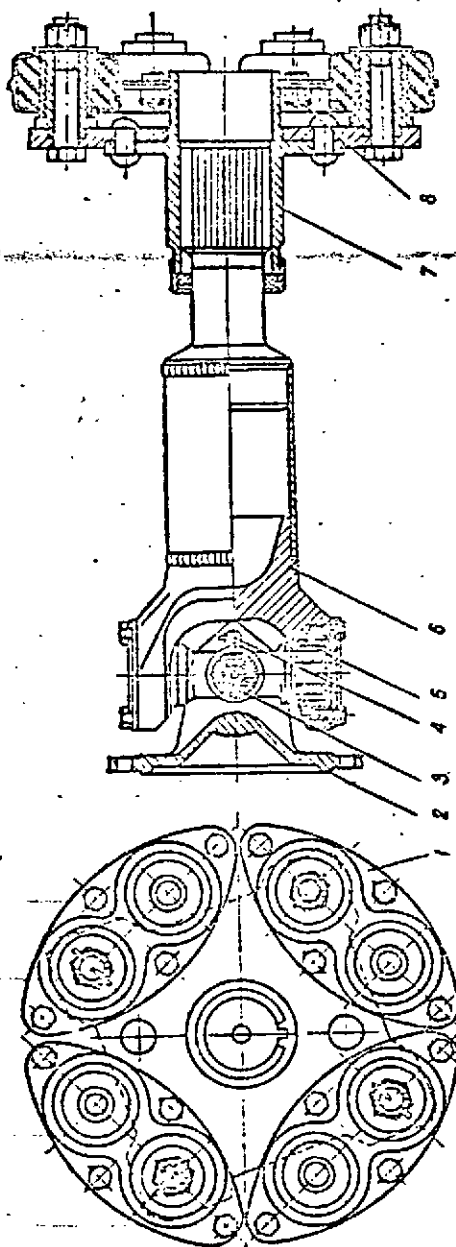


FIG. 91. TORQUE CONVERTER DRIVE PROPELLER SHAFT  
 1 - front universal joint retainer; 2 - rear universal joint flange; 3 - safety valve; 4 - lubrication fittings; 5 - bearing; 6 - retainer; 7 - universal joint yoke; 8 - slip flange; 9 - bolt with nut

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The front universal joint is made on rubber bushings.

Yoke 6 of the rear universal joint is made in the shape of a shaft with a splined end receiving slip flange 7 which is a part of the front universal joint. Yoke 6 is attached to flange 2 by means of a centre cross installed on needle bearings 5. The bearings are lubricated through lubrication fitting 4. Lubricant is filled into the universal joint until it appears from safety valve 3 at the centre of the centre cross. The bearings are sealed by packing rings. Turned onto the threaded end of the slip flange is a cup with a felt ring, preventing dust and dirt from getting into the splined joint.

The front universal joint consists of four retainers 1; each of the retainers is fitted with two rubber bushings. The retainer halves are joined with each other by bolts 8, nuts and cotter pins. One rubber bushing of each retainer is joined to the slip flange by a bolt, nut and a cotter pin; the other rubber bushing of each retainer is joined to the plate of the overdrive gear flange by means of a bushing, bolt and a cotter pin.

Centring of the rubber universal joint is accomplished by means of a spherical surface of the locating flange.

The rubber universal joint of the propeller shaft cushions impact loads when the engine speed is suddenly changed, thus protecting the gears of the overdrive gear against overload.

The intermediate propeller shaft installed between the planetary gearbox and the transfer case is of a conventional design and consists of two universal joints with centre crosses installed on needle bearings. The propeller shaft has a slip splined joint which is protected from dust by a felt seal installed on the threaded shank of the slip yoke. Lubrication is carried out by forcing lubricant through lubrication fittings arranged at the centre of the centre cross and on the slip yoke until the lubricant appears from the safety valves.

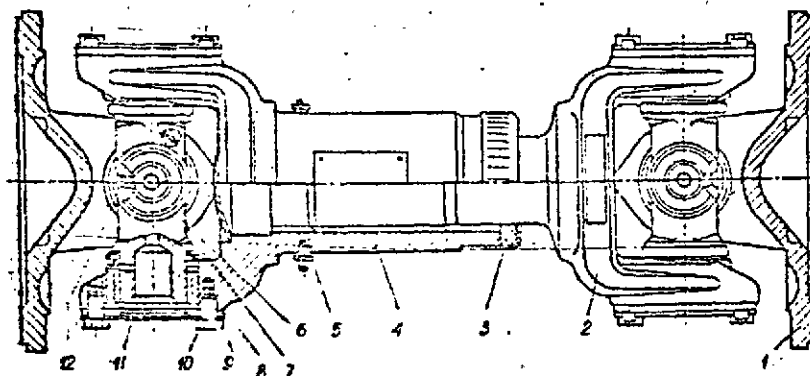


FIG. 92. INTERMEDIATE PROPELLER SHAFT COMPLETE WITH CENTER CROSSES AND FLANGES

1 - large yoke; 2 - propeller shaft yoke; 3 - felt oil seal; 4 - slip yoke assembly; 5 - lubrication fitting; 6 - centre cross assembly; 7 - packing ring; 8 - cover; 9 - lock plate; 10 - bolt; 11 - needle bearing assembly; 12 - safety valve; 13, 14, 15 - auxiliary balance plates

Auxiliary balance plates 13, 14, 15 are placed under the bolts attaching covers 10 (FIG. 92). When balancing the propeller shaft, the balance plates are installed on the lugs of the forks.

The propeller shafts running from the transfer case to the driving axles and between the axles are similar in design with the intermediate propeller shaft but instead of the needle bearings the bushings are fitted on the centre crosses.

Lubrication fittings are installed on the slip yoke of the propeller shaft running from the transfer case to the front driving axles.

The intermediate propeller shaft and propeller shafts running from the transfer case to the driving axles are dynamically balanced. After balancing, alignment marks are made on the tube (shaft) and the slip yoke. During disassembly and reassembly of the propeller shafts it is necessary to line up the above marks, otherwise the balancing will be disturbed which may result in vibrations and damage of the propeller shafts.

#### MOUNTING AND DEMOUNTING OF TRANSMISSION PROPELLER SHAFTS

##### Demounting of Propeller Shafts Intermediate Propeller Shaft

To demount the intermediate propeller shaft, proceed as follows:

1. Unscrew the nuts of the bolts attaching the flanged yokes to the flanges of the transfer case, and planetary gearbox, remove the bolts and shift in the propeller shaft yokes along the splined joint. This done, remove the propeller shaft raising it upward.

2. For disassembly of the universal joints, proceed as follows:

(a) unbend the tabs of the lock plates of the bolts attaching the needle bearing covers, unscrew and remove the bolts, auxiliary balance plates, and also the lock plates and covers. Tie up removed auxiliary balance plates 13, 14 15 (Fig.92) in sets, mark them and accordingly mark the yoke lugs upon which the plates were installed;

(b) drive out one bearing from the yoke by slightly striking the centre cross or the yoke ear face, this done, drive out the second bearing by striking the centre cross or the yoke ear face from the opposite side, remove the two remaining bearings in the same manner and take off the flange-yoke.

3. Disassemble the centre cross, for which purpose remove the packing rings, oil seal cups from the tenons, unscrew the breather and lubrication fitting.

4. Disassemble the propeller shaft for which purpose unscrew the oil seal cup and remove the splined yoke from the slip yoke by slightly striking the yokes, remove the felt oil seal and cup from the splined yoke.

##### Propeller Shaft of Front Axle Drive

The propeller shaft of the front axle drive should be demounted as follows:

1. Disconnect the suction hose of the hydraulic transmission rear pump.

2. Unscrew the nuts of the bolts attaching the propeller shaft to the transfer case flange, remove the bolts.

3. Disassemble the packing of the slip yoke on the opposite end of the propeller shaft, for which purpose unscrew the packing cup on the propeller shaft and remove the rear universal joint with the propeller shaft tube from the slip yoke lowering it backward down; this done, unscrew the bolts attaching the slip yoke to the intermediate support and remove the slip yoke.

Further disassembly of the propeller shaft is carried out similar to disassembly of the transmission intermediate propeller shaft (See the Section "Intermediate Propeller Shaft").

Propeller Shaft or Rear Axle Drive

The propeller shaft of the rear axle drive should be demounted as follows:

1. Unscrew the nuts of the bolts attaching the propeller shaft to the flange of the second rear axle, shift in the propeller shaft forward and remove the bearing housings with the bolts.
2. Disassemble the packing of the slip yoke on the opposite end of the propeller shaft for which purpose unscrew the packing cup on the propeller shaft and remove the rear universal joint with the propeller shaft tube from the slip yoke withdrawing it laterally and upward; this done, unscrew the bolts attaching the slip yoke to the transfer case flange and remove the slip yoke.
3. Disassemble the universal joint at the side of the second rear axle, for which purpose unscrew the bolts attaching the bearing housings to the welded fork and remove the housings with the bearings.

Further disassembly of the propeller shaft is carried out in the same manner as described in the Section "Intermediate Propeller Shaft".

Propeller Shaft of First Front and First Rear Axles

The propeller shaft of the first rear axle should be dismantled as follows:

1. Unscrew the nuts of the bolts attaching the propeller shaft to the flanges of the first and second rear reduction units, shift in the propeller shaft yoke and remove the shaft lowering it down.
2. Further disassembly of the universal joints, centre crosses and the propeller shaft proper is carried out in the same manner as described in the Subsection "Propeller Shaft of Rear Axle Drive", items 3-4.

Overdrive Gear-To-Hydro-Mechanical Transmission Propeller Shaft

The propeller shaft should be dismantled as follows:

1. Disconnect the hydro-mechanical transmission from the engine.
2. To remove the rubber elements, unlock the bolts and unscrew the nuts of the bolts.
3. Disconnect the hoses of the suction and front pumps of the hydro-mechanical transmission.
4. Unscrew the bolts attaching the propeller shaft to the flange of the hydro-mechanical transmission torque converter, shift in the propeller shaft yoke and remove the propeller shaft through the port of the bracket fastening the fuel tanks.
5. Disassemble the second universal joint and the centre cross as prescribed in the Subsection "Intermediate Propeller Shaft".

Mounting of Propeller Shafts

Mounting of the propeller shaft is performed in the order reverse to demounting of a corresponding propeller shaft but when doing so, the following peculiarities should be taken into consideration:

1. The lugs of the propeller shaft yokes should be placed in one plane.
2. The arrows punched on the slip and splined yokes should be aligned.
3. The bearings should be pressed into the bearing sleeves by slightly striking a drift, 25-30 mm in dia, fitted inside the bearing.
4. The centre cross should be installed in the propeller shaft yoke so that the centre cross breather is directed outside from the yoke.
5. During assembly of the propeller shaft the splined joints should be coated with lubricant, grade JCCor Yc.

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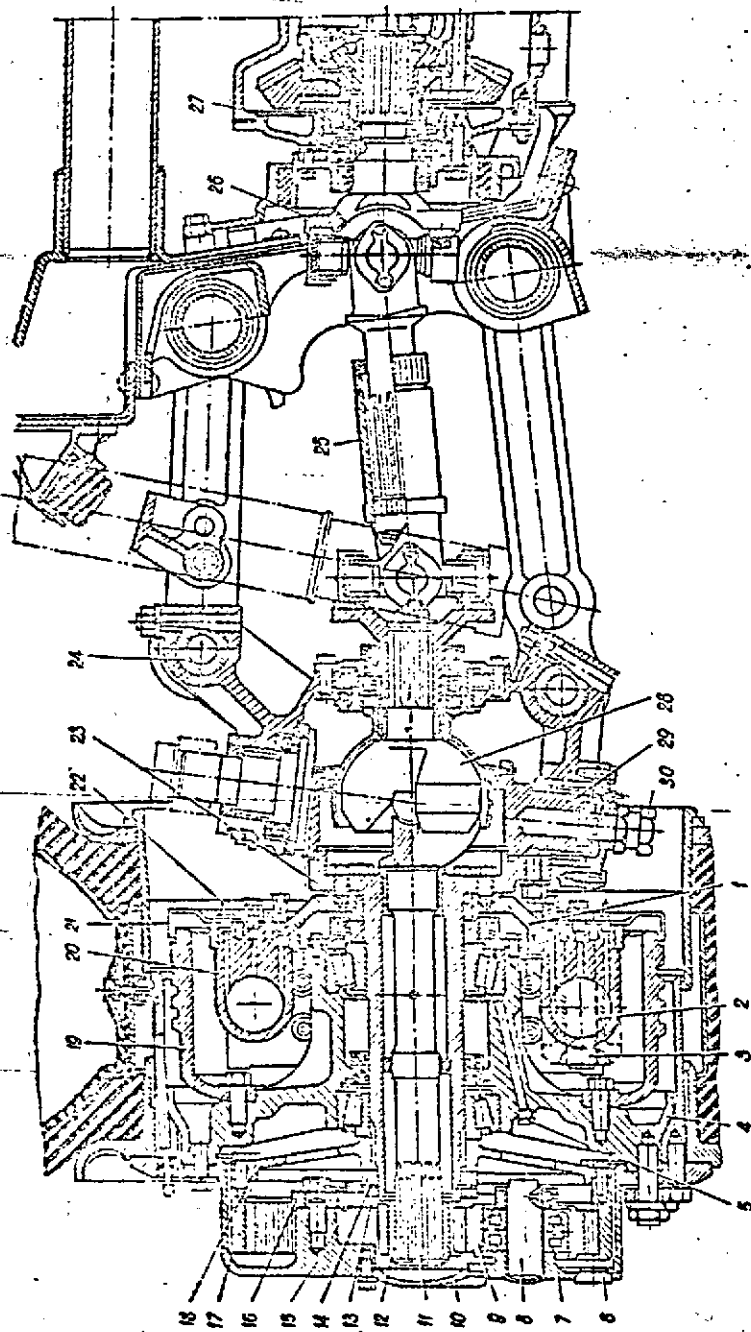


FIG. 01. FRONT DRIVING AXLE.

- 1 - wheel brake supports; 2 - brake wheel; 3 - brake-whor anchor pin; 4 - wheel hub; 5 - plugs; 6 - drain hole plug; 7 - wheel-hub drive outer carrier; 8 - planet pinion axle; 9 - planet pinions; 10 - outer emitter cover; 11 - constant velocity universal joint outer axle shaft; 12 - wheel-hub drive sun gear; 13 - lock nut; 14 - stop washer; 15 - nut; 16 - wheel-hub drive inner carrier; 17 - wheel-hub drive ring gear; 18 - wheel-hub drive casing; 19 - brake drum; 20 - wheel brake cylinder; 21 - wheel brake protective disc; 22 - wheel brake cylinder valves; 23 - steering knuckle transmits; 24 - steering knuckle support; 25 - control axle shaft; 26 - reduction exit axle shaft; 27 - reduction nut; 28 - constant velocity universal joint inner knuckle; 29 - steering knuckle; 30 - thrust bolt

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6. When installing the propeller shaft running from the overdrive gear to the hydro-mechanical transmission it is necessary to fit one of the rubber retainers so that the arrows on the driving and driven flanges are facing each other (so that the retainer works for extension).

7. After installation of the propeller shaft the centre crosses with the bearings should be lubricated with automobile transmission oil until the oil appears from the safety valve; the splined joints should be packed with lubricant, grade *YC* or *YCC*, by forcing the lubricant through a lubrication fitting until it appears from the plug hole or safety valve.

8. When mounting the intermediate propeller shaft the slip yoke can be installed in any position relative to the transfer case or hydro-mechanical transmission.

When mounting the intermediate propeller shaft it is necessary to fit auxiliary balance plates 13, 14, 15 (Fig. 92) marked during dismantling on the respective lugs of the yokes.

The balance plates are installed on cover 6; this done, the lock plates are fitted, the bolts screwed in and the lock plates bent in.

Maintenance of Transmission Propeller Shafts

When servicing the transmission propeller shafts carry out all the operations prescribed in preventive maintenance No.1 according to the Section "Preventive Maintenance of Automobile".

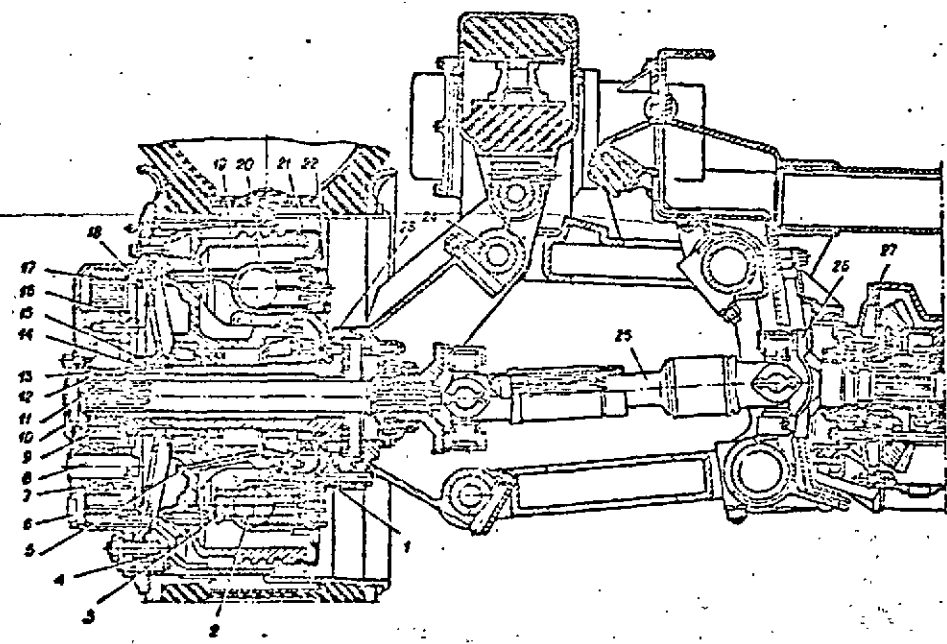


FIG. 91. REAR DRIVING AXLE

- 1 - brake wheel nut; 2 - brake shoe; 3 - brake shoe anchor pin; 4 - wheel hub; 5 - plug; 6 - drain hole plug;
- 7 - wheel-hub drive outer carrier; 8 - planet pinion axle; 9 - planet pinion; 10 - outer carrier cover; 11 - outer axle shaft; 12 - wheel-hub drive sun gear; 13 - lock nut; 14 - stop washer; 15 - nut; 16 - wheel-hub drive inner carrier; 17 - wheel-hub drive ring gear; 18 - wheel-hub drive casing; 19 - brake drum; 20 - wheel brake cylinder;
- 21 - wheel brake protective housing; 22 - wheel brake cylinder valve; 23 - steering knuckle trunion; 24 - suspension support; 25 - carrier axle shaft; 26 - reduction nut axle shaft; 27 - reduction nut

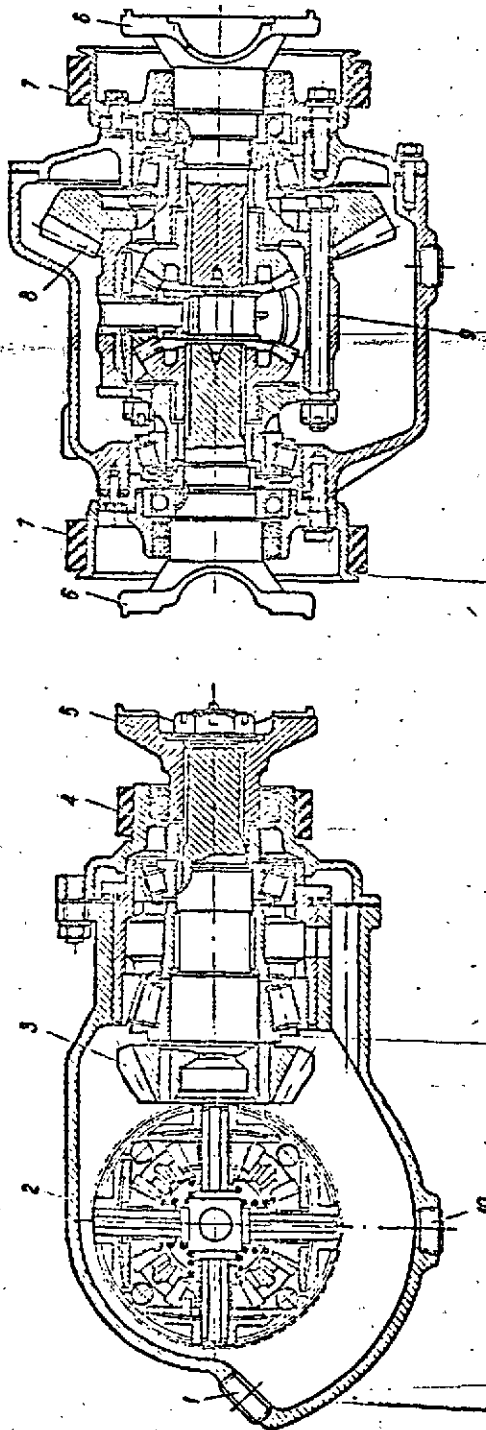


FIG. 95. FIRST AXIS REDUCTION UNIT

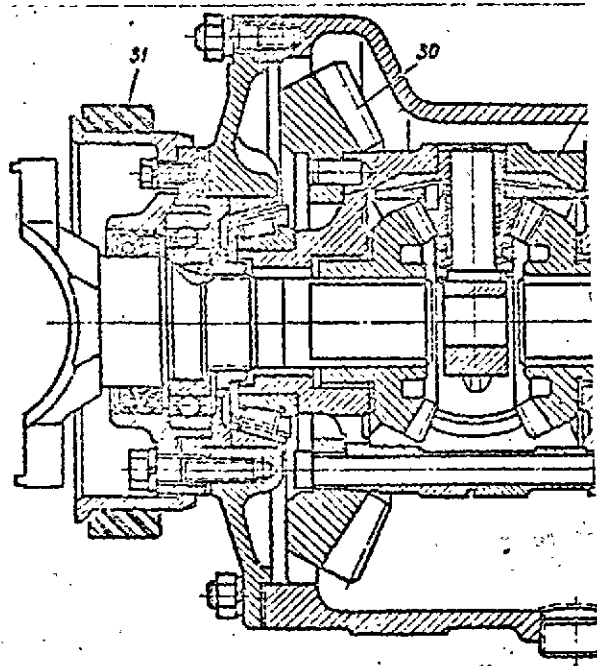
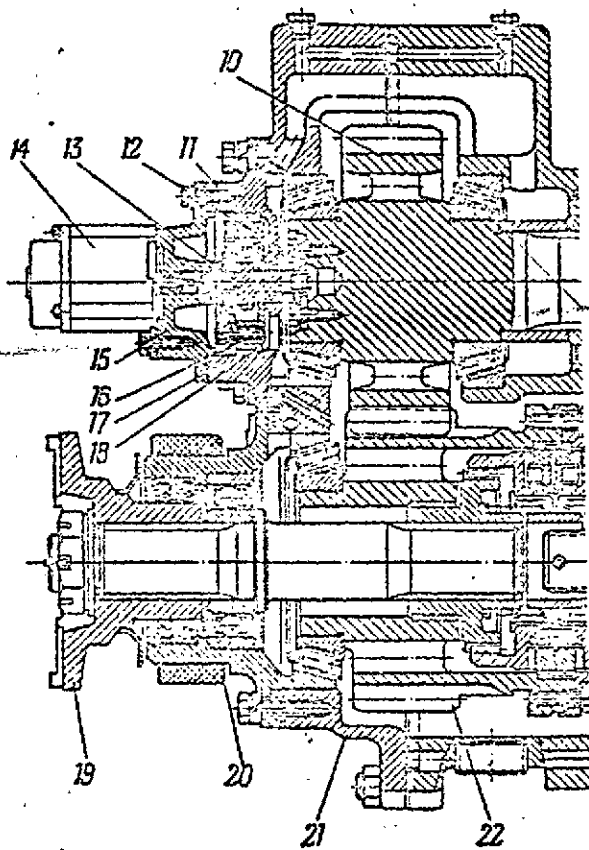
- 1 - filler hole plug
- 2 - side drive housing
- 3 - driving bevel gear
- 4 - rubber ring of reduction unit suspension support
- 5 - driving bevel gear drive flanges
- 6 - axle shaft
- 7 - rubber ring of reduction unit suspension side support
- 8 - driven bevel gear
- 9 - interwheel differential
- 10 - drain hole plug

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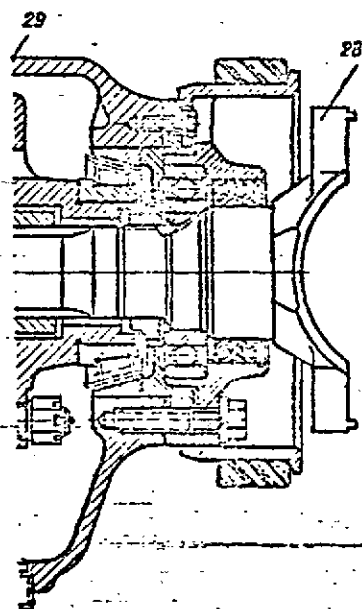
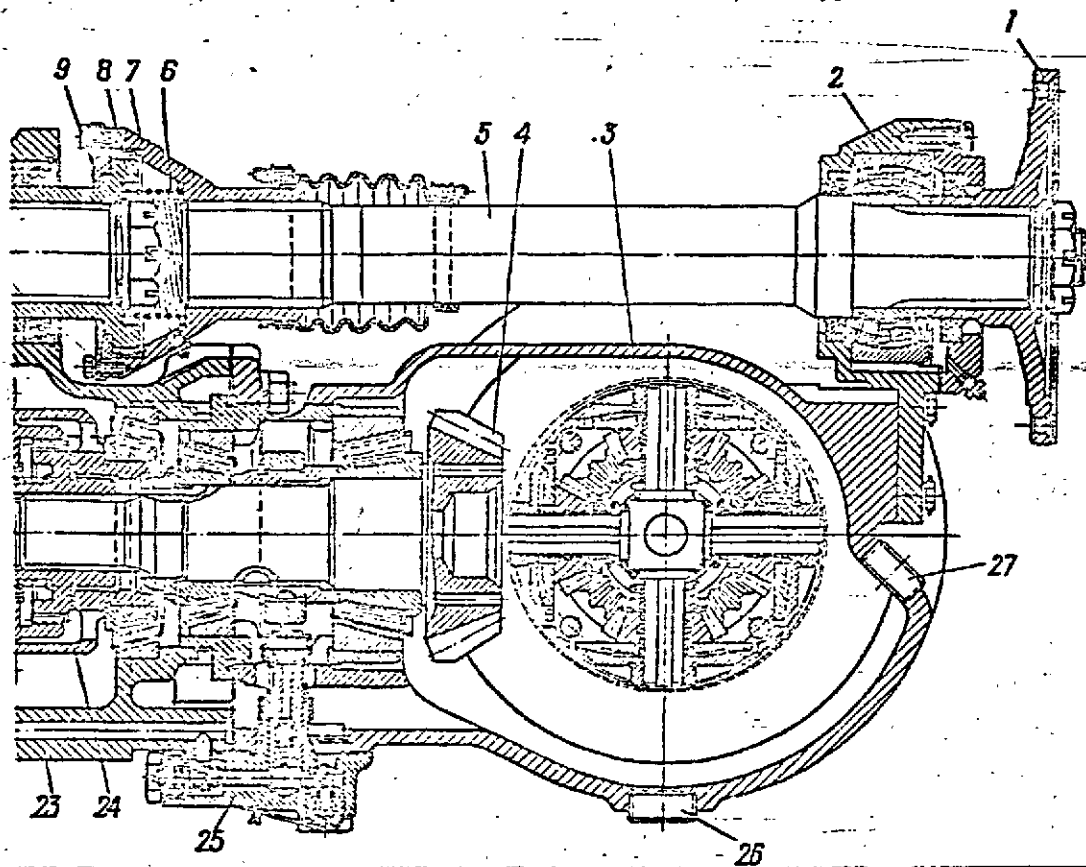
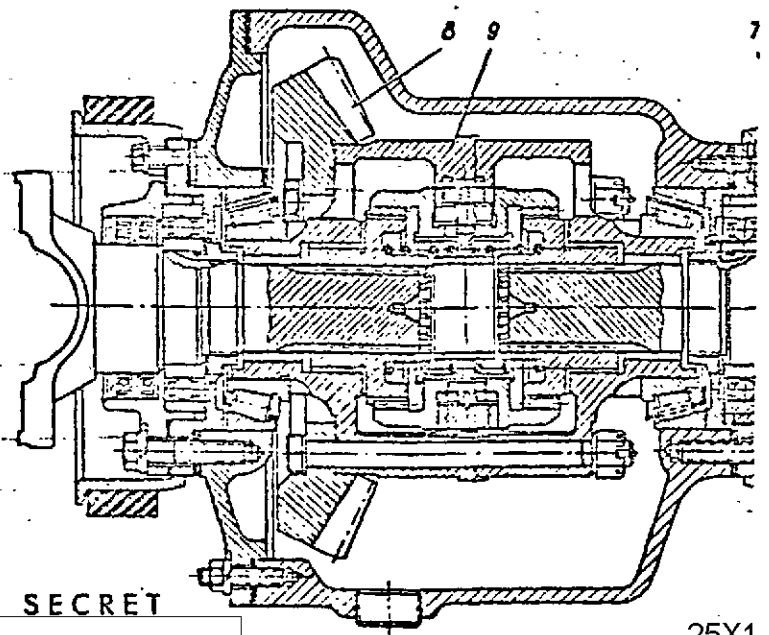
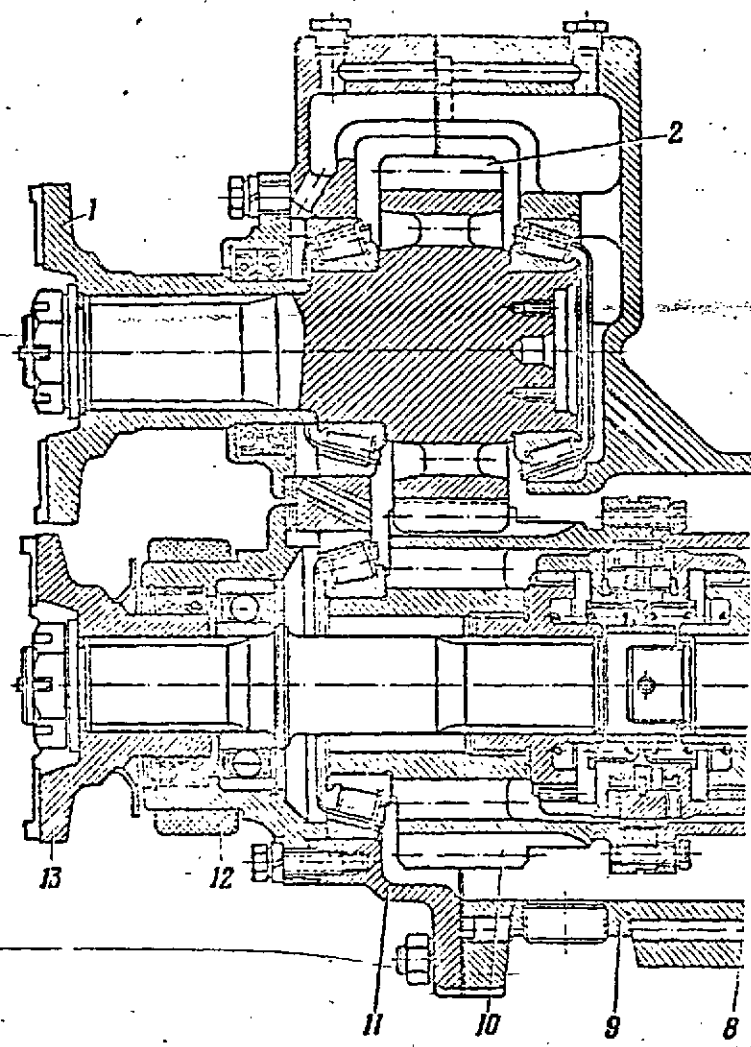


FIG. 96. SECOND AXLE REDUCTION UNIT

1 - propeller shaft flange; 2 - intermediate support body;  
 3 - axle drive housing; 4 - driving bevel gear; 5 - intermediate  
 support shaft; 6 - spring; 7 - toothed coupling; 8 - toothed  
 flange; 9 - rubber packing rings; 10 - spur gear; 11 - planet  
 pinion; 12 - drive washer; 13 - driving gear; 14 - speedometer  
 sending unit; 15 - r.h. gear flange; 16 - outer carrier;  
 17 - ring gear; 18 - inner carrier; 19 - front reduction unit  
 driving bevel gear drive flange; 20 - rubber ring of reduction  
 unit suspension front support; 21 - extreme housing; 22 - driven  
 spur gear; 23 - intermediate housing; 24 - interaxle differential;  
 25 - oil plunger pump; 26 - drain hole plug; 27 - filler hole  
 plug; 28 - axle shaft; 29 - inter-wheel differential; 30 - driven  
 bevel gear; 31 - rubber ring of reduction unit suspension side  
 support

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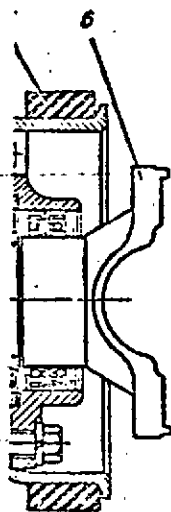
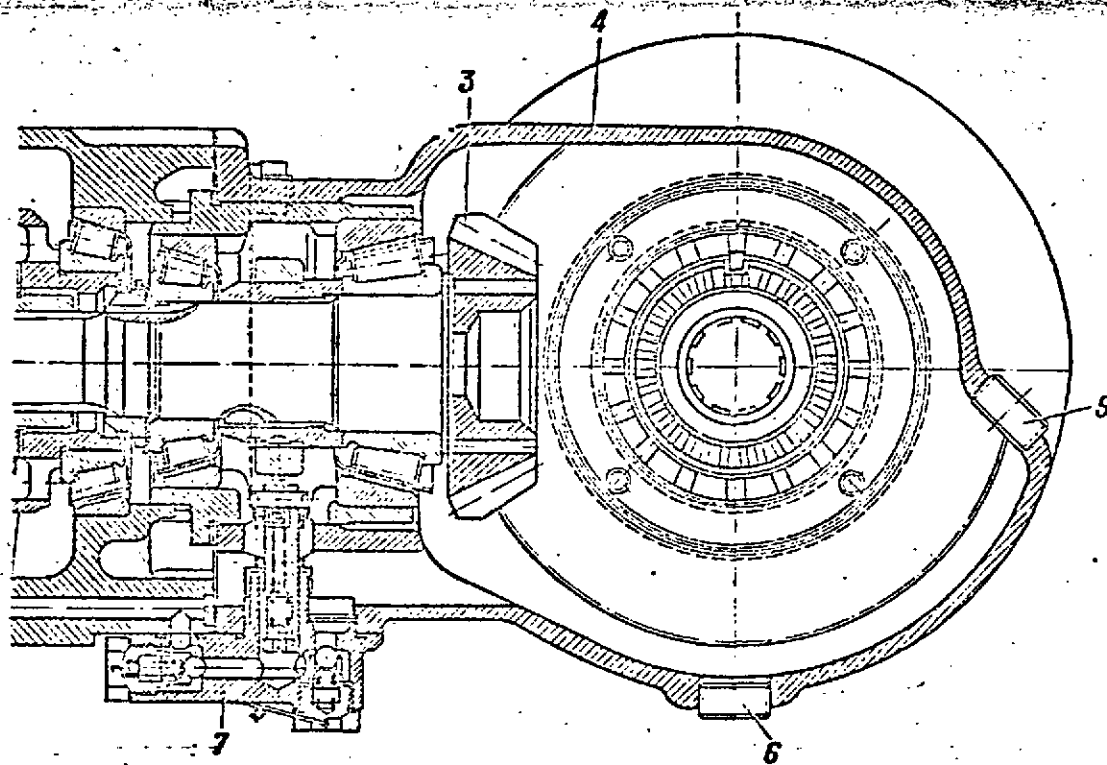


FIG. 97. REAR AXLE REDUCTION UNIT

1 - driving spur gear drive flange; 2 - driving spur gear; 3 - driving bevel gear; 4 - final drive housing; 5 - filler hole plug; 6 - drain hole plug; 7 - oil (plunger) pump;  
 8 - interaxle differential; 9 - intermediate housing; 10 - driven spur gear; 11 - extreme housing; 12 - rubber ring of reduction unit suspension front support; 13 - flange of driving bevel gear drive of first rear axle; 14 - driven bevel gear; 15 - interwheel differential; 16 - front ring of reduction unit suspension side support; 17 - axle shaft

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When checking the propeller shafts for condition it is necessary to remove all detected foreign objects from them. If a radial (side) or end play of the centre cross is revealed, it is necessary to disassemble the universal joint and to check the bearings and centre crosses for condition.

#### DRIVING AXLES

The automobile axle assembly consists of a reduction unit, two cardan axle shafts and two planetary wheel-hub drives (Figs 93, 94).

##### Reduction Unit

The reduction unit transmits the torque from the transfer case to the wheels of the driving axle.

The reduction units of the driving axles are mounted in the frame along the centre line of the automobile. Each reduction unit is attached to the frame on three supports through rubber rings 4 and 7 (Fig.95), 20 and 31 (Fig.96). Side brackets of the reduction unit supports are bolted to the bracket of the upper (tubular) cross member of the frame; the front bracket of the support is riveted to the frame. Covers of the reduction unit support are bolted to the side and front brackets.

The reduction unit is a pair of spiral bevel gears, (driving 3 and driven 8) with interwheel differential 9, which are mounted on tapered roller bearings in axle drive housing 2 (Fig.95) and 3 (Fig.96). Axle shafts 6 are prevented from axial displacement by radial ball bearings.

The intermediate reduction units additionally mount a pair of spur gears 10 and 22 with interaxle differential 24 on tapered bearings in intermediate and extreme housings 23 and 21 which are attached to axle drive housing 3 by studs and nuts.

Driving spur gears 10 of the intermediate reduction units are driven from the transfer case flanges through a propeller shaft.

Driving bevel gears 4 of the reduction units are rotated from driving spur gear 10 of the reduction unit through driven spur gear 22 and interaxle differential 24.

The interwheel differentials in the rear reduction units are a gear, overrunning clutch type. The interwheel differentials in the front reduction units are of a bevel gear type with higher-friction washers. The interaxle differentials in the intermediate reduction units are of a gear, overrunning clutch type.

Oil for lubrication of the upper bearings of the intermediate reduction unit driving gear is delivered by plunger pump 25 (Fig.95) and 7 (Fig.97) mounted on the lower half of the reduction unit housing. The gears and other bearings of the reduction unit are lubricated by splashing.

The housing of the reduction unit final drive is provided with two holes closed by plugs 1 and 10 (Fig.95), 26 and 6 (Figs 96 and 97). One hole is used for filling and the other - for draining oil. The intermediate housing is also provided with an oil drain hole closed by a plug. The side wall of the intermediate housing has a level hole closed by a plug.

The reduction unit housing (Fig.96) mounts intermediate support 2 of the propeller shaft driven from the transfer case. The rear end of shaft 5 is installed inside the support body on a barrel-shaped cylindrical bearing.

Oil seals are fitted at both sides of the bearing. For filling lubricant the support body bottom is provided with a lubrication fitting. To check the quantity of filled lubricant the support body on its side has a level hole screwed into which is a safety valve.

Toothed coupling 7 by means of which the shaft is attached to toothed flange 8 of driving spur gear 10 is fitted on splines of the opposite end of shaft 5. The longitudinal position of the toothed coupling on the shaft is fixed by spring 6 fitted between the coupling and the toothed flange. The gearing is filled with lubricant through a lubrication fitting provided on the coupling. The lubricant is prevented from flowing out by rubber ring 9 and a protective boot.

The speedometer drive of a planetary gear type is mounted on the front end face of extreme housing 21.

Sun (driving) gear 13 of the speedometer drive is rotated from driving spur gear 10 of the reduction unit through drive washer 12 bolted to gear 10. The drive washer has an extended milled notch which receives the sun gear shank.

The sun gear drives two planet pinions 11 which are fitted on the axles secured in inner 18 and outer 16 carriers. The sun gear in the carriers and the planet pinions on the axles are supported by sliding bearings.

The planet pinions run around stationary ring gear 17 bolted to housing 21.

Speedometer sending unit 14 is rotated by a shank of the outer carrier.

The gears and bushings of the speedometer drive are lubricated by splashing.

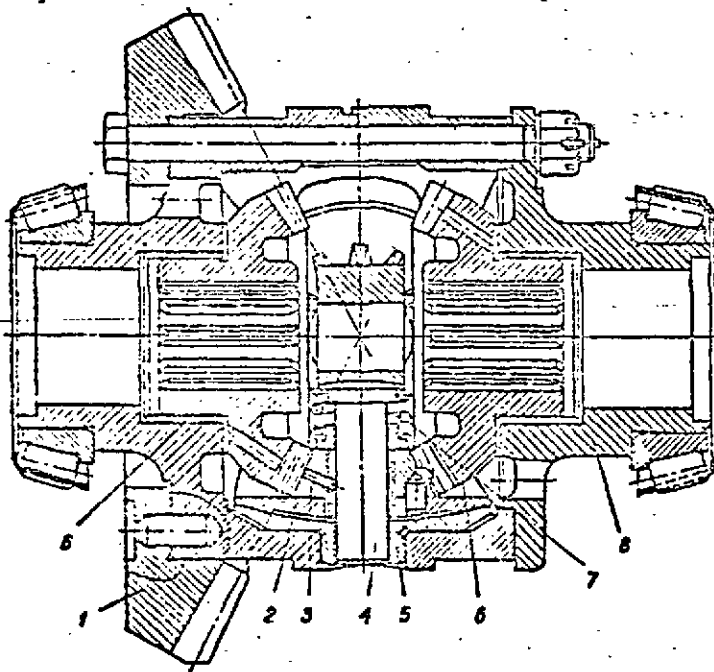


FIG. 98. INTERWHEEL DIFFERENTIAL OF FRONT REDUCTION UNITS

1 - driven bevel gear; 2 - support washer; 3 - planet pinions; 4 - epider; 5 - insert; 6 - axle shaft gear; 7 - spring; 8 - differential case

### Interwheel Differential of Front Reduction Units

The differential of the automobile front reduction units belongs to higher-friction differentials.

The torque from driven bevel gear 1 is transmitted to spider 4 through differential case 8 (Fig.98). This differential operates in the same manner as the conventional bevel unit, however it provides greater division of the torque on the axle shafts.

This is attained by considerable increase of a mean diameter of planet pinion support washers 2 and by introduction of springs 7 constantly pressing the planet pinions against inserts 5 which are stationary relative to the differential case. The axial thrust arising on the planet pinion due to its meshing with axle shaft gears 6 is added to the spring effort, as a result, an increased friction moment is attained on the surfaces of the support washer. If one wheel spins on a slippery spot or ice and the second wheel runs on a good road, the torque arising in the latter will be equal to the torque on the wheel, which spins on the slippery spot, plus the friction moment developed inside the differential, and all this improves the cross country ability of the automobile.

Each spring of the planet pinions is loaded by an effort of 170 kg, therefore for safety purposes disassembly and assembly of the higher-friction differential should be performed in a special device.

### Interwheel Differential of Rear Reduction Units

#### Design of Self-Locking Differential

The differential of the automobile rear reduction units belongs to self-locking differentials operating on the principle of an overrunning clutch.

The torque from driven bevel gear 1 (Fig.99) is transmitted to driving coupling 4 through differential case 3.

The driving coupling has a number of opposing rectangular teeth arranged on both faces. By means of these teeth the torque from the driving coupling is conveyed to two half-couplings 5 having two rows of teeth on their faces - outer and inner. The outer driving row of the half-coupling teeth gets in mesh with the identical teeth of the driving coupling. The inner row of the half-coupling teeth is of a special shape; these teeth are intended for disengaging the half-coupling from the driving coupling. Split ring 9 fitted on the outside diameter of the half-coupling teeth inner row ensures noiseless operation of the differential. From each half-coupling the torque is transmitted to axle shaft gear 6 and the axle shaft through involute splines. Centre ring 11 which is held from axial displacement by lock ring 10 is installed inside the driving coupling.

Both faces of the centre ring are provided with teeth of a special shape opposing each other.

Spaces between these teeth receive the teeth of the half-coupling inner row and also the teeth of the split rings. Under definite conditions the centre ring teeth interacting with the half-coupling teeth contribute to disengagement of half-coupling 5 and driving coupling 4.

The half-coupling is held in a disengaged position by split ring 9 which is prevented from turning by key 2 installed in the driving coupling.

The half-couplings are constantly pressed against the driving coupling by spiral springs 7 resting with their extreme coils on the axle shaft gears and the half-couplings through sleeve 8. Distance bushing 12 installed between the axle shaft gears prevents the axle shaft gears from displacement when the axle shafts are installed.

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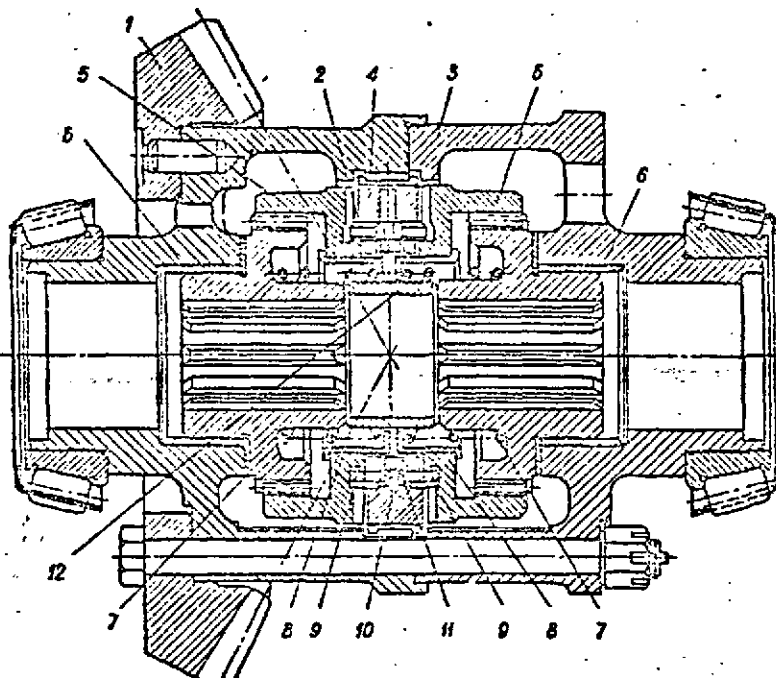


FIG. 99. INTERWHEEL DIFFERENTIAL OF REAR REDUCTION UNITS

1 - driven bevel gear; 2 - key; 3 - differential case; 4 - driving coupling; 5 - half-coupling;  
6 - axle shaft gear; 7 - spring; 8 - spring sleeve; 9 - split spacer ring; 10 - lock ring;  
11 - centre ring; 12 - distance bushing

#### Operation of Self-Locking Differential

When the automobile is moving on a smooth straight road the differential does not operate: all parts of the differential are locked up and the axle shafts rotate as one unit at a speed of the driven bevel gear.

When driving off the road, separate rotation of the wheels (of one driving axle) is impossible, both wheels are compulsorily rotated at the same speed, thus increasing the common traction and improving the automobile cross-country ability.

When the automobile makes a turn, the leading wheel tends to rotate faster than the driven bevel gear and the driving coupling. In this case the half-coupling of the leading wheel resting with its shaped teeth on the centre ring teeth goes off the driving coupling and gets out of engagement. The split spacer ring fitted on the half-coupling rotates together with it until the notch edge thrusts against the key installed in the driving coupling. At this moment the faces of the split spacer ring teeth will oppose the faces of the centre ring teeth and will hold the half-coupling from engagement. During the entire turn the leading half-coupling will be disengaged and will not transmit the torque to the half axle. The power will be applied only to the half-coupling engaged with the driving coupling.

When the automobile is turned on slippery roads the half-coupling of the leading wheel may not disengage. In this case the turn is accomplished due to slippage of the lagging wheel.



When the automobile completes its turn the rotation speeds of the leading and lagging half-couplings become equal. The split spacer ring somewhat slides back, its teeth go off the centre ring teeth and the half-coupling actuated by the compressed spring gets in mesh with the driving coupling. When making a turn at coasting, the lagging coupling and not the leading one will disengage as in this case the driving element is the leading wheel and not the differential case.

When driving the automobile straight backward the differential operates in the same manner as when moving forward, but in this case the opposite sides of the driving teeth of the driving coupling and half-coupling are locked up. Operation of the differential at turns while moving backward does not differ from operation of the differential at turns while moving forward.

#### Interaxle Differential of Intermediate Reduction Units

The interaxle differential of the intermediate reduction unit is designed to ensure differential connection between the reduction units.

The overrunning-type interaxle differential is similar to the interwheel differential of the rear reduction units but differs from it only in a differential case.

#### Cardan Axle Shafts and Constant Velocity Universal Joints

The driving gear of the wheel-hub drive of the steerable wheels is driven from axle shaft 26 of the reduction units through cardan axle shaft 25 (Fig.93) and outer axle shaft 11 with the constant velocity universal joint. The cardan axle shafts are an open type with centre crosses on needle bearings. The centre crosses and slip yokes of the cardan axle shafts are provided with lubrication fittings for filling lubricant.

The constant velocity universal joint is intended to transmit the torque from the cardan axle shafts to the wheel-hub drives of the steerable wheels.

Constant velocity universal joint inner knuckle 28 is mounted in a ball housing on one ball bearing and one roller bearing. The outer knuckle of this universal joint is made integral with outer axle shaft 11. Each knuckle of the universal joint has four circular grooves accommodating four driving balls. In case of relative displacement of the knuckles the balls roll along the grooves.

To prevent axial displacement of the knuckles relative to each other a centre (fifth) ball of a smaller size is set between them.

The balls of different universal joints are not interchangeable.

For normal operation of the constant velocity universal joint clearance C (Fig.100) between the face of universal joint 7 and bushing 8 of trunnion 1 should be equal to 0.25-0.37 mm. This clearance is obtained by turning in adjusting nut 6 as far as it will go, i.e. until a sudden increase of resistance is felt during turning, backing the nut through 1/4 - 1/6 turn and unscrewing it further until the holes for a cotter pin on the nut and the knuckle get aligned for the first time.

When replacing the universal joint, bushing 8 of trunnion 1 should be replaced too if the wear of the working surface of its face exceeds 0.5 mm. Failure to observe this requirement may result in knocking of the joint, its self-disassembly and damage.

For filling the constant velocity universal joint with lubricant and checking, steering knuckle 29 (Fig.93) is provided with two plugs arranged at one level on opposite sides. Depending on a wheel turn one hole is used for filling and the other - for checking.

An oil seal preventing penetration of lubricant from the wheel-hub drive space into the space of the constant velocity universal joint is fitted on outer axle shafts 11 of the front wheels. An oil seal preventing penetration of lubricant from the inner bearing space into the wheel brakes is installed after the inner bearing of the hubs in all the wheels.

The driving gear of the wheel-hub drives of the rear wheels is rotated from axle shafts 26 (Fig.94) of the reduction units through cardan axle shaft 25 and outer axle shaft 11.

The propeller shafts of the rear axle shafts are similar in design with the front propeller shafts.

#### Mounting and Demounting of Cardan Axle Shafts

##### Demounting of Cardan Axle Shafts

To demount the cardan axle shafts, perform the following operations:

1. Unbend the tabs of the lock plates of the bolts attaching the housings of the needle bearings of the universal joint, unscrew the bolts and remove the universal joint with the bearing housings.
2. Remove the sleeve with the bearings and press out the bearings from the sleeves through a hole, 2 mm in dia.
3. Remove the centre cross from the yoke for which purpose proceed as follows:
  - (a) unbend the tabs of the lock plates, unscrew the bolts attaching the bearing covers, take off the lock plates and covers;
  - (b) drive out one bearing from the fork by slightly striking the centre cross; this done, drive out the other bearing by striking the centre cross from the opposite side.
4. Disassemble the centre cross for which purpose remove the packing rings, oil seal retainers from the tenons, unscrew the breather and lubrication fitting.
5. Dismantle the cardan shaft, for which purpose unscrew the nut and drive the splined yoke off the slip yoke by slightly striking the yokes, remove the felt packing and cup from the splined yoke.

##### Mounting of Cardan Axle Shafts

Mounting of the cardan axle shafts is carried out in the order reverse to their demounting but, when doing so, the peculiarities described in Section "Mounting of Cardan Shafts" should be taken into consideration.

##### Wheel-Hub Drive

The planetary-type wheel-hub drives with spur gears are mounted on the outside of the wheel hubs. Driving (sun) gear 12 (Figs 93 and 94) of the wheel-hub drive rotates three planet pinions 9 which are fitted on axles 8 secured in inner 16 and outer 7 carriers. The planet pinions run around stationary ring gear 17. The ring gear is bolted to wheel-hub drive casing 18 which is fitted stationary on the splines of steering knuckle trunnion 23.

The outer carrier is a driving element of the wheel hub. The outer carrier is bolted to the hub. The bearings and gears of the wheel-hub drive are lubricated by splashing. The outer carrier is fitted with plug 6 for draining lubricant.

Filling of the wheel-hub drive with lubricant is carried out, with cover 10 of outer carrier 7 removed.

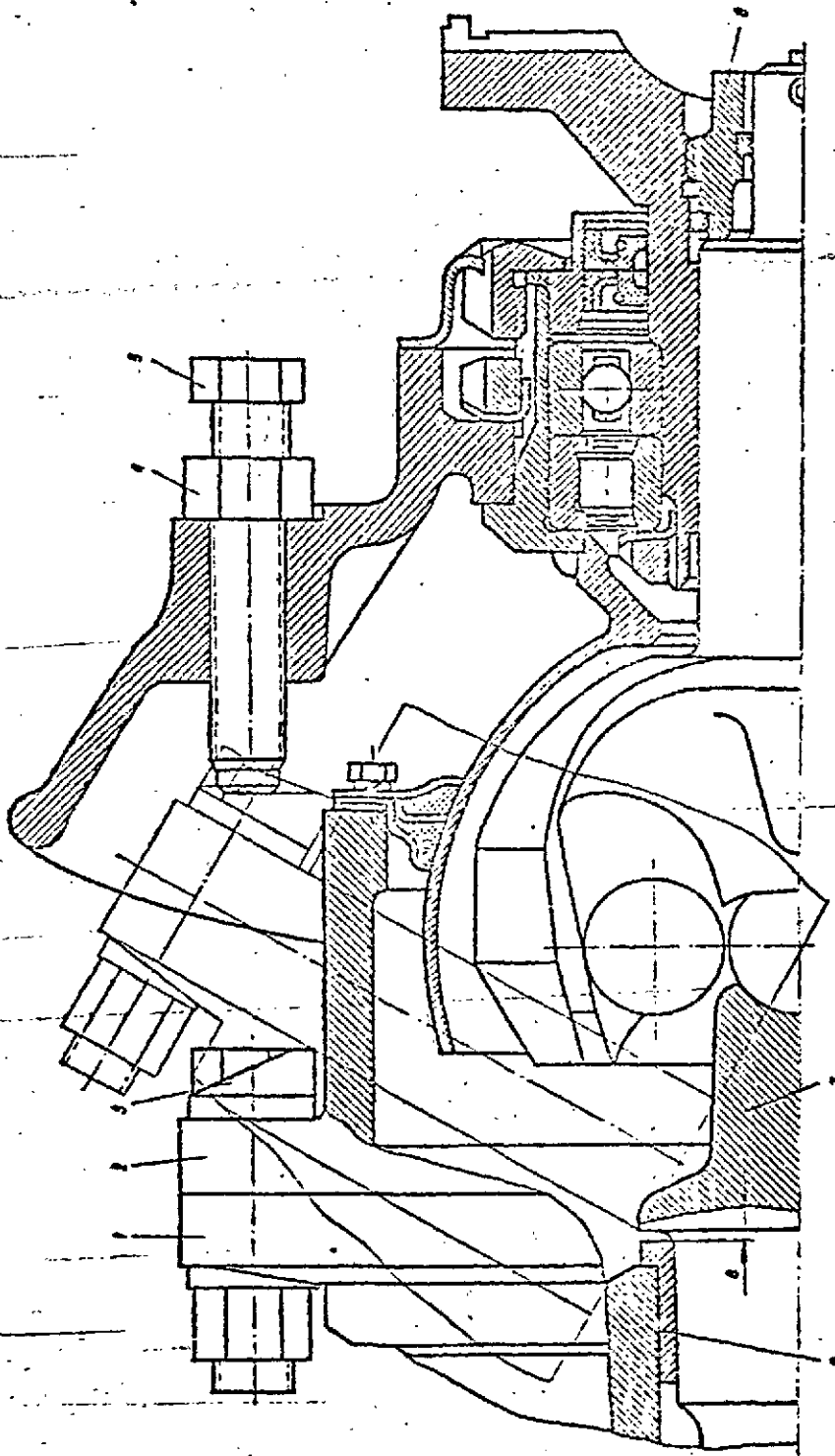


FIG. 100. ADJUSTMENT OF WHEEL INFLU TURNING  
1 - transom; 2 - steering knuckle body; 3 - slip (limited); 4 - lock nut; 5 - thrust bolt; 6 - adjusting nut;  
7 - spherical joint; 8 - bushing

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Maintenance of Driving Axles

When servicing the driving axles carry out all the operations prescribed in the Section "Preventive Maintenance of Automobile".

Troubles and Remedies of Mechanical Transmission

Trouble	Cause	Remedy
1	2	3
Spontaneous disengagement of transmission cut-in coupling on overdrive gear	Loose locking of coupling	Tighten spring by lock screw, having removed gaskets, or replace spring
Intensified noise of gears in overdrive gear	<ol style="list-style-type: none"> <li>1. Low oil level in housing</li> <li>2. Wear of gear teeth</li> <li>3. Wear or damage of bearings</li> </ol>	<p>Add oil into housing to normal level</p> <p>Overdrive gear is subject to repair</p> <p>Overdrive gear is subject to repair</p>
Overheating of overdrive gear	<ol style="list-style-type: none"> <li>1. High or low level of oil in housing</li> <li>2. High level of oil in housing</li> </ol>	<p>Set normal level of oil in housing</p> <p>Unscrew plug 13 (Fig. 83) and see that pump and oil seal are in order. If necessary, replace</p> <p>Replace rubber rings</p>
Spontaneous disengagement of transfer gearshift coupling or differential lock-up clutch	Rubber rings of pneumatic gear shifter or differential lock-up switch are worn or damaged	Replace rubber rings
Intensified noise of gears in transfer case	<ol style="list-style-type: none"> <li>1. Low oil level in transfer case</li> <li>2. Wear of gear teeth</li> <li>3. Wear or damage of bearings</li> </ol>	<p>Add oil into transfer case to normal level</p> <p>Transfer case is subject to repair</p> <p>Transfer case is subject to repair</p>
Overheating of transfer case when moving on hard-surface roads at high speeds	<ol style="list-style-type: none"> <li>1. Low or high level of oil in transfer case</li> <li>2. Transfer case differential is locked up or at fault</li> </ol>	<p>Add oil into transfer case to normal level. See that lock-up clutch is disengaged</p> <p>If return spring is weak or cambered, replace it</p> <p>After this, check differential for operation for which purpose disconnect intermediate propeller shafts and rotate flange of one of output shafts. If, with output shaft rotating in one</p>

1	2	3
<p>Torque in rear reduction units is transmitted to one axle shaft only</p> <p>Torque is transmitted to one of two axles only</p> <p>Spontaneous disengagement of sliding gear in power take-off unit</p>	<p>Spring pressing half-coupling against driving coupling of interwheel differential is heavily cambered or broken</p> <p>Spring pressing half-coupling against driving coupling of interaxle differential is heavily cambered or broken</p> <ol style="list-style-type: none"> <li>1. Weak lock spring</li> <li>2. Loose attachment of fork to rod</li> </ol>	<p>direction, the other output shaft rotates in reverse direction, differential is in order. If it does not take place, differential is locked up and transfer case is subject to repair</p> <p>Interwheel differential is subject to repair</p> <p>Interaxle differential of intermediate axle is subject to repair</p> <p>Tighten spring by lock screw, having removed gaskets or replace spring</p> <p>Tighten up bolt by coupler and secure it with safety wire</p>

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## Chapter V

### RUNNING GEAR, FIFTH WHEEL ASSEMBLY, CAB

#### RUNNING GEAR

The running gear comprises: steering mechanism, wheel hubs, wheels, suspension and frame.

#### Steering Mechanism

The steering mechanism serves for turning the steerable wheels.

Steering knuckle 29 (Fig.93) is provided with two pins which form the pivot. The steering knuckle support is mounted on these pins in two needle bearings and a thrust bearing (located at the top). The steering linkage arm is secured on tapered splines of the upper pin. Steering knuckle support 24 is provided with bosses having holes for attaching the suspension arms. Arranged inside the inner space of the steering knuckle is a constant-velocity universal joint.

An axial clearance of 0.5-0.2 mm is set in the steering mechanism between thrust bolt 30 and the lower pin of the steering knuckle. During disassembly and assembly of the steering mechanism the axial clearance should be adjusted within the above limits.

For adjusting the clearance, screw in thrust bolt 30 as far as it will go, then back it out through 1/8-1/10 of a turn (approximately through 3/4 of the head flat) and lock it with a lock nut.

During adjustment of the clearance the steerable wheels should be under load (placed on the ground).

The steering knuckle support has two threaded holes receiving thrust bolts 5 (Fig.100) which are intended to limit the turning of the wheel hub.

To prevent the constant-velocity universal joints from self-disassembly and damage the thrust bolts should be screwed in so that the turning angle of the hub does not exceed 29°.

For this purpose, turn the hubs through an angle of 29° from the straight forward position, screw in bolt 5 until it comes in contact with stop 3 secured on the steering knuckle flange and screw on lock nut 4.

For lubrication of the steering knuckle bearings provision is made for two lubrication fittings: one located on the upper pin of the steering knuckle and the other arranged in the cover of the lower pin sleeve.

Maintenance of Steering Mechanism

When servicing the steering mechanism, carry out the operations prescribed in preventive maintenance No.1 according to the Section "Preventive Maintenance of Automobile".

Wheel Hubs

The wheel hub (Figs 93 and 94) is installed on two taper roller bearings.

The hub outer surface is provided with a mounting cone used for installation of the wheel rim. From the inside the hub has a centering collar for the brake drum attached to the hub by bolts. Finishing of the brake drum working surface is performed in assembly with the hub, therefore the brake drums are not interchangeable.

Adjustment of Bearings and Demounting of Wheel Hub

To adjust the bearings of the wheel hub, do the following:

1. Jack up one wheel of the automobile so that the tyre is clear of the ground. Install the jack head under the suspension arm head at the wheel.

2. Set the wheel so that the plug of the wheel hub drive carrier drain hole is in the lower position.

3. Unscrew the nuts attaching the wheel, remove the clamps and the wheel.

4. Unscrew the attaching bolts and remove cover 10 of the wheel-hub drive outer carrier (Fig.93).

5. Unscrew drain hole plug 5 and drain oil from the wheel-hub drive, screw in the plug.

6. Remove the locking ring and take out sun gear 12 of the wheel-hub drive using a special puller for screwing in the thrust bolt.

7. Unscrew the attaching bolts and remove outer carrier 7 with planet pinions.

8. Unbend the edge of stop washer 14, unscrew lock nut 13 and remove the stop and lock washers.

9. Unscrew nut 15 of the wheel hub bearings through 1/3-1/2 of a turn, check for free rotation of the hub; if the hub rotates with difficulty, eliminate the cause (rubbing of brake shoes, destruction of bearings, etc.).

10. Screw in nut 15 as far as it will go with a wrench having a tommy-bar 1-metre long and apply an effort of 50 kgf.

When screwing in the nut, rotate the wheel to ensure correct arrangement of rollers on races of bearings rings.

11. Reinstall the lock and stop washers. The lock washer should be installed so that the pin of nut 15 enters one of the nearest holes of the washer.

12. Screw in the lock nut and bend the stop washer edge on the nut flat.

13. Carry out the operations listed under Items 1-7 in the reverse order.

If necessary, the wheel hub can be removed with a special puller in the following sequence:

1. Carry out the operations listed above under Items 1-8.

2. Unscrew nut 15 of the wheel hub bearings.

3. Remove wheel hub casing 18 complete with sun gear 17.

4. Screw the protective thrust on the trunnion.

5. Place outer carrier 7 on two bolts.

6. Install the wheel hub puller instead of the outer carrier cover.

7. Rotating the puller screw, remove the wheel hub from the mounting seats of bearings.

\*10. Instead of "10. Screw in nut 15 as far as it will go with a wrench having a tommy bar 1-metre long and apply an effort of 50 kgf" insert as follows: "10. Screw in nut 15 as far as it will go with a wrench having a tommy bar 1-metre long and apply an effort of 50 kgf., then unscrew it through 1/8 or 1/12 of a turn."

8. Unscrew the bolts, remove outer carrier 7 together with the wheel hub puller.
9. Unscrew the protective thrust of the wheel hub removing device and screw the protective cone on the threaded end of the steering knuckle trunnion.
10. Remove the wheel hub from trunnion 23.
11. Install the hub on the trunnion and unscrew the protective cone.
12. Carry out the operations listed under Items 2-3 in the reverse order.
13. Adjust the wheel hub bearings as instructed above.
14. Carry out the operation listed under Item 1.

#### Maintenance of Wheel Hubs

When servicing the wheel hubs, carry out the operations prescribed in preventive maintenance No.1 and No.2 according to the Section "Preventive Maintenance of Automobile".

After tightening of the wheel hub bearings, check the latter for correct adjustment by feeling the wheel hub drive outer carrier for heating during the first 100 km of the automobile run. If the heating of the wheel hub drive outer carrier is perceptible to the hand palm, unscrew the nut of the wheel hub bearings through one hole of the lock washer.

#### Wheel and Tyres

The automobile is equipped with discless wheels having low-pressure tyres. The wheel set (Fig.101) includes: rim, welded of two portions and provided with studs, inner (removable) side ring, spacing ring, outer side ring consisting of three interchangeable sectors, pressure ring, nuts for tightening the tyre on the rim, tyre tube with valve, tyre and flap. The rim is provided with a slot for passing the tyre tube valve while the rim inner surface has welded cover plate 3 for securing the wheel rim and tube valve on the hub. Welded to the inner end face of the rim is locking plate 11 provided with two projections which enter two milled recesses on the inner side ring. The locking plate prevents the side ring and the tyre from rotation on the rim. The tyre is clamped between the side rings and the spacing ring through the pressure ring by means of nuts and studs provided on the rim. The nuts are screwed in until the pressure ring thrusts against the wheel rim. The clamping of the tyre between the side rings provides for tight fitting of the tyre on the rim, prevents it from slipping relative to the rim and excludes penetration of water and dirt inside the tyre.

The wheels are attached to the hub by means of nuts, studs and clamps.

The automobile is equipped with 24-ply tyres having the size of 18.00-24.00

#### Wheel Disassembly and Assembly Procedure

The procedure for removal and disassembly of the wheel is presented in Fig.102. It is forbidden to remove, disassemble and assemble the wheel when the latter is inflated.

To disassemble the wheel, proceed as follows:

1. Jack up the automobile wheel so that it is clear of the ground. Place the jack head under the head of the wheel suspension arm.

2. Screw the valve core out of the tyre tube valve and release the air.

To observe the safety rules it is strictly prohibited to carry out further disassembly of the wheel until the air is released from the tyre tube. (The air pressure in the tyre tube should not exceed the pressure of ambient air).



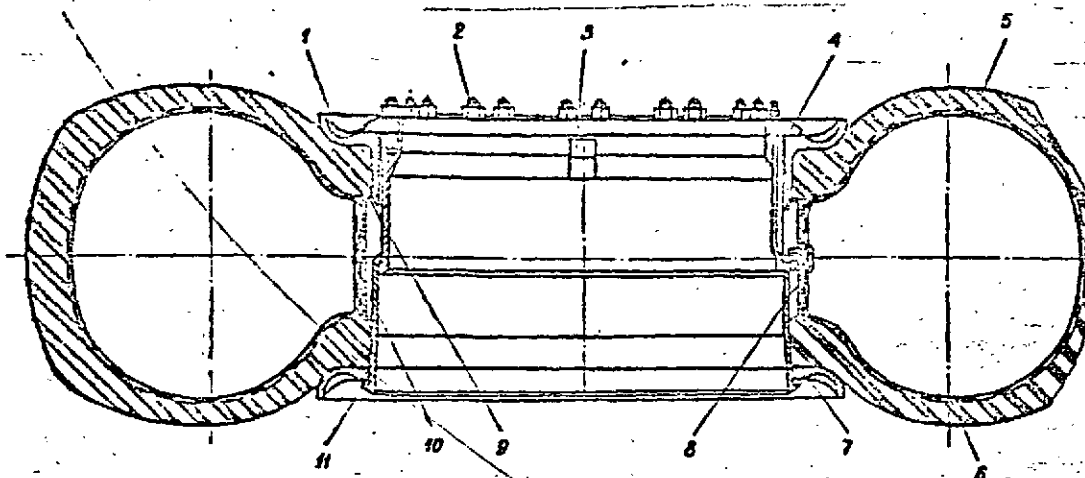


FIG. 101. AUTOMOBILE WHEEL

1 - outer side ring; 2 - nut; 3 - cover plate; 4 - pressure ring; 5 - tyre tube with valve; 6 - tyre; 7 - inner side ring; 8 - flap;  
9 - spacing ring; 10 - wheel rim with studs and cover plate; 11 - locking plate

3. Unscrew the nuts attaching the wheel to the hub, remove the clamps and the wheel. If it is difficult to remove the wheel from the hub, secure the pullers for removal of the wheel from the hub (Fig.102, position "a") on the rim studs having arranged the pullers opposite to each other along the wheel diameter.

Screwing in the thrust bolts of pullers alternately, remove the wheel.

4. Unscrew the attaching nuts and remove the pressure ring, see position "b".

5. Striking the wheel rim with a sledge hammer through a wooden block, remove the sector of the outer side ring, see position "c".

6. Install three demounting clamps on the studs of the wheel rim spacing them equally along the circumference. Rotating the screws of the demounting clamps in turn with a tyre iron, remove the wheel rim out of the tyre, see position "d".

7. Reduce the spacing ring in diameter with the tyre iron and remove the ring out of the tyre, positions "e" and "f".

8. Remove the flap and tube cut of the tyre having previously pumped air out of the tube by means of a tyre tube deflating device.

The device (Fig.103) is an ejector through the guiding pipe of which air is passed under pressure. The air flow running from the suction pipe connected with the tyre tube valve sucks the air contained in the tyre tube.

To use the tyre tube deflating device, proceed as follows:

(a) screw the valve core out of the tyre tube valve;

(b) fit the device connecting hose on the tyre tube valve;

(c) to the device union connect the tyre inflating hose connected with its other end to the brake system air take-off cock located on the frame left-hand side member (it is permissible to use any other source of compressed air);

(d) open the cock and let air flow out through the device guiding pipe.

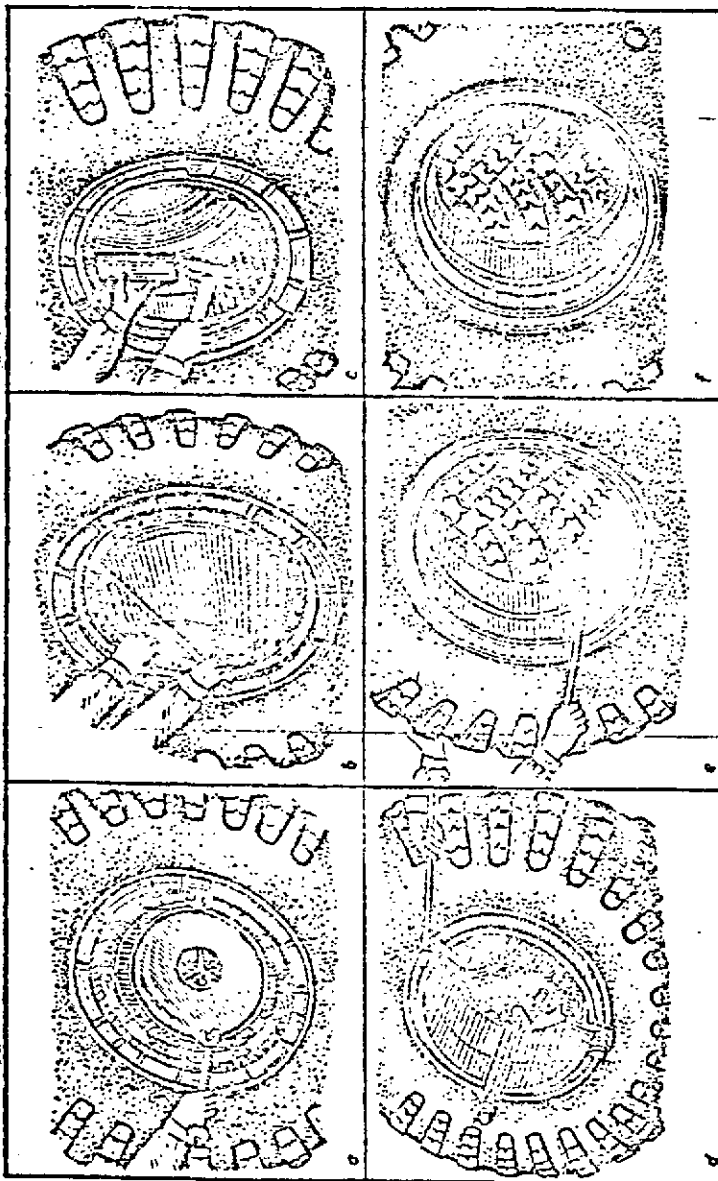


FIG. 102. PROCEDURE FOR REMOVAL AND DISASSEMBLY OF ROTOR.

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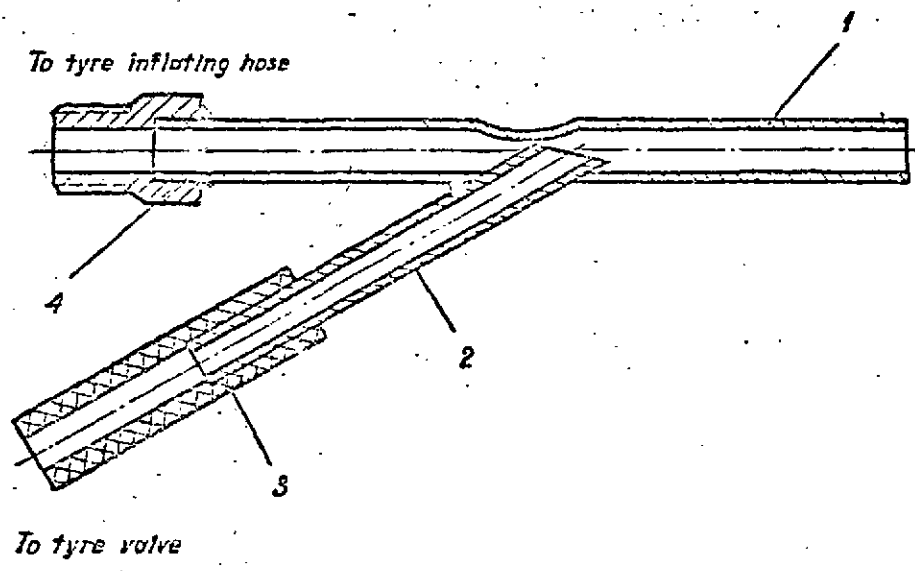


FIG. 103. DEVICE FOR DEFLATING TYRE TUBES

1 - guiding pipe; 2 - suction pipe; 3 - connecting hose; 4 - union

The efficiency of the tyre tube deflating device is ensured when the air used for this purpose is under a pressure of 5-7 kg/cm<sup>2</sup>.

9. Check the condition of the tyre, flap and tyre tube and repair, if required.

10. Dust the tyre inner space, flap and the tyre tube with talc.

Assemble the wheel in the order reverse to disassembly and do the following:

1. Install the tyre on the wheel hub so that the angle of the herringbone tread pattern is directed forward (on the ground the angle of the herringbone tread pattern should be directed backward) and the tyre valve body is directed outside.

2. Spread the tube in the tyre by partially inflating the tube from the air take-off cock located on the left side of the frame.

~~3. All the nuts attaching the pressure ring should be tightened until the pressure ring thrusts against the wheel rim.~~

4. When mounting the wheels on hubs, prevent them from cocking since incorrect installation of the wheels on hubs may cause wobbling of the wheels. Centering of the wheels on their hubs is performed by the conical surface.

At first, fasten the wheel installed on the hub by three nuts equally spaced along the circumference and see that spherical chamfers of the nuts enter corresponding chamfers of holes in the clamps. Tighten all nuts of the wheel completely by tightening up each nut in succession through a half-turn. When tightening the nuts, do not extend the wrench arm since it may cause stripping of the thread or twisting of studs.

To observe the safety rules, inflate the tyres only after all the nuts of the pressure ring attaching the tyre on the wheel rim have been securely tightened, the wheel has been installed on the hub and completely attached (when mounting the tyre on the wheel rim it is permissible to inflate the tube additionally for its correct fitting inside the tyre).

#### Maintenance of Wheels and Tyres

When servicing the wheels and tyres, carry out the operations prescribed by the routine inspection before leaving the park, daily preventive maintenance and preventive maintenance No.1 and No.2 according to the Section "Preventive Maintenance of Automobile".

The air pressure in tyres should be  $4.5 \pm 0.2$  kg/cm<sup>2</sup>. The air pressure in the spare wheel should not exceed 2.2 kg/cm<sup>2</sup>.

When disassembling the spare wheel, deflate the tyre tube. To observe the safety rules it is strictly forbidden to disassemble the spare wheel until the air is out of the tyre tube (the air pressure in the tyre tube should not exceed the pressure of ambient air).

When interchanging the tyres (Fig.104"b"), proceed as follows:

(a) place the steerable wheels instead of non-steerable ones;

(b) place the non-steerable wheels instead of the steerable ones on the other side (obliquely).

Check and, if required, adjust the toe-in of the front steerable wheels.

During operation of the automobile it is also necessary to observe the following main rules pertaining to servicing of the tyres:

- prevent oil and fuel from getting on the tyres;

- observe the driving procedure, avoid abrupt braking, slipping of the wheels, running on tyres with reduced pressure, do not allow overloading of the automobile; violation of these rules will facilitate wear of the tyres;

#### 3. Preliminary attaching of the pressure ring

should be accomplished by means of two bolts which are available in the rim set. Tighten nuts and bolts attaching the flap ring by means of tightening up each diametrically located pair of nuts and bolts in succession. All the nuts and the two bolts of the flap ring attaching should be tightened as far as they will go. Hereat, the pressure ring should thrust the

- do not allow parking of the automobile on deflated tyres.

When replacing the wheels from one side of the automobile on the other, remount the tyre on the wheel rim to observe the direction of the tread pattern, do the same with the spare wheel.

Check and adjust the toe-in of the front steerable wheels on a level ground with the wheels set in the straight forward position and with the rated air pressure in the tyres.

To check the toe-in of the front wheels, proceed as follows:

- check the fastening of the steering linkage levers and tighten them, if necessary;

- install the toe-in gauge on the side of the steering tie rods between the inner side surfaces of the tyres at the edges of lower checkers of the tread pattern in level with the wheel axis (Fig. 104, "a") and measure the length (size A), having rotated the wheel through  $180^\circ$ , install the toe-in gauge as it has been installed on the side of the steering tie rods and measure the length (size B).

The toe-in of the front wheels or the difference  $A - B$  of the distances between the inner surfaces of the tyres measured in front and at the rear of the axle at the level of the wheel axis and on the diameter of 1020 mm should be within the limits of 10-14 mm. If the toe-in of the front wheels does not correspond to the above limits, carry out the adjustment procedure.

To adjust the toe-in of the front wheels, proceed as follows:

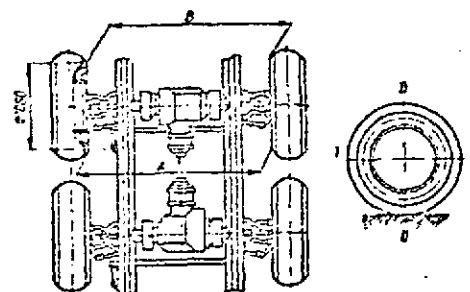
- using the jacks, raise up all the steerable wheels of the automobile to an equal height and place the rests under the suspension arms or under the supports of steering knuckles (it is not recommended to place the rests under the frame to avoid errors in adjustment of the toe-in);

- set the automobile front wheels into the straight-forward position for which purpose, rotate the steering wheel completely to the right and then to the left. Having counted the total number of the steering wheel revolutions, rotate the steering wheel in reverse direction through half of the total number of revolutions; in this case the steering gear arm should be in the vertical position and the pendulums and lower arms of the steering linkage should be parallel with the frame side members;

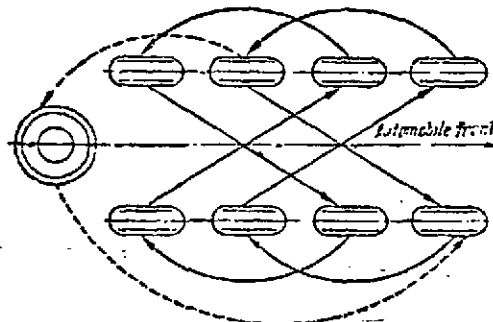
- disconnect the side steering tie rods from the steering linkage arms;

- if necessary, set the pendulums and lower arms of the steering linkage parallel with the frame side members; such a position of the arms can be attained by adjusting the length of the steering drag links screwing the drag link ends on or off for this purpose;

- set the wheels so that the toe-in (the difference of sizes  $A - B$ ) is within



A) STEERABLE WHEELS TOE-IN ADJUSTMENT DIAGRAM



B) ROTATION DIAGRAM OF WHEELS

FIG. 104

the limits of 10-14 mm (take the measurements for two times in mutually perpendicular planes on the wheels of both steerable axles);

- rotating the ends of the steering side rods, adjust their length so as to make it possible to connect them to the steering linkage arms without changing the position of the wheels;
- after connection of the rods, tighten all the coupling bolts of the steering rod ends;
- lower the automobile steerable wheels.

It is permissible to adjust the toe-in of the front wheels on a level ground without jacking up the automobile.

#### Automobile Suspension

The suspension is intended to ensure smooth movement, to cushion dynamic bumps and impacts arising during movement of the automobile. The suspension of the automobile front wheels is an independent (individual) arm-and-torsion bar type.

The suspension of the rear wheels is of a rocker, springless type.

The guiding unit of the suspension is a four-link assembly of a trapezoid type ensuring displacement of the wheel on the arms in the lateral plane. Torsion bars (two per each wheel) serve as a springing element of the automobile front wheels suspension. The torsion bars are arranged longitudinally.

#### Suspension of Front Wheels

Suspension arms 18 and 19 (Fig.105) of a forked type take up all stresses and moments transmitted from the wheel to the frame. The suspension arms are connected with the wheel through steering knuckle support 17 by means of pins 21. The pin is held against rotation in the support by means of special wedge 20 secured with a nut. Connection of the suspension arm with the wheel support is accomplished on bronze bushings.

The suspension arms are connected with the automobile frame by means of suspension-arm tubes 3 and suspension brackets 6 attached to the frame. The connections are accomplished on bronze bushings 2 pressed into suspension brackets 6. Lubrication of bronze bushings is ensured through lubrication fittings.

Upper torsion bar 10 and lower torsion bar 4 are connected by their ends with the suspension arms through splined end pieces 5 and 7 and through the splines of suspension arm tubes 3. The other splined ends of the torsion bars are secured in attachment brackets 15 and 16 bolted to the suspension supporting brackets.

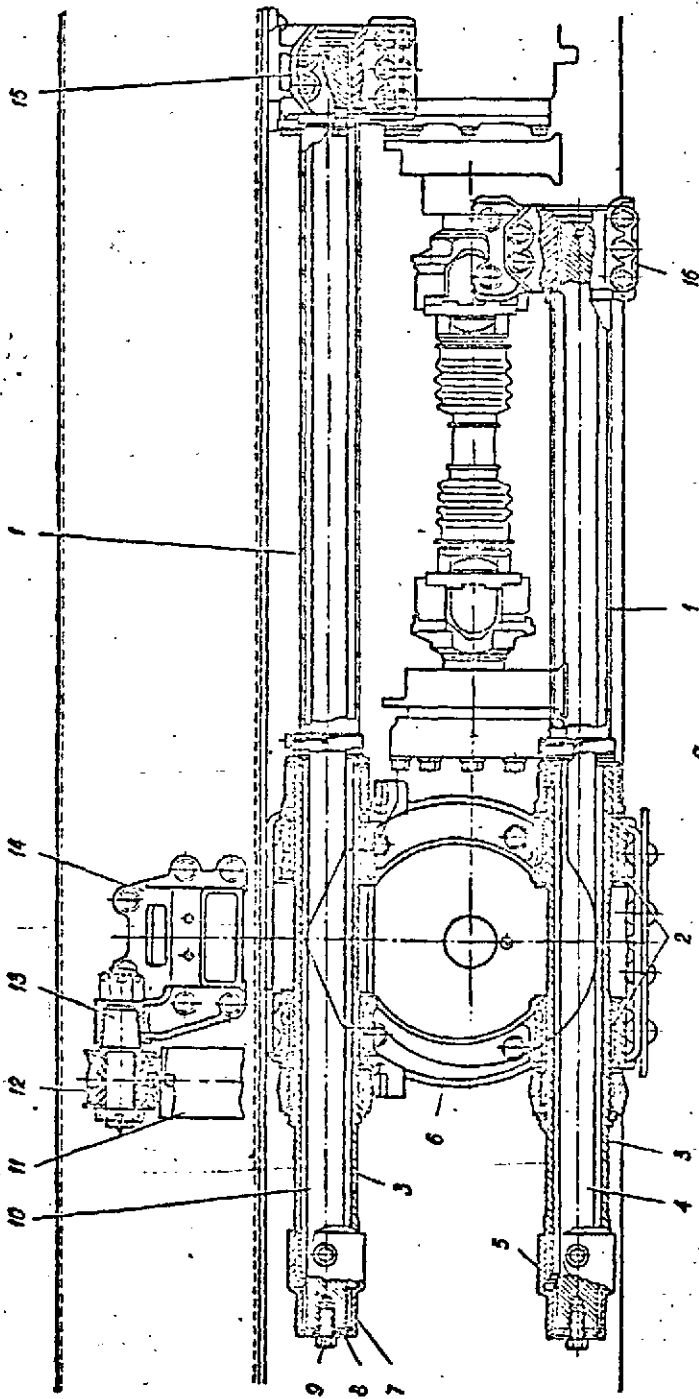
The torsion bars are held against longitudinal displacement by locking plate 8, washer and a bolt. Bolt 9 is locked with a flat washer.

The upper torsion bars are smaller in diameter and longer than the lower ones. As to the direction of twist the torsion bars are divided into torsion bars with a right-hand twist (marked by RP) and left-hand twist (marked by N). The above letter markings are stamped on one of the end faces of each torsion bar.

The direction of twist of the torsion bars installed in the wheel suspension when the wheel moves upwards (to be viewed on the side of the suspension arm tube end piece) should coincide with the direction of their twist according to the marking.

Protective tubes 1 serve for protection of the torsion bars against mechanical damage. The protective tubes are fixed by locking bolts.

Both wheels of the first front axle are equipped with hydraulic shock absorbers 11 of a telescopic type.



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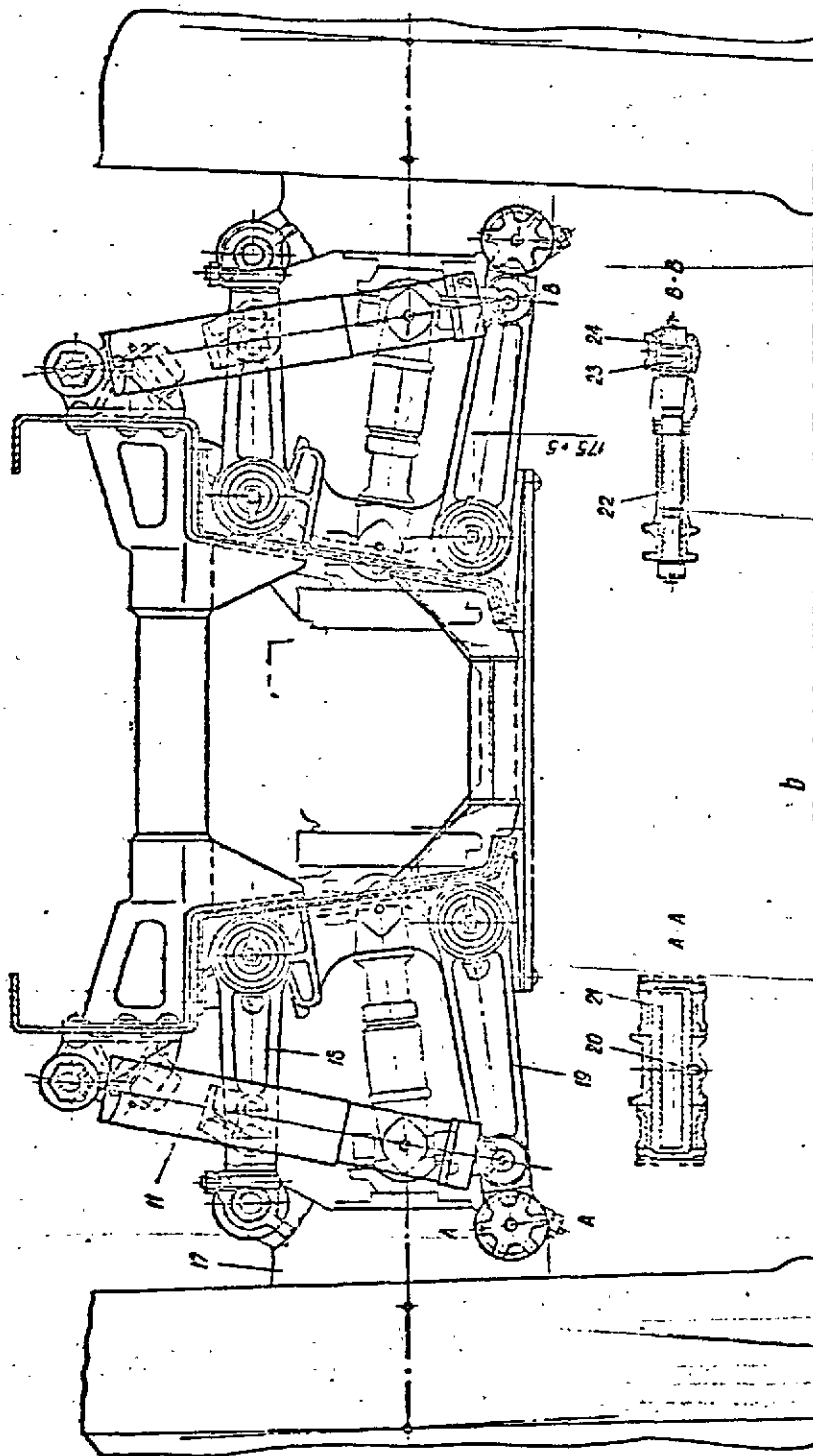


FIG. 103. TORSION BAR SUSPENSION OF FRONT WHEELS

- 1 - protective cover; 2 - lower bushing; 3 - lower spring; 4 - lower torsion bar; 5 - lower spring; 6 - upper spring; 7 - upper spring; 8 - lower bushing; 9 - lower bushing; 10 - upper torsion bar; 11 - shock absorber; 12 - rubber bushing; 13 - pin for attaching shock absorber; 14 - upper knuckle; 15 - bracket for limiting upper travel of wheel; 16 - steering knuckle support; 17 - steering knuckle support; 18 - upper suspension arm; 19 - upper suspension arm; 20 - pin; 21 - pin; 22 - pin; 23 - pin; 24 - rubber bushing

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The shock absorber upper head is connected with bracket 14 by pin 13 and rubber bushings 12. The shock absorber lower head is connected with arm 19 by pin 22 and a cast iron bushing fitted with intermediate rubber bushing 24. The upward travel of the front wheels is limited by bracket 14 whose seat mounts a rubber buffer pad, and by bearing flats of the upper arms.

The downward travel of the front wheels is limited by the stops made integral with suspension brackets 6.

#### Suspension Shock Absorbers

The hydraulic double-acting shock absorbers of a telescopic type serve to damp oscillations of the automobile arising during its movement.

The shock absorber (Fig. 106) consists of two cylinders 11 and 12 connected with each other by covers 5 and 14 of the inner cylinder. Sliding inside inner cylinder 12 is piston 10 connected by rod 7 with shock absorber upper head 1 with the help of which the shock absorber is attached to the frame bracket.

By means of lower head 16 the shock absorber is attached to the suspension lower arm. Tightness of the inner space and cylinders of the shock absorber is attained by means of oil seal 3, rubber gasket 2 and packing ring 15. Protective casing 6 and protective semi-ring 4 prevent dirt from getting on the surfaces of the shock absorber working parts.

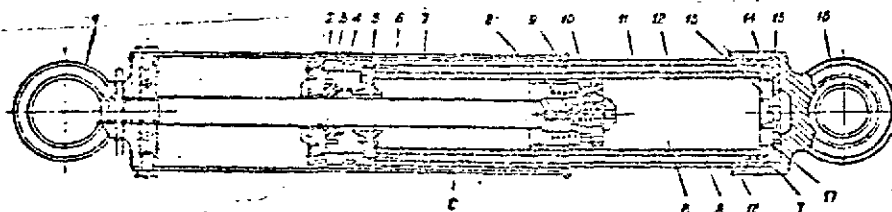


FIG. 106. SUSPENSION SHOCK ABSORBER

1 - upper head; 2 - rubber gasket; 3 - oil seal; 4 - protective semi-ring; 5 - cylinder upper cover; 6 - protective casing; 7 - piston rod; 8 - high-pressure valve; 9 - non-return valve; 10 - piston; 11 - outer cylinder; 12 - inner cylinder; 13 - low-pressure valve; 14 - cylinder lower cover; 15 - rubber ring; 16 - lower head; 17 - compensating valve; 18 - nut; A, B and C - shock absorber spaces

Operation of shock absorber. When the wheel runs over an obstacle (compression stroke) the shock absorber fluid flows from space B into spaces C and A through non-return valve 9 and low-pressure valve 13. In this case the resistance of the shock absorber is not great. When the wheel under the action of elastic force and its own weight moves downward (rebound stroke) the fluid flows from the space C through high-pressure valve 8 and from the space A through compensating valve 17 into the space B.

During the rebound stroke the shock absorber resistance is considerably higher than during the compression stroke.

The value of the shock absorber resistance during the rebound stroke is adjusted at the Manufacturing Plant by changing the number of adjusting washers under the spring of high-pressure valve 8. The shock absorber resistance during the compression stroke is not subject to adjustment.

Installation or Replacement of Torsion Bars

When installing or replacing the torsion bars, observe the following requirements.

1. Make sure the suspension lower arm is positioned so that size 175 + 5 mm (Fig.105) is maintained (the distance along the vertical between the centres of small and large bosses of the arm).
2. Torsion bars with "R" (R.H.) marking should be installed into suspension of the front right-hand wheels while torsion bars with "L" (L.H.) marking should be installed into suspensions of the front left-hand wheels.
3. The splines of torsion bars and splines of the mating parts should be lubricated by consistent lubricant, grade YTB, State Standard GOCT1661-16 (lubricant 1-13).

If the torsion bars are installed correctly and have no sagging the suspension upper arms should be in the horizontal position when the automobile is loaded.

Replacement of the suspension torsion bars of the first axle wheels is accomplished with the help of a special puller in the following sequence:

1. Jack up the automobile frame until size 175 + 5 mm by the lower arm is attained.
2. Remove the stop washer and unscrew bolt 9, take out the washer and locking plate 8.
3. Turn the puller screw threaded end into the threaded hole of the torsion bar up to the screw shoulder.
4. Turning the puller nut, remove torsion bars 4 and 10.
5. Insert new torsion bars and attach them reliably.
6. Remove the jacks from under the frame.

When replacing the torsion bars of the second axle, proceed as follows:

1. Remove suspension torsion bars 4 and 10 of the first axle.
2. Unbend the lugs of locking plates and unscrew the bolts securing the attachment brackets, unlock and unscrew the bolts fixing the protective tubes; remove attachment brackets 15, 16 and protective tubes 1.
3. Carry out the operations listed under Items 1-5.
4. Install the protective tubes, attachment brackets and torsion bars of the first axle and reliably secure them.
5. Remove the jacks from under the frame.

Suspension of Rear Wheels

The suspension of rear wheels is of a rocker (springless) type. The guiding unit of the rear suspension is a four-link assembly of a trapezoid type ensuring displacement of the wheel on the arms in the lateral plane.

The rear wheels are connected in pairs into longitudinal bogies by means of rocker 1 (Fig.107) swinging on rocker axle 8. The rocker axle is secured by wedges 7 in bracket 9 attached to the automobile frame. The hinged joint of the rocker with its axle is accomplished on bronze bushings 10 press-fitted into the rocker. Thrust rings 17 take up the axial forces acting on the rocker. The rocker is held on its axle against axial displacement by nut 16, stop washer 12, lock washer 13 and lock nut 14.

Cap 15 serves to protect the rocker friction surfaces from penetration of dust and dirt.

The wheel is coupled with the rocker by means of a hinged joint of rocker pad box 3. The hinged joint is made on bronze bushings 4 press-fitted into rocker pad box.

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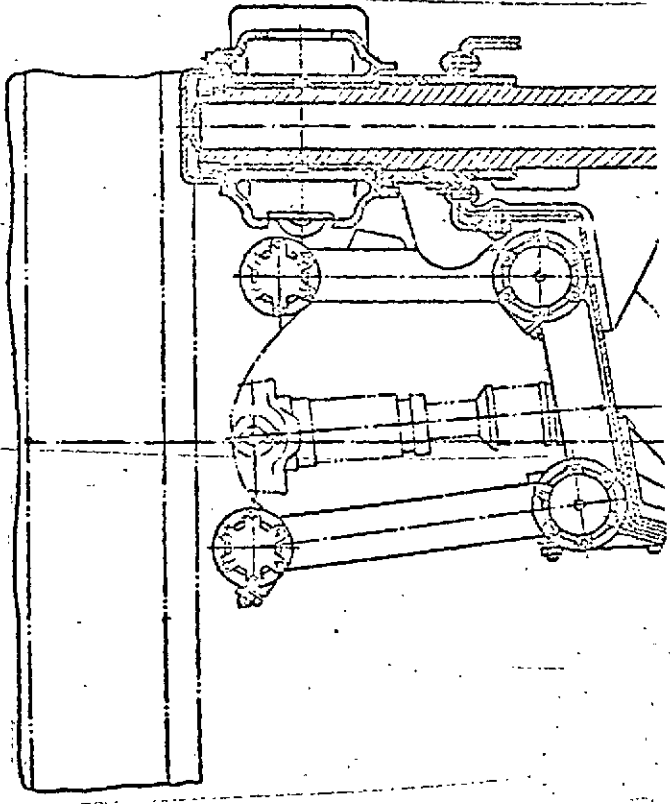
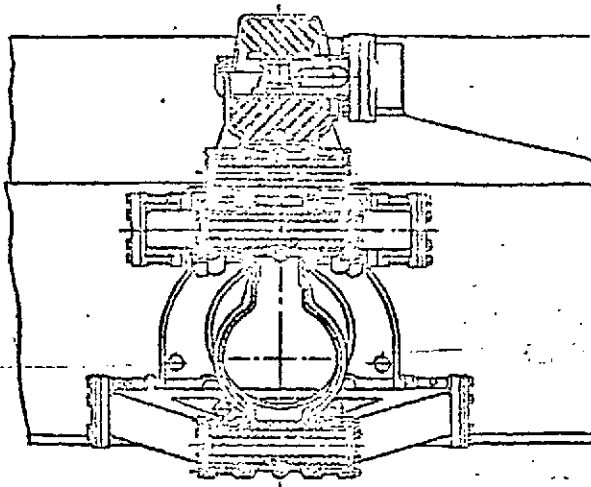
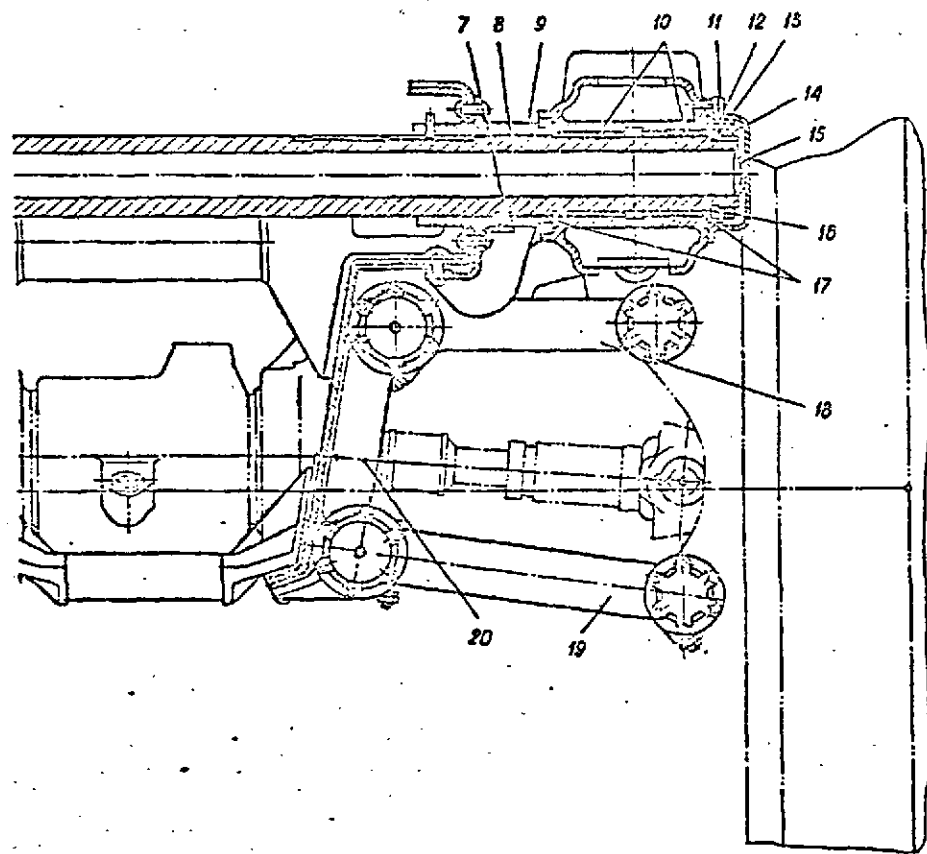
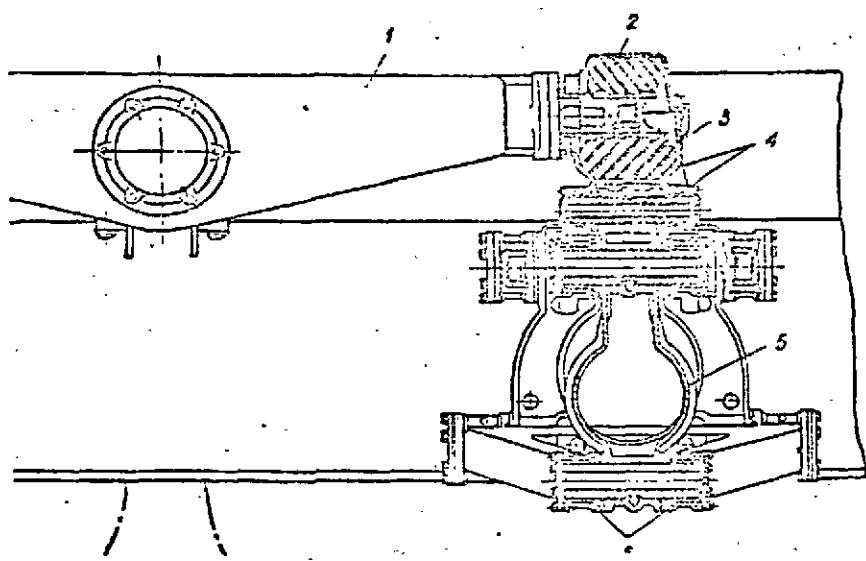


FIG. 107. SUSP

- 1 - rocker; 2 - rocker pad; 3 - rocker pad box; 4,
- 8 - rocker axle; 9 - rocker suspension bracket; 11
- 15 - rocker axle cap; 16 - circular nut; 17 - thru



ASSEMBLY OF AUTOMOBILE REAR WHEELS

5, 10 - bronze bushings; 5 - rear suspension support; 7 - rocker axle wedge;  
 8 - filler hole plug; 10 - stop washer; 13 - lock washer; 14 - lock nut;  
 15 - a ring; 18 - suspension upper arm; 19 - suspension lower arm; 20 - suspension bracket

The rocker ends are fitted into rubber pads 2 whose deformation ensures kinematic ability of the rocker - type suspension.

Suspension arms 18 and 19 are a fork type.

Hinged joints of the arms with rear suspension support 5 and with bracket 20 are made on bronze bushings 6. The suspension arms take up all stresses and moments arising on the wheel.

The suspension rockers take up the load acting on the rear wheels and the elastic forces of the rubber pads arising during their deformation when rear wheels run over an obstacle or bump. The up and down travel of the wheels is limited by rubber pads installed on the frame.

Lubrication of the joints with bronze bushings is ensured through lubrication fittings.

#### Maintenance of Automobile Suspension

When servicing the suspension, carry out all the operations prescribed in preventive maintenance No.1 and No.2 according to the Section "Preventive Maintenance of Automobile".

In case of a considerable sagging of separate torsion bars caused by residual deformation such torsion bars are subject to replacement since the considerable sagging causes sinking of the automobile, disturbs the steerable wheels toe-in and reduces the clearance between the limiter buffer and suspension upper arm. Therefore, if a torsion bar with a residual deformation is not replaced in due time it may cause wobbling of steerable wheels.

If necessary, change the shock absorber fluid.

To change the fluid in the shock absorber, proceed as follows:

- remove the shock absorber from the automobile;
- loosen nut 18 and unscrew shock absorber lower head 16;
- remove inner cylinder cover 14;
- having pressed out non-return valve 9 with the help of a special device, drain the waste shock absorber fluid;
- compress the shock absorber completely;
- having pressed out non-return valve 9 with the help of a special device, pour the fluid into the shock absorber in such an amount that spaces A, B and C are filled up to the end face T (approximately 1,150 cm<sup>3</sup>);
- reinstall inner cylinder cover 14;
- check the condition of rubber packing ring 15 in the shock absorber lower head and replace it, if necessary;
- screw in shock absorber lower head 16 and tighten nut 18;
- reinstall the shock absorber on the automobile.

*(See also next page)*

#### Troubles and Remedies of Suspension

Trouble	Cause	Remedy
Penetration of dirt inside shock absorber	Worn protective ring	Replace protective ring
Leakage of shock absorber fluid from shock absorbers	Worn or damaged oil seal, rubber gasket or packing	Shock absorber is subject to repair.

*Page 181*

\* In the section "Maintenance of Automobile Suspension" insert as follows: "When upper arms occupy the position close to horizontal, then accomplish shock absorbers installing and tightening the upper and lower heads attaching nuts in case of replacing front and rear suspension shock absorbers. It is necessary to secure taper stay bushings in shock absorber attaching joints after having fitted rubber bushings into shock absorber heads. Nuts of shock absorber attaching joints should be screwed as far as they will go."

Frame

The frame serves as a base on which all the units and assemblies of the automobile are mounted.

The welded and riveted frame of a trough type consists of two channel side members and two inclined sills. From below the frame front portion (up to the first axle) is covered with a mud guard plate which can be thrown off to provide easier access to the preheater.

Angle braces which serve for attaching the bumper and front supports of the cab are riveted to the side members at the front portion of the frame. The bumper protects the cab from shocks when driving over an obstacle.

To make the frame more rigid the side members and side sills in the vicinity of the suspension are connected with each other by tubular-section cross members and stamped cross members mounting the front and rear towing gears.

The frame side members mount the brackets for attaching the automobile units while the side sills mount the brackets of the suspension arms and torsion bar attachment brackets.

All the brackets and cross members are attached to the side members and side sills of the frame.

The automobile frame is equipped with two double-damping shock absorbers (front and rear). The rear portion of the frame is covered with a mud guard plate.

Maintenance of Frame

During preventive maintenance No.2, carry out the following operations:

- check the riveted joints of the frame; if the rivets are loose, cut off the loose rivets and install new ones; bolts with nuts and spring washers may be installed temporarily instead of rivets;
- clean the frame of dirt and check the condition of side members, side sills and cross members of the frame.

Automobile Fifth-Wheel Assembly

The fifth-wheel assembly (Fig.108) is designed for hinged coupling of the automobile with a semitrailer. Fifth wheel 1 which bears the semitrailer swings along the automobile axis on fifth-wheel axle 6 coupled with rocker 5. In its turn, the fifth-wheel rocker swings laterally relative to the automobile axis on rocker axle 3 coupled with fifth-wheel bedplate 4. The rocker is equipped with two damping springs 8. Coupling of the fifth wheel with the king pin of a semitrailer is accomplished semi-automatically by means of two grips 11 installed on pins 7. The grips embrace the king pin and are locked in the closed position with grip lock 13 actuated by spring 14 arranged on the rod of the grip lock. After the coupling is over, safety strap 10 arranged on the front end of the fifth wheel and locking the rod of the grip lock should be set vertically. During uncoupling, turn the safety strap and with the help of lever 12, shift the lock into the extreme forward position. In this case, grip lock latch 15 pulled out by spring 16 will engage the projection of the grip lock and will hold the grip lock in the pulled-out position.

When the automobile is driven away the grips are spread by the semitrailer king pin. In this case, pin 17 (provided on the left-hand grip) forces the latch to free the grip lock which under the action of the spring moves backwards until it thrusts against the end faces of the grips and remains in this position until the next coupling.

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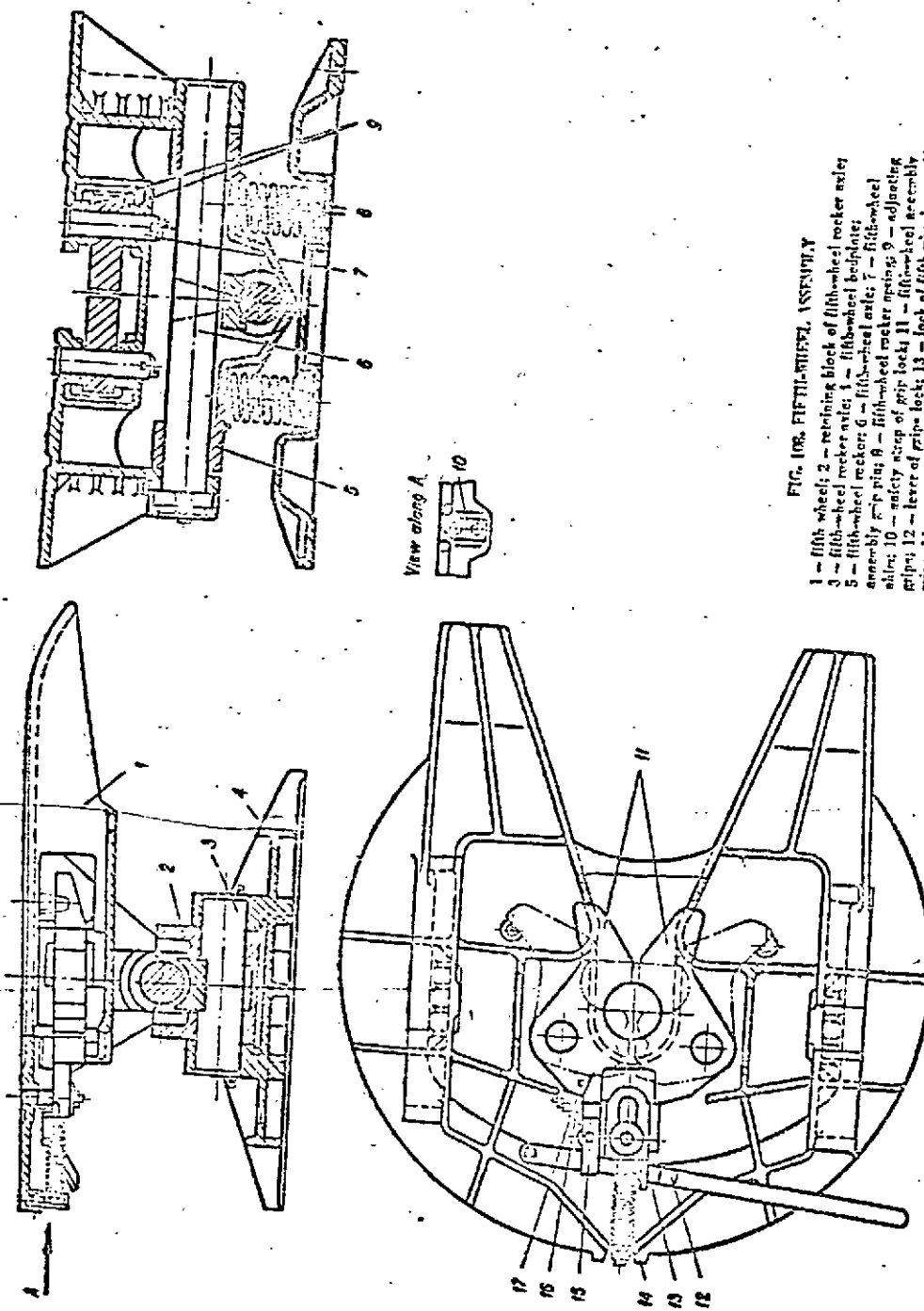


FIG. 108. FIFTH-WHEEL ASSEMBLY  
 1 - fifth wheel; 2 - retaining block of fifth-wheel rocker axle  
 3 - fifth-wheel rocker axle; 4 - fifth-wheel rocker  
 5 - fifth-wheel rocker; 6 - fifth-wheel roller; 7 - fifth-wheel  
 assembly pin; 8 - fifth-wheel roller; 9 - fifth-wheel  
 roller; 10 - safety stop of grip lock; 11 - fifth-wheel assembly  
 pin; 12 - lever of grip lock; 13 - lock of fifth-wheel assembly  
 pin; 14 - spring of fifth-wheel assembly pin; 15 - latch of grip  
 lock; 16 - spring of grip lock latch; 17 - pin



## COUPLING AND UNCOUPLING OF AUTOMOBILE AND SEMITRAILER

When coupling the semitrailer to the automobile, make sure the semitrailer is positioned on a level ground and is braked by the parking brake.

A person supervising the coupling procedure should stand at the side of the semitrailer front portion and give instructions to the driver as to the direction of the automobile driving in reverse gear to ensure correct coupling of the fifth-wheel assembly with the king pin of the semitrailer.

To couple the automobile with the semitrailer, proceed as follows:

1. Turn aside the safety strap of the grip lock located at the front part of the fifth wheel.
2. Shift the lever of the fifth-wheel assembly grip lock into the extreme forward position to open the lock.
3. Slowly drive the automobile in the reverse gear to the semitrailer so that the semitrailer king pin enters the lock of the fifth-wheel assembly. Back the automobile until the lock is closed automatically. This done, make sure the grip lock lever is shifted into the extreme rearward position which ensures the reliable coupling; the safety strap should be in the vertical position and the lever latch in the lower position.
4. Raise the semitrailer landing gear in the travelling position following the semitrailer operating instructions.
5. Attach the connecting hose of the air brake control line to the semitrailer coupling head.
6. Connect the electric cable into the receptacles of the automobile and semitrailer.
7. Open the foot brake manual control cock on the semitrailer (set it in the travelling position having ensured delivery of air from the automobile into the semitrailer system).
8. Open the cut-out cock on the automobile.
9. Release the semitrailer parking brake.

Before uncoupling the automobile from the semitrailer, select a level hard-surface place for parking the semitrailer. After the place is selected and the semitrailer is positioned, uncouple the semitrailer in the following sequence:

1. Close the air system cut-out cock of the automobile.
2. Disconnect the connecting hose of the air brake control line from the trailer coupling head. Close the coupling head with a cover.
3. Apply the semitrailer parking brake.
4. Remove the electric wiring connecting cable and store it in the tool box.
5. Lower the landing gear until it touches the ground and completely supports the front part of the semitrailer in accordance with the semitrailer operating instructions.
6. Turn aside the safety strap arranged at the front part of the automobile fifth-wheel assembly.
7. Shift the lever of the fifth-wheel assembly lock into the extreme forward position. If the lock fails to open it is permissible to back the automobile.
8. Shift in the first gear and slowly, without jerks drive the automobile forward.

In emergency cases it is permissible to couple and uncouple the automobile train when the automobile and semitrailer axes are at an angle of  $90^{\circ}$  in the horizontal plane and up to  $10^{\circ}$  in the vertical plane.

Maintenance of Fifth-Wheel Assembly

When servicing the fifth-wheel assembly, carry out the operations according to the Section "Preventive Maintenance of Automobile".

CABGeneral Description of Cab

The cab is installed on the frame on four rubber pads at the front part of the automobile. The cab is a metal, two-door, closed, four-seat, heated type provided with hatches in the roof and in the cab rear. There are two non-opening windshields each provided with one windshield wiper. The cab doors are equipped with locks and window raisers. Installed at the front part of the cab is an instrument panel. A locker for small articles is provided at the right-hand side of the panel. A first-aid chest is attached to the rear wall of the cab.

Installed on the middle support of windshields is a driver's fan.

The cab is provided with three seats: two extreme are single, while the middle one is a two-men seat. Storage batteries are stowed in the middle seat base. Places for storage of small driver's tools are provided in the bases of extreme seats. Two headlights with a blackout device and two side lamps are installed on the front facing. An electric horn is installed on the left-hand side of the cab, while the swivelling spotlight is mounted on the cab roof.

Supporting hooks for attaching the hood warming cover are welded to the roof and side panels of the cab.

The cab rear wall (in the engine compartment) mounts: air cleaners, engine air starting system bottles, manual fuel priming pump, fuel distributing cock and primary filter. The handles of the fuel priming pump and fuel distributing cock are extended into the cab.

The cab is provided with places for attaching portable water tanks.

The cab water heater is arranged to the right under the instrument panel. The cab heater is connected into the engine cooling system. A self-contained heater is installed to the right on the cab floor. Rear-view mirrors are installed on the cab right and left sides.

Arrangement of Controls and Instruments in Cab

Arrangement of the controls and instruments is shown in Fig.109.

- 1 - Green pilot lamp indicating the temperature of water in the engine cooling system, it lights up at a temperature of cooling liquid 92-97°C.
- 2 - Red pilot lamp of the transfer case, it lights up when the transfer case gear is disengaged.
- 3 - Torque converter lock-up button.
- 4 - Torque converter lock-up green pilot lamp.
- 5 - Torque converter unlocking green pilot lamp.
- 6 - Torque converter unlocking button.
- 7 - Compressor red pilot lamp, it lights up when the pressure of oil in the compressor drops below 0.6 kg/cm<sup>2</sup>.
- 8 - Coolant temperature gauge in the engine right-hand cylinder block.
- 9 - Coolant temperature gauge in the engine left-hand cylinder block.
- 10 - Engine tachometer.
- 11 - Oil pressure gauge of the engine lubricating system.
- 12 - Oil temperature gauge of the engine lubricating system.

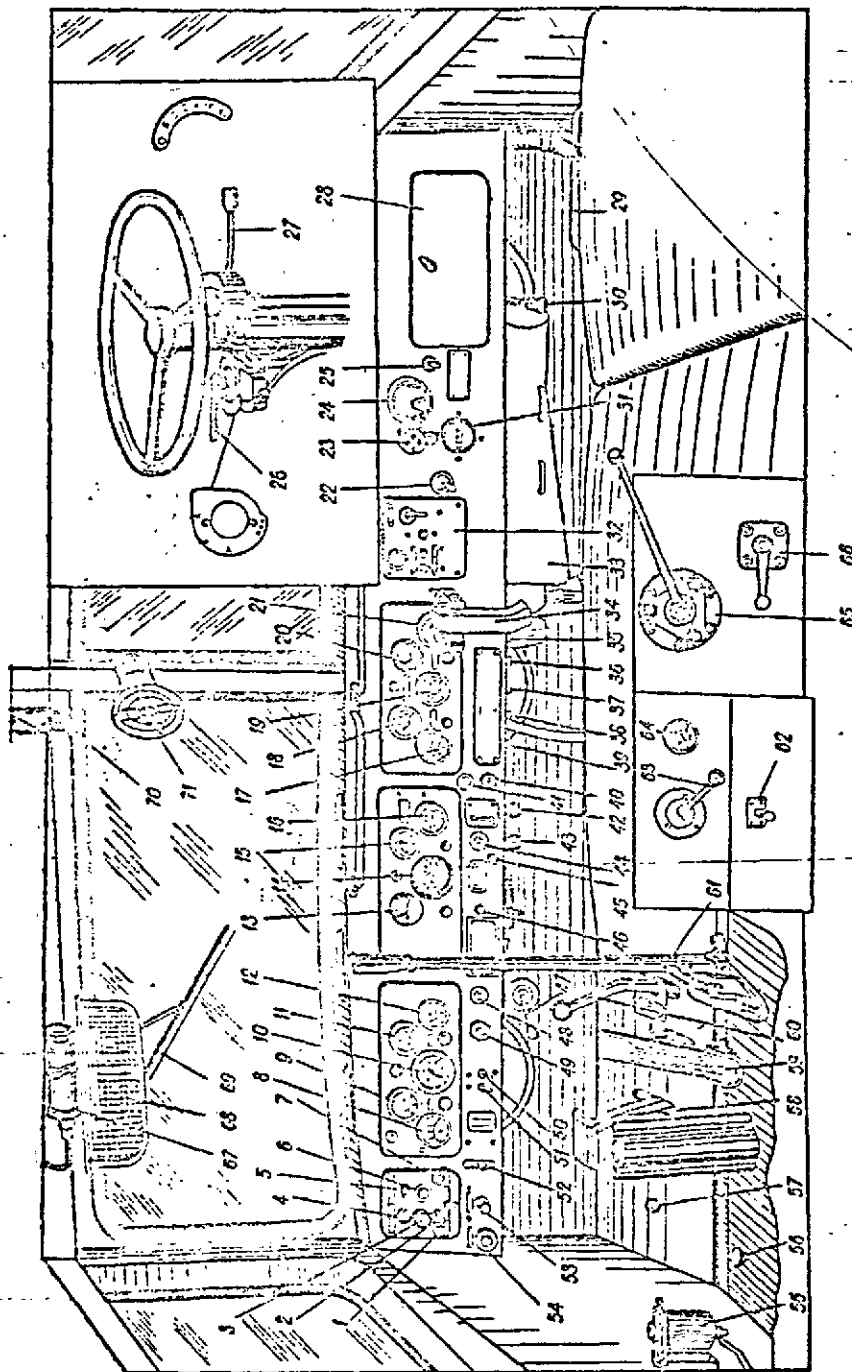


FIG. 109. ARRANGEMENT OF CONTROLS AND INSTRUMENTS IN CAB

- 13 - Voltmeter indicating the charging current. With the button depressed it indicates the voltage of storage batteries or generator.
- 14 - Speedometer indicating the speed of automobile and covered kilometrage.
- 15 - Clock.
- 16 - Brake system air pressure gauge.
- 17 - Oil temperature gauge at the planetary gearbox outlet.
- 18 - Oil pressure gauge of the hydraulic transmission lubricating system.
- 19 - Oil pressure gauge of the planetary gearbox booster.
- 20 - Oil pressure gauge at the torque converter outlet.
- 21 - Oil temperature gauge at the torque converter outlet.
- 22 - Swivelling spotlight switch.
- 23 - Receptacle.
- 24 - Commander's lamp.
- 25 - Commander's lamp switch.
- 26 - Transfer case control cock handle. The handle has four positions: extreme forward (B) - high (direct drive) gear is engaged; second forward (O) - neutral position; third forward (H) - low gear is engaged; rearward position (H + Bz) - low gear is engaged and transfer case differential is locked up.
- 27 - Gearshift lever of planetary gearbox. The lever has five positions: first from the driver (3.J.) - reverse gear is engaged; second from the driver (H) - neutral position; third from the driver (I) - first gear is engaged; fourth from the driver (II) - second gear is engaged and front position (III) - third gear is engaged.
- 28 - Locker for small articles.
- 29 - Self-contained cab heater.
- 30 - Ventilation hatch handle.
- 31 - Hourmeter.
- 32 - Control board of HMI -600 preheater.
- 33 - Cab water heater.
- 34 - Carbine holding bracket.
- 35-39 - Thermobimetal button circuit breaker. Circuit breaker 35 protects the circuit of consumers: plug receptacle, commander's lamp and oil priming pump electric motor; circuit breaker 36 protects: electromagnetic couplings of fans, cab heater electric motor, dome lamp, horn and instrument panel illuminating lamps; circuit breaker 37 protects: sending units of temperature and pressure gauges, compressor oil pressure pilot lamp; circuit breaker 38 protects: torque converter lock-up coils and torque converter lock-up pilot lamps; circuit breaker 39 protects: headlights, swivelling spotlight, side lamps, tail lamps, stop light and pilot lamp.
- 40 - Cab heater cut-in switch.
- 41 - Turn indicators pilot lamp.
- 42-43 - Windshield wiper switch.
- 44 - Instrument panel and cab dome lamp change-over switch. The change-over switch has three positions: upper-cab dome lamp is on; middle - all lamps are off; lower - instrument panel illuminating lamps are on.
- 45 - 5A fuse of breaker relay of the turn indicators.
- 46 - Main light switch. The main light switch has three positions: pushed in completely - all lights are off; in middle position - side lamps and tail lamp are on; pulled out completely - headlights and tail lamp are on.
- 47 - Fuel feed manual control lever.
- When the lever is at the right-hand stop the fuel feed is maximum, when it is at the left-hand stop there is no fuel feed at all.

- 48 - Turn indicator switch.
- 49 - Oil priming pump motor control button.
- 50 - Cooling system fan electromagnetic coupling switch.
- 51 - Engine lubricating system fan electromagnetic coupling switch.
- 52 - Blackout selector switch. The switch has two positions: upper - series resistor is cut in (blackout lighting); lower - series resistor is cut out.
- 53 - Starter control button.
- 54 - Electric horn button.
- 55 - Storage battery (ground) switch is arranged to the left of the driver's seat.
- 56 - Air horn button.
- 57 - Foot dimmer switch.
- 58 - Foot brake pedal.
- 59 - Accelerator pedal.
- 60 - Power take-off unit control lever. The lever has two positions: forward - neutral position; rearward - power take-off engaged.
- 61 - Hand brake lever.
- 62 - Engine emergency shut-down handle is located on the cab rear wall. In case of urgent shut-down of the engine (in emergency cases) the handle should be pulled on.
- 63 - Handle of the engine air starting reducing valve is arranged on the cab rear wall.
- 64 - Air pressure gauge of the engine air starting system is installed on the cab rear wall.
- 65 - Handle of manual fuel priming pump.
- 66 - Handle of fuel distributing cock.
- 67 - Windshield wiper control cock.
- 68 - Sun visor.
- 69 - Windshield wiper blade.
- 70 - Swivelling spotlight control handle.
- 71 - Driver's fan.

#### Cab Heaters

##### Water Heater

The heater (Fig. 110) consists of a fin-and-tube radiator enclosed in the casing, electric motor with a fan, inlet and outlet branch pipes connecting the heater radiator with the engine cooling system by means of pipelines.

Intake of fresh air into the heater is accomplished through the right-hand ventilation hatch the cover of which is opened by handle 5. The incoming air flows to heater radiator & through the filtering screen installed in the ventilation hatch. While passing through the heater radiator the air is heated and by fan 1 is directed to the cab front windshields through the bell mouth, windshield sill duct and nozzles. If necessary, part of heated air can be directed from casing 2 into the cab lower part for which purpose, open the shutter by handle 3.

With the right-hand ventilation hatch closed the intake of air into the heater is accomplished from the cab through a slit provided on the right-hand side of the casing; in this case, the casing shutter should be opened.

The heater is connected into the engine cooling system by a cock arranged on the housing of the cooling system thermostat box. The coolant is drained from the heater through a special cock installed on the delivery pipeline to the right under the cab.

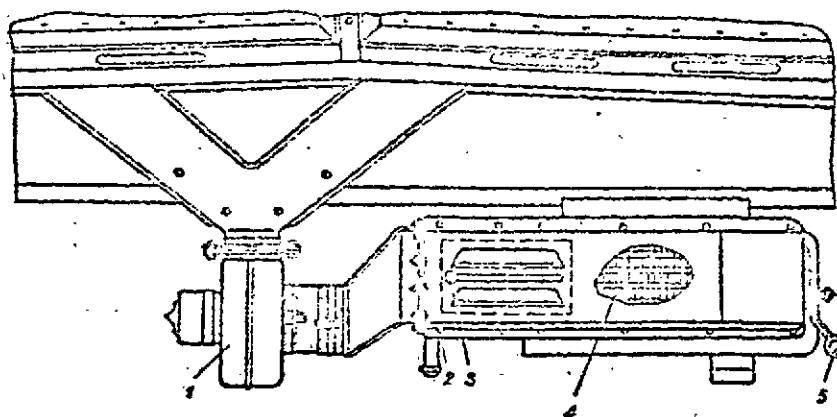


FIG. 110. CAB WATER-TYPE HEATER

1 - fan; 2 - casing; 3 - shutter handle; 4 - heater radiator; 5 - ventilation hatch handle

To ensure normal functioning of the cab heater it is necessary that the temperature in the engine cooling system is  $80^{\circ}\text{C}$ .

The heater electric motor is cut in and out by a switch arranged on the instrument panel.

#### Self-Contained Heater

This heating device operates independently of the automobile engine.

The heating device (Fig. 111) consists of the following main units: heat exchanger (arranged inside which are an electric motor with a fan and blower), electromagnetic fuel pump, electromagnetic fuel feed valve, fuel feed regulator, glow plug and fuel tank.

#### Specifications

Used fuel - gasoline, State Standard (ГОСТ ) 2084-54.

Fuel consumption lit/hr - 0.25.

Rated voltage in electric circuits - 24 V.

Power consumption - 24 W.

Capacity Cal/hr - 1500.

#### Operation of Heating Device

The heating device is cut into operation by a switch arranged on the instrument panel.

Switch 2 (Fig. 112) has two working positions: II - ON and I - OFF.

When the heating device is switched on the following units start to operate: electric motor 9 (Fig. 113) with fan 10 and blower 8, electromagnetic diaphragm fuel pump 6 (Fig. 112) and glow plug 7.

The fuel pump (Fig. 111) draws fuel from the tank and delivers it through settler 2 and open electromagnetic valve 4 to fuel feed regulator 3 and further along the pipeline to combustion chamber 4 (Fig. 113).

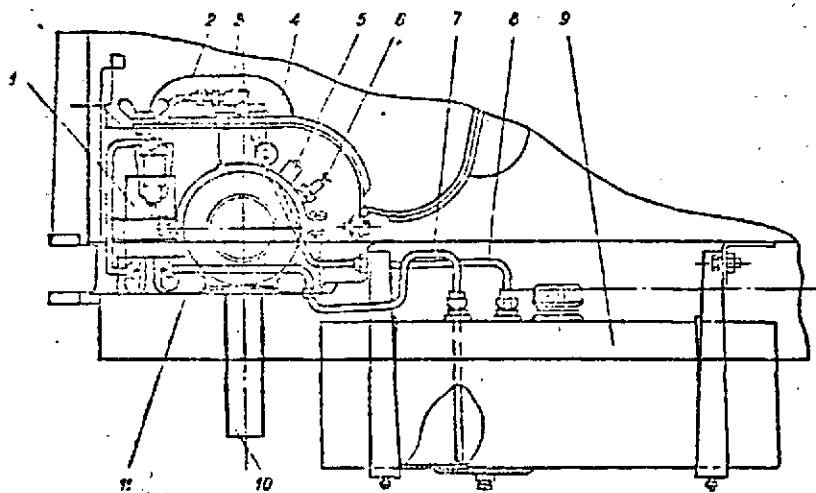


FIG. 111. CAR SELF-CONTAINED HEATER

1 - electromagnetic fuel pump; 2 - blower; 3 - fuel feed regulator; 4 - electromagnetic valve;  
5 - temperature-controlled switch; 6 - glow plug; 7 - fuel feed pipeline; 8 - fuel drain pipeline;  
9 - fuel tank; 10 - exhaust pipe; 11 - heater casing

The fan forces cold air into the heat exchanger.

The blower delivers air into the combustion chamber.

The fuel and air mixture delivered into the combustion chamber is ignited by the glow plug.

After 45-60 sec of combustion temperature-controlled switch 5 (Fig.111) operates under the action of the flowing gases temperature and cuts in the glow plug arranged on the instrument panel and the pilot lamp lights up.

Further, continuous combustion in the chamber is maintained automatically.

Burning of fuel heats heat exchanger 1 (Fig.113).

Cold air forced by the fan gets heated while it passes through circular channels of the heat exchanger and is directed into the cab through branch pipe 14.

When the heating installation is switched off the fuel pump gets out of operation and the electromagnetic valve shuts off the delivery of fuel into the combustion chamber; however the electric motor with the fan and blower continues to operate to scavenge fuel vapours and residual gases from the combustion chamber. At this time, the heat exchanger cools down while the pilot lamp is lighting.

When the temperature in the heat exchanger drops to  $+40^{\circ}\text{C}$  the temperature-controlled switch operates as a result of which the electric motor stops and the pilot lamp goes out.

It is forbidden to switch on the heater once again when the pilot lamp is lighting.

If during 5 min after the heater has been switched on the fuel and air mixture fails to ignite, switch off the heater, check the condition of the glow plug and its electric circuit, check the delivery of fuel and blow the combustion chamber with compressed air through cold air intake branch pipe 11.

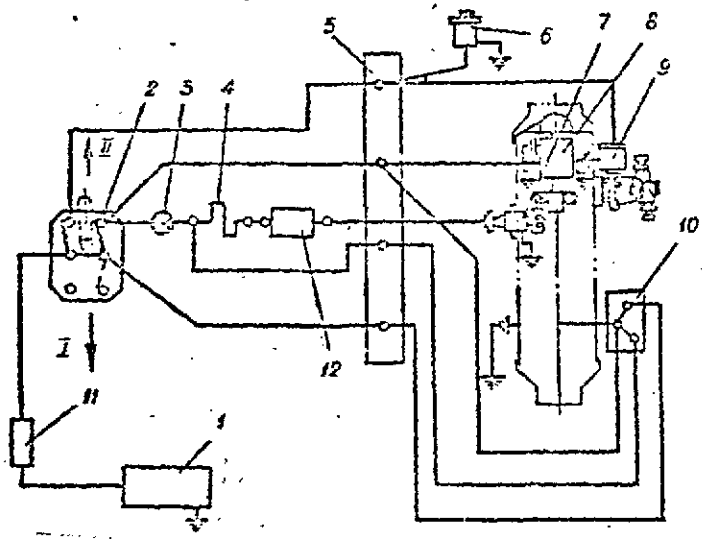


FIG. 112. ELECTRIC DIAGRAM OF HEATER ASSEMBLY

1 - storage battery; 2 - heater switch; 3 - pilot lamp; 4 - reference coil; 5 - four-terminal junction panel; 6 - fuel pump; 7 - glow plug; 8 - heater electric motor; 9 - valve solenoid; 10 - temperature-controlled switch; 11 - safety fuse; 12 - resistor 0.65 ohm

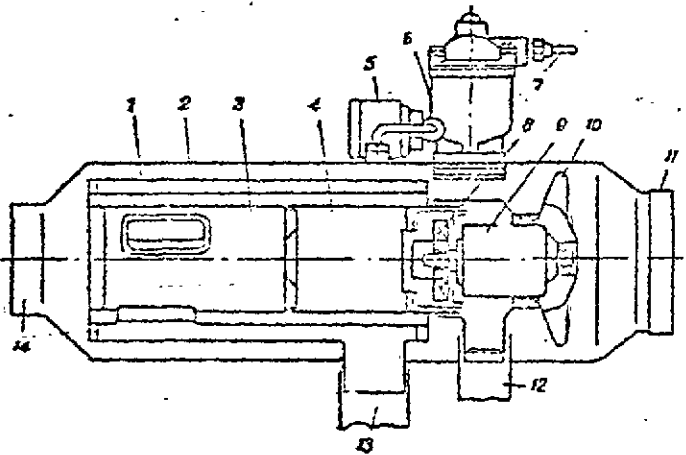


FIG. 113. ELECTRIC MOTOR, FAN AND BLOWER OF HEATER ASSEMBLY

1 - heat exchanger; 2 - heater casing; 3 - afterburning chamber; 4 - combustion chamber; 5 - electric actuator valve; 6 - fuel feed regulator; 7 - fuel feed piping; 8 - blower; 9 - electric motor; 10 - fan; 11 - cold air intake branch pipe; 12 - branch pipe for taking in air for combustion of fuel; 13 - exhaust branch pipe; 14 - heated air outlet branch pipe



#### Maintenance of Heating Device

Every 100 hours of the heater operation, do the following:

- blow the heat exchanger with compressed air under a pressure of  $2.5 \text{ kg/cm}^2$  through the intake branch pipe;
- clean the glow plug of carbon deposit;
- clean and wash the fuel pump filter, clean the pump contacts and, if necessary, adjust the gap between the contacts;
- clean the filters of the settler and fuel feed regulator, regulator jet and pipelines of dirt;
- check the adjustment of the temperature-controlled switch and, if necessary, adjust its operation by the screw; after adjustment, lock the screw.

Besides, to ensure normal operation of the heating device, carry out the operations performed every 100 hours twice in the cold season and in addition, check the condition of the electric equipment.

#### FENDERS AND HOOD

The automobile is provided with fenders (mud guards) arranged above the front wheels and a hood enclosing the engine compartment. The front part of the fenders is attached to the cab. Foot steps are mounted on the front part of the fenders.

The rear part of the fenders consists of horizontal and inclined panels. The rear part of the fenders is attached at the front portion to the cab and at the middle and rear portions to the bracket of fuel tanks and also to the frame.

The engine compartment hood consists of detachable side panels, detachable upper panels located in the vicinity of fuel tanks and opening upper panels providing access to the engine units.

Installed on the fenders at the right and left sides of the power plant are two fire extinguishers secured by clamps to middle side panels of the hood.

The side panels and the upper panel are provided with nozzles for air intake and its outlet from the engine compartment. The nozzles provided in the side panels are adjustable. V-shaped fenders (foot steps) are installed between the second and third axles.

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Chapter VI

AUTOMOBILE CONTROLS

STEERING SYSTEM

Purpose and Design of Steering System

The steering system is designed to steer the automobile in the required direction. The steering system (Fig. 114) consists of steering gear 1 with pitman arm 2, hydraulic booster system (hydraulic booster 3 with safety valve 7, pump 6, oil tank 5, pipelines and hose), drag link 4 and connecting link 14, rods 8 and 9, steering arms 10 and steering linkage arms 11, 13, 15, 17 and 19.

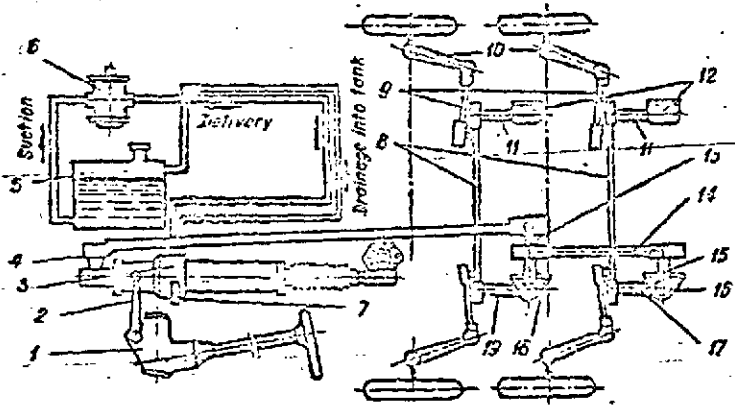


FIG. 114. STEERING SYSTEM DIAGRAM

- 1 - steering gear; 2 - pitman arm; 3 - hydraulic booster; 4 - drag link; 5 - oil tank;
- 6 - pump; 7 - safety valve; 8 - steering linkage tie rods; 9 - steering linkage side rods;
- 10 - steering arm; 11 - pendulums; 12 - brackets of pendulums; 13, 15 - steering linkage upper arm; 14 - connecting link; 16, 18 - brackets of steering linkage arms;
- 17, 19 - steering linkage lower arms

Steering Gear

The steering gear (Fig. 115) is designed to actuate the steering system. It is installed on the left side of the automobile (as viewed forward). Steering gear case 2 is bolted to the bracket riveted to the frame.

Motion from the steering wheel is transmitted to the pitman arm through a pair of bevel gears 4 and 5, worm 8 and nut 10 one side of which is provided with teeth cut in the form of a rack meshed with teeth of the sector of pitman arm shaft 9. For adjustment in meshing of the nut-and-sector pair the sector teeth are made inclined. To reduce friction in the steering mechanism one hundred and ten balls 11 are placed between worm 8 and nut 10. The extreme turns and the middle turn of the nut are grooved and closed by two guiding tubes 6 and 7 also filled with balls. Tubes 6 and 7 divide the nut helical groove in two closed grooves forming independent helical races for balls. When the worm is rotated the balls arranged between the worm and nut roll to one of the nut end faces depending upon the direction of rotation and return back through the tubes.

The steering mechanism case has two holes closed by plugs 1 and 3; one hole is used for filling and the other for draining the lubricant.

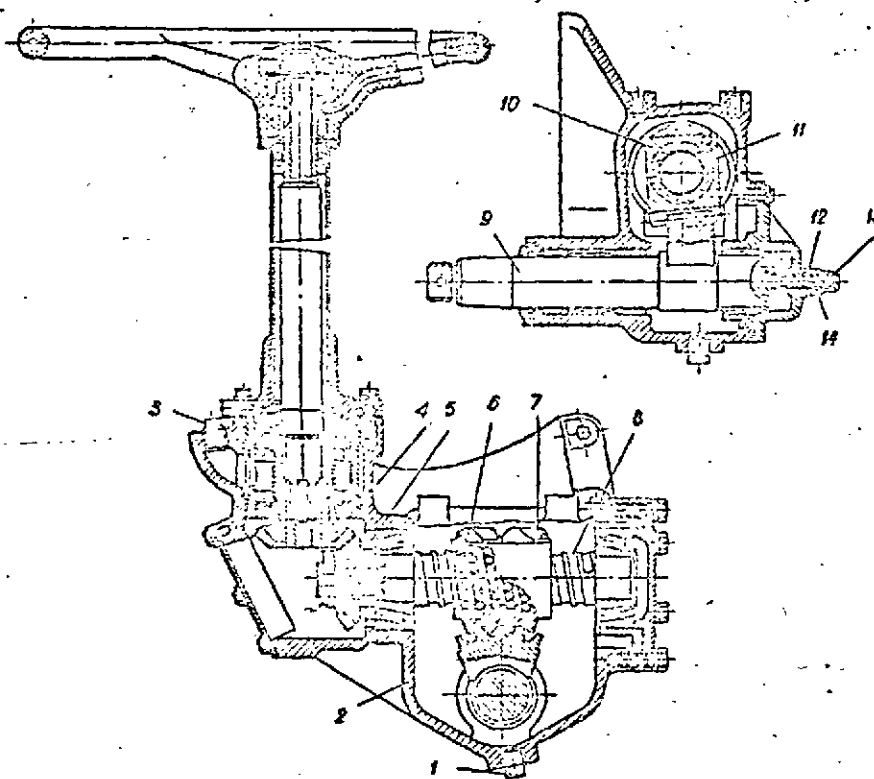


FIG. 115. STEERING GEAR

1 - drain hole plug; 2 - steering gear case; 3 - filler hole plug; 4 - driving bevel gear; 5 - driven bevel gear; 6, 7 - guiding tubes; 8 - steering gear worm; 9 - pitman arm shaft; 10 - steering gear nut; 11 - ball; 12 - lock nut; 13 - cup nut; 14 - adjusting screw

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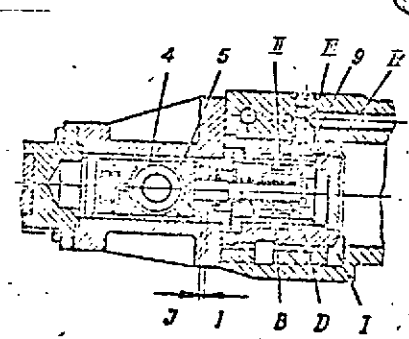
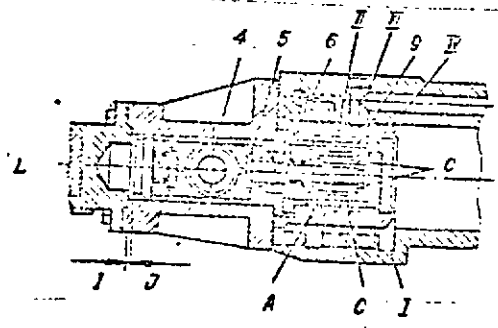
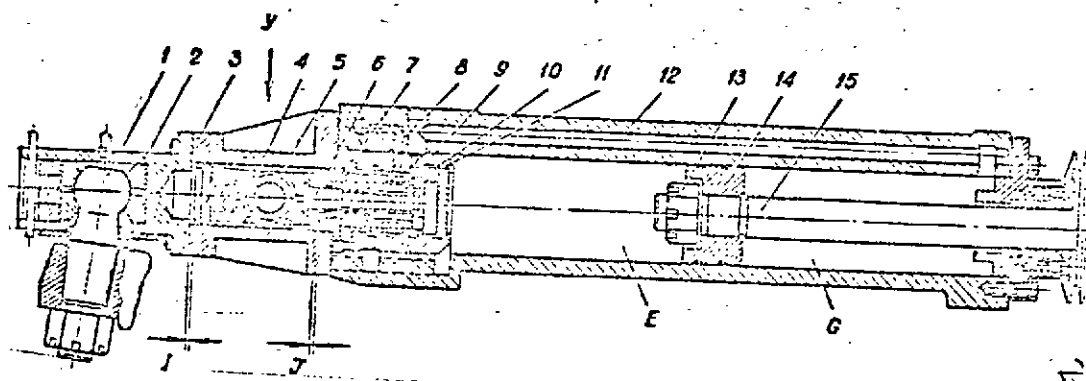
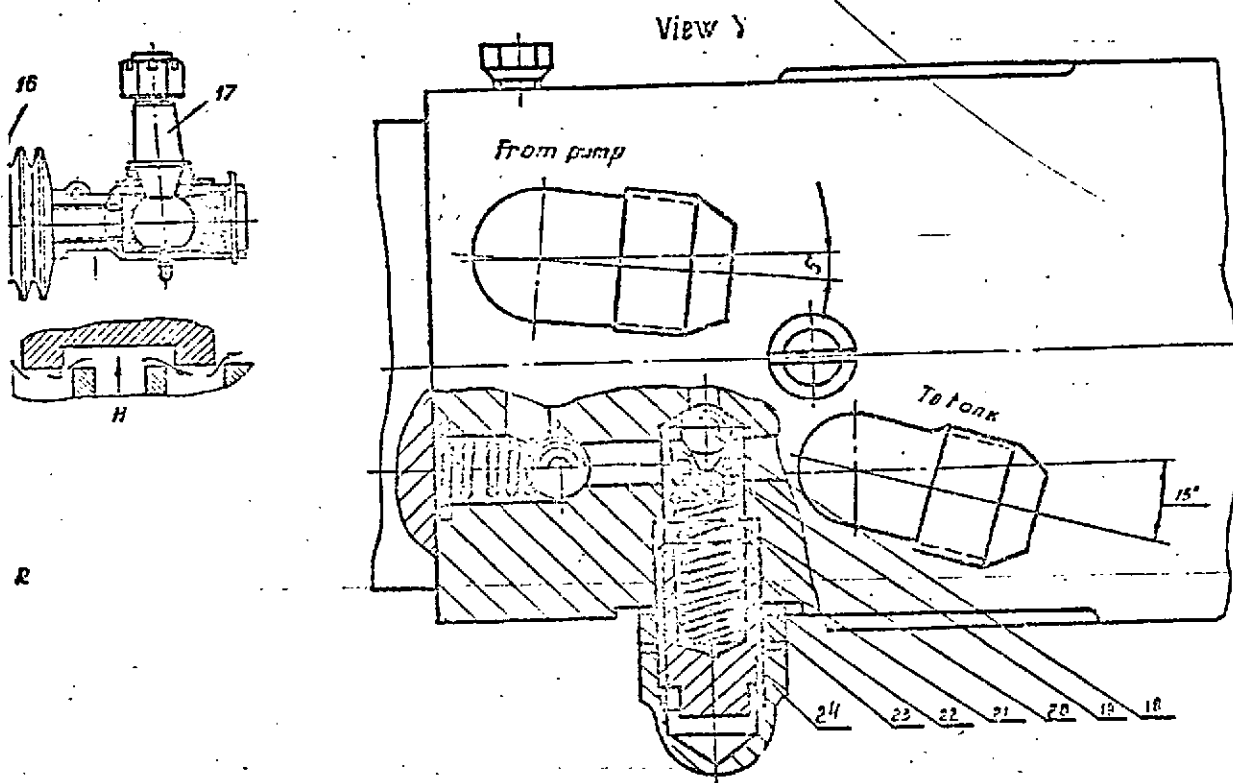


FIG.  
 1, 4, 17 - ball pins; 2 - drag link sleeve; 3 - pitman arm ball pin housing; 5 - movable  
 6 - slide valve rod; 7 - oil seal; 8 - spring; 9 - slide valve; 10 - slide valve barrel;  
 11 - bushing; 12 - hydraulic booster cylinder; 13 - nut; 14 - piston; 15 - booster rod;

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116. HYDRAULIC BOOSTER

sleeve: 16 - protective boot; 18 - ball 3/8"; 19 - safety valve seat; 20 - spring; 21 - adjusting screw;  
 22 - packing ring; 23 - nut 1/20x1.5; 24 - safety valve cap; I, II, III, IV - channels; A - drain  
 slit of channel I; B - delivery slit of channel I; C - delivery slit of channel III; D - drain slit  
 of channel III; E, G - cylinder spaces; I, J - clearances; L - left-hand turn; R - right-hand turn

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Hydraulic Booster

The hydraulic booster is designed to make the automobile steering easier.

The hydraulic booster (Fig. 116) is cast iron cylinder 12 with channels and a safety valve. Piston 14 with packing rings is arranged inside the cylinder.

The piston is secured at the end of rod 15 by nut 13. The other end of the rod is fixed to the frame bracket by means of ball pin 17. The rod is protected from dust and dirt by boot 16. Ball pins 1, 4 and 17 are installed in retaining blocks which are pressed to the spherical surface of the pins by springs and nuts.

Safety Valve

Safety valve 7 (Fig. 114) serves to limit the pressure of working fluid in the steering gear hydraulic booster.

When pressure in the system exceeds  $70 \text{ kgf/cm}^2$  for which the safety valve spring is adjusted, the valve opens and connects the pressure chamber in its body with the drain channel.

The ball type valve built into the hydraulic booster is adjusted at the Manufacturing Plant and lead sealed. During the service period the valve is not subject to adjustment.

Steering System Hydraulic Booster Pump

The pump (Fig. 117) is designed to deliver the working fluid into the hydraulic booster and to ensure its circulation in the hydraulic system of the steering gear. The automobile is equipped with a R.H. rotation gear pump of HB-46 type having the capacity of 55 lit/min at 1,300 r.p.m. of the pump shaft.

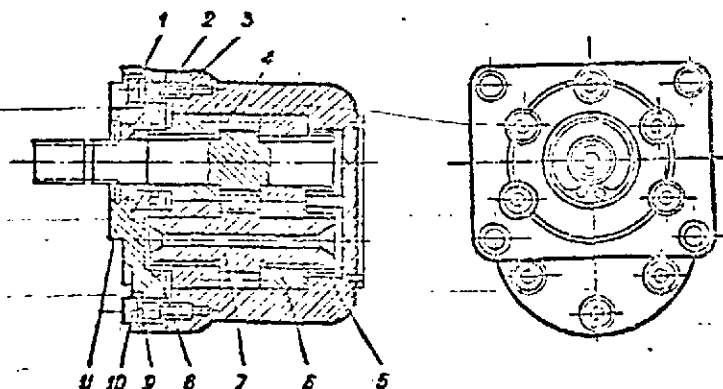


FIG. 117. HYDRAULIC BOOSTER PUMP HB-46

1 - locking ring; 2 - frame-type oil seal; 3 - packing ring; 4 - driving gear; 5 - pump housing; 6 - bushings; 7 - driven gear; 8 - packing ring; 9 - spring washer; 10 - screw; 11 - pump cover

Pump housing 5 has two blind stepped holes accommodating gears 4, 7 and bushings 6. The bushings cover the holes accommodating the gears and at the same time serve as bearings of the pump shafts made integral with the gears.

The pump housing is closed by cover 11 attached to the housing by means of screws. The cover is provided with a centering projection for axial alignment of the pump shaft with the drive shaft, and holes for mounting bolts.

Packing ring 3 and oil seal 2 prevent leakage of working fluid from the pump housing.

Packing rings 8 are installed for sealing the clearances between mating surfaces of the bushings and the cover.

Face clearances in the pump are taken up automatically and are kept within the thickness of an oil layer which depends upon the viscosity of working fluid and total specific pressure.

During rotation of the gears the tooth recesses which come out of mesh are filled with working fluid carried by the tooth recesses and kept between the recesses and the pump housing. At subsequent meshing of the teeth the fluid is forced out of the tooth recesses and delivered into the pipeline.

#### Hydraulic Booster Oil Tank

The oil tank is installed on the frame at the left-hand side. The cap of the oil tank filler neck is provided with a valve communicating the tank with the atmosphere only in case of excessive pressure ( $0.4-0.45 \text{ kgf/cm}^2$ ) in the tank. The oil tank filler neck is provided with a screen filter. An oil dipstick with two marks is installed on the oil tank. The upper mark on the dipstick denotes the maximum oil level in the tank while the lower mark denotes the minimum permissible oil level. A screen-type oil header is provided inside the tank. The drain hose running from the hydraulic booster and the suction hose running from the pump are connected to the oil tank.

#### Operation of Steering System

When the steering wheel is rotated pitman arm 2 (Fig. 114) acting on ball pin 4 (Fig. 116) shifts movable sleeve 5, rod 6 with slide valve 9 into either direction depending upon the sense of the steering wheel rotation.

The movable sleeve is able to move to the left or right due to presence of clearances "I" and "J".

When the steering wheel is rotated to the left the pitman arm actuates ball pin 4 thus causing movable sleeve 5 to move to the right. As a result, the clearance "J" reduces to the minimum. Slide valve 9 also moves to the right (position "L"). At the same time, holes "A" and "C" are covered by edges of the slide valve on the right-hand side thus shutting off the passage of fluid into channel IV (for draining). The fluid from channel II (from the pump) passes through open (left-hand) part of holes "C" into channel III and space "G" of the cylinder causing the cylinder to move to the right.

At this time, the fluid from space "E" through channel I, open (left-hand) part of holes "A", holes "C" in the slide valve passes via channel IV and pipelines into the hydraulic booster oil tank. The hydraulic booster cylinder moves to the right until rotation of the steering wheel is stopped. As a result, the slide valve will be set in the neutral position "N" having interconnected channels II (from the pump) and IV (drainage into the tank). In this case, the pressure of fluid in spaces "E" and "G" of the hydraulic booster cylinder will be equal.

When the steering wheel is rotated to the right the movable sleeve moves to the left. The clearance "J" reduces to the minimum. Slide valve 9 also moves to the left (position "R").

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As a result, holes "A" and "C" are covered by edges of the slide valve on the left-hand side thus shutting off the passage of fluid into channel IV (for draining). The fluid from channel II (from the pump) passes through open (right-hand) part of holes "A" into channel I and space "E" of the cylinder causing the cylinder to move to the left.

At this time, the fluid space "G" through channel III, open (right-hand) part of holes "C" passes via channel IV and pipelines into the tank. The hydraulic booster moves to the left until rotation of the steering wheel is stopped. As a result, the slide valve will be set in the neutral position "Z" interconnecting channels II (from the pump) and IV (drainage into the pump). In this case, the pressure of fluid in spaces "E" and "G" of the hydraulic booster cylinder will be equal.

When the hydraulic booster cylinder moves backward or forward drag link 4 (Fig.114) one end of which is secured on the cone of ball pin 1 (Fig.116) moves together with the cylinder. The other end of drag link 4 (Fig.114) is connected with upper arm 13 of the steering linkage. Lower arm 19 rigidly connected with arm 13 through the vertical shaft moves steering linkage tie rod 8 which is hinged with side rods 9 adjustable in length and with steering arms 10. Movement of the tie rod causes movement of the side rods which turn the arms of the steering linkage and wheel of the steerable axle in the direction of the automobile turning.

Turning of the second axle wheels is accomplished by means of connecting link 14. Design of the second axle steering linkage is similar to that of the first axle.

The steering rods are connected with the arms by means of tapered ball pins. The steering arms are installed on tapered herringbone splines of the steering knuckle shafts and pins and are secured by nuts.

#### Adjustment of Steering System

The steering wheel tilting with the wheels set in a straight-forward position and with the engine running should not exceed  $32^\circ$  or 150 mm of the steering wheel arc length.

When checking the steering wheel tilting carefully watch the beginning of turning of the steering wheel and steerable wheels.

In case of excessive steering wheel tilting, check the attachment of the steering wheel, steering column, steering gear case, pitman arm and steering gear arms. If necessary, eliminate loosening at attachment points.

If in result of the above operations the steering wheel tilting has not been reduced, adjust the steering system. Adjust the steering system in succession, first adjust the hinged joints of steering rods and then the meshing of the nut with the steering gear sector.

Adjustment of the hinged joints of steering rods is required if the rods shift relative to the ball pins.

For adjustment, remove the cotter pin from the hinged joint, screw in its plug as far as it will go, then back it out so that the plug can be locked with a cotter pin. This done, repeat this operation with the remaining hinged joints of the steering rods.

If upon adjustment of hinged joints of the steering rods the steering wheel tilting exceeds  $32^\circ$  or 150 mm of the steering arm arc length, adjust the meshing of the nut with the steering gear sector.



- To adjust the meshing, do the following:
- unscrew the attaching nuts and remove (lower) the front mud guard plate of the frame;
  - unlock and unscrew the nut of the ball pin of the pitman arm sleeve and disconnect the steering system hydraulic booster;
  - unscrew the protective cap, loosen lock nut 12 (Fig.115) and tighten adjusting screw 14 to a position at which the steering wheel rotates freely through any angle without jamming. In this case, the steering wheel tilting should not exceed  $9^{\circ}$  or 43 mm of the steering wheel arc length;
  - holding adjusting screw 14 against turning, tighten lock nut 12 and screw on protective cap 13;
- Note: If the steering wheel tilting exceeds  $9^{\circ}$  or 43 mm of the steering wheel arc length, remove the steering gear from the automobile and send it for adjustment to a repair shop.
- connect the steering system hydraulic booster, screw in and cotter the nut of the pitman arm sleeve ball;
  - reinstall the front mud guard plate of the frame and screw in the attaching nuts.

#### Maintenance of Steering System

When servicing the steering system, carry out all operations of the preventive maintenance according to the Section "Preventive Maintenance of Automobile".

Attachment of the steering gear rods and arms should be checked by turning the steering wheel in both directions with the engine running. Attachment of the steering arms should be additionally checked by swinging the arm with a hand.

In case the steering arms are replaced or removed and reinstalled, see that the steering arms bearing the conventional numbers are installed to their proper places: the steering arm with number 238 - on the first right-hand wheel, with number 239 - on the first left-hand wheel, with number 242 - on the second right-hand wheel, with number 243 - on the second left-hand wheel.

When installing the steering arm on the steering knuckle pin align the marks on the steering arm end face and on the steering knuckle pin.

Before adding oil into the tank of the steering system hydraulic booster, thoroughly clean the plug and filler neck of dirt. Filling the tank with oil should be performed only from a clean vessel and only through a screen in the tank filler neck to prevent dirt and sand from getting into the steering system hydraulic system. It is forbidden to fill the tank with oil containing water.

During the initial filling of the tank, do the following:

- fill the tank with oil up to the upper mark on the oil dipstick;
- start up the engine and turn the wheels from one to the other extreme positions to fill the system with oil;
- top up the tank to the upper mark on the oil dipstick.

To facilitate filling the system with oil during operation of the engine screw out the filler neck plug of the oil tank or the oil dipstick.

Troubles and Remedies of Steering System

Trouble	Cause	Remedy
Hydraulic booster fails to operate	Mechanical damage of pump	Repair or replace pump
Hydraulic booster fails to turn wheels in one direction	1. Barrel of hydraulic booster slide valve is damaged 2. Sleeve of pitman arm ball pin is scorred	Replace barrel Replace sleeve
Hydraulic booster turns wheels under an excessive effort applied to steering wheel	1. Pump fails to build up required pressure 2. Oil level in hydraulic booster tank has dropped	Replace or repair pump Add oil
Leakage of oil through hole of pitman arm ball pin	Oil seal of slide valve axle is worn out	Replace oil seal
Leakage of oil through oil seals of hydraulic booster rod	Oil seals are worn out	Replace oil seals

BRAKESPurpose and Design of Brakes

The automobile is equipped with two independent brake systems: foot (wheel) brake with an air-hydraulic drive acting on all the wheels and hand brake with a mechanical control linkage acting directly on the automobile transmission.

The brake system and the foot (wheel) brake drive of the automobile consists of the following units: compressor 7 (Fig.118), two master brake cylinders 2, wheel brake hydraulic cylinders 1, cut-out cock 12, coupling head 13, two air bottles 15 with drain cocks 14, air take-off cock 11, pressure regulator 9, safety valve 8, brake valve 5, stop light switch 6, brake system pressure gauge 4, towing air valve 3, hoses and pipelines of wheel brakes and moisture-and-oil separator 10.

Compressor

During operation of the engine the compressor charges the brake system air bottles with air ensuring operation of the foot brakes and control of the transfer case.

The two-cylinder, water-cooled compressor is installed on the overdrive gear and is driven by two V-belts. Installation of the compressor is shown in Fig.119.

Design of the compressor is shown in Fig.120.

Compressor pulley 1 is mounted on the tapered nosepiece of the crankshaft by means of a key.

The compressor drop-forged crankshaft rotates in ball bearings mounted in compressor crankcase 11 and front cover 2. The split big ends of connecting rods 5 are lined with babbitt. The big end cap is attached to the connecting rod by two bolts. The non-split small ends with bronze bushings are coupled with pistons 3 by means of piston pins 4.

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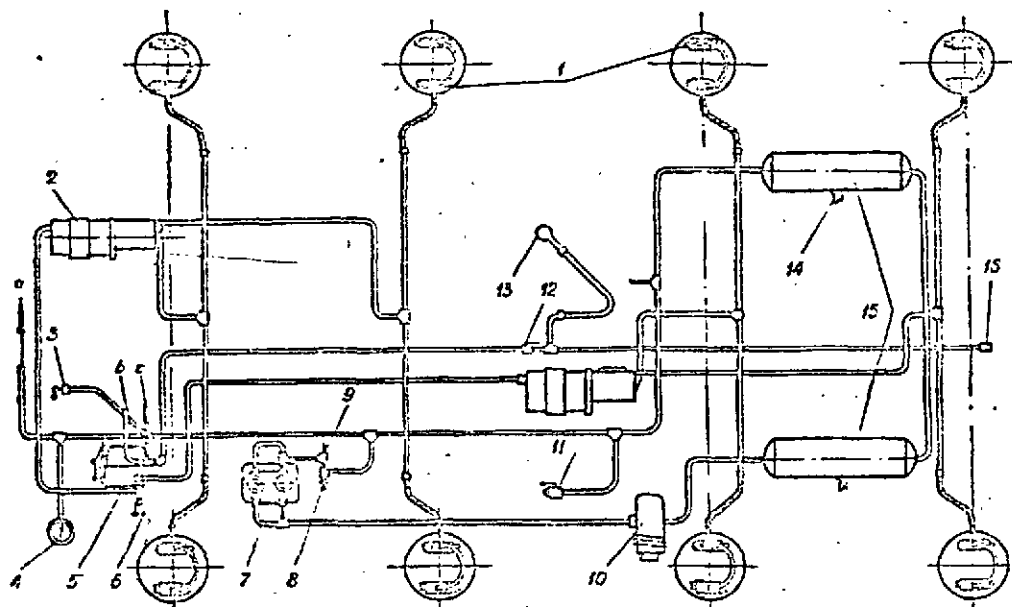


FIG. 118. BRAKING SYSTEM KEY DIAGRAM

1 - wheel brake cylinders; 2 - master brake cylinder; 3 - towing air valve; 4 - brake system pressure gauge; 5 - brake valve; 6 - stop light switch; 7 - compressor; 8 - safety valve; 9 - pressure regulator; 10 - moisture and oil separator; 11 - air take-off cock; 12 - cut-out cock; 13 - coupling head; 14 - drain cock; 15 - air bottles; 16 - nipple; a - to windshield wipers; b - to air horns; c - to transfer case control valve;

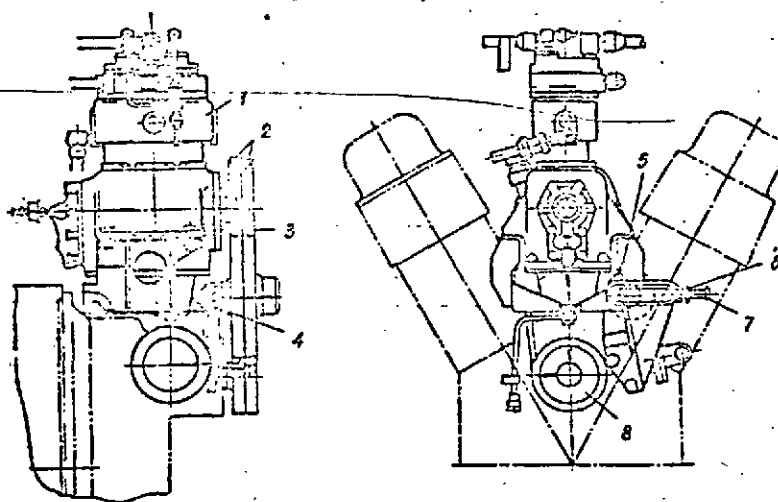


FIG. 119. COMPRESSOR INSTALLATION

1 - compressor; 2 - compressor drive belts; 3 - compressor pulley; 4 - belt tensioner axle securing nut; 5 - belt tensioner; 6 - lock nut; 7 - tensioner bolt; 8 - compressor driving pulley

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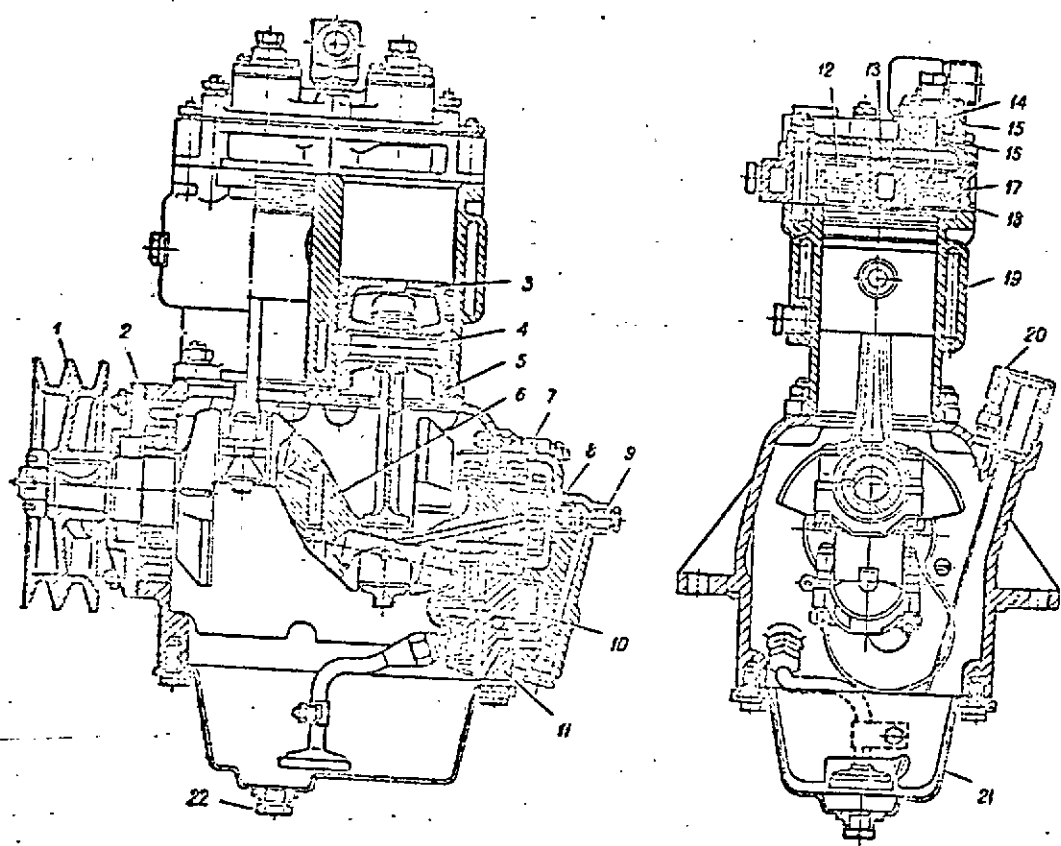


FIG. 120. COMPRESSOR

- 1 - pulley; 2 - front cover; 3 - piston; 4 - piston pin; 5 - connecting rod; 6 - crankshaft; 7 - rear cover; 8 - end face sealing; 9 - plug; 10 - oil pump; 11 - compressor crankcase; 12 - delivery valve; 13 - cylinder head cover; 14 - unloading device diaphragm; 15 - unloading device piston; 16 - spring; 17 - suction valve; 18 - cylinder head; 19 - cylinder block; 20 - filler neck cap; 21 - compressor oil pan; 22 - drain hole plug

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Cylinder block 19, cylinder head 18 and cylinder head cover 13 of the compressor are cast of iron. The compressor cylinder head cover accommodates a special unloading device consisting of diaphragm 14, piston 15 with push rod and return spring 16.

The unloading device ensures switching on the delivery of air into the brake system at a pressure of 5.65-6.0  $\text{kgf/cm}^2$  and switching off the delivery of air into the system at a pressure of 7.0-7.35  $\text{kgf/cm}^2$ . Such operation of the unloading device is preestablished by adjustment of the pressure regulator.

When the pressure in the system rises up to 7.0-7.35  $\text{kgf/cm}^2$  the pressure regulator releases air into the unloading chamber, diaphragm 14 under the action of air pressure deflects, piston 15 with the push rod moves down and opens suction valve 17 thus connecting both cylinders of the compressor with the suction pipeline. In this case, the compressor operates at idling.

Suction valves serve at the same time as unloading valves. Delivery valve 12 and suction valve 17 are interchangeable.

The compressor is provided with an individual lubricating system. Gear oil pump 10 is arranged in rear cover 7 of the compressor crankcase. The pump is driven from the compressor crankshaft through a pair of spur gears. Oil drawn by the pump from compressor oil pan 21 through the filtering screen is directed via the pipe and drilling in the crankcase to the rear cover and further into the crankshaft inner space from where it is delivered for lubrication of the crankpins. Adjustment of the oil pressure within 0.6-2.5  $\text{kgf/cm}^2$  is performed at the Manufacturing Plant by means of gaskets installed under the adjusting bolt head. The remaining friction parts of the compressor are lubricated by splashing.

From the rear cover oil is delivered into the crankshaft through a drilling in end face sealing 8 consisting of a packing bush and pressure spring. The sending unit of the emergency oil pressure pilot lamp located on the instrument panel is installed instead of plug 9. The sending unit contacts close when pressure in the compressor drops below 0.6  $\text{kgf/cm}^2$  and the pilot lamp on the instrument panel lights up.

Oil is filled into the compressor oil pan through a filler neck closed by cap 20 and drained through plug 22. The amount of oil in the compressor crankcase is checked by an oil dipstick with the filler neck cap unscrewed.

The compressor cooling system is connected into the common cooling system of the engine. The coolant for the compressor is taken from the thermostat box after the engine. The coolant is discharged from the compressor into the intake pipe of the radiator.

#### Moisture-and-Oil Separator

The moisture-and-oil separator is designed for cleaning the air delivered by the compressor of dust, moisture, water and oil vapours. The moisture-and-oil separator is installed on the left-hand side member between the second and third axles and is connected into the air delivery pipeline..

The moisture-and-oil separator (Fig.121) consists of housing 1 with impellers 2 attached to the housing by means of distance bushings 3 and coupler 4, pan 5 with deflecting washer 7 and drain cock 6 for draining the condensate. Air through space "A" flows tangentially to the inner surface of housing 1 and under the action of impellers 2 acquires rotary motion. Particles of dust, droplets of moisture and oil settle down on the wall and drain into pan 5. Cleaned air passes into the bottles through space "B".

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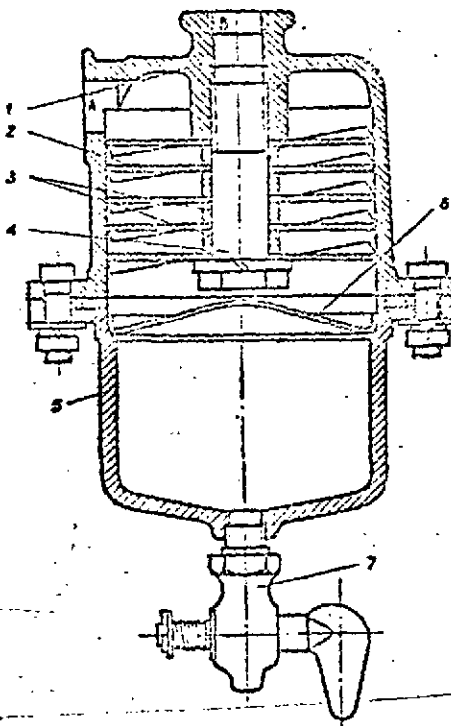


FIG. 121. MOISTURE AND OIL SEPARATOR

- 1 - housing; 2 - impeller; 3 - distance bushings; 4 - coupler;
- 5 - pan; 6 - drain cocks; 7 - deflecting washer

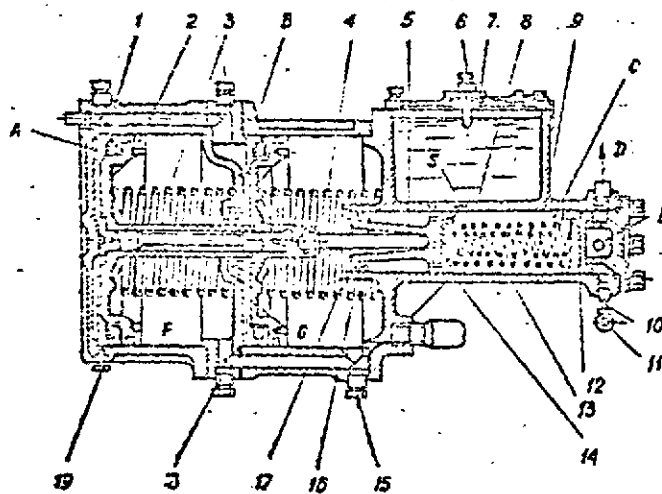


FIG. 122. MASTER BRAKE CYLINDER

- 1 - air chamber body; 2 - piston with collar and packing ring; 3 - air chamber piston return spring; 4 - rod; 5 - piston; 6 - level gauge; 7 - filler hole plug;
- 8 - fluid chamber housing; 9, 13 - return springs; 10 - by-pass valve;
- 11 - valve cap; 12, 14, 15 - collars; 15, 18 - plugs; 17 - locking ring;
- 19 - plug; A, B, F, G - air chamber apertures; 5 - hole; D - to wheel cylinders

Master Brake Cylinder

Due to different diameters of the pistons of the air and fluid chambers the master brake cylinder (Fig.122) builds up a high pressure ( $120 \text{ kgf/cm}^2$ ) of the brake fluid in the wheel brake cylinders (at an air pressure of  $5 \text{ kgf/cm}^2$ ) ensuring the required expanding effort on the wheel brake shoes.

The master brake cylinder ensures operation of the front wheel brakes and the other one ensures operation of the rear wheel brakes.

The master brake cylinder consists of two chambers: air and fluid. Air chamber body 1 consists of three parts cast of aluminium. Fluid chamber housing 8 is cast of grey iron. When the brake pedal is depressed compressed air from the air bottles flows into spaces "A" and "B" of the master brake cylinder through the brake valve and air pipelines. Under the action of compressed air pistons 2 rigidly coupled with each other shift rod 4 which in its turn actuates piston 5 of the fluid chamber. Collar 14 moving together with the piston covers hole "S" due to which the pressure in space "C" rises and the fluid having pressed out the edges of collar 12 flows into space "E". From space "E" the fluid is delivered under the pressure to the wheel brake cylinders.

Release of the brake pedal causes releasing of the brakes in which case the air from spaces "A" and "B" of the master brake cylinder air chamber is expelled into the atmosphere through the brake valve, and pistons 2 and 5 return into the initial position under the action of return springs 3, 9, 13 and wheel brake shoe return springs.

With the purpose to exclude possible formation of air locks and to reduce the time of the hydraulic drive operation a residual pressure of the brake fluid ( $0.8-1.6 \text{ kgf/cm}^2$ ) is constantly maintained in the pipeline from space "E" to the wheel brake cylinders due to action of springs 9 and 13. Spaces "F" and "G" are constantly connected with the atmosphere through the common ventilating system of the automobile units.

Notes: When mounting and demounting locking ring 17 (Fig.122), observe the safety rules.

Wheel Brake Cylinder

To transmit the required effort to the wheel brake shoes each wheel is equipped with two brake cylinders. The single-acting wheel brake cylinder (Fig.123) consists

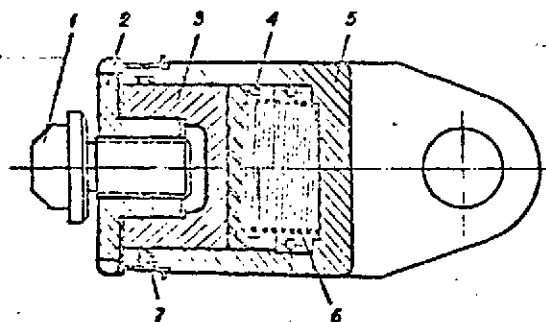


FIG. 123. WHEEL CYLINDER

1 - wheel brake shoes adjustment screw; 2 - wheel brake shoes adjustment nut; 3 - wheel brake cylinder piston; 4 - wheel brake cylinder piston cap; 5 - wheel brake cylinder body; 6 - wheel brake cylinder spring; 7 - packing ring

of the following parts: cylinder, piston, packing ring, rubber cup, wheel brake cylinder spring, adjusting nut with protective cap, adjusting screw and protective cap spring.

The pressure of brake fluid in the wheel cylinder is equal to  $120 \text{ kgf/cm}^2$  (at an air pressure in the system of  $5 \text{ kgf/cm}^2$ ).

Cut-Out Cock

The plug-type cut-out cock is installed near the fifth-wheel assembly in the left-hand side member pipeline running to the

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brake system of a semitrailer or trailer and is used for cutting out this pipeline from the brake system of the automobile when the latter operates without a semitrailer or trailer.

The out-out cock should be opened after connection of the brake system of a semitrailer or trailer and closed before disconnection.

#### Coupling Head

The coupling head is used for connecting the brake system of a semitrailer or trailer to the automobile brake system. After uncoupling of a semitrailer or trailer the coupling head cover should be closed to prevent penetration of dirt.

The automobile is additionally provided with an air outlet to the brake system of a trailer (Fig. 118). This pipeline is fitted on its end with nipple 16 secured to the bracket which is located on the left-hand sill at the rear part of the automobile. The nipple is closed with a plug. If the automobile is to be used for towing a trailer it is necessary to change places of the plug and coupling head of the semitrailer flexible hose.

#### Air Bottles

The automobile is equipped with two air bottles each of 43-litres capacity. The air bottles are designed for storage of compressed air. For draining the condensate the air bottles are provided with cocks at their lower part.

#### Air Take-Off Cock

The cock is designed for taking off air through a special hose to inflate the tyres. The hole used for connecting the hose should be constantly closed with a cap nut (when air is not taken off) to prevent clogging of the cock.

#### Pressure Regulator

The pressure regulator (Fig. 124) automatically maintains within the preestablished limits the pressure of air charged by the compressor into the air bottles. It is installed on the hood frame near the compressor in the engine compartment. The pressure regulator is a two-ball valve mechanism loaded through rod 7 by spiral spring 9. The spring is tightened by adjusting cap nut 10.

Installed at the lower part of pressure regulator body 1 is cover 13 of hair filter 2 to which the pipelines running from the air bottles are connected. The side hole of the pressure regulator is connected by a pipe with the space under the diaphragm of the compressor unloading device. When the air pressure in the air bottles reaches 7.0-7.35 kgf/cm<sup>2</sup> lower valve 3 opens and upper valve 4 closes compressing spiral spring 9. As a result, the unloading device of the compressor is out into operation and the latter runs at idling.

When the pressure in the air bottles drops to 5.65-6 kgf/cm<sup>2</sup> the balls actuated by spring 9 move down, the regulator cuts out the unloading device and the compressor starts to charge air into the air bottles.

The maximum pressure in the system maintained by the regulator is preestablished by tightening the spring. The minimum pressure at which the regulator cuts the compressor into operation is adjusted by changing the clearance between upper seat 5 and the valve with the help of shims 12 placed between the upper seat and the pressure regulator body.

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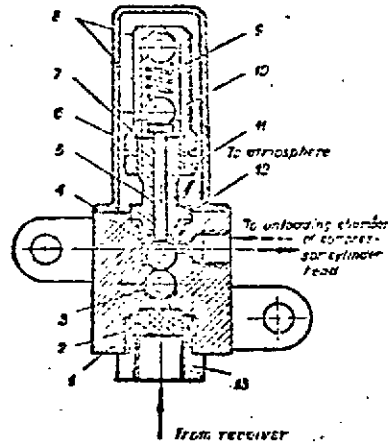


FIG. 124. PRESSURE REGULATOR

- 1 - body; 2 - air filter; 3 - lower ball valve;  
 4 - upper ball valve; 5 - upper seat;  
 6 - protective casing; 7 - rod; 8 - centering  
 balls; 9 - spring; 10 - adjusting cap nut;  
 11 - lock nut; 12 - adjusting screw;  
 13 - filter cover

The safety valve (Fig. 125) serves to protect the air system against an excessive rise of air pressure in case the pressure regulator is out of order. The safety valve is installed together with the pressure regulator in the engine compartment above the compressor. The safety valve consists of a body into which are screwed on one side the valve seat and on the other the adjusting screw pressing the ball valve to the seat by means of a spring acting through the rod. The valve is adjusted for a pressure of 8.0-8.5 kgf/cm<sup>2</sup> at which it opens and releases air from the system through the side hole in the body.

#### Brake Valve

The brake valve (Fig. 126) is a combination valve of a piston type providing for simultaneous control of the wheel brakes of the automobile and towed semitrailer.

The brake valve is composed of two cylinders combined in one housing 17. The upper cylinder larger in diameter serves to control the brakes of a semitrailer while the lower cylinder smaller in diameter serves to control the brakes of the automobile.

Adjusting spring 9 fitted on lower control rod 8 is arranged in the groove of cover 10. One end of the spring thrusts the nut fitted on the control rod nut. The adjusting spring is tightened preliminarily by turning the control rod by its lug. The other end of the spring thrusts against the stamped adjusting bushing with shaped slots. The end of the spring thrusts against the stamped adjusting bushing with shaped slots. The end of bolt 5 screwed into duty adjustment ring 6 of the brake valve enters the stove slots. The tightening of spring 9 of the lower control rod is additionally changed by turning the duty adjustment ring.

By changing the spring tightening it is possible to vary within definite limits the beginning of air delivery into the brake pipeline of the automobile relative to the beginning of air release from the semitrailer pipeline thus accomplishing the advanced or retarded braking of the semitrailer.

The drive of the semitrailer brakes is of a single pipeline type; the brakes are applied when the pressure drops in the semitrailer connecting pipeline.

For braking the semitrailer at halt a mechanism of the semitrailer brake hand-operated drive connected with the hand brake lever is accommodated in the space of the brake valve upper cover.

With the brake pedal released balancing spring 16 shifts upper cylinder piston 18 with the collar into the extreme right-hand position. As a result, piston rod 4 thrusts against valve 1 and presses the latter from the outer seat allowing the air delivered from the air bottles through one of the side holes in the space of valves on the side of springs to pass into the right-hand space of the upper cylinder and into the semitrailer pipeline.

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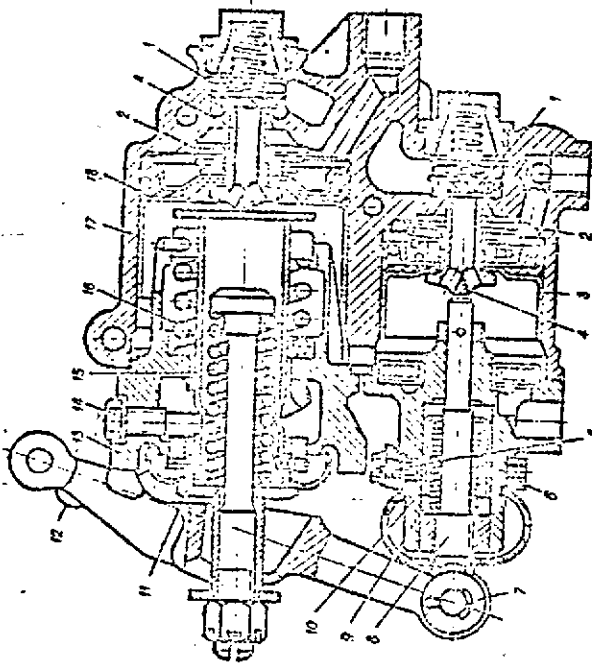


FIG. 126. BRAKE VALVE  
1 - valves 2 - piston return spring 3 - piston rod 4 - piston rod 5 - bolt  
6 - dash adjustment ring 7 - lever 8 - lower cylinder piston 9 - adjusting spring  
10 - cylinder lower cover 11 - adjusting nut 12 - hand-operated drive lever  
13 - cylinder upper cover 14 - stop bolt 15 - balancing spring 16 - balancing  
spring 17 - brake valve housing 18 - upper cylinder piston

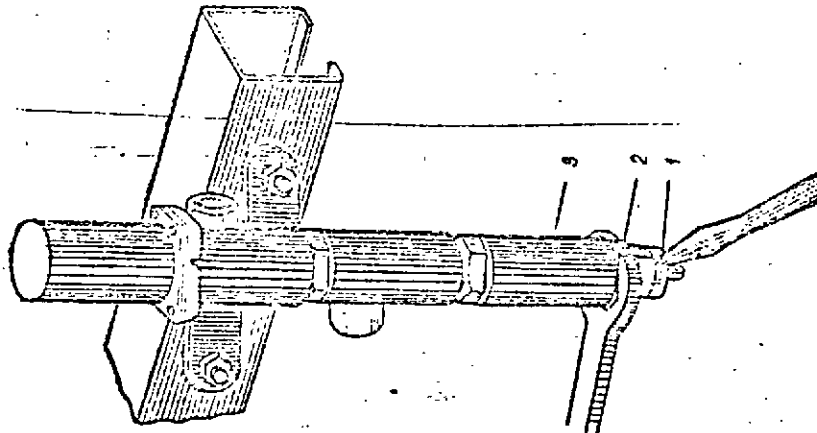


FIG. 125. ADJUSTMENT OF SAFETY VALVE  
1 - adjusting screw 2 - lock nut 3 - valve body

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When a definite pressure in the semitrailer pipeline is reached the compressed air acting on piston 18 compresses balancing spring 16 due to which the valve is pressed to the outer seat shutting off the delivery of air into the semitrailer pipeline. The pressure depending upon the tightening of the balancing spring is maintained in the brake pipeline of the semitrailer.

Spring 9 of lower cylinder control rod 8 presses out this rod from piston rod 4 until it thrusts against the ring which allows conical return spring 2 to shift lower cylinder piston 3 into the extreme left-hand position.

Lower valve 1, in this case, is pressed to its outer seat due to which the automobile brake pipeline (master brake cylinders) is connected with the atmosphere through the hollow rod of the lower cylinder piston.

When the brake pedal connected by a rod with brake valve lever 7 is depressed balancing spring 16 gets compressed and upper cylinder piston 18 actuated by spring 2 and compressed air starts shifting to the left together with rod 4. As a result, upper valve 1 is pressed to its outer seat thus shutting off the delivery of compressed air from the air bottle. Then, upper piston rod 4 departs from the valve and the compressed air remaining in the semitrailer pipeline passes through piston hollow rod 4 into the left-hand space of the cylinder connected with the atmosphere.

Drop of pressure in the semitrailer pipeline causes its braking, since in this case the air distributing valve on the semitrailer operates and passes air from the air bottle provided on the semitrailer to the brake chambers of the semitrailer wheel brakes.

Thus, in case of uncoupling or breakage of the air hose connecting the air systems of the automobile and semitrailer the latter will be automatically braked as air from the semitrailer pipeline passes out into the atmosphere.

Simultaneously with the action taking place in the upper cylinder the lower end of brake valve lever 7 presses upon the lug of control rod 8 and overcoming the resistance of the spring shifts the control rod inside the brake valve. By its opposite end the control rod actuates lower piston rod 4 and shifts piston 3 with the collar to the right. As a result, the rod end face at first presses to the rubber washer of lower valve 1 thus shutting off communication of the automobile brake pipeline with the atmosphere and then presses out valve 1 from the outer seat making it pass the air from the air bottles into the right-hand space of the lower cylinder and further into the brake pipeline of the automobile thus braking the latter.

When braking the automobile at halt by the hand brake connected with the lever of the hand-operated drive, brake valve lever 12 causes turning of the axle with shaped cams by which the axle presses on the circular bushing rigidly connected with tube 15 of balancing spring 16 and reduces the spring resistance to shifting of upper cylinder piston 18. The piston shifts to the left and at the same time rod 4 departs from valve 1 due to which air passes out of the semitrailer pipeline and the semitrailer is braked by compressed air; in this case the compressed air is not admitted into the automobile brake pipeline.

#### Towing Air Valve

The towing air valve (Fig. 127) is used for delivery of compressed air into the brake system of a towed automobile. The valve is installed in the front part of the automobile on the left-hand side member (under the cab). The towing air valve is a valve mechanism consisting of housing 1 which accommodates spring 2 and cover 5 serving as a seat of valve 3.

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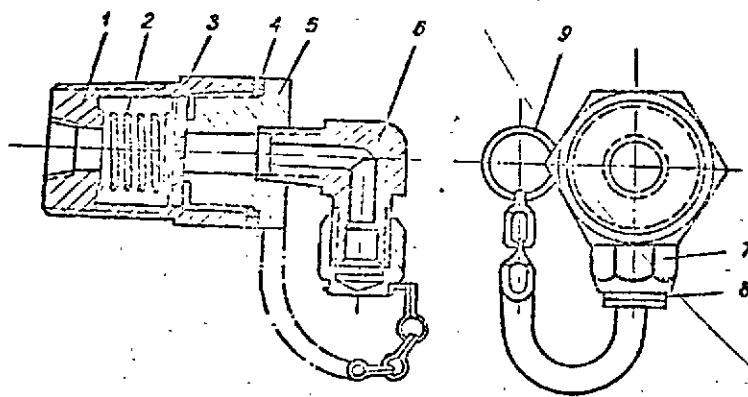


FIG. 127. TOWING AIR VALVE

- 1 - valve housing; 2 - spring; 3 - valve; 4 - gasket; 5 - cover; 6 - elbow; 7 - nut;
- 8 - chain ring; 9 - chain

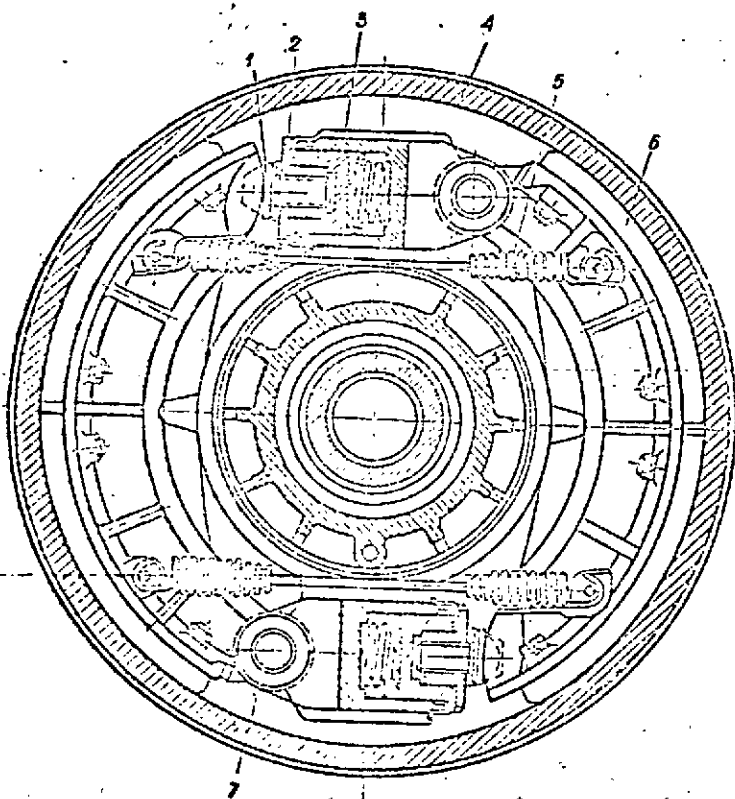


FIG. 128. WHEEL BRAKE

- 1 - adjusting screws; 2 - adjustment nut; 3 - steel brake cylinder; 4 - brake drum; 5 - return spring; 6 - brake shoe with lining; 7 - brake shoe anchor pin

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Wheel Brakes

The wheel brakes are of an open type. Support 1 is fitted on splines and secured by bolts to the trunion of steering knuckle 23 (Figs 93 and 94). Brake shoes 6 (Fig.128) with friction linings are secured by their ends to anchor pins 7 fitted into the bored holes in bodies of the wheel brake cylinders attached to the support. The other ends of the brake shoes freely rest against adjusting screws 1.

The clearance between the brake shoe and brake drum is adjusted by rotating adjusting nut 2. The wheel brakes are covered by protective discs.

Operation of Air-Hydraulic Drive of Wheel Brakes

When the brake pedal is depressed the delivery of compressed air from the air bottles into the brake valve upper cylinder ceases. In this case, the compressed air from the semitrailer pipeline passes outside through the brake valve. The drop of pressure in the pipeline of the semitrailer causes its braking.

At the same time, the lower end of the brake valve lever acting on the lower control rod, piston rod and the valve shuts off communication of the automobile brake system with the atmosphere; as a result, the compressed air from the air bottles passes into the space of the brake valve lower cylinder and then in the automobile brake system to the master brake cylinders.

Under the action of compressed air the pistons of the master brake cylinder air chamber are shifted and through the rod actuate the piston of the fluid chamber.

From the fluid chamber of the master brake cylinder the compressed fluid passes via the pipeline into the wheel brake cylinders. Under the action of compressed fluid the piston of the wheel brake cylinder shifts and through the adjusting screw actuates the wheel brake shoe pressing it to the brake drum. Thus, the braking of the automobile is accomplished.

Adjustment of Brake Air Drive

The required pressure of air delivered by the compressor to the air bottles is achieved by adjustment of the pressure regulator.

To adjust the pressure regulator, proceed as follows:

- remove casing 6 (Fig.124), back out lock nut 11 and rotating cap nut 10 so that the compressor is switched off at a pressure of 7.0-7.35 kgf/cm<sup>2</sup>; when cap nut 10 is screwed in the pressure increases, when screwed out the pressure decreases. After adjustment, fix the cap nut with lock nut 11;

- changing the number of shims 12, make so that the compressor is switched on at a pressure of 5.65-6.0 kgf/cm<sup>2</sup>; when the number of shims is increased the pressure increases, when it is reduced the pressure decreases.

In case the pressure regulator gets out of order the safety valve which should be adjusted for a pressure of 8.0-8.5 kgf/cm<sup>2</sup> puts into operation.

For checking and adjusting the safety valve, do the following:

- disconnect the air pipeline running from the pressure regulator to the compressor;

- start the engine and check the functioning of the safety valve by the air pressure gauge;

- loosen lock nut 2 of adjusting screw 1 (Fig.125);

- screwing in adjusting screw 1 to increase the pressure or screwing it out to decrease the pressure, adjust the safety valve functioning;

- screw in the lock nut of the adjusting screw;
- shut down the engine and connect the air pipeline running to the pressure regulator.

Subject to adjustment in the brake valve are the advanced braking of the semitrailer and unbraking pressure in the semitrailer pipeline.

When towing light semitrailers adjusting ring 2 (Fig.129) of the brake valve should be set in position "H"; in this case, the value of advanced braking of the semitrailer relative to the automobile will be minimum.

When towing heavily loaded semitrailers the ring should be set in position "P". This causes maximum advanced braking of the semitrailer and prevents the semitrailer from overrunning the automobile.

Position "H" is intermediate, it corresponds to normal adjustment of the brake valve and provides for good operation of the brakes under normal conditions.

The pressure of air delivered to the semitrailer is checked by a pressure gauge connected for this purpose to union 4 or to the automobile coupling head. The pressure should be within 4.8-5.3 kgf/cm<sup>2</sup> at an air pressure in the automobile air bottles of 6.0-7.0 kgf/cm<sup>2</sup>.

If necessary, the pressure should be adjusted within the above limits for which purpose:

- loosen stop bolt 14 (Fig.126) of the balancing spring tube;
- rotating adjusting nut 11 of the balancing spring, adjust the unbraking pressure of air in the semitrailer pipeline;
- screw in stop bolt 14 of the balancing spring tube.

Subject to adjustment in the compressor is the tension of driving belts.

Normal deflection of the belts at the middle of the run between the compressor pulley and the belt tensioner under the effort of 10 kg should be within the limits of 13-19 mm. When deflection of the belts is increased, carry out the adjustment with the help of the belt tensioner, for which purpose:

- unscrew belt tensioner axle securing nut 4 (Fig.119);
- loosen lock nut 6 and rotating tensioner bolt 7, adjust tension of the belts;
- screw in the belt tensioner axle securing nut;
- holding tensioner bolt 7 against rotation, tighten up lock nut 6.

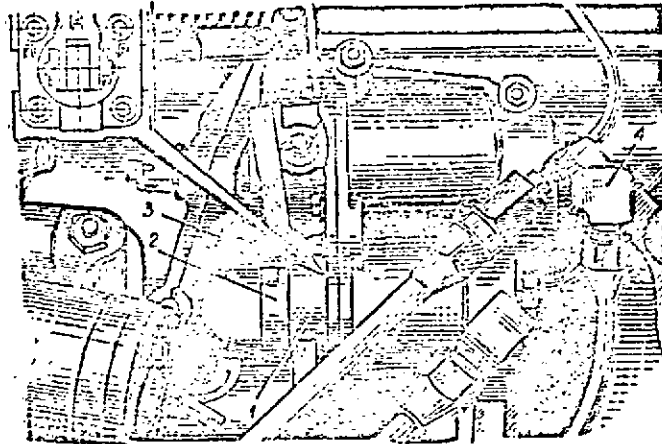


FIG. 129. ADJUSTMENT OF SEMITRAILER ADVANCED BRAKING  
1 - cover of brake valve lower cylinder; 2 - adjusting ring of semitrailer advanced braking; 3 - adjusting ring bolt; 4 - union

Adjustment of Brake Pedal Free Travel

Pedal 1 (Fig. 130) should freely move within the full travel and accurately return into the neutral position under the action of spring 4.

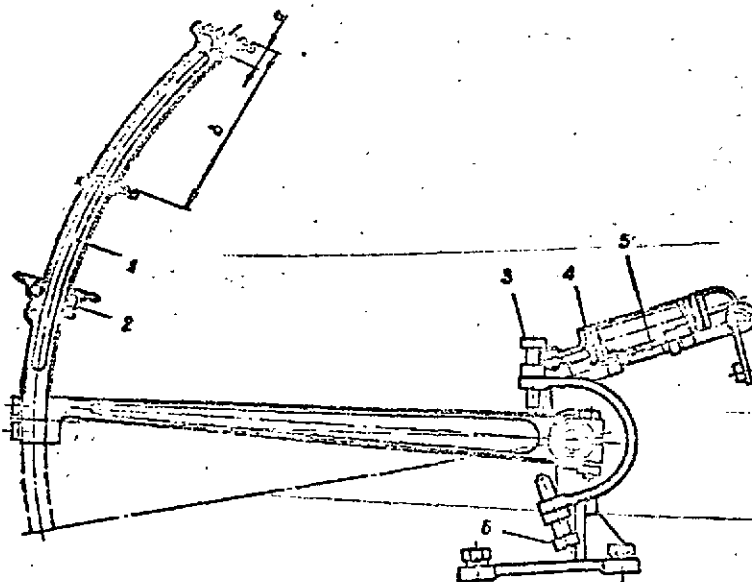


FIG. 130. ADJUSTMENT OF FOOT BRAKE PEDAL TRAVEL

1 - foot brake pedal; 2 - rubber boot; 3 - upper adjusting bolt; 4 - return spring; 5 - rod to brake valve; 6 - lower adjusting bolt; a - pedal free travel; b - pedal full travel

Adjustment of the brake pedal travel should be performed at a pressure in the brake system of  $5.65-7.35 \text{ kg/cm}^2$  and accomplished in the following sequence:

- the pedal is set in the initial position by upper adjusting bolt 3 so that rubber boot 2 freely rests against the floor inclined panel;
- the full travel of the pedal is limited by lower adjusting bolt 6;
- the pedal full travel along the chord is equal to  $200 \pm 5 \text{ mm}$ ;
- check the pedal for presence of free travel;
- the pedal free travel along the chord equals  $12 \pm 4 \text{ mm}$  and is adjusted by the fork provided on rod 5;
- tighten up all the coupling bolts and lock the fork on the rod.

Adjustment of Wheel Brakes

The wheel brakes should be adjusted in the following sequence:

- unscrew the bolts attaching the protective discs of the rear axle wheel brake and remove the protective discs;

- check the clearance between the brake drums and the brake shoes.

The clearance between the brake drum and the brake shoes measured throughout the length of each lining of the brake shoe should be within the limits of  $0.3-0.8 \text{ mm}$ .

- rotating adjusting nut 2 (Fig. 128), set the required clearance;
- reinstall the protective discs of the rear axle wheel brake and screw in the attaching bolts.

When adjusting the brakes of steerable wheels it should be borne in mind that both protective discs can not be removed simultaneously. Uncover the bolts attaching the right-hand protective disc, shift it down and towards the left-hand protective disc.

Check and adjust the clearance between the brake drum and the front shoe, re-install the right-hand protective disc and screw in the attaching bolt. Adjust the clearance between the brake drum and the rear shoe in the above manner; while doing so shift the left-hand disc down and towards the right-hand protective disc.

With the automobile in motion, check the operation of the wheel brakes.

The brakes should simultaneously brake the right- and left-hand wheels.

To facilitate removal of the pins and return springs of the brake shoes special pullers are furnished. To remove the brake shoe pins, proceed as follows:

- remove the wheel hub;
- screw the puller bolt into the pin threaded hole as far as it will go;
- holding the bolt head against rotation, turn the outer nut clockwise.

To remove the return springs, do the followings:

- mount the puller on the pin of springs;
- turn the puller through 180°.
- remove the spring.

Install the springs in the order reverse to removal.

#### Hand Brake

The hand brake acts on the transmission and is designed for braking the automobile at halt. It is forbidden to use the hand brake when the automobile is moving.

The hand brake set (Fig.131) includes the following main parts: support which at the same time serves as a support of the transfer case front suspension, brake drum and brake band with adjusting device.

The hand brake support is bolted to the front of the transfer case housing while the brake drum is secured to the front flange of the transfer case.

When the hand brake lever is pulled on, the effort through a system of rods and levers is transmitted to the pressure cam which while turning pulls upward the coupler of the brake band. In this case, the coupler transmits the effort to the lower lug of the band due to which the clearance between the brake drum and the band is taken up at the lower part of the brake.

While rotating the pressure cam acts on the upper lug of the hand brake band pressing the latter to the brake drum. Thus, the braking of the automobile is accomplished.

#### Adjustment of Hand Brake

To adjust the hand brake, proceed as follows:

- unlock and loosen setting bolt 1, insert a feeler gauge 1 mm thick between the brake drum and brake band at the support and press the feeler gauge by the setting bolt so that it can be moved under an effort of 2-3 kgf/cm<sup>2</sup>; cotter the setting bolt;
- loosen lock nut 5 and nut 4 of the brake band top run coupler and insert a feeler gauge, 2 mm thick, between the brake drum and the end of the brake band top run, press the feeler gauge by nut 4 as instructed above and tighten the lock nut;



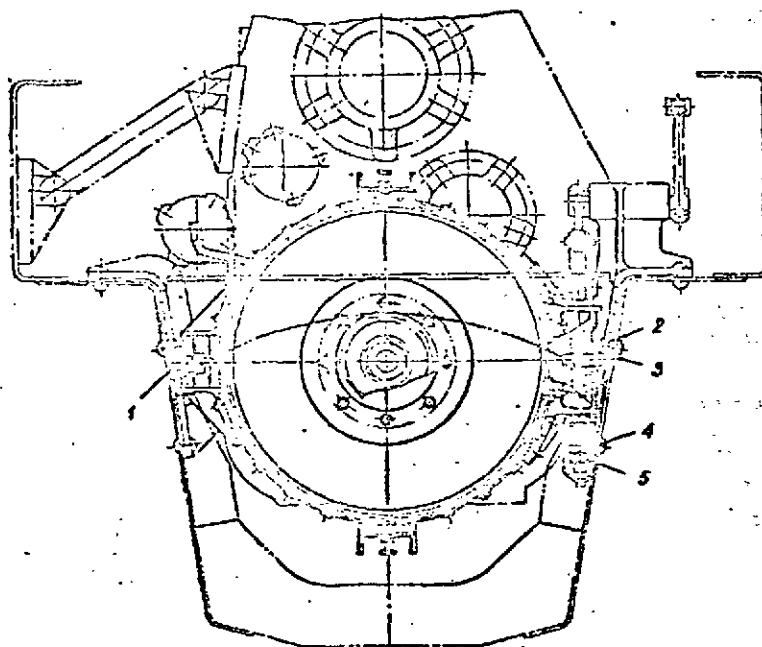


FIG. 151. HAND BRAKE

1 - setting bolt; 2, 5 - lock nuts; 3 - nut of brake band lower run coupler; 4 - nut of brake band top run coupler

- loosen lock nut 2 and nut 3, insert a feeler gauge, 2 mm thick between the brake drum and the end of the brake band lower run, clamp the feeler gauge by nut 2 as instructed above, and tighten the lock nut;
- after adjustment the value of clearance should be within 0.3-2 mm at any point.

#### Maintenance of Brakes

When servicing the brakes, carry out the operations prescribed in the Section "Preventive Maintenance of Automobile".

During routine inspection before leaving the park with a trailer, do the following:

- check that the out-out cocks on the automobile and semitrailer are open;
- check the automobile and semitrailer brakes for effective action; the brakes should ensure quick stopping of the automobile and simultaneous braking of all the wheels.

Pressure in the brake system should be within 5.65-7.35 kgf/cm<sup>2</sup>, if the pressure is lower, pump air into the system; if the pressure is higher, wash and adjust the pressure regulator of the automobile air system.

Page 414, line 6 from above.

Insert as follows: "4. When checking brake in tension state a feeler gauge 0.1mm thick should not pass between the brake bend and the brake drum. The value of local clearance is admitted up to 0.3-0.4mm thick on two, three sections of the band 80-100mm long each, hereat, a feeler gauge 0.3-0.4mm thick should pass as far as the band middle."

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If while draining the condensate from the moisture-and-oil separator it is revealed that after 24 hours of operation the condensate contains more than 15-20 cm<sup>3</sup> of oil it testifies to malfunctioning of the compressor.

To measure the level of brake fluid in the master brake cylinders, proceed as follows:

- 1 - unscrew level gauge 6 (Fig.122) complete with the plug.
- 2 - place the level gauge plug on the hexhedral end face of the housing filler plug. The brake fluid level should be within the marks on the level gauge.

For tightening up the nuts attaching the compressor brackets proceed as follows:

- drain the coolant from the cooling system;
- disconnect from the compressor the air pipelines and the coolant delivery and outlet pipelines; disconnect the drain pipe clamp;
- remove the compressor driving belts;
- unscrew the bolts attaching the compressor to the bracket and remove the compressor;

- tighten up the nuts attaching the compressor bracket to the overdrive gear housing;

- reinstall the compressor and screw in the attaching bolts;
- connect the air pipelines and coolant delivery and outlet pipelines to the compressor;

- mount and adjust the tension of the compressor driving belts;
- fill the cooling system with coolant.

To remove the compressor cylinder head and to check the condition of the valves, valve springs and unloading diaphragms, proceed as follows:

- before removing the cylinder head, drain the cooling liquid from the cooling system;

- disconnect the intake and delivery pipelines;
- disconnect the pipes connected to the unloading chambers and the pipes discharging hot coolant from the compressor;

- unscrew the nuts attaching the cylinder head cover and the cylinder head, and carefully remove the cylinder head from studs;

- wet the carbonized crown of the piston with kerosene, remove the carbon deposit by stiff hair brushes taking care to prevent carbon deposit and other hard particles from getting into the crankcase space. It is forbidden to use emery paper, copper or steel scrapers for removal of carbon deposit;

- if a gummy carbon deposit is detected in the delivery branch pipe, remove it in the above way;

- to replace the valve springs, screw the valve bodies out of the cylinder head using a special wrench;

- inspect the valves and if a deep circular groove resulting from wear is detected on the working surface of the valves, replace the latter with new ones. When installing the valves whose working surfaces have double-side grinding place them with non-worked surfaces on the seats;

- if minor pits or traces of wear are detected on the valve seats, replace the latter with new ones;

- install the valves and springs, and tightly screw the valve bodies into the cylinder head body. The valves should open when lightly pressed with a hand finger and close without seizing under the action of valve springs;

- reinstall the cylinder head and cylinder head cover of the compressor; while doing so, install new paronite gaskets 0.5 mm thick under the cylinder head and cover and tighten the nuts on studs as far as they will go;

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- to replace the defective diaphragm, remove the cover from the unloading chamber take out the diaphragm and replace it with a new one, then reinstall the cover having checked the position of the gasket under the cover, and turn in the screws attaching the cover as far as they will go;

- connect all the pipelines to the compressor;
- fill the cooling system with coolant.

If the pressure regulator fails to operate or operates irregularly, remove it from the automobile, disassemble and wash all the parts in solvent until carbon deposit is completely removed.

Prior to assembly, thoroughly check the parts or blow them with compressed air; after assembly, adjust the pressure regulator and check it for tightness.

The pressure regulator which fails to be repaired or adjusted should be replaced with a new one.

When checking the brake air drive for tightness the air pressure in the system should be at least  $6 \text{ kgf/cm}^2$ .

The drop of air pressure in the system is permissible by  $1 \text{ kgf/cm}^2$  during 20 min with the engine shut down and released brakes, and by  $1.5 \text{ kgf/cm}^2$  with the engine shut down and the brakes applied.

In case of a greater pressure drop, find out the place of air leakage and eliminate the trouble. A place of intensive air leakage is found out by sound while a place of minor air leakage is found out due to soapy bubbles for which purpose places suspected of air leakage should be coated with a soap solution.

If checking of the brake fluid level in the master brake cylinder reveals a considerable drop of the level without traces of the fluid leakage, check the master brake cylinder air chambers for presence of brake fluid for which purpose, unscrew plug 19 (Fig.122). If the amount of brake fluid in air chambers exceeds  $1.5-2 \text{ cm}^3$ , disconnect the fluid reservoir and replace the outer collar.

During initial filling of the master brake cylinder with the brake fluid or in case air has penetrated into the cylinder the brake system should be subjected to bleeding.

~~Filling the empty brake system with brake fluid is accomplished by groups of wheels: at first the front and then the rear, or vice versa.~~

Bleeding the wheel brakes should be accomplished through by-pass valve 22 (Figs 93 and 94) of the wheel upper cylinder in the following sequence:

- unscrew filler hole plug 7 (Fig.122) of the master brake cylinder and fill the latter with brake fluid;
- remove the rubber cap from upper by-pass valve 22 (Fig.93) of the wheel cylinder and mount on its spherical tip a special rubber hose intended for bleeding the brakes. Dip the open end of the hose in a glass vessel filled with brake fluid and having the capacity of at least 1 litre. The vessel should be filled with fluid up to half of its height;

- unscrew the by-pass valve through  $1/2-3/4$  of a turn and depress the brake pedal for several times. Depress the pedal quickly and release slowly. As a result, the fluid under the pressure of the master brake cylinder piston will fill the pipeline and force the air out of it. The fluid should be pumped through the master brake cylinder until air bubbles cease to come out of the hose dipped into the vessel with the brake fluid. While bleeding the brakes, add the brake fluid into the master brake cylinder reservoir preventing the latter from getting empty since otherwise the brake system will be again filled with air;

- tightly screw in the wheel cylinder by-pass valve, remove the rubber hose and reinstall the rubber cap. The by-pass valve should be screwed in with the brake pedal depressed;

- bleed the brakes of the front or rear wheels in turn starting with a wheel most distant from the master brake cylinder.

After bleeding all the wheel brakes add fluid into both master brake cylinders up to the level 20-25 mm lower than the upper edge of the filler hole and tightly screw in the plug.

To check the condition of the brake drum and brake shoe linings, proceed as follows:

- remove the wheel;
- remove the cover of the wheel-hub drive outer carrier, unscrew the plug of the drain hole and drain the oil from the wheel-hub drive;
- remove the locking ring and take out the wheel-hub drive sun gear;
- remove the wheel-hub drive outer carrier together with planet pinions;
- unbend the stop washer edge, unscrew the lock nut and remove the stop and lock washers;
- unscrew the nut of the wheel hub bearings and remove the wheel-hub drive crown gear together with the casing;
- screw the sleeve of a wheel hub puller on the threaded end of the steering knuckle trunnion;
- reinstall the wheel-hub drive outer carrier and secure it by three bolts equally spaced along the circumference;
- secure the wheel hub puller on the outer carrier and rotating the thrust screw, pull the hub off the bearings;
- remove the puller and the outer carrier of the wheel-hub drive;
- unscrew the sleeve of the wheel hub puller and screw the protective cone on the threaded end of the steering knuckle trunnion;
- remove the wheel hub with the brake drum;
- check the condition of the brake drum and brake shoe linings. Scores on the brake drum working surface are not tolerable; replace the brake shoe linings if the heads of screws attaching the lining to the brake shoes project above the lining surface or are sunken by less than 2 mm, in this case the new lining should be preliminarily turned along the brake drum diameter; the brake drum with scores on the working surface should be sent to a repair shop for turning;
- reinstall the wheel hub with the brake drum;
- screw the protective cone off the threaded end of the steering knuckle trunnion;
- reinstall the wheel-hub drive crown gear and adjust the wheel hub bearings;
- reinstall and attach the wheel-hub drive outer carrier with planet pinions;
- fill the wheel-hub drive housing with oil;
- reinstall the wheel-hub drive sun gear and secure it with the locking ring;
- reinstall the outer carrier cover;
- remove the brake protective discs and adjust the clearance between the brake drum and the brake shoe linings;
- reinstall and secure the wheel.

In the process of a seasonal preventive maintenance, carry out the operations prescribed in the next scheduled preventive maintenance and change the brake fluid.

To change the brake fluid, perform the following operations:

### 1. Preparation for Draining Brake Fluid

- remove wheel brake protective discs 21 (Figs 93 and 94);
  - clean the wheel brake cylinders, connections of hydraulic pipelines and hoses of dirt;
  - rotating nut 2 (Fig.123), turn in screw 1 until it thrusts against the nut face;
  - depressing the brake pedal, apply the brakes five times.
- During all the operations pertaining to changing of the brake fluid, maintain the air pressure in the brake system of at least 5 kgf/cm<sup>2</sup>.

### 2. Draining Brake Fluid

- on the wheel most distant from the master brake cylinder, remove the cap from by-pass valve 22 (Figs 93 and 94) of the wheel upper cylinder and mount on its spherical tip a special rubber hose intended for bleeding the brakes;
  - unscrew the by-pass valve through 1-1.5 of a turn and depressing the brake pedal repeatedly, drain the brake fluid into a jar until the fluid ceases to flow out of the hose with the brake pedal depressed.
- As soon as required, pour the brake fluid from the jar into a special vessel.
- In the course of the operations pertaining to draining of brake fluid, cover the vessel with clean cotton waste as the fluid flows out in the form of a strong jet, splashes and mist.

### 3. Blowing Brake System

For blowing the hydraulic system, use a hose intended for inflating the tyres and hose intended for blowing the brakes taken from the SPTA set. Connect the hoses with each other for which purpose, unscrew the tip from the tyre inflating hose head and fit the brake blowing hose on this head;

- disconnect the breathing pipe of the fluid chamber housing 8 (Fig.122) having turned the filler plug elbow through 180° and screw the hose on the threaded portion of the elbow; connect the other end of the hose to the air take-off cock arranged on the automobile side member;
- hang a bucket under the master brake cylinder fluid chamber;
- remove cap 11 (Fig.122) from by-pass valve 10 and mount on its spherical tip a special-rubber hose intended for bleeding the brakes; dip the hose end into a jar;
- unscrew the by-pass valve through 1.5-2 of a turn, open the air take-off cock and blow the cylinder space until dripping of fluid stops;
- after the blowing, tightly screw in the by-pass valve and put on the cap;
- unscrew the bolts attaching the cover of fluid chamber housing 8, remove the cover (for the left-hand master brake cylinder, disconnect and raise up the protective casing in addition) and using dry cotton waste, carefully remove the residual fluid from the reservoir. When removing the fluid, see that no threads of cotton waste are left in the housing.

Install the cover and blow the hydraulic pipelines and wheel brake cylinders through the breathing elbow arranged on the master brake cylinder cover observing the following sequence:

- on all wheels, remove in turn cap 22 from the by-pass valve of the lower cylinder, fit the hose intended for bleeding the brakes on the valve and dip its end into a jar;

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- unscrew the valve through 1.5-2 turns and by delivery of compressed air, remove the fluid until dripping stops;

- screw in the valve after the beginning of blowing the pipeline and wheel brake cylinder of the opposite (from the automobile axis) wheel.

Blow the wheel brake cylinders of each wheel for which purpose:

- remove the hose from the breathing elbow of the master brake cylinder and fit it on the by-pass valve of the upper brake cylinder. Fit the hose for bleeding the brakes on the valve of the lower cylinder and dip its free end into a jar;

- turn out the upper and lower by-pass valves;

- keep blowing until dry air starts to flow out of the by-pass valve of the lower brake cylinder. After removal of fluid from each wheel, screw in all the by-pass valves of the brake cylinders.

Carry out the operations listed under Items 2-3 for the hydraulic system of the second master brake cylinder.

#### 4. Washing and Lubrication of Brake System

- fill the brake system with fluid, grade BCK BTY MXX No.1608-47 or BCK BTY MXX No.4226-54 and bleed the wheel brakes according to the sequence specified in the Section "Servicing of Brakes";

- apply the brakes five times, each time keeping the brake pedal for 1-2 min in the "applied" position;

- drain the fluid, grade BCK(BCK) according to Items 2-3;

- adjust the wheel brakes in the sequence specified in the Section "Adjustment of Wheel Brakes".

#### 5. Filling Brake System

- fill the brake system with fluid, grade PTE-22 in the sequence specified in the Section "Maintenance of Brakes";

- turn the breathing elbows into the initial position and connect the breathing pipes;

- install and secure the protective casing of the left-hand master brake cylinder;

- install and secure the protective discs on all wheels.

Collect the drained brake fluid into a separate container and subject to chemical analysis. If it meets the specifications it is permitted to use the fluid according to its designation.

Waste brake fluids drained from the hydraulic system and not fit for further use should be annihilated:

- fluid, grade PTE-22, should be diluted with 10-15-fold volume of water, drained into a pit at least 0.5 m deep and covered with soil;

- fluid, grade BCK (BCK), should be burned in a boiler furnace in combination with boiler fuel or on a wood fire at a place safe against fire hazard.

Used cotton waste should also be annihilated.

#### Troubles and Remedies of Brakes

Trouble	Cause	Remedy
Wheel brakes fail to operate	1. Insufficient amount of fluid in master brake cylinder	Add fluid into master brake cylinder and bleed system

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Trouble	Cause	Remedy
<p>Brake fluid gets into air chamber of master brake cylinder</p> <p>With engine shut-down compressor emergency oil pressure pilot lamp is lighting</p>	<p>2. Leakage of fluid from wheel cylinders or pipelines</p> <p>3. Leakage of air from air chamber of master brake cylinder or from pipelines</p> <p>Outer collar of fluid chamber is damaged</p>	<p>Replace packing cups of wheel cylinders and eliminate leakage from pipelines</p> <p>Replace packing collars of master brake cylinder air chamber and eliminate leakage from pipelines</p> <p>Replace collar</p>
	<p>1. Oil level in compressor crankcase has dropped</p> <p>2. Pilot lamp sending unit is damaged</p> <p>3. The suction pipe intake is clogged</p> <p>4. Face sealing in compressor rear cover is worn or damaged</p>	<p>Restore normal oil level in compressor crankcase (add oil to mark "H" on oil dipstick)</p> <p>Replace sending unit</p> <p>Wash and blow suction pipe intake with compressed air</p> <p>Remove cover, take out sealing bush, clean it of gummed oil and wash in diesel fuel; clean working surface of burrs. In case sealing bush is heavily damaged, replace it</p>
	<p>5. Oil pump reducing valve is clogged</p> <p>6. Air in compressor lubricating system</p>	<p>Unscrew plug of reducing valve, remove spring and ball and wash in diesel fuel; wipe seat and re-install parts in reverse order</p> <p>Remove air from system for which purpose with engine running, screw out sending unit of emergency oil pressure pilot lamp until clearances appear along thread. When oil starts to flow out in a solid stream, screw in sending unit. With the engine shut-down, pump system with oil through hole for sending unit</p>

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Trouble	Cause	Remedy
Insufficient pressure in system or pressure rises slowly	1. Leakage of air from system 2. Compressor suction pipeline is clogged 3. Pressure regulator fails to operate 4. Compressor valves are untight	Eliminate leakage of air  Blow through suction pipeline  Disassemble and wash pressure regulator  Check condition and tightness of valves If necessary, grind or replace valves Compressor is subject to repair
Abnormal knocking and noise in compressor		

#### Ventilation System of Automobile Units

The ventilation (breathing) system of units serves for communicating the automobile main units with the atmosphere and comprises a system of pipelines (Fig.132).

The system includes ventilation of axle reduction units, master brake cylinders and units of the hydro-mechanical and mechanical transmissions.

The above units are ventilated by means of brass and copper pipelines different in section.

The ventilation system of the reduction units of axles includes breathing tank 14 which serves as an expansion tank for the pipelines. The tank is divided into three sections. The pipelines of the intermediate reduction units of axles are connected to different sections, while the pipelines from the final reduction units are connected into one common section.

When the automobile is in motion oil forced out of the reduction units collects in the tank sections. At a halt, this oil drains through the pipelines back into the housings of axles.

The pipelines running from the units are extended outside above the fording depth line of the automobile and are fitted at the ends with air cleaners 12 which serve for cleaning air admitted to the units.

The ventilating cleaners are installed as follows: two on the rear brace of fan beams and one on the hood rear panel.

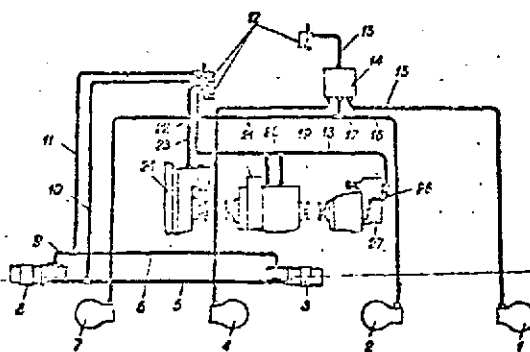


FIG. 132. VENTILATION (BREATHING) SYSTEM OF AUTOMOBILE UNITS

1 - second rear axle reduction unit; 2 - first rear axle reduction unit; 3 - master brake cylinder; 4 - second front axle reduction unit; 5 - left-hand brake cylinder pipes; 6 - left-hand brake cylinder tank pipes; 7 - first front axle reduction unit; 8 - right-hand brake cylinder pipes; 9 - right-hand brake cylinder tank pipes; 10 - pipe running from brake cylinders to air cleaners; 11 - pipe of brake cylinder tanks; 12 - air cleaners; 13 - pipe running from breathing tank to air cleaners; 14 - breathing tank; 15 - fourth axle pipes; 16 - third axle pipe; 17 - first and third axle pipes; 18 - transfer case pipes; 19 - second axle pipe; 20 - pipe of gearbox breathers; 21 - first axle pipe; 22 - overdrive gear pipe; 23 - torque converter and gearbox pipes; 24 - overdrive gear; 25 - transmission control unit; 26 - transfer case back pipes; 27 - transfer case

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The cleaner consists of a housing in which a cleaning element is packed between two covers.

Maintenance of Ventilation System of Automobile Units

When servicing the ventilation system of the automobile units, carry out the operations prescribed in preventive maintenance No.2 according to the Section "Preventive Maintenance of Automobile".

## Chapter VII

### ELECTRICAL EQUIPMENT GENERAL INFORMATION

The automobile electrical equipment consists of sources and consumers of electric power, auxiliary equipment, instruments and wires.

Starter storage batteries and generator are sources of electric power.

Consumers of electric power are as follows: starter, cab heater electric motor, engine oil priming pump electric motor, preheater boiler electric motor and glow plug, electric horn, fan electromagnetic couplings, torque converter interlock solenoids, lighting and signalling facilities.

The auxiliary equipment includes: storage battery switch, electric fittings (buttons, switches, junction blocks, inspection lamp receptacle and receptacle for supplying semitrailer lighting facilities).

The instruments are as follows: voltmeter, tachometer, speedometer, pressure gauges, temperature gauges and hourmeter.

The automobile electric circuit is of a single-wire system in which the automobile frame serves as a common minus for all the consumers of current. The negative terminal of the storage batteries is connected to the frame through the storage battery switch. Thus, all the consumers of electric power operate from the storage batteries only when the storage battery switch is cut in.

For reliable grounding a braided conductor is introduced between the cab and the engine. One end of the braided conductor is attached to the rear cab wall while the other is secured to the cover of the engine front support.

The two-wire system is used only for wiring the emergency lighting receptacle and commander's lamp which are not connected with the storage battery switch.

Supply of the tachometer does not depend on the automobile electric system.

The rated voltage in electric circuits is 24 V.

The general diagram of the automobile electrical equipment is shown in Fig.133.

#### ARRANGEMENT OF ELECTRICAL EQUIPMENT

The sources of electric power are arranged as follows: storage batteries in the cab under the middle seat in a special box; generator - on the right-hand side of the engine. The starter is attached by clamps on the right-hand side of the engine (as viewed forward).

The generator regulator and starter contactor as well as the voltmeter shunt and slave charging terminals are arranged in the engine compartment on the right-hand side of the cab rear wall. The bracket of the voltmeter shunt mounts the fuses of the generator regulator and the speedometer. The storage battery switch is located in the cab near the driver's seat.

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The instruments, lock-up mechanism control panel, preheater control panel, pilot lamps, starter button, electric horn button, blackout selector switch, switches of electromagnetic couplings, main light switch, switch of dome lamp and instrument scales illumination, safety fuse of turn indicator breaker relay, switches of heaters, swivelling spotlight switch, oil priming pump button, turn indicator switch, commander's lamp switch and emergency lighting receptacle are arranged on the instrument panel. The foot dimmer switch and air horn button are located on the left-hand side of the cab inclined floor. The stop light switch is installed in the engine compartment at the top left-hand side of the cab rear wall. The breaker relay of turn indicators and the safety fuses are arranged under the instrument panel. The headlights and side lamps are installed at the front edges of the cab panel, the swivelling spotlight - on the cab roof, stop light and license plate illuminating lamp - on the left-hand side of the engine hood rear wall. The electric horn is installed on the left-hand side wall of the cab.

Sending units of the instruments and pilot lamps are installed as follows:

- sending units of pressure gauges indicating the oil pressure in the torque converter, boosters of the gearbox friction clutches and in the gearbox - on the cover of fuel tanks;
- sending unit registering oil pressure in the engine - on the left-hand lower side of the cab rear wall;
- sending unit registering air pressure in the brake system - in the cab, under the instrument panel;
- sending units of engine coolant temperature gauges - in branch pipes discharging the coolant from the cylinder heads;
- sending unit of gearbox oil temperature gauge - in the gearbox pan;
- sending unit of torque converter oil temperature gauge - at the lower part of the torque converter;
- tachometer generator - at the front part of the left-hand cylinder head;
- speedometer transmitters - on the second front axle;
- sending unit of compressor emergency oil pressure pilot lamp - on the rear wall of the compressor;
- sending unit of coolant overheating pilot lamp - on the thermostat box;
- contact assembly of the transfer case pilot lamp - on the right-hand side of the transfer case.

The hood lamps are located on the hood box in the engine compartment.

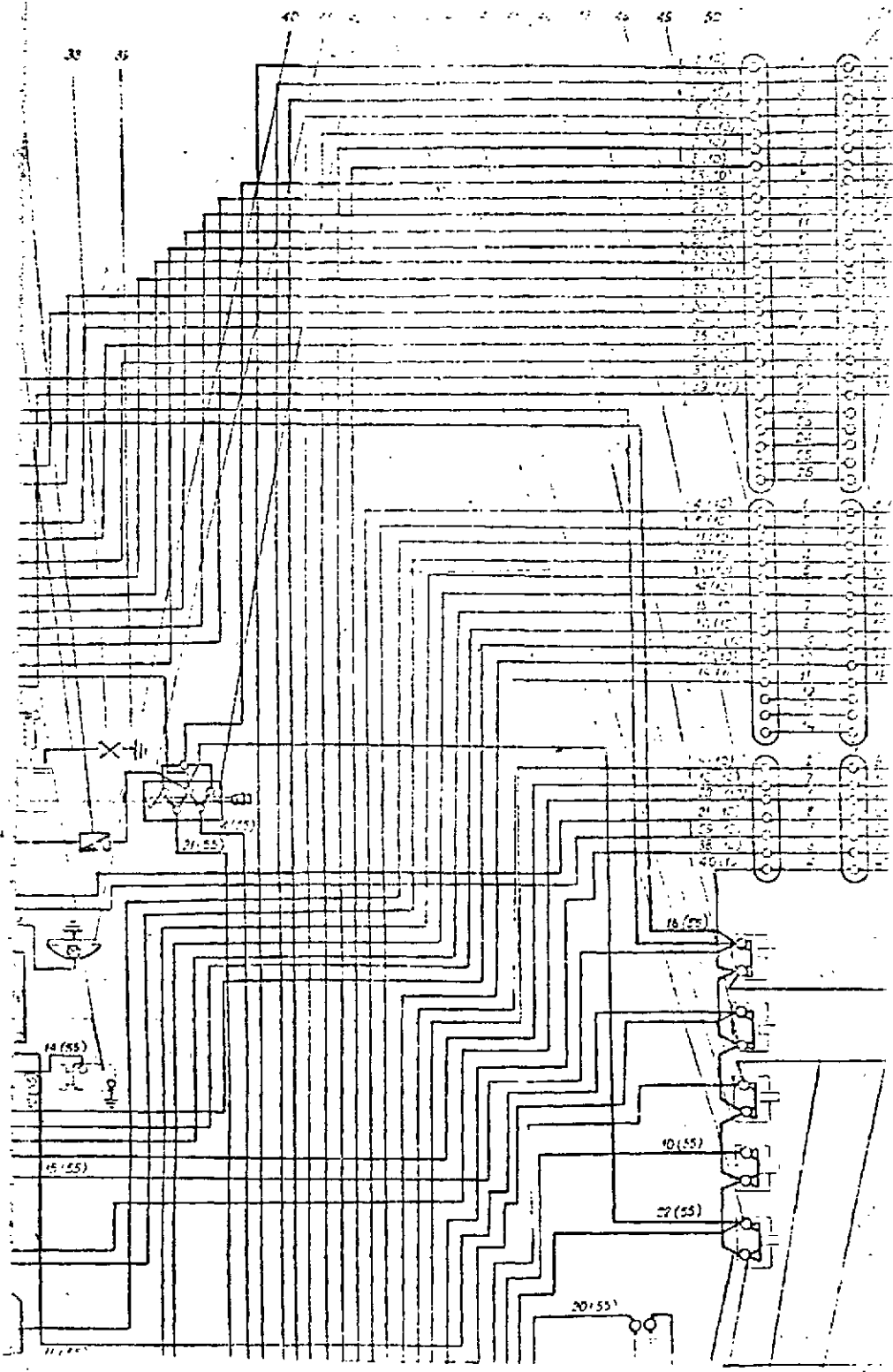
The inspection lamp receptacles are installed in the engine compartment on the hood box and on the fifth-wheel assembly. Plug connector used for connecting the electrical equipment of a semitrailer or trailer are installed respectively on the fifth-wheel assembly and on the rear cross member of the frame. The torque converter lock-up mechanism coils are arranged in the lock-up mechanism on top of the transmission. Blocking capacitors are installed at the brushes of the electromagnetic couplings.

#### SOURCES OF ELECTRIC POWER

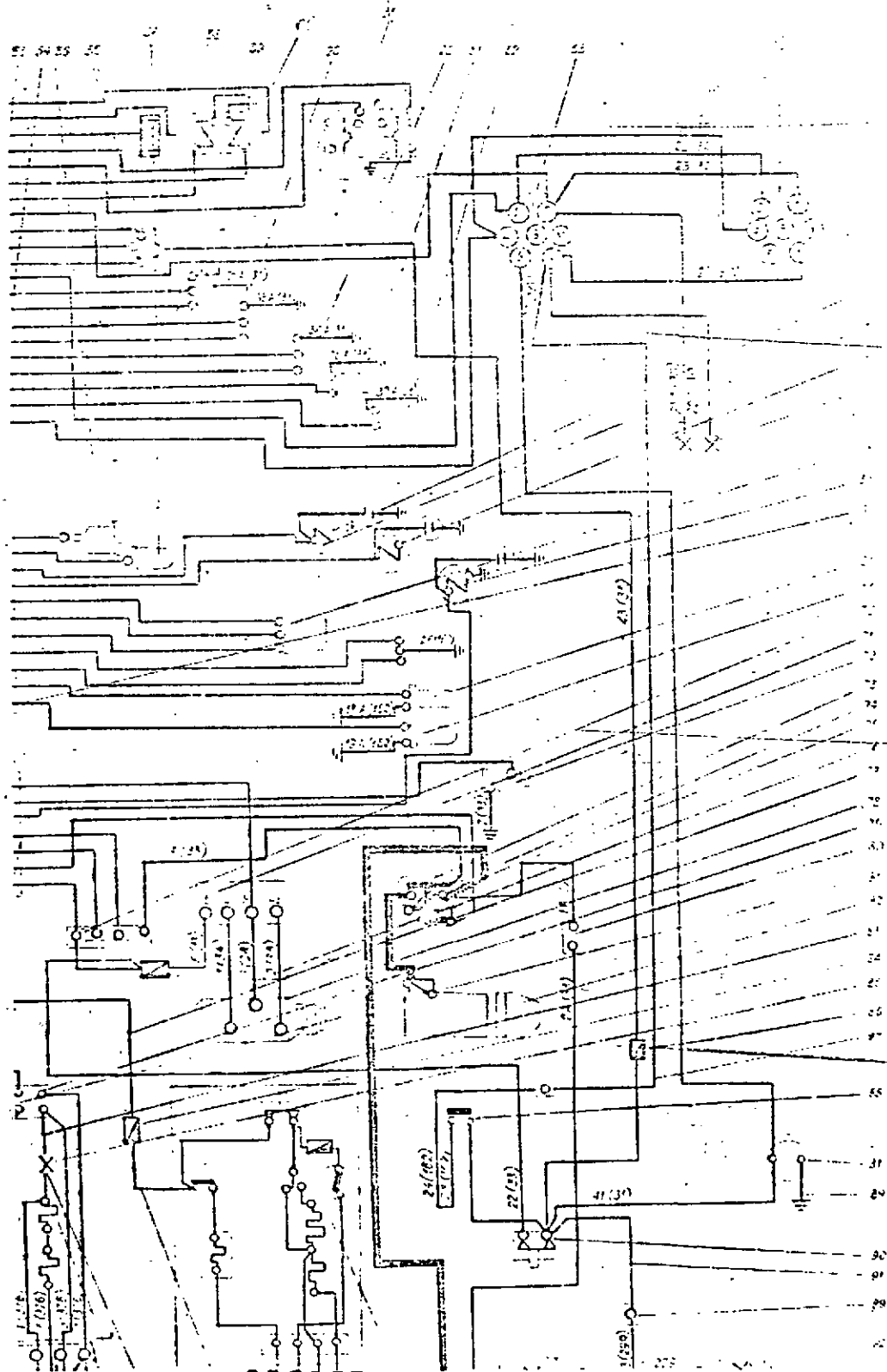
##### Starter Storage Batteries

The automobile is equipped with four 24-V starter acid storage batteries of 12 CT-70 type each having the capacity of 70 a-hr. The storage batteries are connected with each other in parallel (Fig.133).

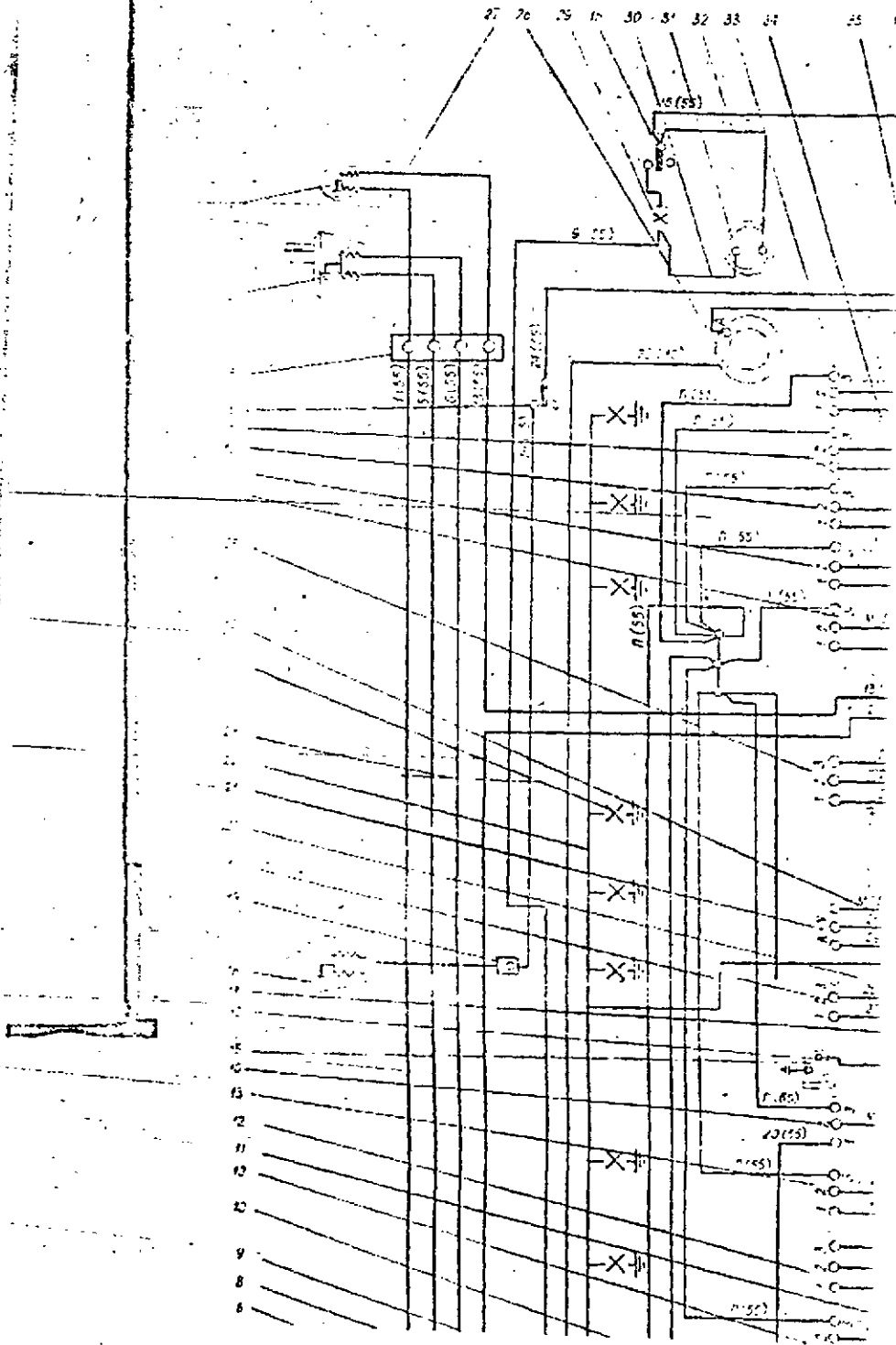
The negative terminal of the extreme left-hand battery is connected to the ground through a BB-404 storage battery switch.



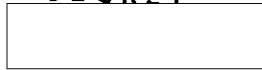
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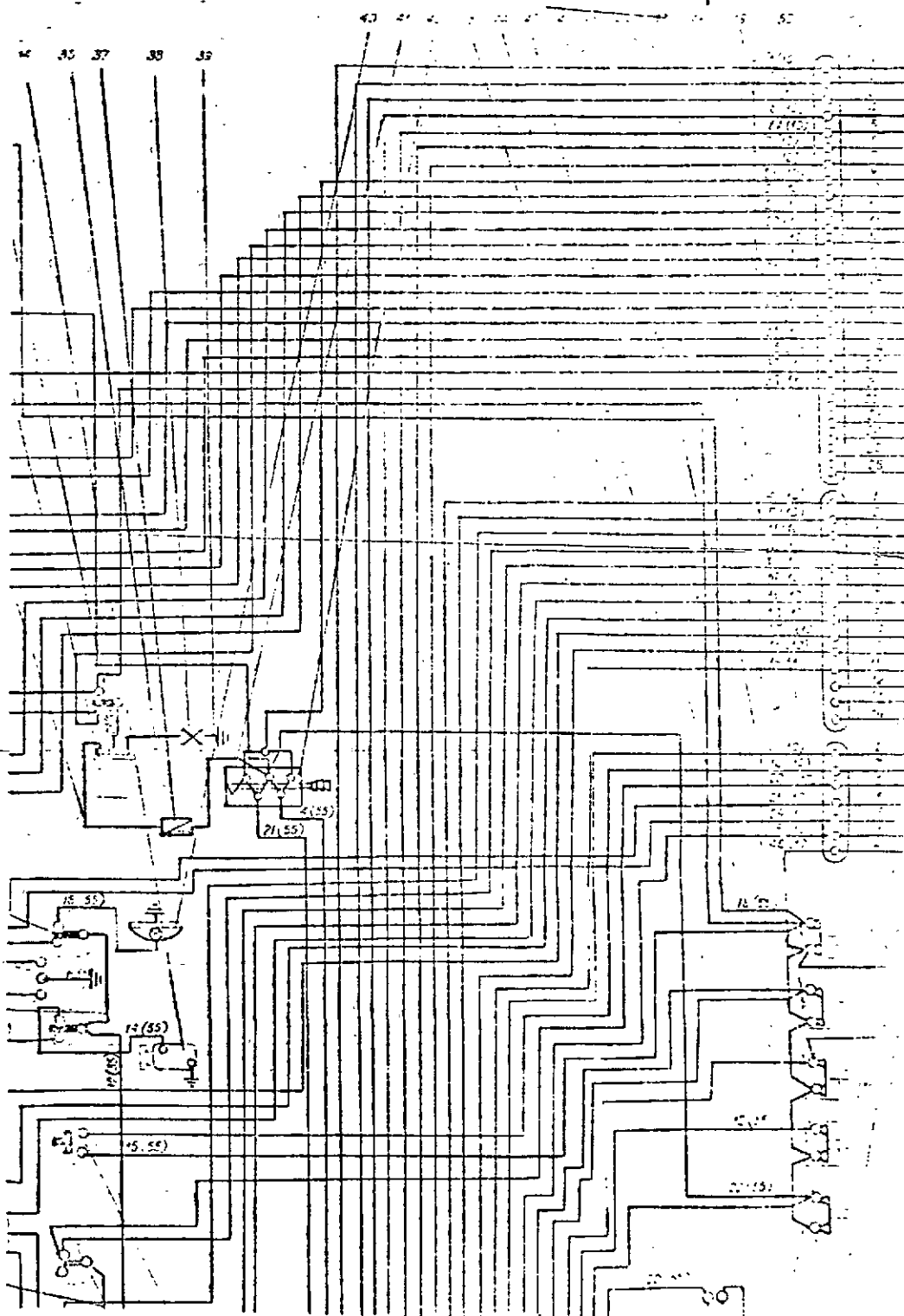


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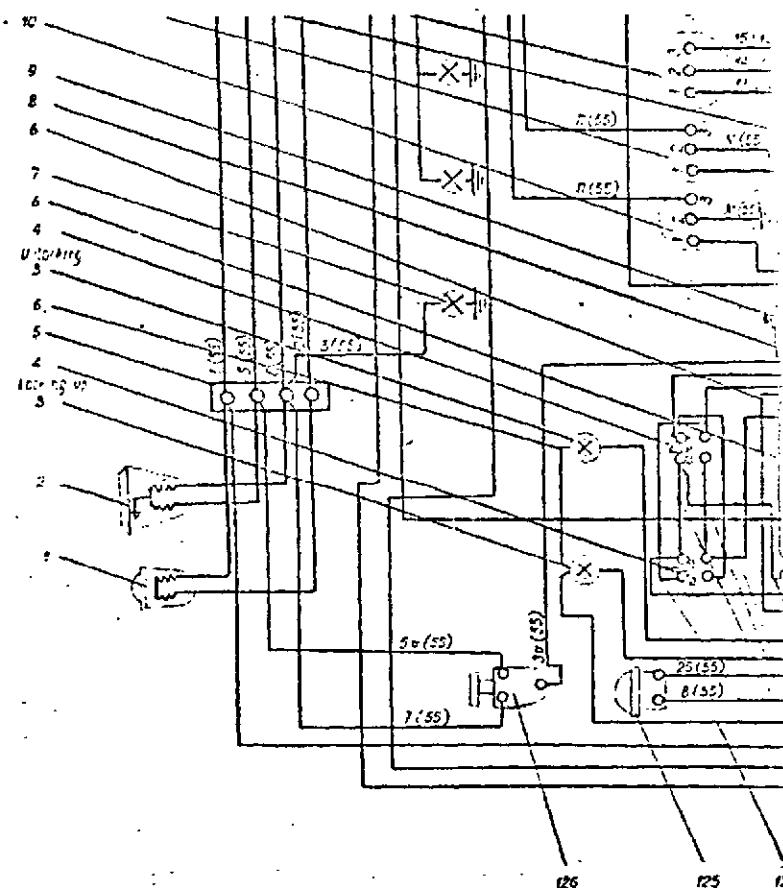


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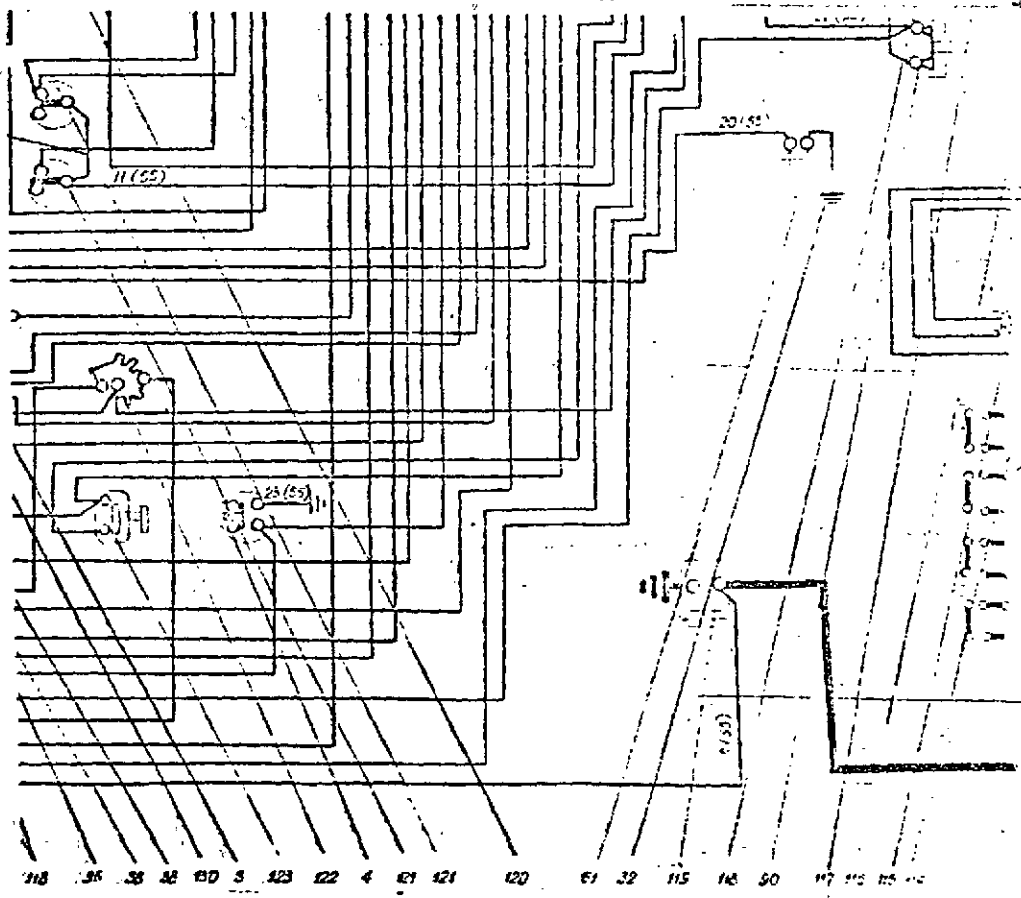
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1 - side lamp, 2 - headlight, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234, 235, 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 285, 286, 287, 288, 289, 290, 291, 292, 293, 294, 295, 296, 297, 298, 299, 300, 301, 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 312, 313, 314, 315, 316, 317, 318, 319, 320, 321, 322, 323, 324, 325, 326, 327, 328, 329, 330, 331, 332, 333, 334, 335, 336, 337, 338, 339, 340, 341, 342, 343, 344, 345, 346, 347, 348, 349, 350, 351, 352, 353, 354, 355, 356, 357, 358, 359, 360, 361, 362, 363, 364, 365, 366, 367, 368, 369, 370, 371, 372, 373, 374, 375, 376, 377, 378, 379, 380, 381, 382, 383, 384, 385, 386, 387, 388, 389, 390, 391, 392, 393, 394, 395, 396, 397, 398, 399, 400, 401, 402, 403, 404, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 439, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460, 461, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472, 473, 474, 475, 476, 477, 478, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 490, 491, 492, 493, 494, 495, 496, 497, 498, 499, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514, 515, 516, 517, 518, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 530, 531, 532, 533, 534, 535, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559, 560, 561, 562, 563, 564, 565, 566, 567, 568, 569, 570, 571, 572, 573, 574, 575, 576, 577, 578, 579, 580, 581, 582, 583, 584, 585, 586, 587, 588, 589, 590, 591, 592, 593, 594, 595, 596, 597, 598, 599, 600, 601, 602, 603, 604, 605, 606, 607, 608, 609, 610, 611, 612, 613, 614, 615, 616, 617, 618, 619, 620, 621, 622, 623, 624, 625, 626, 627, 628, 629, 630, 631, 632, 633, 634, 635, 636, 637, 638, 639, 640, 641, 642, 643, 644, 645, 646, 647, 648, 649, 650, 651, 652, 653, 654, 655, 656, 657, 658, 659, 660, 661, 662, 663, 664, 665, 666, 667, 668, 669, 670, 671, 672, 673, 674, 675, 676, 677, 678, 679, 680, 681, 682, 683, 684, 685, 686, 687, 688, 689, 690, 691, 692, 693, 694, 695, 696, 697, 698, 699, 700, 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 711, 712, 713, 714, 715, 716, 717, 718, 719, 720, 721, 722, 723, 724, 725, 726, 727, 728, 729, 730, 731, 732, 733, 734, 735, 736, 737, 738, 739, 740, 741, 742, 743, 744, 745, 746, 747, 748, 749, 750, 751, 752, 753, 754, 755, 756, 757, 758, 759, 760, 761, 762, 763, 764, 765, 766, 767, 768, 769, 770, 771, 772, 773, 774, 775, 776, 777, 778, 779, 780, 781, 782, 783, 784, 785, 786, 787, 788, 789, 790, 791, 792, 793, 794, 795, 796, 797, 798, 799, 800, 801, 802, 803, 804, 805, 806, 807, 808, 809, 810, 811, 812, 813, 814, 815, 816, 817, 818, 819, 820, 821, 822, 823, 824, 825, 826, 827, 828, 829, 830, 831, 832, 833, 834, 835, 836, 837, 838, 839, 840, 841, 842, 843, 844, 845, 846, 847, 848, 849, 850, 851, 852, 853, 854, 855, 856, 857, 858, 859, 860, 861, 862, 863, 864, 865, 866, 867, 868, 869, 870, 871, 872, 873, 874, 875, 876, 877, 878, 879, 880, 881, 882, 883, 884, 885, 886, 887, 888, 889, 890, 891, 892, 893, 894, 895, 896, 897, 898, 899, 900, 901, 902, 903, 904, 905, 906, 907, 908, 909, 910, 911, 912, 913, 914, 915, 916, 917, 918, 919, 920, 921, 922, 923, 924, 925, 926, 927, 928, 929, 930, 931, 932, 933, 934, 935, 936, 937, 938, 939, 940, 941, 942, 943, 944, 945, 946, 947, 948, 949, 950, 951, 952, 953, 954, 955, 956, 957, 958, 959, 960, 961, 962, 963, 964, 965, 966, 967, 968, 969, 970, 971, 972, 973, 974, 975, 976, 977, 978, 979, 980, 981, 982, 983, 984, 985, 986, 987, 988, 989, 990, 991, 992, 993, 994, 995, 996, 997, 998, 999, 1000.

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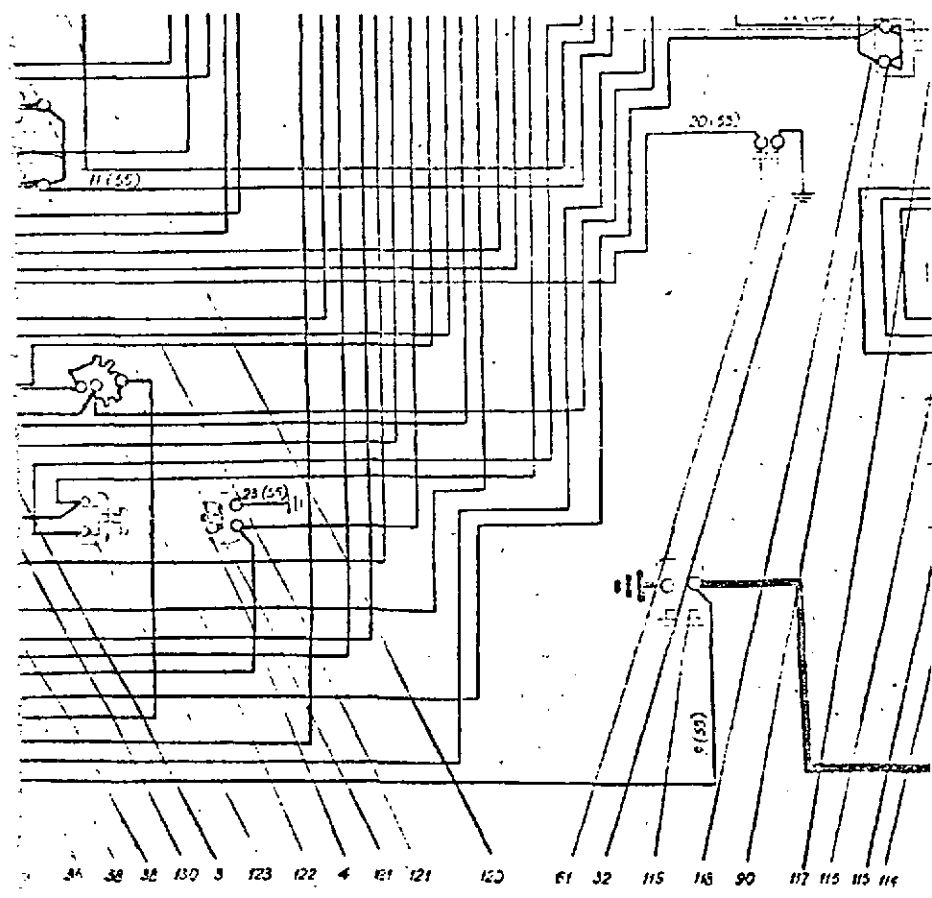
4 - button; 5 - cam-operated junction block; 6, 11, 15, 21, 41, 81, P1, P2, G1, G4, G5, G8, 101, 101, 106, 110, 111, high beam pilot lamp hold in 9 - blackout indicator watch; wear indicator; 13 - engine oil pressure indicator; - switch; 18 - travelling spotlight; 19 - parking lamp; - oil pressure; 22 - battery for lamp illuminating; - white instrument panel; 24 - lamp; 25 - speedometer; - dial; 27 - main loop wire brush; 28 - horn;

FIG. 122. ELECTRICAL EQUIPMENT DIAGRAM FOR MAINTENANCE AND REPAIR OF THE AIRCRAFT.

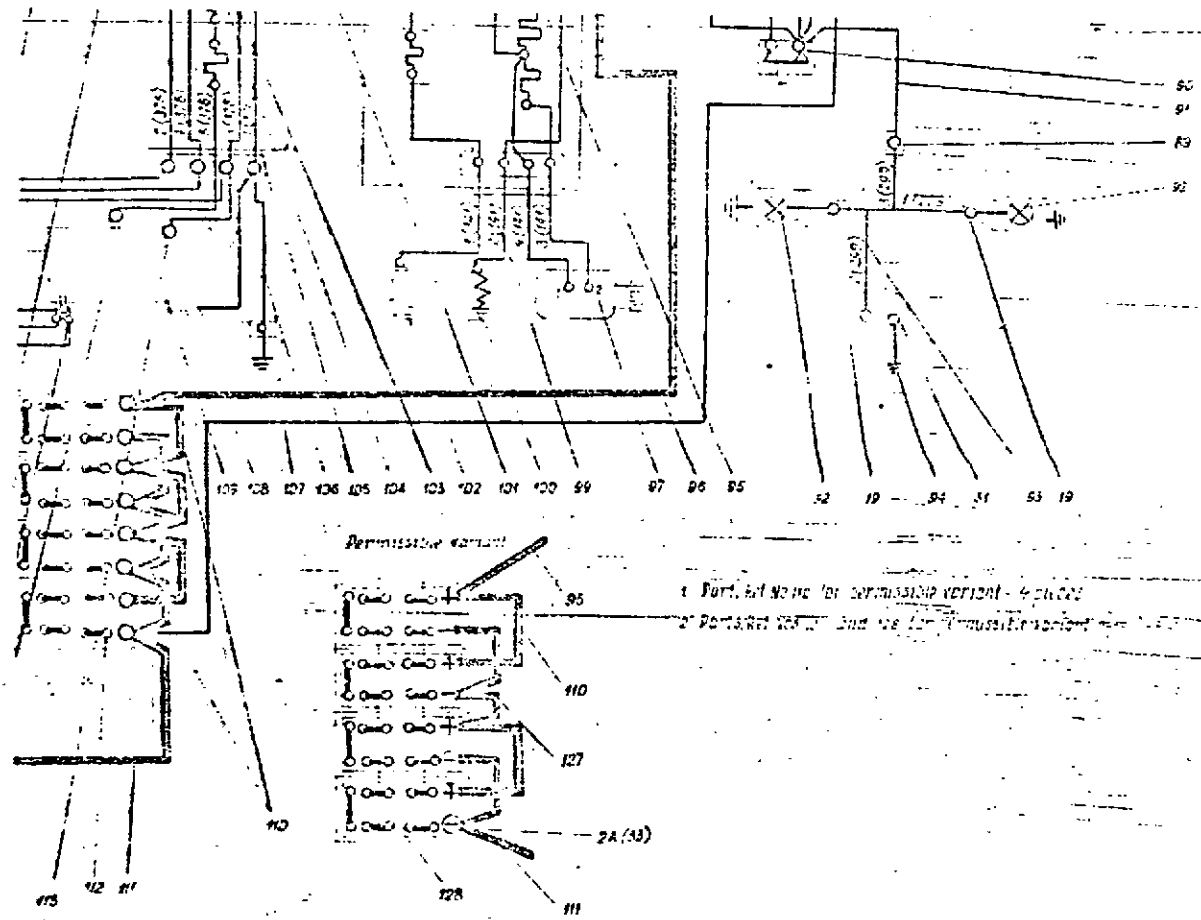
Light switch, 41 - motor base (20); 8 - safety lamp (11, 17, 46, 57, 58 and 59 - pilot's warning; 25 - engine pressure indicator; 19 - parking lamp; 18 - travelling spotlight; 13 - wear indicator; 11 - blackout indicator; 9 - high beam pilot lamp hold in; 5 - junction block; 6, 11, 15, 21, 41, 81, P1, P2, G1, G4, G5, G8, 101, 101, 106, 110, 111 - electrical equipment; 22 - battery for lamp illuminating; 24 - lamp; 25 - speedometer; 27 - main loop wire brush; 28 - horn;

4 - button; 5 - cam-operated junction block; 6, 11, 15, 21, 41, 81, P1, P2, G1, G4, G5, G8, 101, 101, 106, 110, 111, high beam pilot lamp hold in; 9 - blackout indicator watch; wear indicator; 13 - engine oil pressure indicator; - switch; 18 - travelling spotlight; 19 - parking lamp; - oil pressure; 22 - battery for lamp illuminating; - white instrument panel; 24 - lamp; 25 - speedometer; - dial; 27 - main loop wire brush; 28 - horn;

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The automobile may be equipped with four 12-V starter acid storage batteries of 6 CTRM -14CM type each having the capacity of 140 a-hr. The left-hand group of batteries, as viewed forward, consists of two 12-V storage batteries connected with each other in parallel. The right-hand group of batteries also consists of two 12-V storage batteries connected with each other in parallel and with the left-hand group in series. The left-hand group of batteries is connected with the ground through the BS-404 storage battery switch. The connecting diagram of the storage batteries provides the electrical system with current at 24 volts.

When installing or removing the storage batteries the ground switch should be cut out. Prior to installing the storage batteries, wipe the surface under the battery cover and the terminals with clean cotton waste.

When connecting the storage batteries with wires, remove the protective cases from the terminals.

When connecting the wires to the terminals, take care not to short the terminals with any metal object.

After the wires are connected, coat the terminals, their bolts and wire shoes with petrolatum.

#### Maintenance of Storage Batteries

The storage batteries should be serviced in conformity with the Section "Preventive Maintenance of Automobile" and instructions issued by the storage battery Manufacturing Plant and furnished with the automobile.

The level of electrolyte in the storage batteries should be checked once in 10-15 days but in hot season of the year as well as during intensive operation of the automobile it should be checked every 5-6 days.

The electrolyte level should be 8-10 mm above the baffle plate (upper edge of plates). In case the electrolyte level has dropped, add distilled water into the storage batteries. Add the electrolyte only in case it is known for sure that it has been spilled. In winter, to prevent freezing of water, add it just before driving out.

The surface of storage batteries should be wiped with clean cotton waste. To neutralize the action of acid spilled on the battery surface it is recommended to wipe it by cotton waste moistened with a 10-per cent solution of ammonium hydroxide or washing soda. This done, wipe the battery surface dry with clean dry cotton waste.

To ensure trouble-free functioning of the storage battery and complete output of its capacity the battery should constantly be kept in charged state. During normal operation, the battery should be charged monthly at a charging station irrespective of the state of charge. Every six month the batteries should be subjected to charge-discharge cycle irrespective of their being in operation or storage. To make slave charging of storage batteries possible without removing them from the automobile, the latter is provided with a special terminal box installed in the engine compartment on the right-hand side of the cab rear wall.

The storage battery should be sent to a charging station for charging if its discharge exceeds 50 per cent in summer and 25 per cent in winter.

The state of the storage battery charge as by the specific gravity of electrolyte can be determined depending upon the climatic conditions by the data of the table given below (at +15°C).

When reducing the specific gravity of electrolyte, measured with a hydrometer, to normal (+15°C), introduce a correction of 0.0007 per each degree the actual temperature of electrolyte deviates from the normal. When the electrolyte temperature

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exceeds the normal the calculated correction should be added to the hydrometer reading, when the electrolyte temperature is below the normal the correction should be subtracted.

It should be remembered that operation of a discharged storage battery in winter may cause freezing of electrolyte and bring the batteries out of order. The state of a storage battery can also be checked with a battery cell tester. If the storage battery is in good condition and normally charged the voltage upon connection of the battery cell tester should fall in each battery cell to at least 1.7 V and remain stable during 5 seconds.

It is forbidden to use the batteries having the difference in specific gravity of electrolyte among the battery cells in excess of 0.01 and in voltage (without load) in excess of 0.1 V.

Climatic zones	Specific gravity of electrolyte in fully charged battery	Specific gravity of electrolyte in battery discharged by 25 per cent	Specific gravity of electrolyte in battery discharged by 50 per cent
Northern zones with continental climate and temperature of ambient air below $-40^{\circ}\text{C}$ :			
in winter	1.31	1.27	1.23
in summer	1.27	1.23	1.19
Northern zones with minimum temperatures of ambient air down to $-40^{\circ}\text{C}$	1.29	1.25	1.21
Central zones	1.27	1.23	1.19
Southern zones	1.25	1.21	1.17

The batteries with cracks on the sealing compound should be repaired by melting the sealing compound with a heated iron spatula or by any other method not requiring application of open flame. The sealing compound should be melted and cooled down before placing the battery for charging.

It is strictly forbidden to interconnect the battery terminals for spark testing.

After operation of the automobile as well as during repairs of electric equipment the battery switch should be cut out.

#### Troubles and Remedies of Storage Batteries

Trouble	Cause	Remedy
1	2	3
Rapid discharge of storage batteries on automobile	1. Batteries on automobile fail to be charged from generator	Using ammeter, check for presence of charging current. Find out cause of absence of charging current and eliminate trouble (See Section "Troubles in Generator and Generator Regulator")

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1	2	3
<p>When starter is switched on voltmeter reads voltage below 17-18V. Starter armature rotates slowly</p> <p>Rapid loss of electrolyte in one or several battery cells, wet spots and salt crystallization on nonblock surface</p> <p>Rapid "boiling out" of electrolyte and its splashing through vent holes</p> <p>When storage battery is checked with a battery cell tester voltage in one or several battery cells is close or equal to zero</p>	<p>2. Rapid self-discharge due to contamination of electrolyte or leakage of current along surface of storage batteries</p> <p>3. Reduced capacity of batteries caused by sulphation of battery plates</p> <p>1. Oxidation of terminals or loose fastening of wires on terminals</p> <p>2. Storage batteries are heavily discharged</p> <p>Crack in container</p> <p>Generator regulator is out of adjustment</p> <p>Short circuit inside battery cell</p>	<p>Thoroughly wipe battery surface with cloth moistened in 10 per cent solution of ammonium hydroxide, then wipe surface dry with a clean dry cloth. If self-discharge persists, send batteries to a charging station</p> <p>Send battery to a charging station for elimination of sulphation or replacement of battery plates</p> <p>Clean wire lugs and terminals, securely connect wire shoes to terminals and coat them from outside with lubricant, grade VH (petrolatum)</p> <p>Remove batteries from automobile and send them to a charging station</p> <p>Send batteries to a repair shop for repair</p> <p>Send generator regulator to a repair shop for adjustment and repair</p> <p>Send battery to a repair shop for repair</p>

#### Generator

The P-731 generator (Fig. 134) is a four-pole, D.C., shunt-wound, enclosed, air-cooled type. It operates in conjunction with a PPT-24M generator regulator and is designed for supplying the current consumers and for charging the storage batteries. The generator is installed on the lugs of the engine crankcase upper half at the right-hand side and is attached by two clamps. The generator shaft is driven from the engine crankshaft through a semi-rigid coupling of the generator drive. The generator is automatically cut in and out of the circuit by the generator regulator at starting and stopping of the engine. The generator is cut in at 650-750 r.p.m. of the engine crankshaft.

Rated voltage - 28 V  
 Rated power - 1,500 W

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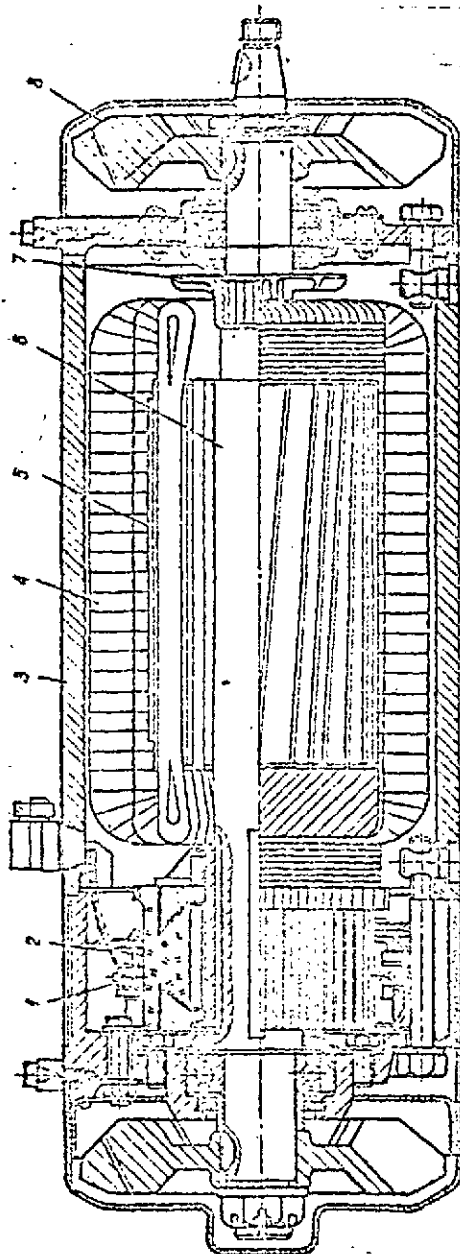


FIG. 134. GENERATOR  
 1 - commutator; 2 - brushes; 3 - generator frame; 4 - excitation windings; 5 - armatures; 6 - armature shaft; 7 - fan; 8 - motor fan

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Sense of rotation - right-hand (as viewed on the drive side).

Wiring system - single-wire.

The generator and generator regulator can be checked for proper operation by the ammeter observing the charging current of the storage batteries.

### Generator Regulator

The generator is equipped with a generator regulator of IPT-24H type. The generator regulator serves for automatically cutting the generator in and out of the circuit, adjusting the generator voltage at different speeds of the engine and for protecting the generator against overloading.

The generator regulator consists of automatically operating devices: cut-out relay 5 (Fig.135), voltage regulator 7 and current regulator 6.

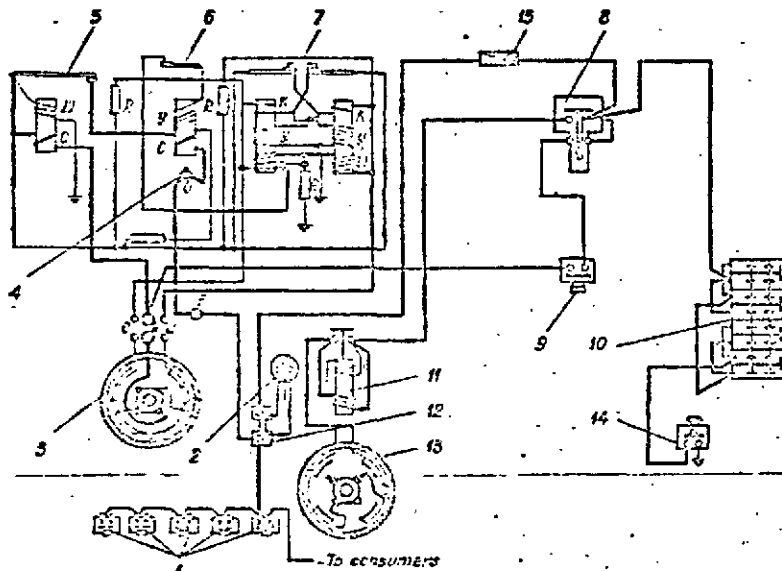


FIG. 135. KEY DIAGRAM OF STARTING AND COMMON OPERATION OF GENERATOR, GENERATOR REGULATOR AND STORAGE BATTERIES

1 - thermal bimetal circuit breaker; 2 - voltmeter; 3 - generator; 4 - filter; 5 - cut-out relay; 6 - current regulator; 7 - voltage regulator; 8 - starting relay; 9 - starter button; 10 - storage battery; 11 - drive relay; 12 - voltmeter shunt; 13 - starter; 14 - storage battery switch; 15 - generator regulator safety fuse.

The cut-out relay disconnects the generator from the storage batteries when the generator voltage becomes lower than the voltage of storage batteries and connects the generator to the storage batteries when the generator voltage exceeds the voltage of storage batteries. The generator voltage may be lower than the voltage of storage batteries when the engine runs at a speed below 650-750 r.p.m. and the generator voltage in this case will not reach 24V. The out-in voltage of the cut-out relay is 24.5-26.5V. The charging of storage batteries starts at 650-750 r.p.m. of the engine crankshaft.

With increase of the engine speed to the maximum value the speed of the generator armature rises approximately twice as high due to which the generator voltage will

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Position II is canceled in Fig. 135 and in the text under it.

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rise up. To maintain the generator voltage within definite limits use is made of a voltage regulator. The voltage maintained by the voltage regulator is within 26.5-28.5V. A current regulator is used to protect the generator against overloading. The current regulator is adjusted for a maximum load within 43-52A. The generator regulator wiring is of a single-wire type.

#### Maintenance of Generator and Generator Regulator

Maintenance of the generator consists in cleaning it of dust, dirt and oil; checking its fastening on the engine, checking the wires for reliable connection on the terminals and in checking the generator output charging current.

Maintenance of the generator regulator consists in checking the wire lugs for reliable connection to the generator regulator terminals.

During preventive maintenance No.1 and No.2, carry out all the operations prescribed in the Section "Preventive Maintenance of Automobile".

The charging current produced by the generator should be considered normal if the generator with properly charged storage batteries produces, just after the engine has been started by the starter, the charging current the value of which, according to the ammeter readings, drops as the storage batteries get charged.

To check the condition of the commutator and brushes, carry out the following operations:

- drain the coolant from the engine cooling system;
- remove the right-hand spark arrester;
- remove the bracket of the spark arrester and the bracket of the right-hand fender;
- remove the pipeline connecting the thermostat box with the engine oil tank and close the holes in branch pipes of the thermostat box and oil tank with wooden plugs;
- drain oil from the engine oil tank;
- screw the guiding pipe with the oil dipstick and the filler neck out of the engine oil tank and close the holes with wooden plugs;
- remove the oil tank;
- cut out the storage battery switch;
- disconnect the electric wires and remove the generator cover bands;
- remove the generator;
- check the condition of brushes and replace them, if necessary.

The brushes should be free of cracks, chipping and other defects.

When replacing the brush, file it off to fit the commutator and lap it to the commutator having wrapped the latter with glass paper for this purpose;

- blow the generator with compressed air;
- reinstall the generator in the reverse sequence.

#### Troubles and Remedies of Generator and Generator Regulator

Trouble	Cause	Remedy
1	2	3
Generator fails to get excited. Voltmeter does not register charging	1. Wire connecting generator terminals "E" with terminals of generator regulator is broken	Check condition of wire and reliably connect it to terminals

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Operation of Winch

The winch operation is controlled from the driver's cab.

To engage the winch for paying out the wire rope, proceed as follows:

- shut down the engine;
- set the handle of the transfer case control cock in the neutral position;
- engage the power take-off unit;
- start the engine;
- set the gearshift lever of the gearbox into the second gear position and see that the engine speed does not exceed 1,750 r.p.m.

A sharp rise of the engine speed does not provide for increase of the pulling effort on the wire rope but may cause disengagement of the winch (slipping of the safety coupling and its premature wear) therefore, during operation of the winch the engine speed should be raised gradually.

The wire rope paid out from the winch should be pulled away manually.

It is permissible to pay out the wire rope until the portion of the wire rope painted red appears from the winch or the automobile horn starts to sound and in an extreme case, until the red pilot lamp on the instrument panel starts to light. When the red pilot lamp lights up, immediately stop paying out the wire rope.

It is strictly forbidden to pay out the wire rope after the pilot lamp has gone on. Failure to observe this rule will result in breaking of the wire rope from its fitting place on the drum and in damage to the winch.

To completely stop the paying-out of the wire rope, disengage the power take-off unit or shut down the engine. In case, when it is necessary to stop the paying-out before the painted portion of the wire rope appears from the winch or before the horn starts to sound the gearshift lever of the gearbox should be set in the neutral position.

In this case, it should be born in mind that paying-out of the wire rope may not cease completely and will continue at a very low speed due to dragging of the gearbox discs.

When paying out the wire rope under load the effort on the wire rope should not exceed 6 tons.

It is permissible to pay out the wire rope under load with a subsequent pulling throughout the entire length of the winch wire rope for not more than two times in succession. If the number of paying-out operations (pulling operations) is greater it is necessary to let the reduction gear and automatic brake of the winch cool down to a temperature +60°C (to be checked by hand feel).

To engage the winch for pulling, shift in the reverse gear in the gearbox and see that the engine speed does not exceed 1,750 r.p.m.

For procedure of hauling track-laying vehicles onto a semitrailer, refer to "Operating and Maintenance Instructions of MA3-5247E, MA3-5247F Semitrailers".

For self-recovery of a stuck automobile (Fig.167) proceed as follows:

- pay out the wire rope;
- attach the wire rope (with the help of crow bar 2) to stationary object 3; when selecting an object and paying out the wire rope, take into account that the kink angle should not exceed 10°;
- engage the winch for winding.

For recovery of a stuck automobile (Fig.168), proceed as follows:

- drive to the stuck automobile so that the angle of the wire rope kink does not exceed 10°;

- remove the storage batteries from the automobile and store them in heated premises;
- pour 100 gr of spirit into the compressor delivery pipeline to prevent the air system units from freezing;
- cover the entire automobile with a tent to protect it from snow drifts.

Note: During a continuous parking the M1B-537A automobile (coupled with a semitrailer) should be covered with a tent which ensures warming the automobile by hot air from an air heating plant 8P-27 and at the same time keeps it ready for immediate driving. At the lower part, the tent has a rope for its lightening. The front portion of the tent is provided with flaps for access to the cab and preheater. The rear portion of the tent has a curtain, the folds of which are connected with each other by straps and at the top are secured to the hooks arranged on the semitrailer cross member.

Service Materials

Fuel

The engine should be operated only on a quality diesel fuel having an appropriate certificate.

The grade of fuel recommended for the engine is a high-speed diesel fuel, State Standard (FOCT) 4749-49. When this grade of fuel is not available, use diesel fuel, State Standard (FOCT) 305-62.

Note: When employing the fuel, State Standard (FOCT) 305-62 at the same time, use the oil with additives neutralizing the adverse effect of sulphur (MSTATM-339) State Standard (FOCT) 2312-57; ASHEM-1812M-1 State Standard (FOCT) 7189-54, BHEM NN-360.

Depending upon the temperature of ambient air, use fuel of summer or winter grades.

Arctic fuel, grades M and A is used in regions with cold climate where the temperature of ambient air is below -30°C. The fuel, grade M has a light fraction composition, reduced viscosity and a very low pour point temperature. The light fraction composition of fuel and octane number 40 ensure starting the engine at low temperatures.

Winter fuel, grades B3 and B is used at a temperature of the ambient air down to -30°C. The fuel has a light fraction composition and low pour and turbidity point temperatures which ensures satisfactory operation of the engine in winter.

Summer fuel, grades B1, B2 and B, C is used in spring, summer and autumn when the temperature of ambient air is above +5°C. The summer fuel has a heavier fraction composition and a higher full-boiling point and viscosity.

In winter it is permissible to delute diesel fuel with tractor kerosene, State Standard (FOCT) 1142-52.

The ratio of components in the mixture in relation to the ambient air temperature is given in the Table:

Table

Temperature of ambient air, °C	Composition of fuel
From +5°C to -25°C	50% of fuel, grades M, A and 50% of kerosene
From +5°C to -35°C	30% of fuel, grades M, B and 70% of kerosene
From -30°C to -35°C	75% of fuel, grades B3, B and 25% of kerosene
From -35°C to -45°C	30-50% of fuel, grades B3, B and 70-50% of kerosene

In addition, it is permissible to use the fuel of grades T-1 and TC-1, State Standard (FOCT) 1027-62 in winter at a temperature of ambient air below  $-30^{\circ}\text{C}$ .

Reliable operation of the engine also depends upon the correct storage and filling of fuel.

Before filling the tanks it is recommended to settle the fuel during 10 days. As a result, dirt particles and water will settle down from fuel on the reservoir bottom and when fuel is taken from upper layers of the reservoir the engine will be fed with clean fuel.

The fuel tanks should be filled from a fuel filling column or fuel servicing truck whose dispensing gun is provided with a silk (caprone) filter.

When filling the fuel system take particular care to prevent water, snow, sand and other mechanical impurities from getting into the fuel tanks.

It should be remembered that reliable operation of the diesel engine fuel system greatly depends upon the cleanness of fuel.

#### Oils and Lubricants

When operating the automobile use only quality oils and lubricants having an appropriate certificate.

All information pertaining to the engine and automobile assemblies lubrication intervals depending upon the automobile run is given in the Section "Preventive Maintenance of Automobile".

For lubrication of the engine use is made of oil, grade MT-16N, State Standard (FOCT) 6360-58 or PTY HM27-62 and BTY 449-55.

At an ambient air temperature above  $+5^{\circ}\text{C}$  it is permissible to use the following oils for lubrication of the engine: LE-22, State Standard 1013-49; MC-20, State Standard 1013-49, LC-20C, State Standard 9320-60. At a temperature from  $+5^{\circ}\text{C}$  to  $-25^{\circ}\text{C}$  it is allowed to use oil, grade MC-14, State Standard (FOCT) 1013-49 for lubrication of the engine.

Oil, grade MT-16N is also used for lubrication of the compressor, overdrive gear, fan drive reduction gears, transfer case, power take-off unit, intermediate and final reduction units of the axles and wheel-hub drives.

When operating the automobile in arctic regions and in zones with the ambient air temperature below  $-25^{\circ}\text{C}$ , use oil, grade MT-16N, State Standard (FOCT) 6360-58 for lubrication of the engine and other mechanical units instead of oil, grade MT-14N.

For lubricating the hydraulic transmission and steering gear, use a mixture containing 70 per cent of spindle oil, grade AN, State Standard (FOCT) 1642-52 and 30 per cent of oil, grade MT-16N, irrespective of the season of operation.

For operation of the steering system hydraulic booster, use spindle oil, grade AN and at a temperature of ambient air below  $-35^{\circ}\text{C}$ , use instrument oil (MEN), State Standard (FOCT) 1805-51.

For operation of the suspension shock absorbers, use a mixture containing 50 per cent of transformer oil and 50 per cent of turbine oil.

For lubricating the universal joints of the transmission, fan drive and wheel propeller shafts, use automobile transmission oil, State Standard (FOCT) 3781-53 or transmission oil of summer and winter grades, State Standard (FOCT) 542-50.

For lubricating the constant-velocity universal joints and bearings of the steering knuckle king pins, use automobile lubricant, grade AN (for propeller shafts), State Standard (FOCT) 5730-51.

For lubricating the hub inner bearings, toothed connection and intermediate support of the second axle drive propeller shaft, hubs of fans, tensioners, use

universal high-melting, water resistant lubricant, grade YTB (1-13), State Standard (ГОСТ) 1531-61 or (1-13C), BTB-5-5E.

For other friction units, use universal, medium-melting lubricant, grade YC, State Standard (ГОСТ) 1033-51. This State Standard specifies production of three grades of solid oils: pressure gun solid oil (YC-1), J (YC-2) and T (YC-3).

The pressure gun solid oil (YC-1) is used at low temperatures, i.e. during winter period of operation.

The solid oil, grade J is used as a universal winter and summer lubricant. The use of solid oil, grade T, at a temperature below  $-10^{\circ}\text{C}$  is difficult.

Solid oil, grade T, is used in the summer period of operation.

Along with lubricant, grade YC it is permissible to use universal, medium-melting, synthetic lubricant, grade YCC, State Standard (ГОСТ) 4366-56. When operating the automobile in arctic regions, use lubricant, grade YTBMA (UNATEM-201). State Standard (ГОСТ) 6267-59 instead of lubricants, grades YTB (1-13), (1-13C), YC and YCC.

Lubricant, grade YTBMA, may be used under all operating conditions at an ambient air temperature below  $0^{\circ}\text{C}$  and down to  $-60^{\circ}\text{C}$  as well as at any positive temperature.

#### Coolant

A 1.5 per cent water solution of emulsole 3-1A (3-25) clean water or antifreeze should be used as a coolant for the engine cooling system.

The quality of water is determined by its ability not to cause formation of scale and corrosion of metal in the cooling system.

Natural water contains various dissolved salts and mechanical impurities which cause formation of scale as well as chloride and other compounds which cause corrosion of metals. Therefore, water taken from natural water basins should be cleaned and softened.

Water is cleaned of coarse suspended particles by settling and from fine particles by filtering through several alternating layers of gravel and quartz sand. In case filtering plants are not available, water taken from natural basins should be filtered through a thick fabric.

Water is softened by adding trisodium phosphate in the amount of 2 gr/per one litre of water. 1.5 per cent water solution of emulsole is used according to the State Standard (ГОСТ) 1975-53.

In winter time, depending upon the temperature of ambient air, use only antifreeze, grade "40" or "65", State Standard (ГОСТ) 159-52.

At a temperature of the ambient air not lower than  $-40^{\circ}\text{C}$ , use antifreeze, grade "40". In case of lower temperatures, use antifreeze, grade "65".

The freezing point and composition of antifreeze are determined with the help of a hydrometer.

To determine the composition of antifreeze with the help of the hydrometer, pour the tested liquid at a temperature of  $+20^{\circ}\text{C}$  (permissible deviation of the temperature is within  $\pm 1^{\circ}\text{C}$ ) into a glass cylinder and dip the hydrometer in it (Fig. 147).

When oscillations of the floating hydrometer cease, take the reading against the upper meniscus of the liquid making sure that the hydrometer does not touch the cylinder walls.

If the composition of coolant is determined at a temperature which is below or above  $+20^{\circ}\text{C}$ , use the data given in the Table to determine the actual content of ethylene glycol.

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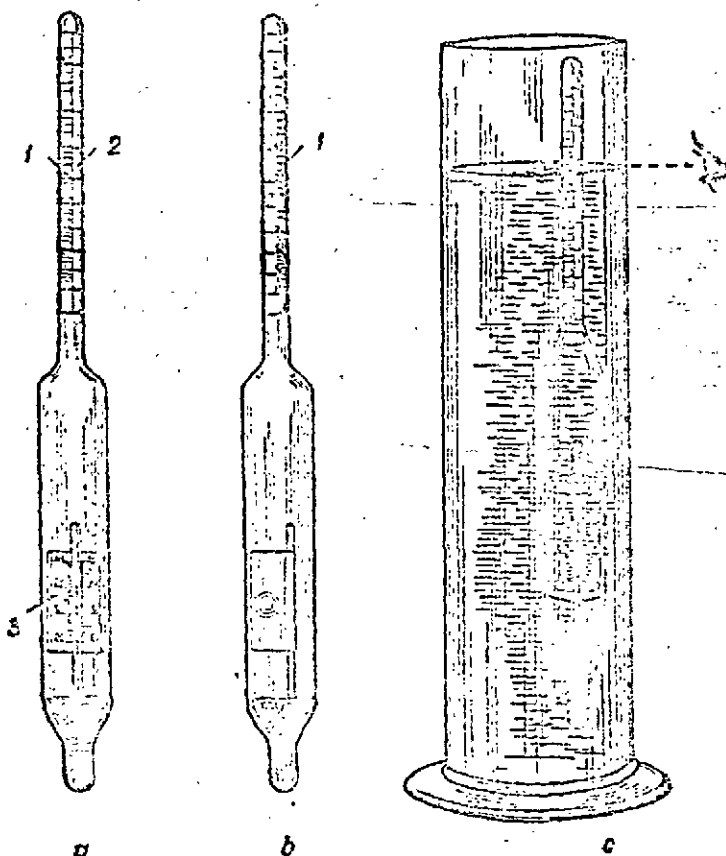


FIG. 147. HYDROMETER FOR DETERMINING COMPOSITION AND FREEZING POINT OF ANTIFREEZE

a - front view; b - side view; c - determination of composition and freezing point; 1 - scale for determining content of ethylene glycol in per cent; 2 - scale for determining freezing point of antifreeze in centigrade; 3 - thermometer scale

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Table

Temperature of tested coolant, °C	Readings of hydrometer and content of ethylene glycol in coolant, per cent by volume									
+40	23	32	42	46	50	55	60	64	69	
+30	27	36	46	50	55	60	65	70	75	
+20	30	40	50	55	60	65	70	75	80	
+10	33	44	54	59	65	70	76	81	87	
0	35	47	58	63	69	76	81	87	95	
-10	37	50	62	67	73	82	89	96	-	
-20	39	52	65	71	77	88	96	97	-	

Examples showing how to use the Table

(a) at a temperature of the tested liquid  $-20^{\circ}\text{C}$  the hydrometer reading on the scale "glycol in volume per cent" is 77. In the line corresponding to the temperature  $-20^{\circ}\text{C}$  we find figure 77, then in the same column, above figure 77, we find, in the line corresponding to the temperature  $+20^{\circ}\text{C}$ , figure 60 which indicates the actual content of ethylene glycol in per cent;

(b) at a temperature of the liquid  $+40^{\circ}\text{C}$  the hydrometer reading on the same scale is 42. In the line corresponding to the temperature  $+40^{\circ}\text{C}$  we find figure 42 and then in the same column, below figure 42, in the line corresponding to the temperature  $+20^{\circ}\text{C}$ , we find the actual content of ethylene glycol which is equal to 50 per cent.

In case of low concentration of ethylene glycol (below 48 per cent for grade "40" and below 58 per cent for grade "65") add the required amount of ethylene glycol into the coolant; if the ethylene glycol is not available, evaporate the coolant until the normal ratio of ethylene glycol and water is obtained.

Antifreeze is stored and transported in a hermetically sealed metal containers which should be free from the residue of petroleum products to prevent foaming. The containers should be provided with inscription "Poison" and a sign adopted for denoting poisonous substances.

It is forbidden to transfer antifreeze with the help of a hose sucking it into the mouth. Accidental swallowing of even a small amount of antifreeze may cause heavy poisoning with lethal effect. After handling of the ethylene glycol antifreeze (acceptance, delivery, filling the cooling system, checking the coolant quality) the hands should be thoroughly washed.

Fluid for Hydraulic Brakes

For hydraulic brakes, use brake fluid, grade FTE-22 (BTW 3759-53) which is a mixture containing various glycols, water and anticorrosive additive; as a rule, the fluid is of green colour.

The fluid is intended for use at any season of the year and under any climatic conditions.

The low freezing point ( $-65^{\circ}\text{C}$ ) and good viscosity-temperature characteristics of the fluid, grade FTE-22, allow it to be used under severe winter conditions.

The fluid, grade FTE-22, is poisonous. It is forbidden to suck it into the mouth as well as to take meals until the hands contaminated with the fluid are thoroughly washed.

Special measures for protection of the skin and respiratory tracts when handling the fluid are not necessary.

If for any purpose the master and wheel brake cylinders have been removed and disassembled, it is mandatory to coat the faces of hydraulic cylinders, the pistons and the collars, in the process of their assembly, with a solid thin layer of brake fluid, grade BOK (BYV MSH No.1608-47), or grade BOK (BYV MSH 4226-54) preventing formation of drops and overflows. Change the fluid, grade FTE-22 once in 6 months during the seasonal preventive maintenance following the procedure given in the Section "Servicing of Brakes".

To prevent the air system units from freezing at low temperatures and to wash the contacts of electrical equipment commercial ethyl alcohol (hydrolized), State Standard (ГОСТ) 8314-57 is used for the air brake system.

PREVENTIVE MAINTENANCE OF AUTOMOBILE

Kinds of Maintenance

With the purpose to check the serviceability of the automobile, to prevent premature wear of parts and to keep the automobile in constant technical readiness it is mandatory to carry out routine inspections and periodical preventive maintenance operations.

Maintenance of the automobile depending upon the terms and scope of operations is subdivided as follows:

- routine inspection before leaving the park;
- routine inspection en route (at halts);
- daily preventive maintenance (upon arrival to the park);
- preventive maintenance No.1 to be carried out every 1,000-1,200 km of the automobile run<sup>x)</sup>;
- preventive maintenance No.2 to be carried out every 5,000-6,000 km of the automobile run<sup>x)</sup>.

Scope of Operations Carried Out during Preventive Maintenance of Automobile

The operations pertaining to the preventive maintenance of the automobile should be carried out in conformity with the given Table and the Lubrication Chart of Units and Assemblies. The more detailed description of operations pertaining to servicing of different assemblies and systems (methods of carrying out the operations, adjustment data, etc.) is given in the corresponding sections of the descriptive part of the book.

Instructions pertaining to preventive maintenance	Kinds of preventive maintenance				
	Routine inspection before leaving the park	Routine inspection en route (at halts)	Daily preventive maintenance	Preventive maintenance No.1	Preventive maintenance No.2
1	2	3	4	5	6
1. Clean the automobile of dirt (dust, snow), wash	-	-	+	+	+

<sup>x)</sup>Taking into account the specific conditions of the automobile operation allowing a short-time operation of the engine at halt, each hour of the engine operation (when planning the preventive maintenance operations) should be considered equal to 20 km of run.



1	2	3	4	5	6
<p>and wipe the cab windows, fenders and hood, headlights, side lamps, licence plates and black-out device. When washing the automobile, do not direct the water jet onto the air cleaners, generator regulator, starter relay, sending units of the instruments and other electrical equipment as well as into the flywheel casing ports if breathers are not installed</p>					
<p>2. Check the automobile for cleanlines and, if necessary, remove dust (snow), wipe the windshields, headlights, side lamps and licence plates</p>	+	-			
<p>3. Inspect the automobile visually and check the assemblies and units of the automobile and their pipelines for leakage of oil, fuel, coolant and brake fluid</p>	+	+	+	+	+
<p>4. Check the condition of the semi-trailer running gear, stowage of load on the semitrailer and the reliability of coupling with the automobile</p>	+	+			
<p><u>Engine and Its Systems</u> 5. Check for presence of in the fuel tanks and drain condensate (not earlier than 5 hours after stopping of the automobile)</p>	+	-	-	+	+

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1	2	3	4	5	6
6. Fill the fuel tanks. Fill the fuel tanks from fuel filling columns or fuel servicing trucks equipped with filters and settlers	-	-	+	+	+
7. Wash the inner space of the fuel injection pump with oil heated to a temperature of 110-120°C according to the recommendations of the operating instructions	-	-	-	+	+
8. Check and tighten the fastenings of fuel tanks and brackets of the fuel tanks	-	-	-	+	+
9. Drain oil from the drain tank	-	-	+	+	+
10. Remove and wash the primary fuel filter	-	-	-	-	+
11. Remove and wash the secondary fuel filter	-	-	-	-	+
12. Check setting of the fuel injection advance angle and compare it with the data registered in the Service Log	-	-	-	-	+
13. Check fastening of the engine supports and condition of their rubber shock absorbers	-	-	-	-	+
14. Remove the elements of the air cleaner, wash them and clean their housings. Wet the elements with engine oil. In winter time, do not wash the air cleaners	-	-	-	+	+
15. Check fastening of the air cleaners, intake and exhaust manifolds and spark arresters	-	-	-	-	+

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1	2	3	4	5	6
16. Drain condensate from the spark arresters	-	-	+	+	+
17. Clean the spark arresters of carbon deposit and blow them with compressed air for which purpose, remove the inner pipes	-	-	-	-	+
18. Check the oil level in the engine oil tank and top up, if necessary	+	+	+	+	-
19. Drain 0.5 litre of oil from the oil tank sump (not earlier than 5 hours after stopping of the automobile)	-	-	-	+	-
20. Remove and wash the screen filter of the engine oil tank header	-	-	-	-	+x)
21. Wash the slotted cleaning section and casing of the oil filter, replace the cardboard filtering element	-	-	-	-	+x)
22. Check the coolant level in the cooling system and top up, if necessary. If the cooling system is filled with antifreeze and leakage is not detected, add only water	+	+	+	+	+
23. In winter time, check the composition of antifreeze (for procedure of determining the composition of antifreeze, refer to the Section "Service Materials"	-	-	-	+	+

x) When the engine and other units are lubricated with oil MT-14E it should be changed every 2,000-2,400 km of run.

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1	2	3	4	5	6
24. Check the condition and, if necessary, adjust the tension of the fan drive belts (excessive tension brings the belts out of order)	-	-	+	+	+
25. Check fastening of radiators, radiator beams, brackets of fans and tensioners	-	-	-	-	+
26. Check the air pressure in the air bottles of the air starting system	+	-	+	+	+
27. Check fastening of the air bottles of the air starting system	-	-	-	+	+
28. Check fastening of the preheater and its pumping unit	-	-	-	+	+
29. Check for leakage from check holes of the cylinder block jackets and holes on the cooling system circulation pump	-	-	+	+	+
30. Start and warm the engine as instructed in the Section "Preparation of Automobile for Movement". In the process of the engine warming, check for leakage of fuel, oil and coolant from its systems and pipelines	+	-	-	+	+
31. Listen to the operation of a warmed engine at various speeds and check its operation by the instruments	+	-	-	+	+
32. Check the functioning of the engine emergency shut-down device and adjust, if necessary	-	-	+	+	+

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1	2	3	4	5	6
33. Eliminate all revealed troubles and fill in the Service Log	-	-	+	+	+

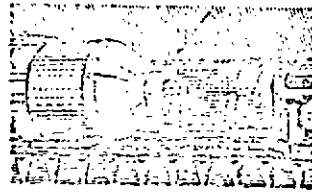


FIG. 148. CHECK HOLES ON CYLINDER BLOCK

Power Train

34. Check fastening of the overdrive gear housing to the engine flywheel casing

35. Clean the magnetic plug of the overdrive gear and transfer case housing when changing oil

• 36. Unscrew the container of the hydraulic transmission hydraulic cyclone and clean it of dirt

• 37. Wash the filter of the hydraulic transmission and torque converter tank

38. Remove and wash the headers of the front and rear pumps located in the hydraulic transmission tank

39. Remove and wash the headers of the planetary gearbox suction pump

	-	-	-	+	+
	-	-	-	-	+ (xx)
	-	-	-	+ (xx)	+
	-	-	-	-	+
	-	-	-	-	+

(xx) to be carried out every other preventive maintenance

1	2	3	4	5	6
40. Clean the magnetic plugs of the hydraulic transmission tank and planetary gear case when changing oil	-	-	-	-	+
41. Check fastening of the transfer case to the frame brackets	-	-	-	-	+
42. Check fastening of the transfer case torque rod	-	-	-	-	+
43. Check operation of the transfer case gear-type and plunger oil pumps at 1,000-1,200 r.p.m. of the engine with the direct gear of the hydraulic transmission engaged	-	-	-	+	+
44. Check fastening of the power take-off unit to the transfer case	-	-	-	-	+
45. Check the condition and fastening of the propeller shafts and interaxle propeller shafts and their universal joints	-	-	-	+	+
46. Check fastening of the intermediate support of the second axle propeller shaft to the final drive housing	-	-	-	+	+
47. Check and tighten the stud nuts of the axles arranged along the split plane of the housings	-	-	-	+	-
48. Check the condition and tightness of fitting of the protective boots on the propeller shaft joints	-	-	-	+	+
49. Check fastening of the extreme housing to the intermediate one and fastening of the intermedi-	-	-	-	+	+

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1	2	3	4	5	6
etc housing to the final drive housing in intermediate reduction units					
<u>Running Gear and Suspension</u>					
50. Check fastening of the wheel-hub drive outer carrier to the wheel hub	-	-	-	+	+
51. Check the condition and fastening of the shock absorbers	-	-	-	+	+
52. Check fastening of the torsion bars	-	-	-	+	+
53. Check the condition and fastening of the suspension arms	-	-	-	+	+
54. Check fastening of the wheel trunion to the steering knuckle of steerable wheels and to the support of the rear wheels suspension	-	-	-	-	+
55. Check air pressure in the wheel tyres	+	-	-	+	-
56. Inspect fastening of the wheels (the spare wheel included) and check the condition of tyres	-	+	+	+	-
57. Check tightening of the wheel nuts	-	-	+	+	-
58. Check and, if necessary, adjust the bearings of the front and rear wheel hubs	-	-	-	-	+
59. Check and, if necessary, adjust the toe-in of the front steerable wheels	-	-	-	-	+
60. Interchange the tyres according to the rotation diagram. While doing so, disassemble all the wheels and powder the inner space of tyres, flap and the tyre tube with talc	-	-	-	-	+

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1	2	3	4	5	6
61. Check fastening of the cab	-	-	-	+	+
62. Check fastening of the fifth-wheel assembly to the support and fastening of the support to the frame	-	-	-	+	+
63. Check the condition of the locking device	-	-	+	+	+
<u>Brakes</u>					
64. Check the oil level in the compressor crankcase and top up, if necessary	+	-	+	+	-
65. Check the condition and tension of the compressor drive belts	-	-	+	+	+
66. Check the availability and storage of sprags	+	+	+	+	+
67. Drain condensate from air bottles of the air brake system	-	-	+	+	+
68. Drain condensate from the moisture-and-oil separator	-	-	+	+	+
69. Drain condensate from the master brake cylinders (in winter time)	-	-	+	+	+
70. Check the compressor fastening	-	-	-	+	+
71. Check the air system for tightness and functioning of the air pressure regulator and adjust the latter, if necessary	+	-	+	+	+
72. Check the brake fluid level in the master brake cylinders and, if necessary, top up and bleed the system	-	-	-	+	+
73. Check the condition and functioning of the safety valve and, if necessary, adjust it according to the recommendations given in the operating instructions	-	-	-	-	+

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1	2	3	4	5	6
74. Check the service-ability of the safety valve by releasing air (for this purpose, pull the valve stem)	+	-	-	+	-
75. Check the clearance between the shoes and drum of the foot brakes on all the wheels and adjust, if necessary	-	-	-	+xx)	+
76. Check the clearance between the brake band and drum of the hand brake and adjust, if necessary	-	-	-	+	+
77. Remove the compressor cylinder head and check the condition of valves, valve springs and unloading diaphragm. Clean the compressor parts of gum deposit	-	-	-	-	+
78. Remove the moisture-and-oil separator, wash it without disassembly, with butyl alcohol until oil and dirt are completely removed; this done, reinstall the compressor	-	-	-	-	+
79. Check fastening of the brake valve, master brake cylinders, air bottles, coupling head and cut-out cock	-	-	-	-	+
80. Check the pressure of air delivered to the semitrailer	-	-	-	-	+
81. Check the condition of the brake drums and foot brake shoes	-	-	-	-	+xx)
82. Wash the air cleaners in the ventilation system of assemblies	-	-	-	-	+xx)
<u>Steering Gear</u>					
83. Check fastening of the steering linkage arms	-	-	-	+	+
84. Check the tilting of the steering wheel	-	-	+	+	+

1	2	3	4	5	6
85. Check the condition and tightness of protective boots on the joints of the steering rods and hydraulic boosters.	-	-	+	+	+
86. Check and, if necessary, tighten the fastening elements of the steering gear case and pitman arm.	-	-	-	+	+
87. Check fastening of the steering system hydraulic booster tank.	-	-	-	+	+
88. Check setting of thrust bolts limiting the turning of wheels.	-	-	-	+	+
89. Check the position of bolts on the steering gear attaching bracket which limit the extreme position of the pitman arm. The bolts should be set so that a simultaneous or slightly earlier thrust of the pitman arm against the limiting bolts is obtained at extreme positions relative to the thrust of the wheel. trunnion against the limiting bolts provided on the steering knuckle.	-	-	-	+	+
<u>Electrical Equipment</u>					
90. Check charging of the storage batteries by the voltmeter for which purpose, depress the button arranged on the voltmeter. If at starting of the engine by the starter the voltage drops below 17 V, recharge the storage batteries.	+	-	+	+	+
It is permissible to charge the storage batteries from a charging plant directly on the automobile. For this purpose, connect the wires having the sectional area not less than 10 mm <sup>2</sup> , which run from the charging plant,					

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1	2	3	4	5	6
to the automobile terminals arranged under the engine compartment hood at the upper part of the cab rear wall	+	-	+	+	+
During slave charging of the storage batteries the battery switch should be out ont					
91. Check the headlights, side lamps, tail light, horns, windshield wiper and foot dimmer switch for proper functioning	+	-	+	+	+
92. Check the electrolyte level in the storage batteries	-	-	every 10-15 days	+	+
93. Check the TEO-601MT contactor for reliable fastening	-	-	-	+	+
94. Check the wires for cleanliness and reliable fastening to the terminals of the storage batteries and generator regulator	-	-	-	+	+
95. Check the lamps illuminating the instruments and the cab dome lamp for proper functioning	+	-	-	+	+
96. Check the condition and fastening of electric wires	-	-	-	+	+
97. Check the condition and functioning of the instruments	+	-	-	+	+
98. Check the starter, generator and its drive for reliable fastening	-	-	-	-	+
99. Remove the generator and check the condition of the commutator and brushes	-	-	-	-	+) (H)
100. Remove the starter from the automobile, check the condition of the commutator, brushes and starter drive mechanism	-	-	-	every 3 months	+
101. Remove the contactor cover and inspect the contacts. In case of excessive burning, clean the contacts	-	-	-	-	+) (H)

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	2	3	4	5	6
102. Check the condition and correct adjustment of headlights	-	-	-	-	+
103. Check the specific gravity of electrolyte, clean the vent holes in storage battery plugs	-	-	every 30 days	+	+
104. With the automobile in motion check the operation of the planetary gearbox, transfer case, driving axles, steering gear, brakes and speedometer	+	-	-	+	+
105. Immediately after stopping the automobile, check the degree of heating of the wheel hubs, brake drums and axle housings	-	+	+	-	-
106. Check the completeness, serviceability and storage of the driver's tools, fastening of the containers, trenching tools and fire extinguishers	+	-	+	+	+
107. Eliminate the detected troubles	+	+	+	+	+
108. Lubricate the automobile units and assemblies according to the Lubrication Chart	-	-	-	+	+
<u>Additional Work to be Carried Out when Operating in Arctic Regions</u>					
1. Fill the compressor delivery pipeline with 100 gr of commercial ethyl (hydratized) alcohol to prevent freezing of condensate in the automobile air system units and apply the brakes for 2-3 times	-	-	+	+	+
2. When the automobile is parked for more than 24 hours cover the automobile with a tent	-	-	+	-	-
3. Check the fastening and condition of the warming cover	+	+	+	+	+

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1	2	3	4	5	6
<u>Additional Work to be Carried Out When Operating on Sandy and Desert Terrain</u>					
1. In case of continuous shut down periods in operation of the automobile, check the electrolyte level in the storage batteries	+	-	-	-	-
2. At a temperature of ambient air above +30°C, check additionally the condition and tension of belts of the fans and compressor	-	+	-	-	-
3. Check the availability and condition of gaskets in the caps of fuel tanks	-	-	+	+	+
4. Check the radiator cap for tight fitting	-	-	+	+	+
5. Check the serviceability of the sun visor and windshield wipers	-	-	+	+	+
6. Check the specific gravity of electrolyte and clean the vent holes in storage battery plugs	-	-	+	-	-
7. Check the condition and tightness of fitting of protective boots on propeller shaft joints	-	-	+	-	-
8. When the automobile is parked for more than 24 hours or at night, cover the automobile with a tent	-	-	+	-	-
9. Remove and wash the breather of the engine crankcase	-	-	+	+	+
10. Check the condition of brake drums and brake shoe linings of the foot brakes	-	-	-	+	+
<u>Additional Work to be Carried Out when Operating on Mountain Terrain</u>					
1. In case of continuous shutdown periods in operation of the automobile, check the electrolyte level in the storage batteries	+	-	-	-	-

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1	2	3	4	5	6
2. Check the condition and tension of the compressor belts	-	+	-	-	-
3. Check the condition and fastening of mechanisms and parts of the steering gear	-	+	-	-	-
4. Check the radiator cap for tight fitting	-	-	+	+	+
5. Check the serviceability of the sun visor and windshield wipers	-	-	+	+	+
6. Check the electrolyte level in storage batteries	-	-	every 3 days	-	-
7. In connection with sharp fluctuations of the ambient air temperature, drain water from the cooling system in case of continuous parking of the automobile	-	-	+	+	+
8. Check and, if necessary, adjust the toe-in of front steerable wheels	-	-	-	+	-
9. Check the condition of brake drums and brake shoe linings of the foot brakes	-	-	-	+	+

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The tanks should be filled with fuel from a fuel-filling column through a dispensing gun provided with a silk (caprene) filter. It is not recommended to fill fuel from buckets. The amount of fuel in the tanks is measured with a dipstick.

The lubricating system should be filled only with clean oil passed through a screen filter.

For instructions pertaining to the oil to be used in the lubricating system refer to the Section "Service Materials". To top up the oil tank of a new automobile or to change oil in the lubricating system, proceed as follows:

- clean the cap and filler neck of the tank of dust and dirt;
- unscrew the tank filler neck cap and insert a funnel with a screen into the filler hole;
- fill the tank with oil up to the mark "H" (Full) on the oil dipstick;
- start the engine and run it for 3 min at a speed of 800-1,000 r.p.m. to fill the channels and pipelines of the engine with oil;
- stop the engine and let the foam settle down;
- check the oil level in the tank;
- add oil into the tank up to the mark "H" (Full) on the oil dipstick and screw on the cap.

The total amount of oil filled into the lubricating system comprises 90 litres.

The minimum permissible amount of oil in the tank is 30 litres, if the amount of oil is less than 30 litres it is forbidden to start the engine.

After filling or topping up the cooling system, fuel system and lubricating system, proceed as follows:

- make sure the gearshift lever of the planetary gearbox is in the neutral position and the torque converter is unlocked;
- set the handle of the fuel distributing cock into the position at which the right-hand fuel tank is out in (with both tanks filled up);
- bleed air from the fuel system (after filling the empty system, in case of leakage of air through untight connections, during washing of fuel filters or replacement of the fuel injection pump), for which purpose depress the button of the air bleed valve and building up a pressure of at least 3.5 kgf/cm<sup>2</sup> by means of the oil priming pump, pump fuel by the hand-operated pump during 1-2 min;
- cut in the battery switch;
- cut in the electric oil priming pump.

When the pressure in the lubricating system reaches not less than 3.0 kgf/cm<sup>2</sup>, without cutting out the pump, crank the engine through 3-4 turns with the fuel delivery cut off.

**WARNING!** Do not keep the electric oil priming pump cut in in excess of one minute.

#### PREPARATION OF ENGINE FOR STARTING AT AMBIENT AIR TEMPERATURE BELOW PLUS 5°C

Preparation of the engine for starting at an ambient air temperature below plus 5°C includes the same operations on filling and checking of the engine systems as in the case of preparing the engine for starting at a temperature above plus 5°C, but is distinguished by some peculiarities.

For a winter period of operation the preheater boiler should be connected into the cooling system for which purpose, install the gasket with the side having the hole between the flanges of the branch pipe of the pipeline running from the preheater boiler to the thermostat box.

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Fill the cooling system with antifreeze and the fuel system with winter grade fuel. Additional instructions pertaining to filling the coolant and fuel, see in the Section "Service Materials".

The total amount of cold antifreeze to be filled into the cooling system comprises 95 litres. In this case, the level of antifreeze in the radiator should be 10-15 mm above the radiator core tubes with the filler necks of both radiators open. Prior to starting, warm up the engine by the preheater.

The loss of antifreeze caused by evaporation (in case there is no leakage) should be replenished by water. During preventive maintenance operations, check the content and freezing point of the antifreeze.

The coolant is drained from the cooling system simultaneously through the drain cocks arranged on the circulation pump, on cooled exhaust manifolds, on the delivery pipeline of the cab heater and on the preheater boiler, from the plug provided on the heated pipe of the main oil line, in this case the filler neck caps of the radiators should be removed.

The cab heater drain cock is located under the cab on the right-hand side of the automobile.

The drain cocks of cooled exhaust manifolds are opened by turning them clockwise when looking on the side of the flange into which the cock is screwed in.

To open the drain cock located on the preheater boiler, disconnect the mud guard plate from the bumper and lower it down.

To remove the remaining coolant from the circulation pump, crank the engine slightly by the starter without delivery of fuel.

After filling the cooling system with antifreeze, fuel system with winter-grade fuel and lubricating system with oil, do the following:

- make sure the gearshift lever of the planetary gearbox is in the neutral position and the torque converter is unlocked;
- set the handle of the fuel distributing cock into the position at which the right-hand fuel tank is cut in (with both tanks filled up);
- disconnect the radiators having slipped down the shutter arranged in the thermostat box branch pipe;
- disconnect the fans for which purpose, set the switches of the fan electromagnetic couplings on the instrument panel into the OFF position;
- bleed air from the fuel system by pumping fuel with the hand-operated fuel pump;
- cut in the battery switch;
- cut in the preheater electric motor for 10-15 sec by setting the electric motor change-over switch into the OPERATION (РАБОТА) position. The electromagnetic valve switch should be in the SCAVENGE (НПОЛНЕНИЕ) position;
- cut in the preheater glow plug and keep it cut in during 30-40 sec, as a result the reference coil should glow bright-red;
- shift the electromagnetic valve switch from the SCAVENGE (НПОЛНЕНИЕ) position into the OPERATION (РАБОТА) position and the electric motor selector switch into the START (ВКЛ) position;
- in case of a stable operation of the preheater (indicated by peculiar noise when the ignition of fuel takes place without the glow plug, release the glow plug control lever and shift the electric motor selector switch into the OPERATION (РАБОТА) position;
- during warming the engine by the preheater when the coolant is warmed up to +45°C periodically but not in excess of 20 sec switch on the electric oil priming pump;

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- when the coolant is heated to  $+65^{\circ}\text{C}$  and the oil priming pump ensures pumping of oil, switch on the preheater;
- cut in the electric oil priming pump.

When pressure in the lubricating system reaches at least  $3.0 \text{ kgf/cm}^2$ , crank the engine by the starter without cutting out the pump through 3 turns with the fuel delivery cut off.

#### STARTING AND WARMING OF ENGINE

The engine can be started by the starter or compressed air. Both starting systems operate independently from each other. The main starting method is by the starter. The air starting system is an auxiliary (stand-by) means used in case of the starter failure.

When using any of the systems the engine should be prepared for starting. At the temperature of ambient air below  $-15^{\circ}\text{C}$  when the oil in the hydraulic transmission becomes thick, disconnect the hydraulic transmission from the engine before starting the engine by the lever located on the overdrive gear.

#### Starting the Engine by Starter

When starting the engine by the starters:

- make sure that the fuel feed control handle is in the position at which the fuel feed is cut off;
- make a warning signal;
- depress the accelerator pedal  $1/3$  of its full travel; build up a pressure of at least  $3 \text{ kgf/cm}^2$  by the oil priming pump;
- depress the starter button (the period of keeping the button depressed is 5 sec).

If the engine starts, release the button.

If at the first attempt the engine fails to start or runs irregularly, repeat the starting not earlier than after 15 sec. If after three-four attempts the engine fails to start or runs irregularly, stop starting and find the cause of failure. After elimination of troubles, repeat starting the engine.

#### Engine Starting by Compressed Air

To start the engine by compressed air, open the shut-off valve on one of the bottles. The shut-off valve is located in the engine compartment on the cab rear wall. Using the oil priming pump, build up a pressure of at least  $3 \text{ kgf/cm}^2$ , and then open the air starting reducing valve arranged on the cab rear wall having turned the valve handle counter-clockwise. Right after starting, close the reducing valve and the shut-off valve on the bottle.

The pressure of air delivered into the air distributor should be at least  $60 \text{ kgf/cm}^2$  in summer and  $75 \text{ kgf/cm}^2$  in winter (by the pressure gauge). If at starting the pressure gauge registers the pressure not less than  $60 \text{ kgf/cm}^2$  and the engine fails to be started, immediately close the reducing valve and then the shut-off valve on the bottle, and find the cause of the engine failure. After elimination of troubles, repeat starting of the engine.

**Note:** In case of extreme necessity to start the engine with the storage batteries of the automobile discharged and with lack of compressed air in the air starting system it is permissible to start the engine from external storage batteries. For this purpose, using a wire with the section of  $70 \text{ mm}^2$ , connect the positive terminal of external storage batteries, interconnected in the same way as the storage batteries on

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the automobile, to the contactor terminal connected to which is the wire running from the automobile storage batteries, and the negative terminal to the automobile ground.

#### Engine Starting by Towing

Starting the engine by towing is permitted only in emergency cases when the electric starter is out of order or it is impossible to use compressed air for starting the engine.

To start the engine by towing, proceed as follows:

- couple the automobile to be towed with the towing automobile by means of a tow bar;
- at an ambient air temperature below +5°C, warm the coolant and oil by the preheater;
- start to tow the automobile with its planetary gearbox set at neutral and increase the speed of towing to at least 10-20 km/hr;
- tow the automobile until oil pressure in the planetary gearbox boosters reaches 9.0-13.0 kgf/cm<sup>2</sup> and in the engine lubricating system at least 3.0 kgf/cm<sup>2</sup> for which purpose periodically switch on the electric oil priming pump;
- make sure that the direct gear is engaged in the transfer case, then shift in the second gear in the planetary gearbox; lock up the torque converter and depress the accelerator pedal through 1/3 of its full travel;
- after the engine is started, unlock the torque converter, stop the automobile and set the gearshift lever of the planetary gearbox into the neutral position and set the minimum stable speed of the engine (500-600 r.p.m.);
- remove the tow bar.

In cases of extreme necessity it is permissible to couple the towed automobile (without semitrailer) with the towing automobile by a flexible towing wire rope if the towing air valve is available. After coupling of the automobiles, make preparations for towing as instructed in the Section "Automobile Towing".

Towing the automobile with the purpose to start its engine is permitted only in the forward direction and on a straight road having no turns, since the steering gear booster does not function with the engine shut down that makes the automobile steering difficult.

The brake system of the towed automobile should be in good order.

#### Engine Warming after Starting

Right after the engine starting, set the minimum stable idling speed (500-500 r.p.m.) by means of the manual fuel feed control handle. After starting the engine which has been previously warmed, cut in the radiators having raised the shutter as soon as the temperature of coolant reaches +70°C.

It should be born in mind that the temperature of coolant in the cooling system will drop due to mixing of coolant in the entire cooling system. To raise the temperature of coolant, run the engine at an idling speed of 600-800 r.p.m. and gradually increasing the engine speed to 1,000-1,100 r.p.m., bring the temperature of coolant to +45°C. The engine is considered to be warmed and ready for normal service under all operating conditions when the oil and coolant outlet temperatures are not below +55°C.

After warming the engine at an ambient air temperature below -15°C, stop the engine and connect the hydraulic transmission to the engine. Start the engine once again and keep warming it until the temperature of oil in the torque converter and gearbox rises up to +20°C.

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Continuous operation of the engine at a halt at a speed less than 1,400 r.p.m. and particularly at low temperatures of ambient air is not recommended.

Continuous operation of the engine at a low speed as well as under low loads causes an intensive discharge of non-burnt mixture from the engine cylinders into the exhaust duct.

This leads to gumming of the pistons, piston rings, valves and their bushings which brings the engine out of order. Besides, during discharge of the non-burnt mixture it accumulates in the exhaust duct and at changing over to higher speeds and loads causes overheating, warpage and puncture of the exhaust duct packing gaskets.

Puncture of the packing gaskets is fire-hazardous as the non-burnt mixture is discharged into the engine compartment.

In all cases, when untight places are detected in the exhaust duct, urgently take measures to eliminate the deficiencies by tightening the nuts and bolts of the exhaust duct, replacing damaged packing gaskets, and by additionally winding untight places with asbestos packing; while doing so, wash all contaminated surfaces of the parts.

To ensure normal operation of the engine, do not run the engine continuously at a low speed and under low loads.

In case the automobile engine is employed at a low speed and under low loads, do the following:

- before and after operation of the engine clean and blow through the spark arrester without fail according to the automobile operating instructions;
- during operation, periodically load the engine to clean the exhaust duct of accumulated condensate;
- regularly tighten the nuts attaching the manifolds and check the condition of asbestos packings at the joints of the automobile exhaust pipes.

When it is required to keep the automobile ready for immediate operation at low temperatures of ambient air, follow the instructions given in the Section "Particularities of Automobile Operation in Winter".

#### ENGINE STOPPING

Prior to stopping the engine, gradually reduce its speed to 1,200-1,300 r.p.m. and run the engine at idling until the temperature of coolant and oil drops to  $+70^{\circ}\text{C}$ .

It is forbidden to stop the engine when the temperature of coolant and oil is higher than  $+70^{\circ}\text{C}$  since it may cause an inadmissible rise of the engine temperature.

To stop the engine, slowly shift the manual fuel feed control handle into the position of fuel feed cut-off and release the accelerator pedal.

For emergency stopping of the engine in case of the engine racing or when it is impossible to cut off the fuel delivery due to jamming of the fuel injection pump control rack, quickly pull out the engine emergency stopping handle located to the right of the driver on the cab rear wall, and keep it pulled out until the engine stops completely.

After stopping of the engine, do not fail to cut out the battery switch.

#### AUTOMOBILE DRIVING

Only the drivers who have studied and passed the examinations on the design, operating instructions and driving rules of the given automobile may be admitted to driving.

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Placing the Automobile in Motion and Driving on Roads  
On Level Road

It should be taken into account that placing the automobile in motion always requires a greater effort than that required during the automobile motion in the same gear.

Therefore, the automobile should always be placed in motion in the first gear.

To place the automobile in motion, proceed as follows:

- start and warm the engine as instructed in the Section "Preparation of Automobile for Driving";
- check readings of the hydraulic transmission instruments; the oil pressure in the torque converter should be 3.0-4.0 kgf/cm<sup>2</sup>, the oil pressure in the planetary gearbox boosters should be 9.0-13.0 kgf/cm<sup>2</sup>, the oil pressure in the hydraulic transmission lubricating system should be 1.0-1.5 kgf/cm<sup>2</sup>;
- check the air pressure in the brake system and in the tyres: the air pressure in the brake system should be at least 5.65 kgf/cm<sup>2</sup> while the air pressure in the tyres should be 4.5±0.2 kgf/cm<sup>2</sup>;
- reduce the engine speed to 600-800 r.p.m.;
- make sure that the high or low gear is engaged in the transfer case;
- shift in the first gear in the planetary gearbox;
- release the hand brake lever and sound the horn;
- smoothly depressing the accelerator pedal place the automobile in motion;
- at first metres of driving, sharply depress the brake pedal to make sure the brake system operates reliably.

In winter the following should be taken into account:

- it is permissible to place the automobile in motion when the temperature of oil in the torque converter and planetary gearbox is not less than +20°C;
- for warming thick lubricant in the automobile units at an ambient air temperature below -15°C, place the automobile in motion smoothly and at first 1-2 km drive the automobile at a speed not exceeding 20-30 km/hr.

Accelerate the automobile after placing it in motion in the first gear, then change over to the second gear and to the third gear without locking up the torque converter. In this case, the maximum torque on the driving wheels required for placing the vehicle in motion and smooth acceleration of the automobile are ensured.

For better utilization of the engine power, do not change over to a higher gear during acceleration until the engine r.p.m. and the automobile speed cease to increase at full fuel feed. In case of stable driving on a good road in the third gear, lock up the torque converter. The locking-up of the torque converter excludes the loss of power in the torque converter and intensive heating of oil in the hydraulic transmission.

If the automobile is loaded so that it is required to drive it in the second gear on a good road (for example, when towing a heavy-weight semitrailer), lock up the torque converter in the second gear. The torque converter is not locked up in the first gear.

To provide for economic operation of the automobile and to ensure trouble-free operation of the torque converter it is recommended to use the following speed ranges:

- in the first gear - 6-15 km/hr;
- in the second gear:
  - with the torque converter unlocked - 10-25 km/hr;
  - with the torque converter locked up - 25-35 km/hr;

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- in the third gear:

with the torque converter unlocked - 20-45 km/hr;

with the torque converter locked up - 45-60 km/hr.

The above speed ranges of driving should be used with the engine operating at full fuel feed and with the direct gear engaged in the transfer case.

It is not recommended to drive at speeds below 6 km/hr in the first gear, 10 km/hr in the second gear and below 20 km/hr in the third gear since the torque converter will operate at low gear ratios causing deterioration of the economy characteristics of the automobile and a sharp increase of the oil temperature in the torque converter.

When driving the automobile in the low gear of the transfer case (at full fuel feed) the recommended speed ranges in all gears of the planetary gearbox will be approximately two times lower.

When reducing the automobile speed for negotiation of obstacles (ditch, rut, railroad crossing, etc.), unlock the torque converter for which purpose, depress the unlocking button on the instrument panel and change over to the second and then to the first gear depending upon the road conditions and while doing so, adjust the fuel feed.

To slow down the automobile when negotiating the obstacles which do not require shifting of the gears, it is sufficient to release the accelerator pedal and apply the foot brake, if necessary. When the automobile is coasting on roads with hard surface, it is forbidden to disengage the gear in the planetary gearbox.

When driving on turns, reduce the automobile speed and take measures ensuring safe driving.

On Upgrade

As a rule, continuous parking of the braked automobile on an upgrade is not recommended.

In case of an emergency stopping of the automobile on the upgrade, brake the automobile by the hand and foot brakes, and place sprags (furnished with the automobile) under the rear axle wheels; this done, release the foot brake.

The procedure of placing the automobile in motion on an upgrade depends upon the upgrade steepness as well as upon the nature and condition of the road.

When placing the automobile in motion on the upgrade, do the following:

- carry out the first five operations given in the Section "Placing the Automobile in Motion on Level Road";
- shift in the first gear in the planetary gearbox;
- sound the horn, gradually release the hand brake lever and simultaneously increasing the engine speed by depressing the accelerator pedal, start moving;
- drive to a level section of the road and stop the automobile;
- put the sprags to their proper place and go on moving.

In winter, it is of particular importance to take into account the condition of snow cover on the upgrade on which the automobile has been stopped and depending upon the snow cover condition, take the required measures (adding of sand, digging down, etc.) to ensure reliable placing the automobile in motion and negotiation of the upgrade.

As a rule, an upgrade should be negotiated straightway. Oblique movement with a heeling sharply reduces the maximum traction power, causes slipping of the automobile and impairs the conditions for negotiating the upgrade.

Due to the same reasons, avoid the straightway movement on a hillside.

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Before negotiating an upgrade the driver should engage that gear in the planetary gearbox (if necessary, he should engage the low gear in the transfer case) in which negotiation of the upgrade by the automobiles is ensured without reshifting the gears.

On particularly heavy upgrades, lock up the transfer case differential.

For locking up the transfer case differential, set the valve handle located to the left on the steering column into position "H + EJ".

On an upgrade, drive the automobile without stops and turns.

If due to any reasons the upgrade cannot be negotiated, take precautionary measures and slowly move down having shifted in the reverse gear and set the minimum stable speed of the engine.

Move down gradually preventing acceleration of the automobile.

When driving in column the automobiles should negotiate the upgrade in turn. Simultaneous driving of two automobiles on the upgrade is forbidden.

#### On Downgrade

As a rule, continuous parking of the automobile on a downgrade is not recommended.

In case of emergency stopping of the automobile on the downgrade, brake the automobile by the hand and foot brakes and place the sprags under both wheels of the front axle; this done, release the foot brake.

The procedure for placing the automobile in motion on a downgrade, depends upon the downgrade steepness as well as upon the nature and condition of the road.

In all cases, descending in the low gear is more safe.

On a short downgrade with a good road it is permissible to descend in a higher gear than on a continuous downgrade with a bad road.

To start the automobile braked on the downgrade, proceed as follows:

- carry out the first five operations given in the Section "Placing the Automobile in Motion on Level Road";
- shift in the reverse gear in the planetary gearbox;
- sound the horn, gradually release the hand brake lever and simultaneously increasing the engine speed, back out the automobile for 1-2 m and disengage the reverse gear;
- brake the automobile by the foot and hand brakes and hold it in such a position until one of the crew members removes the sprags from under the wheels;
- shift in the required gear in the planetary gearbox ensuring safe driving on the downgrade, release the hand brake lever, sound the horn and releasing the foot brake pedal start to descend by coasting without cutting in the fuel feed.

**WARNING!** Coasting of the automobile on a slippery downgrade is forbidden.

The speed of coasting automobile on a downgrade should be maintained within the limits depending upon the condition of a road and visibility.

**WARNING!** In winter it is forbidden to drive the automobile by coasting on a snow-covered or ice-glazed downgrade. Always place the automobile in motion on the downgrade with the second gear engaged in the planetary gearbox and with the torque converter locked up to use the engine for additional braking of the automobile.

When negotiating a steep downgrade, take all the precautionary measures providing for a safe descent.

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Stopping of Automobile

To stop the automobile, proceed as follows:

- release the accelerator pedal;
- unlock the torque converter (if it has been locked up) and set the gearshift lever of the planetary gearbox in the neutral position;
- if necessary, slightly brake the automobile with the foot brake;
- after the automobile is stopped, apply the hand brake.

For emergency (immediate) stopping, do the following:

- quickly release the accelerator pedal and simultaneously unlock the torque converter if it has been locked up;
- depress the foot brake pedal;
- after the automobile is stopped, disengage the gear by setting the gearshift lever in the neutral position;
- apply the hand brake.

After stopping the automobile on an upgrade, place the sprags under both wheels of the rear axle, on a downgrade, place them under both wheels of the front axle.

When parking the automobile on level sections of the road and in case of emergency stopping of the automobile on upgrades and downgrades in winter it should be taken into account that freezing of the hand brake band and wheel brake shoes to the drums is possible due to penetration of water or snow. To prevent freezing of the brakes, release all the brakes after having taken the precautionary measures (placing the sprags under the wheels, etc.) excluding any possibility of spontaneous movement of the automobile.

Running-In of Automobile

The running-in of a new automobile with the purpose to ensure complete wearing in of its parts and mechanisms should be carried out during the first 2,000 km of run.

The complete scope of the running-in procedure includes the running-in tests performed at the Manufacturing Plant during a 600-km run.

After the running-in tests performed at the Manufacturing Plant the automobile is completely ready for service without any restrictions referring to the operating conditions.

When running in the automobile, observe the following basic requirements referring to the preventive maintenance:

- run in the automobile only on the recommended grades of fuel and oil;
- when in motion, constantly observe the readings of instruments and in due time take the measures to correct abnormal operation of the automobile units and assemblies;
- at halts, check the units and assemblies for heating; in case of excessive heating, reveal the causes and eliminate the troubles.

When running in the automobile, unscrew the plug on the washer attaching the steering system hydraulic booster; after the running-in procedure is completed, screw in the plug.

After the first 1,000 km of run including the running-in tests performed at the Manufacturing Plant, carry out the refastening operations prescribed in preventive maintenance No.1, check and top up the capacities of all the assemblies, lubricate the bearings of the propeller shaft centre crosses, constant-velocity universal joints and bearings of the king pins.

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After the running-in of automobiles, i.e. after 2,000 km of run, carry out preventive maintenance No.1 in the full scope once again, and additionally:

- change oil in the engine;
- remove and wash the oil filter housing, slotted cleaning section and replace the cardboard filtering element;
- change oil in the hydraulic transmission;
- unscrew the container of the cyclone filter of the hydraulic transmission and clean it of dirt; in case, a great amount of metal dust or metal particles is detected, find out the place of damage;
- remove and wash the filter of the hydraulic transmission tank;
- remove and wash the filter of the torque converter;
- remove and wash the headers of the front and rear pumps located in the hydraulic transmission tank;
- remove and wash the headers of the planetary gearbox suction pump;
- check the intermediate and final reduction units of the driving axles for proper fastening to the frame;
- check and, if necessary, adjust the bearings of the wheel hubs;
- clean the magnetic plugs of the overdrive gear housing, hydraulic transmission tank, planetary gearbox and transfer case;
- change oil in the compressor crankcase, fan drive reduction gear housings, overdrive gear housing, transfer case housing, power take-off housing, housings of the axle reduction units, wheel-hub drive casings and in the steering gear case.

After the automobile has been run in during a 2,000-km run and the above operations have been carried out the automobile is considered to be ready for normal service.

#### DRIVING THE AUTOMOBILE UNDER POOR ROAD CONDITIONS

##### Negotiation of Different Obstacles on Roads

Obstacles which are encountered on roads and cause a sharp increase of load on the wheel should be negotiated with the torque converter unlocked and with low gears engaged in the planetary gearbox and transfer case. In separate cases, the locking-up of the transfer case differential should be used.

Pumps and obstacles (stumps, stones, etc.) not exceeding in height the automobile ground clearance should be passed between the wheels if there is no possibility to pass them by. Obstacles exceeding in height the ground clearance should be passed by.

If the automobile fails to negotiate an obstacle and bogs down, stop the attempt to negotiate the obstacle and tow it by another automobile.

##### Fording

Prior to fording, do the following:

- investigate the ford depth (it should not exceed 1.3 m), condition of the bottom ground and select the approach and departure places with sloping banks;
- mark with stakes the ford width and most deep places.

The engine speed should be constant and not less than 1,700 r.p.m. When crossing the ford, prevent the engine from shutting down; drive the automobile in gears providing for ascending the far bank.

When crossing a ford exceeding one metre in depth mechanical admixtures (sand, etc.) may penetrate into the housings of the circulation and fuel feed pumps through the check holes together with water and cause wear of the circula-

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tion pump textolite packing washers, wear of the fuel feed pump packing collars as well as add to leakage of oil, coolant and fuel from these pumps.

To prevent this trouble, fill the check holes in the housings of the circulation and fuel feed pumps before crossing the ford with consistent lubricant ИММАН-201/УТБ-А/, State Standard (ГОСТ) 6267-59 or УТБ (1-13), State Standard (ГОСТ) 1631-61.

After the ford has been crossed, remove the lubricant from the check holes completely.

Fords having the depth less than 1 m may be crossed with the check holes open.

If at crossing of the ford the automobile engine has stalled and there is a danger that water will penetrate into the cylinders, immediately stop the engine and recover the automobile from the ford with the help of a towline; this done, drain oil with water from the lubricating system and remove water from the cylinders by rotating the engine crankshaft manually in the direction of normal rotation with the injectors removed. In this case, fill the engine with hot fresh oil. Start the engine and run it at halt at a service speed for 30 min with the oil temperature of at least 70°C to remove the remaining water from the engine. Attentively examine and listen to the engine during its operation. If no defects are detected it is permissible to go on with driving the automobile.

In winter, right after fording the brakes should be dried for which purpose, drive the automobile for a certain distance with the brakes slightly applied.

#### Driving on Ice

Crossing a river on ice should be attempted only after a thorough investigation of the ice thickness and condition, place of approach onto the ice and place of departure at the far bank as well as the depth of snow cover on the ice and banks.

The ice thickness permissible for safe crossing is given in the Table.

Permissible Thickness of Ice in Case of Crossing Rivers

Automobile load	Thickness of ice, cm	
	single automobile	group of automobiles
1. Automobile without load	35	42
2. Automobile with semitrailer:		
without load	46	56
with full load	71	84

If the ice strength is not sufficient it can be reinforced by a matting made of logs (girders) or planks. The matting should be nailed together by cramps, spikes or bound with wire, flooded with water and frozen up.

The automobile should be driven on the ice and matting at a low speed without jerks, turns and stopping. The distance between the automobiles at crossing should be not less than 30 m. Before driving on the ice all the personnel except for the automobile driver should alight, the cab doors and the hatch in the cab roof should be opened.

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Driving on Bridges and Railroad Crossings

If the capacity and reliability of a bridge are not known, halt the automobile, inspect and if necessary reinforce the bridge; taking all the precautionary measures, cross the bridge in the first gear. All the personnel except for the automobile driver should alight. If the bridge cannot provide for a reliable crossing, look for a by-pass.

When crossing the railroad (at railroad crossings), drive the automobile in the first or second gear with the torque converter unlocked and taking all the precautionary measures.

Driving of Automobile with Semitrailer<sup>x)</sup>

The automobile should be driven to the semitrailer for coupling carefully at a low speed of the engine.

Only one man must supervise the coupling (uncoupling). The man who supervises the coupling (uncoupling) should be positioned so that he can simultaneously observe the automobile driver and the man performing the coupling. The driver must attentively watch the signals made by the man who supervises the coupling (uncoupling), through the cab door window.

After the coupling is over, check that the lock of the fifth-wheel assembly grips is reliably closed, connect the hose of the semitrailer air brake system using for this purpose the coupling heads, open the cut-out cock setting the cock handle in the direction of the automobile driving and make sure that the coupling is correct and reliable. Connect the automobile and semitrailer electric systems by means of the connecting electric wire.

Make sure that the adjusting ring on the cover of the brake valve lower cylinder is set in the position "P" when towing heavily loaded semitrailers or in the position "E" when towing empty semitrailers. Before driving out, run a certain distance to check operation of brakes and reliability of coupling with the semitrailer.

Start from the halt, accelerate and brake the automobile with the semitrailer smoothly. Change over to the next higher gear only after the automobile train has gained the sufficient acceleration.

When towing a semitrailer, take into account that maneuverability and passability of the automobile train is determined by the passability of a heavyweight semitrailer but not by that of the automobile.

Perform the turns of the automobile train at speeds ensuring safe driving.

To uncouple the semitrailer from the automobile, carry out the operations prescribed for coupling in the reverse order.

As a rule, the coupling (uncoupling) of the semitrailer should be performed on a level ground. In emergency cases the coupling (uncoupling) is permissible with misalignment of the automobile and semitrailer axes up to an angle of  $90^{\circ}$  in the horizontal and up to  $10^{\circ}$  in the vertical planes on the condition that the conjugating surfaces of the fifth-wheel assembly and semitrailer bedplate can be aligned and the precautionary measures are taken.

After the coupling (uncoupling) is over, inspect the fifth-wheel assembly and eliminate detected deficiencies.

As a rule, it is forbidden to halt the automobile train on an upgrade or downgrade. In case of emergency stopping of the automobile train, take all the required

<sup>x)</sup> For peculiarities in operation of semitrailers, see the instructions on corresponding semitrailers.

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measures (brake the automobile and semitrailer by the parking brakes having placed the sprags under the rear wheels of the automobile and semitrailer, etc.) preventing the automobile train from spontaneous movement.

Descending of the automobile train on a downgrade requires particular attention of the driver.

Before crossing a ford by the automobile train it is recommended to uncruple the semitrailer and to cross the ford by the automobile to determine the possibility of crossing the ford by the automobile train.

**WARNING!** It is forbidden to drive the automobile train with the brake system of the automobile or semitrailer out of order.

Movement of the automobile train in deep mud, sand or snow depends upon the passability of the semitrailer.

#### Towing of Automobile by Another Automobile

For towing an automobile whose engine is in the serviceable condition the use is made of a flexible towing line (wire rope) the quality of which should meet the requirements of the safety rules. In cases, when it is necessary to tow an automobile whose engine is in the serviceable condition but the power train is out of order the latter should be disengaged from the engine by the lever located on the overdrive gear. In the process of towing the engine of the towed automobile should be operating for delivery of compressed air into the automobile brake system and for driving the pump of the steering system hydraulic booster.

Place the automobiles in motion only after the air pressure in the air systems has reached at least  $2.65 \text{ kgf/cm}^2$ . Start movement smoothly in the first gear having previously checked the functioning of the brake system at halt, then shift in a higher gear in the process of driving. Shift on the gears avoiding a sharp drop of the driving speed for which purpose, completely accelerate the automobile and then quickly shift in the gear. Change over to a lower gear slightly reducing the fuel feed.

In the process of towing, prevent sharp variations of the driving speed since it may result in slackening of the wire rope and its breakage at a jerk. The driver of the towing automobile should watch the wire rope and keep it always tightened. Sudden stops inevitably lead to collision of the automobiles.

If required, the towing by a towbar with the engine of a towed automobile out of repair is permitted. In this case, it is necessary to remember that an effort to be applied to the steering wheel of a towed automobile will be greater since the steering gear hydraulic booster does not function.

After coupling the automobiles, take a tyre inflating hose from the SFA set and screw off the head with the nipple. Pass the hose through the ports in brackets of pads of the towing automobile third and fourth axles and secure it on the towbar at three points by fastening belts. When fastening the hose to the towbar, make the hose slacken so that its length is 1.2-1.5 time greater than the length of the towbar. Coil the superfluous portion of the hose and attach it with a belt near the coupling head of the towing automobile (Fig.145).

Connect one end of the hose to the air take-off cock of the towing automobile and the other end to the towing air valve of the towed automobile. Having thoroughly checked the hose connection, deliver compressed air having opened for this purpose the valve of the air take-off cock.

For towing, select a route with slight grades and without sharp turns. Keep the driving speed within the limits ensuring safe driving but not exceeding

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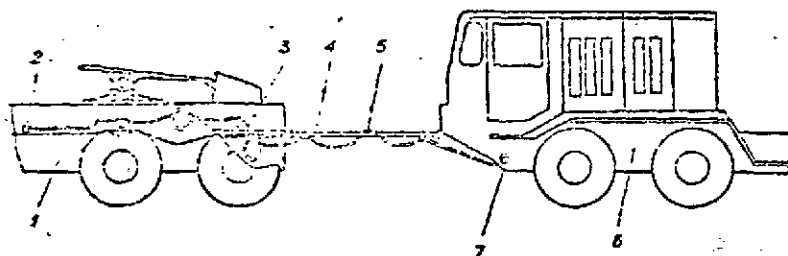


FIG. 114. DIAGRAM OF COUPLING FOR TOWING AUTOMOBILE BY ANOTHER AUTOMOBILE

1 - towing automobile; 2 - air take-off cock; 3 - hoses; 4 - towing bar; 5 - fastening belts;  
6 - towed automobile; 7 - towing air valve

15 km/hr. Take particular care and be more attentive when driving on a turn. Stop the automobile only on a horizontal section of the road gradually slowing down the vehicle.

#### Checking Automobile Operation in Motion

During the automobile movement the readings of the instruments should be as follows:

- engine speed:	
maximum	2,100 r.p.m.
minimum	1,400 r.p.m.
- temperature of coolant in cylinder blocks:	
recommended	80-90°C
maximum	105°C
- engine oil outlet temperature:	
recommended	80-90°C
maximum	110°C
- oil pressure in engine lubricating system main oil line	6-10 kgf/cm <sup>2</sup>
- oil pressure in planetary gearbox boosters	9-13 kgf/cm <sup>2</sup>
- oil pressure in torque converter	3-4 kgf/cm <sup>2</sup>
- oil pressure in hydraulic transmission lubricating system	1.0-1.5 kgf/cm <sup>2</sup>
- oil temperature in torque converter:	
recommended	70-115°C
permissible	40-125°C
- oil temperature in planetary gearbox	20-95°C
- air pressure in brake system	5.65-7.35 kgf/cm <sup>2</sup>
- air pressure in tyres	4.5±0.2 kgf/cm <sup>2</sup>

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PECULIARITIES OF AUTOMOBILE OPERATION IN WINTERPreparation of Automobile

Reliable, safe and durable operation of the automobile greatly depends upon the qualitative and timely preparation for winter operation.

Depending upon the region of the automobile service all the operations pertaining to the preparation of the automobile for winter operation should be started and completed before the outbreak of cold weather and the seasonal preventive maintenance should be carried out as well.

When operating the automobile in winter it is necessary to take a number of measures ensuring the required temperature conditions of fuel, coolant and lubricating materials.

For recommendations pertaining to filling winter grades of fuel, coolant and winter grades of lubricants, refer to the Section "Service Materials".

To facilitate the filling and starting of the engine at an air temperature below  $+5^{\circ}\text{C}$  it is recommended to fill the engine oil tank and compressor oil pan with oil heated to a temperature of  $80-90^{\circ}\text{C}$ .

It is necessary to check and obtain an appropriate specific gravity of electrolyte in the storage batteries.

The electrolyte specific gravity in the northern zones with a minimum ambient air temperature of down to  $-40^{\circ}\text{C}$  should be  $1.29 \text{ gr/cm}^3$  while in zones with severe continental climate and ambient air temperature below  $-40^{\circ}\text{C}$  it should be  $1.31 \text{ gr/cm}^3$ .

In zones of Extreme North and at ambient air temperatures below  $-35^{\circ}\text{C}$  the warming cover should be put on the hood of the engine compartment and the radiator and fuel tanks compartment.

Prior to putting on hood warming cover 5 (Fig.146), pass over rope 4 along the cab top having previously run it through hand rails 1 and tie it to lower hooks 2 arranged on the cab side panels.

At the front the warming cover is attached to the rope and at the remaining places it is secured to the clamps by straps provided on the warming cover.

Automobile Operation

Start and warm the engine according to the instructions given in the Section "Preparation of Automobile for Movement".

To facilitate the engine starting each time after the operation is over, disengage the hydro-mechanical transmission from the engine by the lever located on the overdrive gear.

If in winter the difficulty in starting the warmed engine is due to the fact that fuel is not fed into all the cylinders, fill the pump space with 3-3.5 litres of oil which has been previously heated to a temperature of  $+110-120^{\circ}\text{C}$ . As a result the entire pump will be warmed up and the shifting of the fuel injection pump control rack will be eased when the rod connected to the governor lever is moved.

Drain oil through the drain pipeline.

If with the automobile in motion the temperature of oil in the torque converter drops below  $+40^{\circ}\text{C}$  and in the planetary gearbox below  $+20^{\circ}\text{C}$  it is not recommended to lock up the torque converter with the purpose of raising the temperature of oil in the hydraulic transmission.

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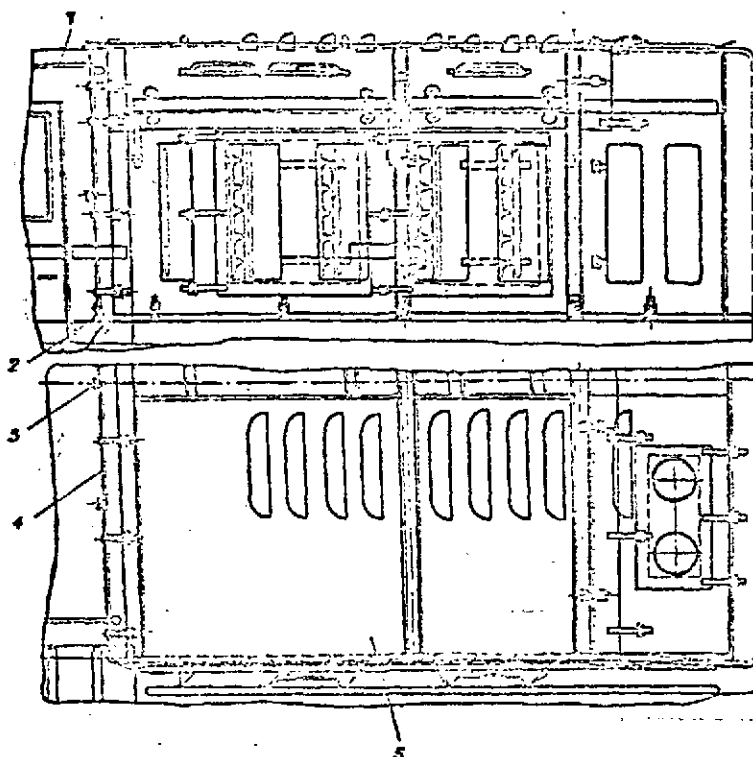


FIG. 146. HOOD WARMING COVER INSTALLATION

1 - hand rail; 2 - lower hooks; 3 - supporting hooks; 4 - rope; 5 - warming cover

The temperatures of the engine coolant and oil should be within the limits specified in the Subsection "Checking Automobile Operation in Motion".

Watch the condition of storage batteries with particular care not allowing the voltage to drop below 20 V by the voltmeter with the electric starter switched on.

When it is necessary to keep the parked automobile ready for immediate operation at low temperatures of ambient air, proceed as follows:

- park the automobile in warm premises;
- if the warm premises is not available, cover the automobile with a tent and warm it with hot air supplied from a periodically or constantly operating air heating plant EP-27 with the purpose to prevent the temperature in the cooling and lubricating systems of the engine as well as in the hydro-mechanical transmission and transfer case from dropping below +5°C.

Drain condensate from the air bottles and the moisture-and-oil separator through the cock and from the master brake cylinders through two drain plugs. The condensate should be drained from the above mentioned units if the air pressure is available in the systems after arrival of the automobile to the park.

When the automobile is parked for a continuous period of time outdoors, proceed as follows:

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- pay out the wire rope and attach it to the towing gear of stuck automobile 2 having braked the automobile by the parking brake (use of the foot brake is permissible);

- engage the winch for winding and start the recovery; if the recovery automobile skids, place sprags under its wheels. Besides, it is permissible to attach the automobile by means of a tow line to another braked automobile or to another stationary object without using the sprags in this case.

If, when pulling the load, the safety coupling operator, do not allow it to slip in excess of 2-3 sec and immediately stop the pulling.

In this case, pull the load with the help of a pulley block (Figs 169, 170) furnished with the automobile

SPTA set, or by winches on two automobiles.

Do not allow more than two slips of the safety coupling during one pulling operation.

For procedure of handling the pulley block, refer to "Operating and Maintenance Instructions of MA3-5247E,F Semitrailers".

When operating the winch, observe the following precaution measures:

- carefully watch the pulled load;
- do not leave the cab when the winch is operating;
- do not allow jerks when pulling the load; a sharp increase of load may cause breakage of the wire rope;
- it is forbidden to pull the load with the automobile in motion as the dynamic loads which are inevitable in this case will cause breakage of the wire rope;
- during operation of the winch, do not stand near the tightened wire rope;

- when winding the wire rope, see that the thimble does not thrust against the block of guide-rollers as it may cause breakage of the wire rope and damage to the winch;

- do not allow the paying-out of the wire rope after the portion of the wire rope painted red has appeared from the winch or after the horn has sounded and the pilot lamp has gone on;

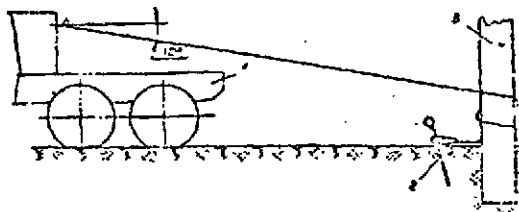


FIG. 167. DIAGRAM FOR SELF-RECOVERY OF STUCK AUTOMOBILE  
1 - stuck automobile; 2 - crow bar; 3 - stationary object

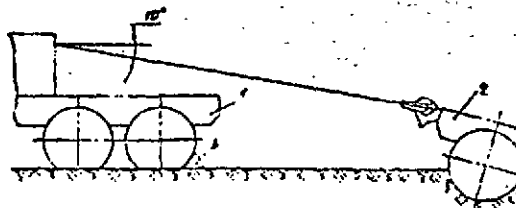


FIG. 168. DIAGRAM FOR RECOVERY OF AUTOMOBILE BY ANOTHER AUTOMOBILE

1 - recovery automobile; 2 - recovered automobile; 3 - sprag

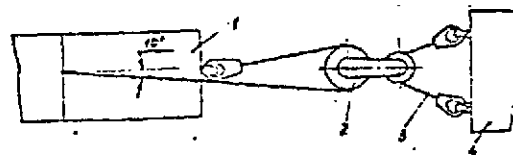


FIG. 169. DIAGRAM FOR SELF-RECOVERY OF AUTOMOBILE BY MEANS OF PULLEY BLOCK AND STATIONARY OBJECT

1 - stuck automobile; 2 - pulley block; 3 - wire rope; 4 - stationary object

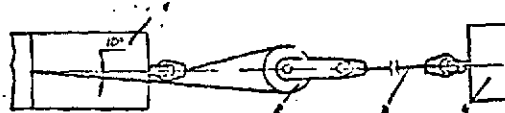


FIG. 170. DIAGRAM FOR RECOVERY OF AUTOMOBILE BY MEANS OF PULLEY BLOCK

1 - recovery automobile; 2 - pulley block with small roller removed; 3 - wire rope; 4 - recovered automobile

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- do not allow formation of loops when unwinding or winding the wire rope.

#### Preventive Maintenance of Winch

Routine inspection before operation of the winch:

- check fastening of the winch to the subframe and automobile frame.

Daily preventive maintenance (to be carried out in case of the winch operation):

- check the condition of the winch;
- clean the winch wire rope of dirt and wash the wire rope cleaner.

The lubricant in the winch units should be changed according to the winch lubrication chart depending upon the number of pulling operations performed but not less than once a year.

#### Adjustment of Winch Mechanisms

##### Adjustment of Safety Coupling

In the process of the winch operation the safety coupling spring gets weakened due to which the winch fails to develop the required pulling effort (15 t). To restore the rated pulling effort the winch safety coupling should be subjected to adjustment for which purpose, proceed as follows:

- reliably stop the automobile (place the sprags under the wheels or attach the automobile with the help of a tow line to an anchor or any other stationary object);
- pay out the wire rope for a length of 5-6 m and hook it to any object through a dynamometer;
- remove the safety wire and turn out locking screw 8 (Fig.161) of adjusting nut 7;
- gradually rotating adjusting nut 7, obtain the required pulling effort on the wire rope registered by the dynamometer. The pulling effort on the wire rope is checked by the dynamometer with the winch engaged for pulling.

When performing the above operations, be careful when selecting an object for attaching the wire rope as well as when adjusting the safety coupling.

Adjustment of the safety coupling should be performed with the winch put out of operation and with the wire rope slackened.

Note: Rotation of the adjusting nut clockwise increases and counter-clockwise reduces the effort on the wire rope (to be viewed on the side of the safety coupling). After adjustment, assemble the coupling in the reverse order and make sure the adjusting nut pin enters the shaft groove.

##### Adjustment of Wire Rope Level Winding Device

To obtain the correct laying of the wire rope on the winch drum it is necessary to adjust the wire rope level winding device for which purpose, proceed as follows:

- unwind wire rope 7 (Fig.159) from winch drum 11;
- remove wire rope pay-out limit electric indicator 10;
- remove the idle gear of the wire rope level winding device drive;
- rotating the screw of wire rope level winding device 12, set the fork of the wire rope level winding device in the extreme right-hand position. In this case, the wire rope fitting place in drum 11 should be at the extreme top point;

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- reinstall the idle gear with drum 11 held in the above position. It is permissible to turn the gear in either side to provide for meshing of the gears;
- wind the wire rope on winch drum 11;
- adjust wire rope pay-out limit electric indicator 10 as instructed below.

#### Adjustment of Pay-Out Limit Electric Indicator

To adjust the pay-out limit electric indicator (Fig. 165), proceed as follows:

- rotating adjusting screw 4 by pin 2 clockwise, set nut 1 into the extreme position;
- rotating adjusting screw 4 by pin 2 counter-clockwise, obtain the cutting-in of button switch 9 (a click is heard). Rotating screw 4 further, obtain (after 1.75-0.5 of a turn) the cutting-in of second button switch 7 (a click is also heard). If button switch 7 is cut in not after 1.75-0.5 of a turn of screw 4, carry out the adjustments for which purpose, proceed as follows:
  - remove the cover of the pay-out limit electric indicator;
  - having loosened screws 6, carry out the adjustment by shifting switch 9 or 7;
  - reinstall the cover.

To install the pay-out limit electric indicator on the winch, proceed as follows:

- pay out the wire rope from the winch drum so that 4-7 turns of the wire rope are left on the drum;
- set nut 1 so as to obtain the cutting-in of button switch 9. Install the pay-out limit electric indicator in such a position on the bracket of the wire rope level winding device so that pin 2 enters the grooves on the level winding device screw and secure it.

Connect the wires.

Note. Letter "G" standing for "HORN" is marked near the lead of button switch 9 while letter "L" standing for "PILOT LAMP" is marked near the lead of button switch 7.

- wind 10-15 turns of the wire rope on the drum and pay it out. When the horn sounds (switch 9 is cut in) there should be 4-7 turns of the wire rope left on the drum; when the pilot lamp lights up (switch 7 is cut in) there should be 2.5-4 turns of the wire rope left of the drum.

After adjustment of the pay-out limit electric indicator, wind the wire rope completely.

#### Storage of Winch

The winch should be put in storage when performing operations pertaining to preparation of the automobile for a long-term storage.

To put the winch in storage, check the level of oil in the winch reduction gears and top up, if necessary.

Unwind the wire rope from the winch drum. Clean the wire rope level winding device of dust and dirt. Lubricate the winch parts which have no protective coatings with universal medium-melting lubricant.

Lubricate the gears and grooves of the traction rollers with oil, grade MT-16N. Clean the wire rope of dirt and lubricate with the engine waste oil when winding it on the drum.

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Troubles and Remedies of Winch

Trouble	Cause	Remedy
1	2	3
Winch fails to develop rated pulling effort	Safety coupling spring weakened	Adjust safety coupling and lock nuts. Effort on the wire rope should be $15 \pm 0.5 t$ (to be checked by dynamometer)
Wire rope fails to be paid out without load	1. Wire pay-out port clogged 2. Insufficient pressure of pressure roller	1. Clean port 2. Tighten pressure roller spring to a size not less than 58 mm
When portion of wire rope painted red appears worn and red pilot lamp fail to operate	Pay-out limit indicator is out of adjustment	Adjust pay-out limit indicator
When winch is engaged for paying out, wire rope collecting drum rotates spontaneously and wire rope has no tension between drum and traction rollers	1. Ratchet pawl spring broken 2. Insufficient torque of friction clutch	1. Replace spring 2. Increase friction clutch torque by means of adjusting nuts having previously removed the cover
Wire rope laying on drum disturbed	1. Wire rope level winding device is out of adjustment 2. Wire rope level winding device is out of repair	1. Adjust wire rope level winding device 2. Disassemble wire rope level winding device and eliminate the trouble
When winch is engaged for pulling, collecting drum fails to rotate while traction rollers revolve	Insufficient torque of drum friction clutch	Adjust drum friction clutch

AUTOMOBILE MA3-537A

The MA3-537A automobile differs from the basic model MA3-537 in lack of the fifth-wheel assembly and in availability of the body and winch.

Body

The all-metal welded body has a hinged tail gate. The body floor is provided with latches for access to the transmission and winch assemblies. At the rear the body floor has a depression (bay). The body is attached to the frame by means of brackets, bolts, nuts and springs. The springs are installed on the front bolts.

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WinchPurpose and General Design of Winch

The winch is designed for use in the following cases:

- recovery of stuck automobiles, tractors and trailers;
- hauling in of trailers on a steep upgrade when the automobile train fails to negotiate an upgrade;
- conveying a trailer over the bridge if the bridge capacity does not allow simultaneous passing of the automobile train;
- hauling the trailer when a ford cannot be negotiated by the automobile train.

The winch is equipped with a wire rope having the working pay-out length of 100 m.

Maximum pulling effort is 15 t.

The winch (Fig.171) is arranged under the body at the rear part of the automobile and is mounted on the rocker axle and special cross member.

The winch is driven from the power take off unit through cardan shaft 3.

The winch (Fig.172) consists of frame 4, reduction gear 5, traction rollers 1 and 3, winch drum 9, wire rope level winding device 7, pay-out limit electric indicator 6 and block of guide rollers 5 (Fig.171). The winch welded frame serves for connection of all the winch assemblies.

The winch reduction gear is designed to increase the torque transmitted from the power take-off unit to the traction rollers, to automatically brake the wire rope and to limit the winch pulling effort.

The main units of the winch reduction gear (Fig:173) are as follows: safety coupling, automatic brake, planetary gear and oil pump.

The safety coupling automatically disengages the winch when the effort on the wire rope exceeds the permissible value thus protecting the winch parts from overloading.

The safety coupling is assembled in a separate casing and attached to the reduction gear. The safety coupling consists of the following main parts: casing 19, driving half-coupling 3 and driven half-coupling 4, spring 2, case with balls 18, driving gear 5 and adjusting nut 1.

When the wire rope is under an effort exceeding the permissible value the driving half-coupling starts to slip relative to the driven half-coupling due to which the winch will be disengaged from the drive. Disengagement of the safety coupling is accompanied by peculiar clicks which warn the driver that the effort on the wire rope exceeds the permissible value.

When the effort on the wire rope is reduced to normal the coupling will cut into operation automatically.

The coupling is adjusted with the help of nut 1 by changing the degree of the spring compression.

The automatic brake is used for stopping the load when the kinematic circuit from the engine to the reduction gear is disconnected as well as for braking the load when it is lowered on a grade. The brake operates automatically without participation of the driver.

The planetary gear consists of sun gear 13, carrier 7, three planet pinions 6 and epicyclic gear 9 and is designed for increasing the torque transmitted from the engine to the traction rollers.

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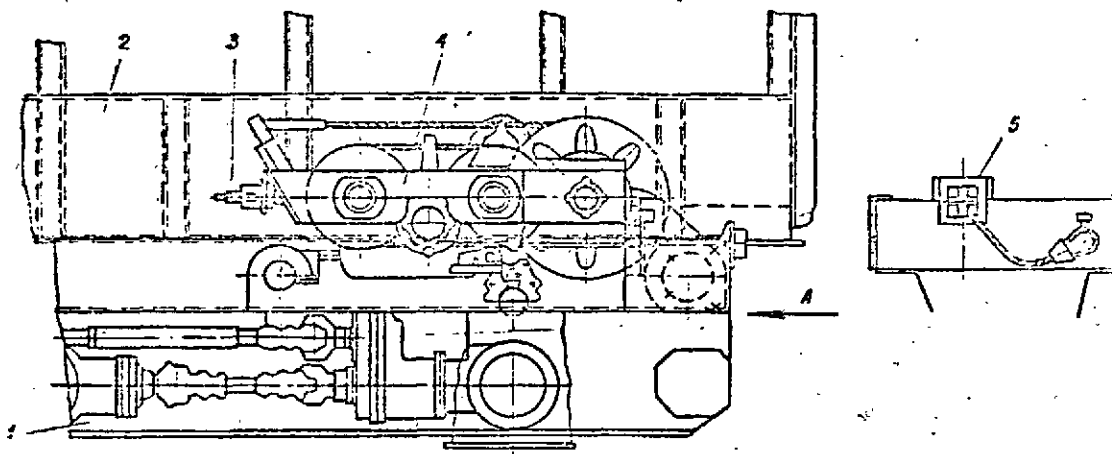


FIG. 171. WINCH INSTALLATION

1 - automobile chassis; 2 - automobile body; 3 - winch cardan shaft; 4 - winch; 5 - block of guide rollers

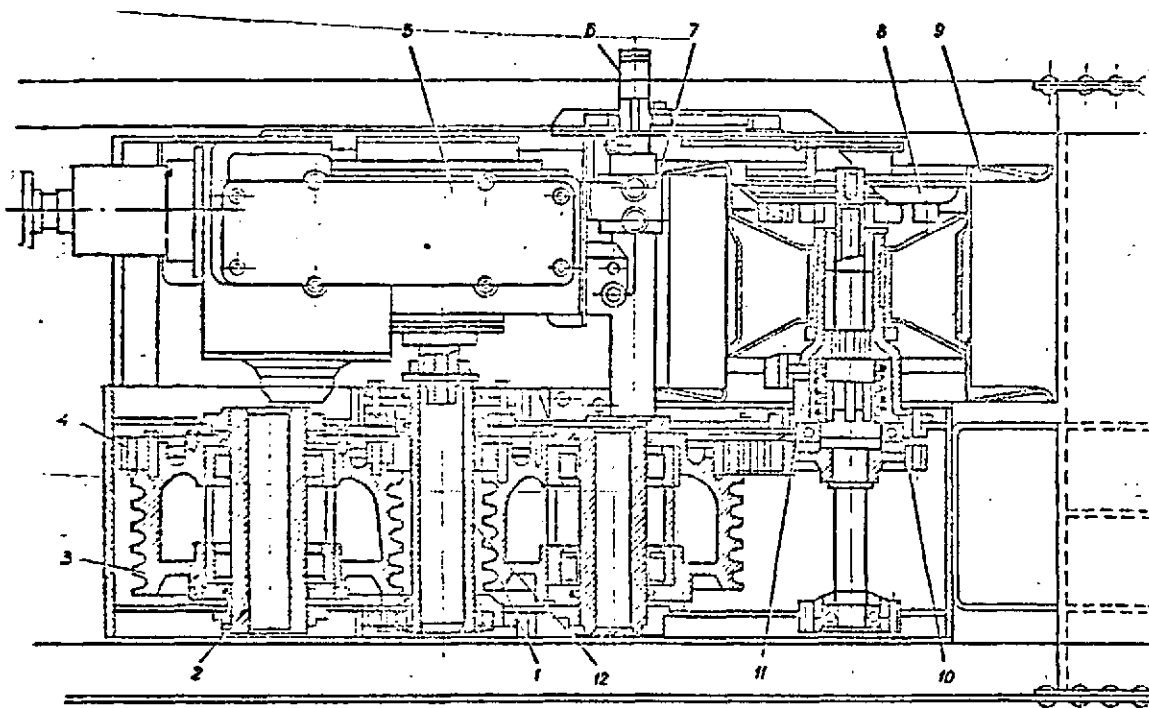


FIG. 172. WINCH

1, 3 - traction rollers; 2 - axle of traction rollers; 4 - winch frame; 5 - reduction gear; 6 - pay-out limit electric indicator; 7 - wire top; 8 - winding device; 9 - drum friction clutch; 10 - winch drum; 11 - ratchet mechanism; 12 - driving gear of traction rollers

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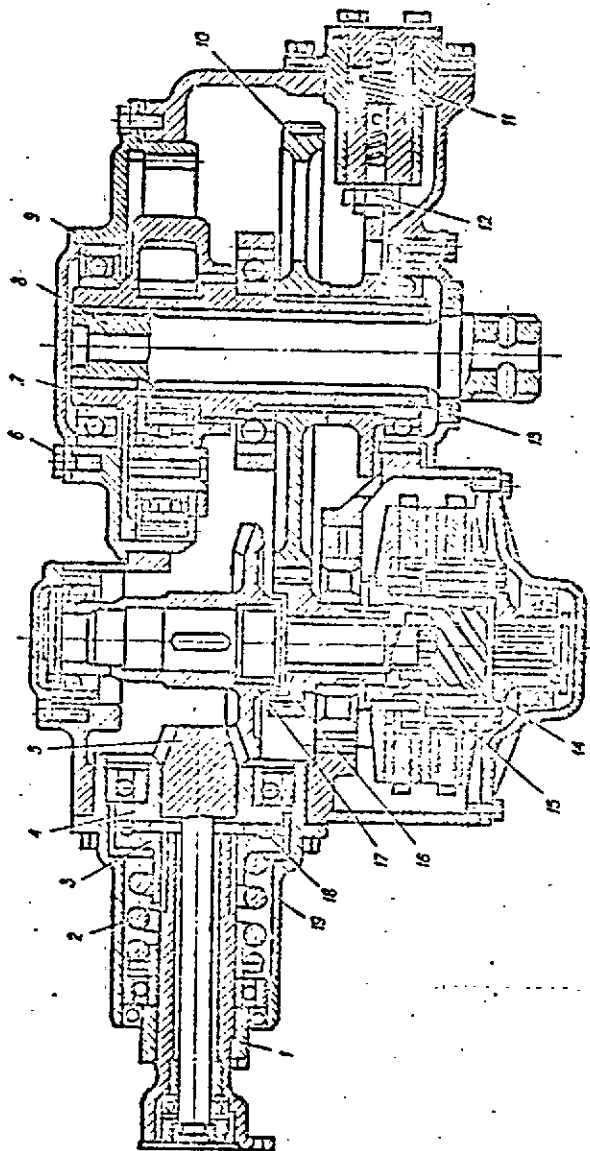


FIG. 17A. WINCH REDUCTION GEAR

- 1 - adjusting nut; 2 - springs; 3 - driving half-couplings; 4 - driven half-couplings; 5 - driving gear; 6 - planet pinions;
- 7 - carrier; 8 - output shaft; 9 - epicyclic gear; 10 - driven spur gear; 11 - plunger pump drive gear;
- 12 - plunger pump drive gear; 13 - sun gear; 14 - nut; 15 - nut; 16 - driving spur gear; 17 - driven spur gear; 18 - ball; 19 - safety coupling casing

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Cam 12 of the oil pump drive is installed on the sun gear splines. The torque is transmitted to the traction rollers through shaft 8 coupled with the carrier by splines. The oil pump serves for delivery of oil to the automatic brake and safety coupling.

Traction rollers 1 and 3 (Fig. 172). As to the purpose and design they are identical with traction rollers of the M43-537T automobile winch and are described above.

Winch drum. The purpose and design of the drum are identical with those of the winch drum used on the M43-537T automobile. The difference consists in the fact that the drum is arranged behind the traction rollers and is driven by these rollers through gear 10 (Fig. 172).

Winch wire rope. The component parts of the wire rope are completely similar to those of the wire rope used on the M43-537T automobile. The difference consists in the fact that the thimble of the M43-537A automobile wire rope is attached on the right side of the automobile rear cross member.

Wire rope level winding device, pay-out limit electric indicator and block of guide rollers. The purpose, design and description of the above assemblies are given above in appropriate subsections.

Operation, preventive maintenance and adjustment of the winch mechanisms.

Operation, preventive maintenance and adjustment of the winch mechanisms are identical with those of the winch used on the M43-537T automobile and are described above.

Lubrication of Winch Units

For lubricating points, grades of used lubricants, terms and procedure of performing the lubricating operations, refer to the Lubrication Chart having excluded the items pertaining to lubrication of the winch drive reduction gear and toothed coupling.

Storage, Troubles and Remedies of Winch

Instructions on storage, list of possible troubles, their causes and remedies are described above in appropriate subsections.

AUTOMOBILE M43-537A

The M43-537A automobile differs from the basic model M43-537 in availability of a generator plant with starting and regulating equipment installed behind the engine compartment.

The generator plant consists of a DC 93-4 synchronous, three-phase, A.C. generator with an exciter, starting and regulating equipment mounted in a separate electric cabinet, drive reduction gear, platform and a shroud. The generator is driven from the power take-off unit by means of a cardan shaft.

A detailed description of design and operating rules of the generator is presented in the maintenance and operating instructions of DC 93-4 synchronous three-phase generator.

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## Appendix 1

PURPOSE, STORAGE AND APPLICATIONS  
OF AUTOMOBILE INDIVIDUAL SPTA SET

Each automobile is furnished with an individual set of spare parts, driver's tools and accessories (SPTA set) which is necessary for servicing the automobile in operation and for performing all basic adjustments on mechanisms and units of the automobile.

The SPTA set is intended for use en route and in a garage (at parking) to perform the preventive maintenance operations and minor repairs of the automobile. As to the spare parts included in the individual SPTA set, it should be mentioned that they are intended for use during the guaranteed service period of the automobile; expenditure of the spare parts should be registered in a special document.

- Notes:
1. In a fifth-wheel automobile tractor a part of the carried-on SPTA set may be stored on the semitrailer. In this case, the delivery sheet is furnished with a diagram showing the arrangement of this part of the SPTA set.
  2. Some parts of the on-vehicle SPTA set upon expenditure are replenished from the non-carried SPTA set.

Places for storage and fastening of parts from the on-vehicle SPTA set are specified in the SPTA set delivery list under the headline "On-Vehicle Set of Tools and Spare Parts" in the column "Storage Place".

When the automobile is shipped to the Customer the on-vehicle SPTA set is placed, with the purpose to ensure its safety, into a wooden box of the on-vehicle SPTA set.

Upon acceptance the Customer stows the on-vehicle SPTA set on the automobile according to instructions given in the delivery list.

Some parts from the SPTA set as, for example, sprags, tow line, spare wheel, pulley block, etc. having considerable dimensions are not packed into a box but are shipped without package together with the automobile according to special instructions.

The non-carried SPTA set is appended to each automobile and is considered to be its inseparable outfit. This set is stored in a garage (at parking) and serves as a supplement to the on-vehicle SPTA set during preventive maintenance and minor repairs of the automobile.

It is forbidden to disintegrate the non-carried SPTA set and to use it for other purposes.

The method of packing of some parts from the SPTA set is specified in the delivery list under the headline "Non-Carried Set of Tools and Spare Parts" in column "Storage Place". All parts of the non-carried SPTA set are stored by the Customer at his will.

When the automobile is shipped to the Customer the non-carried SPTA set is packed in a wooden box of the non-carried SPTA set.

- Note: The SPTA set of the engine Manufacturing Plant in its part pertaining to the non-carried set is delivered in a package of the engine Manufacturing Plant.

Wooden boxes of the non-carried and on-vehicle SPTA sets are provided only for their transportation but not for the storage of sets.

Upon acceptance of the SPTA set the Customer will check the availability of all its parts against the delivery list appended to the automobile. Each part of the SPTA set is marked according to the instructions given in columns 4 and 5. Then, the condition of the SPTA set is checked and, if necessary, the set is repacked or reflushed (for non-carried SPTA set).

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Lubrication Chart of Units and Assemblies and Used Grades of Oils and Lubricants

Used grade of oil (lubricant)	Application		Number of lubricating points on auto-mobile	During preventive maintenance No.1	During preventive maintenance No.2	Instructions on lubrication
	Fig. No.	Description of lubricating point				
1	2	3	4	5	6	7
1. Oil MT-16n State Standard (ГОСТ) 6360-58 or ИТТ ИИ 27-62 and БТУ 449-55	149a	Engine oil tank	1	Check level	Change	The level should be up to the mark II on the oil dipstick
Oil MT-14n <sup>x</sup> State Standard (ГОСТ) 6360-58 is used in Arctic regions and at am- bient air tempera- ture below -25 C instead of oil MT-16n	149b	Compressor crank- case	1	Same	Same	The level should be up to the upper mark on the oil dipstick (with the plug unacrossed)
	149c	Overdrive gear housing	1	Same	Change xx	The level should be up to the mark on the oil dipstick
	149d	Transfer case	1	Same	Change xx	The level should be up to the lower edge of the level hole
	149e	Power take-off housing	1	Same	Change xx	The level should be up to the lower edge of the level hole
	149z	Housing of axle intermediate and final reduction units	4	Same	Change xx	The level should be: (a) in final reduction units - up to the lower edge of the filler hole; (b) in intermediate reduction units - up to the lower edge of the level hole

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1	2	3	4	5	6	7
	149C	Wheel-hub drive housing	8	Check level	Change <sup>xx</sup>	The level should be up to the hole lower edge with the outer carrier cover removed
	149h	Housing of front reduction gear of fans drive	2	Same	Change <sup>xx</sup>	The level should be up to the lower edge of the level hole
	149i	Housing of rear reduction gear of fans drive	2	Same	Change <sup>xx</sup>	The level should be up to the lower edge of the level hole
	149j	Rear suspension rocker	2	Same	Check level	The level should be up to the lower edge of the level hole
	149k	Body of pump variable-speed governor	1	Same	Same	The level should be up to the lower edge of the level hole
	150a	Hydraulic transmission tank	1	Check level 1-2 min after stopping of engine	Change; when changing, drain oil from planetary gearbox, torque converter and tank	The level should be up to the lower edge of the upper level hole
	150b	Steering gear case	1	Check level	Change	The level should be up to the lower edge of the filler hole
	151	Tank of steering system hydraulic booster	1	Check level	Change <sup>xx</sup>	The level should be up to the upper mark on the oil dipstick

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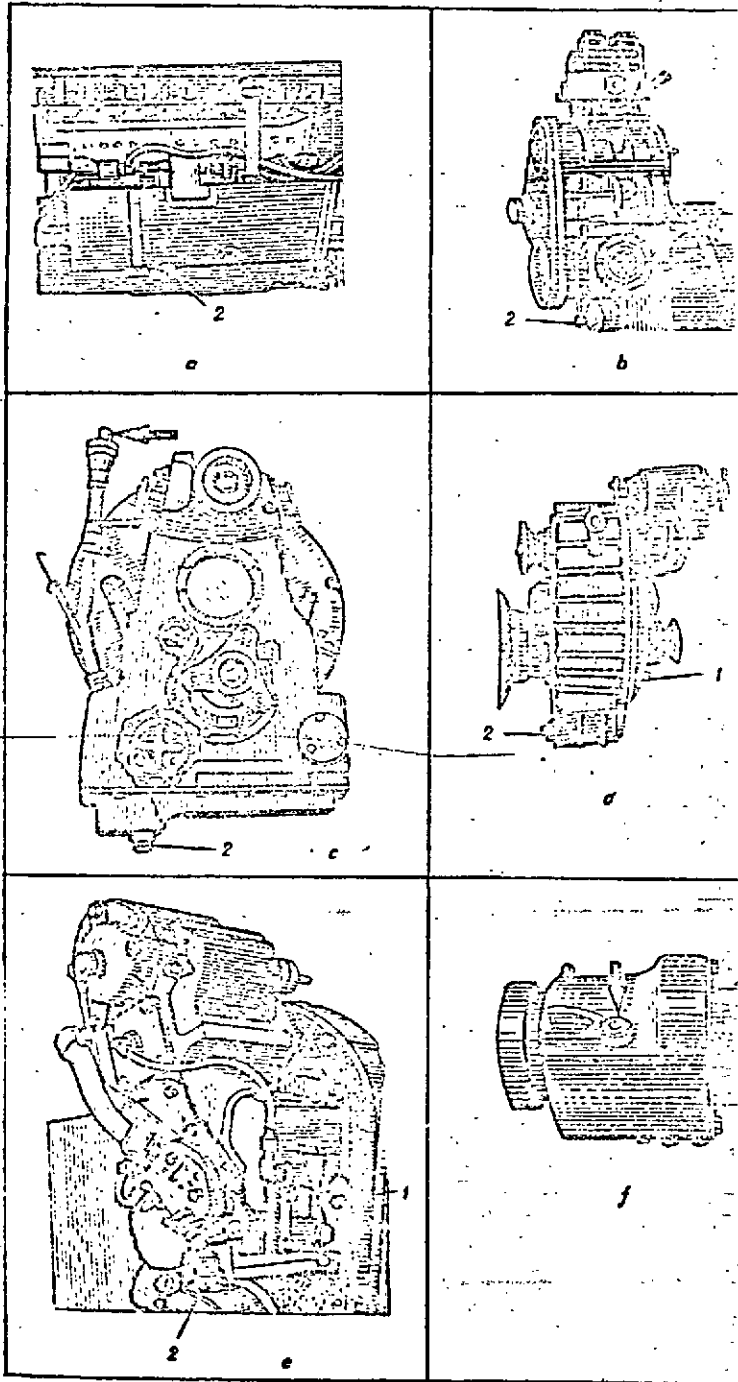
ii. Mixture, containing:  
- 70% of spindle oil AV, State Standard (TOCT) 1642-52;  
- 30% of oil MT-16n

iii. Spindle oil AV, 151 State Standard (TOCT) 1642-52. At a temperature of ambient air below -35°C oil (UBH), State Standard (TOCT) 1005-51 is used instead of spindle

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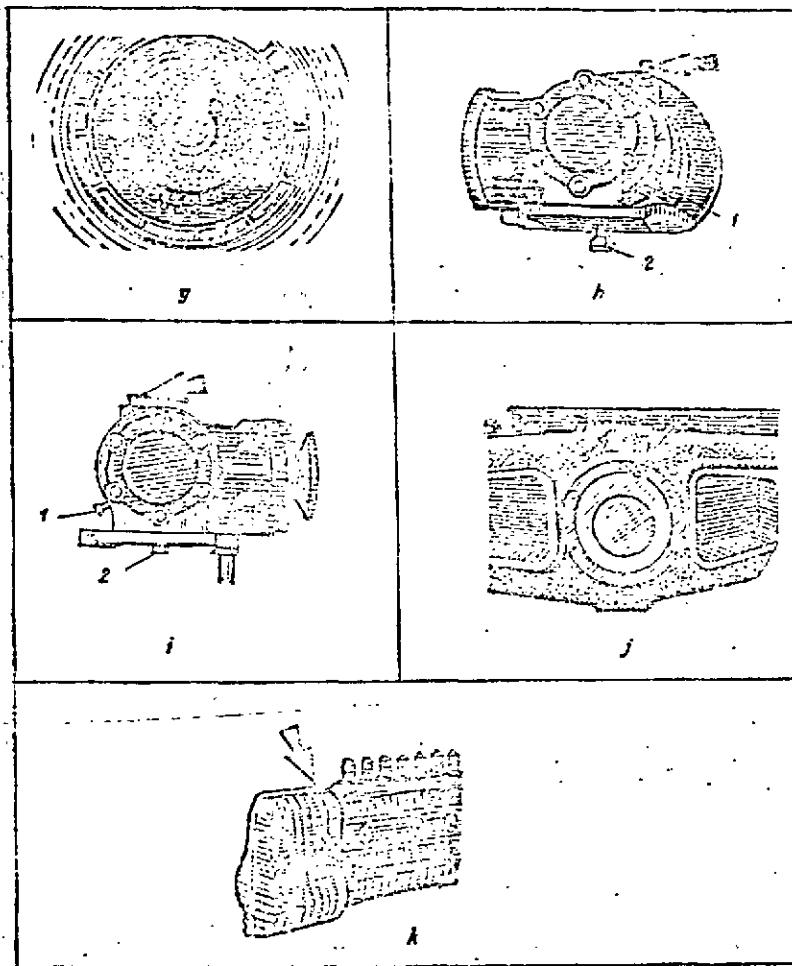


FIG. 149. POINTS TO BE LUBRICATED BY  
VT-16a OIL

a - engine oil tank; b - compressor crank case;  
 c - overdrive gear housing; d - transfer  
 case; e - power take-off housing; f - axle  
 reduction unit housing; g - wheel hub drive  
 housing; h - fan drive front reduction gear  
 housing; i - fan drive rear reduction gear;  
 j - rear suspension rocker; k - pump variable-  
 speed governor; 1 - check hole closed with  
 plug; 2 - drain hole closed with plug

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1	2	3	4	5	6	7
IV. Automobile transmission oil, State Standard (FOCT) 3701-53 (substitute - automotive transmission oil, summer and winter grades, State Standard (FOCT) 542-50	152a	Universal joint of propeller shafts of drive to hydraulic transmission, transfer case and intermediate and final reduction units of driving axles	11	+	+	Force until fresh lubricant appears from the safety valve
	152b	Universal joint of wheel-hub drive propeller shaft and fans drive cardan shaft	24	+	+	Same
V. Automobile lubricant AM (for propeller shafts), State Standard (FOCT) 5730-51	153a	Constant-velocity universal joints	4	+	+	Fill the lubricant heated to liquid state up to the lower edge of the filler check hole
	153b	Bearings of steering knuckle king pins	8	+	+	Force until fresh lubricant appears from the safety valve; in steering assemblies not provided with safety valve, force until fresh lubricant appears from clearances between oil seal and steering knuckle pin
VI. Lubricant YTB (1-13), State Standard (FOCT) 1631-61 (substitute of lubricant YTB is lubricant (1-13c),	154a	Fan hub	4	+	+	Force until fresh lubricant appears from the check hole
	154b	Fan belt tensioner	2	+	+	Force with a hand-operated grease gun until resistance is felt

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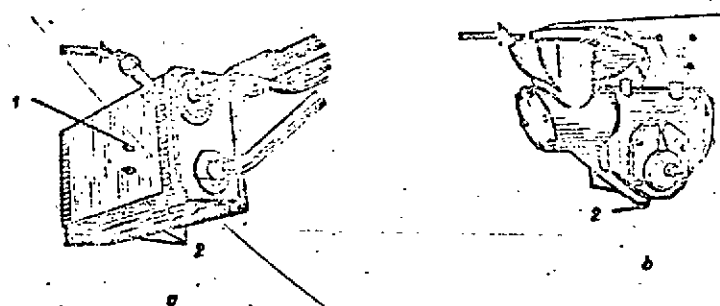


FIG. 150. POINTS TO BE LUBRICATED BY MIXTURE CONTAINING 50 PER CENT OF OIL AV AND 50 PER CENT OF OIL MT-16a

a - hydraulic transmission tank; b - steering gear case; 1 - level hole closed with plug; 2 - drain hole closed with plug

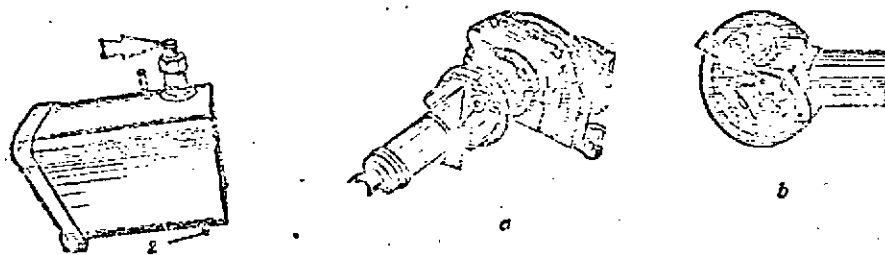


FIG. 151. STEERING SYSTEM HYDRAULIC BOOSTER TANK

2 - drain hole closed with plug

FIG. 152. POINTS TO BE LUBRICATED BY TRANSMISSION OIL

a - universal-joint of propeller shaft; b - wheel-hub drive universal-joint of propeller shaft

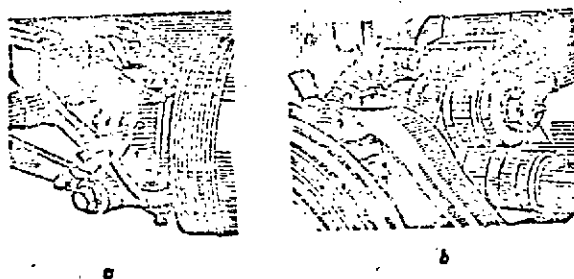


FIG. 153

a - constant-velocity universal joint; b - steering knuckle king pin bearings

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1	2	3	4	5	6	7
MTV (5-58). In Arctic regions lubricant UMATRA-201 State Standard (FOOT) 6267-59 is used instead of lubricant YTB (4-19)	154a 154d 154c	Compressor belt tensioner Toothed connection of second axle drive propeller shaft Intermediate support of second axle drive propeller shaft	1 1 1	+	+	Force until fresh lubricant appears from the check hole Same Force until fresh lubricant appears from the hole for safety valve (during lubrication the safety valve should be unscrewed) Lubricate with the nut of the wheel hub bearings tightened. Force until fresh lubricant appears from the check hole Unscrew the plug and force until fresh lubricant appears from the plug hole; this done screw in the plug Force until fresh lubricant appears from the clearances Same
VII. Lubricant VC, State Standard (FOOT) 1039-51 (substitute - lubricant JCC State Standard (FOOT) 4366-56). In Arctic regions lubricant UMATRA-201, State Standard (FOOT) 6267-59 is used instead of lubricant VC	154f 155a 155b 155c 155d 155e 155f	Inner bearing of wheel hub Bearing of shaft of steering linkage levers Bearings of pendulum arm shaft Joints of steering tie rods Joints of steering drag links and rod of the steering system. hydraulic booster Ball pin of the pitman arm sleeve Slip yoke of the intermediate and final reduction units drive propeller shaft	8 2 2 12 5 1 2	- + + + + + +	+ + + + + + +	Force until fresh lubricant appears from the clearances Force until fresh lubricant appears from the clearances Force until fresh lubricant appears from the clearances Force until fresh lubricant appears from the clearances Force until fresh lubricant appears from the clearances Force until fresh lubricant appears from the clearances Force until fresh lubricant appears from the clearances

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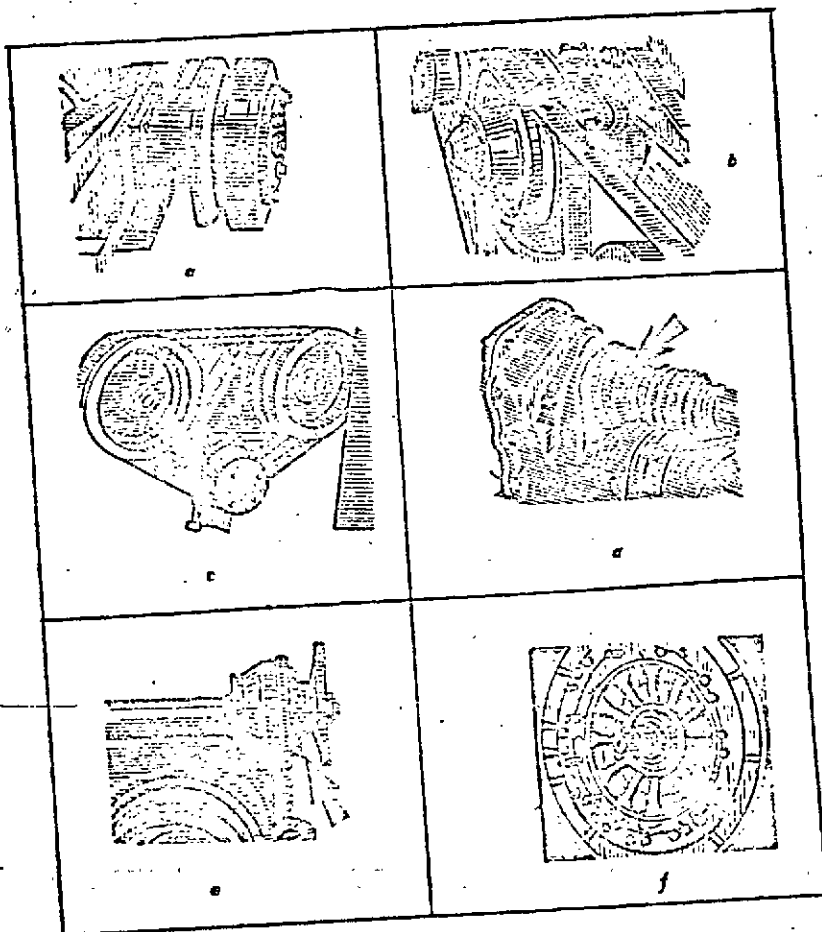


FIG. 154. POINTS TO BE LUBRICATED BY LUBRICANT STB (1-13)

a - fan hub; b - fan belt tensioner; c - compressor belt tensioner; d - toothed connection of second axle drive propeller shaft; e - intermediate support of second axle drive propeller shaft; f - wheel hub inner bearing

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1	2	3	4	5	6	7
	155S	Slip yoke of wheel drive propeller shaft	8	+	+	Force until fresh lubricant appears from the clearances
	155h	Bushing of suspension arms bracket located at frame	32	+	+	Same
	155i	Bushing of steering knuckle support arms	16	+	+	Same
	155j	Bushing of rear suspension support arms	16	+	+	Same
	155k	Bushing of rocker pad box axle	4	+	+	Same
	155l	Bushing of shock absorber axle	2	+	+	Same
	155m	Bushing of hand brake lever pin	1	+	+	Same
	155n	Bushing of hand brake control linkage intermediate lever and planetary gearbox	2	+	+	Same
	155o	Bushing of pin of hand brake control linkage/intermediate lever and planetary gearbox	1	+	+	Some
	155p	Bushing of hand brake control linkage rear lever pin	1	+	+	Same
	155r	Bushing of planetary gearbox control linkage vertical shaft located on steering column	1	+	+	Same

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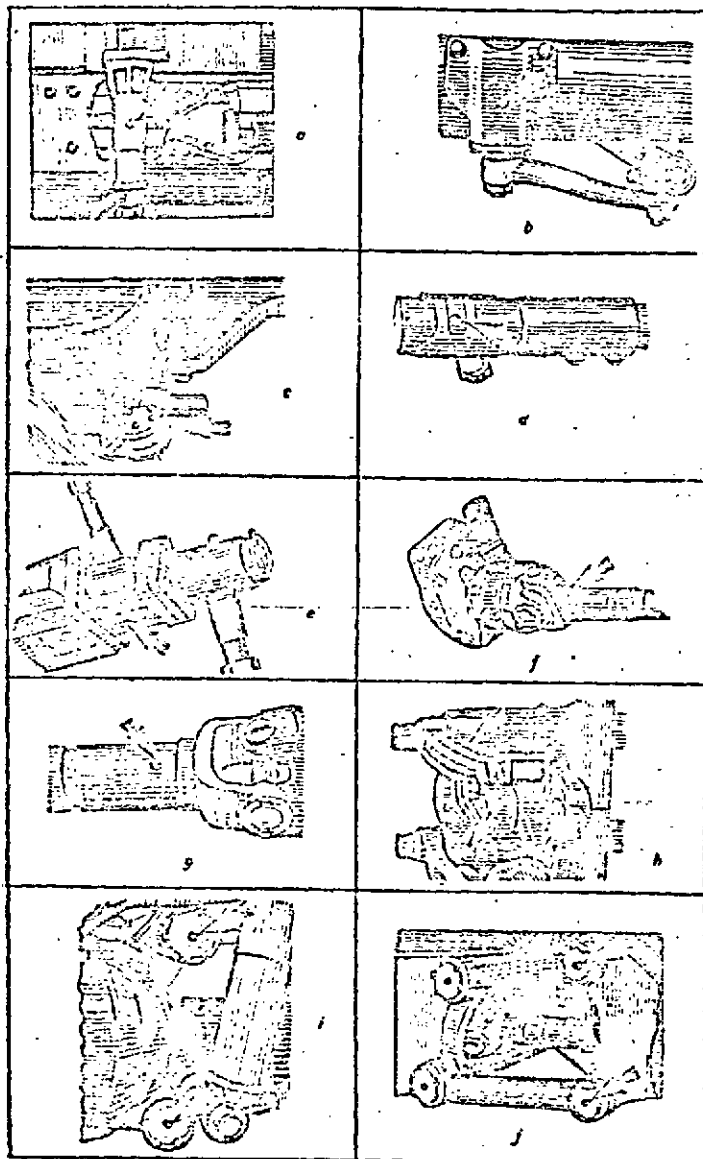
1	2	3	4	5	6	7
	155a	Bushing of planetary gearbox control linkage intermediate lever pin	1	+	+	Force until fresh lubricant appears from the clearances
	155t	Vertical shaft of planetary gearbox control linkage	1	+	+	Same
	155u	Shaft of power take-off unit intermediate linkage	3	+	+	Same
	155v	Bushing of power take-off unit control rear bracket shaft	1	+	+	Same
	155w	Bushing of power take-off control bracket shaft	1	+	+	Same
	155x	Splined connections of interaxle propeller shafts and propeller shaft of rear axle drive	-	+	-	Force until fresh lubricant appears from the holes in plugs
	156	Support of fifth-wheel axle	2	+	+	Same
	156	Support of fifth-wheel rocker axle	2	+	+	Same
	156	Pin of fifth-wheel assembly grip	2	+	+	Same
	156	Bearing surface of fifth-wheel	2	+	+	Same appears from the holes in plugs With the semitrailer coupled, force until fresh lubricant appears from the clearances

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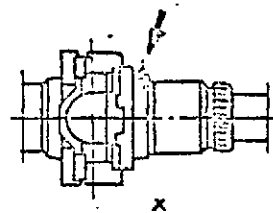
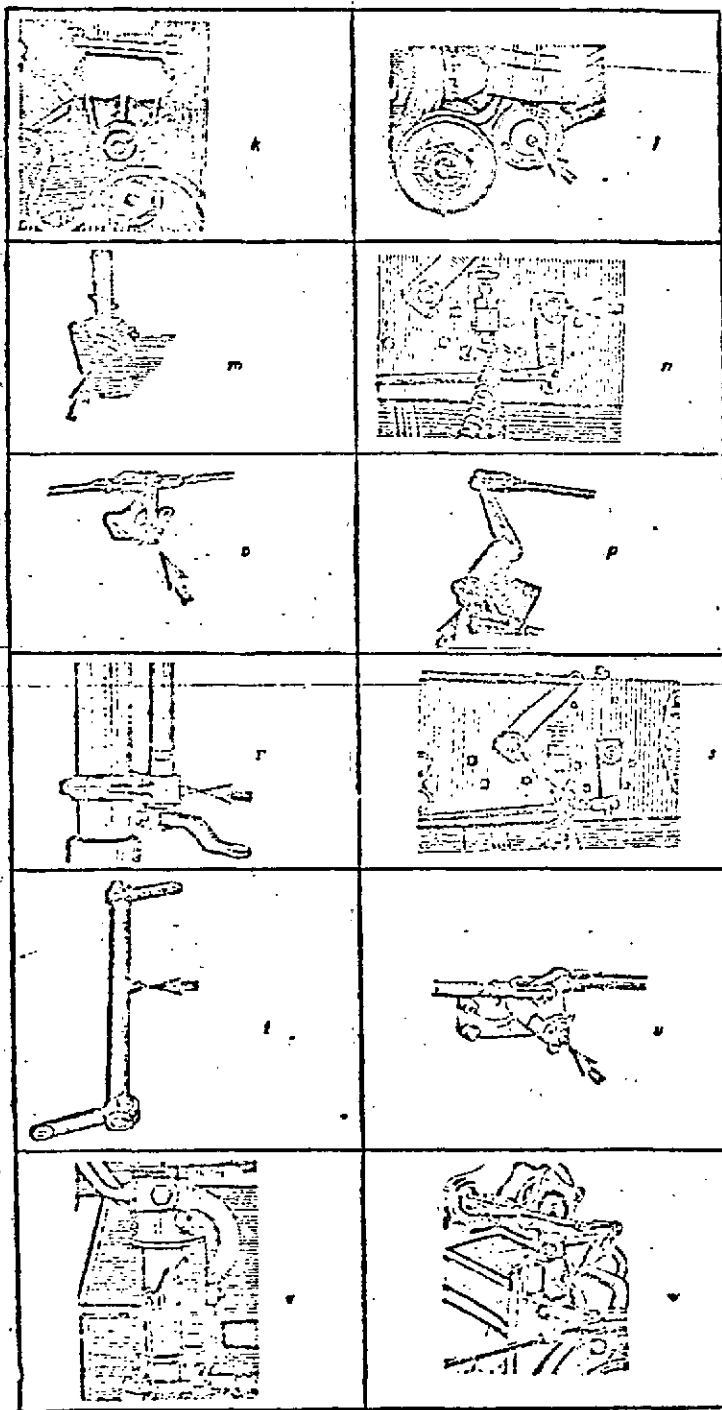


FIG. 155. JOINTS TO BE LUBRICATED BY LUBRICANTS VC AND 3 Cc

- a - bearings of steering linkage shaft levers;
- b - pendulum-arm shaft bearings;
- c - hinges of steering tie rods;
- d - hinges of steering trax links and rod of steering system hydraulic booster;
- e - pitman arm sleeve ball pin;
- f - slip yoke of intermediate and final reduction units drive propeller shaft;
- g - slip yoke of wheel-hub drive propeller shaft;
- h - suspension arm bracket bushing on frame;
- i - bushing of steering knuckle support arms;
- j - bushing of rear suspension support arm;
- k - bushing of rocker pad box axle;
- l - shock absorber axle bushing;
- m - bushing of hand brake lever pin;
- n - bushing of hand brake control linkage intermediate lever pin;
- o - bushing of hand brake control linkage intermediate lever pin and planetary gearbox;
- p - bushing of hand brake control linkage rear lever pin;
- q - bushing of planetary gearbox control linkage vertical shaft on steering column;
- r - bushing of planetary gearbox control linkage intermediate lever pin;
- s - planetary gearbox control linkage vertical shaft;
- t - shaft of power take-off unit control linkage intermediate bracket;
- u - bushing of power take-off unit control linkage rear bracket shaft;
- v - bushing of power take-off control linkage bracket shaft;
- w - bushing of power take-off control linkage bracket shaft;
- x - splined joints of interaxle propeller shafts and propeller shaft of rear axle drive

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1	2	3	4	5	6	7
	157	Anchor pins of foot brake shoes	If	-	+	Unscrew the plugs, screw in the lubrication fittings and force until fresh lubricant appears from the clearances. Unscrew the lubrication fittings and screw in the plugs
						

FIG. 174. LUBRICATING POINTS OF THE TRAIL ASSEMBLY

FIG. 157. ANCHOR PINS OF FOOT BRAKE SHOES

VIII. Mixture, containing:  
 50% of transformer oil State Standard (ГОСТ) 982-56 and 50% of turbine oil, State Standard (ГОСТ) 32-53

Suspension shock

2

Change<sup>xx)</sup>

- Notes!**
1. When automobiles are operated on sandy and desert terrain, before lubricating and filling oil, remove dust and sand not only from the places to be lubricated or filled with oil but also from the adjacent places and particularly from those that are located above with the purpose to prevent dirt from getting on the lubricated parts or into the filled cavities during the lubricating procedure. After cleaning the holes in the lubrication fittings at places to be lubricated with a consistent lubricant, force the lubricant until it appears outside. Do not wipe off the forced out lubricant.
  2. When the automobile is operated on a sandy and desert terrain, change oil in the housings of the overdrive gear, transfer case, power take-off unit and reduction units of the axles every 4,000-8,500 km of run.

<sup>xx)</sup> When the engine and other units are lubricated with oil M7-14n it should be changed every 2,000-2,600 km of run.  
 xx) to be carried out every other preventive maintenance procedure.

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Winch Lubrication Table

No.	Fig. No.	Description of Mechanism	Number of Lubricating points	Description of lubricant		Change of lubricant				Instructions on lubrication
				main	substitute	every 30 pulling operations	every 60 pulling operations	every 120 pulling operations		
1	2		4	5	6	7	8	9	10	
1	1500	Winch drum	1	Oil HT-16n	-	-	-	0		Unscrew the drum fastening bolt. Turn the drum with its hole down and drain old oil. Turn the drum with its hole up, fill 3.5 lit of fresh oil and screw in the bolt
2	1580	Axle of intermediate gear of wire rope level winding device	1	Graphite lubricant YC-A, State Standard (GOST) 3333-55	-	0	-	-		Remove the gear, remove old lubricant and pack fresh lubricant into the space between the bushings
3	1580	Lead screw of wire rope level winding device	1	Graphite lubricant YC-A, State Standard (GOST) 3333-55	-	0	-	-		Wash the lead screw helical groove with fuel and lubricate
4	1580	Winch reduction gear	1	(GOST) 3333-55 Oil HT-15n, State Standard (GOST) 5560-55	-	-	0	-		Drain old oil. Fill 10 lit of diesel fuel into the housing and rotate the reduction gear for 2-3 min Drain the fuel and fill fresh oil up to the level hole

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1	2	3	4	5	6	7	8	9	10
5	1580	Axles of by-pass rollers	2	Graphite lubricant YCc-A, State Standard (FOCT) 3333-55	Lubricant YCc-1 or YCc-2	-	-	0	Remove the roller and axle with diesel fuel. Lubricate manually during assembly
6	1581	Bearings of traction rollers Gear	4	Automobile lubricant YCc, State Standard (FOCT) 4366-53	Lubricant YCc-1 or YCc-2	-	-	0	Remove the covers and fill the spaces of bearings with lubricant
7	1581	Toothed coupling of winch shaft	1	Lubricant (FOCT) 201, State Standard (FOCT) 6267-59	Lubricant YCc	-	-	0	Disassemble, wash and fill the space with lubricant during assembly
8	1582	Teeth of gears of traction rollers	1	Oil MT-16N, State Standard (FOCT) 6360-50	-	-	0	-	Use waste oil
9	1582	Axle of winch pressure roller	1	Graphite lubricant YCc-A, State Standard (FOCT) 3333-55	-	0	-	-	Lubricate manually
10	1582	Propeller shaft universal joints	2	Automobile transmission oil, State Standard (FOCT) 3781-53	Summer and winter for Grodec, St. Stand. (FOCT) 542-50	0	-	-	Fill the lubricant until it appears from the safety valve

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1	2	3	4	5	6	7	8	9	10
11		Winch drive reduction gear	1	OIL NT-16N	-	-	0	-	Remove old oil and fill fresh oil. The level should be up to the lower edge of the level hole

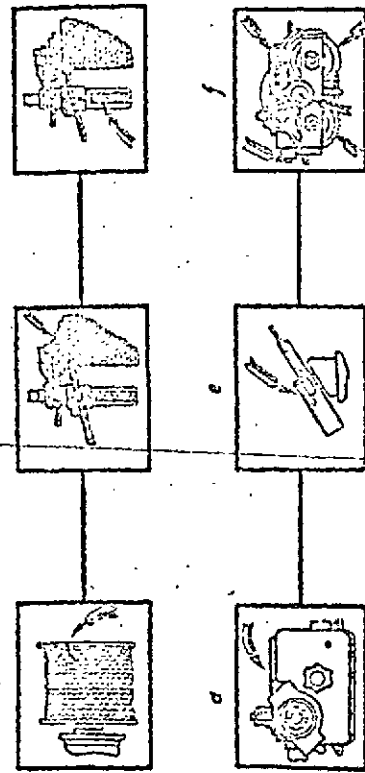


FIG. 15L. DIAGRAM OF WINCH LUBRICATING POINTS

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## SEASONAL PREVENTIVE MAINTENANCE

(To be carried out in spring and autumn)

Nos	Scope of operations and specifications of their performance
1	2
1	Carry out completely the scope of operations prescribed in the scheduled preventive maintenance and additionally, proceed as follows:
2	<p><u>When changing over to winter period of operation</u></p> <p>Put in order the automobile engine preheater and the cab heater (wash the filter of the electromagnetic valve, clean the drain pipe of dirt and the glow plug, injector and burner of carbon deposit).</p> <p>For cleaning the injector, unscrew fuel pipe 19 (Fig.46), disconnect the plug connector of the electromagnetic cut-out valve, unscrew electromagnetic valve 18, injector union and injector 17.</p> <p>Disassemble the injector, wash plate filter 8 (Fig.49), clean the hole in chamber 2 of dust and clean the central orifice in injector body 1 having washed it with gasoline or clean fuel.</p> <p>It is forbidden to use metal objects for cleaning the injector.</p> <p>During assembly, pay particular attention to correct installation of the chamber and its secure tightening with a screw, check the injector for spraying by cutting in the preheater without screwing the union into the burner. The angle of spray should be not less than 60°. The spray should be fine and have the shape of a foglike cone.</p>
3	Cut the preheater and cab heater into the common engine cooling system and check their operation.
4	Unlock the electromagnetic coupling of the fans drive and install the brush of the current collector ring.
5	Fill the engine cooling system with antifreeze,
6	Remove and wash the primary and secondary fuel filters. Drain the fuel of summer grade from the fuel tanks, wash them and fill with fuel of winter grade.
7	Drain oil, grade MT-16n from the variable-speed governor housing and fill it with a mixture containing 50 per cent of oil, grade MT-16n, and 50 per cent of diesel fuel, grade E5 or DA. When changing oil, wash the governor housing with diesel fuel and hot oil.
8	Change the fluid PTE-22 used for hydraulic brakes.
9	If necessary, paint the automobile.
1	<u>When changing over to summer period of operation</u>
2	Drain antifreeze from the engine cooling system.
3	Cut the preheater and cab heater out of the common engine cooling system.
4	Check the condition and functioning of the radiator cap valves.
5	Interlock the electromagnetic coupling of the fans drive and remove the brush of the current collector ring.
6	Drain the fuel of winter grade from the fuel tanks and fill them with fuel of summer grade.

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1	2
6	Drain the mixture containing 50 per cent of oil MT-16H and 50 per cent of diesel fuel from the variable-speed governor housing fill it with oil, grade MT-16H. When changing oil, wash the variable-speed governor housing with diesel fuel and hot oil.
7	Change the fluid JTM-22 used for hydraulic brakes.
8	If necessary, paint the automobile.
9	When operating on sand and desert or mountain terrain, wash the engine cooling system, if required.

## INSTRUCTIONS ON ENGINE OVERHAUL OPERATIONS

To restore the performance characteristics (power, specific fuel and oil consumption) of a used engine to the level of a new engine characteristics and to ensure its working capacity (up to the first major repair) a partial overhaul which is the running repair of the engine should be performed.

The partial overhaul is performed after 500 hrs of the engine operation in case of excessive pressure of gases in the crankcase characterized by stoking from the breather, loss of compression, difficult starting of the engine and drop of oil pressure below permissible limits.

In case the above defects are not revealed the commission appointed by the head of the using agency depending upon the technical condition of the engine may prolong its service life for 100-200 hrs without partial overhaul; in case of such a decision a special document should be drawn up.

The partial overhaul is performed by repair personnel of the using agency with the participation of the automobile driver. During the partial overhaul of the engine, perform the operations prescribed in preventive maintenance No.2 and proceed as follows:

- inspect the pistons; if required, correct the revealed defects (eliminate coarse scores, remove carbon deposit, free stuck piston rings);
- replace worn compression and oil control rings with new ones;
- lap the valves to their seats (if required, mill the seats and grind the valve faces);
- adjust the injectors and fuel injection pump; if required, replace the spray tips complete with needles, slotted filters, injector springs, plunger springs, plunger pairs, delivery valves, high-pressure pipes;
- in case of leakage, replace packings of the circulation pump;
- if worn, replace the rubber disc of the charging generator drive coupling.

- Notes:**
1. The necessity of parts replacement is determined in result of inspection.
  2. In case of urgent necessity to dismantle the cylinder heads it is mandatory to replace the rubber packing rings of pipes which by-pass the coolant from the jackets into cylinder heads and the gasket placed between the jacket and cylinder head.
  3. During the partial overhaul use is made of the individual set of spare parts, spare parts taken from a service set provided for 10 automobiles as well as the parts received from the Manufacturing Plants by orders.

## MAIN SAFETY RULES AND FINE PRECAUTIONS TO BE OBSERVED DURING

## OPERATION OF AUTOMOBILE

1. It is forbidden to start and drive an unserviceable automobile.
2. It is forbidden to use the preheater, to start and warm the engine in closed premises with poor ventilation in order to prevent poisoning by carbon monoxide.

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3. Before starting the engine and putting the automobile in motion the driver should make a warning signal.
4. Before starting the engine, make sure that the gearshift lever is in the neutral position.
5. With the engine running it is forbidden to adjust the mechanisms and eliminate the noise.
6. To avoid burns, be careful when draining hot liquid from the cooling system radiators or hot oil from the automobile assemblies.
7. The antifreeze (ethylene glycol mixture) used in the engine cooling system and brake fluid ITM-22 used for the automobile hydraulic brakes are poisonous. It is forbidden to suck the liquids into the mouth as well as to take meals until the hands contaminated with the liquid are thoroughly washed.
8. When working with the wire rope (towing or operating the winch) it is necessary to warn the people around about a possible danger in case of the wire rope breakage.
9. Strictly observe the traffic rules in cities and inhabited localities as well as when driving over the railroad crossings and bridges.
10. When filling the automobile with fuel or determining its level in the tanks as well as during inspection of the fuel tanks it is forbidden to use open flame, to light a fire or smoke near the place of refuelling or parking of automobiles.
11. It is forbidden to keep wiping materials (rags, cotton waste, etc.) oiled or moistened with fuel on the automobile.  
All the automobile assemblies should be dry; traces of leaked fuel or oil should be wiped off.
12. Thoroughly inspect the insulation of wires and electric contacts as the electric spark may be the cause of fire.
13. It is forbidden to warm the automobile assemblies by open flame (torch, blow lamp, etc.).
14. Strictly observe the fire precautions when operating the preheater. It is strictly prohibited to leave the operating preheater without supervision.
15. For extinguishing fire on the automobile, use fire extinguishers and other handy means (tarpaulin, etc.) and in extreme cases, use sand for this purpose.  
It is forbidden to pour water into inflamed fuel.

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## C h a p t e r II

## MODIFICATIONS OF MAS-537 AUTOMOBILE

## AUTOMOBILE MAS-537F

The MAS-537F automobile is a fifth-wheel tractor equipped with a winch. The winch is borrowed from Item LTO-59 and is slightly altered for use on the given modification. Besides, in contrast to the MAS-537 automobile the electric system is provided with a wire rope pay-out limit electric indicator and a pilot lamp is installed on the cab instrument panel.

WinchPurpose and General Design of Winch

The winch is intended for hauling track-laying vehicles on a semitrailer.

In separate cases it is permissible to use the winch for self-recovery or recovery of stuck vehicles. In this case, the angle of the wire rope linking should not exceed  $10^\circ$  in all planes.

The winch is equipped with a wire rope having the working pay-out length of 100 m. Maximum pull is 15t.

The winch (Fig.159) is arranged behind the engine compartment above the automobile hydraulic transmission and is mounted on special subframe 16 installed on four brackets attached to the frame. The winch is driven by a propeller shaft from the power take-off unit through auxiliary drive reduction gear 9.

The winch consists of reduction gear 1, two traction rollers 13, drum 11, wire rope 7, wire rope level winding device 12, pressure roller 3, two by-pass rollers 15, block of guide rollers 4 and pay-out limit electric indicator 10.

Welded frame 14 of the winch is designed for connection of all winch assemblies. To protect the winch from precipitation a protective cover is provided.

The winch reduction gear is designed to increase the torque transmitted from the power take-off unit to the traction rollers, to automatically brake the wire rope and to limit the winch pulling effort.

The main units of the reduction gear (Fig.160) are as follows: safety coupling, automatic brake, planetary gear and oil pump. Besides, the reduction gear is provided with a reversing device and its control mechanism. In the winch of a MAS-537F automobile the reversing device is not used.

The safety coupling (Fig.161) automatically disengages the winch when the effort on the wire rope exceeds the permissible value thus protecting the winch parts from overloading.

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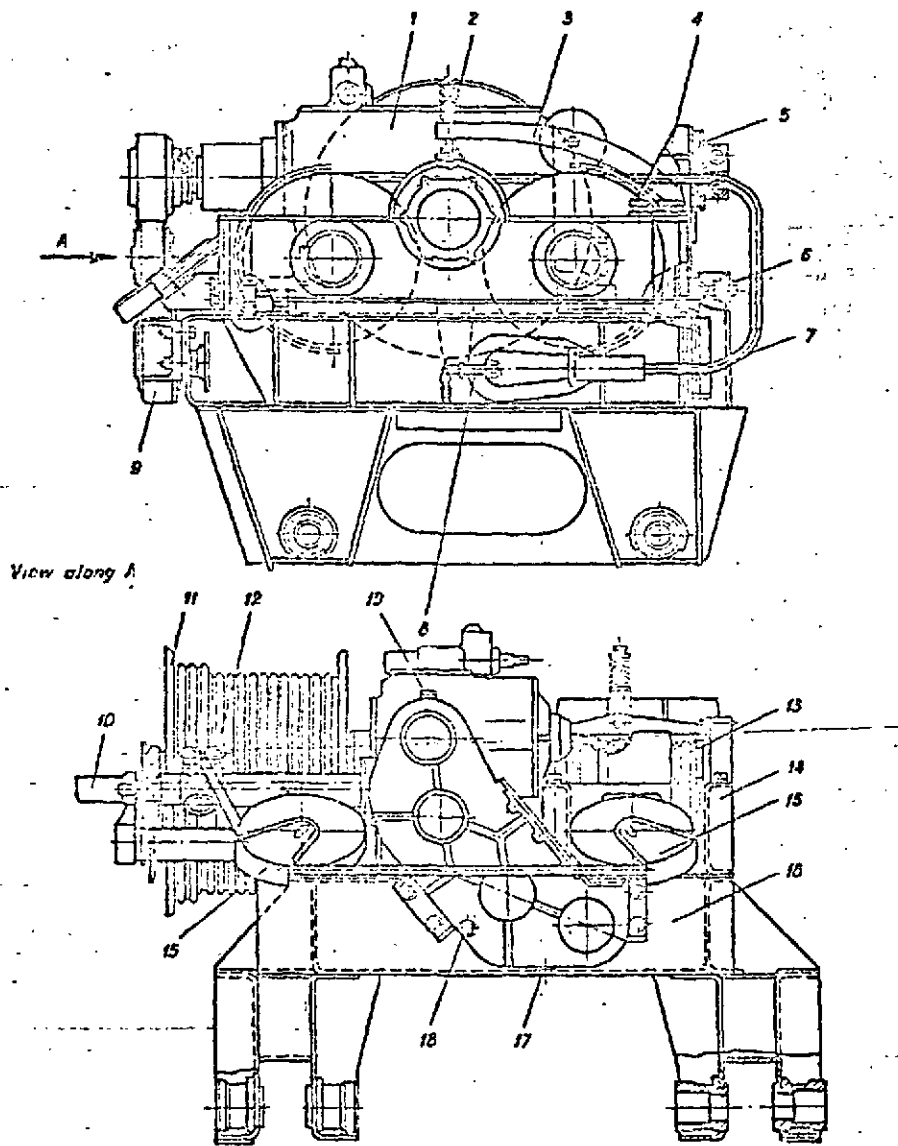


FIG. 159. WINCH

- 1 - reduction gear; 2 - spring; 3 - pressure roller; 4 - block of guide rollers; 5 - cleaner;
- 6 - thrust bolt; 7 - wire rope; 8 - locking pin; 9 - drive reduction gear; 10 - pay-out limit electric indicator; 11 - drum; 12 - wire rope level winding device; 13 - traction roller;
- 14 - winch flange; 15 - by-pass roller; 16 - subframe; 17 - drive reduction gear drain hole plug; 18 - check hole; 19 - filler hole plug

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The safety coupling is assembled in a separate casing and attached to the reduction gear. The safety coupling consists of the following main parts: casing 14, driving half-coupling 16 and driven half-coupling 2, spring 5, cage 4 with balls 3, gear 9 and adjusting nut 7.

When the wire rope is under an effort exceeding the permissible value the driving half-coupling starts to slip relative to the driven half-coupling due to which the winch will be disengaged from the drive. Disengagement of the safety coupling is accompanied by peculiar clicks which warn the driver that the effort on the wire rope exceeds the permissible value.

When the effort on the wire rope is reduced to normal the coupling will out into operation automatically.

The coupling is adjusted with the help of nut 7 by changing the degree of the spring compression.

The automatic brake is used for stopping the load when the kinematic circuit from the engine to the reduction gear is disconnected as well as for braking the load when it is lowered on a grade. The brake operates automatically without participation of the driver.

The planetary gear (Fig.160) consists of sun gear 12, carrier 13, three planet pinions 9 and epicyclic gear 8 and is designed for increasing the torque transmitted from the engine to the traction rollers.

Cam 14 of the oil pump drive is installed on the sun gear splines.

Secured to the outer face of the epicyclic gear is a tube which mounts the winch drum.

The power to the winch drum is taken off the carrier splined end while to the traction rollers it is taken off through shaft 20 coupled with the carrier by means of splines.

The oil pump serves for delivery of oil to the automatic brake and safety coupling.

Traction rollers 48 and 55 (Fig.162) are designed to build up a traction effort on the wire rope due to the friction forces arising when the wire rope reels along the V-shaped grooves of rollers.

As to the design the traction rollers are identical. The front traction roller differs from the rear one only in arrangement of the V-shaped grooves for the wire rope (on the rear roller the grooves are slightly displaced towards the winch reduction gear). The traction rollers rotate on roller bearings and are driven from the driving gear coupled with winch reduction gear shaft 35 by means of splines.

The winch drum serves for collection of the wire rope running from the traction rollers.

The winch drum is a welded construction inside which a friction clutch with a ratchet mechanism is installed. The drum friction clutch serves for providing constant tension of the wire rope on the drum and traction rollers. The ratchet mechanism serves for braking the friction clutch. When the winch wire rope is paid out the ratchet mechanism brakes the drum and, when the wire rope is wound it unbrakes the drum.

The clutch back plate is made integral with the gear which serves for driving the wire rope level winding device.

From the drum to traction rollers the wire rope is directed by means of by-pass (guiding) rollers 15 (Fig.159).

Pressure roller 3 is mounted above the first groove of the rear traction roller.

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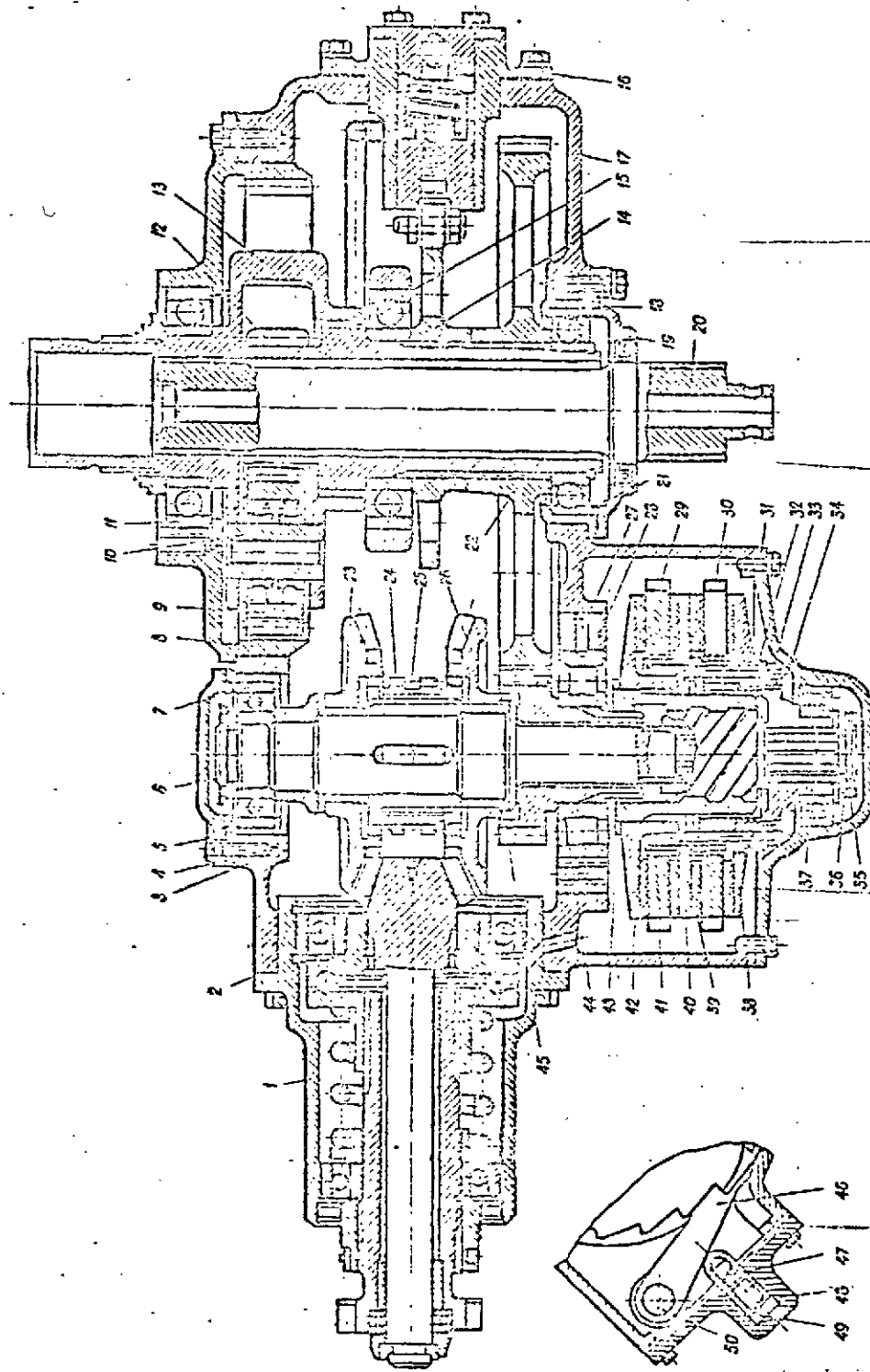


FIG. 150. FIFTEEN REDUCTION GEAR

- 1 - safety couplings; 2, 3 - adjusting shims; 4, 10, 31, 40 - covers; 5, 10 - bearings
- 6, 20 - shafts; 7, 11, 15, 21 - ball bearings; 8 - epicyclic gear; 9 - planet
- 10 - planet pinion axis; 11 - sun gear; 12 - carrier; 13 - planet; 14 - oil pump; 17 - reference gear housing; 22, 45 - gears; 23, 26 - level gears; 24 - couplings; 25 - applied bushing
- 27 - pin; 28 - spacer; 29, 30 - catch wheels; 35, 40 - epicyclic; 37, 41 - axes;
- 34 - bolt; 35 - locking ring; 36 - split disc; 37 - spherical ball bearing; 38 - back plate;
- 39 - middle plate; 40 - screws; 41 - pinion; 42 - pressure plate; 43 - roller bearing;
- 46 - pawl; 47 - sleeve; 50 - shaft

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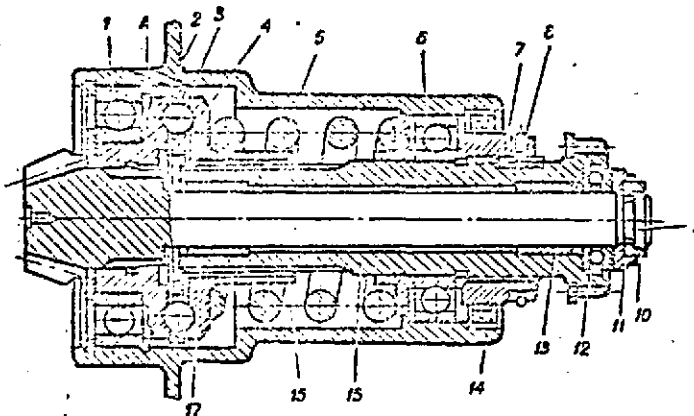


FIG. 161. WINCH REDUCTION GEAR SAFETY COUPLING

1, 6 - ball bearings; 2 - driven half-coupling; 3 - ball; 4 - cage; 5 - springs; 7 - adjusting nut; 8 - locking screw; 9 - gear; 10 - semi-rings; 11 - rings; 12 - thrust ball bearing; 13, 17 - bushings; 14 - casing; 15 - shaft; 16 - driving half-couplings; 14 - oil delivery hole

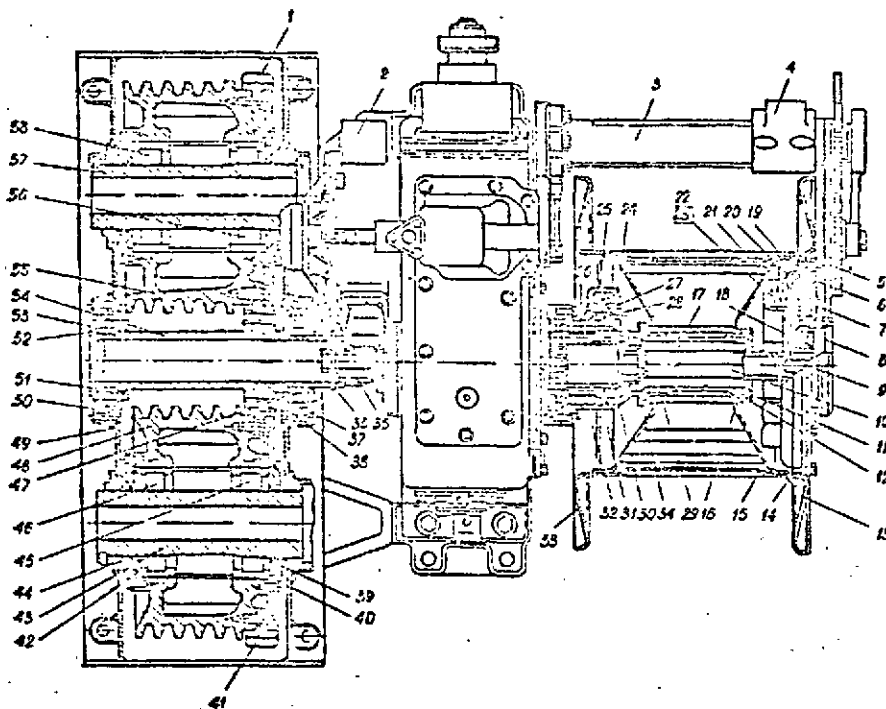


FIG. 162. WIRE ROPE DRUM AND TRACTION ROLLERS

1, 41 - toothed rims; 2 - reduction gear; 3 - wire rope level winding device tube; 4 - wire rope level winding device casing; 5 - wire rope level device gear; 6 - drum; 7, 19 - discs; 8 - cover; 9 - shaft; 10 - tube; 11, 12, 52 - locking rings; 13, 33 - flanges; 14, 30 - rings; 15 - rim; 16, 20 - bushings; 17, 18 - hubs; 20 - thrust washers; 21, 38, 59 - sleeves; 22, 23, 25, 26 - springs; 24, 37, 40, 42, 53 - covers; 27 - axle; 28 - pawl; 31 - ratchet; 32 - coupling; 34 - oil seal; 35 - reduction gear shaft; 36 - lockpins; 39, 44 - washers; 43, 57 - traction roller axles; 45, 46, 47, 54, 55 - roller bearings; 48, 55 - traction rollers; 49 - watch frame; 51 - ball bearing; 54 - driving gear

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The pressure roller serves for additional pressing of the wire rope to the traction roller which adds to paying out the wire rope from the winch without load.

The winch wire rope (Fig. 163) consists of steel rope 2 with wire braiding 1 at the ends, thimble 4 and wedge 3. The inner end of the wire rope is secured to the drum flange with a clamp. Thimble 4 serving to connect the wire rope with a hauled load is attached to the wire rope outer end by means of wedge 3.

In the travelling position the wire rope end with the thimble is secured at the left side of the subframe by locking pin 8 (Fig. 159).

In case the wire rope is fitted into the thimble after installation of the wedge it is necessary to tighten the wire rope with an effort at which the winch safety coupling will operate. The free end of the wire rope projecting from the thimble should be within 65-100 mm.

The wire rope level winding device is designed for uniform winding of the wire rope on the winch drum.

The wire rope level winding device operates as follows: during rotation of lead screw 4 (Fig. 164) which is driven from the winch drum by means of drive gears 9 and 11, slide 12 installed in the carriage moves along the lead screw thread (the screw thread is perpetual, i.e. the left-hand thread is connected with the right-hand thread by a smooth transition) together with the carriage to the right or left according to the laying of the wire rope on the drum.

The wire rope is placed between rollers 6, 7 and 8.

The wire rope will be laid correctly if at the beginning of winding the place of the wire rope fitting in the drum flange is positioned on top of the drum (on the vertical axis) and the carriage of the wire rope level winding device is arranged at the extreme right-hand position (as viewed forward).

The position of the carriage is adjusted by turning the lead screw with gear 11 removed. After adjustment the gear should be installed in its proper place.

The wire rope pay-out limit electric indicator is attached to the wire rope level winding device on the right side (as viewed forward).

The pay-out limit electric indicator (Fig. 165) is designed for closing the appropriate electric circuits with the purpose of making sound and light signals indicating the necessity to stop paying-out of the winch wire rope.

The mechanism consists of body 3 which mounts screw 4 with nut 1 and two button switches 7 and 9.

When the winch wire rope is completely wound on the collecting drum, nut 1 is at the extreme left-hand position. During rotation of the screw coupled with the wire rope level winding device by pin 2, nut 1 while moving along the screw thread to the right presses out at first the head of switch 9 thus causing the sound signal and then the head of switch 7 causing the light signal. As a result, a red lamp lights up on the instrument panel and the sound signal is switched off.

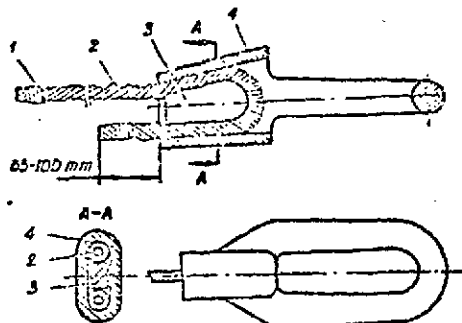


FIG. 163. WINCH WIRE ROPE

1 - braiding; 2 - rope; 3 - wedge; 4 - thimble

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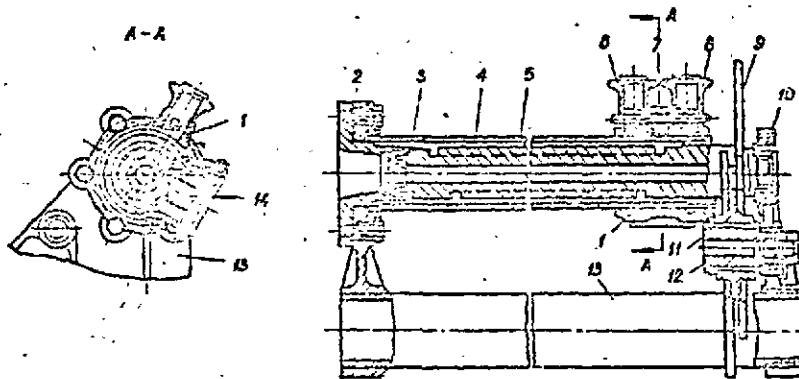


FIG. 164. WIRE ROPE LEVEL WINDING DEVICE

1 - carriage; 2 - adjusting chain; 3, 10 - bushings; 4 - lead screw; 5 - pipe; 6, 7, 8 - guide rollers; 9, 11 - drive gears; 12 - axle; 13 - brackets; 14 - slide

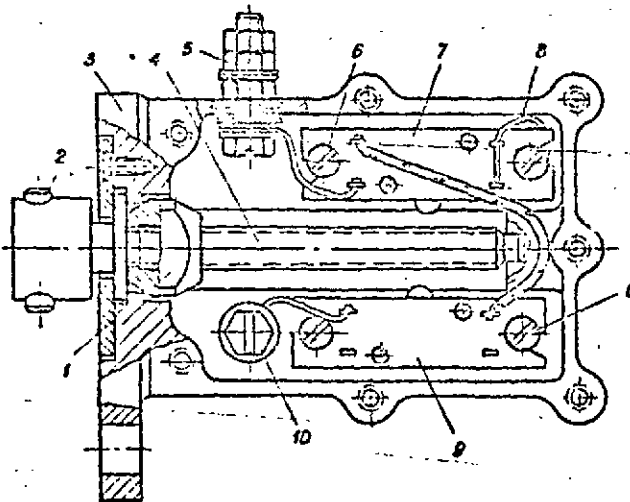


FIG. 165. PAY-OUT LIMIT ELECTRIC INDICATOR

1 - nut; 2 - pin; 3 - body; 4 - screw; 5 - circuit terminal; 6 - adjusting screw; 7, 9 - bottom switches; 8 - ground wire; 10 - adjusting screw

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The pay-out limit electric indicator is adjusted so that the sound signal is switched on when 4-7 turns of the wire rope are left on the winch collecting drum; the light signal is switched on when 2.5-4 turns of the wire rope are left on the collecting drum.

Block of guide rollers 4 (Fig.159) serves to guide the wire rope running to the traction rollers. The block design does not allow the power hauling to be performed at angles exceeding  $10^\circ$  relative to the automobile centre line.

Wire rope cleaner 5 is arranged inside the block of guide rollers. The cleaner is used for cleaning the wire rope running into the winch of dirt and snow.

Winch subframe 16 (Fig.159) is a welded construction serving for attaching the winch to the automobile frame. Arranged in special brackets at the rear part of the subframe are two thrust bolts which take up all pulling efforts of the winch. The thrust bolts should always be screwed in so that they thrust against the rear plate of the winch and reliably locked by nuts.

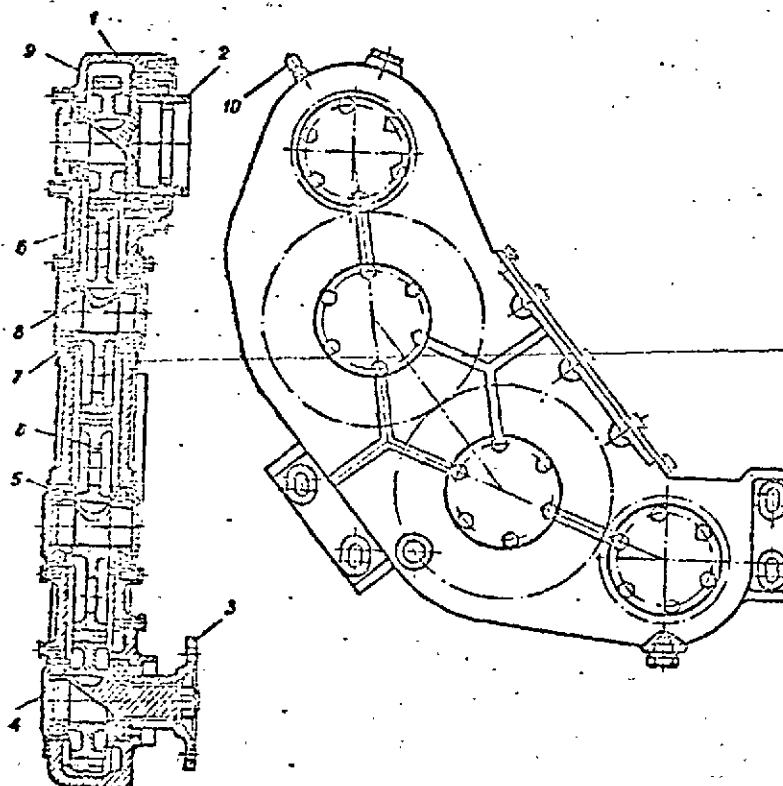


FIG. 166. AUXILIARY REDUCTION GEAR

1 - housing; 2 - shaft; 3 - drive flange; 4 - drive shaft; 5 - cover;  
6 - large gear; 7 - bearing; 8 - axle; 9 - small gear; 10 - breather

The auxiliary reduction gear (Fig.166) serves to lower the winch drive axis. The reduction gear consists of housing 1 and four gears 6 and 9 secured on axles 2, 4, 8. The reduction gear has no controls and requires no adjustments.

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1	2	3
Generator is excited but no charging results	<p>2. Generator regulator is out of order</p> <p>1. Wire is disconnected from generator regulator terminal "B"</p> <p>2. Generator regulator fuse is blown out</p> <p>3. Generator regulator is out of order</p>	<p>Send generator regulator to repair shop for repair</p> <p>Connect wire</p> <p>Replace fuse</p> <p>Send generator regulator to repair shop</p> <p>Send generator regulator to repair shop for repair</p>
Generator overheats	<p>1. Generator is overloaded due to misadjustment of current regulator</p> <p>2. Short circuit in armature winding or field windings</p>	<p>Generator is subject to repair</p>
Excessive sparking at generator brushes	<p>1. Brushes are insufficiently pressed to commutator</p>	<p>Check condition of brushes and brush holders</p> <p>Fit brushes or replace them in case of wear</p> <p>Generator is subject to repair</p>
Charging current considerably changes with variation of engine speed (the voltmeter pointer fluctuates excessively)	<p>2. Commutator is worn out</p> <p>3. Generator operates with overloading</p> <p>1. Commutator is dirty or irregularities caused by burning are detected on its surface</p> <p>2. Brushes are insufficiently pressed to commutator</p> <p>3. Generator regulator is out of order</p>	<p>Send generator regulator to repair shop for adjustment of current regulator</p> <p>Clean commutator with glass paper No.200. Wipe commutator with clean cloth soaked in gasoline</p> <p>Check condition of brushes and brush holders. Fit brushes or replace them in case of wear</p> <p>Send generator regulator to repair shop for repair</p>
When engine is stopped out-out relay fails to disconnect generator from circuit (voltmeter pointer registers discharge)	<p>Baked contacts of the cut-out relay</p>	<p>Immediately cut out battery switch, Send generator regulator to repair shop for repair</p>

## CONSUMERS OF ELECTRIC POWER

Starter

The starter of a CT-710 type (Fig.136) is designed for starting the engine and rated for a short-time duty operation. The starter is installed on the lugs of the engine crankcase upper half in its rear part to the right (as viewed forward). The starter is a D.C., series excitation electric motor. The starter is provided with a drive mechanism with an overrunning friction clutch and a PCT-20 drive relay. The drive relay and drive mechanism serve for automatically meshing the starter pinion with the engine flywheel gear ring at starting.

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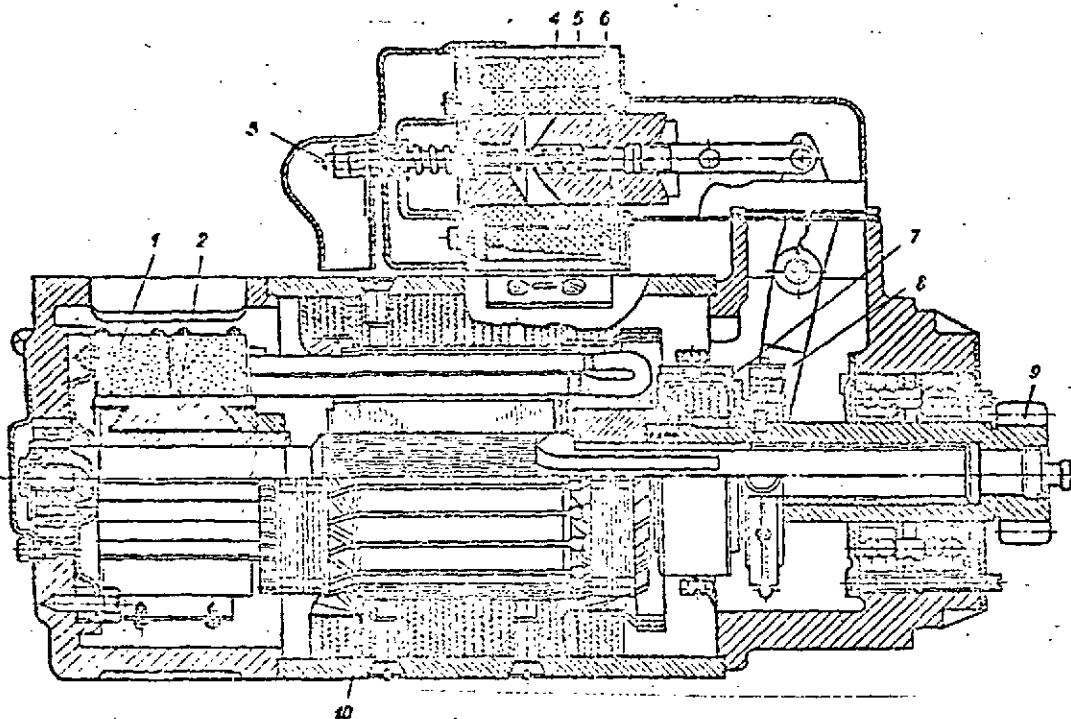


FIG. 136. STARTER

1 - brush; 2 - commutator; 3 - output bolt; 4 - coil yoke; 5 - drive relay coil; 6 - drive relay armature; 7 - friction clutch; 8 - lever; 9 - starter pinion; 10 - starter structure

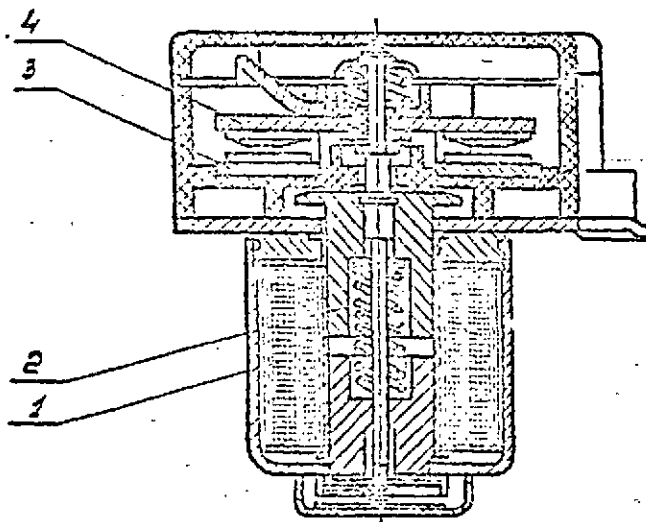


FIG. 137. CONTACTOR COIL

1 - electric magnet; 2 - core; 3 - fixed contacts; 4 - movable contacts

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The starter employs a single-wire system with the minus connected to the ground (body).

Starter maximum power - 15 h.p.

Speed corresponding to maximum power - 1,100 r.p.m.

Rated voltage - 24 V.

Maximum brake torque with account of voltage drop in wires - 19 kg-m.

Sense of rotation - right-hand if viewed on the drive side.

Starter pinion travel - 24±1.5 mm.

Number of teeth in starter pinion - 11.

The drive friction clutch is adjusted at the Manufacturing Plant for a torque of 24-28 kg-m. The starter employs an electromagnetic connection system accomplished through a TKC-601ET contactor and type EK-322 button. The circuit is provided with interlocking which prevents the starter from being switched on when the engine is running.

The starter button of a EK-322 type is designed for remotely switching the starter on and off. The button is operated by depressing its rod. The button is arranged on the instrument panel.

The TKC-601ET contactor (Fig.137) is an electromagnetic device designed to remotely switch the starter on at starting the engine.

The rated voltage of the relay is 24 V. The contact system is rated for current of up to 1,200 A

The storage battery switch of a BE-404 type (Fig.138) is designed for connecting and disconnecting the storage batteries from the automobile body (ground). The storage battery switch employs a single-wire system. The switch is cut in by depressing the knob and cut out under the action of springs when the switch latch is depressed.

To ensure charging of storage batteries when the engine is running it is forbidden to cut out the battery switch. Only in case of serious troubles in the electric system should the battery switch be cut out with the engine running.

#### Starter Operating Rules

When starting the engine it is forbidden to use heavily discharged storage batteries (in excess of 50 per cent in summer and in excess of 25 per cent in winter) since it leads to fusing of the starting relay contacts and brings the starter out of order.

It is allowed to depress the starter button for not more than 5 sec. If the engine starts to fire, immediately release the starter button. The lag in releasing the starter button may bring the starter out of order (due to racing of the starter armature) despite the availability of interlocking.

It is allowed to depress the button only after the flywheel and the starter pinion are brought to a complete stop. With the engine running it is strictly forbidden to depress the button. If the engine fails to start, switch on the starter again not less than 15 sec later. Premature switching of the starter fails to ensure cooling of the starter drive relay and mixing of electrolyte in the storage batteries. If upon three attempts the engine fails to start, inspect the engine, eliminate the troubles and make an attempt to start the engine by the starter.

After the engine is started, immediately release the starter button.

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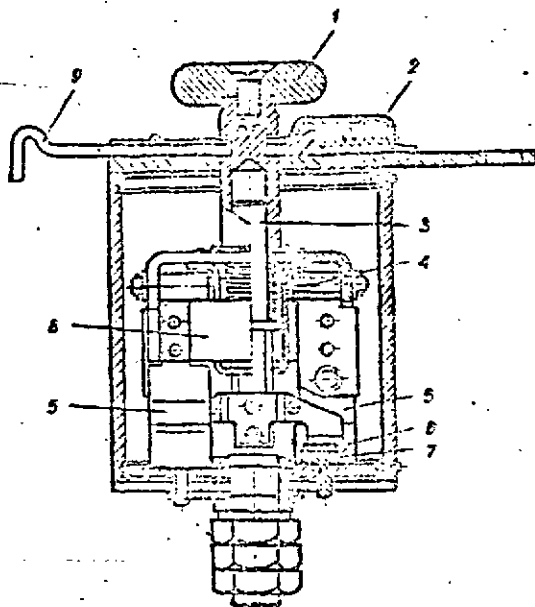


FIG. 133. STORAGE BATTERY SWITCH

1 - knob; 2 - latch spring; 3 - rod; 4 - rod spring; 5 - main contact;  
6 - auxiliary contact; 7 - fixed contact; 8 - connecting plate; 9 - latch

Maintenance of Starter

When servicing the starter, carry out all the operations prescribed in the Section "Preventive Maintenance of Automobile".

To protect the starter from penetration of moisture when washing the automobile, do not direct a stream of water on the starter, contactor and latches of the engine flywheel casing (if breathers are not installed in the casing ports). Carefully watch the face clearance between the teeth of the starter pinion and engine flywheel gear ring. An excessive clearance may cause milling of the flywheel gear ring teeth by the teeth of the starter pinion.

To check the condition of the starter, proceed as follows:

1. Cut out the battery switch.
2. Disconnect the electric wires.
3. Remove the starter, for which

purpose:

- turn the automobile wheels completely to the left;
- drain oil from the engine oil tank;

- unscrew the nuts and remove the bolts attaching the right-hand spark arrester of the engine exhaust system;
  - remove the right-hand bracket of the fender together with the spark arrester;
  - remove the propeller shaft between the first and second axles;
  - disconnect all the oil pipelines from the engine oil tank;
  - remove the reducing valve, filler neck and oil dipstick;
  - unfasten and remove the engine oil tank;
  - unfasten and remove the starter.
4. Remove the starter cover band.
  5. Wipe the contaminated commutator with clean cotton waste wetted with gasoline and check the brushes for proper fitting to the commutator.
  6. In case of excessive burning of the commutator, clean it with glass paper No.200. After cleaning, wipe the commutator by cotton waste wetted with gasoline.
  7. Check the condition of brushes and replace them, if necessary. The brushes should be free of cracks, chipping and other defects. When replacing the brush, file it off to fit the commutator having wrapped the latter with glass paper.
  8. To remove the brush dust, blow the commutator and brush holders with dry compressed air.
  9. Reinstall the starter cover band.
  10. Check the condition of the starter relay contacts for which purpose:
    - disconnect the feed jumper of the starter relay coil;

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- remove the starter relay cover, inspect and, if necessary, clean the working surfaces of the contact bolts and contact disc of the starter relay;

- reinstall the cover and connect the feed jumper of the starter relay coil.

11. Reinstall the starter in the order reverse to that prescribed in Item 3.

12. Check the setting clearances between the teeth of the starter pinion and flywheel gear ring.

In the axial direction the starter should be installed so that the driving pinion (in the initial position) is by 4-0.5 mm short of the engine flywheel gear ring.

In height the starter should be installed so that with the starter pinion meshed with the flywheel gear ring the backlash is within the limits of 0.6-1.2 mm.

The backlash is adjusted by changing the number of shims (under the starter or pad). The starter is checked for correct installation by means of a flat feeler gauge.

#### Troubles and Remedies of Starter

Trouble	Cause	Remedy
1	2	3
With button depressed starter fails to be switched on	1. Battery switch is not out in  2. Wires loosely fastened on terminals 3. Breakage in starting circuit 4. Starter button is out of order	Cut in battery switch  Fasten wires on the terminals of storage batteries Find out place of breakage and eliminate trouble Starter button is subject to repair
Starter armature fails to rotate but pinion is meshed with flywheel gear ring	1. Loose fastening of jumper on drive relay or on output bolt of starter frame 2. Storage batteries are discharged 3. Contacts of drive relay fail to close	Tighten nut which fastens jumper  Send batteries to charging station Send starter to repair shop for repair
Starter armature rotates with insufficient speed	1. Storage batteries are discharged 2. Poor contacts in working circuit of starter	Send batteries to charging station Tighten nuts fastening wires If necessary, clean contacts Dress dents on tooth faces
At repeated switchings of starter knocking of starter pinion against gear ring is heard  Clattering of pinion is heard when starter button is depressed	Gear ring teeth are dented  1. Storage batteries are discharged 2. Shunt winding of drive relay is broken at place of connection to ground	Send batteries to charging station  Starter is subject to repair

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1	2	3
When starter button is released starter armature rotates at great speed (the starter is idling)	Baked contacts of contactor or damaged starter button	Cut out battery switch, clean connector contacts. If contacts are baked, send contactor to repair shop or replace
Starter pinion fails to rotate and to come in meshing	Breakage in one of drive relay windings	Send starter to repair shop for repair
Drive relay excessively heats	Disconnect wire from storage battery terminal (poor contact)	Connect wire and tighten terminal
With engine shut down and the battery switch cut in voltmeter (if button is depressed) does not register voltage of storage batteries	1. Wire running from voltmeter terminal is disconnected  2. Voltmeter is out of order	Connect wire  Replace voltmeter

#### Lighting System

The automobile is equipped with two headlights having blackout devices, two side lamps and tail lamp with a blackout rim. All the lighting devices except for a passenger lamp function when the ground switch is cut in. When driving at night the road surface is illuminated by two headlights with two-filament bulbs.

When filaments of 60 c.p. each are switched on it corresponds to the headlight high beam and in this case the high beam pilot lamp on the instrument panel lights up.

The headlights are switched over from the high beam to the lower beam by a foot dimmer switch arranged on the inclined panel of the cab floor. To mark the place of parking (halt) of the automobile and when driving at night with the headlights switched off use is made of side lamps which at the same time serve as front turn indicators.

The headlights, side lamps and the tail lamp are switched on by means of a main light switch. The cab interior is illuminated by a dome lamp; the instruments are illuminated by lamps mounted into the instrument panel. The dome lamp and illumination of the instrument panel are cut in by means of a change-over switch. The passenger lamp and its switch are installed to the right on the instrument panel. The under-hood space of the engine compartment is illuminated by two hood lamps. The swivelling spotlight controlled from the driver's cab is installed on the cab roof. The swivelling spotlight can be rotated through 360° about its vertical axis and through ±35° about its horizontal axis. The swivelling spotlight is cut in by a switch arranged on the instrument panel.

The automobile lighting system makes it possible to obtain full-light lighting (H3), partial blackout (43) and blackout lighting (H3). For changing the glow of headlight bulbs a blackout selector switch is installed on the instrument panel. In case of the blackout lighting (H3) the switch handle is at the upper position and brightness of the headlights is reduced due to connection of a series resistor into

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the circuit of the headlight bulb filaments; in this case, the covers of the headlight blackout devices are thrown into the lower position and latched. The cover of the tail lamp blackout rim is thrown into the upper position and latched. The side lamps and the dome lamp are dimmed out by inserts furnished with the automobile, for which purpose they should be installed between the lens gasket and body of the side lamp or dome lamp. In case of partial blackout (B3) the position of covers of the headlights and tail lamp is the same as in case of the blackout lighting; the handle of the light selector switch is in this case in the lower position and the series resistor of the headlight bulbs is shorted.

When the automobile is operated under normal conditions (with full-light lighting B3) the covers of the headlight blackout devices should be thrown up and latched, while the cover of the tail lamp should be thrown down and latched. The handle of the blackout selector switch should be in the lower position.

#### Maintenance of Lighting and Signalling Devices

The servicing of the lighting and signalling devices consists in keeping them clean and in good condition, inspecting the wires and checking the wire shoes for reliable connection to the terminals of devices.

During the routine inspection carried out before leaving the park and during the daily preventive maintenance, check all the lighting and signalling devices for proper functioning and wipe the lenses of the headlights and tail lamp from the outside, if necessary.

During preventive maintenance No.1, check also the fastening of all the lighting and signalling devices while during preventive maintenance No.2, check the adjustment of headlights.

If dust has penetrated into the sealed-beam unit, remove it and without disassembly, wash with clean water and then thoroughly dry it in the open air. When replacing a defective bulb in the headlight, see that no dust penetrates inside the sealed-beam unit.

To replace the bulb in the headlight, remove the protective rim, withdraw the sealed-beam unit and take out the carbolite bulb holder.

#### Adjustment of Headlights

To adjust the headlights, proceed as follows:

- position the unloaded automobile on a horizontal site perpendicular to the aiming screen at a distance of 5 metres from the screen. Distinct horizontal and vertical lines should be drawn on the screen. The horizontal line should be drawn at a distance of 1,670 mm from the floor level; three vertical lines should be drawn perpendicular to the horizontal line at a distance of 820 mm from each other; the middle vertical line should pass along the automobile axis (Fig.139);
- set the covers of the headlight blackout devices into the lower position;
- switch on the lights and changing it over by the foot dimmer switch, make sure that the filaments of the high and lower beams are simultaneously glowing in both headlights. The light selector switch should be set in the lower position;
- switch on the high-beam light and cover the left-hand headlight with a light-proof cloth;
- remove the protective rim of the right-hand headlight;
- rotating the adjusting screws (Fig.140), adjust the position of headlights so that the centre of hot spot registers with the right-hand vertical line of the screen and the visor shadow passes at the level of the screen horizontal line;

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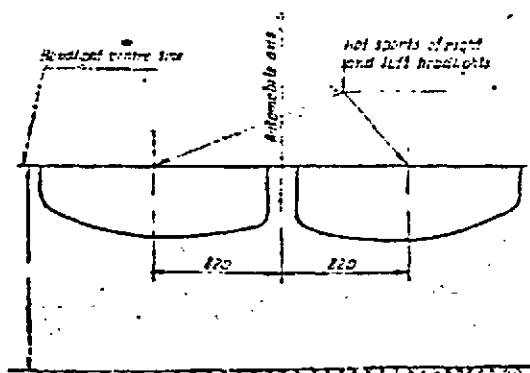


FIG. 139. ADJUSTMENT OF HEADLIGHTS.

- reinstall the protective rim of the right-hand headlight;
- remove the lightproof cloth from the left-hand headlight and cover the right-hand headlight;
- remove the protective rim of the left-hand headlight;
- rotating the adjusting screws, adjust the position of the headlight so that the centre of hot spot registers with the left-hand vertical line of the screen and the visor shadow passes at the level of the screen horizontal line;
- reinstall the protective rim of the left-hand headlight;
- remove the lightproof cloth from the right-hand headlight and check the arrangement of hot spots on the aiming screen. Upper edges of both hot spots should be arranged on one line;
- set the covers of the headlight blackout devices into the upper position;
- switch off the lights and drive away from the horizontal site.

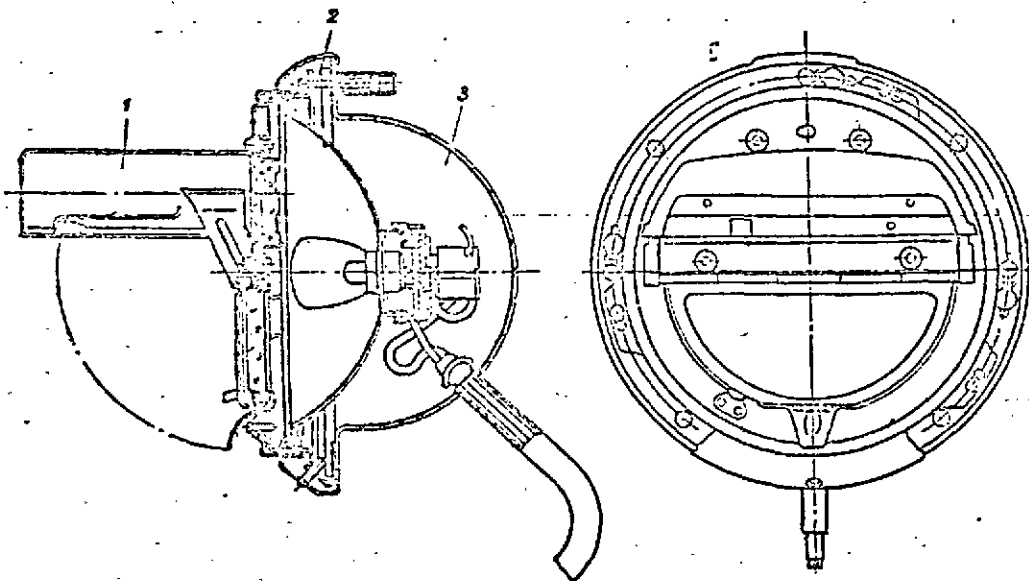


FIG. 140. HEADLIGHT

1 - blackout device; 2 - adjusting screw; 3 - headlight

## INSTRUMENTS

The instruments and fuses, their designation and arrangement are described in the Section "Arrangement of Controls and Instruments in Cab".

The instruments and fuses employed in the automobile are as follows:

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- the TCM-15 distance electric pressure gauges with the measuring range up to 15 kgf/cm<sup>2</sup> and 3MMV-3 remote electric pressure gauges with the measuring range up to 3 kgf/cm<sup>2</sup> are designed for remote measurement of liquid or air pressure.

The pressure gauge set consists of a pressure sending unit, indicator 1 (Fig.141), flexible hose (only for TCM-15 pressure gauge) and plug connectors.

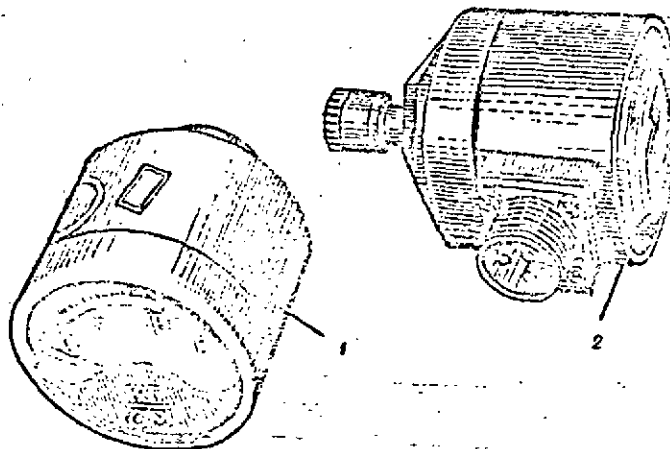


FIG. 141. DISTANCE ELECTRIC PRESSURE GAUGE TCM-15

1 - remote indicator; 2 - pressure sending unit

The sending units and indicators are respectively interchangeable.

Liquid or air acts on the flexible diaphragm arranged in the sending unit housing. Deflection of the diaphragm through a system of levers shifts the slide of a potentiometer which varies its electric resistance.

Variation of the potentiometer resistance proportional to the pressure of liquid or air is introduced into the electric circuit of the indicator due to which the indicator pointer is deflected to a division of the scale corresponding to the measured pressure.

Troubles and Remedies of Pressure Gauge

Trouble	Cause	Remedy
1	2	3
When battery switch is out in pointer fails to move away from left-hand stop	1. No current supply  2. Moisture or dirt has penetrated into plug connectors  3. Open brush contact in sending unit	Check current supply to sending unit  Tightly screw in plug connector union nut  Clean plug connectors  Replace sending unit

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1	2	3
When battery switch is cut in, pointer presses to left-hand stop	4. Dirty plate damper  1. Confused polarity of supply wires  2. Broken wire running from terminal 2 <sup>x</sup> or poor contact of terminal 2 in plug connector	Remove, disassemble and clean damper  Check supply wires for correct connection  Find out and eliminate breakage of wire, securely tighten plug connector union nut
When battery switch is out in pointer presses to right-hand stop	Broken wire running from terminal 1 or poor contact of terminal 1 in plug connector	Find out and eliminate breakage of wire, securely tighten plug connector union nut
With battery switch cut in and without pressure in system indicator pointer sets at the middle of scale	Breakage in resistance coils inside indicator	Replace indicator

<sup>x</sup>) Numbers of terminals are given on plug connectors of instruments.

- the TV3-48 distance electric temperature gauges with the measuring range from -50°C to +150°C and TV3-48T distance electric temperature gauges with the measuring range from 0° to 120°C.

The electric temperature gauge set (Fig.142) consists of indicator 1, sending unit 2, companion part of plug connector 3 and fastening ring 4.

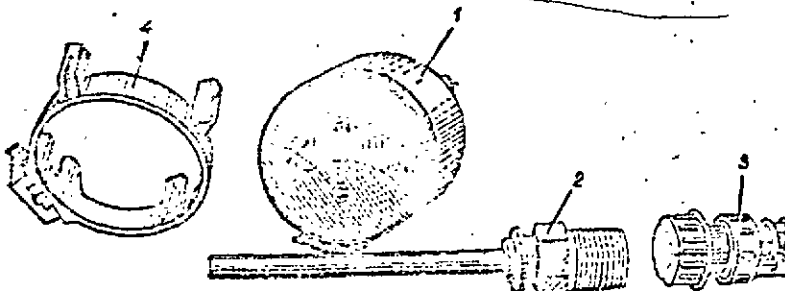


FIG. 142. REMOTE ELECTRIC TEMPERATURE GAUGE  
1 - indicator; 2 - sending unit; 3 - connector plug; 4 - fastening ring

The principle of operation of electric temperature gauges is as follows: variation in temperature of the measured medium causes variation in resistance of a sensitive element arranged inside the sending unit. Variation in resistance of the sending unit sensitive element proportional to the temperature of the measured medium is introduced into the electric circuit of the indicator due to which the in-

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indicator pointer is deflected to a division of the scale corresponding to the measured temperature.

Troubles and Remedies of Temperature Gauge

Trouble	Cause	Remedy
1	2	3
With master switch out in pointer remains at left-hand stop	1. Current supply wire broken or no contact with ground 2. Supply wire is short-circuited to ground 3. Moisture or dirt has penetrated into plug connectors	Repair wire. Ensure reliable connection with ground Repair or replace wire Clean plug connectors
Indicator pointer is thrown to end of scale Irregular functioning of indicator	Broken wire connecting sending unit with indicator Poor contact in supply wire or in connection to ground	Repair or replace wire Repair or replace wire, ensure reliable connection to ground

The BM-240 (or BM-340) voltmeter is mounted in metal housing 1 (Fig. 143). Arranged at the face of the housing near button 3 is corrector setting screw 4 by means of which the pointer is set to zero division if with the consumers switched off and the generator out of operation the pointer is displaced from the zero division. To measure the voltage of storage batteries or generator, depress button 3, in this case the voltmeter will read the voltage. With the button released the voltmeter reads the value of current. With the engine shut down and consumers switched on the voltmeter registers discharge current, while with the engine running it registers the charging current.

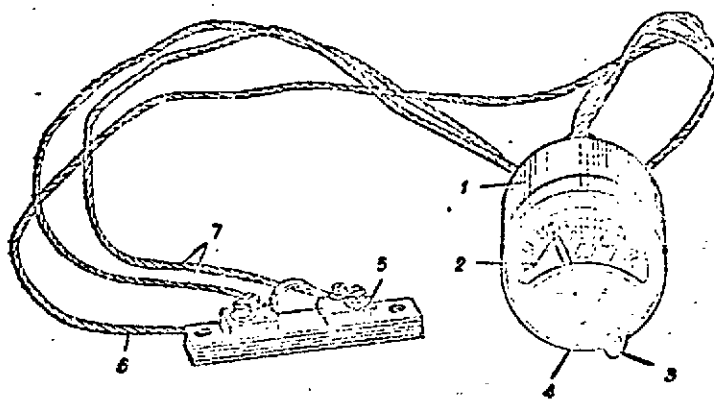


FIG. 143. VOLTMMETER

1 - housing; 2 - scale; 3 - button; 4 - corrector setting screw; 5 - shunt; 6 - voltmeter wire; 7 - ammeter wire

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The distance electric tachometer is designed for constant measurement of the engine crankshaft r.p.m. The tachometer consists of a T3-3B indicator and ET-5 generator. The tachometer range of measurement is from 0 to 3,000 r.p.m.

The distance electric speedometer is designed for measuring the automobile speed and kilometrage. The speedometer set consists of indicator CH-110 and sending unit H3-302.

#### Troubles and Remedies of Speedometer

Trouble	Cause	Remedy
With automobile moving forward speedometer pointer deflects to left up to the stop	Incorrect connection of wires to terminals of speedometer indicator or sending unit	Exchange wires of terminals 1 and 2 on speedometer indicator or sending unit
In motion speedometer pointer remains at zero	1. Fuse link blown out 2. Broken wires between the transmitter and indicator 3. Speedometer sending unit is out of order	Replace fuse link Find out and correct damaged wire Replace transmitter

The electric hourmeter is designed for registering the time of engine operation in hours. The hourmeter capacity is 1,000 hrs. The hourmeter is provided with an electric rewinding mechanism. The accuracy of readings is 0.1 hour. The plus of the storage battery is connected to terminal "+A" of the hourmeter while the generator plus is connected to terminal "P".

When the generator produces the voltage of 8 V the hourmeter starts to function automatically.

#### Maintenance of Instruments

When servicing the instruments, carry out all the operations prescribed in the Section "Preventive Maintenance of Automobile".

To check the condition of instruments, do the following:

- inspect the fastening and check the condition of the instruments in the cab on the instrument panel. If necessary, wipe the instrument scales with clean cotton waste;
- inspect the fastening of sending units;
- check all the connections of pressure and temperature sending units for tightness;
- check the union nuts of plug connectors of the sending units for reliable tightening;
- check the condition of electric wires of all the sending units and indicators.

#### WIRES

All the connections of electric equipment and instruments are made mainly with HPEA wire having the vinyl chloride insulation. The electric wires are combined into bunches secured by polyvinyl chloride tape and enclosed in flexible metal hose of PE-LIX type.

Depending upon the power of consumers the wires of the following sections are used:

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- (a)  $70 \text{ mm}^2$  - for connecting the groups of storage batteries, starter supply and negative wire of the battery switch;
- (b)  $10 \text{ mm}^2$  - for storage battery slave charging circuit and fuses supply wire;
- (c)  $4 \text{ mm}^2$  - for some jumpers and starter relay;
- (d)  $2.5 \text{ mm}^2$  - for conductor running to the main light switch and for some jumpers;
- (e)  $1.5 \text{ mm}^2$  - for wires running from the generator terminal "E", hourmeter and stop light switch;
- (f)  $1 \text{ mm}^2$  - for lighting circuits, fan couplings, pilot lamps and instruments.

The wires running to the generator, generator regulator, tachometer and speedometer are shielded (Fig. 144).

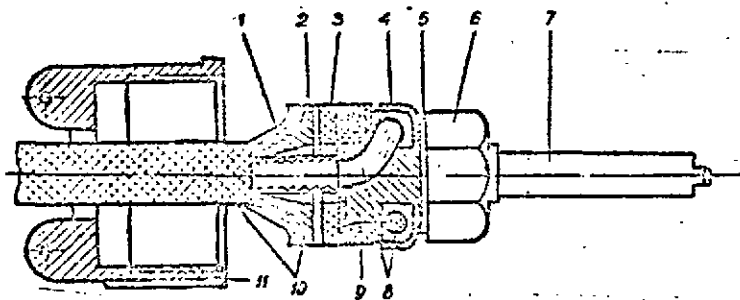


FIG. 144. SHIELDED WIRE TERMINATION IN WIRE SHOE

1 - outer taper bushing; 2 - inner taper bushing; 3 - rubber washer; 4 - cup; 5 - washer; 6 - nut; 7 - contact plug; 8 - wire bare end; 9 - textolite washer; 10 - wire shielding braiding; 11 - union nut

The ends of wires to be fastened by a screw or bolt with a nut are provided with soldered shoes.

To provide for reliable soldering of the shoes the wire cores are previously subjected to tinning.

To distinguish the wires in a bunch the end of each wire is fitted with a metal collar bearing the number of wire.

#### FUNCTIONING OF ELECTRICAL EQUIPMENT

The automobile electrical equipment functions under two kinds of operating conditions: with the engine shut down and with the engine running.

When the engine is shut down all the consumers of electric power are supplied from the storage batteries.

The consumers employing a single-wire system of connection function when the battery switch is cut in. Receptacles of the inspection and passenger's lamps employing a two-wire system of connection function with the battery switch cut out.

The electric current flowing from the positive terminal of the storage battery is supplied to the safety fuses wherefrom it is distributed among the electric power consumers.

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Having passed through the power consumers the current flows to the automobile ground and returns to the negative terminal of the storage batteries through the battery switch.

The starter is supplied directly from the storage batteries.

If the engine runs at a speed less than 650 r.p.m. all the power consumers are supplied from the storage batteries.

When the engine speed increases to above 650-750 r.p.m. all the power consumers are supplied from the generator as, in this case, the generator voltage reaches 24.5-26.5 V and the cut-out relay connects the generator into the automobile electric circuit.

From the positive brushes of the generator the current flows through the generator regulator and voltmeter shunt to the safety fuses wherefrom it passes to the consumers. With the battery switch out in part of the current is directed for charging the storage batteries.

As the storage batteries are charged only when the battery switch is out in it is not permitted to cut it out with the engine running.

Having passed through an appropriate consumer the current returns through the ground to the negative brushes of the generator.

#### TROUBLE SHOOTING PROCEDURE RECOMMENDED FOR ELECTRICAL EQUIPMENT

A trouble occurring in the electric circuit of any power consumer causes failure in its operation.

Minor troubles in the electrical equipment are remedied by the driver. Troubles in lead-sealed and complicated devices (generator regulator, voltmeter, electric motor, etc.) should be corrected in an electric repair shop.

To reveal the trouble it is necessary to be well acquainted with the functioning of the entire electric system and its diagram and to be able to identify the main electric circuits both on the diagram and in the electric system of the automobile. The main electric circuits are as follows: charging circuit, starter circuit, instrument and lighting circuits, preheater electric devices circuit, torque converter interlock circuit and transfer case engagement circuit.

Before revealing a trouble it is necessary to detect by external symptoms in which circuit the trouble has occurred. When detecting the trouble, follow a definite sequence. Start detecting the trouble with check-up of a corresponding safety fuse. Besides, check the condition of the circuit, switching on for this purpose the consumers operating in parallel; this operation will reduce the time required for detection of the trouble.

For example, the electric motor of the cab heater fails to operate. By switching on the lamps illuminating the instrument panel or the dome lamp it is possible to check whether the safety fuse on the electric instrument board is intact. If the lamps illuminating the instrument panel and the dome lamp are lighting it means that the heater electric motor is defective. If the lamps illuminating the instrument panel and the dome lamp fail to light, by switching on any other power consumer, for example, the horn, it is possible to check whether the voltage is available on the electric instrument board.

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Troubles and Remedies of Electrical Equipment

Trouble	Cause	Remedy
1	2	3
With engine running and battery switch out in voltmeter, when button is depressed, reads no voltage of generator	<ol style="list-style-type: none"> <li>1. Wire of generator or voltmeter is broken or disconnected from terminals</li> <li>2. Generator fails to excite</li> <li>3. Voltmeter is out of order</li> </ol>	<p>Find breakage and repair; connect wire</p> <p>Check condition of generator. Send defective generator to repair shop for repair Replace voltmeter</p>
With engine running and battery switch out in voltmeter does not register charging	<ol style="list-style-type: none"> <li>1. Broken wires in generator-to-storage batteries circuit</li> <li>2. Generator regulator safety fuse is blown out</li> <li>3. Generator or generator regulator is out of order</li> </ol>	<p>Find and repair breakage; connect wire</p> <p>Replace safety fuse</p> <p>Check generator and generator regulator for proper condition</p>
Bulbs of headlights, revivelling spotlight, side lamps and tail lamps fail to light	<ol style="list-style-type: none"> <li>1. Circuit breaker has operated</li> <li>2. Poor contact on junction block</li> <li>3. Bulb is blown out</li> <li>4. No contact in bulb holder of headlight, side lamp, tail lamp</li> <li>5. Broken wire in circuit of headlight, side lamp, tail lamp</li> <li>6. Switch is out of order</li> </ol>	<p>Depress button to cut in circuit breaker</p> <p>Tighten contacts</p> <p>Replace bulb</p> <p>Repair bulb holder having ensured reliable contact between holder and bulb</p> <p>Find out and eliminate breakage; connect wire</p>
Bulbs of stop light fail to light	<ol style="list-style-type: none"> <li>1. Circuit breaker has operated</li> <li>2. Poor contact on junction block and in stop light switch</li> <li>3. Bulb is blown out</li> <li>4. No contact in stop light holder</li> <li>5. Broken wire in stop light circuit</li> </ol>	<p>Repair or replace switch</p> <p>Depress button to cut in circuit breaker</p> <p>Tighten contacts</p> <p>Replace bulb</p> <p>Repair holder having ensured reliable contact between holder and bulb</p> <p>Find out and eliminate breakage; connect wire</p>

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1	2	3
<p>Instrument panel illuminating lamps or the dome lamp fail to light</p>	<ol style="list-style-type: none"> <li>1. Circuit breaker has operated.</li> <li>2. Bulb is blown out</li> <li>3. No contact in bulb holder</li> <li>4. Broken wire in circuit of instrument panel illuminating lamps or dome lamp</li> <li>5. Switch is out of order</li> </ol>	<p>Depress button to cut in circuit breaker</p> <p>Replace bulb Repair holder having ensured reliable contact between holder and bulb</p> <p>Find and eliminate breakage; connect wire</p> <p>Repair or replace switch</p>
<p>Electric motor of oil priming pump fails to operate</p>	<ol style="list-style-type: none"> <li>1. Circuit breaker has operated</li> <li>2. Broken wire in electric motor circuit</li> <li>3. Switch on instrument panel is out of order</li> <li>4. Electric motor is out of order</li> </ol>	<p>Depress button to cut in circuit breaker</p> <p>Find and eliminate breakage; connect wires Replace switch</p> <p>Replace electric motor</p>
<p>Electric motor of cab heater fails to operate</p>	<ol style="list-style-type: none"> <li>1. Circuit breaker has operated</li> <li>2. Broken wire in electric motor circuit</li> <li>3. Switch on instrument panel is out of order</li> <li>4. Electric motor is out of order</li> </ol>	<p>Depress button to cut in circuit breaker</p> <p>Find and eliminate breakage; connect wire Replace switch</p> <p>Replace electric motor</p>
<p>When electromagnetic coupling is cut in fan impeller fails to rotate</p>	<ol style="list-style-type: none"> <li>1. Circuit breaker has operated</li> <li>2. Current slip ring and brush are dirty</li> <li>3. Damaged or worn brush</li> <li>4. Broken wire in electromagnetic coupling circuit</li> <li>5. Switch on instrument panel is out of order</li> </ol>	<p>Depress button to cut in circuit breaker</p> <p>Clean current slip ring and brush</p> <p>Check condition of brush and replace in case it is damaged or worn</p> <p>Find and eliminate breakage; connect wire</p> <p>Replace switch</p>

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1	2	3
<p>When lock-up button or unlocking button of torque converter is depressed pilot lamp fails to light</p>	<p>1. Circuit breaker has operated</p> <p>2. Bulb is blown out</p> <p>3. No contact in bulb holder</p> <p>4. Lock-up button or unlocking button of torque converter is out of order</p> <p>5. Broken wire in circuit of the lock-up mechanism coils</p> <p>6. Jamming of the lock-up control valve or one of movable contacts</p>	<p>Depress button to cut in circuit breaker</p> <p>Replace bulb</p> <p>Repair holder having ensured reliable contact between holder and bulb</p> <p>Repair or replace button</p> <p>Find out and eliminate breakage; connect wire</p> <p>Remove cover, take out limiter and slide valve, and wash them.</p> <p>Assemble them after washing</p>

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**Chapter VIII****AUTOMOBILE OPERATION****PREPARATION OF AUTOMOBILE FOR MOVEMENT**

When putting the automobile into operation, fill the automobile systems with coolant, oil and fuel depending upon the ambient temperature. Check that oil is available in tanks of the hydraulic transmission and steering system hydraulic booster, in the crankcase of the compressor and housings of the overdrive gear, transfer case, intermediate and final reduction units of all the axles, wheel-hub drives and in the steering gear case.

Check that the brake fluid is available in the master brake cylinders and when driving out, check the automobile brake system for reliable operation.

In all cases when preparing the automobile for movement, carry out the routine inspection of the automobile, prepare the engine for starting, start and warm it up.

**PREPARATION OF ENGINE FOR STARTING AT AMBIENT  
AIR TEMPERATURE ABOVE PLUS 5°C**

Prior to starting, fill the appropriate systems of the engine with coolant, fuel and oil.

The cooling system is filled with coolant, see the Section "Service Materials".

The total amount of water solution of emulsol or water filled into the cooling system comprises 100 litres.

To check filling of the cooling system with coolant, crank the engine by the starter without delivery of fuel and then, check the coolant level in the radiator. The level should be 20-25 mm above the radiator core tubes with the filler necks of both radiators open.

It is recommended to add coolant into the cooling system but not to change it completely. The more rarely it the coolant changed, the lesser is the amount of scale formed in the cooling system. Before filling the cooling system, reduce the temperature of coolant in the engine to 70°C.

Fuel should be filled according to the instructions given in the Section "Service Materials".

The total amount of fuel filled into the fuel tanks comprises 840 litres, i.e. 420 litres per each tank. The fuel to be filled should be clean and contain no mechanical admixtures or water. Penetration of water into the fuel system may cause irregular operation of the engine.

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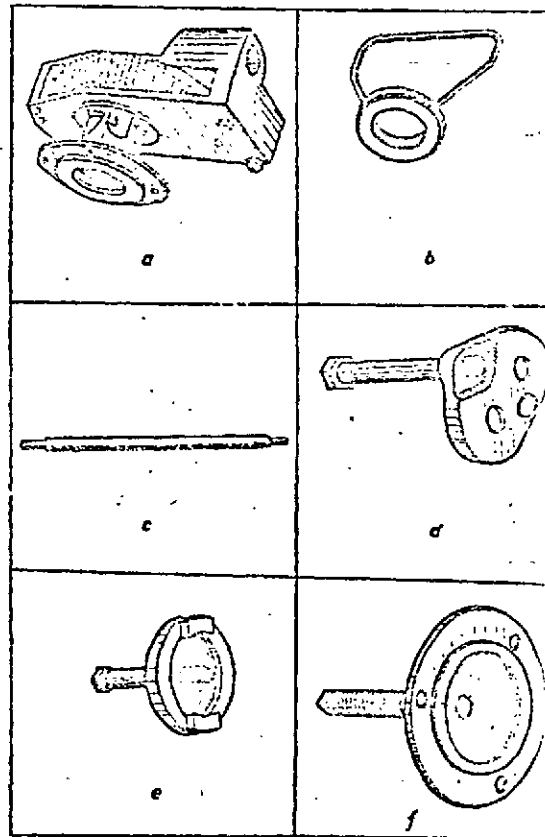
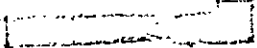
The standard equipment included into the automobile individual SPTA set may be periodically changed with accumulation of the operating experience and alteration of the technical documents.

## Automobile Service Appliances.

Fig. No.	Part. No.	Description and application of part
1	2	3
175a	537-3924005-A	Device for manual barring of engine crankshaft
175b	535A-3918020	Device for removal of filter elements of hydraulic transmission filters
175c	535A-3916498	Tool for removal of slide valves of hydraulic transmission control unit
175d	537-3918230	Fixture for removal of wheel from hub
175e	537-3918325	Sun gear puller
175f	537-3918350	Wheel hub puller
175g	537-3918356	Protective thrust (complete with part 537-3918350)
175h	537-3916130	Tommy bar for rotating adjusting nut of wheel brake cylinder
175i	537-3918356	Tool for removal and installation of brake shoe return springs
175j	537-3918340	Brake shoe anchor pin remover
175k	535A-3918110	Tyre removing device
175l	537-3918240	Torsion bar remover
175m	535A-3918612	Mandrel for fitting hoses of hydraulic transmission
175n	535A-3918080	Mandrel for driving in oil seals
175o	535A-3918086	Mandrel guide (complete with part 535A-3918080)
175p	535A-3918092	Mandrel for driving in oil seals
175r	535A-3918096	Mandrel guide (complete with part 535A-3918092)

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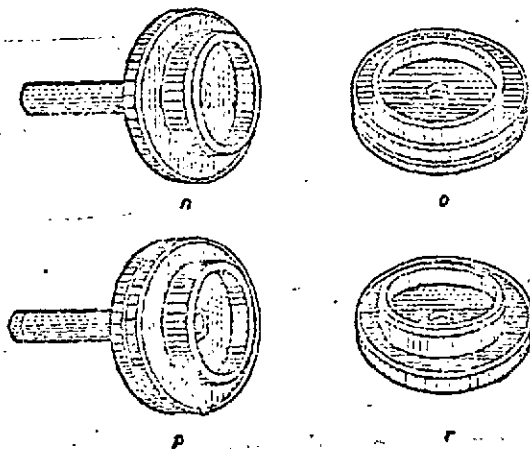
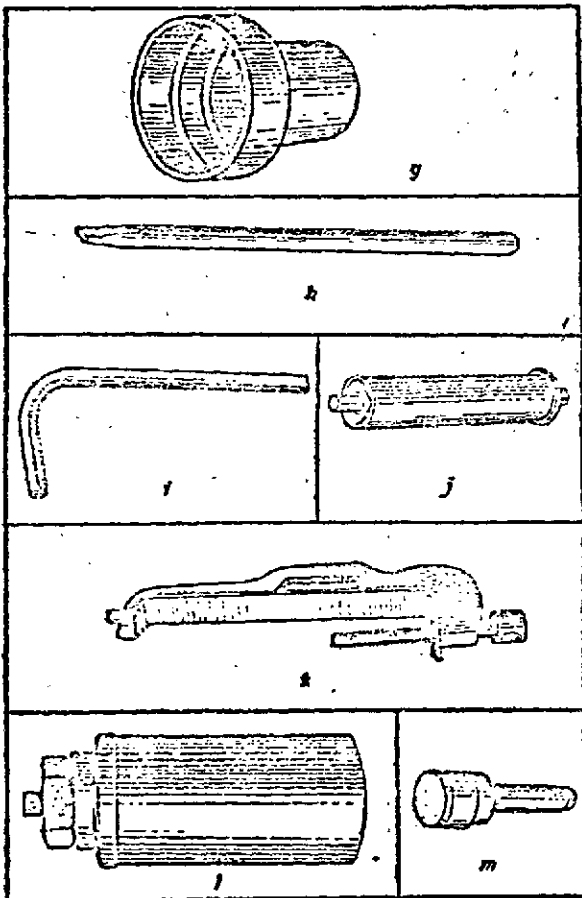


FIG. 174 SET OF APPLIANCES

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Appendix 3

LOADING AND FASTENING AUTOMOBILE ON  
RAILWAY FLATCAR AND UNLOADING

The automobile is transported on a four-axle railway flatcar.

It is recommended to load and unload the automobile from the flatcar end on a ramp with the angle of gradient not exceeding  $20^\circ$ . Before loading the flatcar floor should be cleaned of dirt and debris, and in winter time it should be cleaned of snow and ice and covered with a thin layer of sand.

The automobile is loaded on and unloaded from the flatcar under its own power.

The longitudinal axis of symmetry of the automobile installed on the flatcar should coincide with the longitudinal axis of symmetry of the flatcar. After the automobile has been installed into the required position the hand brake lever should be pulled on as far as it will go and the battery switch cut out.

The automobile is fastened by bracings made of four strands of wire 5 mm in diameter (Fig.177).

At the front, four bracings are used for fastening: two bracings are secured to the towing hook and end stake pockets while two other are attached crosswise to the first side stake pockets and to the heads of the front wheel suspension lower arms.

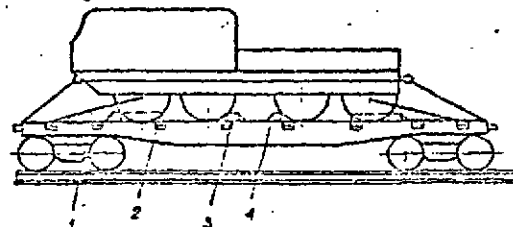


FIG. 176. AUTOMOBILE FASTENING DIAGRAM  
1 - longitudinal wire bracing; 2 - chock block preventing automobile from lateral displacement; 3 - chock block preventing automobile from lengthwise displacement; 4 - fastening clamp

At the rear, four bracings are used for fastening: two bracings are secured to the towing hook and rear side stake pockets while two other are attached crosswise to the last but one side stake pockets and to the heads of the rear wheel suspension lower arms.

Besides, to prevent the automobile from lengthwise displacement a chock block having the dimensions of  $120 \times 200 \times 500$  mm should be placed across the flatcar against the front and rear wheels from the outer side. Each chock block should be nailed to the flatcar floor by four  $8 \times 250$  mm nails.

To prevent the automobile from lateral displacement a chock block having the dimensions of  $180 \times 200 \times 500$  mm should be placed close to the extreme front and rear wheels from the inner side. Each chock block should be nailed to the flatcar floor by four  $8 \times 250$  mm nails. The chock blocks should be tightly fitted to the automobile wheel tyres.

The pressure in tyres should be  $4.5 \text{ kgf/cm}^2$ .

In summer, water should be drained out of the cooling system. In winter, the cooling system should be filled with antifreeze.

Unloading the automobile from a flatcar

Before driving down from the flatcar, proceed as follows:

1. Unfasten the automobile.
2. Check that fuel is available in the tanks and set the fuel distributing cock into the position at which the right-hand fuel tank is cut in. If necessary, top up.
3. In summer (at an ambient air temperature above  $+5^\circ\text{C}$ ) fill the cooling system with water.

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## Appendix 2

MOUNTING OF FITTINGS ON HIGH-PRESSURE  
HOSES OF HYDRAULIC TRANSMISSION

If a high-pressure hose of the hydraulic transmission is out of order it should be remounted using the fittings of an old hose.

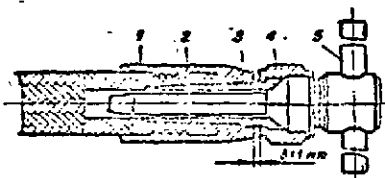


FIG. 175. MOUNTING OF FITTINGS ON HIGH-PRESSURE HOSES

1 - sleeve; 2 - mandrel; 3 - nipple; 4 - nut;  
5 - tommy bar

To mount the fitting on a new hose, secure sleeve 1 (Fig. 176) in a vice with copper jaws, insert the hose into the sleeve and rotating the hose manually to the left, screw in until it thrusts against the inner end face of the sleeve. If screwing-in of the hose is difficult, lubricate its end with solid oil. Then, mount nipple 3 on mandrel 2 provided in the SP2A set and secure it with nut 4. Insert the nipple and mandrel end lubricated with solid oil into the free end of the sleeve and rotating the mandrel by a tommy bar clockwise, screw in the nipple

as far as it will go; in this case, the clearance between end faces of the sleeve and nut should be within the limits of  $3 \pm 1$  mm. Then, using a wrench, loosen the nut and remove the mandrel from the hose. Wash the assembled hose with diesel fuel and test it under a pressure of  $20 \text{ kg/cm}^2$ .

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## Appendix 4

## PREPARATION OF AUTOMOBILE FOR STORAGE

General

Preparation of an automobile for storage implies keeping a serviceable and completely equipped automobile in a condition ensuring its long-term storage and preparation for operation in a shortest period of time.

1. When inactivated for periods over 30 days the automobile is subject to placing in limited storage (up to 3 months) or in long-term storage (over 3 months). If inactivation periods do not exceed 30 days, after 15 days of the automobile shutdown wash the inner space of the fuel injection pump, then start the engine, let it run for 10-15 min and apply the brakes for 15-20 times with the pressure of air in the system not less than 5 kgf/cm<sup>2</sup>.

2. To prevent corrosion, operate at halt 1-2 min in each gear of the planetary gearbox with the transfer case in neutral or run the vehicle for 10-15 km engaging all the gears of the planetary gearbox. It is permissible to combine the operations of this item with the operations prescribed in item 1.

3. The term for preparing a used automobile for a long-term storage should not exceed 12 days.

4. Processing or reprocessing of the automobile should be performed in a closed premises with a temperature of ambient air not below +5°C.

When the automobile is stored on an open ground or in non-heated premises it is permissible to perform processing or reprocessing of the automobile only in dry calm weather at a temperature of ambient air not below +5°C.

5. The fuel and lubricating materials used for processing the automobile should correspond to State Standards (ГОСТ ) which must be certified by documents.

6. The storage batteries should be removed from the automobile and sent to a charging station not later than 5 days since the moment of placing the automobile in a limited or a long-term storage. After charging the batteries should be stored in a depot.

7. The automobile subject to storage should undergo scheduled preventive maintenance.

8. The automobile placed in a limited or long-term storage should be fully filled with fuel, oil, working fluid of the hydraulic transmission, coolant (water solution of emulsion or water in summer, or antifreeze in winter). The tyres should be inflated.

9. The automobile should be provided with an on-vehicle SPTA set stored according to the delivery list.

10. Before processing the automobile should be cleaned of dust and dirt both inside and outside. All places having corrosion traces (except for ground surfaces) should be cleaned by emery paper or a wire brush and then wiped by cotton waste moistened with white spirit.

The outer layer of paint on units and assemblies of the automobile should be restored.

11. When processing the automobile, apply the lubricant to parts, units and assemblies of the automobile only with a hair brush. Before lubricating, wipe the parts by cotton waste moistened with white spirit or aviation gasoline containing no tetraethyl lead antidetonant. It is forbidden to apply the lubricant on the automobile parts by fingers.

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12. Place the automobile being in storage on metal or wooden supports (trestles) so that the wheels are clear of ground by 8-10 cm.

The trestles are to be placed under the reinforcing horizontal plates of the automobile frame. On a soft ground, place boards under the trestles.

13. Cab doors, engine compartment hoods and filler neck caps of the automobile placed in storage should be sealed.

14. When storing the automobile placed in storage on an open ground it should be covered with a tent. The tent should be fastened so as to prevent accumulation of water or snow on its surface. All freely hanging ends of the tent should be tied and should not touch the ground.

15. The fact of placing the automobile in storage should be recorded in the automobile Service Log.

16. The premises where the automobile is stored should be provided with fire-fighting equipment.

List and Scope of Operations to be  
Performed when Preparing Automobile  
for Limited Storage

The operations to be performed when preparing the automobile for placing in a limited storage are as follows:

1. Operations pertaining to processing of the engine, fuel injection pump and governor should be performed after the appropriate operations have been carried out on the fuel cooling and lubricating systems and after the oil has been changed in the transmission units.

2. For processing the engine, do the following:

- drain oil from the tank and engine crankcase;
- fill the engine oil tank with 30 litres of fresh oil, grade MT-16N, heated to a temperature of 80-90°C;
- start the engine and let it run idle for 10-15 min at a speed of 500-600 r.p.m.;
- drain the washing oil out of the engine system and fill the engine oil tank with conditioned oil, grade MT-16N, heated to a temperature of 80-90°C irrespective of a season of the year.

When filling the cooling system with water, add 300-500 gr of commercial potassium bichromate, State Standard (ГОСТ) 2652-48 in water to protect the cooling system parts from corrosion. Potassium bichromate should be dissolved in water prepared for filling.

3. Start and warm the engine until the temperature of coolant and oil reaches 45°C.

The engine is warmed with the purpose of applying a layer of lubricant on oiled surfaces of the engine parts and mechanisms and checking the system for leakage.

4. Immediately after stopping the engine, crank the crankshaft by the starter for 10-15 sec without delivery of fuel (2-3 switchings) to completely remove combustion products from the cylinders.

5. Disconnect the cardan shaft of the left-hand fans drive from the overdrive gear and attach the device for manual barring of the crankshaft to the flange of the overdrive gear. Insert a tyre iron into the device hole. Disconnect the overdrive gear from the transmission.

6. Disconnect the air delivery pipe running from the air bottles and connect a lever-plunger gun to the air distributor of the air starting system through an adapter union.

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7. Using a syringe fill each cylinder with 150 cm<sup>3</sup> of MT-16H oil heated to a temperature of 50-60°C.

The oil used for processing should be subjected to a laboratory analysis and, if moisture is detected, the oil should be dehydrated by heating to a temperature of 115-120°C. Heating of the oil within the above temperature range should be continued until formation of foam on the oil surface ceases.

To fill the air distributor body with oil the initial filling should contain 250-300 cm<sup>3</sup> of oil and the rest of fillings should contain 150 cm<sup>3</sup> of oil each.

8. The initial filling should be performed with the crankshaft set at 53° TDC (53° B.M.T.)  
1 l.h. 1 r.h.  
The rest of fillings should be performed through 60° of the crank angle, i.e. with the crankshaft set at: 113°, 173°, 233°, 293°, 353°, 53°, 113°, 173°, 233°, 293° and 353°.

To facilitate reading of the above degrees, make six marks with chalk on the flywheel rim. Proceed with filling oil only after these marks have been lined up with the pointer attached to the flywheel casing.

9. After all the cylinders have been filled with oil, crank the crankshaft by the starter for 10-15 sec (2-3 switchings) without delivery of fuel to ensure application of a uniform oil film on the faces of the cylinders.

To prevent the engine from starting the change-over cock of fuel tanks should be closed and the fuel feed control lever should be set in the FUEL FEED OFF (ПО-ЛЖА БМЖЕЧЕНА) position. In case of firing in the engine cylinders the filling of oil into the cylinders should be repeated.

10. Disconnect the lever-plunger gun from the air distributor and connect the pipe delivering air from the air bottles.

11. After the processing of cylinders is completed, close the engine exhaust pipes with plugs made of soft wood and coated with lubricant, grade VG.

12. For processing the fuel injection pump, do the following:

- close the fuel injection pump drain pipe with a plug;
- set the manual fuel feed control lever in the FUEL FEED OFF position;
- unscrew the filler hole plug on the fuel injection pump housing (on top of the front part) and pour in 4.0-4.5 litres of dehydrated oil, grade MT-16H, heated to a temperature of 50-60°C;
- after the fuel injection pump housing is filled with oil, depress the accelerator pedal or stroke the manual fuel feed control lever several times to ensure reliable lubrication of the fuel injection pump control rack and toothed rims;
- in 5-10 min after the fuel injection pump housing has been filled with oil (after the oil has flown from the pump upper space into the lower space), remove the plug from the drain pipe and drain oil out of the fuel injection pump housing;
- screw in the filler hole plug.

13. For processing the governor, proceed as follows:

- unscrew the drain hole plug and drain waste oil out of the governor;
- screw in the drain hole plug;
- unscrew the filler hole plug on the governor housing and fill the housing completely (2.7-3 litres) with dehydrated oil, grade MT-16H, heated to a temperature of 50-60°C;
- unscrew the drain hole plug and drain the oil;
- screw in the drain hole plug and unscrew the level hole plug;
- fill the governor with dehydrated oil, grade MT-16H, screw in the plugs and lock them.

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**Note:** To improve the quality of the engine processing it is recommended before filling the oil to run the engine on inhibited oil, grade MT-16n or MC-20, and to use these grades of oil for filling the cylinders and processing of the fuel injection pump and engine governor spaces. Inhibitors added to the oil are as follows: 0.5-1 per cent (by volume) of silico-organic liquid No. 5, TY KKH 2416-54 or 2-3 per cent of triethanolamine soap (mixture containing 50 per cent of oleic acid, State Standard (GOST) 10475-63 and 50 per cent of triethanolamine TY 1931-42).

14. Scavenge the injector-type preheater boiler having set for 10-15 sec the electric motor switch in the OPERATION (РАБОТА) position and the electromagnetic valve switch in the SCAVENGE (ИЗОЛВБ) position.
  15. Wrap the radiator cap with a paraffined paper and tie it with wire to the filler neck. Glue up the paraffined paper to the radiator filler neck and bind it with twine.
  16. Check the condition of fans and loosen the belts on the drives of the fans and compressor. Replace worn belts with new ones.
  17. Thoroughly inspect all the rubberized hoses of the cooling system; replace the hoses having separation of layers or cracks with new ones.
  18. Remove the windshield wipers and keep them in the cab.
  19. Close (glue up) the side air intake ports leading to the first cleaning stage of the air cleaner with paraffined paper.
  20. Check tightening of all terminals in the electric system, coat them slightly with a universal low-melting lubricant (petrolatum) preventing the lubricant from getting on the wire insulation.
  21. Coat the surfaces of valves and other non-painted parts of the air starting system with a universal low-melting lubricant (petrolatum).
- Charge the air bottles with compressed air to a pressure of 125-150 kgf/cm<sup>2</sup>. If necessary, send the air bottles for testing and marking.
22. The planetary gearbox gearshift lever and the transfer case control lever should be set in the neutral position; the hand brake should be released.
  23. Wrap the filter of the engine ventilation system with paraffined paper.
  24. Coat the non-painted parts of towing gears with lubricant, grade YCc.
  25. Clean the tools of dirt and corrosion traces, paint the non-working surfaces of the tools with black enamel, and coat the working surfaces with a universal low-melting lubricant (petrolatum). After treatment, wrap the tools with paraffined paper and stow them according to the packing list.

List and Scope of Operations to be Performed  
when Preparing Automobile for Long-Term

Storage

In addition to operations performed to prepare the automobile for limited storage proceed as follows:

1. When preparing the automobile for storage for a term exceeding 6 months, drain the working fluid (lubricant) out of the torque converter, planetary gearbox and tank of the hydraulic transmission. Fill the hydraulic transmission tank with 25-30 litres of lubricant, grade AY, heated to a temperature of 50-60°C, start the engine and let it run at a low speed for 10-15 min with the gearshift lever of the planetary gearbox set in neutral. Drain the washing oil and fill the hydraulic transmission with fresh working fluid up to the level of the upper level plug.
2. When preparing automobile for storage for a term exceeding 6 months, wash the housing of the overdrive gear, transfer case, intermediate and final reduction units of axles, fans drive reduction gear and wheel-hub drives for which purpose, proceed as follows:

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- drain old lubricant;
- fill the housings up to half of their filling capacities with oil, grade ET-16N, previously heated to a temperature of 60-80°C;
- run the transmission in each gear during 3-5 min;
- drain the washing oil;
- fill the housings with fresh lubricant according to the norms specified in the Lubrication Chart.

3. Perform three-time filling of oil as instructed in the previous subsection "Operations to be Performed when Preparing Automobile for Limited Storage" except for the doubled initial filling of oil for filling the air distributor casing which should be performed only once.

4. Glue up the generator vent ports with greased paper.

5. Wrap (close) the lenses of headlights and side lamps on the outside with paper; glue up the paper to the shell of a headlight or side lamp.

6. Remove and check the condition of shock absorbers. Repair the faulty shock absorbers, fill them with fluid and reinstall.

7. When preparing automobile for storage for a term exceeding 6 months, remove the wheels from hubs, disassemble and check the condition of wheels, eliminate the revealed defects. Wash and dry the tyres and tyre tubes; slightly dust the inner surfaces of tyres with talc. Clean and paint the rims, spacing and side rings. Assemble the wheels, mount them to their proper places and inflate to normal pressure.

8. When preparing an automobile having the run over 15,000 km for storage for a term exceeding 6 months, wash the cooling system, if necessary.

#### Preventive Maintenance of Automobile

##### Being in Storage

Preventive maintenance of the automobile being in storage should be performed within the terms and scope prescribed below.

1. Once a month, remove the tent from the automobile:

- check the positioning of the automobile on supports (trestles);
- check whether the lead seals are intact;
- open the automobile and check the condition of outer surfaces of assemblies and mechanisms; in case corrosion traces are revealed, clean the attacked surface, then lubricate or paint;
- clean the automobile of dust, moisture and dirt both outside and inside;
- in good weather, open the cab doors of a serviced automobile for ventilation;
- check the connections of pipelines for leakage of fuel, oil, coolant and brake fluid;
- check the condition of rubberized hoses and rubber articles;
- check the condition of glued sealing paper and plugs in assemblies and mechanisms; if necessary, restore the glued paper and replace the plugs;
- check the pressure in tyres and, if necessary, bring it to normal from an external air source;
- close and seal the cab doors and engine compartment hoods;
- cover the automobile with the tent;
- check and charge the storage batteries stored in a depot.

2. Twice a year - in spring and autumn (when preparing the automobile for summer and winter periods of operation), carry out the operations prescribed for seasonal preventive maintenance and in addition, proceed as follows:

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- during scheduled charging of storage batteries, bring the electrolyte specific gravity to a value corresponding to the season of operation;
  - fill the cooling liquid corresponding to the season of operation;
  - prepare the engine for starting according to the Section "Removal of Automobile from Storage";
  - start and warm up the engine to normal temperature and listen to its operation at a constant speed;
  - during operation of the engine shift in the first gear for 1-2 min to put the gears of the transmission assemblies in a new position;
  - rotate the steering wheel 5-6 times in both directions as far as it will go;
  - process the engine as instructed above;
  - check the level of brake fluid in the reservoirs of master brake cylinders and top up, if necessary;
  - apply lubricant to all lubricating points in accordance with the automobile lubrication chart;
  - change lubricant in all lubricating points of the winch according to the winch lubrication table;
  - check the condition of the SPTA set, if necessary, clean the tools and accessories of corrosion traces; paint non-working surfaces and lubricate working ones.
3. After a year-long uninterrupted storage and further every year, perform the following operations when the weather is dry and warm;
- prepare the engine for starting as instructed in the Section "Removal of Automobile from Storage";
  - start and warm up the engine to normal temperature;
  - without removing the automobile from the supports, check operation of assemblies and mechanisms of the automobile by shifting in all the gears in turn with the engine running;
  - check functioning of all instruments and presence of current in all the circuits;
  - process the engine as instructed above;
  - add fuel into the fuel tanks.
4. Once in five years when performing scheduled reprocessing of the automobile change fuel, lubricants and special liquids in the engine systems and in the transmission assemblies.

#### Removal of Automobile from Storage

The automobile is removed from storage to prepare it for further service. To remove the automobile from the storage proceed as follows:

1. Remove the tent from the automobile.
2. Remove lead seals from the cab doors, engine compartment hood, plugs and caps of filler necks and tool boxes.
3. Check the pressure in the tyres and, if necessary, bring it to normal.
4. Remove the automobile from supports.
5. Remove the glued sealing paper and plugs.
6. Clean the outer parts of the automobile assemblies and mechanisms of preservative lubricant.
7. Install the storage batteries and connect the wires to them.
8. Check the electric circuits for presence of current.
9. Check the level of oil, fuel and coolant and top up, if necessary.
10. Prepare the engine for starting for which purpose, proceed as follows:

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- if the automobile was stored in non-heated premises, fill the fuel injection pump housing before starting with two litres and the governor body with one litre of oil, grade M-16N, heated to a temperature of 80°C and then drain it to the level of the level hole;
  - crank the engine crankshaft by the starter for 10-15 sec (2-3 switchings) without delivery of fuel;
  - set the handle of the fuel distributing cock in the position at which the right-hand fuel tank is cut in (both tanks should be filled);
  - using the electric oil priming pump, build up a pressure of at least 3 kgf/cm<sup>2</sup> in the lubricating system;
  - bleed air from the engine fuel system.
11. Start the engine and warm it until the temperature of the coolant and oil reaches 45°C and listen to its operation at different speeds.
- In this case, it should be born in mind that at starting of an engine removed from limited storage about 2 litres of oil will be thrown out from the exhaust pipes and at starting of an engine removed from long-term storage about 6 litres of oil will be thrown out from the exhaust pipes.
12. Drive the automobile for a test run during which check operation of all assemblies and mechanisms and correct the detected troubles.

#### Used Fuels and Lubricants

In addition to fuels and lubricants used during operation of the automobile the following materials are employed to prepare the automobile for storage:

1. Aviation gasoline, grade B-70, State Standard (TOCT) 1012-54.
2. Universal low-melting lubricant, grade JH (petrolatum), State Standard (TOCT) 782-59.
3. Preventive compound HC-40 (BIT 603-59)
4. Aluminium paint AKC (TY MZH 1668-47).
5. Varnish No.170 (TY MZH 1208-45)
6. Putty 33E-3 (BIT 367-54).
7. Silicon fluid No.5 (TY MZH 2416-54)
8. Oleic acid, State Standard (TOCT) 10475-63.
9. Triethanolamine, TY 1931-42.

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## Appendix 5

INSTALLATION OF AUTOMOBILE ON SUPPORTS SO  
PREPARE IT FOR STORAGE

The automobile should be positioned on supports on a level ground with asphalt coating or hard soil by means of two 12-ton jacks appended to the automobile SPTA set.

Installation of the automobile on supports on a hard-soil ground should be started with jacking up the front part of the automobile for which purpose, proceed as follows:

- place the sprags under the wheels of the first and fourth axles;
- place a flooring made of three boards (dimensions 1600x110x70) perpendicular to the automobile centre line under the horizontal reinforcing cross member of the first axle so that the central board of the flooring is against the rear lower arms of the first axle suspension;
- install the jacks under the horizontal reinforcing cross member at places where the rear portions of brackets of the first axle suspension arms are located having previously built up the flooring under the jacks to a height of 300-310 mm;
- simultaneously operating the two jacks, evenly raise up the front portion of the automobile for a full lift of the jacks;
- extend the flooring towards the front bumper by 2-3 boards and install intermediate supports having the diameter of not less than 200 mm and height of 600 mm; install the intermediate supports under the front part of the horizontal reinforcing cross member at places where the front portions of brackets of the first axle suspension arms are located;
- evenly and slowly lower down the jacks until the front portion of the automobile is reliably held on the supports; this done, remove the jacks from under the automobile;
- build up the flooring under the jacks to a height of 420 mm;
- install the jacks onto the initial places and evenly continue to raise up the front portion of the automobile for a full lift of the jacks;
- install the supports having the diameter of not less than 250 mm and height of 640 mm under the front part of the horizontal reinforcing cross member at places where the front portions of brackets of the front axle suspension arms are located having previously placed under each support two boards (dimensions 400x110x70) so that they are perpendicular to the flooring centre line.

To jack up the rear portion of the automobile, proceed as follows:

- jam the rocker-type suspension of the rear wheels for which purpose, place metal bars between the rear upper arms of the fourth axle suspension and the automobile frame;
- place a flooring made of 3-5 boards (dimensions 1600x110x70) under the horizontal reinforcing cross member of the fourth axle so that it is perpendicular to the automobile centre line;
- install the jacks under the rear lower arms of the suspension having previously built up the flooring under the jacks to a height of 300-310 mm;
- simultaneously operating the two jacks evenly raise the rear portion of the automobile for a full lift of the jacks;
- install under the horizontal reinforcing cross member at places where the rear portions of brackets of the fourth axle suspension arms are located the intermediate supports used previously for jacking up the front portion of the automobile and remove the jacks;

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In winter (at an ambient air temperature below  $+5^{\circ}\text{C}$ ) check that antifreeze is available in the cooling system. If necessary, top up.

4. Before starting the engine in winter, warm it up with the preheater until the temperature of coolant in the cooling system reaches  $+45^{\circ}\text{C}$ . For the preheater handling instructions and engine warming procedure, refer to the Section "Preparation of Automobile for Motion". On an automobile delivered to the User the preheater should be cut in the cooling system.

5. Cut in the battery switch by depressing the handle (located to the left of the driver's seat).

6. Depress the voltmeter button and check the voltage in the electric system. The voltage should be 24 V.

7. Depress the button of the oil priming pump (on the instrument panel) and build up a pressure of at least  $3 \text{ kgf/cm}^2$  in the engine lubricating system.

8. Depress the starter button and start the engine.

9. Warm the engine until it acquires the operating condition in which case the outlet coolant temperature should be at least  $45^{\circ}\text{C}$ .

10. Check the pressure of air in the brake system by the pressure gauge. The pressure should be within the limits of  $5.65\text{--}7.35 \text{ kgf/cm}^2$ .

11. After the above operations have been performed it is permitted to drive down from the flatcar. Drive down in the first or reverse gear engaged in the gearbox taking all the precautionary measures.

As to the rest, follow the recommendations of the present Instructions.

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DELIVERY LIST 537-BK

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— 1 —

*Introduction*

*Spare parts, tools and accessories (SPTA) are divided into two sets: on-vehicle set and non-carried set.*

*For railway shipment or transportation by water the SPTA sets are stowed in two wooden cases according to their names excluding the following parts of SPTA set:*

- 1. 52078-3913240-A - jack pad assembly } placed in the cab*
- 2. 537-3927010 - sprags*
- 3. 537-3933310 - vehicle canvas cover assembly - placed in the cab*
- 4. 537-3101011 - wheel assembly - transported on railway flat car*
- 5. 537-3907010 - towing cable complete with thimbles - placed on the bumper*
- 6. SPTA for engine A12A-525 - sealed by the manufacturer - placed on the flat car*
- 7. 537-3914006-K - engine winter cover assembly } placed in the cab*
- 8. 537-3314010-K - top section of engine winter cover*
- 9. 537-3912149 - Mat - is placed behind the middle back of the seat.*
- 10. 712-27-CD.276 - Pulley block, assy - in the cab.*

*At the point of destination the customer arranges the on-vehicle SPTA set according to the instructions of the Delivery List.*

*The non-carried SPTA and portions not having the instructions on unsetting set is stowed at the customer's discretion.*

*The wooden cases are designed only for transportation of SPTA set, but not for its storage.*

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Upon receipt of the SPTA the Customer should check its condition and repack and reslush it, if necessary. Note, For detailed data on design, arrangement and application of the vehicle SPTA set refer. to Appendix 1 to „Automobile MAZ-537 Maintenance and Operation.“

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Nos.	Designation, type, code, Assg. No	Name and GOST, OST, Specifications	Marking of tools and spare parts		Quantity	Place of stowage	Note
			Inscription	Method of marking			
1	2	3	4	5	6	7	8
1. On-vehicle set of spare parts, tools and accessories							
1	537-3907010	Towing cable complete with shackles			1	On front bumper	
2	537-3927010	Sprags	7010	Stamped	2	In front part of semitrailer	
3	52018-390340-A	Jack pad, assembly	240	Painted	2	In front part of semitrailer	
4	535A-8201016A	Rear view mirror			1	On bracket of cab left side	Removed from vehicle for transportation
5		Portable fire extinguisher OY-5	Fire extinguisher OY-5	Inscription on fire extinguisher plate	2	On right and left fenders	
6		Can, capacity 20 lit, GOST 5105-66	20 lit	Stamped	3	On right and left rear fenders	The 3 cans are in the non-catalogued SP7A box
7	537-3909190	Funnel extension			1	In tool box	
8	502-3905040-A	Cross-cut saw, GOST 979-66 In case, part 537-390-SECRET			1	Behind back rest of passenger seat	

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1	2	3	4	5	6	7	8
9	535A-3909160-K	Bucket				1	Under windshield case <i>In mounted of the windshield's presence over the case</i>
10		Crow bar LO-28, GOST 1405-65				1	In front part of semitrailer
11	537-3905160	Entrenching spade				1	In front part of semitrailer
12	535A-3913050	Sledge hammer, assy, 7.5 kg				1	In front part of semitrailer
13	535A-8201012	Spherical mirror complete with				1	In bracket of cab right side <i>Removed from vehicle for transportation</i>
14	712-27-02.276	Pulley block, assy	712-27 02.276	Stamped		1	In front part of semitrailer <i>Only for vehicles equipped with winch</i>
15	502-39050-10	Axe A2 GOST 1399-58 GOST 1400-48				1	In tool box
16	5293-3909170-K	Oil filling mug				1	In tool box
17	5293-3909180-K	Funnel				1	In tool box
18	24-3912250	Drinking-water tank				2	In front rear wall of cab on r.h. and l.h. side
19	535A-3912010	First aid kit, assy				1	In cab
20	537-3912149	Mat				1	In cab

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1	2	3	4	5	6	7	8
21		Clock, type ABP-11	Clock, type ABP-11	On packing	1	In cab on instrument cluster	removed from vehicle for transportation
22	543-3919530	case for small tools, assy			1	In cab	
23		Wrench 8-10 GOST 2839-62	8-10	Forged	1	In case for small tools	
24	117-3901025-A	Double-head wrench 10-12	10-12	Forged	1	In case for small tools	
25	117-3901032-A	Double-head wrench 14-17	14-17	Forged	1	In case for small tools	
26	9-079	Automobile pliers			1	Same	
27	535A-3912058	Chisel 20x175			1	Same	
27a		Wrench 22x24 GOST 2839-62	22-24	Forged	1	In case for small tools	
28	205-501206	Right 4x120 GOST 7214-54			1	Same	
29	535A-3915520	Ring nut wrench assy 90 + 130	90+130	Stamped	1	In semi-trailer tool box	

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1	2	3	4	5	6	7	8
30	535A-3916300-B1	Wrench for wheel hub bearing nut	300	Stamped	1	In semitaller tool box	
31	530-106	Double-head wrench 14-17	14-17	Forged	1	In case for small tools	
32	330-131-1	Double-head wrench 8-10	8-10	Forged	1	In case for small tools	
33	535A-3916301	Tommy bar of wrench for wheel hub bearing 25x1200	301	Stamped on tag	1	In semitaller tool box	
34	712-27-cd.183	Towing shackle	712-27 cd.183	Stamped	1	In semitaller tool box	
35	117-3901033-A	Double-head wrench 18-22	19-22	Forged	1	In case for small tools	
36	200-3901523-A2	Double-head wrench 27-30	27-30	Forged	1	Same	
37		Adjustable wrench 46, GOST 7275-62	46	Forged	1	In tool box	
38		Screw driver A175-07, GOST 5423-54			1	In case for small tools	
39		Screw driver A250-14, GOST 5423-54			1	In case for small tools	

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1	2	3	4	5	6	7	8
40	11-108-3901000-A	Mounting hammer, 0.5 kg.				1	In tools box
41	535A-3913238	Semi-round file complete with handle				1	In case for small tools
42	535A-3916120	Wrench for steering control rod plugs	120	Stamped		1	In case for small tools
43	537-3918598	Socket wrench for plugs	598	Stamped		1	In case for small tools
44	CR-1215-3912200	Pressure gauge indicator in case (part 205-3912200-61)	120-15	Cast		1	In case for small tools
45	530-107	Wrench 17x19 USSR standard 2839-62	17-19	Forged		1	Same
46	330-163-1	Wrench 24x27 USSR standard 2839-62	24-27	Forged		1	Same
47	430-240	Wrench 32x36 USSR standard 2839-62	32-36	Forged		1	Same
48	305-515257-1	Inspection lamp CN-1 with bulb A 24-21				1	Wrap in paper
49		set of socket wrenches according to plant Delivery List of part				1	In tool box

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1	2	3	4	5	6	7	8
50	205-3916358	Socket wrench			1	In tool box	
51		Brush carrier and brush			2		Removed from vehicle for transportation
52	131-8104210	Fan, assy	4210	Stamped on tag	2	In the cab de tachable front prop	Removed from vehicle for transportation
53		The engine flywheel case plug	2	Inscription in ink on wrapping paper	1	In case for small tools	Unscrewed before the installation of the engine of the machine
54		Wrench 46, GOST 2841-62	46	Stamped	1	In tool box	It is allowed to use wrench 46-50; GOST 2841-62
55	535A-3915570	Single-head wrench 55	55	Stamped	1	Same	
56	535A-3915338	Single-head wrench 65	65	Stamped	1	Same	

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1	2	3	4	5	6	7	8
57	535-3916338	Socket wrench for wheel nuts	358	Stamped	1	In tool box	
58	205-390402-B	Hydraulic jack assy	Hydraulic jack 12-ton	Inscription on jack plate	2	Same	
59	51-3901207-B	Hydraulic jack operating lever	207	Stamped on tag	2	Same	
60	537-3916130	Tommy bar for adjusting service brake	130	Stamped	1	Same	
61	537-3916230	Appliance for removal of wheel from hub	230	Stamped	2	Same	
62	537-3916325	Puller for sun gear	325	Stamped	1	Same	
63	537-3924029	Device for unpressing the back valve of the absorber	4029	Inscription in ink on wrapping paper	1	In case for small tools	
64		The heater NKD-600 SPTA set in accordance with the leading certificate of the heaters plant - dell	3117 NKD-600	Inscription on packing	1 set	In tools box under the seat	Sealed by manufacturer

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1	2	3	4	5	6	7	8
55	1-3911010	lever - plunger grease gun			2	In tool box	
55	535A-3911020	flexible nose for grease gun, assy	1020	Stamped on tag	2	Same	
57	537-1018360	peen end piece for oil tank, assy	360	Stamped	1	Same	
58	337-3917350-A1	compound nose for tire inflation	350	Stamped on tag	1	Same	
69	535A-3913025	Hose for bleeding hydraulic brakes	325	Stamped on tag	1	Same	
70	407-3901340	End piece for cardan shaft lubricating gun assy	340	Inscription in ink on wrapping paper	1	Same	Wrap in wrap- ping paper
71	535A-4508050-3	Setting, Set			4	Same	
72	535A-3509055	Membrane of com- pressor relief valve	535A- 3509055	Pressed	2	Same	
73	CR-AP-10B - -3512000	Air pressure governor	AP-10-B	Stamped	1	Same	Wrap in wrap- ping paper

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1	2	3	4	5	6	7	8
74	12-1308020	Belt I - 15-11-1120; GOST 5813-64	16x11 1120	Pressed	2	In tool box	
75	204-1308027	Belt I - 21-14-1735; GOST 5813-64	21-1735	Pressed	2	Same	
75	535A-1303072	Hose	072	Stamped on tag	1	Same	
77	537-1303063	Hose	063	Stamped on tag	1	Same	
78	535A-1303123	Hose	183	Stamped on tag	1	Same	
79	537-1303010	Hose	3010	Stamped on tag	1	Same	
80	537-1018184	Hose	184	Same	1	Same	
81	535A-8101038	Preheating system case	038	Same	1	Same	
82		Wire dia. 1,6+2mm.			15m	Same	
83	321-20	Hose - connecting water pipes	321-20	By the tipog- raphical way on paper	2	Same	

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1	2	3	4	5	6	7	8
84	537-1303035	Clamp assy	3336	Stamped on tag	2	In tool box	
85	537-1303035	Clamp assy	035	Same	2	Same	
85	297588-N8	Bracing band	588	Same	2	Same	
87	314802-N	Taper sleeve $\phi 10$	802	Inscription in ink on wrapping paper	2	Same	Wrap in wrapping paper
88	379250-N	Taper sleeve $\phi 18$	250	Same	2	Same	Same
89	379270-N	Taper sleeve $\phi 20$	270	Same	2	Same	Same
90		PVC adhesive tape NXL-020 TY-MXN 2892-SS			2502 (50)	Same	
91	297594-N8	Bund 101640	594	Stamped on tag	2	Same	
92	537-3101011	Wheel, assy			1	In front part of engine	
93	535A-1804394	Protective hose	535A-1604294	Painted	1	In tool box	In use at the junction of the engine cylinder

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1	2	3	4	5	6	7	8
<i>ii. Non-carried set of tools, spare parts and accessories.</i>							
1	535A-3915576	Special adjustable wrench for ring nut	576	Stamped	1		
2	535A-3916584	Wrench for ring nut of steering wheel driving taper gear	584	Same	1		
3	535A-3916486	Wrench for threaded bush of planetary gear box	498	Same	1		
4	537-3916494	Wrench for compressor valve and nut of planetary gear box locking device	494	Same	1		by Lester
5	535A-3916538-B	Wrench for nut fastening intermediate shaft and threaded cover of hydraulic transmission	558	Same	1		
6	537-3916265	Wrench for nut fastening ball steers	265	Same	1		
7	535-1802093	Swash	535-1802093	Inscription in ink on wrapping paper	2		Wrap in wrapping paper

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1	2	3	4	5	6	7	8
8	535A-391649P	Mandrel for removal of slide valves	498	Stamped	1		
9	535-3913020	Round-hose pliers for removal of outer lock rings	020	Same	1		
10	537-3933310	Vehicle canvas cover, assy			1		
11	537-130871	Left brush in assembly	471	Inscription in ink on wrapping paper	1	Same	Removed from vehicle for the period of blocking of electric couplings
12	NP-310	Safety fuse, type NP-310	NP-310	Pressed	1	In box for electrical equipment	
13	537-3919630-A	Box for electrical equipment, assy	Electrical equipment	Painted	1		
14		Bulb 24-60+40 FOCT 2023-66	246604000	Inscription on bulb	2	In box for electrical equipment	Underlay with cotton wool
15		Bulb A 24-32+4 FOCT 2023-68	246324000	Inscription on bulb cap	2	Same	Same

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1	2	3	4	5	6	7	8
16		<i>Lamp</i> A-24-3 10CT2023-66	248 326	<i>Inscription</i> on bulb cap	2	<i>In box for</i> electrical equipment	<i>Inter lay</i> with cot- ton wool
17		<i>Bulb</i> A 24-21 10CT2023-66	248 2126	<i>Same</i>	2	<i>Same</i>	<i>Same</i>
18		<i>Bulb</i> A24-1 10CT2023-66	248 126	<i>Same</i>	9	<i>Same</i>	<i>Same</i>
19	537-1306114	<i>Hand packing</i>	114	<i>Inscription</i> in ink on wrapping paper	1	<i>Same</i>	<i>Wrap in</i> wrap- ping paper
20	M94.211.001-F	<i>Safety fuse,</i> type NP-25	NP-25	<i>Pressed</i>	1	<i>Same</i>	
21	M94.002.F4	<i>Safety fuse</i> type NP-3	NP-3	<i>Same</i>	1	<i>Same</i>	
22		<i>Temperature gauge</i> TY3-48 (set)	Type TY3-48	<i>Inscription</i> on packing	1	<i>Same</i>	
23		<i>Pressure gauge</i> T3M 15 (set)	Type T3M-15	<i>Same</i>	1	<i>Same</i>	
24		<i>Oil pressure gauge,</i> type 3DMY-3 (set)	Type 3DMY-3	<i>Same</i>	1	<i>Same</i>	
25	CR-746-371000052	<i>Change-over</i> switch, type N4555	SECRET N45-52	<i>Stamped</i>	1	<i>Same</i>	

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1	2	3	4	5	6	7	8
26		Temperature gauge 743-487 (set)	Type 743-487	Inscription on packing	1	In box for electrical equipment	
27		SPTA set for en- gine D12A-525 according to Appen- dix 1 of the engi- ne Manufacturer			1		Sealed by Ma- nufac- turer
28	2119A	Fuse link NB-60A-C	60A-C	Stamped	4	In box for electrical equipment	
29	PC401-372600004	Turn Indicator breaker	PC 401	Stamped	1	Same	
30	CK-11111-38105000	Sending unit of emer- gency oil pressure	11111	Same	1	Same	
31	M3-302-3730000	Sending unit of electrical tachometer	M3 302B	Stamped	1	Same	
32		Set of spare parts for pump HW-45 in pump Manufac- turer's packing	3M7- HW-45	Written in ink on packing	1 set		Packed by the delivere plant
33	2019	Fuse link NB-6-A	6-A	Stamped	4	In box for electrical equipment	

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1	2	3	4	5	6	7	8
34	537-3914006-K	Engine winter cover, assy.			1		Installed on vehicle according to automobile operating instructions
35	537-3914010-K	Top section of engine winter cover, assy.			1		
36	537-3401040	Booster hose, assy	1040	Stamped on tag	1		
37	535A-1035058	hose	058	Same	1		
38	200-3401025	Oil seal, assy	200-3401025	Pressend	2		
39	535A-1512083	regulating swash plate	083	Inscription in ink on wrapping paper	5		wrap in wrapping paper
40	537-1303144-B	Leading hose of the left radiator	144	Stamped on tag.	1		
41	537-1303145-B	Leading hose to the right radiator.	145	Same	1		
		SPT. completed by:					

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1	2	3	4	5	6	7	8
<i>iii Technical documents appended to automobile</i>							
1	<i>535A-8207025</i>	<i>Pocket for documents</i>				1	
2		<i>Delivery list for set of socket wrenches, Гапо*</i>				1	
3	<i>537-BK</i>	<i>Delivery List of Automobile MAZ-537</i>				1	<i>system</i>
4		<i>Supplement to Operation and Maintenance Instructions of Automobile MAZ-537 and its modifications.</i>				1	
5		<i>Automobile MAZ-537 Description and Operating Instructions.</i>				1	
6		<i>Certificate of automobile (tractor)</i>				1	
7		<i>Certificate of hydraulic transmission</i>	<i>simple</i>	<i>car by te</i>		1	<i>transmission</i>

In pocket for documents

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1	2	3	4	5	6	7	8
8		Brief instructions on operation and maintenance of dry-charged storage batteries; type 12 cr-70			1	In pocket for documents	
9		Caution			1	In wind-shield	Assembled for time of transportation
10		Heater PJA-600 SPTA register			1	On the heater SPTA set packing.	
The technical documentation list attached to engine D 12A							
		Folder for documents			1		
		Service Log of Engine D 12A			1		
Documents are completed by the controller:							

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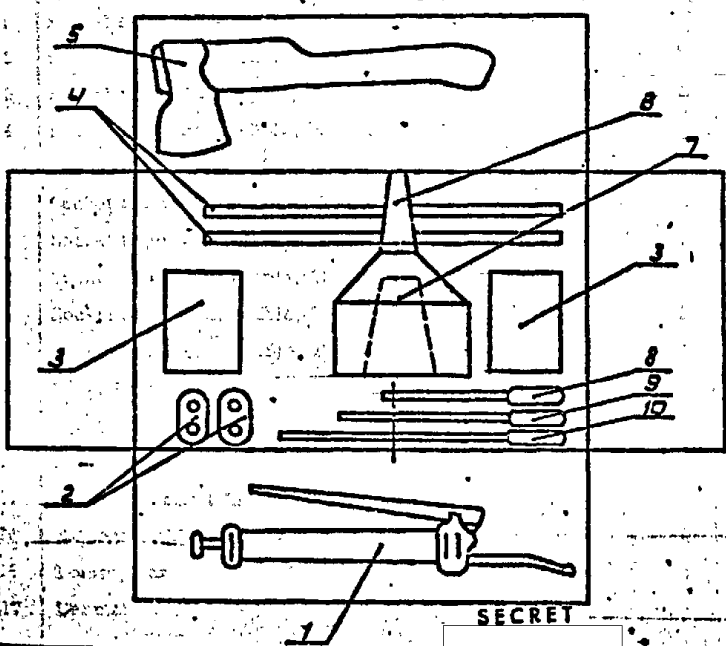
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Scheme  
of the placing of the fastened details in  
the instrument case



Nb	Description	Name	Qty
1	411-3911010	the gun	1
2	537-3918230	the wheel piler	2
3	225-3901502-B	the jack	2
4	51-3901207-B	hydraulic jack	2
		operating lever	
5	502-3905040	the bench axe	1
6	5298-3909180K	the funnel	1
7	5298-3909180K	the mug	1
8	535A-3916670	the nut key S-55	1
9		the key 46	1
		FACT 2641-62	
10	535A-3916333	the nut key S-65	1

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Export

DELIVERY LIST "TAPO" ("GARO")

1. Set of socket wrenches

Nos	Description	Quantity
1	Socket head changeable, 10 mm	1
2	Socket head, changeable, 11 mm	1
3	Socket head, changeable, 12 mm	2
4	Socket head, changeable, 14 mm	2
5	Socket head, changeable, 15 mm	1
6	Socket head, changeable, 17 mm	2
7	Socket head, changeable, 19 mm	2
8	Socket head, changeable, 22 mm	1
9	Socket head, changeable, 24 mm	1
10	Socket head, changeable, 27 mm	1
11	Hinged handle	1
12	Square head ratchet wrench	1
13	Stud driver	1
14	Ball-and-socket joint	1
15	Extension, 250 mm	1
16	Tommy bar	1
17	Dermateen cover	1

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