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FOREIGN SCIENCE AND TECHNOLOGY CENTER

ZIL MOTOR VEHICLES
TECHNICAL MAINTENANCE AND REPAIR OF THE ZIL-157K, ZIL-130, ZIL-131 AND THEIR MODIFICATIONS
PART I

by

A. G. [illegible], et. al.

USSR

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	ROLE	WT	ROLE	WT	ROLE	WT

General Purpose Truck
Vehicle Maintenance
Vehicle Maintenance Manuel
Motor Vehicle Engine
Unarmored Vehicle Specification
Engine Fuel System
Wheeled Vehicle Power Train
Wheeled Vehicle Transmission
Wheeled Vehicle Transfer Case
Wheeled Vehicle Differential
Engine Cooling System
Engine Lubrication System
(U) ZIL130 Cargo Truck
(U) ZIL157 Cargo Truck

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13. ABSTRACT

Part I of the book (the only part included here) presents descriptions of the in-line and V-shaped engines, transmissions, transfer cases and drive axles of the ZIL trucks. Presentation includes technical servicing, disassembly, repair and assembly of the components described. Also included in each section are tables presenting nominal and repair dimensions for all the parts of the various components.

Details of illustrations in this document may be better studied on microfiche

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Section I. General Information on the Motor Vehicles

Chapter 1. Brief technical characteristics of the motor vehicles

The ZIL-164A series of motor vehicles was produced by the plant in the period from 1962 to the end of 1964. The ZIL-164A was the change-over model between the ZIL-164 and the ZIL-130, whose production was begun at the end of 1964 and continues to the present time.

Production of the 3-axle cross-country ZIL-157K motor vehicle series was begun at the end of 1961. The ZIL-157K is also a change-over model between the ZIL-157 and the ZIL-131. The ZIL-157K is still being produced at the present time.

At the end of 1966, the plant began production of the ZIL-131, a new series of 3-axle cross-country motor vehicles.

The new ZIL-130 and ZIL-131 motor vehicles differ advantageously from the ZIL-164 and ZIL-157. Design of the new motor vehicles and the characteristics of their assemblies significantly improved: productivity, load capacity, dynamics, power reserve, and reliability of the motor; reliability of the transmission and running gear; improved working conditions for the driver, and decreased labor consumption in technical servicing. Improved terrain crossing capabilities and ability to ford streams should be added to the items listed for the cross-country vehicles.

A distinct peculiarity of the ZIL-130 and ZIL-131 vehicles is that their engine power and transmission design and running gears are rated for systematic operation of these motor vehicles as tractors with trailers and semi-trailers. Performance and over-all weight of tractor-trailer combinations are presented in Appendices

3 and 6 (see Part 2).

The new motor vehicle models are naturally more complex than the old ones, and require higher skills in driving, technical maintenance and repair.

Specifications for the ZIL-130 and ZIL-131 motor vehicles were determined to a significant degree by the requirements of GOST (All-Union State Standard) 9314-59, which set the allowable load limits for motor vehicle road beds. In this GOST, all motor vehicles and tractor-trailer combinations are broken down into two groups according to axle load: group A and group B. Group A is intended for use on category I and II roads, allowing a maximum load on a single axle of ten tons, and group B is intended for use on all roads allowing a maximum load on a single axle of six tons (for group B dump trucks, a load of 6.5 tons is allowed). For tandem drive axle carriages used on 3-axle motor vehicles with a distance between the carriage axles of less than three meters, a maximum load (on the tandem carriage) of 18 tons is allowed for group A transport means, and 11 tons is allowed for group B.

For elimination of increased drive wheel skidding in 2-axle motor vehicles, it has been established that the optimum distribution of weight for a truck must be 30% on the front axle and 70% on the rear axle (see Appendix 3, Part 2).

At the beginning of its production, the ZIL-130 had a dual payload capacity: 5.5 and 4 tons, meaning that its payload capacity was equal to 5.5 tons when used on category I and II roads, and 4 tons on roads of the overall network. The weight of a towed trailer was equal to 6.4 tons. Later, beginning in 1966, with the special agreement of the Committee on Standards of the USSR Council of Ministers, in connection with the inconvenience caused by the dual payload capacity, the payload capacity for the single truck was set at 5 tons for all roads except category IV and V local use access roads. The weight of a towed trailer was increased to 8 tons. In connection with this, the gross weight on the rear axle of a loaded truck of the ZIL-130 series was increased from 6 to 7 tons.

It should be noted that for ZIL-130 motor vehicles going out of the country, where allowable gross weight on a single axle is greater than 6 tons, the plant established payload capacity at 6 tons (gross weight on the rear axle of a cargo truck in this case is equal to 8 tons).

Design features of the motor vehicles

The ZIL-130[1] motor vehicle (Photo 1-1) is the basic model of the series of 2-axle cargo trucks with rear axle drive. It has a 4 X 2 wheel formula and a wheel base of 3800 mm. The truck is powered by the ZIL-130 model 8-cylinder

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[1] Dimensions and weight data on the motor vehicle are presented in Appendix 4 (see Part 2), and characteristics of the assemblies are given in corresponding chapters.

V-shaped carbureted engine, which has a maximum power of 150 hp. It has a single disk clutch and a five-speed transmission with two synchronizers for second-third and fourth-fifth gears. Fifth gear is straight drive. The steering mechanism is equipped with hydraulic power which is mounted in the mechanism itself. The truck has a comfortable three-place all-metal cab with a wide panoramic windshield. The bed is a metal-wood combination. The truck is intended for continuous work with a trailer whose overall weight is 8 tons. The payload capacity of the initial model of the truck was 5.5-4 tons, overall trailer weight was 6.4 tons, and maximum speed was 85 kilometers per hour. In 1966, the ZIL-130 was designated ZIL-130-66. The base ZIL-130 model of 1966 production differs from the initial base model by a number of improved assemblies and parts, and also with an increased payload capacity of 5 tons and a trailer payload capacity of 5 tons (with a trailer gross weight of 8 tons). The GKP-817 trailer was a special creation for work with the ZIL-130 truck, and its bed dimensions are as follows: length, 4700 mm; width, 2350 mm; and side height, 572 mm. Top speed of the truck was increased to 90 kilometers per hour.

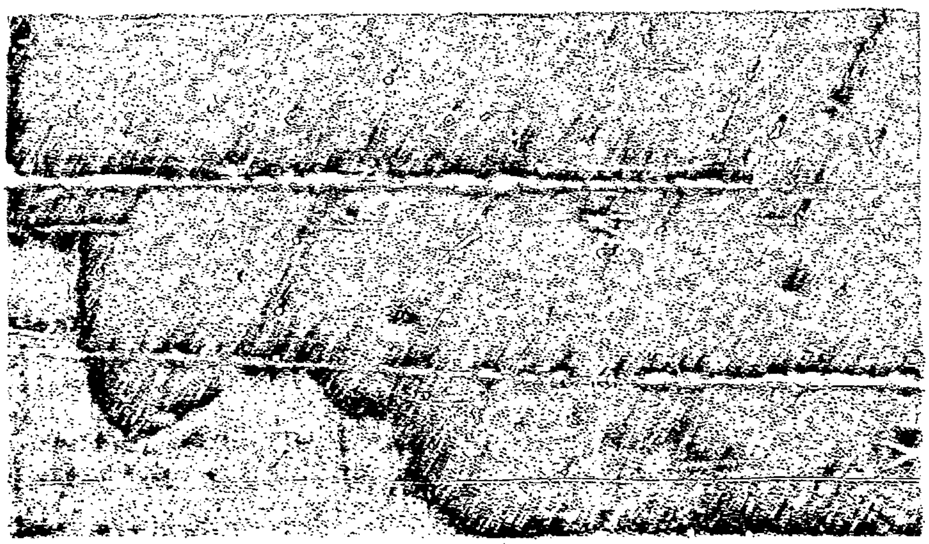

Plate 1-1 ZIL-130 truck

Improvement of assemblies on the ZIL-130 truck was conducted systematically by the plant; therefore, beginning in 1968, the plant designated the base truck as the ZIL-130-68, although the external parameters of the technical specifications were not changed. The plant is also preparing introduction of a number of improvements for the corresponding ZIL-130-70 truck.

The ZIL-130V1 truck (Plate 1-2) is a saddle tractor-truck, one of the modifications of the ZIL-130 truck series. Wheelbase is 3300 mm. The truck is intended for use with a semi-trailer, with an initial overall weight of 10.5 tons, and beginning with output of the ZIL-130V1-66 model, 12.4 tons. The truck differs from the base model by a short frame and Cardan drive, reduction gear with a higher gear ratio, and absence of a bed, which is replaced by the saddle for connection with a trailer. The spare tire bracket is missing on the tractor-truck.

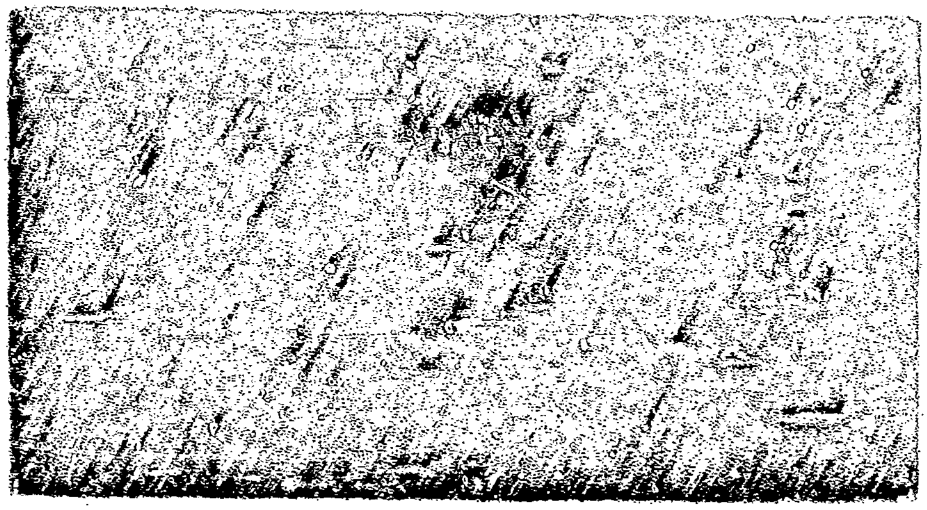

Plate 1-2. ZIL-130V1 (ZIL-130V1-66) saddle tractor-truck

The OdAZ-885 type semi-trailer, especially developed for work with the ZIL-130V1-66 tractor-truck, has a gross weight of 12.4 tons, and a payload capacity of 9 tons.

The ZIL-130G truck (Plate 1-3) is a long wheel base tractor-truck, one of the basic modifications of the ZIL-130 truck series. Wheel base is 4500 mm. The truck is intended for transporting loads with low specific weight. It differs from the base model by its increased length of frame, Cardan drive, and bed. All other indicators, including changes according to the year of output, fully correspond to the base model.

The ZIL-MMZ-555 truck (Plate 1-4) is a construction dump truck on a ZIL-130D1 chassis with a metal hopper bed which tips up to the rear. Wheel base is 3300 mm and payload capacity of 4.5 tons. The truck differs from the base model by its shortened frame and Cardan drive. For raising the bed, the power take off box (with the pump driving oil into the dump raising mechanism) is mounted on the transmission.

The ZIL-130D1 chassis does not have a towing mechanism. The plant puts out the ZIL-130D2 chassis for the ZIL-MMZ-555 dump truck, which is to be used with a trailer whose gross weight is 7.5 tons. The ZIL-130D2 chassis is equipped with a towing mechanism, pneumatic power for trailer brakes, and electric power for the trailer taillights. The hydraulic drive for raising the trailer bed is installed by the Mytishchinskii Machine Building Plant during assembly of the raising mechanism. Dump trucks which are equipped for work with a trailer are designated ZIL-MMZ-555A.

The ZIL-157K truck (Plate 1-5) is the base model of the 3-axle multipurpose cross-country truck with drives on all three axles, uniform wheel setting, and a centralized system of regulating air pressure in the tires. The wheel formula is 6 X 6. The truck is different from the ZIL-157 by installation of a number of assemblies from the ZIL-130: single disk clutch, 5-speed transmission equipped with two synchronizers, interchangeable cardan drive, and also interchangeable transfer case and some parts of the brake system. The truck has a 6-cylinder in-line carbureted engine of 110 hp. The running gear consists of three drive axles, of which the front axle has steering knuckles and independent spring suspension, and the rear two axles do not have steering knuckles and are suspended from the balancing carriage, which is equipped with one pair of springs. The steering mechanism does not have hydraulic power. Tire pressure can be regulated. Detailed specifications are given in Appendix 1 (see Part 2). The truck is equipped with an all-metal cab and wooden bed. Payload capacity of the truck is 2.5 tons on dirt roads and 4.5 tons on roads with asphalt covering. Top speed is 65 kilometers per hour. The truck can work with a trailer whose gross weight is 3.6 tons.

The ZIL-157KG truck is one of the modifications of the ZIL-157K truck, differing by a shielded electrical system.

The ZIL-157KV truck (Photo 1-6) is a saddle tractor-truck built on the basis of a ZIL-157K, and intended for work with a semi-trailer which has an allowable gross weight of 6.25 tons[1] on dirt roads, and 11.15 tons on asphalt roads. A saddle arrangement for connecting a semi-trailer is installed on the tractor-truck. The rear wheel carriage and frame are covered by fenders. The spare tire rack has two receptacles: one for a tractor-truck spare, and the other for a semi-trailer spare. The ZIL-157KV truck may be specially ordered units with a shielded electrical system and in this case it is designated ZIL-157KVG.

The ZIL-157KE truck is one of the modifications of the ZIL-157K truck series, and differs from the ZIL-157K by the fact that is is produced only in the form of a chassis, intended for assembly of special bodies or units and has fuel tanks on either side of the cab with a capacity of 150 liters each.

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[1] Weight of the towed trailer may be increased to 8.6 tons, but on roads with cobble-gravel surface covering ., maximum speed of the tractor-trailor combination must not exceed 40 km per hour, and on dirt roads 20 km. per hour.

... absence of a bed, the total weight of the unit ... or loaded body ... increased by 570 kilograms, the weight of the bed, over specifications ... the base truck.

... ZIL-157KE may also be especially ordered with a shielded electric... and in this case the chassis is designated ZIL-157KEG.

Plate 1-3. ZIL-130G tractor-truck with extended wheel base

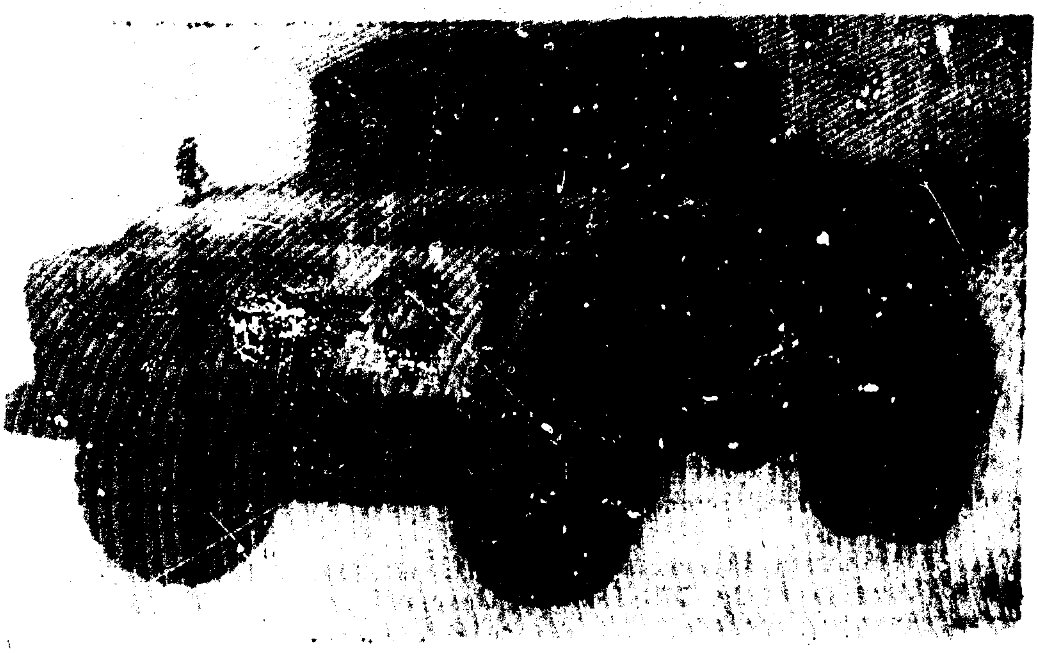

Plate 1-4. ZIL-MMZ-555 dump truck

The ZIL-131 truck[1] (Plate 1-7) is the base model of the series of 3-axle multipurpose cross-country trucks with drive on all three axles. Wheel formula is 6 X 6. The truck is powered by an 8-cylinder V-shaped carbureted 150 hp motor. All electric equipment is shielded. The clutch is single disk, and the transmission is 5-speed with two synchronizers for second-third and fourth-fifth gears. Fifth gear is straight drive. The transfer case is twin-shaft, having high, low, and neutral speeds. The torque moment in the transfer cases is transmitted to the cardan shafts, one of which connects the transfer case to the front axle and the second of which connects the transfer case to the middle axle and through it to the rear one. The front axle has independent suspension, and the two rear ones are suspended from the balancing carriage with one pair of springs. Hydraulic power steering is assembled in the steering mechanism. The truck is equipped with a three-place all-metal cab and a wooden platform having metal bindings and metal cross bars. Lateral extensions on the sides of the bed form folding benches, and provisions are made for installation of an additional bench in the middle of the bed.

Payload capacity of the truck for operation on different roads with various coverings, including off-road conditions, is 3.5 tons, and on roads with hard surfaces and good composition, 5 tons. Weight of the towed trailer on mixed roads is 4 tons, and on hard roads, 6.5 tons.

The truck is equipped with 12.00-20 tires with centralized control of air pressure in them. For increased cross-country capability, the truck is equipped with a winch. The truck can ford streams 1.4 meters in depth.

Plate 1-5. ZIL-157K truck

[1] Dimensions and weight data on the vehicle are given in Appendices 3 and 5 (see Part 2), and specifications of assemblies are given in corresponding chapters.

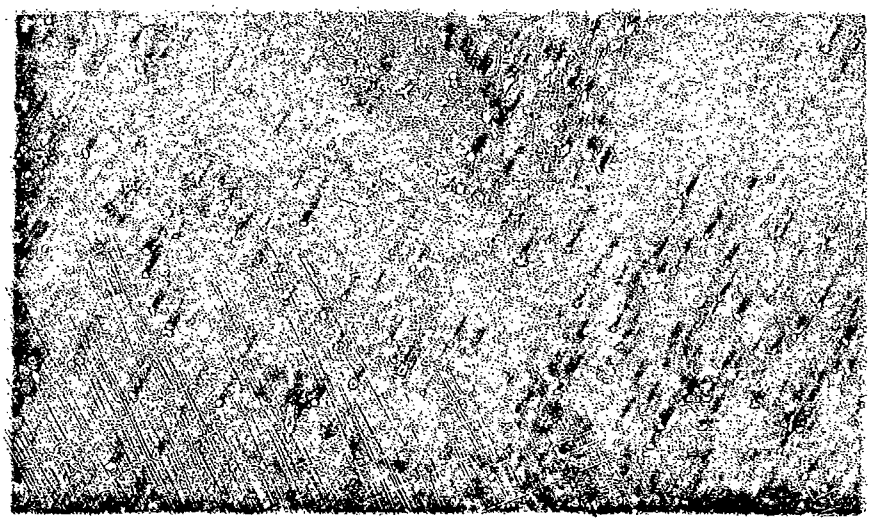

Plate 1-6. ZIL-157KV saddle tractor-truck

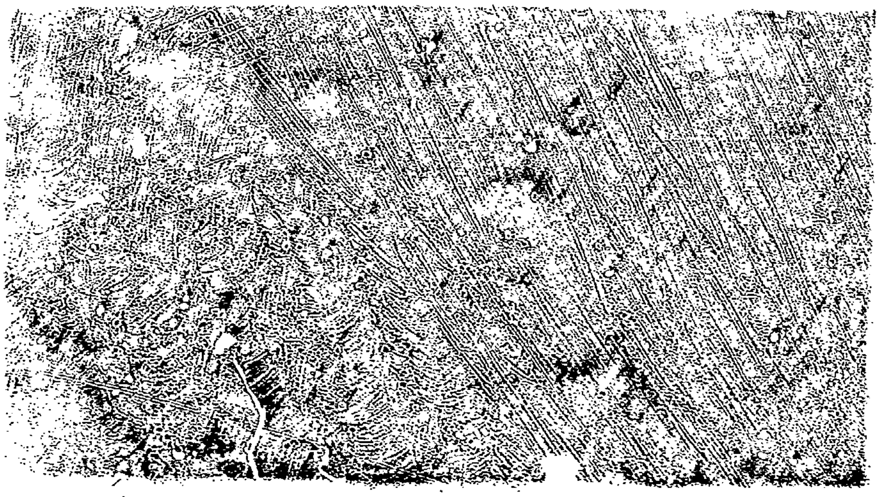

Plate 1-7. ZIL-131 truck

The ZIL-131A truck is a modification of the ZIL-131, and differs from the base truck by the non-shielded instruments of its electrical equipment.

The ZIL-131V truck (Plate 1-8) is a saddle tractor-truck created on the base of the ZIL-131 and intended for work with a special semi-trailer whose gross weight is:

On all types of road, including off-road conditions, 7.5 tons;
On improved dirt roads, 10 tons;
On roads with asphalt or concrete surfaces, 12 tons.

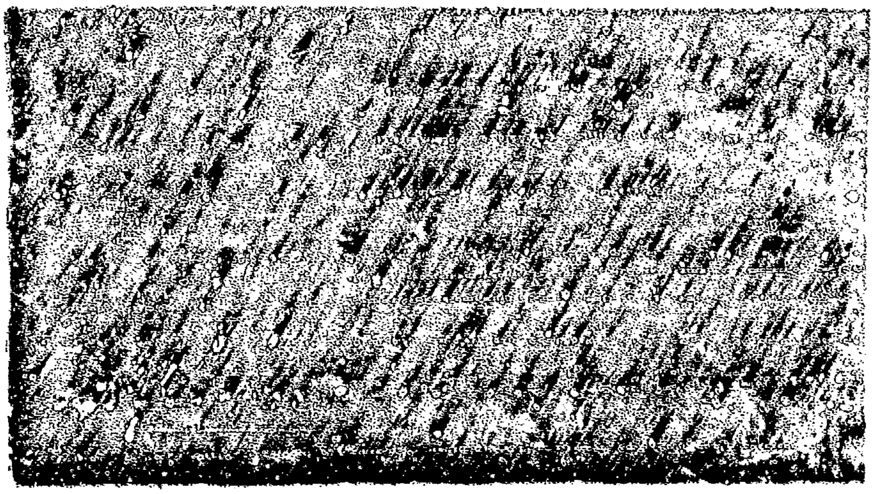

Plate 1-8. ZiL-131V saddle tractor-truck

The tractor-truck has a saddle arrangement for connecting the trailer installed on it, and a rear wheel carriage and frame are covered by fenders. The spare tire bracket has two receptacles, one for a tractor-truck tire, and a second for a trailer tire.

tractor-trailer combinationsare shown in Plate 1-9.

Reliability Indices of the Motor Vehicles

Reliability is not a new operational property of motor vehicles. In 1938, during Y.A. Chudakov's development of his method for evaluating motor vehicle design according to measured values of various operational properties, this property was included among the basic ones. In the last five to seven years, the question of increasing product reliability in machine construction has received much attention, and therefore the question of reliability of machines in general, and in automobile design in particular, has made a significant move forward.

Reliability is an aggregate property, evaluated according to operational and technical properties of separate assemblies and of the assembled motor vehicle, according to indicators of longevity, freedom from trouble, repairability (adaptability to technical service and repair), and, finally, preservability.

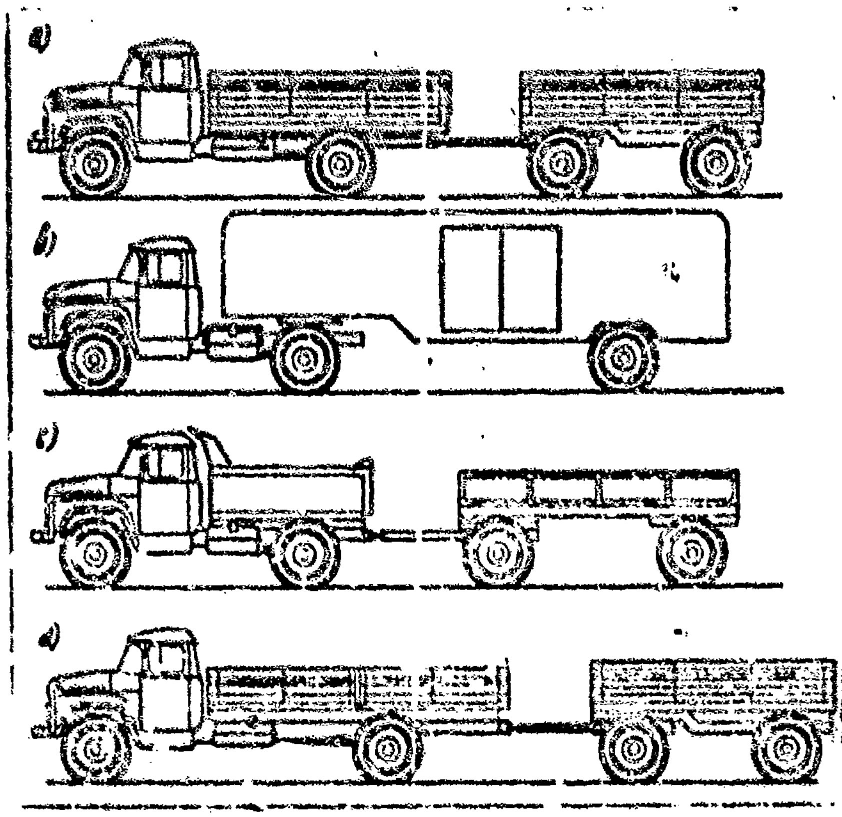

Plate 1-9. Assembled tractor-trailer combination. a) panel-type truck and two-axle trailer; b) tractor-truck and semi-trailer; c) dump truck and two-axle trailer; d) long wheelbase panel-type truck and two-axle trailer.

Soviet scientists and engineers, working in the area of motor vehicle reliability, are developing a system of indicators with which it would be possible to objectively evaluate the complex property of reliability and the composite elements of which it is assembled. This work is still not completed, but some axioms and propositions have received general recognition and already may serve as orientation for determination of perfection of motor vehicles and their assemblies, and may be used for planning purposes.

(a) Автомобиль и его агрегаты	(b) [illegible]
(c) Автомобиль в целом	[illegible]
(d) Двигатель	[illegible]
(e) Коробка передач	[illegible]
(f) Передний мост	[illegible]
(g) Задний мост	[illegible]
(h) Рулевой механизм	[illegible]

Table 1-1. Longevity of 2-axle ZIL-130 motor vehicles and their basic assemblies (for category I operational conditions), 1000 km.

Key: a) motor vehicle and its assemblies
b) ZIL-130 (produced 1964-1966)
c) motor vehicle as a whole
d) engine
e) transmission
f) front axle
g) rear axle
h) steering mechanism

NOTE: 1. The numerator shows operation of new assemblies before repair and the denominator shows their operation after major overhaul.
2. The plant is conducting systematic work on increasing longevity of assemblies, and the data presented may be increased for motor vehicles of later manufacture.
3. Longevity shown in the table may be reduced in the following circumstances:
by 10% for saddle tractor-trucks and trucks systematically used with one trailer, working primarily in conditions of category I operation;
by 15% for saddle tractor-trucks working with semi-trailers and trailers, or for trucks with two trailers working primarily in conditions of category I operation;
by 20% for trucks used primarily under conditions of category II operation;

by 30% for tractor-trucks using one trailer in conditions of category II operation;
by 35% for saddle tractor-trucks working with a semi-trailer or a trailer, or for trucks with two trailers, working in conditions of category II operation;
by 40% for trucks and tractor-trucks working primarily in conditions of category III operation in the regions of the far north or equal conditions.

It is recognized by all that reliability in motor vehicles and their parts may be assured only by the joint efforts of the workers of the manufacturing plants and those of motor vehicle transport.

For solving problems connected with determination of reliability, workers in the automobile industry need systematic and reliable information from motor transport enterpsises.

Methods of assembling information and transmitting it to the plants are now being worked out, and at the plants, they serve to determine service periods and find means of perfecting assembly construction.

Normative service periods for motor vehicle construction products are at present worked out for only 2-axle general purpose motor vehicles. These norms are worked out in kilometers of running for motor vehicles with carbureted engines (for category I operational conditions with observance of instructions on operations, technical service, and repair).

Data on longevity of 2-axle ZIL motor vehicles and their basic assemblies are presented in Table 1-1.

Controlled fuel consumption of the trucks is given in Table 1-2.

a) Автомобили	b) Расход топлива, л
1) ЗИЛ-130 и автомобиль-самосвал на его шасси	[illegible]
2) ЗИЛ-130-66	[illegible]
3) ЗИЛ-130В1	[illegible]
4) ЗИЛ-157К	[illegible]
5) ЗИЛ-157КВ	[illegible]
6) ЗИЛ-131 и ЗИЛ-131А	[illegible]
7) ЗИЛ-131В	[illegible]

Table 1-2. Controlled fuel consumption of the trucks

Key: a) trucks
b) fuel consumption, liters
1) ZIL-130 and dump truck on its chassis
2) ZIL-130-66
3) ZIL-130 V1
4) ZIL-157K
5) ZIL-157KV
6) ZIL-131 and ZIL -131A
7) ZIL-131V

Note: Controlled fuel consumption on a 100-kilometer course is that consumption of fuel by a fully broken in and tuned, loaded truck, measured in summer on a dry, horizontal section of road with an asphalt-concrete covering, having a rise no greater than 1.5%, with movement of the truck in straight drive at a speed of 30-40 kilometers per hour. Temperature of the liquid in the engine cooling system must be 80-90°C.

Chapter 2. Technical maintenance and repair of the trucks

Technical maintenance

Technical maintenance is the aggregate of the technical activity on the truck whose fulfillment assures its maintenance in a condition of technical readiness. The period and amount of technical maintenance foresees its planning and preventive conduct through an earlier established run of the truck. Timely conduct of the operations of inspection, connection tightening, adjustment, and lubrication prevents the possibility of failure occurence in the truck's assemblies.

Significantly improved technical maintenance and continuing repair may be expected if an effective system of technical diagnosis is developed. Transfer from use of average statistical quantities and periodic technical service to determination of actual requirements for each motor vehicle in various preventive operations would allow significant decreases in labor expenditure on technical servicing, increased technical readiness of the motor vehicle, and would allow a decrease in the number of spare parts.

Technical diagnosis equipped with modern equipment can provide high reliability of the set diagnosis, and also allow timely and qualitative elimination of the occurence of poor adjustment in the motor vehicle's assemblies.

The motor vehicle plant collectives and workers of motor vehicle transport are constantly faced with the task of systematically reducing labor consumption on technical maintenance. The basic directions toward the achievement of this goal are: adaptation of new or improved construction solutions, use of improved oils and lubricants, determination of more rational technical service areas and scopes, and, finally, mechanization and improvement of the technical service processes.

Experimentation on the ZIL-130 produced in 1964 and 1965, conducted by NIIAT (State Scientific Research Institute of Automotive Transport), together with the plant imeni I.A. Likhachev and NAMI (Scientific Research Institute for Motor Vehicles and Automobile Engines) showed the possibility of significantly increasing the run between technical services. Table 2-1 presents the period of technical services for 2-axle and 3-axle motor vehicles. Considering the improvements of the ZIL-130 and ZIL-131 trucks and the conducting of additional research, these periods may be even further extended.

Technical service of trucks breaks down into the following types according to period, scope of operations performed, and labor consumption: DS (daily service; TS-1 (first technical service); TS-2 (second technical service).

The basic purpose of TS-1 and TS-2 is to decrease intensity of parts' wear and increase parts' longevity and reliability by finding and preventing deficiencies through timely performance of control, lubricating, tightening, adjusting, and other work.

Basic data on motor vehicle assembly adjustment and control are presented in Appendix 8 (see Part 2).

a) [illegible]	b) [illegible]	c) d) [illegible]	e) [illegible]	f) d) [illegible]	e) [illegible]
I	[illegible]	[illegible]	[illegible]	[illegible]	—
II	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
III	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table 2-1. Motor vehicle technical service periods, km

Key: a) operating conditions category
b) operating conditions
c) technical service - 1
b) ZIL-130
e) ZIL-157K, ZIL-131
f) technical service - 2
I) Urban and suburban roads, primarily with asphalt, concaete, and other improved hard surfaces, in good condition
II) Suburban roads, primarily with rubble, gravel, cobblestone, and other hard stone surfaces, in satisfactory condition. Work under conditions of heavy urban traffic
III) Dirt, mountain, or unrepaired roads, with rubble, gravel, cobblestone, or other hard surfaces. Work under conditions of increased maneuvering (on construction roads, in quarries, foundation pits, or in timber developments)

Note: A run of less than the recommended is set for heavier operating conditions, and also with operation of dump trucks and trucks with trailers and semi-trailers. If the average monthly run of the truck is less than the TS-1 , it should be performed no less frequently than once per month, and the TS-2 should be performed at least twice per year.

Technical service of a motor vehicle foresees use of only those oils and lubricants recommended by the plant.

Organization of qualified technical service of the motor vehicle at the motor transport enterprise does not free the driver from the necessity of daily checking the technical condition of the motor vehicle. It is necessary to check the level of cooling liquid, fuel, and oil, check for leaks, condition of tires, springs, illumination, and signal equipment, listen to all arising noises and knocks, determine their reason, and if possible eliminate them.

To ease access to the under-hood area of the ZIL-130 and ZIL-131 trucks during technical service of the motor and its assemblies, use of a step (Plate 2-1) which can be manufactured (Plate 2-2) at the motor transport enterprise is recommended.

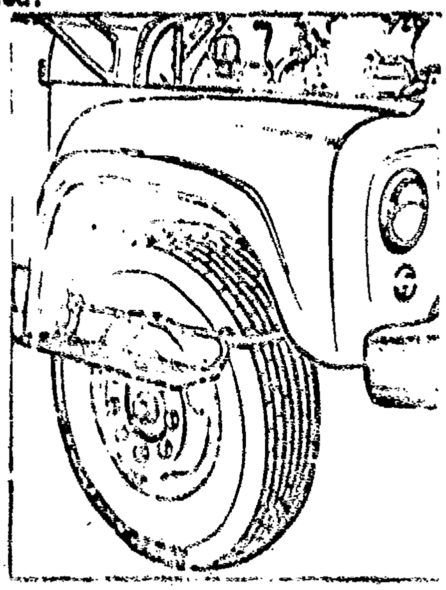

Plate 2-1. Step installation on front wheel of ZIL-130 truck

Daily technical service (EO) control work

Before moving out onto the line, inspect the truck and check: its completeness, condition of registration numbers, glass and rear view mirror, paint, proper operation of door mechanisms and bed latches, springs, wheels and tires, steering wheel free play, power steering condition, operation of signal and illumination lights, windshield wipers and washers (on the ZIL-130 and ZIL-131 trucks), check for leaks in the hydraulic power steering system and brake system, and check the fuel and engine cooling systems.

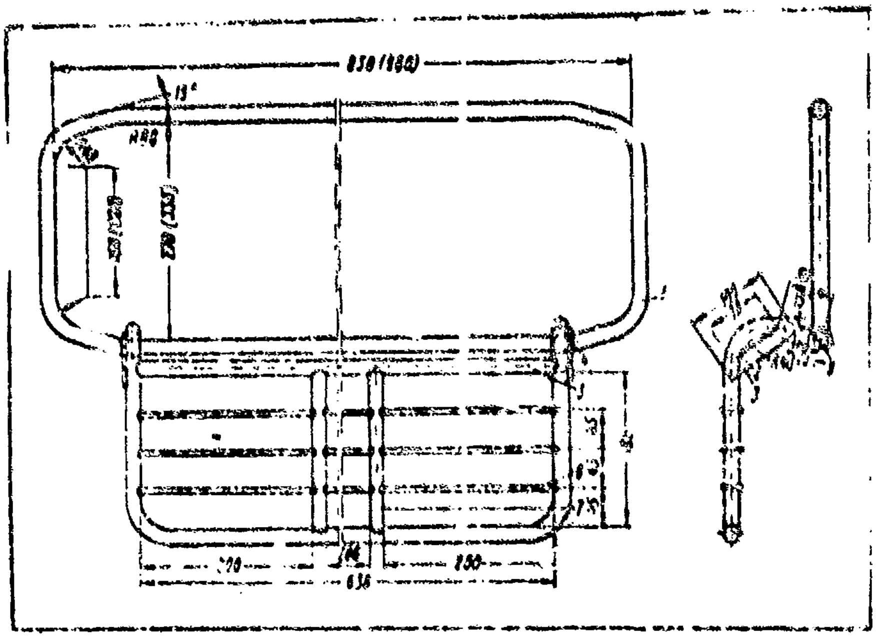

Plate 2-2. Step (dimensions in parentheses for ZIL-151 truck):
1) support ring 2) bracket 3) corner plate 4) support ring 5) longitudinal cross bar 6) longitudinal grid 7) lateral cross bar 8) bracket collar

With the presence of a trailer, check the coupling and open the brake system connecting valves on the tractor-truck and the trailer.

For trucks with a winch, ensure that the winch cable is tightly wound on the drum, the cable hook is securely fastened, the drum engagement lever is in the "engaged" position, and the power take off lever is in the neutral position and securely fastened with a lock.

After starting the engine, crankshaft revolutions should not be forced until cooling liquid reaches a temperature of 50°C; and at the beginning of movement, check brake and steering adjustment.

During movement of the motor vehicle, keep checking instrument readings, listen for unexpected noises, attempt to determine the reason for them (and, if necessary, stop the truck and eliminate them).

On returning to the line in a truck with a V-engine, after shutting down the engine, if the filter has crude cleaning, turn its lever. Sweep out the truck cab and platform.

Oil and fuel tasks. Check the level and, if necessary, add oil to the engine crankcase.

Check fuel level in tank and add if necessary.

Check water level in radiator. During open storage and a cold time of year, drain the water from the cooling system at the end of the working shift. For this, the radiator cap must be opened. Cleaning and washing tasks. Sweep out the cab and platform. Wash the truck. Wipe off the radiator face, cowling, fenders, headlamps, parking lights, turn indicators, taillights, cab windows, and registration numbers.

First technical service (TS-1)

During first technical service, it is necessary to perform all daily technical service tasks and, besides this, the following tasks.

Control tasks. In the assemblies and systems of the truck, it is necessary to check:

In the engine--tightness of the oil and cooling systems;
Drive belt tension;
Fastening of motor mounts, intake and exhaust manifolds, and assemblies on the motor;
Condition and tightness of the caps of the fuel tank, radiator, and crank case filler;
Reliability of the throttle linkage connection with the lever and that of the choke cable with its lever;
Adjustment and work of the throttle and choke;
Electric system--fastening, insulation, and operation of the illumination and signal devices: headlamps, parking lights, turn indicators, taillights, stop signal, horn, and dashboard;
Clutch--presence of spring stretching; free and full pedal travel and, if necessary, adjustment;
Transmission and transfer case--fastening of the transmission to the bell housing and of the transfer case to the frame cross member (for ZIL-157K and ZIL-131);
In the Cardan drive--condition of universal joints;
Fastening bolt tension on the support plates of the needle bearings;
Fastening of flange bolts on propeller shafts and the intermediate bearings;
In the drive axles--fastening of the case cover and the differential itself in 3-axle trucks and half-shaft flanges.

During the first TS-1 on the ZIL-131 truck, the bolts fastening the reduction gear to the axle rollers located inside the case must be tightened. It is necessary to remove the side covers of the case before tightening. Tightening torque must be 9-11 kg-meters. In future, this operation is performed during TS-2;

In the steering mechanism and front axle--tightness of the hydraulic steering system (for ZIL-130 and ZIL-131 trucks);
Tightness of the steering box and pitman arm of the mechanism;
Tension on the stop nut adjusting the pitman arm shaft screw, without changing the position of the screw;

Tightness of nuts of the balljoint and spindle levers;
Free play in the steering wheel and slack in the steering shaft universal joints;
Tightness of steering mechanism universal shaft wedges (for ZIL-130 and ZIL-131 trucks);
Amount of play in front wheel bearings, and if necessary, adjust bearing tighness;
In the brakes--condition and tightness of hydraulic lines and control mechanisms, and bleed if necessary;
Rod end pins in brake housings and amount of free and working travel of the brake pedal;
Brake cover drive;
Condition of the pneumatic drive safety valve; condition of the hand brake drive and action, with brake adjustment if necessary;
In the running gear--condition of frame, springs, spring hangers and shock absorbers;
Tightening of the spring shackle nuts and fastening bolts of the front spring hangers, and also the U-bolts of the front spring brackets. On the ZIL-157K and ZIL-131 trucks, tighten the rear spring hub bracket studs and the bolts for fastening the balancing suspension axle brackets. On new trucks, the nuts of the front shock absorber reservoirs must be tightened once during operation (during the third TS-1);
Tightening of sway bar nuts;
Condition of the rubber axle travel bumpers;
Condition of tires and air pressure in them, inflate if necessary, remove foreign objects from tire tread and between dual wheels;
Tighness of connection in pipes and flexible lines of the tire air regulation system;
In the cab, body, and tailgate--Fastening of bed U-bolts to truck frame;
Condition of support and and coupling mechanism on a saddle tractor-truck;
Fastening of the cab;
Fastening of the fenders and mud guards;
Lubricating and cleaning tasks. Perform all lubricating operations in accordance with the truck's lubrication chart (Appendices 10 and 11, see Part 3);
Drain condensation from the air tanks of the air brake system.

Checking the truck after technical service. Check work of the engine, instruments, operation of the steering mechanism, brakes, and other assemblies and mechanisms of the truck while moving.

During technical service of dump trucks and tractor-trucks, additionally check:
Fastening of the sub-frame to the frame;
In a tractor-truck, condition of the support and coupling or towing mechanism;
Fastening of the cover on the dump body ax axx brackets;
Condition of the body rest and its fastening to the sub-frame;
Condition of the tailgate and its locking mechanism and suspension;
Fastening of the power take-off box to the transmission;

Absence of leaks in the hydraulic system of the raising mechanism;
Oil level in the raising mechanism tank, with addition as necessary;
lubricate the dump body access, ball joint fastenings, and hydraulic lift suspensions through the pressure lubricating fittings.

On tractor-trucks, grease the support and coupling towing mechanism.

Second technical service (TS-2)

During the second technical service, it is necessary to perform all operations of TS-1 and, besides, this, all the following tasks.

Control tasks. In the truck's assemblies and systems, it is necessary to check:

In the engine--fastening of the radiator, its casing, and hood latch;
Condition of the louvres and fan;
Fastening of the compressor and its operation;
Fastening of the pulley, fan blades, and water pump;
Condition and fastening of the intake and exhaust water hoses and the overflow pipe, catch basin, and lower and side splash panels;
Tightness of cylinder head nuts and bolts (check on a cold engine);
Fastenings of the radiator, fuel tank, and preheater control panels;
Cleanliness of the crankcase ventilation system valve. Clean the valve every other TS-2. During engine oil change, wash the coarse oil cleaning filter element and the oil filler pipe filter in kerosene. On trucks with in-line motors, the fine cleaning filter should be changed and sediment removed (from the sediment bowl) during oil change; at the same time the oil is changed, clean the dirt off the inside surface of the centrifugal oil cleaning filter jacket cover and wash the filter screen in gasoline or kerosene;
Clearance between the valves and the push rods on in-line engines (adjust if necessary). On the engines in the ZIL-130 and ZIL-131 trucks and their modifications, it is necessary to check the clearance between the valves and the rocker arms every other TS-2.

During each removal of the engine oil pan, clean residual coked oil from the oil pickup screen;
Compression in motor cylinders (every other TS-2), condition of the water pump body, drain cocks, water hoses and lines of the oil and water radiators, and diffusers and spacing rods of the radiator;
In the fuel system--absence of fuel leaks, and fastening of the carburetor, fuel pump, and tanks;
Condition of the fine cleaning filter (remove and wash if necessary);
Fuel level in the carburetor float chamber, checked through the control aperture with a control pipe with the engine running at idle. It is recommended that the carburetor be removed from the engine, dismantled, and cleaned twice a year;
Clean and check the engine speed governor. It is necessary to check the basic carburetor parts once per year. Once per year (in the pring), it

is recommended that the fuel pump be removed and checked on an instrument;

Ease of starting and operation of engine;

Fuel consumption during movement of the truck in a measured distance;

Cleanliness of the filtering element of the fuel filter and sedimentation bowl (wash if necessary);

Cleanliness of the fuel pump screen (clean if necessary). During operation of the truck in sandy desert areas, clean the screen every TS-1;

Drain the residue from the fuel tanks. For trucks with V-engines, fuel sediment should be drained twice per year. Wash the fuel tanks when necessary, no less than once per year (in the Spring);

In the electrical system--degree of charge of the storage battery under load, removing and recharging the battery if necessary;

Condition of the commutator, brushes, and brush holders of the generator and the starter (for ZIL-130 and ZIL-131 trucks, every other TS-2);

Operation of the voltage regulator with volt-amp meter, dismantling and adjusting voltage regulator if necessary;

Cleanliness of spark plugs, cleaning them and setting the clearance between electrodes when necessary;

Condition of the distributor points or trucks not having transistorized ignition systems), cleaning them and setting the clearance between them when necessary. Rub the inside surface of the distributor cap, the side electrodes of the cap, the rotor and blade with a clean cloth soaked in gasoline;

Installation and operation of lights;

In the transmission and transfer case--operation of the transmission and transfer case;

Fastening of the top and side covers of the transmission case and bearing shaft covers;

Condition of seals and correctness of control lever locking of the transfer case;

Tightness of bearings, adjusting bearing sand drive control, if necessary (bearings are not adjusted in the transfer case of the ZIL-131);

Fastening of the line connecting the electric-air valve to the front axle drive engagement chamber (on the ZIL-131 truck);

In the Cardan drive--slack in the universals;

Fastening of the propeller shaft flanges and intermediate bearing bracket;

Fastening of the intermediate bearing support, tightening the nut if necessary,

In the drive axles--tightness and condition of the axle and reduction gear carriage; tightness of the kingpin bearings on the front axle and main drive conic gear bearings of the drive axles of 3-axle trucks, adjusting if necessary. Exchange the upper and lower kingpin bearings on 3-axle trucks (every 30,000 kilometers of running);

Adjust hub bearings of front and rear wheels every other TS-2;

Tightening of fastening of drive pinion flange and differential housing in 2-axle trucks (every 20,000 kilometers);

Support plates of the differential planetary gears and half-shaft gears on drive axles of 3-axle trucks (every 30,000-50,000 kilometers), for which it is necessary to disassemble the axle. The plate must be replaced in case of excessive wear;

In the steering mechanism and front axle--condition of the front axle beam;

Angles of installation and rotation of the front wheels, adjusting if necessary;

Fastening of the steering column to the bracket in the cab and of the steering wheel to the shaft;

Axial play in the front axle spindle bearings of 3-axle trucks, adjusting if necessary.

Wash the filter screens of the hydraulic power steering pump every other TS-2 (for ZIL-130 and ZIL-131 trucks);

In the brakes-- fastening if the brake valve to the frame;

Adjustment of wheel brake drive;

Fastening of the hand brake drum on the power shaft;

Every other TS-2, simultaneously with oil changes, in the hub bearings, check: fastening of the brake wheel chamber to the brackets and the brackets to the axle housing;

Condition of brake shoes, linings, drums, springs and wheel bearings;

Fastening of the spreader cam support and brake shoe bins of the front and rear wheels;

Fastening of backing plates to the spindles and rear axle housing;

Fastening of air tanks;

In the running gear--absence of misalignment of the front and rear axle;

Condition of the towing and support-coupling mechanism;

Cleanliness of the pipes and hoses of the air pressure regulation system for tires on 3-axle trucks, blowing out the pipes and hoses when necessary;

Fastening of the balancing suspension bracket on 3-axle trucks. Every other TS-2, remove the hubs of the balancing mechanism, wash them in kerosene, check the seals and packing rings, and adjust them;

Fastening of the front spring, pillow block, and shock absorber. Make sure there is no oil leakage from the shock absorber, and replace the fluid or the shock absorber when necessary;

Condition and fastening of the wheels; when necessary, rotate wheels in accordance with the tire rotation diagram. Front wheels of the ZIL-130 truck must be balanced;

In the cab, bed, and tailgate--fastening of the fenders, running boards, mudguards, fuel tank to its brackets, and the brackets to the frame;

Lubrication. Perform all lubricating operations in accordance with the truck lubrication chart.

Checking the truck after technical servicing. Check operation of the engine, steering mechanism, brakes, and other assemblies, mechanisms, and parts of the vehicle while running.

During technical service of dump trucks and tractor-trucks, additionally check: fastening of the pump and its control valve, and the power take off lever bracket;

Fastening of elements of the tailgate locking installation control mechanism and adjustment of the drawbar of its drive;

Remove the drainplug from the raising mechanism housing and drain the residue;
Change (according to chart) the oil in the raising mechanism and clean the oil tank filter element.

In a tractor-truck, check (while uncoupled) the support and coupling or towing mechanism, tighten the plate to the frame and the saddle bracket to the plate, and lubricate the support and coupling or towing mechanism.

Twice per year (before onset of the fall-winter or spring-summer periods), check:
Clearance between valve stems and rocker arms, adjusting if necessary;
Cleanliness of the engine crankcase ventilation valve, cleaning if necessary;
Operation of the thermostat and removal of scale from the engine cooling system when necessary;
Condition of generator brushes and commutator;
Fuel tank cleanliness, draining residue when necessary;
Condition of starting preheater;
Density of electrolyte in the storage battery, charging the battery when necessary;
Operation of the brakes, adjusting when necessary;
Cleanliness of the drain holes in the cab doors.

Additional technical service in special operating conditions.

In low air temperatures and in the regions of the far north, it is recommended to: use transmission lubricant recommended by the plant for areas of the far north;
Fill the engine cooling system with low freezing point liquid;
Start the engine only using the starting preheater;
So as not to harm tires and to prevent premature transmission parts wear, movement of the vehicle must be started smoothly, without interruptions, and for the first 15-30 minutes, it should be moved in first or second gear at a speed of 5 kilometers per hour;
Park the vehicles on parking places in shelters which are protected from the wind, and tightly cover the motor with canvas;
Remove the storage battery and place it in a warm location;
Heat the winch case before using it;
Do not park the truck with reduced air pressure in the tires;
Closely check the air seal of the tires during inflation or parking;
To avoid freezing the brakes to the drums during long stands, do not brake the trucks; the handbrake should not be set on the truck or the trailer (or semi-trailer);
Release the air from the brake system of the truck and trailer (or semi-trailer) through the valves on the air chambers of the wheels of the truck (truck-train). In this case, it is necessary to set blocks.
In sandy desert regions under conditions of very sandy locations, it is recommended that parts be disassembled and assembled during technical service in shelters or tents;

Clean the vents of all assemblies and check condition and fastening of the protective boots on the propellor shafts daily;
Systematically clean sand from the radiator and engine;
Clean sand from the air filter, wash the screens, and check the level and cleanliness of oil in the air filters daily;
Check the level of electrolyte in the storage battery daily and fill it with distilled water early;
Clean sand and dirt from the surface of the storage battery and the holes in its caps regularly;
Pay particular attention to tire conditions during control inspections while running;
During TS-1, clean the filters and residue from the engine fuel system, check operation of the fuel tank air vents, clean the valve pipes, and the line connecting the main and auxiliary tank;
During extended stands at high temperature, it is recommended that the storage battery be removed from the truck and stored in a cool place.

Technical Service of Trailers and Semi-trailers

Wide use of the ZIL-cargo trucks as tractor-trucks in truck-trains makes preventive maintenance on the trailer assembly necessary long with that of the tractor-truck.

Construction of trailers and semi-trailers decrees a period and character of work conducted on their technical service which is identical to that of tractor-trucks.

Daily servicing of trailers and semi-trailers includes cleaning and washing, and control and inspection operations. Checking the condition of springs, tires, fastening of wheels and the coupling mechanisms with the tractor-truck, condition of brakes, illumination and signal lights require special attention.

The scope of the first technical service for trailers and semi-trailers additionally includes tightening and lubricating operations. Special attention should be paid to the condition of the coupling mechanism (the connecting pin and its axis), the towing installation of the tractor-truck, condition of the saddle installation and its fastening to the frame, and condition of springs, rods, and the turning mechanism.

The scope of the second technical service foresees deeper preventive maintenance of the trailer or semi-trailer, including lubrication of the hubs, checking condition of the brake valves, and checking synchronicity of brake wear on the trailer and tractor-truck.

Lubrication of the Truck

Service life of the truck depends on its timely and careful lubrication, as well as on the quality of the oils and greases used.[1]

Appendix 10 (see Part 2) presents a lubrication chart for a 2-axle truck, and Appendix 11 presents a lubrication chart for a 3-axle cross country truck.

Labor consumption is given for conditions of category II operation, and therefore, for category I operations, labor consumption must be decreased by 20%, and for category III operations, it should be increased by 25%.

a) Вид технического обслуживания и ремонта и трудоемкость	b) ЗИЛ-130 (выпуска 1964-1966 гг.)
c) Трудоемкость, чел-ч:	
ЕО	0,45
ТО-1	2,8
ТО-2	1[illegible],0
d) Удельная трудоемкость, чел-ч на 1000 км пробега:	
ЕО	3,0
ТО-1	0,8
ТО-2	1,[illegible]
e) Суммарная удельная трудоемкость технического обслуживания, чел-ч на 1000 км пробега	5,0
f) Удельная трудоемкость текущего ремонта, чел-ч на 1000 км пробега	6,0

Table 2-2. Technical service and continuing maintenance labor consumption norms[2]

Key:
a) type of technical service, maintenance, and labor consumption
b) ZIL-130[3] (produced 1964-66)
c) labor consumption, man hours: DS, TS-1, TS-2
d) ɪpecific labor consumption, man hours per 1000 km run: DS, TS-1, TS-2
e) total specific labor consumption for technical service (man hrs. per 1000 km run)
f) specific labor consumption for continuing maintenance, man hrs. on 1000 km run

[1] Designation of the oils and greases used for the ZIL trucks is given in Appendix 9 (se. Part 2).
[2] L·bor consumption norms are given for the base truck.
[3] Norm developed by NIIAT, ZIL, and NAMI.

Labor consumption of technical service and continuing maintenance of other trucks increases by comparison with the basic models:

By 10% for saddle tractor-trucks and trucks working with trailers;

By 10% for dump trucks and by 20% during work at short distances (less than 5 km) or with trailers.

The plant is conducting systematic work on improvement of the tricks produced, and therefore, for ZIL-130 trucks of later production, the labor consumption norms may be decreased.

a) Виды работ	b) ЗИЛ-130	c) ЗИЛ-ММЗ-555
d) Контрольные	21,[illegible]	21,[illegible]
e) Крепежные	[illegible]	20,1
f) Регулировочные	[illegible]	7,7
g) Смазочные и заправочные	[illegible]	20,0
h) Электротехнические	1[illegible],3	13,0
i) Работы по обслуживанию системы питания	3,0	2,[illegible]
j) Работы по обслуживанию шин	7,4	6,[illegible]

Table 2-3. Distribution of labor con sumption of TS-1 according to type of work, %

Key: a) type of work
b) ZIL-130
c) ZIL-MMZ-555
d) control
e) tightening
f) adjusting
g) lubricating and filling
h) electrical
i) work on fuel system service
j) work on tire service

Repair

The mission of repair is elimination of deficiencies arising in the truck or in its parts by the most effective means, with the fullest use of the entire resource of parts or assemblies.

Motor vehicle repair production has at its disposal large reserves of economic effectiveness and usage of the resource of all parts and assemblies is today practically impossible without using repair or exchange of some parts with retention of others.

a Виды работ	b ЗИЛ-130	c ЗИЛ-ММЗ-555
d Общий осмотр автомобиля	1,1	1,1
e Контрольные	28,1	28,5
f Крепежные	19,8	19,7
g Регулировочные	7,6	7,5
h Смазочные	19,0	18,9
i Электротехнические	15,5	16,8
j Работы по обслуживанию системы питания	6,1	4,0
k Работы по обслуживанию шин	5,6	5,8

Table 2-4. Distribution of labor consumption of TS-2 according to type of work, %

Key:
- a) type of work
- b) ZIL-130
- c) ZIL-MMZ-555
- d) general truck inspection
- e) control
- f) tightening
- g) adjusting
- h) lubricating
- i) electrical
- j) work on fuel system wervice
- k) work on tire service

A large amount of research has shown that any disassembly and assembly of an assembly, even if the part is not repaired, decreases its service life by 20%. This takes place because of the fact that during each disassembly, the character of fit and relative position of the run-in assembly surfaces of the parts are unaviodably changed. This attests first to the fact that disassembly of parts should take place only when it is an actual necessity and second, to the fact that any measures used during disassembly to secure the best installation of the parts in their same places (punching, marking with paint, or making marks on the assembled part) are highly profitable in the practice of conducting all types of repair.

A proposition on technical servicing and repair of running gear was established to the effect that repair breaks down into two types: continuing and major. Construction features of new truck models such as the ZIL-130 and the ZIL-131, especially in the areas of engines, with their high service life, give basis for a large number of specialists to speak out for resurrection of the rules of the earlier-dropped "medium" type of repair.

Actually, the presence of low-wear cylinder sleeves, crankshafts and camshafts which are tempered as the result of heating in a large number of the engines coming in for major overhaul has excluded the necessity for work on these basic parts and, in practice, made major overhaul of these engines no more than a deepened check on the technical condition of the assembly, with washing, adjustment, and exchange of some parts.

This scope includes the idea of "medium overhaul" and must apparently serve as the basis for renewal of this type of overhaul in the rules.

All existing types of repair may be performed either on separate assemblies or on the motor vehicle as a whole. The assembly method of repair is most widely used.

In recent years, the idea of maximum centralization and specialization of repair of separate parts without sending the entire assembly to the repair plant has received increasing acceptance. Such centralization for repair of cylinder sleeves and their assemblies, pistons, and rings to overhaul dimensions, or of crankshafts with their assembly with repair bearings, renewal of worn out valves, carburetors, and a large list of other parts would allow creation of a new type of motor vehicle repair enterprise. Highly specialized, mechanized, and fitted with modern equipment, the motor vehicle repair enterprises, putting out high quality production on the basis of rebuilt used parts, could successfully significantly raise the effectiveness of repair activity and, most important, free the industrial plants from shipment of a large quantity of spare parts.

Continuing maintenance of the motor vehicle (assembly) has the purpose of eliminating noticed deficiencies, for the most part by means of rebuilding or exchanging deficient parts, components, and assemblies. The mission of decreasing unneeded expenditures for spare parts sharply poses the task of collecting parts and assemblies removed in the process of continuing maintenance and sending those which can be rebuilt to shops of the motor vehicle transport enterprises or to special repair plants.

Major overhaul of a motor vehicle (assembly) is intended to renew the working capability lost during the process of operation. The quality of performance of major overhaul must provide a between-overhaul run of 80% of the run of a new motor vehicle (assembly), counting the fact that in the process of operation, due to aging of parts, their wear, and the poorer condition of assembly, their decreased resource is unaviodable. Worldwide practice in motor vehicle repair production knows, however, that under conditions of high demands for technical condition of the repaired parts in modern repair technology, the service period of assemblies after major overhaul is no lower than that of new ones.

Achievement of this repair quality must also become a mission for the motor vehicle repair enterprises.

Positive solution of this mission may be achieved only when the technical equipment and skills present in motor vehicle repair production correspond to the level present in motor vehicle production. This is possible only under conditions of organizition of industrial major overhaul built at the enterprises of second production of overhauled products with a sharp increase in the size of motor vehicle repair enterprises and their narrow specialization for overhaul of a determined make of motor vehicle.

The major reasons for service life decrease in overhauled components and assemblies are:

Unsatisfactory washing and cleaning of the part;

Changed parts assembly fit in comparison with original;

Non-observance of parts bolt torque; balance, norms, and weight differences assigned by the plant.

The basic technical requirements for sections conducting overhaul, aside from dependence on where the overhaul is performed, must be the following.

The sections must be equipped with the necessary pullers, mandrels, attachments, and tools.

During disassembly, it is necessary to: press out parts with pullers, drifts, mandrels, or light taps with a copper (wooden) mallet; carefully remove inserts, separating them from their adjoining surfaces; maintain integrity of paired gears.

The dismantler must know the parts subjected to punching or marking by another means, for keeping their balance or observing the character of fit.

With defective parts, in checking their technical condition, dirt, scale, coke, and corrosion should be carefully cleaned from them. Parts control begins with a careful inspection. Parts of the steering mechanism and brake drive must be checked for absence of cracks by magnetic defectoscopy.

Before assembly, all parts must arrive for assembly free from dirt, scale, or coke.

Oil passages must be cleaned and checked.

Painted parts having a damaged lacquered layer must by repainted. The internal hollows of the cooling system on the surfaces contacting hot water are not painted.

Nicks, burrs, and shallow marks must be smoothed, and defective threads must be repaired (nicks are not allowed in parts which may be stress concentrators).

All cavities of the lubricating and cooling systems must be checked for tightness.

Roller bearings may be used without exchange if they satisfy the requirements for the technical conditions for overhauled bearings of GOST 6275-57.

Working edges of packing seals must not have breaks, cracks, or traces of rubber layer separation. Besides this, rubber parts must not have evident signs of stretching.

Fastening parts (bolts, nuts, pins) must not have spoiled threads (more than two threads).

Only new lug washers, cotter keys, and safety wire may be used.

Assembly must take place under conditions providing cleanliness of assembled components. The assembly sections for components must be equipped with work benches or stands, eliminating component assembly on the floor. Assembly of parts and components must take place according to drawings and schematics from the plant.

During engine assembly, soft cloths and not textile ends should be used for wiping.

During assembly, rubbing surfaces of parts should be lubricated with clean oil. It is recommended that all inserts except those specially stipulated be lubricated with sealer before being installed. Seating of bushings, seals and bearing rings is accomplished with special mandrels. During tightening of connections which are backed with rubber inserts, excessive force should not be used, or the insert will be ruined.

Increased assembly accuracy when using parts with wear (within allowable limits) is necessary to achieve the individual coupled detail of the part.

Bearings

In the process of use, various defective parts having ball or roller bearings are discovered. The most characteristic of these are shown in Table 2-5.

During disassembly of the parts, force during bearing pressing must be applied to the face of the outside race (when pressing the bearing from the body) and to the face of the inside race (when removing the bearing from a shaft). Forced transmittal through the rolling body or through the separators is not allowed.

Bearings removed from disassembled parts must be carefully washed. They are considered useful for repeated installation in an assembled part if they correspond to the requirements of GOST 6275-57 for ball and roller bearings.

Use of bearings with traces of corrosion, burns, cracks, chips, dents, impressions, and other mechanical damage on the assembly or working surfaces of the ring or rotating body is not allowed.

Bearing assembly should take place so that during their installation on a shaft, pressing force is applied to the inside race, and during their assembly in a body, it should be applied to the outside race.

Defect symptom	Defect cause
Excessively high temperature or noise during operation of the part	Overtightening the bearing during adjustment; absence of lubrication in the part; bearing misalignment; excessive wear or destruction of bearing parts; dirt in bearings.
Throwing of lubrication from the part	Wear of bearings; damage to packing insulation; excessive lubrication; liquified grease due to bearing overheating

Table 2-5. Symptoms and causes of bearing defects

Hydraulic, screw, or other presses are used for pressing bearings. Assembly tubes, sockets, mandrels, and insert rings are used as attachments. If unavoidable, pressing bearings on a shaft with hammer blows on an assembly cup is allowed. Hammer blows on the bearing ring are not allowed.

Normal work of the bearing may be assured only if precise coincidence of the axes of the shaft and body is established.

Misalignment of the axes will cause overloading of the rotating body and premature bearing breakdown. Overtorquing bearings is just as dangerous as undertorquing them.

Tightening of bearings and bearing assemblies must be accomplished with special care so as to assure their long and proper operation.

Section II. Engines

Chapter 3. The in-line engine

Layout

Production of the in-line four-stroke six-cylinder carbureted engine began in 1947 with the ZIL-120 model, and then the ZIL-164, ZIL-164A, ZIL-157, adn ZIL-157K. These engines were installed in the ZIL-150, ZIL-151, ZIL-164, ZIL-164A, ZIL-157, and ZIL-157K motor vehicles (Plates 3-1, 3-2, 3-3). Basic data on the ZIL-157K engines are presented in Table 3-1.

Beginning in 1947, the engine was modernized several times. In particular, engine power of the later models of the ZIL-157K was increased to 109 hp after installation of a two-throat carburetor and an intake manifold with separated intake chambers. The engine serial number is stamped on a flat surface located on the left side of the cylinder block at the top of its plane opposite the first cylinder. Additionally, the number is stamped on the factory plate located on the right side of the driver's seat frame.

Crankshaft and camshaft mechanisms

The cylinder block (Plate 3-4) is cast of SCh 24-44 cast iron (GOST 1412-54). The double walls of the block form the water jacket along the entire length of the cylinders. For equal valve seat cooling, a brass water distributing pipe is installed in the block.

The bell housing is cast iron. Rear motor mounts are cast together with the bell housing.

The cylinder head is made of an aluminum alloy. Compression chamber displacement is 140.5 cm^3 . Deviation over ± 3 cm^3 between separate chambers is not allowed.

Spark plug holes in the cylinder head have a thread of 14 mm and a pitch of 1.25 mm. A steel-asbestos gasket is installed between the head and block, and the smooth side of the gasket should be against the head during assembly. Some engine modifications use a copper-asbestos gasket.

The head is fastened to the cylinder block with 23 bolts and 7 studs. Three front studs are also used to fasten on the compressor, and four rear ones are used for fastening the attachment to lift the engine.

The pistons are cast of an aluminum alloy. A label is placed on the top of each piston: dimensional piston group according to skirt diameter, weight group of the piston, and dimensional group of the piston according to piston wrist pen hole. Piston dimensions and piston ring groove profile are shown in Plate 3-5.

Wrist pins (Plate 3-6) are hollow and manufactured of low-carbon steel. The exterior surface is subjected to surface tempering with high-frequency current to a depth of 1.0-3.0 mm.

a Параметры	b Величина параметров
c Максимальная мощность при 2800 об/мин, л. с.	100
d Мощность при 2600 об/мин (по ограничителю числа оборотов), л. с.	104
e Максимальный крутящий момент при 1100—1400 об/мин, кГм	34
f Диаметр цилиндра и ход поршня, мм	101,6×114,3
g Степень сжатия	6,2*
h Рабочий объем, л	5,55

Table 3-1. Parameters for ZIL-157K In-line engine

Key:
- a) parameters
- b) amount of parameters
- c) maximum power at 2800 rpm, hp
- d) power at 2600 rpm (according to rpm governor), hp
- e) maximum torque at 1100-1400 rpm, kilogram meters
- f) cylinder bore and piston travel, mm
- g) compression ratio, 6.2[1]
- h) displacement, meters

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[1] The compression ratio of export engines is 6.5.

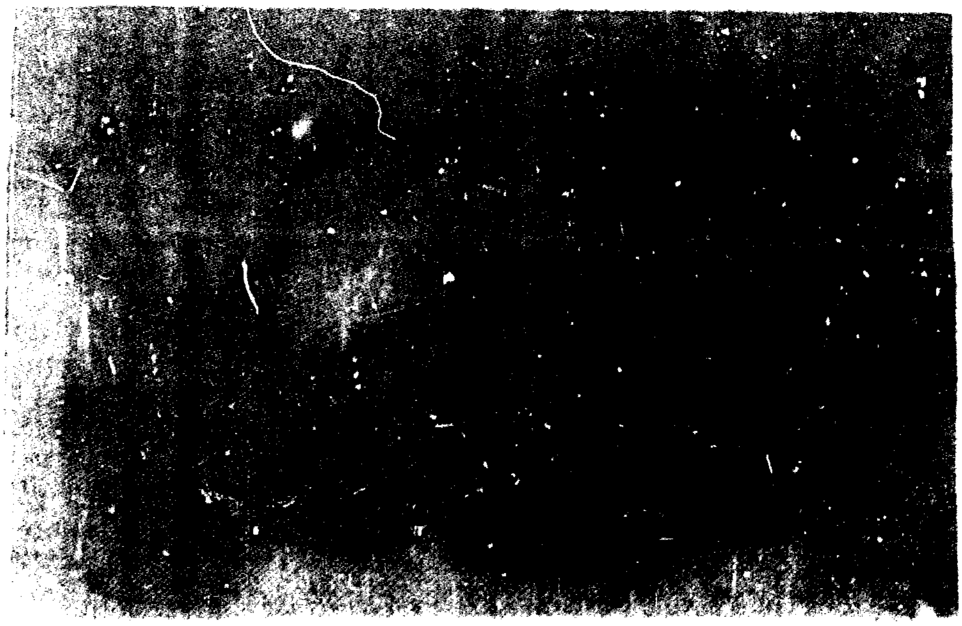

Plate 3-1. ZIL-157K truck engine

The piston rings (Plate 3-7) are cast of cast iron, alloyed copper, and titanium, with a hardness of HRB 98-106. The middle compression ring has a groove along its exterior diameter, and the top compression ring has a groove along its interior diameter.

The top compression ring is chromed

Connecting rods (Plate 3-8) are forged steel, with an I-shaped section.

The crankshaft is a steel forging. To increase wear resistance, the crankshaft and connecting rod bearing surfaces are subjected to surface tempering with high-frequenct current to a depth of 2.5-6.5 mm.

Surface hardness of the shaft surfaces after tempering is HRC 52-62. The crankshaft is balanced. The allowable imbalance is not grerter than 150 gram cm.

Imbalance is eliminated by drilling holes in the surface face from the side of the shaft crank. Crankshaft bearings, main and connecting rod, are equipped with thin-walled interchangeable insorts, made of bimetallic bands. As an anti-friction alloy, the inserts use an ATL-6-6 alloy (antimony 5.5-6.5%; tin 5.5-6.5%; lead remainder).

Thickness of the anti-friction alloy on the inner side of the insert is 0.230-0.305 mm for main journals and 0.180 0.305 mm for connecting rod journals.

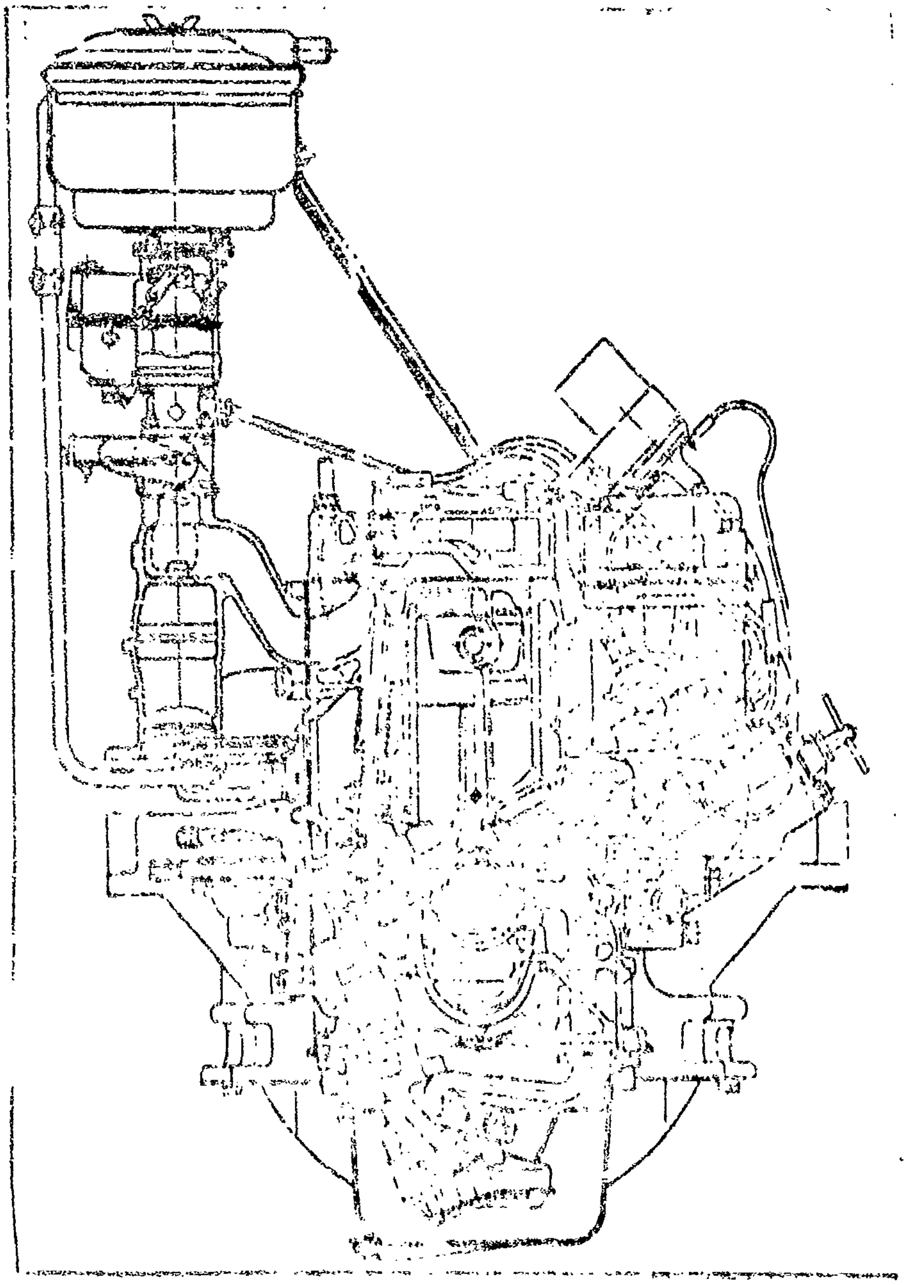

Plate 3-2. Lateral section of ZIL-157K engine

The flywheel (Plate 3-9) is cast iron with a steel-toothed rim for engine starting with the starter.

The rim and flywheel are press-fitted.

The camshaft is steel, forged, and its bearing surfaces, cam lobes, eccentric and gear teeth are hardened with high-intensity heating.

After hardening, the bearing surfaces have a hardness of HRC 54-62, and the cam lobes have a hardness of HRC 65-62.

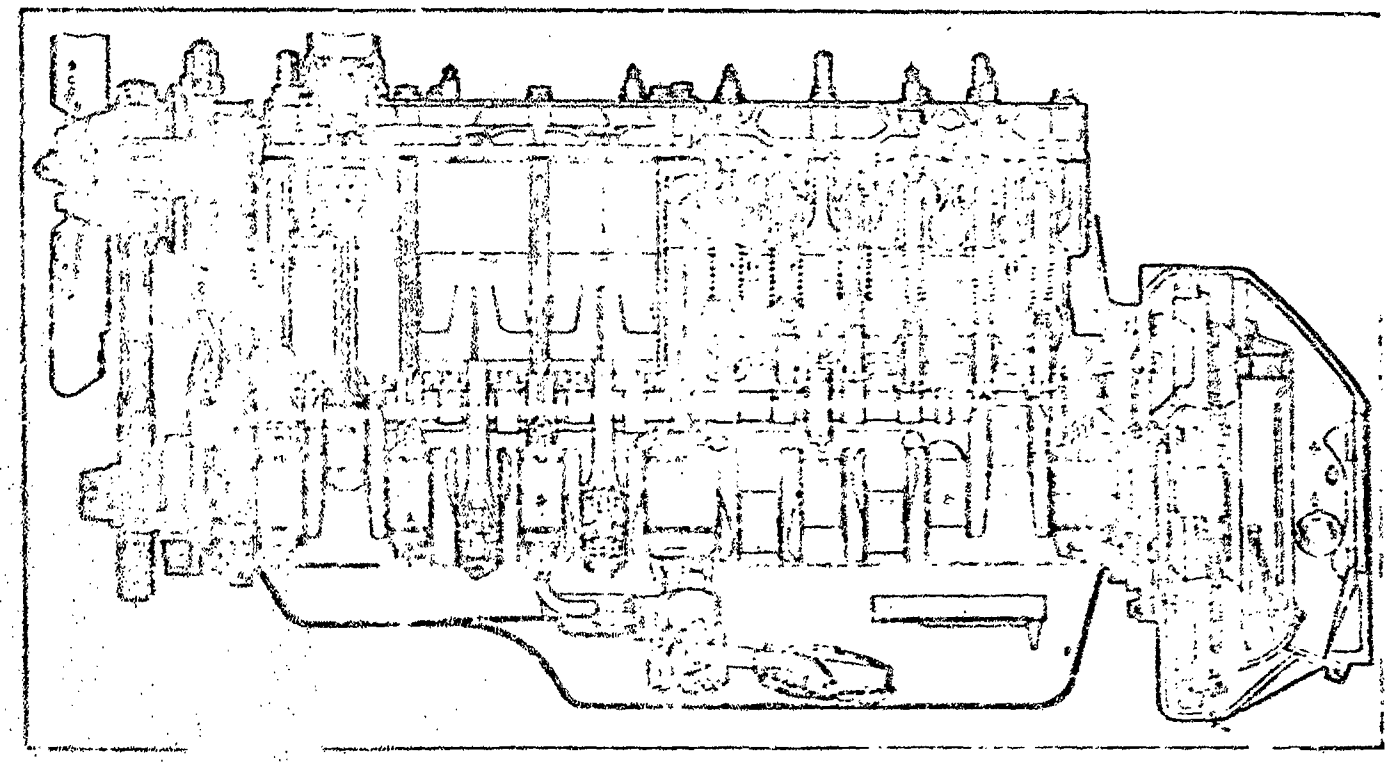

Plate 3-3. Longitudinal section of ZIL-157K engine.

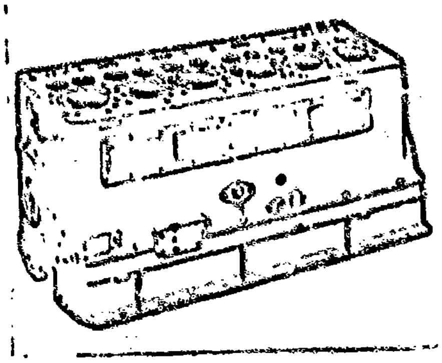

Plate 3-4. Cylinder block

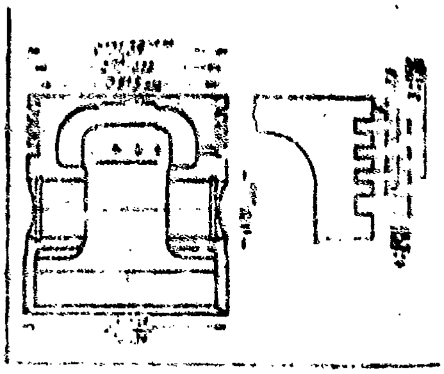

Plate 3-5. Piston

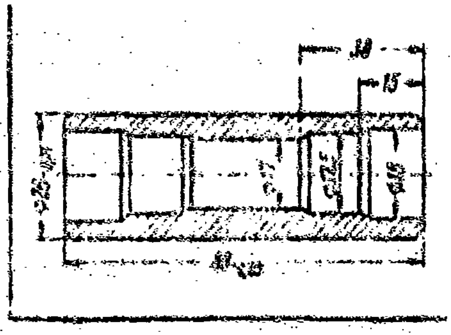

Plate 3-6. Piston wrist pin

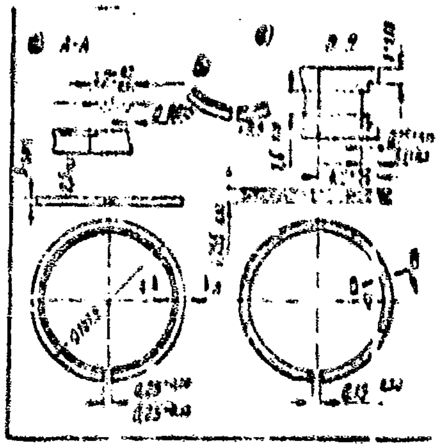

Plate 3-7. Piston ring: a) top compression ring; b) oil ring; c) specification for piston ring repair dimension

Profiles of the camshaft lobes and eccentric are shown in Plate 3-10.

The shaft is installed in the cylinder block in four sliding bearings which are bimetallic bushings pressed into receptacles in the block. The camshaft is prevented from moving in a longitudinal direction by a flange fitted on it and fastened by two bolts to which access is gained through holes in the camshaft gear.

The small camshaft gear (Plate 3-12, a) is steel.

The large camshaft gear (Plate 3-12, b) is cast iron. Fastening of the gear onto the camshaft is shown in Plate 3-13.

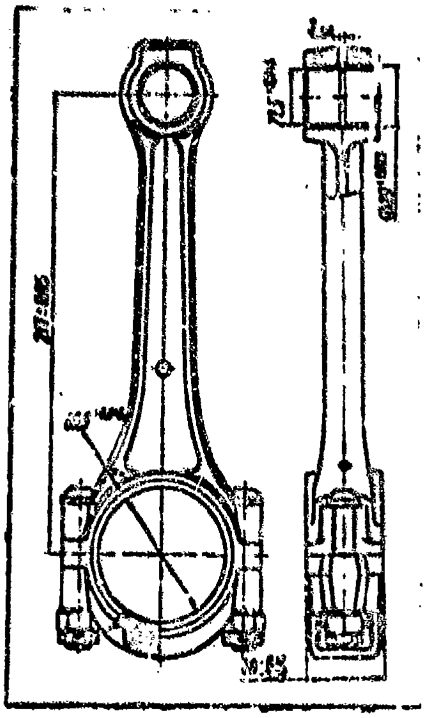

Plate 3-8. Connecting rod

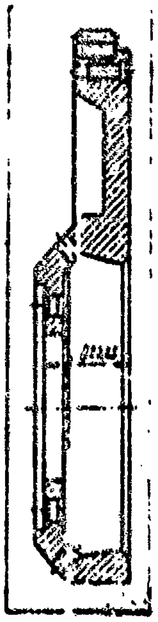

Plate 3-9. Flywheel

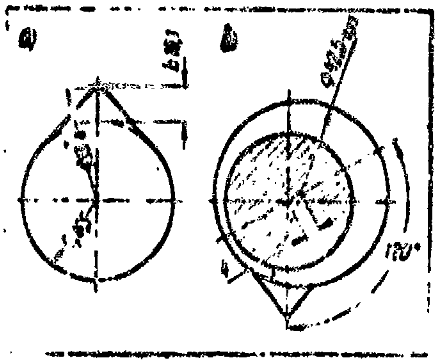

Plate 3-10. Profile
a) lobe
b) eccentric

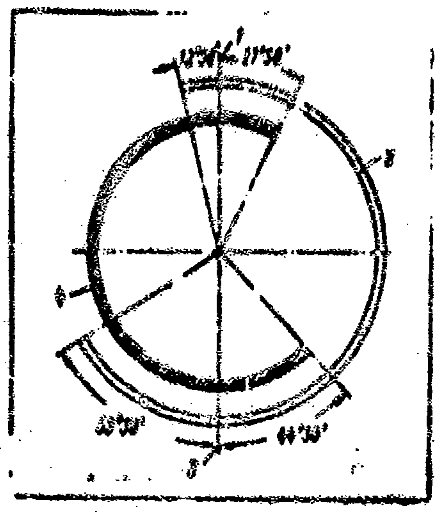

Plate 3-11. Diagram of gas distribution phases: 1) TDC 2) intake 3) BDC 4) exhaust

The camshaft gear cover (Plate 3-14) is cast iron and installed on a gasket. Centering of the cover on the block is accomplished by two locating sleeves through which the cover fastening bolts run. A pin for adjustment of the ignition system is screwed into the camshaft gear cover. Seal 1 of the front end of the crankshaft is pressed into a receptacle in the cover. The seal is self-tightening, and rubber with a metal body.

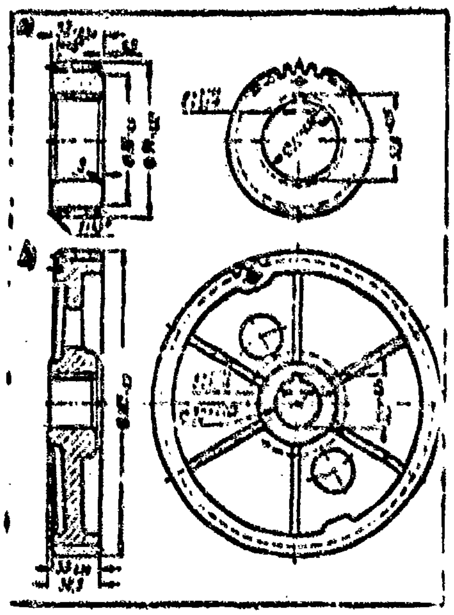

Plate 3-12. Camshaft gear
a) crankshaft gear
b) camshaft gear

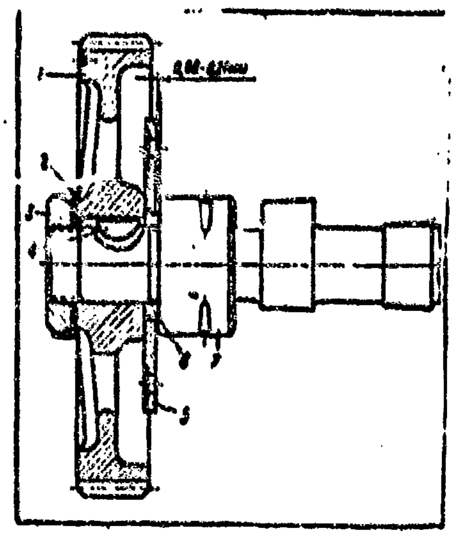

Plate 3-13. Fastening gear onto camshaft
1) gear 2) lock washer 3) nut
4) key 5) support flange
6) spacing ring 7) camshaft

In all instances when there is noticeable wear, visible cracks, or other damage on the working surface of the seal, and also in cases when the rubber of the seal is hardened or stretched, the seal is subject to replacement.

Wear on the bearing surface under the bracket of the front motor mount is allowed to a diameter of 91.65 mm.

Valves. Intake valves (Plate 3-15) are manufactured of chromed steel.

Exhaust valves are composite, with the head manufactured of heat-resistant chromium-silicon steel, and the stem welded to it manufactured of chromium steel. Exhaust valves for engines working with a 6.5 compression ratio are stamped and one-piece (of steel with increased heat resistance). Valve spring

Table 3-2. The camshaft provides the following phases[1] of gas distribution (Plate 3-11):

Intake valve opening	12°30' before TDC
Intake valve closing	59°30' after BDC
Exhaust valve opening	44°30' before BDC
Exhaust valve closing	27°30' after TDC

plates are fastened with a thrust lock. As the result of action of burning gases, corrosion, shock loads, and also deposits of tarry substances in the process of operation of the engine, tightness of the working surfaces of the valves is destroyed.

Destruction of the valve seal with proper clearance between the tappets and valves and proper work of the carburetor and ignition is discovered by the characteristic of popping from the muffler and carburetor; the engine begins to run with a miss, and does not develop full power.

The valve springs are steel and are wound out of wire (65 G steel). Valve tappets and guides. The tappets are steel (Plate 3-16) and the valve guides are cast iron, made in the form of two removable sections for each of the six tappets.

The adjusting bolt 1 of tappet 3 is installed with a stop nut which fastens the bolt in any position determined during adjustment of the clearance between the tappet and the valve. Bolt thread dimensions are M9 X 1. In case of wear on the working surface of the bolt head, it is polished on an abrasive stone. Deviation of the bolt sphere relative to its threads is no greater than 0.1 mm on a radius of 5 mm. Wear on the spherical surface of the tappet plate must not exceed 0.10 mm, and wear on the tappet stem must be no greater than 0.04 mm.

The intake and exhaust manifolds (Plate 3-17) are single iron castings with a central upper flange for mounting of the carburetor and a central lower flange for connection with the exhaust gas collector pipe. The manifolds are intended for use with a 2-throat carburetor with separated intake ports for the front three and the back three engine cylinders. Contact planes of both manifolds and the gaskets beneath them are identical and interchangeable.

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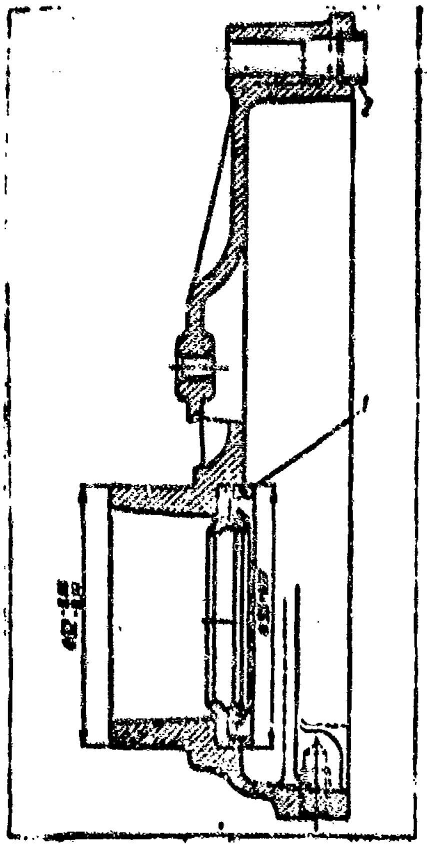
1 Angles of gas distribution phases are given for the moment of beginning and end of closing of the valve with a clearance between the valve and tappet of 0.25 mm.



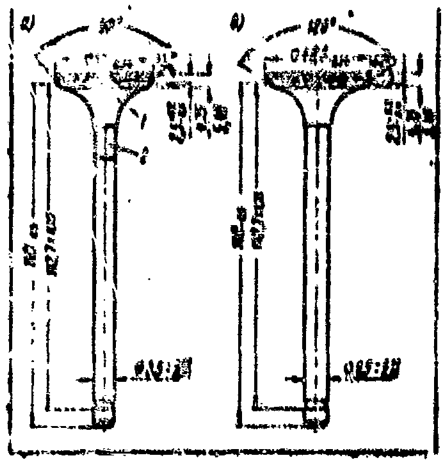


Plate 3-15. Engine valves: a) exhaust b) intake 1) head 2) welding of head to valve stem

Plate 3-14. Camshaft gear cover

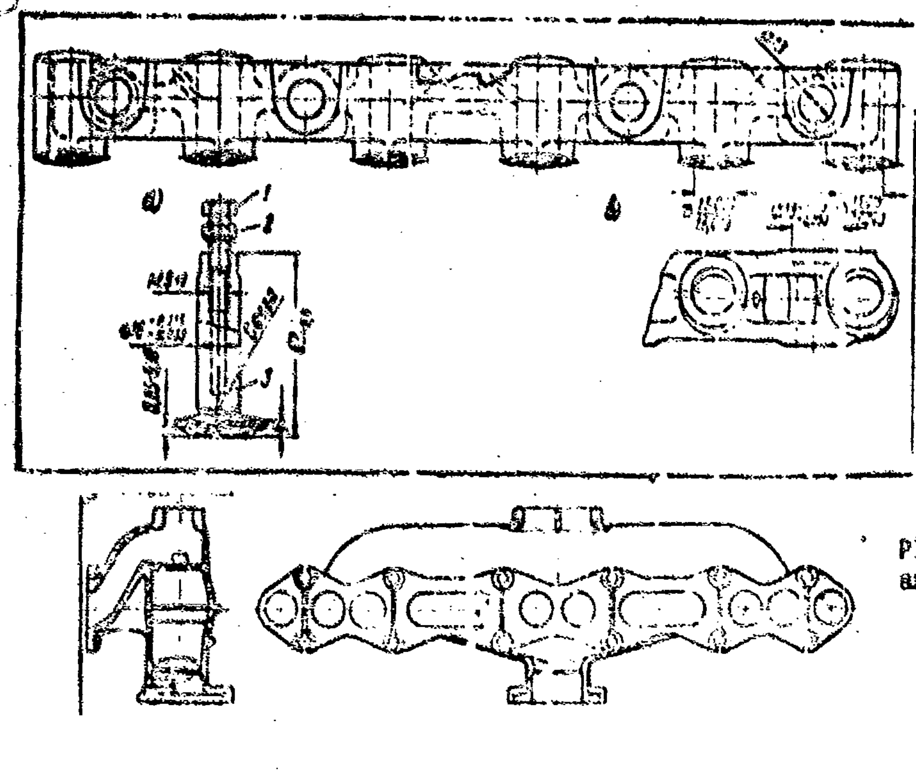


Plate 3-16. Tappet and tappet guiding section:
a) tappet
b) tappet guiding section
1) adjusting bolt
2) stop nut
3) tappet

Plate 3-17. Intake and exhaust manifolds

Lubrication system

The engine lubrication system (Plate 3-18) is combined. The engine is equipped with an oil radiator (Plate 3-19) and a two-section oil pump (Plate 3-20) whose upper section supplies the engine lubrication system and whose lower section pumps oil to the radiator.

The main and connecting rod bearings of the crankshaft, camshaft bearings, breaker -- distributor drive shaft and camshaft gear are lubricated under pressure.

Cylinders, piston wrist pins, camshfft lobes, tappets, and valve stems are lubricated by splashing.

Oil filtering in the system takes place sequentially in the screen filter of the floating oil pickup 17 (see Plate 3-18) of the pump and in the plate coarse cleaning filter. Part of the oil (5-8%), besides this, passes through the fine cleaning filter (Plate 3-21) with a changeable filtering element 11.

Working pressure in the lubricating system is 3-4 kg/cm^2. This pressure is sustained with a spring reduction valve located in the body of the oil pump. With proper operation of the reduction valve, oil pressure in the lubrication system of a warm engine at 1000 crankshaft revolutions per minute must be no lower than 2.5 kg/cm^2. If a deviation from the assigned control pressure is observed during checking, it is necessary to remove the reduction valve in the assembly and check the condition of its parts.

The oil radiator is fastened by four bolts to brackets which are welded on the frame of the water radiator louvres. Removing the radiator from the truck, it is necessary to wash it out with a degreasing solution and hot water. Tightness is then checked with air at a pressure of 4 kg/cm^2 in a water bath. An observed stream is eliminated by soldering with light solder. Small holes in the radiator body are eliminated with welding and consequent cleaning. Blockage of tubes is allowed, but no more than three.

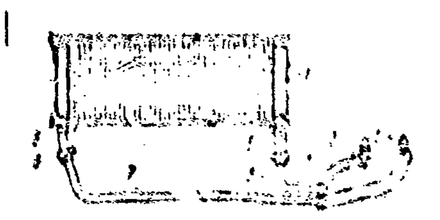


Plate 3-19. Oil radiator and lines:
1) radiator core 2) L-connection
3) radiator valve 4) hose 5) oil intake line 6) hose 7) oil outlet line
8) hose clamp

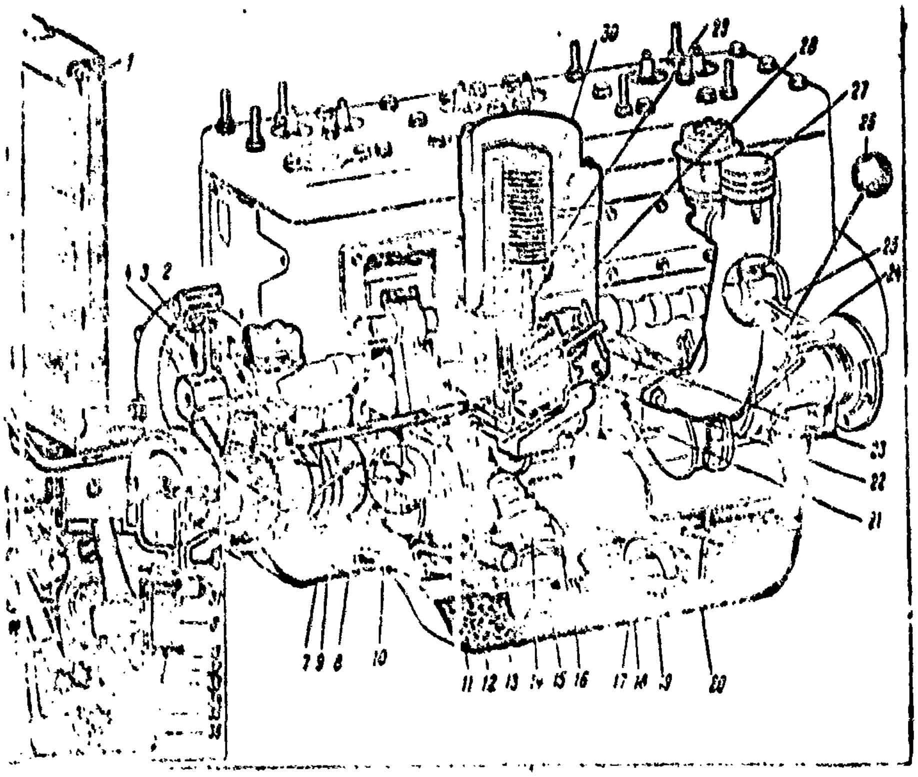


Plate 3-18. Engine lubrication system:

1) oil radiator 2) oil passage to front camshaft bearing 3) opening for oil splashing on camshaft gear 4) oil passage to support flange 5) oil outlet line 6) oil inlet line 7) main oil line 8) oil passage in crankshaft 9) oil outlet line 10) oil radiator shut off valve 11) oil lines to compressor 12) oil passage to filters 13) top section safety valve 14) top section 15) bottom section 16) lower section intake pipe 17) upper section floating oil pickup 18) oil pan 19) drain plug 20) dip stick 21) cleaning plates of coarse cleaning filter 22) filtering plates of filter 23) filter lever 24) oil pressure sending switch 25) oil passage to rear camshaft bearing 26) oil pressure indicator 27) oil filler pipe 28) oil filter body 29) filter central tube 30) fine cleaning filter element 31) oil filter by-pass ball valve 32) upper section driven gear 33) upper section driving gear 34) lower section ball by-pass valve 35) lower section driven gear 36) lower section driving gear

Cooling system

The cooling system (Plate 3-22) of trucks intended for work in temperate climatic zones is closed, with forced liquid circulation. Pressure in the engine cooling system is automatically regulated by valves in the radiator cap and may reach 0.5 kg/cm². At this pressure, water in the system will not boil until it reaches 105°C.

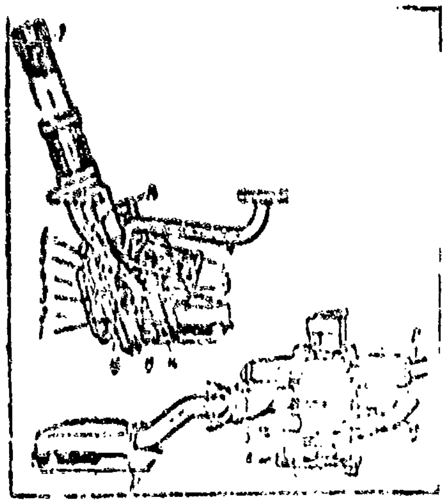


Plate 3-20. Two-section oil pump:
1) lower section driving gear 2) lower section body 3) separating plate 4) upper section body 5) pump drive shaft 6) upper section driving gear 7) pump drive gear 8) lower section intake pipe 9) lower section by-pass valve 10) floating oil pickup 11) upper section oil line 12) upper section reduction valve 13) lower section oil line 14) driven gear shaft 15) lower section driven gear 16) upper section driven gear

Tractor-trucks working with heavy semi-trailers and trucks intended for use in tropical climates are also equipped with a closed type cooling system with forced liquid circulation and introduction of a condensation tank into the system.

Pressure in the system is regulated by valves in the condensation tank cap, and may reach 0.65 kg/cm^2. With this pressure in the system the water will boil at 114°C.

The condensation tank has a volume of 4 liters, is equipped with a neck for fastening the cap to (Plate 3-23), and has a valve 7 located at the bottom part of the tank for release of water. The tank is bolted onto the cab fire-wall beneath the engine hood.

With an increase in water temperature in the engine, the pressure in the cooling system increases, and part of the water is converted into steam which flows along pipe 3 to the condensation tank 4, in which, passing through a layer of water, it is converted to water.

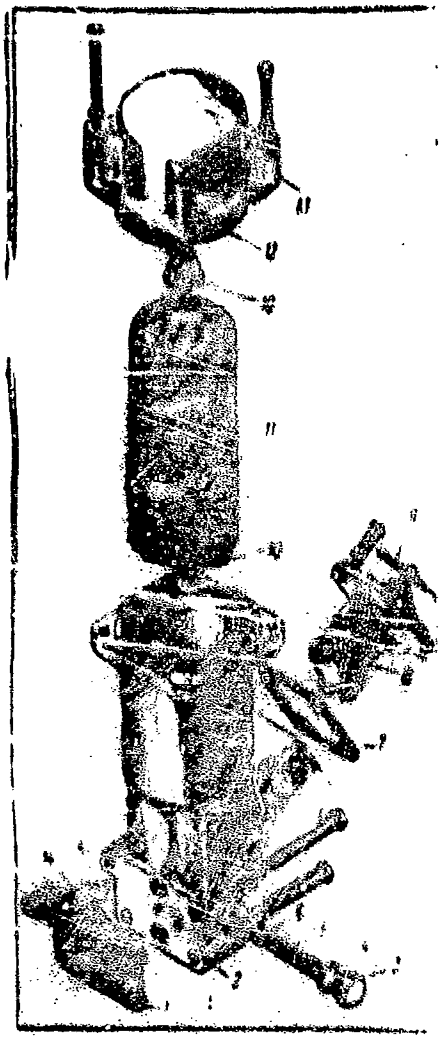


Plate 3-21. Oil filter parts:

1, 7, and 12) gaskets 2) filter body 3 and 14) plugs 4) backing ring 5 and 10) springs 6) by-pass valve bowl 8) coarse cleaning filter element 9) coarse cleaning handle 11) fine cleaning filter element 13) filter body cover

With a decrease in cooling system temperature, pressure in the radiator decreases and a vacuum is formed in the top radiator tank, as the result of which water from the condensation tank is drawn back into the radiator. Water level in the condensation tank therefore changes, depending on the cooling system temperature, and it should not be filled more than half way.

The heavy duty cooling system is composed of a four-row radiator with a tight rubber plug and pipe 3 for exhaust of steam into the condensation tank. The fan pulley on these engines has a smaller diameter, increasing the number of fan revolutions and increasing the effectiveness of the cooling system.

The water pump, fan, thermostat, and water distribution pipes for the cooling systems of all in-line engines are identical. Louvres are not installed on trucks intended for use in the tropics.

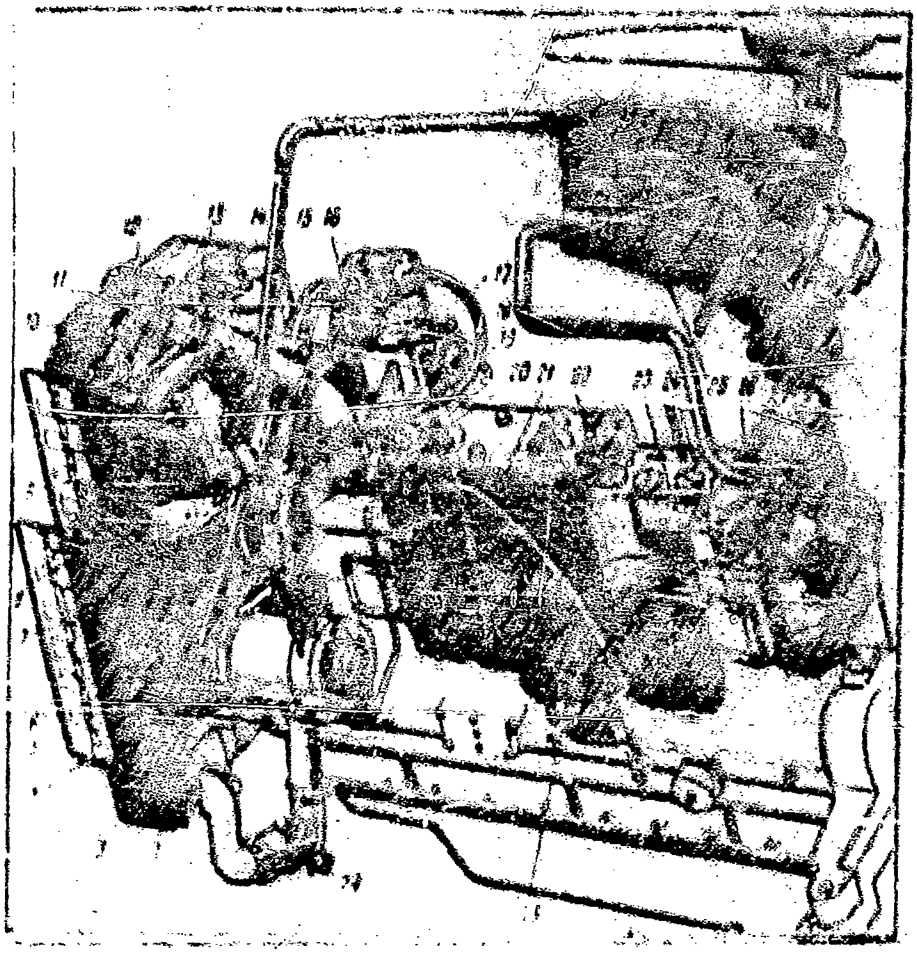


Plate 3-22. Engine cooling system
1) radiator exhaust hose 2) radiator fastening frame 3) fan shroud 4) louvre fastening frame 5) louvre flap 6) flap axis 7) fan and water pump drive pulley 8) radiator pipe 9) fan 10) louvre control rod 11) louvre control angle lever 12) flap drive rod 13) radiator intake pipe 14) radiator filler neck 15) pipe for carrying cooling liquid from heater 16) hose for carrying cooling liquid from compressor head hollow 18) cylinder head pipe 19) thermostat 20) water pump 21) cylinder block water jacket 22) cylinder head water jacket 23) water distributing pipe 24) cylinder block water jacket inspection plate 25) cab heater 26) cooling liquid temperature sending switch 27) cooling liquid temperature indicator 28) valve for draining liquid from water jacket and cylinder head 29) valve for draining radiator liquid

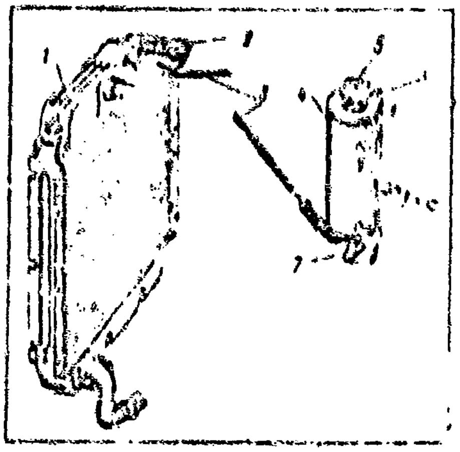


Plate 3-23. Connection of condensation tank to radiator: 1) radiator 2 and 5) caps 3) pipe for exhausting steam from radiator to tank 4) condensation tank 6) steam exhaust pipe 7) drain cock

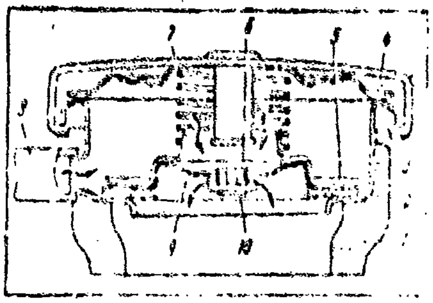


Plate 3-24. Radiator cap: 1) filler neck 2) release valve 3) cap body 4) spring supporting plate 5) release valve plate 6) return valve spring 7) release valve spring 8) steam exhaust pipe 9) inlet valve cup 10) inlet valve

Overflow pressure in the cooling system is automatically regulated by the release valve 2 (Plate 3-24) of the cap, which is installed on the radiator filler neck in the first case (with a pressure of 0.5 kg/cm^2), and on the neck of the condensation tank 4 (see Plate 3-23) in the second case (with a pressure of 0.65 kg/cm^2). The caps are identically constructed, but equipped with different springs 7 (see Plate 3-24) in the release valves. The pressure for which the cap is regulated is stamped on its exterior surface.

The air inlet valve 10 of the cap opens and connects the hollow of the radiator with the atmosphere at a vacuum which is equal to 0.01-0.13 kg/cm^2.

If the rubber backing ring of the valves on the cap is missing or damages, the cooling system will cease to work as a closed one, cooling liquid will boil at 100°C and engine overheating will occur significantly sooner. In this case, the cap should be replaced with a new one or its sealing ring should be replaced.

The cooling system thermostat is a liquid type installed in pipe 3 (Plate 3-25) of the cylinder head. Valve 4 of the thermostat begins to open at a cooling liquid temperature of 70 ± 2°C. At a lower liquid temperature, the bellows is in a compressed position, so that valve 4 of the thermostat is closed, as the result of which the cooling liquid does not reach the radiator. When cooling liquid temperature reaches higher than 70 ± 2°C, the thermostat bellows begins to expand, opening valve 4. At a temperature of 83 ± 2°C, the valve 4 is fully opened (height of valve raising is no less than 9 mm), so that cooling liquid from the cylinder freely passes to the radiator.

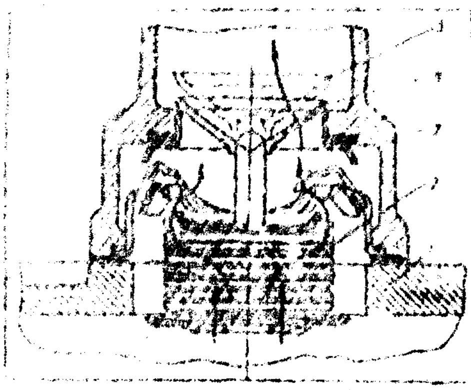


Plate 3-25. Schematic of thermostat operation:
1) cylinder head 2) thermostat bellows 3) cylinder head pipe
4) thermostat valve in closed position 5) thermostat valve in open position

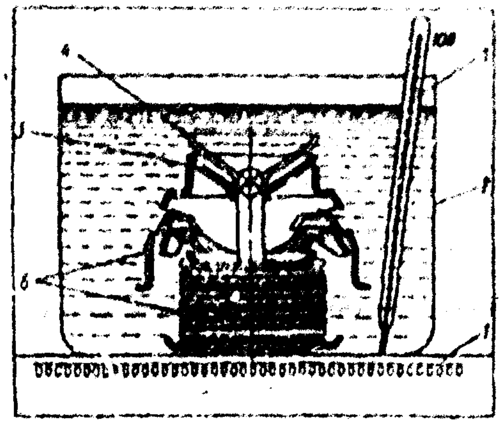


Plate 3-26. Schematic for checking the thermostat:
1) electric hot plate 2) pan
3) thermometer 4) valve position at the end of opening 5) valve position at the beginning of opening 6) thermostat

Plate 3-27. Radiator without fan shroud

Proper operation of the thermostat can be checked by heating it in water (Plate 3-26). Upon reaching a temperature of 70 ± 2°C, the valve of a properly working thermostat must begin to open. The thermostat is not disassembled and repaired.

The radiator (Plates 3-27 and 3-28) is tubed, with the cooling surface executed either in the form of plates or in the form of a corrugated band 0.06-0.10 mm in thickness, arranged in serpentine fashion. The radiator pipes are manufactured of tombac (L90) [copper-zinc alloy]. The cooling band (serpentine), like the cooling plates for radiators of tractor-trucks and trucks shipped to countries with tropical climates, are manufactured of MZ copper.

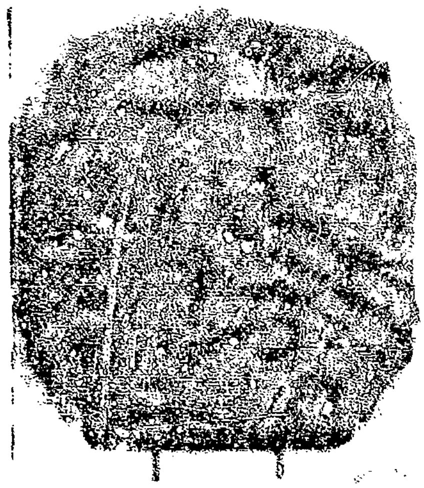


Plate 3-28. Radiator with fan shroud

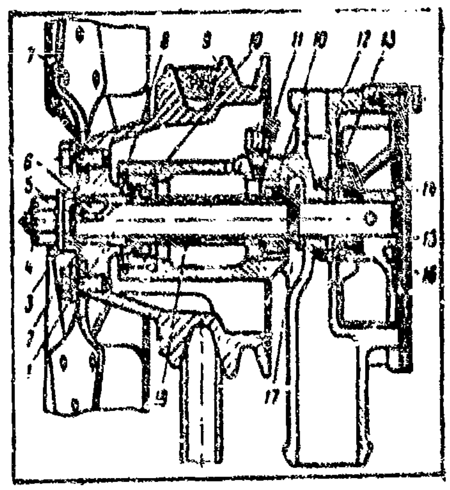


Plate 3-29. Water pump with fan
1) shaft 2) conic bushing 3) washer 4) cotter key 5) nut 6) woodruff key 7) fan 8) locking ring 9) pulley 10) bearings 11) grease nipple 12) body 13) thrust washer 14) seal cup 15) vanes 16) spring 17) deflector 18)distance bushing

Tesing of the radiator for tightness is conducted with compressed air in a water bath with a pressure of 0.8 kg/cm^2 for radiators of normal duty and 1.5 kg/cm^2 for radiators for tropical duty. Upon discovery of a leak, up to five tubes are allowed to be closed off.

The radiator is installed in the truck in a metal frame, to which are fastened the louvres, radiator housing, and diffuser. Connection of this entire assembly to the truck frame is accomplished with two studs welded to the bottom part of the radiator frame, with rubber cushions mounted on them.

The water pump (Plate 3-29) is a centrifugal one producing 240 liters/min at 2800 crankshaft rpm. The gear ratios of the drive pulleys on the water pump and crankshaft are: 1.18 : 1 for standard engines and 1.25 : 1 for engines intended for use in the tropics

In the process of engine operation, bearing 10, the base hole under the bearing in the body 12, the packing assembly and shaft 1 of the pump wear out. Water pump bearings are fitted with grease nipples, providing lubrication and protecting the bearings from dirt and cooling liquid which might reach them.

The fan is six bladed and installed on the front face of the water pump drive pulley. To increase exhaust of heat from the radiator, the fan is encased in a shroud (diffuser), which promotes increased speed of the air stream passing through the radiator. The shroud is fastened to the radiator frame.

Since December 1960, to increase fan effectiveness, more efficient fans, with a blade installation angle of 35° instead of 30°, have been installed on all trucks, and the fan shroud (diffuser) has been somewhat shortened.

The replacement fan and fan shroud are interchangeable with the old ones.

Technical Servicing

Checking of cylinder head fastening bolts and nuts is recommended to be conducted with a torque wrench (Plate 3-30). Torque must be within the limits (10-12 kg meters. Cylinder head nut and bolt tightening should be accomplished in a determined sequence (Plate 3-31) on a cold engine.

Plate 3-30. Checking torque on cylinder head fastening nuts

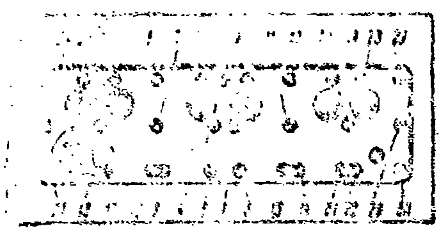


Plate 3-31. Torquing sequence for cylinder head fastening nuts

Clearance between the valves and tappets is checked upon the appearance of valve noise, after which they are adjusted. Valve clearance adjustment should be performed separately for each cylinder, corresponding with the cylin. firing order (1-5-3-6-2-4). Clearance between the tappets and valves for intake and exhaust valves must be 0.20-0.25 mm for engines with a 6.2 to 1 compression ratio, and must be 0.23-0.28 mm for engines with a 6.5 to 1 compressi ratio.

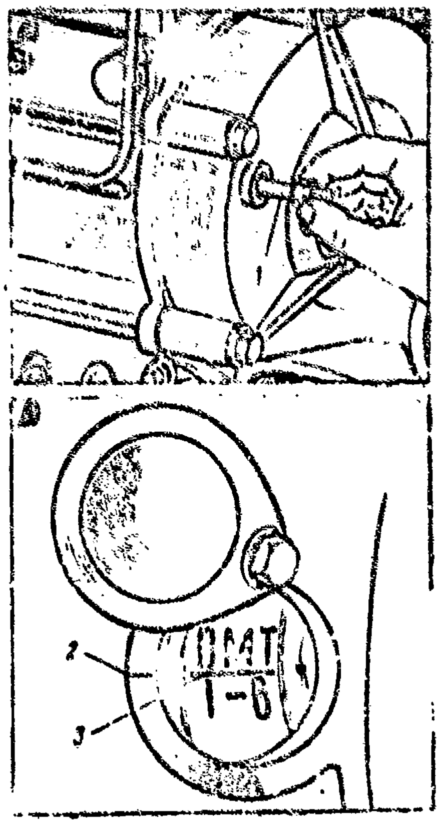


Plate 3-32. Method of setting piston of first cylinder at top dead center: a) with a setting rod b) with mark on flywheel 1) setting rod 2 and 3) marks on flywheel and case

Key: * TDC

Before adjusting clearance, it is necessary to:
Disconnect the fuel line from the fuel pump to the carburetor, restricting access to the valve boxes;
Disconnect the crankcase ventilation pipe and move it to the side;
Unscrew bolts fastening the valve box cover and remove the cover with its gasket. The valve box cover should be removed carefully, attempting not to damage the sealing gasket.

Adjustment of intake and exhaust valve clearances should begin with the first cylinder, for which the piston is set at TDC on the compression stroke with a setting pin or according to markings on the flywheel.

In setting the number 1 piston at TDC, unscrew the setting finger 1 (Plate 3-32, a) and insert its other end in the same hole. Then, turning the crankshaft, continue until the end coincides with the hole in the camshaft gear. After setting the number 1 piston at TDC, screw the setting pin into its place.

In setting the number 1 piston at TDC by the marks on the flywheel, the inspection hole cover on the bell housing must be open so that the flywheel rim is visible. Turning the engine crankshaft with a lever, the number 1 piston is set at TDC when the TDC mark 3 (Plate 3-32, b) on the flywheel coincides with mark 2 on the bell housing. After setting the first cylinder at TDC, close the inspection hole cover and fasten it.

Clearance between the adjusting bolts of the tappets and the valve stems is checked with a leaf gauge (Plate 3-33, a). If the clearance is outside the assigned limits, it must be adjusted. An adjustment is performed in this way:

Holding the tappet with one wrench on its flats, free the tappet adjusting bolt stop nut with another wrench;

Still holding the tappet, turn the tappet adjusting bolt until the required clearance is attained;

Holding the tappet adjusting bolt with one wrench and the tappet with another, tighten the stop nut with third wrench (Plate 3-33, b).

a)

Plate 3-33. Adjustment of valve clearance:
a) checking clearance with leaf gauge
b) adjusting clearance and tightening stop nut

After adjusting the valves of the first cylinder, it is necessary to adjust the remaining valves in the same manner and replace the engine parts removed before valve adjustment.

Start the engine and listen to its operation. The warmed engine must work without valve noise, "coughing" from the carburetor and "backfiring" from the muffler.

Checking compression in the engine cylinders. Compression in the engine cylinders (pressure of compression) lowers according to the amount of wear on the piston rings and cylinder walls.

The normal amount of compression in the cylinders of a warm engine must be within the limits of 6.0-6.8 kg/cm^2. Compression reduction in the process of the engine's operation is allowed to 5.5-6.0 kg/cm^2 for an in-line engine.

The difference between compression readings for separate cylinders must not exceed 0.7-1.0 kg/cm^2.

Compression is taken on a warm engine. To check compression, it is necessary to:

Clean out the dirt collected in the spark plug depression;
Disconnect the spark plug lead and unscrew it;
Open the carburetor throttle and choke fully;
Insert the rubber tip of the compression gauge hose in the spark plug hole of the first cylinder and press it in tightly;
Rotate the crankshaft with the starter several times, so the compression gauge fixes the maximum pressure in the cylinder;
Remove the rubber compression gauge tip from the spark plug hole, take the reading, and open the compression gauge release valve to release air;
Repeat the operation for the remaining cylinders.

With a difference in pressure greater than 0.721.0 kg/cm^2, pour 20-25 cubic cm of fresh oil into the cylinder with the lower compression and repeat the compression check. If the compression reading rises, this shows the presence of air leakage around the piston rings. If the amount of compression after pouring oil in the cylinder remains the same as the reading without oil, this points to leaks between the valves and seats or valve burning.

Checking the coarse cleaning oil filter. It is necessary to clean the filter plates daily, turning the handle three to four rotations (Plate 3-34). The filter should be cleaned with the engine fully warm. Use of an extension lever to ease turning of the filter handle is prohibited. If the filter handle is difficult to turn, the cover bolts must be removed, and the filter removed and washed in kerosene.

When changing the oil in the engine crankcase, the fine cleaning filter element should be changed and residue should be removed from the filter body by unscrewing the plug with a wrench (Plate 3-35). Before installation, the new filter element must be blown off with compressed air to remove pieces of cardboard, hair, and dust which settle between the cardboard plates and would clog oil lines in the future.

Plate 3-34. Cleaning the coarse cleaning oil filter blades

Plate 3-35. Removing the oil filter body drain plug

After changing the filter element, oil level in the crankcase should be checked and should be topped up if necessary. The fine cleaning filter cover bolts must be tightened gradually, criss-cross, so as to eliminate misaligning the cover and breaking its ears.

Adding and changing oil in the engine. Before adding oil to the engine, it is necessary to check the oil level in the crankcase. To check the oil level, it is necessary to stop the engine, wait a few minutes while the oil drains down, remove and wipe the oil dipstick, insert it to the stop, and remove it again. Oil level is determined according to marks on the dipstick. Oil must be (with full oil filters) at the level of the upper 4/4 mark on the oil dipstick. If the oil is located on the 2/4 mark, it is necessary to add.

When changing the oil in the engine crankcase, the used oil is drained while the engine is still warm. Hot oil flows easily and washes dirt from the crankcase walls. The drain plug magnet should be cleaned. The fine cleaning oil filter element should be changed simultaneously with changing the oil.

Fresh oil is poured in through the filler neck. After filling the crankcase with oil, it is necessary to run the engine for a short time to fill the lubrication system, then stop it and check the oil level on the dipstick.

The crankcase air ventilation filter must be serviced at the same time that the engine crankcase oil is changed. Before servicing the ventilation filter, the case should be disassembled, cleaned, and carefully washed with gasoline or kerosene.

In servicing the filter, pour oil used for the engine into a dish, place the filter screen half way into the oil, remove it and hold it for 7-10 seconds with the wetted end down, then shake it and place the screen in the filter body with the wetted end up. After servicing the filter, install the filter cover in its place.

The cooling system. During technical service, check the water level in the radiator, which must be 40 mm below the upper edge of the filler neck, or 70-80 mm lower for anti-freezing liquid. Clean and soft water is recommended for the system.

During hard freezing, it is necessary to warm the radiator using warming jackets on the radiator housing and on the engine hood. Working a cold engine leads to its intensive wear.

During hard freezes, it is recommended that the system be filled with anti-freeze. The most widely used and reliable anti-freeze is type 40 (GOST 159-52), which freezes at a temperature of -40°C. Anti-freeze is poison, and it is therefore necessary to observe safety measures when handling it. During Winter, the cooling system should be filled with hot water, with the valves open. The valves should be closed as soon as warm water begins to flow from them. Starting the engine without cooling liquid is not allowable, in that pouring cold water into a warm engine may cause cracks in the walls of the cylinder block and head. The condition of the radiator plug valves should be periodically checked and the condition of all gaskets should be systematically observed, not allowing liquid leaks from the cooling system.

The condensation tank should be filled to only half its volume (2 liters). The radiator must be periodically washed through from the outside with warm water, cleaning dust, dirt, and oil from it, and then blown out with compressed air. Special attention should be paid to the radiator during operation of the truck on dirt or dusty roads.

If "hard" water is used for engine cooling, scale will be formed in the cooling system. If scale is formed, or also if a significant quantity of corrosion products is observed in the water, the engine cooling system should be cleaned. It is recommended that the cooling system be cleaned once per year (preferably in Spring).

It is recommended that scale be removed from the engine cooling system in the following manner. To clean the cooling system, fill the radiator with a solution of approximately 20 grams of industrial Trilon per liter of water. After the truck has been worked for one day (no less than 6-7 hours), the spent solution is drained and the system is filled with a fresh one. Cleaning continues for 4-5 days. After completion of cleaning, the cooling system is filled with a solution of 2 grams of Trilon per liter of water. The system may also be cleaned by adding hexameth (sodium hexamethylphosphate). The dose is 5-6 mg per liter of water.

When flushing the cooling system with water, the sequence of operations is as follows. First flush the cylinder block water jacket and then the radiator separately in the direction opposite water circulation in the engine. The water hoses must be removed to flush the cooling system. Remove the thermostat pipe and take out the thermostat. Install the pipe, after which water at a pressure of 2-3 kg/cm^2 is directed into the thermostat pipe. During this, the drain valves must be open. Flushing must continue until clean water flows from the water pump pipe and the drain valves. After flushing, drain the water from the engine. The radiator is flushed separately. Water under pressure is directed into the bottom pipe of the radiator and flows out through the top pipe. The radiator cap must be closed. After the draining water becomes perfectly clear, install the water hoses connecting the engine to the radiator and close the drain valves.

Before greasing the water pump bearings, it is necessary to clean dust and dirt from the lubricating point and unscrew the plug from the control opening. Grease is inserted with a grease gun through the grease nipple until all the old grease is forced out and fresh grease appears from the control opening (Plate 3-36).

After greasing the bearings, the plug is screwed into its place.

The drive belts of the fan, generator, and compressor, require periodic checking of their tension (Plate 3-37). They must be tight enough so that under a force of 3-4 kg, lateral deflection of the belt does not exceed 10-15 mm for the compressor drive belt and 15-20 mm for the generator drive belt.

Checking the amount of belt deflection is shown in Plate 3-38.

Tightening the generator belt is accomplished by moving the generator, and tightening the compressor belt is accomplished by moving the compressor.

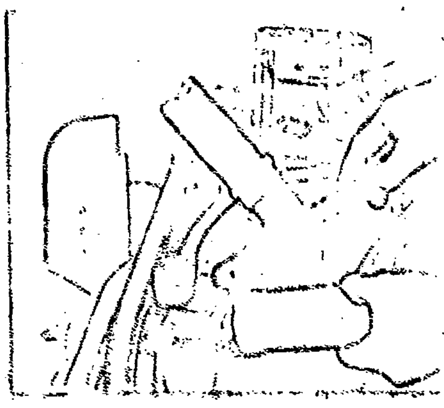


Plate 3-36. Greasing water pump bearings

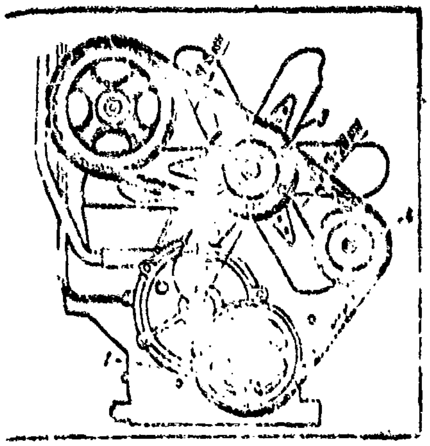


Plate 3-37. Checking drive belt tension:
1) crankshaft pulley 2) compressor pulley 3) water pump pulley 4) generator pulley

Disassembly and Assembly

Removing the power unit

The power unit (engine, clutch, and transmission) is easy to remove if the truck is parked on an inspection pit. This provides the best access to parts underneath. Weight of the power unit is over 0.5 tons, and therefore for its removal it is necessary to use a hoist mechanism with corresponding load capacity and having a height to the hook of no less than 2 meters.

Before removing the power unit, it is necessary to drain the water from the cooling system; it is also desirable to drain the oil from the engine crankcase and from the transmission. It is recommended that small parts removed from the truck be collected in a separate can, and during disconnection of wires, screws and nuts should be screwed into place by hand.

Before removing the power unit from the truck, it is necessary to perform the following preparation tasks:

Remove the hood, together with the hood latch, also disconnecting the electric system wire from the fixtures and transfer blocks;
Disconnect the storage battery, removing the starter wire;
Disconnect the ground cable, unscrewing one cylinder head fastening bolt;
Remove the connecting hoses of the cooling system radiator and heater, and disconnect the oil radiator hoses;
Remove the radiator louvres' drive rod. Free the radiator fastening and remove it together with the jacket, and remove the radiator hanger cushions;
Disconnect the carburetor linkage rod and the throttle and choke cables and remove the throttle return springs;
Unscrew the fastening bolts of the bracket and remove it from the clutch housing;

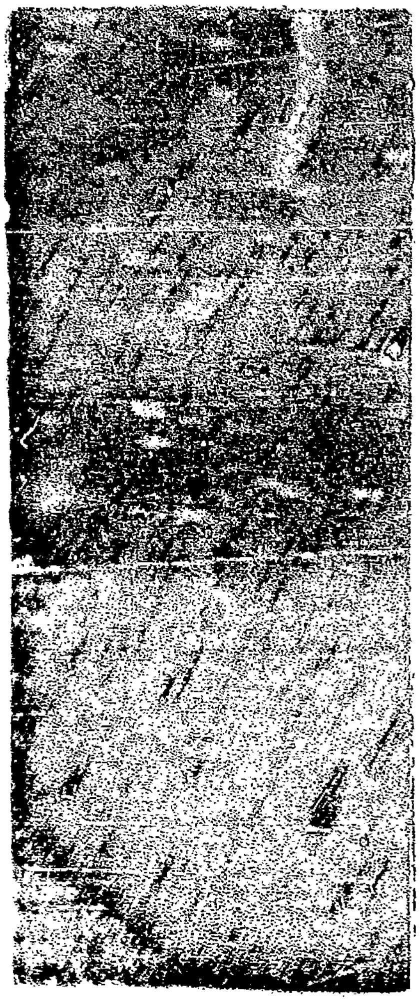


Plate 3-38. Checking and adjusting fan and generator drive belt tension:
a) checking belt tension
b) changing belt tension and tightening nut

Disconnect the fuel line connecting the fuel tank and pump, and the air line running from the compressor head to the pressure regulator and to the air tank;

Disconnect the exhaust collector pipe from the exhaust manifold;

Remove the inspection plate in the cab over the transmission;

Unscrew the transmission cover fastening bolts and remove the cover together with the shift lever;

Cover the transmission with a previously prepared piece of cardboard, fastening it with two or three bolts to prevent foreign objects and dust from falling into the transmission;

Disconnect and remove the handbrake lever, the clutch pedal adjusting rod, and the handbrake drive rod;

Free the bolts of the front motor mounts, of its two rear mounts, and also the engine brace rod fastening;

Unscrew the nuts and disconnect the propellor shaft flange, and unscrew the speedometer drive sleeve;

Disconnect the transfer case control rod. If the truck has a winch, it is necessary to disconnect the universal shaft from the power take-off box and remove its slotted cover.

To remove the power unit from the truck, it is necessary to fasten a 1P-16550 hanger (Plate 3-39) on the extended cylinder head studs, fasten the hook of the hoist installation into the hanger ring, carefully raise the power unit, move it forward and up, and set it on a stand or carriage. Remove the motor mount cushions from the frame cross member.

Engine Disassembly

Before disassembling the engine, it is necessary to clean the dirt and oil from it, wash it with hot water, kerosene, or a degreasing solution, and blow it dry with compressed air.

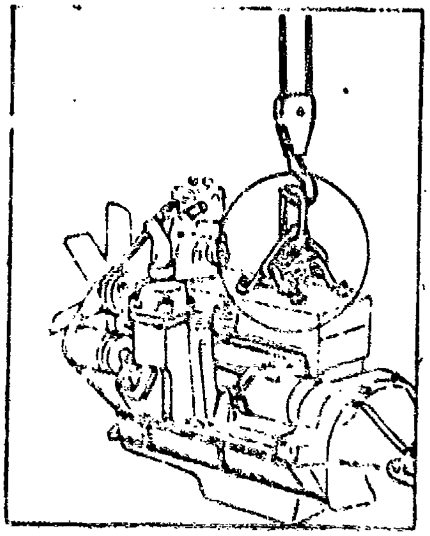


Plate 3-39. Hanger for removing power unit

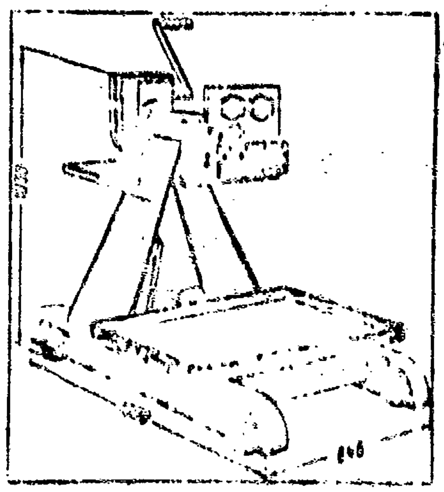


Plate 3-40. Model 2164 portable stand for engine disassembly

A GARO model 2164 portable stand (Plate 3-40) or a carrying stand should be used for engine disassembly. For installing the engine on the stand, it is necessary to remove the oil filter body, and fasten the engine to the stand with bolts screwed into the threaded holes for fastening the filter body.

An engine on the GARO stand may be rotated around a horizontal axis and fixed in any convenient position for its disassembly and assembly. The stand is equipped with wheels. A braking mechanism has been provided for the front wheels of the stand. The rear wheels of the stand are casters. The engine is turned on the stand with a worm reduction gear and manual drive. The maximum force applied to the drive crank is 16 kg.

When using a stand without the moving mechanism for engine disassembly, it is necessary to fasten the engine by its front ears with screw clamps and fix the rear motor mounts to the stand frame with special studs. In this case, it is not necessary to remove the filter body. Rotation of the engine on the stand is accomplished manually around a horizontal axis. The engine may be fixed in a position convenient for its disassembly by an installing pin and a hole in the axle flange. M̶ hanized tools and attachments should be used for engine disassembly.

During engine disassembly, worn-in assembly surfaces of parts capable of future use without repair should be protected. Parts and standards removed from the engine should be placed on a rack or in a prepared can in which they are checked and deficiencies are eliminated after washing so that they may be returned for assembly.

When disassembling an engine which operates on ethylated gasoline, safety measures should be observed.

Engine parts are interchangeable (although some require individual fitting when assembling the parts) and allow their non-individual replacement. Exceptions to this are the connecting rod caps and the main bearing caps. The former are machined in assembly with the connecting rods, and the latter are line bored together with the cylinder block. The connecting rods and their caps during assembly at the plant are stamped with numbers corresponding to their cylinder number, and the main bearing caps are stamped with numbers corresponding to their order in the block. The engine must be disassembled in the following order:

Unscrew the transmission fastening bolts with a box end wrench, separate it from the clutch housing with an assembly spade and, rocking it, remove the transmission with a hanger (Plate 3-41) and drawbar;

Disconnect the plates leading from the air filter to the compressor and to the valve cover, disconnect the brace, unscrew the top wing nut and remove the air filter;

Disconnect the fuel line and the vacuum line to the ignition vacuum advance, free the fastening nuts and remove the carburetor from the engine, and remove the insulating and backing gaskets; when unscrewing the fastening nuts of the fuel lines, it is necessary to use two wrenches to protect them from damage. One of the wrenches prevents the sleeve from turning and the other unscrews the collar nut;

Disconnect the oil lines and water hoses of the compressor, remove the fastening nuts of the compressor and remove it from the engine. When disconnecting the compressor oil lines, it is also necessary to use two wrenches;

Unscrew the bolts fastening the intake and the exhaust manifolds and remove them together with the gasket; the manifold bolts should be unscrewed with a socket wrench (Plate 3-42);

Unscrew the fastening bolt of the ignition coil and remove it;

Before removing the distributor, the tensioning screw (Plate 3-43, a) should be loosened, after which the distributor is removed;

Unscrew the bolts and remove the timing adjustment plate (Plate 3-43, b);

Unscrew the stop screw of the distributor drive shaft (Plate 3-43, c) and remove the shaft from its receptacle (Plate 3-43, d);

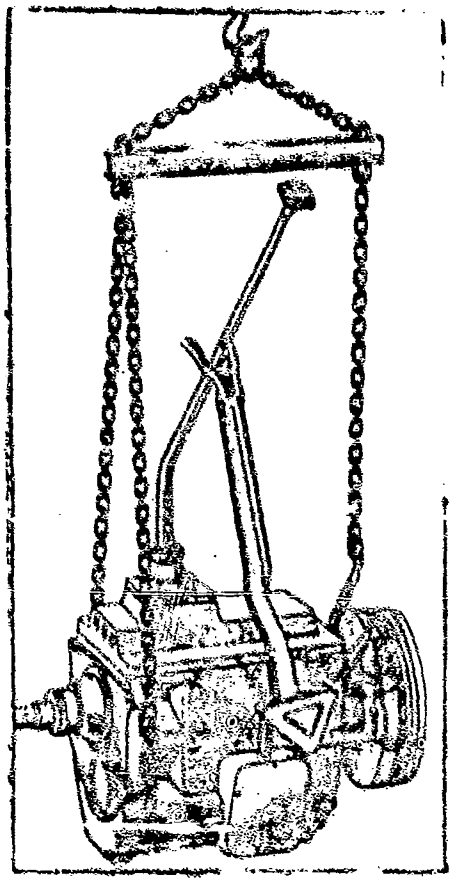


Plate 3-42. Removal of intake and exhaust manifolds

Plate 3-41 (left): Transmission hanger

Unscrew the spark plugs from the cylinder head;
Screw cylinder head removal levers into second and fifth spark plug holes;
Unscrew bolts and nuts of cylinder head fastening studs;
Unscrew bolts fastening the water outlet pipe to the cylinder head;
Remove the pipe with the steam gasket and thermostat;
Unscrew the water connecting pipe to the compressor and the water valve to the heater from the cylinder head;
Remove the cylinder head from the block, attempting to avoid misallignment and damage to the gaskets;
Remove the bolts (Plate 3-44, a) fastening the valve covers, remove both covers with the bolts and ring seals; if the ring gaskets are melted onto the block, they must be carefully separated from the cylinder block surface with a screwdriver or sharp knife;
Unscrew the bolts and remove the oil filter body with its gasket, unscrew the water temperature sending switch and the oil pressure sending switch;
Loosen the plate tension bolt, remove the drive belt from the generator, unscrew the fastening bolts and remove the generator;
Unscrew the fastening nuts of the fuel pump and remove the pump with its gasket;
Unscrew the starter fastening bolts and, moving it from the receptacle in the clutch housing, remove the starter from the engine;
Remove the drive belt from the fan, unscrew the fastening bolts of the fan pump and remove the fan and water pump with its gasket;
For removal of the tappet guiding sections, unscrew the bolts (Plate 3-44, b) fastening each section, and remove the front and rear sections and tappets as assemblies with an assembly spade, shown in Plate 3-44, c;
Mark the valves with a punch or write on each one of them their number according to order; install device 30P-7093 on the cylinder block (Plate 3-44) and, turning the puller screws, compress the valve spring, remove the keys (Plate 3-44,d) and the spring with the valve plate; release the device, remove it from the block, and extract the valve from the valve guide. ...... each valve from the engine in

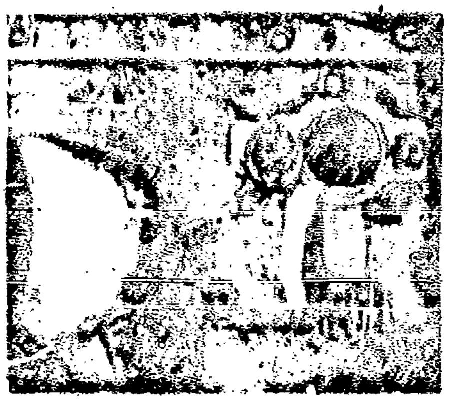


Plate 3-43. Removal of distributor and its drive: a) loosening the tension bolt of the distributor fastening; b) unscrewing timing adjustment plate bolts; c) loosening stop nut and unscrewing fastening bolt of drive shaft; d) removing drive shaft

the same way;

Rotate the engine on the stand ttom side up, remove the bolts fastening the clutch housing cover and move it;

Remove the bolts fastening the oil pan, remove it together with its gasket, separating it with a screwdriver or knife;

To remove the two-section oil pump, it is necessary to unscrew the bolts fastening the two oil lines (Plate 3-45) and the bolts fastening oil pump body, and remove the pump with the gaskets;

To remove the cam gear cover, drive down the ratchet washer, unscrew the ratchet, remove the washer; remove the crankshaft pulley and the front motor mount bracket; the pulley is removed with the two bolts (Plate 3-46, a) intended for fastening the camshaft gear cover, or with a puller (Plate 3-46, b), or with a model 2492 puller, shown in Plate 3-47.

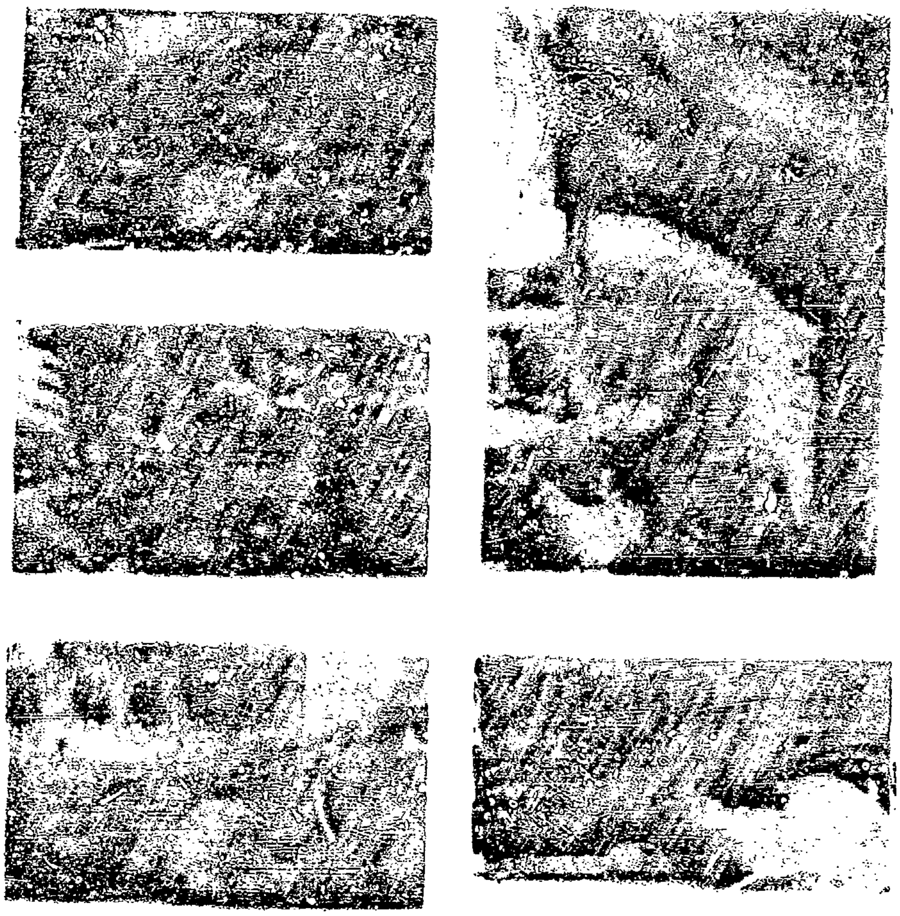


Plate 3-44. Valve removal: a) removal of valve cover fastening bolts; b) removal of tappet guide fastening bolts; c) removal of tappet guide section; d) compression of valve springs e) removal of valve keys, plate, and spring

Plate 3-45. Removal of the oil pump

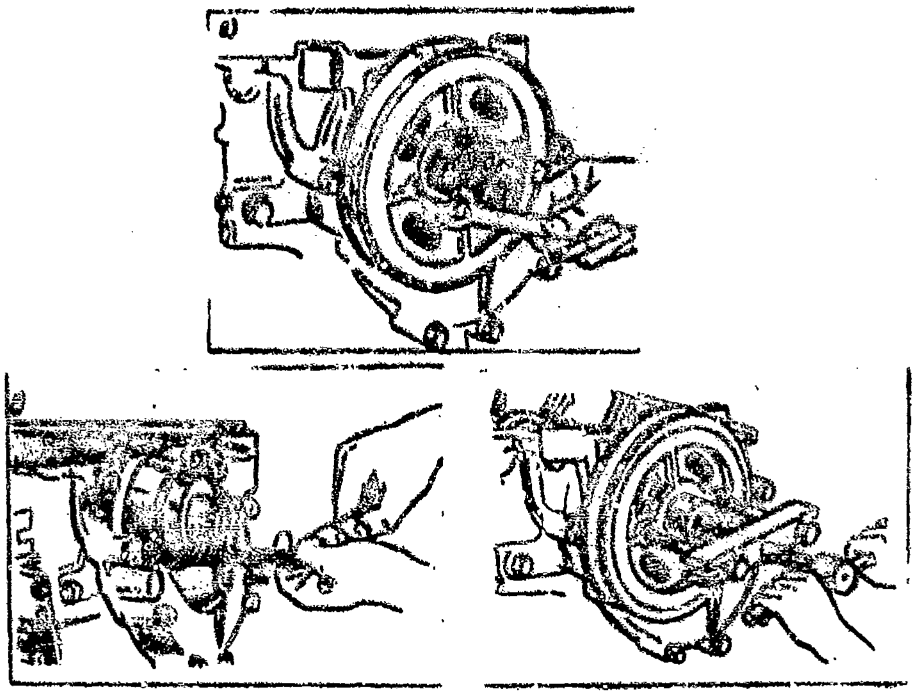


Plate 3-46. Removal of the timing gear cover: a) removal of the crankshaft pulley with pulling bolts; b) removal of the pulley with a puller c) unscrewing the cover fastening bolts

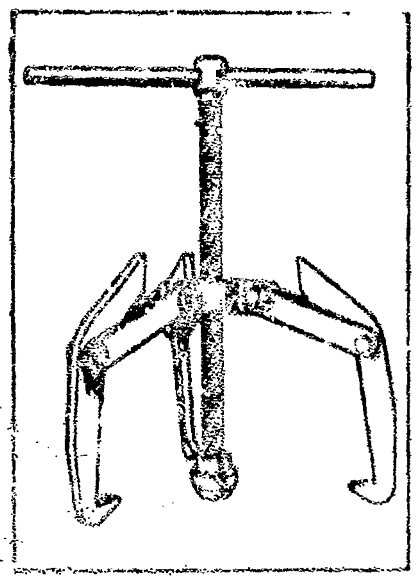


Plate 3-47. Puller for engine crankshaft pulley

Plate 3-48. Withdrawing the piston and connecting rod from the engine cylinder

Unscrew the bolts (see Plate 3-46, c) fastening the cam gear cover, remove the bracket of the engine fastening brace together with the two bolts, remove the camshaft gear cover, trying not to damage the gasket, drive out the crankshaft pulley key, and remove the cover gasket and baffle washer;

Unpin connecting rod nuts with pliers and a screwdriver;

Unscrew the connecting rod cap nuts, remove the caps together with the inserts and gaskets; before removing the caps, it is necessary to check the presence of marks on them indicating the numerical order of their cylinders, and if the marks are absent, mark the cylinder numbers on the caps;

Drive the piston and connecting rod from the cylinder as an assembly; the piston and rod must be driven from the cylinder carefully, observing that the cylinder wall finish is not damaged by the edges of the big end of the connecting rod. A method of drawing the pistons from the cylinders is shown in Plate 3-48;

Before removing the main bearing caps, check for presence of numbers on them, unscrew the cap fastening bolts, and remove the caps and their gaskets;

While removing the rear main bearing cap, it is necessary to use the 60P-1492 puller as shown in Plate 3-49, a. When all main bearing caps have been removed, the number six connecting rod bearing journal is grasped by a special grapple, the hook of the hoist is raised and the shaft is raised (Plate 3-49, b) in assembly with the flywheel and clutch. During removal of the crankshaft, it is necessary to support and guide its free end so as to prevent misalignment. The weight of this assembly is not great, and in the absence of a hoist mechanism, the shaft can be removed by the efforts of two workers. For removal of the inserts from the cylinder block bed, it is necessary to press the insert face from the side opposite its lock (as shown in Plate 3-49, c);

Through the holes in the face of the camshaft gear, unscrew the bolts fastening the support flange to the cylinder block with a socket wrench (Plate 3-50, a) and drive out the camshaft in assembly with its gear (Plate 3-50, b). It is necessary to support the rear end of the camshaft and, besides this, carefully turn it so that the cam lobes do not strike its bearings and the passages in the cylinder block;

The camshaft is driven out in assembly with the camshaft gear and the support flange. The camshaft gear is fitted on the face of the shaft with a maximum clearance of 0.008 mm or a roll clearance of 0.036 mm, and the diameter of the shaft journal at the gear fitting point is 30.015-30.035 mm. Gear rotation on the shaft is prevented by a key, and width of the shaft key way is 5.94525.080 mm with an allowable increase of key way width to a dimension of 6.445-6.990 mm for installation of overhaul dimension keys;

For removal of the gear from the camshaft, it is necessary to bend down the lock washer, unscrew the gear fastening nut (Plate 3-51, a) and remove the locking washer;

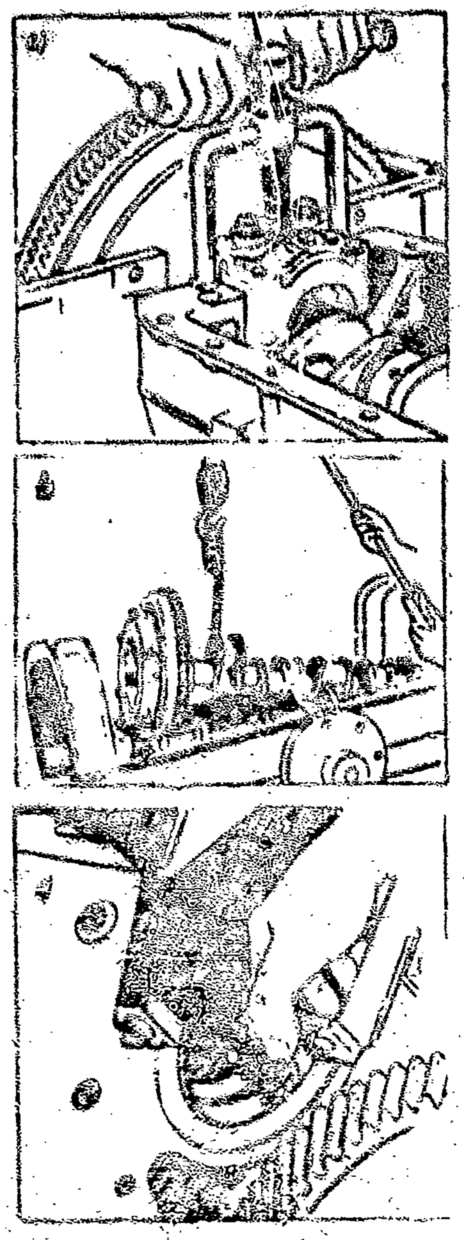


Plate 3-49. Crankshaft removal: a) removing the rear main bearing cap b) removing the crankshaft c) removing the bearing insert

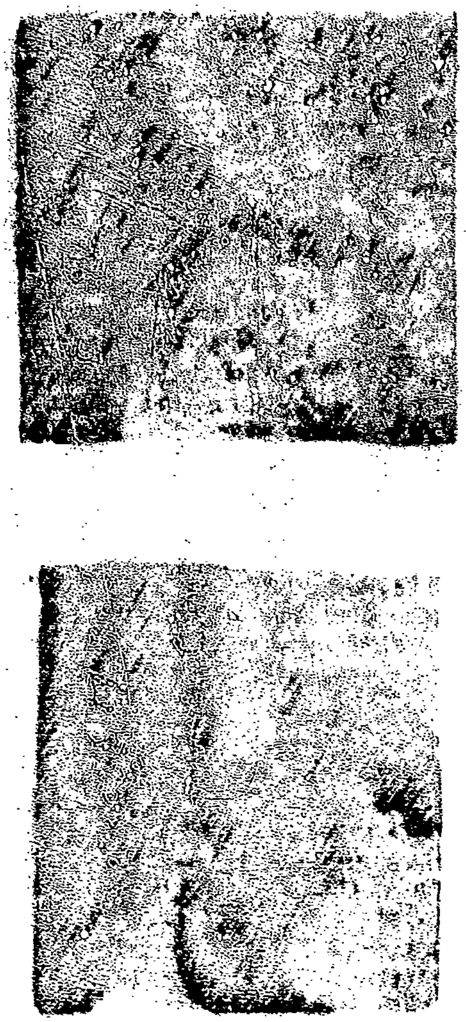


Plate 3-50. Removal of the camshaft: a) unscrewing the support flange fastening bolts b) removing the camshaft

fasten down the camshaft, install puller IOP-7968 on the gear, and pull the gear off (Plate 3-51, b). The gear may be pulled using the attachment shown in Plate 3-51, c, for which the camshaft should be installed in the attachment, fastened in a vise, and the gear pulled off. The flange (Plate 3-51, d) and the spacing ring (Plate 3-51, e) are then removed. The attachment for pulling and pressing the camshaft gear is shown in Plate 3-52;

The hole in the clutch housing is final bored in assembly with the cylinder block, and the clutch housing should therefore not be disconnected from the cylinder block unless necessary. To remove the housing, it is necessary to remove the cylinder block from the stand, free the support clamps, and set it on benches or on a special stand. Unscrew the bolts fastening the housing to the cylinder block with an angular socket wrench and remove the housing.

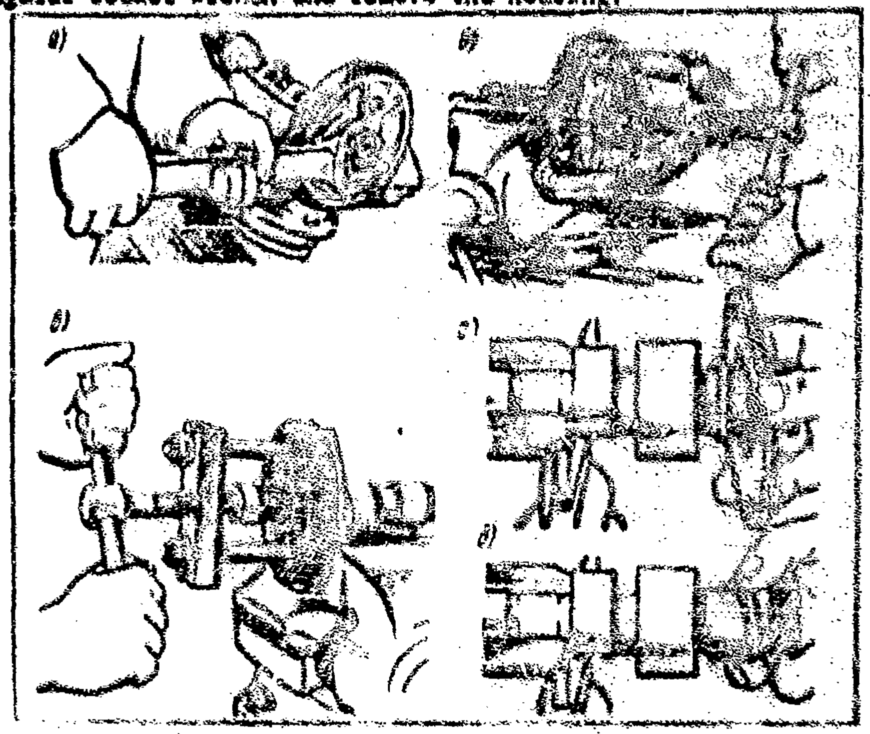


Plate 3-51. Disassembling the camshaft: a) unscrewing the gear fastening nut b) pulling the gear with a puller c) pulling the gear with an attachment d) removing the support flange e) removing the spacing ring

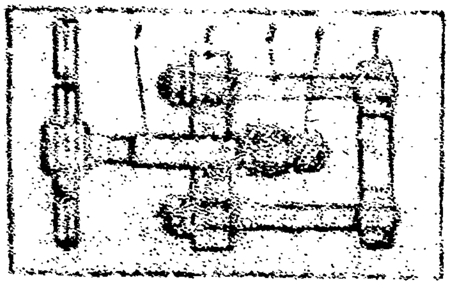


Plate 3-52. Attachment for pulling and pressing the camshaft gear: 1) screw 2) crossbar 3) stud 4) support bushing 5) rim flange

Washing of parts. All parts of the disassembled engine are subjected to cleaning, degreasing, washing, and subsequent checking. Steel and iron engine parts should be washed in a water solution with a concentration of 1.5-2% soda and an additive of 0.2-0.3% sodium nitrate. For washing aluminum parts, a water solution of 1% triethanolamine or pure hot water is used.

After washing, the parts should be dried by blowing them off with compressed air. In that compressed air usually contains water particles, it is recommended that a moisture separator be installed in the compressed air system. Linen cloths are recommended for use in rubbing the parts dry. Use of textile ends is not recommended, in that during their use for parts drying, lint and threads will remain on the parts and will move into the oil passages, clogging them.

The passages should be blown out with compressed air. If the passages are blocked, they must be cleaned out with a metal rod or shaft.

Disassembly and Assembly of Engine Components

The piston and connecting rod. For disassembly, it is recommended that the connecting rod in assembly with the piston be held in a vise and, using attachment 209-7925 (Plate 3-53, a) remove the piston rings, draw out the piston wrist pin, lock rings with smooth-jaw pliers (Plate 3-53, b), press out the wrist pin and remove the piston from the connecting rod. Check the condition of the connecting rod small end bushing.

Before assembly with the piston, the connecting rod and its insert must be fitted to the crankshaft journal, the piston to the cylinder, the rings to the piston grooves and the cylinder, and the wrist pin to the connecting rod small end and the piston holes.

The pistons must be assembled in a cylinder block at a temperature of 10-30°C so that the clearance between the cylinder walls and the piston skirt is within the limits of 0.08-0.10 mm. The size of the clearance is determined with a leaf gauge (Plate 3-54) 0.10 mm thick, 13 mm wide, and no less than 200 mm long. The leaf gauge is drawn into the clearance between the piston and the cylinder with a force of 2.25-3.65 kg. During assembly it is recommended that the piston be installed in the cylinder with its head down, and the leaf gauge must be located on the side opposite the notches in the piston skirt.

After assembling the piston in the cylinder, it is necessary to stamp its cylinder number on the head.

For assembly with the connecting rod, the piston is heated in a water bath or in an electric heating device (Plate 3-55) to a temperature of 75°C. The wrist pin must go into the hole in the face plate of a heated piston smoothly, with the force of a thumb, and the same is true of the hole in the small end of the connecting rod (Plate 3-56).

Plate 3-53. Disassembly of a piston and connecting rod: a) removal of the piston rings b) removal of wrist pin stop rings

Match the cylinder number of the piston and connecting rod.

The connecting rod is grasped in a vise, the piston is mounted on it, and they are connected by insertion of the wrist pin.

The piston must be assembled with the connecting rod in a position so that the arrow stamp on the piston head is aimed toward the stamped boss (mark) on the connecting rod. In this way, the oil-throwing holes in the big end of the connecting rod are directed to the side opposite the grooves in the piston.

After assembling and checking the piston with the connecting rod, it is necessary to install the stop rings in the piston bosses.

Carefully stretch the piston rings, selected according to groove and fitted to the cylinders, and install them on the pistons with a device.

Cleaning coke from the grooves of a piston which has been used is done with a device (Plate 3-57). Coke must be removed precisely and carefully, so as not to damage the groove surface. Coke is removed from the oil exhaust holes with a drill (3 mm in diameter).

Plate 3-54. Fitting pistons according to cylinders with a leaf gauge and dynamometer

Plate 3-56. Fitting a wrist pin to the diameter of the connecting rod bushing

Plate 3-55. Heating pistons in an electric heating device

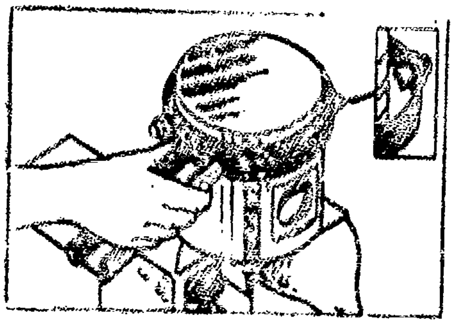


Plate 3-57. Cleaning coke from the piston grooves

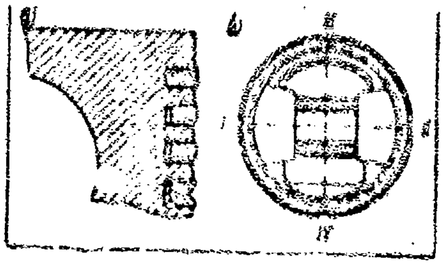


Plate 3-59. Piston ring installation on the piston a) piston ring b) ring gap placement

The schematic of piston ring installation and position of the ring spaces on the piston is shown in Plate 3-58. Clearances in the ring locks after installation in the cylinder for new rings must be: for the top ring, 0.25-0.60 mm; for the bottom ring, 0.25-0.45 mm; for the oil ring, 0.15-0. 5 mm.

Clearance in the piston ring lock is adjusted with a small-grained file.

Clearance is checked with a leaf gauge when the ring is installed in the cylinder (Plate 3-59) or with a calibrating ring (Plate 3-60).

Plate 3-59. Checking piston ring lock clearance in cylinder block

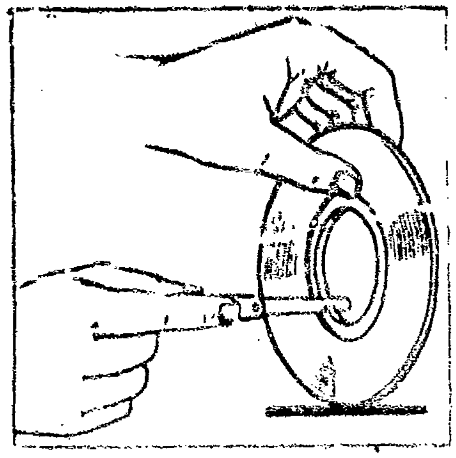


Plate 3-60. Checking piston ring lock clearance with a gauge

Clearance and piston ring height between the ring and the groove of a new piston must be 0.035-0.072 mm for the compression rings, and 0.035-0.080 mm for the oil rings. The clearance is checked with a gauge (Plate 3-61). The rings are fitted to the piston grooves in the process of rubbing, using small-grained emery paper. Rings installed in the piston grooves must move freely.

During removal and installation of the rings, it is convenient to use the 20P-7985 device (see Plate 3-53, a).

Ring elasticity is checked on a device (Plate 3-62) using an elastic band. The amount of compression force for new compression and oil rings must be no less than 2.15 kg.

The connecting rod bottom end is machined in assembly with its cap, and therefore during disassembly, checking, and assembly, the rod and cap should be kept as a unit. Connecting rod bearing caps are centered along ground surfaces of tension bolts. It is also not recommended to switch connecting rod

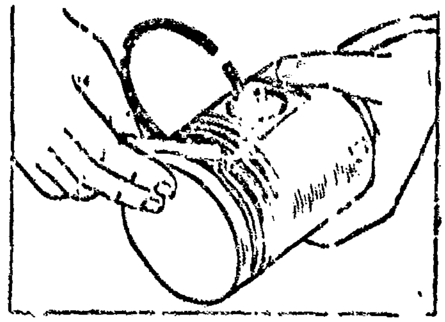


Plate 3-61. Checking clearance between ring and piston groove

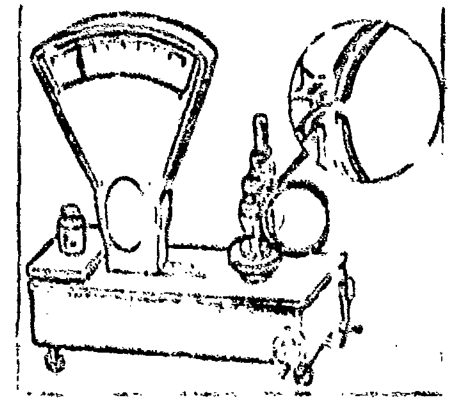


Plate 3-62. Checking piston ring elasticity on a device

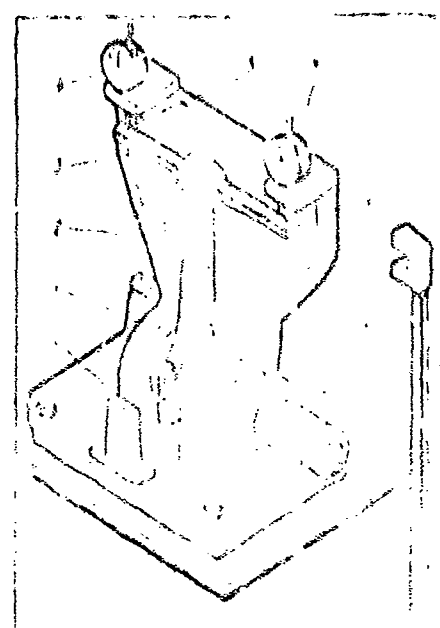


Plate 3-63. Device for checking alignment of top and bottom connecting rod ends and straightening the rod: 1) body 2) connecting rod 3) mandrel for rod top end 4) indicators 5) index projections 6) wrench 7) mandrel for rod bottom end 8) support

assemblies between engines, because they are selected and assembled at the manufacturing plant according to weight within the limits of 1440-1560 grams. In selection of new rods for assembly, they should also be chosen according to weight. Weight adjustment is performed by means of removing metal from the tail portion of the rod cap with a special tool.

During operation of the engine, the connecting rod is subjected to bending and twisting. Non-parallelness of the axes of the top and bottom connecting rod ends is not allowed to be greater than 0.04 mm, and deviation from their position in one plane (twisting) must be no greater than 0.06 mm on a length of 100 mm.

Checking for bending and twisting takes place on a device (Plate 3-63). When checking, the mandrel 3 is inserted in the bushing of the top end of the checked connecting rod, and in the bottom end of the rod is installed mandrel 7 (without inserts) with the simultaneous installation of the rod and mandrel in the attachment. After this, rotating the rod on mandrel 7, it, together with mandrel 3, is pressed against the projections 5. The rod is considered usable if both ends of mandrel 3 and the top end of the rod are pressed against the reference projections 5 and the indicators do not show deviation. Connecting rods having a deviation in axial parallelness no greater than 0.10 mm and deviation in axial twist no greater than 0.20 mm are allowed to be corrected.

Connecting rod correction takes place, without removing it from the device, with wrench 6, or grasping the connecting rod in a device (Plate 3-64). It is recommended that rod twist be corrected by first twisting it somewhat more than required to eliminate the deformation, and then twisting it in the opposite direction until the axes of the rod holes become parallel. This method of correction increases connecting rod resistance to deformation during its future use in an engine. Correction of a bent connecting rod may be performed on a hand press.

Disassembly of the crankshaft, flywheel, and clutch. The crankshaft is balanced in assembly with the flywheel and clutch. The allowable imbalance is no more than 150 gram cm. Disbalance of the flywheel and clutch may be eliminated by drilling holes 15 mm in diameter and no more than 25 mm in depth on the interior side of the flywheel at a radius of 184 mm.

Distance between the holes must be no less than 20 mm.

In order to maintain the balance of the crankshaft, flywheel, and clutch in assembly, it is recommended that marks be placed on the assembled parts before removal of the clutch from the flywheel, to be used as reference when reassembling the unit.

Removal of the clutch from the flywheel. Mark the relative position of the clutch jacket on the flywheel, note the installation position of the balancing washers on the clutch cover, unscrew the clutch cover fastening bolts with a socket wrench, remove the pressure plate in assembly with the cover and clutch disengaging levers, and remove the clutch disk in assembly.

Flywheel removal. Unpin the flywheel fastening nuts, unscrew them with an angular socket wrench (Plate 3-65), remove the flywheel, and drive the bolts out of the crankshaft flange. The flywheel diameter under the ring is 395.055-395.067 mm. The internal dimension of the flywheel ring is 394.700-395.025 mm. The ring can be removed from the flywheel only with a press. To fit a new ring, it must be heated to a temperature of 300-400°C, after which the ring is installed on the flywheel.

The flywheel is statically balanced in assembly with the ring. Allowable imbalance is no more than 100 gram cm.

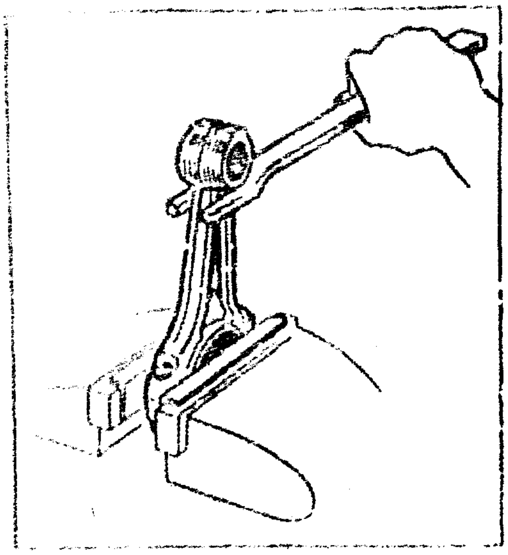


Plate 3-64. Connecting rod connection

Plate 3-65. Removal of flywheel from crankshaft

The surface of the flywheel which is assembled with the clutch disk is ground and polished. If marks or scoring appear on the working surface of the flywheel, grinding or turning of the flywheel surface is allowed to a dimension of 47 mm. The flywheel is fitted onto the crankshaft flange on six non-symetrically positioned bolts. If the fastening bolt holes are worn to more than the allowable dimensions, the flywheel must be replaced with a new one.

If the threads in the holes for fastening the clutch pressure plate are worn or damaged, new holes may be drilled between the old ones and tapped with a thread M 10 X 1.5. The diameter of the circumference on which these holes are drilled is 381 mm.

In the process of the engine's operation, the flywheel ring teeth are worn from the face in the places where they are engaged by the starter gear. If wear is present along the length of the teeth within the limits of up to 5 mm, the ring teeth should be accurately rounded off with a file. For wear over 5 mm, the ring should be removed and pressed on in a reversed position.

If the front bearing of the transmission drive shaft must be changed, it should be pulled out before removal of the flywheel, using puller 2-K-109 (Plate 3-66) or a crank puller (Plate 3-67).

Pulling the gear from the crankshaft journal is done with puller 1P-21305 (Plate 3-68).

A crankshaft going into repair must be checked for absence of bending. The amount of bend must not exceed 0.05 mm. Checking of the shaft for bend is done with an indicator, with the shaft set on supports on its end main bearing faces (Plate 3-69). If the shaft is bent, it may be corrected on a hand press. For correcting the crankshaft, it must be installed on supports by the end main bearing faces (Plate 3-70) and corrected with the hand press until bend is eliminated, checking this with an indicator.

All oil passages in the shaft must be carefully cleaned of oil coking products and other contamination. It is recommended that passage cleaning be done with a metal jag wire followed by blowing out with air.

Assembly of the crankshaft, flywheel, and clutch. For assembly of the crankshaft, it is necessary to fit two supporting collars on the first main bearing surface, insert the key into the keyway, and press on the crankshaft gear.

Plate 3-66. Pulling the trans-mission drive shaft bearing

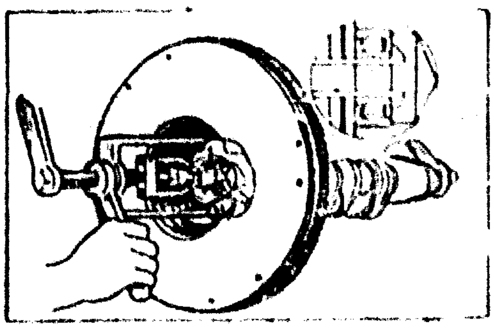


Plate 3-67. Pulling the trans-mission drive shaft bearing with a crank puller

Pulte 3-68. Pulling the gear from the crankshaft

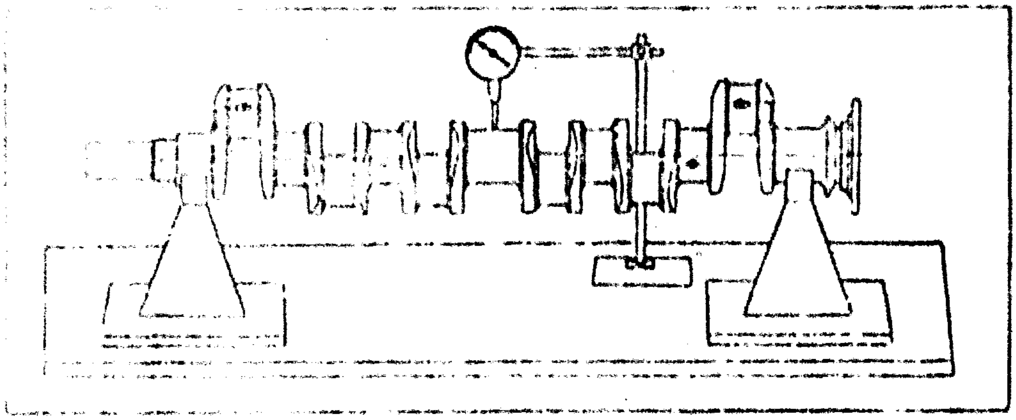


Plate 3-69. Checking the crankshaft for bend

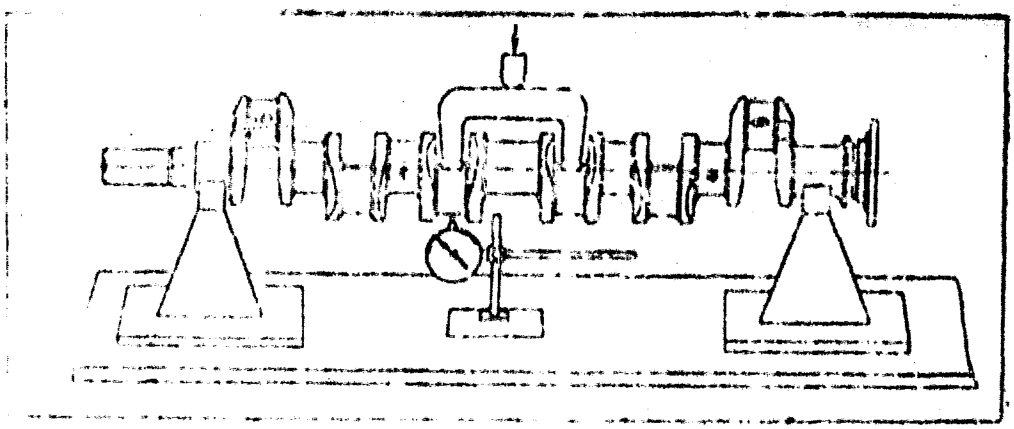


Plate 3-70. Correcting a bent crankshaft

The shaft with the flywheel is set on [illegible]igs (Plate 3-71) and the working surface of the flywheel is checked for oscillation with an indicator. No more than 0.15 mm oscillation is allowed on a radius of 150 mm. Cotter keys are inserted in the flywheel fastening nuts. The cotter keys of each bolt must lie tightly against the bolt face.

Lubricate the bearing cavity in the crankshaft flange with i-13s grease and press the bearing for the front end of the transmission drive shaft into it. Screw in the lubricator for bearing lubrication. Check to see that grease from the lubricator reaches the bearing.

Using the transmission drive shaft for a mandrel, install a new clutch disk in its place. Install the clutch cover assembly on the flywheel and fasten it with the bolts. Torque moment on the bolts must be 3-4 kg meters (assembly and adjustment of the clutch is presented in Chapter 6, "The Clutch").

During installation of the clutch on the flywheel, the markings made during disassembly of the clutch must be adhered to, so that the crankshaft balance remains as before. If this condition is violated, it is necessary to balance the crankshaft in assembly with the flywheel and clutch.

Dynamic balancing takes place on a special machine. Static balancing of the flywheel in assembly may be performed on balancing knives. When installed on the knives, the shaft must not spontaneously rotate when set in any position. The method of eliminating imbalance was presented above.

It is recommended that disassembly of the oil pump be conducted in the following order.

Wash the assembled pump in a degreasing solution, pull out the pin holding the oil pickup with pliers, and remove it from the pump line. Unscrew the bolts fastening the oil exhaust pipe, disconnect it, and remove the gasket. Unscrew the reduction valve plug and pull out the spring and plunger.

For two-sectioned pumps: unscrew the bolts fastening the pickup line of the top and bottom sections and disconnect them with the gaskets. Unscrew the by-pass valve plug, and remove the spring and ball. Unscrew the bolts fastening the body of the bottom section and remove it from the top body in assembly with the axle and driven gear of the bottom section, and also carefully remove the regulating gasket.

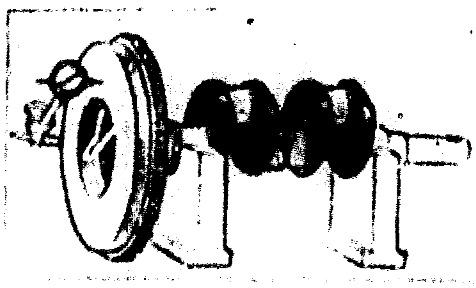


Plate 3-71. Checking oscillation of flywheel working surface

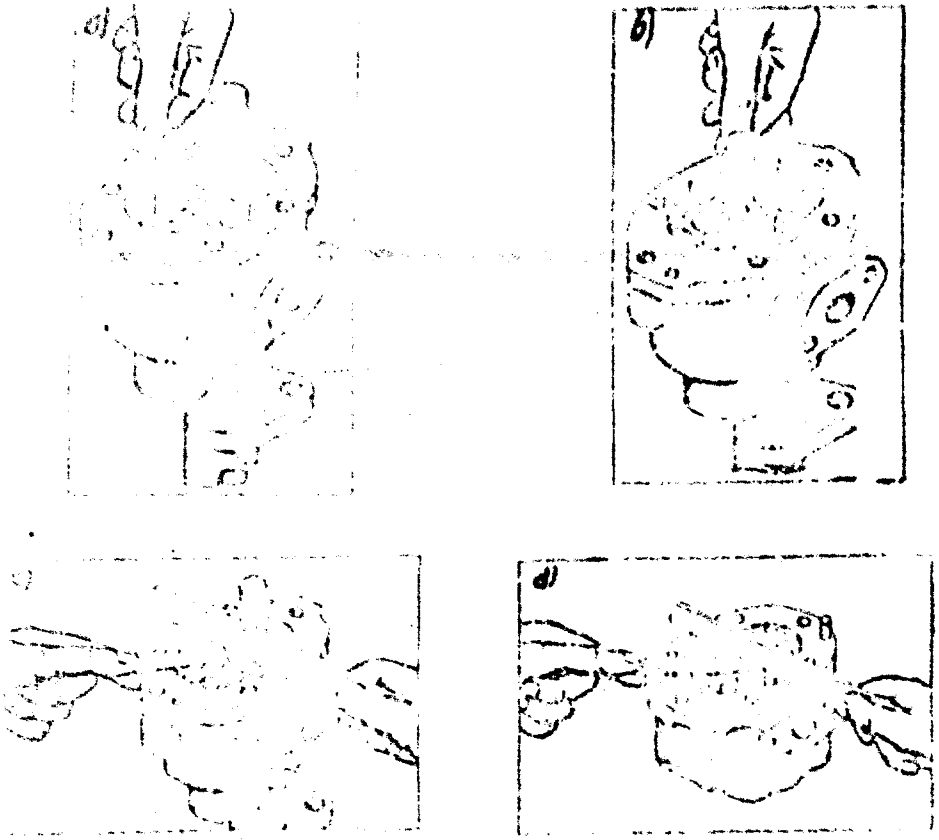


Plate 3-72. Checking clearances in an oil pump with the gauge and straightedge:
a) checking clearance between gear teeth and body walls
b) checking clearance in gear teeth engagement
c) checking clearance between top section gear faces and intermediate cover d) checking clearance between bottom section gear faces and intermediate cover

To draw the drive shaft with its gear from the body, it is necessary to: for a single-section pump, knock out the pin, pull the pump drive gear, and withdraw the shaft in assembly with the gear; for a two-section pump, having removed this drive gear, draw out the drive gear and intermediate cover together with the shaft.

To press off the shaft of the driven gear, it is necessary to stand the top body of a one-section or two-section pump, and also the body of the bottom section of a two-section pump on the gaskets and press out the shafts.

For removal of the drive gear, it is necessary to: for a one-section pump, install the shaft in the device or a vise and pry up the lock ring with a screwdriver, press the drive gear from the shaft, and pry the key from the key way; for a two-section pump, besides this, move the top section drive gear upward along the shaft, remove the lock ring and press off the bottom section gear, pry the key from the shaft key way, remove the intermediate cover, and press off the top section gear and pry out the second key.

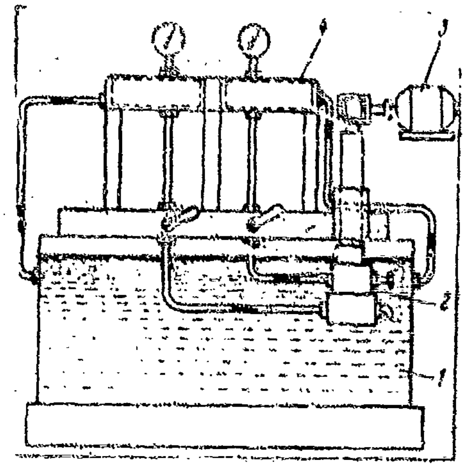


Plate 3-73. Schematic of stand for testing oil pumps:
1) oil bath 2) tested pump 3) electric motor 4) stand chamber

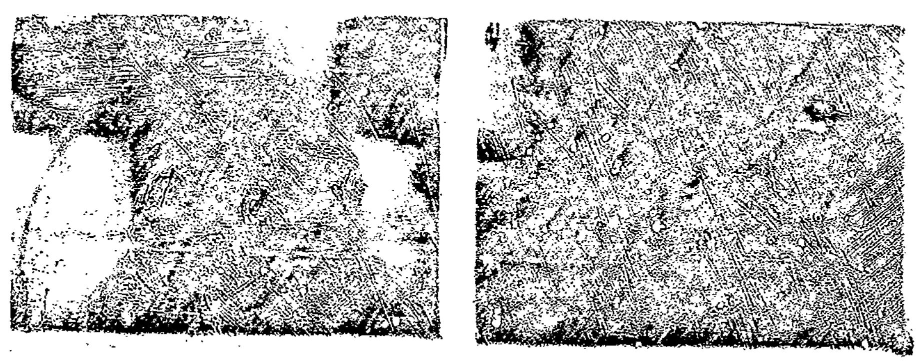


Plate 3-74. Disassembly of oil filters: a) removal of fine cleaning filter element b) removal of coarse cleaning filter

The parts, cleaned of oil residue and washed out in kerosene, must freely move in the body of the reduction valve.

The reduction valve spring must have the following dimensions: length in free state, 72 mm; under load of 3.2-3.5 kg, 57 mm. The spring of the bottom section by-pass valve of the pump must have the following dimensions: length in the free state, 35 mm; under load of 1.7-2.1 kg, 32 mm. Working pressure of the by-pass valve is 1.2-1.5 kg/cm^2.

Assembly of the pump takes place in the opposite sequence to its disassembly. The parts going for assembly must have been carefully washed out. It is desirable that all paper gaskets be replaced with new ones. Oil pump parts must be washed in a degreasing solution, and their usability must be checked.

During assembly of the pump, it is necessary to pay attention to the following: the shaft of the driven gear must sit in the body with a roll clearance of 0.10-0.052 mm. The pump drive gear must be fitted on the drive shaft with a clearance of 0.014 mm or a roll clearance of 0.025 mm. The pump drive gear pin must be carefully flattened on both ends. Clearance between the body face and the drive gear must be 0.3-0.5 mm.

During installation of the gear in the pump body, it is necessary to measure the clearance between the gear teeth and the walls of the pump receptacle with a gauge. This clearance must be within the limits of 0.025-0.275 mm (Plate 3-72, a). The clearance in gear engagement must be within the limits of 0.150-0.550 mm (Plate 3-72, b). The clearance between the gear faces and the intermediate cover of the body must be within the limits of 0.10-0.25 mm (Plate 3-72, c and d).

The pump drive shaft, installed in the body, must rotate freely by hand without binding after the bolts are tightened. Clearance between the pump gear faces and the cover is adjusted with the gaskets. In case of binding, add gaskets

The oil pickup, hanging on the pipe, must freely roll on its shaft, and the pin must be spread so that it cannot fall out. It is recommended that the assembled pump be checked. The schematic of a stand for checking pumps is shown in Plate 3-73.

Checking of the pressure developed by a pump takes place in liquid petrolatum T (GOST 1840-51) with the latter at a temperature of 18-20°C. Pressure at 675 pump revolutions per minute must be no less than 2.5 kg/cm^2 for the upper section and no less than 0.9 kg/cm^2 for the lower section. The reduction valve must open at a pressure of 3-4 kg/cm^2, and the by-passed valve in the lower section must open at a pressure of 1.2-1.5 kg/cm^2.

Disassembly of the oil filter body. For disassembly, it is necessary to install the filter body in a device or a vise, unscrew the bolts fastening the cover, and remove the cover and gasket. Remove the top spring compressing the changeable filter element. Pull the fine cleaning filter element from the body (Plate 3-74, a), and remove the bottom compressing spring.

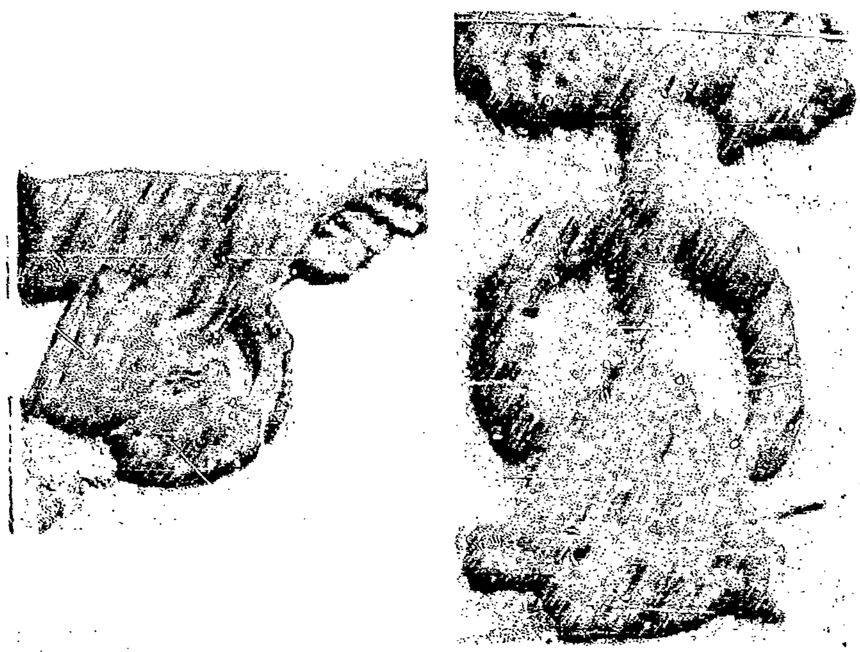


Plate 3-75. Pulley removal:
a) unscrewing the nut b) pressing off the pulley with a puller

Unscrew the bolts fastening the coarse cleaning filter element, pull out the element in assembly (Plate 3-74, b), and remove the gasket. Unscrew plug 3 (Plate 3-21) of the by-pass valve together with the backing ring, and draw out spring 5 and bolt 6.

Disassembly of the coarse cleaning filter elem...t is performed in case of damage to the blades or heavy dirtying.

Assembly of the oil filter body takes place in the reverse sequence. The parts are carefully cleaned and the fine cleaning element and paper gaskets are changed. The coarse handle must be easily turnable by hand. The moment of rotation must be no more than 0.4 kg meters. The by-pass valve has a length in free state of 52 mm, and under a load of 0.9-1.1 kg, its length is 44 mm.

The body cover bolts must be tightened (tightening torque 9-12 kg meters) sequentially, so as not to damage the cover flange. The assembled filter is checked for tightness under pressure of 6 kg/cm^2 for a period of one minute.

Check operation of the by-pass valve, which must open under pressure of 1.0 kg/cm^2.

It is recommended that the water pump be disassembled in the following order.

Unscrew the bolts fastening the cap and remove the cap and gask... Unscrew the lubrication fitting from the body. Unscrew the bolts fastening the pump cover and remove the cover and gasket.

Unpin the nut fastening the pulley and unscrew it, holding the shaft by its blade to prevent rotation. Plate 3-75, a, shows how to hold the shaft to prevent rotation. Remove the pump shaft pulley with a press or with a 20P-7968 puller with a 20K-97-1 cap (Plate 3-75, b). Unscrew the water pump cap.

Remove the bearing lock ring with pliers (Plate 3-76, a). Remove the conic bushing (Plate 3-76, b) and key. Press off the water pump shaft in assembly with the vane and packing (Plate 3-77, a). Press the bearing out of the pump body (Plate 3-77, b) with a press, and drive out the water-throwing washer.

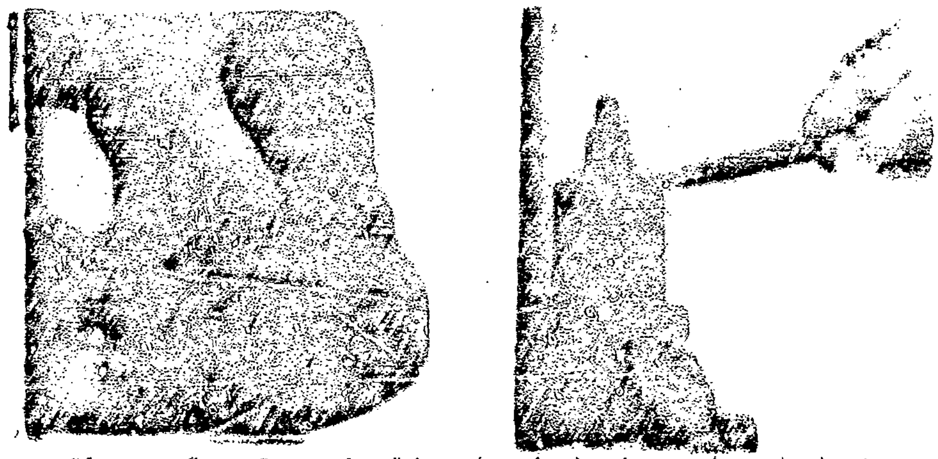


Plate 3-76. Removal of bearing lock ring and conic bushing:
a) removal of ring b) removal of conic bushing

To disassemble the seal from the vanes, it is necessary to remove the spring ring of the water-throwing washer and the lock ring of the seal from the shaft, then remove the textolite support washer, the rubber collar (gland), the gland compression ring, the compression spring, and the gland support ring.

When changing the vanes, drive out the vane fastening pin and press it from the shaft. If the bearings and parts of the seal assembly (support washer and collar) are worn, they should be replaced with new ones. The support washer is manufactured of graphitized textolite.

When changing the parts of the packing unit, it is necessary to remove the pump cover, press shaft 1 (see Plate 3-29) in assembly with vanes 15 and the glands out of the body, replace the worn parts of the packing unit, and assemble the pump.

Assembly of the water pump is conducted in the following sequence: assemble the seal and vanes on the shaft, for which the vanes should be pressed on and fastened with a pin; fit the support rim, compressing spring, compressing rim, rubber collar, and textolite support washer on the shaft in order; fasten the seal with the lock ring and fit the spring ring for the water-throwing washer on the shaft, setting it the ring groove of the shaft.

Insert the shaft in the pump body, fit the water-throwing washer on the shaft, and press on the rear bearing; screw the grease fitting into the body and fill the pump body hollow with 1-13c grease, install the spacing bushing, press on the front bearing the same as the rear one, fasten the bearing with the lock ring (see Plate 3-76, a), after which the shaft must rotate freely in the bearings.

Install the cover and gasket on the pump body and fasten it with bolts, set the key in the shaft key way, install the conic bushing, install two more bolts for fastening the pump to the engine in holes in the body, mount the generator tensioning bar on one of the bolts, install the pulley and set it in its place, screwing on the pulley fastening nut; if a stamped pulley is used, the boss is fastened onto the conic bushing; pin the pulley nut, install the cap on the body with a gasket and fasten it with bolts.

For disassembling the radiator from its housing, it is necessary to unscrew the nuts fastening the radiator housing to the sides of the diffuser and remove the housing from the radiator.

Unscrew the bolts and nuts fastening the diffuser, sides, and louvres, and then disconnect the parts.

During disassembly of a radiator on which an oil radiator is installed, it

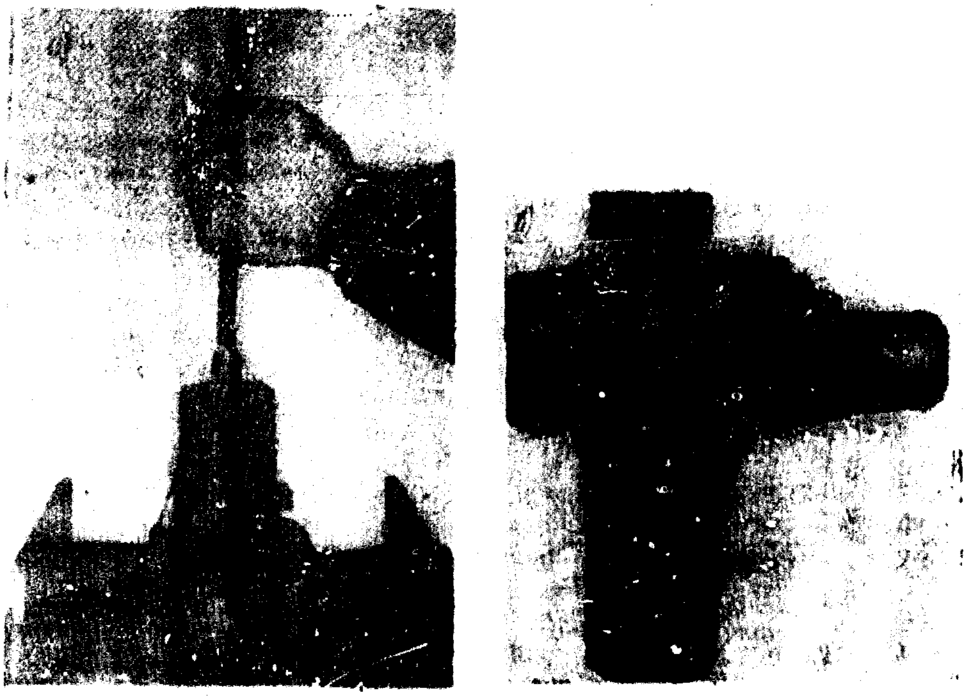


Plate 3-77. Pressing out water pump parts: a) shaft
b) bearings

is necessary to unscrew the bolts fastening the oil radiator to the two brackets which are welded to the louvre frame and disconnect the oil radiator.

Assembly of the unit takes place in the reverse order.

Assembly of the engine

It is recommended that engine assembly take place on a rotating stand without the moving installation or on a model 2164 GARO stand with a moving installation (see Plate 3-40).

All parts and components going into assembly are carefully washed and checked for usability in assembly. Assembled parts must be selected and fitted, and if necessary, assembled with specific parts. Methods of fitting assembled parts are presented in corresponding sections touching on each part or component.

The cylinder block, either new or rebuilt, goes into assembly complete with camshaft bushings, valve guides, and clutch housing. All oil passages in the engine must be cleaned out and blown out with compressed air.

Before assembly, the cylinder block should be fastened on the stand, turning its crankcase separation plane upward. The main bearing caps are bored together with the cylinder block, and are therefore not interchangeable. Boring takes place with gaskets, 0.05 mm thick, installed in the cap butt joints. The caps of the middle and rear bearings are fastened with four bolts, and the caps of the remaining bearings are fastened with two bolts each. The holes for fastening the main bearing caps are symmetrical in relation to the crankshaft axis.

The main bearing caps are centered in slots in the block along the sides. These slots are positioned non-symmetrically, eliminating possiblity of incorrect installation. The nominal dimension of the main bearing insert beds is 70.50-70.53 mm. Total difference in hole axiality must not exceed 0.04 mm and deviation between the axes of two adjoining holes must not exceed 0.0 mm.

Crankshaft installation. Remove the main bearing caps, rub the beds in the cylinder block and in the caps under the inserts with a cloth, and blow the cylinder block out with compressed air. Install the selected inserts in the main bearing beds. Check coincidence of the oil passages.

Insert the rim with the 7th bearing packing glands in the slot in the block and in the slot in the cap (Plate 3-78), and also insert the rubber seals of the rear bearing face in their receptacles (Plate 3-79). Install inserts in beds in the main bearing caps. Check the crankshaft in assembly with the flywheel, clutch, camshaft gear, and support collars, set it in a convenient position, blow out the oil passages with compressed air and rub the main faces of the shaft with a cloth.

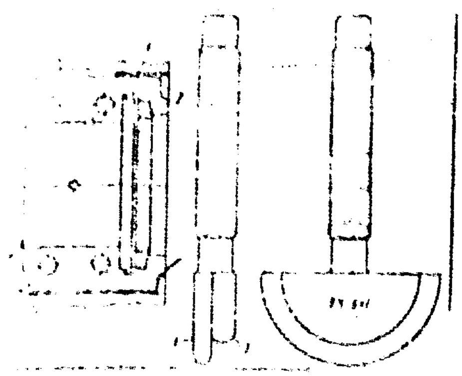


Plate 3-78. Installation of the rear main bearing seal in a cylinder block: 1) seal rim 2) graphite-asbestos seal 3) small projection of semi-circular mandrel 4) large projection of semi-circular mandrel 5) cylinder block

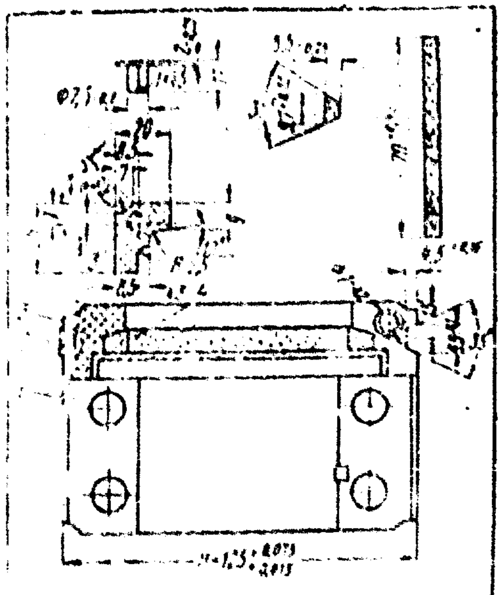


Plate 3-79 Rear main bearing seal: 1) rear bearing cap 2) wooden seal 3) rubber seal 4) graphite-asbestos gland

Lubricate the surfaces of the upper inserts with clean engine oil and lay in the crankshaft (see Plate 3-49, b). Lay the 0.05 mm thick brass inserts in the cap butt joints. Lubricate the surfaces of the bottom inserts and main faces of the shaft with oil. Install the main bearing caps in their places. The side surfaces of the caps which have the numbers must be directed toward the camshaft side of the engine.

Install the bolts with spring washers, and, screwing them in at first by hand, finally tighten them with an angular socket wrench. It is recommended that the middle and rear caps be tightened diagonally.

Check main bearing bolt tightness with a torque wrench. Tightening torque must be 8-10 kg meters for the middle and rear bearings, and 11-13 kg meters for the remaining bearings.

The front crankshaft bearing has support rings (Plate 3-80) made of a bimetallic band on each of its sides to absorb axial stresses arising during operation of the shaft. The support rings, which have sides cast of an anti-friction alloy, are for the front support ring on the side of the camshaft gear, and the rear one on the side of the crankshaft. The total clearance between the support ring and the crankshaft journal, and also between the support ring and the camshaft gear is set within the limits of 0.05-0.23 mm. The means of measuring axial clearance is shown in Plate 3-81. Clearance between jig faces and the faces of the remaining main bearings must be no less than 0.75 mm.

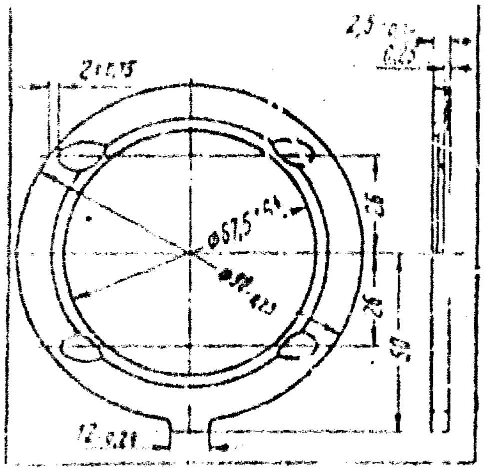


Plate 3-80. Crankshaft support ring

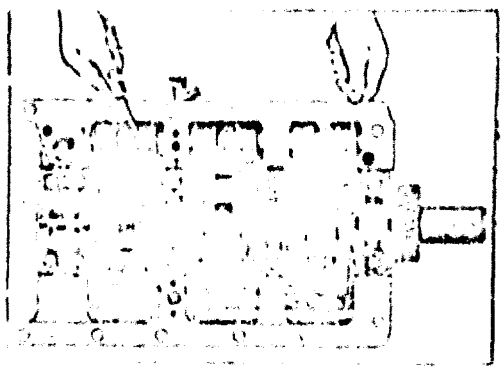


Plate 3-81. Checking crankshaft axial clearance

Support rings (front and rear) are produced with a thickness within the limits of 2.46-2.50 mm. The rear support ring is produced with a repair thickness dimension within the limits of 2.66-2.70 mm, which is set with ring weawhen crankshaft slack is greater than 0.23 mm.

Check ease of rotation of the crankshaft. The moment of shaft rotation must be no greater than 7.0 kg meters.

Wet the wooden seals in oil, insert them in the vertical slots of the rear main bearing cap, press them to the end with a mallet, and then smooth off the projecting faces of the seal flush with the separation plane of the cylinder block.

Sealing the crankshaft. To eliminate oil leakage from the front end of the crankshaft, a rubber casing type gland is installed on the front end of the crankshaft.

A spiral oil-moving passage is located near the rear main bearing gland on the crankshaft base.

Before installation of the crankshaft, the rear main bearing rims with asbestos packing must be tightly fitted into their nests in the bearing caps and cylinder block. Gland packing must not fall between the surfaces of the cap and the cylinder block after installation of the shaft and tightening of the bearing caps.

Thin-walled bearing inserts are manufactured to a high degree of precision, and therefore their repair or any sort of fitting with filing or scraping is not allowable. The only method of eliminating insert deficiencies is their exchange.

There must be a clearance between the crankshaft cheek and the bearing insert within the limits of: for main bearings, 0.026-0.100 mm, and for connecting rod bearings, 0.026-0.083 mm. Checking the amount of radial clearance may be done with a set of control gauges made of copper foil, 0.025, 0.05, 0.075, and 0.1 mm in thickness, cut in the form of strips 6-7 mm wide and somewhat smaller in length than the width of the insert. Edges of the gauges must be smoothed with an abrasive whetstone to prevent damage to the insert surface.

The radial clearance checking operation takes place in this way: remove the cap and insert from the bearing being checked and lay the previously lubricated minimum thickness (0.025 mm) control gauge on the insert surface. After installation of the cap and insert in their place and tightening of the bolts, rotate the shaft by hand. During this, the bolts of the remaining bearing caps must be loosened. If the shaft is rotated too easily, the clearance is greater than 0.025 mm. After this, the gauge is replaced with the sequential thickness sizes until such time as the shaft is impossible to turn. The thickness of the gauge with which the shaft can be rotated with noticeable effort is taken as equal to the actual amount of clearance in the bearing.

During checking of the clearances with control gauges, it is recommended that the bearing bolts be tightened with a torque wrench to attain tightness which is equal and constant in amount. To avoid damaging the insert surface, the shaft should not be rotated more than 60-90°.

A simpler and sufficiently reliable method of checking, for an experienced mechanic, is checking clearances in bearings which are lubricated with oil "by feel." In this way, it is considered that with normal clearances, the connecting rod (without the piston) assembled on the shaft journal with a fully tightened cap, must freely fall under its own weight from the horizontal position down to a vertical one. With normal clearances in the main bearings, the crankshaft, with fully tightened caps and without connecting rods, must be able to be rotated manually with a starting crank and without noticeable effort.

Exchange of crankshaft bearing inserts. The inserts are exchanged as a pair--upper and lower halves simultaneously.

In exchanging inserts without repair of the shaft, the exchange operations may be performed on the engine without removing it from the chassis, just as on an engine mounted on a repair stand. In this instance, for exchange of connecting rod inserts, it is necessary to remove the oil pan and oil pump pipe with a pickup. Then, sequentially rotating the crankshaft 120° at a time, it is set in a position for removal of the first and sixth, second and fifth, and third and fourth connecting rods.

Having set the crankshaft in the required position, it is necessary to: unpin and unscrew the connecting rod bolt nuts, remove the rod cap, move the rod and piston slightly upwards along the cylinder, extract the insert from the rod and cap, wipe down the insert beds with a cloth, and install the new inserts; wipe down the connecting rod journal on the crankshaft, lubricate it with engine oil, pull the rod down to the face, install the rod cap in its place so that the number on the cap and on the rod are on the same side, screw on the connecting rod bolt nuts, place one gasket 0.05 mm thick in the butt joint under the cap, tighten the nuts with a wrench to a torque moment of 8-10 kg meters and pin them.

The same operation is conducted for removal of the next pair of inserts.

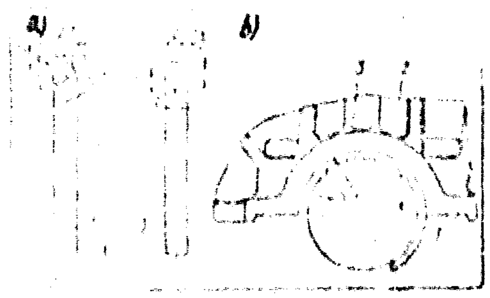


Plate 3-82. Exchange of crankshaft upper inserts: a) insert extractor b) method of extracting upper insert; 1) upper insert 2) cylinder block rib 3) insert extractor

After exchanging the connecting rod bearing inserts, it is necessary to install the oil pump pickup and delivery tube with the oil pickup, which have previously been cleaned and washed in kerosene, had their gaskets checked and replaced if necessary, and then been installed on the engine, making sure that the oil pickup does not touch the walls of the oil pan, after which the oil pan is fastened into place and filled with oil.

For changing main bearing inserts, it is necessary to unscrew the main bearing bolts, remove the caps, and change the inserts.

For changing inserts without removing the crankshaft, the special extractor 3 (Plate 3-82) is used, easing removal of the upper half of the insert. For this: the bearing cap is removed; the crankshaft is set so as to expose the oil passage holes in the main bearing face; the extractor 3 is inserted into the oil passage hole; the crankshaft is turned until the extractor dog lies against the face of the insert and its head is set parallel to the formed exterior surface of the insert; the crankshaft is rotated 180°, and the worn out bearing 1 is extracted. The new insert is installed in the reverse sequence. The shaft face must be carefully dried, and the insert lubricated with liquid oil.

After changing the insert, is is necessary to install the cap in its place, placing a gasket on each side of it and tightening the bolts. Tightening torque for the front and intermediate bearings is 11-13 kg meters, and for the cap of the middle and rear bearing, it is 8-10 kg meters. Lock washers in good condition are installed beneath the bolt heads.

After tightening only the main bearings, the torque applied to rotate the engine crankshaft must be no greater than 7 kg meters, and after tightening the main and connecting rod bearings, it must be no greater than 10 kg meters.

The dimensions of the crankshaft bearing inserts are selected according to the diameter of the shaft journals of the assembled engine. The connecting rod journals may be measured without removing the shaft from the cylinder block. For measuring the main bearing faces, the shaft must be removed. After any exchange of inserts, it is necessary to check the clearance in each of the bearings, so as to insure that shaft repair and selection of repair insert dimensions were done properly.

If the crankshaft is changed in an engine, it is also necessary to change all the inserts. For such an exchange, the plant produces set No. 120-1000107-B--crankshaft with normal dimension connecting rod and main bearing inserts. The set includes: a new crankshaft, seven pairs of main bearing inserts, six pairs of connecting rod inserts, and two thrust rings.

During the process of the engine's operation, appearance of small localized breaks in the anti-friction layer of main or connecting rod bearing inserts, not totaling more than 15% of the surface, need not be taken as indications of insert failure.

When installing pistons with connecting rods, the cylinder block is turned so that its cylinders are up. Laterally, one after the other, take the piston and connecting rod in assembly. Carefully wipe the insert bed in the big end of the connecting rod with a cloth, unscrew the nuts and remove the connecting rod cap and inserts which are installed between the connecting rod and the cap. Place brass or copper ends on the connecting rod bolts to protect the cylinder wall from damage during installation of the connecting rod and piston.

Check and blow out the holes in the bottom end of the connecting rod serving to splash oil on the cylinder holes and the camshaft lobes, place the inserts in the rod and the cap and check coincidence of the oil passages. Dry off the upper connecting rod insert and piston with a cloth, install the rings on the piston, and place the ring butt joints on the piston in the proper position (see Plate 3-58). Wipe down the cylinder block and the connecting rod journal of the shaft with a cloth.

Lubricate the surfaces of the connecting rod insert, piston, piston rings, and cylinders with clean engine oil.

Mount device K-1288 (Plate 3-83) on the piston from the skirt side and install the piston together with the connecting rod in the cylinder (Plate 3-84). The "forward" mark on the piston head must be directed toward the front part of the engine. The piston rings must be freely compressed in the device. Drive the piston along the cylinder with the wooden mandrel (Plate 3-85) and lead the connecting rod bearing to the crankshaft journal. Lubricate the connecting rod journal of the shaft and pull the bottom end of the connecting rod to the connecting rod journal. Remove the protective caps from the connecting rod bolts, set the insert and connecting rod cap in place, and tighten it. The side of the connecting rod cap having the stamped connecting rod order number must be directed toward the valve chamber side of the block. Ensure that the diametric clearance in the connecting rod bearings was selected normally.

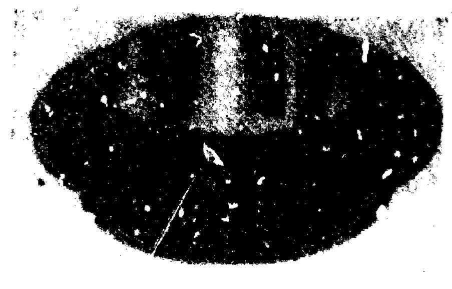


Plate 3-83. Device K-1288 for piston installation

Plate 3-84. Installation of piston and rings in cylinder with a device

Plate 3-85. Moving piston and connecting rod along cylinder with wooden mandrel

Check the total clearance between the connecting rod bearing faces and crankshaft journals with a gauge. The clearance must be 0.075-0.260 mm.

It is expedient to install the piston and connecting rod assembly in the cylinders in the following sequence: first and sixth; second and fifth, third and fourth.

Finally, tighten the connecting rod bolt nuts and check their tightness with a torque wrench. Torque moment on the nuts must be within the limits of 5.5-8.0 kg meters. In tightening the nuts, it is necessary to bring their slots into position for pinning. Bringing the nuts to coincidence between their closest slots and the pinning hole must be done only in the direction of increasing tightness.

Check the tightness of main and connecting rod bearings by means of rotating the crankshaft. The moment of shaft rotation must be no greater than 10 kg meters. Having finished checking the tightness of the connecting rod bearings, it is necessary to pin the rod bolt nuts.

Assembly of the camshaft includes installation of the spacing ring 6 (see Plate 3-13), support flange 5, key 4, and gear 1.

The gear must be pressed onto the shaft until it rests against the spacing ring. After pressing on the gear, the lock washer is installed, the nut is screwed on, tightened until it refuses to move, and a washer is driven up against one of the flats of the nut. The support flange must move freely after this, and clearance between the flange and the face of the support cheek must be 0.08-0.21 mm.

Journal oscillation of the large camshaft gear hub on the side lying against the support flange is not allowed to be greater than 0.04 mm. Oscillation of the journal on its rim is not allowed to be greater than 0.16 mm. Gear oscillation is checked with an indicator (Plate 3-86).

For pressing on the gear, the shaft must be mounted on a device (Plate 3-87) and fastened in a vise. Then press on the gear.

In the process of engine operation, the support flange also wears out. Increased axial clearance causes longitudinal slack in the shaft and a knock in the engine. The amount of clearance may be decreased by decreasing the height of the spacing ring.

Axial clearance in the camshaft may be checked without removing the engine from the truck, or with an engine already removed, with an indicator, for which it is necessary to remove the camshaft gear cover, mount the indicator (Plate 3-88) against the journal of the camshaft gear rim, and measure the axial clearance, shaking the gear slightly with a tap wrench.

If the camshaft bushings are worn more than the allowable limit, it is necessary to press them out of their nests in the cylinder block with a device (Plate 3-89) and press in new bushings using the same device.

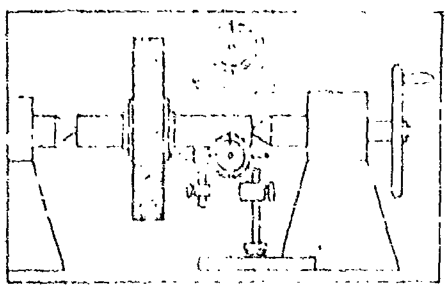


Plate 3-86. Checking journal oscillation of the hub and rim of a crankshaft gear

Plate 3-87. Pressing on a camshaft gear with a device

When pressing in rebuilt or new bushings, the holes for lubrication in the bushing must exactly coincide with the passages in the cylinder block body. Pressed-in bushings must be fitted by development to the diameter of the support journals of the camshaft to assure a normal clearance in the bearings within the limits of 0.05 0.10 mm.

Installation of the camshaft and the cam gears. Wipe out the camshaft supports in the cylinder block with a cloth, check coincidence of the oil passages and lubricate the shaft journals and lobes with engine oil.

Install the camshaft in the cylinder block with the gear and flange in assembly (see Plate 3-50, b), connecting the crankshaft and camshaft gears so that the tooth noted with a dot on the crankshaft gear goes into the cut noted with a dot on the camshaft gear (Plate 3-90). Check the amount of clearance between the teeth of the camshaft gears.

For checking clearance in the camshaft gear teeth, use of a device which fastens on the front face of the cylinder block with a screw (Plate 3-91) is recommended. The end of the lever should rest against the lateral surface of the camshaft gear. With the crankshaft remaining stationary, rotate (by the amount of clearance) the camshaft gear, taking up the clearance between the gear teeth, and determine the amount of clearance according to the hand on the indicator. For used gears, the clearance is allowed in the limits of 0.04-0.25 mm, and for new gears, the allowable clearance is 0.04-0.12 mm. Clearance should be checked in three points at an angle of 120°, and deviation in the clearance for used gears must be no greater than 0.10 mm, and for new gears, it must be no greater than 0.06 mm. Having checked the clearance, it is necessary to co-locate the holes of the support flange with the threaded holes in the cylinder block and fasten the camshaft with bolts and lock washers, using a socket wrench (see Plate 3-50, a), inserting it in the gear holes.

The tightening moment of the flange fastening bolts must be 2.3-2.8 kg meters, after which the axial clearance must be maintained within the limits of 0.08-0.21 mm. Lubricate the gears, fit the oil deflector on the end of the camshaft, install the screen and camshaft gear cover with gaskets and fasten them, installing the bracket for the engine suspension swaybar beneath the first and second bolts on the right side. The bolts are tightened in two passes. Torque moment must be 7-8 kg meters.

Installation of the oil pump and engine oil pan. Turn the block crankcase upward. Set the oil pump on the cylinder block, connect its drive gear with the gear formed on the camshaft, and fasten the body and pipe leading oil to the engine main oil line to the engine block with bolts. Install gaskets beneath the pipe flange. With installation of a two-section oil pump, besides this, fasten the pipe conducting oil to the oil radiator, also installing gaskets beneath the flanges.

Before installing the oil pan, it is necessary to make sure that there are no foreign objects inside the engine. After that, liberally lubricate the bottom part of the cylinders with oil, and also lubricate the external side of the piston wrist pins, and the main and connecting rod bearings.

Lay a gasket on the cylinder block plane, blow out the oil pan with compressed air and install it on the cylinder block. Screw in the bolts with lock washers by hand, and tighten the oil pan using a socket wrench. Tighten the bolts in two passes.

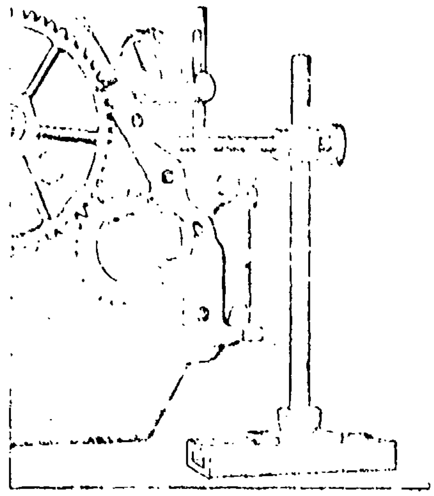


Plate 3-88. Measuring axial camshaft clearance with an indicator

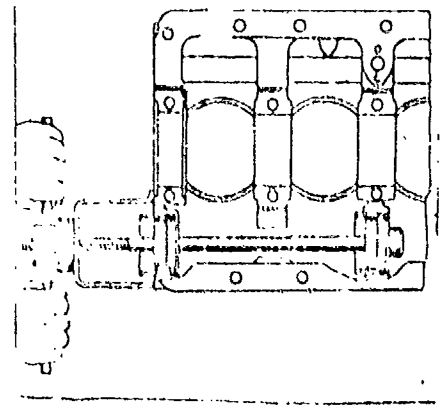


Plate 3-89. Pressing out and press fitting camshaft bushings

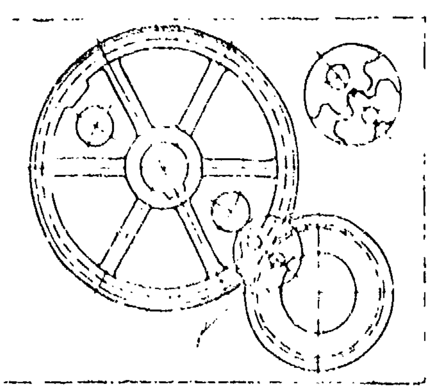


Plate 3-90. Position of marks on gears during installation of gas distribution system

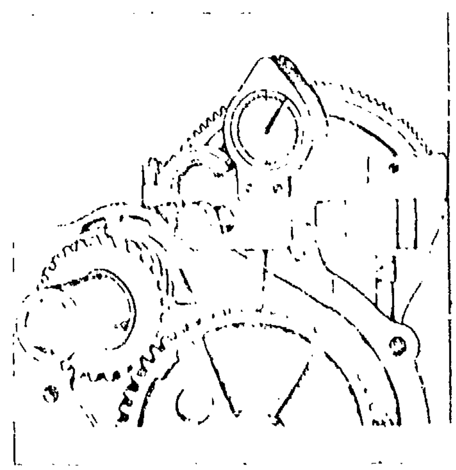


Plate 3-91. Checking clearance between camshaft gear teeth

Installation of the clutch housing cover and disengagement fork. Install the clutch disengagement fork in the housing and fasten the bushing flange with bolts. Install the clutch housing cover and housing plate and fasten them with bolts.

Installation of valves and tappet sections. Rotate the engine on the stand, setting the cylinders upward. Blow out the valve chamber space with compressed air.

Tightness of valves is renewed by lapping the working faces of the valves against their seats. If there are pits or marks on the working face of the valve which are impossible to eliminate by lapping, the face is subjected to grinding, with consequent lapping against the seat. Rotation of the valve during the process of manual lapping is accomplished with a drill which rotates the valve across its section, first to the right and then to the left.

If the valve has a slot in its head, it is held by mandrel using this slot, and if there is no slot, it is held by a rubber suction cup.

During lapping, it is recommended that a slightly elastic spring be installed beneath the valve. Lapping paste or light abrasive powder mixed with engine oil is used to accelerate lapping.

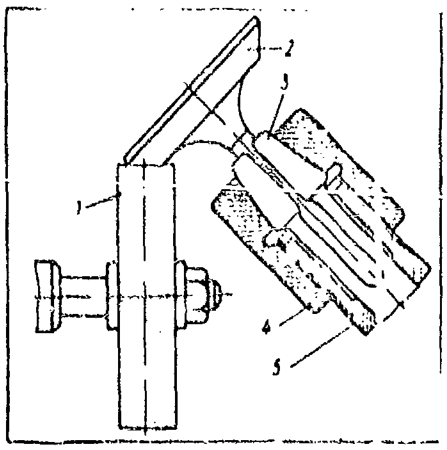


Plate 3-92. Grinding a valve face:
1) grinding wheel 2) valve
3) jaw chuck 4) nut 5) body

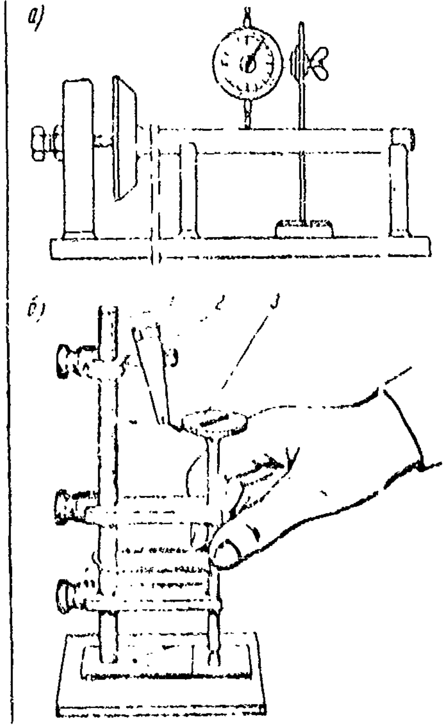


Plate 3-93. Checking a valve:
a) checking stem straightness
b) checking working face 1) device upright 2) indicator 3) valve

In a case where the working surface of the valve is worked out (worn), it undergoes grinding. Valve working faces may be ground on a circular grinding machine or on a model 2178 table grinder with the valve fastened in a jaw chuck (Plate 3-92). Construction of the machine allows installation of the valve at the required angle relative to the grinding wheel. The face of an intake valve is ground at an angle of 30°, and that of an exhaust valve is ground at an angle of 45°. The grinding machine also allows the valve stem face to be ground if it is worn.

The working face of a valve may be ground if the height of the cylindrical belt on the valve head exceeds 0.3 mm. Valves whose belt is less than 0.3 mm in height are replaced.

The valve stem must be straight. Straightness is checked with an indicator on jigs (Plate 3-93, a). Valve stem curvature must not exceed 0.015 mm on 100 millimeters of length. Clearance between the valve stem and guide bushing must be within the limits of 0.02-0.08 mm. Working surface oscillation in a valve relative to the axis of its stem is checked on a device (Plate 3-93, b). The amount of oscillation must not exceed 0.03 mm. Valve st wear along the diameter must not exceed 0.05 mm. If the wear present is greater than that indicated, the valve is

Testing valves for tightness may take place with a model NIIAT instrument. For this, the instrument is tightly set on top of the lapped-in valve, as shown in Plate 3-94, and air is forced into the space in the cylinder with a squeeze bulb. In this, if the air pressure of 0.7 kg/cm^2 does not fall in the course of half a minute, the valve is well lapped in.

Valve seating tightness may also be checked by sending air under the valve through the exhaust or intake passage of the cylinder block (Plate 3-95) and through a tube with a rubber washer which is tightly pressed against the passage. To determine the location of air leakage, kerosene or liquid oil is poured on the valve. The location of air leakage is revealed by the appearance of bubbles.

After lapping and checking valve tightness, the cylinder block and valves should be carefully washed and blown off with compressed air.

The maximum allowable increase in valve guide diameter due to the effect of wear is 0.08 mm, and with a greater increase in guide diameter, it should be exchanged. The valve guides must be pressed out with a device (Plate 3-96,a).

The guide is pressed into the cylinder block with an interference of 0.013-0.075 mm with a mandrel 7 (Plate 3-96, [illegible]). After pressing the guide into the block, its dimension should be brought to specifications by reaming (Plate 3-96, c).

If the valve guides are changed in the engine, this operation should be performed before the valve seats are corrected by milling.

Plate 3-94. Method of checking valve tightness with NIIAT instrument

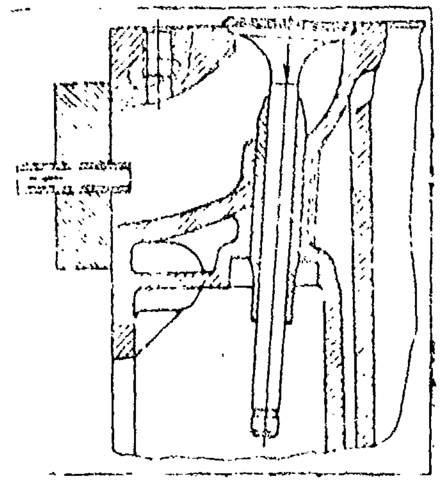


Plate 3-95. Checking valve tightness by sending air under the valve

The valve seats are formed in the cylinder block. Wear on the seat face leads to improper valve seating, which causes penetrating gases to form pits on the working surface of the valve seat. Small pits in the seat may be eliminated by lapping, and deeper ones by milling or grinding with consequent lapping of the valve to the working face of the seat. For an intake valve seat, a cutter (miller) whose teeth are positioned at an angle of 30° is used, and for exhaust seats, this angle is 45°.

Width of the working face of the valve seats must be 2.5-3.0 mm. With a width of seat working face greater than 3.0 mm, it is necessary to decrease the face by milling the seat at angles of 75° and 15° to the axis of the valve guide.

Valve seat faces are repaired in the following order: machine the working surface of the valve seat with a miller at an angle of 45°, as shown in Plate 3-97, a, and b, and remove the face at the bottom part of the valve seat with a miller at an angle of 75° (Plate 3-97, c); remove the face of the upper part of the seat with a miller at an angle of 15° (Plate 3-97, d) and grind the working surface of the valve seat with a grindstone (Plate 3-97, e). These same operations are performed for a seat with a 30° seat face.

A working surface of the seat is ground using an electric drill with a special mandrel (Plate 3-98, a), and the guide rod 1 is selected according to the diameter of the valve guide. Before grinding the valve seat, the stone on the grinding device should be trued with a diamond (Plate 3-98, b).

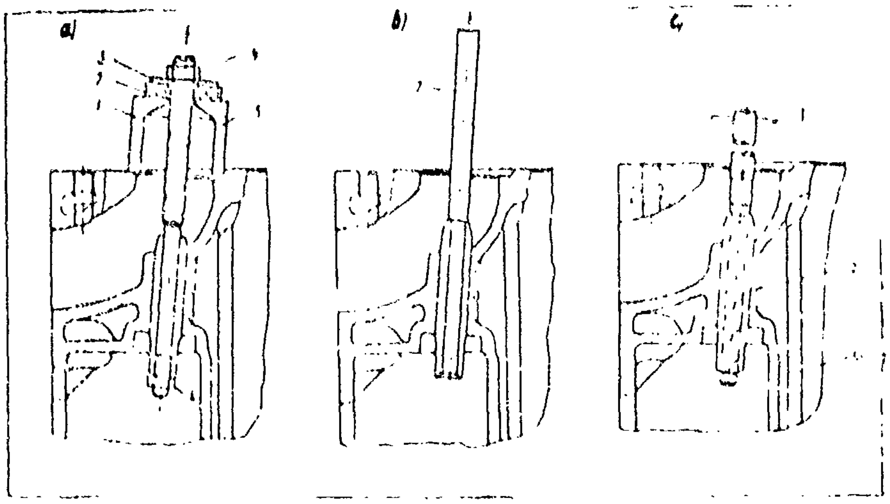


Plate 3-96. Changing valve guides: a) pressing guide out b) pressing guide in c) reaming guide 1) puller body 2) support ball bearing 3) washer 4) nut (drawing) 5) puller shaft 6) nut (backing) 7) mandrel 8) handle 9) counter bore reaming 10) cylinder block

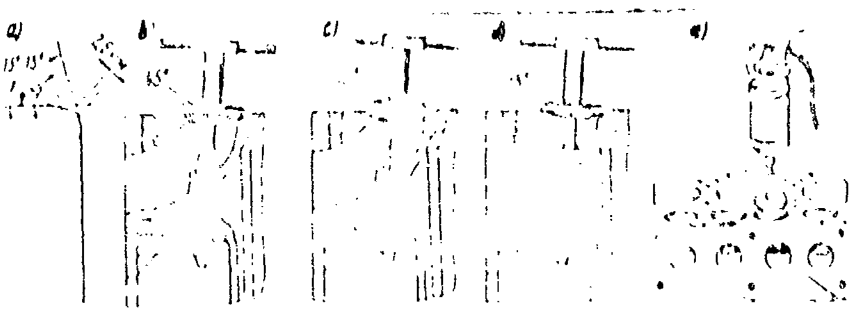


Plate 3-97. Valve seat correction: a) machining angles and dimensions of valve seat b) machining seat at 45° angle c) removing seat face at 75° angle d) removing seat face at 15° angle e) grinding working face of seat with abrasive stone

After grinding the valve seat, it is necessary to check the accuracy of its machining with a device (Plate 3-99). Oscillation of the working surface of the valve seat relative to the axis of the valve guide hole is not allowed to be greater than 0.03 mm.

The tappet. Wear on the spherical surface of the tappet plate must not exceed 0.10 mm. Wear on the tappet shaft diameter must not exceed 0.04 mm. Worn out tappets and tappet guide sections must be replaced or repaired.

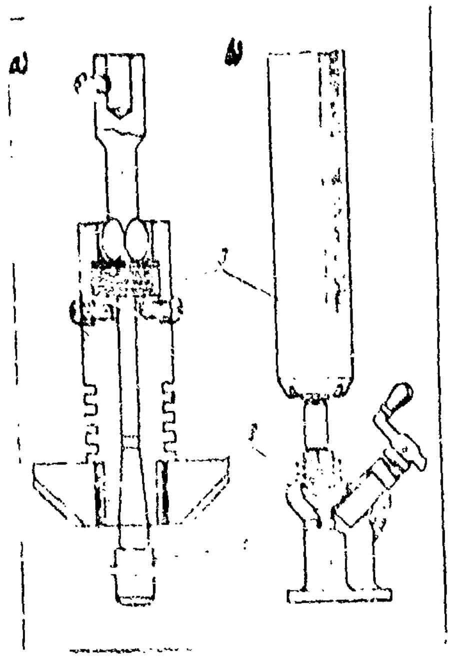


Plate 3-98. Universal device for grinding valve seats: a) device for grinding b) device for truing grindstone 1) guide rod 2 grind stone 3) device

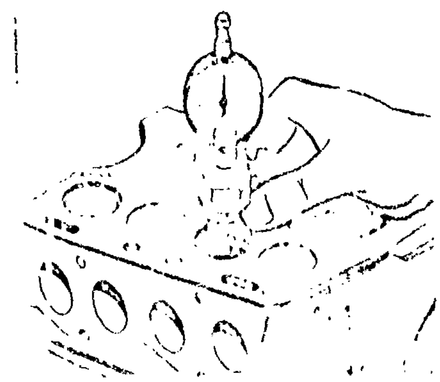


Plate 3-99. Checking valve seat oscillation

Worn out tappet guide holes may be rebuilt to repair dimensions.

Tappets which are correctly selected according to the dimensions of the guide holes and lubricated with oil must freely fall through the guide holes under their own weight.

Lubricate the valve stems with engine oil and install the valves in the cylinder block receptacle. Next, mount the spring and plate on the valve stem (see Plate 3-84, e), and then, compressing the spring with device 20P-7992 (see Plate 3-44, d), install the **keys** and remove the device.

Install the rear tappet section in assembly with the tappets, for which the crankshaft must be turned to a position in which the fifth lobe of the camshaft is directed upward, and after this, rotate the crankshaft by 120° to the position in which the eighth lobe of the camshaft is directed straight upward, and then install the front tappet section. Tighten the tappet sections with bolts (see Plate 3-44, b). Torque moment is 7.0-9.0 kg meters.

Adjust clearance in the valves. Then lubricate the cam lobes with oil, install the valve chamber covers with gaskets and fasten them with bolts (see Plate 3-44, a).

Installation of the cylinder head. Check, and if necessary, carefully wipe the cylinders, piston heads, and cylinder head with a cloth, and then blow them out with compressed air. Lay the cylinder head gasket with its smooth side toward the block. Screw in the seven studs at first by hand, and then tighten them with a stud tightener.

Install the cylinder head, insert the bolts, and tighten them with an angular socket wrench in two passes. Cylinder head bolt torque should be checked with a torque wrench. The torque moment for bolts and nuts must be within the limits of 10-12 kg meters. The head fastening bolts should be tightened in the order shown in Plate 3-31.

Installation of the front motor mount bracket, the crankshaft pulley, and the ratchet. Install the front motor mount bracket on the projection of the camshaft gear cover as shown in Plate 3-100, a, so that the depression in the bracket is directed toward the side of the camshaft gear cover.

Install the key in the key way in the end of the crankshaft and press the pulley on the shaft (Plate 3-100, b). Install the locking washer on the end of the shaft and screw the ratchet into the threaded hole in the crankshaft. Tighten the ratchet with a wrench and crimp the locking washer.

Plate 3-100. Installation of the front motor mount bracket and pressing the crankshaft pulley: a) bracket installation b) pulley pressing

Installation of exterior parts and assemblies on the engine. Install the intake and exhaust manifolds with the gasket and fasten them with bolts (see Plate 3-42). For convenience in performance of this operation, two helping studs can be screwed into the block and the manifolds mounted on them. Later, after having fastened the manifolds with bolts, the studs are unscrewed and the final two bolts are screwed into their places. Torque moment on the manifold fastening bolts must be 4-5 kg meters.

Curvature of the intake and exhaust manifold contact surface must be less than 0.7 mm on its entire length, and no greater than 0.4 mm for a row of continuous flanges. Checking of this is done with a leaf gauge and straightedge gauge.

If the straightness of the contact plane does not fall within the assigned limits of tolerance, its correction must be conducted by milling or manual fitting with a file. The presence of small cracks on the internal part of the manifold need not serve as an indication of failure.

During repair, the walls of the manifolds should be checked and cleaned of formations of deposits on them, since a significant quantity of these deposits noticeably constricts the passage section of the manifolds, decreasing its power and economy. Cleaning is done with a metal brush and jag wire with subsequent washing in kerosene and blowing out with compressed air. After cleaning, the manifolds should be checked for tightness under pressure of 3-4 kg/cm^2.

Screw in the two studs for fastening the fuel pump, install the fuel pump with the gasket beneath it, and tighten the nuts.

Check the cylinder block for presence of the water distributing pipe. Install the water pump with its gasket on the front part of the block and fasten it with bolts. Mount the compressor drive belt and the fan belt on the pulley, including the crankshaft pulley in them.

Install the compressor on the cylinder head and fasten it, tightening the nuts on the studs to a preliminary position. Mount the drive belt on the pulley, tighten the belt and final tighten the compressor nuts.

Install the starter and fasten it with bolts.

Install the oil filler pipe in assembly with the air filter of the crankcase ventilation system and fasten the pipe with bolts. The bolts must be tightened evenly to prevent breakage of the flanges on the tube.

Install the oil filter body in assembly with its gasket on the cylinder block area for it, and fasten it with bolts.

Screw the cooling liquid temperature indicator switch to its receptacle in the cylinder head. Screw the oil pressure indicator switch into its receptacle in the cylinder block main oil line.

Install the ignition coil on the cylinder head and fasten it with bolts.

After having inserted the thermostat in the water pipe, install it with its gasket on the cylinder head and fasten it with bolts. The bolts must be tightened evenly to protect the pipe flanges from damage.

Install the generator brackets on the cylinder block and fasten them with bolts. Install the generator on the brackets and fasten it. Connect the tensioning arm, mount the generator drive belt on its pulley, and tighten the belt.

Install the heat insulation gasket on the upper flange of the intake and exhaust manifolds, install the engine revolution governor, and then install the carburetor with its gasket and fasten it with nuts. Connect the fuel line from the fuel pump to the carburetor and fasten it.

Install the engine air filter on the carburetor and fasten it. Connect the air separation tube to the compressor and fasten it on the filter and on the compressor.

Connect the cooling system hoses to the compressor, to the cylinder head sleeve, and to the water pump cap sleeve and fasten them. Connect the inlet and outlet oil lines for lubrication of the compressor and fasten them.

Bring the transmission up on a hydraulic jack (type 32P-1270), raise the transmission, and, having connected it to the clutch housing, fasten it with bolts, tightening them with an angular socket wrench until they refuse to turn.

Installation of the distributor. Since not only the distributor was removed from the engine but also the intermediate shaft for its drive, it is necessary to install the drive shaft before installing the ignition. For this, the piston in the first cylinder must be set at TDC on its compression stroke, according to the mark on the flywheel or according to the setting rod on the camshaft gear cover.

Install the intermediate distributor drive shaft with the body as an assembly in the cylinder block receptable and rotate the shaft so that the slot in its sleeve, which is displaced by 0.5 mm relative to the shaft axis, is directed toward the side of the cylinder block. Then, turning the shaft slightly in a counter-clockwise direction, drop it with the body into the receptacle in the block so that the drive gear teeth are engaged with the gear on the camshaft. The intermediate drive shaft of the distributor must rotate and sit in a position so that the slot in its sleeve is parallel to the camshaft axis with the slot displaced toward the cylinder block, after which the stop bolt is tightened and clenched on the engine.

Install the plates of the manual timing adjuster on the cylinder block space for them, and fasten them with bolts. Loosen the upper plate tension bolt of the octane corrector and install the distributor on the engine, having previously turned the shaft so that the projection on the distributor connecting sleeve, having a displacement of 0.5 mm relative to the axis of the shaft, is directed to the side of the vacuum regulator, which must be directed upward toward the ignition coil. In this, the rotor electrode must be located opposite the terminal of the first cylinder on the cap. After this, tighten the distributor fastening tension bolt on the cylinder block. Install the high tension wires and connect them with the spark plugs.

For checking ignition timing, it is necessary to install the wires in place, fasten them on their corresponding terminals of the equipment, and connect the wire of the primary circuit to an auxiliary battery.

Rotating the adjusting nut, co-locate the indicating arrow of the upper plate of the octane corrector with the zero mark on the lower plate. Turn on the ignition and rotate the distributor body counter-clockwise with the adjusting nuts until the appearance of a spark between the end of the middle wire from the ignition coil and ground (by a distance of 2-3 mm). Initial contact point breaking may be checked with a timing light connected to the engine ground and to the low tension terminal of the distributor. Tighten the adjusting nuts of the octane corrector in this position. Then, check for the correct installation of wires in the distributor cap, corresponding with the ignition firing order (1-5-3-6-2-4).

Running the engine in

To increase the service period of an engine, it is run in after assembly. The engine running-in process allows checking of the quality of repair work performed, presence of local over-runs, extraneous noises or knocks, and leaks or lack of tightness. It also allows fine adjustment of clearance between valves and tappets on a warm engine, setting of ignition timing, adjustment of the carburetor for engine idle, as well as checking the level of fuel in the carburetor float chamber, and pressure and temperature in the engine lubricating and cooling systems.

After a short running-in period, a short-time load can be applied to the engine with a partially closed throttle, and one or two power control points can be taken during its operation. After overhaul, the engine should be run in according to the schedule shown in Table 3-2.

The engine is considered usable if it can be started with a starter or with a handcrank, works at any speed without missing, runs smoothly at idle (400-600 rpm), does not leak oil, water, or fuel, and does not have extraneous noises and knocks. Oil pressure at 1000 rpm must be no less than 2.5 kg/cm^2. If a defect is uncovered in an engine during the process of its running in, the responsible parts are exchanged and the engine undergoes a second running in, using either the full schedule or a partial one.

Running in and testing of engines takes place on stands. Hydraulic brakes, electrodynamometers on direct current or specially equipped normal de-synchronous alternating current motors can be used to load the engine. Plate 3-101 presents an engine stand equipped with an alternating current electric motor.

Installation of the power unit in the truck

Install the power unit on the special carriage and bring it to the truck, disconnect the hand brake drive lever, remove the cover and lever from the transmission, and cover the transmission with a piece of cardboard which has been specially prepared for it. Fasten the mechanism hook to the engine hanger and set the engine on the truck frame, simultaneously placing the top suspension cushions beneath the front motor mount. Install the front suspension bolts with the bottom cushions and fasten the front engine suspension. Install the bolts on the rear engine suspension and fasten them. Install the transmission cover and fasten it with bolts. Connect the exhaust pipe with its gasket and fasten it to the flange of the exhaust manifold with bolts. Install the handbrake drive lever, fasten it and connect it with the brake. Connect the clutch disengagement mechanism and install the pedal return spring. Connect the propeller shafts and fasten them with bolts. Connect and fasten the speedometer cable.

Connect the transfer case drive and fasten it. If the truck has a winch, it is necessary to install and fasten its drive.

Install and fasten the inspection plate in the cab floor with bolts. Connect and tighten the compressor line and fuel line. Install the throttle control bracket and fasten it. Fasten the throttle control pedal rod to the bracket and fasten it. Install and connect the rod with the throttle lever and with the throttle control bracket, and install the carburetor leakage return spring. Fasten the manual choke and throttle cables to their brackets and fasten them with screws.

Install the radiator in assembly with its jacket on the frame with rubber cushions and fasten it. Connect the drawbar to the louvre lever, and pin and fasten the drawbar bracket of the dashboard. Install the bottom radiator pipe with a gasket and fasten it with bolts. Then connect the hose with the water pump and the hose with the cylinder head pipe, and fasten the clamps with screws. Install the hood spacing rod and preliminarily fasten it.

Connect the wires for the generator, starter, ignition coil, distributor, and sending switches for the indicators of cooling liquid temperature and oil pressure and fasten them on their poles. Fasten the multiwire conductors on poles of the connecting blocks, connect the "ground" crosspiece and fasten it

a) Приработка	b) Нагрузка, л. с.	c) Число оборотов коленчатого вала, об/мин	d) Время приработки, мин
1) Холодная	—	500–600	20
2) То же	·	8?0–900	10
3) Горячая без нагрузки	—	900–1100	10
4) То же	—	1300–1500	10
5) Горячая под нагрузкой	10–15	1200–1400	15
6) То же	15–20	1400–1?00	1?

Table 3-2. Schedule of engine running-in

Key: a) running-in
b) load, hp
c) number of crankshaft revolutions, rpm
d) run-in time, minutes
1) cold
2) same
3) hot, without load
4) same
5) hot, under load
6) same

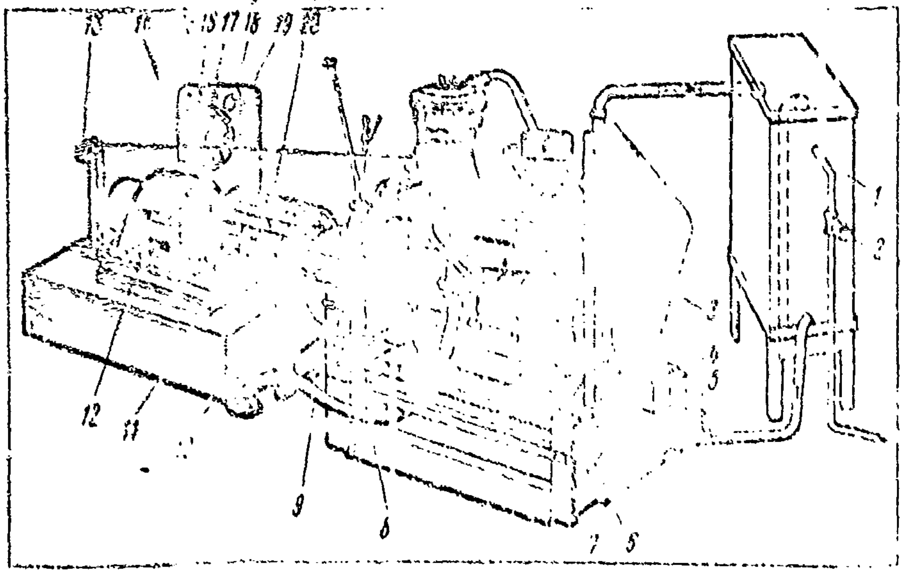


Plate 3-101. Stand for running in and testing engine: 1) tank with water 2) valve shutting off water from water line 3) protective grating 4) and 10) nuts fastening engine on stand 5) water shutoff valve 6) engine 7) stand frame 8) fuel shutoff valve 9) exhaust gas collector pipe 11) universal drive 12) electric motor 13) throttle control drive 14) electric motor control buttons 15) manometer for oil pressure in engine lubrication system 16) water thermometer 17) oil thermometer 18) tachometer for number of engine crankshaft revolutions 19) dial for weights 20) protective grating

to the cylinder head with a bolt, and fasten the "ground" wire and starter wire to the poles of the storage battery and tighten them.

Install the engine hood and fasten the hood bar.

Dimensions of parts

Engine cylinders are measured in two directions which are perpendicular to each other, along the axis of the crankshaft and perpendicular to it, and also in two belts at distances of 10-15 and 65-70 mm from the upper plane of the cylinder block.

Maximum allowable cylinder wear should be considered to be 0.4 mm. Planar irregularities on the surface of the block where it is assembled with the cylinder head are not allowed to be greater than 0.2 mm on the entire length of the block, and no greater than 0.05 mm on the length of 50 mm; along the surface lying against the oil pan, no greater than 0.2 mm on the entire length, and no greater than 0.05 mm on the length of 50 mm; on the surface lying against the intake and the exhaust manifolds, no greater than 0.4 mm. If planar irregularities in the surfaces noted above exceed those allowable, it is necessary to true these surfaces by scraping or fine milling.

Before the cylinders go in for repair, it is necessary to determine the degree of wear on their walls. Wall wear is measured by an indicating plug gauge of dimensic 100-150 mm, set at the nominal cylinder diameter. To maintain stable measurements, it is desirable that all measurements be taken at a constant temperature of the surrounding medium of 10-30°C.

Cylinders are overhauled by boring and subsequent honing. It is recommended that the portable machine model 2407 be used for boring cylinders. The cylinders should be bored leaving a margin of 0.02-0.08 mm for honing. Honing is accomplished with abrasive blocks or drilling machines or on model 2291 finishing machines.

During boring, deviation of the perpendicularity between the cylinder axis and the crankshaft axis must not exceed 0.05 mm on a length of 100 mm. The nominal and repair dimensions of cylinders are given in Table 3-3. Dimension groups are given for individual selection of pistons.

All cylinders of a single block are repaired to a single repair dimension. The maximum conicity and ovality of an overhauled cylinder is not allowed to be greater than 0.025 mm. Some cylinders, whose diameters for some reason fall outside the limits of the maximum dimension 103 or 120 mm, may be repaired by the method of sleeving. The number of sleeves in a single block may not exceed three. Sleeves are manufactured of the cast iron used in cylinder blocks.

Размер	Увеличение диаметра цилиндра	Размеры цилиндров			
		номинальный и ремонтный	группы		
			I	II	III
Номинальный	—	101,56 / 101,62	101,56 / 101,58	101,58 / 101,60	101,60 / 101,62
1-й ремонтный	0,5	102,06 / 102,12	102,06 / 102,08	102,08 / 102,10	102,10 / 102,12
2-й »	1,0	102,56 / 102,62	102,56 / 102,58	102,58 / 102,60	102,60 / 102,62
3-й »	1,5	103,06 / 103,12	103,06 / 103,08	103,08 / 103,10	103,10 / 103,12

Table 3-3. Nominal and repair dimensions for cylinders, mm

Key: a) dimension
b) cylinder diameter increase
c) cylinder dimensions
d) nominal and repair
e) groups
f) nominal
g) first overhaul
h) second overhaul
i) third overhaul

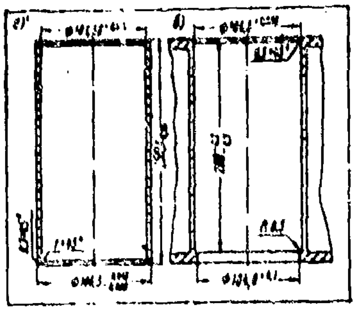


Plate 3-102. Dimensions
a) sleeve b) sleeve cavity

Dimensions of the sleeve and sleeve cavity in the cylinder block are presented in Plate 3-102. For pressing the sleeve into the cylinder block, hot water should be poured into the water jacket, and the sleeve should be cooled as much as possible and lubricated with oil. Sleeves are pressed in by a press with an interference of 0.05-0.10 mm. The face of the pressed-in sleeve must be flush with the upper plane of the cylinder block.

The clutch housing. On the clutch housing assembly surfaces with the cylinder block and with the transmission, planar irregularity is not allowed to be greater than 0.4 mm, and non-parallelness of these planes relative to each other is not allowed to be greater than 0.35 mm.

Height of the housing support lugs must be within the limits of 70.25-69.75 mm. Wear of the support lugs along height is allowed to 64 mm. The diameter of the holes for the rear motor mount bolts must be within the limits of 19.75-21.0 mm. If the holes are greatly worn, it is permissible to ream them and install bushings. The internal diameter of the bushing for the clutch disengagement fork shaft must be within the limits of 25.06-25.17 mm.

Holes for the clutch disengagement fork shaft may be reamed to the overall dimensions shown in Table 3-4.

In reaming the holes, bushings are pressed in with an interference of no greater than 0.10 mm. After pressing, both bushings are bored simultaneously to ensure their coaxiality. Nonalignment of the bushings is allowed to be no greater than 0.025 mm and nonparallelness relative to the surface lying against the cylinder block is allowed to be no greater than 0.1 mm on a length of 100 mm.

The clutch housing is centered on the cylinder block with two installation rings. When the clutch housing is exchanged, it is installed on the rings, which are pressed in the face of the cylinder block, and it is fastened with bolts. The bolt torque moment must be equal to 8-10 kg meters. After tightening, alignment of the holes centering the transmission with the axis of the crankshaft should be checked, along with the perpendicularity of the rear face of the housing relative to the axle of the crankshaft.

This checking is performed with device IV-2376, fastened on the crankshaft flange (Plate 3-103). The amount of oscillation of the internal surface of the hole and the face of the clutch housing relative to the axis of the crankshaft must not exceed 0.2 mm.

The cylinder head. Planar irregularity of the cylinder head must not exceed 0.3 mm on its entire length or 0.1 mm on a length of 100 mm. If curvature is present which exceeds the mentioned amounts, the cylinder head surface must be milled or scraped, keeping in mind that the volume of the combustion chamber may not be decreased by more than 2 cm^3. Control of the assembly surface of the cylinder head is done with a set of gauges on a control plate or with a straightedge gauge.

Testing the cylinder head for tightness should be done with water or emulsion at a pressure of 3-4 kg/cm^2 over the course of three minutes.

Plate 3-103. Checking alignment and perpendicularity of the clutch housing relative to the crankshaft axis: a) device installation b) checking alignment and perpendicularity with two indicators simultaneously 1) cylinder block 2) crankshaft flange 3) wing nut fastening the device to the crankshaft flange 4) device shaft 5) clutch housing 6) indicator for checking flanged clutch housing hole 7) indicator for checking plane lying against transmission

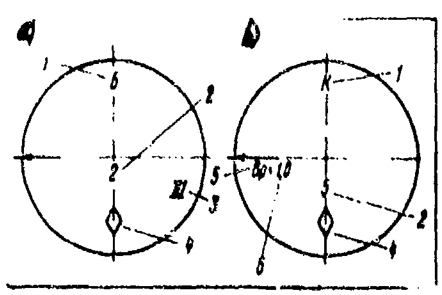


Plate 3-104. Piston marking: a) nominal dimension b) overhaul dimension 1) dimensional group according to skirt diameter 2) dimensional group according to weight 3) dimensional group according to wrist pin hole diameter 4) location of DTC stamp 5) designation of piston overhaul group 6) overhaul dimension of piston

Pistons. Marking of a piston of nominal dimensions is shown in Plate 3-104, a, and that of a piston of overhaul dimensions is shown in Plate 3-104, b, Repair and nominal piston dimensions are presented in Table 3-5. To provide individual selection of pistons according to cylinders, each of the presented dimensions is divided into dimensional groups, in which the pistons follow every other 0.02 mm increment, according to skirt diameter.

a. Размер	b. Первоначальный	c. Допустимый без ремонта
d Номинальный . .	30,000–30,045	30,07
e 1-й ремонтный . .	30,250–30,295	30,32

Table 3-4. Dimensions of holes for fork shaft bushings, mm

Key: a) dimension
b) initial
c) allowable without repair
d) nominal
e) first repair

a. Размер	b. Увеличение диаметра	c. Размеры юбки (в плоскости оси пальца)			
		d номинальный или ремонтный	e группы		
			I	II	III
f Номинальный . .	—	101,48 / 101,54	101,48 / 101,50	101,50 / 101,52	101,52 / 101,54
g 1-й ремонтный .	0,5	101,98 / 102,04	101,98 / 102,00	102,00 / 102,02	102,02 / 102,04
h 2-й » . .	1,0	102,48 / 102,54	102,48 / 102,50	102,50 / 102,52	102,52 / 102,54
i 3-й » . .	1,5	102,98 / 103,04	102,98 / 103,00	103,00 / 103,02	103,02 / 103,04

Table 3-5. Dimensions of pistons, mm

Key: a) dimension b) cylinder diameter increase c) skirt dimension (in wrist pin axis plane) d) nominal and repair e) groups f) nominal g) first overhaul h) second overhaul i) third overhaul

a. Размер	b. Обозначение группы			
	I	II	III	IV
c. Номинальный $\left(\frac{27,985}{27,995}\right)$	$\frac{27,9925}{27,9950}$ Голубой f.	$\frac{27,9900}{27,9925}$ Красный g.	$\frac{27,9875}{27,9900}$ Белый h.	$\frac{27,9850}{27,9875}$ Черный i.
d. 1-й ремонтный (+0,12)	28,105—28,115			
e. 2-й » (+0,20)	28,185—28,195			

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Table 3-6. Dimensions of piston wrist pin hole,mm

Key: a) dimension
b) group designation
c) nominal
d) first repair
e) second repair
f) blue
g) red
h) white
i) black

a. Размер	b. Увеличение диаметра	c. Обозначение диаметра пальца по группам				d. Обозначение ремонтного размера
		I	II	III	IV	
e. Номинальный $28^{-0,01}$	—	$\frac{27,9975}{28,0000}$	$\frac{27,9950}{27,9975}$	$\frac{27,9925}{27,9950}$	$\frac{27,9900}{27,9925}$	—
f. 1-й ремонтный . . .	0,12	$\frac{28,1175}{28,1200}$	$\frac{28,1150}{28,1175}$	$\frac{28,1125}{28,1150}$	$\frac{28,1100}{28,1125}$	БР или АР1 l.
g. 2-й » . . .	0,20	$\frac{28,1975}{28,2000}$	$\frac{28,1950}{28,1975}$	$\frac{28,1925}{28,1950}$	$\frac{28,1900}{28,1925}$	БР или АР2 m.
		Голубой h.	Красный i.	Белый j.	Черный k.	

Table 3-7. Piston wrist pin dimensions, mm

Key: a) dimension
b) diameter increase
c) designation of wrist pin diameter according to group
d) designation of repair dimension
e) nominal
f) first repair
g) second repair
h) blue
i) red
j) white
k) black
l) BR or AR1
m) BR or AR2

With perpendicular measurements, ovality in a new piston skirt is allowed to be no greater than 0.15 mm, and piston skirt conicity must be within the limits of 0.04-0.06 mm.

Piston weight must be within the limits of:
For a piston of nominal dimensions, 782-822 grams;
For a piston of +0.5 overhaul dimensions, 782-836 grams;
For a piston of +1.0 mm overhaul dimensions, 790-846 grams;
For a piston of +1.5 mm overhaul dimensions, 814-854 grams.

In a set of pistons for one engine, variations in piston weights are allowed to be no greater than 8 grams. Fitting the pistons by weight is done through boring the internal diameter of the piston skirt belt.

To facilitate individual selection of piston wrist pins, the pistons are broken down into four various groups, according to the diameter of their wrist pin holes, in correspondence with Table 3-6. Marking of the different groups according to nominal wrist pin hole diameter is done by either marking Roman numerals on the piston head (see Plate 3-104) or with paint on the face of the wrist pin hole. Ovality and conicity of the piston wrist pin hole is not allowed to be greater than 0.0025 mm.

Piston wrist pins and rings. Nominal and repair dimensions of piston wrist pins are presented in Table 3-7. The wrist pin is fitted into the piston hole with an interference of 0.0025-0.0075 mm.

The piston wrist pin stop rings must sit in their grooves in the piston with some interference, and must not be able to be rotated by hand. Rings which have lost their elasticity are replaced.

Nominal and repair dimensions of the compression and oil rings are presented in Table 3-8.

Connecting rods which go into repair with deficiencies in the correct cylindrical form of their holes by more than 0.01 mm or which do not fall in the limits of the directed dimension are discarded.

The diameter of the connecting rod big end hole with the nuts torqued must be within the limits of 65.500-65.518 mm (see Plate 3-9). Repair of a connecting rod small end usually includes machining the old bushing for a repair dimension piston wrist pin (when the piston is capped) or exchanging the small end bushing with its subsequent machining for a wrist pin of nominal dimensions (when the piston is exchanged).

During repair of the connecting rod small end hole, the dimensions for the bushing and for the wrist pin in the bushing must correspond to the dimensions shown in Table 3-9.

The wrist pin bushing is pressed into the hole with an interference of 0.147-0.220 mm.

While pressing in the bushing, and also while boring it, it is necessary to ensure that a clearance of 2-3 mm is maintained between the internal faces of the bushing pressed into the connecting rod small end which must provide normal access of lubrication to the piston wrist pin.

For a better fit in bushings which are newly pressed into the connecting rod small ends, and also to compact the surface layer of metal in the bushings, they should be drawn with a smooth broach, and the broach diameter should be 0.5-0.6 mm smaller than the final diameter of the hole for the wrist pin. After drawing with a broach, the bushing is fitted by drilling to the nominal or repair dimension diameter of the piston wrist pin shown in Table 3-7.

For selection of piston wrist pin-connecting rod combinations, the holes in the connecting rod small end (along the bushing) are divided into dimensional groups through each 0.0025 mm. Non-cylindricality of the bushing hole is not allowed to be greater than 0.0025 mm.

The final-machined hole for a piston wrist pin of any dimension (standard or repair) has to be such that, with a temperature of +20°C, the piston wrist pin smoothly moves into the bushing hole under the pressure of a man's thumb. Height clearance between the piston wrist pin and the bushing hole within the limits of 0.0045-0.0095 mm corresponds to this fit.

The crankshaft. The nominal dimension of a crankshaft main bearing journal is 65.97-66.00 mm, and that of a connecting rod bearing journal is 61.975-62.00 mm. The shaft journals are measured with a micrometer, 50-75 mm in size. The shaft journal should be measured on no less than 2 planes which are perpendicular to each other.

Ovality or conicity in the journals of a new shaft, or a shaft which has undergone regrinding, must not exceed 0.01 mm. Surface smoothness of the main and connecting rod journals is assured by grinding and subsequent polishing.

Length of crankshaft journals in mm is:

Connecting rod	38.00-38.10
Main:	
First	43.55-43.62
Second	38.00-38.34
Third	38.00-38.34
Fourth	70.00-70.40
Fifth	38.00-38.34
Sixth	38.00-38.34
Seventh	59.50-59.90

The radii of the connecting rod and main journal fillets are 1.0-3.0 mm. The axes of the connecting rod journals must be parallel to the axes of the main journals. Nonparallelness must not exceed 0.02 mm on the length of each connecting rod journal. Shaft journal wear (non-cylindricality) for connecting rods over 0.05 mm, and for mains over 0.07 mm, requires their regrinding to repair dimensions.

Repair dimensions of crankshaft journals are presented in Table 3-10.

a) Размер	b) Увеличение	c) Наружный диаметр кольца
d) Номинальный	0,0	101,6
e) 1-й ремонтный	0,5	102,1
f) 2-й "	1,0	102,6
g) 3-й "	1,5	103,1

Table 3-8. Piston ring dimensions, mm

Key: a) dimension
b) increase
c) exterior ring diameter
d) nominal
e) first repair
f) second repair
g) third repair

a) [illegible]		d) [illegible]					
		e) [illegible]		f) [illegible]			
				g) [illegible]			
b) [illegible]	c) ремонтный	b) [illegible]	c) ремонтный	I	II	III	IV
29,500 / 29,523	29,800 / 29,830	29,670 / 29,700	29,820 / 29 [illegible]	27,0[illegible] / 26,9945	28,0045 / 26,9970	28,0030 / 27,0000	27,0065 / 27,0070
				Голубой	Красный	Белый	Черный

Table 3-9. Dimensions of the connecting rod small end and bushing, mm

Key: a) connecting rod small end hole for bushing
b) nominal
c) repair
d) bushing dimensions for wrist pin
e) exterior diameter
f) interior nominal diameter of bushing
g) designation of bushing diameter according to groups

The small gear of the camshaft drive is pressed onto the crankshaft. Journal diameter beneath the gear is 49.980-50.034 mm. The interior diameter of the gear hole is 50.000-50.027 mm. Oscillation of the journal beneath the gear must not exceed 0.04 mm. Face oscillation of the small gear must be no greater than 0.025 mm, measured at the side directed toward the face of the main bearing. The diameter of the journal under the fan drive pulley is 45.950-45.975 mm. Width of the keyway is 5.945-5.990 mm. Repair of the key way by milling is allowed to a repair dimension of 6.445-6.490 mm. Face oscillation of the shaft flange on which the flywheel is mounted must not exceed 0.06 mm. Flange width is 8.14-8.50 mm. Diameter of the holes for flywheel fastening is 14.00-14.035 mm.

a Размер	b Уменьшение диаметра	c Размеры шеек коленчатого вала: d коренных	e шатунных
f номинальный		6[illegible],97 / 66,00	61,975 / 62,000
g 1-й ремонтный	0,3	65,67 / 65,70	61,675 / 61,700
h 2-й "	0,6	65,37 / 65,4[illegible]	61,375 / [illegible]
i 3-й "	[illegible]	64,97 / 65,00	[illegible] / [illegible]
j 4-й "	[illegible]	64,47 / [illegible]	[illegible] / [illegible]
k 5-й "	2,0	63,97 / 64,00	[illegible] / [illegible]

Table 3-10. Repair dimensions for main and connecting rod journals of crankshaft, mm:

Key: a) dimension
b) diameter decrease
c) crankshaft journal dimensions
d) main
e) connecting rod
f) nominal
g) first repair
h) second repair
i) third repair
j) fourth repair
k) fifth repair

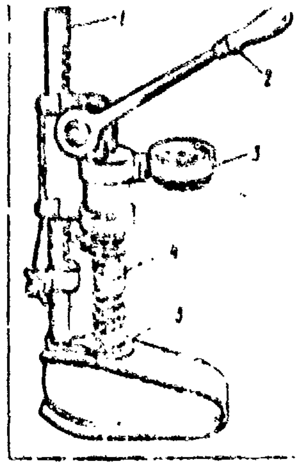

Plate 3-105. Model NIIAT device for checking valve springs:
1) device stand 2) lever 3) manometer
4) spring being checked 5) lower base

Inserts. Nominal and repair insert dimensions are presented in Table 3-11. Marking of the repair dimension inserts (0.3, 0.6, 1.00, 1.50, 2.00) is placed on the steel surface of the insert near its butt joint. Nominal dimension inserts do not have markings.

The camshaft. Diameters of support journals and the amount of their wear allowable without being repaired are presented in Table 3-12.

In grinding the support journals of the shaft to the third and fourth repair dimensions, the oil pump drive gear must be ground along its diameter to the same dimension. Surface smoothness of the lobes and shaft journals is provided by grinding. Oscillation of the front face of the first journal of the shaft is not allowed to be greater than 0.03 mm. After regrinding the journals, it is recommended that shaft straightness be rechecked.

Camshaft lobe profile is identical for intake and exhaust valves. The height of valve lift is 10.1 mm (see Plate 3-10, a). Lobe wear must not exceed 1.2 mm in height. Lobe wear is measured with an indicator according to the difference between the maximum and minimum diameters of the lobe.

Wear on the fuel pump drive eccentric is allowed to a dimension of 41.0 mm. The nominal dimension of the eccentric is 41.65-42.50 mm (Plate 3-10, b). A camshaft on which the lobes or eccentric are worn greater than the allowance is replaced.

Camshaft bearings are bored in the cylinder block parallel to the crankshaft bearings. The distance between the axes of these bearings is 133.35-133.40 mm, and the hole diameter in the block for the camshaft bearings is equal to 60.00-60.03 mm.

Camshaft bearing inserts are thin-walled, stamped from bimetallic tape, and pressed into their receptacles with an interference of 0.045-0.135 mm. Data on the camshaft bushings is presented in Table 3-13. The allowable misalignment of pressed in bushings must not exceed 0.06 mm. Allowable camshaft bushing wear is no greater than 0.05 mm. Camshaft gear dimensions are presented in Plate 3-12, b.

Valve guide inserts. Valve guides, manufactured of type CCh 15-32 (GOST 1412-54) are pressed into the block.

Diameter of the holes in the cylinder block for valve guides is 17.000-17.027 mm. The exterior diameter of the valve guide is 17.040-17.075 mm. Dimensions of the internal holes of the bushings, in mm, are the following:

Nominal dimension, 9.500-9.530
Repair dimension, 9.250-9.280

Valve springs are formed of wire, 3.75 mm in diameter. There are a total of eleven coils, of which 8.5 are working ones. The internal diameter of a coil is 24.00-24.52 mm. Spring height in a free condition must be within the limits of 90-93 mm, and under load of 21.5-23.75 kg, it must be 70 mm. After freeing the spring from the load, it must not have residual deformation. Springs which do not respond to these requirements are exchanged. Height and elasticity of springs are checked on a device (Plate 3-105). The amount of load on the spring is determined according to the manometer 3.

a) Размер	b) Коренные вкладыши: d)	e)	f)	c) Шатунные вкладыши: d)	e)	f)
g) Номинальный	1,87 / 2,00	2,230 / 2,237	64,02[illegible] / 64,03[illegible]	1,50 / 1,60	1,730 / 1,737	62,01[illegible] / 62,041
1) 1-й (−0,[illegible]) ремонтный	2,02 / 2,15	[illegible] / [illegible]	63,720 / 63,735	1,64 / 1,63	1,860 / 1,8[illegible]	61,712 / 61,741
2) 2-й (−0,[illegible]) ремонтный	2,17 / 2,30	2,[illegible] / 2,357	63,4[illegible] / 63,435	1,67 / 1,80	2,030 / 2,037	61,412 / 61,441
3) 3-й (−1,00) ремонтный	2,[illegible] / 2,45	2,730 / 2,737	63,026 / 63,0[illegible]	1,8[illegible] / 1,95	2,230 / 2,237	61,012 / 61,041
4) 4-й (−1,50) ремонтный	2,54 / 2,70	2,9[illegible] / 2,987	64,0[illegible] / 64,3[illegible]	2,07 / 2,20	2,4[illegible] / 2,487	60,512 / 60,541
5) 5-й (−2,00) ремонтный	2,79 / 2,93	3,230 / 3,237	64,020 / 64,035	2,29 / 2,45	2,730 / 2,737	60,012 / 60,041

Table 3-11. Dimensions of main and connecting rod inserts, mm

Key: a) dimension b) main bearings c) connecting rod bearings d) steel band thickness e) overall insert thickness f) diameter of bearing (insert) g) nominal 1) first repair 2) second repair 3) third repair 4) fourth repair 5) fifth repair

a) Размер	b) [illegible]	c) d) [illegible]	c) e) [illegible]
f) Номинальный	—	53,02 / 53,01	53,00
1) 1-й ремонтный	0,20	58,73 / 53,70	53,60
2) 2-й	0,40	58,53 / 53,53	[illegible]
3) 3-й	0,60	53,33 / 53,34	[illegible]
4) 4-й	0,80	53,13 / 53,18	53,08

Table 3-12. Diameters of crankshaft bearing journals and their wear allowable without repair, mm

Key: a) dimension
b) diameter decrease
c) journal dimension
d) before wear
e) allowable without repair
f) nominal
1) first repair
2) second repair
3) third repair
4) fourth repair

The valve seat. If the seat of an intake or an exhaust valve is worn by more than 1.5 mm, a substitute valve seat can be pressed in (Plate 3-105). Dimensions of the cavity in the cylinder block for the replaceable valve seat are presented in Table 3-14. Type CCh 18-36 (GOST 1412-54) iron is used for manufacturing replacement seats. The dimensions of the replacement valve seat are presented in Table 3-15. After pressing, the seat is calked in, and the working surface of its face is ground.

Valve tappets. Tappet dimensions, as well as dimensions of the internal diameter of the holes in the tappet guides, are presented in Tables 3-16 and 3-17.

The two end holes of each tappet guide section have a dimension of 0.016-0.021 mm larger than the middle holes to compensate for linear deviation.

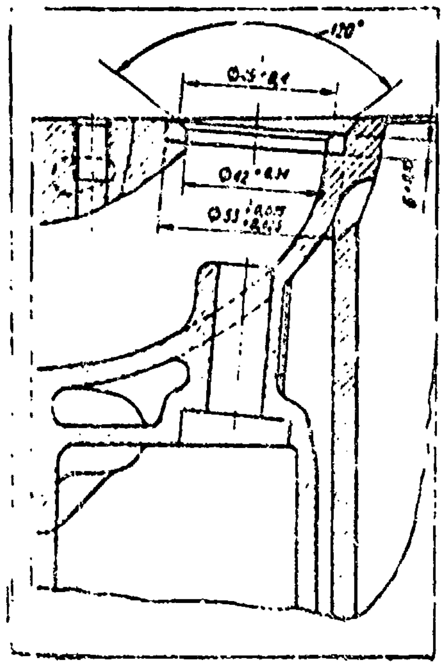

Plate 3-106. Replaceable intake valve seat, installed in cylinder block

a Наружный диаметр	b Внутренний диаметр		e Уменьшение
	c номинальный	d ремонтный	
60,075 — 60,135	54,000 — 54,030	53,800 — 53,830	0,20
		53,600 — 53,630	0,40
		53,400 — 53,430	0,60
		53,200 — 53,230	0,80

Table 3-13. Dimensions of camshaft bushings, mm

Key: a) exterior diameter
b) interior diameter
c) nominal
d) repair
e) decrease

NOTE: Length of front and rear journals is 32 mm. Length of middle journals is 22 mm.

a Клапан	b Диаметр гнезда	c Глубина гнезда
d Впускной	53,00—53,05	6,00—6,10
e Выпускной	48,00—48,05	6,00—6,10

Table 3-14. First repair dimensions of cavities in cylinder block for pressing in valve seats, mm

Key: a) valve
b) cavity diameter
c) cavity depth
d) intake
e) exhaust

a Клапан	b Наружный диаметр, мм	c Высота, мм	d Ширина рабочей фаски, мм	e Угол рабочей фаски, град
f Впускной	53,075—53,125	5,90—6,00	2,5	30
g Выпускной	48,075—48,125	5,90—6,00	2,5	34

Table 3-15. First repair dimensions of replacement valve seats

Key: a) valve
b) exterior diameter, mm
c) height, mm
d) working face width, mm
e) angle of working face, °
f) intake
g) exhaust

The oil pump. The diameter for the hole for the drive shaft in the oil pump body must be within the limits of 15.03-15.06 mm. If the hole diameter is increased to more than 15.12 mm, the body must be exchanged or the hole repaired.

The oil pump drive shaft diameter must be 14.998-15.00 mm. If the shaft diameter is decreased to 14.970 mm, it should be replaced. Curvature of the shaft is not allowed to be greater than 0.03 mm. Width of the key way must be within the limits of 2.950-2.990 mm. Increase in key way width is allowed to a dimension of 3.040 mm without being repaired.

The nominal dimension of the driven gear shaft must be within the limits of 15.070-15.082 mm. With equal wear, shaft diameter decrease is allowable to 15.030 mm. One-sided shaft wear is not allowable. A worn out shaft should be pressed out and replaced with a new one. The nominal dimension of the hole in the body for the driven gear shaft must be within the limits of 15.03-15.06 mm. If the hole diameter is increased to 15.070 mm, the body is exchanged.

a)	b)	c) d)	c) e)
f) Номинальный	—	15,967 / 15,984	15,94
1) 1-й ремонтный	−0,25	15,717 / 15,734	15,69
2) 2-й	−0,50	15,467 / 15,484	15,44
3) 3-й	+0,25	16,217 / 16,234	16,10

Table 3-16. Valve tappet dimensions, mm

Key:
a) dimension
b) decrease or increase in tappet diameter
c) tappet diameter
d) initial
e) allowable without repair
f) nominal
1) first repair
2) second repair
3) third repair

The nominal dimension of the driven gear hole (Plate 3-107) for the shaft must be within the limits of 15.100-15.127 mm. With an increase in the gear hole to a diameter over 15.170 mm, the gear should be replaced or undergo repair by means of installing a bushing.

a)	b)	c)		d)	
		e)	f)	e)	f)
g)	—	16,000 / 16,019	16,02	16,016 / 16,040	16,00
1)	−0,25	15,750 / 15,769	15,82	15,766 / 15,790	15,84
2)	−0,50	15,500 / 15,519	15,57	15,516 / 15,540	15,59
3)	+0,25	16,250 / 16,269	16,32	16,266 / 16,290	16,34

Table 3-17. Diameter of holes in tappet guide sections, mm

Key: a) dimension
b) decrease or increase in guide hole
c) for middle holes
d) to end holes
e) initial dimension
f) allowable dimension without repair
g) nominal
1) first repair
2) second repair
3) third repair

The surface of the pump cover which is assembled against the gear faces must be flat. Deviation in flatness and wear are not allowed to be greater than 0.05 mm.

It is necessary to pay attention to the oil pickup hole in the pump inlet sleeve. With a large clearance between the pickup pipe and the sleeve, air leakage occurs and oil pressure decreases. If the pipe wears, it is necessary to replace it or sleeve it.

The water pump. In the water pump, the nominal dimension of the hole for the front bearing is 46.992-47.018 mm, and for the rear bearing, it is 39.980-40.007 mm. With an increase in the diameter of the front hole to more than 47.05 mm, or of the rear one to greater than 40.04 mm, the pump body must be exchanged. If necessary, the pump body may be repaired by means of drilling out the holes in the body and installing bushings with subsequent fitting of the internal diameter of the bushings to the nominal dimension. Dimensions of the water pump body are shown in Plate 3-108.

The water pump shaft has a diameter of 17.012-17.030 mm (Plate 3-109). When the shaft wears to a diameter of less than 17.00 mm, it must be replaced with a new one. Shaft curvature is allowed to be no greater than 0.03 mm. Key way width must be 3.945-3.990 mm, and with an increase in key way width to a dimension greater than 4.02 mm, the shaft must be replaced with a new one.

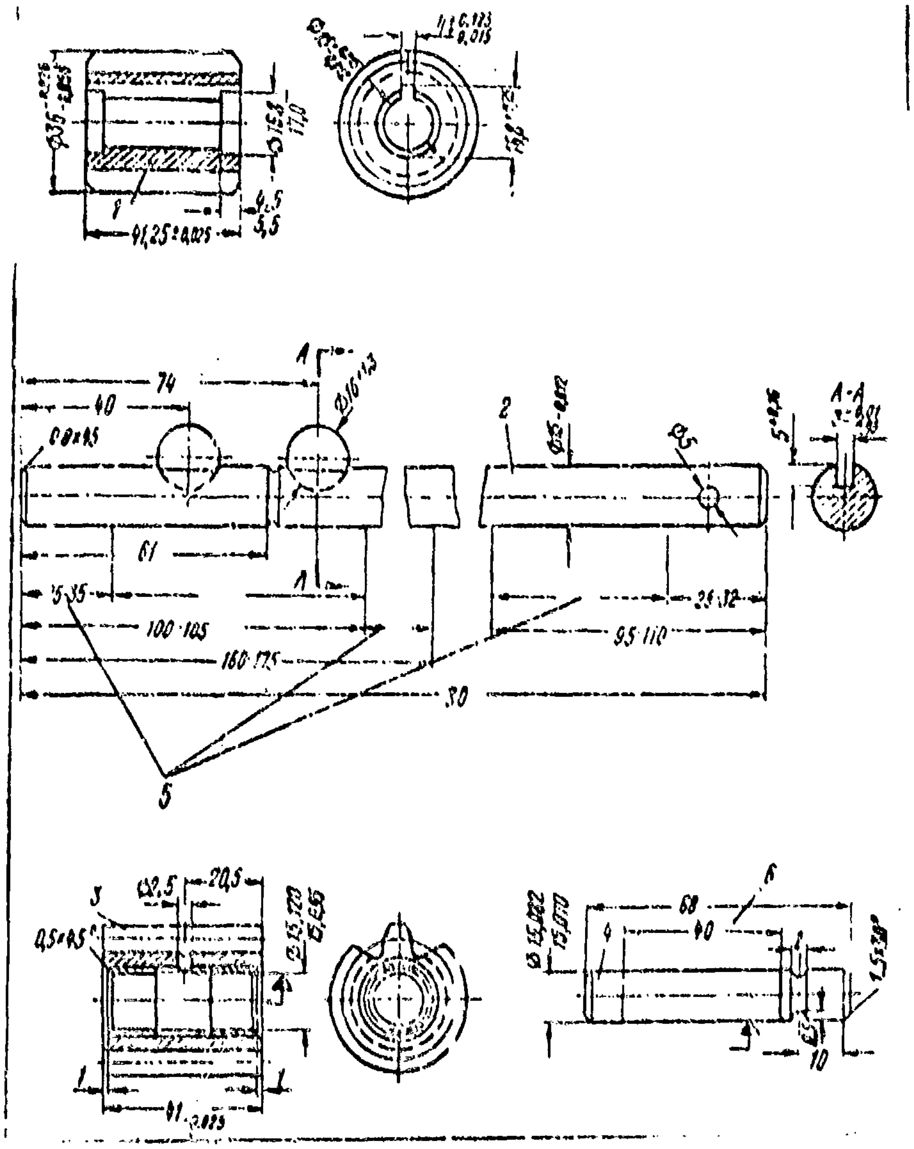

Plate 3-107. Dimensions of oil pump parts: 1) driven gear 2) drive shaft 3) drive gear 4) driven gear shaft 5) areas of shaft heating 6) area of drive gear shaft heating

Cracks and chips on the vanes are not allowed. The diameter of the hole for the vane shaft has a dimension in the limits of 16.965-17.000 mm. The vanes are fitted on the shaft with an interference of 0.065 mm or with a clearance of 0.08 mm and subsequent fastening with a pin.

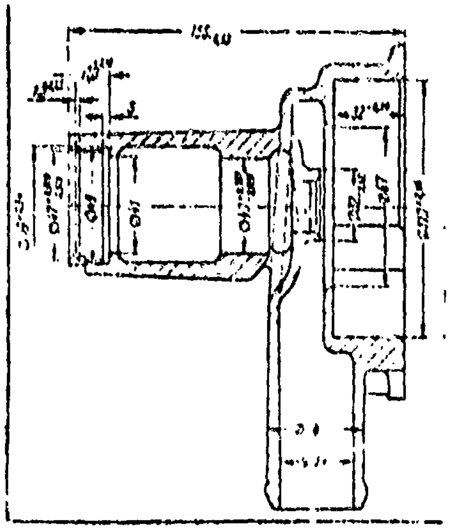

Plate 3-108. Water pump body

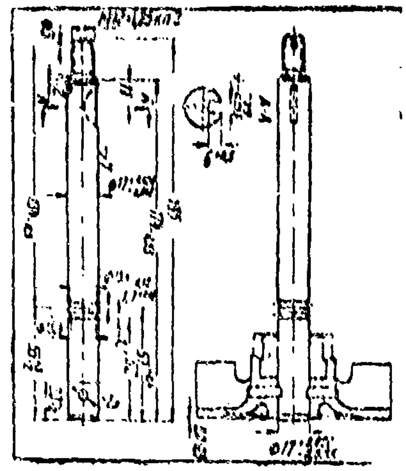

Plate 3-109. Water pump shaft with vanes and without vanes

Methods of renewing the cylinder block

The cylinder block is the base part and must be discarded as rarely as possible, leading to all possible methods of repair.

Renewal of threaded holes. If threads in the cylinder block are cut or worn, repair dimension threads are tapped or thread stoppers are inserted. Beaten down threads are trued with a tap. A thread stopper may be installed under the condition that the walls of the threaded hole have sufficient thickness.

The threaded hole can be renewed with thread stoppers in this way: the damaged hole is drilled out, threads are tapped in it, and the thread stopper is covered with red lead and screwed into the hole. After installation of the thread stopper, its head is cut off and the stopper is fastened in its receptacle by punching, copper soldering, or pinning. After this, the stopper is marked, and a new hole is drilled according to the mark and new threads are tapped in it.

Cracks in the cylinder block are sealed by one of the following methods: installation of a patch; pinning; sealing with epoxy resins; or electric arc welding.

In sealing cracks with epoxy resins, two recipes of adhesive mastics (in parts by weight) are used:

	Recipe No.	Recipe No. 2
ED-6 epoxy resin	100	100
Dibutylphthalate	20	20
Crushed No. 7 asbestos	--	50-100
Steel powder	160	--
Maleic or phthalmic anhydride	--	30-35
Polyethylene-polyamine or hexamethyldiamine	10	--

The order for preparation of the mastic is as follows: the epoxy resin is heated together with the packing in a water bath to a temperature of 60-80°C, after which the dibutylphthalate, serving as the plasticizer, goes into it. The mixture is carefully stirred and the filler is added. Steel powder serves as the filler. The mixture is again stirred, cooled to room temperature, and sealed up.

The surface which is to be sealed is cleaned of rust and dirt. The ends of the crack are drilled with a 3-3.5 mm drill, then, using a grinding wheel, the face is removed from the two sides at an angle of 90-120° to a depth equal to four-fifths of the whole thickness. The prepared surface is decreased with acetone and set out for 3-5 minutes, until the solvent is fully evaporated.

The hardener, polyethylene-polyamine (hexamethyldiamine) or maleic (phthalmic) anhydride is added to the prepared epoxy resin mixture. The mixture is carefully stirred. Upon adding the hardener, the mixture will spontaneously heat, and therefore the hardener must be added in separate portions, not allowing the mixture to heat higher than 40°C.

In this form, the mastic is usable at a temperature of 15-20°C for a period of 20 minutes, and at a zero temperature, it may be kept for eigh hours. For better adherence of the mastic to the metal, the place subjected to sealing is heated to a temperature of 60-80°C.

A prepared mixture is applied with a spatula, carefully smearing it into the prepared surface. A second layer of mastic is applied on top of the crack, running over it by 10 mm on each side and 2-3 mm higher than the surface of the block.

A fiberglass patch can be applied after application of the mastic.

Forty-eight hours are required for full setting of the mastic prepared according to Recipe No. 1 at a temperature of 15-20°C. To accelerate the process, the cylinder block must be heated. Setting of the mastic prepared according to Recipe No. 2 requires heating to a temperature of 120-140°C and holding for a period of 16-24 hours.

Electric arc welding of cracks is done with a copper electrode 3 mm in diameter, wrapped with tin plate or aluminum covered plate. The welding is done with direct current with reversed polarity (minus on the part, plus on the electrode). It is recommended that the power of the welding current be maintained within the limits of 120-130 amperes.

The ends of the crack are drilled with a 3-3.5 mm drill. The place of welding is cleaned of oxides, grease and dirt. The crack is excavated, sloping its edges so that the overall angle is 60-70°.

To avoid the appearance of new cracks, the cylinder block cannot be heated, and it is necessary to weld in 10-21 mm sections and allow it to cool to a temperature of 50-70°C.

A chalk coating on the electrode increases stability of the welding arc.

While welding, the arc must be kept short, not allowing deep melting of the part metal.

Chapter 4. The V-Engine

General description

The ZIL-V-engines are 8-cylinder, carbureted, and 4-stroke, with a 2-row cylinder arrangement. The angle between the rows of cylinders is 90°. Production of the engine was first undertaken at the plant in 1964. The engine (Plates 4-1 and 4-2) is installed in the ZIL-130 and ZIL-131 trucks.

The base of a large group of basic parts of identical dimensions, such as cylinder blocks, crankshaft, its bearings, connecting rods, and gas distribution mechanism parts, made possible the creation of a series of short stroke engines capable of working in the most difficult conditions. Assembling the cylinder block with sleeves having an internal diameter of 100 mm produces an engine with a working volume of 6 liters, and assembly with sleeves having an internal diameter of 108 mm produces an engine with the working volume of 7 liters. Piston stroke in both cases is 95 mm.

The 7 liter engine carries the designation ZIL-375, and is used in trucks manufactured by the Ural motor vehicle plant.

Basic parameters of the V-engines are:

Maximum power at 3100 rpm (at governor speed), hp......................150
Beginning of engine crankshaft revolution governor operation, rpm......3100+100
Maximum torque at 1800-2000 rpm, kg meters..................................41

Cylinder bore and piston stroke, mm.........100 X 95
Compression ratio 6.5 : 1
Displacement, liters........................ 6

The basic differences between the ZIL-130 (plates 4-3, 4-4), ZIL-131 (Plates 4-5, 4-6), and ZIL-131A engines are given in Appendix 1 (see Part 2). The plant number of the engine is stamped on a special surface located on the top face of the cylinder block, in the front right hand part. The number is also stamped on the plant plate, which is located on the right side of the driver's seat frame.

Plate 4-1. ZIL-130 engine

The crankshaft-connecting rod and gas distribution mechanisms

The cylinder block (Plate 4-7) is cast of type CCh 18-36 iron (GOST 1412-54). With the exception of the tappet guide holes, all friction surfaces in the cylinder block are changeable: the cylinder sleeves, crankshaft bearing inserts, and the camshaft support bushings. This block construction makes it practically non-wearing.

Without the sleeves in the block, the engine cooling system hollow is an open space which is easily accessible for cleaning out scale.

To provide high block strength, the bottom assembly surface (cylinder block to oil pan) is dropped below the axis of the crankshaft by 65.9-66.1 mm.

The order of cylinder numbering is shown in Plate 4-8.

The cylinder block sleeves (Plate 4-9) are wet, directly wetted by the cooling liquid. The sleeves are cast of type CCh 18-36 iron (GOST 1412-54). To increase corrosion resistance in the sleeves, an insert 2 (manufactured of acid resistant alloyed iron) is pressed into its upper part.

The clutch housing (Plate 4-10) is iron. The rear engine mount feet are cast together with the clutch housing. Final drilling of the holes centering the transmission on the clutch housing takes place with the housing in assembly with the cylinder block, and therefore disassembly of the housing and the block is not recommended. The housing should be disconnected from the block only if necessary.

In the ZIL-131 engine, a plug with a hole through it and a pin inserted in it is screwed into the bottom cover of the clutch housing. This hole serves (also in the ZIL-130 housing) to drain oil which has gotten into the clutch housing.

In the operating instructions, it is projected that before fording a stream with a ZIL-131, the plug with the pin will be unscrewed from the housing cover and a spare plug without a hole will be screwed in. This spare plug is located on the bearing cover of the front axle reduction gear drive shaft.

After fording the stream, the plugs must be exchanged.

The cylinder head. Two heads (Plate 4-11), manufactured of aluminum alloy, are installed on the V-engine. Each head is fastened to the cylinder block with 17 bolts.

Four bolts on each cylinder head are also used for fastening the rocker arm shaft supports. Location of each cylinder head on the block is accomplished with two pins which are pressed into the cylinder block.

Since 1967, the cylinder heads have been manufactured with holes 12 mm in diameter (instead of 10 mm) for fastening the exhaust manifold in its middle part.

The steel-asbestos reinforced gasket is installed between the head and the cylinder block. Holes in the cylinder block for spark plugs have a thread of 14 mm and a pitch of 1.25 mm.

Intake and exhaust valves for each row of cylinders are located on each cylinder head.

The pistons are manufactured of AL 30 aluminum alloy (GOST 2685-63) and covered with tin. An iron ring is cast into the piston head, and the groove

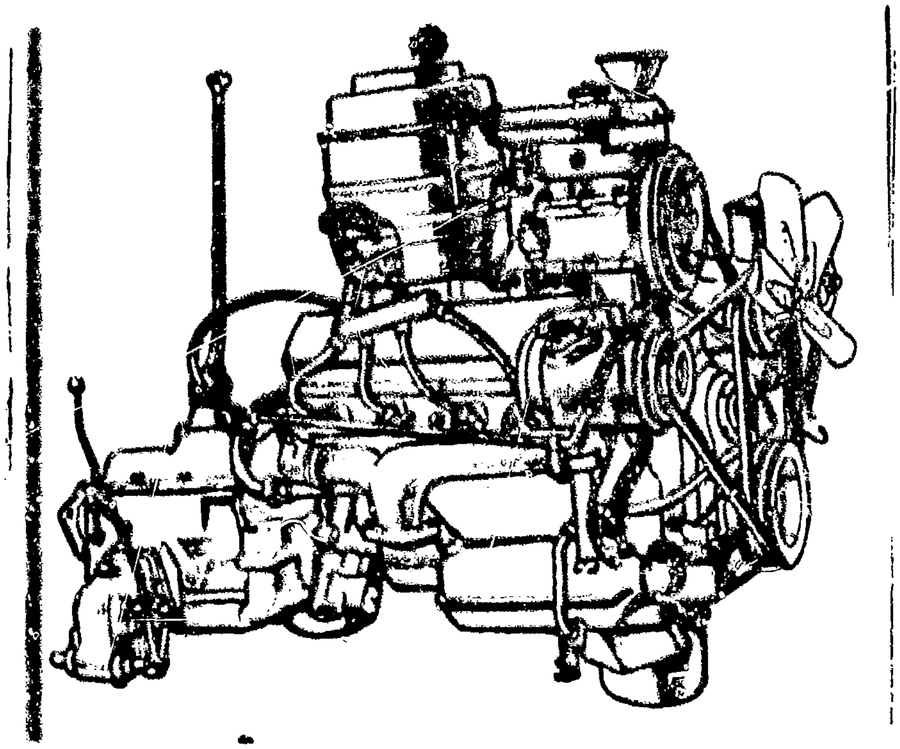

Plate 4-2. ZIL-131 engine

for the top, most stressed, compression ring is cut in this ring.[1] The piston, profile of piston grooves, and their dimensions are shown in Plate 4-12.

A piston skirt has the form of an elliptical cone whose large base is located at the bottom edge of the skirt, and the largest axis of the ellipse lies in a plane perpendicular to the axis of the piston wrist pin. For the purpose of redistributing pressure on the cylinder wall and eliminating rocking of the piston skirt near TDC, and consequently, for decreasing noisiness of the engine's operation, the axis of the piston wrist pin is displaced from the axis of the piston by an amount of 1.6 mm.

Piston wrist pins (Plate 4-13) are manufactured of 15Kh steel (GOST 4543-61).

Piston rings are shown in Plate 4-14. Compression rings are cast of iron, alloyed with molybdenum (GOST 846-58), of HRB 98-106 hardness. The surfaces of the two top compression rings are chromed. The oil ring is composite, consisting of two flat steel rings and two spreaders, an axial one and a radial one. The surface of the flat steel rings is chromed.

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1 Use of aluminum pistons without iron rings is permissible.

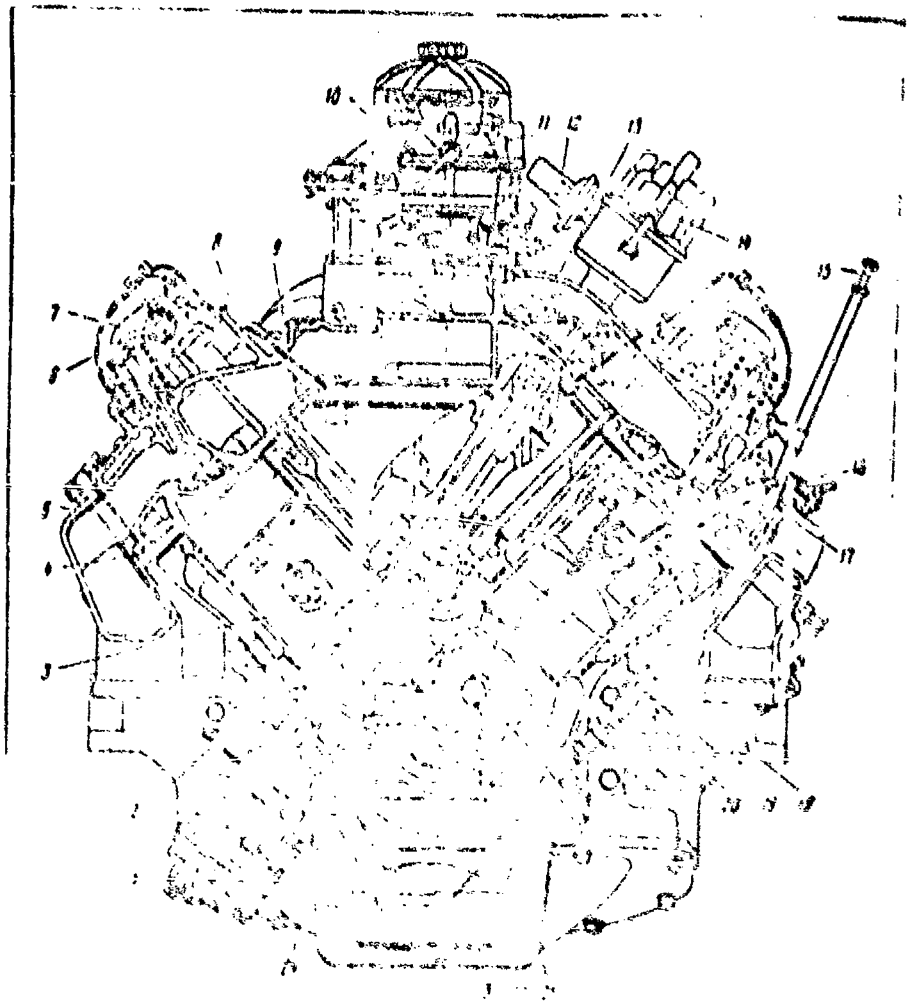

Plate 4-2. Cross section of ZIL-130 engine:
1) oil pump 2) cylinder block 3) piston
4) cylinder head gasket 5) exhaust manifold
6) valve cover 7) rocker arm 8) cylinder
9) tappet push rod 10) centrifugal oil
cleaning filter 11) carburetor 12) distributor
drive body 13) intake manifold 14) distributor
15) oil dipstick 16) spark plug 17) spark
plug protective plate 18) tappet 19) starter
plate 20) starter 21) oil pan 22) oil pickup
23) cylinder sleeve 24) connecting rod

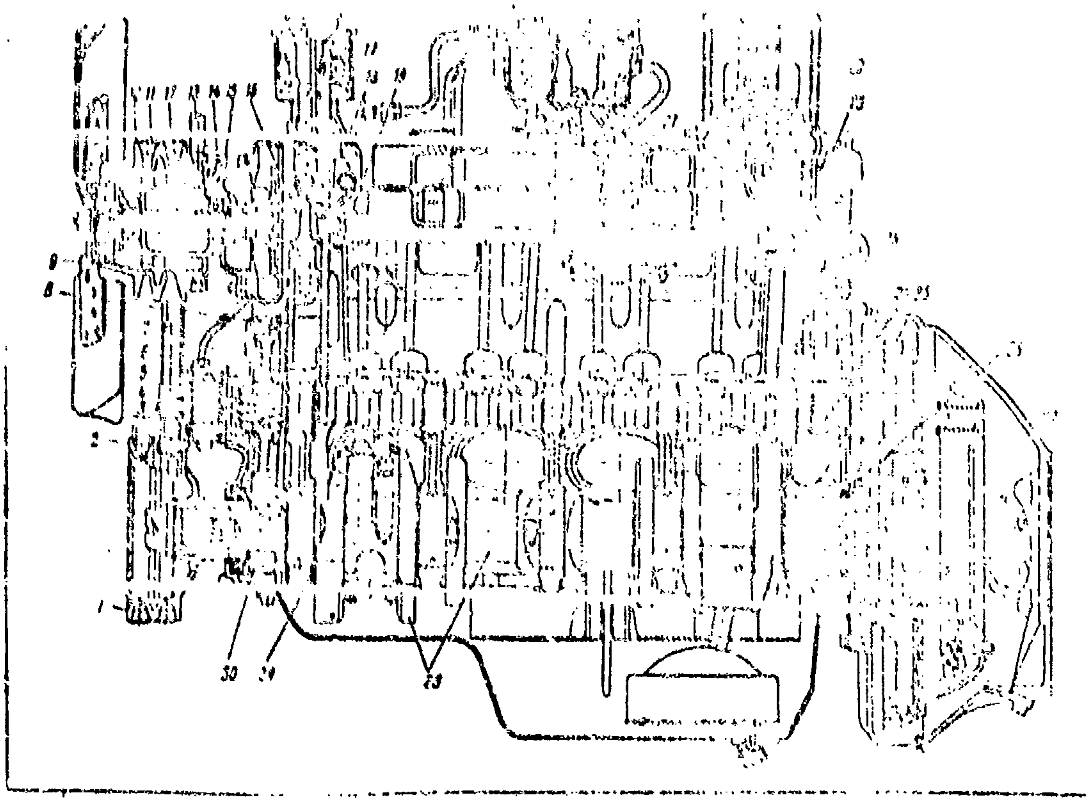

Plate 4-4. Profile section of ZIL-130 engine:
1) crankshaft pulley 2) ignition timing index 3) revolution governor switch 4) switch drive shaft 5) shaft spring 6) space ring 7) support flange 8) camshaft gear cover 9) water pump 10) water pump and fan pulley 11) generator drive belt 12) belt for hydraulic power steering pump 13) compressor drive belt 14) plug 15) lubrication fitting 16) engine lifting rings 17) crankcase ventilation filter 18) fuel pump 19) pump rod 20) fuel fine cleaning filter 21) ventilation system valve 22) centrifugal oil cleaning filter 23) oil pressure indicator switch 24) camshaft 25) insert 26) seal 27) clutch 28) crankshaft 29) support ring 30) crankshaft gear

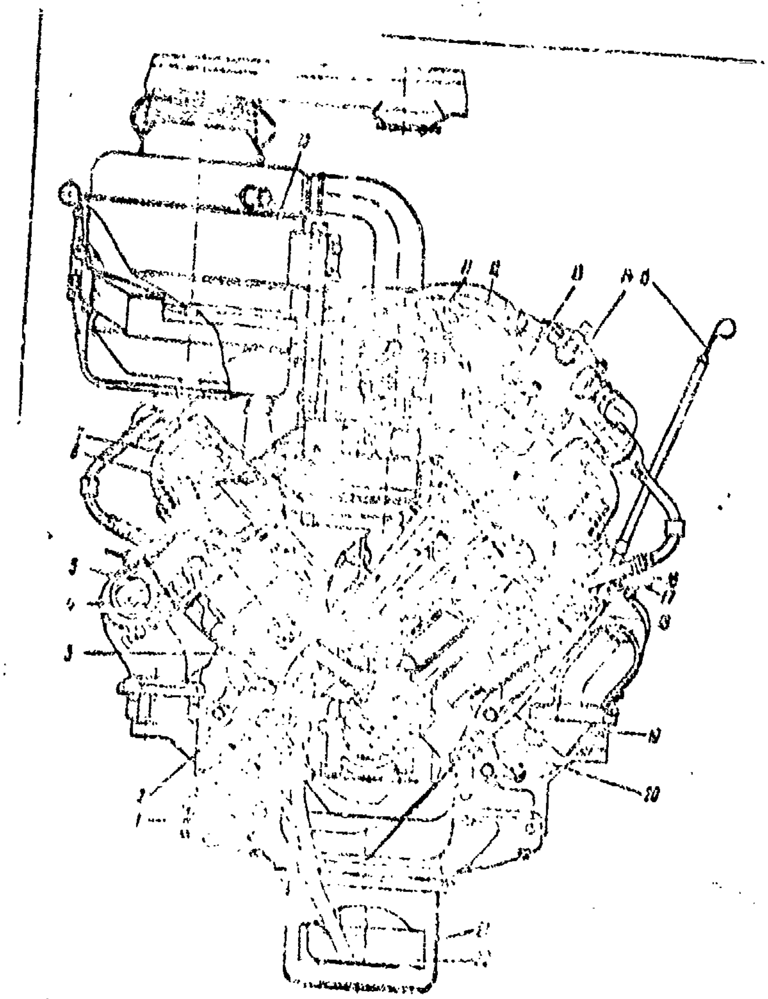

Plate 4-5. Cross section of ZIL 131 engine:
1) oil pump 2) cylinder block 3) piston with connecting rod 4) cylinder head gasket 5) exhaust manifold 6) valve cover 7) rocker arm 8) cylinder head 9) push rod 10) air filter 11) carburetor 12) distributor drive body 13) intake manifold 14) distributor 15) oil dipstick 16) spark plug 17) spark plug protective plate 18) tappet 19) starter plate 20) starter 21) oil pan 22) oil pickup

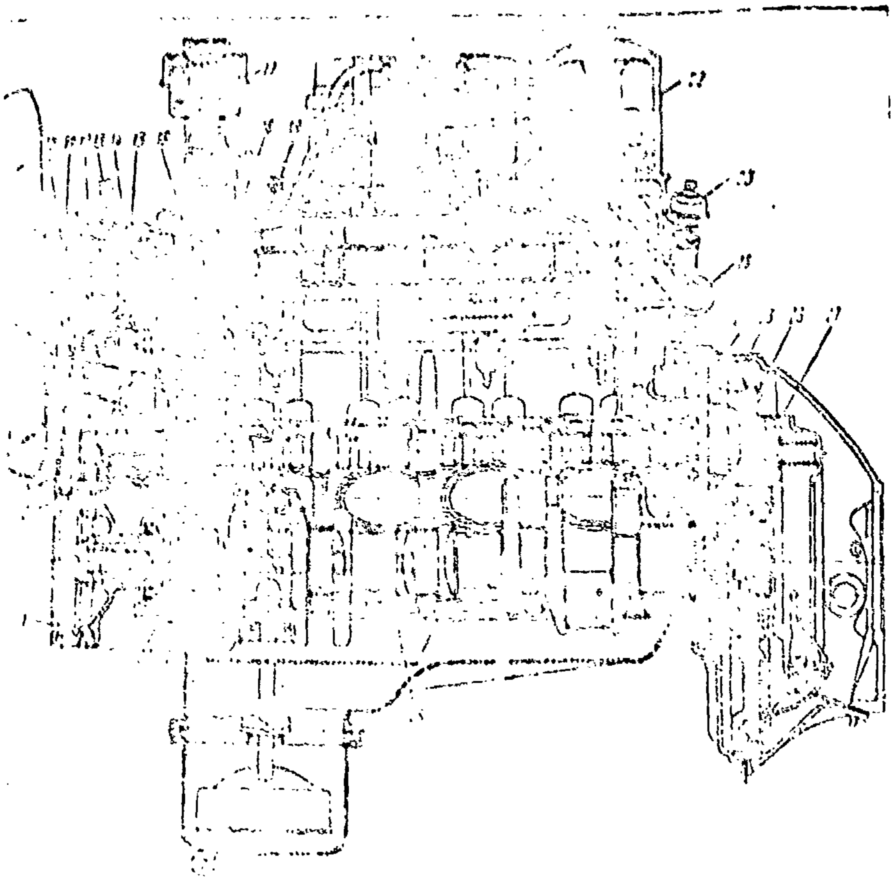

Plate 4-6. Longitudinal section of ZIL-131 engine:
1) crankshaft pulley 2) ignition timing index 3) revolution governor switch 4) switch drive shaft 5) shaft spring 6) space ring 7) support flange 8) camshaft gear cover 9) water pump 10) water pump and fan pulley 11) generator drive belt 12) belt for hydraulic power steering pump 13) compressor drive belt 14) plug 15) lubrication fitting 16) engine lifting rings 17) crankcase ventilation filter 18) fuel pump 19) pump rod 20) fuel fine cleaning filter 21) ventilation system valve 22) centrifugal oil cleaning filter 23) oil pressure indicator switch 24) camshaft 25) insert 26) seal 27) clutch 28) crankshaft 29) support ring 30) crankshaft gear

Plate 4-7. Cylinder block

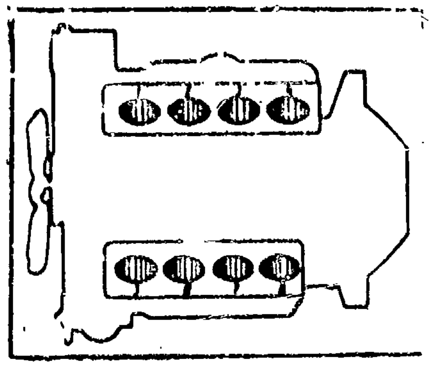

Plate 4-8. Order of cylinder numbering

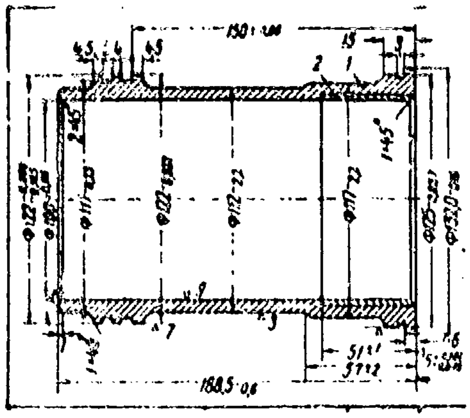

Plate 4-9. Cylinder block sleeve:
1) sleeve 2) sleeve insert

Part of the engines in 1964 and 1965 were released by the plant with iron oil rings. The connecting rods (Plate 4-15) are forged steel, with an I-section.

The crankshaft (Plate 4-16) is forged steel. To increase wear resistance, the main and connecting rod journals are subjected to surface hardening to a depth of 3.0-6.5 mm, with high frequency current. After hardening, the hardness of the shaft journal surfaces is HRC 52-62. The crankshaft is balanced. Allowable imbalance is no more than 30 gram cm. Imbalance is eliminated by drilling the crankshaft counterweights.

The crankshaft bearings, main and connecting rod, have thin-walled, easily removable inserts which are executed of trimetallic bands: a steel band, a sublayer of copper and nickel, and a layer of antifriction alloy.

ALT-6-6 alloy (antimony 5.5-6.5%; tin 5.5-6.5%; lead remainder) is used as the antifriction alloy in inserts. Thickness of the antifriction alloy on the inserts is 0.08-0.12 mm. In the transfer to inserts made of steel-aluminum bands, their longevity is doubled over inserts made of trimetallic bands.

Sealing the crankshaft. Installation of crankshaft seals and packing is described in engine assembly. To eliminate oil leakage from the rear main bearing, oil-driving spiral grooves 4 are formed on the shaft journal (see Plate 4-16), and the seal area is knurled.

The flywheel (Plate 4-17) is iron, with a steel-toothed ring fitted on it for starting the engine with the starter. The flywheel and starter ring are press fitted.

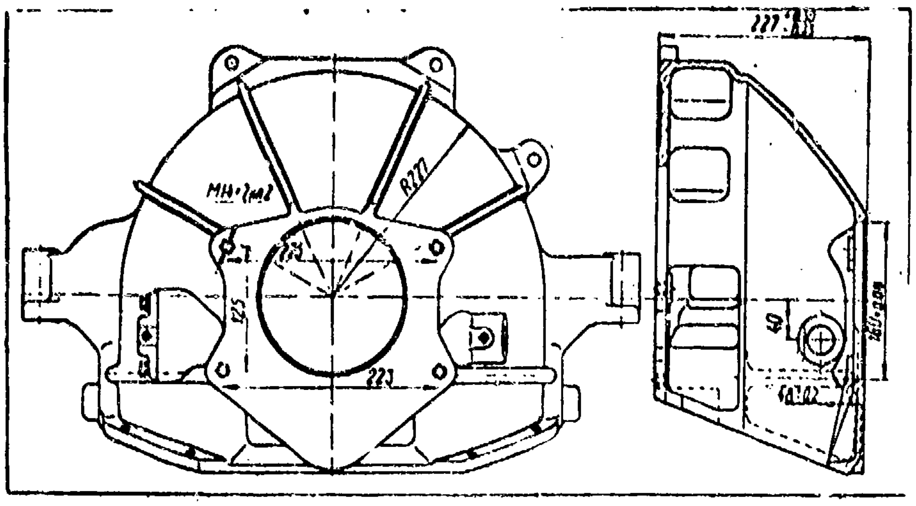

Plate 4-10. Clutch housing

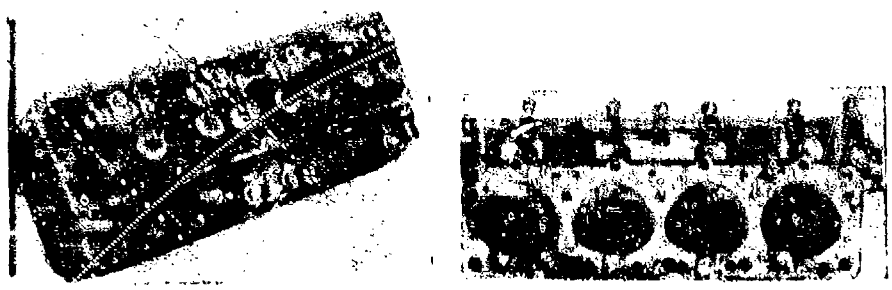

Plate 4-11. Cylinder head in assembly: a) view from rocker arm side b) view from compression chamber side

The camshaft (Plate 4-18) is steel, forged, and its support journals, lobes, and eccentric are subjected to surface hardening through high frequency current to a depth of 2-5 mm. After hardening, the journals have a hardness of HRC 54-62.

The gas distribution diagram for the engine is presented in Plate 4-19. The camshaft provides the following phases[1] of gas distribution:

Intake valve opening..........................31° before TDC
Intake valve closing..........................83° after BDC
Exhaust valve opening.........................67° before BDC
Exhaust valve closing.........................47° after TDC

There is an eccentric on the drive shaft which drives the fuel pump, acting on the pump lever through rod 10 (see Plate 4-18). Spiral gear 15 is cut on the back end of the crankshaft, and, engaged with gear 13 and rotating shaft 17, drives the oil pump and distributor.

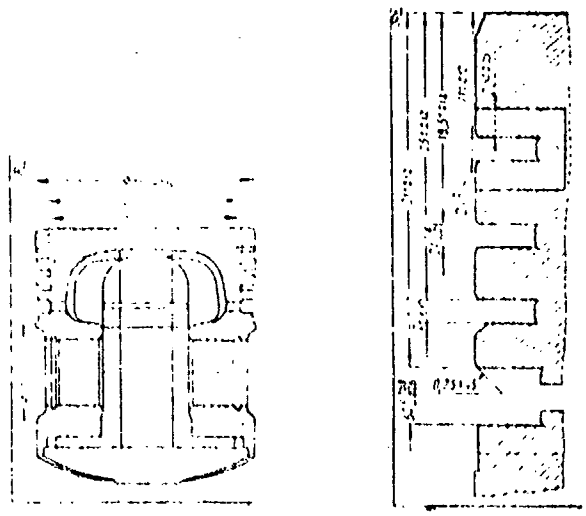

Plate 4-12. Piston: a) piston in section b) piston groove profile

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[1] Angles of gas distribution are given with a clearance of 0.30 mm between the rocker arm and the face of the valve stem.

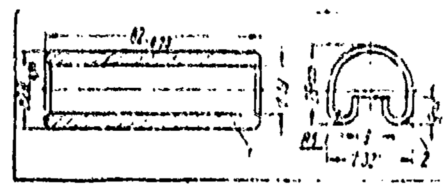


Plate 4-13. Piston wrist pin and stop ring:
1) wrist pin 2) ring

Nut 5, fastening the camshaft gear simultaneously fastens the drive assembly of the centrifugal engine revolution governor switch, which consists of shaft 3 with spring 4 and washer 2, which in connection with the shaft goes into a slot in nut 5 and is fastened by stop ring 1.

The camshaft is installed in the cylinder block on 5 sliding bearings, which are bimetallic bushings pressed into the cylinder block. The camshaft is held in the cylinder block in a longitudinal direction by flange 9, which is mounted on it and fastened on the cylinder block with two bolts.

The profile of the camshaft lobes (Plate 4-20) is identical for both the intake and exhaust valves. The height of tappet lift is 6.85 ± 0.5 mm, and the height of valve lift is 10.25 mm.

The camshaft gears. The crankshaft gear (Plate 4-21, a) is steel. The camshaft gear (Plate 4-21, b) is cast iron.

The camshaft gear cover (Plate 4-22), made of aluminum alloy, is installed on a gasket. The cover is centered with two installation pins which are pressed into the cylinder block. The centering holes in the cover have a dimension of 10.023-10.050 mm.

The toothed indicator for timing setting and the switch of the centrifugal engine revolution governor are fastened onto the camshaft gear cover. The seal 1 of the front end of the crankshaft is pressed into assembly in the receptacle in the cover. The seal is self-pressing, and rubber with a metallic body, which is pressed into the cover receptacle with a mandrel 2 and hammer.

In all cases where there is noticeable wear, visible cracks, or other damage on the working surface of the seal, and also in cases where the seal rubber is hardened or stretched, the seal is replaced.

The valves (Plate 4-23) are overhead, located in the cylinder head inclined to the axis of the cylinders, and are brought into motion by the camshaft through a push rod, tappet, and rocker arm. The valves are manufactured of heat resistant steel, and the valve stems are chromed. The stem of the exhaust valve has a canal which is filled with sodium coolant, and for increased wear resistance, the working face has a surface made of heat resistant alloy. Holes in the valve are closed with a plug which ensures tightness. The plug must sit tightly in its receptacle.

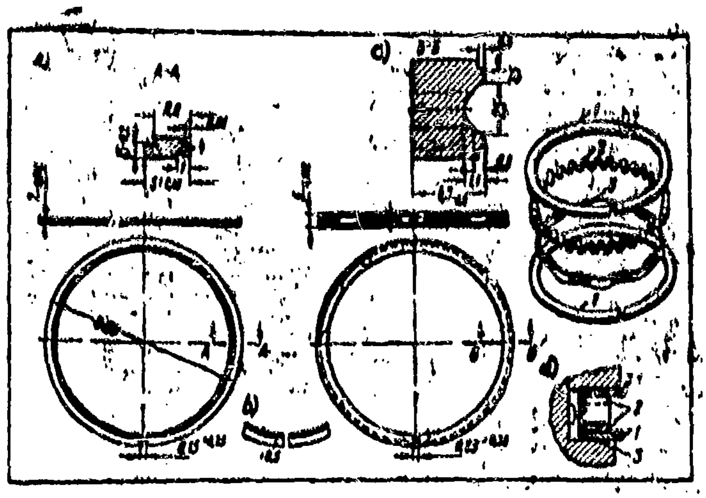


Plate 4-14. Piston rings:
a) middle compression ring b) designation of repair dimension piston ring c) iron oil ring d) cross section of disassembled oil ring 1) ring disks 2) axial spreader 3) radial spreader 4) chromed cover layer of ring

To increase the life of the working surface of the exhaust valve, it has a compulsory rotating mechanism.(Plate 4-24, a). The mechanism consists of: a stationary body 4, five balls 5, and five return springs 12, located in depressions in the body, a conic disk spring 11, a washer 6 which absorbs valve spring load, and also a lock ring 7.

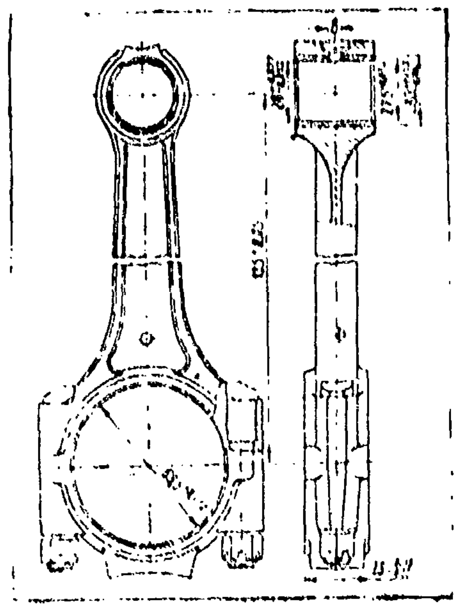


Plate 4-15. Connecting rod

The support washer and disk spring are freely fit with a clearance on body 4, which is located in a special receptacle in the cylinder head. With a closed valve, the effort of spring 8 through the support washer 6 is transmitted to the exterior edge of the disk spring 11 (Plate 4-24, b), which at that moment rests on the shoulder of the body 4 on its internal edge. During opening of the valve, through action of the compressed valve spring, the conic disk spring 11 begins to straighten out and rotate around the balls, pressing on them. From this moment, the force of the valve spring begins to be transmitted to the balls 5 (plate 4-24, c), which, rolling along the inclined surface of the cavity in body 4, rotate the conic disk spring 11 and support washer 6 around their axes, rotating the valve spring and valve together with them.

During closing of the valve, pressure of the valve spring decreases, and bend of the disk spring increases and, nearing its initial position, it ceases pressing on the balls. At this moment, the balls 5 are freed, and through action of the springs 12, returned to their original position, preparing the mechanism for the next step of rotation. If the rotation mechanism is damaged, it should be replaced.

The plate 9 of the valve spring is fastened with two keys 10, fitted on the valve stem, and holds the spring and valve in the cylinder head in assembly.

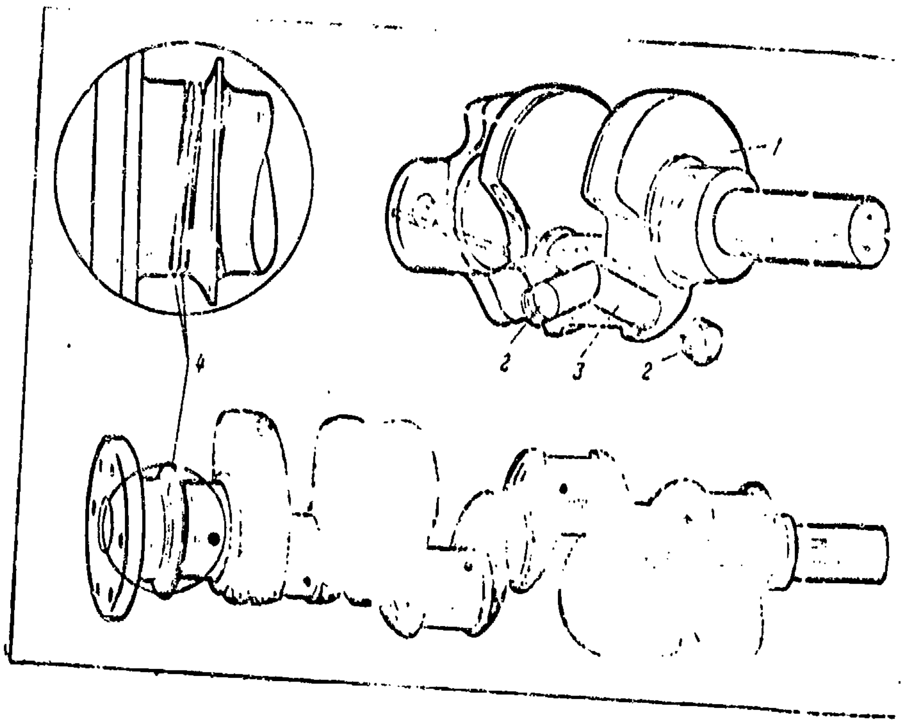


Plate 4-16. Crankshaft:
1) counterweight 2) plug 3) dirt collector 4) oil driving spiral grooves

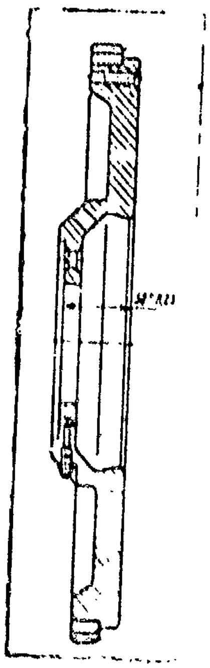


Plate 4-17. Flywheel

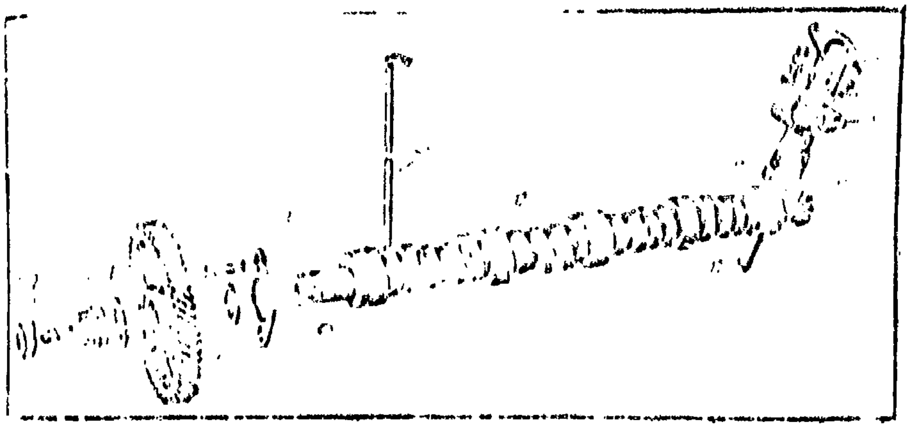


Plate 4-18. Camshaft:
1) lock ring 2) centrifugal switch drive shaft washer
3) centrifugal switch drive shaft 4) shaft spring 5) gear fastening nut 6) lock washer 7) camshaft gear 8) spacing ring 9) support flange 10) fuel pump drive rod 11) end of fuel pump lever 12) camshaft 13) oil pump and distributor drive gear 14) drive body flange 15) gasket 16) shaft gear 17) oil pump and distributor drive shaft

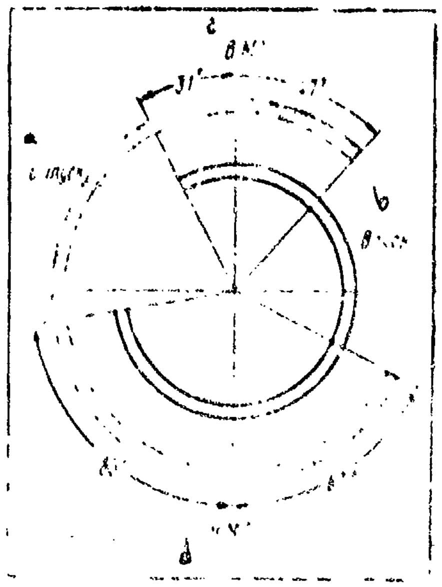


Plate 4-19. Diagram of gas distribution

Key: a) exhaust c) TDC
b) intake d) BDC

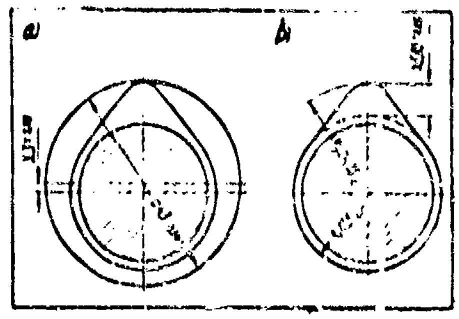


Plate 4-20. Camshaft lobes:
a) profile of eccentric for lifting fuel pump lever b) profile of lobe for lifting valve

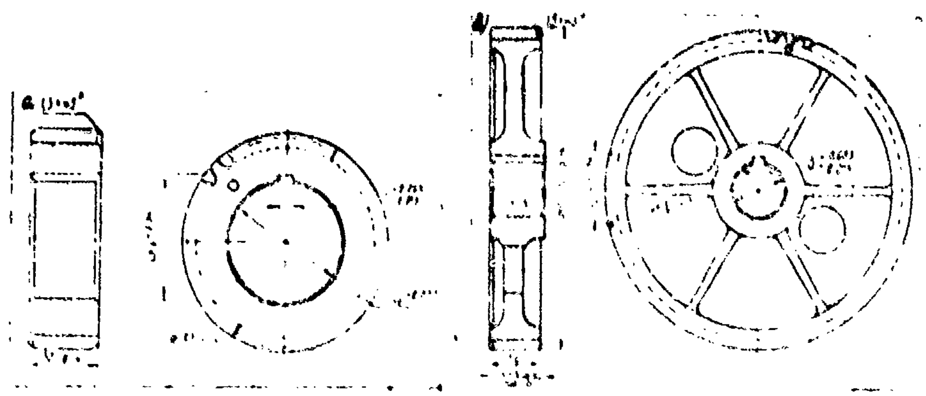


Plate 4-21. Camshaft gear:
a) crankshaft gear b) camshaft gear

In the process of the engine's operation, the valves will begin to leak as the result of harmful action of hot gases, corrosion, shock loads, and deposits of gummy substances on the working surface. Valve leakage with proper clearances between the stems and rocker arms (0.25-0.30 mm in a cold condition) and also with a properly adjusted carburetor and ignition equipment, is revealed through characteristic popping from the muffler and carburetor (the engine runs with a miss and does not develop full power).

The valve guides are pressed into the cylinder head. The valve springs are manufactured of type C-65-A wire. Valve seats are inserted and manufactured of heat resistant steel with a hardness of HRC 33-45. Seat dimensions are presented in Table 4-15.

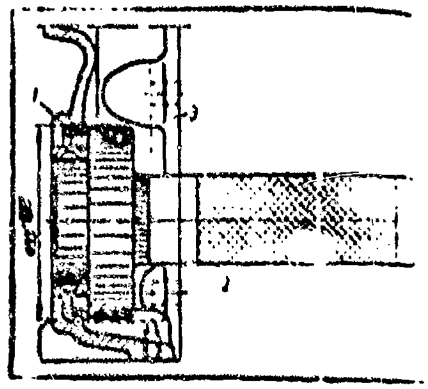


Plate 4-22. Camshaft gear cover:
1) seal 2) mandrel for pressing in seal 3) cover body

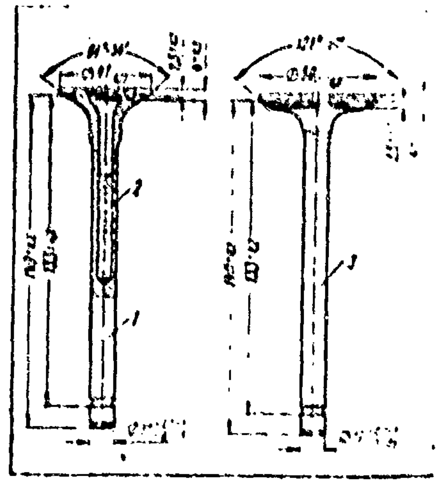


Plate 4-23. Valves:
1) exhaust valve 2) sodium filler 3) intake valve

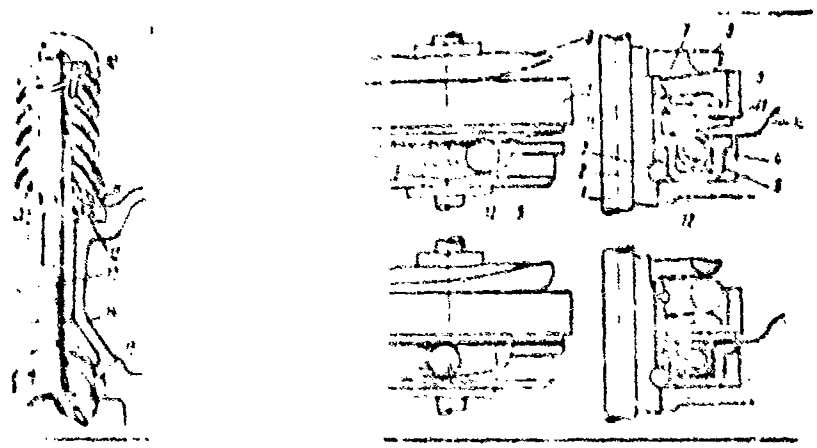


Plate 4-24. Exhaust valve rotation mechanism:
a) exhaust valve installed in cylinder head b) initial working position of mechanism c) final working position of mechanism 1) exhaust valve 2) valve guide 3) lock ring 4) stationary body 5) ball 6) support washer 7) lock ring 8) valve spring 9) valve spring plate 10) valve keys 11) disk spring 12) return spring 13) sodium filler 14) cylinder head 15) inserted valve seat

The tappets (Plate 4-25) are steel and hollow-bodied. They are arranged in holes in the upper part of the cylinder block. The holes do not have inserted bushings. To increase workability of the assembly pair (tappet and lobe), special cast iron is cast on the face of the tappet 5. Hardness of the tappet sphere surface is no less than HRC 60, hardness of the tappet cup surface is within the limits of HRC 30-35, and hardness of the sphere beneath the push rod is no less than HRC 40

The valve push rod is steel. The tips of the push rod are heat treated with high frequency current so as to provide a hardened depth of no less than 2 mm and a hardness of the heated layer of no less than HRC 55.

The valve rocker arms are steel stampings. The ball surface of the rocker arm nose is hardened during during heating with high frequency current. Depth of the hardened layer is no less than 2 mm. A bronze bushing is pressed into the hole in the rocker arm. Interference in pressing this fitting must be 0.145-0.220 mm.

The adjusting screw is steel and has a passage for carrying oil from the rocker arm hole to the upper tip of the push rod. The end of a screw with a spherical surface is subjected to hardening by heating with high frequency current to a depth of 1.2-2.0 mm.

Hardness of the sphere surface must be no less than HRC 52.

The rocker arm shaft (Plate 4-26) is manufactured of 45 steel (GOST 1050-60) and is hollow-bodied, allowing oil flow to the rocker arm assembly. The shaft surface is hardened by heating with high frequency current to a layer depth of 1.0-2.5 mm with a hardness of HRC 52-62 in the areas where the rocker arms ride on it.

Rocker arms with spacing springs and stands for fastening the shafts to the cylinder head are located on the shaft.

Stands 5, 7, and 13 of the shaft of the rocker arms 10 are cast of wrought iron and fitted with center steel bushings 14, pressed into their bolt holes. The rocker arm shaft is fastened to the cylinder head with four stands

The two middle stands are simultaneously oil removers. The rocker arm spacing spring 6 is steel, and is manufactured of 65G wire.

The intake manifold (Plate 4-27) is cast of aluminum alloy, installed on the top of the engine and fastened on studs with nuts to both cylinder heads with rubber gaskets 12, and its end parts are fastened with rubber packing 7 and 13. The intake manifold simultaneously serves to heat the burning mixture, because passages 9, moving the burning mixture to the cylinders, are bathed in the hot liquid of the cooling system.

The carburetor, radiator pipe, and the oil filler neck with the crankcase ventilation filter and parts of the crankcase gas exhaust system are fastened on upper flanges of the intake manifold. On the top of the manifold is the inscription with the numbers: "Firing order 1-5-4-2-6-3-7-8."

The intake manifold works at lower heat rates then the rest of the engine, and therefore it is not subjected to a great deal of warming.

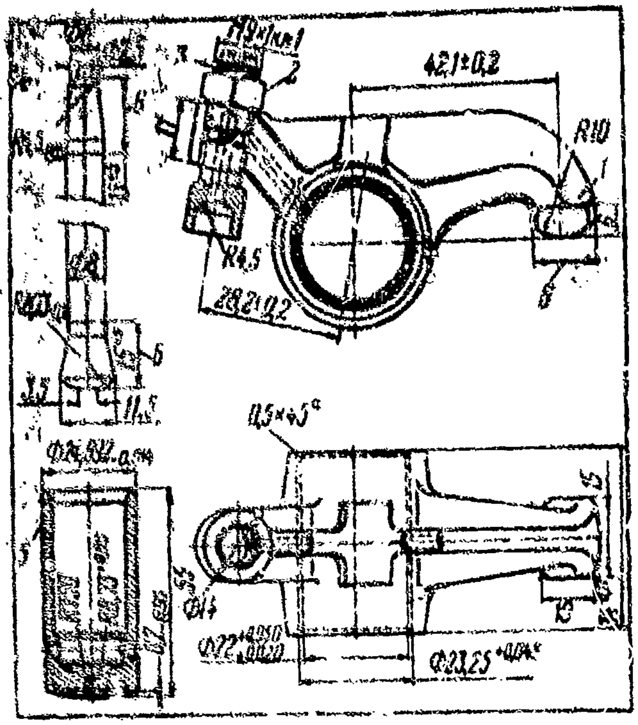


Plate 4-25. Valve mechanism parts;
1) valve rocker arm 2) stop nut 3) rocker arm adjusting screw
4) tappet push rod 5) tappet 6) hardened area

Exhaust manifolds. For the ZIL-130 engine, the exhuast manifolds are unit cast out of cast iron. For the ZIL-131, the manifolds are composite and cast out of wrought iron for their protection when fording streams. The right and left manifolds and their gaskets are interchangeable.

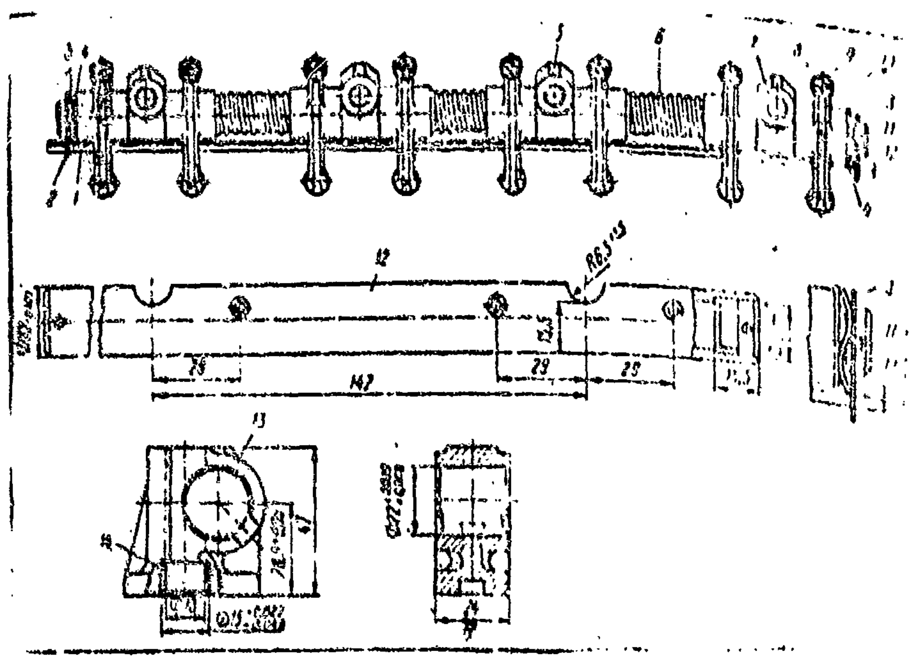


Plate 4-26. Shaft and rocker arm assembly:
1) oil line 2) line bracket 3) spring spacing washer 4) flat washer 5, 7, and 13) shaft stands 6) spacing spring 8) adjusting screw 9) screw stop nut 10) valve rocker arm 11) pin 12) rocker arm shaft 14) stand centering insert

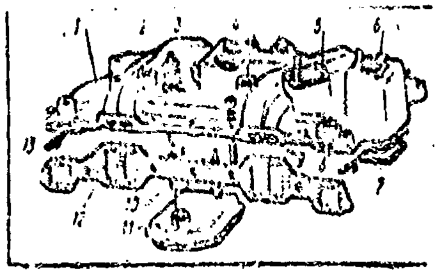


Plate 4-27.
1) manifold body 2) crankcase ventilation valve body 3) pipe fitting 4) milled surface for fastening carburetor 5) milled surface for fastening radiator pipe 6) milled surface for fastening oil filler neck 7 and 13) manifold face seals 8) cooling system passage 9) passages 10) oil trap and ventilation valve connecting sleeve 11) oil trap 12) manifold gasket

The lubricating system

The V-formed engine lubrication system is mixed (under pressure and by splattering). Plate 4-28, a, shows a lubrication schematic for engines equipped with a partial flow filter (centrifugal filter and coarse oil cleaning filter), and Plate 4-28, b, shows a schematic with a full flow centrifugal cleaning filter (without coarse oil cleaning filter). The design of the full centrifugal oil cleaning filter is more perfect. Its installation in the engine began in the second half of 1967.

An oil radiator, installed in front of the water radiator, is projected for oil cooling.

Oil is pumped to the main and connecting rod crankshaft bearings, to the camshaft bearings, to the bearings of the distributor and oil pump drive shaft and to the tappets under pressure. Oil is pumped under varying pressure to the rocker arm bushings through the hollow-bodied rocker arm shaft, at which the oil arrives through passages 8, leading from the middle bearing of the camshaft. Oil gets to the remaining working parts of the engine by gravity feed and splattering.

Oil is sucked through the stationary oil pickup 17 to the oil pump 3 from the oil pan. The oil pump moves oil through passage 4 in the rear wall of the block to the oil filter body, where the entire stream passes through the coarse cleaning plated filter 5. Part of the oil, about 50%, goes from the coarse cleaning filter to centrifugal oil cleaning filter 6, and from there to the oil pan.

The basic oil stream from the coarse cleaning filter goes into the distributing chamber 7, which is located on the rear wall of the cylinder block. From the distributing chamber, the oil moves in two longitudinal main passages 12 and 16, from which it goes to the crankshaft main bearings, and from them to the camshaft bearings. The oil moves through drillings in the crankshaft to hollows in the connecting rod journals, where it is additionally cleaned, and through holes in the connecting rod journals, it goes to the connecting rod bearings.

If the engine has a full flow centrifugal oil cleaning filter, all the oil is cleaned in it alone, moves from it to the distributing chamber 7, and then into the longitudinal passages 12 and 16 and to the lubricated parts of the engine.

The big end of the connecting rod has a hole, and when it coincides with the hole in the crankshaft journal, oil is splashed onto the cylinder walls, from where it is removed by the oil ring, and then through holes in the oil ring groove, it moves to the inside of the piston and lubricates the wrist pin bearings in the piston end boss and in the small end of the connecting rod. Oil moves from the front right end of the main passage 16 through line 13 for lubricating the crankshaft and the connecting rod mechanism of the compressor.

The middle camshaft journal has two holes, bifurcated at an angle of 40°, and when these coincide with holes in the cylinder block, once per camshaft revolution, oil for lubricating the valve mechanism flows into passage 8 in each cylinder head.

From passage 4 (Plate 4-29) in the cylinder head, oil flows to hollow 3 through a slot in the bearing surface of the shaft stand and through the clearance between the stand and the connecting rod shaft fastening bolt. From hollow 3, oil flows from holes in the shaft to bushings in the rocker arms 2, and through passage 7 to the spherical joint between the testing screw 6 and tappet push rod 5. Oil flows through passage 8 to the cylinder head surface and, falling into the passages for the push rods, flows into the crankcase.

The valve stems in their guides and the exhaust valve rotation mechanism are lubricated with an oil mist and drops of oil which flow by gravity from the rocker arm mechanism joint.

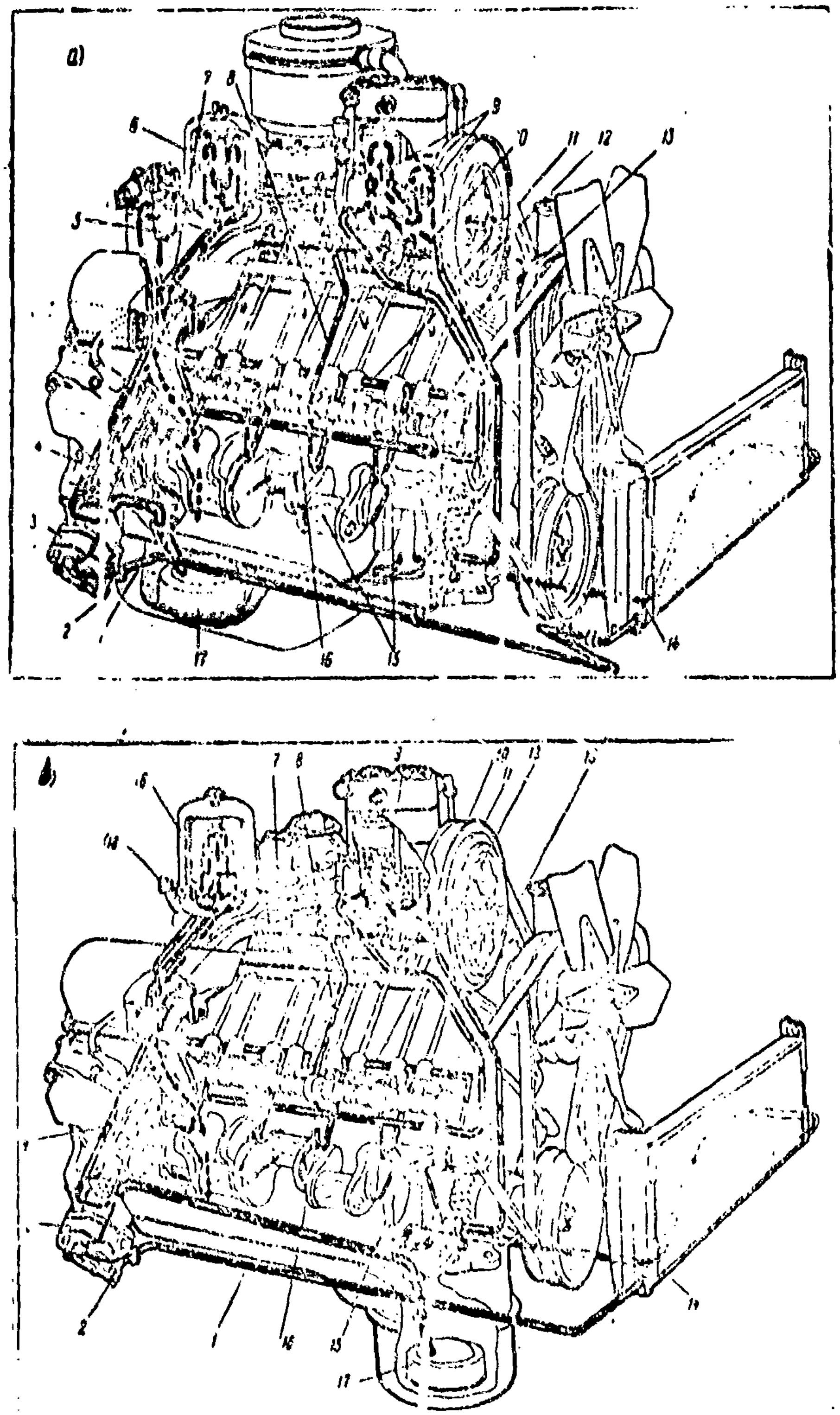


Plate 4-28

Plate 4-28 (on previous page): Schematic of engine lubrication:
a) ZIL-130 b) ZIL-131
1) pipe oil feed to the oil radiator 2) shut-off valve for oil radiator 3) oil pump 4) passage leading oil from pump to filter 5) coarse cleaning filter 6) centrifugal cleaning filter 7) distribution chamber 8) oil feed passage to rocker arms 9) direction of oil feed to compressor crank and connecting rod assembly 10) hollow rocker arm shaft 11) pipe for oil flow from compressor 12) left main passage 13) oil feed line to compressor 14) oil flow line from radiator 15) dirt collectors and crankshaft connecting rod journals 16) right main passage 17) oil pickup 18) oil pressure indicator switch

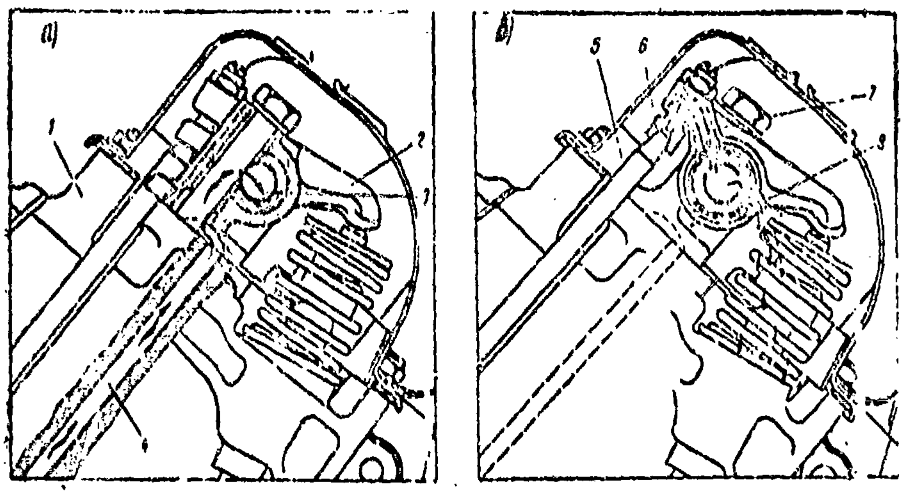


Plate 4-29. Schematic of rocker arm mechanism lubrication: a) oil flow to rocker arm shaft b) rocker arm lubrication and oil exhaust 1) cylinder head 2) rocker arm 3) rocker arm shaft hollow 4) oil passage in cylinder head 5) push rod 6) adjusting screw 7) passage for oil supply to screw and push rod joint 8) oil exhaust passage from rocker arm shaft

The oil pump (Plate 4-30) is geared, with two sections. Productivity of the upper section of a new pump at an engine crankshaft speed of 3100 rpm is 50 liters per minute, and that of the lower section is 23 liters per minute. The upper section of the pump moves oil to the centrifugal oil cleaning filter, and then to the engine lubrication system. Working pressure created in this section and in the lubrication system is maintained by a reduction valve installed in the intermediate cover of the pump, and adjusted to 2.75-3.30 kg/cm^2. In the event of pressure increase, the reduction valve bypasses oil from the pressure hollow of the oil pump to the suction one.

With a properly working upper section reduction valve, oil pressure in the lubrication of a new warm engine at 1200 crankshaft rpm, must be no lower than 2.5 kg/cm^2. For a warm engine in operation, the minimum allowable oil pressure in the lubrication system must be 1.5 kg/cm^2 at 1800 rpm, and 0.5 kg/cm^2 at 500 rpm.

With an oil pressure lower than the cited limits, operation of the engine is not allowed, in order to prevent its early failure. If deviation from the cited reference pressures are observed during checking, it is necessary to remove the reduction valve assembly and check the condition of its parts. The parts, after having oil residue cleaned from them and having been washed in kerosene, must freely move in the reduction valve body.

The bottom section of the pump moves oil from the oil radiator through a needle valve which is screwed into the pump cover body. Pressure in this section is supported by a by-pass valve which is installed in the lower section body and adjusted to a pressure of 1.2-1.5 kg/cm^2.

Crankcase ventilation of the ZIL-130 engine is forced, with extraction of worked-out gases into the engine intake manifold through valve 5 (Plate 4-31).

The valve is installed in the intake manifold in a hole connected to the internal space of the engine. When valve 5 is opened, gases are sucked along tube 3 to the central portion of the intake manifold 6, from which they are attracted together with the burning mixture into the engine cylinders 7 and burned there.

The extraction of gases basically takes place during the operation of the engine with a fully opened throttle, when vacuum in the intake manifold increases and the valve falls under its own weight, fully opening the passage section for exhaust of gases which are accumulated in the engine crankcase.

When the engine is operating with the throttle plate less than fully open, the valve 5, due to action of the weaker vacuum in the intake manifold, moves upward, the upward step section of the valve moves into the hole in the pipe nipple 3 and decreases the passage section for gas exhaust.

Fresh air moving into the engine crankcase is cleaned in filter 1, which is fastened on the oil filler pipe.

Before reaching valve 5 on the passage from the inner hollow of the engine, spent gases pass through an oil trap 2, which separates particles of oil from the gases being extracted.

The ZIL-131 engine has, besides this, a valve on tube 3 between valve 5 and the intake manifold for shutting off the ventilation system. When fording streams, this valve must be closed.

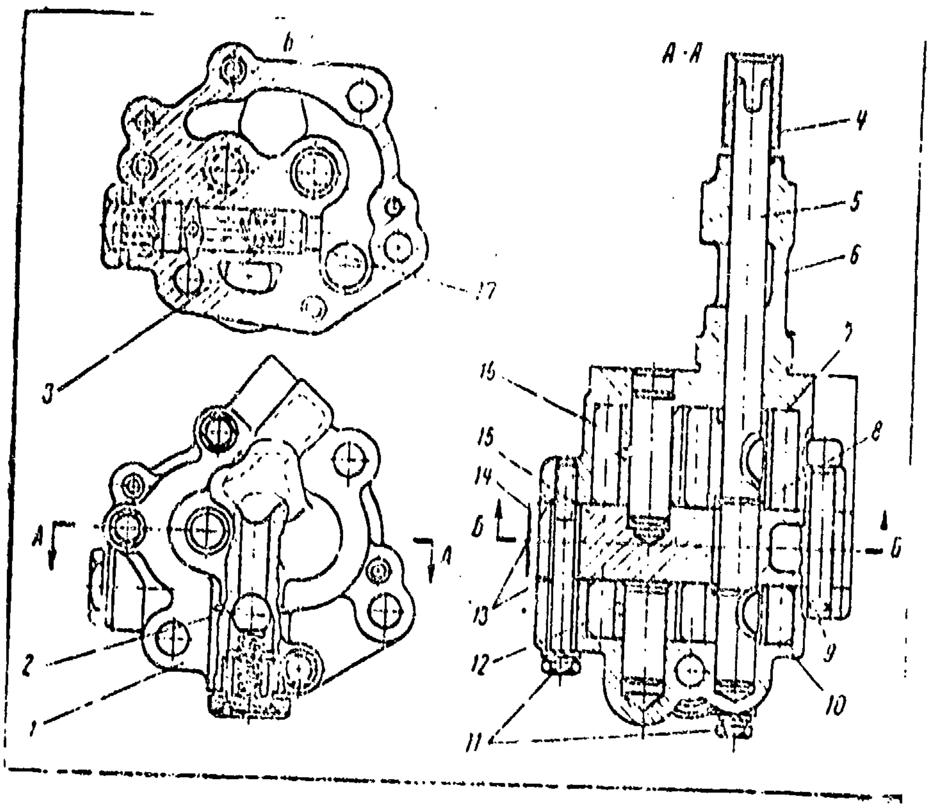


Plate 4-30. Oil pump:
1) lower section body 2) bypass valve 3) reduction valve plunger 4) centering sleeve 5) pump shaft 6) upper section body 7) upper section drive gear 8) stop ring 9) pin 10) lower section drive gear 11) bolts 12) lower section driven gear 13) gaskets 14) plug 15) pump intermediate cover 16) upper section driven gear 17) reduction valve spring

The oil filters. The coarse cleaning oil filter (Plate 4-32) is a slotted type, with plates, and with a by-pass valve adjusted to a pressure drop of 1 kg/cm². The by-pass valve spring must have a length of 62 mm in its free state and a length of 44 mm under a load of 0.9-1.1 kg. The centrifugal oil cleaning filter works with reaction drive. Both filters are connected and installed in one aluminum housing. For ease in turning the coarse cleaning filter element, the filter on the ZIL-131 truck has a lengthened handle.

The centrifugal oil cleaning filter rotates due to reaction to the force of the oil stream projected through two nozzles under pressure. Under oil pressure of 2.75-3.30 kg/cm², the filter body and the oil in it rotate at a speed of 5000-6000 rpm. Due to action of the arising forces, mechanical articles located in the oil are thrown against the cover, where they adhere, forming a tightly packed deposit which must be periodically removed. Period between cleanings is set in the lubrication chart.

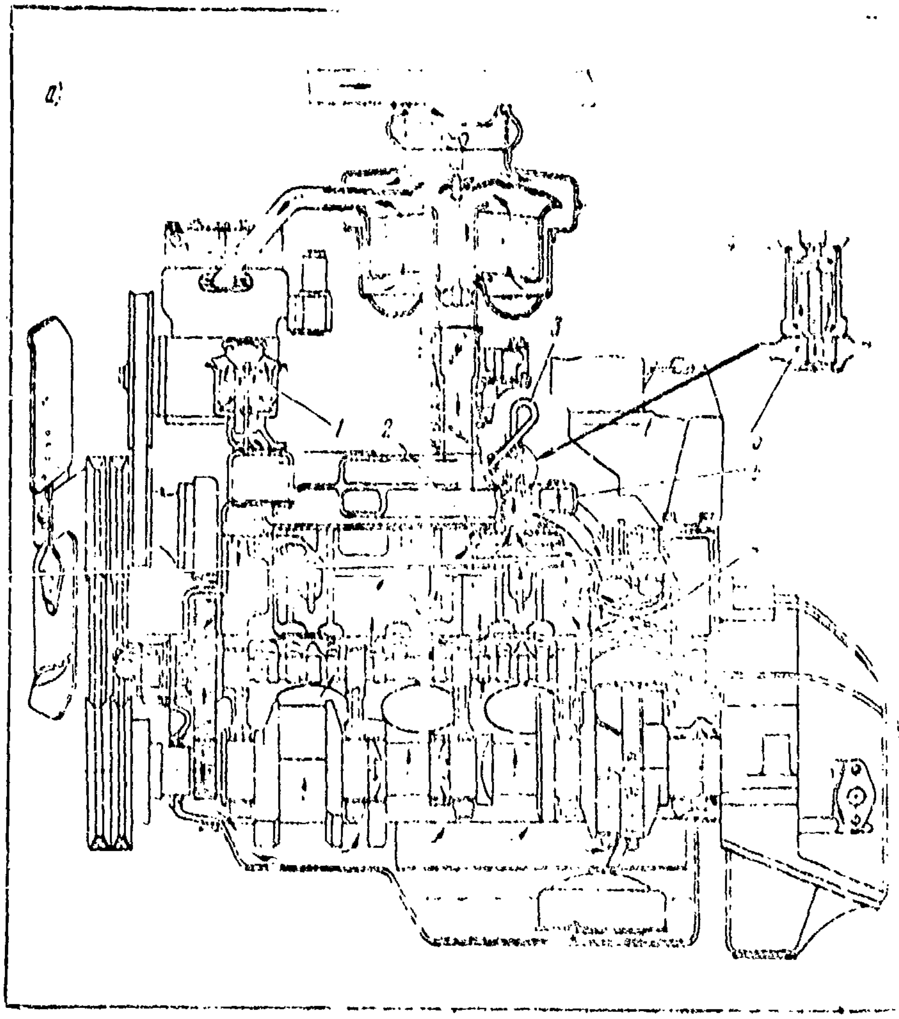


Plate 4-31. Schematic of engine crankcase ventilation: a) ZIL-130 b) (on next page) ZIL-131 1) oil filler tube filter 2) oil trap 3) gas exhaust tube 4) nipple 5) valve 6) intake manifold 7) engine cylinder

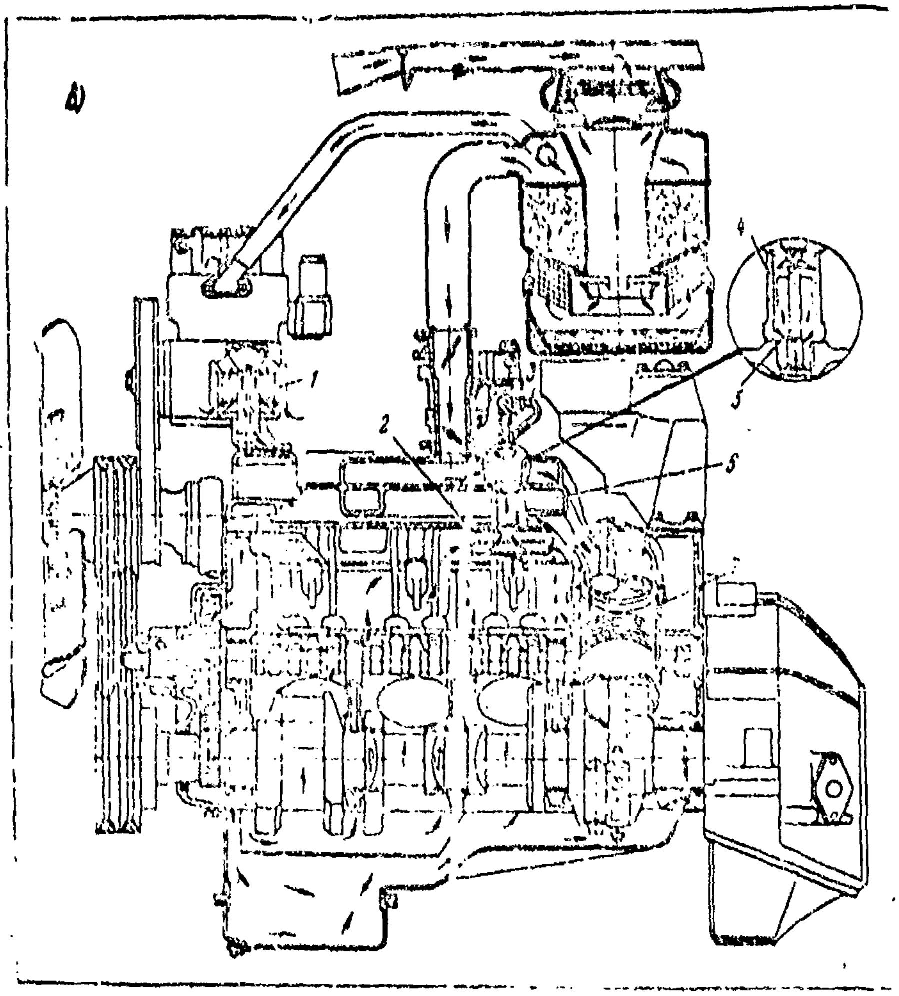


Plate 4-31 b.

Cleaned oil passes through the nozzles into the oil filter body 1, from which it drains into the oil pan.

Centrifugal oil cleaning in the engine is additionally provided in the dirt collectors formed in the connecting rod journals of the crankshaft. The crankshaft dirt collectors should be cleaned when the inserts are replaced.

Since the third quarter of 1967, the new design (without coarse cleaning filter) oil filter (Plate 4-33) has been installed on the ZIL-130 and ZIL-131 engines. This is a full flow centrifugal oil cleaning filter with reaction drive.

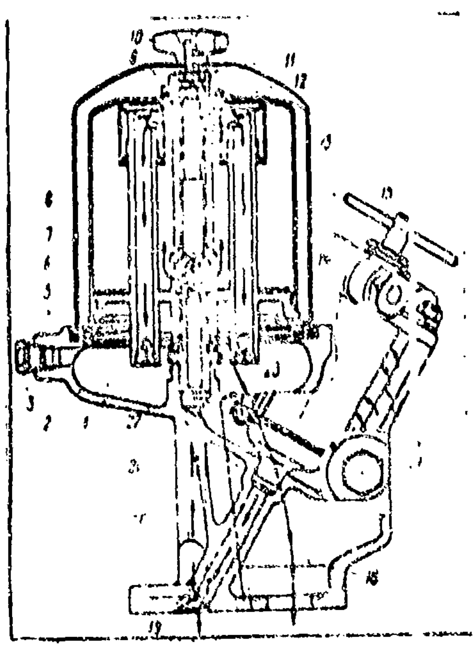


Plate 4-32. Combined oil filter (centrifugal cleaning filter and coarse cleaning filter):
1) body 2) nozzle 3) plug 4) jacket packing ring 5) jacket 6) cover packing ring 7) centrifugal oil cleaning filter body 8) cover 9, 10, 11) nuts 12) stop ring 13) mesh filter 14) hollow shaft 15) handle 16) coarse cleaning plate filter 17) plug for draining oil from coarse cleaning filter 18) direction of motion from filter to crankcase 19) direction of oil motion from filter to lubricating system 20) direction of oil movement in centrifugal oil cleaning filter 21) direction of oil movemetn from oil pump to coarse cleaning filter body 22) support bearing 23) oil deflection plate

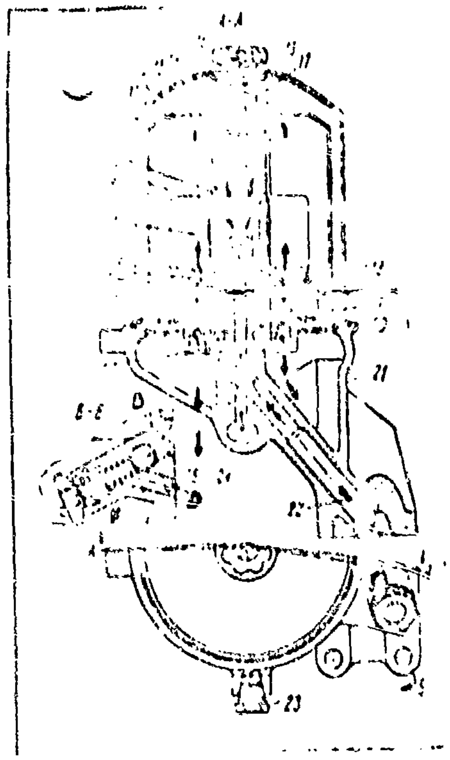


Plate 4-33. Full flow centrifugal oil cleaning filter:
1) nozzles 2) gasket 3) body 4) cover packing ring 5) cover 6) mesh filter 7) filter insert 8) jacket 9) shaft 10) insert packing ring 11) stop ring 12) gasket 13) washer 14) filter cover nut 15) jacket fastening nut 16) shaft 17) support washer 18) shaft pipe 19) bearing support ring 20) support bearing 21) filter body 22) passage directing oil to centrifuge 23) plug 24) passage directing oil to engine block distributing chamber 25) direction of oil in engine oil pan 26) by-pass valve ball 27) by-pass valve pressure passage D and F) by-pass canals

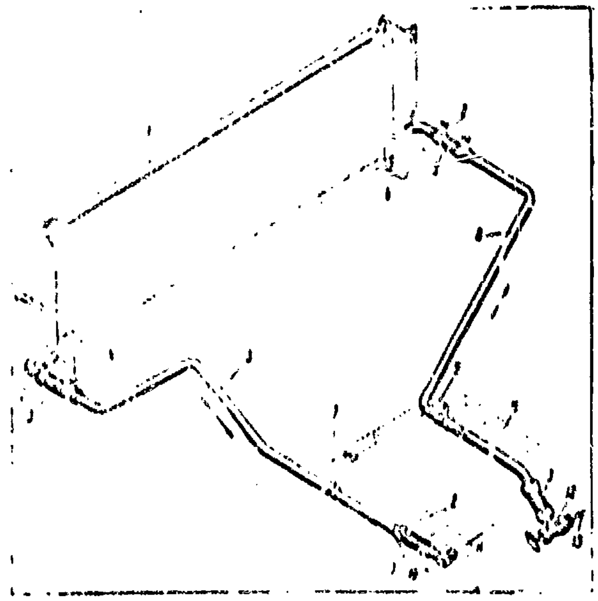


Plate 4-34. Oil radiator:
1) radiator frame 2) tension clamps 3) connecting hose 4 and 6) radiator side brackets 5) radiator oil exhaust line 7 and 9) line fastening brackets 8) radiator oil intake line 10) angle fitting 11) engine oil pan 12) valve 13) direction of oil from oil pump lower section 14) direction of oil into oil pan

Oil, driven by the engine pump, goes into passage 22 of the filter body. From this passage, oil moves under insert 7 through the circular clearance around pipe 18 and through the radial holes in the tube and filter body 3. From here, part of the oil moves to the nozzles 1 through the mesh filter 6, preventing the nozzles from clogging, and the other part of the oil, passing through the holes in the insert, has dirt removed from it in the filter. The principle of operation of the full flow filter is the same as that of the combined filter (centrifugal cleaning filter and coarse cleaning filter). Oil, passing through the nozzles, flows into the engine oil pan.

Clean oil, driven above insert 7, through the radial holes in the upper portion of body 3, through the circular clearance around shaft 9 and the radial holes in the upper part of the shaft, moves into tube 18 and into passage 24 of the filter body and the cylinder block distributing chamber, and then into the longitudinal engine lubrication system passages.

The by-pass valve ball 26 is installed in the passage of filter body 21 and is adjusted to a pressure drop of 1 kg/cm^2. The by-pass valve is intended to release part of the oil into the distributing chamber of the cylinder block avoiding the filter, when starting a cold engine with high oil viscosity, and also with significant wear of the engine bearings and the increased flow of oil through the filter in connection with this.

The by-pass valve spring is manufactured of class 1 spring wire, 0.9 mm in diameter (GOST 9389-60) and has 14 working coils. The length of the spring is 58.5 mm in a free condition, and 34 mm under a load of 1.06-1.26 kg, and spring diameter is 11.5 mm.

The full flow filter in assembly is interchangeable with the partial flow filter. Certain of their parts, besides the jacket, are not interchangeable.

The oil radiator (Plate 3-34) is fastened by four bolts to brackets which are fastened to the frame of the water radiator louvres. In 1966, height of the oil radiator was decreased to 28.5 mm (three rows of pipes were eliminated).

The cooling system

The engine cooling system (Plate 4-35) is liquid, closed type, with forced cooling liquid circulation. For normal engine operation, temperature of the cooling liquid is maintained within the limits of 80-95°C.

The cooling system includes: the water jacket of the cylinder block and head, water pump with its drive, fan with its shroud (diffuser), radiator, plug valves, radiator louvres, thermostat, connecting pipes with hoses, drain valves and control devices. The boiler of the starting preheater is hooked into the cooling system.

The cooling liquid, heated to a temperature of 80-95°C, moves from the bottom tank of the radiator 2 to the water pump 5 through the pipe and rubber hoses. It is then driven by the water pump into both hollows of the water jacket of the cylinder block 13, bathing the cylinder sleeves on all sides. The liquid simultaneously rushes through holes in the cylinder block into the space of the cylinder head cooling jacket, bathing and cooling the ribs for the valve receptacles, after which it moves into the space in the intake manifold 11, where it heats the working mixture moving into the engine cylinders. From the space in the intake manifold, the liquid moves into the upper radiator tank, passing through the upper pipe 9, thermostat 10, and rubber hose. The liquid is cooled in the radiator and once more repeats the process of circulation through the closed circuit through the engine cooling spaces.

When the engine is cold and while the liquid is heating, it circulates through a (small) closed circuit in the following order. From a space in the intake manifold 11, liquid moves through hose 7 into the space in the compressor, and then through hose 6 into the hollow of pump 5, from which it is again directed into the engine cooling system, avoiding the radiator. When

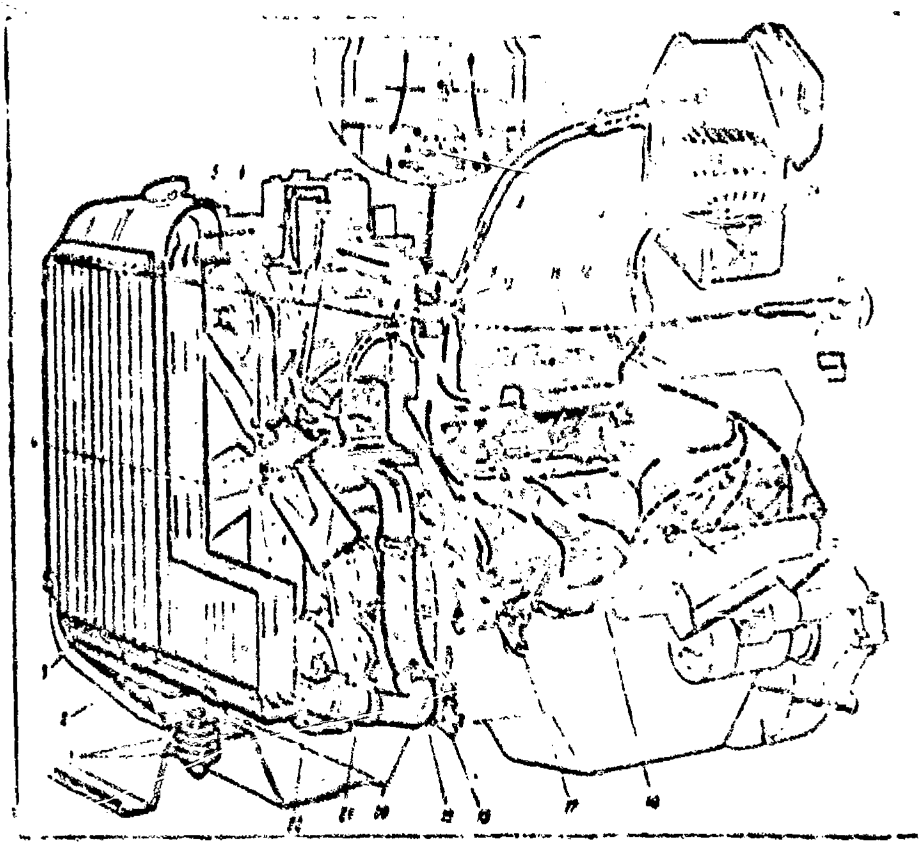


Plate 4-35. Cooling system of the ZIL-130 (ZIL-131) engine:
1) radiator support 2) radiator 3) radiator louvres 4) fan 5) water pump 6) water hose from compressor 7) water hose to compressor 8) water hose from heater 9) upper pipe 10) thermostat 11) intake manifold 12) heater water shut-off valve 13) water hose to heater 14) cab heater 15) louvre operation handle 16) cylinder block 17) cylinder block water jacket drain plug 18) radiator drain cock 19) radiator bottom pipe 20) drain cock control lever 21) lower pi[illegible] 22) augmentor hose

the cooling liquid is heated and reaches a set temperature, the thermostat valve opens and begins to release liquid into the radiator, and it will then circulate around a (large) closed circuit through the radiator.

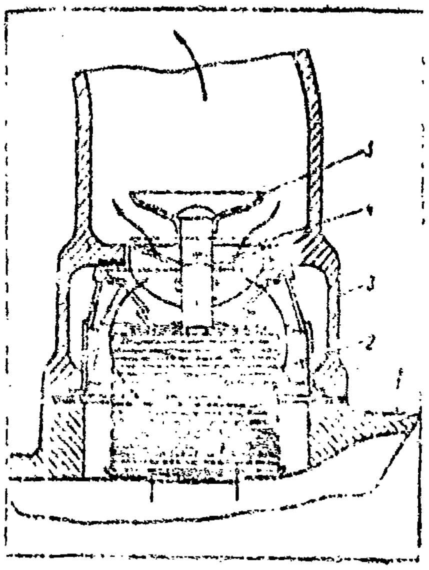


Plate 4-36. Liquid type thermostat with pipe:
1) intake manifold 2) bellows 3) pipe
4) valve in closed position 5) valve in open position

For improving the working conditions of the engine cooling system and to eliminate the possibility of overheating the engine, an exhaust mainline was introduced in 1967; it connects the cylinder head cooling jacket hollow with the intake hollow of the water pump through augmenter hose 22 and lower pipe 21. With this, hot water exhaust takes place constantly with the thermostat valve either closed or open. The first models of the ZIL-130 engine have a liquid type thermostat. Later models have thermostats with hard fillers.

The liquid type thermostat is installed in its pipe 3 (Plate 4-36), which is installed on the intake manifold. The thermostat valve begins to open when the cooling liquid reaches a temperature of 70 ±2°C. At a lower liquid temperature, the cylinder of bellows 2 is in a pressed condition, with which valve 4 of the thermostat is closed, as a result of which the cooling liquid does not reach the radiator. When the cooling liquid reaches 70 ±2°C, the corrugated cylinder of the bellows begins to expand. With a temperature of 83 ±2°C, the valve 4 is fully opened to a valve raising height of no less than 9 mm, with which the cooling liquid from the intake manifold space is freely directed into the radiator.

With the installation of a liquid thermostat, a radiator cap with valves maintaining cooling system overflow pressure at 0.65 kg/cm^2 was used. With this pressure, water in the system boils at a temperature of 114°C.

A thermostat with a hard filler has an active mass of a mixture of ceresin and powdered copper. The active mass 2 (Plate 4-37, a) is located in a thin-walled copper capsule 1 enclosed with a rubber diaphragm 3. A rubber buffer is installed above the diaphragm, protecting it from damage. A rod 5 is installed above the buffer and is connected through lever 8 with valve 6, which is retained in the closed position by spring 9.

When the cooling liquid is heated to a temperature within the limits of 69 ±2.5°C, the active mass in the capsule begins to melt and expand, moving the diaphragm upward.

With this, the diaphragm acts on the buffer and the rod, which, rising, presses on the lever and opens the valve. With a temperature of 83 ±2°C, the valve is fully opened and the cooling liquid begins to circulate around the large circuit through the water radiator.

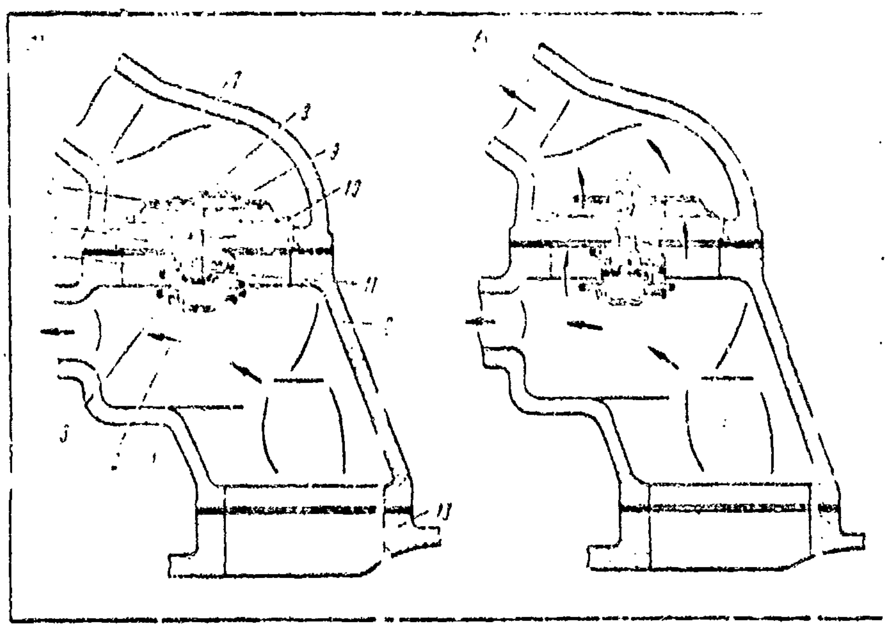


Plate 4-37. Schematic of operation of thermostat with hard filler: a) thermostat with closed valve b) thermostat with open valve 1) copper capsule 2) active mass 3) rubber diaphragm 4) body 5) rod 6) valve 7) upper pipe 8) lever 9) spring 10) valve seat 11) rubber buffer 12) lower pipe 13) intake manifold

Plate 4-37 b shows the thermostat valve in an open position. When cooled, the active mass hardens, its volume decreases, the diaphragm moves downward, and the valve is closed by action of the spring. When this happens, the cooling liquid begins to circulate around the small circuit, missing the radiator. Thermostats are not repaired. The allowable overflow pressure of 1 kg/cm^2 requires precise tightening of the hose clamps. If the clamps are insufficiently tightened, the overflow pressure might blow off the hose. Overflow pressure is regulated by the outlet valve 6 (Plate 4-38), which opens at a pressure of 1.0 kg/cm^2. At this pressure, water in the cooling system boils at 119°C.

The inlet valve 9 of the cap opens and connects the radiator hollow with the atmosphere at a vacuum equal to 0.01-0.13 kg/cm^2.

If the rubber packing washers of the valves on the cap are missing or damaged, the cooling system will not work as a closed one, cooling of the liquid will begin at 100°C, and the engine will begin overheating significantly sooner. In these cases, either the cap should be replaced or the vacuum washers of the valves should be replaced.

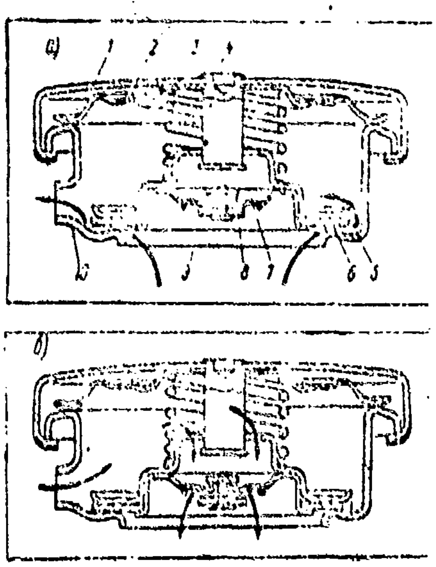


Plate 4-38. Radiator cap:
a) with open outlet valve
b) with open inlet valve
1) cover body 2) support washer
3) outlet valve spring
4 and 5) outlet valve cup
6) outlet valve (packing) 7) inlet valve cup 8) inlet valve spring 9) inlet valve (packing)
10) overflow opening

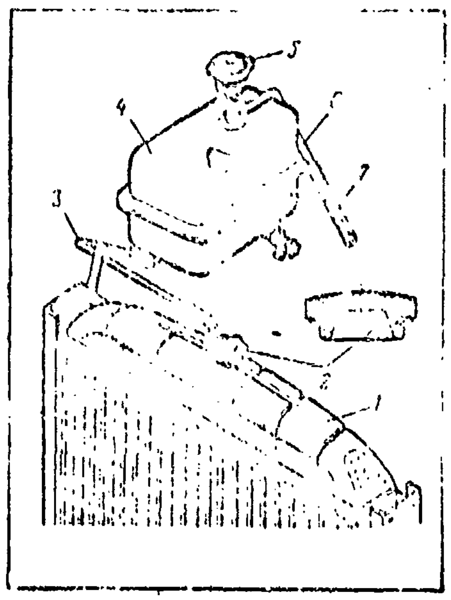


Plate 4-39. Connection of condensation tank to radiator:
1) radiator 2) radiator cap (without valves) 3) connecting line 4) condensation tank 5) tank cap (with valves) 6) overflow line 7) rubber hose

On special order, the ZIL-130 and ZIL-131 trucks intended for work in tropical climatic conditions are equipped with a condensation tank 4 (Plate 4-39). With this arrangement, cap 5 with valves is removed from the radiator and installed on the condensation tank, and the radiator neck is covered with cap 2 (without valves).

The presence of the condensation tank makes the engine cooling system more effective, working without loss of water. With an increased water temperature in the radiator (to boiling temperature), steam moves along the connecting line 3 to tank 4 and condenses into water. When the water temperature decreases, the vacuum is created in the top tank of the radiator, and water is sucked from the condensation tank back into the radiator, bringing it to its full level.

The radiator (Plate 4-40) is tubed, with a cooling surface executed in the form of blades 0.15 mm thick or in the form of a corrugated band 0.1 mm thick layed in a serpentine manner. The radiator tubes are made of L90 tombac. The cooling band (serpent) for the radiator is manufactured of M3 copper, as are the cooling plates.

A three-row radiator is used for the ZIL-130 motor vehicles, and the ZIL-131 and ZIL-130B motor vehicles are assembled with four-row radiators. The radiator, together with its louvres and fan shroud, is fastened with bolts into a special frame, which is fastened with a central bolt through rubber cushions to a frame cross-member of the truck. The top ends of the frame, locked in with the tension rod and reinforcement of the radiator jacket, serve as the front support for the truck's body work, including the radiator jacket.

Water release from the radiator hollow is accomplished through drain cock 18 (see Plate 4-35), whose valve is rotated by lever 20.

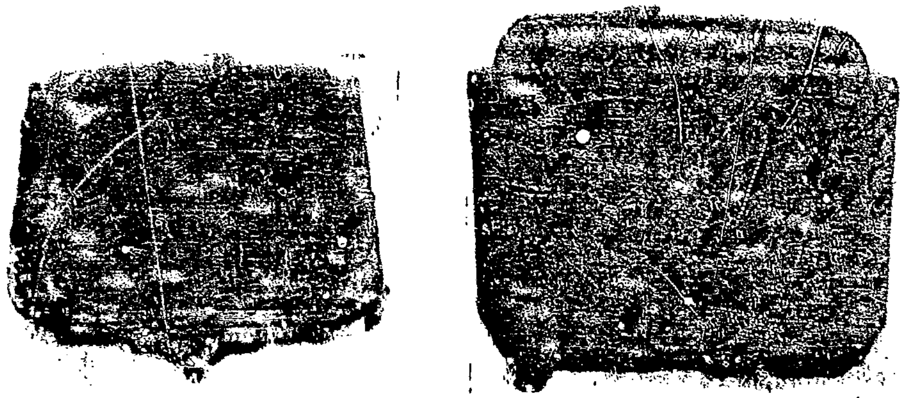


Plate 4-40. Cooling system radiator:
a) with shroud
b) without shroud

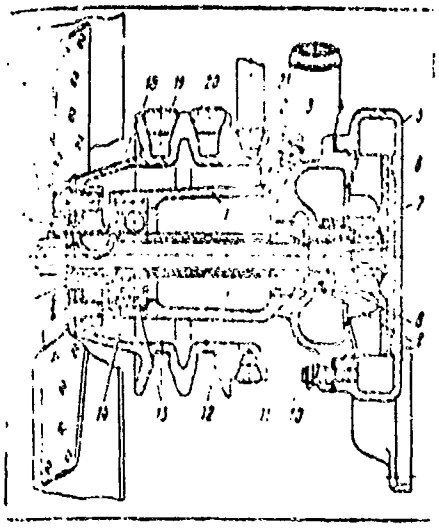


Plate 4-41. Water pump with fan of ZIL-130 engine: 1) bearing body 2) plug 3) lubrication fitting 4) gasket 5) pump body 6) impeller 7) rubber packing 8) support washer 9) impeller race 10) deflector 11 and 13) bearings 12) spacing bushing 14) water pump shaft 15) conic pulley bushing 16) pulley flange 17) fan 18) pulley 19, 20, and 21) drive belts

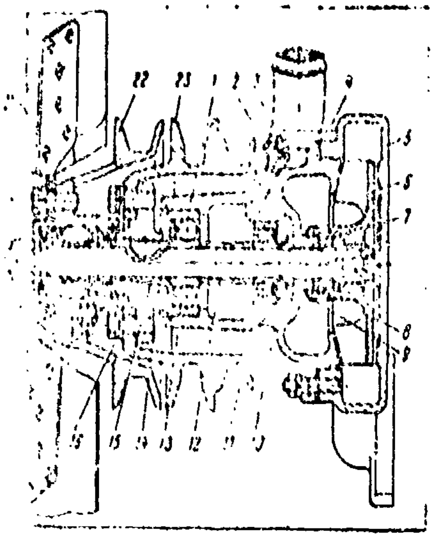


Plate 4-42. Water pump with fan of ZIL-131 engine: 1) bearing body 2) plug 3) lubrication fitting 4) gasket 5) pump body 6) impeller 7) rubber packing 8) support washer 9) impeller race 10) deflector 11 and 13) bearings 12 and 19) spacing bushings 14) water pump shaft 15) pulley bushing 16) pump pulley flange 17) lubrication fitting 18) bearings 20) nut 21) fan 22) pulley 23) pump pulley

The water pump. The ZIL-130 engine uses a pump with a fan whose hub is rigidly fastened to the pump shaft with a key (Plate 4-41). The ZIL-131 engine uses a pump with a fan whose hub is installed on the shaft on two ball bearings (Plate 4-42). This allows the fan drive belt to be loosened for deep fording, stopping rotation of the fan without stopping operation of the water pump, compressor, or hydraulic power steering pump.

Both water pumps are centrifugal, with a productivity of 350-360 liters per minute at an engine crankshaft speed of 3000 rpm. The turning ratio between the water pump drive pulleys and the crankshaft is 1.17 : 1.

In the process of the engine's operation, the following water pump parts wear out: bearings 11 and 13 (Plates 4-41 and 4-42), bearings 18 (Plate 4-42), bearing seat holes in the pump body 1 and in the pulley hub 22, and the packing and pump shaft assembly.

Water pump bearings have a packing which holds grease and protects them from dirt.

The water pump shaft is subjected to hardening by heating with high-frequency current. The depth of the hardened layer is 1-3 mm. Hardness is HRC 52-62.

The fan is six-bladed with turned-out ends, which increase its effectiveness. To increase the exhaust of heat from the radiator, the fan is enclosed in a shroud (diffuser), which promotes the increased speed of the air stream passing through the radiator.

Blade material thickness on the first models of the trucks was 1.2 mm. Since 1964, blade material has been 1.5 mm thick.

It should be kept in mind that up to 1965, fans with single cross pieces were installed on the ZIL-130 motor vehicles and fastened with bolts 25 mm in length. Since 1965, fans with double cross pieces have been installed and fastened with bolts which are 28 mm long.

The starting preheater. Some of the ZIL-157K, ZIL-130, and all of the ZIL-131 motor vehicles are equipped with P-100 starting preheaters (Plate 4-43).

The starting preheater works on gasoline. In consideration for its mounting on various engines, the preheater pipes are welded on in various fashions, and for this reason the preheater boils are not interchangeable. The preheater is a one-pice boiler 18, consisting of four cylinders inserted one inside the other, welded together and forming a combustion chamber 28, heat pipe 31, and gas exhaust 32, with two liquid hollows 29 and 30, which are connected together (heat exchanger). The boiler is permanently connected to the engine cooling system.

On the ZIL-130 engine, fuel flows from the tank to the boiler combustion chamber by gravity. For even flow of fuel to the combustion chamber, and to provide a normal burning process, the fuel feed regulator 7 is provided, and consists of a float chamber with adjusting needle 9 and solanoid valve 8. Fuel level in the float chamber is adjusted by the needle valve. From the float chamber, fuel flows to the solanoid blocking valve along a passage. The valve works in the following manner: when the switch 23 on the control panel is disengaged, the core, under action of the spring, blocks the fuel line; when the switch is engaged, current flows to the coil, the core is withdrawn, and fuel flows unhindered to the boiler combustion chamber.

Air is driven to the combustion chamber by a fan which is turned by electric motor 5, which is installed under the engine hood in the ZIL-130 and ZIL-131 motor vehicles, and in the cab on the ZIL-157K motor vehicle.

The mixture is ignited with a glow plug 14. After steady burning takes place in the chamber, the plug is turned off and fuel ignition is sustained by the burning flames.

Control of the preheater's electrical system is concentrated on panel 21, on which the glow plug switch 24 is installed. The control spiral (resistance) 22, sequentially engaged in the plug circuit, and the switch 23 of the solanoid and fan electric motor are also installed on the panel. This switch has three positions:

Position 0	Everything off (handle pushed in to the limit)
Position I	Fan electric motor on (handle pulled to middle of its travel)
Position II................................	Fan electric motor and solanoid valve on (handle pulled out to stop)

After ignition, the hot gases move in a twisting stream along the heating pipe and transfer heat to the heated liquid or into the boiler. Gases flowing out of the outlet pipe are directed to the engine oil pan by trough 16 and warm the oil located in it. The liquid hollow of the preheater boiler is connected with the engine cooling system by pipes 19 and 15.

Engine starting sequence using the preheater. For preheating and starting an engine in which there is no water, it is necessary to prepare 32-35 liters of water. Close the radiator louvres, and with heavy freezing, install the warming cover on the radiator jacket, open the radiator cap, close the preheater boiler drain cock and preheater pipe drain cock. If there is no fuel in the tank or it is insufficient, it is necessary to fill the tank with fuel, unscrewing the plug. Pour 1.5 liters of water into the preheater boiler through funnel 3.

Move the handle of switch 23 into position II for 15-20 seconds, so that the fan electric motor is on and the solanoid valve is open. In very low temperatures, this time must be increased to 60 seconds.

Place the switch handle into position 0 and turn on the glow plug. When a light red glow is attained on the control spiral, ignition will occur in the combustion chamber, during which a weak pop will be heard. Then start the preheater, moving the handle of switch 23 into position II. When steady operation of the preheater is attained, turn off the glow plug.

If, for some reason, the preheater does not begin to work, repeat its starting. When 1-2 minutes have elapsed after starting of the preheater, add 6-8 liters of water to the engine through the boiler funnel, close the funnel cap and continue heating the engine. When water in the engine is warm and light steam appears from the radiator filler neck, turn the engine crankshaft a few times with the starting crank. For the crankshaft to be ready for starting the engine, it must be rotated easily.

After heating the engine, turn off the preheater, moving switch 23 into position I (to boiler flowing) and close valve 4. When humming of the flame in the preheater boiler stops (after 50-60 seconds), turn off the fan and, after moving the switch to position 0, start the engine.

If this order of preheater shutdown is not observed, flames may shoot up and ignite the air hose 13. Warming the engine at middle revolutions, it is necessary to add water to the engine through the radiator filler neck until the entire volume of its cooling system is filled.

The P-100 preheater can be used equally well with either water or anti-freeze as a cooling liquid. Since the preheater boiler need not be used during the summer, it is recommended that it be removed and kept at the motor vehicle transport enterprise warehouse for the summer period.

Technical servicing. Assembly drive belts (Plate 4-44 a) on the engine must be tightened so that bend of one side of the belt under a load of 4 kg is within the limits of 8-14 mm for the hydraulic pump and generator belts and 5-8 mm for the compressor belt. Belt tightening (Plate 4-44 b) of the generator, fan (water pump), and power steering hydraulic pump is accomplished by moving the generator and hydraulic power steering pump.

On compressors having a cast pulley 1 (Plate 4-45) with an adjustable groove width, compressor belt tensioning is accomplished by the method of screwing in the thread adjusting sleeve to the wrench 3, with stop screw 4 loosened. The amount of compressor belt bending with cast or stamped pulleys must be 5-8 mm under a load of 4 kg.

The factory is preparing a method of compressor belt tightening by moving the compressor for introduction into production. This involves changing its brackets, in which longitudinal holes are made to move the compressor in a direction perpendicular to the geometric axis of the engine.

Tightening the cylinder head fastening bolts should be done on a cold engine. Each cylinder head is fastened to the block with 17 bolts. Bolts fastening the head to the cylinder block must be tightened with a torque wrench, allowing the torque moment to be controlled. When the engine heats up, cylinder head tightening bolt torque increases, and when it cools, bolt torque decreases. Cylinder head bolt torque moment must be 7-9 kg meters on a cold engine, and closer to the lower limit (7 kg meters) with lower engine temperatures. With an engine temperature of 20-25°C, the moment must be closer to the upper limit of 9 kg meters. For the first 6000 km of running, the cylinder head fastening bolts must be tightened at every TS-1, and after this period, every TS-2.

Tightening of cylinder head bolts should be done in a determined sequence (Plate 4-46) beginning from the center of the head. Attention should be paid to the fact that on the ZIL-130 and ZIL 131 engines, four bolts fastening the rocker arm shaft are also cylinder head fastening bolts, and should also be tightened. Whenever the cylinder head fastening bolts are tightened, it is necessary to check for possible changes in the clearn. between the rocker arms and the valves. The rocker arm cover nuts should be tightened equally to a moment of 0.5-0.6 kg meters, and no more. Increasing the torque moment on the rocker arm cover will lead to deformation of the rubber gasket installed beneath it.

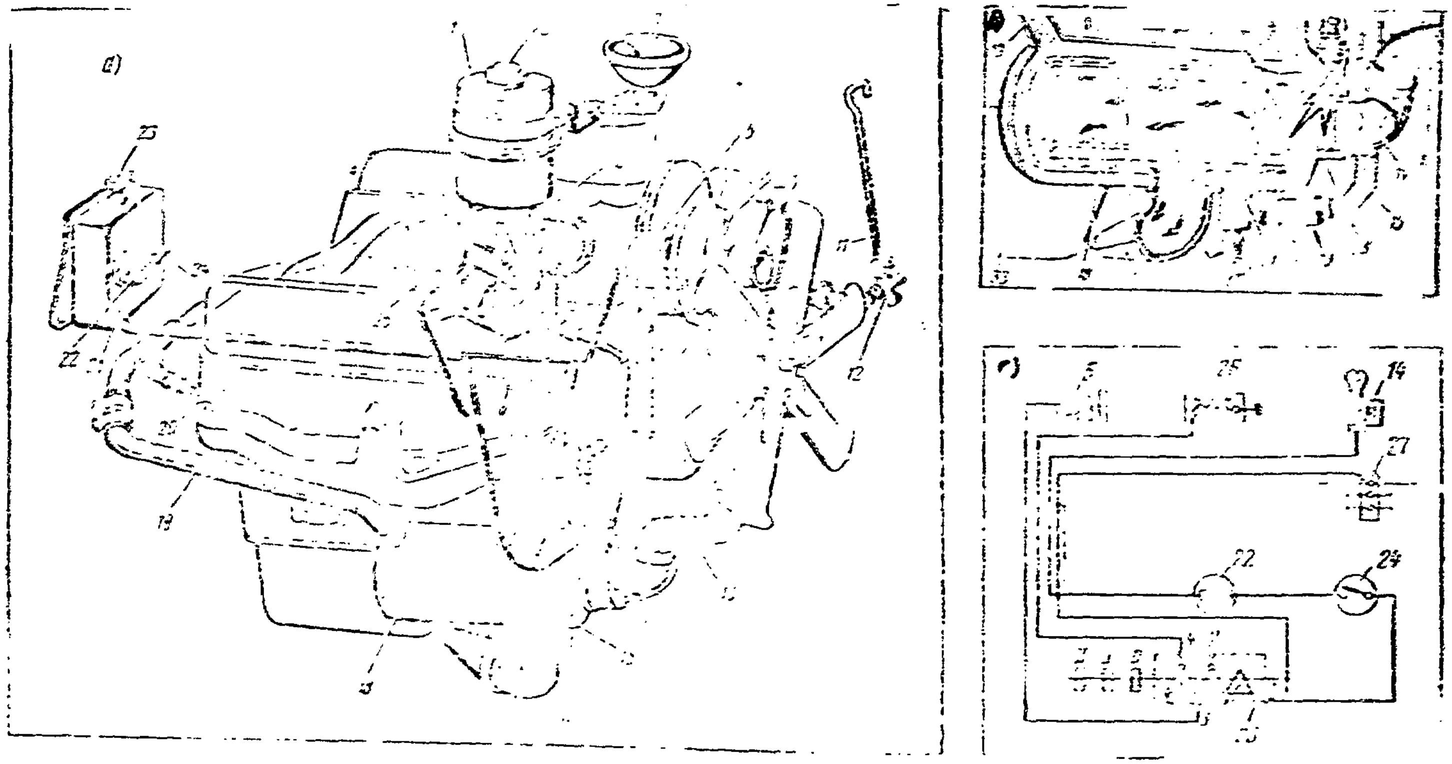


Plate 4-43. Preheater:

a) overall view of preheater b) schematic of preheater motor operation c) control panel electrical diagram 1) fuel tank 2) tank cap 3) filling funnel 4) valve 5) electric motor with fan 6) tank drain cock 7) fuel feed regulator 8) solanoid valve 9) adjusting needle 10) line from regulator to boiler combustion chamber 11) valve control lever 12) preheater line drain valve 13) air supply hose 14) glow plug 15) outlet line 16) air funnel 17) boiler drain valve 18) heater boiler 19) feeder line from boiler to engine 20) feeder fitting 21) control panel 22) control spiral

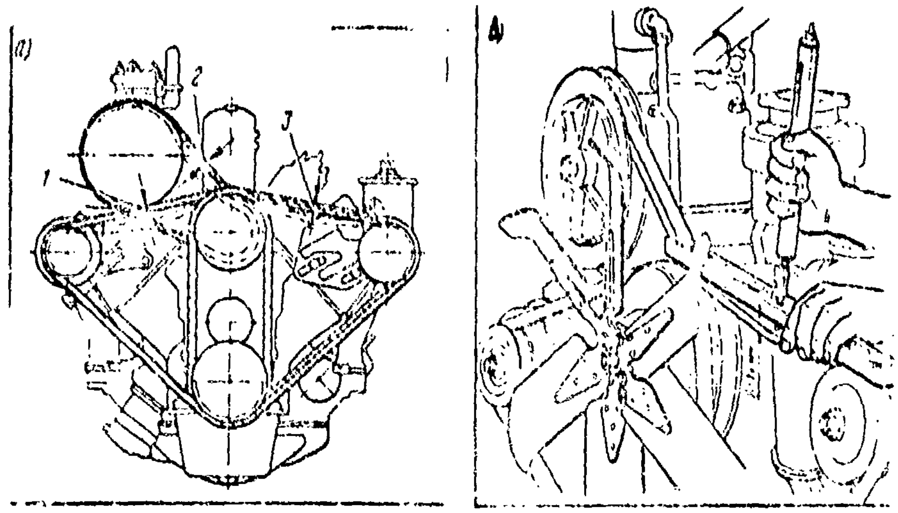


Plate 4-44. Location diagram and method of checking engine drive belt tightness:
a) belt location diagram b) method of checking hydraulic power steering pump drive belt tightness 1, 2, and 3) drive belt

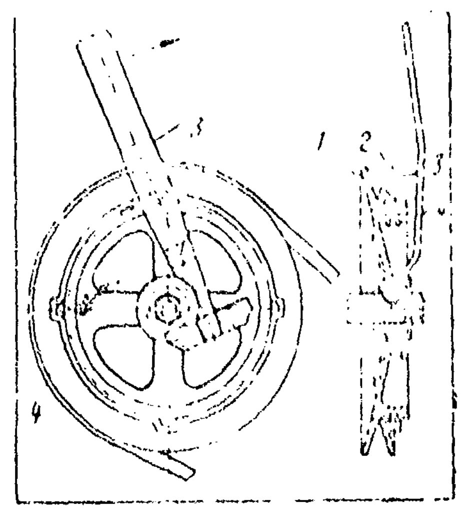


Plate 4-45. Method of adjusting compressor drive belt tension

[Key to Plate 4-43, continued]: 23) switch 24) glow plug switch 25) line for draining fuel 26) solanoid valve coil 27) connecting panel for left nozzle 28) combustion chamber 29) boiler internal liquid cavity 30) boiler external liquid cavity 31) boiler heat pipe 32) boiler exhaust gas passage 33) engine oil pan

Checking and adjusting clearances in the engine valves is necessary upon appearance of splattering in the valves. Before adjusting clearances, it is necessary to remove the high tension leads, disconnect them from the spark plugs, unscrew the rocker arm cover nuts, and remove the covers and gaskets. Clearances between the valves and rocker arms is adjusted on a cold engine, with the adjusting screw and stop nut which are on the short end of the rocker arm.

Adjustment of clearances by the first method is done in the following order. Set the piston on the number 1 cylinder at TDC (compression stroke), using the installed notched indicator (Plate 4-47). For this, the crankshaft should be rotated until the mark on the shaft pulley coincides with the TDC mark on the indicator.

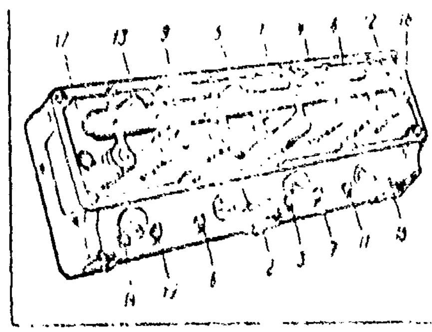


Plate 4-46. Tightening order of cylinder head bolts

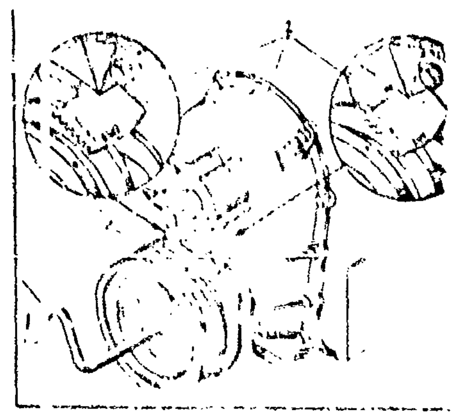


Plate 4-47. Setting the piston of the number 1 cylinder at TDC using the notched indicator: 1) mark on pulley 2) notched indicator (Numbers show rotation of the crankshaft in degrees)

In this case, both valves, intake and exhaust, of the first cylinder will be closed, the maximum clearance will be formed between the valve stem and the contact end of the rocker arm; it can be measured with a leaf gauge and, if necessary, adjusted.

To adjust the clearance, it is necessary to loosen the stock nut with a wrench while holding the adjusting screw with a screwdriver (Plate 4-48, a). After this, the leaf gauge is inserted between the valve stem and the contact end of the rocker arm, and the adjusting screw is turned with a screwdriver (Plate 4-48, b), setting the required clearance. After this, leaving the leaf gauge in the clearance, tighten the adjusting screw with the stop nut, using the wrench and screwdriver (Plate 4-48, c). After adjustment, the clearance must be equal to 0.25-0.31 mm for intake and exhaust valves, so that a 0.25 mm leaf gauge may freely pass through the clearance, and a 0.30 mm gauge cannot pass through.

For adjusting the clearance in the valves of the other seven cylinders, it is necessary to rotate the crankshaft with a crank by one quarter of a revolution (by 90°) and perform the adjustment according to the indicated method. With clearance adjustment being performed sequentially, agreeing with the cylinder firing order 1-5-4-2-6-3-7-8, which is illustrated by the connecting lines and arrows on Plate 4-48, d. In order to accurately turn the crankshaft by one quarter of a revolution, it is necessary to make marks on the crankshaft pulley with soap, separating them by an angle of 90°, with the number 1 cylinder located at TDC (compression stroke). In the second method, valves are adjusted simultaneously for several cylinders. Adjustment takes place in the following sequence. Set the piston of the number 1 cylinder at TDC (compression stroke) according to the method shown above, and adjust the clearances of the: intake and exhaust valves of the first cylinder, exhaust valve of the second cylinder, intake valve of the third cylinder, exhaust valve of the fourth cylinder, exhaust valve of the fifth cylinder, intake valve of the seventh cylinder, and intake valve of the eighth cylinder. Clearances in the remaining valves should be adjusted after rotating the crankshaft 360° (a full revolution). After completing valve clearance adjustment, it is necessary to install the rocker arm cover with its gasket in place and fasten it with nuts and flat washers. Start the engine and listen to it run. A warm engine must work without valve clatter, "coughing" in the carburetor, and "backfiring" in the muffler.

To avoid grinding of the ball springs, it is necessary in any disassembly of an engine having run 70,000 km to disassemble the exhaust valve rotating mechanisms and turn the ball disk springs upside down so that their worn side is down.

The order of checking compression in a V-engine is the same as in in-line engine cylinders. Compression in the cylinders of a warm V-engine must be within the limits of 7.5-8.5 kg/cm^2.

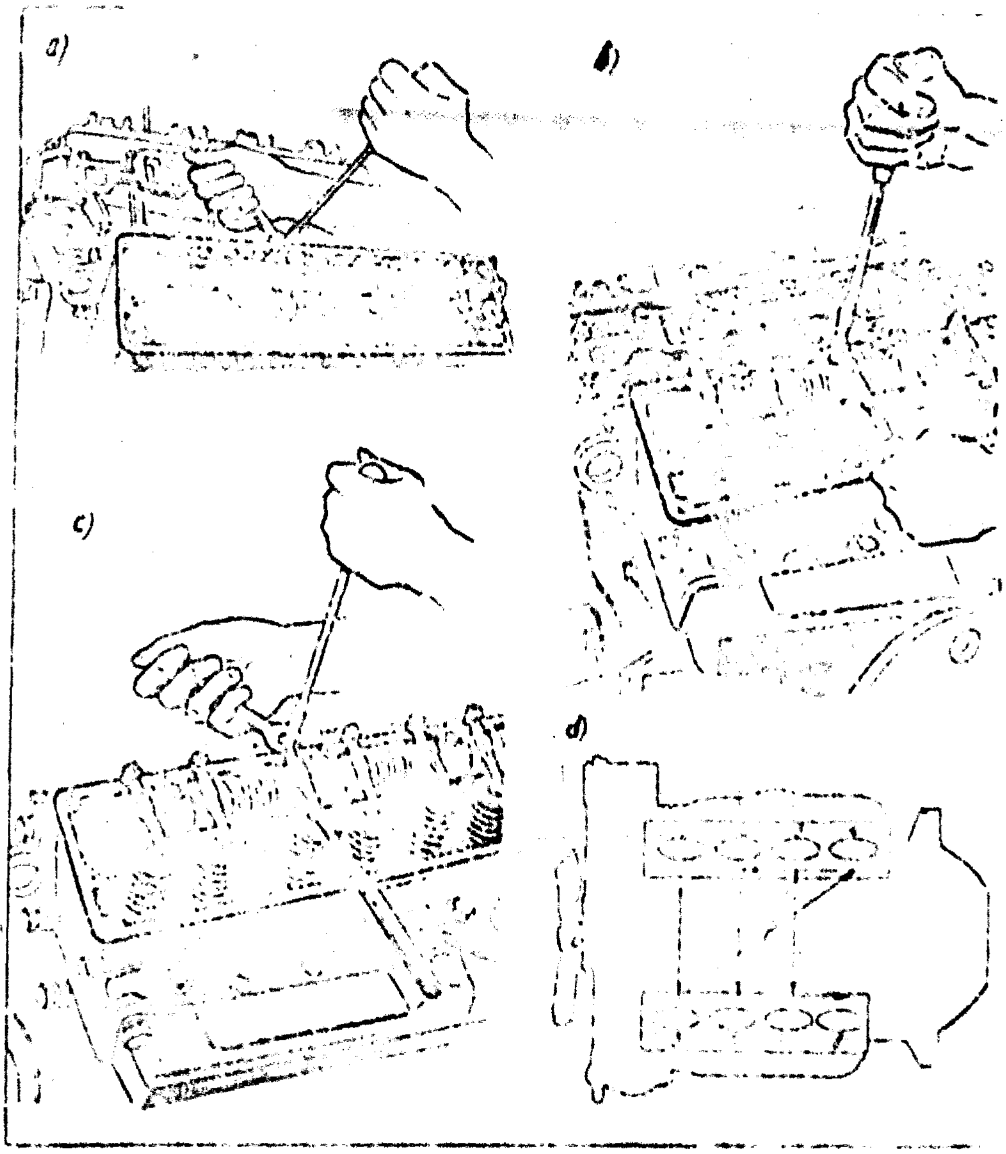


Plate 4-48. Valve adjustment:
a) loosening the stop nut b) adjusting and checking clearance with a leaf gauge c) tightening the stop nut and adjusting screw d) cylinder numbering order (arrows indicate cylinder firing order)

Compression decrease during operation is allowable [illegible] g/cm^2.

It is necessary to clean the plates of the coarse oil cleaning filter daily, turning its handle by three to four revolutions. The filter should be cleaned with a completely warmed engine. Use of an extension lever to ease rotation of the filter handle is forbidden. If the filter handle turns with difficulty, it is necessary to unscrew the cover bolts, remove the filter, and wash it out in kerosene. For convenient access to the oil filter handle, an extension running along the filter axis is built into the ZIL-131.

Checking the proper operation of the partial flow centrifugal oil cleaning filter is done by sound. After stopping the engine, the filter will continue to work for 2-3 minutes, making its own peculiar sound during this operation. The absence of this sound indicates that the filter is not working. The filter is cleaned every TS-2, at the same time that the engine oil is changed. To clean the filter, it is necessary to: unscrew nut 10 (see Plate 4-32) and remove the jacket, then, having unscrewed plug 3, hold the jacket with a large punch inserted in the hole left by the plug, unscrew the nut, remove the filter cover, and clean dirt deposits from it. A layer of deposits more than 8-10 mm thick must not be allowed on the filter cover. After cleaning, wash the filter and screen in gasoline or kerosene.

If the filter works poorly, it is necessary to remove the body from the shaft and clean the shaft, bushings, and nozzles. Before uncovering the filter, it is recommended that the oil be drained from it by unscrewing plug 17. This takes approximately 30 minutes after stopping the engine.

The full flow centrifugal oil cleaning filter is cleaned in the same way as is a partial flow filter. After cleaning and finishing assembly, check the operation of the filter on a warm engine by sound.

The crankcase ventilation air filter is serviced simultaneously with changing oil.

For servicing, the crankcase ventilation filter is disassembled, dirt is cleaned from it, and it is carefully washed in gasoline or kerosene.

After the crankcase ventilation filter is washed, fresh engine oil is poured on and the filter is assembled.

Before the water pump bearings are lubricated, it is necessary to clean the dust and dirt off the area around the lubrication fitting and the control opening, and to unscrew the plug from the control opening.

Grease should be pressed in with a grease gun through the pressure lubrication fitting until fresh grease appears from the control opening. After lubricating the bearings, the plug is installed in place.

Disassembly and assembly

Removing the power unit

To provide the best access to the motor vehicle's parts from below (during removal of the power unit), it is recommended that the motor vehicle be placed over an inspection pit, over which there is a hoist mechanism. The weight of the power unit in assembly without fluid is 540 kg; therefore it is necessary to have a hoist mech. ism with a load capacity of no less than 1 ton for its removal. Height to the hook must be no less than 2 meters.

Before removing the power unit from the motor vehicle, it is necessary to drain the water from the cooling system and desirable to also drain the oil from the engine crankcase and the transmission. Water is drained through three drain cocks. During disassembly, it is recommended that small parts be placed in a separate box, and when wires are disconnected from electrical equipment, screws and nuts should be screwed back into their places by hand.

Before removing the power unit, it is necessary to perform the following preparatory tasks. Remove the storage battery nest hatch cover and free the positive terminal of the battery, remove the starter l d, and, in the ZIL-131 motor vehicle, disconnect the ground with the switch.

Raise the engine hood and disconnect the leads from electrical equipment and the front terminal blocks, and remove the distributor cap and rotor.

Loosen the hose clamp screws and remove the water and oil radiator hoses. Remove the heater hoses and lines.

Disconnect the louvre cable and p... it, together with its jacket, from the hole in the cab fire wall.

Free and remove the radiator jacket.

Unscrew the radiator fastening nuts, remove the radiator either by hand or with device KZ-0355 (Plate 4-49, 8), and remove the rubber cushions with their spacing bushing.

Disconnect the carburetor linkage and remove: the accelerator linkage, the manual throttle cable, and the manual choke cable.

Disconnect and remove: the compressed air outlet line from the compressor; the pressure regulator line; and the fuel inlet line to the fuel pump.

Disconnect the high and low pressure hoses from the hydraulic power steering pump body.

Disconnect the steering mechanism power inlet and remove the steering column universal shaft.

Driving off the stop rings and unscrewing the nuts, disconnect the exhaust collector pipe from the exhaust manifold.

Unscrewing the fastening bolts, remove the inspection cover in the floor of the cab.

Unscrewing the fastening bolts, remove the transmission shift lever housing with its gasket in assembly with the shift lever.

Cover the hole in the transmission cover with a cardboard cover, fastening it down with two bolts.

Disconnect the speedometer drive, unscrewing the sleeve tensioning nut.

Disconnect the foot brake drive, removing the rod from the pedal lever.

Disconnect the drive for the manual trailer brakes.

Remove the handbrake lever from the transmission, unscrewing its fastening bolts.

Disconnect the universal shaft from the handbrake drum, unscrewing its fastening nuts.

Disconnect the clutch drive, separating its drawbar and pedal lever.

On the ZIL-131, disconnect the universal shaft from the flange on the transmission output shaft.

Disconnect the transfer case drive and control lever.

If the motor vehicle has a winch, disconnect the universal shaft of the power take off box, and remove its cover and control lever.

Free the fastening bolts of the front mounts and two rear mounts of the engine, as well as the engine bracing rod.

Engage the hoist apparatus (Plate 4-49, a) in the brackets of the engine, and carefully raising it and moving it forward, remove the power unit from the motor vehicle.

Upon removing the power unit from the motor vehicle, install it on a special carriage (Plate 4-50,a) for its transportation to the disassembly point.

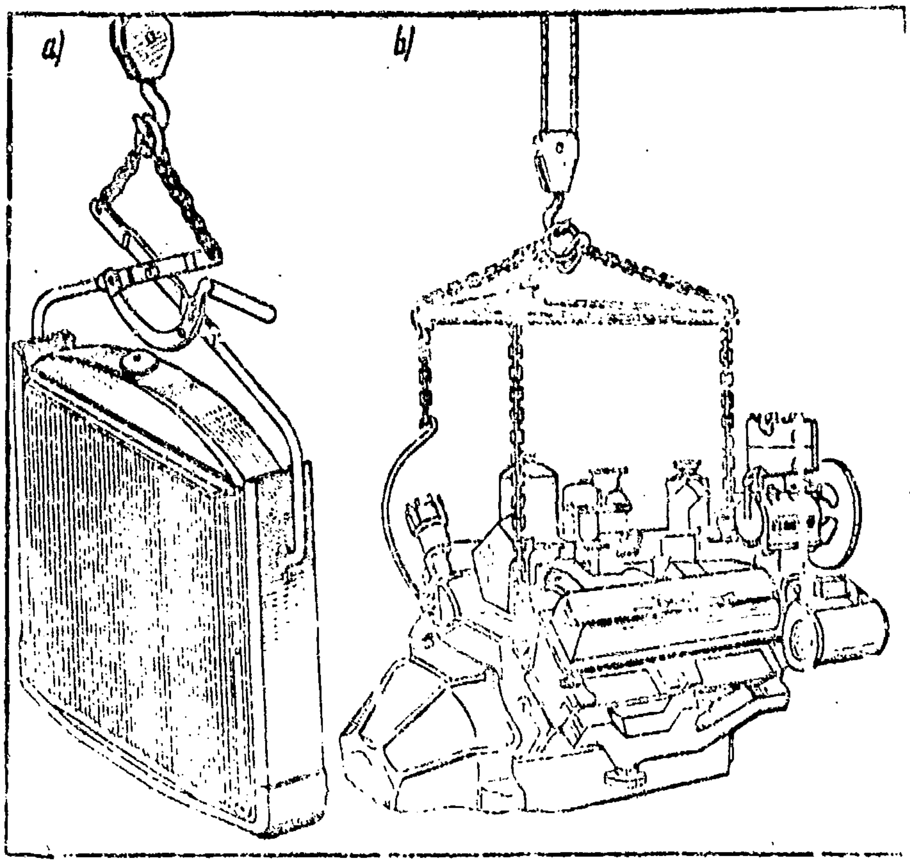


Plate 4-49. Devices for removal from motor vehicle of:
a) the radiator b) the engine

Engine disassembly

Before disassembling the power unit, it is necessary to clean the dirt and oil from it, washing it in kerosene or with a degreasing solution. For drying, blow the engine off with compressed air.

It is expedient to conduct removal of the assemblies and parts mounted on the engine with the engine mounted on a GARO model 2473 stationary rotating stand, or on the stand shown in Plate 4-50, b. Rotation of the engine around the horizontal axis of the stand is accomplished with a worm mechanism installed on the stand. The engine may be held during disassembly or assembly in any position with a brake on the worm mechanism. During engine disassembly, run-in parts assembly surfaces which are usable for re-installation without being exchanged should be protected from damage.

Parts of assemblies removed from the engine should be placed in a specially prepared box, in which they are again placed for assembly after washing, checking, and elimination of deficiencies.

The majority of engine parts are interchangeable (although many require individual fitting to their assembled parts) and allow their non-individualized exchange, with the exception of connecting rod caps and main bearing caps (the first are machined with the connecting rods in assembly, and the second are machined in assembly with the cylinder block). Connecting rods, with their caps in assembly, are stamped at the factory with numbers corresponding to the number of their cylinders, and main bearing caps are stamped with numbers corresponding to the main bearing order number.

Before installing the engine on the stand, the transmission must be removed from it. For this, the transmission and fastening bolts should be unscrewed with a box and wrench, the transmission disconnected from the clutch housing with the help of an assembly pry bar and, rocking it, it is removed with a block and tackle or hydraulic jack model 444 (see Plate 4-50,a).

Air filter removal. Disconnect the lines leading from the air filter to the compressor, remove the transfer cover with its sleeve, unscrew the compression nut and remove the air filter, and then remove the transfer flange.

Carburetor removal. Disconnect the fuel line running from the fine cleaning filter, the vacuum advance line, and the two lines running to the centrifugal switch, free the fastening nuts, and remove the carburetor and heat insulating gasket.

Remove the engine crankcase ventilation filter, unscrewing its fastening bolts.

The fine cleaning fuel filter. Disconnect the pipe from the fuel pump, unscrew the fastening nuts of the bracket, and remove the filter in assembly with the bracket and pipes.

Oil filters. Unscrew the oil pressure indicator switch from the filter line. Disconnect the drain lines. Unscrew the filter body fastening bolts and remove the filter together with its packing gasket from the engine.

The distributor and distributor drive. In the ZIL-131 motor vehicle, remove the shielding hoses. In all motor vehicles, unscrew the cooling liquid temperature indicator switch. Unscrew the bolts fastening the distributor to the pump plate of the octane corrector and remove it.

For removal of the octane corrector plates, it is necessary to unscrew the bolts fastening the plate to the top flange of the distributor drive body.

For removal of the distributor drive, it is necessary to unscrew the bolts fastening the drive body to the cylinder block and pull the distributor drive in assembly with its body, shaft, and gear from the nest in the block.

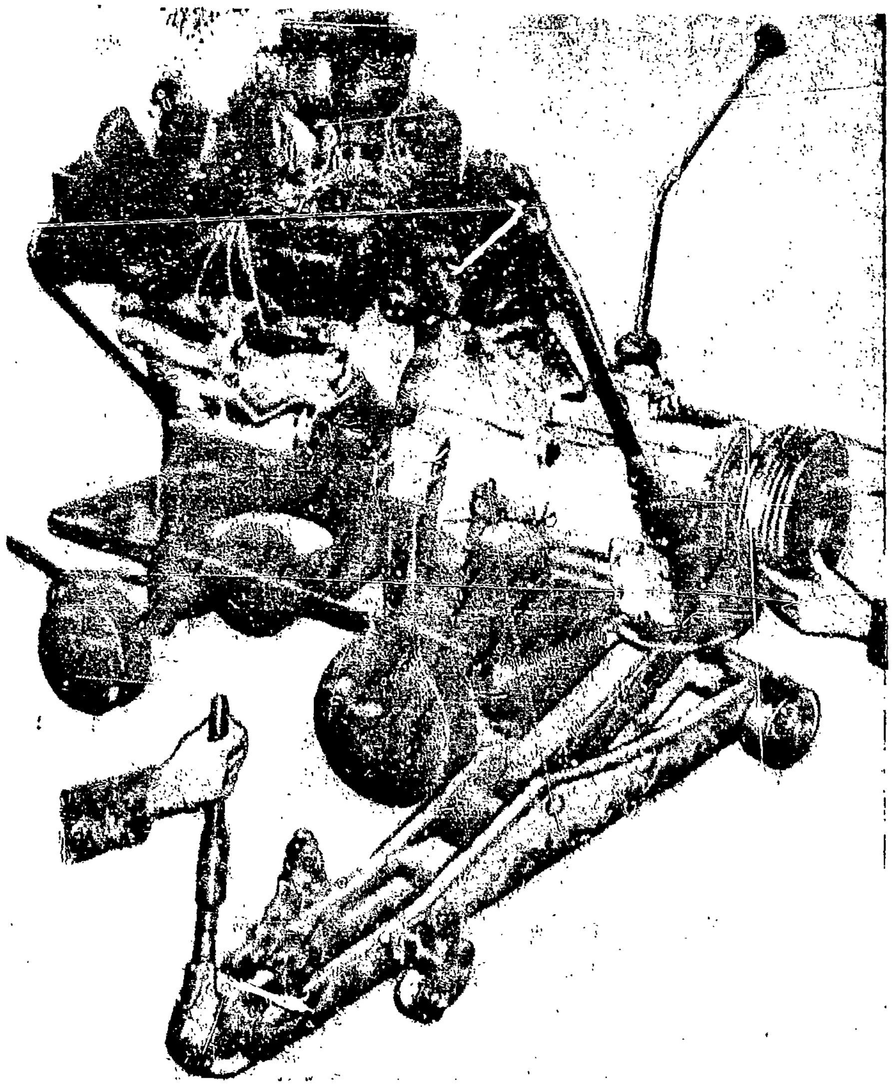


Plate 4-50. Engine installation for disassembly:
a) on a cart

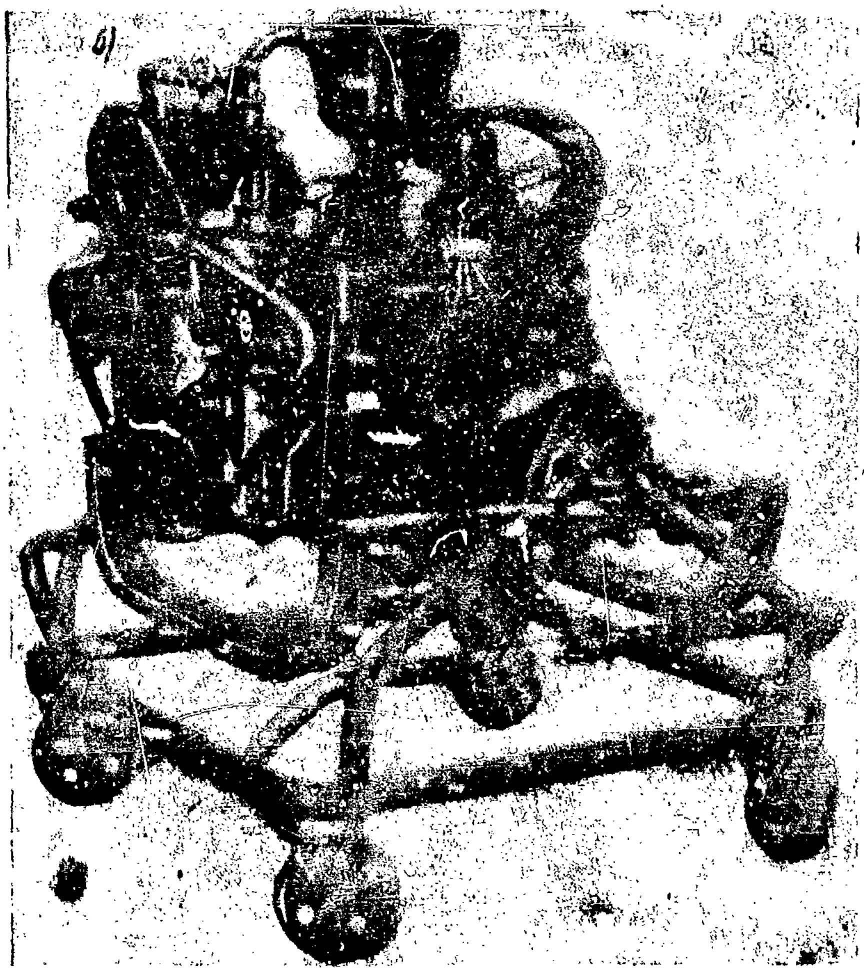


Plate 4-50 b. On a rotating stand

The starter. Unscrew the bolts fastening the starter to the clutch housing and pull the starter from its receptacle in the housing.

The generator. Unscrew the nuts fastening the generator tensioning arm. Unscrew the nuts fastening the generator to its bracket and, freeing the generator pulley from its drive belt, remove the generator and generator drive belt.

Unscrew the generator brackets from the engine, unscrewing their fastening bolts.

The hydraulic power steering pump. Unscrew the nuts fastening the tensioning bracket to the cylinder head, and, freeing the pump fully from its drive belt, remove the pump in assembly with the brackets and pump drive belt.

Remove the bracket from the pump, unscrewing its fastening bolts.

The fuel pump. Unscrew the pump fastening nuts and remove it together with its gasket.

The compressor. Unscrew the coupling nuts fastening the lines supplying cooling liquid to the compressor from the intake manifold and exhausting liquid from the compressor to the water pump, and remove the lines.

Unscrew the coupling nuts of the lines supplying oil to the compressor from the oil main line of the cylinder block and exhausting oil from the compressor to the engine crankcase, and remove these lines.

Unscrew the bolts fastening the compressor to its bracket and, freeing the pulley from its drive belt, remove the compressor and compressor drive belt.

For removal of the bracket from the engine, it is necessary to unscrew the nuts fastening the bracket to the cylinder head.

The starting pre-heater. On motor vehicles equipped with starting preheaters, it is necessary to drain the fuel from the tank and disconnect: the electric leads from the preheater instruments; the air supply hose from the fan and from the boiler; the fuel line from the regulator and boiler; lines for cooling liquid from the engine and boiler.

Remove from the engine the funnel and pipe; fuel tank; preheater electric motor and fan; fuel feed regulator with its solenoid valve; unscrew the glow plug and remove the boiler with its funnel.

The centrifugal crankshaft revolutions governor switch. Unscrew the coupling nuts fastening the lines connecting the switch to the carburetor and remove them. Unscrew the bolts fastening the centrifugal switch to the camshaft gear cover and remove the switch with its gasket.

The fan and water pump. Unscrew the bolts fastening the fan to its hub and remove the fan, drive belts, and pulleys. Unscrew the bolts fastening the water pump body to the base of the block and remove the pump with its gaskets.

The oil pump. Unscrew the bolts fastening the oil pump and remove the pump with its gaskets.

The cooling system upper pipe. Unscrew the nuts fastening the pipe to the intake manifold and remove the pipe in assembly with the thermostat and pull the thermostat from the pipe.

The spark plugs. To protect the spark plugs from damage, unscrew them from their holes in the cylinder head. The holes are closed with plugs.

The exhaust manifolds. During removal of the exhaust manifolds, it is necessary to disconnect the spark plug protector plates, pull out the oil dipstick, and disconnect the control drive rods of the cooling system drain cocks.

Unscrew the nuts fastening the exhaust manifold and remove it with its gasket. If the gasket is burnt onto the cylinder head surface, it must be carefully separated with a screwdriver. The operation is repeated with the second exhaust manifold. During removal of the exhaust manifolds from the ZIL-131 engine, they must not be disassembled. When there is no necessity to remove the exhaust manifolds separately, they may be removed in assembly with the cylinder heads.

The intake manifold. Unscrew the nuts fastening the intake manifold to the cylinder heads with a socket wrench, and, lightly tapping it with a hammer, remove the manifold by hand. Remove the two gaskets and two rubber seals, carefully separating them from their contact surfaces. Unscrew the cooling liquid temperature indicator switch from its receptacle.

The rocker arm covers. Unscrew the nuts fastening the covers and remove them together with their gaskets.

The rocker arm shafts, push rods, and tappets. Unscrew the four bolts fastening the rocker arm shaft to each cylinder head with a socket wrench. Remove the shaft in assembly with the rocker arms and stands, withdraw the tappet push rods, and pull the valve tappe from their nests in the cylinder block with a metal rod whose end is bent to a right angle.

For removal of the rocker arms and stands (see Plate 4-26), it is necessary to unpin one end of the shaft and remove from it: the first flat washer, spacing spring washer 3, the second flat washer 4, the first rocker arm, the rocker arm stand, the second rocker arm, the spacing spring, and then remove all the remaining rocker arms, stands, and spacing springs

The cylinder heads. Unscrew the cylinder head fastening bolts with an angle socket wrench and remove them. Remove the gaskets. If the gaskets are burned, it is necessary to carefully separate them with the screwdriver.

Removal of the engine oil pan, clutch housing cover, oil trap, and oil pump pickup. Rotate the engine on the stand by 90° and set it vertically with the clutch housing downward. Unscrew the bolts fastening the clutch housing shield and cover, and remove them. Unscrew the bolts fastening the oil pan with the socket wrench and remove it from the engine by hand. Remove the oil pan gasket, carefully separating it from the cylinder block surface with a screwdriver. Unscrew the bolts fastening the oil trap and remove it. Unscrew the bolts fastening the oil pump pickup and remove it together with its gasket.

The piston and connecting rod assembly. Unpin the connecting rod bolt nuts, unscrew the connecting rod nuts with a socket wrench, check the stamping on the caps and connecting rods, and if necessary mark them with a punch, and then remove the caps from the rods, tapping lightly on the caps with a hammer, and remove the connecting rod bolts.

Rotate the engine on the stand by 90°, drive the pistons out of the cylinders in order, install the connecting rod caps in their places and fasten them with their bolts and nuts, screwing them on by hand.

During removal of the piston and connecting rod assemblies, it is necessary, after having removed the connecting rod bolts, to remove the connecting rod caps in pairs (1 and 5, 2 and 6, 3 and 7, and 4 and 8), rotating the crankshaft during this process with a lever on the toothed crown of the flywheel.

The flywheel pulley and camshaft gear cover. Drive the lock washer away from the edge of the crank ratchet, unscrew the ratchet with a socket wrench, having locked the crankshaft with a wooden mandrel placed under a crank of the shaft.

For removal of the crankshaft pulley, a three-pronged puller is used (Plate 4-51). A model 2492 puller can be used. After removal of the pulley, drive out the key from the crankshaft slot.

Plate 4-51. Crankshaft pulley removal

For removal of the camshaft gear cover, it is necessary to unscrew the cover fastening bolts with a socket wrench and remove it, lightly tapping it with a wooden mallet, and remove the cover gasket, carefully separating it from the cylinder block surface.

The crankshaft. Unscrew the main bearing cap fastening bolts with a socket wrench and remove them, check the cap stamping and mark the caps with a punch if necessary, then remove the caps together with the inserts, and the rear cap together with the rubber end with seals. Remove the oil deflector from the shaft.

Remove the crankshaft with the flywheel and clutch in assembly, using a block and tackle.

Remove the main bearing inserts, and lay them in numerical order. Remove the rear main bearing seal. Set the main bearing caps in place.

The camshaft. In order to remove the camshaft from the engine cylinder block, it is necessary to remove the rocker arm shaft with the rocker arms in assembly, pull out the push rods and tappets, remove the camshaft gear cover, unscrew the two bolts fastening the flange through the holes in the gear, (Plate 4-52), and pull out the camshaft.

In pulling out the shaft, it is necessary to pay particular attention to ensure that the tops of the lobes do not strike the camshaft bearings and damage their surfaces. The shaft is pulled out in assembly with the camshaft gear and flange.

The camshaft gear (Plate 4-53) may be fitted on the shaft with a maximum clearance of up to 0.008 mm, or with a maximum interference of 0.036 mm.

The diameter of the shaft where the gear fits on it is 30.015-30.036 mm. The gear 1 is prevented from turning on the shaft by key 10. Width of the shaft keyway is 5.954-5.990 mm. If the keyway is worn, its width is allowed to be increased to a dimension of 6.945-6.990 mm for installation of a repair dimension key.

For removal of the camshaft gear from the shaft, it is necessary to pull off the lock ring 6, unscrew the gear fastening nut 5, remove it and pull out shaft 2 with spring 11 of the centrifugal switch drive, and remove the washer.

Install the camshaft on a press and press off the gear (Plate 4-54), then remove the support flange 7 (see Plate 4-53), and the spacing ring 8, from the gear.

Removal of the gear from the shaft may also be accomplished with the model 2491 puller (Plate 4-55, a), as shown in Plate 4-56, a, as can fitting the gear on the shaft (Plate 4-56, b).

The clutch housing is final machined in assembly with the cylinder block, as a result of which it is not interchangeable. Therefore, it should not be removed from the cylinder block unless necessary.

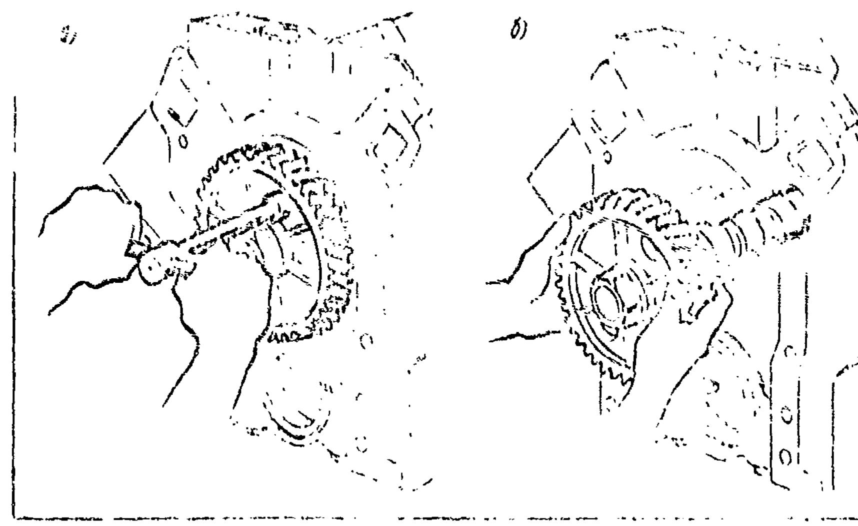


Plate 4-52. Camshaft removal.
a) unscrewing camshaft fastening bolts
b) removing the shaft

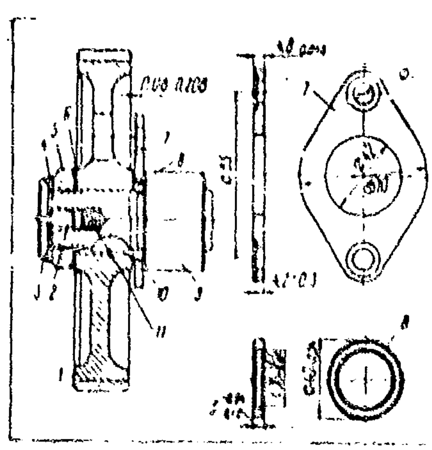


Plate 4-53. Gear fastening on the camshaft:
1) gear 2) centrifugal switch drive shaft 3) stop ring
4) drive shaft washer 5) nut
6) lock washer 7) support flange 8) spacing ring
9) camshaft 10) key 11) drive shaft spring

Plate 4-54. Pressing the gear from the camshaft

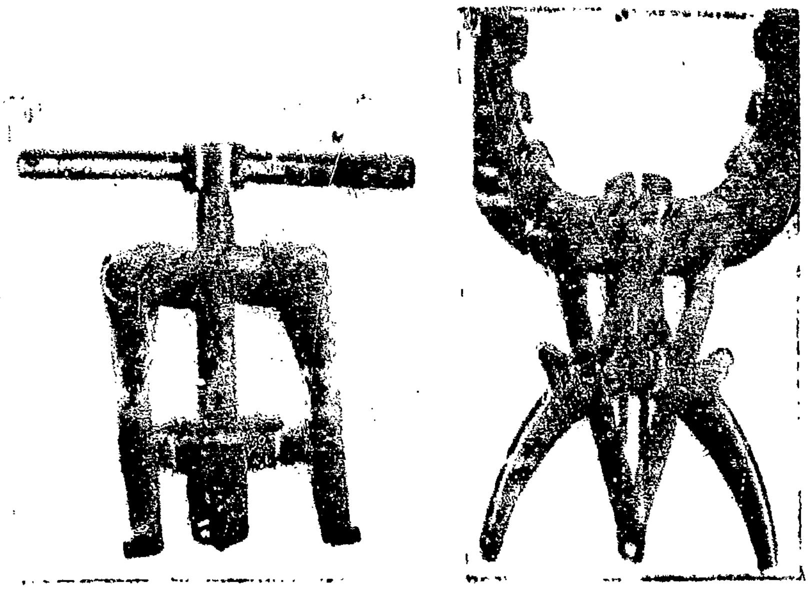


Plate 4-55. Pullers:
a) camshaft gear (model 2491) b) piston ring (model 2479)

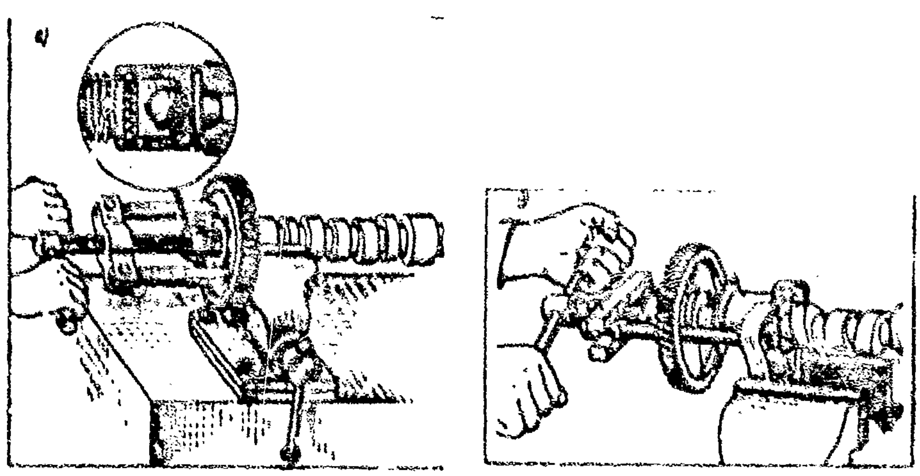


Plate 4-56. Pressing off and pressing on the camshaft gear:
a) pressing off b) pressing on

Remove the cylinder block with the clutch housing from the stand with a hoist, free the hoist from the compression brackets of the stand, and set the cylinder block on supports or a bench. Unscrew the bolts fastening the clutch housing the the cylinder block with a box end wrench, and remove the clutch housing in assembly with the disengagement fork and the clutch pedal lever.

For removal of the clutch disengagement fork from the housing, it is necessary to unscrew the lever tension bolt and remove the lever from the fork shaft. Drive the lever key from its slot in the fork shaft. Unscrew the bolts fastening the flange with the bushing and pull the bushing with its flange and sell from its receptacle in the housing. Then, having freed the right end, and moving it in the bushing nest hole, remove the clutch disengagement fork.

Removal of scale from the cooling water jacket.

Scale in the cylinder block water jacket is removed mechanically or with a solution (20 grams of trilone per 1 liter of water).

In a case where there is no necessity to press out the sleeves but scale removal is required, the two face plugs on the rear part of the block and the side collars, together with the cooling system drain cocks, should be unscrewed for washing out the cylinder block cooling jacket.

Disassembly and assembly of engine components.

The piston-connecting rod assembly. It is recommended that the connecting rod and piston be fastened into a vise for disassembly. Remove the piston rings (Plate 4-57) with a model 2479 puller (see Plate 4-55, b), remove the piston wrist pin stop rings with pliers, press out the wrist pin and disconnect the piston from the connecting rod. Check the condition of the connecting rod small end bushings, the wrist pin and the piston

During removal of an assembled oil ring, it is necessary to remove the circular disks with a device, and then manually extract the spreader.

Before assembly of the connecting rod and piston, the connecting rod with its inserts must be matched to the shaft journal, the piston matched to the cylinder sleeve, the rings matched to the piston groove, and the clearance in the butt joints to the cylinder. The wrist pin must be matched according to the connecting rod small end bushing, and the holes in the piston bosses.

Piston matching. All operations of matching the pistons to the cylinder sleeves must be conducted at a temperature of 17-22°C.

When a piston is exchanged while the cylinder sleeves are used without regrinding, it is expedient to remove the upper edge (shoulder) of the sleeve which is formed as a result of sleeve wear above the level of the top piston ring with a scraper or small-grained abrasive wheel.

The pistons must be matched according to the cylinders so that clearance between the cylinder walls and the piston skirt is within the limits of 0.3-0.5 mm. The amount of clearance is determined the method of pulling through a band thickness gauge which is 0.08 mm thick, 10 mm wide, and no greater than 200 mm long.

The band thickness gauge is pulled into the clearance between the piston and cylinder with a force of 3.5-4.5 kg (with the piston stationary).

It is recommended that piston matching take place with the piston turned head down, and the band used must be located on the side opposite the notches in the piston skirt. Pistons may be matched with sleeves without pressing the sleeves out of the cylinder block (Plate 4-58, a), or in sleeves which have been pressed from the cylinder block (Plate 4-58, b).

Having matched the piston according to cylinder sleeves, it is necessary to stamp or paint (chalk) the order number of their cylinders on the piston heads.

For assembly with the connecting rod, a piston is heated in a water bath or in an electrical heating apparatus (see Plate 3-55) to a temperature of 75°C.

Plate 4-57. Removal and installation of piston rings

During this, the wrist pin must enter in the boss hole of the warmed piston freely, under the force of a man's thumb

With this assembly, after the piston cools, the necessary interference within the limits of 0.0025-0.0075 mm will appear

Check the order number of the piston and connecting rod.

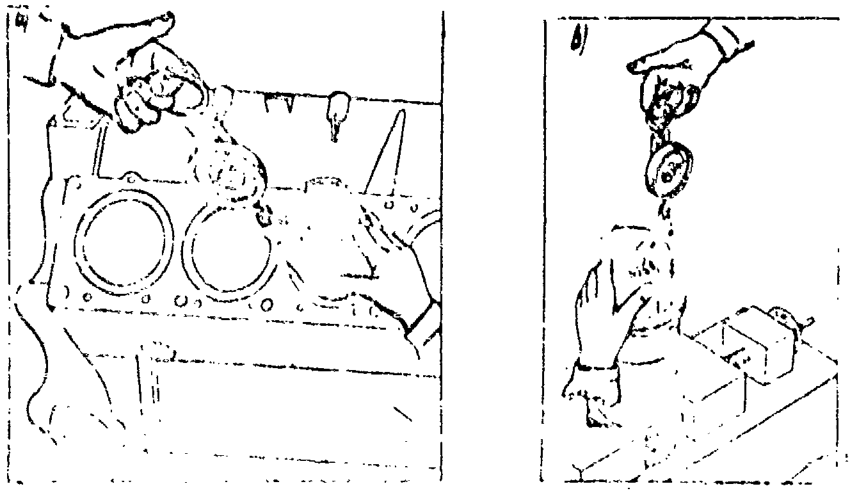


Plate 4-58. Matching pistons according to sleeves:
a) matching piston to sleeve installed in the cylinder block
b) matching piston to sleeve pressed out of the cylinder block

The connecting rod is fastened in a vise, the piston is set on it and, inserting the wrist pin, it is assembled with a connecting rod.

During assembly with the connecting rod, the piston must be set so that the mark milled into the piston head is directed toward the front. The boss stamped on the connecting rod for the left group of cylinders must also be directed toward the front, i.e., toward the same side as the mark on the piston. For the right group of cylinders during piston assembly with the connecting rods, the connecting rod bosses must be directed toward the rear, and the mark of the piston heads toward the front.

With this assembly of the piston and connecting rods of the left group of cylinders, the oil slinging holes in the bottom ends of the connecting rods will be directed toward the side of the piston notches, and for the right group of cylinders, they will be directed toward the side opposite the piston notches.

After assembling and checking the piston and the connecting rod, it is necessary to install the stop rings in the piston bosses, fastening the wrist pins with this.

Then, carefully rub off the piston rings, matched according to grooves and fitted according to cylinders, and install them on the piston with the aid of a model 2479 device (see Plate 4-57).

The pistons' differences in assembled weight of units to be installed on one engine must not exceed 12 grams.

In this assembly, the connecting rods must of the same weight group.

Cleaning coke from piston ring grooves on a used piston is accomplished with a device shown in Plate 3-57. Coke must be cleaned exactly and carefully, so as not to damage the surface of the grooves.

Coke is cleaned from the oil outlet holes with a metal rod or a 3 mm drill.

In a case when the piston wrist pin is replaced with a pin of increased (repair) dimensions without replacing the piston, it is necessary to ream the hole in the piston bosses to a dimension providing the necessary interference (0.0025-0.0075 mm).

To maintain coaxiality of the holes, it is recommended that a reamer (Plate 4-59) with guiding tips be used. With this, the holes are reamed sequentially: first one, and then the other.

While reaming one of the holes, use the second for installation of the guide bushing. The reamer is equipped with a tail which is inserted into bushing 2. The exterior diameter of the bushing is in the form of a shallow cone.

The method of measuring clearance in the locks of new rings or their installation in the cylinder or in the control caliber is shown in Plates 3-59 and 3-60, and measurement of clearance in height between the ring and the piston groove is shown in Plate 3-61.

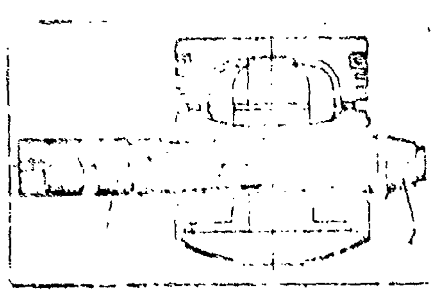


Plate 4-59. Reaming the wrist pin hole in a piston:
1) reamer 2) guiding bushing

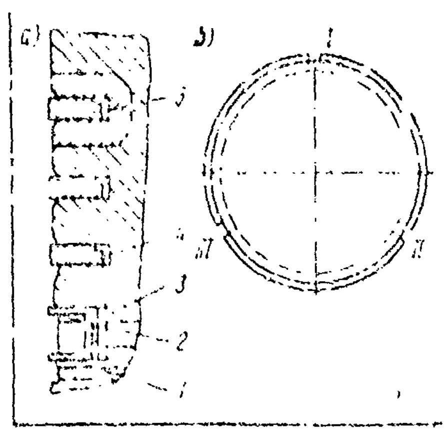


Plate 4-60. Piston ring installation:
a) location of the internal ring grooves in the piston grooves b) location of the ring butt joints on the piston
1) circular disk of assembled oil ring
2) axial spreader 3) radial spreader
4 and 5) compression rings

Clearance on a piston ring of corresponding dimension may be fitted in the lock with a fine toothed file. Fitting of the rings to the piston grooves should be done with fine-grained emery paper. The emery paper is laid on a flat plate and, lightly pressing, the ring is rubbed by hand. Rubbing continues until the required clearance between the ring and the groove is attained. A ring installed in the piston groove must move freely.

Increased clearance in the ring butt joint does not necessarily indicate reason for its discard. Usability of a piston ring can be determined by measuring the compression in the cylinders.

Operational experience of the ZIL-130 engine has shown a long piston ring life (up to 150,000-180,000 km of the motor vehicle's operation). Rings should not be changed unless necessary.

Premature exchange worsens the operation of the engine and increases wear on the cylinders. Ring installation should be done in accordance with Plate 4-60. Locate the compression ring butt joints around the circumference of the piston at 120° with an assembled oil ring. With installation of a cast iron oil ring, the ring butt joints should be located around the piston circumference through each 90°.

Ring flexibility in compression is checked with a flexible band instrument (see Plate 3-62). The compression force of the top compression ring must not be less than 2.1 kg, that of the bottom compression ring, 2.3 kg, and oil (cast iron) ring, no less than 2.1 kg, and for the disks of an assembled oil ring, 0.48-0.53 kg.

The bottom end of the connecting rod is machined in assembly with its cap; therefore, during disassembly, checking, and assembly, the connecting rod and rod cap should be kept as a unit.

The connecting rod caps are centered according to ground surfaces on the rod bolts.

It is also not recommended that connecting rod units be changed among engines, since at the manufacturing plant, rods are selected and grouped according to weight. During selection and grouping of new rods, they should be selected according to the weight of one group. The rods are fitted according to weight by means of removing metal from the bosses on the cap and on the connecting rod end. Accuracy of selection according to weight of a group of rods for one engine is 16 grams.

Nonparallelness of the axes of the big end and little end holes of a connecting rod, and also deviation from a single plane (warping), is not allowed to be greater than 0.04 mm on a length of 100 mm.

The connecting rod in assembly is checked with a device (see Plate 3-63). The method of checking is described in Chapter 3.

Connecting rods having deviation from axial paralleiness no greater than 0.08 mm and deviation in axial twisting of no greater than 0.08 mm on a length of 100 mm are admitted for correction.

The connecting rod may be corrected in a device (see Plate 3-63) or in a vise (see Plate 3-64) with a wrench or hand press.

The diameter of the connecting rod big end hole with the bolt nuts tightened must be within the limits of 69.500-69.512 mm (see Plate 4-15), and its nonellipticity must be no greater than 0.08 mm.

Connecting rods which go into repair with deviation in cylindrical form of their holes greater than 0.01 mm, or which do not fall within the limits of the indicated dimensions are discarded.

Repair of a connecting rod small end usually includes machining of the bushing for a repair dimension piston wrist pin (when the piston is capped) or exchange of the small end bushing and its consequent machining to a nominal dimension wrist pin (when a piston is exchanged). The connecting rod small end bushing is pressed into the hole with an interference of 0.147-0.200 mm, after which the hole for lubricating the wrist pin is drilled in it.

For the best contact of bushings newly pressed into connecting rod small end holes, and also for compacting the surface layer of the bushing metal, they should be previously subjected to drawing with a broach before reaming the hole, and the broach diameter must be 0.45-0.50 mm smaller than the final diameter of the hole for the wrist pin.

After drawing with a broach, the bushing is fitted with a reamer to the diameter of a nominal or repair dimension piston wrist pin.

Noncylindricality of the bushing hole is not allowed to be greater than 0.0035 mm.

Final machining of the hole for a piston wrist pin of any dimension (standard or repair) must be such that, at a temperature of +20°C, the piston wrist pin smoothly moves into the bushing hole with the effort of a man's thumb (see Plate 3-55). This fit corresponds to a clearance between the piston wrist pin and the bushing hole in the connecting rod within the limits of 0.0045-0.0095 mm.

For convenience in operation and repair, the factory produces a set of eight sleeves with pistons, rings, and wrist pins matched to them. This set bears the designation number 130-1000108.

The set, packed in a box, is shipped to requesters. For installation of a given set in an engine, it is necessary to remove the layer of preservative, and wash the parts in kerosene or gasoline. The pistons and rings are installed in those sleeves with which they came from the plant.

When sleeves are ground to repair dimensions, they are matched into similar groups, and used with repair dimension pistons and rings.

The crankshaft-flywheel-clutch assembly. The engine crankshaft is balanced in assembly with the flywheel and clutch. Allowable imbalance is not greater than 70 gram cm. Imbalance in the flywheel is eliminated by drilling holes 15 mm in diameter and no more than 25 mm deep on the internal side of the flywheel at a radius of 184 mm. Distance between the holes must be no less than 40 mm.

In the interest of maintaining the set (crankshaft-flywheel-clutch), it is recommended that marks be placed on the assembled parts before the clutch is removed from the flywheel, and that they be used in reassembling the part so as to maintain its balance.

Removal of the clutch from the flywheel. Mark the relative position of the clutch cover on the flywheel, unscrew the clutch cover fastening bolts with a socket wrench, remove the pressure plate in assembly with the clutch cover, and remove the driven disk in assembly.

Flywheel removal. Unpin the flywheel fastening nuts, unscrew them with an angle socket wrench (see Plate 3-65) and remove the flywheel. Drive the bolts out of the holes in the crankshaft flange.

If the front bearing of the transmission input shaft requires exchange, it should be pressed from the shaft with a puller (Plate 4-61, a) before removal of the flywheel, or, after flywheel removal, with a model 2476 puller, shown in Plate 4-61, c. After setting the clamps on the race faces of bearing 7, (Plate 4-61, b), they are spread by threaded support 3, and then the bearing is driven out by striking the slide against the support of shaft 5.

When crankshafts (see Plate 4-60) go in for repair, the deposits accumulated in their dirt collectors 3 should be cleaned out and oil coking products should be cleaned out of the passages. To clean out the dirt collectors, plugs 2 must be unscrewed.

The passages are cleaned with a wire brush.

The crankshaft must be checked for straightness.

The amount of bend in a crankshaft must not exceed 0.05 mm.

If bend is present, the shaft may be corrected on a hand or hydraulic press. To check the crankshaft, it is necessary to set it with its extreme end journals on supports, and determine the amount of bend with an indicator.

If the shaft is not straight, it is corrected on the press until bend is eliminated, simultaneously checking shaft straightness with the indicator (see Plates 3-69 and 3-70).

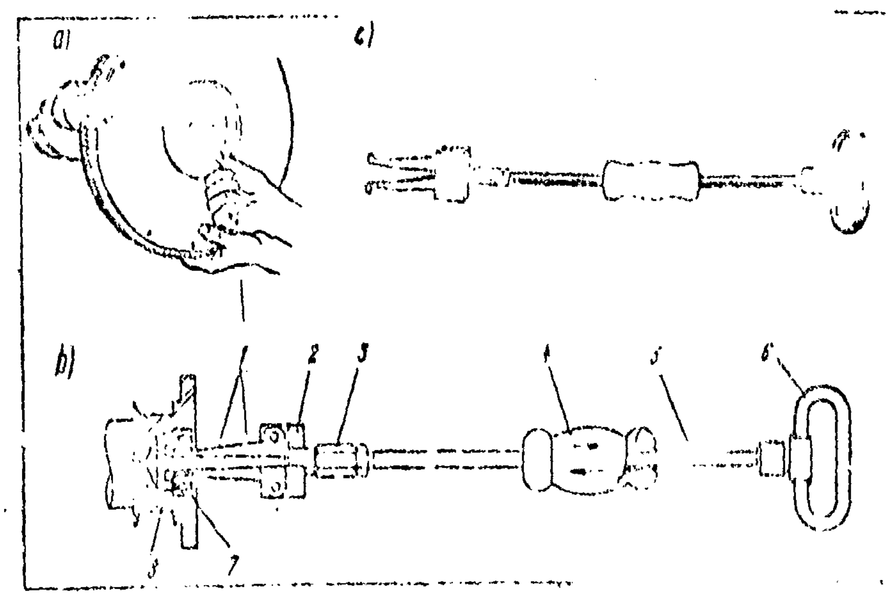


Plate 4-61. Pressing out the transmission input shaft bearing: a) pressing the bearing out with a screw puller b) pressing the bearing out with a slide hammer c) exterior view of the model 2476 slide hammer 1) clamps 2) clamp retainer 3) support 4) slide 5) guiding shaft 6) handle 7) bearing 8) crankshaft

The gear is pressed from the shaft journal with a 1P-21305 puller, as shown in Plate 3-68.

Unit assembly. For assembly of the crankshaft, it is necessary to mount two support washers on the first main journal, insert the key in its slot, and press on the crankshaft gear.

Install the flywheel on the crankshaft flange, align the holes in the flywheel and flange, insert the bolts, screw the nuts on them, and tighten them with an angle socket wrench. Torque [illegible] is 14-15 kg meters.

Set the shaft with the flywheel on mounts (see Plate 3-71) and check oscillation of the working surface of the flywheel with an indicator. Oscillation is allowed to be no greater than 0.10 mm. Place cotter keys in the flywheel fastening nuts. The sides of the pin on each bolt must lie tightly against the bolt face.

Grease the bearing receptacle in the flywheel flange with 1-13c grease and, with the aid of a mandrel, press the pilot bearing into it. Screw in the lubrication fitting for greasing the bearing. Check the passage of grease from the lubrication fitting to the bearings.

Install the clutch driven disk and housing in assembly with the pressure plate on the flywheel and preliminarily fasten it with the bolts. Then, using the transmission input shaft or a mandrel in place of it, center the driven disk and final tighten the housing bolts. Torque moment is 2.0-3.0 kg meters.

During installation of the clutch on the flywheel, it is necessary to go by the marks placed during clutch disassembly, so that the crankshaft balancing will remain as before. If these conditions are not held to, it is necessary to balance the crankshaft in assembly with the flywheel and clutch.

Dynamic balancing takes place on a special machine. Allowable imbalance is 70 gram cm. Static balancing of the crankshaft in assembly may be done on balancing knives. A shaft, set on prisms, must not spontaneously rotate after it is stopped in any position.

Assembly and adjustment of the clutch and its balancing are presented in Chapter 6.

Balancing. In the process of operation and during regrinding of the shaft journals, or with repair or exchange of the clutch and its parts, imbalance of the crankshaft-flywheel-clutch assembly will increase. All these changes will lead to increased load on the bearings, increased vibration, and other undesirable phenomena, influencing longevity and working ability of the engine in the most unfavorable manner after its repair.

Observations have shown that during the repair process, imbalance of the crankshaft-flywheel-clutch assembly increases to 1500 gram cm (allowable imbalance is 70 gram cm). The basic reasons for increased imbalance in the given assembly during engine major overhaul are: increased imbalance in the parts (crankshaft, flywheel, clutch disks), and also movement of the flywheel and clutch axes relative to the crankshaft axis. Therefore, during an engine's major overhaul, it is absolutely necessary that the crankshaft be dynamically balanced.

Basic equipment for crankshaft balancing is the model 2468 TsKB machine.

Crankshaft imbalance is eliminated by drilling holes in the journals of the end threws, and the assembly is balanced by drilling holes in the flywheel face.

The oil radiator. After removal from the motor vehicle, the oil radiator must be washed out with a degreasing solution and hot water, then checked for tightness with air at a pressure of 4 kg/cm^2 in a water bath. If a leak is discovered, it is eliminated by soldering the pipes with light solder. Small holes in the radiator body are eliminated with welding and subsequent cleaning.

It is recommended that disassembly of the oil pump (see Plate 4-30) be conducted in the following order.

Wash the pump out in a degreasing solution and fasten it in a vise. Unscrew the three bolts 11 fastening the lower section body, remove the bolts, remove the lower section body with its gasket, remove the lower section driven gear 12, and drive the shaft out of the body, lightly tapping it with a hammer. Unscrew plug 14 and remove the reduction valve (spring 17 and plunger 3). Press off the centering sleeve 4 on a bench press, remove the drive shaft 5 in assembly with the two drive gears 7 and 10, and with the intermediate cover 15, remove the gasket and upper section driven gear from the body and press out the driven shaft.

Fasten the pump shaft into a vise with soft inserts and remove the lower section drive gear from it, then extract the first key from the shaft keyway, remove lock ring 8 with a screwdriver, and remove the intermediate cover. Move the gear along the shaft and remove the second lock ring with a screwdriver. Press off the drive gear on a bench press and remove the second key from its keyway.

After disassembly, wash the pump parts and check their geometric dimensions.

For checking tightness and appearance of leaks through invisible cracks, it is recommended that the oil pump body, intermediate cover, and lower section cover be checked with water under a pressure of 4 kg/cm^2.

Oil pump assembly takes place in a sequence opposite to that of disassembly. All paper gaskets must be replaced with new ones during assembly. Installation of the drive shaft in the pump body requires that a clearance of 0.030-0.078 mm be maintained between the shaft and holes in the body.

During installation of the drive gears, the clearance within the limits of 0.018-0.057 mm must be maintained between the shaft and gear hole.

During pump assembly, special attention should be paid to the following. The driven gear shaft must be pressed into the body with an interference within the limits of 0.010-0.052 mm. The centering sleeve must be fitted onto the drive shaft with an interference within the limits of 0.004-0.048 mm. If the sleeve rocks (fits with a clearance) on the shaft, it should be replaced. When the centering sleeve is pressed on, the dimension from the pump shaft face to the upper end of the sleeve should be kept equal to 8 mm.

Clearance between the gear teeth and walls of the body receptacle must be within the limits of 0.100-0.175 mm (Plate 4-62). Clearance in the gear teeth engagement must be within the limits of 0.140-0.240 mm. Clearance between the gear teeth faces and the intermediate cover must be within the limits of 0.120-0.195 mm, and between the gear faces and the lower section body, clearance must be within the limits of 0.135-0.188 mm.

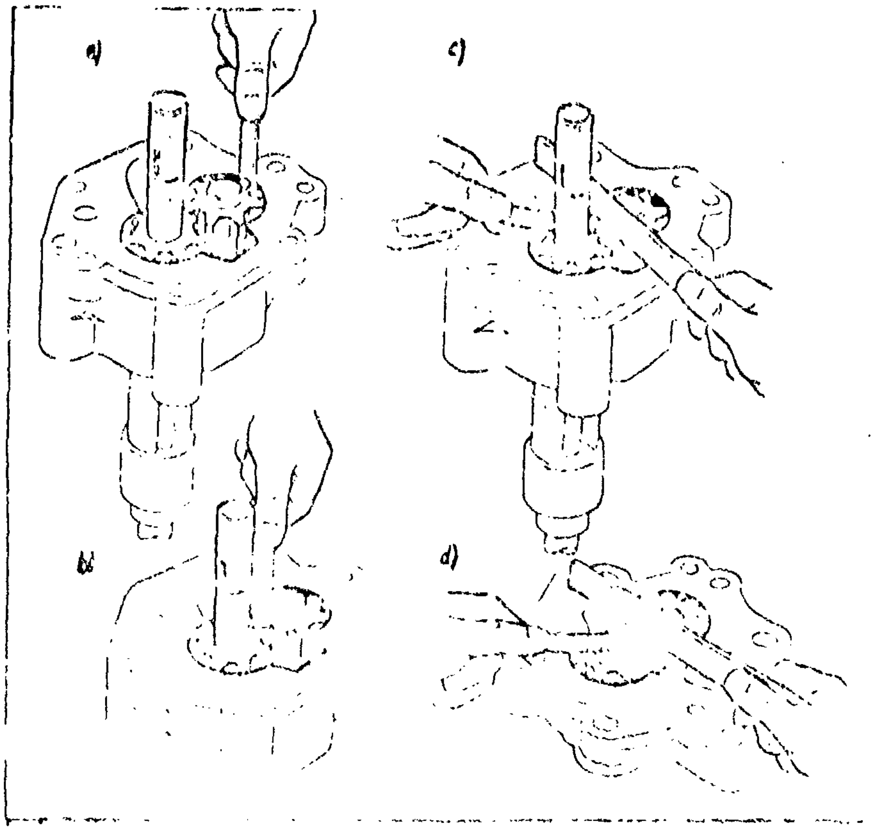


Plate 4-6. Checking clearances in the oil pump:
a) between the body wall and gear b) in gear engagement
c) between the body surface and teeth faces d) between the lower cover surface and teeth faces

The drive shaft of the pump, installed in the pump body, after tightening of the bolts must turn easily by hand without binding. Clearance between the pump gear faces and the cover is adjusted with inserts. If binding occurs, inserts must be added.

The assembled pump should be tested (Plate 4-63). Checking of pressure developed by the pump is done with petroleum based oil T (GOST 1840-51) at an oil temperature of 18-20°C, outlet hole of 4.0 mm and loading nozzle length of 6.0 mm. Pressure at 400 rpm of the pump shaft must be no less than 2.4 kg/cm² for the upper section, and no less than 0.6 kg/cm² for the lower section.

The upper section reduction valve must open at a pressure of 2.75-3.3 kg/cm^2, and the lower section by-pass valve must open at a pressure of 1.2-1.5 kg/cm^2 with a corresponding increase in the number of pump shaft revolutions. The oil pump is driven through reductor 10 of the electric motor 11. The pump draws oil with a sucking action from tank 5 through pipe 6, whose end must be dropped into the tank to the minimum level. Pressure created by the oil pump is checked by manometers: manometer 12 for the upper section, and manometer 13 for the lower section, installed in pressure chmmbers 16 and 14, respectively. Oil flows from the pressure chambers through the loading nozzles 15 and then into the lower tank through pipe 20.

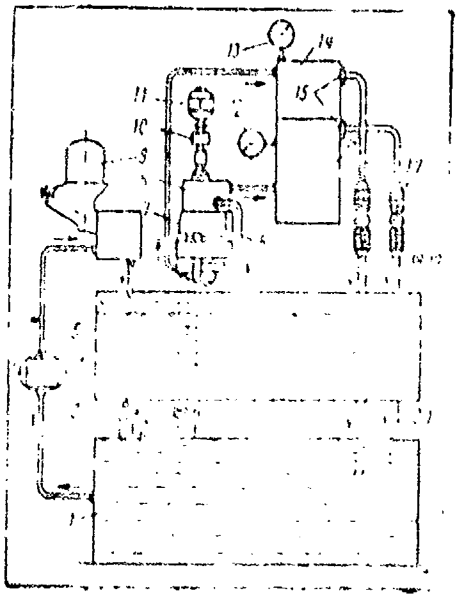


Plate 4-63. Stand for testing oil pump:
1) lower tank 2) drain pipe for maintainance of oil level in upper tank 3) pipe for draining oil into lower tank 4) pump 5) upper tank 6) pipe for oil feed from upper tank to pump 7) oil pump 8) transfer sleeve 9) centrifugal oil cleaning filter 10) reductor 11) electric motor 12) manometer for checking oil pressure in pump upper section 13) manometer for checking oil pressure in pump lower section 14) pressure chamber for pump lower section 15) loading nozzles 16) pressure chamber for pump upper section 17) valves 18) maximum oil level in tank 19) minimum oil level in tank 20) lines for oil flow from pressure chambers to lower tank

Oil is pumped from the lower tank by pump 4 and flows into filter 9, from which cleaned oil flows into the upper tank. To maintain the necessary oil level in the upper tank, drain pipe 2 is installed and excess oil flows through it into the lower tank.

Disassembly and assembly of the oil filters. For disassembly of the oil filter body, it is necessary to install it in a vise. Unscrew plug 3 (see Plate 4-32), insert a metal rod into the hole and brace the centrifugal oil cleaning filter body.

Removal of the coarse cleaning filter. Unscrew the four nuts fastening the filter cover and remove the plated filter 16 in assembly with the cover and gasket from the body.

Disassembly of the coarse cleaning filter element is done when the blades are damaged or heavily loaded with dirt.

Removal of the partial flow centrifugal oil cleaning filter. Unscrew nut 10 fastening the filter jacket and remove the jacket 5 and jacket packing ring 4. Unscrew the nut 11 fastening the filter, remove the spring and support washers, and then remove filter body 7 from shaft 14.

In order to remove filter body 7 from the shaft, it is necessary to remove cover 8 while rotating nut 9. During rotation, nut 9 moves stop ring 12 with it. The stop ring, moving to cover 8, raises it upward. With this, the cover, sliding along the packing ring 6, is separated from the filter body.

Remove the upper support washer of the ball bearing, remove the support washer of bearing 22 from shaft 14, and press off the oil deflecting screen 23. Drive off the lock washer with a screw driver, unscrew the filter shaft from the body, and remove the lock washer. Then, remove the filter body from the vise.

If nut 9 does not have to be replaced, ring 12 should not be removed and the nut should not be disconnected from cover 8. Remove the two screen filters 13 from the hollow side shaft of the body 7, remove packing ring 6 from the filter body base, and unscrew nozzles 2 from the lateral holes in the hollow filter body shaft with a screwdriver.

Filter assembly is done in the reverse sequence. The parts must be carefully cleaned of dirt and washed. The rubber packing rings of the cover and filter jacket must not have signs of stretching or hardening, otherwise they should be replaced.

If the shaft bushings (lower and upper) are worn, they must be replaced with new ones. Bushings are pressed into the body with an interference of 0.145-0.200 mm. After pressing in the bushings, they must be machined with a reamer to a diameter equal to that of the shaft, maintaining a clearance between the shaft and bushing within the limits of 0.03-0.09 mm.

To assure coaxiality of the interior surfaces of the bushings, they must be machined by a reamer with a single installation.

Non-coaxiality of the diameters for the bushings must not exceed 0.015 mm.

With a normally tightened shaft seal, the handle of an assembled coarse cleaning oil filter must easily rotate by hand. The torque moment of handle rotation must be no greater than 0.4 kg meters.

The coarse cleaning filter by-pass valve must open at an oil pressure of 1 kg/cm^2.

An assembled oil filter must be checked with petroleum oil T (GOST 1840-51). With an oil pressure of 2.5 kg/cm^2 and temperature of 18-20°C, rotation speed of the centrifugal oil cleaning filter body must be no less than 5000 rpm.

Disassembly of the full flow centrifugal oil cleaning filter.

Disassembly and assembly of the full flow filter is done in the same way as that of the partial flow filter, with the additional operations of removing the springs, insert 7 (see Plate 4-33), and screened filter 6.

Before assembly of the full flow filter, the parts are washed, cleaned, and checked. The assembled filter must be checked with petroleum oil T (GOST 1840-51) at an oil temperature of 18-20°C.

The body 3 of an assembled filter must freely (by hand) rotate on its axis without interference or binding.

With oil feed into passage 22 at a pressure of 0.3 kg/cm^2, and with passage D closed, the filter body must begin turning.

With oil feed into passage 22 at a pressure of 3 kg/cm^2, and oil drainage from passages D and F through a nozzle 2.5 mm in diameter and 2 mm long, filter body rotation must be no less than 5000 rpm.

With oil feed into passage 6 at a pressure of 0.8 kg/cm^2 with passage 22 blocked, the by-pass valve must be closed, and with a pressure of 1 kg/cm^2, the valve must open. In this, oil from passage B must flow into passage F in a constant stream.

Disassembly of the water pump. For disassembly, it is necessary to clean oil and dirt from the pump and wash it in a degreasing solution. It is recommended that disassembly of a pump from a ZIL-130 engine be conducted in the following sequence.

Unscrew the bolts fastening the fan, remove the fan and pulley from its hub.

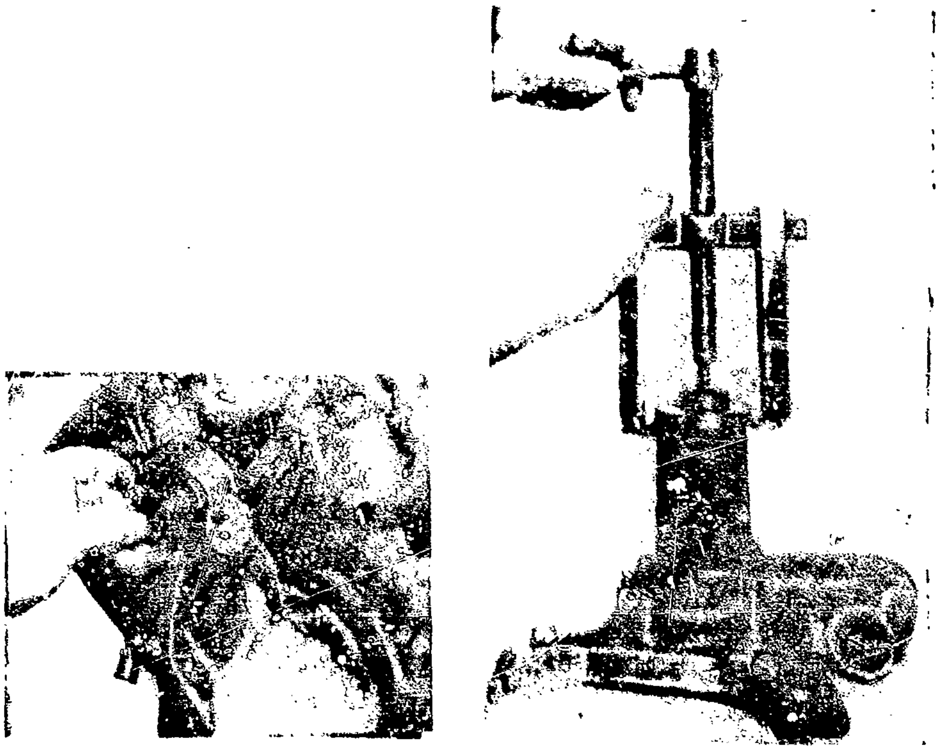


Plate 4-64. Pulley hub removal:
a) with the bolts
b) with the puller

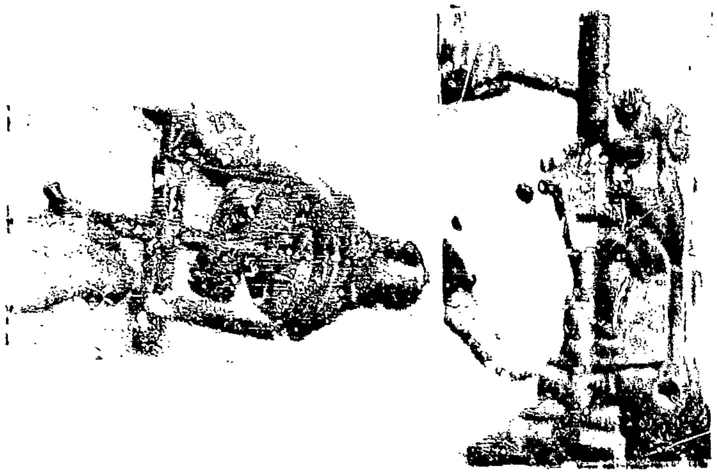


Plate 4-65. Removing and installing water pump parts: a) removal of the impellor from the shaft b) pressing the shaft with bearings into the water pump body

Unpin the nut fastening the hub and preliminarily screw two bolts into the hub and hold it with a wedge, so that it cannot rotate together with the shaft. Unscrew the nut and remove the hub from the shaft.

For removal of the hub, puller bolts (Plate 4-64, a) or a special puller (Plate 4-64, b) should be used. Remove the split conic bushing with a screwdriver and drive out the key.

Unscrew the nuts fastening the bearing body to the pump body with a socket wrench and separate them, lightly tapping on them with a hammer. Remove the gasket, carefully separating it from the body with a screwdriver.

Unscrew the bolt fastening the impeller of the water pump shaft, preventing shaft rotation with a screwdriver. Remove the impeller from the shaft with a puller (Plate 4-65).

To draw the packing from the impeller receptacle, it is necessary to remove the packing in assembly and the textolite support washer with a screwdriver, and then separate the rubber cuff and spring.

Remove the front bearing lock ring with pliers (see Plate 3-76, a). Press the shaft in assembly with the bearings out of the body on a press. Unscrew the lubrication fitting and the control plug.

Fasten the pump shaft in a vise and remove the stop ring and the water slinging washer. Press the bearings off the shaft, with the front and rear bearings being pressed simultaneously, and the spacing bushing located between the bearings [illegible] freed.

Disassembly of the pump from the ZIL-133 engine should be conducted in the following sequence. Unscrew the bolts fastening the fan 21 (see Plate 4-42), and remove it from the pulley. Unpin nut 20, and, holding water pump pulley 23 by hand, unscrew it. Remove the fan pulley together with bearings 18 from shaft 14 of the pump by hand or with a puller. Remove the spacing ring from the shaft by hand, and then remove pump pulley 23 in assembly with its hub 16 with a puller. Remove the conic bushing 15. The pump pulley may be removed without its hub, after having unscrewed its fastening bolts. A pulley hub 16 may be removed with puller bolts (see Plate 4-64, a) or with a puller (see Plate 4-64, b). After this, the pump from the ZIL-131 engine is disassembled the same as is a pump from the ZIL-130 engine.

To remove bearings 18 (see Plate 4-42) from the hub hollow of the fan pulley 22, it is necessary to remove the stop ring, and then the bushings with the spacing ring 19.

Water pump assembly. Before assembly, wash out the pump parts, clean the rust off the pump and bearing bodies, and check usability of the parts. During pump assembly, it is necessary to check for face clearance between the impeller and the bearing and pump bodies.

Assembly of the pump from a ZIL-130 engine takes place in the following order.

Press the bearings on the shaft, having inserted the spacing bushing between them.

Mount the water slinging washer on the shaft and fasten it with a spring ring.

Insert the packing assembly and the textolite support washer in the impellor cavity, having lubricated their frontal surfaces with a thin layer of graphite lubricant and fasten them with a collar, pressing it on with a mandrel. Screw in the lubrication fitting and the control plug. Lubricate the bearing body with high-temperature grease lubricant 1-13c and press in the shaft with its bearings on a press (see Plate 4-65). Insert the front bearing support stop ring into its slot in the body, install the key in its keyway, mount the split conic bushing on the shaft, install the hub on the bushing, fasten it with a nut and flat washer, and pin it. The nut torque moment must be within the limits of 8.5-10.0 kg meters.

Install the impellor on the shaft, lightly tapping it with a hammer, and fasten it with a bolt and support washer.

Install the bearing body with its gasket on the pump body studs and fasten it with nuts.

If the studs are exchanged, it is recommended that they be coated with red lead or rubber pitch before being screwed into the body.

Mount the pulley and fan on the hub and fasten them reliably with bolts and spring washers.

Assembly of the water pump from a ZIL-131 engine is the same as that for a water pump of the ZIL-130 engine. Before installation of the fan pulley on the water pump shaft, it is necessary to insert bearings 18 (see Plate 4-42) and the spacing bushing 19 into its hollow and fasten them with a stop ring, after which the pulley and bearings are fitted onto the pump shaft and fastened in assembly with the fan.

In connection with the introduction of an exhaust mainline into the engine design and interruption of the interchangeability in engine cooling system parts, the factory has produced a parts set under the number 130-1300053, intended for modernization of ZIL-130 and ZIL-131 engines which were produced earlier. The set includes the following parts: a water pump with plugs in assembly; an outlet pipe with thermostat in assembly; a by-pass hose from the pipe to the water pump; an outlet hose from the pipe to the radiator; an outlet hose spacing spring; an underwater hose from the radiator to the water pump; an underwater hose spacing spring; a pipe gasket; M10 X 1 X 25 pipe fastening studs; M10 X 1 nuts; spring washers 10 mm in diameter; 10.2 mm diameter washers; by-pass hose clamps; M5 X 25 clamp screw; and M5 nuts.

In June 1965, a heat-treated pump shaft was introduced for water pumps of the ZIL-130 engine. The shaft has a threaded portion for the fan pulley fastening nut with a diameter of 14 mm (instead of 12 mm). The dimensions of the keyway for the fan pulley fastening key were simultaneously changed and the hub was changed in correspondence with this. The new pump shafts can be installed in assembly with a fan hub, nut, washer, key, and conic bushings on ZIL-130 trucks produced before June 1965 as a parts set under the number 130-1307021.

Disassembly and assembly of the radiator with its jacket in assembly. For disassembly of the radiator and its removal from the motor vehicle, it is necessary to first disconnect the oil radiator, for which the following should be done: unscrew the fastening bolts to the water radiator suspension frame, loosen the two fastening screws of the oil radiator hoses, and remove the oil radiator in assembly with its brackets.

To disconnect the hoses from the pipes, it is necessary to loosen the tension screws with a screwdriver and remove the rubber hoses. For removal of the brackets from the oil radiator, it is necessary to unscrew the nuts, drive the bolts out, and remove the two brackets from the oil radiator frame. In the ZIL-131 motor vehicle, besides this, it is necessary to disconnect and remove the oil radiator of the hydraulic power steering system.

To disconnect the suspension frame from the radiator, it is necessary to unscrew the bolts fastening the right and left radiator plates and disconnect the radiator from the frame suspension.

Then, unscrew the nuts fastening the fan shroud to the right and left plates of the radiator, drive out the bolts, disconnect the fan shroud from the radiator and remove the radiator frame brace.

For removal of the louvres, it is necessary to unscrew the nuts fastening the louvres to the radiator plates, drive out the bolts, and disconnect the louvres from the radiator.

Before assembly, it is necessary to clean dirt from the radiator and wash it out with a regular water hose. Water under pressure should be directed into the lower pipe of the radiator so that it flows out of the upper pipe. The radiator cap must be closed. After the water flowing out of the radiator becomes clean, the washing out process may be stopped.

The cleaned and washed-out radiator must be checked for tightness by air under a pressure of 1.5 kg/cm^2 with the radiator placed in a water bath.

Assembly of the radiator parts is conducted in the reverse order.

Engine assembly

It is recommended that the engine be assembled on a GARO model 2473 stationary rotating stand, or on a stand such as the one shown in Plate 4-50, b.

The ZIL-131 engine is assembled with provisions for sealing all assembly surfaces. As packing, non-leaking pastes U-20a (TU 3512-54) and UN-25 (VTU MKhP 3336-52) are used.

Before assembly, coat the following with a backing of non-leaking paste: the rear face of the cylinder block, the front face of the clutch housing (including the starter contact flange), the butt surfaces of the upper and lower parts of the clutch housing (including the groove for the gasket), the threads of the bolts fastening the lower part of the clutch housing and the threads in the cylinder block, gaskets, and also the starter flange. This coating is not necessary for the ZIL-130 engine.

The cylinder block goes into assembly pre-assembled with the clutch housing, and with a matched set of main bearing caps, camshaft bushings, cooling system valves, and lubrication system plugs. All oil passages in the cylinder block must be washed out and blown out with compressed air.

For cleaning the oil passages in the cylinder blocks, the end plugs of the longitudinal oil mainline and the tappet lubrication passages should be unscrewed. The cylinder block should be tested for tightness of its cooling system with water (under a pressure of 3-4 kg/cm^2).

For testing the cylinder block, all connecting passages from the cylinder head assembly surface should be closed, the drain valve should be unscrewed from the cylinder block, the nipple with a water hose screwed into its threaded hole, and testing conducted.

The front and rear face surfaces of the cylinder block may have a non-flatness no greater than 0.1 mm. Non-flatness of the oil pan assembly surface is not allowed to be greater than 0.15 mm on its entire length or 0.04 mm on a length of 50 mm. Non-flatness of the assembly surfaces of the intake manifold and the cylinder head must not be greater than 0.15 mm on their entire length, or 0.04 mm on a length of 50 mm. Non-flatness is checked with a straightedge gauge and leaf gauges, laying the straightedge on the plane and measuring clearances between the straightedge and the plane with a gauge.

Before assembly, the front part of the cylinder block is fastened to the stand with supports, and the rear part is fastened with bolts and nuts, connecting the clutch housing supports to the stand.

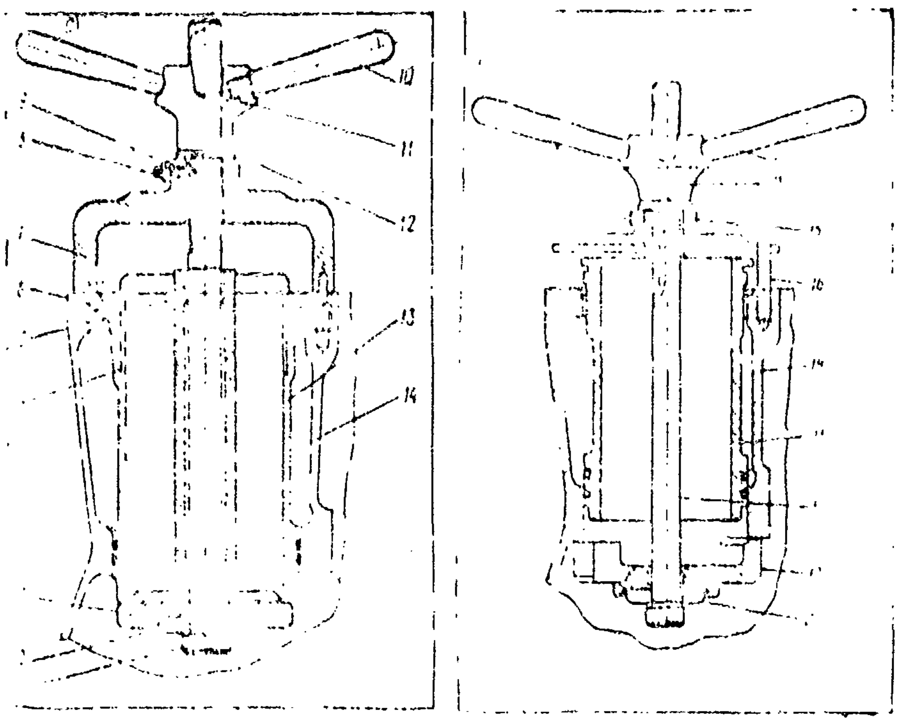


Plate 4-66. Model 2500 device for pressing out and pressing in cylinder sleeves:
a) pressing out b) pressing in 1) rod 2 and 12) rod washers 3) sleeve support ring 4) rubber sleeve protector 5) drive bushing 6) pins 7) puller body 8) stop screw 9) stop nut 10) handle 11) working nut 13) sleeve 14) cylinder block 15) pressure plate 16) guide stud 17) cup

Cylinder sleeves are pressed out with the model 2500 device shown in Plate Plate 4-66, a. The sleeves are pressed in with the same device. The method of pressing is shown in Plate 4-66, b.

Sleeve installation. Mount the rubber packing rings on the sleeves, attempting not to tighten them excessively and watching so that the rings do not become twisted when they are laid into the circular grooves of the sleeve. The sleeves should be installed in the cylinder block carefully, not allowing the packing rings to be cut on the sharp edges of the boring and the block.

When the sleeves are pressed into the cylinder block, the upper part of the sleeve is self-sealed by pressure between the block and cylinder head on the sleeve shoulder. The lower part of the sleeve is sealed by rubber rings. The shoulder of a sleeve seated in its cavity must project above the upper surface of the block by 0.027-0.10 mm.

The clutch housing is installed on the cylinder block with two bushings which are pressed into the block face. When the clutch housing is changed, it is installed on installing bushings and fastened with bolts. The torque moment is 8-10 kg meters. Coaxiality of the holes, centering of the transmission with the crankshaft axis and perpendicularity of the rear face of the housing relative to the crankshaft axis are checked after installation of the crankshaft.

The clutch housing is checked with a IU-2376 device which is fastened on the crankshaft flange (Plate 4-67). The amount of oscillation of the interior surface of the hole and the clutch housing face relative to the crankshaft axis must not exceed 0.1 mm.

The cylinder block is rotated on the stand so that the crankcase assembly surface is upward (Plate 4-68).

Crankshaft installation Remove the main bearing caps. Press the pin preventing the seal from rotating into the rear main bearing cap with its sharp end upward. Press the pin in with the mandrel, protecting its sharp end from damage. Rub down the insert beds in the cylinder block and caps with a soft cloth and blow out the cylinder block with compressed air. Insert the matched upper inserts into the main bearing beds in the block.

Insert the rear bearing seal into the slot in the cylinder block and into the slot in the cover (Plate 4-69), and then install the rubber face packing of the rear bearing cap into its receptacle.

Install the lower halves of the inserts into the main bearing beds. During this, it is necessary to carefully ensure that the upper and lower inserts are not confused, since the upper inserts have holes for oil feed to the main bearings and for oil supply to the camshaft bearings. If the inserts are incorrectly installed, the oil passages will be blocked and the bearings will work without lubrication, which will lead to immediate failure of the engine.

Take the crankshaft in assembly with the flywheel, clutch, camshaft gear, and support washers, set it in a convenient position with the aid of a device (see Plate 3-49), blow out the oil passages with compressed air, rub down the shaft main journals with a soft cloth, lubricate the surfaces of the top inserts with clean engine oil, and lay the crankshaft in the cylinder block bearings. Check the projecting ends of the rear bearing seal, and if necessary clean them. Lubricate the surfaces of the lower inserts and the main journals of the shaft with oil. Install the main bearing caps in their places.

Insert the bolts and spring washers and screw them in at first by hand, and then tighten them with an angular socket wrench.

Check the main bearing bolt tightness with a torque wrench. The torque moments for the bolts on all the bearings must be 11-13 kg meters. After tightening the bolts, check the ease of crankshaft rotation. The moment of rotation must be no greater than 7 kg meters.

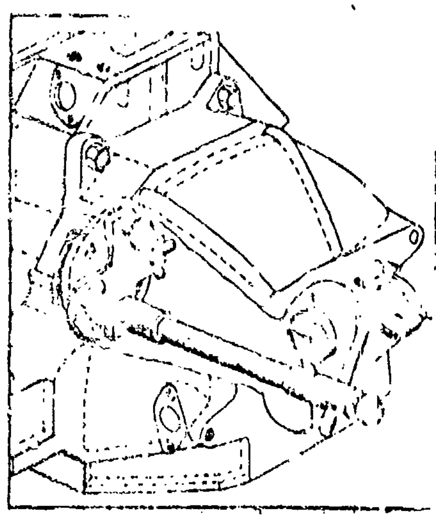


Plate 4-67. Checking coaxiality and perpendicularity of a clutch housing installed on the cylinder block

Thrust washers. The front crankshaft bearing has thrust washers (Plate 4-60) on both sides for absorbing axial loads arising during operation of the engine. These are made of bimetallic bands. Washer thickness is 2.46-2.50 mm. The washers installed on the shaft must be formed of anti-friction alloy: the front one, on the side of the camshaft gear, and the rear one on the side of the crankshaft.

If the axial clearance in the crankshaft shown in Plate 4-71 is increased to 0.4 mm as a result of thrust washer wear, they should be replaced.

Axial clearance between the front support journal of the crankshaft and the thrust washer is checked with the oil pan removed with a leaf gauge and lever. Moving the shaft forward and backward in the direction of the longi-

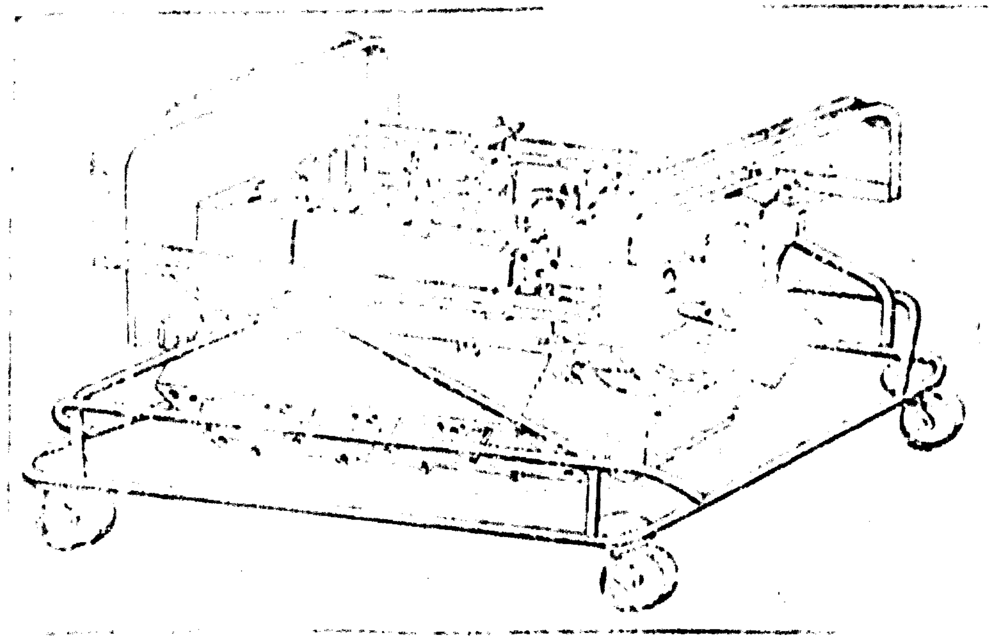


Plate 4-68. Stand with cylinder block

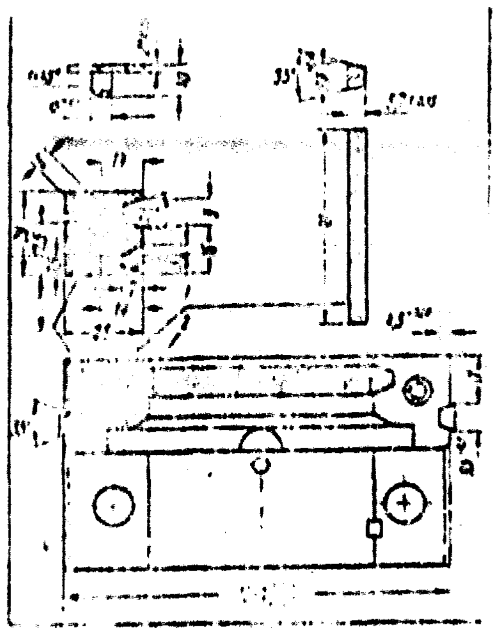


Plate 4-69. Packing the rear main hearing:
1) wooden packing 2) seal 3) rubber packing
4) cover

tudinal axis of the engine, clearance is measured and must be within the limits of 0.075-0.25 mm in the first main bearing, and the clearance is free in the remaining bearings. The amount of clearance in the first main bearing is set by the thickness of the thrust washers. Axial clearance in the crankshaft may be checked without removing the engine from the motor vehicle (see Plate 4-74), for which it is necessary to remove the camshaft gear cover.

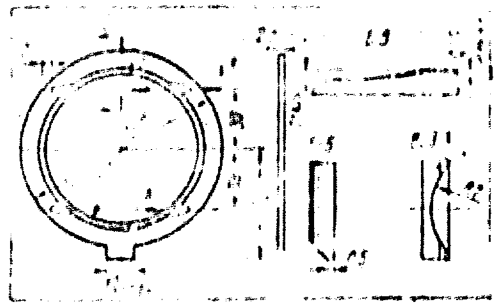


Plate 4-70. Crankshaft thrust washer

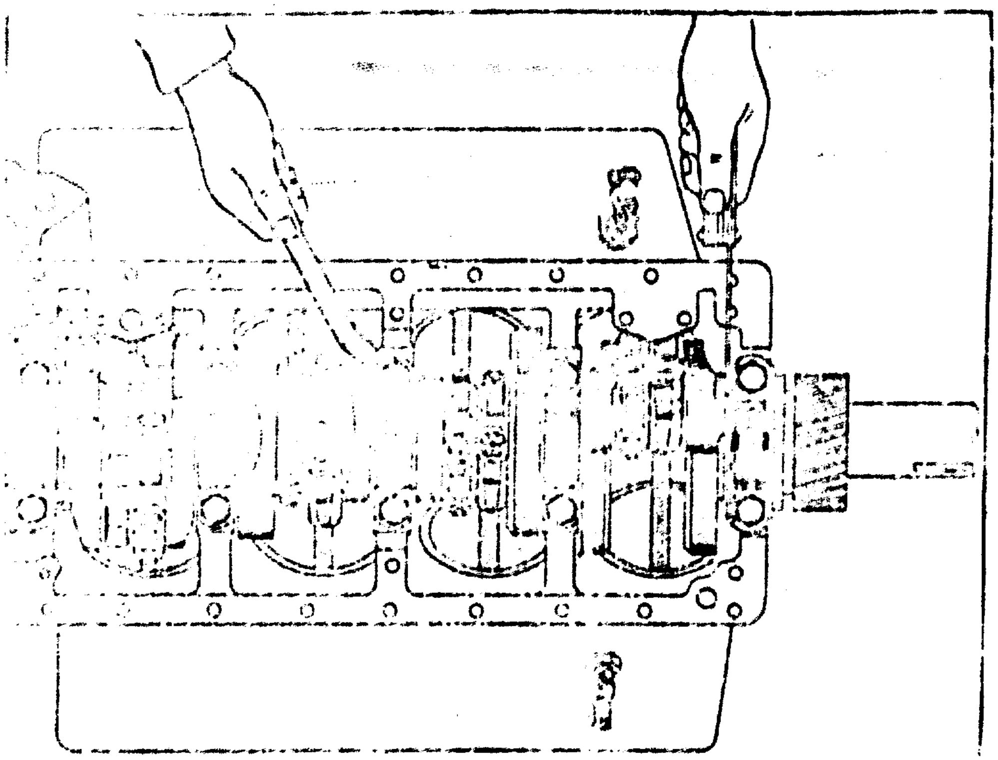


Plate 4-71. Checking crankshaft axial clearance

Insert the wooden packing in the vertical slots of the rear main bearing cap and press them to the end with a hammer. Smooth the projecting face of the wooden packing off flush with the assembly surface of the bearing cap and the cylinder block.

Crankshaft supports and packing. Crankshaft main bearing caps are bored together with the cylinder block, and therefore they are not interchangeable. During boring, the caps are fastened with bolts. Torque moment is 11-13 kg meters.

The main bearing caps are centered in slots in the cylinder block along shoulders which are located nonsymmetrically, eliminating incorrect installation of the caps.

The nominal diameter of the main bearing insert beds is 79.500-79.525 mm. Non-coaxiality of the beds is not allowed to be greater than 0.02 mm.

The front crankshaft journal is packed with a rubber seal which has a metallic casing, and is installed in the camshaft gear cover.

The rear journal of the shaft is packed with seal 2 (see Plate 4-69), which is made of graphite-asbestos cord, and is installed in the groove formed in the cylinder block and cap 4 of the rear main bearing.

The seal is pressed in with a hammer and mandrel set on seal 2. The seal is also pressed into the slot in the bearing cap. Projecting ends of the seal are precisely cut off.

The rear bearing cap is packed along its lateral surface with wooden seals 1, which are installed in slots in the lateral surfaces of the rear cap. It is recommended that the wooden seals be replaced whenever the rear main bearing is disassembled. The seals must be manufactured of dry pine wood.

The rubber seals 3 are installed in the rear part of the journal surface of the rear main cap. They should be replaced whenever necessary, or when the rubber is cut or stretched.

The flywheel is mounted on the crankshaft flange by six nonsymmetrically positioned bolts.

The nominal dimension of four of the holes is 14.000-14.035 mm (maximum allowable is 14.0?o mm), and that of the other two is 14.3 mm. It should be kept in mind that since October 1964, the flywheel fastening bolts have been lengthened by 4 mm, and their nuts have been increased in height by 5 mm.

There must be a clearance between the crankshaft journals and the bearing inserts of a new engine within the limits of 0.026-0.085 mm for main bearings and 0.026-0.072 for connecting rod bearings. When steel-aluminum inserts are used, this clearance must be 0.032-0.076 mm for connecting rod bearings and 0.050-0.107 mm for main bearings.

Changing crankshaft bearing inserts. It is necessary to keep in mind that up to May 1966, the lower inserts of the front and intermediate bearings did not have lubrication passages. To improve lubrication, since May 1966, lubrication passages have been provided in these inserts.

To replace connecting rod inserts, it is necessary to remove the oil pan, its baffle, and oil pickup. Then, rotating the crankshaft, set the connecting rods at their extreme lower position with respect to the indicated order of connecting rods (1st and 5th; 2nd and 6th; 3rd and 7th; 4th and 8th).

Having set the crankshaft in the required position, it is necessary to: unpin and unscrew the connecting rod bolt nuts, remove the connecting rod cap, move the connecting rod and piston somewhat upward in the cylinder, pull the inserts from the rod and cap, rub the insert beds with a cloth and install the new inserts; rub the connecting rod journals of the crankshaft with a cloth, lubricated with oil (engine), pull the connecting rod to the journal, set the cap in place so that the numbers on the cap and on the rod are on the same side, screw the nuts on to the connecting rod bolts, tighten them to a torque moment of 7.0-8.0 kg meters, and pin them. This same operation is conducted for the second connecting rod on the same journal of the shaft.

Sequentially rotating the crankshaft by 90° each time, conduct the same operations for changing the inserts of the next pair of connecting rods. For exchanging the main bearing inserts, it is necessary to unscrew the bolts fastening the main bearing caps, remove the caps, and change the inserts.

When the inserts are exchanged without moving the crankshaft from its bed, extractor 3 (see Plate 3-82) is used, easing the removal of the insert upper halves.

For this, the following must be done: remove the bearing cap; set the crankshaft so that the oil passage hole in the main journal is uncovered; insert the extractor 3 in the oil passage hole; rotate the crankshaft until the extractor fingers rest against the face of the bearing and set its head parallel to the exposed exterior surface of the insert; rotate the crankshaft by 180° and extract the worn insert as shown in Plate 3-82.

The new insert is installed in the reverse sequence. The shaft journal must be carefully rubbed off with a soft cloth, and the insert must be lubricated with engine oil. After exchanging the inserts, install the covers in place, insert the bolts with their spring washers, and tighten them. The torque moment must be 11-13 kg meters.

After the main bearings are tightened, the moment applied for rotation of the engine crankshaft must not be greater than 7 kg meters, and after tightening the main and connecting rod bearings, it must not be greater than 10 kg meters.

After exchanging the bearing inserts, it is necessary to set the oil pickup and oil pan baffle in place, having previously cleaned and washed them in kerosene, and checked the gasket and replaced it if necessary. Then, install and tighten the oil pan and fill the crankcase with fresh oil.

After any exchange of bearings (with shaft journal repair or without it), it is recommended that clearance be checked in each of the bearings, so as to ensure that repair of the shaft and selection of the repair inserts were done properly.

Whenever a crankshaft on an engine is replaced with a new one, it is necessary to simultaneously exchange all inserts. For this exchange, the factory puts out a set (130-1000107), a crankshaft with normal dimension connecting rod and main bearing inserts and thrust washers.

Installation of the pistons with connecting rods in the engine cylinders. For installation of the pistons with connecting rods, rotate the cylinder block, setting it on the stand vertically, front end upward, and insert the pistons in the cylinders correspondingly: 1st and 5th, 2nd and 6th, 3rd and 7th, and 4th and 8th, arranging the connecting rod bearings in pairs on their corresponding connecting rod journals of the crankshaft.

Sequentially, one after the other, take the piston with the connecting rod in assembly and carefully wipe down the bed for the insert in the connecting rod big end with a soft cloth, unscrew the nuts, and remove the rod cap.

During installation of the connecting rod with the piston, it is necessary to mount tin or copper tips on the connecting rod bolts, so as to protect the mirror finish of the cylinder sleeves from damage.

Check and blow out the holes in the lower end of the connecting rod which serve to splash lubrication on the cylinder walls, and install the inserts in the connecting rod and in the cap. Wipe off the upper connecting rod inserts, pistons, cylinder sleeves, and connecting rod journals with a soft cloth. Lubricate the connecting rod insert surface, piston, piston rings, and cylinder sleeves with clean engine oil.

Insert the piston with the connecting rod in the cylinder, having directed the mark on the piston head forward. Mount the device (Plate 4-72, a) on the piston from the skirt side, and compress the piston rings. The rings must compress freely. During installation of the piston in the cylinder, the piston rings may be compressed with the help of a model 7477 device (Plate 4-72,b). Moving the piston along the cylinder with a wooden mandrel, bring the connecting rod bearing to the crankshaft journal. Lubricate the shaft journal with oil, and pull the connecting rod big end to it. Remove the protective tips from the connecting rod bolts, set the lower connecting rod cap in place, and fasten it with a connecting rod bolt, using a socket wrench.

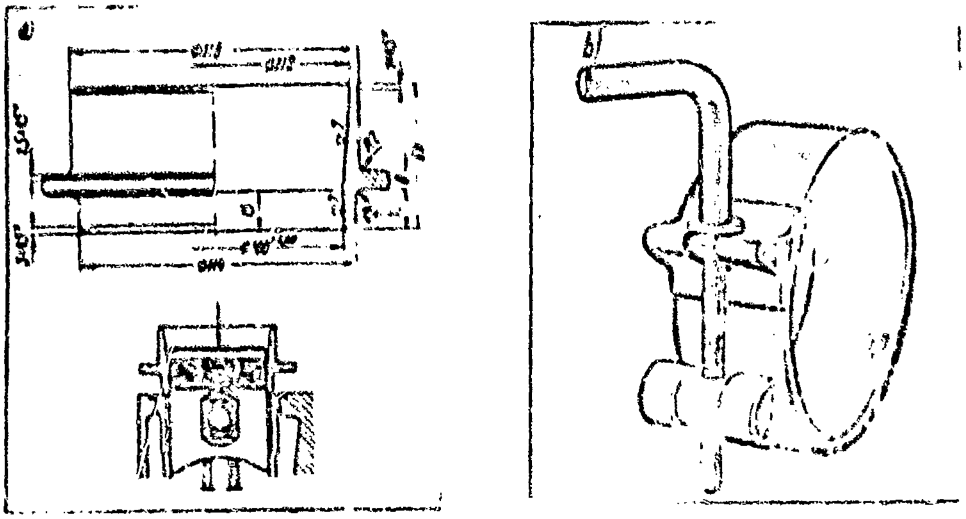


Plate 4-72. Device for installation of the piston with its rings in the cylinder:
a) device in the form of a steel conic ring b) band device

The same operations are conducted during installation of the remaining pistons in the cylinders.

Check the total clearance between the faces of the connecting rod bearings and the faces of the crankshaft journal with a leaf gauge (Plate 4-73). Clearance must be 0.30-0.56 mm.

Final tightening of the connecting rod bolt nuts is done with a torque wrench. The torque moment on the nuts must be within the limits of 7.0-8.0 kg meters. Screwing on the nuts, it is necessary to bring their slots into alignment with the pinning holes. The nuts are brought to coincidence of their closest slots with the pinning holes in the bolts only in the direction of increased tightness.

After tightening the main and connecting rod bearings, rotation of the crankshaft should be checked. The moment for shaft rotation with properly selected radial clearances in the bearings must be no greater than 10 kg meters. Having finished checking connecting rod bearing tightness, it is necessary to pin the connecting rod bolt nuts, bending out both ends of the cotter key.

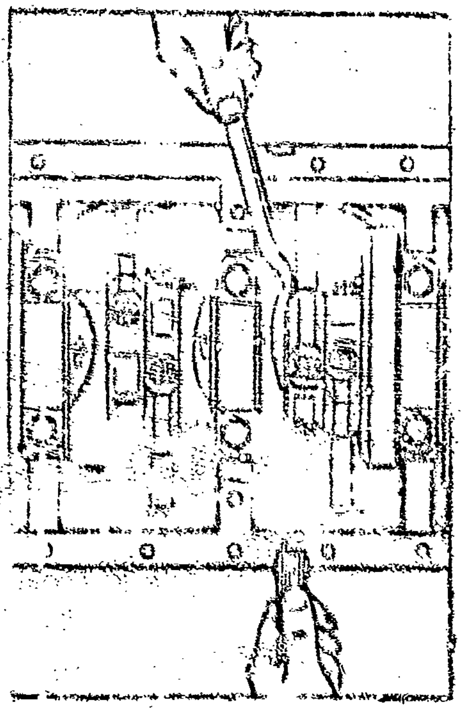


Plate 4-73. Checking axial clearance in connecting rod bearings

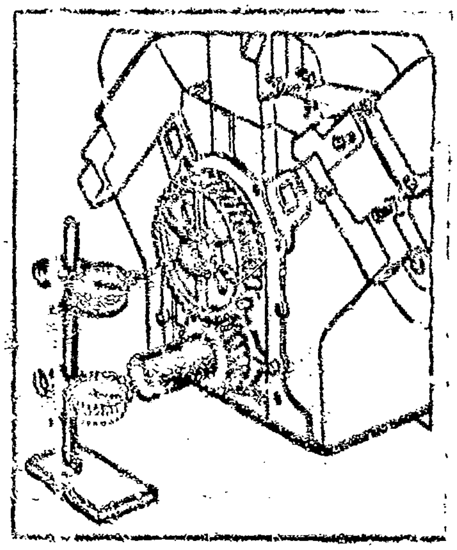


Plate 4-74. Checking axial clearance of the crankshaft and camshaft with an indicator

Assembly of the camshaft includes installation of the spacing ring, support flange, key and gear.

Press the gear onto the shaft until it rests against the spacing ring. After pressing the gear on, install a lock washer, tighten the nut until it stops, and bend the lock washer onto one flat of the nut. During this, the support flange must freely rotate, and clearance between the flange and the face of the support journal of the shaft must be 0.080-0.208 mm.

In the process of engine operation, the support flange also wears out. Increased axial clearance causes longitudinal movement of the shaft, and a knock in the engine. The amount of clearance may be decreased by using a smaller spacing ring by the amount of wear on the flange and face of the front shaft journal.

Axial clearance in the camshaft may be checked without removing the engine from the motor vehicle or on a removed engine with an indicator (Plate 4-74), for which the camshaft gear cover is removed, the indicator is installed against the face of the camshaft gear rim and axial clearance is checked, moving the shaft forward and backward in an axial direction with a lever.

Clearances between the camshaft journals and bushings must be within the limits of 0.030-0.090 mm for the first four shaft journals, and 0.025-0.077 mm for the fifth shaft journal. In the process of operation, increased clearance may be allowed to 0.135 mm for all bushings.

To set the clearance between the shaft journal and the bushing, it is necessary to measure the camshaft journal with a micrometer, and measure the hole in the bushing which is installed in the cylinder block with an indicating plug gauge. Variation between the dimension of the shaft and the dimension of the bushing provides an amount of clearance which must be no greater than 0.135 mm.

In case of camshaft bushing wear to more than the indicated limit, the bushings should be pressed out of their receptacles in the cylinder block with a model 2591 tool set (Plate 4-75), and then new bushings pressed in with the same tools.

The method of pressing out bushings is shown in Plate 4-76, a; the method of pressing them in is shown in Plate 4-76, b.

When repair or new bushings are pressed in, they must be set so that the lubrication holes formed in the bushings precisely coincide with the holes in the cylinder block.

The pressed-in bushings must be fitted with a reamer to the diameter of the camshaft support journals, providing a clearance between the shaft journal and bushing within the limits of 0.03-0.09 mm.

During reaming of the bushings, it is necessary to remember that the thickness of the antifriction layer in the bushing is small, and therefore a very small amount of non-concentricity in the bushing or increased thickness of shavings removed may lead to localized removal of the antifriction layer and to the operation of the crankshaft in steel.

After reaming of the bushings, it is necessary to carefully blow out the bearings and cylinder block with compressed air, removing all shavings, and once more to check the coincidence of the oil holes in the bushings with the passages in the cylinder block.

The plug of the rear camshaft support must seal tightly. Its installation with red lead or another sealer is allowable.

The characteristic deficiencies in the camshaft which arise in the process of work of the shaft are: its bending, and wear on the bearing journals, lobes, and keyways.

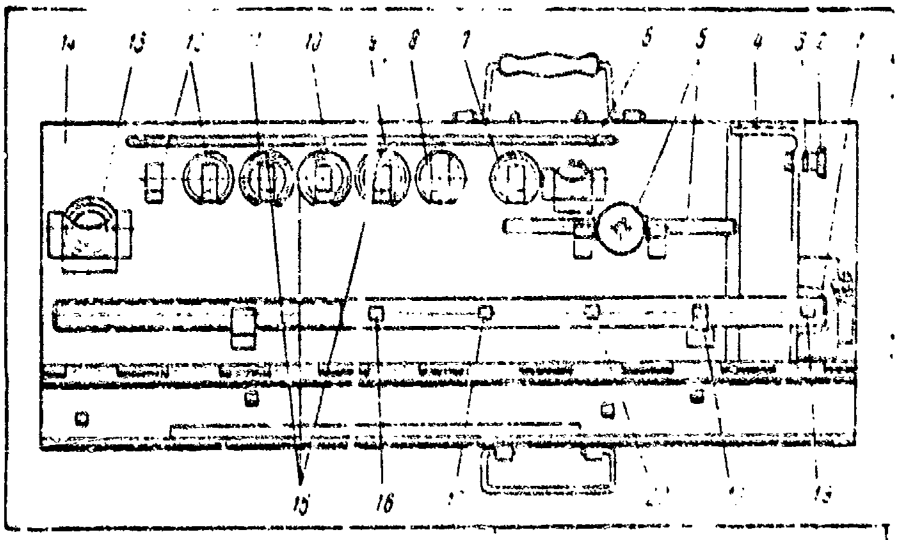


Plate 4-75. 'Tool set for repairing the camshaft seating location:
1) working screw 2) tension screw 3) set screw 4) bracket 5) nut handle 6) washer 7) mandrel for pressing out rear bushing 8) guiding mandrel 9) mandrel for pressing in front bushing 10) mandrel for pressing in middle bushings 11) mandrel for pressing in rear bushing 12) mandrel for pressing out front and middle bushings 13) centering bushing 14) storage box 15) pins 16, 17, 18, 19, and 20) slots

For checking straightness of the shaft, set it with its extreme supports on prisms; the shaft journals should be checked with an indicator (Plate 4-77). If oscillation of the middle journal exceeds 0.025 mm, the shaft must be corrected.

In connection with the fact that the diameter of the rear camshaft journal support is smaller than the other journals, it is necessary to make support 5 of the tool smaller in height.

Cam lobe wear in height must not exceed 0.65 mm. Wear on the fuel pump drive eccentric is not allowed to be greater than 0.80 mm. The nominal dimension of the eccentric is 42.66-43.00 mm (see Plate 4-20, a). A camshaft on which lobes or the eccentric are worn above the allowable dimension must be exchanged.

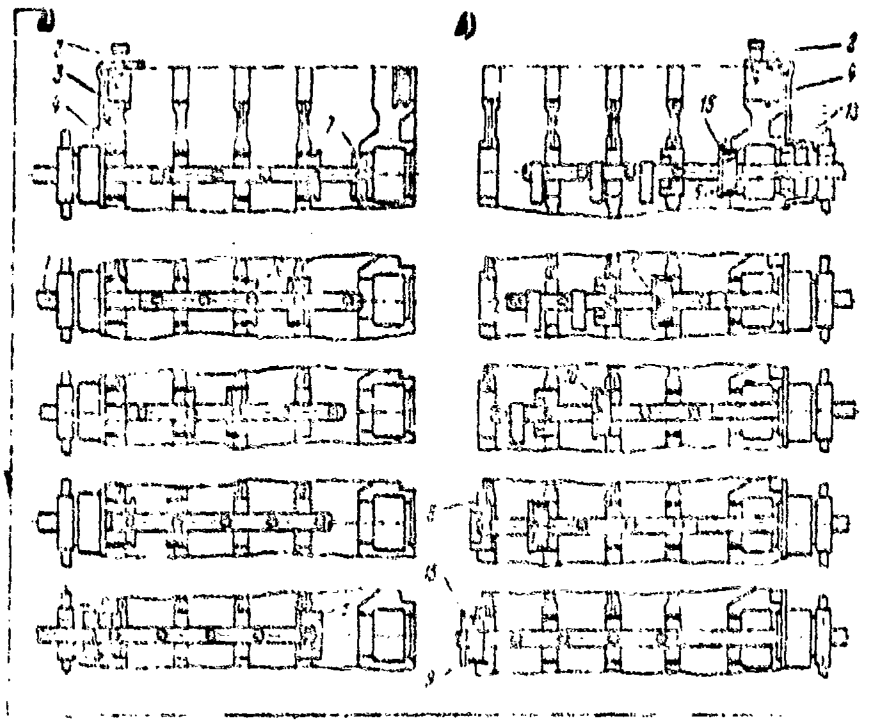


Plate 4-76. Pressing out and pressing in camshaft bushings with a model 2501 tool set: (see caption to Plate 4-75 for numbers)
a) pressing out
b) pressing in

Smoothness of the lobe surfaces and shaft journals is assured by grinding. Oscillation of the front face of the first journal of a shaft is not allowed to be greater than 0.025 mm.

After regrinding the journals, it is recommended that shaft straightness be checked again. Non-cylindricality of the journals must be no greater than 0.02 mm.

Installation of the camshaft. Rotate the cylinder block to a horizontal position, setting the crankcase assembly surface upward. Wipe down the camshaft bearings in the cylinder block with a soft cloth, check coincidence of the oil passages, and lubricate the shaft journals and lobes with engine oil.

Install the camshaft with its gear, flange with a spacing ring and with the drive for the centrifugal revolutions governor switch in assembly, into the cylinder block. Installation is conducted carefully, without damaging the surfaces of the bearing bushings, lobes, and bearing journals of the shaft.

The camshaft and crankshaft gears are set so that the tooth which is marked by a dot on the crankshaft gear goes into the slot marked by a dot on the camshaft gear (Plate 4-78). Check the amount of clearance between the gear teeth with an indicator (Plate 4-79).

The clearance must be within the limits of 0.04-0.05 mm. The clearance should be checked in three places on the gear circumference at angles of 120° from each other.

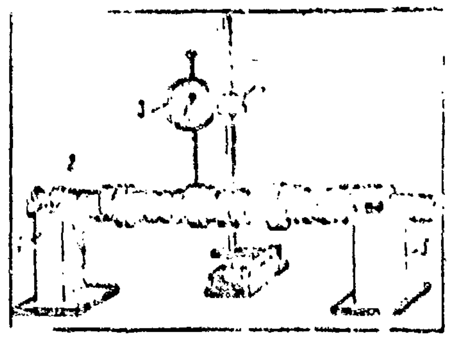


Plate 4-77. Checking the camshaft for bend:
1 and 5) supports 2) shaft 3) indicator
4) indicator set screw

Having checked the clearance, it is necessary to align the holes in the support flange with the threaded holes in the cylinder block and fasten the camshaft flange with bolts and spring washers with a socket wrench (see Plate 4-52, a), directing it through the two holes in the gear. Torque moment on the bolts must be 2.0-3.0 kg meters. After tightening the bolts fastening the flange, axial clearance between the face of the shaft journal and the support flange must be no greater than 0.08-0.208 mm.

Lubricate the camshaft gear, mount the oil deflector on the end of the camshaft, install the camshaft gear cover in assembly with its seal and gasket, and fasten the cover with bolts, installing the bracket for the engine suspension sion reaction rod beneath the bolt on the right side. Torque moment on the bolts is 2.0-3.0 kg meters.

Install the centrifugal switch for the engine revolution governor on the camshaft gear cover and tighten it, having installed the toothed indicator for setting the pistons at TDC beneath the two switch fastening bolts on the cover beforehand.

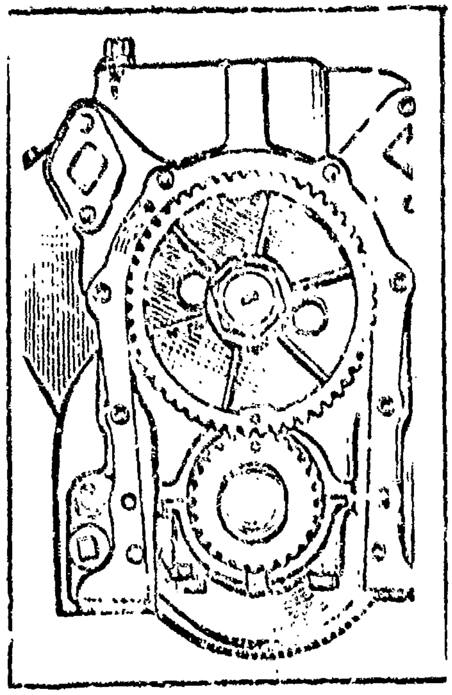


Plate 4-78. Position of marks on gears during setting of gas distribution phases

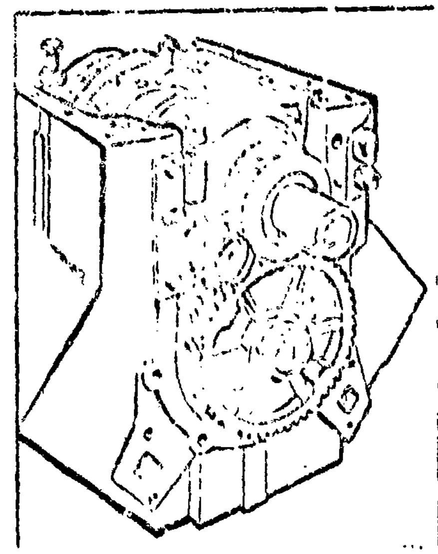


Plate 4-79. Checking clearance in the gas distribution gear teeth engagement

For installation of the crankshaft pulley, install the key in its slot on the shaft and press the pulley on with a mandrel, screw in the crank ratchet with its stop washer, tighten it with a wrench, and, having made sure that the ratchet is screwed in to its end, lock it with the washer by bending the washer's edge up against a flat on the crank ratchet.

Installation of the oil pan on a ZIL-130 engine. Install the baffle and fasten it with bolts, and install and fasten the oil pickup in assembly with bolts. Ensure that there are no foreign objects in the engine, and check to ensure that the oil pickup does not strike against the oil pan.

Lay the gasket on the cylinder block assembly surface, blow out the oil pan with compressed air, and install it on the cylinder block. Screw in the oil pan fastening bolts with spring washers by hand, and tighten them with a socket wrench. The bolts should be tightened sequentially from the middle of the oil pan toward the ends.

During installation of the oil pan on a ZIL-131 engine crankcase, the gasket should be glued to the oil pan to afford capability of forming streams. In this, it is necessary to prevent glue from falling on the upper part of the gasket, which lies against the cylinder block assembly surface.

Before installing the oil pan, it is necessary to grease the assembly surface of the engine crankcase and the gasket with UN-25 (VTU MKhP 3356-52) non-leaking packing paste.

Installation of the clutch housing cover and disengaging fork. Install the clutch disengaging fork in the housing and fasten the fork flange with bolts. Install the clutch housing cover and cover plate, and fasten them with bolts. Rotate the engine on the stand, setting the cylinders upward.

Assembly of the cylinder heads. For installation, carbon deposits should be cleaned from the combustion chambers with a metal brush or scraper.

Non-flatness of the surface of the head which lies against the cylinder block must not exceed 0.15 mm on its entire length, and 0.03 mm on a length of 50 mm. Non-flatness of the surface beneath the flanges of the exhaust and intake manifolds must not exceed 0.15 mm.

If the cylinder head surfaces are warped by amounts exceeding those cited, they should be milled or scraped. During milling, it is necessary to remember that compression chamber volume should not be decreased by more than 1.5 cm^3.

Control of milling or scraping should be accomplished with a set of leaf gauges on the control plate or along a straightedge gauge.

The valves. For removal of the valves, it is necessary to set the cylinder head on a bench, and, compressing the springs with a model 2486 puller (Plate 4-80), remove the keys, remove the plate and spring, and then pull the valve out of the guiding bushings. Brackets are formed on the rear faces of the cylinder heads for lifting the engine. During cylinder head repair, these brackets need not be removed.

The cylinder heads are washed with a 1% solution of triethamolamine in water, or with pure hot water.

Scale in the cooling hollows of the cylinder heads is removed with the same solution as that in the cylinder block (20 grams of technical trilone per 1 liter of water).

The cylinder heads are checked for tightness with water or emulsion fed under a pressure of 3-4 kg/cm^2.

Compression chamber volume is 119.5-122.5 cm^3. Chamber volume is checked with the valves installed in the spark plugs, screwed in with water poured into the compression chamber with a measuring vessel.

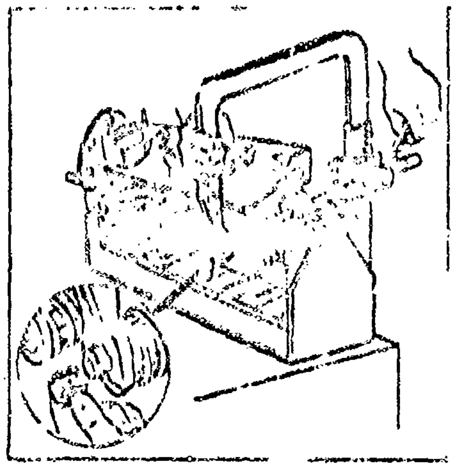


Plate 4-80. Valve removal

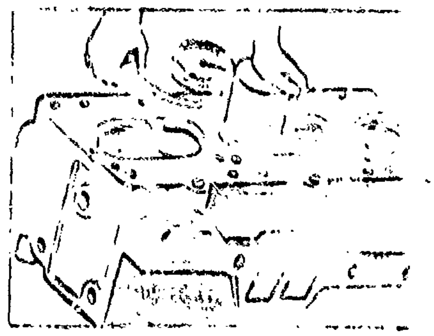


Plate 4-81. Checking a valve for tightness

Valve tightness is renewed in the process of lapping the working faces of the valves and their seats. If pits or marks are present on the working face of the valve and cannot be removed by lapping, the face is subjected to grinding and subsequent lapping in its seat.

Rotation of the valve in the process of manual lapping is accomplished with a drill which rotates the valve laterally to the right and to the left. If the valve has a slot in its head, it is grasped by a mandrel which goes into this slot, and if there is no slot in the valve head, it is grasped by a rubber suction cup.

During lapping, it is recommended that a low-elasticity spring be placed beneath the valve. To accelerate lapping, lapping paste or light emery powder mixed with engine oil is used.

The working face of the valve may be ground if the height of the cylindrical belt on the valve head exceeds 0.3 mm. Valves whose belt is smaller than 0.3 mm should be discarded.

The valve stem must be straight. The nominal diameter of the stem for an exhaust valve is 10.915-10.940 mm, and for an intake valve, it is 10.895-10.920 mm. Checking for straightness is conducted with an indicator on prisms (see Plate 3-93, a). Valve stem curvature must not exceed 0.015 mm on a 100 mm length. Oscillation of the working surface of a valve face relative to the axis of the stem is checked on a device (see Plate 3-93, b).

The amount of oscillation must not exceed 0.03 mm. The allowable wear of a valve stem diameter without repair is: for an exhaust valve, 10.90 mm, and for an intake valve, 10.88 mm.

If wear on the stem exceeds 0.015 mm, the valve should be replaced. During repair, the valve stem diameter may be increased by 0.25 mm.

In a case where the working face of a valve is worked out (worn) or there are pits or marks on the face, the valve is subjected to grinding. Working faces of valves may be ground on a circular grinding machine by fastening the valve into a jaw chuck 3 (see Plate 3-92) or on a special table grinding machine model 2178. Machine construction allows installation of the valve at the required angle relative to the grinding wheel. The face of an exhaust valve is ground to an angle of 30° (relative to the horizontal axis), and that of an intake valve is ground to an angle of 45°. The grinding machine described above is also capable of grinding a valve stem face if it is worn.

Valves may be tested for tightness with a NIIAT instrument. For this, the instrument is tightly installed over the lapped-in valve, as shown in Plate 4-81, and air is pumped into the space in the cup with the squeeze bulb. If, during this process, the residual air pressure of 0.7 kg/cm^2 does not fall during the course of half a minute, the valve is lapped in correctly.

Valve contact tightness may also be checked by feeding air under the valve through the exhaust or intake passages of the cylinder head, which is analogous to checking the valves on an in-line engine (see Plate 3-95, b). Air is directed through a pipe with a rubber gasket which is pressed tightly against the passage. For determining the location of air leakage at a valve, kerosene or liquid oil is poured on. If the valve is not tight, air will leak from beneath the valve in the form of bubbles.

After lapping and checking the valves for tightness, the cylinder head and valves should be washed out and blown out with compressed air.

The valve guides. Maximum allowable wear on the valve guide holes must not exceed 0.05 mm. With a large increase in the bushings' diameter, they should be replaced. The valve guides are pressed out with a device (Plate 4-82, a).

When valve guides are pressed into holes in the cylinder head, it is necessary to mount a stop ring on the guide and press the guide in with a mandrel until the stop ring rests against the head (Plate 4-82, b).

To make pressing of the guides easier, it is recommended that the cylinder head be heated to a temperature of 180°C. If an installation for heating the head is not available, guide pressing without heating is allowable.

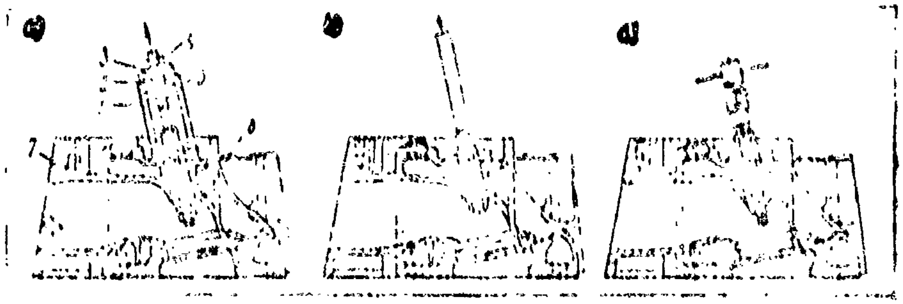


Plate 4-82. Replacing valve guides:
a) pressing guides out b) pressing guides in c) fitting guides with a reamer 1) puller body 2) support bearing 3) washer 4) pulling nut 5) shaft 6) support nut 7) cylinder head

After pressing the guides into the cylinder head, the dimension of the hole in the guide is brought to the diameter of the valve stem to be installed in it with a reamer (Plate 4-82, c), maintaining a warm clearance between the bushing and the stem which must be: 0.060-0.112 mm for an exhaust valve, and 0.080-0132 mm for an intake valve.

It is recommended that clearances within the valve guide be maintained within the described limits, since if they are increased, heat dissipation is worsened, acting negatively on the longevity of the working face of the valve.

Valve guides should be replaced before correcting valve seats by grinding.

The valve seat. Wear of the seat face will lead to leaky valve seating, in which passing gases will form oxidation and pits on the working surface of the face, and sometimes on the valve. Small deficiencies in the seat may be corrected by lapping the valve into the seat, and deep ones may be corrected by grinding (Plate 4-83), with consequent lapping of the valve against the working face of the seat.

Conic abrasives at an angle of 30° (relative to the horizontal axis) are used for exhaust valve seats and abrasives at a 45° angle are used for intake valve seats.

Valve seat working face repair is conducted by grinding with special abrasive stones, since steel millers are not as hard as the valve seat alloy. For exhaust valves, grinding is conducted in the following order: the working surface of the valve is preliminarily machined with a conic stone to an angle of 30°, as shown in Plate 4-83, b; then, the face at the lower part of the valve seat is removed by a miller at an angle of 75° (Plate 4-83, c), after which the face on the upper portion of the seat is removed at an angle of 15° (Plate 4-83, d); the working surface of the valve seat is then machined smooth with a fine grained conic wheel at an angle of 30° (Plate 4-83, e). These same operations are conducted for intake valve seats using the base conic stone at an angle of 45°.

Before correcting the valve seat, the condition of the valve guides should be checked. If the latter must be replaced, this operation should be performed before the seats are corrected, since the base for machining the receptacle is the valve guide. Smooth milling may replace grinding with an abrasive stone and corresponding dressing of the stone (see Plate 3-98).

If width of the working face of the seat is greater than 1.4 mm for an intake valve, or greater than 1.1 mm for an exhaust valve, it is necessary to reduce the face by grinding the seat at angles of 75° and 15° (see Plate 4-83).

Having finished correction of the valve seat, it is necessary to check the accuracy of its machining with an indicator. Oscillation of the working surface of the valve relative to the axis of the valve guide hole is not allowed to be greater than 0.035 mm.

If the valve seats are worn too much to be corrected by grinding, they are pressed out of the cylinder head with a device (Plate 4-84), and new seats are pressed in.

Before pressing in the valve seat, the cylinder heads should be heated to a temperature of 180°C. The seats are pressed in with a mandrel (Plate 4-85) until they rest against the bottom of their cavity. The valve seat is fitted with an interference of: 0.140-0.200 mm for exhaust valves, and 0.148-0.200 mm for intake valves.

Seat faces are machined, achieving their coaxiality relative to the guide bushings, and then the valves are lapped into them.

After the valve seats have been repaired, the cylinder head is washed out and blown out with compressed air.

During installation of the valves in the cylinder head, the stem and valve guides should be lubricated with a thin layer of oil.

Set the head on a bench and insert the valves. Install the valve rotation mechanisms on the intake valves (see Plate 4-24). For the exhaust valves, mount the spring support washers install the valve springs, mount the rubber cuffs on the exhaust valves, install the plates on the springs, and then, compressing the springs with the puller (see Plate 4-80), install the valve keys, fastening the valves with their springs into the cylinder head.

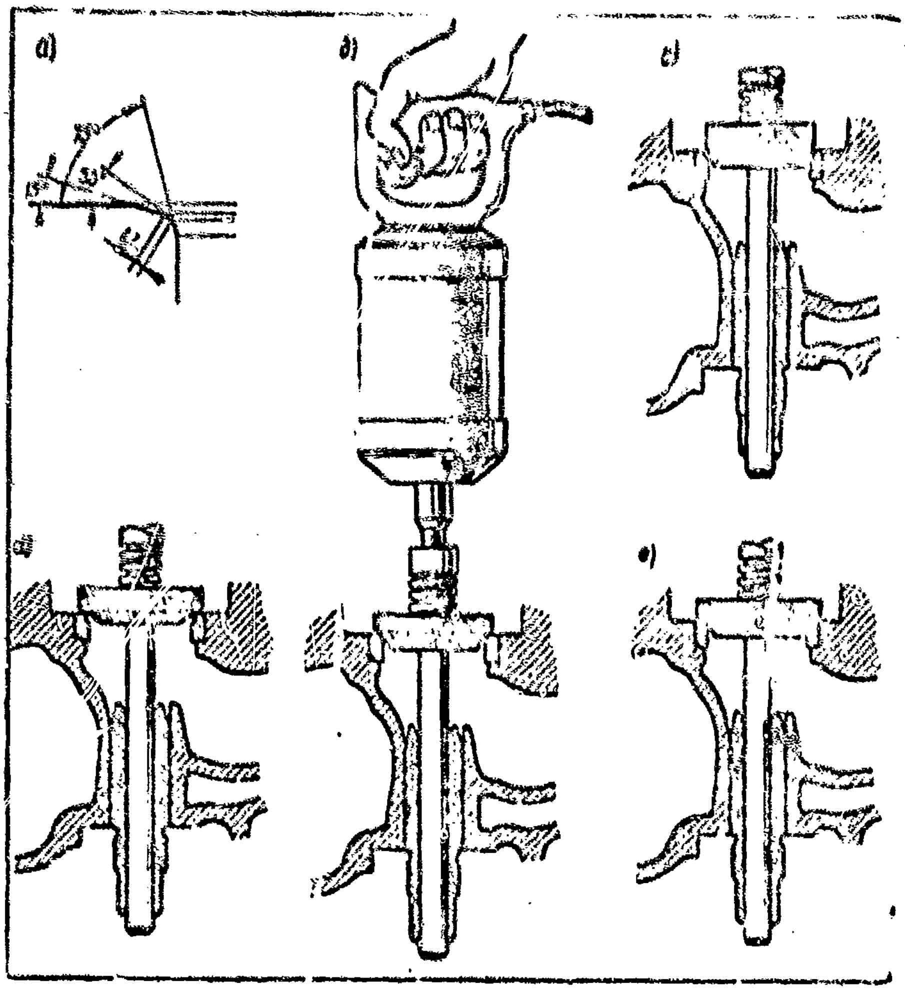


Plate 4-83. Correcting valve seat faces:
a) angles of machining and face dimensions b) coarse seat machining to an angle of 30° c) removal of seat face at an angle of 75° d) removal of the face at an angle of 15° e) fine machining of the seat at an angle of 30°

If the rocker arm bushings are replaced, the oil passage hole depicted in Plate 4-25 must be drilled in them.

Wear on the rocker arm surface which contacts the valve stem may be eliminated by smoothing it with a hand file, but a radius of 10 mm curvature must be maintained.

Cylinder head installation. Check the upper part of the cylinders, making sure that there is no dirt in them, and if necessary wipe the pistons and the assembly surface of the block and blow them off with compressed air. The cylinder head gasket may be installed on the cylinder block on either side.

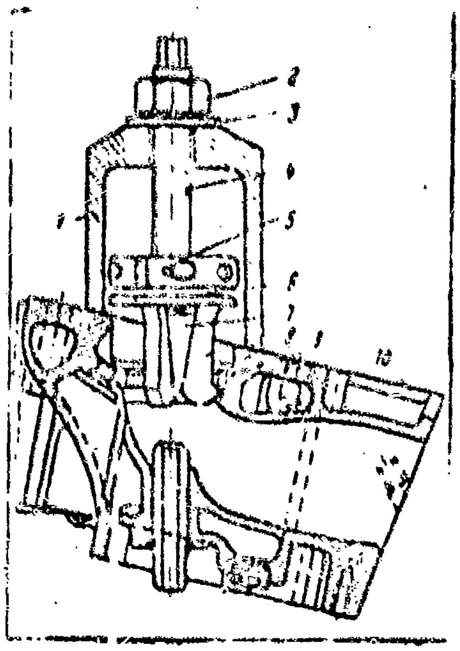


Plate 4-84. Pressing an inserted valve seat out of the cylinder head: 1) puller device body 2) nut 3) washer 4) screw with spreader cone 5) special nut with three fingers 6) tension spring 7) finger spreader cone 8) device finger 9) inserted seat 10) cylinder head

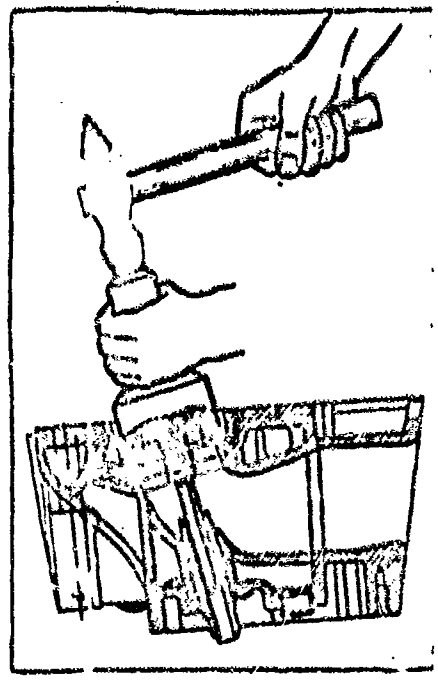


Plate 4-85. Pressing valve seat into cylinder head

Set the head on the pins on the cylinder block. Install the tappets into their receptacles in the cylinder block, lubricate them with clean oil, install the push rods, directing their upper ends into the holes in the head. Worn out tappets must be replaced or repaired.

Clearance between the wall of the guiding hole and the tappet shaft must be within the limits of 0.008-0.045 mm.

A tappet which is correctly selected according to the dimension of its guiding hole in the cylinder block must freely fall into the hole under its own weight, for which the tappet must be lubricated with a thin layer of oil. Assemble the shaft, after having mounted the rocker arms and the spacing springs, and placing the shaft stands as shown in Plate 4-26, and fasten the rocker arms with pins, inserting them into the holes in the end of the shaft.

Install the shaft assembly on the cylinder head, connecting the tappet push rod ends with the rocker arms. Insert the bolts with flat washers into the holes in the rocker arm shaft stands, and preliminarily tighten them. Then, install the remaining bolts with flat washers and, having connected the spark plug protective shields and drain gutters, tighten the cylinder head. Torque moment on the bolts is 7-9 kg meters. Bolt tightening order is shown in Plate 4-46. Bolt tightness is checked with a torque wrench. All the installation operations are repeated on the second cylinder head. The cylinder head bolts are tightened on a cold engine.

There must be no nicks or dents on the assembly surfaces of the intake manifold with the heads and cylinder block, and if they are present, they must be smoothed off with a fine grained file or scraper. The surface must be clean, smooth, and free from traces of corrosion.

Warping of the contact surfaces is checked with a straightedge gauge and a set of leaf gauges. Non-flatness of the surface is not allowed to be greater than 0.10 mm. If surface non-flatness exceeds the limits specified, the manifold should be replaced.

The manifold must also be checked for tightness under a pressure of 3-4 kg/cm^2. Before checking, it is necessary to clean tar deposits from passage 9 (see Plate 4-27) and scale from passage 8. Scale is separated with the solution used for cleaning the hollows in the cylinder block water jacket.

The surfaces of the intake manifold flanges must be straight. Maximum deviation must not exceed 0.2 mm. Straightness is checked with a straightedge gauge and leaf gauge (Plate 4-86).

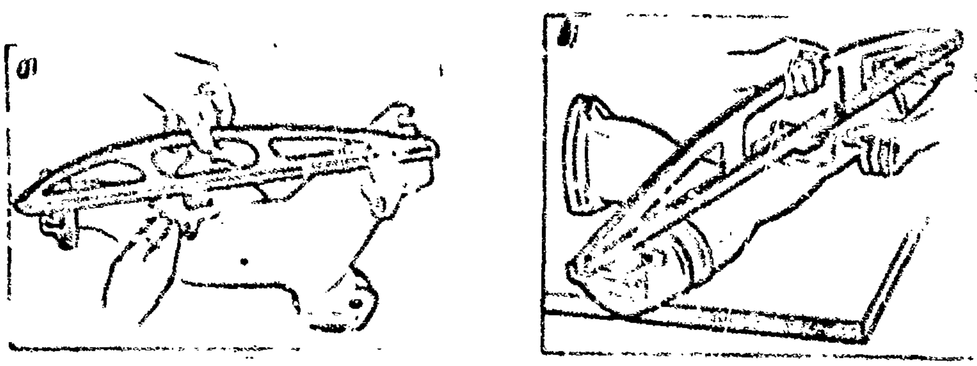


Plate 4-86. Checking the intake manifold:
a) ZIL-130 engine b) ZIL-131 engine

The presence of small cracks on the interior portion of the manifold does not necessarily mean that it is ruined.

During repair, the walls of the manifold should be checked, and deposits formed on them should be cleaned off, since a significant amount of deposits noticeably constricts the passage section in the manifold, decreasing the power of the engine and lowering its fuel economy. The manifold is cleaned with a metal scraper or wire brush with subsequent washing in kerosene and blowing out with compressed air.

Intake manifold installation. Install the oil trap on the interior side of the intake manifold on the two pins, and fasten it with nuts. Screw the crankcase ventilation valve assembly into its receptacle on the exterior side of the manifold, screw the sleeve into the outlet passage of the manifold, install the pipe for exhaust of worked-out gases on the sleeve and fasten it with nuts. For the ZIL-131 engine, the crankcase ventilation valve must be in assembly with a shut-off valve. Screw the water temperature switch into its receptacle. Then, lay the packing gaskets on the assembly surfaces of the cylinder block and cylinder heads, install the intake manifold on the cylinder block studs, and fasten it with nuts. The torque moment on the nuts must be 1.5-2.0 kg meters. The nuts should be tightened evenly and sequentially (from the center to the edges).

Installation of exhaust manifolds on the ZIL-130 engine. Install the exhaust manifold with its gasket and fasten it on the studs with nuts and flat washers. Repeat the same operation on the other manifold. Torque moment on the nuts must be within the limits of 4.0-5.0 kg meters.

Simultaneously with installation of the left manifold, fasten on the starter shield, and install the dipstick tube, which is fastened with a nut on the sleeve in the hole between the cylinder head and the manifold.

Before installation of the exhaust manifolds on the ZIL-131 engine, they must be assembled. The exhaust manifold is assembled on a device which must provide positioning of the exhaust manifold flanges in a single plane, and proper location of the manifold holes to an accuracy of 0.25 mm. The butt of the gasket must be located beneath the tension bolt on the clamp. The clamps are installed with tension bolts from beneath. The axes of the bolts must be perpendicular to the flanges fastening the manifolds to the cylinder head. After mounting the gasket on the cylinder head studs, install the assembled exhaust manifold and fasten it with nuts and flat washers. Torque moment on the nuts fastening the assembled exhaust manifold is 4-5 kg meters for the center flange and 3-3.5 kg meters for the end flanges.

After installation of the exhaust manifolds on the engine, check the clamp bolt tightness. Torque moment must be 1.4-1.7 kg meters.

Conduct the same operation on the other manifold.

The exhaust manifolds may be installed in assembly with the cylinder heads, after they have been installed on the cylinder heads.

Installation of the oil filters. Install the oil filters with their gaskets, connect the drain passage and fasten the filter body with bolts and screw the oil pressure indicator switch into the filter body.

Installation of the oil filler pipe with the crankcase ventilation filter. Install the filter with the oil filler pipe, having previously laid down the gasket and installed the fuel pump rod, and fasten them with bolts and washers. If the engine has a straight flow of hot water from the cylinder head cooling jacket hollow into the pump hollow, install an additional pipe and thermostat and connect its hose to the water pump. Install the upper pipe and fasten it.

Installation of the water pump and fan. Install the water pump with its gasket, having previously mounted the drive belts of the compressor, the hydraulic power steering pump, and the generator on the pulley. Fasten the water pump in assembly with the fan on the engine with bolts (on the ZIL-131 engine, the generator drive belt is also the drive belt for the fan).

Install the valve operation levers and fasten them with pins.

Fuel pump installation. Install the fuel pump on its studs after installation of its gasket, and fasten the pump with nuts and washers.

Installation of the carburetor and air filter. After laying its gasket, install the carburetor on studs which are screwed into the intake manifold and fasten it with nuts. Install the tune pipes and fasten their ends on nipples in the carburetor and centrifugal switch with the coupling nuts. Connect the regulator vacuum line to the nipple on the carburetor (only on the ZIL-130 engine). Fasten the transfer flange on the carburetor, install the air filter body with its filtering element on the carburetor, and fasten it with a nut, and then install the transfer cover with its sleeve and fasten it with a wing nut.

On the ZIL-131 engine, the air filter is installed on two studs which are screwed into the intake manifold. The filter is connected to the carburetor by a rubber hose.

Installation of the fine cleaning fuel filter. Install the filter in assembly with its bracket on the intake manifold body and fasten it with nuts and washers. Connect the filter tubes to the fuel pump, and fasten their coupling nuts.

Installation of the hydraulic power steering pump. After fitting its drive belt on the pulley, install the pump in assembly with its bracket on studs which are screwed into the face of the cylinder block, and fasten it with nuts and washers. Simultaneously, adjust the tension on the drive belt, as shown in the description of the engine's technical service.

Compressor installation. Install the compressor on studs which are screwed into the face of the right cylinder head, simultaneously fitting its drive belt on the pulley, and then fasten the compressor with nuts and washers. Adjust the drive belt tension as shown in the engine's technical service.

Connect the compressor cooling system lines and fasten them on their nipples with the coupling nuts, connect the compressor lubrication system lines and fasten their coupling nuts.

Connect the compressor to the air filter with the air outlet line and fasten it.

Generator installation. Install the generator brackets on the body of the compressor cover, and fasten them with bolts and washers. After mounting its drive belt on the pulley, install the generator on the brackets. Then, align the holes in the generator cover and brackets, insert the bolts, and fasten them with nuts and washers.

Adjust the tension on the drive belt, and fasten the generator tensioning arm with a nut as shown in the description of the engine's technical service.

Starter installation. After connecting the starter gear with the toothed ring of the flywheel, install the starter in its receptacle in the clutch housing, and, holding it by hand, tighten its bolts.

Installation of the distributor drive. Before installing the distributor drive in its receptacle in the cylinder block, it is necessary to lubricate the drive gear and shaft with engine oil.

On an installation which has been disassembled and assembled, the distributor drive should be installed in the following sequence. Set the number 1 piston at TDC, as shown in the description of the engine's technical service.

Position slot 11 (Plate 4-87) of shaft 12 on the drive in the body so that it is parallel to mark 14, which is formed on the top flange 9 on the drive body, and its movement is directed toward the distributor gear cover.

In this position, install the distributor drive assembly into its receptacle in the cylinder block . During this, ensure that the holes in the lower flange 6 of the drive body coincide with the holes in the block at the moment of initial engagement of gear 13 on the drive and the distributor shaft gear, after which slot 11 of the distributor drive shaft, set in place, must be located parallel to the axis connecting the holes on the upper flange 9. In this position, fasten the distributor drive body onto the cylinder block 7 with bolts 5. If the distributor drive does not seat to its end during installation because of misalignment of the drive shaft top with the oil pump driving shaft slot, it is necessary to rotate the engine crankshaft by two revolutions, simultaneously pressing lightly on the distributor drive body.

Set the engine crankshaft with the starting crank so that the mark on the crankshaft pulley is located opposite the mark 9 on the ignition setting indicator at the end of the second crankshaft revolution (Plate 4-47). Rotation of the crankshaft by an amount of a 90° angle setting (on the indicator mark 9) allows setting of the earliest angle of ignition advance, providing easy engine starting.

Installation of the distributor, spark plugs, and high tension leads. Before installing the distributor, it is necessary to check, and if necessary adjust, the clearance between the contact breaker points and also align the indicator arrow on the upper plate to the zero mark on the lower plate of the octane corrector.

Install the ignition distributor in assembly with the octane corrector plates on flange 9 (see Plate 4-87) of the drive body, so that the vacuum regulator is directed toward the side of the carburetor, and the rotor electrode is located opposite the pole for the first cylinder. In this position, fasten the octane corrector plates with two bolts 10, thereby fastening the distributor. Connect the line to the vacuum regulator nipple and fasten it.

During installation of the spark plugs and high tension leads, blow out the depressions in the cylinder block for the plugs with compressed air, pull the plugs from the holes, and screw in the spark plugs.

While screwing the spark plugs into holes whose access is not fully free, a wrench must be used to ease correct guidance of the threaded portion of the plug. For this, the spark plug is inserted in the wrench and fastened in it with a small wooden wedge. Torque moment on the spark plugs is 3.2-3.8 kg meters.

Install the high tension leads, connecting their ends to the spark plugs and to the holes in the distributor cap. On the ZIL-131 engines, fasten the shielding hoses of the spark plugs.

Installation of the high tension leads must be conducted in correspondence with the cylinder firing order (1-5-4-2-6-3-7-8), considering that the distributor rotor rotates in a clockwise direction.

The ignition setting is checked (with the storage battery connected) by a small rotation of the distributor, causing a spark in the number 1 cylinder. The checking order is the following.

Loosen bolt 8 fastening the upper plate of the octane corrector to the distributor body to provide rotation of the latter by hand. If rotation is affected by the adjusting nut 3 of the octane corrector, then the bolt fastenning the upper plate must not be loosened, or else rotation of the distributor body will not occur.

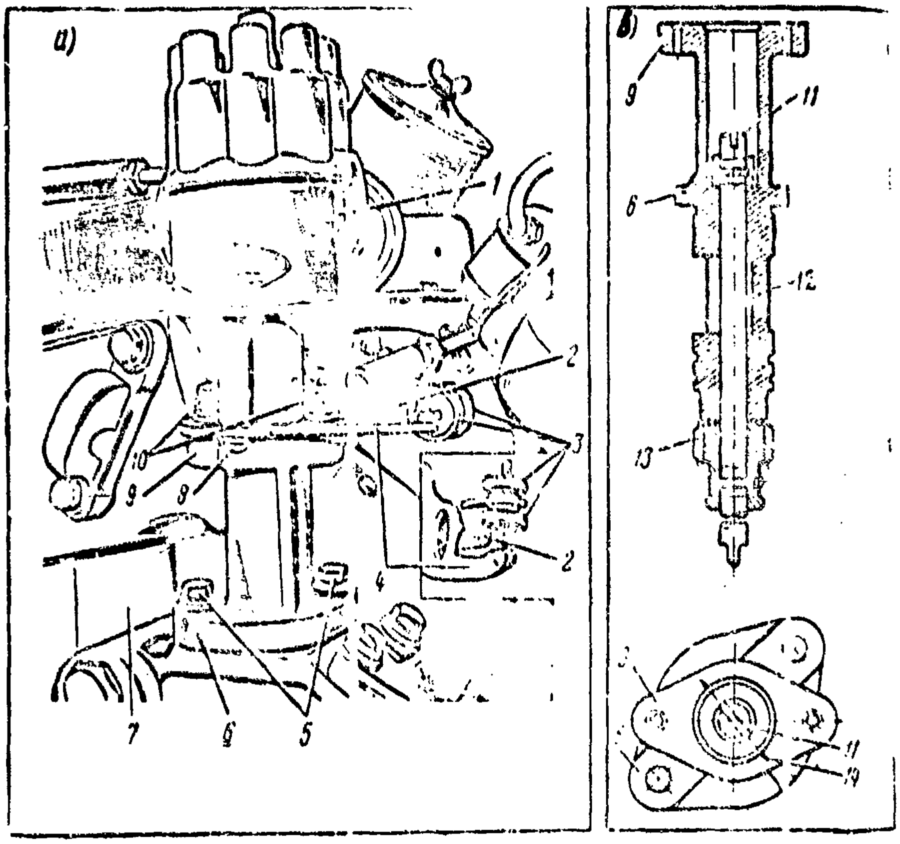


Plate 4-87. Installation of the distributor on a ZIL-130 engine:
a) distributor installed on the engine b) drive of distributor and oil pump 1) distributor 2) octane corrector lower plate 3) adjusting nut 4) octane corrector upper plate 5, 8, and 10) bolts 6) lower flange 7) cylinder block 9) upper flange 11) drive shaft slot 12) drive shaft 13) drive shaft gear 14) mark on flange

Switch on the ignition and rotate the distributor body in a counterclockwise direction to the position where the contact breaker points begin to open and a spark appears between the ends of the central lead and the engine ground in an air clearance of 2-3 mm for a non-transistorized ignition system, and 3-10 mm for a transistorized ignition system. In this position, tightly fasten bolt 8, fastening the upper plate of the octane corrector to the distributor, thereby fastening it on the drive body. The beginning of contact point opening may also be checked by the lighting of a lamp connected to the engine ground and to the low tension pole of the distributor.

Installation of the transmission. Set the transmission on a hydraulic hoist cart 444 (see Plate 4-50, a) and move it to the engine. Raise it to the necessary height, connect it to the clutch housing, and fasten it with bolts, using an angular socket wrench until the bolts refuse to turn further. Having finished assembly, it is necessary to conduct running-in and testing of the engine.

Running the engine in

Plate 4-88 shows a stand with electric brake for running in and testing a V-shaped engine.

During old running-in of the engine, the electric motor works as a motor and requires alternating electric current from the network. During hot rolling of an engine being tested, the electric motor works as a generator, transmitting electric current into the network. Current transmission in this process passes through electric rheostat 15, whose control is effected with handle 16 of the drive. The electric motor is started and stopped with buttons 17. The generator stator is connected with a weighing mechanism. The weighing mechanism of the electric motor is located in the body of the device control panel 24.

The electric motor is connected with the tested engine by a Cardan drive which is covered by protective grating 13. Control of the carburetor throttle is effected by rod 26.

Before testing, the engine is filled with oil corresponding to the lubrication chart, and also 15-20 grams of oil are poured into each cylinder through the spark plug holes. The engine is installed on the stand and fastened with a Cardan shaft of the stand fastened to the flange of the transmission, and the engine connected to the cooling system and the fuel system (on gasoline or gas). The protective grating is installed.

Engine running-in is conducted with the transmission in high gear. Engine crankshaft revolutions are increased by a smooth opening of the throttle.

During the running-in process, the engine is listened to, and the absence of extraneous knocks, leaks, localized overheating, or other deficiencies is assured.

Running in and testing the V-shaped engine after repair should be conducted according to the rate shown in Table 4-1.

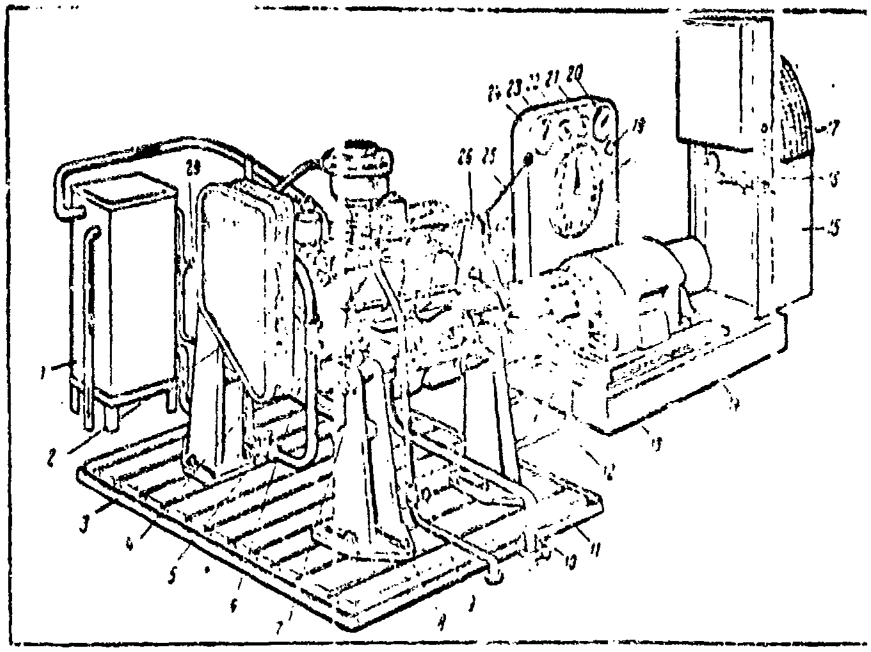


Plate 4-88. Stand for rolling and testing engines (ZIL-130 and ZIL-131):
1) tank with cooling liquid 2) engine 3) stand base 4) pulley protective screen 5) cooling system shut-off valve 6) front engine mount fastening nut 7) liquid fuel shut-off valve 8) stand upright fastening nut 9) gas fuel shut-off valve 10) exhaust pipe fastening bolt 11) stand upright 12) rear motor mount fastening bolt 13) Cardan shaft protective grating 14) electric motor 15) liquid rheostat 16) rheostat control handle 17) electric motor control buttons 18) scale dial 19) indicator lamp 20) tachometer 21) oil thermometer 22) water thermometer 23) engine oil pressure gauge 24) panel body 25) transmission lever 26) throttle control rod 27) hand brake lever 28) clutch pedal 29) water line shut-off valve

After running the engine in, it is recommended that the hot oil be drained and fresh oil be poured in.

An engine in which defects requiring parts disassembly are discovered during the process of testing is subjected to a repeated testing.

TABLE 4-1

Schedule of Running In Engine

Running-in	Load, hp	Number of crankshaft revolutions, rpm	Running-in time, minutes
Cold	--	400-600	15
Same	--	800-1000	20
Hot, without load	--	1000-1200	20
Same	--	1500-2000	15
Hot, under load	15-20	1600-2200	25
Same	40-60	2500-2800	25

Installation of the power unit in the motor vehicle

Before installing the engine, it is necessary to check the fastening of the motor mounts on the frame. If loosened rear motor mount fastenings are discovered during this, it is necessary to unpin the rear mount bolts, tighten the nuts, and re-pin them. If the front mount fastenings are loose, it is necessary only to tighten the bolts and spring washers.

To install the engine on the frame, it is necessary to move it to the motor vehicle on a transport carriage, mount the chain hooks of the device on the brackets for lifting the engine, raise the engine with a hoist (see Plate 4-49, b), and install it on the three mounts · the motor vehicle frame.

Insert one bolt in each of the rear motor mounts from the bottom, screw nuts onto the bolts, and tighten and pin them.

Insert two bolts in the holes in the front motor mounts, mount the electric equipment "ground" connector on the right bolt, screw on nuts with spring washers, tighten them, and then fasten the second end of the connector to the frame cross member.

Connect the reactor bar to the front motor mount and fasten it.

After installing and fastening the engine in the automobile frame, it is necessary to install the transmission shift lever housing and fasten it with bolts and spring washers. Connect the speedometer cable to the transmission and fasten it.

Connect the exhaust pipe to the flanges of the exhaust manifold of the engine on both sides, fasten them with bolts and nuts, and block them with washers, bending the edges up against flats of the nuts.

Connect the lever for hand drive of the pneumatic brakes to the hand brake control lever and fasten it. Connect the brake valve rod to the foot brake pedal lever and fasten it (for adjustment of brake linkage, see Chapter 16).

Connect the clutch rod to the clutch pedal lever and fasten it (for adjustment of clutch pedal free play, see Chapter 6).

Connect the propellor shaft. Install the cab floor inspection plate and fasten it with bolts.

Connect the carburetor linkage, cable for the manual choke and throttle, and fasten them. Connect the lines to the fuel pump and compressor and tighten them.

Connect the hoses to the hydraulic power steering pump and tighten them.

Install the cooling system radiator in assembly with the oil radiator on the front frame cross member, fasten the radiator with nuts on the stud, and pin the nut. Install the radiator jacket and fasten it to the fenders and splash guard with bolts, and then connect the radiator louvre control cable. Connect the hoses (upper and lower) of the water radiator pipes and fasten them. Connect the oil radiator hoses and fasten them.

Connect the ignition system and lighting system leads and fasten them on the poles of the appliances and transfer panels. Connect the starter lead to the storage battery post and fasten it, and then fasten the cover and lateral shield of the storage battery.

On the ZIL-131 motor vehicle, additionally connect the drive control for the transfer case and winch, and connect the hydraulic power steering oil radiator.

Close the engine hood, start the engine, and check the operation of all assemblies and accessories of the engine.

Parts dimensions

Cylinder sleeves. The geometric dimensions of the sleeves (Plate 4-89) may be measured without pressing them out of the cylinder block. The cylinder sleeves may also be measured after they are pressed out. The sleeves are measured in two mutually perpendicular directions, along the axis of the crankshaft and perpendicular to it, and also in two levels in height, at distances of 10-15 and 40-50 mm from the top surface of the cylinder block.

Maximum allowable wear of the cylinder sleeves is 0.4 mm. If wear in this amount is present, the sleeve should be pressed out of the cylinder block and sent into repair for regrinding to a repair dimension or to be replaced by a new one which is released by the factory as a set with the piston and rings.

Table 4-2 presents the dimensions of a sleeve (nominal and three repair). For providing selection of a piston according to the repair sleeve, the latter are divided into six groups within the limits of each repair dimension. Each group is designated by one or two letters. Corresponding pistons are designated by the same letters.

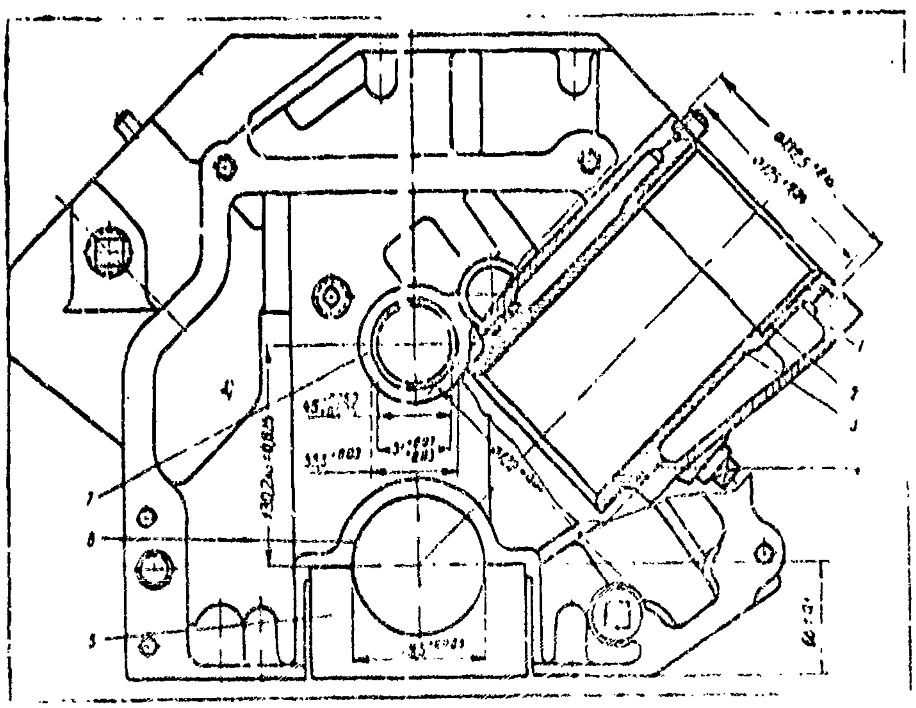


Plate 4-89. Fitting dimensions in a cylinder block for sleeves, inserts, and camshaft bushings:
1) cylinder block 2) insert 3) cylinder sleeve 4) sleeve packing 5) rear main bearing cover 6) nest for insert 7) receptacle for camshaft bushing

All sleeves of a cylinder block must have a dimension within the limits of one repair dimension. The maximum ovality or conicity of a sleeve is not allowed to be greater than 0.020 mm. The working surface of a sleeve must be smooth and polished, with a surface roughness of no less than 9th class.

Cylinder sleeves whose diameters are outside the limits of the maximum repair dimension by 101.56 mm are not repaired.

TABLE 4-2 Nominal and Repair Dimensions of Sleeves, mm

a) Размер	b) Увеличение	c) Группа	d) Диаметр гильз
e) Номинальный	—	А	100,06—100,05
		АА	100,05—100,04
		Б	100,04—100,03
		ББ	100,03—100,02
		В	100,02—100,01
		ВВ	100,01—100,00
f) 1-й ремонтный	0,5	Г (G)	100,56—100,55
		ГГ	100,55—100,54
		Д	100,54—100,53
		ДД	100,53—100,52
		Е	100,52—100,51
		ЕЕ	100,51—100,50
g) 2-й »	1,0	Ж (zh)	101,06—101,05
		ЖЖ	101,05—101,04
		И (I)	101,04—101,03
		ИИ	101,03—101,02
		[illegible]	101,02—101,01
		КК	101,01—101,00
h) 3-й »	1,5	Л (L)	101,56—101,55
		ЛЛ	101,[illegible]—101,[illegible]
		М	101,[illegible]—101,[illegible]
		ММ	101,53—[illegible]
		Н (N)	101,52—[illegible]
		НН	101,[illegible]—[illegible]

Key: a) dimension; b) increase; c) group; d) sleeve diameter; e) nominal; f) first repair; g) second repair; h) third repair

Regrinding of sleeves to repair dimensions in connection with the thin-walled sleeves and the presence of Ni-Resist [heat resistant iron alloy] inserts in them presents significant technological difficulties and must be conducted in special shops which have the required equipment available.

The clutch housing. The surface of the clutch housing (see Plate 4-10) assembled with the cylinder block and with the transmission housing may not deviate more than 0.15 mm from perfect flatness.

The height of the support fingers of the housing must be within the limits of 70.00-69.26 mm. Wear on the support fingers in height is allowed to 64 mm. The diameter of the holes for the rear motor mount bolts must be within the limits of 20.00-20.28 mm. If the holes are greatly worn, they are allowed to be reamed and have bushings inserted.

Holes for pressing in bushings for the clutch disengagement fork shaft are executed within the limits of 30.00-30.045 mm. Bronze bushings are pressed into these holes with an interference of 0.10 mm.

The internal dimension of the bushings is 25.06-25.13 mm. The maximum wear on the bushings is allowed within the limits of up to 0.7 mm. Worn out bushings must be pressed out and replaced with new ones which are pressed in.

After pressing them in, both bushings must be reamed simultaneously to assure their alignment. Nonalignment in the bushings is not allowed to be greater than 0.025 mm, and non-parallelness (in relation to the surface lying against the block) is not allowed to be greater than 0.1 mm on a length of 100 mm.

For a housing in the spare parts inventory, non-parallelness of the face surfaces assembled with the cylinder block and the transmission is not allowed to be greater than 0.05 mm on a length of 100 mm. Oscillation of the surface of the hole centering the transmission is not allowed to be greater than 0.15 mm, and this is checked by installing the housing on a device with locater holes on installing fingers, and simultaneously resting the housing on its surface, which is assembled against the cylinder block on the device base.

The designation of the piston group according to skirt diameter and dimension groups according to wrist pin holes in the front part of the piston are marked on their heads. Designations of piston markings of nominal and repair dimensions are shown in Plate 4-90.

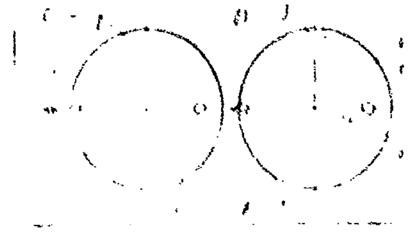


Plate 4-90. Piston markings of nominal and repair dimensions:
a) nominal dimension piston b) repair dimension piston 1 and 8) wrist pin axes 2 and 3) group designation according to piston skirt diameter 4) designation of repair dimension piston 5) designation of piston repair group 6 and 9) location of OTC stamp 7 and 10) designation of front part of piston

Piston dimensions are shown in Table 4-3. To provide individual selection of pistons according to cylinders, each of the presented dimensions is divided into dimensional groups into which the pistons go according to skirt diameter, with increments of 0.01 mm. Piston skirt conicity must be within the limits of 0.035-0.050 mm. The difference between the maximum and minimum diameters of the skirt is 0.52 mm. The piston skirt surface must be smoothly polished, without dents or nicks, and must have a surface roughness of no less than 8th class. The pistons are manufactured according to weight to an accuracy of ±2 grams, and therefore they are not selected and marked according to weight.

TABLE 4-3 Piston Dimensions, mm

a) [illegible]	b) [illegible]	c) [illegible]	d) [illegible]
e) [illegible]	—	A [illegible]	[illegible]
		[illegible]	[illegible]
		[illegible]	[illegible]
		[illegible]	[illegible]
		[illegible]	[illegible]
		[illegible]	[illegible]
f) 1-й [illegible]	[illegible]	[illegible]	[illegible]
		[illegible]	[illegible]
		[illegible]	[illegible]
		[illegible]	[illegible]
		[illegible]	[illegible]
		[illegible]	[illegible]
g) [illegible]	1,0	[illegible]	[illegible]
		[illegible]	[illegible]
		[illegible]	[illegible]
		[illegible]	[illegible]
		[illegible]	[illegible]
		[illegible]	[illegible]
h) [illegible]	1,5	[illegible]	[illegible]
		[illegible]	[illegible]
		[illegible]	[illegible]
		[illegible]	[illegible]
		[illegible]	[illegible]
		[illegible]	[illegible]

Key:
a) dimension
b) diameter increase
c) group
d) dimensions (in a plane perpendicular to the wrist pin axis)
e) nominal
f) first repair
g) second repair
h) third repair

TABLE 4-4 Holes for Piston Wrist Pins, mm

a) [illegible]	b) [illegible]			
	I	II	III	IV
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
c) [illegible]	[illegible] d)	[illegible] e)	[illegible] f)	[illegible] g)

Key:
a) nominal dimension
b) dimension group
c) marking collar
d) blue
e) red
f) white
g) black

To ease individual selection of piston wrist pins, the pistons are divided according to diameter of their wrist pin holes into the four dimensional groups shown in Table 4-4. Marking of the dimensional group according to diameter of the wrist pin holes is done by putting paint on the wrist pin boss. Ovality or conicity of the wrist pin holes in the piston is not allowed to be greater than 0.0025 mm.

Piston wrist pin dimensions are presented in Table 4-5. Roughness of the wrist pin surface must be no lower than 10b class. Surface hardness of the wrist pin is HRC 58-65. Depth of the hardened layer is 1.0-1.4 mm.

The wrist pins are fitted into the piston bosses with an interference of 0.0025-0.0075 mm.

Piston wrist pin stop rings must fit into their grooves in the piston with some interference and must not rotate in them by hand. Rings which have lost their elasticity are replaced. Dimensions of stop rings are shown in Plate 4-13.

Allowable noncylindricality of a wrist pin must not be greater than 0.0025 mm.

Compression and oil rings. Nominal and repair dimensions for compression and oil rings along their exterior diameters, including those of the circular disk of a composite oil ring, are presented in Table 4-6. Clearances in the ring lock and between the rings and the piston grooves are presented in Table 4-7. Piston ring hardness is HRB 98-106.

For convenience in operation and repair, the factory produces a set of piston rings for one engine, which may consist of either cast iron or composite oil rings. Each set of piston rings for an engine has a number assigned to it: 130-1000101-A for those with cast iron oil rings; and 130-1000101 for those with composite oil rings.

The connecting rod. During repair of the connecting rod small end (see Plate 4-15), dimensions for the bushing and for the wrist pin must correspond to the dimensions shown in Table 4-8.

For selection of piston wrist pin-connecting rod pairs, the holes in the connecting rod small end (along the bushing) are divided into dimensional groups every 0.0025 mm.

TABLE 4-5 Piston Wrist Pin Dimensions, mm

a)	b)	c) I	c) II	c) III	c) IV	d)
e)	—	[illegible]	[illegible]	[illegible]	[illegible]	—
f)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	i)
g)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	j)
h)		k)	l)	m)	n)	

Key: a) dimension
b) diameter increase
c) designation of wrist pin diameter according to group
d) designation of repair dimension
e) nominal
f) first repair
g) second repair
h) color of marking
i) green
j) rose
k) blue
l) red
m) white
n) black

Table 4-6. Piston Ring Dimensions, mm

a)	b)	c)
d)	—	[illegible]
e)	0,5	[illegible]
f)	1,0	[illegible]
g)	1,5	[illegible]

Key: a) dimension
b) increase
c) exterior ring diameter
d) nominal
e) first repair
f) second repair
g) third repair

a) [illegible]	b) [illegible]	
	c) [illegible]	d) [illegible]
f) [illegible]	[illegible]	[illegible]
g) [illegible]	0,15–[illegible]	[illegible]
h) [illegible]	[illegible]	[illegible]
i) [illegible]	0,3–1,0	—

Table 4-7. Clearances in ring locks and between rings and piston grooves, mm

Key: a) piston rings
b) clearances
c) in ring lock
d) in height between rings and groove
f) upper compression
g) lower compression
h) cast iron oil
i) composite steel circular disk oil

a) [illegible]	b) [illegible]			
	I	II	III	IV
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
c) [illegible]	d) [illegible]	e) [illegible]	f) [illegible]	g) [illegible]

Table 4-8. Connecting rod small end dimensions, mm

key: a) nominal dimension of connecting rod small end hole for bushing
b) internal nominal dimension of bushing for wrist pin according to group
c) color marking
d) blue
e) red
f) white
g) black

The crankshaft. Crankshaft journal dimensions are presented in Table 4-9. The factory is preparing a transfer to the use of inserts manufactured of steel-aluminum bands. In the transfer to the new band, main bearing journals will be decreased by 0.5 mm. The diameter of the connecting rod journals will not be changed. Longevity of the aluminum inserts is almost twice as high as that of the trimetallic ones. Shaft journal diameter is measured with a 50-100 meter micrometer. Shaft journals should be measured on no fewer than two respectively perpendicular places, and on two belts along the length of the journal.

Non-cylindricality in the journals of a new shaft or of a shaft which has undergone regrinding must not exceed 0.01 mm.

Main and connecting rod journal surface smoothness is assured by grinding and subsequent polishing and must not be lower than 9th class.

Crankshaft connecting rod journal length is 58.00-58.12 mm; main journal length is: 32.075-32.160 mm for the first journal, 31.00-31.17 mm for the second, third, and fourth journals, and 45.00-45.17 mm for the fifth journal.

The radii of the connecting rod and main journal fillets are 1.0-2.0 mm. The axes of the connecting rod journals must be parallel to the axes of the main journals, with non-parallelness not exceeding 0.01 mm.

Non-cylindricality of worn shaft journals is not allowed to be greater than 0.05 mm for connecting rod journals, and 0.07 mm for main journals. If the shaft journals are worn more than the allowable limits, the shaft is subjected to regrinding to repair dimensions.

Journal diameter beneath the small timing gear and beneath the crankshaft pulley is 45.950-45.975 mm. The internal diameter of the gear hole is 46.000-46.027 mm.

Oscillation of the journal beneath the gear must not exceed 0.03 mm on a length of 50 mm.

Facial wobbling of the small timing gear installed on a mandrel must be no greater than 0.04 mm, measured on the side where the gear fits against the face of the main bearing.

Keyway width is 6.015-6.065 mm. Keyway repair by milling is allowed to a repair dimension of 6.445-6.490 mm.

Facial wobble of the shaft flange on which the flywheel is installed must not exceed 0.05 mm. Thickness of the flange is 11.57-12.2 mm. The diameter of the holes for the flywheel fastening bolts is 14.000-14.035 mm.

Bearing inserts. Insert dimensions are presented in Table 4-10. Bearing inserts which are decreased by 0.05 mm are used without regrinding the shaft journal. Markings of repair dimension inserts (0.05; 0.30; 0.60; 1.00; 1.25; 1.50; 2.00) are placed on the steel surface of the insert. Nominal dimension inserts have no markings.

Camshaft bearing journals. The diameter of the bearing journals on the camshaft, and also the amount of their allowable wear and journal repair dimensions are presented in Table 4-11.

Repair dimensions of the support flange (see Plate 4-53) of the camshaft are given in Table 4-12.

a. Размер	b. Уменьшение диаметра	c. Размеры шеек коленчатого вала	
		d. коренных	e. шатунных
f. Номинальный	—	74,98–75,00*	65,48–65,50
g. 1-й ремонтный	0,05	74,93–74,95	65,43–65,45
2-й "	0,30	74,68–74,70	65,18–65,20
3-й "	0,60	74,38–74,40	64,88–64,90
4-й "	1,00	73,98–74,00	64,48–64,50
5-й "	1,25	73,73–73,75	64,23–64,25
6-й "	1,50	73,48–73,50	63,98–64,00
7-й "	2,00	72,98–73,00	63,48–63,50

Table 4-9. Crankshaft journal dimensions, mm

Key:
- a) dimension
- b) diameter decrease
- c) crankshaft journal dimensions
- d) main
- e) connecting rod
- f) nominal
- g) first repair

* Dimensions are given for inserts manufactured of trimetallic bands.

The camshaft bearings are bored into the cylinder block parallel to the crankshaft bearings with a distance of 130.191-130.241 mm between the axes of these bearings (see Plate 4-89).

Diameters of the holes in the block for the camshaft bushings are 55.5-55.53 mm for the four front bearings and 49.5-49.53 mm for the rear bearing.

The camshaft bushings are thin-walled, stamped of a bimetallic band, and pressed into their receptacles with an interference of 0.120-0.210 mm. Dimensions of the camshaft bushings are given in Table 4-13.

a) Размер	b)	c)		d)	
		e)	f)	e)	f)
g) Номинальный	--	1,80/1,70	2,237/2,[illegible]	1,60/1,52	1,987/1,980
h) 1-й ремонтный	0,05	1,80/1,70	2,262/2,255	1,60/1,52	2,012/2,005
2-й "	0,30	2,00/1,90	2,387/2,380	1,70/1,67	2,137/2,130
3-й "	0,60	2,15/2,05	2,537/2,530	1,90/1,80	2,287/2,280
4-й "	1,00	2,30/2,20	2,737/2,730	2,05/1,95	2,487/2,480
5-й "	1,25	2,43/2,33	2,862/2,855	2,20/2,10	2,612/2,605
6-й "	1,50	2,53/2,43	2,987/2,980	2,30/2,20	2,737/2,730
7-й "	2,00	2,80/2,68	3,237/3,230	2,60/2,48	2,987/2,980

Table 4-10. Dimensions of main and connecting rod inserts, mm

Key: a) dimension
b) dimension decrease
c) main bearing insert dimensions
d) connecting rod bearing insert dimensions
e) band thickness
f) overall insert thickness
g) nominal
h) first repair

* Dimensions are given for inserts manufactured of trimetallic bands.

Allowable non-alignment of the interior diameters of bushings which are pressed in and fitted according to the diameter of the shaft journal must not exceed 0.03 mm. Allowable wear of camshaft bushings is no greater than 0.05 mm.

a) Размер	b)	c) Размеры шеек			
		1-й, 2-й, 3-й и 4-й		5-й	
		d)	e)	d)	e)
f) Номинальный	—	50,980 / 51,000	50,9[illegible]	44,983 / 45,000	44,933
g) 1-й ремонтный	0,20	50,780 / 50,800	50,73[illegible]	44,783 / 44,8[illegible]	44,733
h) 2-й ремонтный	0,40	50,58[illegible] / 50,600	50,530	44,583 / 44,600	[illegible],533
i) 3-й ремонтный	0,60	50,380 / 50,400	50,3[illegible]	44,383 / 44,400	44,33[illegible]
j) 4-й ремонтный	0,80	50,180 / 50,200	50,13[illegible]	[illegible],183 / 44,200	44,133

Table 4-11. Diameters of camshaft bearing journals, mm

Key: a) dimension
b) diameter decrease
c) journal dimensions
d) nominal or repair
e) allowable without repair
f) nominal
g) first repair
h) second repair
i) third repair
j) fourth repair

a) Размер	b)	c) Размеры толщины фланца	
		d) первоначальный	e) допустимый без ремонта
f) Номинальный	—	4,782—4,800	4,552
g) 1-й ремонтный	0,2	4,582—4,600	4,362
2-й "	0,4	4,382—4,400	4,152
3-й "	0,6	4,182—4,200	3,932

Table 4-12. Support flange repair dimensions, mm

Key: a) dimension
b) flange thickness decrease
c) flange thickness dimensions
d) initial
e) allowable without repair
f) nominal g) first repair

Camshaft gears. The internal diameter of the small timing gear (see Plate 4-21) is 46.000-46.027 mm. The width of the keyway is 6.015-6.065 mm. Facial wobble of the small timing gear hub on the side lying against the face of the main journal is not allowed to be greater than 0.04 mm relative to the fitting hole on the gear. Wobble is checked with an indicator. The internal diameter of the camshaft gear is 30.000-30.023 mm. The width of the keyway is 6.015-6.065 mm. If the keyway is worn, a new one may be cut at an angle of 90° from the old one. The limiting width of the gear keyway allowable without repair is no greater than 6.1 mm. If the gear keyway is moved, the mark on the gear must also be moved. Facial wobble on the large timing gear on the side lying against the support flange is not allowed to be greater than 0.04 mm. Wobble on the remaining surfaces is no greater than 0.15 mm. Wobble is checked with an indicator (see Plate 3-86). The valve guides are cast iron. The diameter of the holes in the cylinder head for the valve guides is 19.00-19.033 mm. The valve guides are pressed in with an interference of 0.014-0.065 mm. The internal diameter of the guides is presented in Table 4-14.

The valve springs are manufactured of 5.0 mm diameter wire. The total number of coils is 6 3/4 ± 1/8, of which 4 3/4 are working coils.

The exterior diameter of the coil is 39.5-40.0 mm.

The height of the spring is 58 mm in a free condition, 48.25 mm under a load of 26.8-30.8 kg, 38 mm under a load of 60-68 kg, and no more than 32.5 mm with the coils compressed together. After the spring is freed from load, it must not have any residual deformation. Springs which do not respond to these requirements are discarded.

Spring height and elasticity are checked on an instrument (see Plate 3-105). The amount of load on a spring is set according to a manometer.

Dimensions of the receptacles in the cylinder head for inserted seats, and dimensions of the valve seats are presented in Table 4-15.

Tappet holes. The diameters of holes are divided into two dimensional groups; 25.011-25.000 and 25.023-25.011 mm. The designation of the groups is marked on the bosses on the cylinder block in line with the holes.

If wear (ovality or conicity) appears in the tappet guide holes, it is recommended that their geometry be corrected using a reamer, bringing them to the repair dimensions presented in Table 4-16.

Tappets. Nominal and repair dimensions of tappets are presented in Table 4-17. Non-cylindricality in tappets is not allowed to be greater than 0.007 mm.

Wear on the spherical surface of a tappet must not exceed 0.10 mm, and wear on the tappet cuff in diameter must be no greater than 0.04 mm.

The rocker arm spacing spring (see Plate 4-26) is wound of 2.5 mm diameter wire. The full number of coils is 9 ± 1/4, of which 7 are working coils. The internal diameter of the spring is 23.0-23.52 mm.

The height of the spacing spring must be 69 mm in a free condition and 36 mm under a load of 10-12 kg. After freeing the spring from the load, it must not have any residual deformation. Springs with residual deformation are replaced.

a. Размер	b. Увеличение диаметра	c. Внутренний диаметр втулок	
		[illegible]	[illegible]
d. Номинальный	—	51,030—51,070	45,025—45,060
e. 1-й ремонтный	0,20	50,830—50,870	44,825—44,860
f. 2-й ремонтный	0,40	50,630—50,670	44,625—44,660
g. 3-й ремонтный	0,60	50,430—50,470	44,425—44,460

Table 4-13. Camshaft bushing dimensions, mn

Key: a) dimension
b) diameter increase
.) internal bushing diameter
d) nominal
e) first repair
f) second repair
g) third repair

a. Размер	b. Внутренний диаметр
c. Номинальный	11,000—11,027
d. Ремонтный (+0,25)	11,250—11,277

Table 4-14. Internal diameter of 'alve gulder, mm

Key: a) dimension c) mominal
b) internal diameter d) repair (+0.25)

a. Параметры	b. Размер
c. Гнезда в головке цилиндров под седла клапанов	
d. Впускного клапана номинального диаметра	56,500—56,530
e. Впускного клапана ремонтного диаметра (+0,3)	56,800—56,830
f. Выпускного клапана номинального диаметра	48,000—48,027
g. Выпускного клапана ремонтного диаметра (+0,3)	48,300—48,327
h. Глубина гнезда	9,00—9,10
i. Седла клапанов	
j. Для впускного клапана:	
k. Наружный номинальный диаметр	56,670—56,700
l. Наружный ремонтный диаметр (+0,3)	56,970—57,000
m. Ширина рабочей фаски	1,1
n. Угол рабочей фаски	30°
o. Для выпускного клапана:	
p. Наружный номинальный диаметр	48,175—48,200
q. Наружный ремонтный диаметр (+0,3)	48,475—48,500
r. Ширина рабочей фаски	1,4
s. Угол рабочей фаски	45°
t. Высота седел клапанов	8,90—9,00

Table 4-15. Dimensions of inserted valve seats and receptacles in the cylinder heads for pressing them in, mm

Key:
a) parameters
b) dimension
c) receptacle in cylinder head for valve seat
d) nominal diameter intake valve
e) repair diameter intake valve (+0.3)
f) nominal diameter exhaust valve
g) repair diameter exhaust valve (+0.3)
h) receptacle depth
i) valve seats
j) for exhaust valve:
k) exterior nominal diameter
l) exterior repair diameter (+0.3)
m) working face width
n) working face angle
o) for exhaust valve:
p) nominal exterior diameter
q) repair exterior diameter (+0.3)
r) working face width
s) working face angle
t) valve seat height

TABLE 4-16 Dimensions of Tappet Holes, mm

a. Размер	b.	c.	d.
e. Номинальный	—	25,000 / 25,023	25,04
f. 1-й ремонтный . . .	+0,1	25,100 / 25,123	25,14
g. 2-й »	+0,2	25,200 / 25,223	25,24

Key: a) dimension
b) dimension increase
c) repair dimension
d) allowable without repair
e) nominal
f) first repair
g) second repair

TABLE 4-17 Dimensions of Tappets, mm

a. Размер	b.	c. Величина размеров	
		d.	e.
f. Номинальный	—	24,978 / 24,962	24,970
g. 1-й ремонтный . .	0,1	25,078 / 25,062	25,070
h. 2-й » . . .	0,2	25,178 / 25,162	25,170

Key: a) dimension
b) tappet diameter increase
c) dimension value
d) nominal or repair
e) allowable without repair
f) nominal
g) first repair
h) second repair

The oil pump. The spring in the reduction gear of the oil pump upper section must have the following dimensions: 62.0-65.2 mm in a free condition, and 50 mm under a load of 6.10-7.30 kg. The diameter of the wire is 1.74-1.80 mm (65 G steel). A spring with residual deformation should be replaced.

The spring of the by-pass valve of the lower section of the pump must have the dimensions of: length in a free condition, 35 mm, and length under a load of 1.7-2.1 kg, 22 mm.

The diameter of the hole in the body (Plate 4-91) of the oil pump for the driving shaft of the pump must be within the limits of 15.03-15.06 mm. If the hole diameter is increased to 15.10 mm and more, the body must be exchanged or the hole repaired. Depth of the cavity for the gear is 37.950-38.000 mm, and if this depth is increased to 38.1 mm, the body is subjected to replacement or repair. The diameter of the cavity for the gear in the body and the cover must be 42.225-42.275 mm, and if this diameter is increased to 42.4 mm, the body or the lower cover is replaced or repaired.

The nominal dimension of the hole for the driven gear shaft in the body and in the lower cover of the pump must be within the limits of 15.030-15.060 mm. If this hole diameter is increased to 15.10 mm, the body and lower section are discarded.

Depth of the hole for the gear in the lower section of the pump must be 16.965-17.000 mm, and if this depth is increased to 17.1 mm, the cover must be replaced or repaired.

Diameter of the drive shaft 1 (Plate 4-92) of the oil pump must be 14.982-15.000 mm. If this shaft diameter is increased to 14.950 mm and smaller, it should be replaced. Shaft curvature is not allowed to be greater than 0.025 mm.

Width of the keyway in the shaft must be within the limits of 2.950-2.900 mm. Keyway width is allowed to increase to a dimension of 3.040 mm without being repaired, with a corresponding increase in key size.

The nominal dimension of the shaft (Plate 4-93) of the drive gear must be within the limits of 15.070-15.082 mm. If the shaft is worn equally, the diameter is allowed to be decreased to 15.042 mm. One-sided wear of a shaft is not allowed. A worn out shaft should be pressed out and replaced with a new one. The nominal dimension of the holes in the driven gear for their shafts must be within the limits of 15.100-15.127 mm. If this gear hole dimension is increased to a diameter of 15.170 mm and more, the gear should be replaced or repaired by installing a bushing.

The nominal exterior diameter of the drive gears 2 and 3 (see Plate 4-92) of the lower and upper sections of the pump is equal to 42.100-42.125 mm, and if the diameter is decreased to 42.0 mm, the gear should be discarded.

Tooth length on the drive and driven gears of the upper section of the pump is equal to 37.975-38.000 mm, and with a decrease in this tooth length to 37.9 mm, the gears are discarded.

Tooth length of the drive and driven gears of the pump lower section is 16.975-17.000 mm, and if this tooth length is decreased to 16.9 mm, the gear is discarded.

The assembly surface of the intermediate pump cover (Plate 4-94), which is assembled against the faces of the gears, must be parallel and flat. Non-parallelness is allowed to be 0.03 mm on a length of 50 mm. Non-flatness of the cover surface or wear on it is allowed to be no greater than 0.04 mm.

The surface of the lower pump cover (see Plate 4-91) which touches against the faces of the gears must be flat. Non-flatness of the cover surface or wear is not allowed to be greater than 0.04 mm, and non-parallelness is allowed to be 0.08 mm on a length of 100 mm.

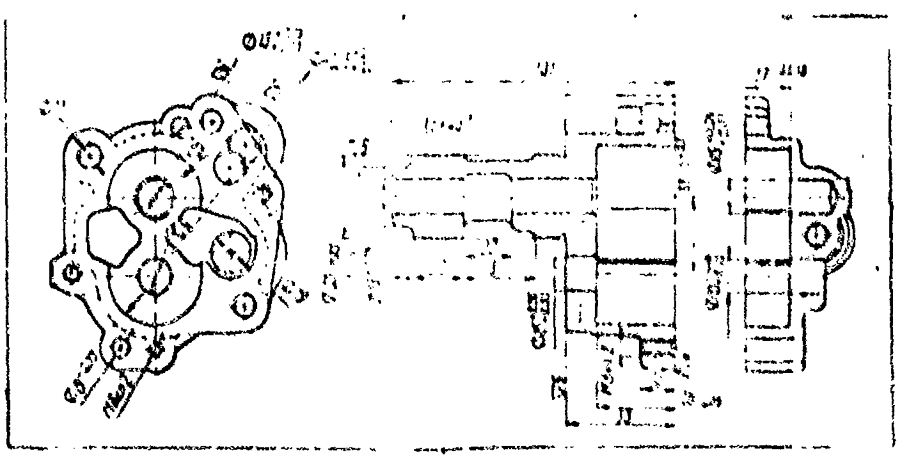


Plate 4-91. Oil pump body with cover

The partial flow filter for centrifugal oil cleaning. The nominal diameter of the shaft bushing hole (Plate 4-95, a) must be 10.500-10.527 mm for the upper section and 15.095-15.120 mm for the lower section.

The nominal diameter of the shaft assembled with the bushings is 10.445-10.470 mm for the upper section and 15.040-15.065 mm for the lower section.

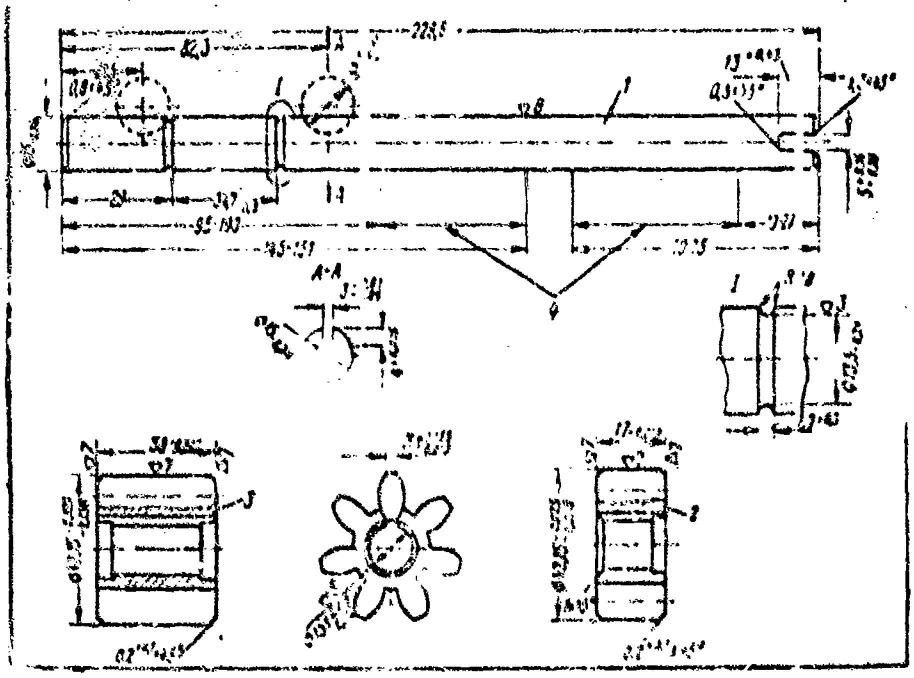


Plate 4-92. Oil pump drive shaft with gears;
1) shaft 3) lower section drive gear 3) upper
section drive gear

The by-pass valve spring has 12 coils. The length of the spring in a free condition is 62 mm, and under a load of 0.9-1.1 kg, it is 44 mm. Spring diameter is 11.5 mm. The spring material is "V" hardness spring wire of group 1, 1.0 mm in diameter (GOST 5047-49).

The full flow centrifugal oil cleaning filter. Plate 4-95, b, shows the body and shaft of the filter and their basic dimensions. The nominal dimension of the shaft bushing hole is 14.000-14.027 mm for the upper bushing and 17.000-17.035 mm for the lower bushing. The nominal diameter of the shaft assembled with the bushings is 13.935-13.970 mm on the upper journal and 16.948-16.970 mm on the lower journal.

The water pump. In the water pump, the nominal dimension of the hole for the front bearing is 61.990-62.020 mm, and for the rear bearing, it is 46.992-47.018 mm. If the front hole diameter is increased to more than 62.04 mm, and the rear one is greater than 47.042 mm, the bearing body must be replaced.

The nominal dimension of the hole for the fan pulley hub bearing is 39.980-40.007 mm. If this diameter is increased to 40.027 mm, the pulley must be replaced.

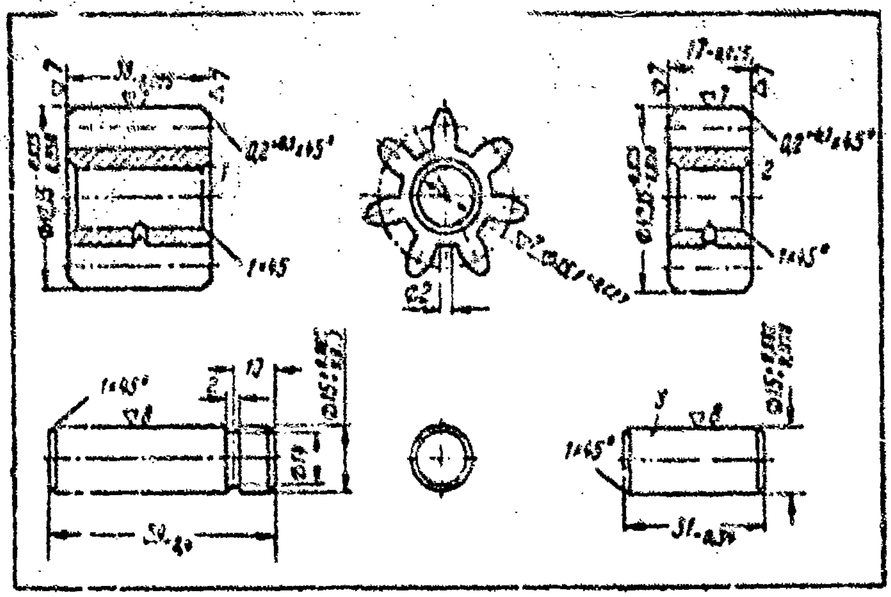


Plate 4-93. Oil pump shaft with driven gears:
1) upper section driven gear 2) lower section driven gear
3) lower section driven gear shaft 4) upper section driven gear shaft

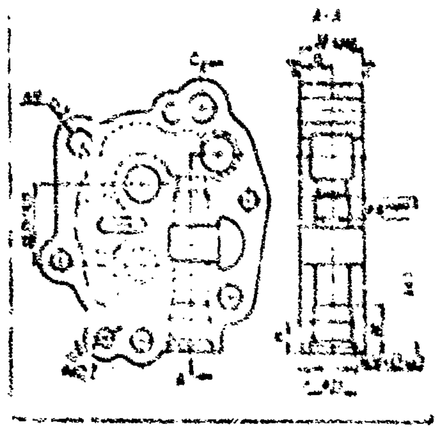


Plate 4-94. Oil pump intermediate cover

The geometric dimensions of the water pump bearing body are shown in Plate 4-96.

Dimensions of the pump impeller body are shown in Plate 4-97. Non-flatness of the flange surface assembled against the bearing body is not allowed to be greater than 0.1 mm. The plane lying against the cylinder block must be parallel to the flange surface connected with the bearing body. Non-parallelness of these planes is not allowed to be greater than 0.2 mm. If non-parallelness and non-flatness are greater than these, the pump body must be replaced.

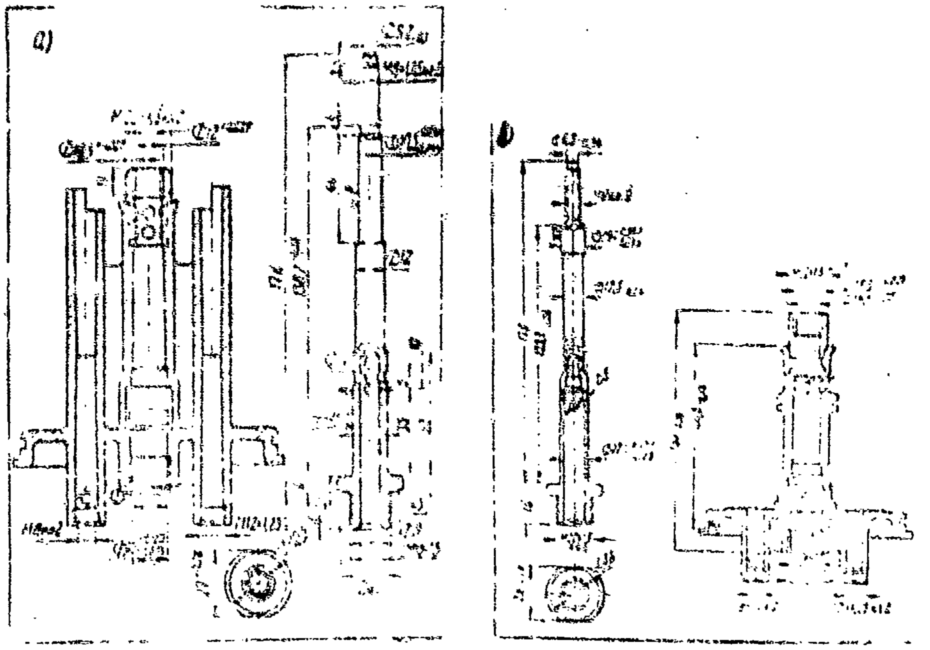


Plate 4-95. Oil filter body and shaft:
a) partial flow
b) full flow

The water pump shaft from a ZIL-130 engine (Plate 4-98) has a diameter of 16.988-17.000 mm. The water pump shaft of a ZIL-131 engine differs from the pump shaft of a ZIL-130 engine in the position of its keyway. If the shaft is worn to a diameter of less than 16.976 mm, it must be replaced with a new one. Shaft curvature is not allowed to be greater than 0.03 mm. The width of the keyway must be 3.945-4.045 mm, and if the keyway is worn to a dimension of greater than 4.08 mm, the shaft must be replaced.

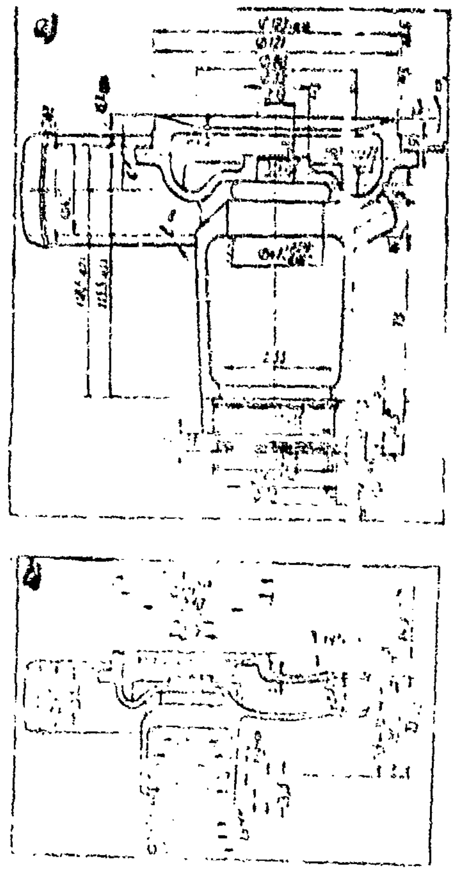


Plate <-96. Water pump body of the:
a) ZIL-130 engine
b) ZIL-131 engine

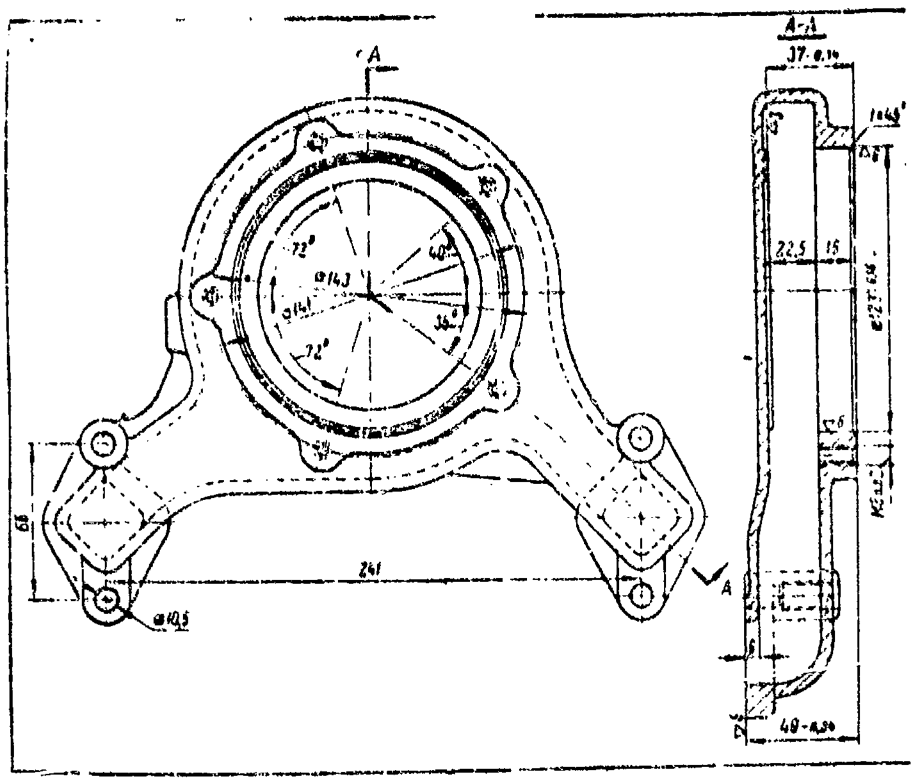


Plate 4-97. Water pump impeller body

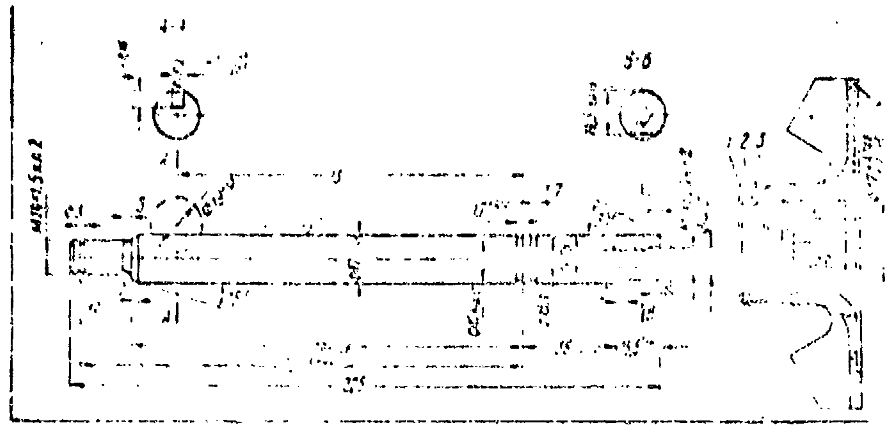


Plate 4-98. Water pump shaft with impeller of the ZIL-130:
1) band 2) textolite packing washer 3) collar 4) impeller

Chapter 5. The Engine Fuel System

Arrangement

The schematic of operation of the fuel systems of all ZIL engines are principally identical (Plates 5-1, 5-2, 5-3). Fuel tanks are welded and stamped of lead treated sheet. Fuel feed from the tanks is forced by a diaphragm type fuel pump. All carburetors are vertical, downdraft, with one or two throats. The air filters are of the oil-inertia type. All engines are equipped with crankshaft revolution speed governors.

For information on the intake and exhaust manifolds of in-line engines, see Chapter 3, and for information on V-shaped engines, see Chapter 4.

During disassembly, all small parts of the assemblies should be collected in special boxes or in boxes which have compartments in them.. Calibrated holes (jets and valves) of the carburetors and pumps must not be cleaned with metal rods, since this operation may change the dimensions of the holes, leading to their unusability.

Fuel tanks. Depending on the purpose of the motor vehicle on which the fuel tanks are mounted, they vary in volume. Table 5-1 shows the volume and number of tanks.

Fuel pumps. Diaphragm fuel fpumps of the following types are installed on ZIL engines: on the ZIL-157K engine, B-9B (Plate 5-4) or B-10B; on the ZIL-130 engine, B-9 (Plate 5-5) or B-10; on the ZIL-131, B-10 (Plate 5-6).

Characteristics of the fuel pumps are presented in Table 5-2.

The B-10B fuel pump differs from the B-10 pump only by its plunger arm. The pressure of all pumps at zero feed is no greater than 0.296 kg/cm^2.

The efficiency of a fuel pump is determined by its productivity (liters per hour) and maximum pressure (mm in a column of mercury or kg/cm^2), which are determined on special installations or directly on the engine. The listed parameters on installations are usually measured at 1300-1400 crankshaft rpm of the engine activating the fuel pump, with the fuel sucking and pumping height of 0.5 mm, fuel lines with an interior diameter of 6 mm, and zero fuel feed into the carburetor float chamber.

Автомобиль	Количество баков	Емкость бака, л
ЗИЛ-157К	2	150; 65
ЗИЛ-157КБ, ЗИЛ-157КВ	2	150; 150
ЗИЛ-130 и ЗИЛ-130Г	1	170
ЗИЛ-130Д1	1	125
ЗИЛ-130В1	2	125; 125
ЗИЛ-131, ЗИЛ-131А и ЗИЛ-131В	2	170; 170

ЗИЛ = ZIL, В = V, Г = G, Д = D, Л = L

Table 5-1. Number and volume of fuel tanks installed on motor vehicles

Key: a) motor vehicle
b) number of tanks
c) tank volume, liters

Тип насоса	Характеристика	Производительность при 1300—1400 об/мин распределительного вала, л/ч
Б-9Б	Насос с двумя впускными клапанами	140
Б-9	То же	140
Б-10	Насос с тремя впускными и тремя выпускными клапанами . .	180
Б-10Б	То же	180

Б = B

Table 5-2. Pump characteristics

Key: a) pump type
b) characteristics
c) productivity at 1300-1400 crankshaft rpm, liters/hr
d) pump with two inlet valves
e) same
f) pump with three inlet and three outlet valves

Varying (nonuniform) quantities of fuel in volume are automatically fed by the fuel pump for various working rates of the engine depending on its fuel consumption. This takes place in the following manner.

A change in fuel consumption causes a variation in its level in the carburetor float chamber, consequently changing the blocking force of the fuel feed needle valve. Therefore, a fuel back pressure which has a changing value is created in the fuel line connecting the fuel pump to the carburetor. The less the needle valve is open, i.e., the less fuel the engine is consuming,

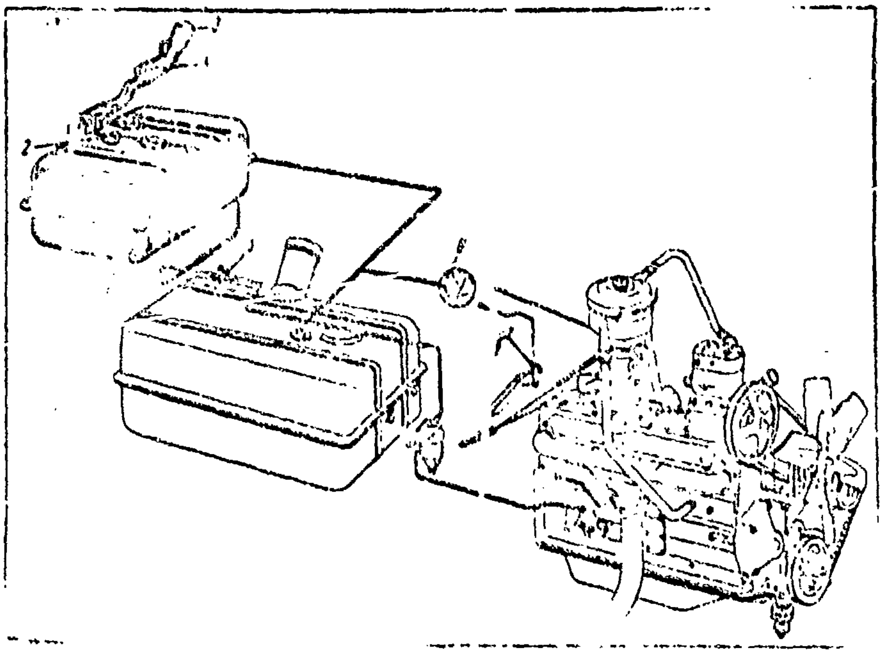


Plate 5-1. Fuel system layout of ZIL-157K engine: 1) auxiliary tank 2) fuel level sending switch 3) fuel filler cap 4) filler neck 5) fuel valve 6) fuel level indicator

the greater is the amonnt of this back pressure. As the result of this back pressure, the pump diaphragm does not move upward by a full stroke, but only partially, depending on fuel expenditure at the given moment of the engine's operation. When fuel in the carburetor float chamber reaches a set level (in correspondence with adjustment of the float) the needle valve closes, back pressure reaches its maximum value, and the pump stops feeding fuel. This phenomenon is called the zero fuel feed, during which pump pressure is measured with a manometer installed on the outlet line (on the transfer) of the pump.

Carburetors. Downdraft carburetors with constant suction diffusers and balanced float chambers are installed on the ZIL trucks. The necessary composition of the mixture in the carburetors is attained as the result of pneumatic restriction of the fuel lead and the use of two economizer valves (with mechanical and pneumatic drives).

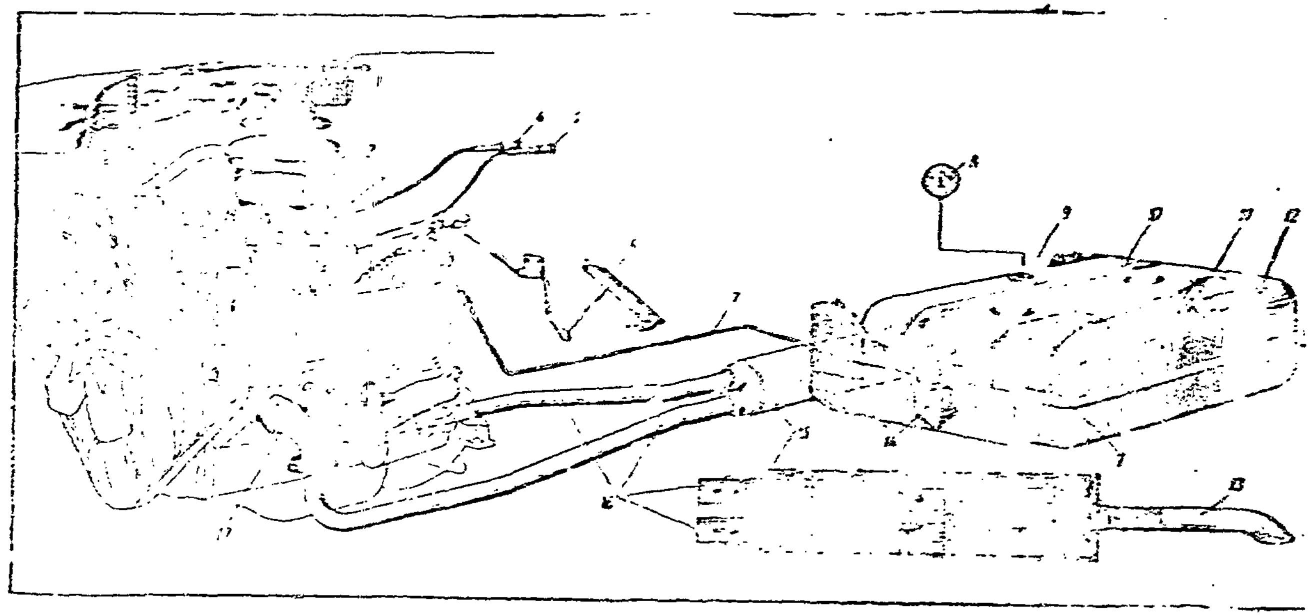


Plate 5-2. Fuel system layout of the ZIL-130 engine:
1) passage supplying air to air filter 2) air filter 3) carburetor 4) manual choke control handle 5) manual lever control throttle 6) accelerator pedal 7) fuel lines 8) fuel level indicator 9) fuel level sending switch 10) fuel tank 11) fuel filler cap 12) fuel valve 13) muffler tail pipe 14) filter and sediment bowl 15) muffler 16) exhaust pipes 17) exhaust manifold 18) fuel pump

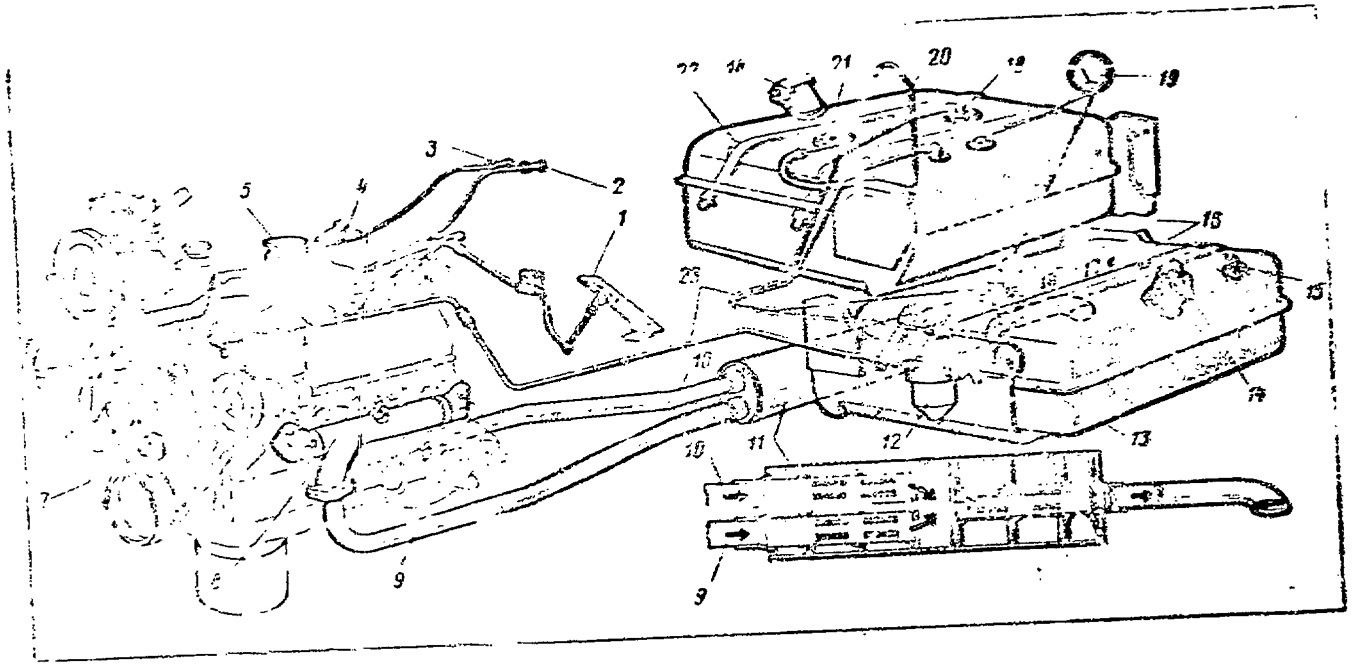


Plate 5-3. Fuel system layout of the ZIL-131 engine:
1) accelerator pedal 2) manual throttle control handle 3) manual choke control handle 4) fine cleaning oil filter 5) carburetor 6) fuel pump 7) centrifugal revolution governor sending switch 8) exhasut manifold 9 and 10) exhaust pipes 11) muffler 12) filter and sediment bowl 13) fuel shut-off valve 14) fuel filler cap 15 and 18) angle connectors 16) fuel tanks 17) fuel level sending switch 19) fuel level indicator 20) fuel tank air vent 21) valve box 22) steel tank fastening strap 23) fuel lines

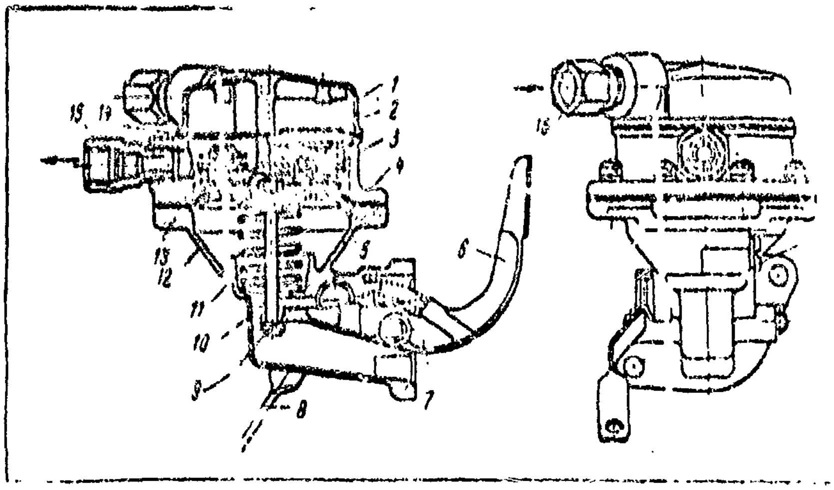


Plate 5-4. B-9B fuel pump:
1) cover 2) screen filter 3) inlet valve 4) head 5) diaphragm 6) rocker arm 7) rocker arm spring 8) handle for manual fuel pumping 9) support washer 10) rod 11) diaphragm rod spring 12) body 13) outlet valve 14) gasket 15) fitting for fuel outlet 16) fitting for fuel inlet 17) control hole plug

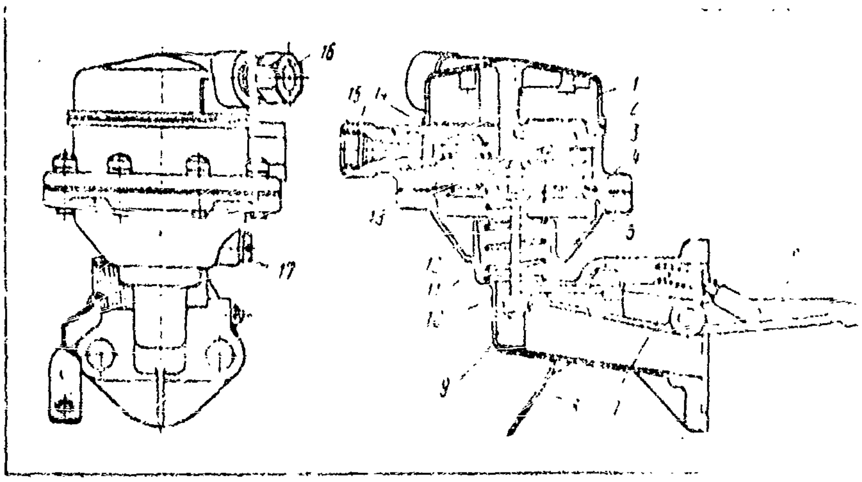


Plate 5-5. B-9 fuel pump (see Plate 5-4 for nomenclature)

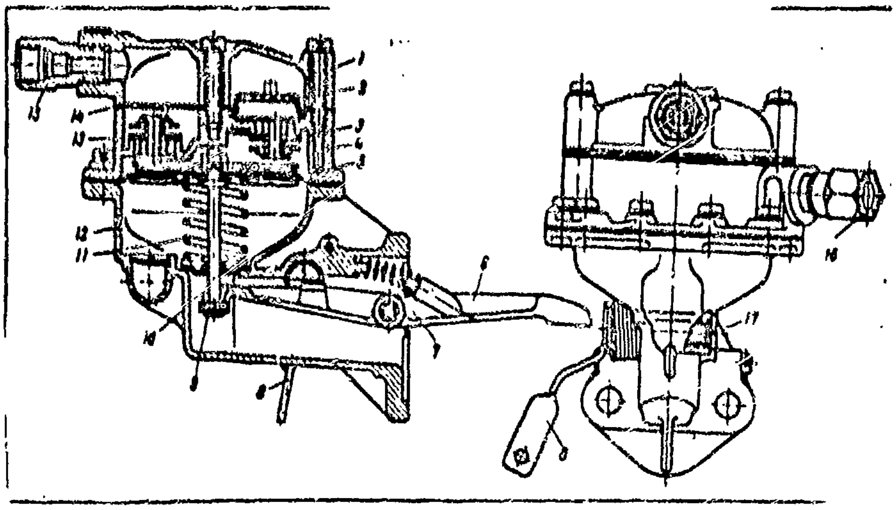


Plate 5-6. B-10 fuel pump (see Plate 5-4 for nomenclature)

The carburetors have an idling system with feed from the main fuel passage for each throat. The carburetors have accelerator pumps with mechanical drive to enrich the mixture.

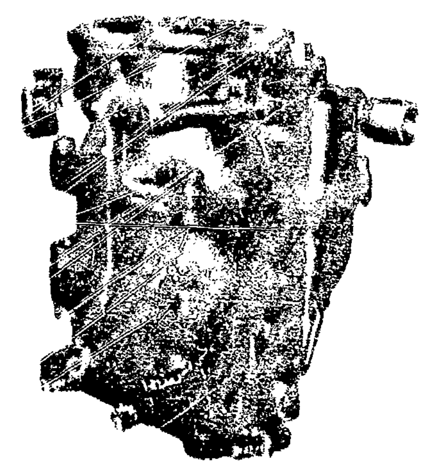


Plate 5-7. K-84M carburetor

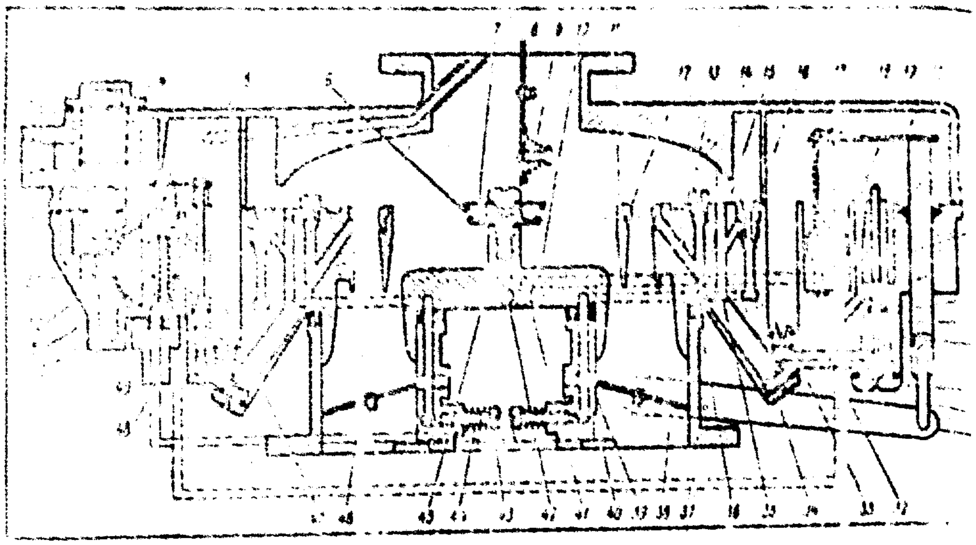


Plate 5-8. Layout of K-84M carburetor
1) cover 2) float chamber needle valve 3) screened filter 4) filter plug 5) balancing passage 6) air chamber 7) accelerator pump spray nozzle 8) choke plate 9) air valve 10) float chamber body 11) small diffuser 12) circular gap 13) air jet 14) high speed jet 15 and 25) holes 16) idle jet 17 and 21) rods 18, 28, 44, and 50) springs 19 and 52) pistons 20) bar 22) inlet vlave 23 and 36) gaskets 24) plunger 26) seat 27) mechanical drive economizer valve 29 and 34) plugs 30) drawbar 31) lever 32) fuel passage 33) main jet 35) valve 37) mixing chamber body 38) throttle 39) idle system upper holes 40) idle system holes 41) accelerator pump passage 42) needle valve 43) idle system adjusting screw 45) central screw 46) pneumatic drive economizer valve 47) guide 48) valve seat 49) needle 51) economizer valve piston gasket 53) float

The float chamber, accelerator pump, economizers, and choke are common to all the carburetors.

To increase reliability and longevity, beginning in 1966, K-88A carburetors, differing from the K-88 carburetors by the absence of the pneumatic drive economizer valve, were installed on the V-shaped engines. In construction of the K-88A carburetors, the float lever was strengthened with a non-corroding contact plate. The accelerator pump drive unit was improved and strengthened by the introduction of heat treamment of its parts and metal-ceramic bushings, the diameter of the throttle shaft was increased, and the construction of its fastening was strengthened, and gasoline-resistant shaft bearing lubrication was introduced. Additional cross pieces formed immediately on the casting were introduced into the diffusion portion of the carburetor. This improves even feeding of the engine cylinders with fuel by about 5% and provides an increase in the engine's torque moment in the area of low revolutions by by 2 kg m.

Carburetor	Characteristic: Carburetor	Characteristic: Revolution governor	Motor vehicle engine
K-84M	Two-throat. Each throat has two diffusers and a separate idle system with an accelerator pump and economizers.	Pneumatic type with two throttles, non-symmetrically installed with a separate body.	ZIL-157K
K-88 and K-88A	Two-throat, with diaphragm operation of the revolution governor mechanism. Each carburetor throat has two diffusers and a separate idle system with an accelerator pump and economizers.	Pneumo-centrifugal type, consisting of a centrifugal switch which receives rotations from the timing gear mechanism and has a diaphragm drive which acts on the throttle.	ZIL-130 ZIL-131

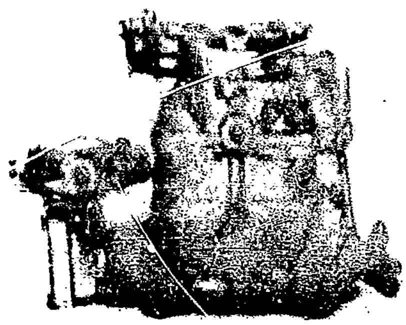


Plate 5-9. The K-88 (K-88A) carburetor

Carburetor types (Plates 5-7, 5-8, 5-9, 5-10) and their characteristics are presented in Table 5-3

Basic data on carburetors and their adjustment parameters are presented in Table 5-4.

The schematic of drive control for the K-84M carburetor is shown in Plate 5-11, and that for the K-88 and K-88A carburetors is presented in Plate 5-12.

The control cables must not be sharply bent at any angle. There must be no traces of corrosion on the cables

The cable jacket must not have gaps or breaks. All threaded and articulated connections must be in proper working order.

The return spring must not have residual deformation.

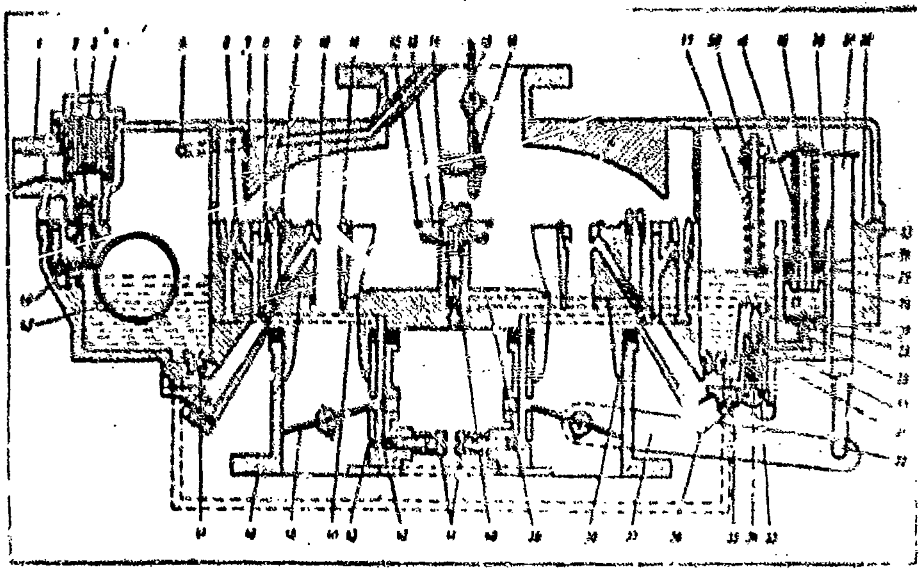


Plate 5-10. Layout of the K-88A carburetor:
1) cover 2) float chamber needle valve 3) screen filter 4) filter plug 5) balancing passage 6) idle jet 7) holes 8) high speed jet 9) air jet 10) small diffuser 11) circular gap 12) accelerator pump spray nozzle 13) air chamber 14) central screw 15) choke plate 16) air valve 17, 19, and 21) rods 18) spring 21) bar 22) circular passage 23) float chamber body 24) collar 25) collar spring 26) rod bushing 27) holes 28) intermediate plunger 29) inlet ball valve 30) seat 31) ball valve 32) draw bar 33 and 36) plugs 34) spring 35) fuel passage 37) lever 38) gasket 39) accelerator pump passage 40) needle valve 41) idle system adjusting screw 42) idle system upper hole 43) idle system lower hole 44) passage 45) throttle 46) mixing chamber body 47) main jet 48) float 49) float spring 50) nut

Air filters. The following types of air filters are installed on the ZIL engines: VM-15A on the ZIL-157K engine; VM-16 on the ZIL-130 engine, and VPM-3 on the ZIL-131 engine.

The VM-15A and VM-16 filters are of the oil-inertia type, with two-stage air cleaning and a special pipe for supplying air to the compressor. The filtering element of the VM-15A filter is caprone [polycaprolactam resin and fiber].

The VM-16 air filter (Plate 5-13) works in the following manner. Due to action of the suction created by the engine, dust-laden air moves through the pipe in the fence into the inlet circular gap 13 and, moving downward along it, comes into contact with the oil, in which the first inertial cleaning of the largest dust particles from the air takes place

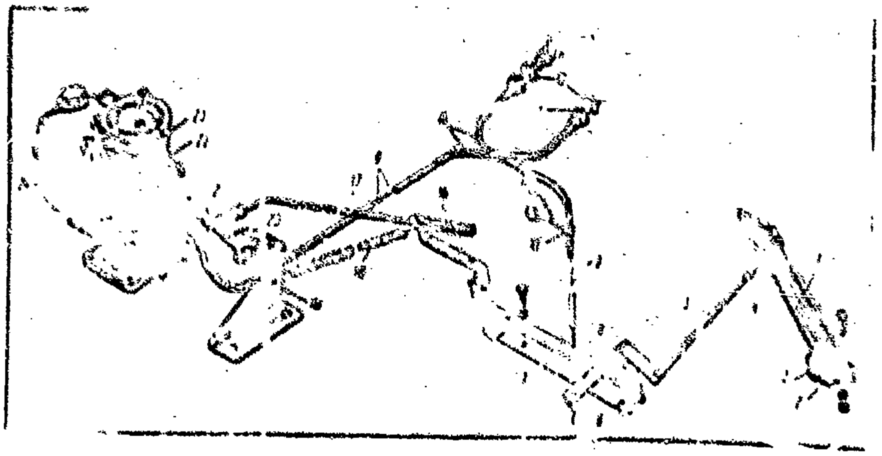


Plate 5-11. Control apparatus of the K-84M carburetor
1) pedal 2) pedal pin 3) pedal bracket 4) pedal rod nut 5) pedal rod 6 and 24) cable clamp screws 7) throttle control apparatus stationary bracket 8) throttle control apparatus moving bracket 9) cables 10 and 22) cable jacket clamps 11) choke control handle 12) manual throttle control handle 13) pressure rings 14) pressure nuts 15) cable jackets 16) compensator spring 17) intermediate rod 18) return spring 19) bracket 20) rotating crank 21) throttle crank rod 23) carburetor

Together with the air stream, oil from the space 16, located beneath the deflector 3, is partially splashed into the filtering element 6, lubricating it, as the result of which cleaning effectiveness is increased. Excess oil flows through the circular openings 14 in the inclined plane of the deflector 3 into oil bath 7. In this manner, oil is circulated along the inclined surface of the deflector and washes fallen dust particles from it. Washed-off dust particles settle to the bottom of the oil bath.

Air is supplied to the filter through air passage 2 (Plate 5-14) in the engine hood, which is connected to the air filter with a corrugated pipe. Either fresh air or heated air from the space beneath the hood may be fed into the passage, depending on the position of plate 5, located in the air passage. During the cold time of year, the hole supplying the passage with exterior air should be covered, and only opened during operations under difficult road conditions.

During the warm time of year, it is necessary to open the holes supplying the passage with exterior air. The use of exterior air whose temperature is lower than the temperature of the air in the space beneath the hood allows an increase in filling the cylinders, and greater engine power will be received.

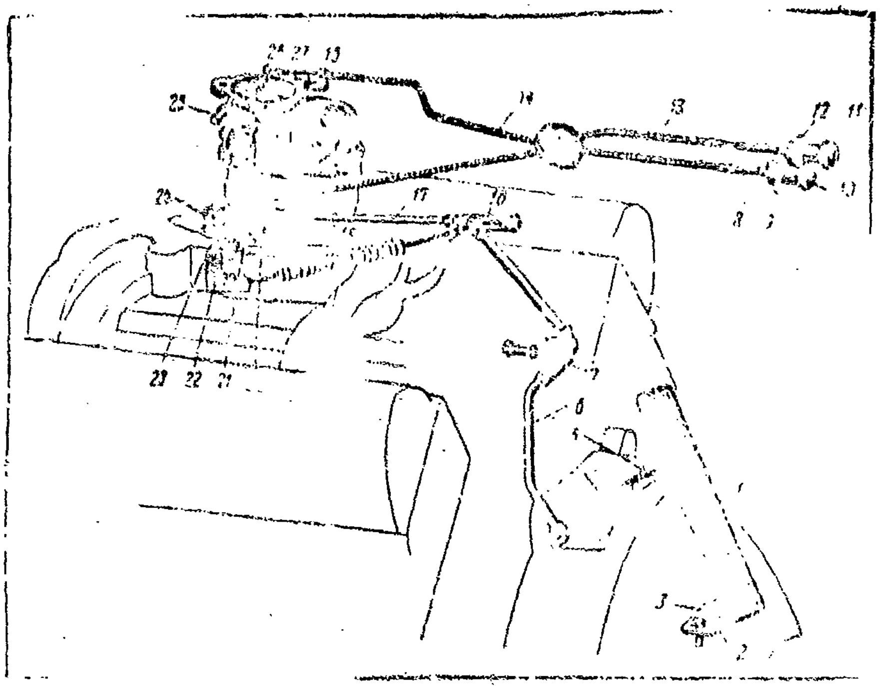


Plate 5-12   Control mechanism of the K-88 and K-88A carburetor:
1) pedal 2) pedal pin 3) pedal bracket 4) pedal rod
5 and 20) stop nuts 6) throttle control mechanism lever 7) bracket
8) tension nut 9 and 12) tension rings 10) choke control handle
11) manual throttle control handle 13 and 14) cable jackets
15) cable jacket clamp 16) rod end with compensator spring
17) throttle lever rod 18 and 27) cables 19) return spring
21) throttle lever 22) spring bracket 23) rod fork 24) fork pin
25) carburetor 26) choke lever

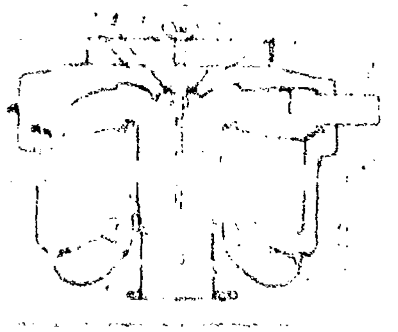


Plate 5-13. VM-16 air filter
1 and 11) ducts 2) oil bath
3 deflector 4,5, and 10) sealing gaskets 6) filtering element
7) tension screw 8) wing nut
9) thumb screw 12) air outlet
line to compressor 13) circular
gap 14) circular passage
15) filter body 16) space

Operation of the engine without the filter or with no oil in the filter is not allowed!

It should be remembered that the service life of an engine depends to a significant degree on the proper operation of the air filter, and consequently, on its timely cleaning and servicing.

The VPM-3 air filter (Plate S-15) is of the foam oil and inertial type, with three-stage air cleaning and a special pipe for supplying air to the compressor. The air filter works in the following manner.

Dust-laden air is drawn into the central pipe 7 due to the action of the suction created by the engine and, moving downward, comes into contact with the oil ; the largest dust particles are cleaned from the air during this first cleaning. Under action of the air pressure, oil moves from the center of the deflector 15 to the holes 3 and partially moves into the throttling chamber 12 and the foam oil retaining packing 9, while part of the oil flows through holes 3 into the space 20 of the oil bath 16.

In its turn, oil spouts from the space 20 through the central hole 18, due to the difference in oil levels in space 20 and area 1 above the deflector, and, moving along the deflector 15, cleans the dust from it.

Oil arriving in the throttling case 12 and in the foam oil retaining packing 9 is strongly foamed. Foamed oil and the filtering packing clean the smaller dust particles from the air.

The air stream holds the oil in the packing 9 and casette 12. Since the oil constantly moves into the foam oil retaining packing, its excess flows downward along the walls of the packing. Part of the oil flowing along the exterior walls of the packing reaches holes 3, through which it moves into the oil bath space.

During travel of the air above the deflector in area 2, a suction is created, as the result of which a layer of oil flowing along the internal walls of the packing and slots 5 in the ejector 19 is sucked up and held by the air stream, forming an oil mist which reaches the deflector 15, through which air flows, partially carrying the oil into the packing 9 and casette 12.

The accumulating dirty oil remains in the oil bath 16, where dust settles out into a sediment. Feed and return of oil into the packing, oil movement along the deflector, and the work of the ejector provide oil circulation. Considering that the engine does not work for an extended period of time at one rate, but changes it, the working rate of the oil filter is also changed correspondingly.

In this case, oil arrives at varying heights in the packing, i.e., sometimes rising to the maximum height, and then flowing into the oil bath, providing additional washing of the packing.

Air is supplied to the filter the same way as in the ZIL-130 motor vehicle.

It should be remembered that the service life of the engine, especially that of one working off the road, depends to a significant degree on the proper operation of the air filter and on its timely cleaning and servicing.

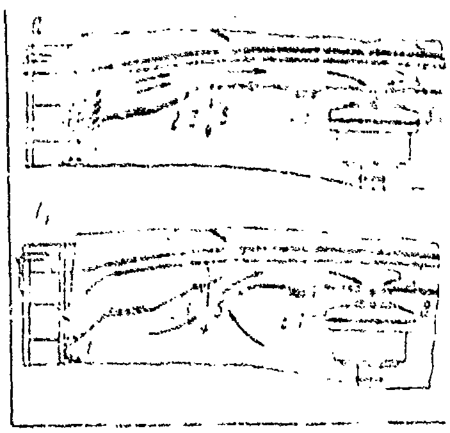


Plate 5-14. Diagram of air supply to the air filter:
a) through hood louvres b) from the under-hood space
1) hood louvres 2) air passage in the hood 3) valve spring 4) valve shaft (handle) 5) valve 6) plug in hole for installation of an air filter used on other motor vehicles 7) air filter 8) bulkhead

The engine crankshaft revolution speed governor is shown in Plates 5-16 and 5-17. In the ZIL trucks, fuel passes through the two-stage cleaning through a sediment filter (Plate 5-18) and a fine cleaning fuel filter (Plate 5-19).

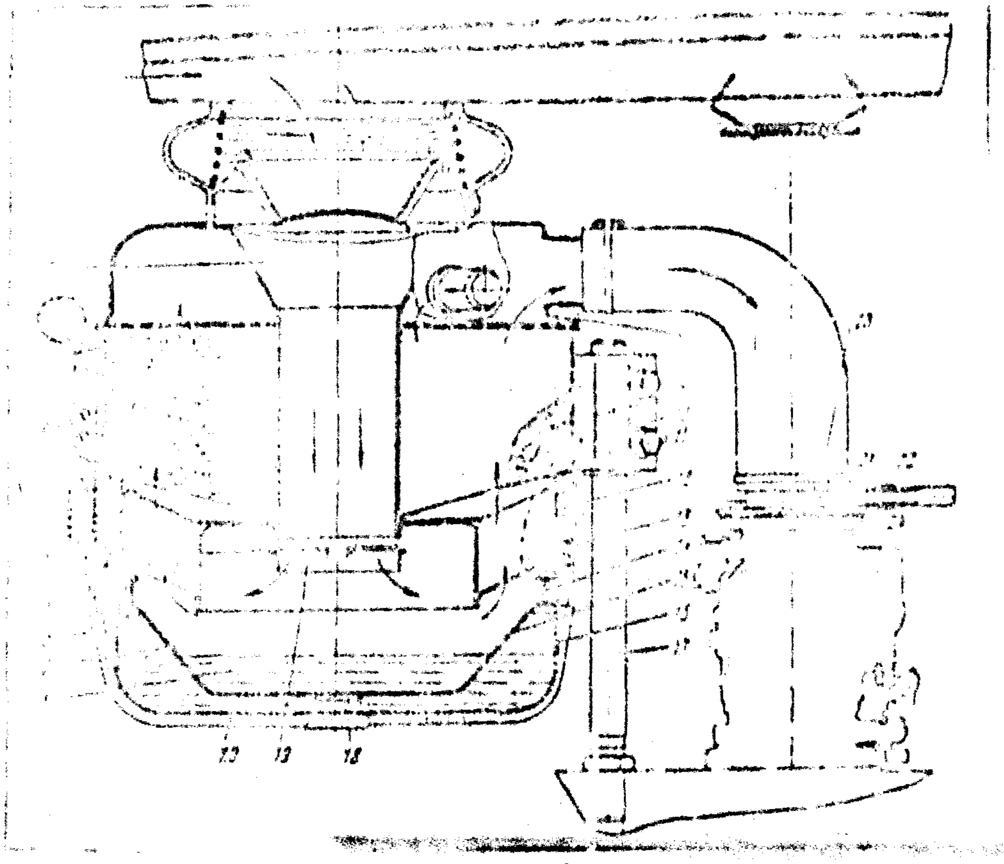


Plate 5-15. VPM-3 air filter:
1) area above the deflector 2) area above the oil level 3) holes 4) cable 5) slot 6) lever 7) central pipe 8) body 9) foam oil retaining packing 10) bracket 11) stand for fastening bolt 12) throttling casette 13) rubber washer 14) spring 15) deflector 16) oil bath 17) stand 18) central hole 19) ejector 20) oil bath space 21) inlet tube for distributor ventilation 22) rubber hose 23) outlet tube for distributor ventilation 24) carburetor

Plate 5-16. Revolution governor for K-84M carburetor:
1) formed pawl 2) rod 3) spring 4) fine adjustment adjusting nut 5) coarse adjustment adjusting screw 6) small cover 7) piston 8) rod 9) passage connecting sleeve 10) passage connecting the governor vacuum mechanism with the carburetor air space 11) governor body 12) governor throttle 13) carburetor throttle shaft 14) needle bearing

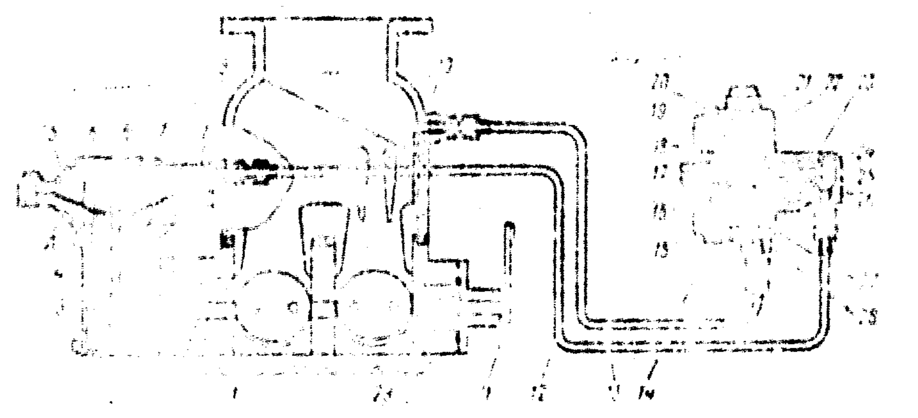


Plate 5-17. Schematic of connecting the centrifugal revolution governor switch to the diaphragm mechanism of a K-88 (K-88A) carburetor:
A-B) spaces 1) throttle 2 and 3) jets 4) diaphragm mechanism spring 5) diaphragm mechanism cover 6) diaphragm 7) rod 8) lever 9 and 10) holes 11) throttle drive lever 12 and 13) lines 14) centrifugal switch spring 15) washer 16) seat gasket 17) slot in rotor shaft for connecting with camshaft 18) seal 19) cover 20) spring tension adjusting screw 21) plug 22) rotor 23) filter 24) metal-ceramic bushing 25) switch body 26) passage 27) valve 28) valve seat hole 29) forked joint

Table 5-4. Basic parameters of carburetors

Parameters	Carburetors		
	K-84M	K-88	K-88A
Diffuser diameter, mm:			
1. small	8.5	8.5	8.5
2. large	26.0	29.0	29.0
Mixing chamber diameter, mm	32.0	32.0	36.0
Air throat diameter, mm	56.0	56.0	60.0
Distance from fuel level in float chamber to the top assembly surface of the body, mm	18-19	18-19	18-19
Float weight, grams	18.7-19.7	18.7-19.7	19.2-20.2
Carburetor height, mm	156	153.5	153.5
Passage capability of metering elements when checked with water under a pressure of 1000 ± 2 mm in a water column and a temperature of +20°C, cm^3/min:			
1. main jet	247-253	350.5-359.5	311-319
2. high speed jet (in sprayer)	--	--	--
3. high speed jet (separate)	261.5-268.5	360.5-369.5	1125-1175
4. valve jet in economizer with pneumatic drive	408.5-411.5	372.5-377.5	--
5. valve jet in economizer with mechanical drive	--	--	212-218
6. air jet	103.5-106.5	103.5-106.5	2.14-2.26
Diameter of idle jet, mm			
1. fuel hole	0.60-0.66	0.60-0.645	0.60-0.66
2. air hole	1.80-1.92	1.80-1.92	1.6-1.72 1.8-1.92
Vacuum at the moment of pneumatically driven economizer valve opening, mm in a column of mercury	125-135	125-135	--
Distance between the edge of the throttle and the wall of the mixing chamber at the moment of mechanical drive economizer valve opening, mm	9.0	9.0-9.3	9.0-9.3
Full opening of the throttle, (distance between the edge of the throttle and the wall of the mixing chamber), mm	13.5-14.5	13.8-14.8	14.5-14.8
Productivity of the accelerator pump for ten full strokes of the piston at a rate of 20 pumps per minute, cm^3	17, no less	15-20	15-20

Technical servicing

During daily service, the fuel level in the tank should be checked and it should be filled if necessary. Visually inspect the tightness of the line connections and, in case fuel is leaking, tighten the nuts.

During TS-1, check the connection of the rods to the throttle control lever and choke, the action of the controls, and the full travel of closing and opening of the throttle and choke.

Check the condition of the rubber pipe oonnceting the engine air filter to the hood.

Check the condition of the fuel accessories.

The filter-sediment bowl. The plug should be periodically unscrewed, and sediment from the sediment filter body allowed to drain out.

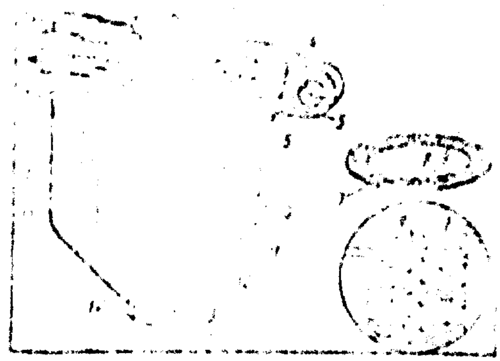


Plate 5-18. Filter-sediment bowl: 1) filter cover 2) bolt 3, 5, 13, and 17) gaskets 4) fuel flow passage 6) filtering element washer 7) filtering element plate 8) holes in plates for passage of fuel 9) projections on plates 10) filtering element ring 11) rod 12) spring 14) plug 15) filter body 16) filtering element 18) fuel outlet passage

The filtering element of the fuel filter should be washed out during the TS-2. For washing the filtering element, it is necessary to close the fuel tank valve, unscrew bolt 2 (see Plate 5-18), fastening the filter cover, and disconnect the body 15 of the filter-sediment bowl, together with the filtering element.

If ethyl gasoline is being used, unscrew the plug beforehand, and drain the gasoline, not allowing it to fall on the hands and clothing.

During disassembly of the filter-sediment bowl, attention should be paid to protecting the gaskets providing the seal between the body and cover. Having removed the body, wash it out with clean gasoline and inspect the parts.

The plates 7 on the filtering element must not be damaged.

After washing, checking, and assembly of the filter-sediment bowl, install it in place and tighten the bolt on the cover.

The fine cleaning fuel filter. For disassembly of the filter, it is necessary to loosen the nut (see Plate 5-19), move bracket 6 away, remove cup 5 in assembly with the filter, and pull the cup gasket from the body. Pull screen filter 3 with spring 4 from the cup.

After disassembly, wash the parts in acetone or clean gasoline. Blow the parts and filter body passages out with compressed air.

After washing and checking the filter, assemble it and install it in place. During disassembly, washing, and assembly of the filter, it is necessary to handle the screened filter very carefully.

On some engines, the screened filter has been replaced with a ceramic filter 9.

Checking and adjusting the carburetor on the motor vehicle. If an insufficient supply of fuel is reaching the carburetor, it is necessary to check:

The proper installation of intake manifold gaskets and the absence of air leaks into the manifold and carburetor;

The proper operation of the fuel pump (checking by means of pumping with the manual pumping lever with the fuel line disconnected from the carburetor);

The proper opening of the throttle (if the throttle does not open fully, it is necessary to adjust the throttle linkage).

The foot drive of the K-84M carburetor is adjusted with the two threaded ends on rod 21 (see Plate 5-11) and on rod 17, as well as with the threaded rod 5 on the pedal.

The foot feed of the K-88 and K-88A carburetors is adjusted with the threaded fork 23 (see Plate 5-12) and rod 4.

Adjustment for full opening of the throttle must be accomplished so that the throttle control pedal does not reach the floor of the cab by 3-5 mm. After completing the adjustment, it is necessary to tighten the rods with stop nuts.

Manual throttle control is adjusted by the clamps which are installed on the ends of the control cables so that with the handle 11 fully moved out, there is a clearance of 2-3 mm between the bracket and the clamp fastened on the cable.

During adjustment of the choke, it is necessary to set handle 10 of the manual control so that it does not reach the support screen of the cab by 2-3 mm. In this position, with a fully open choke, connect cable 27 of the control with lever 26 of the choke, and fasten it with a screw.

In a case of a properly working fuel pump and the absence of air leaks through the gaskets, it is necessary to look for the reason for poor fuel supply in the carburetor itself, for which it is necessary to unscrew and check the screened filter and, if it is not clogged, check the passage in the fuel feed valve unit.

For inspection and cleaning of the fuel feed valve passage, remove the air filter, disconnect the choke cable, remove the carburetor cover, check the condition of the passages, wash them out with clean gasoline, and blow them out with compressed air.

If the needle valve passages are cleaned, the reason for poor fuel feed might be clogging of the carburetor jets. For checking and cleaning the jets, the carburetor should be removed.

For cleaning the passages and blowing out the jets, unscrew the plugs from the high speed jet passages and from the mechanical economizer passage. Then blow out the jets and carburetor passages with compressed air.

Blowing out the assembled carburetor (through the fuel supply holes, balancing pipe, or other) with compressed air is not allowed, since it may lead to crumpling of the float.

After checking and cleaning the passages and jets, assemble the carburetor, install it on the engine, and check its fuel feed during the engine's operation at various rates.

In case of increased fuel consumption, the full opening of the choke should first be checked, and the fuel level in the carburetor should be checked in the following manner: unscrew the control plug from the float chamber body, and with the engine running at idle, check the fuel level, which must be visible through the hole. If fuel runs out of the hole, the condition of the float or the fuel feed valve unit should be checked.

To eliminate these deficiencies, the carburetor cover should be removed and the fuel feed valve unit checked. If the needle valve does not fit tightly in its seat, blow out the valve unit with compressed air and remove fuel residue.

If the cone and seat of the needle valve are worn, the valve will sit in its seat too late. As a result of this, the fuel level in the float chamber will rise. To eliminate this deficiency, it is necessary to bend the float lever or adjust the setting of the valve body.

Before adjusting the carburetor, it is necessary to warm the engine and check to see that the ignition accessories are operating properly. Special attention must be directed toward the proper operation of the spark plugs and the proper clearance between their electrodes. For adjusting the qualitative composition of fuel during operation at an idling rate, start the engine, set the throttle at the minimum opening with which the engine will run reliably and without missing, with the stop screw 2 (Plates 5-20, 5-21). Then check the qualitative adjustment.

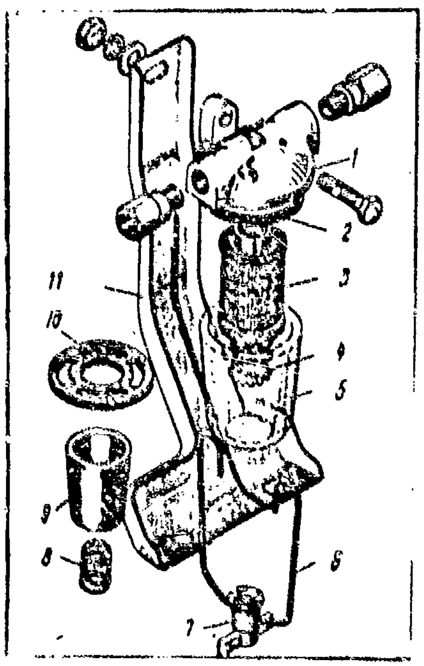


Plate 5-19. Fine cleaning filter:
1) body 2) screened filter packing gasket 3) screened filter 4) spring 5) filter cup 6) bracket 7) tension nut 8) ceramic filter spring 9) ceramic filter 10) ceramic filter packing gasket 11) bracket

Plate 5-20. Adjusting the idle on a K-84M carburetor: 1) mixture quality screw 2) mixture quantity screw

The two-throat K-84M, K-88, and K-88A carburetors each have two screws 1 and require separate adjustment for each throat. The screws for qualitative adjustment are located underneath and are screwed into the fuel passage. When this screw is unscrewed, the mixture is enriched, and when it is screwed in, the mixture is leaned.

Having adjusted the composition of the mixture, it is necessary to attempt to decrease the number of revolutions at idle by unscrewing the throttle stop screw.

A properly adjusted carburetor must provide steady operation of the engine at an idle speed of 400-500 rpm.

For checking the proper adjustment of the engine's idle, the throttle pedal should be depressed and immediately released. If the engine stops working after this, the idle speed must be increased by moving the carburetor stop screw.

The air filter is serviced simultaneously with changing the engine oil. Before servicing the air filter, it is necessary to disassemble all the parts, clean the dirt from them, and carefully wash them out in gasoline or kerosene.

After washing, the filtering element is bathed in engine oil, and before installation of the element into place, the oil must drain down. Oil is poured into the filter bath to the bottom edge of the arrow stamped on the bath wall. Besides the arrow, the words "oil level" appear on the bath wall. If the oil level in the filter bath is higher than a set norm, excess oil will be carried into the engine by the air stream, leading to increased deposit formation and coking of the rings.

Disassembly and assembly

Fuel tanks. If leaks in the fuel tanks are discovered, the tanks must be repaired. Before repairing the fuel tanks, they must have dirt and corrosion products cleaned off their outsides, and they must be washed. The internal space of the tank is washed with a hot solution of caustic soda and water. During this process, the tank not only has the dirt cleaned from it, but gasoline fumes are also eliminated from it. After it is washed, the tank is checked for tightness. For this, all holes in the tank are closed with plugs, an air hose is connected to the drain valve nipple, and the tank is loaded into a water bath. Checking is conducted at a pressure of 0.3-0.4 kg/cm^2. The location of escaping air bubbles will indicate the location of a leak.

Small cracks are eliminated by soldering with soft solder. Larger cracks or perforations are repaired by laying on a patch. The ends of the cracks are drilled and the patch is soldered on with heavy solder or welded by gas welding.

Cracks in the fuel tank may also be welded by gas or electric welding. To prevent the possibility of the tank exploding from the accumulation of gasoline fumes in it during welding, it is recommended that the tank be washed out with a hot solution of caustic soda and water before welding it. For more of a protection from the possibility of the tank exploding during welding, exhaust gases of a carbureted engine are often used, filling the tank with them from a hose and spark arrester before welding the crack.

If the tank has large cracks or holes in it, it should be replaced. To remove the fuel tank from a two-axle ZIL-130 truck, it is necessary to: unscrew the coupling nuts fastening the fuel lines running from the fuel tank to the filter-sediment bowl and remove the lines, disconnect the lead from the fuel level indicator switch, unscrew the stop nuts and nuts fastening the two steel bands to the tank brackets, and remove the top steel bands and the fuel tank.

For removal of the filter-sediment bowl, it is necessary to: unscrew the coupling nuts fastening the line running to the fuel tank and the line running to the tank valve, and remove them; unscrew the nuts fastening the filter and remove the filter-sediment bowl.

For removal of the fuel tanks from a saddle trailer truck, it is additionally necessary to disconnect the line connecting the two fuel tanks, unscrew the two coupling nuts, and also disconnect the fuel level indicator switch line from the second tank.

Installation of fuel tanks on two-axle motor vehicles takes place in the reverse sequence.

Removal of the main fuel tank and filter-sediment bowl from three-axle motor vehicles is the same as for two axle motor vehicles.

To remove the auxiliary fuel tank from the ZIL-157K motor vehicle, it is necessary to: unscrew the nuts on the bridges fastening the bed to the frame and remove the bridges; unscrew the nuts fastening the front and center brackets of the bed to the right frame rail; set jacks under the rear part of the bed, or connect a hoist to it, and raise the bed far enough so that it is possible to pull out the fuel tank through the gap formed between the bed and the frame. Disconnect the filler neck hose and the air vent, loosen the clamp tension screws with a screw driver, remove the fuel line running to the fuel tank, disconnect the electric line from the fuel level indicator switch, and then unscrew the nuts fastening the steel bands of the tank, remove the bands, and pull out the fuel tank.

For removal of the auxiliary tank filler neck, it is necessary to unscrew the nut fastening the neck bracket and remove the tank filler neck.

Installation of fuel tanks on the ZIL-157K motor vehicles takes place in the reverse sequence. On the ZIL-131 motor vehicle, the fastenings on the right and left tanks are identical.

If the valves in the fuel tank caps are damaged, the cap assembly must be replaced.

To replace defective fuel lines, besides using spares, the factory produces a pipe made of L96 tombac from 1000-2000 mm long (the pipe is drawn with a diameter of 8 X 0.75, soft, GOST 617-53). Fuel lines of any dimensions for all motor vehicles can be fabricated of these pipes and the fittings for them (also produced by the factory for spare parts)

Replacement of the fuel level indicator switch. For removal of the fuel level indicator switch, it is necessary to unscrew the screws fastening the switch, remove the switch in assembly with its float from the tank, and remove the sealing gasket.

If necessary, unscrew the fuel valve and drain plug from the tank. A new fuel level indicator switch is installed in its receptacle in the tank with its packing gasket and fastened to it with screws. Screw the fuel valve, angle fitting, or drain plug into the tank, and tighten with a wrench. Install the fuel filter in the tank filler neck, and close the filler neck cap, pressing it down by hand and rotating it to the right.

It is recommended that the B-9 and B-9B fuel pumps be disassembled in the following sequence. If necessary, unscrew the fittings: 1) the fuel supply fitting from the cover, and 2) the fuel outlet fitting from the pump head. Unscrew the screws fastening the head to the pump body and remove the head, carefully separating the pump diaphragm.

Unscrew the two screws fastening the cover to the pump head, remove the cover, cover packing gasket, and screened filter.

The filter may also be removed without removing the pump head.

For removal of the valves, it is necessary to press out the valve rods (Plate 5-22, a), remove the band, valve, and valve spring. The valve unit should not be disassembled except in extreme necessity.

For removal of the diaphragm with its pull rod, it is necessary to press out the pump arm shaft, withdraw the pump arm from the body, and remove its return spring from it. Pull the diaphragm in assembly with its rod and diaphragm spring out of the body.

To extract the manual pump drive shaft, it is necessary to free the manual pumping handle from its spring and withdraw the shaft together with the spring.

Plate 5-21 Adjusting the idle on a K-88 and K-88A carburetor (for position designations, see Plate 5-20).

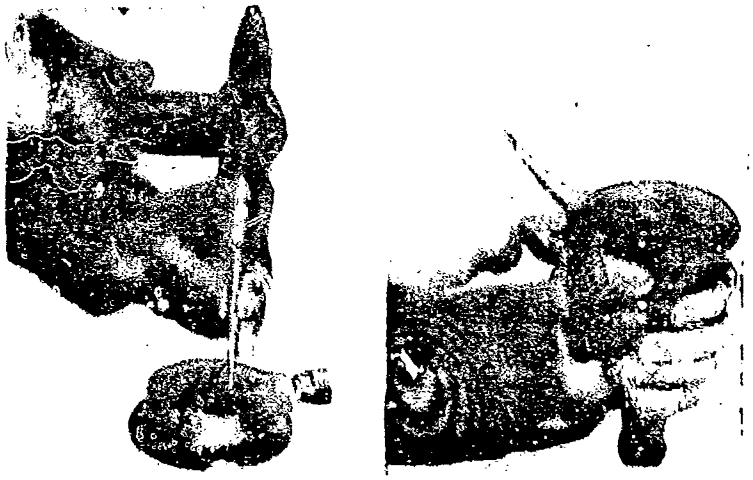


Plate 5-22. Disassembly of the fuel pump units:
a) pressing out the valve rod
b) unscrewing the diaphragm fastening nut

For disassembling the pump diaphragm, it is necessary to fasten the diaphragm rod in a vise (a hand vise can be used) with soft inserts, unscrew the nut fastening the diaphragm to the rod (Plate 5-22, b), remove the spring washer, the upper compression washer, the diaphragm, the lower diaphragm washer, and the pull rod washer.

The two support washers of the pump arm which are fitted onto the pull rod and fastened by clenching the end of the rod are removed only when they are to be replaced.

Assembly of the B-10 and B-10B pumps is similar to the assembly of the B-9 and B-9B pumps.

Checking the fuel pump parts. After disassembly, the parts of the fuel pump should be checked for usability. There must be no burrs, holes, dents, cracks, or corrosion on the body, head, or parts of the pump.

The diaphragm linen must not be torn or damaged.

Wear on the working surface of the lever which rubs against the camshaft eccentric is not allowed to be greater than 0.2 mm, and wear on the lever in contact with the diaphragm pull arm must be no greater than 0.5 mm. If wear is greater on these surfaces, the lever must be replaced.

The pump diaphragm spring is tested for elasticity on a CARO model 357 device (Plate 5-23). The spring being tested is mounted on the stock of the device, and its height is measured along a scale without a load and with a load. The scale indications must correspond to the characteristic presented in Table 5-5.

In checking the outlet valves of the B-9 and B-9B pumps of the first series, it is necessary to remove the head from the pump body, and then remove the head cover. When checking the outlet valves of the B-10 pump, only the head cover is removed, without removing the head from the pump body.

Fuel pump assembly. Assembly of all fuel pumps is identical. During assembly, it is necessary to assemble the diaphragm, for which: a washer, lower pressure washer, diaphragm plates (hav[illegible] [illegible]igned their holes), and upper washer are mounted on the pull rod, [illegible], with the pull rod gripped in a vise (see Plate 5-22, b), the diaphra[illegible] fastened on with its nut.

Insert the diaphragm spring in the pump body and install the diaphragm in assembly with its push rod. Then insert the manual drive shaft in the hole in the body, install the spring on the shaft and fasten it.

Install the pump arm in the body, connect its forked end with the diaphragm pull rod, install the return spring, and fasten the pump arm by its shaft, pressing it into the hole in the body.

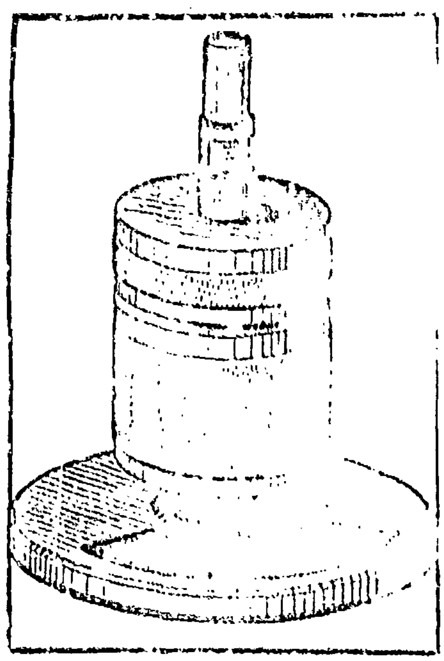


Plate 5-23. GARO model 357 device for checking diaphragm springs

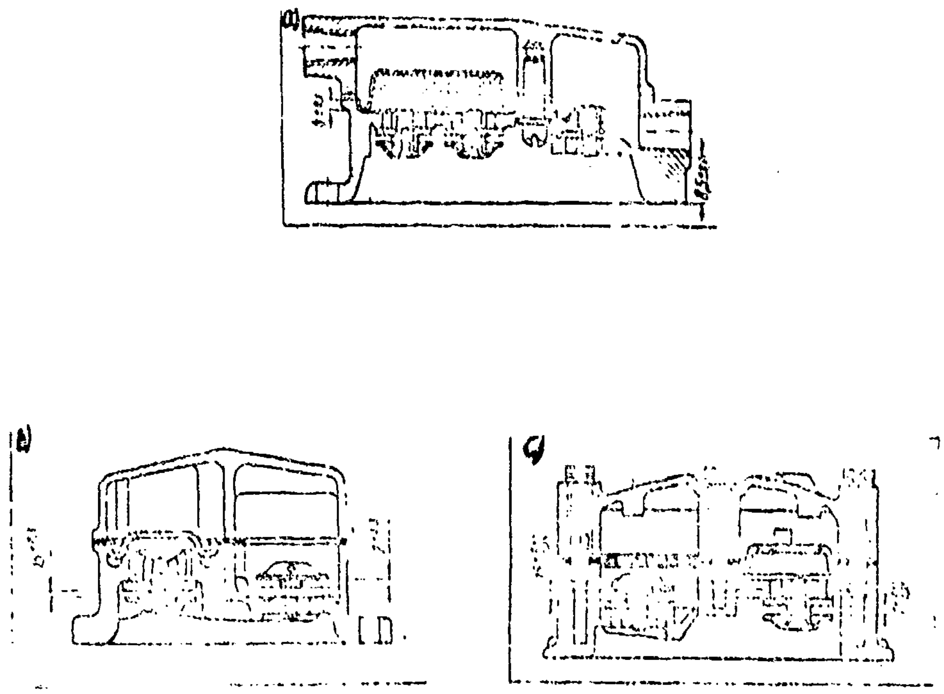


Plate S-24. Installation of fuel pump valves:

a) B-9B
b) B-9
c) B-10 and B-10B

Assemble the head body, for which the inlet and outlet valves are installed, fastening them with rings. For the outlet valve of the B-9B fuel pump, the distance from the face of the band rod to the surface of the head body must be within the limits of 8.4-8.6 mm (Plate 5-24, a). For the inlet valves of the B-9B pump, distance from the face of the band rod to the assembly surface of the pump cover body must be within the limits of 3.9-4.1 mm.

For the B-9, B-10, and B-10B fuel pumps during installation of the valves, the distance between the valve and ring is measured and must be within the limits of:1 1.5-1.8 mm for the inlet valves of the B-9 pump, 2.0-2.3 mm for the outlet valves of that pump (Plate 5-24, b); 0.65-1.45 mm for the inlet valves of the B-10 and B-10B pumps, and 1.15-1.95 mm for the outlet valves of that pump (Plate 5-24, c).

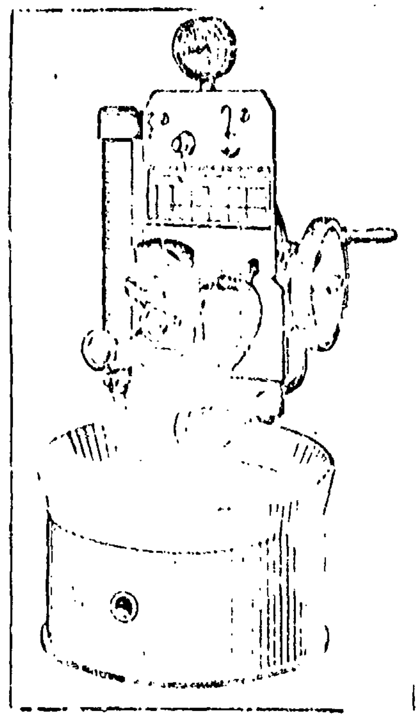


Plate 5-25. GARO model 374 device for checking fuel pumps

Install the screened filter on the inlet valves and fasten the cover with its gasket. The assembled head is installed on the body, the fastening bolts are screwed in by hand, and the diaphragm is dropped downward by moving the lever (arm). Tighten the head in this position.

Screw in the fittings in the head and cover, and screw the threaded plug with its gasket into the control aperture in the body if the plug was unscrewed during disassembly.

It is recommended that fuel pumps be tested on a GARO model 374 device (Plate 5-25). Pressure developed by the pump and its capacity are checked on the device (data is presented in Table 5-2 and in the text).

Disassembly of the K-84M carburetor. Unscrew the screws fastening the cover, unscrew the central screw with a screwdriver, remove it together with the fiber washer, and remove the cover (Plate 5-26, a).

Пружина	Высота пружины		Число витков в пружине		Диаметр	
	без нагрузки	с нагрузкой	всего	рабочих	пружины	проволоки
Пружина диафрагмы[1] насосов Б-9 и Б-9Б . . .	48–49	28,5 (при нагрузке 5–5,6 кГ)	5,5–6,5	3,5–4,5	24	1,8
Пружина диафрагмы насосов Б-10 и Б-10Б . .	50–51	28,5 (при нагрузке 9,5–10,3 кГ)	6–7	4–5	24	[illegible]
Пружина клапана[2] . .	9–11	—	,5–8,5	5,5–6,5	7,3–7,7	0,4

Key: a) spring
b) spring height
c) without load
d) with load
e) number of spring coils
f) total
g) working
h) diameter
i) spring
j) wire
k) B-9 and B-9B pump diaphragm spring[1]
l) B-10 and B-10B pump diaphragm spring
m) valve spring[2]
n) (with a load of 5-5.6 kg)
o) (with a load of 9.5-10.3 kg)

[1] Diaphragm manufactured of lacquered fabric.
[2] After compression to 4.5 mm, the spring must have no residual deformation.

When the central screw is being withdrawn from its receptacle and the cover is being removed, it is necessary to remember that the accelerator pump needle valve is not fastened and may fall from its receptacle.

To extract the needle valve from its receptacle, it is necessary to tilt the body and, placing the hand against the receptacle, remove the valve, as shown in Plate 5-26, b.

Disassembly of the cover. Carefully grasp the cover in a vise with soft jaws, unscrew the fuel feed fitting, unscrew the fuel feed valve filter plug, remove it together with its gasket, and remove the screened filter from the valve space. Unscrew the fuel feed valve body (Plate 5-26, c) and remove it in assembly with the valve, packing, and adjusting gaskets (the valve in assembly with the needle and seat is pressed into the valve body and is not disassembled).

Remove the choke drive spring with a screwdriver. Unscrew the screws fastening the choke to its shaft, remove the choke in assembly with the reverse valve, withdraw the choke drive shaft from the body in assembly with its pressure screw and drive cable clamp.

Unscrew the bolt fastening the caple clamp bracket and remove the bracket in assembly with the cable clamp.

Disassembly of the float chamber body. Remove the gasket from the body, carefully separating it from the carburetor body wurface with a screwdriver.

Unpin the accelerator pump rod, disconnect the rod from the drive lever, pull the bracket out of the hole for the lever and pump rod, and remove the assembled accelerator pump body from its cavity..

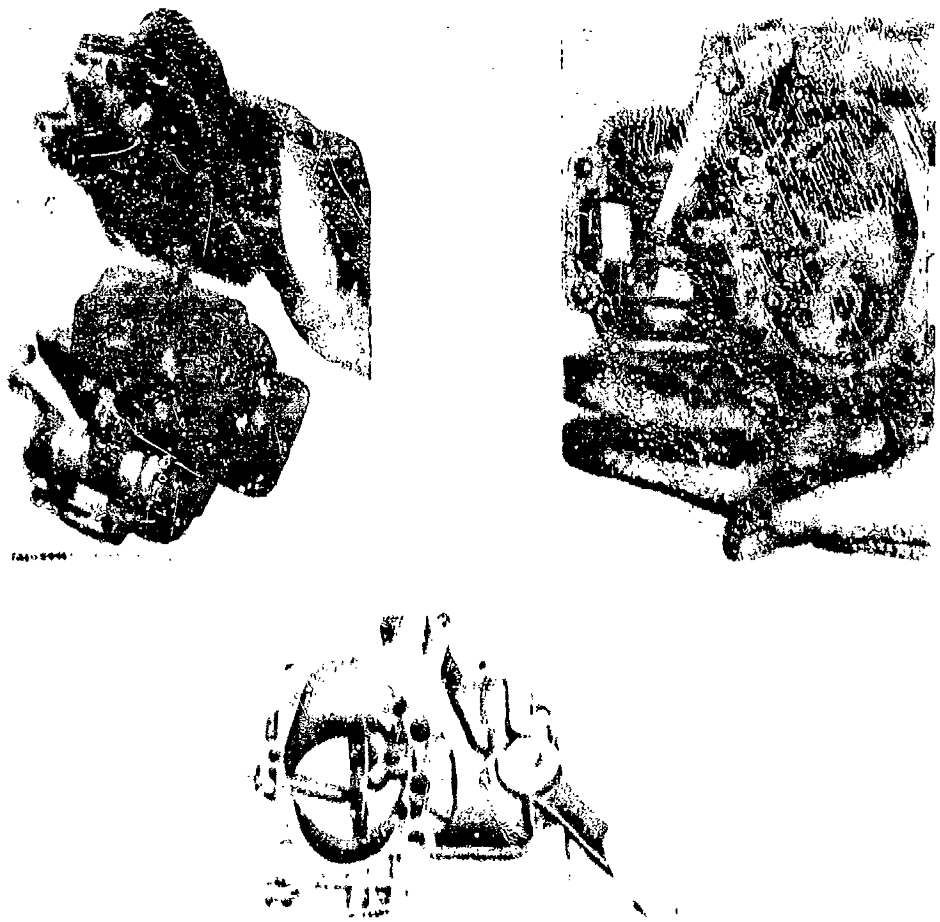


Plate 5-26. Removal and disassembly of the K-84M carburetor cover:
a) cover removal b) extracting the accelerator pump needle valve c) unscrewing the fuel feed valve body

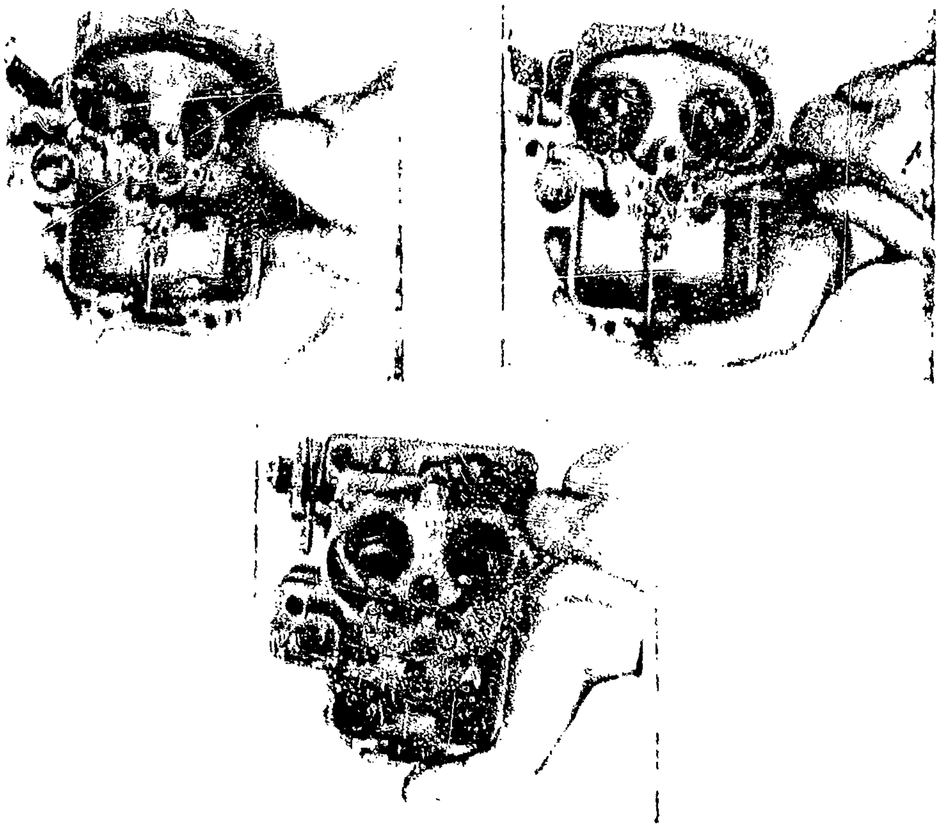


Plate 5-27. Removal of the K-84M carburetor jets: a) removal of the main jet b) removal of the idle jet c) removal of the air jet

Remove the float and its shaft, the mechanical economizer valve rod, the pneumatic economizer, the economizer piston spring, and if necessary, extract the packing gasket of the piston.

With a screwdriver, unscrew the two main jets (Plate 5-27, a), the two idle jets (Plate 5-27, b), and the valve body of the economizer with pneumatic drive. Unscrew the two air jets (Plate 5-27, c) with a wrench. In case of extreme necessity, remove the lock ring with a screwdriver and pliers, and take out the accelerator pump inlet ball valve.

Unscrew the plug (Plate 5-28, a) from the valve passage of the economizer with mechanical drive, unscrew the economizer valve assembly (Plate 5-28, b), and if necessary remove the packing gasket. The valve seat is pressed into the body inwhich the spring and mechanical economizer valve are located, and therefore this unit is not disassembled.

Unscrew the plugs from the passages in the body, then the high speed jets. For separation of the float chamber body from the lower part of the carburetor, it is necessary to loosen the fastening bolts with a wrench and then unscrew them with a screwdriver. Remove the mixing chamber body (Plate 5-29, a), lightly tapping on it with a wooden hammer, and then remove the insulating gasket, separating it from the body with a screwdriver (Plate 5-29, b).

Disassembly of the accelerator pump. Remove the stop ring fastening the piston rod to the drive rod plate with a screwdriver, disconnect the lever with the drive rod from the pump piston rod, and then remove the spring and spring support washer from the piston rod, after which the piston (rubber cuff) and piston compression spring are removed from the rod.

Disassembly of the mixing chamber. Unscrew the fitting from the vacuum regulator pipe and the two idle adjusting screws.

For removal of the throttle plate shaft, it is necessary to unscrew the screws fastening the plate and remove the shaft in assembly with its drive lever

After disassembling the carburetor parts, wash them in acetone, a solution based on acetone, or in clean gasoline, and the passages, jets, and all parts and units of the carburetor are blown out with compressed air. The painted surface of the mixing chamber body must be washed only in gasoline, since acetone will dissolve the paint protecting the body from corrosion.

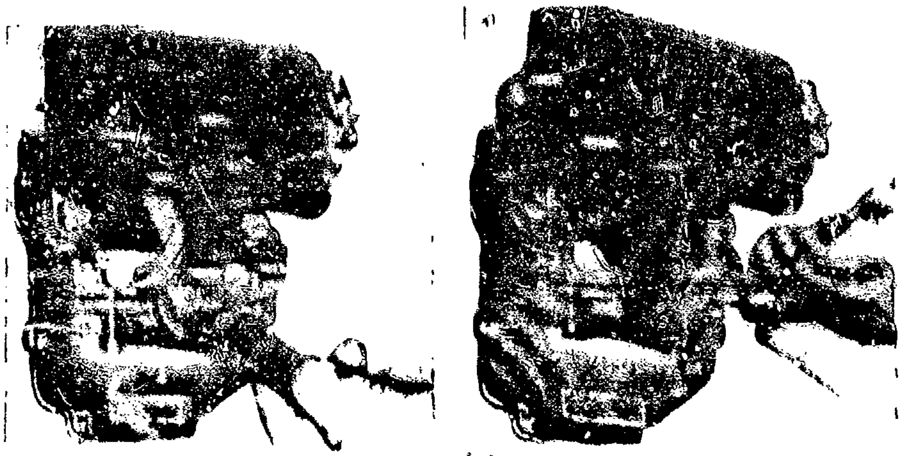


Plate 5-28. Removal of the economizer valve of the K-84M carburetor:
a) unscrewing the valve plug of the economizer with mechanical drive b) unscrewing the valve of the economizer with mechanical drive

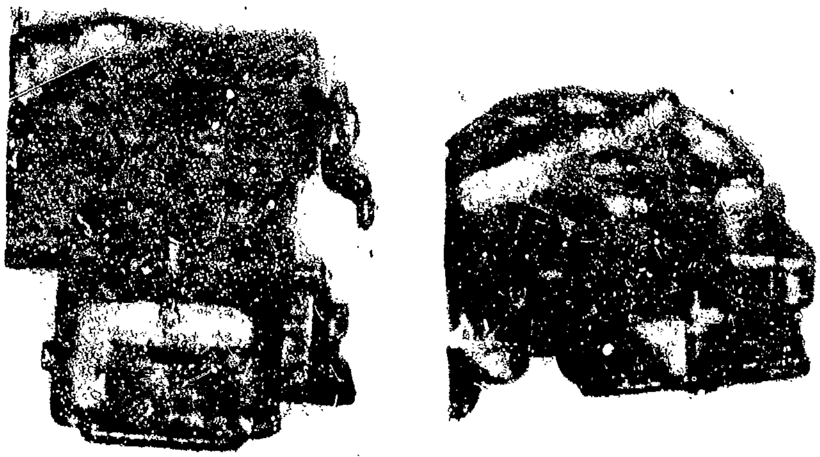


Plate 5-29. Removing the lower part of the carburetor: a) removing the lower part of the carburetor b) removing the insulating gasket

Checking float tightness. Before setting about checking and adjusting the fuel level in the carburetor float chamber, it is necessary to insure the proper condition of all the float mechanism parts.

Tightness of the float is checked by immersing it in hot water at a temperature of 60-80°C and holding it there for a period of no less than 0.5 minutes. If the float seal is destroyed (escaping air bubbles appear on it), it must be soldered, after first removing all the fuel from it. After soldering, the float should again be checked for tightness and weight.

The weight of the float in assembly with its lever must correspond to the data presented in Table 5-4. If, after soldering, the weight of the float exceeds that allowable, it is necessary to remove excess solder and bring the weight of the float to the required amount in this way, without destroying its hermetic state.

The float chamber needle valve is to check for tightness on a special installation (Plate 5-30).

Creating a suction of 1000 mm in a water column from the water level in tank 1, and, having closed valve 7, check the tightness of the valve.

The allowable amount of water drop in the column over a period of 0.5 minutes must be no greater than 10 mm on scale 3. Lapping the needle into its seat is allowed to obtain the seal. If tightness is not achieved by these means, the needle valve unit must be replaced.

Installation of the valve on the cover of the carburetor is checked with a template (Plate 5-31, a). The distance from the upper point of the needle valve rod sphere to the surface of the carburetor cover must be equal to 13.2-13.8 mm for the K-84M, and 13.5-13.8 mm for the K-88 and K-88A (Plate 5-31, b). If necessary, adjust the installation of the valve with gaskets.

Checking the passage capability of the carburetor metering elements. Plate 5-32 shows one of the possible layouts of a device for checking the passage capability of the metering elements (jets, atomizers) for a period of time by means of the absolute usage of water.

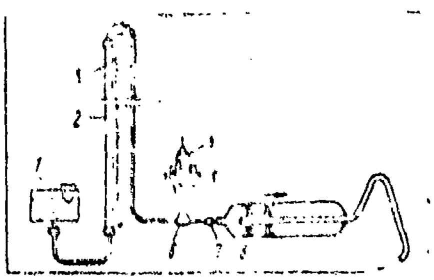


Plate 5-30. Diagram of installation for checking float chamber needle valve tightness: 1) tank 2) glass tube 3) graduated scale 4) needle valve 5) body 6) tee 7) valve 8) piston

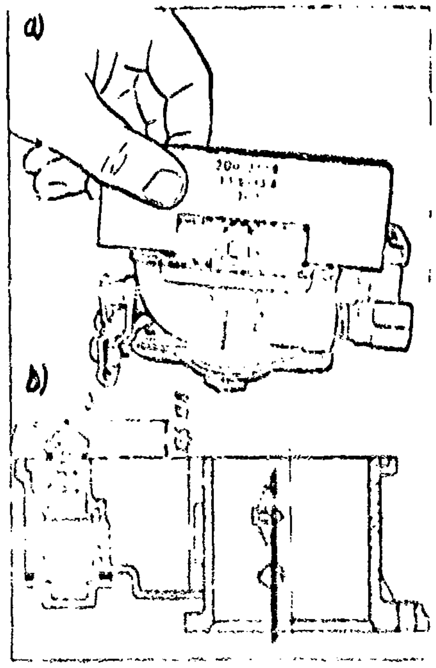


Plate 5-31. Checking installation of the float chamber valve: a) checking valve installation with a template b) installation dimensions of the fuel feed valve 1) upper body of the carburetor 2) valve body 3) gasket

Passage capability, cm^3/ minute, of the metering elements, is checked by determining the time for a flow of water through it at a temperature of 19-21°C at a pressure equal to 1000 ± 2 mm in a column of water.

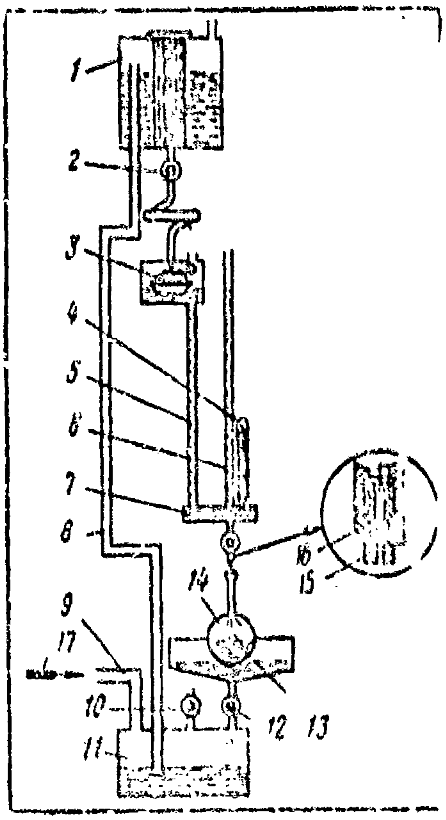


Plate 5-32. Diagram of device for checking passage capability of carburetor metering elements:
1) upper tank 2, 10, 12) valves 3) float chamber 4) thermometer 5, 6, 8, and 9) pipes 7) body 11) lower tank 13) trough 14) measuring flask 15) metering element 16) holder 17) direction of compressed air feed

Water flows from the upper tank 1 through valve 2 into the float chamber 3, in which a constant water level is maintained. From float chamber 3, water flows through tube 5 into body 7, which is raised along glass tube 6 to a determined height, and simultaneously flows through the tested metering element 15, which is fastened into holder 16.

Water flowing through the tested metering element flows into trough 13, and from there through valve 12 into the lower tank 11. Water can flow as needed from the lower tank to the upper tank 1 along pipe 8 under the force of compressed air introduced through pipe 9, during which valves 10 and 12 must be closed. After the upper tank 1 is filled, valves 10 and 12 must be open. The water column must be equal to 100 mm.

Temperature of the water flowing out is checked by thermometer 4.

After the measuring vessel 14 (usually a measuring flask with a high small diameter neck) has been set beneath the stream of water flowing out, and the time of its filling has been measured in seconds, it is possible to determine the passage capability of one or another metering element at a given water pressure. For this, it is necessary to divide the quantity of water in the measuring vessel (in cm^3) by the time elapsed to fill the vessel (in seconds), and multiply the result obtained by 60, to give the passage capability in cm^3/minute.

The nominal passage capability of various metering elements of the carburetor are presented in Table 5-4.

For normal operation of the carburetor, it is also necessary to check the tightness of the valve of the economizer with mechanical drive. Checking may be conducted on the installation shown in Plate 5-30.

Assembly of the K-84M carburetor. Assembly of the carburetor takes place in the reverse sequence, fastening the units and parts with the same tools used during disassembly.

During assembly, it is necessary to ensure that there is no hanging or wedging of the economizer valves, accelerator pump, choke, or throttle.

The clearance between the choke and the mixing chamber body must be no greater than 0.05 mm.

Checking and adjusting the moment of the mechanical drive economizer valve opening. After installing the accelerator pump drive, it is necessary to check and possibly adjust the moment of opening of the mechanical drive economizer valve. The distance between the edge of the throttle and the wall of the mixing chamber at the moment that the economizer valve opens must be 9.0 mm for the K-84M carburetor. This distance may be measured by a template or a special measuring instrument. If there is a deviation from this value, adjustment must be conducted by means of bending the accelerator pump rod bar on the K-84M carburetor The bar is bent only on a section of 30 mm (Plate 5-33).

Checking carburetor tightness. Tightness of the carburetor may be checked on a special GARO meodel 355 device (Plate 5-34) for checking carburetors. The carburetor being checked, 5, is installed on bracket 7 and is pressurized by means of supplying fuel to it at an excess pressure of 0.2 kg/cm^2 from tank 13 along pipe 3 and hose 2. Pressure in the system is created by pumping air into the tank of the device through reverse valve 12 by a hand pump or from a pneumatic power system. Maximum pressure in the tank is limited by

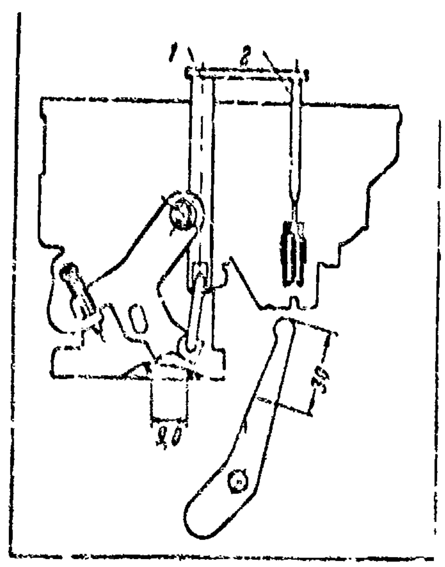


Plate 5-33. Diagram of adjusting the moment of the mechanical drive economizer valve opening:
1) bar 2) pull rod

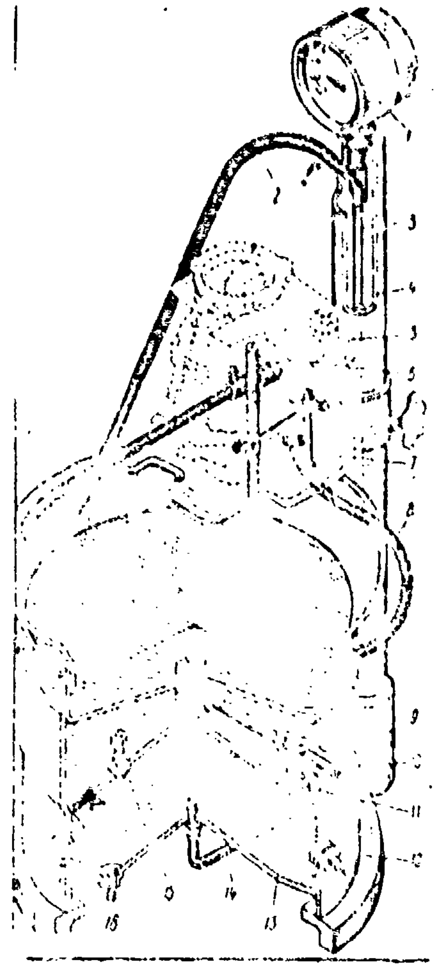


Plate 5-34. GARO model 355 device for checking carburetors:
1) manometer 2 and 8) rubber hoses
3) fuel feed line 4) device stand
5) tested carburetor 6) control pipe
7) bracket 9) bath 10) valve handle
11) valve 12) reverse 13) tank
14) filler valve 15) safety valve
16) observation port

safety valve 15, which is adjusted to a pressure of 0.5 kg/cm^2. The tank is filled with fuel through valve 14, during which it is necessary to lower air pressure in the tank beforehand, for which it is connected to the atmosphere through valve 11. Valves 14 and 11 are blocked together so that in the beginning, with the rotation of handle 10 by 90°, valve 11 opens and releases air from the tank, and then with a rotation of the handle by another 90°, valve 14 opens, connecting the tank with bath 9, intended for supplying fuel to the device tank. Fuel level in the tank is checked through observation port 16. Fuel level in an assembled carburetor may be checked on the same model 355 device. For this, the plug covering the mechanical drive economizer valve passage is unscrewed, and a fitting with rubber hose 8 is screwed in its place. Rubber hose 8 ends with a glass tube 6 which has two marks on it, indicating the limits of fuel level deviation. With the proper position of the float, the fuel level in the carburetor float chamber with an excess fuel pressure in front of the needle valve of 125-170 mm in a column of mercury must be 18-19 mm from the upper assembly plane of the carburetor.

To attain the proper value of fuel level in the float chamber, the float bracket may be bent.

Checking the accelerator pump mechanism. Using the fuel supply into the carburetor float chamber from the model 355 device, check the operation of the piston mechanism, which must work reliably and provide a capacity of no less than 17 cm^3 for ten full strokes of the piston at a rate of 20 pumps per minute.

The throttle plate lever must be pumped from the fully closed to fully opened positions of the plate.

The quantity of fuel is determined by measuring it with a vessel.

Before starting measurement, stroke the pump several times to ensure that it works.

Disassembly order of the K-88 and K-88A carburetors is similar to the disassembly order for the K-84M carburetor, and therefore only the differing operations are presented below.

Plate 5-35, a, shows the unscrewing of the central hollow screw, removal of the upper body of the cover (Plate 5-35, b), gasket (Plate 5-35, c), and float (Plate 5-35, d) of the K-88 carburetor.

Plate 5-36, a, shows removal of the accelerator pump and pneumatic economizer mechanisms (Plate 5-36, b), as well as the removal of the mechanical economizer valve plunger (Plate 5-36, c) of the K-88 carburetor.

Plate 5-37, a, shows the unscrewing of the pneumatic drive economizer valve body, and Plate 5-37, b, c, and d, show unscrewing of the jets from the K-88 carburetor. The float chamber body and insulating gasket of the K-88 and K-88A carburetors are then removed from the mixing chamber body.

Removal and disassembly of the diaphragm mechanism. Unscrew the bolts (Plate 5-38, a) fastening the side cover of the lever mechanism, and remove the cover with its gasket. Remove spring 1 (Plate 5-38, b) from the lever pin 2 and pin body with a screwdriver, unpin rod 4 of the diaphragm, separate it from the lever 2, unscrew fastening nut three on the throttle plate shaft, and remove the lever. Unscrew screws 5 fastening the body of the diaphragm

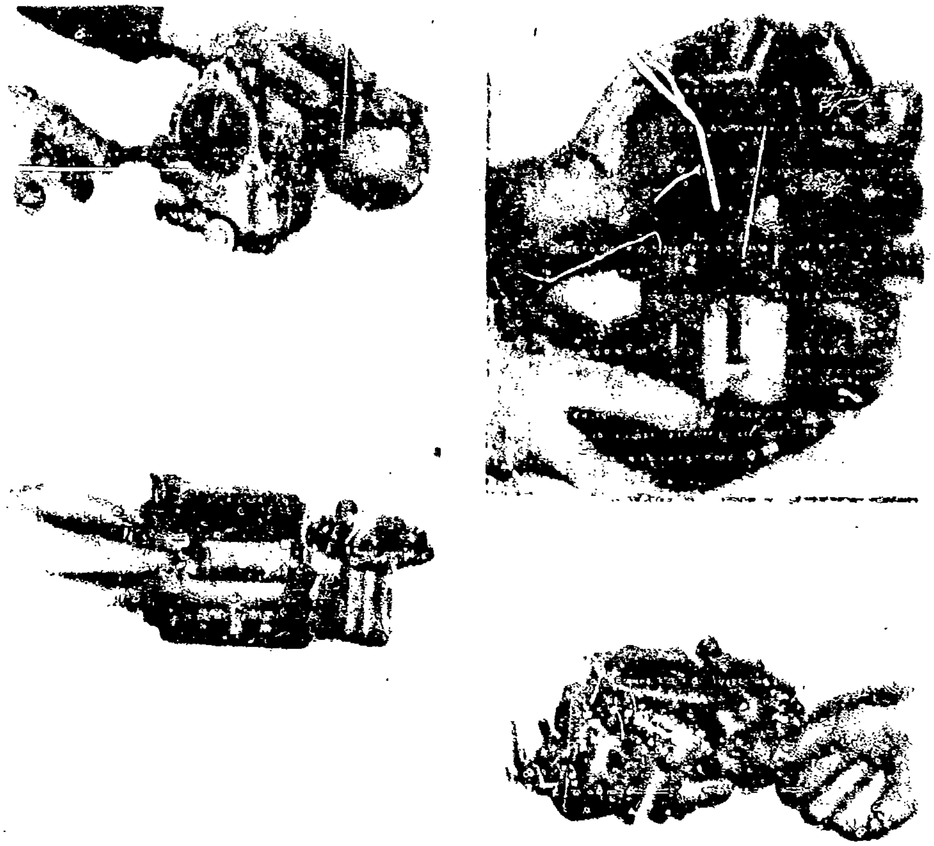


Plate 5-35. Removal of the cover and disassembly of the K-88 carburetor:
a) unscrewing the central screw b) removing the cover
c) removing the body gasket d) removing the float

mechanism to the body of the mixing chamber, disconnect the body and remove the body gasket, remove the compression spring of the collar and carefully pull the bearing collar from its receptacle.

For removal of the diaphragm, it is necessary to unscrew the screws (Plate 5-58, c) fastening the upper cover to the diaphragm mechanism body, remove the cover, and pull out the diaphragm assembled with the rod 4 from the body (see Plate 5-38, b).

The diaphragm unit is not disassembled, since the diaphragm is compressed between two washers and fitted on a rod whose end is crimped.

Assembly of the K-88 and K-88A carburetors. After checking the components and parts, assemble the carburetor in the following order. Assembly of the mixing chamber body. Insert the shaft with the forked hinges throttle actuator into the actuator body. The shaft must rotate freely in the body bushing with a clearance of 0.035-0.143 mm.

Insert the ball bearings into their receptacles in the body and fasten one bearing from the side of the actuator with a locking ring. Insert the throttle shaft in the body and fasten both throttle plates onto the shaft with screws. Install the gasket and the actuator body with the forked shaft and fasten it with screws. Install the connecting lever shaft and the throttle actuator lever on the end of the forked shaft with a support screw, and fasten them with a nut.

Screw the two idle adjusting screws and one support screw into the body after mounting springs on them.

Assembly of the diaphragm mechanism. Insert the diaphragm with its rod into the mechanism body. Install the top cover and fasten it on with screws.

Screw the air and vacuum jets into the mechanism body. Insert the collar and spring into the bearing receptacle. Install the diaphragm mechanism body with its gasket in the mixing chamber body and fasten it with screws. Install lever 2 (see Plate 5-38, b) of the diaphragm mechanism on the throttle plate shaft and fasten it with a nut. Connect the lever with the rod 4 of the diaphragm and fasten the rod with a cotter key. Mount a spring on the lever pin and on the body pin.

Install the side cover of the lever mechanism with its gasket and fasten it with screws (see Plate 5-38, a).

Assembly of the float chamber body of the K-88 and K-88A carburetors (see Plate 5-35, 5-36, and 5-37), assembly, installation, and checking of the accelerator pump, connecting and fastening the float chamber body to the mixing chamber body, and assembly, installation, and fastening of the cover (see Plate 5-35, a, b) take place the same as in the K-84M carburetor.

During installation of the accelerator pump and connecting rod to the linkage, it is necessary to connect the linkage rod, fasten it with screws, and cinch the screws with stop plates.

After assembling the carburetor, install the rod connecting the choke and throttle plate levers.

The carburetor is checked for tightness. The K-88 and K-88A carburetors are checked for tightness on an instrument the same as that for the K-84M.

Disassembly of the engine revolution governor (K-84M carburetor). Remove the seal, unscrew the screws fastening the front and side covers, and remove them with their gaskets.

If necessary, carefully remove the two jets (upper air and lower vacuum) from the diaphragm mechanism body with a screwdriver.

Disassembly of the mixing chamber. Unscrew the nut fastening the throttle drive lever and the connecting lever, and remove the levers. Unscrew the screws fastening the drive body and the bearing, remove the body together with the forked control shaft, and remove the shaft from the body.

To extract the throttle shaft, it is necessary to remove the stop ring of the bearing from the side of the control and press out the shaft. Extract the two ball bearings from the mixing chamber body by hooking them with a curved metal rod (the bearings sit in their receptacles freely). If necessary, unscrew the idling system adjusting screws and stop screw.

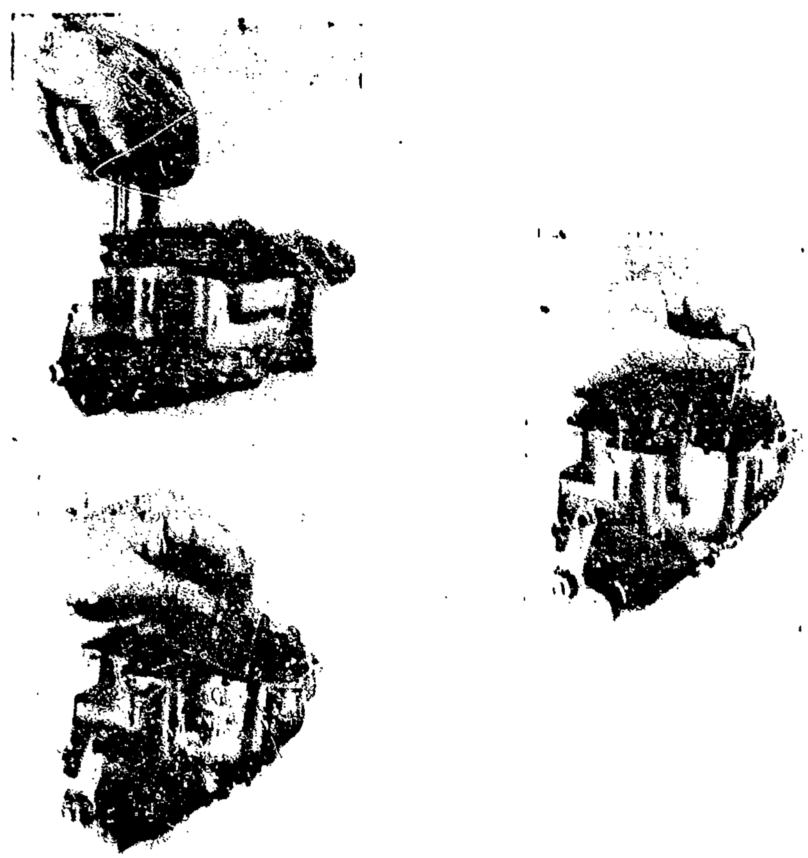


Plate 5-36. Removal of float chamber parts of the K-88 carburetor:
a) extracting the accelerator pump and rod
b) removing the pneumatic economizer mechanism
c) removing the mechanical economizer plunger

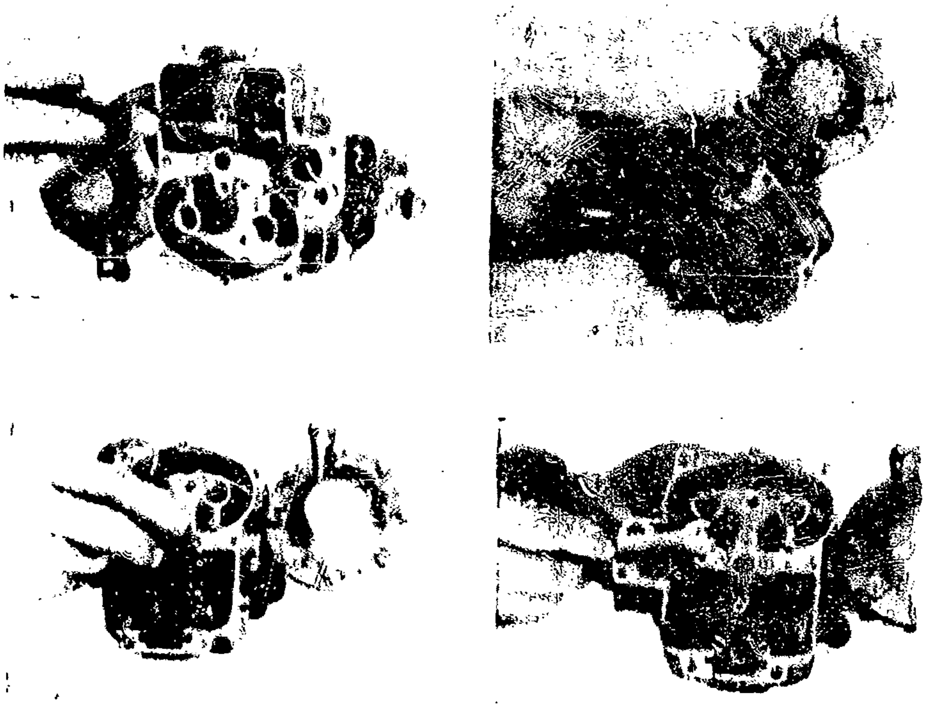


Plate 5-37. Removal of jets from a K-88 carburetor:
a) unscrewing the pneumatic drive economizer valve body b) unscrewing the main jet c) unscrewing the idle jet d) unscrewing the air jet

Checking the basic components of a carburetor. Before checking an assembly, all parts, assemblies, and passages of the carburetor are washed out in acetone or clean kerosene, and the throttle drive body is blown out with compressed air. If a bushing is worn so that its clearance is increased to a dimension of more than 0.143 mm, it is necessary to replace the drive body in assembly with the bushing or drill the worn bushing out of the body, renew the hole to its nominal dimension of 10.4-10.435 mm, and press in a new bronze bushing with an interference of 0.055-0.080 mm.

After the bushing has been pressed in, its interior diameter should be reamed out to a nominal dimension of 8.0-8.058 mm (nominal dimension of the shaft with the forked hinged throttle actuator is 7.915-7.965 mm).

Tightness of the float and the assembled float chamber needle valve and passage capability of the metering elements of the K-88 and K-88A carburetors are checked the same as the K-84M carburetor.

Assembly of the K-88 and K-88A carburetors. After checking the components and parts, assemble the carburetor in the following order. Assembly of the mixing chamber body. Insert the shaft with the forked hinges throttle actuator into the actuator body. The shaft must rotate freely in the body bushing with a clearance of 0.035-0.143 mm.

Insert the ball bearings into their receptacles in the body and fasten one bearing from the side of the actuator with a locking ring. Insert the throttle shaft in the body and fasten both throttle plates onto the shaft with screws. Install the gasket and the actuator body with the forked shaft and fasten it with screws. Install the connecting lever shaft and the throttle actuator lever on the end of the forked shaft with a support screw, and fasten them with a nut.

Screw the two idle adjusting screws and one support screw into the body after mounting springs on them.

Assembly of the diaphragm mechanism. Insert the diaphragm with its rod into the mechanism body. Install the top cover and fasten it on with screws.

Screw the air and vacuum jets into the mechanism body. Insert the collar and spring into the bearing receptacle. Install the diaphragm mechanism body with its gasket in the mixing chamber body and fasten it with screws. Install lever 2 (see Plate 5-38, b) of the diaphragm mechanism on the throttle plate shaft and fasten it with a nut. Connect the lever with the rod 4 of the diaphragm and fasten the rod with a cotter key. Mount a spring on the lever pin and on the body pin.

Install the side cover of the lever mechanism with its gasket and fasten it with screws (see Plate 5-38, a).

Assembly of the float chamber body of the K-88 and K-88A carburetors (see Plate 5-35, 5-36, and 5-37), assembly, installation, and checking of the accelerator pump, connecting and fastening the float chamber body to the mixing chamber body, and assembly, installation, and fastening of the cover (see Plate 5-35, a, b) take place the same as in the K-84M carburetor.

During installation of the accelerator pump and connecting rod to the linkage, it is necessary to connect the linkage rod, fasten it with screws, and cinch the screws with stop plates.

After assembling the carburetor, install the rod connecting the choke and throttle plate levers.

The carburetor is checked for tightness. The K-88 and K-88A carburetors are checked for tightness on an instrument the same as that for the K-84M.

Disassembly of the engine revolution governor (K-84M carburetor). Remove the seal, unscrew the screws fastening the front and side covers, and remove them with their gaskets.

For removal of the regulating unit parts (adjusting screw and nut, and the spring and rod), it is necessary to partially unscrew the adjusting nut 4 (see Plate 5-16) so that rod 2 can be freely removed from the rod of the shaped lug 1. After this, the parts of the regulating unit are removed from the passage of the body in assembly.

To remove rod 8 with its piston 7, it is necessary to unscrew the screws fastening the throttle plates, withdraw the plate pin from the slot in the fod, remove the plate, and then pull the rod and piston from the cylinder in body 11.

Pull shaft 13 with lug 1 and the needle bearings 14 from their recess, and knock out (if necessary) the plug from the bearing receptacle.

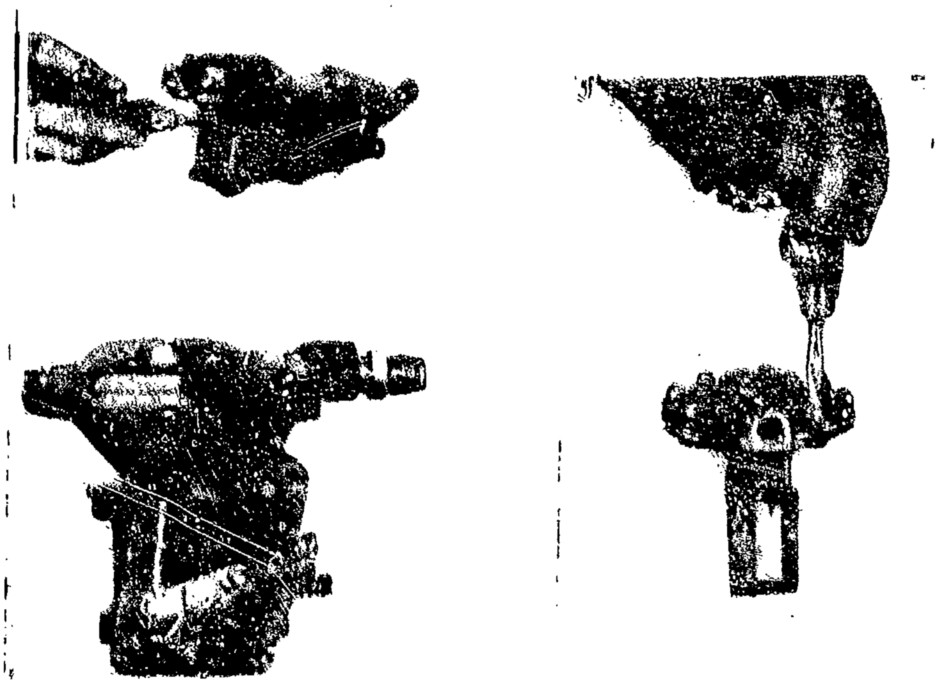


Plate 5-38. Disassembly of the engine revolution governor diaphragm mechanism:
a) removing the lever mechanism cover b) diaphragm mechanism from lever mechanism side c) removal of diaphragm cover
1) spring 2) lever 3) nut 4) diaphragm rod 5) diaphragm mechanism body fastening screw

For removal of the regulating unit parts (adjusting screw and nut, and the spring and rod), it is necessary to partially unscrew the adjusting nut 4 (see Plate 5-16) so that rod 2 can be freely removed from the rod of the shaped lug 1. After this, the parts of the regulating unit are removed from the passage of the body in assembly.

To remove rod 8 with its piston 7, it is necessary to unscrew the screws fastening the throttle plates, withdraw the plate pin from the slot in the rod, remove the plate, and then pull the rod and piston from the cylinder in body 11.

Pull shaft 13 with lug 1 and the needle bearings 14 from their recess, and knock out (if necessary) the plug from the bearing receptacle.

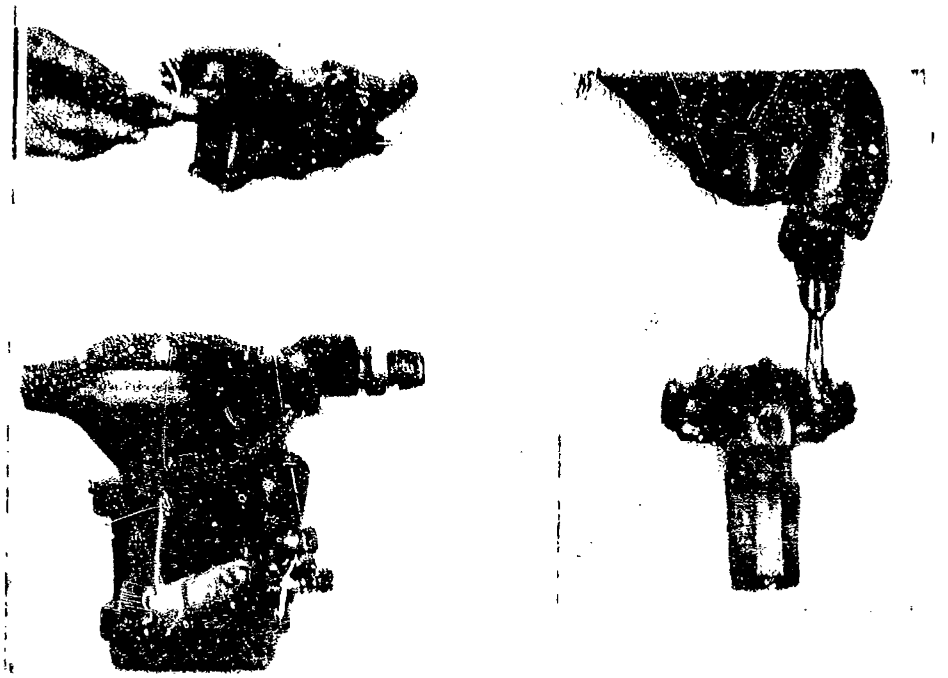


Plate 5-38. Disassembly of the engine revolution governor diaphragm mechanism.
a) removing the lever mechanism cover b) diaphragm mechanism from lever mechanism side c) removal of diaphragm cover
1) spring 2) lever 3) nut 4) diaphragm rod 5) diaphragm mechanism body fastening screw

Assembly. Assembly should take place in the following order: lubricate the bearings with 1-13c grease, insert the shaft with its needle bearings and formed lug in its recess and press in the plug.

Install the piston and rod in their cylinder, set the plate with its pin on the shaft, connect the rod slot with the plug pin and fasten it on its shaft with screws. Install the second plate on the shaft and fasten it with screws.

Insert the regulating unit parts in the body passage with the bent end of the spring going into the slot in the body passage. After mounting the spring on the lug pin, connect the spring to the shaped lug. Having previously screwed in the adjusting nut, tighten the spring.

Install the side cover with its gasket on the body, and fasten it with screws. The front cover is installed and fastened after it has been checked and the governor adjusted.

The revolutions governor is checked and adjusted on the engine or on a special installation. During adjustment, it is necessary to remember that: the stronger the spring tension, the higher the number of engine revolutions at which the governor will trigger, and conversely, the lower the spring tension, the lower the number of engine revolutions at which the governor will trigger.

A properly adjusted governor must trigger at 2600-2750 engine crankshaft rpm.

Plate 5-39, a, shows a GARO model 419 device for checking the revolution governor adjustment, and Plate 5-39, b, shows the schematic of the device.

The revolution governor 2 is fastened onto the assembly surface 9 and arrow 12, which has arm 10, is installed on plate 8 of the governor.

After this, the movable scale body is rotated so that the end of the arrow coincides with the zero degree division.

Elasticity of spring 3 of the governor is checked according to deviation of arrow 12 when load 11, weighing 100 grams, is hung at points II and III of arm 10. With this, the information received is compared with the data on plate 13, which is fastened onto the device.

The governor is adjusted by changing the tension on its spring with screw handle 7. Rotating the coarse adjustment screw 5, a preliminary setting is achieved, and rotating hollow bodied screw handle 6 into nut 4, a fine adjustment is achieved, performing the final setting of the revolution governor.

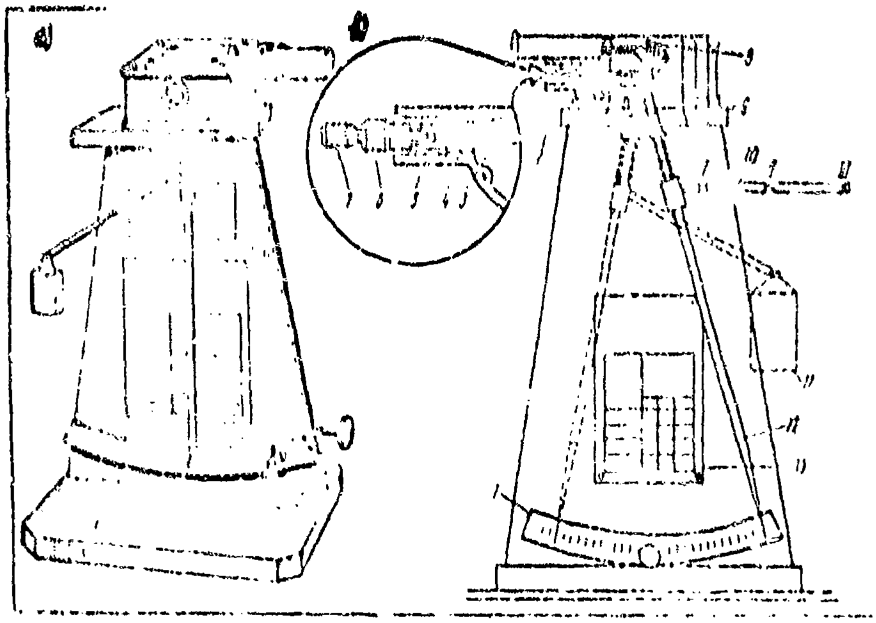


Plate 5-39. GARO model 419 device for checking a maximum revolution governor of an in-line engine:
a) device in assembly b) device schematic 1) scale
2) revolution governor 3) governor spring 4) governor fine adjusting nut 5) governor coarse adjusting screw 6) hollow bodied screw handle 7) screw handle 8) governor plate
9) device assembly surface 10) arrow arm 11) control weight
12) arrow 13) plate with adjusting data

The revolution governor of the K-88 and K-88A carburetors. The engine revolution governor consists of two mechanisms: the centrifugal switch installed on the camshaft gear cover, and the diaphragm mechanism installed on the mixing chamber of the carburetor.

The centrifugal switch is disassembled and assembled separately from the diaphragm mechanism, but adjusted together with it.

Disassembly of the centrifugal switch is not recommended unless it is needed. During repair, the centrifugal switch must be disassembled in the following order.

Unscrew the screws fastening cover 19 (see Plate 5-17), remove it from the body in assembly with seal 18, remove the seal from the cover, and if necessary remove the gasket.

Remove rotor 22 in assembly with its support washers from the body, and then remove the washers from the rotor.

For disassembly of the rotor, it is necessary to remove the stop ring fastening the valve seat with a screwdriver, and then knock out seat 28 of the valve, lightly tapping the rotor on a wooden object. Then, if necessary, remove gasket 16 of the seat.

Rotating the adjusting screw handle 20 to the left, free spring 14 from the threaded screw (the end of the spring which is decreased in diameter is a thread for the adjusting screw). Unscrew valve 27 in assembly with the spring (the adjusting screw does not separate from the spring, since it is rolled into the body of the rotor) and separate the spring from the valve.

For disassembly of the switch body, it is necessary to unscrew plug 21 with its gasket from the hole for setting the switch spring, and then unscrew the lubrication fitting with its gasket and pull out wick 23 with a screwdriver or metal rod with a bent end.

Unscrew the sleeve of the pipe connecting the diaphragm mechanism from the body and the sleeve from the pipe connecting the above-throttle space of the carburetor.

If necessary, press the metal-ceramic bushing 24 of the rotor axis out of the body.

Checking. The switch valve must fit against its seat along its entire circumference. Valve lapping is permitted. A lapped-in valve is checked for tightness with a vacuum of 1000-1100 mm in a water column for a period of one minute. With a valve wet in gasoline, a pressure drop is not allowed.

The internal dimension of the rotor shaft bushing must be 13.0-13.035 mm. The nominal dimension of the rotor shaft is 12.93-12.95 mm.

If wear is present, the bushing and shaft must be replaced. A new bushing is pressed in with an interference of 0.005-0.040 mm and is fitted according to the shaft diameter with a clearance of 0.055-0.105 mm.

The cover seal must be in good condition. The sharp edges of the seal rubber must not have signs of stretching. The threads in the holes for the sleeves must be in good condition.

Assembly of the centrifugal switch. Switch assembly takes place in the reverse order from disassembly.

Having installed the valve and spring, seat and gasket, and fastened them with a stop ring in the rotor, assemble the rotor. The rotor valve must freely move in the guide.

Mount the spacing washer on the rotor, install it in the body, having guided the shaft into the rotor bushing, and mount the support washer.

Insert the rubber casing seal in the cover, set the cover on the body with its gasket, and fasten it with screws.

Soak the felt wick in engine oil, with the excess oil being allowed to drain off.

Adjusting the centrifugal switch. In the process of operation, the centrifugal switch valve spring might lose its elasticity, and the governor will cut in at a lower number of engine revolutions, as a result of which the maximum speed of the motor vehicle will be decreased.

Therefore, the assembled centrifugal switch must be checked, and if necessary, adjusted so that it, in connection with the diaphragm mechanism, will cut in at the assigned maximum number of engine crankshaft revolutions.

Checking and adjusting the centrifugal switch should be done during the process of testing the engine on the stand after overhaul.

For adjusting, the tested centrifugal switch is installed on the engine and fastened with bolts. After starting the engine, with fully opened throttles, check the number of engine crankshaft revolutions at which the centrifugal switch must cut in on the tachometer. The switch must cut in at 3100 engine crankshaft rpm. If the switch cuts in at a higher or lower number of revolutions, it is necessary to stop the engine, and then, without removing the switch from the engine, unscrew plug 21 and adjust the rotor by turning the adjusting screw 20 with a screwdriver and changing the tension on spring 14.

When the screw is turned to the right, the switch rotor spring tension is increased, and when it is turned to the left, the spring tension is decreased respectively increasing or decreasing the number of engine crankshaft revolutions at which the switch begins to cut in.

After adjustment, the plug should be screwed into the hole in the switch body, the engine should be started, and the result of adjustment checked.

Having finished adjustment, remove the centrifugal switch from the stationary engine, seal it, and ship it for installation on a motor vehicle engine.

Section III. Transmissions

Chapter 6. The Clutch

Layout

The single-disk clutch of the ZIL-130, ZIL-157K, and ZIL-131 motor vehicles (Plate 6-1) provides transference of a twisting moment of up to 41 kg meters.

The pressure plate 8 in assembly with the cover 3 is fastened to the flywheel with eight centering bolts having a body diameter of 10.000-9.942 mm and a shoulder length of 12.5 mm. The twisting moment is transmitted from the clutch cover to the driven disk through pressure plate 8 by four pairs of spring plates 5.

Four levers 30 are fastened onto the pressure plate on brackets, and, resting on their center parts, rotate on pins 25, which are mounted on the support forks 27. The support forks are fastened to the cover 3 with adjusting nuts 28. To decrease friction, the lever pins and forks work on needle bearings 26, which are packed with grease during assembly of the clutch.

The pressure force of the clutch is created by 16 springs, which are installed between the clutch cover and the pressure plate. Insulating washers 9 are laid beneath the pressure plate side of the springs. The pressure plate and cover assembly are statically balanced to an accuracy of 90 gram cm.

The driven disk is steel, with riveted friction plates and hub 15, and has a friction type torque vibration damper consisting of eight springs with supporting plates and two damper disks. The driven disk assembly is statically balanced to an accuracy of 25 gram cm.

The clutch throwout bearing is of closed construction. It is packed with grease only during its assembly at the factory.

During disengagement of the clutch, bearing 32 of the sleeve presses against the inner ends of the four levers 30, and the outer ends, transfering the force to the pressure springs 10, withdraw the pressure plate 8 from flywheel 2.

A packing gasket is installed between the clutch housing and its cover on the ZIL-131 motor vehicle. A packing gasket is also installed beneath the flange of the clutch disengagement fork. Both gaskets are installed with sealing paste (VTU MKhP 3336-52). The front and rear faces of the clutch housing are packed with the same paste during assembly of the power unit. To seal the clutch disengagement forks, rubber rings are installed on their journals on both sides.

A special resinene shield is located on the lower part of the front face of the clutch housing and covers the opening in the clutch housing. The shield is fastened to the clutch housing with two bolts and is pressed against the lower surface of the cylinder block by a projection on the front part of the clutch housing cover. During assembly, it is necessary to first screw in the bolts fastening the shield to the point where the bolt heads touch the spring washers, and then, without finally tightening them, tighten the bolts fastening the clutch housing cover, and only after this, tighten the bolts fastening the shield. In all operations connected with disassembly of the clutch, it is necessary to use the sealing paste (VTU MKhP 3336-52) in the points mentioned above during installation of the assemblies in their places. A tube of this paste is supplied with each ZIL-130 motor vehicle. The basic data on the clutch are presented in Table 6-1.

The pressure plate is manufactured of SCh 18-36 cast iron (GOST 1412-54).

The clutch pressure plate lever is manufactured of 35 steel (GOST 1050-60). The depth of the cyanidized layer is 0.15-0.30 mm. Hardness is HRC 56-62. The number of levers is four.

The lever pins and support fork of the lever are manufactured of 15 steel (GOST 1051-39). The depth of the cyanidized layer of the pins is 0.15-0.30 mm. Hardness is HRC 56-62.

The driven disk is manufactured of 50 steel (GOST 3680-57, GOST 914-56). Hardness is HRC 35-40. The disk is subjected to phosphatization. The driven disk hub is manufactured of 40Kh steel (GOST 4543-61). Hardness is HB 255-285. The disk is phosphatized and passivated in a solution of bichromate.

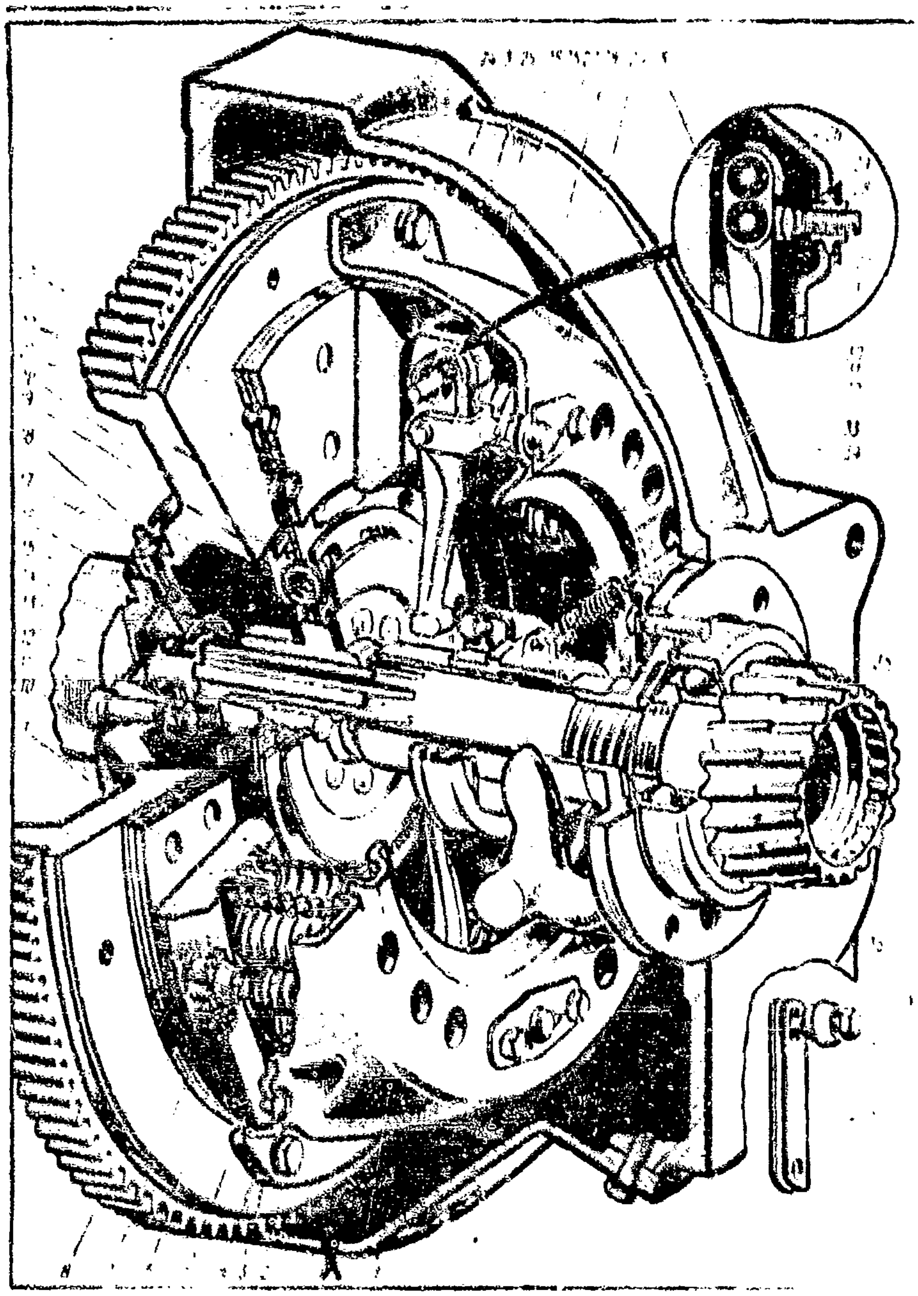


Plate 6-1. Single-disk clutch:
1) housing cover 2) flywheel 3) clutch cover 4 and 13) rivets 5) paired spring plates 6) bolt 7) formed bushing 8) pressure plate 9) insulating washer 10) pressure spring 11) damper disk 12) damper plate 14 and 32) ball bearings 15) hub 16) crankshaft flange 17) damper intermediate disk 18) lubrication fitting 19) oil deflector 20) elastic sleeve spring 21) sup-

[Plate 6-1, continued]

port plate 22) driven disk lining 23) steel driven disk 24) clutch housing 25) pins 26) needle bearings 27) support fork 28) adjusting nut 29) compression plate 30) pressure plate lever 31) guide sleeve 33) sleeve spring 34) throw out bearing sleeve 35) transmission input shaft 36) clutch disengagement fork

Table 6-1. Technical characteristics of the single-disk clutch

Parts and their parameters	ZIL-157K	ZIL-130 and ZIL-131
Clutch assembly		
Number of driven disks	1	
Full clutch pedal travel, mm	180	
Pedal working travel, mm	130-150	
Pedal free travel, mm	30-45	35-50
Number of friction linings	2	
Friction lining material	Asbestos composition	
Diameter of friction liners, mm:		
Exterior	341-342	
Interior	186-187	
Friction liner thickness, mm	3.9-4.1	
Diameter of holes for rivets in liner, mm	4.0-4.3	
Diameter of holes in liners for rivet heads, mm	9.5-9.7	
Thickness of shoulder in friction lining recess for rivet, mm	1.25-1.50	
Pressure springs		
Number of pressure springs	16	
Height of spring in free condition, mm	61.7-63.0	
Control height of spring, mm	45	
Load with spring at control height, kg	64-72	
Minimum allowable load at control height, kg	60	
Elastic sleeve spring (damper)		
Number of springs	8	

Spring height in free condition, mm		24.35-24.65	
Spring control height, mm (no less)		22.5	
Load with spring at control height, kg		50-65	
Spring height under compression to the point of coil touching, mm		21-22	
Clutch disengagement sleeve return spring			
Number of springs		1	
Spring length in free condition, mm (no greater)		36	
Spring control length, mm		56	
Load with spring at control length, kg		1.5-2.5	
Minimum allowable load with spring at control length, kg		1.2	
Clutch linkage spring			
Number of springs	1		1
Height in free condition, mm	130		180
Spring control height, mm	70		147
Load with spring at control height, kg	23-28		9-12
Minimum allowable load with spring at control height, kg	18		7
Clutch pedal return spring			
Number of springs	1		1
Spring length in free condition, mm	173		132
Spring control length, mm	217		174
Load with spring at control length, kg	23-31		22-29
Minimum allowable load with spring at control length, kg	20		18

The clutch disengaging sleeve is manufactured of SCh 15-32 cast iron (GOST 1412-54).

The clutch disengaging fork is manufactured of 45 steel (GOST 1050-60). Hardness of the tempered surface is HRC 52-62. Depth of the tempered layer is 1.0-4.0 mm.

The flange of the clutch disengaging fork is manufactured of SCh 15-32 cast iron (GOST 1412-54). The bushing of the fork flange is manufactured of KCh 35-10 wrought iron (GOST 1215-59).

The clutch disengaging fork lever is manufactured of KCh 35-10 wrought iron (GOST 1215-59).

The clutch disengaging linkage is shown in Plate 6-2.

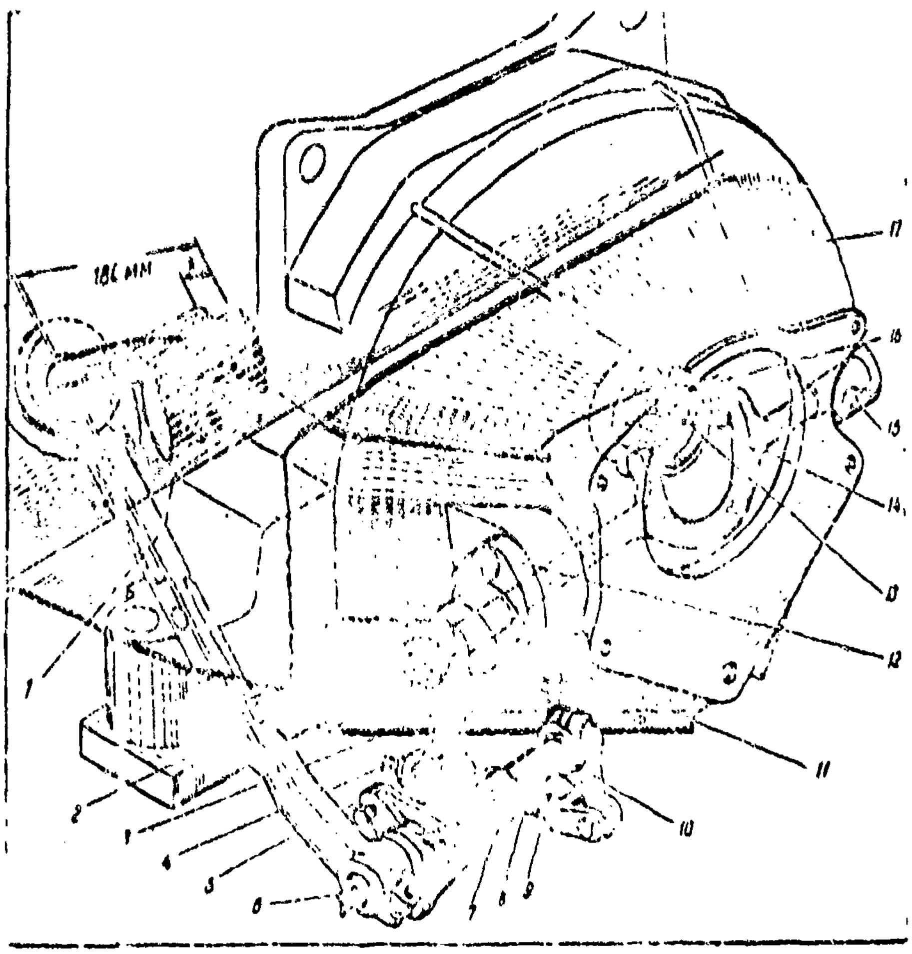


Plate 6-2. Clutch disengaging linkage of the ZIL-130 motor vehicle:
1) pedal 2) return spring 3 and 10) levers 4) stop nut 5) shaped adjusting nut 6, 11, and 15) lubricatinn fittings 7) pedal shaft 8) spacing spring 9) rod 12) flange 13) sleeve spring 14) clutch disengaging fork 16) sleeve with bearing 17) clutch housing

Technical servicing

The single-disk clutch is not adjusted on the motor vehicle. If necessary, the clutch is removed and adjusted.

Care for the clutch includes cleaning the dirt from it and the timely tightening of bolts fastening the clutch housing to the cylinder block. These bolts are torqued (torque moment is 8-10 kg meters). The bolt heads are stopped with plates whose ears are bent up against a flat on the bolt head.

Care for the clutch linkage consists of adjusting the pedal free travel by means of changing the length of the rod. The clutch disengagement sleeve bearing does not require lubrication during operation. The clutch disengagement fork and pedal shafts are lubricated according to the lubrication chart (see Appendices 10 and 11--see Part II). For adjustment of the clutch disengaging linkage, see Plate 6-10.

Disassembly and assembly

During removal of the clutch, it is necessary to unscrew the bolts fastening the transmission to the clutch housing, disconnect the transmission from the housing, and remove it.

Unscrew the bolts fastening the clutch housing shield and remove it.

Unscrew the bolts fastening the lower cover of the clutch housing and remove the cover.

Loosen the tension bolt fastening the lever on the fork shaft, remove the lever, and drive out the key.

Loosen the two bolts fastening the bushing flange and remove it.

Pull out the clutch disengagement fork, after previously moving it to the left and inclining it downward.

The clutch is dynamically balanced in assembly with the crankshaft at the plant. To maintain the balance, before removing the clutch from the flywheel, it is necessary to make marks on the flywheel and the pressure plate cover. This will allow them to be installed in their original position, not destroying the factory balancing.

Unscrew the bolts fastening the pressure plate cover to the flywheel. While unscrewing the bolts, rotate the flywheel sequentially. The bolts must be unscrewed gradually and in sequence, in order to avoid deforming the cover.

Remove the pressure plate in assembly and remove the clutch driven disk.

Disassembling the pressure plate. Before beginning disassembly, mark the relative positions of all parts of the clutch. For disassembly of the pressure plate, an auxiliary flywheel and steel disk 9.8 mm thick must be used in place of the driven disk. In place of the steel disk, any hard lining of the given dimensions can also be used. If necessary, various attachments with quick clips can be used for pressure plate disassembly, but with the mandatory installation of the pressure plate disk on eight centering studs or bolts with the consequent pressure of the jacket on its feet.

For disassembly of the clutch pressure plate, it is necessary to set the flywheel on the bench, lay the disk on the working surface of the flywheel, set the pressure plate in assembly with its cover on it, and fasten it to the flywheel with lengthened bolts. The bolts must be 10-12 mm longer than the normal bolts used for fastening the cover.

It is recommended that disassembly of the pressure plate take place in the following order. Unpin the bolts fastening the support plates, unscrew them, and remove the plates from the clutch cover. Unscrew the adjusting nuts with a special wrench.

Unscrew the bolts fastening the paired spring plates, and remove the guiding bushings from the shaped holes in these plates. Then gradually unscrew all the bolts fastening the cover to the flywheel, until pressure is completely released from the pressure plate, and then screw out these bolts completely. Remove the cover, the pressure springs, and the insulation washers.

Mark the position of each clutch disengaging lever relative to the pressure plate, unpin and remove the pins connecting the levers with the pressure plate, remove the levers in assembly with the support forks, and extract the rollers from their receptacles in the levers. Unpin and drive out the pins connecting the levers with the support forks, remove the forks from the levers, and extract the rollers from their receptacles in the levers. Remove the pressure plate from the auxiliary flywheel.

If there are no additional bolts of extended length available, disassembly of the pressure plate may be conducted in the following manner.

Install the pressure plate in assembly on the flywheel, with the steel auxiliary disk 9.8 mm in thickness, and fasten them with normal bolts.

Unpin and unscrew the bolts fastening the support plates and remove the plates from the cover. Unscrew the bolts fastening the paired spring plates and drive the guide bushings from their shaped holes in the plates. Preliminarily unscrew the adjusting nuts and leave them on the forks (on approximately half the height of the threaded portion of the nut); then unscrew all the normal bolts fastening the clutch cover on the flywheel, and after this, pressing on the cover by hand, finally unscrew the adjusting nuts, unscrewing them pair-wise on opposite sides of the cover until the springs are fully freed from pressure. After this, remove: the clutch cover, pressure springs, insulation washers, clutch disengaging levers, and pressure plate from the flywheel.

Having disassembled the clutch, it is necessary to wash out all the parts in a degreasing solution, check them for usability, and if necessary, replace unusable parts with new ones.

Assembly of the pressure plate. The pressure plate should be assembled in a sequence which is the reverse of that for disassembly on an auxiliary flywheel (used as a tool), placing a device (Plate 6-3) for regulating the position of the clutch disengaging levers beneath the pressure plate.

Allowable deviation in parallelness between the surfaces of the shoulders of the device must be no greater than 0.01 mm. In this, the plane of the surfaces of the shoulders must be parallel to surface three of the projection on which the control plate is installed. The allowable nonparallelness is no greater than 0.02 mm.

Set the flywheel on a metal working bench, lay the steel disk or adjusting device on it, and set the clutch pressure plate on them.

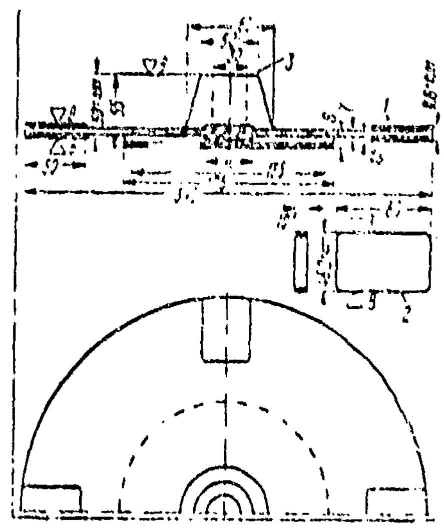


Plate 6-3. Device for regulating the position of clutch disengaging levers: 1) device shoulders 2) control plate 3) device projection surface for installing the control plate

Assemble the needle bearings. For this, insert a technological ball which is 8.8-9.9 mm in diameter, and made of soft oil-resistant rubber in the hole in the lever, and then insert 19 rollers, lightly lubricated with oil, between the rubber ball and the wall of the hole in the lever. Insert 19 rollers into the second lever hole by the same method.

Align the holes on the support fork with the hole in the lever. In this, the spherical projection on the inside end of the lever must be directed the same way as the threaded end of the fork. After pushing out the rubber ball, insert the short pin in the aligned holes. Place cotter keys in the pon.

If a rubber ball is not available, the rollers may be assembled by placing a layer of grease on the surface of the hole, and the needle rollers are placed in the second hole after assembly of the lever with the fork.

Observing the marks made during disassembly, install the lever in the slot in the pressure plate bracket, after aligning the holes in the lever and in the bracket. After driving out the rubber ball, insert the long pin in the aligned holes. Insert cotter keys in the pin.

Install the remaining levers by a similar method. During this, the heads of identical pins must be in the same positions relative to the pressure plate.

Install the insulating washers on the pressure plate, and set the pressure springs on the washers. Align the marks made during disassembly for maintaining balance on the cover and plate, and set the clutch cover on the springs, guiding them onto the projections of the inner surface of the cover. In this, the threaded ends of the support forks must go into the holes in the cover.

Lightly pressing on the cover, screw the adjusting nuts onto the threaded ends of the fork by one or two turns.

Align the holes in the support feet of the cover with the threaded holes in the auxiliary flywheel, insert the lengthened centering bolts, and draw the cover feet to the flywheel, screwing in all the bolts gradually and in sequence.

Install the bushings into the formed holes in the paired spring plates, screw in the bolts fastening these plates, tighten the bolts,(torque moment is 1.0-1.5 kg meters), and then lock them by driving the thin edge of the bushing onto a flat of the bolt head.

Screw in the adjusting nuts with a wrench (Plate 6-4) until the face of the nut coincides with the face of the threaded end of the fork.

Install the support pressure plates on the adjusting nuts, screw in the bolts fastening these nuts, and tighten them preliminarily until the ends of the plates touch the jacket.

Adjusting the clutch disengaging levers. Without removing the assembled pressure plate of the clutch from the auxiliary flywheel (used as a tool), it is necessary to adjust the positions of the levers relative to the working surface of the pressure plate.

Rotating the adjusting nuts with a wrench (Plate 6-5, a), set all the levers in such a position that the distance from the working surface of the pressure plate to the top of the spherical projections on the inner ends of the levers is within the limits of 39.7-40.7 mm. With this, the ends of the levers must lie in the same plane, parallel to the working surface of the pressure plate with inaccuracy of no more than 0.5 mm.

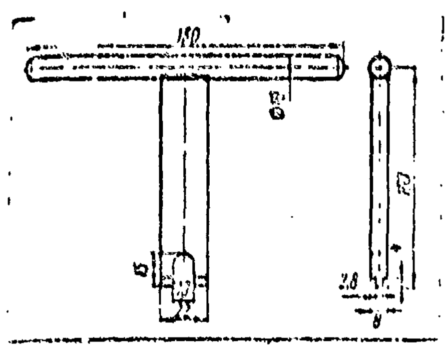


Plate 6-4. Wrench for adjusting the clutch

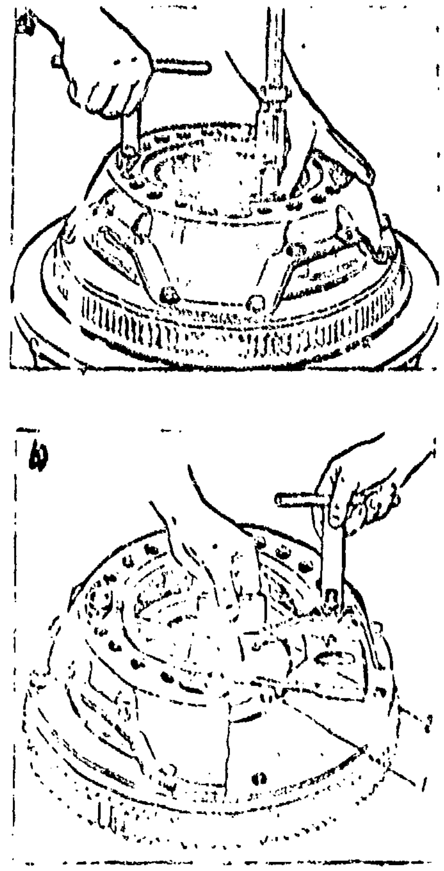


Plate 6-5. Clutch adjustment:
a) adjusting and checking the position of the levers with a bar depth gauge;
b) adjusting and checking the positions of the levers with the device and control plate; 1) device 2) control plate

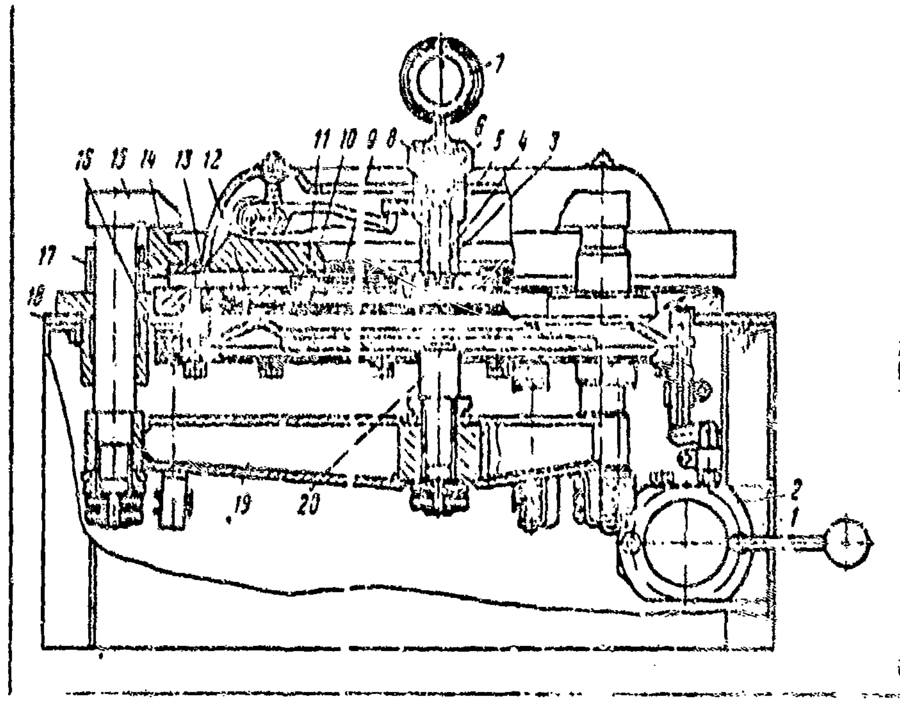


Plate 6-6. Device for adjusting the clutch:
1) body 2) valve 3 and 20) rods 4) measuring installation body 5) measuring bushing 6) spring 7) indicator 8) movable ring 9) disk 10 and 11) studs 12) diaphragm 13) cover 14) pressure ring 15) lever 16) busing 17) limiting bushing 18) plate 19) spider

In case the pressure plate of the clutch is assembled on a device for adjustment (see Plate 6-3), ahe levers should be installed with the control plate as shown in Plate 6-5, b. In this, the spherical projections of the levers must touch the control plate 2, which is installed on the projection of the device 1.

Disassembly, assembly, and adjustment of the clutch may be conducted on a GARO model R-207 device (Plate 6-6). The clutch springs are compressed by three turning levers 15 through compression ring 14. The levers are brought into their working position with the help of a pneumatic chamber with a central rod 20 and spider 19.

The necessary mutual position of the working planes of the clutch pressure plate and the support plane of the clutch housing is provided by disk 9 with calibrating support studs 10.

The measuring device is installed on rod 3, which is fastened in the center of cover 13.

With the assembled clutch on the R-207 device, the clutch disengaging levers are set by rotating the adjusting nuts with a wrench in such a position that the distance from the working surface of the pressure plate to the top of the spherical projections or the inner ends of the levers is within the limits of 39.7-40.7 mm.

In this, the ends of the levers must be located in the same plane, parallel to the working surface of the pressure plate, with inaccuracy of no greater than 0.5 mm, which is checked by indicator 7.

Having finished clutch adjustment, tighten the bolts fastening the support plates (torque moment is 1.0-1.5 kg meters). Then pin the bolts (as a set of eight) with lightly annealed steel wire, 1 mm in diameter.

Punch the threaded connection of the adjusting nut with the threaded end of the fork on one point.

Unscrew the bolts fastening the cover to the auxiliary flywheel and remove the pressure plate in assembly with the cover. During this, all the bolts are unscrewed gradually and sequentially to avoid deformation of the clutch cover.

Changing the friction liners. The liners on the driven disk are changed if they are scored, peeled, or if the friction liners are worn down to the heads of the rivets. The liners are replaced in the following manner. Lay the driven disk on backing blocks set so that there is a gap wide enough for passage of the rivet heads between them. This position of the blocks is necessary to prevent deformation of the steel disk.

Knock out the rivets with a punch and remove the worn-out friction liner. The diameter of the working end of the punch must be 2.[illegible] mm. The rivets should be knocked out from the side where they are rolled in. Remove the second friction liner in the same manner.

If the new friction liners do not have holes for eight rivets, they must be drilled, using the steel driven disk as a guide.

The diagram for drilling holes in the new liners for the rivet heads and holes for rolling the rivets out is shown in Plate 6-7, a. The liners must be fastened to the driven disk with brass rivets whose dimensions are given in Plate 6-7, b.

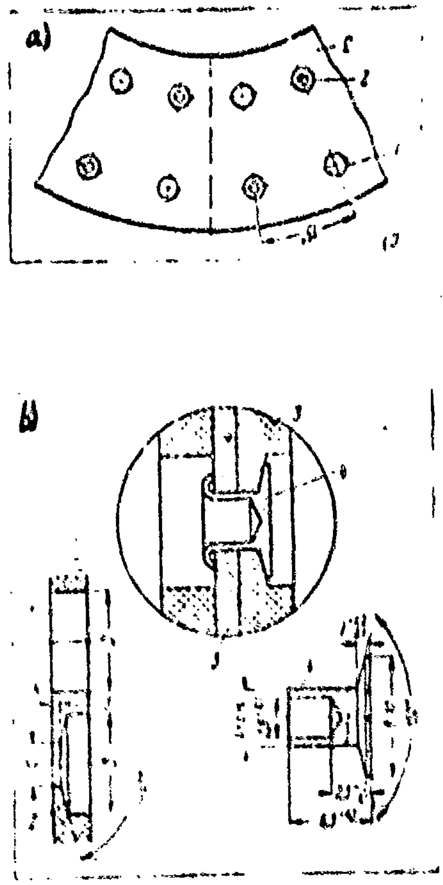


Plate 6-7. Fastening the friction liners of the clutch driven disk with rivets:
a) diagram of hole positions for rivets b) riveted connection 1) through hole for rolling the rivet 2) receptacle for rivet head 3) driven disk friction liner 4) rivet 5) steel disk

For fastening the friction liners, it is necessary to lay the steel driven disk on the friction liner and align the holes in the liner and the disk using a rod which is 4 mm in diameter. Insert the rivet into its receptacle in the liner so that its tubular portion projects above the steel disk. Rest the head of the rivet on the cylindrical insert 4 (Plate 6-8) which is 9 mm in diameter and installed on the table of a bench press (backing plates assuring the horizontal position of the driven disk must be placed on the diametrically opposite side beneath the insert).

Set the projecting end of the working part 8 of the plunger on the rivet and roll it, pressing on the mandrel of the plunger 7 with a press, as shown in Plate 6-8, a. After pressing, the rivet must have a circular bead, on which one or two radial breaks are allowable. There must be no clearance between the steel disk and the circular bead. The rolled-out rivet must not rotate or move in an axial direction. The second rivet is clinched on the diametrically opposite side of the disk. The remaining rivets are rolled in an arbitrary order. The friction liner on the other side of the steel disk is clinched on in a similar order. There must be no cracks in the linings after rolling the rivets.

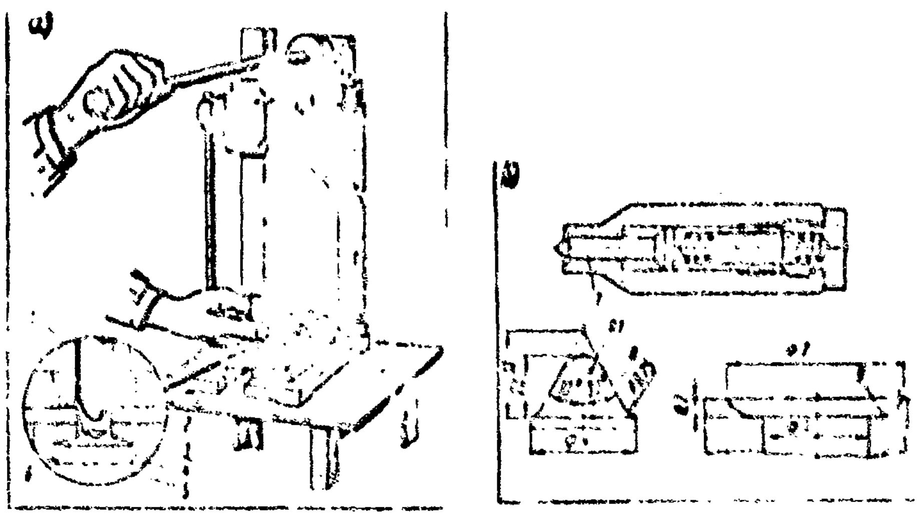


Plate 6-8. Rolling the rivet fastening the driven disk friction liner:
a) rolling the rivets with a press b) mandrel 1) punch
2) friction liner 3) rivet 4) insert 5) plate 6) steel disk
7) mandrel plunger 8) plunger working part 9) mandrel working part

The driven disk may become warped during exchange of the friction liners. Therefore, the driven disk with its newly riveted liners should be checked for the absence of warping. The method of checking is shown in Plate 6-9. Oscillation of the driven disk is not allowed to be greater than 0.8 mm, and non-flatness is not allowed to be greater than 0.5 mm. If oscillation exceeds a given amount, the driven disk should be corrected with a special clamping device as shown in the illustration.

If the rivets fastening the hub loosen, they must be tightened or replaced. If the springs in the elastic sleeve (damper) of the driven disk are broken, they should be replaced.

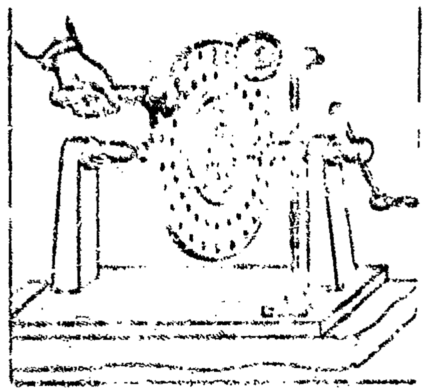


Plate 6-9. Checking and correcting the clutch driven disk

Installation of the clutch in the motor vehicle. Install the driven disk, directing the projecting part of the disk hub toward the flywheel install the pressure plate and cover assembly on the flywheel, aligning the marks made on the cover and flywheel during disassembly, and tighten the cover on the flywheel by preliminarily screwing in several of the fastening bolts by hand.

Center the driven disk relative to the flywheel with a grooved mandrel or auxiliary transmission input shaft, inserting it into the grooved hole in the driven disk hub and in the bearing in the crankshaft flange. Screw in the partially fastened bolts and final tighten the cover to the flywheel, having placed spring washers beneath the head bolts beforehand. All the bolts must be tightened gradually and sequentially.

Remove the auxiliary shaft from the grooved hole. Install the clutch disengagement fork and the fork flange and fasten it with bolts and spring washers.

Then, install the key in the fork shaft keyway, mount the fork lever, and tighten the lever stop screw.

Install the transmission on the pins in the clutch housing and connect the fork to the clutch throw out bearing sleeve. Tighten the nuts fastening the transmission to the clutch housing.

Install the housing cover and shield and fasten them with bolts.

The clutch linkage in all ZIL trucks has identical construction, and therefore all operations connected with disassembly, assembly, and adjusting of the linkage are the same for all of the trucks.

During disassembly of the clutch disengaging linkage, it is necessary to remove the return spring 2 (see Plate 6-2) of the clutch pedal 1. Unscrew stop nut 4 and the spherical adjusting nut 5 of the pedal rod. Take rod 9 out of the holes in the fork of lever 3 and remove the support washer and spacing spring 8. Remove the cotter key from the pin connecting rod 9 and lever 10 of the pedal shaft, remove the washer, withdraw the pin, and remove the rod (in motor vehicles with in-line engines, remove the pin connecting the support ring and pedal shaft, and then remove the support ring and clutch pedal from the shaft. Loosen the fastening tension screw of lever 10 and remove it from the shaft. Loosen the fastening tension bolt of the pedal and remove the pedal from the shaft. Pull the pedal shaft from its bracket. Unscrew the nuts fastening the pedal shaft bracket and remove the bracket from the longitudinal frame rail.

After disassembly, all parts of the linkage should be washed out and inspected, and unusable parts should be replaced with new ones if necessary.

If the hole for the axis (shaft) of the clutch pedal is worn more than the allowable amount, it is recommended that the hole be drilled out and a repair bushing be installed.

Worn-out faces of the bosses (hubs) of the pedal are renewed by welding with subsequent machining.

If the pedal is bent, it is recommended that it be straightened.

Assembly. Align the holes in the bracket of pedal shaft 1 with the holes in the longitudinal frame rail, insert the bolts with their heads outside, and screw nuts onto them, with spring washers inserted beneath the nuts. Insert the shaft in the bracket, mount the clutch pedal on the shaft, with its fluted surface upward, and tighten its tension bolt (in motor vehicles with in-line engines, mount the support ring, and after aligning the holes in it with the holes in the axis, insert a cotter key and bend out its ends).

Mount lever 10 on shaft 7 and tighten its tension bolt.

Align the holes of the forked end of rod 9 with the holes in lever 10 of the pedal, insert the connecting pin with its head toward the side of the longitudinal frame rail, and fasten it with a cotter key.

Mount spring 8 and its washer on rod 9, insert the end of the rod in the holes in lever 3 of the fork, and screw on the spherical adjusting nut 5 (with its spherical side toward the fork lever), and then screw on the stop nut by hand.

Install the return spring 2 and fasten its pins at the pedal and the bracket on the frame cross member.

After assembly of the linkage, clutch pedal free travel must be adjusted with the engine installed in the motor vehicle with the help of a measuring device.

Adjustment. Install the measuring device (Plate 6-10, a) on the inclined floor of the cab, and then, rocking the pedal by hand, determine the free play A of the pedal (see Table 6-2).

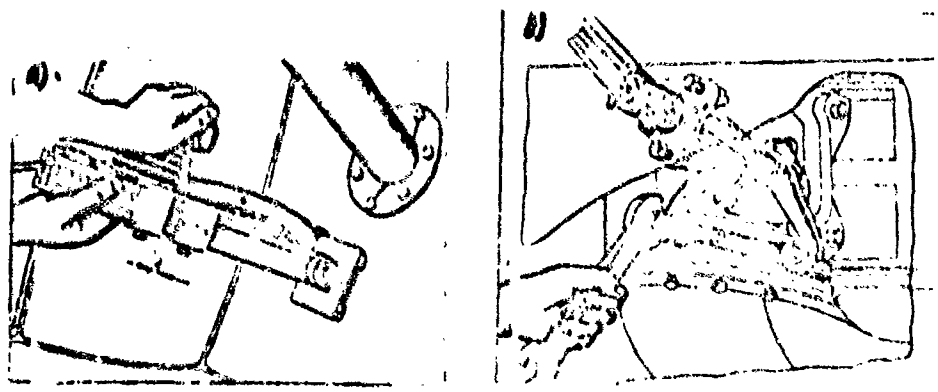


Plate 6-10. Adjustment of the clutch pedal free play:
a) measurement of the pedal free play with a device
b) adjustment of the pedal free play A = amount of clutch pedal free play

With proper adjustment, the free play of the clutch pedal must provide a clearance between the ends of the levers and the throw out bearing within the limits of 3.0-4.0 mm.

If the amount of pedal free play does not correspond to the indicated dimension, the linkage should be adjusted. For this, it is necessary to unscrew the stop nut on the clutch disengaging rod by several turns, after which, turning the adjusting spherical nut with a wrench (Plate 6-10, b), adjust the amount of pedal free play. In this operation, pedal travel is decreased by turning the nut to the right, and increased by turning the nut to the left. After adjustment, the stop nut is tightened, without allowing rotation of the spherical adjusting nut during tightening of the stop nut.

After adjustment, start the engine and check the proper operation of the clutch.

Dimensions of parts

The pressure plate. Thickness of the pressure plate, measured along the bosses for fastening the paired spring plates, is 25.72-26.00 mm. With overhaul of the pressure plate, the working surface is allowed to be ground down to a dimension of no less than 24.7 mm.

Non-flatness of a new disk or one which has been repaired is not allowed to be greater than 0.1 mm. Warping of a pressure plate is not allowed to be greater than 0.8 mm without being repaired.

Pressure plate levers. The diameter of the holes for the needle bearings in the pressure plate levers is 11.42-11.47 mm. Allowable dimension of the hole in a lever without being repaired is 11.49 mm.

The number of rollers in one joint of the lever is 19. Roller diameter is 1.59-1.60 mm. The diameter of the pins for the fork and lever is 8.17-8.20 mm. The allowable dimension of the pin without being repaired is 8.15 mm. The diameter of the hole in the support fork of the lever and in the pressure plate bracket for the lever pin is 8.2000-8.258 mm.

The allowable dimension of these holes without repair is 8.3 mm.

If the pins or holes in the lever, fork, and bracket of the pressure plate are worn more than the allowable amounts, they should be replaced.

The driven disk. The diameter of the driven disk is 342 mm. Thickness of the steel disk is 1.8 mm. Thickness of the disk in assembly with its friction liners is 9.44-10.16 mm. The limiting allowable thickness of a disk before replacement of the friction lining is 6.4 mm.

The nominal width of a slotted groove in the hub is 5.89-5.94 mm.

The allowable width of a slotted groove without repair is 6.05 mm. If the slotted groove is worn more than the allowable value, the hub is replaced.

Non-flatness of the working surface of the driven steel disk must be no greater than 0.3 mm. Non-flatness of the disk in assembly with its friction liners is not allowed to be greater than 0.5 mm.

Oscillation of the working surface of the driven disk in assembly with its friction liners with the hub installed on a grooved mandrel is not allowed to be greater than 0.8 mm.

If the rivets fastening the friction liners are loose or the liners are worn more than the allowable values, they should be replaced.

The clutch disengagement sleeve. The distance between the faces of the clutch disengagement sleeve and the clutch disengagement fork is 85.54-85.77 mm. The length of the face at the fork is 11 mm. The allowable dimension before being overhauled is 12.0 mm.

The diameter of the hole in the sleeve for the race of the transmission input shaft bearing is 47.60-47.65 mm. The allowable dimension before overhaul is 47.9 mm.

If the hole in the sleeve for the face of the bearing race is worn, the sleeve should be replaced.

The diameter of the face of the sleeve for the outside ring of the clutch throw out bearing is 55.002-55.032 mm.

The clutch disengaging fork. The diameter of the support faces of the clutch disengaging fork is 24.955-25.000 mm. The allowable dimension of the fork faces without being repaired is 24.92 mm. If the support faces of the clutch disengaging fork are worn more than the allowable amount, the fork should be replaced.

The distance between the ends (faces) of the fork is 86.00-86.23 mm. The allowable dimension between the ends of the fork without being repaired is 88.00 mm. It is recommended that the fork faces be repaired by welding and subsequent machining.

a Размер	b Номинальный	c Допустимый без ремонта
d Диаметр оси педали	24,955—25,000	24,9
e Диаметр отверстия в педали под ось	25,000-25,084	25,12
f Диаметр отверстия во втулке кронштейна под вал педали	25,0-25,05	25,085
g Диаметр отверстия в педали под палец тяги	—	—
h Диаметр отверстий в тяге под соединительный палец	12,24-12,30	12,6
i Диаметр отверстия в рычаге вала педали под соединительный палец	12,3-12,34	12,7
j Диаметр соединительного пальца	11,88—12,000	11,8

Table 6-2. Dimensions of clutch linkage parts, mm.

Key:
- a) dimensions
- b) nominal
- c) allowable without repair
- d) pedal shaft diameter
- e) diameter of shaft hole in pedal
- f) diameter of bushing in bracket for pedal shaft
- g) diameter of hole in pedal for rod pin
- h) diameter of hole in [illegible] for connecting pin
- i) diameter of hole in pedal shaft lever for connecting pin
- j) diameter of connecting pin

Width of the keyway is 5.945-5.990 mm. The allowable dimension of the keyway without being repaired is 6.01 mm.

Oscillation of the support faces of the clutch disengagement fork is not allowed to be greater than 0.12 mm. If oscillation is greater than that allowable, the fork must be corrected.

Diameter of the hole for the fork flange bushing is 30.000-30.045 mm. The allowable dimension without being repaired is 30.07 mm. If the hole for the bushing in the flange is worn, it should be reamed out to a repair dimension of 30.250-30.289 mm.

The exterior diameter of the flange is 41.95-42.00 mm. The allowable dimension without being repaired is 41.90 mm. If the exterior diameter of the flange is worn to more than the allowable, the flange should be replaced.

The diameter of the hole in the flange bushing for the clutch disengaging fork is 25.060-25.130 mm. The allowable dimension without being repaired is 25.17 mm. If the hole in the bushing is worn to more than the allowable dimension, the bushing should be replaced.

The diameter of the hole in the lever for the clutch disengaging fork shaft is 25.977-25.010 mm. The allowable dimension of the hole for the fork shaft without being repaired is 25.3 mm.

The diameter of the hole for the clutch disengaging rod is 24 mm.

If the lever is bent, it should be straightened. If the threads in the holes for the fork lever fastening tension bolt are damaged, it is recommended that the hole be welded up, drilled out, and tapped with a M10 X 1.5 class 2 thread.

The dimensions of parts for the clutch disengaging linkage are presented in Table 6-2.

Chapter 7. Transmissions

Layout

The plant began to produce the transmissions for the ZIL-130 motor vehicle in April of 1961. Transmissions for the ZIL-157K and ZIL-131 motor vehicles and their modernizations have some minor design differences from the transmissions of the ZIL-130 motor vehicles.

The transmission for the ZIL-130 motor vehicle is three-throw, five-speed, with all gears except low gear and reverse gear in constant engagement.

The transmission is equipped with two inertia type synchronizers for engagement of second and third, and fourth and fifth gears.

The transmission of the ZIL-130 motor vehicle is assembled with a drum type hand brake (Plate 7-1, a).

The transmission (Plate 7-1, b) without the hand brake and with changed cover and additional levers for controlling the transfer case and the front drive axle is intended for installation on the three-axle ZIL-157K and ZIL-131 motor vehicles. There is no speedometer drive in the transmissions for the three-axle motor vehicles, since it is installed in the transfer case.

Various modifications on the transmission (Plate 7-2) differ in gears 19 and 21 of the speedometer drive, which are calculated on the [illegible] transmission ratio of the rear axle.

Since the third quarter of 1967, the front bearing of the transmission input shaft has been installed with a separator instead of a needle bearing. In connection with this, the design of the input shaft journal for the bearing and the receptacle for the bearing in the input shaft were changed, and the stop ring was eliminated.

To prevent water from falling into the transmission (Plate 7-3) when fording streams, the transmission gear selection lever of a ZIL-131 motor vehicle is sealed with a rubber boot and tension clamps. The transmission housing surface which fits against the clutch housing, the transmission cover, inspection hole cover, and bearing cover are also sealed with a special paste (VTU MKhP 3336-52). The internal space of the transmission is connected with the atmosphere through ventilating tube 17.

In all operations connected with opening and disassembling the transmission, assembly is conducted with the use of the noted sealing paste.

All transmissions have a factory serial number which is stamped on the upper right boss of the transmission housing.

Technical Characteristics of the Transmission

Transmission type	Mechanical, with five speeds forward and one reverse
Synchronizers	Two inertia type for engagement of second and third, and fourth and fifth gears
Transmission ratios:	
First gear	7.44
Second gear	4.10
Third gear	2.29
Fourth gear	1.47
Fifth gear	1.0 (straight)
Reverse gear	7.09
Maximum torque moment transmitted by the transmission, kg meters	41

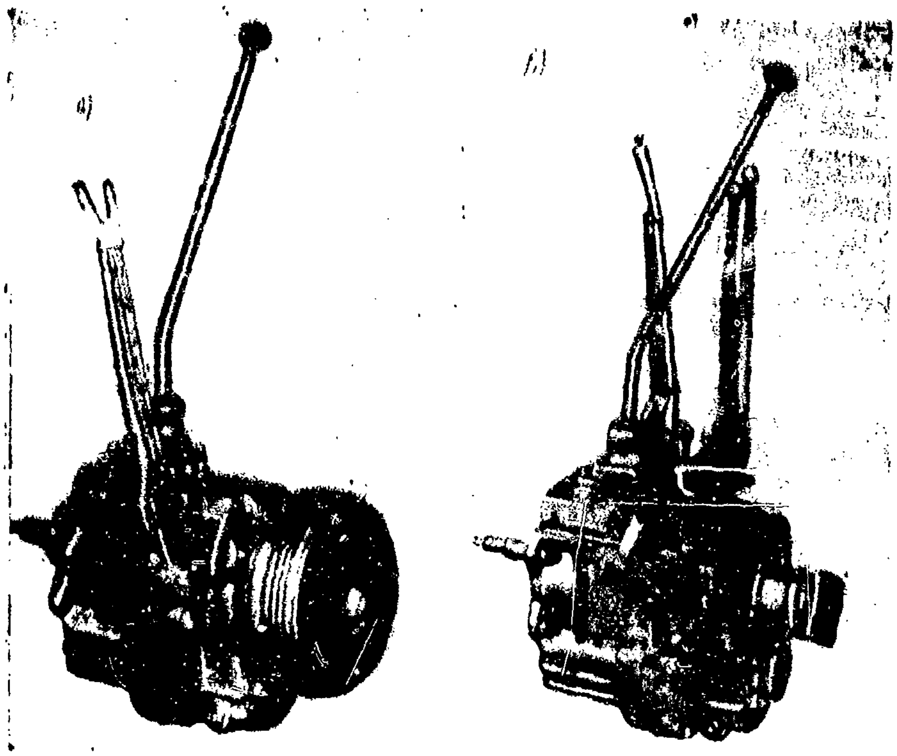


Plate 7-1. Overall view of transmissions:
a) for ZIL-130 motor vehicles
b) for 3-axle motor vehicles

Gear selection	Lever, installed on the transmission cover
Power take-off	From the reverse gear cluster
Maximum take-off power, hp	30

The transmission housing is cast of type SCh 18-36 iron, GOST 1412-54.

The input shaft (Plate 7-4) is manufactured of 25 KhGM steel. Depth of the hardened layer is 0.5-0.7 mm, hardness of the surface layer is HRC 60-65, and hardness of the core is HRC 35-45.

The input shaft gear and synchronizer carrier 10 (Plate 7-5) is manufactured of 25 KhGM steel, and the depth of the hardened layer is 0.5-0.7 mm. Hardness of the surface layer is HRC 57-60, and hardness of the core is HRC 35-45.

The input shaft (Plate 7-6) is manufactured of 25 KhGM steel; depth of the hardened layer is 0.8-1.1 mm, and hardness of the surface layer is HRC 60-65, and hardness of the core is HRC 35-45.

The intermediate shaft (Plate 7-7) is manufactured of 25 KhGM steel; depth of the hardened layer is 0.8-1.1mm, hardness of the surface layer is HRC 57-60, and hardness of the core is HRC 35-45.

The gear cluster is manufactured of 25 KhGM steel; depth of the hardened layer is 0.5-0.7 mm, hardness of the surface layer is HRC 57-60, and hardness of the core is HRC 35-45.

The reverse gear cluster shaft is manufactured of 25 KhGM steel; depth of the hardened layer is 0.5-0.8 mm, and hardness of the surface layer is HRC 60-65.

The gear selector lever unit is shown in Plate 7-8, and the transmission cover is shown in Plate 7-9.

Technical service

During TS-2, it is necessary to check the fastening of the transmission to the clutch housing, the fastening of the side and top covers, and to wash out the air passage in the vent, whose clogging causes increased pressure in the transmission housing and will lead to oil leaks. The magnetic plug in the drain hole should be cleaned when oil in the transmission housing is changed (every six TS-2).

Whenever changing or adding lubricant, it is necessary to clean dust and dirt off the transmission.

Lubricant should be measured immediately after stopping the motor vehicle, when the unit is still warm, and fresh oil should be poured in through the filler hole in the transmission housing up to the level of that hole. If there is a power take-off box on the transmisiion, oil must be poured in through the hole on the power take-off box housing.

The front bearing of the transmission input shaft is lubricated through the lubrication fitting 18 (see Plate 6-1), which is screwed into the passage in the crankshaft flywheel.

To lubricate the bearing, it is necessary to remove the clutch housing cover from beneath the automobile and rotate the crankshaft so that the lubrication fitting is directed downward. On the ZIL-130 and ZIL-131 motor vehicles, beginning in April 1967, a bearing was installed with a constant supply of lubricant (for the entire time of its operation). In this case, the passage is blocked with a plug.

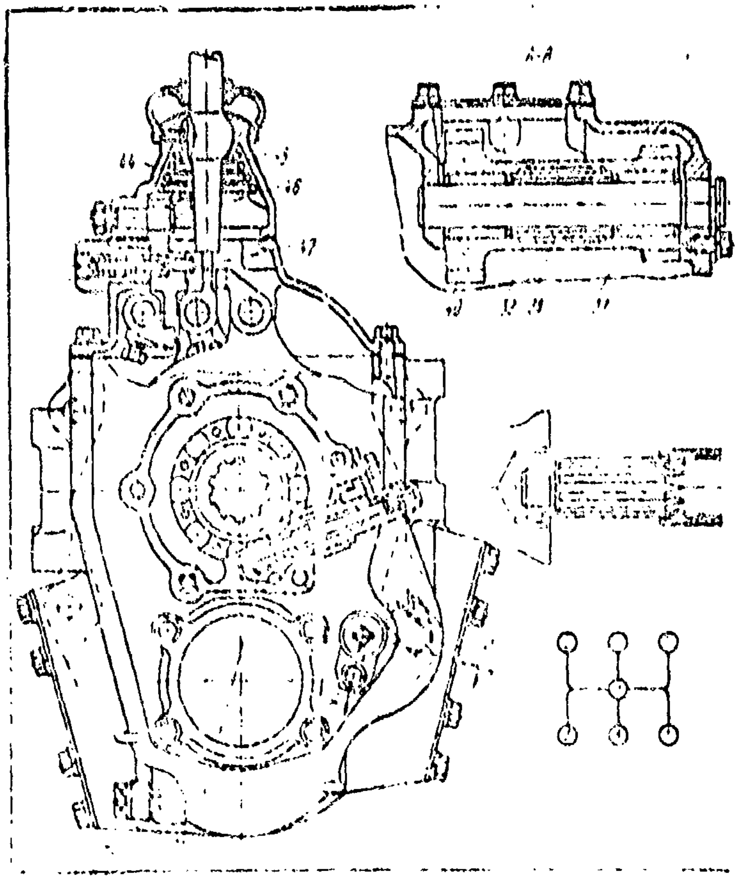
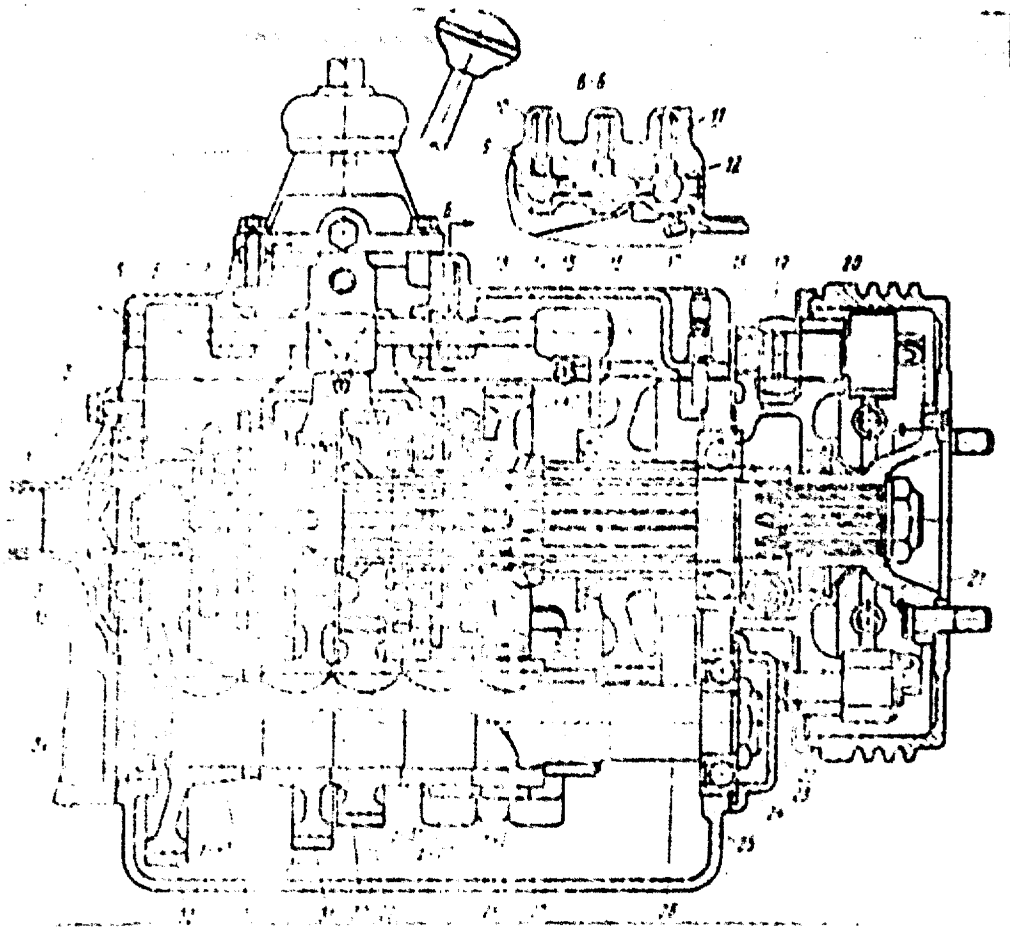
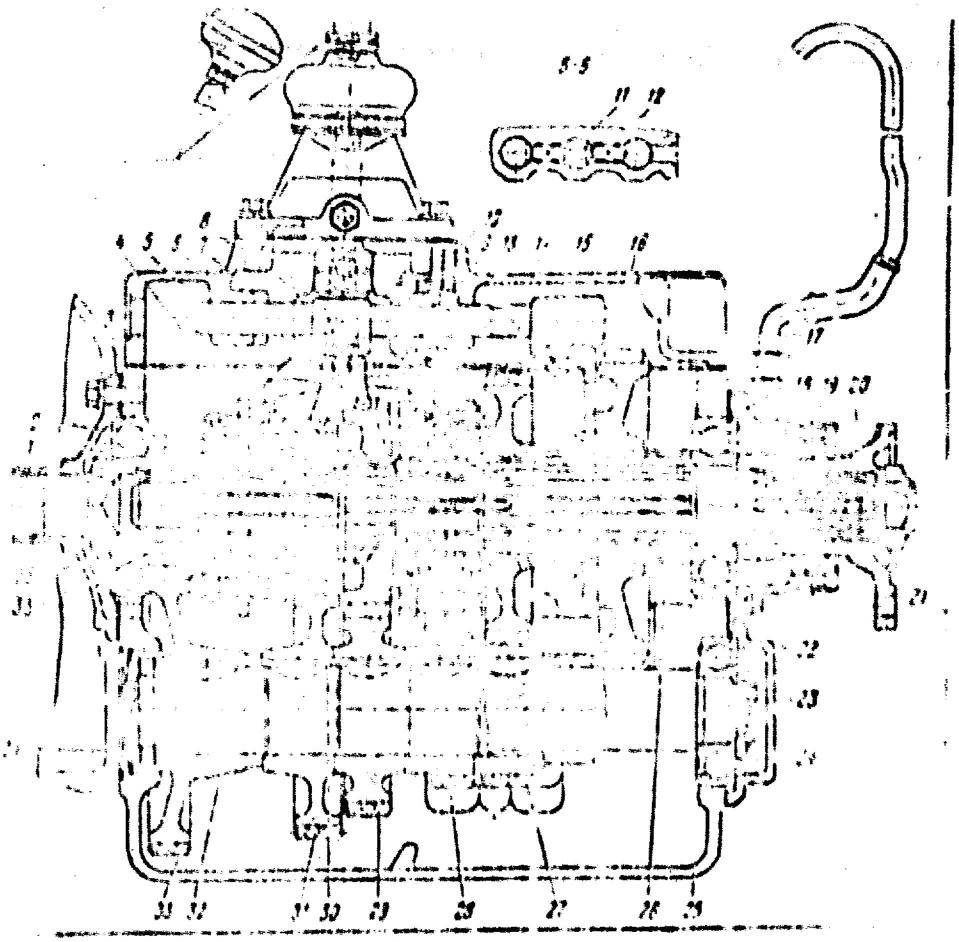


Plate 7-2. Transmission of ZIL-130 motor vehicle:
1) input shaft 2, 18, 24, 34, 35, and 37) bearings 3) input shaft bearing cover 4) fourth and fifth gear synchronizer 5 and 31) fourth speed gears 6 and 29) third speed gears 7) fourth and fifth speed changing fork 8) second and third speed changing fork 9) catch lock ball 10) catch lock spring 11) lock pin 12) lock ball 13) second and third speed synchronizer 14 and 27) second speed gears 15) first and reverse gear changing fork 16) first and reverse gear 17) vent 19) speedometer drive gear 20) hand brake drum 21) speedometer driven gear 22) intermediate shaft bearing cover 23) bearing fastening nut 25) transmission housing 26) output shaft 28) reverse gear 30) fourth speed gear bushing 32) intermediate shaft 33) intermediate shaft constant engagement gear 36) input shaft bearing fastening nut 38) spacing bushing 39) reverse gear cluster shaft 40) reverse gear cluster 41) filler hole plug 42) drain hole plug 43) transmission cover 44) lever housing 45) lever spring 46) lever 47) protector support



[Plate 7-2, continued]



[Plate 7-3, continued]

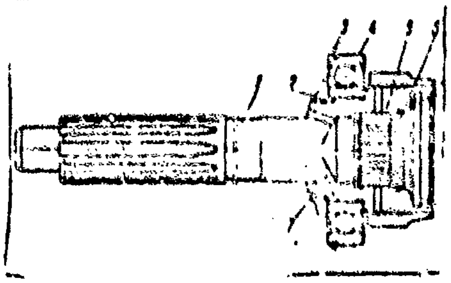


Plate 7-4. Transmission input shaft assembly:
1) shaft 2) nut 3 and 6) lock rings 4) bearing 5) needle bearing rollers 6) thin edge of nut pressing into shaft slot

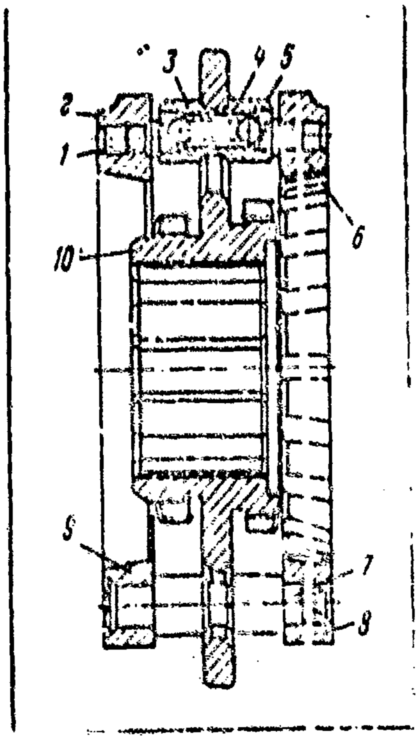


Plate 7-5. Synchronizer
1) catch lock support 2 and 9) conic ring 3) catch lock 4) catch lock spring 5) catch lock ball 6) profile of spiral passage on conic surface of ring (for rapid passage of oil from the cone surface at the moment of gear changing) 7) blocking finger 9) conic surface of ring 10) synchronizer carrier

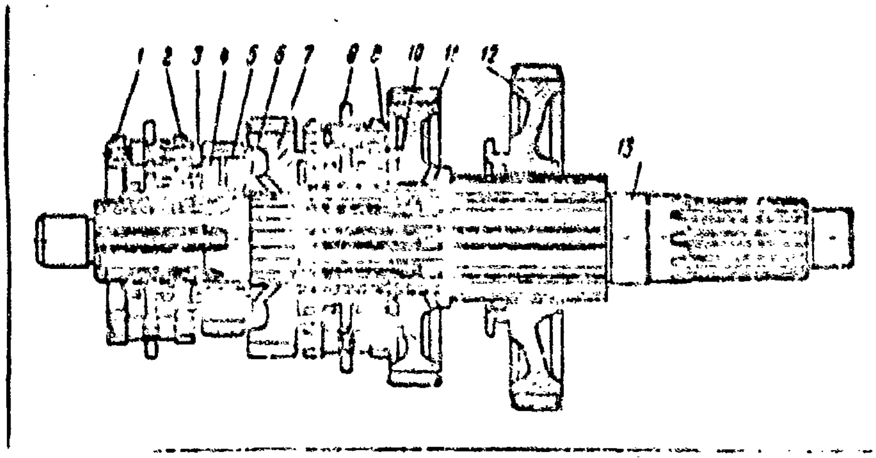


Plate 7-6. Transmission output shaft assembly:
1) fourth and fifth gear synchronizer 2 and 9) lock rings 3, 6, and 10) support washers 4) fourth speed gear 5) fourth speed gear bushing 7) third speed gear 8) second and third gear synchronizer 11) second speed gear 12) first speed gear 13) output shaft

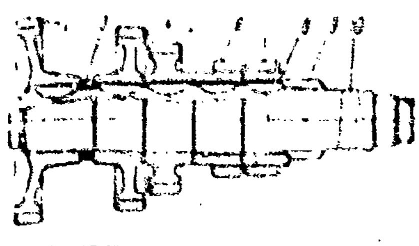


Plate 7-7. Transmission intermediate gear in assembly:
1) lock ring 2) constant engagement gear 3) spacing bushing 4) fourth speed gear 5) third speed gear 6) reverse gear 7) second speed gear 8) key 9) first speed toothed ring 10) shaft

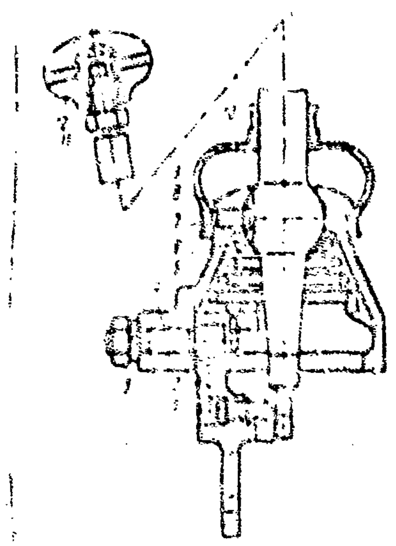


Plate 7-8. Gear changing lever unit in section.
1) protector 2) intermediate lever for selecting first and reverse gears 3) nut 4) intermediate lever axi 5) spring 6) ring 7) catch loc. 8) lever housing 9) protective sleeve 10) gear changing lever 11) nut 12) knob

Disassembly and assembly

Removal of the transmission from the motor vehicle. For removal of the transmission, it is necessary to unscrew the bolts fastening the inspection hole cover above the transmission in the cab and remove it, and unscrew the flange fastening the propellor shaft. On two-axle motor vehicles, disconnect the bracket of the intermediate support from the frame cross member, and free the propellor shafts.

Disconnect the clutch adjusting rod and return spring. Disconnect the speedometer drive shaft. Remove the housing with the gear changing lever and the manual brake lever. Unscrew the second flange of the propellor shaft from the transfer case and remove the propellor shaft.

On three-axle motor vehicles, the levers installed on the transmission must be disconnected from their rods and removed.

If there is a winch on the motor vehicle, it is necessary to disconnect the propellor shaft from the power take-off box and remove the transmission together with the power take-off box.

Unscrew the bolts fastening the transmission to the clutch housing with a box end wrench. Disconnect the transmission from the clutch housing and remove it (Plate 7-10) with a model 444 hydraulic jack.

Remove the transmission from the motor vehicle. The housing with the transmission control lever and the brake lever may be left in place.

Disassembly. Engage the transmission with a hanger (Plate 7-11, a), raise it with a hoist, and set it on a device (Plate 7-11, b) intended for disassembly and assembly of the transmission.

Before disassembly, it is necessary to drain the oil by unscrewing the plug, and clean and wash the outside of the transmission.

Removal of the hand brake (the operation relates only to the ZIL-130 motor vehicle). Unscrew the nut fastening the flange on the output shaft, and remove the flat washer and flange in assembly with the drum. Disconnect the spring of the shoes, and unscrew and remove the bolts and spring washers. Unpin and remove the rod connecting the drawbar fork with the brake lever. Remove the hand brake bracket in assembly with the brake shoes, protective disk, and seal from the transmission. Extract the two installation bushings of the bracket from the holes in the housing with pliers.

For removal of the handbrake drive lever from the transmission, it is necessary to unscrew the two bolts fastening the sector and the one bolt fastening the lever, remove the lever plate, brake drive lever assembly, the two spacing bushings, and the lever sector.

Removal and disassembly of the transmission selector lever housing.

Unscrew the four bolts fastening the lever housing and remove the housing with the lever in assembly and the housing gasket.

Fasten housing 8 (see Plate 7-8) of the lever in a vise with the lever down.

Holding the head of the intermediate lever shaft, unscrew nut 3 fastening the shaft, remove the spring washer and shaft 4 with the intermediate lever 2. Then remove the shaft from the hole in the lever andthe protector 1. Extract spring 5 from the housing, remove support 6 ' the lever, remove lever 10 in assembly and the lever catch lock 7. For removal of the protective boot, it is necessary to loosen nut 11 and unscrew handle 12.

Beforedisassembling the transmission cover with the gear selector mechanism on a three-axle motor vehicle, it is necessary to remove the lever for engaging the transfer case and the front axle, and also the lever for hand brake drive.

Removal and disassembly of the transmission selector mechanism. Unscrew the bolts fastening the transmission cover, remove the cover in assembly with the gear selector mechanism, and remove the cover gasket. If the gasket is stuck, it is necessary to carefully separate it with a screwdriver or other tool.

The transmission selector mechanism is disassembled on a device (Plate 7-12) on which the cover is fastened in a position convenient for disassembly. If there is no device available, the cover is installed in a vise. Unpin the stop bolts fastening the forks and the protector heads on rods 9, 10, and 11 (see Plate 7-9), unscrew the stop screws fastening the forks 3, 5, and 6, and the bolts fastening the rod heads. Move one of the gear selector rods with a pry, and press out the plug from its receptacle. Moving the rod, remove the fork and, holding the catch lock balls by hand, remove the rod with the other hand. The two other gear selector rods are removed by similar means.

Removal and disassembly of the input shaft. Disconnect the return spring from the clutch throw out bearing sleeve, and remove the sleeve and bearing in assembly. Unscrew the four bolts fastening the input shaft front bearing cover, and remove the cover and its gasket.

In order to remove the input shaft from its recess in the transmission housing, it is necessary to press out the bearing with a 40P-5019 puller (Plate 7-13) and remove the shaft and bearing in assembly.

To withdraw the front input shaft bearing from the input shaft recess, it is necessary to fasten the shaft in a vise, remove the stop ring 6 with a screwdriver (see Plate 7-4), and remove the rollers 5 of the bearing.

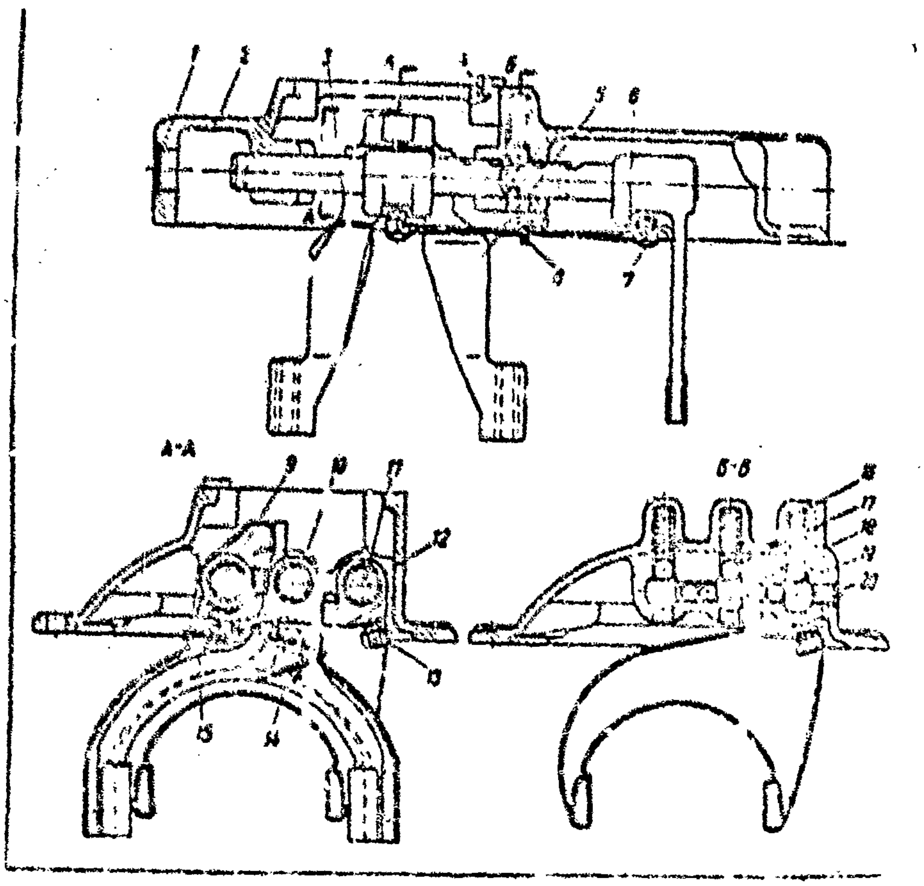


Plate 7-9. Transmission cover in assembly:
1 and 20) plugs 2) cover 3) fourth and fifth gear fork 4) installing bushing 5) second and third gear fork 6) first and reverse gear fork 7 and 13) stop bolts 8, 14, and 15) tie wire 9) second and third gear selector rod 10) fourth and fifth gear selector rod 11) first and reverse gear selector rod 12) first and reverse gear rod head 16) catch lock spring 17) catch lock ball 18) lock pin 19) lock ball

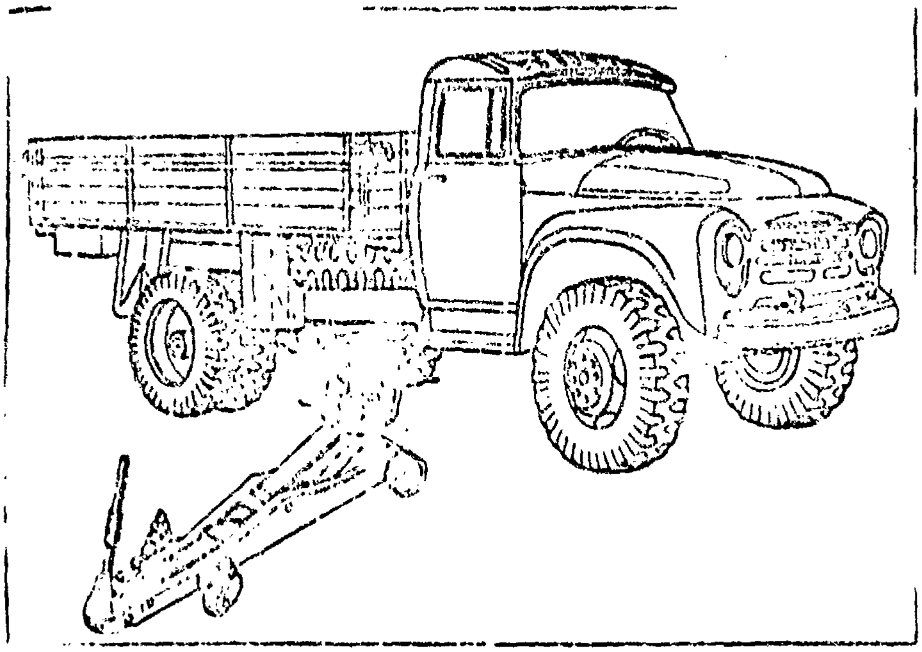


Plate 7-10. Removing the transmission from the motor vehicle

To unscrew the nut fastening the bearing 4, mount the shaft in the device shown in Plate 7-14, drive down the thin edge 7 (see Plate 7-4) of nut 2, unscrew the nut fastening the bearing, and press off bearing 4 with a device.

Removal and disassembly of the input shaft. Remove the speedometer drive gear from the end of the input shaft. Press the input shaft gear together with the shaft out of their recess in the transmission housing with a mandrel and hammer. Press the bearing off the shaft (Plate 7-15), and remove the input shaft in assembly with its gears and synchronizers from the transmission housing.

Remove synchronizer 1 (see Plate 7-6) for fourth and fifth gears and first speed gear 12 from the shaft. Remove the lock ring 2 (see Plate 7-6) fastening the fourth speed gear with two screwdrivers (Plate 7-16) Remove the support washer 3 together with fourth speed gear 4 and steel bushing 5 together with its stop. Remove support washer 6 and third speed gear 7, and remove second and third gear synchronizer 8. Remove the lock ring fastening the second speed gear with two screwdrivers. Remove support washer 10 and second speed gear 11. The synchronizers should not be disassembled unless necessary.

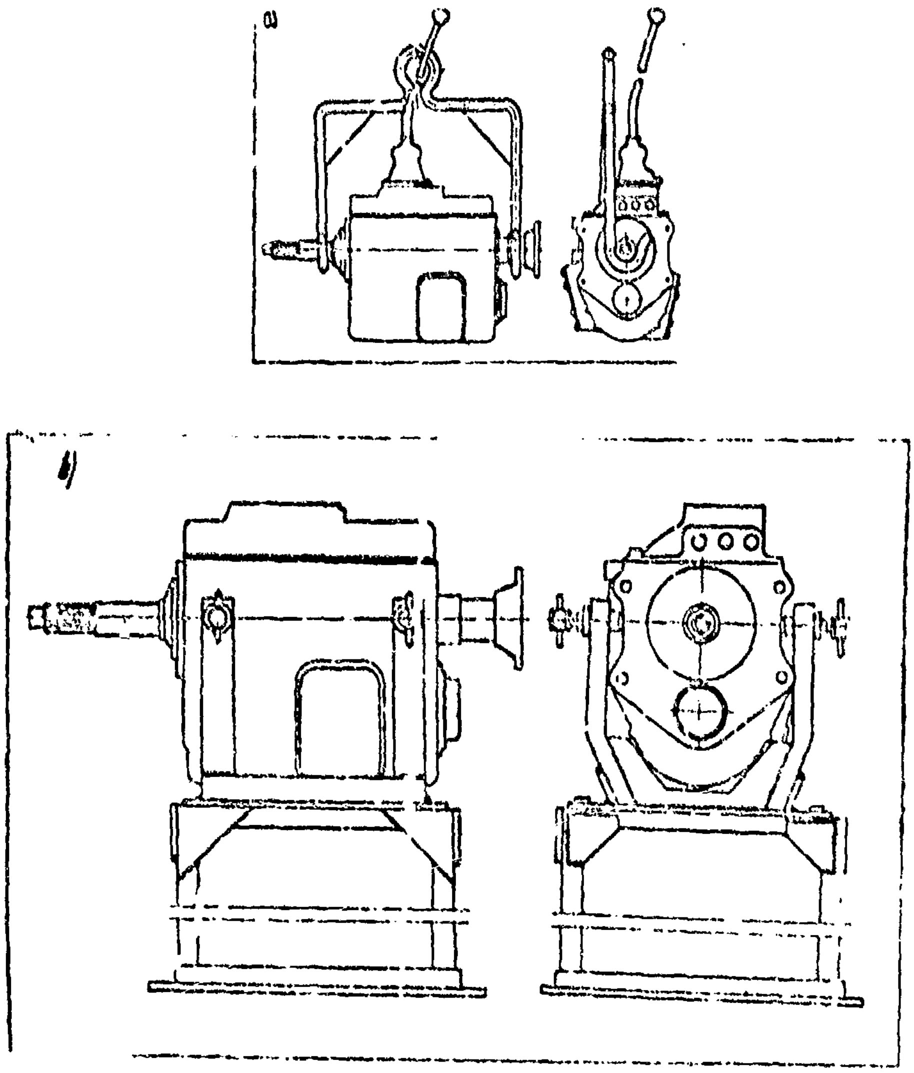


Plate 7-11. Device and sling for raising and moving the transmission:

a) sling
b) device

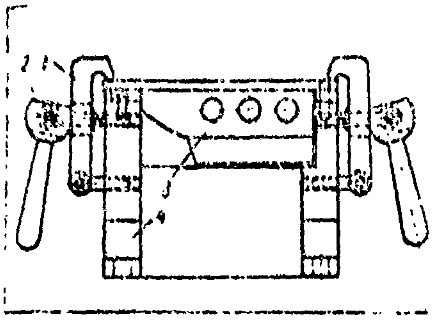


Plate 7-12. Device for disassembling and assembling the transmission cover:
1) pressure lever 2) pressure eccentric 3) cover 4) device frame

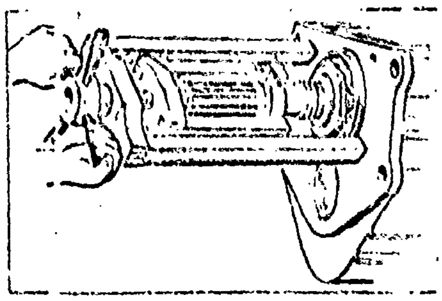


Plate 7-13. Pressing out the input shaft bearing with a 40P5019 device

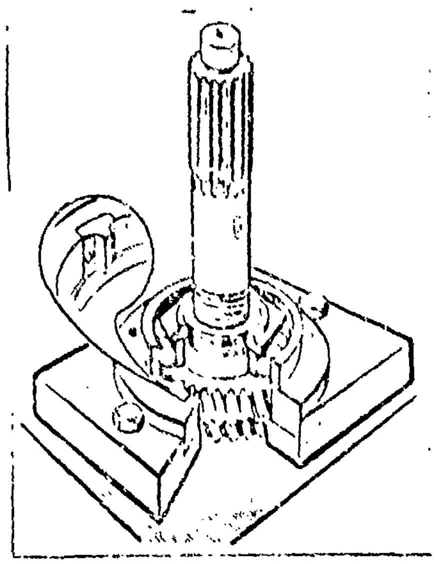


Plate 7-14. Disassembling the input shaft with the device

Removal and disassembly of the intermediate shaft and reverse gear cluster. Unscrew the bolt fastening the reverse gear cluster shaft stop, remove the stop, and remove the cluster shaft, the gear cluster, the two roller bearings, and the spacing bushing from the housing.

Unscrew the four bolts fastening the intermediate shaft rear bearing cover, remove the cover and gasket, drive down the thin edge of the nut, brace the intermediate shaft gear with a lever, and unscrew the nut fastening the rear bearing.

Press the rear bearing, together with the intermediate shaft, out of the receptacle in the transmission housing, and move the shaft and gears along their axis toward the bearing. Press out the intermediate shaft rear bearing with a puller, the same way as the input shaft bearing was pressed out (see Plate 7-15). Remove the intermediate shaft with its gears in assembly from the housing.

Remove the intermediate shaft front bearing from its recess in the housing. If necessary, drive out the plug covering the front bearing with a mandrel and remove its stop ring.

For disassembly of the intermediate shaft, remove lock ring 1 (see Plate 7-7), press all the gears off the shaft, and pry keys 8 from the keyways. The gears may be pressed off with a device (Plate 7-17, a) or a support. Plate 7-17, a, shows a constant engagement gear being pressed off.

The last two gears, reverse gear and second gear 6 and 7 (see Plate 7-7) must be pressed off simultaneously. For removing the shaft 39 (see Plate 7-3) of the reverse gear cluster, a model 2489 puller is used (Plate 7-18).

Assembly of the transmission takes place in the following order. Assembly and installation of the intermediate shaft: install key 8 in its slot in the shaft (see Plate 7-7), and subsequently press onto the shaft the second speed gear (interference 0.005-0.055 mm), the reverse gear (fit from interference of 0.04 mm to clearance of 0.01 mm), the third and fourth speed gear (interference of 0.015-0.065 mm), which have been previously matched according to their journals. Install the spacing bushing, press the constant engagement gear (interference of 0.015-0.065 mm), and fasten it with a lock ring. The ring is installed with a screwdriver. All gears on the intermediate shaft must be pressed on until they are supported at their faces.

Install the transmission housing on the device (see Plate 7-11), check the condition of its shaft bearing surfaces, the absence of cracks and the amount of wear in the holes for bearings. Cracks and perforations in the transmission housing are not acceptable. If the holes for the bearings are worn more than the allowable dimensions, the transmission housing is subjected to removal by a method of pressing in repair bushings.

Damage to the threads in the housing holes is allowed within the limits of no greater than 2 turns.

Deviation of the front and rear faces of the housing relative to the axis of the hole for the input shaft bearing is allowable within the limits of 0.08-0.15 mm.

Non-parallelness of the axes of the intermediate and the input shaft, and deviation from the common plane passing through them, must not exceed 0.07-0.12 mm on the entire length of the housing.

Misalignment of the remaining shaft bearing planes in the transmission housing must be within the limits of 0.15-0.3 mm.

Install the ring of the front roller bearing of the intermediate shaft in its receptacle in the transmission housing (fit from an interference of 0.01 mm to a clearance of 0.033 mm). Mount the roller bearing on the front ring of the intermediate shaft (clearance of 0.015-0.047 mm). Install the intermediate shaft in assembly with its gears in the housing, first driving the rear end of the shaft into the recess for the ball bearing, and then installing the front end of the shaft with its roller bearing assembly into its external ring.

Press the ball bearing assembly with its lock ring on the rear end of the intermediate shaft (interference of 0.003-0.032 mm), direct it into the recess in the housing, and install the bearing together with the shaft in its recess in the housing with a mandrel (fit from an interference of 0.012 mm to the clearance of 0.038 mm). Screw on the nut and tighten it. Torque moment is no less than 25 kg meters. Punch the nut, bending its thin edge into the slot in the shaft. Install the rear cover and gasket and fasten the cover with bolts and spring washers.

Install the stop ring in the receptacle in the housing for the front bearing, and fit it with a mandrel, insert the plug into its receptacle and press it in with a mandrel.

Deviation of the intermediate shaft journal relative to its axis are not allowed to be greater than 0.03 mm. Incorrect shaft journals may be repaired by chroming with subsequent machining to nominal dimensions.

Deviation of the transmission gear faces is not allowed to be greater than 0.05 mm. If cracks or great wear on the teeth or grooves are present on the gears, the gears should be replaced.

Small chips on the sides of the teeth should be smoothed off. Chips are not allowed on the working surfaces.

Small depressions of a fatigue character (pitting) on the working surface of a gear tooth are allowed on an area no greater than 15% of the entire surface. Sharp edges, small dents or burrs on the gear teeth should be smoothed off.

Install the roller bearings in the holes of the reverse gear cluster, inserting the spacing bushing between them, install the gear cluster in the transmission housing, install the gear cluster shaft (with a fit of: large diameter shaft end--from an interference of 0.052 mm to a clearance of 0.004 mm, and small diameter shaft end--with a clearance of 0.007-0.06 mm). Install the stop plate in its depression and fasten the shaft with bolts and spring washers.

Assembly and installation of the output shaft and synchronizers. Install the shaft with its rear end down in a vise with soft inserts, and assemble the shaft parts in the following sequence. Mount first speed gear 12 (see Plate 7-6) on the grooves, install second speed gear 11, mount the support washer 10 on the shaft, and fasten the gears with a lock ring by fitting it into the depression on the shaft with a special mandrel. Install second and third speed synchronizer 8 on grooves on the shaft and, after inserting support washer 6, install third speed gear 7 on the shaft journal. Install bushing 5 of the third speed gear, directing its catch lock groove into the grooved slot in the shaft. Install fourth speed gear 4 on the bushing, mount support washer 3, and fasten the gear with lock ring 2, fitting it into the depression in the shaft with a hollow bodied mandrel. The ring must fit tightly in its groove. Install fourth and fifth gear synchronizer 1 on grooves on the shaft.

Remove the shaft from the vise.

Oscillation of the output shaft journal relative to its axis is not allowed to be greater than 0.05 mm. Fatigue type chipping of the hardened layer on the journal surface is not permissible.

The requirements for the gears of the output shaft are the same as for the gears of the intermediate shaft.

If the parts of the synchronizer are worn or its springs lose their elasticity, the synchronizer assembly should be replaced.

Facial and radial oscillation for a new synchronizer relative to the housing is allowed to be up to 0.1 mm.

Guiding the rear end of the shaft into its recess in the transmission housing, install the output shaft assembly in the housing, mount the bearing in assembly with its lock ring on the end of the shaft and, guiding it into its recess in the housing, press in the bearing together with the shaft with a mandrel.

Assembly and installation of the input shaft. For assembly, the shaft is installed in a device (see Plate 7-14), and the bearing is pressed on (interference is 0.003-0.038 mm). Install lock ring 3 in its groove (see Plate 7-4), screw on nut 2 and tighten it. Tightening moment is no less than 20 kg meters. Then fasten the nut, driving its thin edge 7 into the slot in the shaft.

Remove the shaft from the device, fasten it in the vise, and install the rollers 5 of the needle bearing in their recess. The rollers must be in the same group according to dimensions. The rollers must be installed using grease. The last roller (the locking one) is installed from the face freely, without interference, and the rollers are fastened with lock ring 6, installing it in its groove on the shaft. After assembly, the rollers must rotate freely, without falling from their receptacle. Remove the shaft from the vise.

If the journals and grooves on the shaft are worn more than the dimensions admissible without being repaired, the shaft should be replaced.

Worn-out shaft journals may be repaired by chroming with subsequent machining by grinding to nominal dimensions.

Oscillation of the input shaft journal at the bearing relative to its axis is not allowed to be greater than 0.025 mm. If the shaft is bent or twisted, it must be replaced.

Damage to the threads beneath the ball bearing fastening nut are not allowed to cover more than 1.5 of the thread turns.

The input shaft gear teeth must not have cracks. Small dents, burrs, and chips on the tooth faces should be smoothed off.

Small depressions of fatigue nature (pitting) are admissible on the working surfaces of the teeth, but must not cover more than 15% of the surface.

Install the input shaft with its bearing in assembly in the housing receptacle (bearing fit is from an interference of 0.012 mm to a clearance of 0.038 mm), and guide the end of the input shaft into its needle bearing. Install the input shaft bearing cover with its gasket, fasten them with bolts and spring washers, mount the sleeve and clutch throw out bearing on the cover guide, and install the return spring on the sleeve.

Assembly of the transmission cover is conducted in the reverse sequence as disassembly.

Cracks or chips are not admissible on the transmission cover, especially those passing through the edge of the flange and the bolt holes or passing through the holes for the gear changing rods.

If the aperture for the ball support of the gear changing lever is worn greater than the allowable dimensions, the cover should be replaced.

If the holes in the transmission housing cover for the gear changing rods are worn, the cover should be replaced or repaired by installing bushings.

Crookedness of the gear changing rods is not allowed to be greater than 0.1 mm. Bent rods may be repaired by straightening. Gear changing rods which are worn greater than the allowable dimensions should be replaced or renewed by chroming and machining.

Wear on the slots in the rods for the catch lock balls is admissible so long as the clearance between the formed template and the slot does not exceed 0.6 mm. If this margin is exceeded, the rod should be replaced.

If there are cracks or chips on the gear changing forks, heads, or lever, they should be replaced.

Bent gear changing forks and levers may be straightened.

If the fingers on the gear changing forks are worn more than the allowable dimension, the forks should be replaced.

If wear is present on the slot in the fork and head for the gear changing lever or the holes in the fork and head for the gear changing rod, they should be replaced.

If the groove for the gear changing lever catch lock is worn, the lever should be replaced.

During assembly of the transmission cover, first insert rod 11 (see Plate 7-9) with the first and reverse gear changing fork, then rod 10 with the fourth and fifth gear changing fork, and finally rod 9 with the second and third gear changing fork. After the rods and forks have been installed, they should be fastened with stop bolts 7 and 13, and tied off with wires 8, 14, and 15, wound through their ends.

Check the transmission and set the first speed gear and the synchronizer carrier in the neutral position. Install the transmission cover with its gasket, driving the ends of the fork into the slot in the first speed gear and the slots in the fingers of the other forks onto the disks of the synchronizer carrier. Then fasten the cover with bolts and spring washers.

Assembly of the gear changing lever housing. Fasten the housing into a vise, insert catch lock 7 (see Plate 7-8) of the lever in holes in the housing, install gear changing lever 10 after coating its spherical surface with grease, mount support 6 of the spherical part of the lever onto its tail, install lever spring 5, turning its bent out end as shown in the illustration, and guide the spring up beneath the neck of the housing.

Assemble intermediate lever 2 after installing the protector 1 and shaft 4, lubricated with grease, in it. Install the lever together with the shaft in the housing, then fasten it to the housing with nut 3 and a spring washer. Remove the housing from the vise, install the protective boot 9, screw the round knob 12 onto the gear changing lever, and tighten it with nut 11.

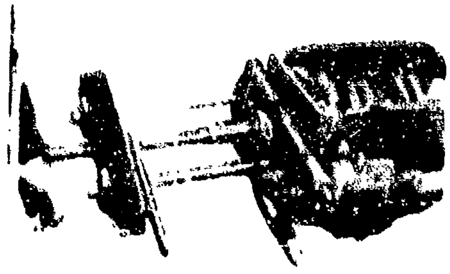


Plate 7-15. Pressing the rear bearing off the driven shaft

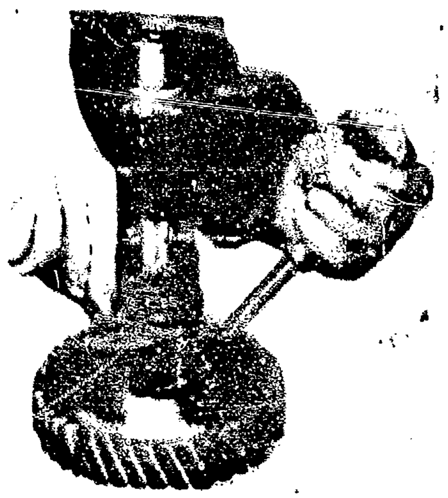


Plate 7-16. Removing the fourth gear locking ring from the driven shaft

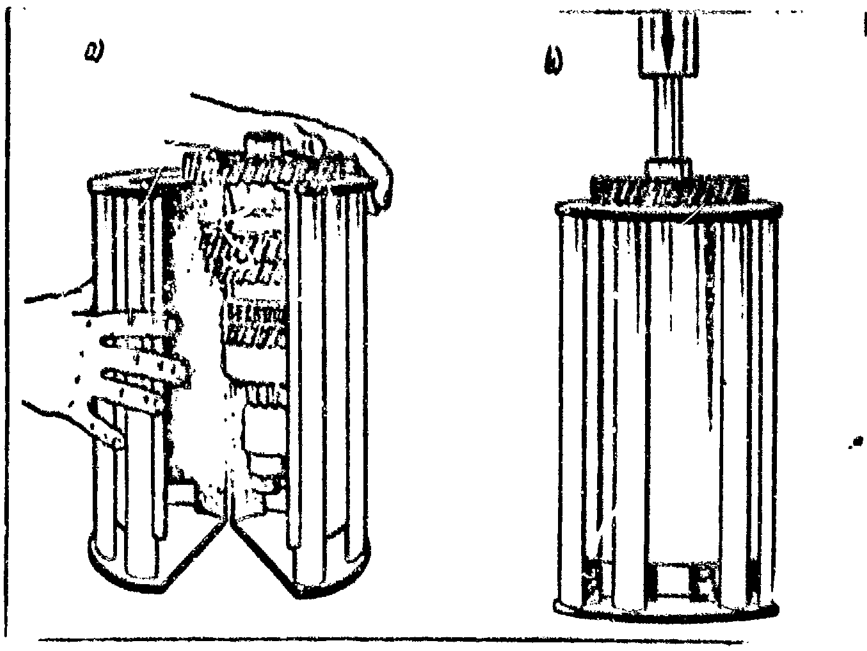


Plate 7-17. Disassembly of the intermediate shaft:
a) installation of the intermediate shaft in a device
b) pressing off the constant engagement gear

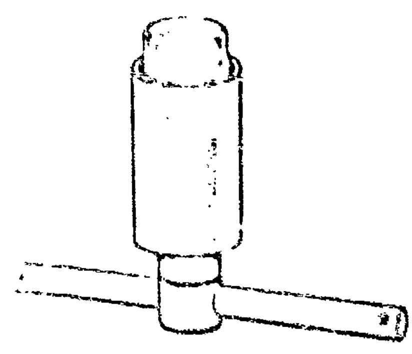


Plate 7-18. Puller for the reverse gear block shaft (model 2489)

Install lever housing 8 with its gasket guiding the end of the intermediate shaft into the hole in the first and reverse gear rod head, and the end of the gear changing lever into the slot in the gear changing fork. Fasten the lever housing with bolts and spring washers.

During assembly of the ZIL-130 motor vehicle transmission, it is necessary to install the speedometer drive warm gear on the end of the input shaft. Install the stationary part of the hand brake in assembly and fasten it with bolts and spring washers. Mount the brake shoe tension springs with a device, install the flange in assembly with the brake drum on the grooves, mount the support washer on the shaft, and screw on and tighten the nut. The tightening moment is no less than 30 kg meters. Lock the nut by driving its thin edge into the slot in the output shaft.

It is recommended that all cover gaskets be installed with No. 80 grease. After assembly, it is necessary to pour oil into the transmission up to the level of the control plug and check the transmission on a special stand. The transmission should be run in by an electric motor for a period of three to five minutes each for each of the gears.

During the process of running the transmission in, it is checked for normal engagement of the gears, increased gear noise during engagement, and knocks, oil leaks at the seals and joints, and also for other deficiencies.

The properly working transmission is installed on the engine with a hydraulic jack or block and tackle, and fastened to it on studs with nuts and spring washers. The tightening moment of the nuts must be 12-15 kg meters.

The transmission housing is centered along the flange of the input shaft rear bearing cover (this cover simultaneously serves as the support for the clutch throw out sleeve).

Parts dimensions

Dimensions of transmission parts for the motor vehicles are presented in Table 7-1, 7-2, 7-3, 7-4, 7-5, 7-6, 7-7, 7-8, and 7-9.

Table 7-1. Dimensions of holes for bearings in transmission housing, mm

Hole diameter	Nominal	Allowable without repair
For input and output shaft bearings	109.986-110.023	110.05
For front intermediate shaft bearing	71.9[illegible]-72.02	72.06

[Table 7-1, continued]

For front end of reverse gear cluster shaft	29.987-30.020	30.50
For rear end of reverse gear cluster shaft	32.000-32.039	32.06

Table 7-2. Basic dimensions of the input shaft, mm

Dimension	Nominal	Allowable without repair
Tooth thickness on shaft grooved portion	5.14-5.64	5.00
Diameter of roller bearing receptacle	43.98-44.067	44.08
Diameter of shaft journal at ball bearing	60.003-60.023	59.98
Diameter of shaft end journal	24.96-24.98	24.94
Tooth length (number of teeth of the constant engagement gear--20)	26.0	--
Tooth thickness (measured at a height of 6.128 mm)	7.17-7.21	7.0
Tooth length (number of teeth in the first speed gear--18)	7.0	
Slot width	4.63	4.8

Table 7-3. Dimensions of output shaft journals and grooves, mm

Dimension	Nominal	Allowable without repair
Diameter of the shaft front end journal for the roller bearing	27.929-27.950	27.90
Diameter of the journal for the ball bearing	50.003-50.020	49.97
Diameter of the journal for the fourth speed constant engagement gear bushing	46.991-47.009	46.97

[Table 7-3, continued]

Diameter of the journal for the second speed constant engagement spiral gear	60.92-60.94	60.90
Tooth thickness of the shaft grooved portion for the synchronizer:		
Second and third speeds	8.88-8.94	8.78
Fourth and fifth speeds	10.90-10.95	10.80
Diameter of the journal for the speedometer drive gear	45.975-46.000	--
Tooth thickness of the shaft grooved portion for the first speed gear	10.88-10.94	10.78
Tooth thickness of the shaft grooved portion for the flange	5.99-5.94	5.80
Diameter of the journal for the third speed constant engagement spiral gear	51.92-51.94	51.90

Table 7-4. Input shaft gear dimensions, mm

Dimensions	Nominal	Allowable without repair
First Speed Gear		
Number of teeth--45; 25KhGM steel; hardened layer depth--0.5-0.7 mm; hardness of surface layer--HRC 57-60; core hardness--HRC 35-40.		
Tooth length	29.86-30.0	27.0
Tooth width (measured at a height of 1.2 mm)	4.90-4.95	4.7
Grooved portion slot width	11.00-11.06	11.2
Width of slot for gear changing fork	9.2-9.4	9.6

[Table 7-4, continued]

Second speed gear

Number of teeth--42; number of toothed sleeve teeth--24; 25KhGM steel; hardened layer depth--0.5-0.7 mm; surface layer hardness--HRC 60-65; core hardness--HRC 35-45.

Tooth length	29.0	--
Tooth width (measured at a height of 2.5 mm)	4.657-4.687	4.50
Sleeve tooth length	6.5	5.5
Sleeve tooth groove width	4.054	4.2
Second speed support washer thickness	3.952-4.00	3.930

Third speed gear

Number of teeth--33; number of toothed sleeve teeth--23; 25KhGM steel; hardened layer depth--0.5-0.7 mm; surface layer hardness--HRC 60-65; core hardness--HRC 35-45.

Tooth length	28.0	--
Tooth width (measured at a height of 3.5 mm)	5.347-5.387	5.2
Sleeve tooth length	4.6	4.0
Sleeve tooth slot width	6.075	6.2
Diameter of gear hole for shaft journal	52.000-52.018	52.04
Width of third speed gear support washer	3.952-4.00	3.930

Fourth speed gear

Number of teeth--26; number of toothed sleeve teeth--18; 25KhGM steel; hardened layer depth--0.5-0.7 mm; surface layer hardness--HRC 60-65; core hardness--HRC 35-45.

Tooth length	26	--
Tooth width (measured at a height of 3.5 mm)	5.346-5.386	5.2
Sleeve tooth length	7.3	6.0
Sleeve tooth slot width	7.519	7.8
Diameter of gear hole	55.00-55.018	55.02
External diameter of bushing	54.92-54.94	54.90

[Table 7-4, continued]

Width of gear support washer	3.952-4.00	3.930

Speedometer drive worm gear

Number of threads--5; 20 steel, GOST 1050-60; hardened layer depth--0.15-0.20 mm; hardness--HRC 56-62.

Tooth thickness	1.76-1.81	1.70
Diameter of hole in worm gear for output shaft journal	46.000-46.030	--

Speedometer drive driven gear

Number of teeth: on the ZIL-130 and ZIL-130G motor vehicles--17; on the ZIL-130V1 and ZIL-MMZ-555--18; 00 steel (GOST 1050-60); depth of cyanated layer--0.15-0.30 mm; hardness--HRC 65-62.

Tooth thickness in the ZIL-130 and ZIL-130G motor vehicles	2.21-2.26	2.16
Tooth thickness in the ZIL-130V1 and ZIL-MMZ-555 motor vehicles	1.76-1.81	1.70

Output shaft flange

Number of grooves: on the ZIL-130 and ZIL-130G motor vehicles--17; on the ZIL-130V1 and ZIL-MMZ-555 motor vehicles--18; 40 Kh steel (GOST 4543-57), hardened by heating with high frequency current; hardened layer--1-2.5 mm; hardness--HRC 56-62.

Diameter of flange journal for the seal	57.88-58.00	57.80
Diameter of the bolt holes for fastening the propellor shaft flange	14.24-14.36	15.00
Dimension of the flange grooved portion slots	6.00-6.05	6.2

Table 7-5. Basic dimensions of synchronizers, mm

Dimension	Nominal
Second and third speed carrier	
Number of teeth: first ring (left)--23; second ring (right)--24.	
Tooth length:	
First ring	7.7
Second ring	7.7
Full tooth width:	
First ring	6.02
Second ring	3.99
Decreased tooth width:	
First ring	5.42
Second ring	3.39
Synchronizer carrier groove width	9.00-9.09
Diameter in carrier hole for catch lock	14.00-14.07
Fourth and fifth speed carrier	
Number of teeth: first ring (left)--18; second ring (right)--18.	
Tooth length:	
First ring	7.7
Second ring	7.7
Full tooth width:	
First ring	4.567
Second ring	7.454
Decreased tooth width:	
First ring	3.93
Second ring	6.85
Synchronizer carrier groove width	11.00-11.05
Diameter in carrier hole for catch lock	14.00-14.07
Conic ring of the second and third, and fourth and fifth speed synchronizers	
Brass LmTs KA 58 2-1-1; hardness no less than HB = 130.	
Diameter of hole in synchronizer ring for catch lock support	6.00-6.025

Diameter of hole in synchronizer ring for blocking finger 9.00-9.03

Synchronizer catch lock support

A12 steel (GOST 1414-54), hardened layer depth--0.15-0.30 mm; hardness--HRC 56-62.

Diameter of catch lock support journal for conic ring hole 6.030-6.065

Synchronizer blocking finger

45 steel (GOST 1050-60); case hardened by heating with high frequency current; depth of case-hardened surface layer--1-1.25 mm; case hardened layer hardness--HRC 56-62.

Diameter of finger journal for hole in synchronizer conic ring 9.035-9.1[illegible]

Synchronizer spring

Number of coils--9; spring wire steel 0.8 mm in diameter (GOST 9380-60).

Spring diameter	5.57-5.60
Spring length in free condition	13.0
Spring length under a load of 1.5-1.9 kg	9.5
Wire diameter	0.8

Table 7-6. Intermediate shaft journal dimensions, mm

Dimensions	Nominal	Allowable without repair
Shaft journal diameter for ball bearing	40.003-40.020	39.98
Shaft journal diameter for roller bearing	41.983-42.000	41.96
Shaft journal diameter for constant engagement gear	52.045-52.065	--
Shaft journal diameter for spacing bushing	52.045-52.065	--
Shaft journal diameter for fourth speed gear	54.045-54.065	--

[Table 7-6, continued]

Shaft journal diameter for third speed gear	54.545-54.565	--
Shaft journal diameter for second speed gear	55.535-55.555	--

Table 7-7. Parameters of the intermediate shaft gears, mm

Dimensions	Nominal	Allowable without repair
First speed gear		
Number of teeth--13; material and heat treatment as in the intermediate shaft.		
Tooth length	33.38-34.00	32.00
Tooth thickness (measured at a height of 5.6 mm)	8.108-8.148	7.9
Second speed gear		
Number of teeth--22; 25KhGT steel; hardened layer depth--0.5-0.7 mm; surface layer hardness--HRC 57-60, core hardness--HRC 35-45.		
Tooth length	31.0	--
Tooth thickness (measured at a height of 4.6 mm)	6.034-6.074	5.9
Diameter of hole for shaft journal	55.50-55.53	--
Reverse gear		
Number of teeth--20; 25KhGT steel; hardened layer depth--0.5-0.7 mm; surface layer hardness--HRC 57-60; core hardness--HRC 35-45.		
Tooth length	25.72-26.00	--
Tooth thickness (measured at a height of 4.7 mm)	7.462-7.502	7.25
Diameter of hole for shaft journal	55.00-55.03	--
Third speed gear		
Number of teeth--31; 25KhGT steel; hardened layer depth--0.5-0.7 mm; surface layer hardness--HRC 57-60; core hardness--HRC 35-45.		
Tooth length	28.0	--
Tooth thickness (measured at a height of 3.5 mm)	5.347-5.387	5.14

[Table 7-7, continued]

Diameter of hole for shaft journal	54.50-54.53	--

<u>Fourth speed gear</u>

Number of teeth--38; 25KhGT steel; hardened layer depth--0.5-0.7 mm; surface layer hardness--HRC 57-60; core hardness--HRC 35-45.

Tooth length	28.0	--
Tooth width (measured at a height of 3.5 mm)	5.347-5.387	5.14
Diameter of hole for intermediate shaft journal	54.00-54.03	--
Support washer thickness	3.952-4.00	3.90

<u>Constant engagement gear</u>

Number of teeth--43; 25KhGM steel; hardened layer depth--0.5-0.7 mm; surface layer hardness--HRC 57-60; core hardness--HRC 35-45.

Tooth length	25.0	--
Tooth thickness (measured at a height of 2.974 mm)	4.995-5 035	4.8
Diameter of hole for intermediate shaft journal	52.00-52.03	--
Length of spacing bushing	9.97-10.00	9.80

Table 7-8. Dimensions of reverse gear cluster and shaft, mm

Dimensions	Nominal	Allowable without repair
Diameter of hole in gear cluster for roller bearing	42.000-42.027	42.06
Diameter of gear cluster shaft	29.96-29.98	[illegible] 94
Diameter of shaft thickened portion	32.035-32.052	32.025

<u>Cluster large gear</u>

Number of teeth--22

[Table 7-3, continued]

Tooth length	25.72-26.0	--
Tooth thickness (measured at a height of 2.1 mm)	5.576-5.616	5.45
	Cluster small gear	
	Number of teeth--15	
Tooth length	25.48-26.00	--
Tooth thickness (measured at a height of 5.6 mm)	8.115-8.145	8.0

Table 7-9. Dimensions of the transmission housing cover, the lever cover, and gear changing mechanism parts, mm

Dimensions	Nominal	Allowable without repair
	Transmission housing cover	
SCh 1532 cast iron (GOST 1412-54).		
Diameter of the holes for the gear changing rods	19.04-19.08	19.13
	Gear changing lever housing	
SCh 1532 cast iron (GOST 1412-54).		
Diameter of the hole for the intermediate lever shaft	11.000-11.035	11.05
	Gear changing lever	
Steel 20 (GOST 1050-60).		
Diameter of the upper ball support of the lever	37.75-37.92	37.5
Dimensions of the working surface of the lower spherical and	15.78-15.90	15.6
Dimensions of the slot for the upper ball support lock	7.9-8.2	8.35

[Table 7-9, continued]

Intermediate lever for selection of first and reverse gears

25 LK-1 steel, precision cast (GOST 977-53).

Diameter of hole for intermediate lever shaft	14.000-14.035	14.05
Diameter of hole for protector lock	8.0-8.2	8.4
Dimension of the intermediate lever slot	16.0-16.3	16.5

Shaft of the intermediate lever for selecting first and reverse gears

A-12 steel (GOST 1414-54); hardened layer depth--0.3-0.5 mm; surface layer hardness--HRC 56-62.

Diameter of shaft journal for the hole in the gear changing lever housing	10.965-11.00	10.925
Diameter of shaft journal for the hole in the intermediate lever	13.93-13.98	13.8

Rods for changing fourth and fifth, second and third, and first and reverse gears

45 steel (GOST 1050-60), case hardened by heating with high frequency curr[illegible], case hardened layer depth--1-3 mm.

Rod diameter	18.979-19.000	18.95
Radius of detent for catch lock	5.65-5.75	Clearance no greater than 0.6 mm

Fork for selecting second and third, and fourth and fifth gears

25 LK-1 steel, precision cast (GOST 977-53); hardened layer depth--0.3-0.5 mm; hardness--HRC 56-62.

Diameter of hole for gear changing rod	19.02-19.05	19.1
Dimension of slot for gear changing lever	16.00-16.24	16.5
Width of slot for fork fingers	6.8-7.0	7.4

[Table 7-9, continued]

Fork for selecting first and reverse gears

Type 20 steel (GOST 1050-57); hardened layer depth--0.3-0.5 mm; surface layer hardness--HRC 56-62.

Diameter of hole for gear changing rod	19.02-19.05	19.1
Thickness of fork fingers	8.7-8.8	8.5

Head of rod for selecting first and reverse gears

25 LK-1 steel (GOST 977-53); hardened layer depth--0.3-0.5 mm; surface layer hardness--HRC 56-62.

Diameter of hole for gear changing rod	19.02-19.05	19.1
Width of slot for gear changing lever	16.00-16.30	16.6

Gear changing lever spring

Number of coils--4; spring wire, 5 mm in diameter (GOST 5047-49).

Diameter of the largest spring coil	69.3-70.5	--
Diameter of the smallest spring coil	44.38-45.0	--
Length of spring in free condition	39	--
Length of spring under a load of 24-31 kg	26	--
Wire diameter	5	--

Spring of first and reverse gear engagement protector

Number of coils--10; spring wire, class I, 2.2 mm in diameter (GOST 9389-60).

Spring diameter	13.07-13.[illegible]	--
Spring length in free condition	41	--
Spring length under a load of 14-17 kg	33	--
Wire diameter	2.2	--

First and reverse gear engagement protector lock

A-12 steel (GOST 1414-54); cyanated layer depth--0.[illegible]-0.5 mm; surface layer hardness--HRC 56-62.

[Table 7-9, continued]

Protector lock diameter	7.85-7.95	7.75
Lock length	26.22-26.50	--

Chapter 8. The Transfer Case

Layout

A single-throw, two-speed transfer case is installed in the ZIL-157K motor vehicle (Plate 8-1 and Table 8-1).

This case has three output shafts which turn on tapered roller bearings.

The ZIL-131 motor vehicle is equipped with a two-throw transfer case having two output shafts which turn on ball and cylindrical roller bearings. The advantage of these bearings is the fact that they do not require adjustment, either during assembly or during the process of operation of the motor vehicle, as do the tapered roller bearings in the transfer case of the ZIL-157K motor vehicle.

Both transfer cases have a mechanism preventing self-disengagement of the gears. In the transfer case of the ZIL-157K motor vehicle, it is formed on the input shaft 14 (Plate 8-1) and shaft 57 of the front axle drive in the form of grooves having a varied thickness and forming a step on which carrier 22 and sleeve 56 rest during self-disengagement. A diagram of gear positions in the various speeds and distribution of the torque moment during them is shown in Plate 8-2.

In the transfer case of the ZIL-131 motor vehicle (Plate 8-3), the installation preventing self-disengagement is formed on the grooves of both gears 25 and 32, located on shaft 3 of the front axle drive. This installation prevents the self-disengagement of low speed engagement carrier 31 and front axle drive engagement carrier 23. The construction which blocks disengagement of high gear has another arrangement. On the exterior ring of high gear engagement carrier 16 and assembled with the grooved hole of output shaft 19, there is a conic construction, i.e., tooth thickness and slot width along the length in the same diameter are changeable; they have a reverse cone which prevents self-disengagement.

To prevent simultaneous engagement of two speeds in the transfer case of the ZIL-131 motor vehicle, there is a blocking arrangement which consists of balls 46 between rods 36 and 47. When one of the rods is moved, the balls move to the other and lock it.

Plate 8-4 shows the separate air-diaphragm chamber for engagement of the front axle drive and the rod for this chamber in assembly.

Both transfer cases have openings for installation of power take-off boxes. The linkage for control of the transfer case in the ZIL-157K motor vehicle is shown in Plate 8-5, and that for the ZIL-131 motor vehicle is shown in Plate 8-6. Construction of the electro-pneumatic valve controlling the front axle drive of the ZIL-131 motor vehicle is shown in Plate 8-7. When it is not energized, the electro-pneumatic valve is closed by the force of spring 3, and the air-diaphragm chamber 10 (see Plate 8-3) is connected through a vent to the atmosphere.

When current is fed to coil 13 (see Plate 8-7) of the electromagnet, core 12 pulls rod 17, overcoming the force of spring 3 and the resistance of compressed air, and opens inlet valve 20.

When this happens, compressed air enters the space above the membrane in the air-diaphragm chamber, controlling the front axle drive.

Suspension of the transfer case on the ZIL-157K motor vehicle (Plate 8-4,a) is realized by four studs screwed into the body of the transmission and passing through holes in the frame cross member. To provide elastic suspension of the transfer case, rubber cushions are installed on both sides of the cross member. The stud nuts are pinned.

Table 8-1. Technical characteristics of transfer cases

Parameters	ZIL-157K	ZIL-131
Type	Mechanical, single-throw, with two speeds	Mechanical, two-throw, with two speeds
Transmission ratio:		
Low speed	2.27	2.08
High speed	1.16	1.00
Speed selection	Single lever and rod	Single rocking lever and two rods
Front axle engagement	Positive, with a lever and mechanical sleeve	Automatic and positive. Automatic engagement is accomplished with an electrical switch which is turned on during engagement of low speed. Positive engagement is accomplished electrical disengagement in any gear. With automatic or positive engagement, the electro-pneumatic valve and and air-diaphragm chamber switch in.

[Table 8-1, continued]

Middle and rear axle drive	Accomplished from the transfer case shaft to the middle axle and from the transfer case to the rear axle through Cardan drive	Acccomplished from the transfer case output shaft through a single Cardan shaft

Suspension of the transfer case in the ZIL-131 motor vehicle (Plate 8-6, b) is formed on two longitudinal rails which rest on the frame cross member. The rails on the frame cross member have elastic suspension, since they are fastened with bolts having rubber cushions installed on both sides of the support. The transfer case is suspended from the two longitudinal rails on four bolts passing through holes in the longitudinal rails. All nuts on the bolts fastening the longitudinal rails are pinned, as are those on the bolts fastening the transfer case.

Suspension of the transfer case on the ZIL-131 motor vehicle has a number of advantages over suspension of the transfer case on the ZIL-157K motor vehicle. First, the loading points of the supporting elements are spread, decreasing their load. Second, the supporting elements need not be removed during removal of the transfer case, and it is sufficient to unscrew the nuts from the bolts fastening the transfer case to the auxiliary longitudinal rails. Third, when the bolts fastening the transfer case break, they are easily replaced. When the studs fastening the transfer case of a ZIL-157K motor vehicle break, they must, as a rule, be drilled out of the body.

Technical service

During DS, conduct cleaning operations and an external inspection of the transfer case.

During TS-1, it is necessary to check the fastening of the transfer case on the frame and tighten the bolts.

During TS-2, check the blocking of the transfer case control levers and tightness of the tapered bearings in the transfer case of the ZIL-157K motor vehicles. If necessary, adjust the tightness of the bearings.

During TS-2, check the control linkage of the transfer case of the ZIL-131 motor vehicle and if necessary, tighten the stop nuts on the adjusting forks.

Adding and changing the oil in the transfer case must be done within the periods shown in the lubrication charts.

When checking the level of oil in the housing, it is necessary to wash out the air passages in the vent, whose clogging may cause increased pressure in the transfer case housing and oil leakage through the seals.

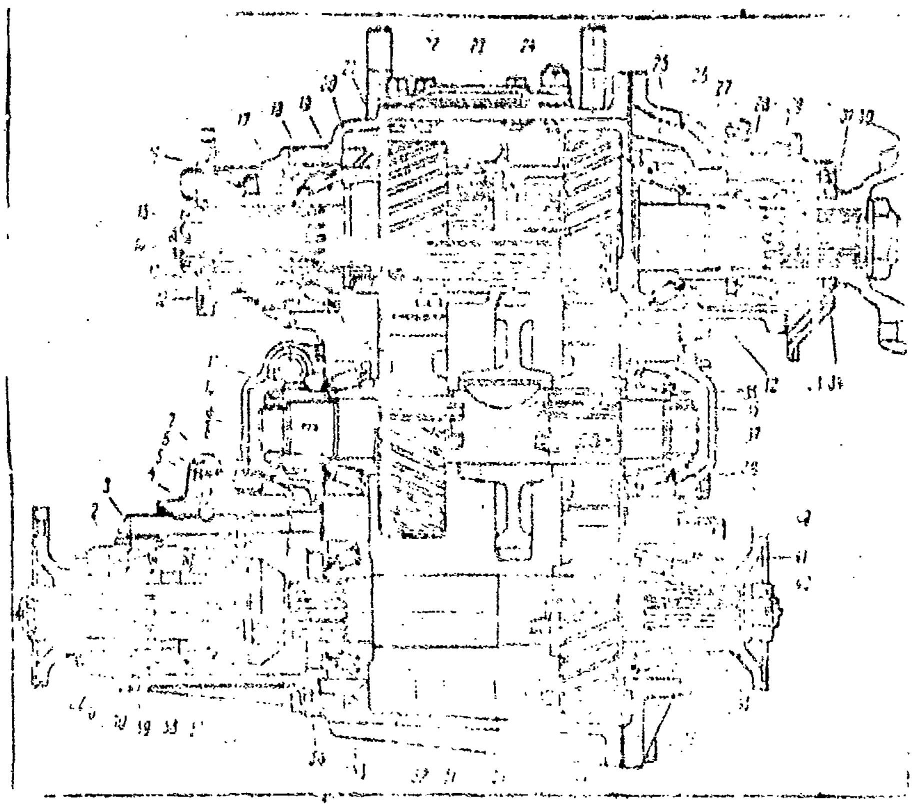


Plate 8-1. Transfer case of ZIL-157K motor vehicle:
1, 16, 30, and 40) flanges 2) oil deflecting washer 3) front axle engagement fork rod 4) catch lock ball 5) stop screw 6) catch lock spring 7) catch lock spring plug 8) plug 9, 18, 24, 25, 29, 38, 41, 53, and 58) tapered roller bearings 10, 17, 37, 45, and 60) bearing covers 11) speedometer drive worm gear 12) input shaft bushing 13, 33, 44, and 61) seals 14) input shaft 15, 36, and 42) nuts 19) support washer 20) input shaft bushing pin 21) drive gear 22) high and low speed engagement gear (carrier) 23) opening cover 26) bearing housing 27) bearing spacing bushing 28) adjusting washer 31) output shaft 32) output shaft gear 34) rear bearing cover (hand brake bracket) 35) lock washer 39) output gear intermediate shaft 43 and 62) dust covers 46) housing 47) housing 48) middle and rear axle drive gear 49) intermediate shaft low speed driven gear 50) intermediate shaft 51) intermediate shaft constant engagement gear 52) middle axle drive shaft 54) front axle drive shaft bearing carrier 55) front axle engaging sleeve fork 56) sleeve 57) front axle drive shaft 59) adjusting gaskets

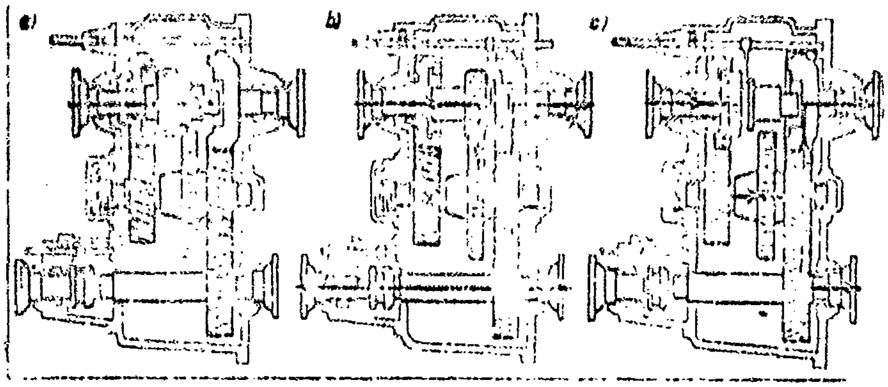


Plate 8-2. Diagram of various gear engagements of the transfer case of the ZIL-157K motor vehicle:
a) neutral position b) low speed and front axle engaged
c) high speed engaged

Before changing or adding oil to the transfer case, dust and dirt should be cleaned from it.

When changing the oil, wash out the transfer case with low viscosity oil (industrial 12 or 20, GOST 1707-57), clean the magnetic plug of the drain hole, and wash out the air passages of the vent

Oil in the transfer case must be measured immediately after stopping the motor vehicle, while the unit is still warm. Oil must be filled to the level of the lower control hole in the transfer case. If a power take-off box is mounted on the transfer case, oil must be filled to the level of the upper control hole.

The transfer case control lever shaft must be lubricated through the pressure lubrication fitting until fresh grease is pressed out.

Disassembly and assembly

The transfer case in the ZIL-157K motor vehicle should be removed with a carriage--the model 444 hydraulic jack (Plate 8-9), installed under its recess 4. Before removing the transfer case, drain the oil from it by unscrewing the drain hole plug. The sequence of operations in removing the transfer case is as follows.

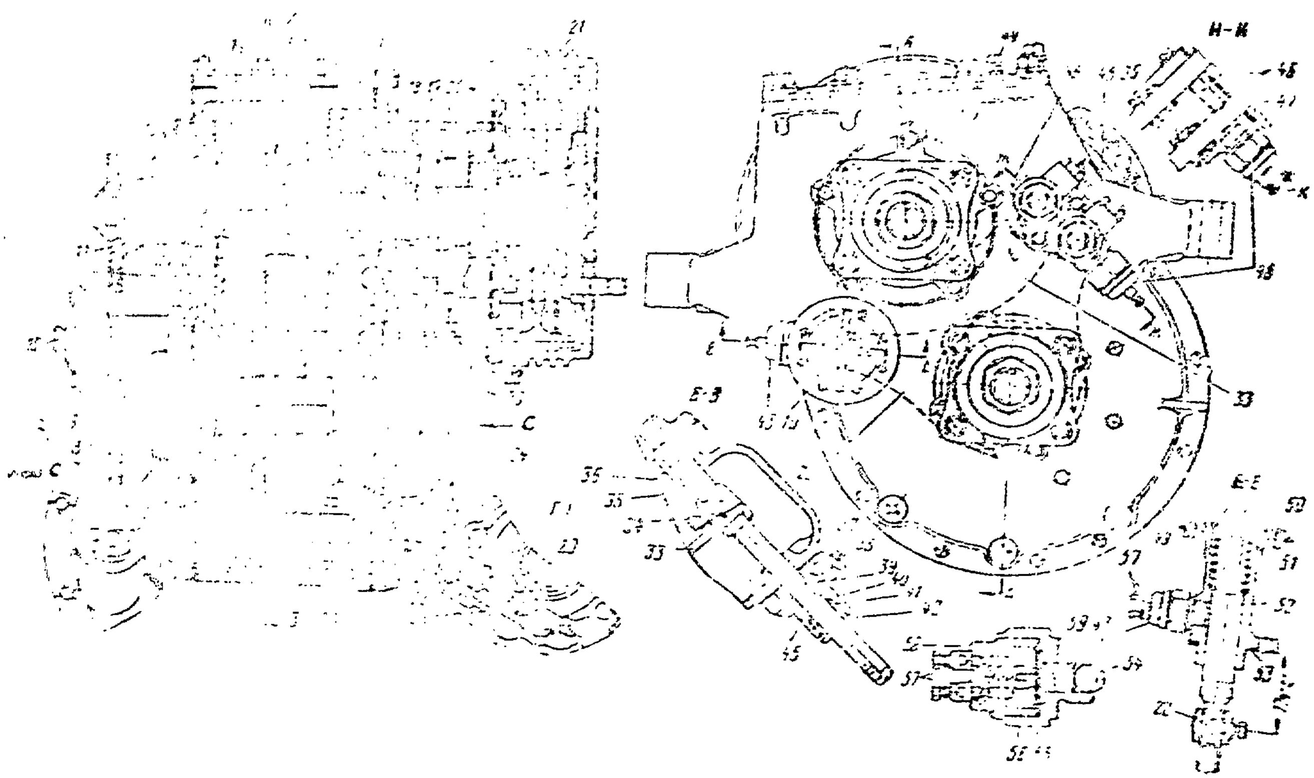


Plate 8-3. Transfer case of ZIL-131 motor vehicle:
1) housing 2) trough 3) front axle drive shaft 4) stop ring 5 and 24) covers 6) oil deflecting ring 7) filler hole plug 8 and 11) flanges 9) flange nut 10) air-diaphragm chamber for engaging front axle drive 12) input shaft 13) seal 14) drive gear 15) key 16) high speed engagement carrier 17) inspection hole cover 18) housing side cover 19) output shaft with gear 20) speedometer worm gear 21) hand brake drum 22) front axle drive engaging fork 23) front axle drive engaging carrier 25) high speed gear 26) drain hole plug 27) speedometer collar 28) holding plate 29) speedometer driven gear 30) needle bearing 31) low speed engaging carrier 32) low speed gear 33) low speed engaging fork 34) stop bolt 35) high speed engaging fork 36) high speed engaging rod 37) catch lock spring plug 38) spring 39) catch lock ball 40) rubber ring 41) felt ring 42) seal nut 43) switch for indicator

[Caption for Plate 8-3, continued]

light signalling engagement of front axle 44) vent 45) catch lock body 46) blocking mechanism balls 47) low speed engaging rod 48) electromagnet switch of electropneumatic valve 49) air-diaphragm chamber body 50 and 50 and 55) diaphragms 51) return spring 52) rod 53) adjusting gaskets 54) switch ball 56) contacts 57) poles 58) pole insulation 59) switch body

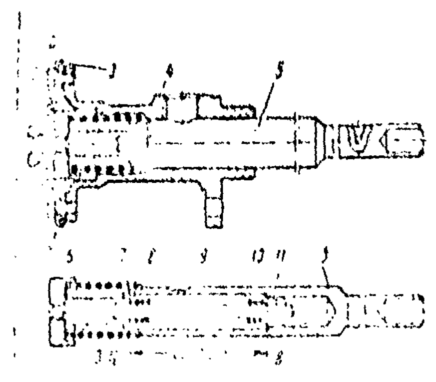


Plate 8-4. Air-diaphragm chamber for engaging front axle drive:
a) chamber in assembly b) chamber rod in assembly
1) diaphragm 2) bolt 3) cover 4) chamber body 5) exterior rod of chamber 6) cup 7) stop ring 8) washer 9) internal rod 10) pressure spring 11) nut 12) rod flat 13) return spring

Park the motor vehicle on a level surface. Set blocks beneath the wheels so that the motor vehicle does not roll forward or backward.

Release the handbrake.

Disconnect the Cardan shafts, transfer case control linkage rods, and handbrake control rod from the transfer case.

Roll the hydraulic jack underneath the motor vehicle and, turning handle 2, raise lever 3 so that the transfer case is located in receptacle 4.

Unpin and unscrew the nuts fastening the transfer case with a box and wrench.

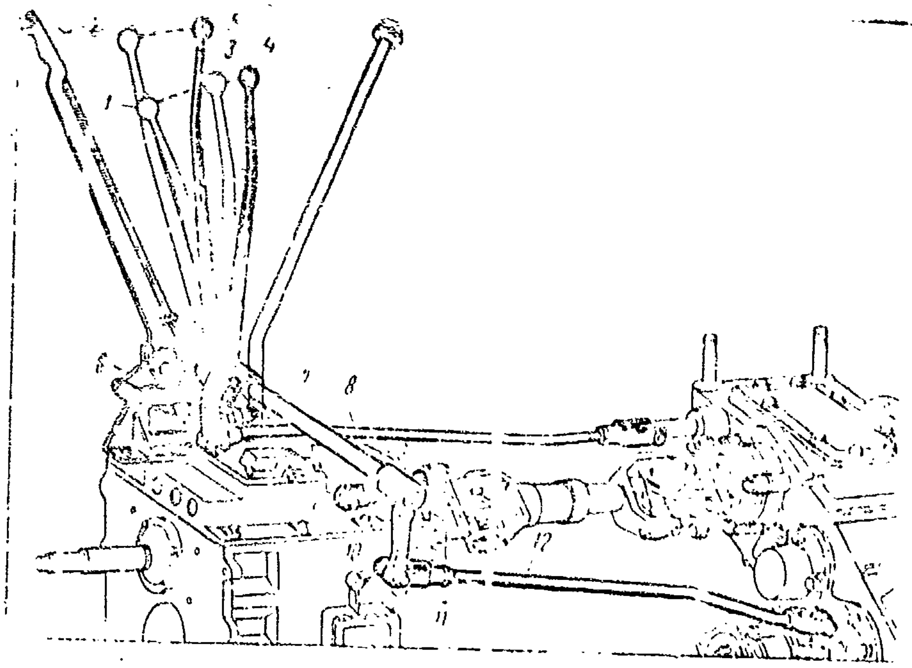


Plate 8-5. Control linkage for transfer case of ZIL-157K motor vehicle:
1) lever position during engagement of low speed 2) lever position during engagement of front axle 3) neutral position 4) lever position during engagement of high speed 5) lever position during engagement of front axle 6) adjusting bolt 7) stop nut 8) speed changing rod 9) control lever shaft 10) front axle engaging rod lever 11) fork 12) front axle engaging rod

Release the lever of the hydraulic jack together with the transfer case, and roll the hydraulic jack with the transfer case from beneath the motor vehicle.

Remove the suspension parts from the transfer case and from the frame of the motor vehicle.

Disassembly of the transfer case from a ZIL-157K motor vehicle. Before disassembling the transfer case, clean the dirt and oil from it, wash it off, and blow it off with compressed air, and remove the handbrake drum from the splined end of the transfer case output shaft. It is recommended that the transfer case be disassembled on a low bench or on a special device.

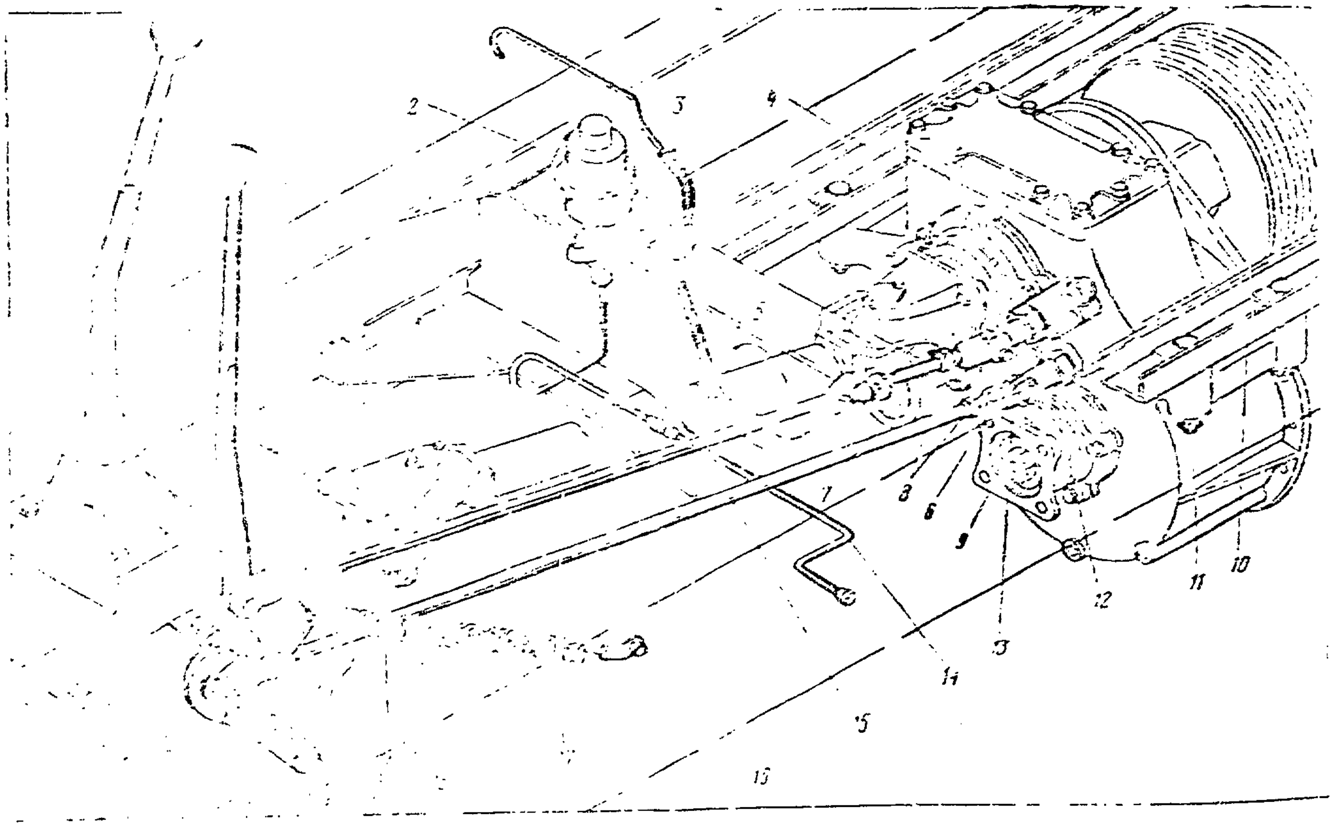


Plate 8-6. Control linkage for the transfer case of the ZIL-131 motor vehicle:
1) speed selecting lever 2) electro-pneumatic valve 3) vent pipe 4) transfer case 5) air supply hose to air-diaphragm chamber 6) rod fork 7) air-diaphragm chamber 8) stop nut 9) flange for front axle drive shaft 10) longitudinal rail 11) transfer case fastening bolt 12) low speed engaging shaft 13) high speed engaging shaft 14) pipe for air supply to electromagnetic valve 15) low speed engaging rod 16) high speed engaging rod 17) return spring 18) transmission 19) lever link

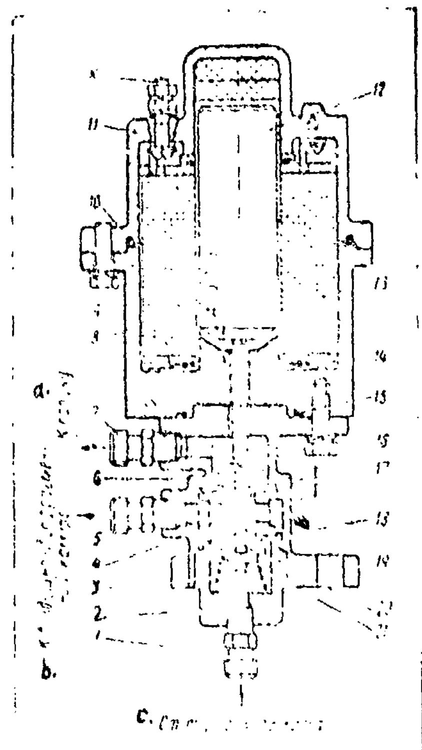


Plate 8-7. Electro-pneumatic valve: 1, 5, and 7) fittings 2) plug 3) valve spring 4) valve seat 6) outlet valve 8) electromagnet body 9 and 16) bolts 10, 15, and 18) packing rings 11) cover 12) core 13) electromagnet core 14) spacing washer 17) rod 19) body 20) outlet 21) nut

Key: a) to vent
b) to air-diaphragm chamber
c) from brake valve

Removal of the flanges from the transfer case shafts. Before removing the flanges, it is necessary to remove the cover and gasket and block the gears so that the transfer case shafts cannot rotate. Unpin and unscrew the nuts fastening each flange in order, and remove them with a 20P-7968 puller (Plate 8-10).

There are a total of four flanges on the case. All the flanges are removed together with the dust guards fastened to them.

Disassembly of the speed changing mechanism (Plate 8-11). For removal of rod 1, it is necessary to unscrew plug 4 of the catch lock and remove spring 5 and ball 3 from their recess. Unscrewing the catch lock plug is shown in Plate 8-12, a. Unpin the tension bolt 6 (see Plate 8-11), fastening gear changing fork 11, and unscrew the bolt with an angular socket wrench (see Plate 8-12, b). Insert metal rod 1 in the hole in rod 2 (Plate 8-13) and, rotating rod 2, unscrew it from the threaded hole in the fork, and then remove fork 7 from the rod (see Plate 8-11), and pull out the rod.

If the seal 2 of the rod is not in proper condition, it must be pressed out

Removal of the transfer case side cover. Unscrew the bolts fastening the side cover with a socket wrench. Lightly tapping with a hammer, separate the cover with a screwdriver, inserting it in the space opposite the catch lock. Remove the side cover together with the driven shaft.

Disassembly of the driven shaft and its bearing carriers. Unscrew the bolt fastening cover 34 (see Plate 8-1) of the rear driven shaft bearing, remove the cover in assembly with its se   and gaskets, and remove the supporting ring. Unscrew the bolts fastening carrier 26 of the bearings, and press out the driven shaft (Plate 8-14, a). With this, simultaneously press off the rear bearing of the driven shaft. After this, remove the adjusting washers and the spacing bushing.

Turn the side cover over, set it on blocks, press out the bearing carrier with a mandrel, and remove its gaskets Press the outer race on the bearing from its recess in the side cover. This operation is accomplished with a hammer and mandrel.

During disassembly of the driven shaft, it is necessary to press the outer race of the rear input shaft bearing from its recess with a puller (Plate 8-14 b).

Press the inner race of the front bearing from the driven shaft with a puller (Plate 8-1[illegible] c).

The puller shown in Plate 8-14, b, should be used for pressing off the outer races (Plate 8-15) of the front 1 and rear 3 bearings of the driven shaft from the bearing recesses in the housing.

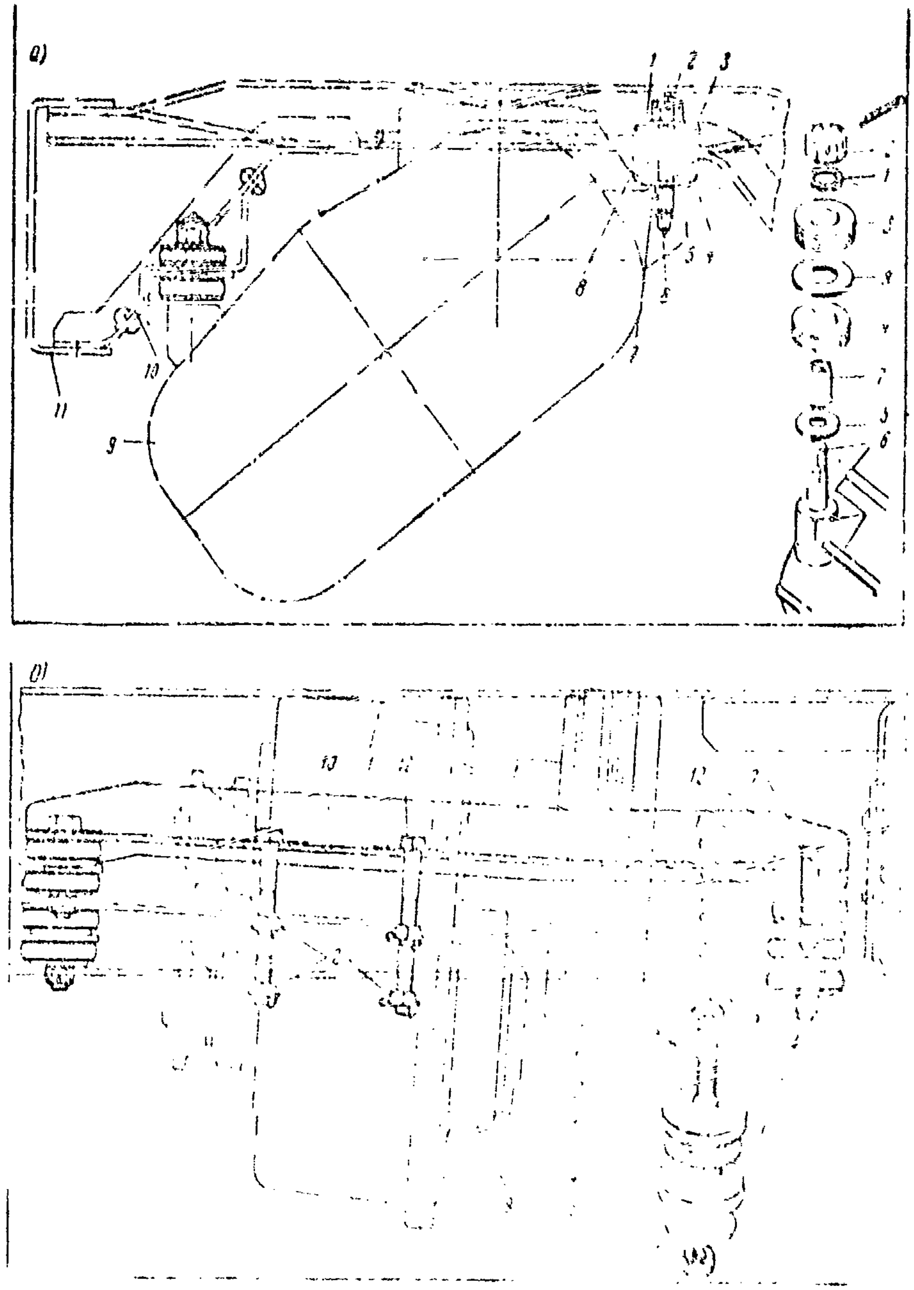


Plate 8-8. Transfer case suspension:
a) ZIL-157K motor vehicle 5) ZIL-131 motor vehicle 1, 5, and 8) washers
2) nut 3 and 4) upper and lower bushings 6) stud 7) spacing bushing
9) transfer case 10) rail for fastenin, transfer case 11) frame 12) bolts

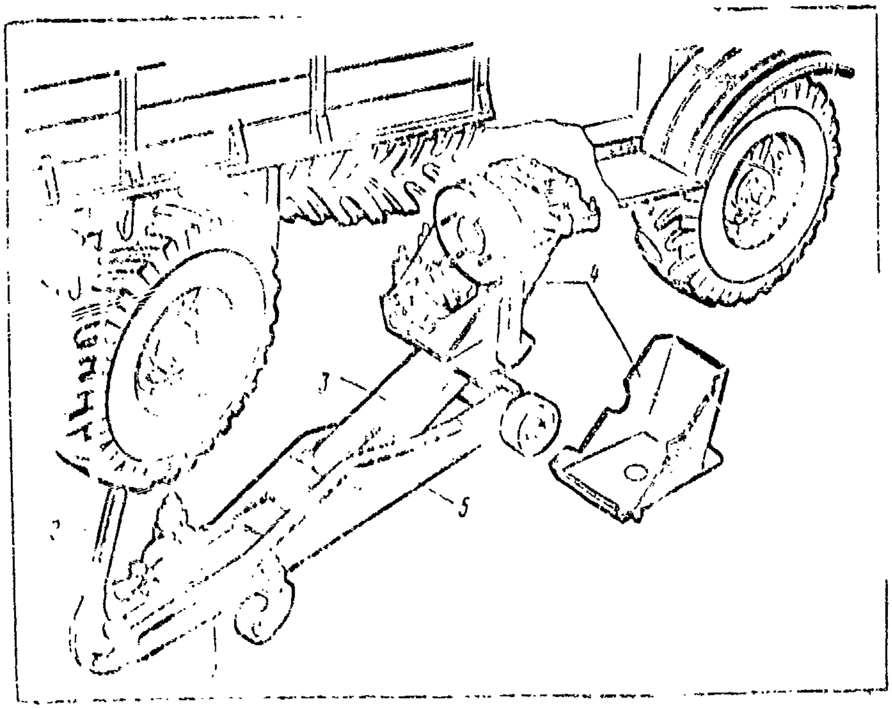


Plate 8-9. Removing the transfer case from the ZIL-157K motor vehicle:
1) jack cylinder 2) handle 3) lever 4) receptacle 5) jack body

Removal and disassembly of the middle axle output shaft. Before removing the output shaft for the middle axle, it is necessary to unscrew the bolts fastening the bearing cover, remove the protector ring, the cover in assembly with the seal, the adjusting and packing gaskets, and the oil deflecting ring.

Pull the shaft 52 (see Plate 3-1) of the middle axle drive from the housing.

For pressing off the front bearing it is necessary to fasten the shaft in a vise in assembly with its gear and bearings, and press off the bearing with a 20P-7968 puller (Plate 8-16).

The rear bearing should be pressed off together with the gear, with the shaft set on supports (Plate 8-17).

Plate 8-10. Removal of the flange from the middle axle output shaft

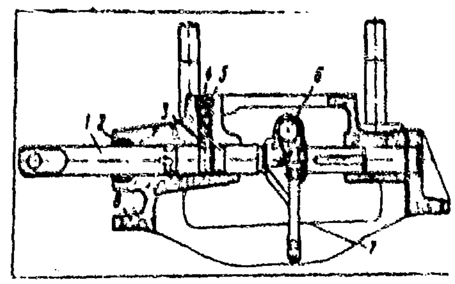


Plate 8-11. Gear changing mechanism:
1) rod 2) seal 3) catch lock ball 4) plug 5) spring 6) tension bolt 7) gear changing fork 8) transfer case housing

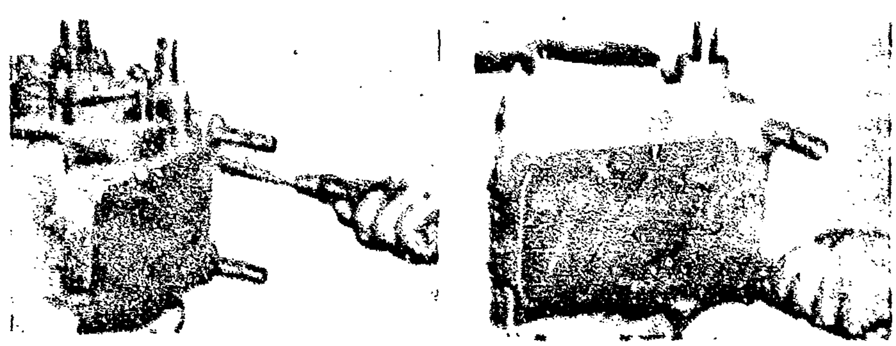


Plate 8-12. Disassembly of the transfer case gear changing mechanism:
a) unscrewing the catch lock plug b) unscrewing the fork tension bolt

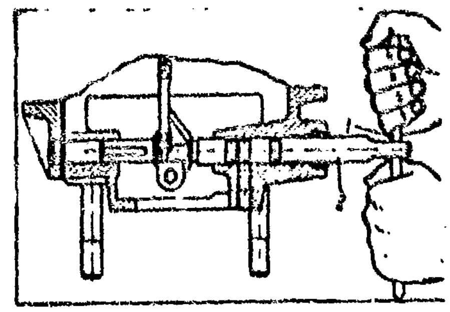


Plate 8-13. Removal of the gear changing mechanism rod:
1) metal handle 2) rod

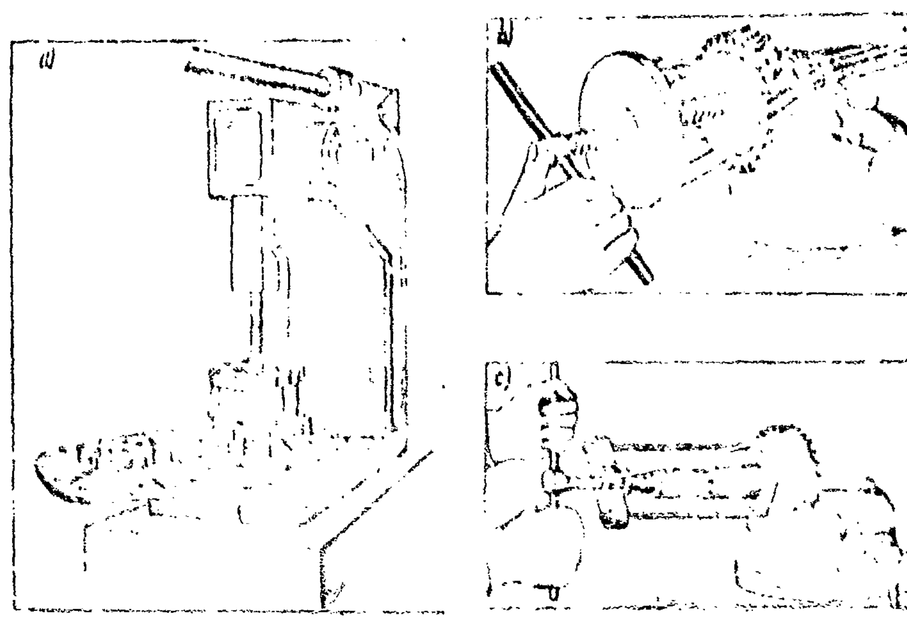


Plate 8-14. Disassembly of the driven shaft unit:
a) pressing out the driven shaft b) pressing the rear input shaft bearing outer race out of the recess in the gear
c) pressing the front bearing off the driven shaft

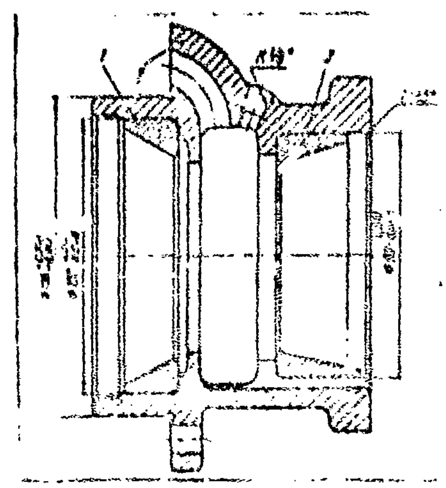


Plate 8-15. The driven shaft bearing carrier in assembly with the bearing races:
1 and 3) bearing outside races
2) bearing carrier

Removal and disassembly of the input shaft. Before removing the shaft, it is necessary to unscrew the bolts fastening the bearing cover, remove the cover in assembly with its seal, lightly tapping on them with a hammer, and remove the adjusting and packing gaskets.

Withdraw the shaft in assembly with the gears and bearings. Press off the bearing inner races with a 20P-7958 puller or with a press (Plate 8-18, a). Remove gear 22 (see Plate 8-1), support washer 19, gear 21, and steel bushing 12 from the shaft. If the bushing fits tightly on the shaft, it must be pressed off with a mandrel and hammer. If the bronze bushing is worn, it is pressed out of the ridge in the gear with a mandrel and hammer.

Removal and disassembly of the bearing carrier and front axle output shaft. For removal of the bearing carrier of the front axle output shaft, it is necessary to unscrew the bolts fastening cover 60 (see Plate 8-1) of the bearing, remove the protective ring and cover in assembly with its seal.

Remove the adjusting gaskets, the packing ring, and the oil deflecting ring.

Unscrew the bolts fastening shaft bearing carrier 54 and remove it by hand, lightly tapping on it with a hammer. Remove the bearing carrier gasket.

The bearing carrier of the front axle output shaft may be removed from the transfer case in assembly with the bearing cover 60 and flange 1.

In this case, it is necessary to unscrew the bolts fastening the bearing carrier and remove it in assembly with the shaft, bearings, and cover.

For disassembly of the front axle output shaft bearing carrier, it is necessary to unscrew the nut fastening flange 1 and remove the support washer and flange. Unscrew the bolts fastening the carrier cover, and remove the dust cover 62, bearing cover 60, oil deflecting washer 2, the support washer, and the adjusting gaskets 59. If the seal 61 is not in proper condition, it should be pressed out of the cover.

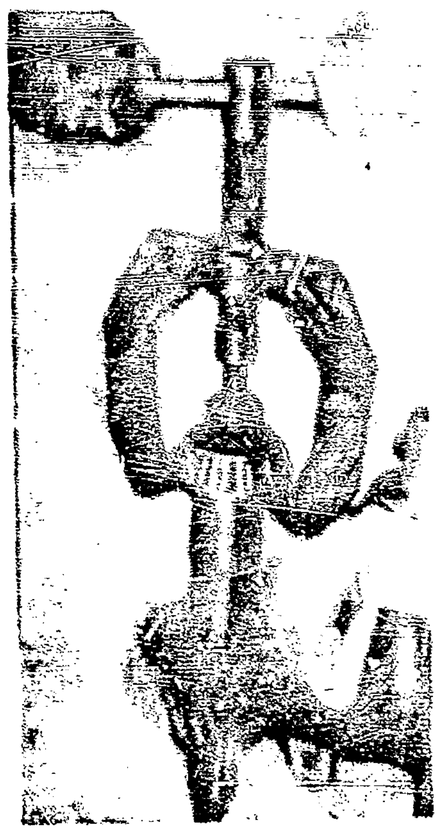


Plate 8-16. Pressing the front bearing off the middle axle output shaft

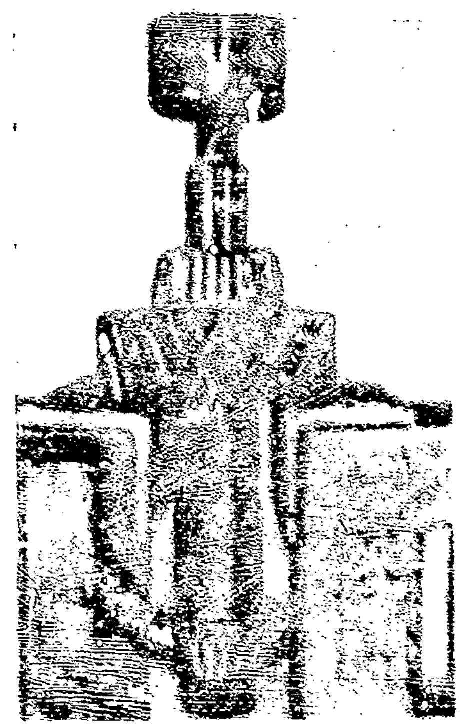


Plate 8-17. Pressing the gear and rear bearing off the middle axle output shaft

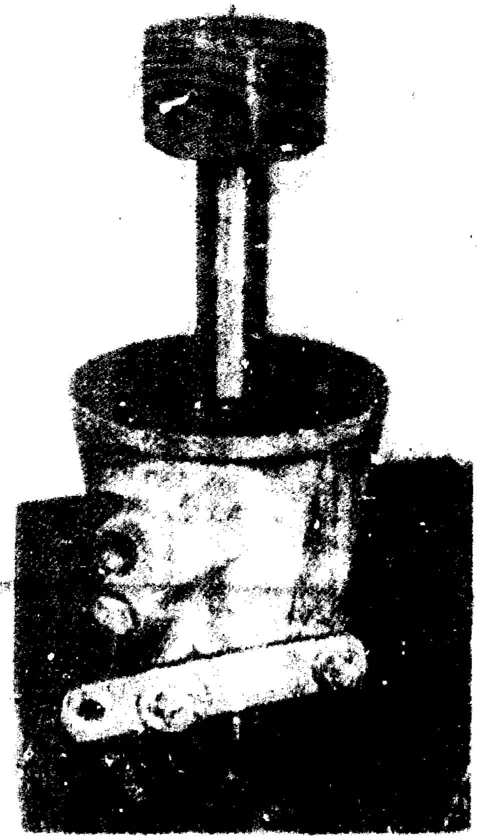


Plate 8-19. Pressing the front axle output shaft bearings from their carrier

For removal of the intermediate shaft rear bearing cover, it is necessary to unscrew the bolts and remove the cover and sealing and adjusting gaskets.

Remove the intermediate shaft in assembly from the housing.

For disassembly of the intermediate shaft, it is necessary to fasten it in a vise, bend down the ears of the lock washers (Plate 8-22,a), unscrew the nuts fastening the worm gear and bearings with a special wrench (Plate 8-22, b), and remove the lock washer and one support washer.

Lightly tapping with a hammer, remove the speedometer worm gear from the shaft and drive the key from its keyway.

Press off the bearing together with the constant engagement gear with a press, using the device shown in Plate 8-23.

Press off the rear bearing and rear and middle axle drive gear with the same device.

Press off the low spee gear across the front end of the shaft, using the same device but without the angle irons.

If there are cracks in the cast iron parts of the transfer case, the parts should be replaced. If the bearing holes are worn more than the allowable dimensions, the transfer case housing should be renewed by pressing in repair bushings.

Damage to threads in the cast iron parts is not allowed to cover more than two turns.

Non-parallelness and deviation from the common plane of the hole axis for bearings in the carrier and cover is not allowed to be greater than 0.05 mm for a length of 250 mm. The carrier and side cover of the transfer case are machined together and comprise a unit. If one of the parts of this unit fails, the two parts should be replaced simultaneously. Their installation with parts from other units is not admissible.

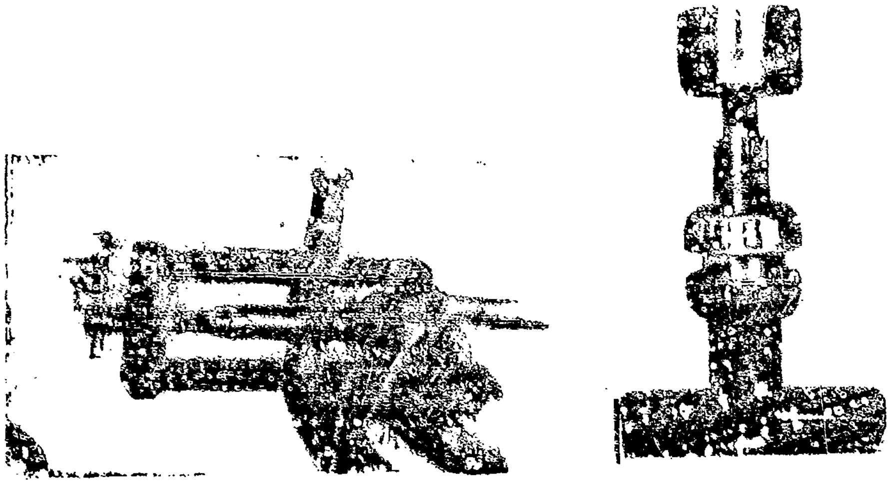


Plate 8-20. Pressing the bearings from the front axle output shaft:
a) with a puller
b) with a press

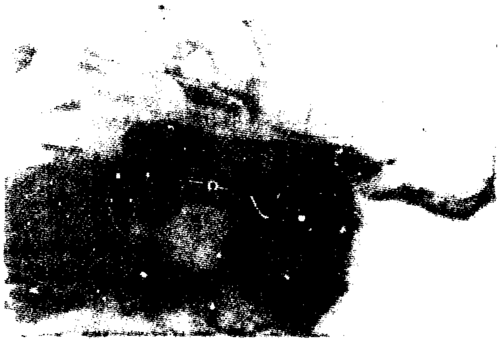


Plate 8-21. Unscrewing the guiding shaft of the speedometer driven gear

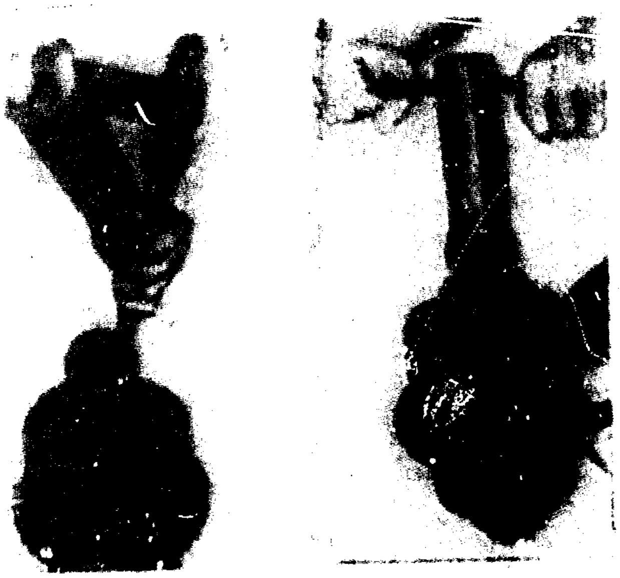


Plate 8-22. Disassembly of the intermediate shaft:
a) bending down the lock washer ears
b) unscrewing the nut fastening the worm gear and bearings

Non-parallelness of the flange faces and centering collar of the cover must be no greater than 0.05 mm. There must be no damaged on the splined assembly surfaces of the flange.

Nicks on the flange surfaces should be smoothed off.

Cracks on the flanges should be welded, or the flanges should be exchanged

Damaged threads on the flange fastening nuts are allowed to cover no more than 1-1.5 turns.

If the shaft journals and splines are worn more than the dimensions allowable without repair, or if bending or twisting are present, the shaft should be replaced.

If there are noticeable traces of wear, increased slack or chips in the bearings, or cracks in the races or chips and corrosion on a fifth of the working surfaces, the bearings should be replaced.

Oscillation on the exterior diameter of the input shaft steel bushing is not allowed to be greater than 0.03 mm. Oscillation on the bushing faces is not allowed to be greater than 0.08 mm.

Oscillation on the journals of the input, output, and intermediate shafts at the bearings is not allowed to be greater than 0.04 mm.

Oscillation of the faces on transfer case gears is no greater than 0.05 mm. If there are cracks or great wear on the teeth or splines of the gears, they should be replaced.

Small chips on the faces of the teeth should be smoothed off.

Chips on the working surfaces are not allowed.

Small failure-type depressions (pitting) on the working surfaces of the gear teeth are allowed on an area no greater than 15% of the entire surface. Sharp edges, small chips, or burrs on the gear teeth should be smoothed off.

Oscillation of the face of the middle axle output shaft where it fits against the bearing is not allowed to be greater than 0.06 mm.

The speed engagement rod is not allowed to be bent more than 0.1 mm. Bent rods may be repaired by straightening.

If the surfaces of the rods are worn more than the allowable dimensions, they should be replaced or have their surfaces renewed by chroming and subsequent machining.

Wear on the passages in the rods for the catch lock balls is allowed as long as the clearance between the shaped template and the depression does not exceed 0.6 mm. If the wear is greater than this, the rods should be replaced.

If there are cracks, chips, or wear on the fingers of the gear engaging forks above the allowable dimensions, the forks should be replaced.

Bent forks may be repaired by straightening.

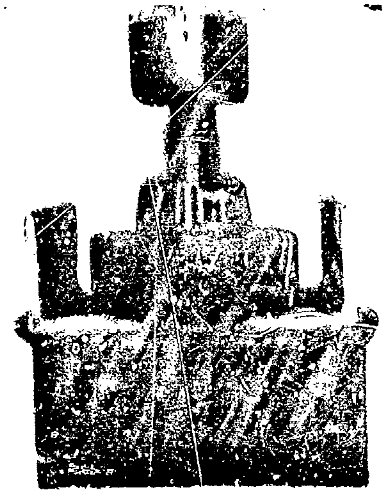


Plate 8-23. Pressing the front bearing off the intermediate shaft together with the gear

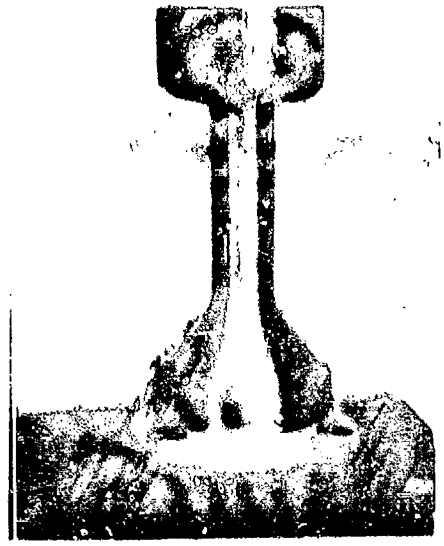


Plate 8-24. Pressing the seal into its recess in the front axle output shaft bearing cover

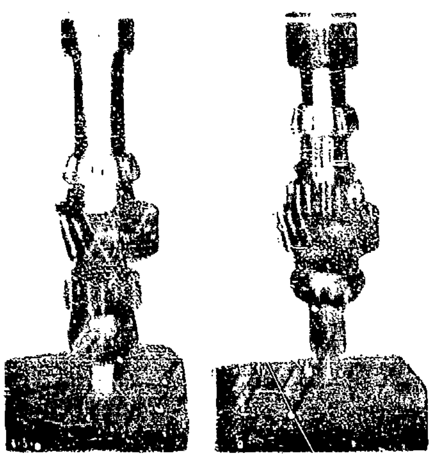


Plate 8-25. Pressing the bearings onto the input shaft
a) front bearing
b) rear bearing

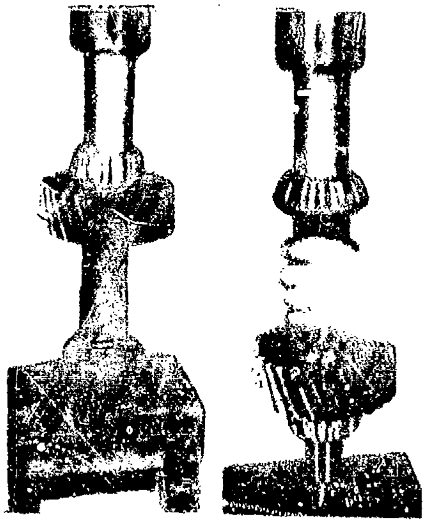


Plate 8-26. Pressing the bearings onto the middle axle output shaft a) rear bearing b) front bearing

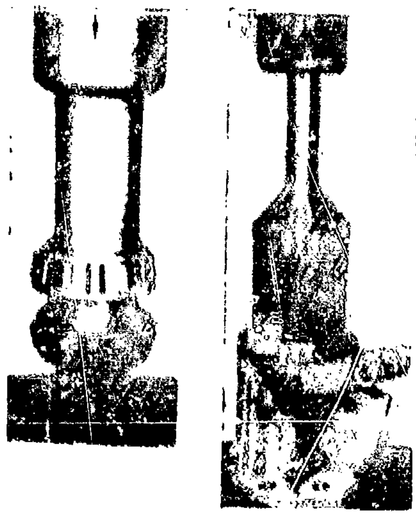


Plate 8-27. Assembling the front axle output shaft bear[illegible]g carrier a) pressing the bearings onto the shaft journal b) pressing on the front shaft bearing outside race

Assembly of the transfer case of the ZIL-157K motor vehicle. Assembly of the housing and bearing cover.

Using a press and mandrel, press the outside races of the middle axle output shaft, [illegible]termediate, and input shaft bearings into their recesses. Screw the plugs into the drain, filler, and control holes.

If necessary, replace or screw in the transfer case suspension studs.

Press seals into all the bearing covers (Plate 8-24).

Assembly of the input shaft. Press the bronze bus[illegible] the input gear 21 (see Plate 8-1) with an interference of 0.12-0.28 mm. The edges of the bushings are bent into the two slots in the gear hub. Install steel bushing 12 on the shaft, guiding its pin 20 into the slot in the shaft. In this operation, a mandrel and hammer should be used, fitting the bushing into place. The bushing fits on the shaft journal with a clearance of 0.024 mm or an interference of 0.02 mm. Install the drive gear with its bronze bushing in assembly on the steel bushing, mount the support washer 19 on the shaft, and press front bearing 18 on the shaft journal (with an interference of 0.003-0.020 mm). Install the low and high range engaging gear 22 on the shaft, and press the rear bearing 24 on the shaft journal (interference is 0.018-0.035 mm). The method of pressing the bearings on is shown in Plate 8-25.

Assembly of the middle axle output shaft. Install the gear on the shaft splines and fit it into place with a hand press or mandrel (conic rate of the splined shaft connection is 1 : 8 on the length of the journal. Press on the front and rear bearings (interference is 0.018-0.035 mm for the front bearing and 0.009-0.027 mm for the rear bearings.

The method of pressing the bearings on is shown in Plate 8-26.

Assembly of the front axle output shaft bearing carrier. Install the rear bearing, spacing ring, and front bearing on the front axle output shaft, pressing both bearings(with an interference of 0.009-0.027 mm) on the shaft journal simultaneously (Plate 8-27, a).

Press the shaft rear bearing outside race into its recess in the housing (interference is no greater than 0.026 mm). Press the rod seal into its recess in the bearing carrier. Insert the rod in the hole in the bearing carrier and mount the changing fork on it. Connect the rod with the drive plate.

Install the shaft with the bearings in assembly in the bearing carrier and press on the front bearing outer race (Plate 8-27, b) (interference no greater than 0.026 mm).

Mount the front axle engagement sleeve 56 on the splined end of the shaft (see Plate 8-1), and install engaging fork 55 in its slot. Fasten the fork by tightening stop screw 5 with a screwdriver, and screw plug 8 into the hole in the bearing carrier.

Install ball 4 of the catch lock with spring 6 in their recess in the carrier, and fasten them with plug 7.

Install the packing and adjusting gaskets on the bearing carrier, mount the support and oil deflecting rings, install the bearing cover with its protector ring, and fasten it with bolts. The front axle output shaft turns freely, without perceptible axial clearance. In cases where the shaft turns tightly or has an axial clearance, it is necessary to adjust the tension on the bearings with a selection of the required number of adjusting gaskets (Plate 8-28).

Install the flange on the splined end of the shaft and mount the support washer. Screwing in the nut, seat the flange in place and pin the nut. The fit of the flange on the splined end is a sliding one.

Assembly of the intermediate shaft. Press the driving gear 39 (see Plate 8-1) of the middle and rear axle drives on the shaft (conic rate of the splined connection of the shaft is 1 : 8 on the length of the journal). Press on rear bearing 38 (interference is 0.009-0.027 mm), install the support and lock washers 35 on the shaft, and fasten the unit with nut 36. The nut is locked by bending ears on the lock washer up into slots in the nut. Install the key in its keyway in the shaft. The key fits with a clearance of 0.40 mm or an interference of 0.060 mm. Press on the low range gear (Plate 8-29).

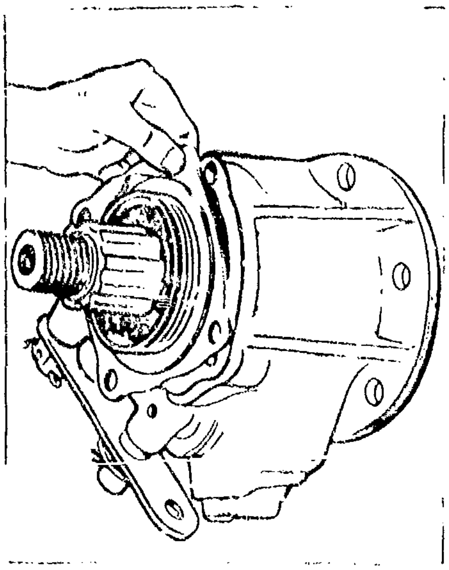


Plate 8-28. Adjustment of tension on the front axle power shaft bearings

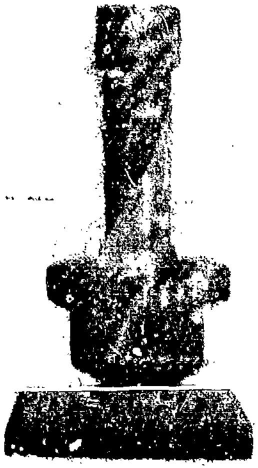


Plate 8-29 Pressing the low range gear onto the intermediate shaft

Press on constant engagement gear 51 (see Plate 8-1) and the front bearing 9.

The ... rate ... the splined connection and the amount of interference on ... bearing is the same as on the other end of the shaft. Install the key in ... keyway in the shaft, and mount the speedometer drive worm gear, fitting it into place with a mandrel and hammer. Install the lock washer and fasten the unit with a nut, locking it by bending up the ears on the lock washer into the slots in the nut.

Assembly of the driven shaft Press the outer race of the input shaft rear bearing into the recess of the toothed ring (interference is 0.025-0.050 mm). Press on the inner ring of its front bearing.

Assembly of the transfer case side cover and installation of the driven shaft. Press the outer races of the middle axle output shaft and the intermediate shaft into their recesses in the cover (interference is no greater than 0.02 0.026 mm). Press outer races 1 and 3 (see Plate 8-15) into the driven shaft bearing carrier (interference is 0.01-0.05 mm). Press the bearing carrier in assembly with its rings into the recess in the cover (interference is no greater than 0.048 mm). Install the driven shaft in the bearing carrier, insert the bearing spacing bushing, mount the adjusting washers on the shaft (Plate 8-30, a) and press on the rear bearing. The transfer case driven shaft must turn freely without perceptible axial clearance. Mount the support washer, install the bearing cover with its gasket, and fasten it with bolts. Install the flange (the fit is free) and fasten it with a nut. Check the tension on the bearings, rotating the shaft with a dynamometer (Plate 8-30, b). The moment of shaft rotation must be within the limits of 0.05-0.13 kg meters (force on the dynamometer is 0.99-2.50 kg). The front axle output shaft must also turn with the same moment and force.

In a case where the moment of shaft rotation lies outside the limits of the indicated parameters, it is necessary to perform adjustments, changing the thickness and number of the adjusting washers (see Plate 8-30, a).

Install the intermediate shaft bearing cover with its packing and adjusting gaskets in the transfer case cover, and fasten it with bolts. Install the support ring on the face of the inner race of the middle axle power output shaft bearing. Lay the oil deflecting washer into its recess in the bearing cover, install the middle axle power output shaft bearing cover with its packing and adjusting gaskets, install the protector ring on the cover, and fasten it to the transfer case cover.

General assembly of the transfer case. Set the transfer case housing on a bench with its open side up, and lay wooden blocks beneath it so that the ends of the shaft do not rest on the bench. Install the input shaft 14 (see Plate 8-1), intermediate shaft 50, and middle axle output shaft 52.

The assembled transfer case cover must be installed on the transfer case housing by laying the sealing gasket and guiding the shaft bearings in their corresponding outer races, which are pressed into the recesses in the cover.

Placing spring washers beneath the bolt heads, screw in the bolts by hand and fasten the cover with bolts. It is recommended that an angle socket wrench be used to tighten the bolts.

Install the bearing carrier of the front axle output shaft on the transfer case housing in assembly with its bearings, sealing gaskets, and adjusting gaskets, and fasten it with bolts.

Having also laid the sealing and adjusting gaskets, install the intermediate shaft front bearing cover, and fasten it with bolts. Insert the speedometer drive driven gear cover in its recess, and fasten its tension nut.

Having mounted the sealing and adjusting gaskets, install the input shaft front bearing cover and fasten it with bolts. Install the flange and fasten it with the nut.

Assemble the gear changing mechanism (see Plate 8-11), for which seal 2 of rod 1 is pressed into the recess in the housing, the rod is inserted into the hole, and fork 7 is mounted onto the end of the rod through the hole in the housing, and the fork ends are guided into the slot in the gear. Insert a metal handle into the hole in the rod and, turning the rod, screw it into the threaded hole in the fork. During this, the high and low range engaging gear must be in the neutral position. Fasten fork 7 with tension bolt 6 and pin the bolt with wire. Install bolt 3, spring 5, and plug 4 of the catch lock in their recess. Close the inspection hole with its cover and gasket, and fasten the cover with bolts and washers.

Adjustment of the ZIL-157K transfer case. The following must be adjusted in the transfer case: tightness of the tapered roller bearings; the position of the faces of the gear teeth of the input, intermediate, and driven shafts; the neutral position of the high and low range engagement gear; and the simultaneous engagement of the front axle and low range.

Bearing tightness is adjusted by changing the number of adjusting gaskets installed beneath their covers (in the output shaft, gaskets are installed between the spacing bushing and the inner race of the rear bearing.).

Adjustment of the bearings of the driven shaft and front axle power output shaft takes place during assembly of the units.

First adjust the driven shaft bearings. They are adjusted after final tightening of the driven shaft bearing carrier 26 (see Plate 8-1) onto cover 46 of the transfer case housing.

After adjusting the driven shaft bearings, the input shaft bearings are adjusted, and then the intermediate shaft bearings and the middle axle output shaft bearings.

The bearing on the front axle output shaft may be adjusted with the front axle output shaft housing 54 removed. With the bearings normally adjusted and the covers fastened, the shafts must turn freely by hand but must not have any axial clearance. Tightness of the input shaft bearings may be checked by means of turning the shaft with a dynamometer. The method of turning the shaft is shown in Plate 8-30, b. The moment on shaft rotation must lie within the limits of 0.05-0.13 kg meters (a force of 0.99-2.50 kg). During the rotation of the shaft, the bearing cover bolts and flange nuts must be tightened all the way.

Adjustment of the position of gear teeth faces is provided by tightening the intermediate shaft bearings. In this, first adjust the bearings, and then move the shaft forward and backward, changing the thickness of the gaskets beneath the intermediate shaft bearing cover on both ends of the case (see Plate 8-30, a and f).

With a decreased gasket thickness on one side, thickness of the gaskets on the other side should be increased by the same amount. The adjustment may be considered fine, if the distance from one gear to the other along the faces of their teeth is identical in both rows. During this, the gear teeth faces must be located in a single line, as shown in Plate 8-2, a.

Setting of the high and low range engagement gear in the neutral position is done by screwing rod 1 (see Plate 8-11) into fork 7 until the teeth faces of the input shaft drive gear touch those of the speed engagement gear. When the gears touch, it is necessary to unscrew the rod back by 1/3-1 revolution, checking to make sure that the axis of the hole for the rod pin is parallel to the assembly plane of the inspection hole. After setting the fork in the required position, it is necessary to fasten it with its tension bolt 6 and pin it with wire. The neutral position of the transfer case is shown in Plate 8-2, a. Plate 8-2, b, shows the simultaneous engagement of the gears for low range and front axle drive, and Plate 8-2, c, shows high range engagement.

Installation of the transfer case in the motor vehicle. Set the transfer case into its receptacle 4 (see Plate 8-9) and roll the hydraulic jack, together with the case, under the motor vehicle. Pumping handle 2, raise the transfer case, guiding its fastening studs into the holes in the frame cross member, having previously mounted the rubber lower suspension cushions 4 (see Plate 8-8, a) on the studs. Install the upper cushions 3 on the studs, screw on nuts 2, and tighten the transfer case. The nuts are pinned.

Adjusting the transfer case control linkage. Install rods 8 and 12 (see Plate 8-5), and fasten their rear ends with pins on the rods for engaging the transfer case shift and engaging the front axle.

Simultaneous engagement (interlocking) of the front axle and low range in the transfer case is achieved by adjusting the position of bolt 6, which is screwed into the lower end of the front axle engaging lever.

For adjusting the simultaneous engagement of the front axle and low range, it is necessary to set the front axle engaging rod in the "front axle engaged" position, and set the speed changing rod in the position corresponding to engagement of low range. In this, full engagement is determined by the clicking of the catch lock when it falls into the detent in the rod.

When low range is engaged, the speed shifting rod is in a position such that the mark placed on the lower side of the rod with a punch must be located at a distance of 40 mm from the machined end of the boss face on the housing

Interlocking of front axle and low range engagement in the transfer case must be adjusted in the following sequence. Set transfer case control lever 4 in a position so that it is inclined forward at an angle of approximately 35° from the vertical position, and connect the front end of rod 8 to the lever, adjusting the length of the lever by turning fork 11. Place cotter keys in the rod pins.

Set front axle engagement lever 5 so that it is inclined forward at an angle of approximately 15° from the vertical position, unscrew adjusting bolt 6 of the lever until the bolt head touches the boss on transfer case control lever 4, and fasten the bolt with nut 7.

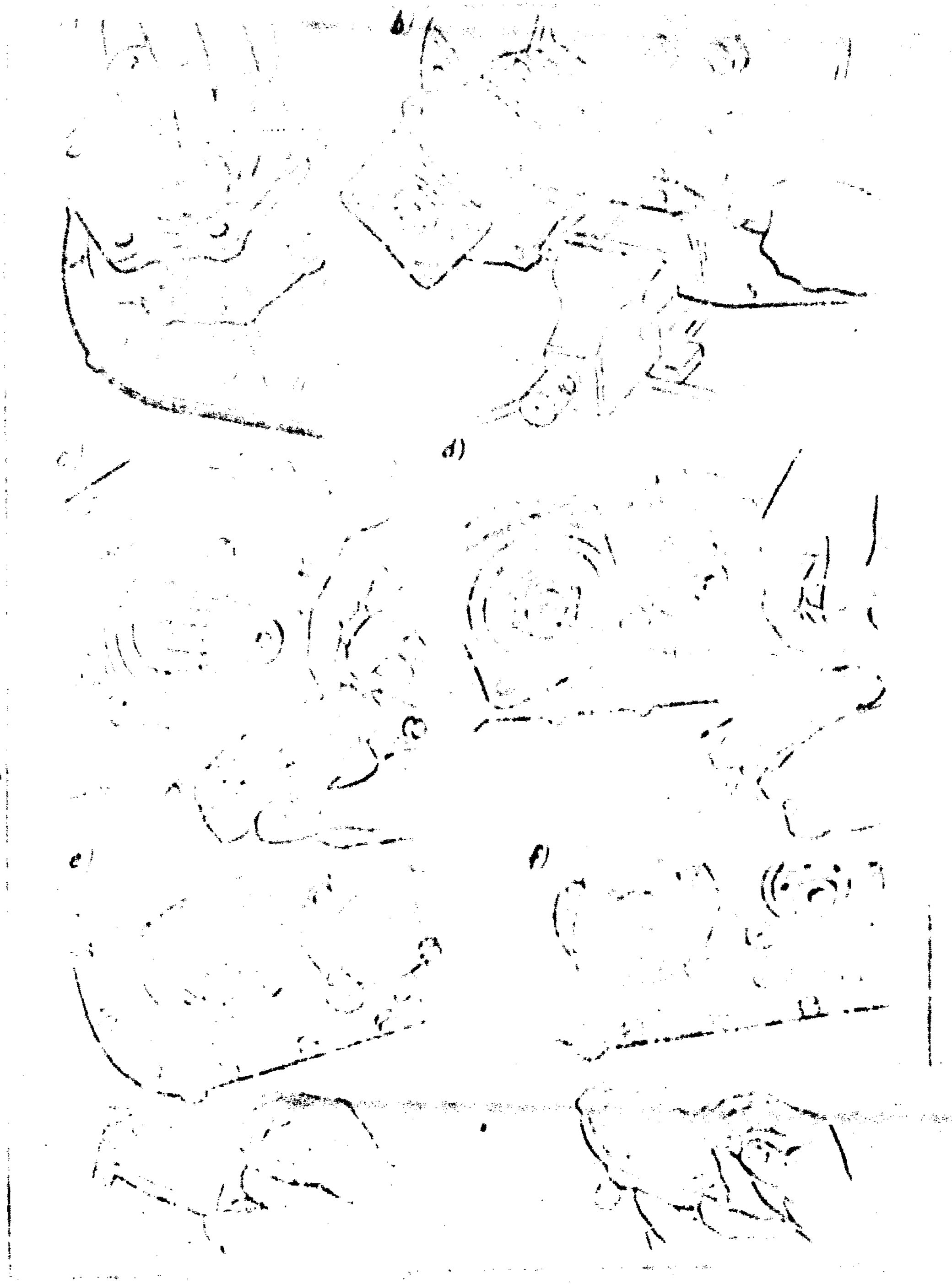


Plate 3-30. Methods of adjusting bearing tightness:
a) changing the number of washers on the driven shaft bearing b) checking driven shaft bearing tightness c) changing the number of gaskets in the input shaft bearing d) changing the number of gaskets in the front bearing of the intermediate shaft e) changing the number of gaskets in the front axle output shaft bearing f) changing the number of gaskets in the intermediate shaft rear bearing

Connect the front end of front axle engaging rod 12 to lever 10, adjusting its length by turning fork 11, and place cotter keys in the rod pin.

The proper setting and adjusting of the length of the transfer case control rods are checked during a short run of the motor vehicle by means of engaging the gears and disengaging the front axle with simultaneous disengagement of low range.

Removal of the transfer case from the ZIL 131 motor vehicle. Disconnect the propeller shafts, control linkage rods, handbrake control rod, air hose, and electric wire to the electric switch from the transfer case. Roll a model 444 hydraulic jack beneath the motor vehicle. Remove the transfer case (see Plate 8-9).

Unpin the nuts, release the suspension bolts, lower the transfer case on the hydraulic jack, and roll it out from beneath the motor vehicle together with the transfer case. Remove the suspension parts from the transfer case and from the motor vehicle frame.

Installation of the transfer case in the motor vehicle is accomplished in a sequence opposite to that of removal.

Disassembly of the transfer case of the ZIL-131 motor vehicle. Before disassembling the transfer case, it is necessary to clean the dirt and oil from it, wash it off and blow it off with compressed air, remove the handbrake together with the drum 21 (see Plate 8-3) and the flange from the splined end of the output shaft, unscrew switches 43 and 48, and remove them together with their sealing and adjusting washers.

Removing the flanges. For removal of the front flanges 8 and 11, it is necessary to open cover 17 of the inspection hole. Unscrew the nuts fasten the cover, remove the parts of the handbrake linkage, and remove cover 17 with its gasket. Block the gears so that the transfer case shafts cannot turn. Unscrew nut 9 fastening the flange, and remove it with a 20P-7968 puller. Remove the other flanges in the same manner. There are a total of three flanges on the transfer case.

Removal and disassembly of the transfer case side cover. Unscrew the bolts fastening the cover with the socket wrench. Lightly tapping on it with a hammer, separate the cover using a screwdriver, inserting it in the notch opposite the catch lock.

Remove the cover together with the driven shaft and the outer race of the front axle power shaft bearing. Unscrew the bolts fastening bearing cover 24 and remove the cover with its sealing gasket. Press the outer race of the front axle output shaft roller bearing out of its recess in the cover with a mandrel and hammer.

Unscrew the bolts fastening the stop plate 27 of the speedometer fitting. Remove the locking plate, and pull out fitting 27 and the speedometer driven gear 29.

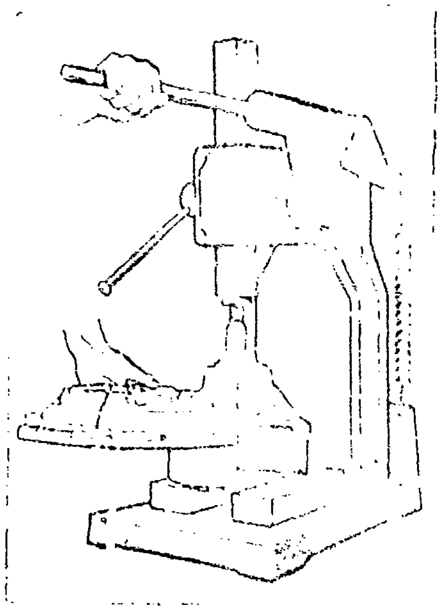


Plate 8-31. Pressing out the driven shaft

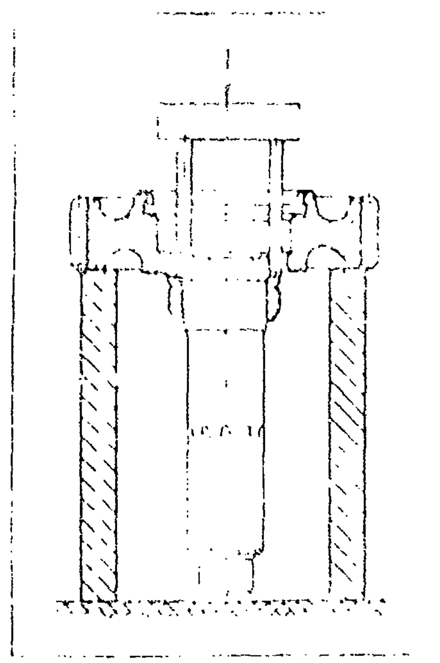


Plate 8-32. Pressing out the inner race of the driven shaft front bearing

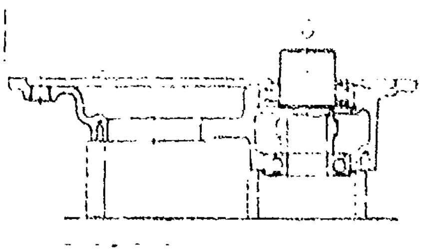


Plate 8-33. Pressing the driven shaft rear bearing out of the cover

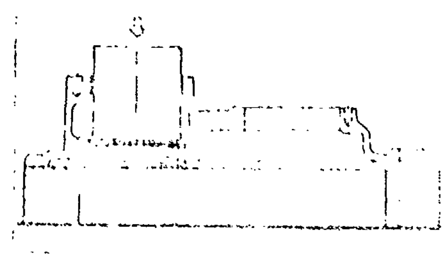


Plate 8-34. Pressing the outer race of the driven shaft front bearing from the cover

Disassembly of the driven shaft. Install the housing side cover with blocks on a bench press, and press out the driven shaft with its gear (Plate 8-31). During this operation, the driven shaft rear bearing is pressed out. In order to remove the inner race of the roller bearing from the driven shaft, it is necessary to set the gear on a support, guide the pins of the device through the hole in the gear hub, and rest them on the bearing race, fater which the race is pressed off the shaft with the press (Plate 8-32).

In order to drive the driven shaft rear bearing from the housing cover, it is necessary to set the cover on a support, and, using a hammer and mandrel (Plate 8-33), press out the bearing together with the speedometer worm gear. Turning the cover over and setting it on a support, press out the outer race of the driven shaft front bearing (Plate 8-34), using a mandrel and hammer.

Disassembly of the gear changing mechanism. Plate 8-3 (Section B--D) shows the gear changing mechanism. In order to remove rods 36 and 47, it is necessary to unpin stop bolts 34, fastening gear changing forks 33 and 35, and unscrew them. After this, unscrew the bolts fastening catch lock body 45 with a socket wrench, and, using a screwdriver, knock out both rods, first from the forks, and then together with the catch lock body from the housing. Withdraw both forks 33 and 35 from the circular slots in their respective carriers 16 and 31, and from transfer case housing 1. Unscrew plug 37 of the catch lock, and remove spring 38 and ball 39.

Set rods 36 and 47 in the neutral position. Knock out one of the rods and then remove ball 46 of the blocking mechanism. Knock out the second rod. Both rods cannot be knocked out simultaneously, nor can one rod be knocked out without the second one in the neutral position, since this will lead to breakage of the blocking mechanism. If the rod seals are not in proper condition, unscrew nut 42 of the seal and replace rubber 40 and felt 41 rings.

Removal and disassembly of the front axle drive engaging mechanism. Plate 8-3 (Section E--E) shows the front axle drive engaging mechanism. For removal of the mechanism, it is necessary to unpin stop bolt 34 fastening front axle drive engaging fork 22, unscrew it from the fork, unscrew the bolts fastening body 49 of the air-diaphragm chamber 10 of the front axle drive, and, using a screwdriver, first knock rod 52 out of the fork, and then out of the transfer case housing 1. The sealing and packing gaskets 53 are removed simultaneously with the front axle drive engaging chamber. After this, remove fork 22 from the circular slot in carrier 23 and from the transfer case housing.

Further disassembly of the mechanism takes place in the following order. Unscrew bolts 2 (see Plate 8-4) fastening cover 3 of the engaging chamber, remove the cover and the diaphragm 1, and remove external rod 5 in assembly from the body 4. For disassembly of the external rod of the mechanism, it is necessary to insert a special 10 mm wrench between the coils of the return spring 19 and grasp the internal rod 9 on its flat 12. Then unscrew cup 6 of the rod spring either by hand or in a vise, remove the wrench from the spring, and remove return spring 13. Holding external rod 5 in a vise, remove stop ring 7 with a screwdriver and hammer. After this, pull the internal rod 9 in assembly from the hollow in the external rod. Then, after unscrewing the stop nut and nut 11, remove compression spring 10 and support washer 8.

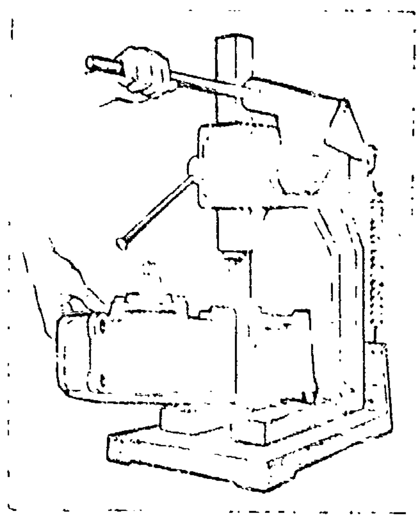


Plate 8-35. Pressing out the front axle output shaft

Removal and disassembly of the front axle power shaft. Remove cover 5 (see Plate 8-3) of the power shaft front bearing. For this, unscrew the bolts fastening the cover, remove the cover in assembly with its seal, and remove the sealing gasket. If the seal in the cover is not in proper condition, it should be pressed out of the cover with a mandrel and hammer. Remove the oil deflecting ring 6 and carrier 23 from the shaft. Before removing the front axle power shaft, it is necessary to move it somewhat forward in the housing by tapping on the rear face of the shaft, so that the bearing lock ring moves away from the housing wall. Then remove the stop ring from the circular slot in the bearing with combination pliers. After this, set the housing on a support and press the front axle power shaft in assembly with its bearing (Plate 8-35) from its receptacle in the housing with a mandrel and hammer or with a press. For disassembly of the shaft, it is necessary to set it on support 13 (Plate 8-36) and press the ball bearing 2 from the front face of shaft 1 with a mandrel and hammer or with a press. Then remove support washer 3, low range gear 4 with its needle bearing 12, low range carrier 5, and high range gear 6 with its needle bearing. If necessary (for replacing the bearing or repairing the shaft), remove inner race 7 of the rear bearing from the shaft. For this, it is first necessary to remove stop ring 8 with combination pliers or a screwdriver, and then press the bearing inner race 7 from the shaft (Plate 8-37) with a 20P-7968 puller and a special ring. After this, remove the needle bearings 12 and intermediate rings 11 and 9 from gears 4 (see Plate 8-36) and 6, and also remove the support ring 10 from low range gear 4. The needle bearing does not have a separator, and therefore it is necessary to lay them in a separate box to avoid losing the needles.

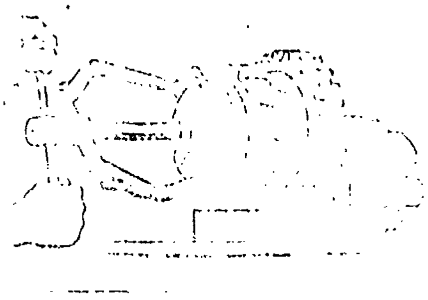


Plate 8-37. Pressing off the inner race of the front axle power shaft rear bearing

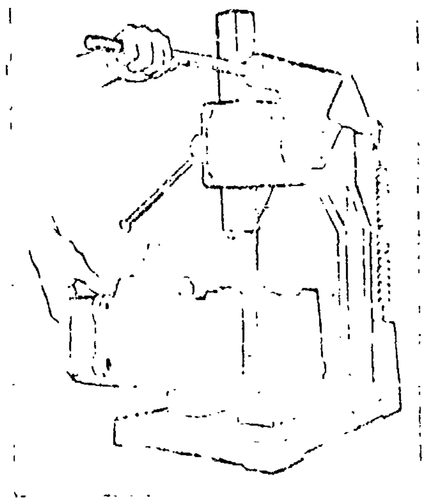


Plate 8-38. Pressing the input shaft out of the housing

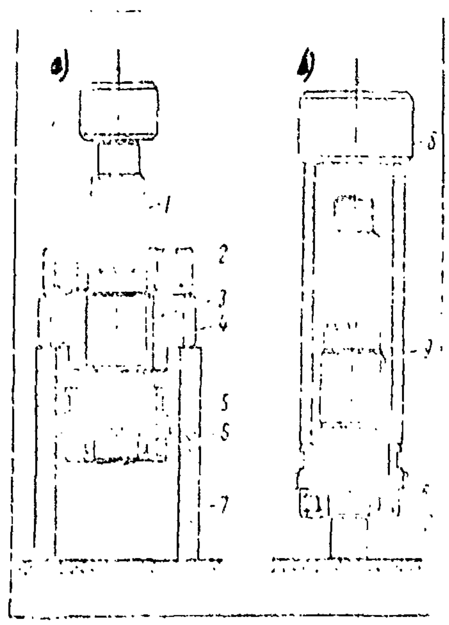


Plate 8-39. Disassembly of the input shaft:
a) pressing off the front bearing and gear b) pressing off the rear bearing
1) shaft 2) front bearing 3) key
4) drive gear 5) high range engaging carrier 6) rear bearing 7 and 10) supports 8) blocks 9) mandrel

In case of necessity, it is possible to bend down the ears of the stop washer, unscrew the fastening bolts in the oil-guiding trough, and remove the trough 2 (Plate 8-3).

Removal and disassembly of the electro-pneumatic front axle power control valve. A diagram of the transfer case control linkage is shown in Plate 8-6. Before removing the electro-pneumatic valve 2, pipe 14 supplying air to the valve, hose 5 supplying air to the air-diaphragm chamber 7 controlling the front axle power, and pipe 3 of the vent should be disconnected from the fittings on the valve body, and the wire should also be disconnected from the hole of the electromagnet.

After this, unscrew the nuts fastening the electromagnetic valve to the frame cross member bracket, unscrew the bolts with their stop washers, and remove the electromagnetic valve.

The electromagnetic valve (see Plate 8-7) consists of body 19 with two valves (inlet and outlet) and the electromagnet body 8.

Before disassembling the electromagnetic valve, it is necessary to clean the dirt and oil off its exterior, wash it off, and blow it off with compressed air. After this, unscrew bolts 16 fastening the electromagnet and, observing caution, separate body 8 of the electromagnet from body 19 of the valve. For removal of the inlet 20 and outlet 6 valves, it is necessary to unscrew plug 2 and remove spring 3. After this, set valve body 19 vertically, and carefully, without striking them, press out the valves in assembly with seat 4 with rod 17, and remove rod 17. In case rings 18 are not in good condition, it is necessary to remove them from seat 4 with a screwdriver for replacement. If the body of the outlet valve 6 or inlet valve 20 are damaged, nut 21 holding the valves on the rod should be unscrewed, and they should be removed for replacement.

Fittings 5 and 7 should not be unscrewed from the valve body unless it is necessary, since their threads may be damaged and their tightness be destroyed, necessitating a full disassembly of the electromagnet. If necessary, the bolts 9 fastening cover 11 to body 8 of the electromagnet should be unscrewed and the cover removed in assembly with coil 13. Remove the core 12 and spacing washer 14 from the body.

If the sealing rings 10 and 15 are not in good condition, they are removed from the circular slots in the body and cover.

Having finished disassembly of the transfer case, it is necessary to wash all parts in a degreasing solution and carefully check the amount of their wear, the condition of their connecting surfaces, the absence of cracks. Then perform the assembly of the transfer case, using all usable parts.

Requirements on transfer case parts. The transfer case housing and side cover are machined together, and therefore they comprise a unit. If one of the parts of this unit fails, both of them should be replaced simultaneously.

Their installation with parts from another unit is not permissible. Cracks on parts of the case are not allowed.

Nonparallelness and deviation from the common plane of the axes of bearing holes in the housing and cover are not allowed to be greater than 0.03 mm on a length of 100 mm.

Requirements for the case, side cover, and gears of the ZIL-131 motor vehicle transfer case are similar to the requirements for those same parts in the transfer case of the ZIL-157K motor vehicle.

If there is wear in the fitting holes in the hubs of the high and low range gears or there are chips on the faces of the gear teeth which are greater than the dimensions allowable without repair, the gears should be replaced.

If splines on the shaft are worn more than the dimensions allowable without repair, or also if they are bent or twisted, the shafts should be replaced. Worn out shaft journals, besides the front axle power shaft journal, intended for work with needle bearings, may be repaired. If the front axle power shaft journal is worn, it should be replaced. The following are allowed: in a new input shaft, oscillation of the surface for the gear relative to the surface for the bearing no greater than 0.05 mm; in a new driven shaft, oscillation of the hole for the input shaft bearing relative to the surface for the driven shaft bearing, no greater than 0.03 mm; in a new front axle output shaft, oscillation of the journal for the needle bearings relative to the surface for the shaft support bearing, no greater than 0.03 mm; damage to threads on the shaft for the flange fastening nut covering no more than 1.5 thread turns.

There must be no damage to the assembly surfaces of the splined portion of the flanges. Chips in the flanges should be smoothed off. If cracks or unallowable wear are present on the flanges, they should be replaced.

If the rear faces of the splines on the carrier enclosing low range and the middle axle drive become dulled, it is necessary to grind the rear face of the carrier by 0.1-0.2 mm so as to regain the sharp edges which prevent self-disengagement.

Nonparallelness of the faces of the flange and centering collar in the bearing covers must be no greater than 0.05 mm. If clearance in the bearings is increased, or there are cracks, chips, or spots of corrosion on the rings, they should be replaced.

The gear engaging rods are not allowed to be bent by more than 0.1 mm. Bent rods may be repaired by straightening. Rod surfaces which are worn more than the allowable dimensions may be repaired. Wear in the notches on the rods for the catch lock balls is allowed as long as the clearance between the shaped template and the notch does not exceed 0.6 mm. If this notch is increased, the rods should be replaced. If there are cracks, chips, or wear on the fingers of the gear changing forks above the allowable dimensions, the forks should be replaced. Bent forks may be repaired by straightening.

Assembly of the transfer case for the ZIL-131 motor vehicle. The transfer case assembly must be sufficiently tight. To this aim, the sealing gaskets of the bearing covers, housing cover, and top inspection hole cover, and also the bolts fastening the covers of the input shaft bearing, the rod catch lock body, the front axle drive engagement chamber body, and the speedometer spline are installed with non-leaking UN-25 sealing paste (VTU MKhP 3336-52) during assembly.

Parts and components prepared for assembly must be carefully washed out and blown out with compressed air.

Assembly and installation of the input shaft. With a hammer, install the key 15 (see Plate 8-3) in its keyway with a fit from clearance of 0.015 mm to interference of 0.065 mm. Press drive gear 14 onto shaft 12 either manually or with a press with an interference of from 0.003-0.047 mm, so that it is simultaneously installed with its keyway on the key. The front bearing is installed in a similar manner, with an interference of from 0.003-0.032 mm. Mount carrier 16 on the splines on the shaft. Then press the rear bearing on the shaft journal with an interference of from 0.003-0.032 mm.

Set the transfer case housing on the support on a bench. The input shaft assembly is installed in the hole for the front bearing of the carrier. With a mandrel and hammer, press the input shaft bearing in assembly with the shaft into the indicator hole with a fit from clearance of 0.038 mm to interference of 0.012 mm. In this, the circular slot on the bearing must project a small amount from the housing. Install stop ring 4 in the slot with combination pliers and a screwdriver. Press the seal into the bearing cover, install the cover together with its sealing gasket, and fasten it on the housing with bolts. The bolt threads should be smeared with sealing paste, and spring washers should be laid beneath their heads.

Assembl and installation of the front axle power shaft. Press the inner race of the roller bearing onto the rear journal of shaft 3 with an interference of from 0.003-0.032 mm with a mandrel and hammer or press. Insert the stop ring into the circular slot with a screwdriver and hammer. Pack the hub of high range gear 25 with solid type grease and insert the rollers (57 pieces) of the bearing, and then install the intermediate ring and assemble the second roller bearing (the rollers in each bearing must not differ in diameter by more than 0.005 mm from each other). After this, carefully install the gear in assembly with the bearings on the journal of shaft 3.

Install the intermediate ring in the low range gear 32 with a fit of from clearance of 0.3 mm to interference of 0.1 mm with a mandrel and hammer. Then assemble and install the needle bearings in the gear hub by the method indicated above. Carefully install the assembled low range gear on the shaft journal. Mount the support washer on the front end of the shaft, and press the front bearing on with an interference of from 0.003-0.32 mm with a mandrel and hammer or with a press.

Set the transfer case housing so that the end of the input shaft does not touch the bench. Take the front axle power shaft in assembly and insert it in the hole in the housing for the front bearing. Press the bearing into the indicated hole with a fit from clearance of 0.038 mm to interference of 0.012 mm with a mandrel and hammer in such a way that the circular slot for the stop ring in the bearing projects somewhat from the housing. Then insert stop ring 4 int the circular slot of the bearing with combination pliers and a screwdriver. Mount the oil-deflecting ring 6 on the splined end of the shaft and press it tightly to the face of the bearing. Press a seal into cover 5, install the cover together with its sealing gasket, and thread it to the housing with bolts, installing spring washers beneath the bolt heads.

Assembly and installation of the front axle drive engagement mechanism. For assembly of the air-diaphragm chamber, it is necessary to mount the first washer 8, pressure spring 10, and second washer 8 on rod 9 (see Plate 8-4). Screw nut 11 onto rod 9, and, continuing to turn the nut with a wrench, compress the spring so that the distance between the external faces of washers 8 is within the limits of 85, 55--85, 85 mm. After attaining this dimension, screw on the stop nut. Insert the assembled rod 9 into external rod 5 and fasten it with stop ring 7. Then mount return spring 13 on the end of the rod, and, inserting a wrench between its coils, grasp them by flat 12 of the rod, and screw cup 6 onto the threaded end of rod 9 until it stops. Removing the wrench, punch the cup in its threads to prevent its spontaneous unthreading. Insert external rod 5 in assembly with internal rod 9 in body 4 of the front axle drive engaging chamber, install diaphragm 1 with cover 3 on the body and fasten it with bolts 2, ensuring tightness of the chamber. The diaphragm should not be excessively stretched, since this will lead to undesirable movement of the flat on the rod 5 relative to the hole for the engaging ball in the diaphragm body.

Before installing the air-diaphragm chamber for engaging the front axle drive in the transfer case housing, it is necessary to install the adjusting gaskets 53 on its body 49 (see Plate 8-3) so as to attain a dimension within the limits of 173.9-174.1 mm from the external gasket to the axis of the hole in the rod for stop bolt 34. Then, after mounting the sealing gasket, insert the rod of the assembled front axle power engaging air-diaphragm chamber in its corresponding hole in the transfer case housing. Install front axle power engaging carrier 23 on gear 25. Insert the fingers of front axle power engaging fork 22 into the circular slot in carrier 23. Gradually moving the front axle power engaging rod into its receptacle in the housing, mount fork 22 on it. Aligning the holes in the fork and the rod, screw in stop bolt 24 until it stops, and pin it with wire.

After this, fasten the body of the front axle drive engaging air-diaphragm chamber to the transfer case housing with bolts and spring washers.

Assembly of the speed changing mechanism. The speed changing mechanism is shown in Plate 8-3 (Sections B--D and H--H). Insert low range engaging rod 47 into the catch lock body 45 so that the flats are visible in all three holes for the catch lock ball (the blocking mechanism ball and the switch). Then place the three balls 46 of the blocking mechanism in the hole between the rods. After this, insert high range engaging rod 36 and screw in the sealing plug with a screwdriver. Insert the speed changing rods 36 and 47 in assembly with the catch lock body 45 and sealing gasket into their corresponding holes in the transfer case housing (with a free-moving fit). Insert lo range engaging fork 33 in the circular slot in carrier 31. Then, moving the rods into the housing, mount the engaging fork on low range rod 47. Insert the high range engaging fork 35 in the circular slot in carrier 16 and likewise mount it on rod 36. After this, move the rod until catch lock body 45 rests against the face of transfer case housing 1, and fasten body 45 to the housing with bolts, placing spring washers beneath their heads. Screw stop bolts 34 into the holes in the fork splines and, moving the forks along the rods, align them so that the conic ends of the bolts move into the corresponding conic holes in the rods. After this, tighten the bolts with a wrench until they stop and tie them off with wire as shown in Plate 8-3, to prevent their coming unscrewed.

Insert the balls 39 and springs 38 into their recess in the catch lock body, and screw in the catch lock plug 37 until it stops.

Assembly of the transfer case housing side cover. Before assembling the side cover 18, it is necessary to prepare the driven shaft of the case, pressing the inner race of the roller bearing onto it with an interference of 0.003-0.03 mm. Then insert the outer race of the driven shaft front roller bearing into the recess in cover 18 until it stops with a fit from clearance of 0.038 mm to interference of 0.012 mm. After this, install the driven shaft with the front bearing inner race pressed on it in the outer race of this bearing, which is installed in the cover. Set the cover on supports, likewise placing supports beneath the driven shaft gears in such a way that the shaft journal for the rear bearing projects from the rear face of the cover. Mount speedometer worm gear 20 and the ball bearing in assembly with its stop ring on the driven shaft. Then press the ball bearing on the shaft journal with an interference of 0.003-0.032 mm with a mandrel and hammer, and also simultaneously install the bearing into the cover hole with a fit from clearance of 0.038 mm to interference of 0.012 mm.

General assembly of the transfer case. Set the assembled transfer case housing on the bench with its open side up, and lay wooden blocks beneath it so that the ends of the shafts do not rest on the bench. Install the sealing gasket on the assembly surface of the housing, aligning the bolt holes in the housing and the gasket. After this, install the assembled cover on the housing, guiding the input shaft bearing into the corresponding recess intthe gear in driven shaft 19, with the front axle power shaft engaging rod simultaneously moving into its corresponding recess in the cover. The cover must be finally centered along the installing pins. Placing spring washers beneath the bolt heads, screw in the bolts by hand and fasten the cover on with bolts. It is recommended that an angle socket wrench be used to tighten the bolts. Press the outer race of the roller bearing of the front axle power shaft 3 into the cover with the hammer and mandrel with a fit from clearance of 0.038 mm to interference of 0.012 mm. Install cover 24 of the front axle drive shaft rear bearing with its sealing gasket and fasten it with bolts, placing spring washers beneath the bolt heads.

Install the speedometer driven gear 29 into cover 18 on the housing so that the front journal of the gear goes into the corresponding recess of the cover with a clearance of 0.135 mm. After this, mount fitting 27 together with its rubber seal onto the speedometer gear with a clearance of 0.026-0.13 mm, simultaneously inserting the fitting into the hole in the housing cover with a clearance of 0.066 mm. Install the locking plate 28 on the speedometer fitting, and fasten it with a bolt and spring washer. Screw the drain hole plug 26 and filler hole plug 7 into the housing cover. Mount rubber 40 and felt 41 packing rings on the low and high range engaging rods, insert them in the catch lock body recess, and fasten them with spring nuts 42. The nuts should be tightened until the packing rings press against the rods along their deameters, and the rods must move freely along their axes into the body.

Install the driven shaft rear bearing cover together with its sealing gasket in assembly with hand brake mechanism on the transfer case housing cover. The cover must be centered along the external diameter of the bearing and with the installing pins.

Placing spring washers beneath the bolt heads, fasten the cover with bolts. Mount the splined flange in assembly with the handbrake drum on the driven shaft, mount the support washer, and fasten the flange with a nut until it is seated. Install and fasten flanges 8 and 11 on the input shaft and the front axle power shaft by a similar method. Install cover 17 with its sealing gasket on the studs of the transfer case housing inspection hole, and then install the parts of the handbrake linkage on the inspection cover. After this, fasten the cover and brake parts to the housing and, having installed spring washers and nuts on the studs, tighten the latter until they are firmly seated.

Checking the proper assembly of the transfer case. Alternately insert the metal handle into the hole and with a hammer move the rod into the extreme left position until the catch lock clicks. Both rods must project from the transfer case by an equal amount. In this position of the rod, the transfer case is set in neutral. If the driven shaft is turned by the handbrake drum, the flanges of the input shaft and the front axle power shaft must not turn. If the rods are moved alternately into the housing, i.e., engaging low or high range, then with rotation of the driven shaft, the input shaft must rotate, and the front axle power shaft must be stationary. If air is supplied to the front axle drive engaging chamber under a pressure of no less than 5 kg/cm^2, the front axle drive must engage. Consequently, with rotation of the driven shaft, the front axle power shaft flange must also rotate regardless of engagement of either range or neutral position of the transfer case. No adjustments besides those indicated above during assembly of the front axle drive engaging chamber are foreseen in the transfer case.

Assembly of the electro-pneumatic valve for front axle drive control in the transfer case. The assembled valve is shown in Plate 8-7. Before assembly, check the travel of valve B, which must be within the limits of 0.6-2.5 mm. Deviation of this valve above that indicated is not allowable. If it takes place, the reason should be found and eliminated. Assembly order is as follows.

Install seat 4 in assembly with valves 6 and 20 and sealing rings 18 in body 19. Insert spring 3 and screw plug 2 into body 19 until it stops. Screw fittings 5 and 7 into the body, and screw one fitting into plug 2. Insert rod 17 into body 19, install packing ring 15, and, guiding the top end of rod 17 into body 8, connect the valve body and the electromagnet body, and then fasten them with bolts 16. After this, check dimension A (the amount of projection of rod 17 above the seat of valve 8). This dimension must be within the limits of 3.3-3.7 mm. If the dimension is larger than that indicated, the electromagnet cannot open the valve, since it does not have the strength to overcome the resistance of air acting on valve 20, and overcome the resistance of spring 3. If the dimension is smaller, valve 6 will not close, and air will escape into the atmosphere, the chamber will empty, and the front axle will not be engaged.

Having checked dimension A, it is necessary to insert support ring 14 and core 12 into body 8. Install sealing ring 10 into cover 11, and then install it in assembly with coil 13 on the electromagnet body 8, and fasten it with bolts 9.

Installation of the transfer case and electro-pneumatic valve in the motor vehicle. Set the transfer case in the receptacle on the hydraulic jack and roll it beneath the automobile. Pumping the jack handle, raise the case to the necessary height. Insert bolts 12 with their welded-on plates into the holes in the longitudinal rails 10 (see Plate 8-8, b) so that the bolts move through the holes in the transfer case housing feet.

Screw nuts 2 onto all the bolts and tighten them with a wrench until they are finally seated. After this, all the nuts are pinned.

Install the electro-pneumatic valve in assembly with the electromagnet on the cross member bracket, insert the fastening bolts, mount the spring washers on them, and screw on the nuts until they are seated. Connect pipe 14 (see Plate 8-6) supplying air from the brake valve to fitting 1 (see Plate 8-7). Install hose 5, connecting it to fitting 5 (see Plate 8-7) of the valve, and connect its other end to the front axle drive engaging chamber. Connect the hose from the vent pipe 3 (see Plate 8-6) to valve fitting 7. Connect the electric wires to poles K (see Plate 8-7) of the electromagnet and to poles K and 57 (see Plate 8 3) of the front axle drive switch and the control lamp.

Adjusting the transfer case control linkage. Fasten the rear ends of the rods to the transfer case speed changing rods with pins. Check to see if the gears can be engaged with lever 1 (see Plate 8-6). If the lever rests against the front or rear edge of the slot in the floor, the linkage rods should be disconnected from the changing rods, stop nuts 8 unscrewed, and, turning threaded fork 6 in one direction or the other, the necessary linkage rod length attained.

After this, tighten the forks with the stop nuts, connect the linkage rods with the changing rods, and put cotter keys in the pins.

The proper installation of the transfer case control linkage rods, and also the proper assembly and operation of the electromagnetic valve and switches controlling the front axle drive should be checked during a brief run of the motor vehicle by means of engaging the speeds. Switch 48 (see Plate 8-3), which closes the electrical circuit of the electromagnet's valve solenoid (see Plate 8-7), must switch in simultaneously with the engagement of low range in the transfer case. During this, the electromagnet must push core 12 out of the coil. The core, through rod 17, opens valve 20 and closes valve 6. At this moment, air moves into drive engaging chamber 10 (see Plate 8-3), which switches in and engages the front axle. During this, switch 43 cuts in simultaneously, closes an electrical circuit, and the control lamp indicating that the front axle is engaged lights up on the instrument panel. When the low range is disengaged, the electromagnet circuit is broken.

Valve 20 is closed and valve 6 is opened by air pressure and the force of spring 5 (see Plate 8-7). Air moves from the front axle drive engaging chamber through the open valve 6 and fitting 7 into the atmosphere. Return spring 51 (see Plate 8-3) disengages the axle drive, and the control lamp on the instrument panel goes out.

Besides this, the compulsory engagement of the front axle drive should be checked. There is a switch on the extreme right hand side of the instrument panel. The left position of the switch handle corresponds to an engaged position of the front axle. In this case, the valve solenoid circuit is closed and the lamp on the instrument panel will light up. The right position of the switch handle corresponds to a disengaged position of the front axle. In this position, the sol noid circuit is broken and the lamp goes out.

Dimensions of parts

Transfer case parts dimensions are given in Tables 8-2 and 8-3.

Table 8-2. Dimensions of transfer case parts for the ZIL-157K motor vehicle, mm

Dimensions	Nominal	Allowable without repair
The housing and its cover		
SCh 18-36 cast iron (GOST 1412-54)		
Diameter of hole for input shaft bearing and middle axle power shaft	99.974-100.009	100.050
Diameter of holes for high and low range changing fork rod: front hole	22.04-22.08	22.12
rear hole	19.04-19.08	19.12

[Table 8-2, continued]

Diameter of hole for fitting driven axle bearing carrier	116.000-116.135	116.050
Diameter of holes for intermediate shaft bearing and middle axle power shaft bearing	89.974-90.009	90.050

<u>Input shaft</u>

12 Kh 2N4A steel (GOST 4543-61); hardened layer depth, 0.9-1.3 mm; surface layer hardness HRC 56-62.

Diameter of journal for front roller bearing and bushing	45.003-45.020	44.98
Diameter of journal for rear roller bearing	40.018-40.035	40.000
Tooth thickness on splined portion of shaft for engaging ge[illegible]	8.935-8.975	8.82
Diameter of shaft threaded end for flange fastening nut	M27 X 1.5 class 2	--

<u>Input shaft drive gear</u>

Number of teeth: external, 28; internal, 16; 30KhGT steel (GOST 4543-61); hardened layer depth, 0.6-0.9 mm; hardness on teeth HRC 56-62.

Length of exterior teeth	48	--
Thickness of exterior teeth (measured at a height of 4.32 mm)	6.523-6.573	6.35
Length of internal teeth	7.75-8.25	7.2
Groove width of internal tooth along arc of separating circumference	8.582	--
Diameter of driving gear hole for bushing	56.065-56.125	56.150
Gear hub	49.900-49.968	49.800

<u>Input shaft low and high range engaging gear</u>

Number of teeth--16, 12Kh2N4A steel (GOST 4543-61), hardened layer depth--0.9-1.3 mm; hardness on teeth--HRC 58-62.

[Table 8-2, continued]

Tooth length	34.0	32.0
Tooth thickness (measured at a height of 5.2 mm)	8.418-8.468	8.20
Groove thickness of gear splined portion	9.015-9.085	9.15
Diameter of gear journal for bushing	61.805-61.905	61.70
Width of slot for fork	10.00-10.2	10.5

Input shaft bushing

Type 20 steel (GOST 1050-60); hardened layer depth--0.7-1.1 mm; hardness--HRC 56-62.

Internal diameter	45.000-45.027	45.050
External diameter	52.940-52.970	52.900

Input shaft drive gear bushing

ATs54-4-2.5 bronze; band thickness, 1.79-1.90 mm (TsMTU 512-41).

Internal diameter	53.012-53.042	53.070
External diameter	56.25-56.35	

Support washer of front roller bearing inner race

Type 65 steel (GOST 1050-60), hardness HRC 52-58.

Thickness	4.84-5.0	--

Input shaft flange

Type 45 steel (GOST 1050-60); case hardened layer depth--1.0-3.0 mm; hardness of case hardened surface for seal--HRC 52-62.

Diameter of journal for seal	61.94-62.00	61.70
Groove width	5.82	5.9
Diameter of holes for flange fastening bolts	14.24-14.36	15.0

Driven shaft

Number of gear teeth--29; 30KhGT steel (GOST 4543-61); hardened layer depth--0.5-0.9 mm; hardness on teeth--HRC 56-62.

Diameter of shaft journal for front bearing	45.009-45.027	44.98

[Table 8-2, continued]

Diameter of shaft journal for rear bearing	39.975-39.990	39.950
Diameter of driven shaft gear recess for input shaft rear bearing	89.950-89.975	90.00
Tooth thickness of shaft splined portion	5.925-5.975	5.8
Diameter of shaft and threads for flange fastening nut	M27 X 1.5 class 2	--
Gear tooth length	40	--
Gear tooth thickness (measured at a height of 4.32 mm)	6.523-6.573	6.32

Driven shaft flange

Type 45 steel (GOST 1050-60); case hardened layer depth--1.0-2.5 mm; hardness of case hardened surface for seal--HRC 56-62.

Diameter of flange journal for seal	54.88-55.00	54.70
Groove width of flange splined portion	6.00-6.05	6.20
Diameter of hole for flange fastening bolts	14.24-14.36	15.0

Driven shaft bearing carrier

SCh 18-36 cast iron (GOST 1412-54).

Diameter of carrier recess for front bearing	99.955-99.990	100.01
Diameter of carrier recess for rear bearing	89.955-89.990	90.01
Diameter of bearing carrier journal for transfer case housing cover	116.013-116.048	--

Intermediate shaft

40KhNMA steel (GOST 4543-61); hardness--HB 341-415.

Diameter of shaft journal for speedometer drive worm gear	33.975-34.00	--

[Table 8-2, continued]

Diameter of shaft journals for front and rear bearings	40.009-40.027	39.990
Tooth thickness of shaft splined portion	12.88-12.97	12.7

Constant engagement gear

Number of gear teeth--29; 30KhGT steel (GOST 4543-61); hardened layer depth--0.6-0.9 mm; tooth surface hardness--HRC 56-62.

Gear tooth length	46.0	--
Gear tooth thickness (measured at height of 4.31 mm)	6.523-6.573	6.32
Groove width on gear splined portion	13.0-13.05	13.10

Middle and rear axle drive gear

Number of teeth--27; 30KhGT steel (GOST 4543-61); hardened layer depth--0.6-0.9 mm; tooth surface hardness--HRC 56-62.

Gear tooth length	40.0	--
Gear tooth thickness (measured at height of 4.32 mm)	6.523-6.573	6.32
Groove width on gear splined portion	13.0-13.05	13.10

Low range gear

Number of teeth--35; 12Kh2N4A steel (GOST 4543-61); hardened layer depth--0.9-1.3 mm; tooth surface hardness--HRC 56-62.

Tooth length	26.5	--
Tooth thickness (measured at a height of 2.54 mm)	6.975-7.025	6.80

Cover for intermediate shaft
and middle axle power shaft bearings

SCh 15-32 cast iron (GOST 1412-54).

Diameter of cover centering collar for hole in transfer case housing	89.93-90.00	--
Diameter of holes for cover fastening bolts	10.7	11.2

[Table 8-2, continued]

Middle axle power shaft

40KhNMA steel (GOST 4543-61); hardness--HB 341-415.

Diameter of shaft journal for front bearing	45.018-45.035	45.00
Diameter of shaft journal for rear bearing	40.009-40.027	39.990
Tooth thickness on shaft splined portion:		
for engaging sleeve	5.75-5.78	5.6
for flange	5.925-5.975	5.80

Middle axle power shaft gear

Number of teeth--28; 30KhGT steel (GOST 4543-61); hardened layer depth--0.6-0.9 mm; tooth surface hardness--HRC 56-62.

Gear tooth length	40.0	--
Gear tooth width (measured at a height of 4.32 mm)	6.523-6.573	6.32
Groove width on gear splined portion	13.00-13.05	13.10

Flange of the middle and front axle power shaft

Type 45 steel (GOST 1050-60); layer depth of surface case hardening for seal--1-3 mm; case hardened layer hardness--HRC 52-62.

Diameter of flange receptacle for flange fork	95.000-95.054	95.1
Diameter of flange journal for seal	54.88-55.00	54.70
Width of groove on flange splined portion	6.00-6.05	6.20
Diameter of hole for flange fastening bolts	14.24-14.36	15.0

Front axle power shaft carrier

SCh 18-36 cast iron (GOST 1412-54).

Diameter of carrier recess for bearing	89.974-90.009	90.040
Diameter of centering projection for installation in transfer case housing hole	99.965-100.000	--

[Table 8-2, continued]

Diameter of hole for engaging fork rod	14.03-14.06	14.1

Front axle power shaft

40KhNMA steel (GOST 4543-61); hardness--HB 341-415.

Diameter of shaft journal for bearing	40.009-40.027	39.99
Tooth thickness on shaft splined portion for flange	5.925-5.975	5.8
Tooth thickness for engaging sleeve	5.75-5.78	5.6
Diameter of shaft and threads for flange fastening r ;	M24 X 1.5 class 2	--

Front axle power shaft engaging sleeve

Number of teeth--12; 40KhNMA steel (GOST 4543-·1); hardness--HB 341-415.

Width of tooth grooves along separating circumference arc	5.86	--
Width of sleeve groove for fork	10.00-10.20	10.4
Diameter of sleeve groove journal for fork	59.88-60.00	59.70

High and low range engaging fork rod

Type 45 steel (GOST 1050-60); case hardened layer depth--1.0-3.0 mm; hardness of case hardened surface--HRC 52-62.

Diameter of fork rod for hole in transfer case housing	21.979-22.000	21.950
Radius of notch for catch lock	5.65-5.75	--

High and low range engaging fork

Type 20 steel (GOST 1050-60); hardened layer depth--0.3-0.5 mm; hardness of hardened layer--HRC 52-62.

Fork finger thickness	9.7-[illegible].8	9.5
Diameter of fork bushing threads	M22 [illegible] 1.5, class 2	--

[Table 8-2, continued]

<u>Front axle engaging fork rod</u>

18KhGT steel (GOST 4543-61); hardened layer thickness--0.7-0.1 mm; hardness of hardened surface--HRC 56-62.

Diameter of rod for hole in fork	13.965-14.000	13.940

<u>Front axle engaging fork</u>

Type 20 steel (GOST 1050-60); depth of nitrided layer--0.3-0.5 mm; hardness of hardened surface--HRC 56-62.

Diameter of hole for engaging fork rod	14.006-14.025	14.045
Thickness of fork fingers	9.7-9.8	9.5

Plate 8-3. Dimensions of transfer case parts of the ZIL-131 motor vehicle, mm

Dimensions	Nominal	Allowable without repair
The housing and its cover (Plate 8-40)		
SCh 15-32 cast iron (GOST 1412-54)		
Diameter of hole for input shaft bearing	119.988-120.023	120.060
Diameter of hole for driven shaft front bearing and front axle power shaft rear bearing	109.988-110.023	110.060
Diameter of hole for front axle power shaft front bearing and driven shaft rear bearing	99.988-100.023	100.060
Diameter of holes for speed changing fork rods and rear hole for front axle power engaging fork rod	19.04-19.08	19.13

[Table 8-3, continued]

Input shaft		
40Kh steel (GOST 4543-61); hardness--HRC 35-40.		
Diameter of journal for front ball bearing	45.003-45.020	44.98
Diameter of journal for rear roller bearing	35.003-35.020	34.98
Diameter of shaft journal for drive gear	50.030-50.047	--
Tooth thickness for engaging carrier along separated circumference with diameter of 56 mm	5.637-5.752	5.5
Tooth thickness of shaft splined portion for flange	5.94-5.99	5.8
Diameter of shaft threaded end for flange fastening nut	M33 X 1.5, class 2	--
Input shaft driving gear		
Number of teeth--25; 25KhGT steel (ChMTU TsNIIChM 761-62); depth of nitrided layer--0.6-0.8 mm; surface layer hardness--HRC 60-65; core hardness----HRC 35-45.		
Tooth length	39	--
Tooth thickness measured at a height of 5.19 mm	7.151-7.191	6.95
Diameter of hole for input shaft journal	50.000-50.027	--
High Range Engaging Carrier		
Number of teeth--27; 25KhGT steel (ChMTU TsNIIChM 761-62); depth of nitrided layer--0.6-0.8 mm; on the surface of the fork groove --0.4mm; surface layer hardness--HRC 60-65; core hardmess--HRC 35-45		
Tooth length	13.2	12
Tooth thickness along arc of separated circumference at a distance of 3.5 mm from the face	5.722-5.637	5.5
Width of tooth grooves along arc of separated circumference for input shaft	5.787-5.872	6.000

[Table 8-3, continued]

Width of groove for fork	10.00-10.20	10.40
Diameter of groove journal for fork	71.88-71.96	71.7

Input shaft and front axle power shaft flange

Type 45 steel (GOST 1050-60); case hardening by means of heating with high frequency current, with a case hardened layer depth of 1.0-2.5 mm; case hardened layer hardness--HRC 56-62.

Diameter of journal for seal	57.88-58.00	57.7
Width of groove in flange splined portion	6.00-6.05	6.20
Diameter of centering hole for Cardan shaft flange, fork	95.000-95.054	95.1
Diameter of holes for Cardan flange fork fastening bolts	14.24-14.36	15.00

Driven shaft

Number of gear teeth--38; number of internal teeth for carrier--26; 25KhGT (ChMTU Ts NIIChM 761-62); depth of nitrided layer--0.6-0.8 mm; surface layer thickness HRC 60-65; core hardness HRC 35-45.

Diameter of journal for front roller bearing	50.003-50.020	49.98
Diameter of journal for rear ball bearing	45.003-45.020	44.98
Diameter of hole in driven shaft gear for input shaft rear bearing	80.000-80.030	80.050
Tooth length	42	--
Gear tooth thickness (measured at height of 5.431 mm)	7.412-7.452	7.2
Tooth length	8	7
Groove width along arc in divided circumference at distance of 3.5 mm from face	5.842-5.927	6.1
Tooth thickness on shaft splined portion for flange	6.94-6.99	6.8

[Table 8-3, continued]

Diameter of shaft and threads for flange fastening nut	M33 X 1.5, class 2	

Speedometer worm gear

Number of turns--5; type 20 steel (GOST 1050-60); depth of cyanated layer--0.15-0.30 mm; hardness--HRC 56-62.

Tooth thickness (measured at height of 1.25 mm)	1.76-1.81	1.6
Diameter of hole in worm gear for driven shaft journal	45.032-45.100	--

peedometer drive driven gear

Number of teeth--17; type 20 steel (GOST 1050-60); depth of cyanated layer--0.15-0.30 mm; hardness--HRC 56-62.

Tooth thickness (measured at height of 1.295 mm)	1.76-1.81	1.6
Diameter of journal for collar	10.940-10.974	10.90
Diameter of rear support journal	7.915-7.965	7.87

Driven shaft flange

Type 45 steel (GOST 1050-60); case hardened by heating with high frequency current with a case hardened layer depth of 1.5-3 mm; hardness of case hardened layer, HRC 56-62.

Diameter of journal for seal	61.88-62.00	61.7
Width of groove in flange splined portion	7.00-7.05	7.20
Diameter of centering collar for Cardan shaft flange fork	94.93-95.00	94.9
Diameter of holes for Cardan shaft flange fork fastening bolts	16.20-16.235	--

Front axle power shaft

Number of teeth for engaging carrier--24; 25KhGT steel (ChMTU TsNIIChM 761-62); nitrided layer depth--1-1.3 mm; on the journals and support faces for the needle bearings--0.8 mm; surface layer hardness--HRC 60-65, and core hardness--HRC 35-45.

[Table 8-3, continued]

Diameter of journal for front ball bearing	45.005-45.020	44.98
Diameter of journal for rear roller bearing	50.005-50.020	49.98
Diameter of journal for gear roller bearings	51.58-51.60	51.55
Tooth length	8	--
Tooth thickness along arc of divided circumference	3.904-3.980	3.7
Tooth thickness of the shaft splined portion for shaft	5.94-5.99	5.8
Diameter of shaft and threads for flange fastening nut	M33 X 1.5, class 2	--

High range gear

Number of teeth--38; number of teeth for engaging carrier--24; 25KhGT steel (ChMTU TsNIIChM 761-62); nitrided layer depth--0.6-0.8 mm, in the supporting holes of the hub and on the faces--no less than 0.4 mm; surface layer hardness--HRC 60-65; core hardness--HRC 35-45.

Tooth length	42	--
Gear tooth thickness (measured at height of 5.43 mm)	7.412-7.452	7.2
Diameter of hole for needle bearings	57.63 57.648	57.67
Tooth length		
for low range engaging carrier:	13	12
for front axle power shaft engaging carrier	11	10
Tooth thickness along arc of divided circumference:		
full	3.904-3.989	3.7
tapered	3.3-3.6	3.1

Front axle drive engaging carrier

Number of carrier teeth--24; 25KhGT steel (ChMTU TsNIIChM 761-62); nitrided layer depth--0.6-0.8 mm, and on surface of groove for fork--0.4 mm; surface layer hardness--HRC 60-65, and core hardness--HRC 35-45.

Tooth length	24	--
Groove width along arc of divided circumference	4.054-4.139	4.30

[Table 8-3, continued]

Width of slot for fork	10.00-10.20	10.40
Diameter of slot journal for fork	96.86-96.95	96.7

Low range gear

Number of teeth--52; number of teeth for engaging carrier--24; 25KhGT steel (ChMTU TsNIIChM 761-62); depth of nitrided layer--0.6-0.8 mm, in the supporting hole of the hub and on the faces--no less than 0.4 mm; surface layer hardness--HRC 60-65; core hardness--HRC 35-45.

Tooth length	39	--
Gear tooth thickness (measured at height of 3.432 mm)	5.916-5.956	5.7
Diameter of hole in hub for needle bearings	57.630-57.648	57.67
Tooth length	14.5	--
Tooth thickness along arc of divided circumference:		
full	3.904-3.989	3.7
tapered	3.3-3.6	3.1

Low range engaging carrier

Number of carrier teeth--24; 25KhGT steel (ChMTU TsNIIChM 761-62); depth of nitrided layer, 0.6-0.8 mm, on the surface of the groove for the fork--0.4 mm; surface layer hardness--HRC 60-56, and core hardness--HRC 35-45.

Tooth length	34	--
Groove width along arc of divided circumference	4.054-4.139	4.30
Width of slot for fork	10.00-10.20	10.40
Diameter of slot journal for fork	96.86-96.95	96.7
Diameter of holes for catch lock balls and blocking mechanism	11.24-11.36	11.5

Low and high range engaging rods

Type 45 steel (GOST 50-60); case hardening by heating with high frequency current with case hardened layer depth of 1-3 mm; hardness of case hardened surface--HRC-52-62.

Rod diameter	18.979-19.000	18.95
Radius of notches for catch lock	5.65-5.75	Clearance no greater than 0.5 mm from template

[Table 8-3, continued]

Radius of notch for block	7.0-7.5	
Diameter of hole in rod for linkage rod fastening pin	12.12-12.24	12.4

Low and high range engaging forks

Type 20 steel (GOST 1050-60); depth of cyanated layer--0.3-0.5 mm; hardness of case hardened layer--HRC 56-62.

Diameter of hole for speed engaging rod	19.02-19.05	9.1
Thickness of fork fingers	9.7-9.8	9.4

Speed engaging rod catch lock body

SCh 15-32 cast iron (GOST 1412-54).

Diameter of holes for speed engaging rods	19.14-19.28	19.5

Front axle power engaging chamber body

AL10V aluminum alloy (GOST 2685-53).

Diameter of hole for front axle power engaging chamber rod	29.000-29.033	29.080
Diameter of centering collar for installation in housing	39.95-40.00	--
Diameter of threads in flange holes	M6 class 2	

Front axle drive engaging chamber rod

Type 45 steel (GOST 1050-60); case hardened by means of heating with high frequency current, with a case hardened layer depth of 1-3 mm; hardness of case hardened layer--HRC 52-62.

Diameter of rod for engaging chamber body	28.93-28.96	28.90
Diameter of rod for transfer case housing cover	18.979-19.000	18.95

[Table 8-3, continued]

Return spring for front axle power engaging chamber		
Number of coils--8; steel spring wire 4 mm in diameter (GOST 5047-49).		
Exterior spring diameter	33.6-34.4	--
Spring length in free condition	60	--
Spring length (under load of 18-23 kg)	48	--
Pressure spring of front axle power engaging chamber		
Number of coils--24; steel spring wire 2.5 mm in diameter (GOST 5047-49).		
Internal spring diameter	8.25-8.75	--
Spring length in free condition	100	--
Spring length under load of 24-30 kg	80	--

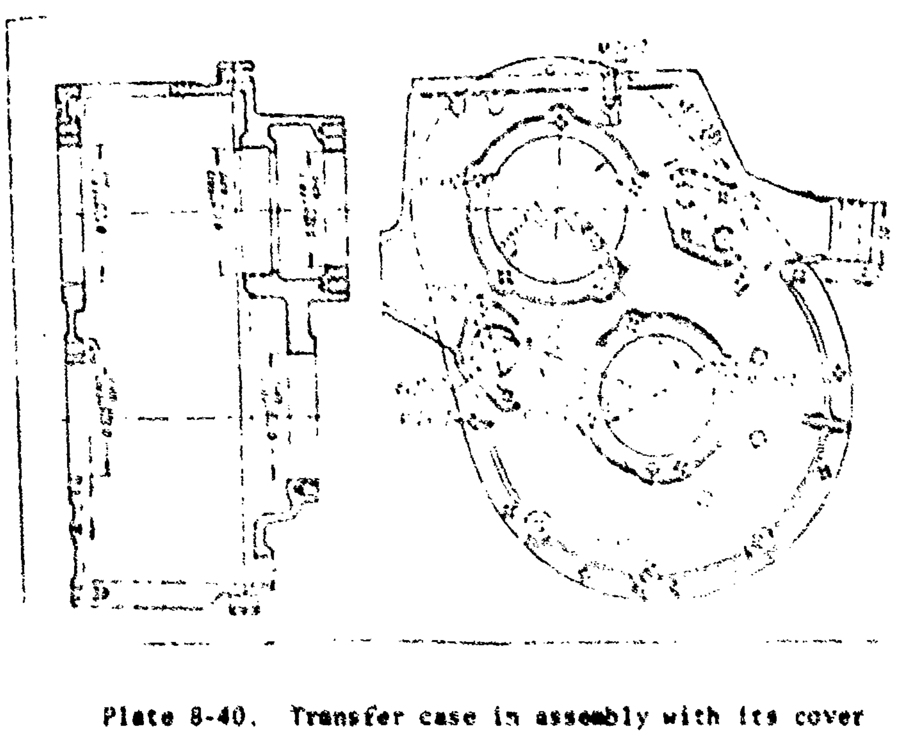


Plate 8-40. Transfer case in assembly with its cover

Chapter 9. Universal Drive [Cardan Drive]

Layout

All ZIL cargo motor vehicles are equipped with open universal drives made of thin-walled welded tubing with universal joint forks welded onto both their ends (or with the fork welded onto one end and a splined end or splined bushing welded onto the other end). All the universal joints run on needle bearings.

Universal drive of the ZIL-130 motor vehicle. Propeller shafts (Plate 9-1) are manufactured of drawn tubing welded out of cold-rolled plate 3 mm in thickness. The external diameter of the tubing is 77 mm. The fork is welded to both ends of the main propeller shaft 12 and to the front end of the intermediate shaft 2. To the rear end of the intermediate shaft is welded a splined bushing 26, on whose exterior diameter is installed ball bearing 5 of the intermediate support.

The universal drive of the motor vehicles is equipped with sealed splined connections. Lubrication of the inner space of bushing 26 is maintained by leakage from baffle 27 which is rolled into the splined bushing, and from the opposite side, by the rubber and felt seals. Both seals, in combination with the splined protective boot 10, prevent the splined connections from becoming dirty. The protective boot is fastened onto the shaft with spring rings.

The construction of all universal joints is identical. The universal joints have rubber seals to hold lubrication and prevent the needle bearings from becoming dirty. The crosses and bearings of all three universal joints are interchangeable.

Universal joint bearings are lubricated through lubrication fitting 11, which is screwed into the cross. To avoid damaging the bearing seals during increased pressure in the process of lubrication, there is a protector valve 14 in the center of the cross which opens under a pressure of 3.5 kg/cm^2.

The intermediate support of the propeller shaft consists of ball bearing 5, on which covers 4 with seals 3 and 7, holding lubrication and protecting the bearings from dirt, are installed and rolled in. The bearing, together with the covers, is installed in the rubber cushion 23 of the support. The brackets of the rear bearing cover go into slots in the support cushion and prevent the bearing from rotating in the cushion.

The intermediate support is fastened to the motor vehicle frame by bolts with support bracket 22 and the cross member. To limit axial travel of the cushion in the support bracket, a cushion stop bracket is installed between the bracket and the frame cross member. Besides this, the lower part of the cushion is fastened to the bracket with a tension clamp for the same purpose.

The support bearing is lubricated through an angular lubrication fitting which is screwed into the bearing cover.

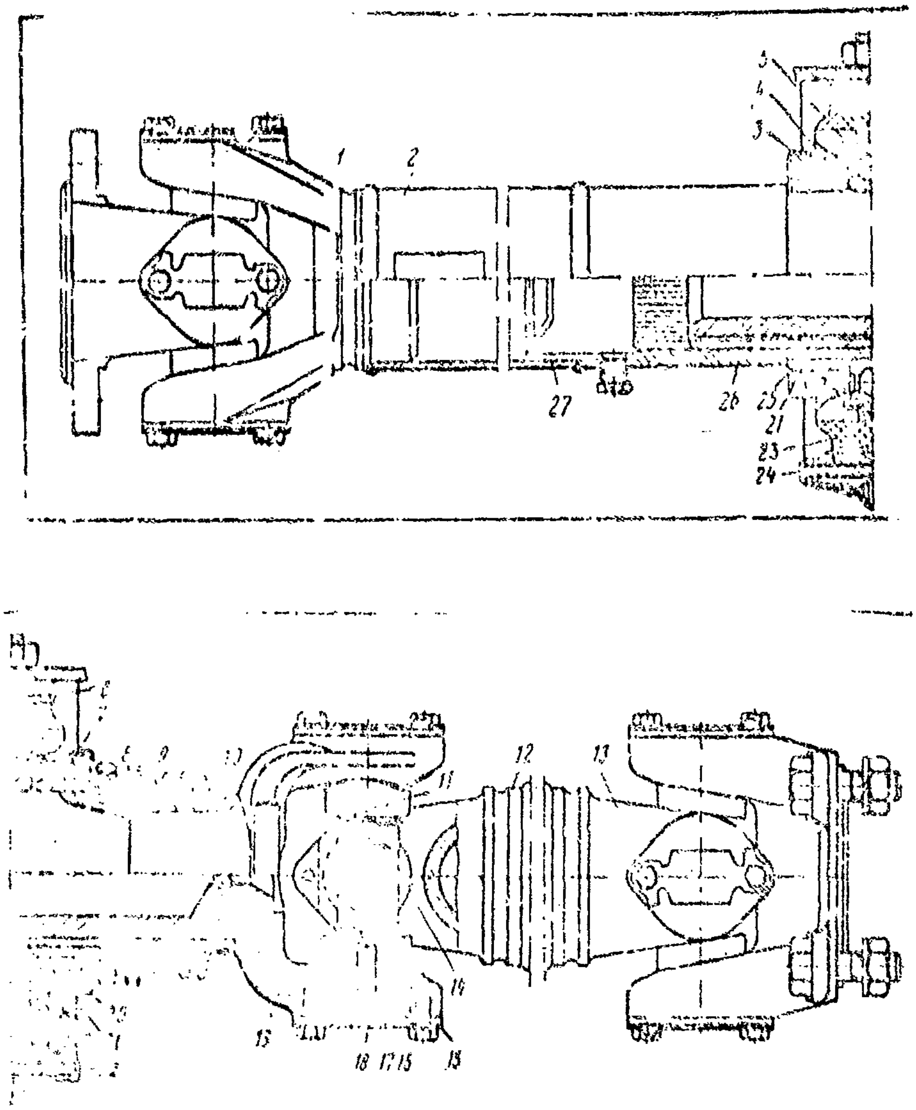


Plate 9-1. Universal drive of the ZIL-130 motor vehicle:
1) front universal joint 2) intermediate shaft 3) and 7) felt seals 4) support cover 5) bearing 6) intermediate support cushion stop bracket 8) seal nut 9) felt seal 10) protective boot 11) lubrication fitting 12) main propeller shaft 13) rear universal joint 14) protective valve 15) locking plate 16) needle bearing 17) cross 18) support plate 19) intermediate universal joint sliding fork 20 and 25) seal deflectors 21) bearing spacing bushing 22) bracket 23) cushion 24) locking clamp 26) bushing 27) baffle

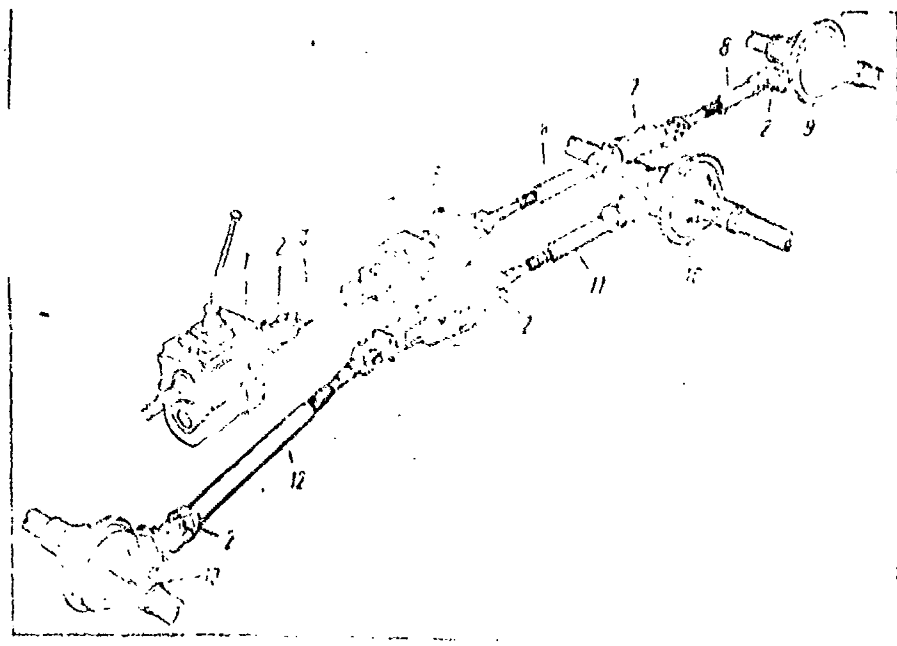


Plate 9-2. Universal drive of the ZIL-157K motor vehicle:
1) transmission 2) universal joints 3) main propeller shaft
4) transfer case 5) handbrake 6) intermediate rear axle propeller shaft 7) intermediate support 8) rear axle propeller shaft 9, 10, and 13) drive axles 11) middle axle propeller shaft 12) front axle propeller shaft

The universal drive of the ZIL-157K motor vehicle is shown in Plate 9-2.

All universal shafts except the main one (located between the transmission and the transfer case) are constructed identically and differ by their length and the dimensions of their forks and flanges. All universal joints are identical and interchangeable. Since September of 1965, the bearings of the crosses have been installed with rubber-bodied seals.

Each propeller shaft (Plate 9-3) consists of a thin-walled tube, on one end of which is welded the stationary yoke, and on the other, a splined end connecting with the sliding yoke.

The main propeller shaft differs from the other shafts by the absence of its protecting sleeve and the dimensions of its splines. The two forks, having a splined end and a splined bushing, are directly connected together, and are connected to the flange fork through the cross and bearings.

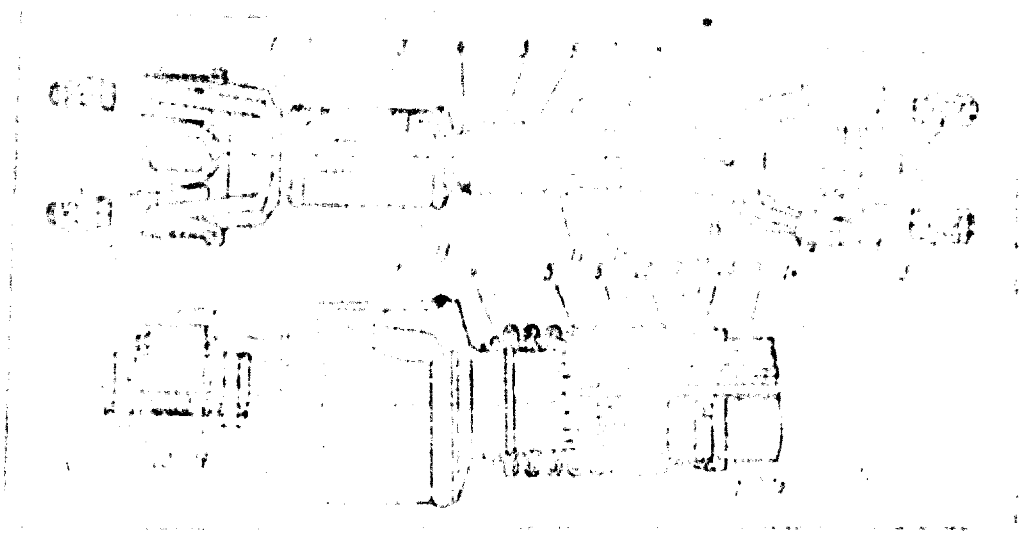


Plate 9-3. Propeller shaft of the rear axle of the ZIL-157K motor vehicle:
1 and 5) lubrication fittings 2) yoke 3) propeller shaft 4 and 17) safety wire 5) protective boot 6) splined end 7) sliding fork seal 8) sliding fork 9) baffle 10) needle bearing 11) universal cross 12) flange yoke 13) protector valve 14) seal 16) seal clamp tab 18) balancing plate 19) support plate 20) locking plate 21) removable balancing plates 22) seal end 23) seal ring clamp

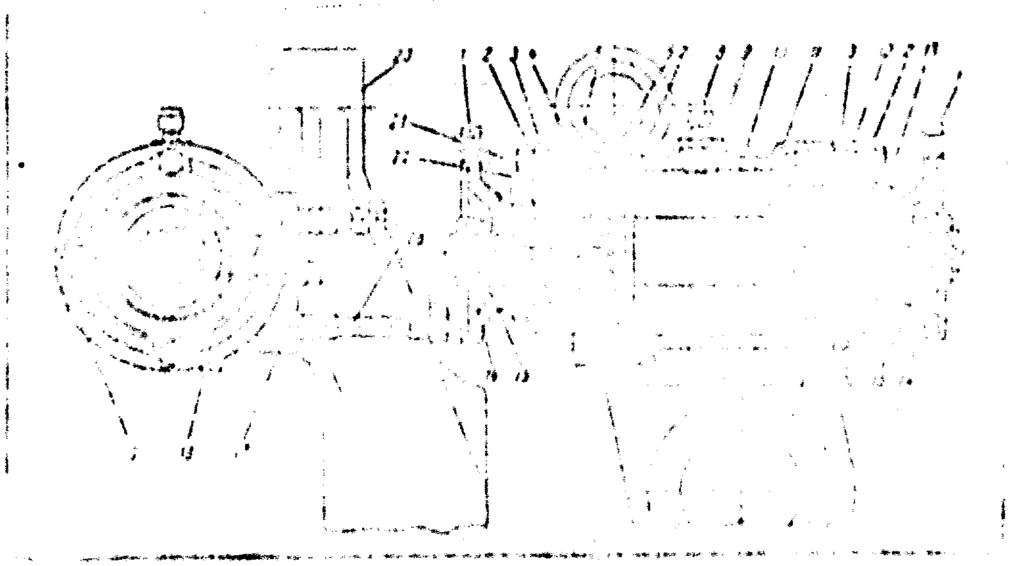


Plate 9-4. Universal drive intermediate support of the ZIL-157K motor vehicle:
1) flange 2) seal 3) bearing cover 4) sealing gasket 5 and 12) oil-deflecting washers 6) support washer 7) tapered roller bearing 8) vent 9) filler hole plug 10) intermediate support shaft 11) housing 13) deflector 14) nut 15) washer 16) adjusting gaskets 17) pin 18) drain hole plug 19) control hole plug 20) upper reaction lever 21 and 23) bolts 22) seal protector ring

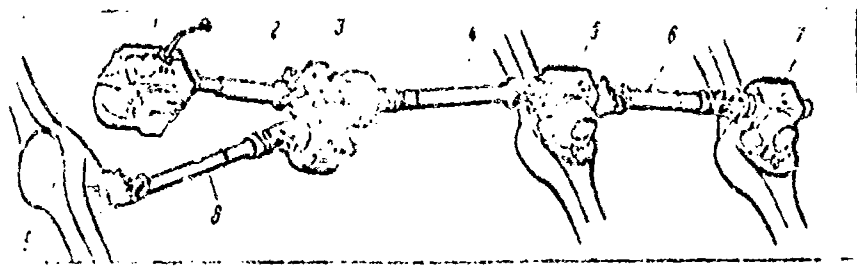


Plate 9-5. Universal drive of the ZIL-131 motor vehicle: 1) transmission 2) main propeller shaft 3) transfer case 4) middle axle propeller shaft 5) middle axle 6) rear axle propeller shaft 7) rear axle 8) front axle propeller shaft 9) front axle

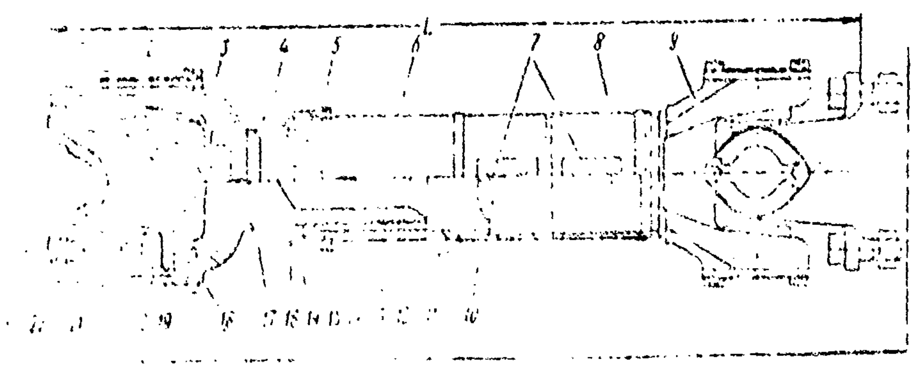


Plate 9-6. Middle axle propeller shaft of ZIL-131 motor vehicle: 1) flange yoke 2) cross 3) splined yoke 4) protective boot 5 and 17) safety wire 6) splined bushing 7) balancing plate 8) propeller shaft 9) yoke 10) baffle 11) plug 12) slotted ring 13) rubber seal 14) slotted washer 15) felt seal 16) nut 18) support plate 19) lock plate 20) needle bearing 21) valve 22) bolt L) propeller shaft length

The support of the rear axle intermediate propeller shaft (Plate 9-4) is fastened to the upper reaction lever 20, which is welded to the jacket of the middle axle half shaft. Shaft 10 of the intermediate support is installed in housing 11 on two tapered roller bearings 7.

The universal drive of the ZIL-131 motor vehicle consists of four propeller shafts with eight universal joints. Construction of the propeller shafts (Plate 9-5) is identical except for the middle axle propeller shaft. Universal joints of shafts 2, 6, and 8 have identical dimensions and are interchangeable.

The middle axle propeller shaft 4 carries a double load, in that it transmits the torque moment to the middle and rear axles, and therefore it has increased dimensions of its bearing cross, splined connection, and its own exterior diameter. The middle axle propeller shaft is manufactured of drawn tubing which is welded out of cold rolled plate 3.5 mm thick. The external diameter of the shaft is 89 mm. An end yoke 9 is welded to one end of the middle axle propeller shaft 8, and a splined bushing 6 is welded to its other end.

Sealed splined connections are used in the propell r shafts of the ZIL-131 motor vehicle. Lubrication in the inner space of the splined bushing 6 is held from one end by baffle 10, which is rolled into the face of the splined bushing, and on the other end by rubber seal 13. Felt seal 15 and external protective boot 4 prevent dirt from getting on the cylindrical part of slide yoke 3 which projects from the bushing. This significantly improves the longevity of the rubber seal and of the splined connection. The protective sleeve is fastened to the shaft by safety wire 5 and 17. Each universal joint consists of flange fork 1 and splined fork 3, or of flange fork 1 and one fork 9, connected together by cross 2, on whose journals are mounted needle bearings 20. To hold the lubrication and protect the bearings from becoming dirtied, they have rubber seals.

The universal joint bearings are lubricated through a lubrication fitting which is screwed into the cross. So as not to damage the bearing seals during increased pressure while lubricating, the cross has a protector valve 21, which opens at a pressure of 3.5 kg/cm^2.

Technical service

During DS, wash and inspect the universal drive from the outside.

During TS-1, it is necessary to check the fastening of the cross bearing support plates and fastening of the propeller shaft flanges. All flange fastening bolts must be tightened until they are firmly seated. If the flange fastening becomes excessively loose, it is necessary to check the balance of the propeller shafts.

If the bolts fastening the bearing support plates on the crosses become loosened, they should be tightened and locked by bending one ear of the locking plate up against a flat of each bolt head.

If significant radial or longitudinal clearance is present in the cross bearings, the universal joints should be disassembled and, if necessary, the bearings or crosses in assembly with the bearings should be replaced.

On motor vehicles having an intermediate support, besides this, the fastening of the intermediate support bracket to the frame cross member (on the ZIL-130 motor vehicle), or to the middle drive axle (on the ZIL-157K motor vehicle), should be checked. On the universal drive intermediate support of the ZIL-157K motor vehicle, during TS-1, it is necessary to blow out the air passages of the vent, whose clogging might cause increased pressure in the bearing housing and serve as reason for oil leakage through the seals.

Before lubricating the Cardan drive units, dust and dirt should be cleaned off the point of lubrication.

It is necessary to pack the bearing of the propeller shaft intermediate support on the ZIL-130 motor vehicle through the pressure lubrication fitting until grease is pressed out of the control hole.

It is necessary to pour transmission oil into the housing of the propeller shaft intermediate support of the ZIL-157K motor vehicle up to the bottom edge of the control hole opened by plug 19 (see Plate 9-4). Universal joint needle bearings are lubricated with transmission oil. Needle bearings 10 (see Plate 9-3) are lubricated through lubrication fitting 1 in cross 11, until oil appears out of protector valve 13. Lubrication of the needle bearings with consistent greases is not allowed.

It is necessary to lubricate the splined propeller shaft connections on the ZIL-157K motor vehicle through the pressure lubrication fitting, pressing the lubricant until it is forced out.

Before lubricating the propeller shaft sliding forks on the ZIL-130 and ZIL-131 motor vehicles and their modifications, it is necessary to disassemble it, unscrew the plug, remove the splined yoke, remove the old grease, wash out the splined sliding yoke and internal space of the splined bushing, and pack this space with fresh lubricant.

Disassembly and assembly

ZIL-130 motor vehicle

For removal of the universal drive from the motor vehicle, it is necessary to unscrew the nuts fastening the shaft rear yoke flange to the rear axle main drive input shaft flange, remove the washers, drive the bolts out of their flange holes, and, supporting the propeller shaft, move it slightly forward and release its rear end onto the floor on a support. Unscrew the bolts fastening the intermediate support to the frame, unscrew the nuts from the front yoke flange fastening bolts, remove the universal drive from the motor vehicle, and take it to the point of disassembly.

Disassembly of the universal drive. Before disassembling the universal drive, it is necessary to clean the dirt from it and wash it in the degreasing solution. To maintain the balance, it is necessary to mark the relative position of the splined end and bushing, and the relative position of the yokes, flanges, cross arms, and bearings with a punch or paint. For disassembly, it is necessary to install the universal drive on the bench.

Remove the locking clamp 24 (see Plate 9-1), the stop clamp 6, and intermediate support bracket 22. Remove the safety wire fastening protective boot 10.

Remove the rubber cushion 23 and rear deflector 20 from the intermediate propeller shaft splined bushing, and then press off bearing 5 of the support in assembly with its covers with a 20P-7968 puller (Plate 9-8).

For pressing off the bearing, split ring 2 should be mounted on the support cover 4 and fastened with tension screw 8, mandrel 6 is inserted into the splined bushing, lever 5 of the puller is installed on the ring, and, turning screw 7, the bearing is pressed off the shaft together with its covers, support seals, and rear spacing bushing 21 (see Plate 9-1). The front spacing bushing 21 and deflector 25 are removed from the shaft.

The universal joints are disassembled with a device (Plate 9-9) which prevents deformation of the yoke and breakage of the bearings and eases disassembly.

Before disassembling the universal joints, the ears of the locking plates should be bent out, bolts fastening these plates should be unscrewed, and the locking and support plates should be removed.

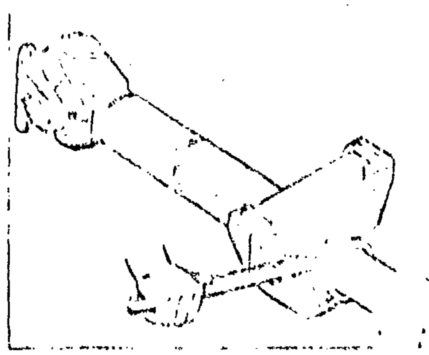


Plate 9-7. Unscrewing the nut fastening the support bearing

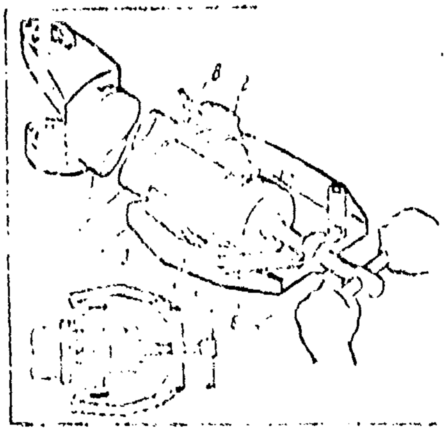


Plate 9-8. Removing the intermediate support bearing:
1) intermediate propeller shaft
2) split ring 3) bearing 4) support rear cover 5) puller lever 6) support mandrel 7) puller screw 8) ring tension screw

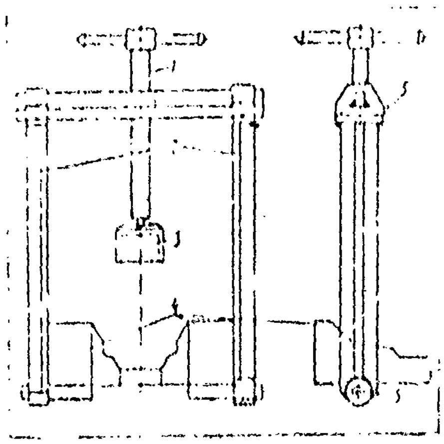


Plate 9-9. Device for universal joint disassembly:
1) working screw 2) extension stand 3) cup 4) support surface 5) catch lock

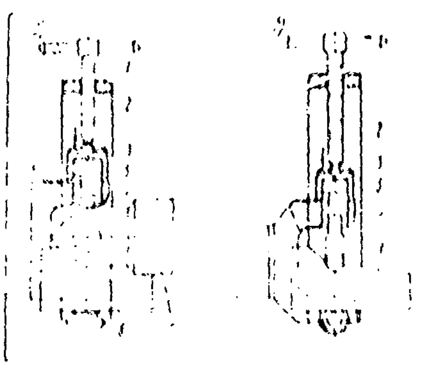


Plate 9-10. Method of disassembling the universal joint with device:
a) pressing the bearings out of the flange yoke b) pressing the bearings out of the propeller shaft yoke
1) working screw 2) extension stands 3) cup 4) flange yoke 5) bearing 6) cross 7) drive shaft yoke 8) support surface

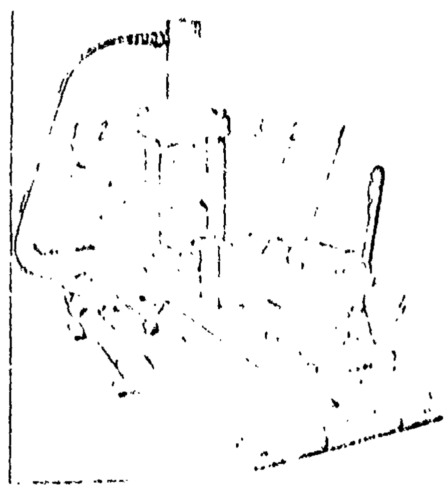


Plate 9-11. Model 684 stand for checking and correcting propeller shafts:
1) centers 2) supports 3) pneumatic press 4) base 5) pneumatic press power handle

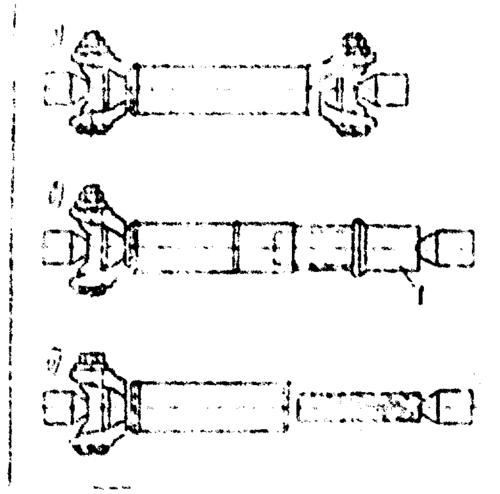


Plate 9-12. Diagram for installing propeller shafts on stand for checking oscillation and correcting. a) for rear axle propeller shaft of ZIL-130 motor vehicle b) for intermediate propeller shaft of ZIL-130 motor vehicle and all propeller shafts of ZIL-131 motor vehicle c) for propeller shafts of ZIL-157K motor vehicle 1) mandrel

The device allows cup 3 to be rested on the face of one of the yokes by turning working screw 1, while the second yoke lies on the support surface 4. With further rotation of screw 1, the support surface draws closer to the cup and the cross bearing moves into the space in the cup. Rotation of the working screw continues until it is in a position in which the bearing easily (by hand) is pushed from the eye hole.

The universal joint is disassembled in two steps. At first, one of the yokes is installed on support surface 8 (Plate 9-10, a) so that is forms the support, and the bearings are pressed out of the yoke which is assembled with it. After both bearings have been pressed out of this yoke, the bearings are pressed out of the yoke which was the supporting one. In the second case, the journals of cross 6, from which the bearings have already been removed, serve as a support (Plate 9-10,b). The journals are set in notches formed in the supporting plate 8 and the bearings are pressed out of the second yoke.

If the indicated device is not available, the universal joint may be disassembled with a bronze mandrel and hammer. In this process, it is necessary to set the mandrel on the body of the needle bearing and, lightly hitting it with the hammer, press out the opposite bearing. Turn the shaft and press out the other bearing, setting the mandrel on the face of the cross journal. Separate the flange yoke from the shaft. The same operations should be conducted for disassembly of the propellor shaft flange yoke crosses.

Control checking. Oscillation of the propeller shaft is checked on a stand (Plate 9-11) by indicators which are installed on a plate. The stand has movable face plates with centers 1 for installation and fastening of the shaft on it. Before installing the shaft on the stand, mandrels (Plate 9-12, a) centered along the faces of the yokes, are inserted in both yokes of the shaft. If oscillation greater than that allowable is present, the shaft should be corrected with press 3 (see Plate 9-11), installing the shaft on support 2. Oscillation, measured along the ends of the shaft, must not exceed 0.4 mm, and that measured along the length of the shaft must not exceed 0.8 mm.

If there is wear in the yoke holes for the needle bearings above the dimensions allowable without repair, the rear axle propeller shaft should be replaced.

Oscillation of the intermediate propell r shaft is checked on a stand (see Plate 9-11) with indicators. Before installing the shaft on the stand, a mandrel (see Plate 9-12, b) centered along the faces of the yoke is inserted in the yoke, and a mandrel centered along the external diameter of the splines on a length of 100 mm is installed in the splined bushing. Both mandrels have conic holes for installing them on the stand centers. If oscillation is present greater than that allowable, the shaft should be corrected using press 3 (see Plate 9-11) with the shaft installed on support 2. Oscillation of the bushing journals for the support bearing must not exceed 0.2 mm.

With wear in the yoke holes for the needle bearings, splined bushing journals for the intermediate support bearing, splined bushing, spacing bushings, or cross journals so that the dimensions allowable without repair are exceeded, it is necessary to replace the parts. Besides this, if the intermediate support bearing covers are dented or damaged, they should also be replaced.

Assembly of the universal drive. Before assembling the parts of the universal drive, wash them and blow them out with compressed air. The needle bearings must be smeared with TAp-15 oil (GOST 8412-57). The lubricating passages in the cross must be cleaned out, and the lubrication fitting and protector valve must be screwed into the threaded holes. Toward the aim of maintaining balance, assembly must take place with consideration for the marks made during disassembly.

Assembly of the universa joints. Press the needle bearing into one of the holes in the yoke, insert one journal of the cross into the yoke hole where there is no bearing, and guide the other end into the bearing. Install the second bearing and, guiding it onto the cross journal, press it in. Install the supporting plates so that the projection on the plate moves into the slot in the bearing face of the cross. Install the locking plates and fasten them with bolts. Torque moment on the bolts must be 1.0-1.5 kg meters. Lock the bolts with the locking plates, bending the ears up against flats on the bolts.

Assemble the remaining universal joints in the same manner.

Balancing propeller shafts. With replacement or repair of any of the propell r shaft parts, dynamic balancing should be done. Dynamic balancing takes place on the ST-1157 or ST-1199 (ZIl) machine shown in Plate 9-13.

The propeller shaft if fastened to a balancing machine adapter by its flange yoke. The propeller shaft is installed with one end in the adapter by a centering collar 94.93-95.00 mm in diameter, and with its other end in a special lunette with centering along the smooth cylindrical journal of the sliding yoke. Imbalance in the propeller shaft in assembly with the flange yoke and sliding yoke is not allowed to be greater than 70 gram cm from each end. If imbalance exceeds 70 gram cm, it should be eliminated by welding additional balancing plates onto the shaft. During balancing, the balancing plates are fastened temporarily with wire on the shaft at a distance of 10 mm from the welded seam. Upon completion of balancing, the plates are welded to the shaft and the wire is removed. The welding must be accurate, without significantly increasing the weight of the propeller shaft. The number of balancing plates must not exceed four on each end of the shaft. If the balancing plates are fastened to the shaft quickly, it is recommended that they be knocked of the shaft and the shaft be balanced again.

The intermediate propeller shaft is also fastened to the adapter of the balancing machine by its flange fork. The propell r shaft is installed with one of its ends in the adaptor with a centering collar which is 94.93-95.00 mm, and with its other end in a special lunette centered along the journal of the splined bushing for its support bearing. A part weighing approximately 10 kg and imitating half the weight of the rear axle propeller shaft is inserted in the splined bushing. This part must be centered according to the external diameter of the splined portion of the bushing. The allowable imbalance on the flange fork end of the shaft is 50 gram cm, and that on the splined bushing end of the shaft is 70 gram cm. The overall imbalance of the drive must not exceed 50 gram cm.

Assembly of the intermediate propeller shaft support and its installation on the shaft. Install the deflector 25 (see Plate 9-1) and the front spacing bushing 21 on the journal of the intermediate propeller shaft. Install the un-disassembled part of the intermediate propeller shaft support (bearing in assembly with its covers and seals) and also the rear spacing bushing 21 on the shaft journal. Press the support onto the shaft (Plate 9-14) with a hammer and mandrel. The mandrel must rest against the rear face of the spacing bushing. Mount the rubber cushion 23 (see Plate 9-1) on the support. Install the second deflector 20 on the shaft, inserting its lower stop into the slot in the shaft.

Connecting the sliding yoke of the propeller shaft with the splined bushing of the intermediate propeller shaft. Install the protective boot 10, nut 8, felt seal 9 with its split washers, the rubber seal and split washer, on the end of the sliding yoke. Insert the splined end of the sliding yoke 19 into sliding bushing 26 and fasten the intermediate support with nut 8, after which the nut must be locked, bending the stop into the slot in it. Fasten the protective boot 10 with its tension clamp or safety wire.

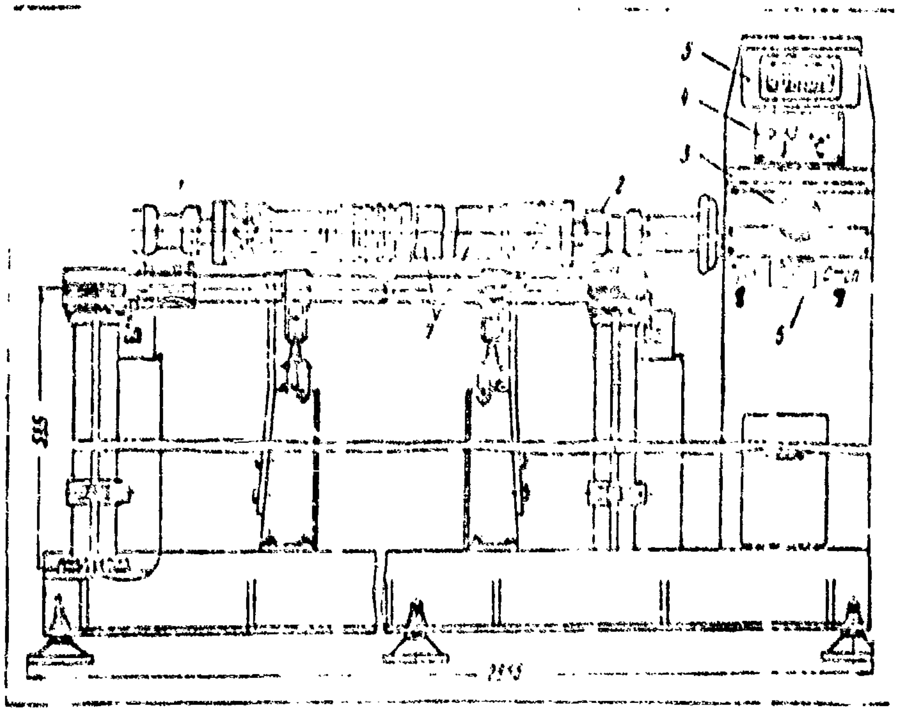


Plate 9-13. Diagram of machine for propeller shaft dynamic balan

1 and 2) adapters 3) graduated circle of collector 4) electric panel 5) galvanometer 6) magnetic starter 7) propeller shaft 8) "start" 9) "stop"

During assembly of the propeller shaft of a ZIL-130 motor vehicle, it is necessary to ensure that the flange forks of the transmission and rear axle are positioned in mutually perpendicular planes. During assembly of the universal drive in the ZIL-130V1 and ZIL-MMZ-555 dump truck, the indicated fork flanges must lie in the same plane.

Installation of the universal drive on the motor vehicle. Connect the rear end of the propeller shaft to the flange of the differential input shaft without tightening the bolts. Raise the universal drive and fasten the intermediate support onto the frame cross member, having mounted the bracket on the support and tightened the bolts. During this process, the support cushion must be perpendicular to the axis of the intermediate propeller shaft.

Tighten the propeller shaft yoke flange on the differential input shaft flange. Connect the intermediate propeller shaft fork flange to the flange of the transmission output shaft. Spring washers must be installed beneath the nuts on all bolts. Nut torque moment is 8-9 kg meters.

The ZIL-157K motor vehicle

Removing the universal drive. Each shaft of the universal drive is removed independent of the others. For removal of any shaft, it is necessary to unscrew the bolts fastening its flanges and, holding the shaft, remove the bolts from the flange holes and withdraw the shaft from beneath the motor vehicle.

For removal of the intermediate support, it is necessary to unpin the bolts fastening the support, unscrew them with a socket wrench, and remove the support assembly from the middl[illegible] drive axle.

Before disassembling the propeller shafts and intermediate support removed from the motor vehicle, it is necessary to clean the dirt from them and wash them in a degreasing solution.

Disassembly of the universal drive. Disassembly of the propeller shafts. It is recommended that the splined connections of the motor vehicle's propeller shaft be disassembled in the following order.

Lay the propeller shaft on a metal working bench, mark the relat[illegible] position of the fork and shaft with a punch, remove safety wire 4 and 17 with comb[illegible]ation pliers (see Plate 9-3), move the protective boot 5 along the shaft axis toward its splined end, bend out tabs 16 of the clamp ring 23, separate the shaft, moving the splined end 6 out of the sliding yoke 8, and then remove the seal in assembly with rings 22 and clamp 23.

The universal joints are disassembled with the device (see Plate 9-9). The method of disassembly is shown in Plate 9-10.

Disassembly of the intermediate support. Fasten the intermediate support in a metal working vise and disassemble it in the following order.

Unscrew the lower plug and drain the oil. Unpin and unscrew nuts 14 (see Plate 9-4) fastening flanges 1, and remove washer 15. Remove the flanges from the splined ends of shaft 10 with a 20P-7968 puller.

Unscrew bolts 21 fastening covers 3, remove the protective rings 22 and covers, tapping on the covers with a hammer. Remove sealing gaskets 4 and adjusting gaskets 16, remove oil-deflecting washers 15 and 12, and support washers 6.

If they are not in proper condition, the rubber bodied seals should be pressed out of the covers.

Install the support cover with its shaft on a press, and press out the shaft in assembly with its bearings and one outer race. Then press out the other outer race. During the pressing operation, the mandrel should be set on the inner race of the bearing or on the face of the shaft.

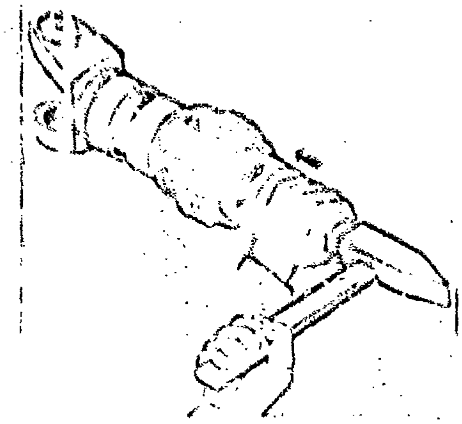


Plate 9-14. Pressing on the intermediate support bearing

Fasten the shaft and press off its bearing with a 20P-7984 puller (Plate 9-15). If necessary, unscrew the plug and vent (if it is not in good condition).

After disassembling the parts of the propeller shafts and intermediate support, it is necessary to wash them in a degreasing solution, blow them out with compressed air, and check their condition.

Control checking. Oscillation of the propeller shaft is checked on a stand (see Plate 9-11). Before installing the shaft on the stand, insert a mandrel into its yoke (see Plate 9-12, b).

Oscillation, measured on the end of the shaft at the yoke, must not exceed 0.3 mm, and that along the length of the shaft must not exceed 0.5 mm; on the splined end, at a distance of 160 mm from the face, oscillation must not exceed 0.2 mm. If oscillation greater than that allowable is present, the shaft should be straightened with a press.

If there is wear on the holes for the bearings, journals, and splines of the shaft, and also on the holes in the intermediate support bearing covers, which is above the allowable dimensions, the worn parts should be replaced.

Assembly of the universal drive. Assembly of the universal joints on 3-axle motor vehicles is done in the same way as is that in 2-axle motor vehicles, with consideration for the marks made during disassembly. Assembly of the splined connection. During assembly of the splined connection of the motor vehicle's rear axle propeller shaft, it is necessary to lay shaft 3 (see Plate 9-3) with the welded yoke and splined end 6 and sliding yoke 8 on a bench. Mount the protective sleeve 5 and seal 7, assembled in clamp 23 with ring seal 32, on the splined end of the shaft. Lubricate the splines with consistent type grease and insert the splined end in the hole of the sliding yoke so that the arrows stamped on the shaft and the sliding yoke are located in the same plane opposite each other. Bend tab 16 of the clamp onto the circular projection of the sliding yoke. Install the protective boot 5 in its place and fasten it with safety wires 4 and 17.

Assemble the splined connections of the front and middle axle propeller shafts, and also those of the rear axle intermediate shaft, in the same order. For assembly of the splined connection of the main propeller shaft, it is necessary to mount the threaded nut, supporting split washer, and felt seal on its splined end. Then insert the splined end into the splined bushing and screw the nut in assembly with the seal onto it until the seal is fully compressed onto the shaft.

The assembled propeller shafts must be dynamically balanced on a machine, Propell r shaft imbalance must not exceed 70 gram cm.

Assembly of the intermediate support. Press the inner races of the tapered bearings onto the shaft (Plate 9-16). Press one outer bearing race into the support body and insert the shaft assembly into the body, guiding one of its ends with its bearing into the pressed-in race.

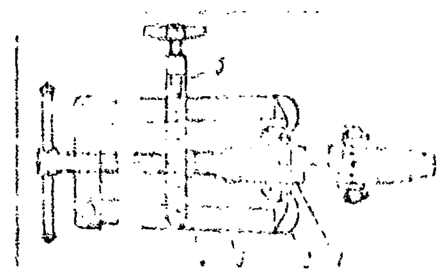


Plate 9-15. Pressing the bearing off the intermediate shaft of a ZIL-157K motor vehicle universal drive: 1) shaft 2) bearing 3) puller 4) seat 5) compression screw

Turn the body over and install the second outer race on the second end of the shaft with its bearing and press the race into the support body. The outer races of the bearings should be pressed in with a mandrel and press.

Install the supporting and oil-repelling washers. During this, it is necessary to pay attention so that the oil-deflecting washer with the inscription Rear is mounted on the rear end of the shaft, and the one with the inscription Front is mounted on its front end.

Assemble the covers with the seal, install one packing gasket on each of their grooves, install the adjusting gaskets on the rear cover, and then install the covers on the body with protecting rings, and fasten them with bolts.

Having fastened the cover with bolts, it is necessary to check the free rotation of the support shaft. With properly adjusted support bearings, the shaft must freely rotate without seizing or noticeable axial clearance. If there is noticeable axial clearance, or if the shaft rotates tightly, tension on the bearings should be adjusted by changing the number of adjusting gaskets beneath the rear cover.

With proper bearing tension, the intermediate support shaft without its flanges must rotate with a moment of 0.4-0.9 kg meters applied to it.

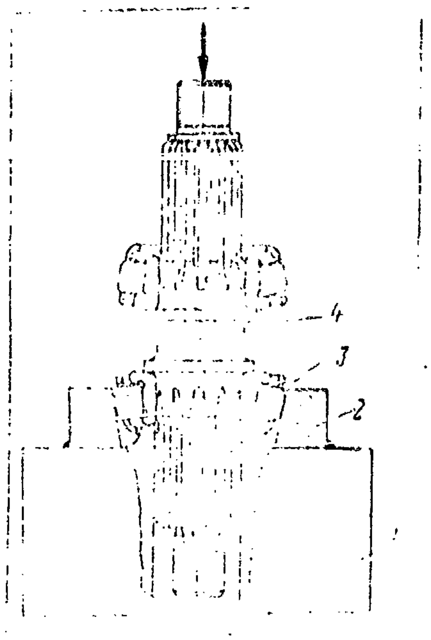


Plate 9-16. Pressing on the intermediate support bearings:
1) support 2) mandrel 3) bearing
4) shaft

After adjusting the bearings, it is necessary to install the flanges on the splined ends of the shaft, fasten them with nuts and washers, and pin the nuts.

Screw the plug into the drain hole and fill the support body with TAp-15 oil (GOST 8412-57). The oil level is checked according to the lateral control hole. Screw the plugs into the lateral and top holes. The top plug must have the vent screwed into it.

Install the intermediate support on the middle drive axle, guiding the installing pins into the holes. Pressing the support to the upper bracket of the reaction lever, screw in the bolts by hand, tighten them with a socket wrench, and pin all four of the bolts together with soft wire. Connect the flanges of the rear axle propeller shaft yoke to the flanges of the rear axle differential input shaft and to the intermediate support, insert the bolts in the flange holes, install spring washers, screw on the nuts and tighten them until they are firmly seated.

Connect the remaining propeller shafts to the flanges of the other assemblies in the same manner.

The ZIL-131 motor vehicle

Removal of the universal drive. During removal of shafts 2, 6, and 8 (see Plate 9-5), it is necessary to unscrew the nuts fastening the flanges and, holding the shaft, drive the bolts out of the flange holes and withdraw the shaft from beneath the motor vehicle. During removal of middle axle shaft 4, it is also necessary to unscrew the nuts fastening the flanges and, holding the shaft, drive out the bolts fastening the flanges to the middle axle. Move the shaft slightly toward the transfer case so as to separate the flanges of the propellor shaft and the middle axle differential input shaft. After this, remove the propeller shaft from the bolts of the transfer case flange and withdraw it from the motor vehicle. The bolts in the transfer case flange are pressed in, and are therefore not removed. Each propeller shaft of the motor vehicle is removed independently of the others.

Disassembly of the universal drive. Before disassembling the propeller shafts removed from the motor vehicle, it is necessary to clean the dirt from them and wash them in degreasing solution. Propeller shafts are disassembled in the following order.

Lay the propeller shaft (see Plate 9-6) on a bench, mark the relative position of yoke 3 and splined bushing 6, remove the safety wire 5 and 17 with combination pliers, move the protective boot 4 away from nut 16 along the axis of the shaft toward yoke 3, unscrew nut 16, and separate the shaft, withdrawing the splined yoke from the bushing. Then remove split ring 12, rubber seal 13, split washer 14, felt seal 15, the second split washer 14, nut 16, and protective boot 4 from the splined end of the propeller shaft yoke.

During disassembly of the universal joints of rear axle propellor shaft 6 (see Plate 9-5) and main propell r shaft 2, the position of the balancing plates screwed onto the faces of the fork ends should be marked, as well as the forks, so that during assembly, they can be placed in their previous positions.

Balancing plates on middle axle propeller shaft 4 and front axle propeller shaft 8 are welded on and do not require marking.

Control checking. Oscillation of the middle axle propeller shaft is checked on a stand (see Plate 9-11). Before installing the shaft on the stand, a mandrel (see Plate 9-12, b) centered along the faces of the yoke is inserted in the yoke, and a mandrel centered along the outer diameter of the splines at a length of 160 mm (at a distance of 140 mm for both remaining shafts) is installed in the splined bushing. Both mandrels have conic holes for installation in the stand centers. Oscillation at the end of the shaft with the yoke must not exceed 0.5 mm, that along the yoke must not exceed 0.4 mm, and that along the length of the shaft must be no greater than 0.7 mm. The requirements concerning oscillation are identical for all shafts. If oscillation greater than the allowable amount is present, the shaft should be straightened with a press.

Assembly of the universal drive. Before assembling the universals, it is necessary to lubricate the needle bearings with TAp-15 oil (GOST 8412-57). The lubricating passages in the cross must be cleaned out and the lubrication fitting and protector valve must be screwed into the threaded holes.

During installation of the universal crosses in the yoke eyes, it should be kept in mind that the cross lubrication fittings must face the side of the shaft and not the side of the flange.

The splined connections of all the shafts are assembled in an identical sequence. For this, it is necessary to lay the shaft in assembly with splined bushing 6 (see Plate 9-6) and splined yoke 3 on a bench. Install the protective boot 4, nuts 16, felt seal 15 with slotted washer 14, rubber seal 13, and slotted ring 12 on the end of the splined fork. Then smear the splined ends of the main propeller shaft, front axle shaft, and rear axle shaft with a quantity of 0.24 kg of consistent type grease on each shaft. Besides this, permanent grease is also packed into the splined bushing. The quantity of 0.46 kg of oil is put into the splined connection of the middle axle propeller shaft. Insert the splined end of the splined fork into the splined bushing. The arrows stamped on the bushing and splined fork must be located opposite each other. If there are no arrows on the parts, it is necessary to assemble the shaft in such a manner that the axes of the yokes (for the bearings) are located in the same plane.

Slotted ring 12 and rubber seal 13 are inserted in the depression in the splined bushing, and slotted rings 14 and felt seal 15 are mounted inside nut 16. During this operation, the slotted washers of the felt ring must be installed so that their slots are on different sides. Then mount the nut on the threaded end of the splined yoke, and tighten it until it is firmly seated.

Install the protective boot 4 in place and fasten it with safety wires 5 and 17. A protective boot is not installed on the main propeller shaft.

If any of the parts of the assembled propeller shafts are replaced or repaired, the shafts must be subjected to dynamic balancing.

Aside from the middle axle shaft, imbalance in the propeller shafts of the ZIL-131 motor vehicle is not allowed to be greater than 70 gram cm on each end. Imbalance on the middle axle propeller shaft is not allowed to be greater than 100 gram cm. Balancing propeller shafts, besides the main and rear axle shafts, is accomplished by welding balancing plates on both ends of the shaft. The number of plates welded onto the shaft must be no greater than three on each side of the shaft. Balancing of the main propeller shaft and the rear axle shaft on the side of the non-splined yoke is also achieved by welding balancing plates to the tube, and on the side of the splined yoke, it is achieved by screwing balancing plates onto the faces of the yoke eyes. Total thickness of the plates screwed onto the eyes must not exceed 3 mm.

Installation of the universal drive on the motor vehicle. Connect the flanges of the rear axle propeller shaft yoke to the flanges of the differential input shafts of the middle and rear axles, insert bolts in the flange holes, install spring washers, screw on nuts, and tighten them until they are firmly seated.

Connect the remaining propeller shafts of the motor vehicle to the flanges of their corresponding assemblies.

Dimensions of parts

Dimensions of the basic parts are presented in Tables 9-1, 9-2, 9-3, 9-4, 9-5, and 9-6.

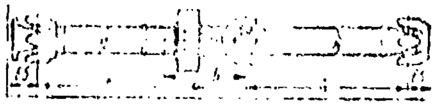


Plate 9-17. Arbitrary designations of dimensions of two-axle motor vehicle universal drive parts

Table 9-1. Dimensions of propeller shafts of the ZIL-130 motor vehicle and its modifications, mm (Plate 9-17)

Length	ZIL-130	ZIL-130B1	ZIL-130G
Rear axle propeller shaft in assembly along the axes of the universal in working position (dimension A)	1425	941	1425

Table 9-1. Dimensions of propeller shafts of the ZIL-130 motor vehicle and its modifications, mm (Plate 9-17)

Length	ZIL-130	ZIL-130B1	ZIL-130G
Rear axle propeller shaft in assembly along the axes of the universal in working position (dimension A)	1425	941	1425
Splined yoke (dimension B)	248	248	248
Intermediate shaft in assembly from front universal to rear face of shaft (dimension C)	594	594	1295

Table 9-2. Dimensions of propeller shafts of the ZIL-157K motor vehicle, mm

Dimension	Dimension value
Total length of propeller shafts in assembly (from flange face to flange face in working position):	
Main shaft	443
Front axle shaft	1350
Middle axle shaft	1196
Rear axle shaft	689
Rear axle intermediate shaft	1267

Table 9-3. Dimensions of propeller shafts of the ZIL-131 motor vehicle, mm

Dimension	Dimension value
Total length of propeller shafts in assembly L between flange faces (see Plate 9-6):	

[able 9-3, continued]

Main shaft	679
Front axle shaft	1238
Middle axle shaft	1098
Rear axle shaft	802

Table 9-4. Basic dimensions of universal drive parts of the Z L-130 motor vehicle, mm

Dimension	Nominal	Allowable without repair
Propeller shafts		
Type 20 steel; tubing drawn of cold rolled plate (TU-1046-62); hardness--HRB 80-100.		
Exterior diameter	77	--
Interior diameter	71	--
Universal yoke (welded on)		
Type 35 steel (GOST 1050-60); hardness--HB 207-241.		
Diameter of hole for needle bearing	38.99-39.027	39.05
Diameter of journal assembled with internal diameter of tube	70.96-71.05	--
Diameter of threads for bearing support plate fastening bolts	M8, class 2	--
Flange yoke		
Type 35 steel (GOST 1050-60); hardness--HB 217-255.		
Diameter of hole for needle bearing	38.99-39.027	39.05
Diameter of centering collar for groove in assembled flange	94.93-95.00	94.91
Diameter of threads for bearing support plate fastening bolts	M8, class 2	--

[Table 9-4, continued]

Diameter of holes for flange fastening bolts	14.24-14.36	15.00
Dimension from axis of bearing hole to support face	65	--

Universal cross

Type 20KhGNTR steel (ChMTU 22-58) TsNIIChM; depth of nitrided layer on journals--1.1-1.5 mm; surface layer hardness--HRC 60-65.

Cross length along journal faces	107.925-107.960	107.80
Journal diameter for needle bearing	24.960-24.980	24.92
Thread diameter for lubrication fitting and valve	K1/8 (GOST 6111-52)	--

Sliding yoke

Type 45 steel (GOST 1050-60); depth of case hardened layer--2-4 mm; hardness of case hardened layer--HRC 42-56.

Diameter of hole for needle bearing	38.99-39.027	39.05
Diameter of centering journal	53.92-53.95	53.87
Exterior centering diameter of splines	61.895-61.935	61.85
Diameter of splined sectioned circumference	55	--
Spline width along arc of sectioned circumference	4.561-4.681	4.000
Groove length	75	--
Diameter of threads for bearing support plate fastening bolts	M8, class 2	--

Intermediate propeller shaft splined bushing

40Kh steel (GOST 4543-61); hardness--HB 255-258.

Diameter of journal for shaft	70.96-71.05	--
Diameter of journal for bearing	69.99-70.01	--
Diameter of splined divided circumference	55	--

[Table 9-4, continued]

Internal splined diameter	54.00-54.06	54.10
External splined diameter	62.00-62.06	62.10
Width of groove in bushing splined portion along arc of separated circumference	4.73-4.815	5.2
Diameter of thread for bearing spacing bushing fastening nut	M70 X 1.5	--
Length of splined portion	155	--

Bearing spacing bushings of intermediate shaft support

Type 45 steel (GOST 1050-60); depth of case hardened layer--1.5-3.0 mm; hardness--HRC 45-56.

Exterior diameter	79.88-80.00	79.70
Interior diameter of spacing bushing	70.00-70.06	70.10

Front and rear covers of intermediate shaft support bearing

08 steel, leaf thickness--1 mm (GOST 3680-57 and GOST 914-56).

Diameter of hole for support bearing	109.965-110.070	--

Table 9-5. Basic dimensions of universal drive parts of the ZIL-157K motor vehicle, mm[1]

Dimension	Nominal	Allowable without repair
Propeller shafts		
Type 20 steel (tubing drawn of cold-rolled plate, TU 1018-61); hardness--HB 80-100.		
External diameter	76[2]	--
Internal diameter	71[2]	--

[1] Dimensions for the flange yoke, universal yoke, universal cross and its bearings for the ZIL-157K motor vehicle are the same as those for the AIL-130 motor vehicle.
[2] Tubes with an external diameter of 77 mm and an internal diameter of 71 mm are acceptable.

[Table 9-5, continued]

Universal sliding yoke		
40Kh steel (GOST 4543-61); hardness--HB 207-241.		
Diameter of hole for needle bearing	38.99-39.027	39.05
Width of groove in yoke splined portion	3.480-3.527	3.9
External diameter of splines	37.960-38.027	38.12
Length of splined portion:		
Main shaft	140	--
Other shafts	130	--
Propeller shaft splined end		
45Kh select steel (0.45-0.50%, GOST 4543-61); hardness--HRC 43-50.		
Tooth thickness	3.410-3.455	3.00
External diameter of splines	37.900-37.950	37.86
Length of splined portion:		
Main shaft	80	--
Other shafts	160	--
Shaft for rear axle propeller shaft intermediate support		
40Kh steel (GOST 4543-61); hardness--HB 321-401.		
Diameter of shaft journal for bearing	40.009-40.027	39.99
Spline thickness	5.925-5.975	5.7
Rear axle propeller shaft intermediate support housing		
KCh 35-10 iron (GOST 1215-59).		
Diameter of hole for bearing	89.974-90.009	90.04
Rear axle propeller shaft intermediate support bearing cover		
SCh 15-32 iron (GOST 1412-54).		
Diameter of hole for seal	82.00-82.07	--

[Table 9-5, continued]

Rear axle intermediate shaft support flange		
Type 45 steel (GOST 1050-60); depth of case hardened layer--1-3 mm; hardness of case hardened layer--HRC 52-62.		
Diameter of flange journal for seal	54.88-55.00	54.60
Diameter of turning for flange yoke	95.000-95.054	95.07
Diameter of hole for fastening bolts	14.24-14.36	15.00

Table 9-6. Basic dimensions of middle axle propeller shaft parts of the ZIL-151 motor vehicle, mm

Dimension	Nominal	Allowable without repair
Propeller shaft		
Type 20 steel (tubing drawn of cold-rolled plate); hardness--HB 80-100.		
Exterior diameter	89	--
Interior diameter	82	--
Universal yoke		
Type 35 steel (GOST 1050-60); hardness -HB 207-241.		
Diameter of hole for needle bearing	50.000-50.027	50.05
Diameter of journal for internal diameter of propellor shaft	82.19-82.26	--
Diameter of threads for bearing support plate fastening bolts	M8, class 2	--
Flange yoke		
Type 35 steel (GOST 1050-60); hardness--HB 207-241.		
Diameter of hole for needle bearing	50.000-50.027	50.05
Diameter of centering journal for turning in flange	94.93-95.00	94.90

[Table 9-6, continued]

Diameter of threads for bearing support plate fastening bolts	M8, class 2	--
Diameter of hole for flange fastening bolts	16.24-16.36	17.00
Dimension from axis of bearing hole to supporting face	76	--

Universal cross

20KhGNTR steel (ChMTU 1285-65) TsNIIChM; depth of hardened layer--1.8-2.2 mm; hardness of surface layer--HRC 60-65.

Length of cross along journal faces	126.91-126-95	126.80
Journal diameters for needle bearings	33.593-33.620	33.55
Diameter of threads for lubrication fitting and valve	K1/8 (GOST 6111-52)	--

Universal splined yoke

Type 45 steel (GOST 1050-60); depth of case hardened layer--2-4 mm; hardness of case hardened surface--HRC 42-56, core hardness--HB 207-241.

Diameter of hole for needle bearing	50.000-50.027	50.05
Diameter of centering journal	63.94-63.97	63.88
External centering diameter of splines	71.895-71.935	71.85
Diameter of splined divided circumference	65	--
Spline thickness along arc of divided circumference	4.596-4.681	4.000
Diameter of threads for bearing support plate fastening bolts	M8, class 2	--
Length of splined portion	75	--

Splined bushing

40Kh steel (GOST 4543-61); hardness--HB 255-285.

Diameter of journal for propeller shaft	82.19-82.26	--

[Table 9-6, continued]

Interior diameter of splines	64.00-64.06	64.10
Exterior diameter of splines	72.00-72.06	72.10
Diameter of spline divided circumference	65	--
Width of splined bushing grooves along arc of divided circumference	4.73-4.815	5.2
Length of splined portion	181	--
Diameter of threads for splined connection packing fastening nut	M85 X 1.5, class 3	--

Chapter 10. The Drive Axle

Layout

The ZIL-130 motor vehicle. Plate 10-1 shows a longitudinal section of the rear axle of a ZIL-130 motor vehicle. The main drive of this axle is two-stage and is made up of a pair of beveled gears with spiral teeth and a pair of cylindrical gears with helical teeth.

The ZIL-130 motor vehicle uses a steel stamped welded drive axle carrier with welded-on flanges for fastening the wheel brake and rear cover supports.

The overall length of the rear axle carrier of the ZIL-130 motor vehicle is 2036 mm, and the tread of the rear wheels is 1790 mm.

The cups of the rear axle differential box are steel. The differential pinions of the ZIL-130 motor vehicle are equipped with bronze bushings.

Half-shafts of the ZIL-130 motor vehicle are steel with reinforced flanges.

The half-shafts are fastened to the ZIL-130 motor vehicle by twelve studs with conic split bushings. Stud diameter is 16 mm.

In line with further increasing the reliability of the rear axle main drive of the ZIL-130 motor vehicle, fastening of the cylindrical drive gear shaft bearing cover was strengthened by increasing the number of cover fastening bolts from six to eight (introduced into production in October 1965).

On the ZIL-MMZ-555 dump trucks, instead of a gear ratio of 6.97 : 1, a gear ratio of 6.45 : 1 is used (introduced into production at the end of the third quarter of 1965).

20NKhM steel is used as the material for the cylindrical drive gear instead of 18KhGT steel.

Further increasing the reliability of the rear axle gears is accomplished by introducing adjusting teeth. With the introduction of this change, the final drive gear ratios were changed: from 6.45 : 1 to 6.32 : 1, and from 6.97 : 1 to 6.99 : 1. The adjustment gears are not interchangeable with the gears manufactured without the indicated correction.

Table 10-1 presents the total gear ratios and the number of teeth in the rear axle final drive gears.

The ZIL-157K motor vehicle. On the ZIL-157K motor vehicle and its modifications, all three axles are driving ones. The front axle assembly is shown in Plates 10-2 and 10-3.

The middle and rear axle assemblies with their balancing suspension are shown in Plate 12-16 (see Part 2).

Each drive axle of the ZIL-157K motor vehicle is a hollow-bodied rail which is disassembled in a vertical plane, and in which the final drive, differential (Plate 10-4), and drive wheel power are located. The final drive and differential of all three axles are interchangeable.

The drive axle final drive consists of a pair of beveled gears with helical teeth. The drive gear in assembly with its bearings, installed in the carrier, is shown in Plate 10-5. The final drive gear ratio is 6.67 : 1. The drive axle half-shafts are not load-bearing. The front axle half-shafts (Plate 10-6) have joints of equal rates of angular motion. The wheels on the front axle are the steering ones.

Steering spindles with ball support 1 are installed on the front axle (Plate 10-7). The steering spindles are connected with the body 10, which turns on tapered roller bearings 8 and 15, installed on king pins 11, which are pressed in and welded on the stationary ball support of the axle rail. Hub 39 (see Plate 10-3) is installed on spindle 46 with tapered roller bearings 38.

All axles of the ZIL-157K motor vehicle (Plate 10-8) are equipped with a centralized system for regulating air pressure in the tires with air being supplied to the tires through passage 4 in the spindle (Plate 10-9) and the circular clearance between spindle 2 and its bushing 1.

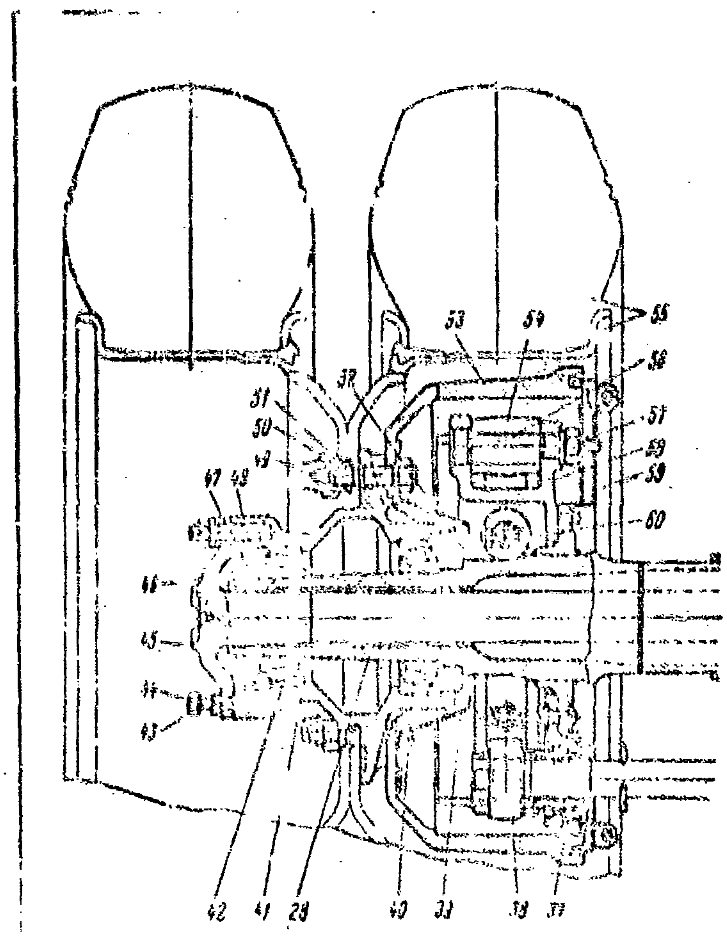
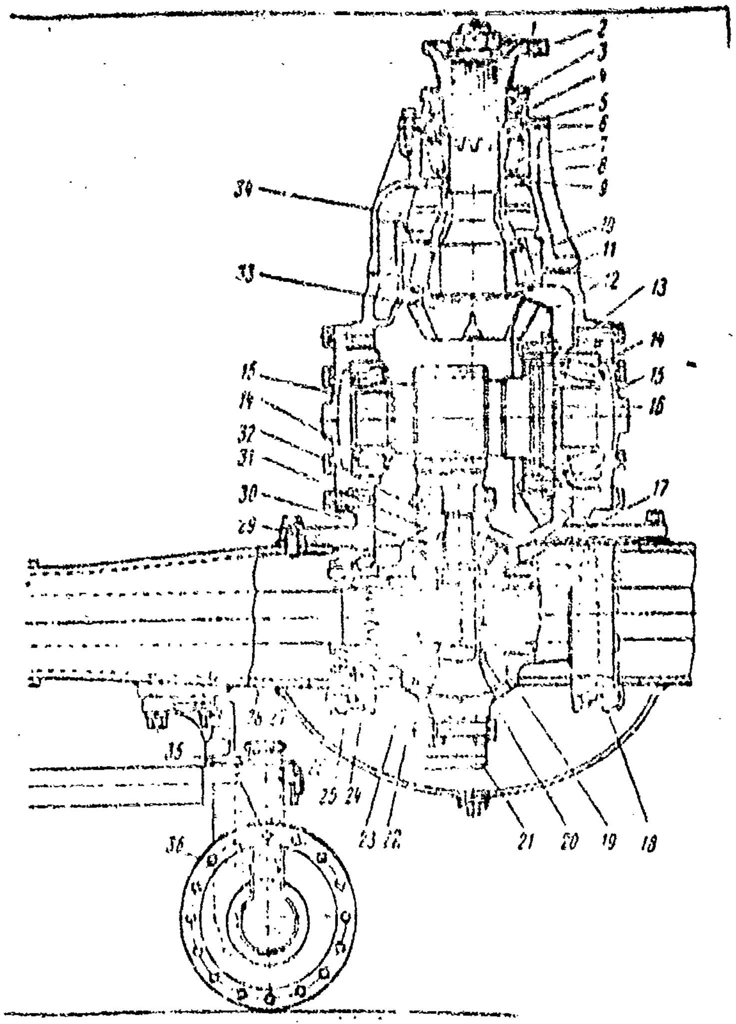


Plate 10-1. Rear axle of the ZIL-130 motor vehicle:
1) nut 2) flange 3) seal 4) cover 5) support washer 6) gasket 7) front bearing 8) bearing carrier 9) adjusting washer 10) rear bearing 11) gaskets for adjusting beveled gear engagement 12) driven beveled gear 13) adjusting gaskets 14) intermediate shaft bearings 15) bearing cover 16) driving cylindrical gear 17) right half-shaft gear 18) differential bearing cover 19) support washer 20) right differential box cup 21) driven cylindrical gear 22) left half-shaft gear 23) left differential box cup 24) differential box bearing 25) differential box bearing adjusting nut 26) stop bolt 27) adjusting lever worm mechanism 28) rear axle housing 29) reduction gear housing



[Plate 10-1, continued]

30) differential pinion 31) differential pinion support washer 32) cross 33) pinion gear 34) spacing bushing 35 and 37) brackets for fastening spreader cam shaft 36) brake chamber 38) spreader cam 39) oil deflector 40 and 42) wheel hub bearings 41) wheel hub 43) bearing adjusting nut 44) puller bolt 45) half-shaft 46) stop nut 47) lock washer 48 and 52) seals 49) box nut for fastening inner wheel 50) nut for fastening outer wheel 51) hub lug studs 53) brake drum 54) brake shoe 55) wheel 56) shoe shaft 57) shoe shaft nut 58) brake support 59) backing plate 60) brake return spring

Plate 10-2. Overall view of the front axle of a ZIL-157K motor vehicle

Table 10-1. Gear ratio and number of gear teeth in the final drive of a ZIL-130 motor vehicle and its modifications

Motor vehicle	Overall rear axle gear ratio	Number of gear teeth			
		Bevel pinion	Bevel driven	Cylindrical driving	Ring gear
ZIL-130 ZIL-130G and ZIL-MMZ-555[1]	6.45 : 1 or 6.32 : 1	13	25	14	47 or 46
ZIL-130V1	6.97 : 1 or 6.99 : 1	11 or 13	25	15 or 11	46 or 40

[1] Rear axles of the ZIL-MMZ-555 motor vehicle were produced with a gear ratio of 6.97 : 1 only until the beginning of the third quarter of 1965.

The ZIL-131 motor vehicle. On the ZIL-131 motor vehicle and its modifications, all three axles are driving ones. The front axle assembly is shown in Plate 10-10 and 10-11.

The middle and rear axle assemblies are shown in Plate 10-12. The drive axle rails are steel and are welded from two stamped halves with welded-on flanges and covers.

The reduction gear of the rear and middle axles (Plate 10-13) is installed above the axle carrier and is fastened to it with a horizontal flange. The reduction gear of the front axle (Plate 10-14) is fastened to the axle carrier with a vertical flange. In all three reduction gears, the double pinion gear shafts and bevel driven gears (Plates 10-15 and 10-16), the differential gears (Plate 10-17), the bearing recesses, and the bearings are interchangeable. The final drive is two-stage, with a pair of beveled gears with spiral teeth and a pair of cylindrical gears with helical teeth. The final drive gear ratio is 7.339 : 1.

The half-shafts are not loaded. The front axle half-shafts (Plate 10-18) have joints with equal rates of angular motion.

The wheels of the front axle are the steering ones. Turning spindles with a ball support (Plate 10-19) are installed on the front axle. All axles are equipped with a centralized system of regulating air pressure in the tires by supplying air to the tires through holes in the spindle (Plate 10-20) and a passage drilled in the half-shaft.

Fitting 4, screwed into the head of the air supply passes through the hole in the spindle.

To provide stream fording capability, all axles are sealed.

Technical service

During DS, conduct cleaning operations and an external inspection of the drive axles.

During TS-1, it is necessary to check the fastening of the reduction gear and the absence of leaks in the drive axle connections.

During TS-2, check for the absence of oil leaks through the seals and connecting flanges. Seals and packing gaskets which are in poor condition must be replaced, and flange connecting bolts and nuts must be tightened. Check the fastening of the half-shaft flanges to the wheel hubs, and the fastening of the front cover of the beveled spindle gear bearing. Wash out the air passages of the vents. Clogging of the vents may cause increased internal pressure in the axle housings, which will serve as a reason for oil leakage through the seals and connections.

On the ZIL-131 motor vehicle, besides the drive axle vents, it is necessary to wash out the additional vents for air exhaust in case of improper functioning of the head seals of the system of air supply to the tires. The appearance of lubrication from the holes in these seals indicates air leakage from the system of regulating air pressure in the tires.

It is necessary to eliminate the reason for this air leakage, and if necessary replace the head for air supply to the tires.

On three-axle motor vehicles, it is necessary to check the fastening of the ball support to the half-shaft body flange and the fastening of the turning spindle arm.

Adjustment of the front axle king pin bearings on a three-axle motor vehicle. Every other TS-2, it is necessary to check the tightness of the front axle king pin bearings and adjust the bearings if there if axial clearance.

Axial clearance of king pin bearings is not allowed.

For adjustment of the king pin bearings on a three-axle motor vehicle, it is necessary to disassemble the steering spindle unit and adjust the bearings by changing the thickness of the set of adjusting gaskets.

After final adjustment, the number and thickness of the gaskets at the top and bottom bearings must be identical or differ by one thin gasket (0.05 mm thick). This is necessary to assure alignment of the turning spindle and ball support.

After adjusting the bearings, tighten the lower and upper cover fastening nuts until they are firm, and check for the correct adjustment of the bearings with a dynamometer. The force necessary for smooth turning of the spindle from one extreme position to the other, applied at the hole of the steering linkage arm, must be 2.25-2.75 kg for a ZIL-157K motor vehicle, and 2.0-2.4 kg for a ZIL-131 motor vehicle.

Tightness of the final drive bevel pinion gear shaft bearings is checked every third TS-2.

For this it is necessary to disconnect the propeller shaft from the shaft flange, set up an indicator directing its rod at the shaft face, and measure the axial clearance. Set the shaft in its extreme position until it stops, at which point the indicator hand should be set in the zero position, and move the pinion gear shaft along its axis with a pry bar.

The deviation of the hand from the zero position shows the amount of axial clearance in the shaft bearings.

Axial clearance in the bearings is not allowed.

The method of checking axial clearance in the shaft bearings of a two-axle motor vehicle is shown in Plate 10-21, and that for a three-axle vehicle is shown in Plate 10-21, b. If a clearance is discovered, it is necessary to unpin the flange fastening nut and attempt to tighten it with a wrench.

If after tightening the nut the axial clearance is not eliminated or the shaft rotates tightly, with great effort, then the bearings must be adjusted.

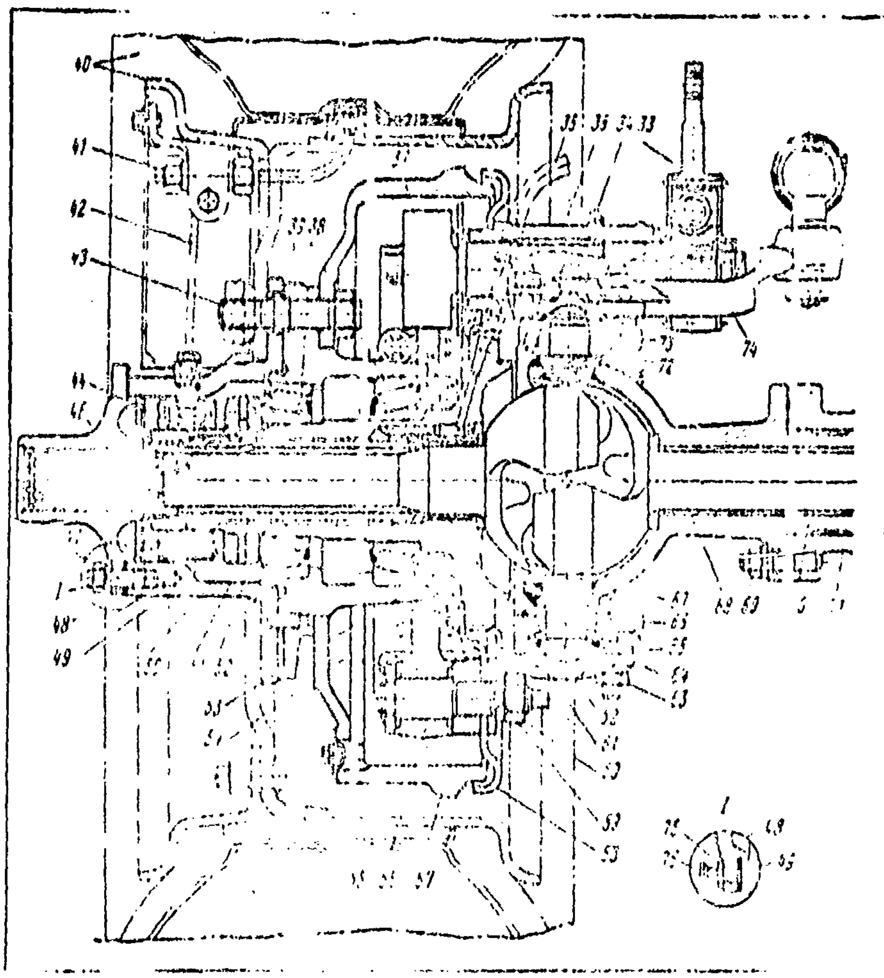
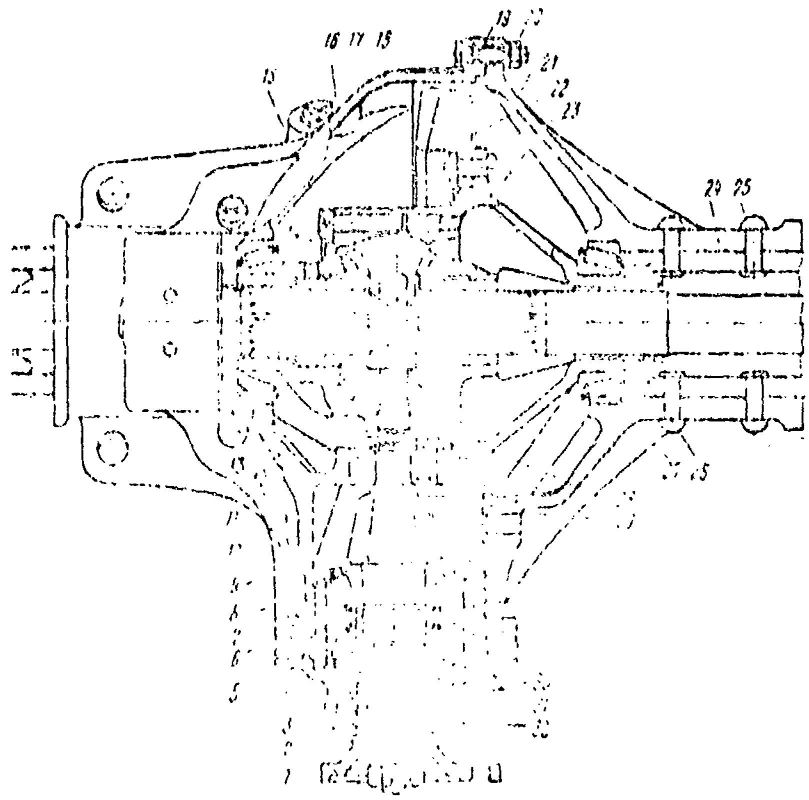


Plate 10-3. Front drive axle of the ZIL-157K motor vehicle in section: 1, 20, 47, 59, 60, 63, and 69) nuts 2) flange 3, 26, 53, 54, and 67) seals 4) cover 5) bearing carrier 6) adjusting gaskets 7) adjusting washers 8, 10, 27, 38, and 73) bearings 9) pinion gear 11, 15, and 31) support washers 12) differential pinions 13 and 23) differential box cups 14 and 68) half-shafts 16) half-shaft gear 17 and 30) bolts 18) axle housing 19) gasket 21) housing cover 22) ring gear 24) half-shaft tube 25) rivet 28) cross 29) support plate 32) deflector 33) brake adjusting lever 34) lubrication fitting 35) spreader cam bracket 36 and 42) air supply tubes 37) spreader cam 39) wheel hub 40) wheel 41) valve



[Plate 10-3, continued]

43) lug stud 44) air supply head 45) air supply passage 46) spindle
48) splined flange 49) hubcap 50) stop nut 51) lug washer 52) nut
55) shoe shaft 56) brake shoe 57) brake drum 58) backing plate 61) stub
axle 62) bearing cover 64) spacing ring 65) adjusting gaskets 66) bolt
70) ball support 71) half-shaft jacket 72) king pin 74) steering arm
75) stop nut 76) puller bolt

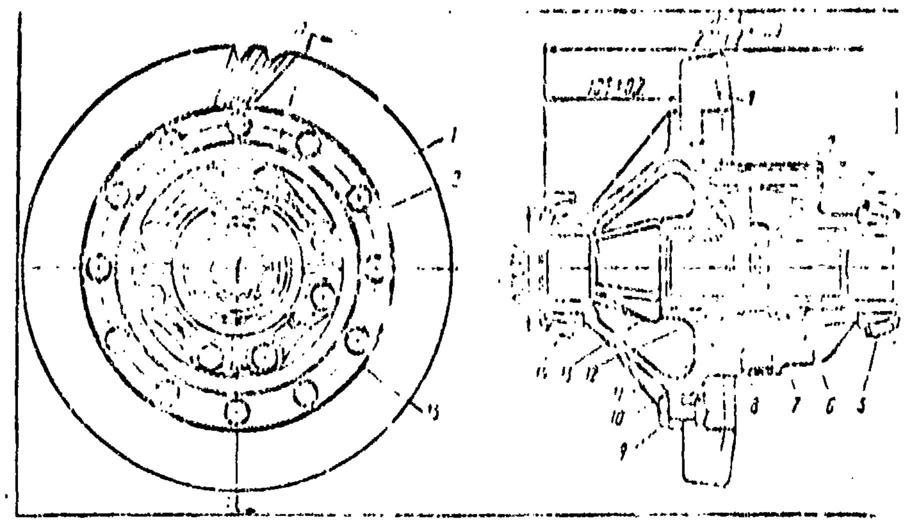


Plate 10-4. Drive axle differential of the ZIL-157K motor vehicle:
1) ring gear 2) bolt 3, 11, and 12) support washers 4 and 10) differential box cups 5 and 14) bearings 6 and 13) half-shaft gears 7) differential pinion 8) cross 9) rivet 15) safety wire

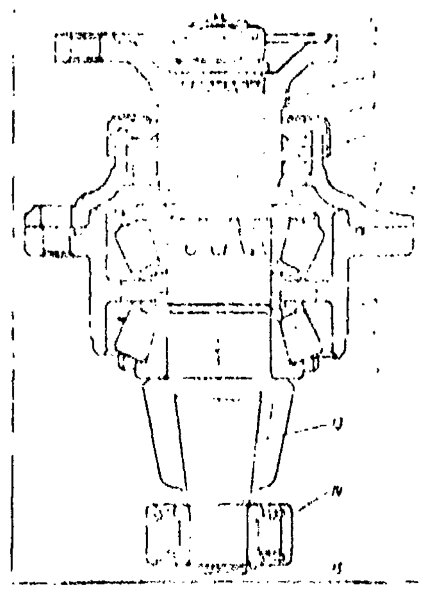


Plate 10-5. Pinion gear in assembly with bearing carrier:
1) nut 2 and 6) support washers 3) flange 4) deflector 5) seal 7) cover 8) sealing ring 9, 12, and 14) bearings 10) adjusting washers 11) bearing carrier 13) pinion gear with shaft 15) stop ring

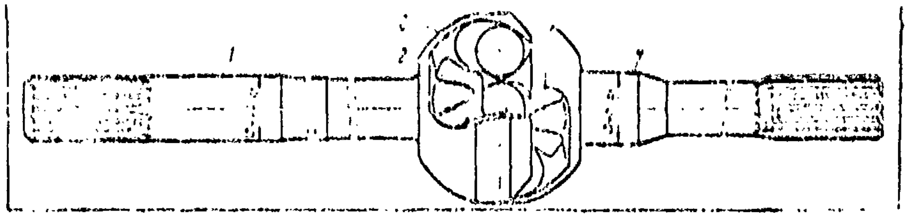


Plate 10-6. Front axle half-shaft assembly:
1) inner half-shaft 2) middle ball 3) outer ball 4) stub axle

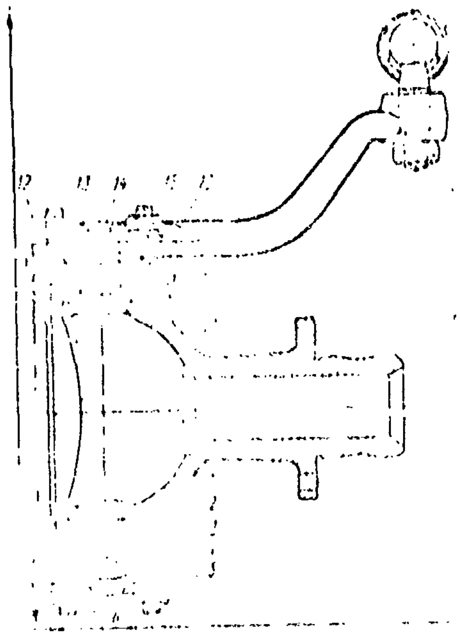


Plate 10-7. Ball support (left) in assembly with cone:
1) ball support 2) seal 3) bolts
4) rubber packing 5 and 13) nuts
6 and 17) support rings 7 and 14) covers
8 and 15) bearings 9 and 16) adjusting gaskets 10) body 11) kingpin
12) beveled split bushing

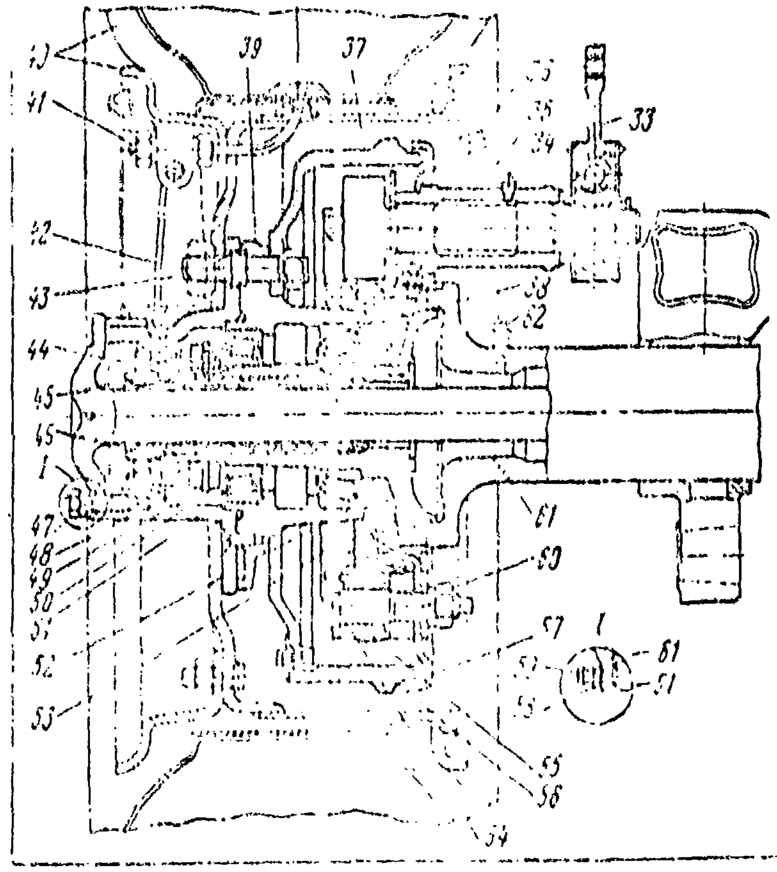
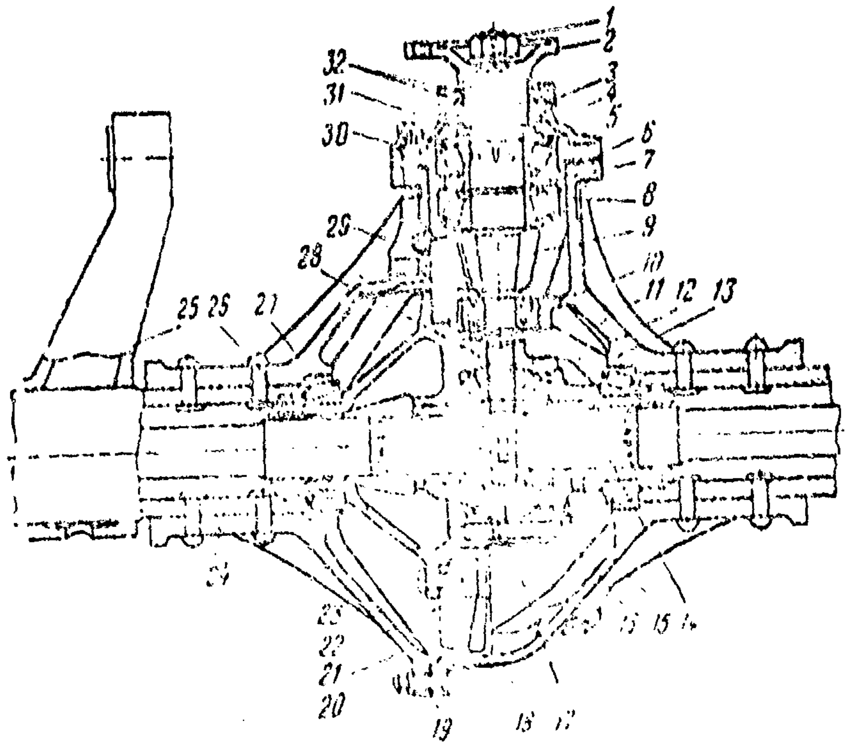


Plate 10-8. Rear drive axle assembly of the ZIL-157K motor vehicle:
1,20, 47, and 60) nuts 2) flange 3) seal 4) cover 5) bearing carrier 6) adjusting gaskets 7) adjusting washers 8,10, 27, and 38) bearings 9) pinion gear 11, 15, and 31) support washers 12) differential pinion 13 and 23) differential box cups 14 and 61) half-shafts 16) half-shaft gear 17 and 30) bolts 18) axle housing 19) gasket 21) housing cover 22) ring gear 24) half-shaft tube 25) torque rod bracket 26, 52, and 53) seals 28) cross 29) support plate 32) deflector 33) brake adjusting lever 34) lubrication fitting 35) spreader cam bracket 36 and 42) air supply lines 37) spreader cam 39) wheel hub 40) wheel 41) valve 43) hub lug stud 44) air supply head 45) air supply passage 46) spindle 48) stop nut 49) lock washer 50) bearing nut 51) hubcap 54) shoe shaft 55) brake shoe 56) brake drum 57) backing plate 58) stop nut 59) puller bolt 62) vent



[Plate 10-8, continued]

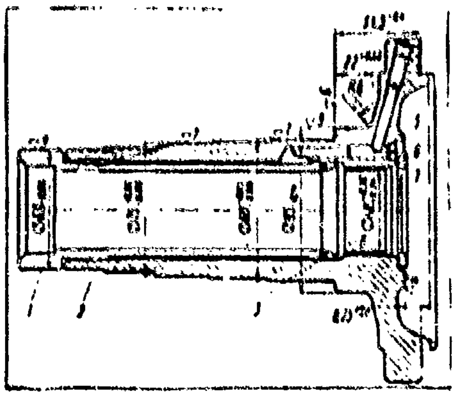


Plate 10-9. Spindle assembly:
1) steel spindle bushing 2) spindle
3) bushing seal 4) air supply passage
5) passage plug 6) support washer
7) bronze spindle bushing

Plate 10-10. Overall view of ZIL-131 motor vehicle front axle

For adjustment of bearings on the final drive bevel pinion shaft in two-axle and three-axle motor vehicles, see the "Disassembly and Assembly" section in this chapter.

The method of checking tightness of bearings on the bevel gear shaft in the rear axle of a two-axle motor vehicle is shown in Plate 10-22, a, for drive axles of the ZIL-157K motor vehicle, it is shown in Plate 10-22, b, and for drive axles of the ZIL-131, it is shown in Plate 10-22, c.

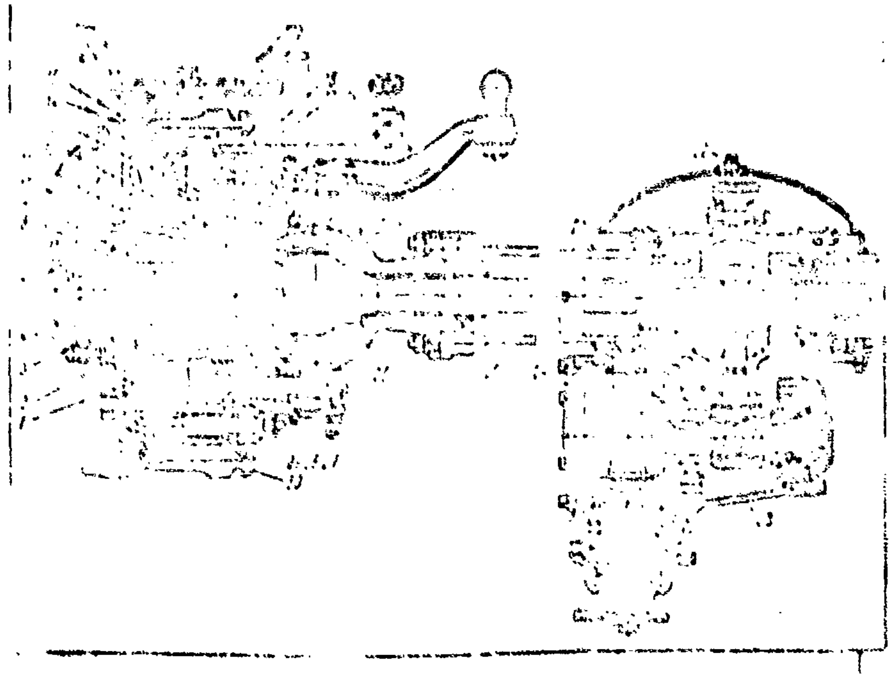


Plate 10-11. Front axle of ZIL-131 motor vehicle in section: 1) hub 2) spindle 3) hub bearing fastening nut 4) protective jacket 5) valve 6) stop nut 7) stub axle splined flange 8) lock washer 9 and 11) hub bearings 10) air supply hose to tire 12, 14, and 29) seals 13) fitting for air supply 15) nut 16) spreader cam bracket 17) angle fitting 18) lubrication fitting 19) inner half-shaft 20) ball support assembly 21) vent 22) control hole plug 23) front axle reduction gear assembly 24) reduction gear housing cover 25) axle carrier 26) ball support control plug 27) air supply head 28) plug 30) backing plate

Lubrication of drive axles. Changing and adding oil should take place within the period shown in the lubrication charts. It is necessary to change the oil in the drive axles of two-axle and three-axle motor vehicles immediately after stopping the motor vehicle, when the drive axle is still warm.

Before changing and adding oil to the drive axles, clean off dust and dirt from the housing around the filler hole plug.

Oil should be drained through all the existing drain holes.

After draining the oil, it is necessary to pour 4-5 liters of low viscosity oil (industrial 12 or 20, GOST 1707-51) and wash out the housing.

Pouring in oil for washing should be done the same as for f[illegible]ng the axle housing.

In the ZIL-131 motor vehicle, there is a drain hole located in the lower part of the front axle housing which serves to drain used oil from that housing. The rear and middle axles each have two drain holes: in the lower part of the housing cover and in the front wall of the reduction gear housing. Used oil should be drained through all existing drain holes.

Control holes during this operation must be closed.

Oil must be poured into the rear axle of two-axle motor vehicle and the drive axles of the ZIL-157K motor vehicle up to the edge of the control hole.

After adding or changing the oil, remaining oil should be carefully cleaned off the surface of the drive axles so as to avoid the adherence of dust and dirt to it.

On the ZIL-131 motor vehicle, oil is poured into the housing of the front drive axle through the control hole located on the front part of the axle in the housing cover. Oil should be added to the reduction gear of the rear and middle axles through the plug in the inspection hole located on the upper wall of the reduction gear housing until a flow of oil appears from the open control hole.

Oil level in the rear and middle axles should be checked during the process of operating the ZIL-131 motor vehicle with oil level indicator 1 (Plate 10-23) which is in the tool set, for which it is necessary to unscrew the rear bolt fastening the reduction gear to the axle housing and insert the oil level indicator in the bolt hole until it rests against the boss of the reduction gear housing flange.

The proper level of oil is marked by a line on the oil level indicator. If the oil level has dropped to below the line, it is necessary to add oil to the housing up to the level of the control hole.

After fording streams or filled ditches with two-axle or three-axle motor vehicles, check and see that no water has gotten into the drive axle housing.

The presence of water in the oil may be determined by a change in the color of the oil. It is checked immediately after stopping the automobile or otherwise it may settle out of the oil. Unscrewing the drain hole plug, drain the water. If water is discolored, it is necessary to drain the old oil from the housing and fill the housing with fresh oil according to the lubrication chart.

During TS-2, it is necessary to add lubrication to the stub axle joint and the king pin bearings of the front drive axle in three-axle motor vehicles. Grease must be pressed in in a warm condition.

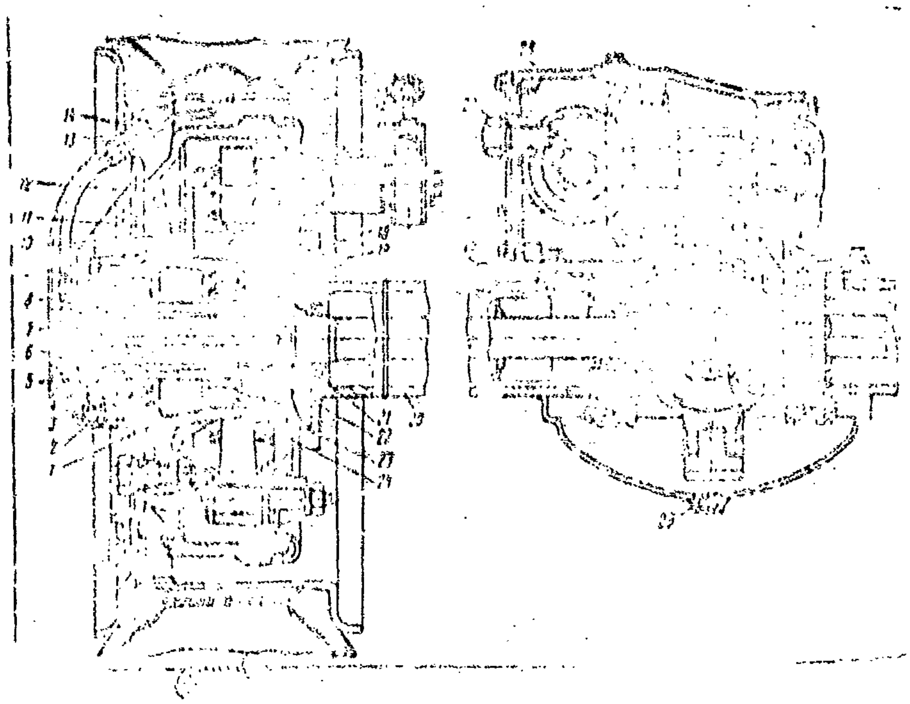


Plate 10.2. Middle and rear axle assemblies of ZIL-131 motor vehicle: 1) hub 2) spreader bushing 3) stub axle 4) spindle 5) protective jacket 6) valve 7) stub nut 8) bearing nut 9) lock washer 10) hose for air supply to tire 11) fitting for air supply to stub axle 12) spreader cam 13) seal 14) nut 15) spreader cam bracket 16) angle fitting 17) lubrication fitting 18) hose connection backing 19 and 25) vent 20) axle housing 21, 23, and 24) seals 22) air supply head 26) reduction gear cover 27) puller bolt 28) reduction gear assembly 29) drain hole plug

Before lubricating the stub axle joint of a ZIL-157K motor vehicle, it is necessary to unscrew the vent installed on the upper portion of the turning spindle body and add grease until it begins to emerge from the vent hole.

Grease must be added to the stub axle joint of the ZIL-131 motor vehicle through the lubrication fitting located on the top cover plate of the right turning spindle body, and the turning arm installed on the left spindle turning body. Grease must be pressed in until it begins to emerge through the control hole located beneath the ball support. The control hole plug must have been previously unscrewed.

The lubrication in the stub axle ball joint of three-axle motor vehicles must be changed every 6,000-12 000 km of operation. When changing the oil, wash out all parts of the turning spindles and stub axle ball joints with low viscosity oil

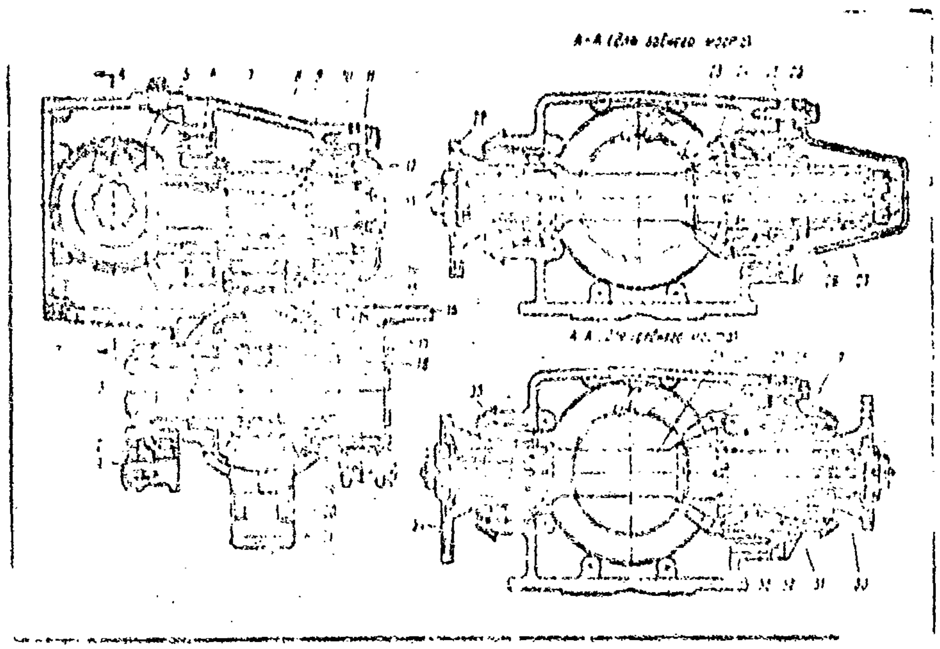


Plate 10-13. Reduction gear assembly of rear and middle axles in the ZIL-131 motor vehicle:
1) bearing cover 2) nut lock 3) adjusting nut 4) drain hole plug 5) driven bevel gear 6) key 7) spacing ring 8) driving cylindrical gear 9) bearing recess 10 and 25) adjusting washers 11 and 26) bearing covers 12) two-row roller bearing 13) adjusting ring 14 and 19) support washers 15) differential pinion 16) reduction gear housing 17) cross 18) half-shaft gear 20) differential box cup 21) ring gear 22, 30, and 34) propeller shaft fastening flanges 23) transfer shaft 24) bevel pinion gear 27) spacing bushing 28) washer 29) bearing cover 31) oil blocking washer 32) tapered roller bearing 33) adjusting washers 35) seal

Fresh grease is packed inside the ball support, in the king pin bearings and in the stub axle ball joint.

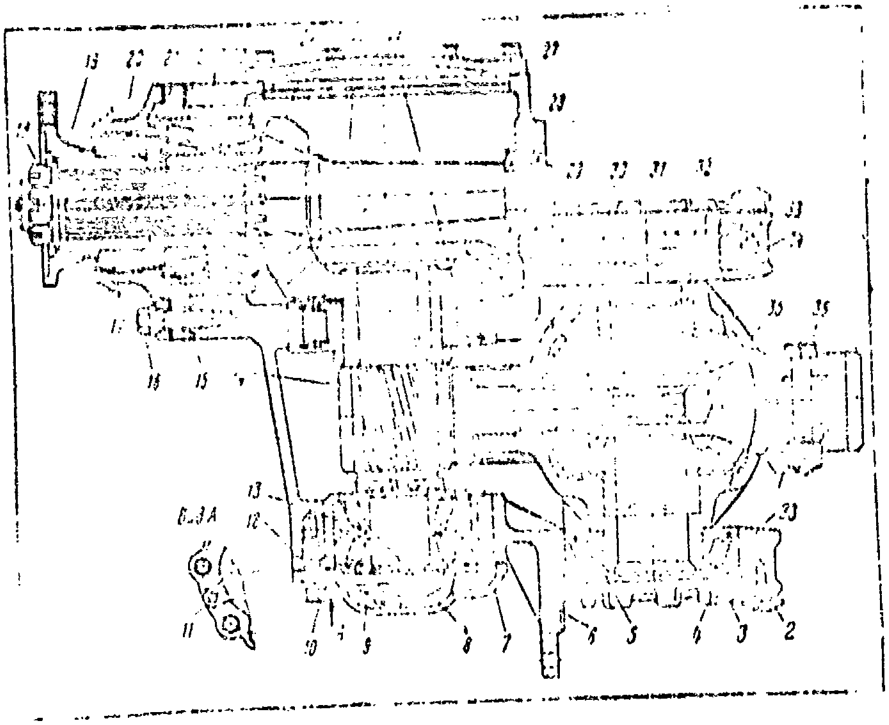


Plate 10-14. Front axle reduction gear of the ZIL-131 motor vehicle: 1) differential box cup 2) bolt 3) stop 4) adjusting nut 5, 8, 22, 26, and 28) bearings 6) reduction gear housing 7, 20, 27, and 33) covers 9, 18, and 34) nuts 10) bearing recess 11) plug 12 and 15) adjusting gaskets 13 and 23) adjusting rings 14) driving cylindrical gear 16 and 36) bolts 17) seal 19) flange 21) bevel pinion gear shaft housing 24) bevel pinion gear 25) driven bevel gear 29) differential pinion support washer 30) half-shaft gear support washer 31) differential pinion 32) half-shaft gear 35) cross

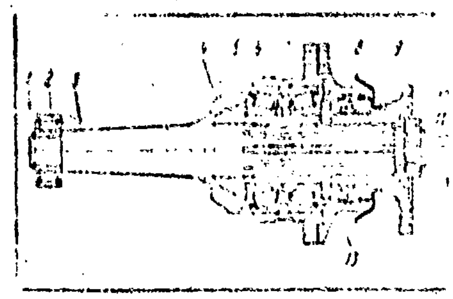


Plate 10-15. Front axle pinion gear with bearings in assembly:
1) stop ring 2 and 5) bearings 3) shaft 4) pinion gear 6) bearing carrier 7) adjusting washer 8) cover 9) flange 10) washer 11) nut 12) cotter key 13) oil deflecting support washer

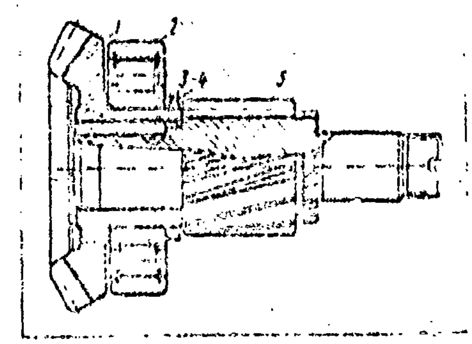


Plate 10-16. Driven bevel and driving cylindrical gear assembly of the reduction gear;
1) driven bevel gear 2) bearing 3) key 4) spacing ring 5) driving cylindrical gear

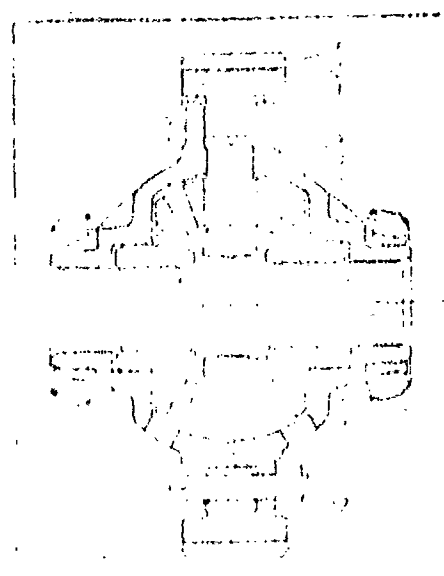


Plate 10-17. Differential assembly:
1) differential ring gear 2) differential box cup 3) cross 4 and 6) support washers 5) differential pinion 7) half-shaft gear 8) bearing 9) bolt

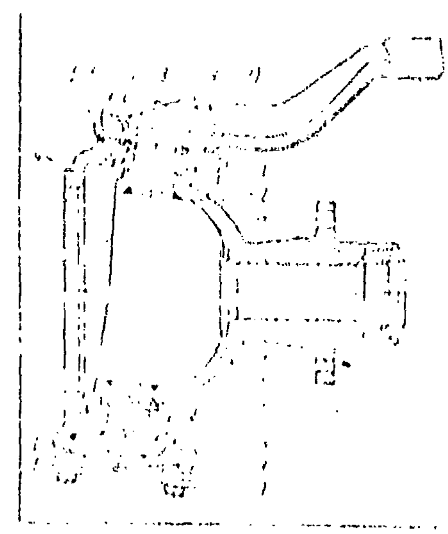


Plate 10-19. Ball support assembly:
1 and 15) plugs 2) king pin bearing cover 3 and 5) adjusting gaskets 4) turning spindle body 6) conic spreader bushing 7) cover with spindle arm 8) lubrication fitting 9 and 19) nuts 10 and 18) bearings 11) packing ring 12) ball support seal 13) half-shaft seal 14) support washer 16) ball support with king pins in assembly 17) plug

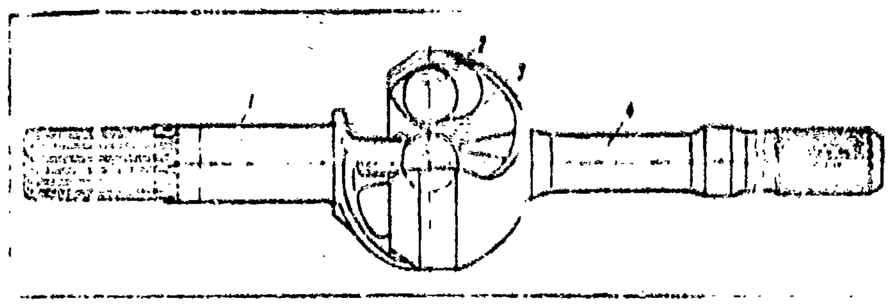


Plate 10-18. Half-shaft assembly:
1) stub axle 2) driving ball 3) center ball 4) inner half-shaft

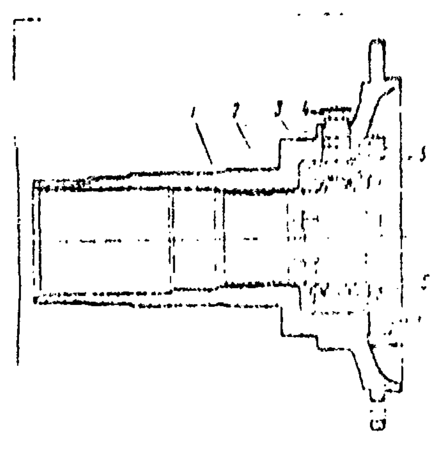


Plate 10-20. Turning spindle in assembly:
1) spindle 2) bushing 3) air supply head assembly 4) fitting 5) support ring 6) support washer

Disassembly and assembly

The ZIL-130 motor vehicle

Removing the rear axle from the motor vehicle. In order to roll out the rear axle of the ZIL 130 motor vehicle, it is necessary to stand the motor vehicle on a level surface or on an inspection pit which is equipped with a hoisting device. With the hoisting mechanism, raise the rear part of the frame so that the rear springs are unloaded.

Disconnect the ends of the rear suspension springs from the frame brackets and raise the frame (Plate 10-24). Disconnect the propellor shaft from the rear axle input shaft flange, having previously set blocks or a jack beneath the reduction gear.

Roll the rear axle out from beneath the frame, holding on to the reduction gear. Lower the frame onto supports.

Disassembly of the rear axle. Remove the wheels, springs, and brake chambers. Drain the oil, knock off the dirt, wash the axle off in degreasing solution, and blow it off with compressed air.

For disassembly of the rear axle, the GARO trust puts out a special stand, model 689-00-00 (Plate 10-25). If this stand is not available, it is possible to disassemble the axle by installing it on supports.

Removal of the half-shafts and hubs. Unscrew the nuts fastening the half-shaft to the hub, remove the spring washers and withdraw the conic split bushings. Screw two M12 X 1.75 bolts into the holes in the half-shaft flange intended for removing the half-shaft,,move it from its place, and then withdraw the half-shaft from the axle housing space and remove the half-shaft flange gaskets. Withdraw the other half-shaft from the rear axle housing in the same manner.

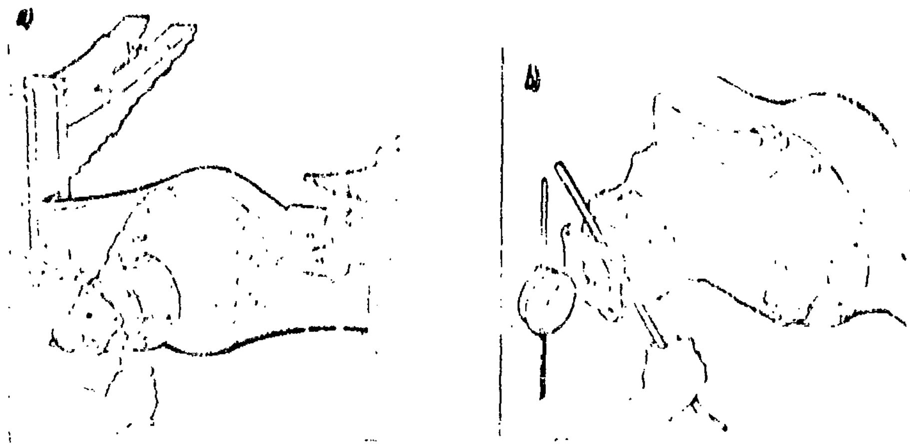


Plate 10-21. Method of checking axial clearance in the bearings of the final drive bevel pinion shaft:
a) ZIL-130 motor vehicle b) ZIL-131 motor vehicle

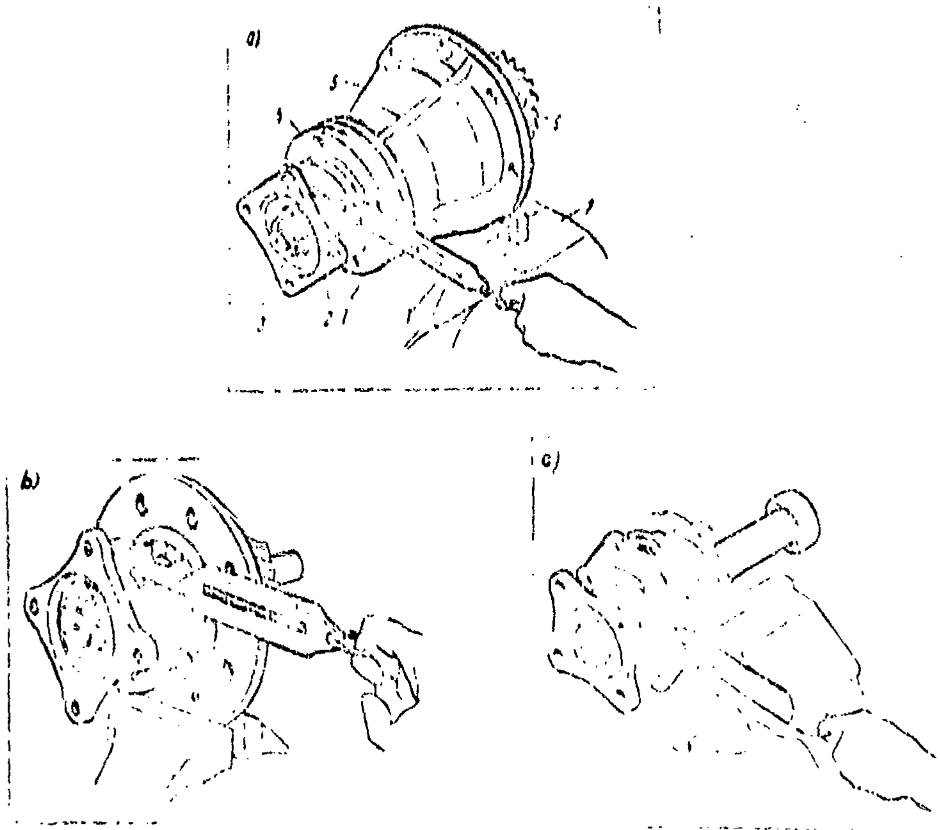


Plate 10-22. Checking tightness of the bearings on the bevel pinion gear shaft:
a) ZIL-130 b) ZIL-157K c) ZIL-131 1) dynamometer 2) flange 3) nut 4) cover 5) bearing recess 6) bevel pinion gear 7) vise

Unscrew the hub bearing outer fastening nut with a special wrench, and remove the lock washer and seal. Unscrew the inner nut fastening the bearings and remove the wheel hub in assembly with the brake drum. Remove the wheel hub bearing and ring with its seal.

Removal and disassembly of the rear axle reduction gear. Turn the rear axle so that the reduction gear is positioned vertically, pointing upward. Unscrew the bolts fastening the reduction gear housing to the rear axle frame rail. Install the bracket (Plate 10-26) on the flange of the final drive reduction gear and withdraw it with a hoist. The reduction gear may be disassembled on a stand or on a level working bench in the following order.

Removal and disassembly of the bevel pinion gear shaft unit of the reduction gear. Unscrew the bolts fastening bearing carrier 8 (see Plate 10-1) and, lightly tapping on the bearing carrier with a hammer, remove the pinion gear shaft 33 in assembly with the carrier. Remove the adjusting gaskets.

For disassembly, set carrier 4 (Plate 10-27) with the bevel pinion gear shaft in device 2 and fasten it with presses 3 and catch lock 1. which will keep the gear from turning. Unpin and unscrew the nut fastening the flange, remove the nut support washer and flange, tapping on them with a hammer. Unscrew the bolts fastening cover 4 (see Plate 10-1), and remove the cover with its gasket and support washer. If the seal is not in good condition, press it out of the cover and replace it with a new one.

For pressing the bevel pinion gear shaft out of the carrier, the unit in assembly should be set on supports of a press, and the shaft pressed out. If a press is not available, this same operation may be performed by striking the end of the pinion gear shaft on a wooden support and withdrawing the bevel pinion gear shaft together with the inner race of rear bearing 10, adjusting washers 9 and spacing bushing 34, from the carrier. Remove the front bearing from the carrier. Press the front bearing outer race from the carrier with a mandrel (Plate 10-28). Press the rear bearing outer race out of the housing by the same method, but using a different mandrel.

It is recommended that the rear bearing be removed from the pinion gear shaft with a 20P-7984 GARO puller (Plate 10-29).

Removal and disassembly of the differential. Bend the blocking plates away from the bolt heads 26 (see Plate 10-1), unscrew the bolts fastening the stop from both sides, and remove the locking plates and adjusting nut stops. Unpin the nuts fastening the bearing covers 18 of the differential box cups, unscrew these nuts with an angular socket wrench, mark the housing supports and covers with a punch or paint, remove them. Also mark and remove adjusting nuts 25 and remove the differential together with its bearings. If necessary, unscrew the studs with a stud turner, having already removed the pin. If the studs are not unscrewed, it is recommended that the bearing cover be set in place and the nuts screwed on.

For disassembly, set the differential in a vise, grasping the ring gear by its rim. Unpin and unscrew the nuts of the bolts fastening the differential box cups and the ring gear. Mark the relative position of the differential box cups with a punch (machining of the recesses for the differential cross takes place with the differential in assembly, and during disassembly the relative positions of the cups must be maintained, not mixing them).

Remove the right cup and right half-shaft gear 17 with its support washer 19, remove the cross with the differential pinions and differential pinion support washers, and after this remove the left half-shaft gear with its support washer.

Remove ring gear 21 from the left differential box cup 23 with a copper mandrel and hammer.

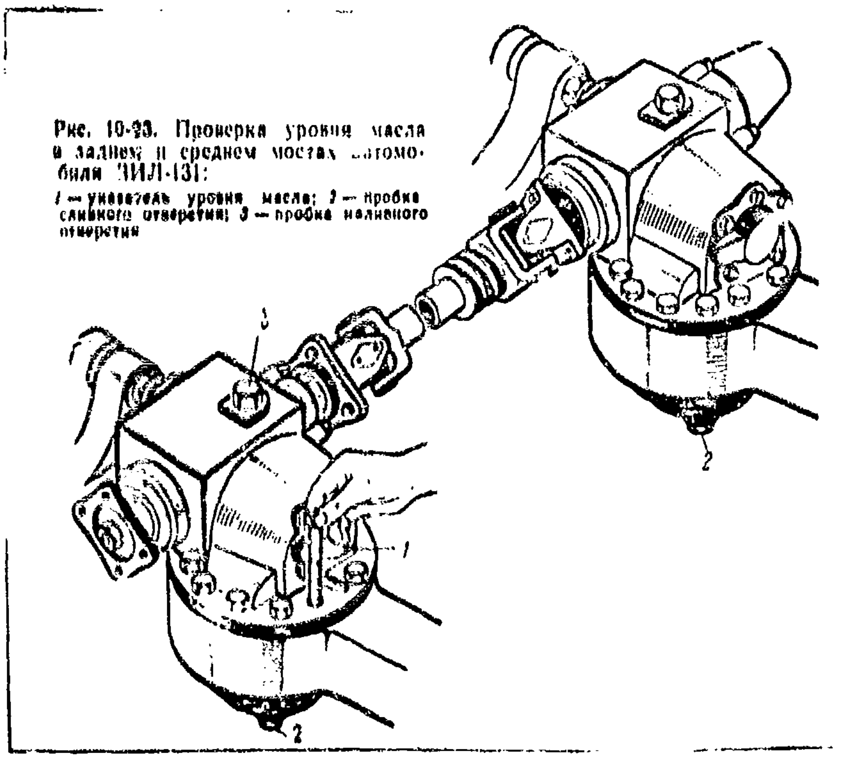
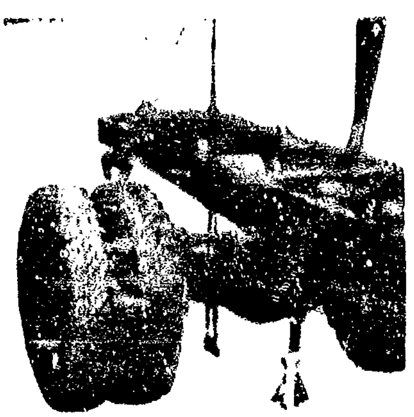


Рис. 10-23. Проверка уровня масла в заднем и среднем мостах автомобиля ЗИЛ-131:
1 — указатель уровня масла; 2 — пробка сливного отверстия; 3 — пробка наливного отверстия

Plate 10-23. Checking the oil level in the middle and rear drive axles of a ZIL-131 motor vehicle:
1) oil level indicator 2) drain hole plug 3) filler hole plug



Pla*e 10-24. Separating the rear axle and frame of ZIL-130 motor vehicle

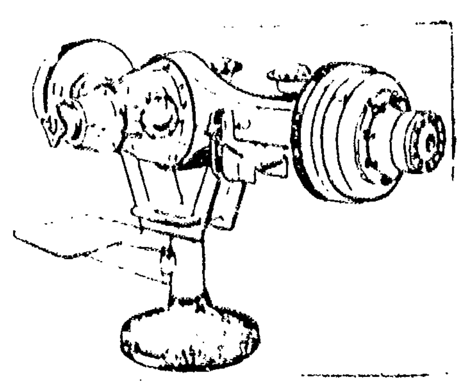


Plate 10-25. GARO model 689-00-00 stand for disassembling and assembling motor vehicle axles

Plate 10-26. Removal of the reduction gear from the rear axle housing of the ZIL-130 motor vehicle

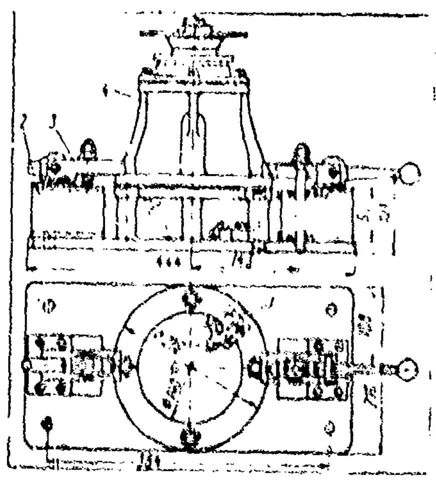


Plate 10-27. Device for disassembling and assembling the pinion shaft bearing carrier

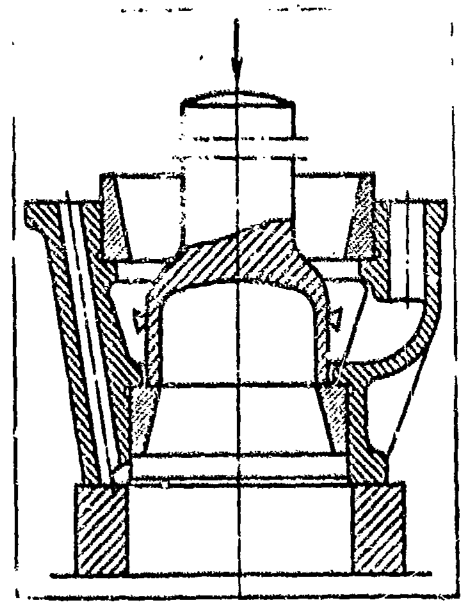


Plate 10-28. Pressing the outer bearing race from the bevel pinion gear carrier

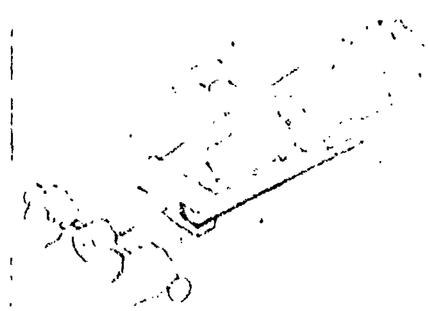


Plate 10-29. Removal of the rear bearing from the bevel pinion gear shaft:
1) crosspiece 2) clamp 3) catch 4) tip 5) screw

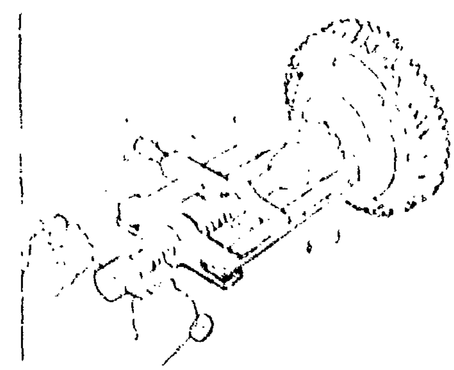


Plate 10-30. Removal of differential box bearings:
1 and 3) screws 2) crosspiece 4) clamp 5) catch 6) tip

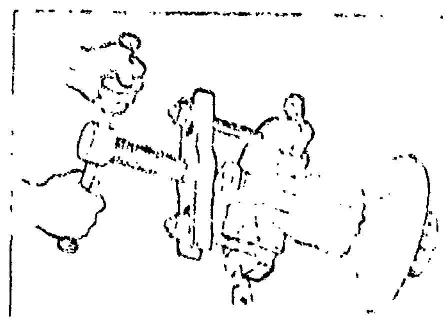


Plate 10-31. Pressing the bearing off the driving cylindrical gear shaft journal

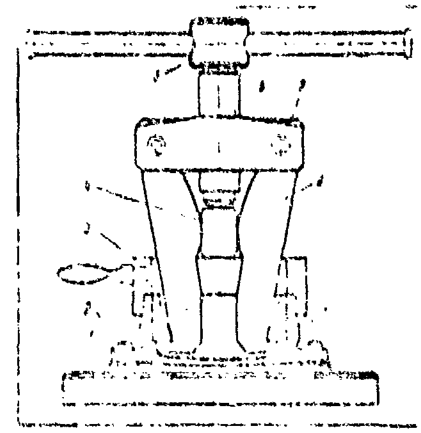


Plate 10-32. Pressing the cylindrical driving gear shaft bearing outer race from its cover:
1) support 2) pin 3) puller ring 4) bar 5) screw 6) crosspiece 7) pin 8) catch 9) bearing race

Plate 10-30 shows the bearing being pressed off the differential box cup journal with a model 2482 puller. In this operation, the puller is installed so that the puller catches 5 move under the face of the inner race of the bearing.

Removal and disassembly of the cylindrical driving gear. Unscrew the bolts fastening bearing cover 15 (see Plate 10-1) with a box and wrench, and remove them in assembly with the adjusting gaskets 13 and with the bearing outer races. Before removal, it is recommended that the covers be marked, and during removal, lightly tap on them with a hammer. The packet of adjusting gaskets for one side should not be confused with the packet of gaskets for the other side, and it is recommended that they be fastened onto their covers by tying them with thin wire. Pull the shaft of the driving cylindrical gear 16 in assembly with the driven bevel gear 12 of the reduction gear housing. A model 2502 puller (Plate 10-31) is used for removal of the bearings with half circles which are installed on the rollers with supports on their faces.

The method of pressing the bearing outer race out of the cover with the model 2480 puller is shown in Plate 10-32.

If there are cracks or chips in the reduction gear housing or bearing covers, the housing and covers should be replaced. Cracks which do not penetrate through the housings can be welded up. Damage to threads is not allowed to cover more than two turns.

Oscillation of the half-shaft, measured at a distance of 80 mm from the flange, is not allowed to be greater than 1.0 mm.

The allowable oscillation of the half-shaft flange face must not exceed 0.2 mm. The allowable amount of half-shaft tube bend is 0.2 mm.

If there are chips, traces of twisting, bending, or cracks on the half-shafts, the shafts should be replaced.

The requirements for rear axle gears are similar to the requirements for gears in transfer cases (see Chapter 8).

If there is loosening in the rivets fastening the ring gear to the flange of the cylindrical driving gear shaft, the rivets should be replaced.

If either the driven or driving beveled gears are replaced, it is necessary to also replace the gear paired with it.

Assembly of the rear axle. Before assembling the parts of the reduction gear, wash them in the degreasing solution, blow them off with compressed air, and check their usability. It is recommended that the assembly surface and sealing gaskets be coated with AK-20 or LB-11 lacquer. The bearings are lubricated with solid type grease.

Assembly of the bevel pinion gear shaft unit and adjustment of its bearings. Press the outer ring of front bearing 7 into the bevel pinion gear shaft bearing housing 8 (see Plate 10-1) with a mandrel until it rests against the fillet in the housing (interference is 0.010-0.068 mm). Turn the housing and press in the outer race of the rear shaft bearing 10 (interference is 0.009-0.059 mm). Mount the inner race of rear bearing 10, spacing bushing 34, adjusting washers 9, front bearing 7, and housing 8 on the shaft of bevel pinion gear 33. Set the assembled bevel pinion gear shaft with a support under a press, and press on both bearings until they stop. The fit of the bearings must be: for the rear bearing, an interference of 0.03-0.038 mm, and for the front bearing, a fit from clearance of 0.015 mm to interference of 0.16 mm.

Install support washer 5. Close the bevel pinion gear shaft housing with cover 4 and its gasket, having previously pressed seal 3 into the cover.

Install flange 2 with its deflector on the shaft splines and press it on. The flange fit on the splines takes place with a clearance of from 0.067 mm to zero. Mount the washer for nut 1 and tighten flange 2 with the nut (the cover is fastened with bolts, and the nut is pinned only after adjusting bearing tightness).

The necessity for adjustment may also be determined by measuring the axial clearance with an indicator, which is installed at the pinion gear shaft face. If the axial clearance in the bearings exceed 0.05 mm, it is necessary to adjust the bearings. Adjustment of the bearings takes place by means of select ing the thickness of the two adjusting washers 9 from those washers put out by the factory in the following dimensions: 2.00-2.02; 2.05-2.07; 2.15-2.17; 2.25-2.27; 2.35-2.37; 2.45-2.47; 2.55-2.57; and 2.60-2.62 mm. The torque moment on the nut fastening the flange is 20-25 kg meters.

Checking the tightness of bearings on the bevel gear assembly is shown in Plate 10-22, a. The moment necessary for rotation of the pinion gear shaft in bearings lubricated with oil must be 0.1-0.35 kg meters, which corresponds to a force of 2.7-9.7 kg. If a smaller or larger moment is required to turn the pinion gear shaft, it is necessary to once again disassemble the unit and change the adjusting washers 9 (see Plate 10-1), assemble the unit, and again check the shaft rotation moment.

While checking the moment of rotation of the pinion gear shaft, bearing cover 4 must be moved to the side of the flange so that the centering projection on the cover goes into the recess in bearing housing 8, and so that seal 3 does not cause resistance to shaft rotation.

After finally adjusting the bearings, fasten cover 4 with bolts and spring washers and flange nut 1. The flange fastening nut on the pinion gear shaft must be tightened until it is seated (torque moment is 20-25 kg meters) and pinned. While tightening the nut, turn the pinion gear shaft so that the bearing rollers are in the proper position between the conic surfaces of the bearing races.

Assembly of the driving cylindrical gear shaft. In a case where the driven bevel gear 13 is removed from the driving cylindrical gear shaft for replacement of the rivets, it is necessary to install the driven bevel on the shaft and rivet it to the shaft flange. It is recommended that before the driven bevel gear is installed on the shaft it be heated to a temperature of 120-160°C, after which it is installed on the shaft flange, with the holes in the gear and flange aligned

After the driven bevel gear cools, its fit on the shaft must have an interference of 0 to 0.096 mm. When the driven bevel gear is replaced it is also necessary to replace the bevel pinion gear paired with it.

Set the shaft of the cylindrical driving gear 3 (Plate 10-33) vertically on the support of device 1, press on the race of bearing 2 with a press, install the race of bearing 4 on the shaft journal, and press on both bearings with mandrel 6 until they seat against the shaft fillet. Bearing fit on the shaft journals must be realized with a clearance of 0.018 mm or an interference of 0.0[illegible] mm.

For assembly of the outer races of the cylindrical driving gear shaft bearings, it is necessary to set the right cover on support 1 (Plate 10-34), and press the outer race of bearing 1 into the recess in cover 2. This same operation is performed for the left cover, using mandrel 4 of a smaller diameter. The ring fits with an interference of 0.0[illegible]-0.59 mm.

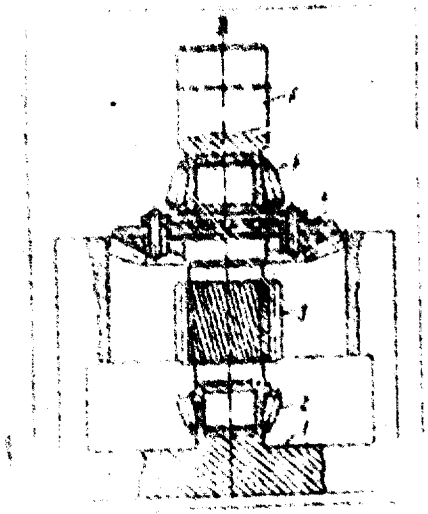


Plate 10-33. Pressing the bearing onto the cylindrical driving gear shaft:
1) device 2 and 5) bearings
3) cylindrical driving gear
4) bevel pinion gear 6) mandrel

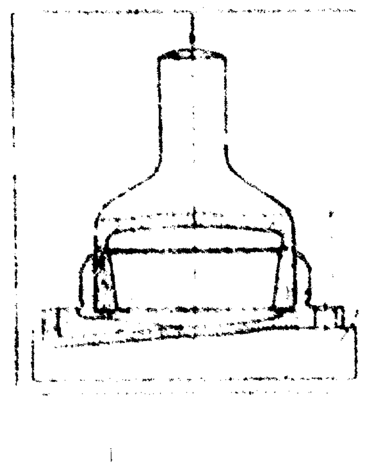


Plate 10-34. Pressing the outer race into the recess in the cylindrical driving gear shaft bearing cover

Assembly of the differential. During assembly, the differential gears should be lubricated with TAp-15 oil (GOST 8412-57). Set the right cup 1 (Plate 10-35) of the differential box on the plate, install bearing 2 on the face of the cup journal, and press it on with mandrel 3. Interference between the bearing and the shaft journal must be within the limits of 0.010-0.048 mm. The sequence of assembly operations for the left differential cup is the same as the sequence for the right one.

Assemble the cross and differential pinions. The differential pinions must be installed on the cross journals with a clearance of 0.03-0.10 mm. The fit of the cross journals in the cups is accomplished with a clearance of 0.05 mm or an interference of 0.01 mm.

Install the left differential box cup on support 12 (Plate 10-36) which has a hole into which the journal with bearing 15 must fit freely. Install the ring gear on the cup, lightly tapping on it with a copper hammer, and set the support washer and left half-shaft gear in the cup. Mount the four pinion gears on the journals of the cross with their supporting spherical washers. Lay the cross in assembly with the pinions on the differential box cup, lay the right half-shaft gear with its support washer on the differential pinions,

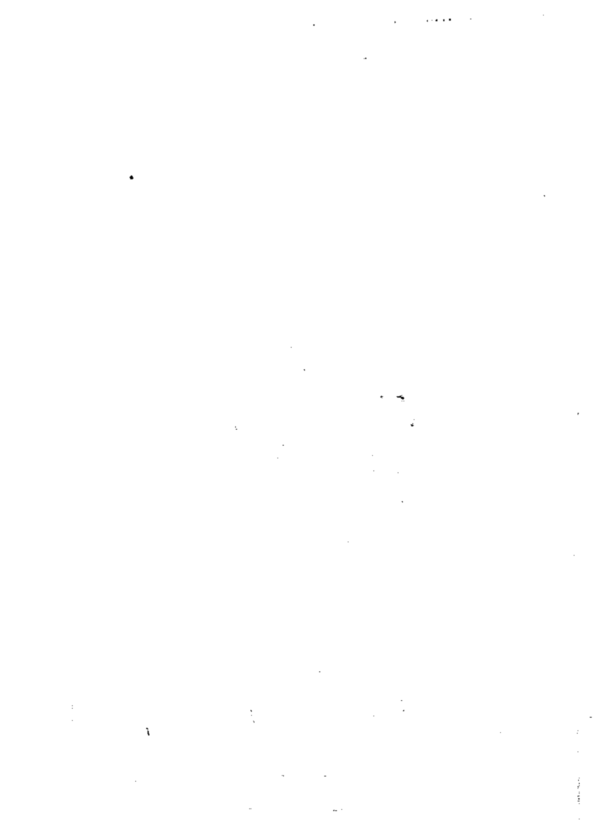


Plate 10-35. Pressing the bearing onto the differential box cup journal

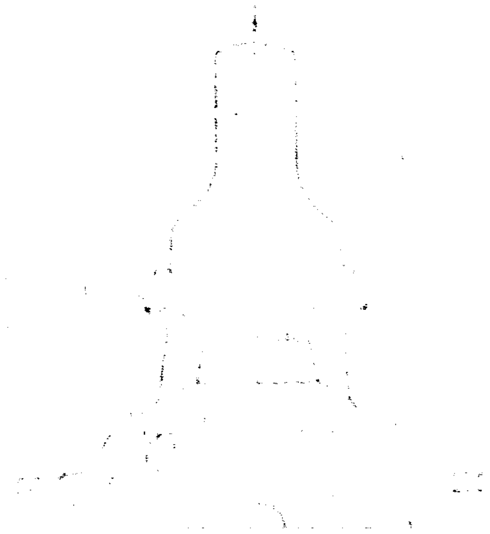


Plate 10-36. Assembly of the differential:
1) ring gear 2) differential box cup 3) cross 4, 8, and 14) support washers 5) differential pinion 6) differential pinion bushing 7 and 15) bearings 9 and 13) half-shaft gears 10) bolt 11) nut 12) support

Install the right differential cup, aligning the cups in accordance with the marks placed on them with a punch during disassembly, insert the bolts into the holes in the ring gear cups, and screw the nuts onto the bolts by hand. Remove the differential from the support and install it in a vise. The nuts are tightened with an angular socket wrench, grasping the ring gear in a vise (nut tightening moment is 12-15 kg meters). Turning the nuts, align their grooves with the holes in the bolts and tie them off with safety wire.

Before tying off the nuts, rotation of the differential gears should be checked. Engagement of the differential gears and their rotation in the assembled differential must be free with rotation of the half-shaft gear by a mandrel installed in its splined hole.

Clearance between the half-shaft gear face and the support washer must be 0.50-1.20 mm on each side. The clearance is checked through the control holes formed in the differential cups.

Assembly of the reduction gear. During assembly of the reduction gear, the cylindrical gear shaft bearing tightness, engagement between the bevel gear teeth, and differential bearing tightness are all adjusted simultaneously.

Installation of the cylindrical driving gear shaft assembly and adjustment of the tightness of its bearing. Install the shaft of the cylindrical driving gear 16 in assembly with the driven bevel gear 12 and inner bearing races into reduction gear housing 29 (see Plate 10-1). Lay the set of adjusting gaskets 13 on the flange of covers 15, install the covers in place in assembly with the bearing outer races pressed into them, and fasten the cover with bolts. Check the preliminary interference of the bearings. The set of adjusting gaskets put out by the factory consists of five pieces of dimensions: 1.0; 0.5; 0.2; 0.1; and 0.05 mm.

It is mandatory that gaskets 0.05 and 0.1 mm thick be placed beneath each cover in the reduction gear housing, with the remaining gaskets being placed according to necessity. During adjustment, the gaskets are removed from both sides in identical thickness and in equal number. After adjusting the bearing tightness, the twisting moment necessary to rotate the shaft in the bearings must be 0.1-0.35 kg meters, which is checked on a dynamometer by fastening it to the driven gear (Plate 10-37).

Installation of the driven bevel gear shaft and adjustment of the bevel gear tooth engagement. Having finished adjustment of the cylindrical driving gear shaft bearing tightness, install the bevel pinion gear shaft in assembly in the reduction gear housing and fasten it with bolts and spring washers.

During installation of the bevel pinion gear shaft assembly, it is necessary to check the tooth engagement between the driving and driven bevel gears (on paint along the contact spot) and, if required, adjust the engagement and set the required clearance between the teeth. The position of the contact spot on the working side of the tooth of a new driven gear with an adjusted gear engagement must correspond to the spot of contact shown in Plate 10-38. A clearance between the teeth must be maintained within the limits of 0.15-0.40 mm for new gears and no greater than 0.5 mm for gears having already been in operation.

The clearance between the teeth is measured with a leaf gauge at the wide part of the tooth on no less than three or four driven gear teeth, located at approximately equal angles around the circumference. The clearance may also be checked with an indicator, whose knife rests against the gear tooth (Plate 10-39). For normal setting of gear teeth engagement according to a point of contact, it is necessary to fasten the housing in assembly with the driven bevel gear shaft on the reduction gear housing, and place a thin layer of oil base paint on the working surfaces of several of the driven bevel gear teeth. After this, rotate the bevel pinion gear shaft in one direction and the other, braking the driven gear by hand. The character of gear engagement is determined according to the spots formed. The method of correcting the contact spot and the proper setting of gear engagement is shown in Table 10-2.

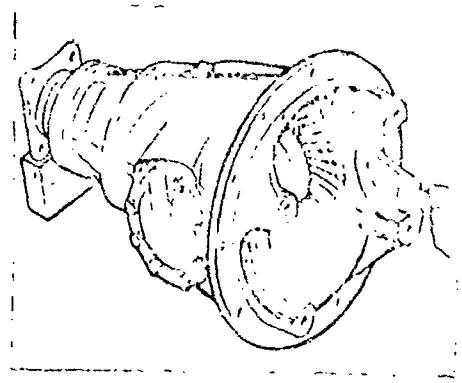


Plate 10-37. Checking tightness of bearings on driving cylindrical gear shaft

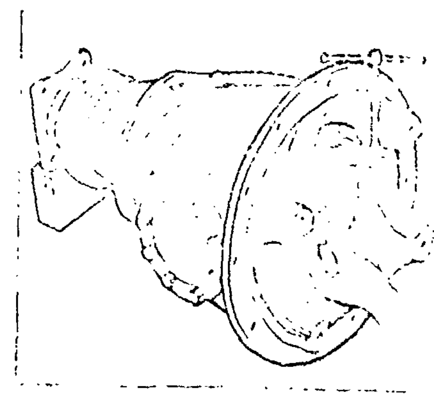


Plate 10-39. Checking axial clearance in bevel gear teeth engagement

Plate 10-38. Proper position of contact spot during assembly of final drive gears:
a) without load b) under load

If the position of the slots in not correct, the normal engagement should be attained by moving the driving and driven gears in an axial direction. Movement of the bevel pinion gear shaft is accomplished by changing the thickness of the set of adjusting gaskets installed between the flange of the pinion shaft carrier and the reduction gear housing. The set of adjusting gaskets put out by the factory consists of five pieces of dimensions: 1.0; 0.5; 0.2; 0.1; and 0.05 mm. Movement of the driven bevel gear is accomplished by moving gaskets from beneath the flanges of one cover of the reduction gear housing to beneath the flange of the other cover, without changing their total thickness, which does not alter the adjustment of the cylindrical gear shaft bearings.

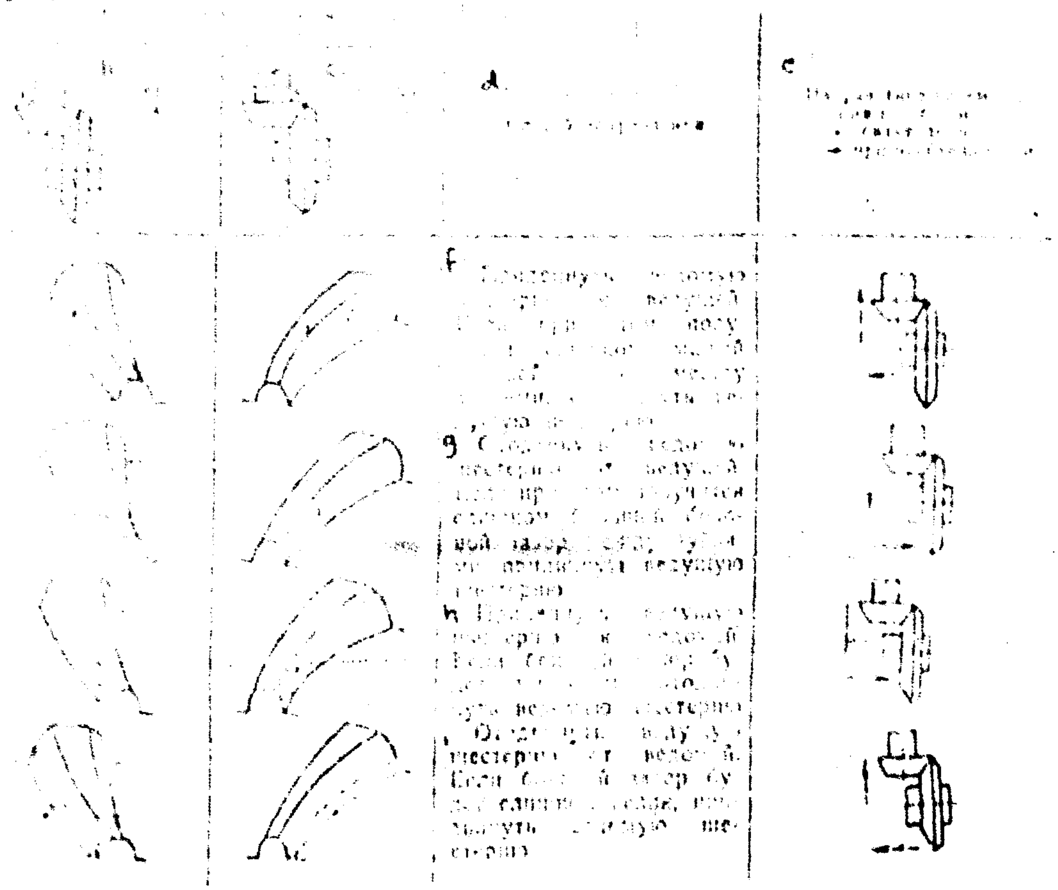


Table 10-2. Methods of correcting points of contact and proper adjustment of final drive gear engagement in two-axle motor vehicles

Key:
- a) Position of contact spots on driven gear teeth
- b) forward
- c) backward
- d) method of correction
- e) direction of gear movement:
  - mandatory
  - if necessary
- f) Move the driven gear to the driving one. If too small a lateral clearance between the teeth results from this, move the driving gear away.
- g) Move the driven gear away from the driving one. If too large a lateral clearance between the teeth results from this, move the driving gear closer.
- h) Move the driving gear toward the driven one. If the lateral clearance is too small, move the driven gear away.
- i) Move the driving gear away from the driven one. If the lateral clearance is too large, move the driven gear closer.

After finally adjusting the position of the driving and driven bevel gears, the torque moment necessary to rotate the cylindrical driving gear shaft in the bearings must remain unchanged within the limits of 0.1-0.35 kg meters.

After finally adjusting the positions of the driving and driven bevel gears, it is necessary to final tighten the bolts fastening the bevel pinion gear shaft housing. Tightening torque must be 6-8 kg meters.

Installation of the differential in the reduction gear housing and adjustment of its bearings. Install and fasten the differential in the reduction gear housing. In a case where the differential fastening studs have been unscrewed, it is necessary to screw them into the threaded holes in the reduction gear housing and pin them.

The differential bearings must be adjusted with a preliminary interference. For elimination of axial clearance, the adjusting nuts 25 (see Plate 10-1) are equally tightened on both sides, so that the toothed ring of the ring gear 21 is symmetrically located relative to the toothed ring of cylindrical driving gear 16. During adjustment of the bearings, the differential is rotated several times to attain a normal distribution of the rollers in the bearing races.

To attain the proper preliminary interference in the differential bearings, the adjusting nuts are tightened on both sides by one slot from the position of zero axial clearance, and the groove in the nut is simultaneously placed beneath its lock. The absence of axial clearance is checked with an indicator, whose knife is installed on the rim of the ring gear (Plate 10-40). Rocking the gear by hand (Plate 10-41), check clearance between the teeth of the paired cylindrical gears with the indicator also, resting the indicator rod on a tooth of the ring gear. Clearance must be within the limits of 0.1-0.7 mm in new gears, and 0.1-1.0 mm for gears which have been in operation.

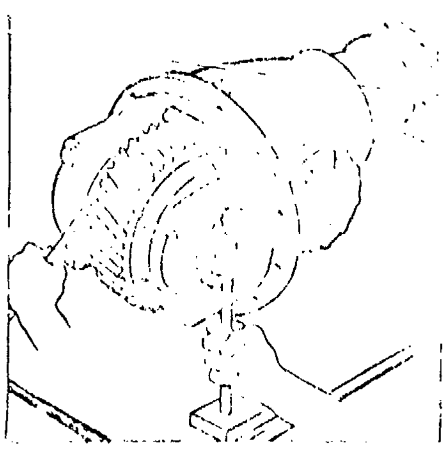


Plate 10-40. Checking axial clearance in differential bearings

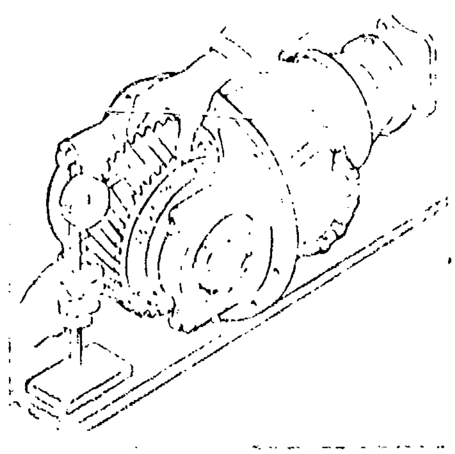


Plate 10-41. Checking clearance between the teeth of the cylindrical gear pair

Having finished adjusting the differential bearings, tighten covers 18 (see Plate 10-1) with their nuts (torque moment is 17-19 kg meters) and pin them. Install the stop with the lock washer on each adjusting nut 25, fasten the stops with bolts 26, and compress the lock washers.

Installation of the reduction gear in the rear axle housing. Screw the plugs into the filler and drain holes, and screw in the rear axle housing vent. Set the rear axle housing on a stand (see Plate 10-25) or on a special support.

Install the reduction gear assembly in the receptacle in the housing, having previously laid its gasket, coated with AK-20 lacquer, on the housing flange. Mount spring washers on the bolts, and fasten the reduction gear assembly with the bolts.

Installation of the brakes and wheel hubs on the rear axle. Install the brake backing plate, spreader cams, adjusting levers, brake shoes, and chambers. Install the hubs and adjust the wheel bearings. For assembly and adjustment of the brakes, see Chapter 16. For assembly and installation of the hubs and adjustment of the wheel bearings, see Chapter 15.

Installation of the half-shafts. Insert the splined end of the half-shaft in the half-shaft tube. Align the splined ends of the half-shaft with the spline holes in the half-shaft gears in the differential, and insert them into the gears. Mount the half-shaft flanges on the wheel hub studs. Place conic spreader bushings and spring washers on the studs and, having screwed on the stud nuts by hand, tighten them with a wrench until they are firm.

Installation of the rear axle on the motor vehicle. Before installing the rear axle on the motor vehicle, it is necessary to install the springs on the axle housing and fasten their U-bolts, install the wheels and fasten them on the lug studs.

Raise the rear part of the frame with the hoist mechanism, and roll the rear axle, in assembly with springs, beneath the frame (see Plate 10-24), install the front ends of the spring in their brackets and fasten them.

Install the rear ends of the springs in the brackets and fasten them. Release the frame onto the motor vehicle suspension, and remove the hoisting apparatus.

Connect the propeller shaft flange yoke to the flange of the rear axle reduction gear, and fasten it with bolts. Put lubrication in the rear axle.

The ZIL-157K motor vehicle.

Removal of the front drive axle from the motor vehicle. Park the motor vehicle on a level space, disconnect the front and rear ends of the front suspension springs from their brackets on the frame, disconnect and remove the shock absorbers, and disconnect the flexible hoses for the brake chamber and centralized system of air pressure regulation in the tires. Disconnect the propellor shaft from the flange of the front axle pinion gear, having previously placed a stand or jack beneath the axle reduction gear.

Raise the frame with a hoist and roll the front axle from beneath the frame. Lower the frame, placing stands beneath it. Remove the wheels and springs.

Removal of the rear and middle drive axles from the motor vehicle. Disconnect the top torque rods from the brackets fastened onto the frame, the flexible lines for the brake chamber and centralized system for air pressure regulation in the tires, and the propellor shafts. Unscrew the nuts fastening the suspension brackets to the frame brackets.

Raise the rear part of the frame and roll the rear axle carriage in assembly with its suspension and wheels from beneath it. Setting a stand beneath it, lower the frame.

Remove the wheels. Disconnect the balancing suspension from the drive axle rail brackets. Before disassembling the drive axles, it is necessary to drain the oil from them. Knock the dirt off the axles, wash them off with degreasing solution, and blow them off with compressed air.

It is possible to remove the middle and rear drive axles or one of them without removing the balancing suspension from the frame. For this, the rear part of the frame should be raised, the heads of the torque rods disconnected from the levers, and one or both axles rolled from beneath the frame. Having placed a stand beneath it, lower the frame.

Disassembly of the front axle. The front axle should be disassembled on a GARO model 689-00-00 stand (see Plate 10-25). If no such stand is available, disassembly may be conducted on a bench.

It is recommended that the front axle be disassembled in the following sequence.

Removal of the half-shafts. Unscrew nuts 47 (see Plate 10-3) fastening the splined half-shaft flange, and screw in the two puller bolts in the threaded hole in splined flange 48. Having previously loosened the stop nuts 75, remove the flange. Remove the flange gasket and pull the deflector ring out of the groove in spindle 46. Unscrew the fitting from the air supply head. Unscrew the screws fastening hubcap 49 and remove it from the hub, lightly tapping on it with a hammer. Remove air supply head 44 from the spindle.

Unscrew stop nut 50 with a special wrench and remove the lock washer. Unscrew nut 52 fastening the bearing and, lightly tapping with a hammer, remove the hub with the brake drum and outside bearing. Press the inside wheel hub bearing off the spindle (see Chapter 15 for disassembly of the wheel hub).

Remove the brake shoes, brake chambers, adjusting lever 33, bracket 35 and spreader cam 37, backing plate 58, and, unscrewing nut 59, remove spindle 45 (see Chapter 16 for brake disassembly).

Pull the inner half-shaft 68 in assembly with the ball joint and stub axle 61 from its jacket. For removal of the second inner half-shaft, the same operation should be conducted.

Disassembly of the ball support. For disconnecting the ball support 70 from half-shaft jacket 71 of the housing and cover, it is necessary to unscrew nuts 69, remove the washers, and press the ball support journals out of the half-shaft jackets with the puller bolts, screwing the bolts into the two threaded holes on the flange of the ball support body with a wrench.

Remove the consistent grease from the body and wash it out with degreasing solution. Unscrew nuts 5 and 13 (see Plate 10-7), fastening the lower and upper body covers. Remove the washers and, lightly tapping with a hammer, remove conic bushings 12 and covers 7 and 14 from the studs. Remove the adjusting gaskets 9 and 16 and the support ring 6. Unscrew bolts 3 fastening seal 2, and remove it in assembly. Remove the rubber seal 4 from its slot in the body. Unscrew the studs from the body flanges.

Set the body with the ball support on a stand, and press the outer race of lower bearing 8 out with a mandrel. Press the inner race of bearing 8 from the bottom king pin of the ball support.

Turn the ball support 5 (Plate 10-42), directing the lower king pin 4 into slot 3, and remove the support from body 2 in assembly with the upper king pin bearing. Press the upper bearing off the king pin journal with a 20P-7968 puller, and a 20K-103-2 ring or other similar puller.

Removal and disassembly of the differential. Disconnect and remove the steering tie rod. Unscrew nuts 20 (see Plate 10-3), remove the washers and bolts fastening the housing and cover, and then, lightly tapping with a hammer, separate cover 21 from housing 18, remove gasket 19, and remove the differential in assembly with the ring gear. Press the outer races 5 (Plate 10-43) of the bearings from their recesses in the cover and housing, and press out the seals (Plate 10-44). Press the bearings off the differential box cup journals with a 20P-7968 puller (Plate 10-45).

Fasten the differential in a vise and unpin and unscrew the bolts 2 (see Plate 10-4) fastening the differential box cups. Remove cup 4 together with the bolts, and remove the bolts. During removal of the cup, it is necessary to remove half-shaft gear 6 with support washer 3, remove cross 8 with the differential spindles 7 and support washers 11, and remove half-shaft gear 13 with support washer 12.

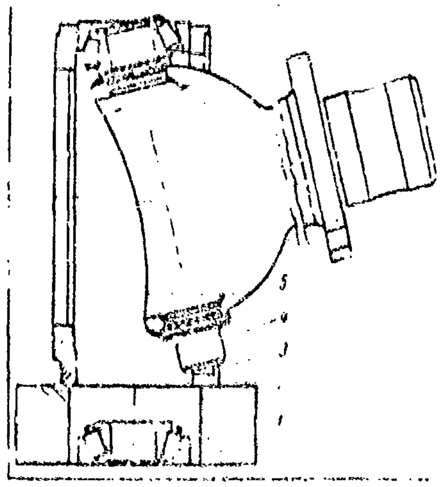


Plate 10-42. Method of separating the ball joint and body:
1) stand 2) body 3) auxiliary slot 4) king pin 5) ball support

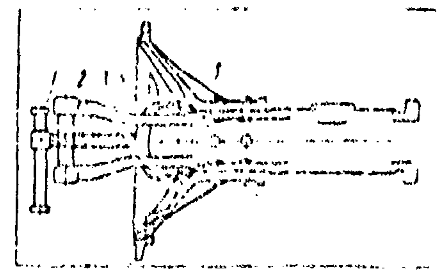


Plate 10-43. Pressing the differential bearing outer race from the cover recess:
1) handle 2) screw 3) grip 4) support bracket 5) bearing race

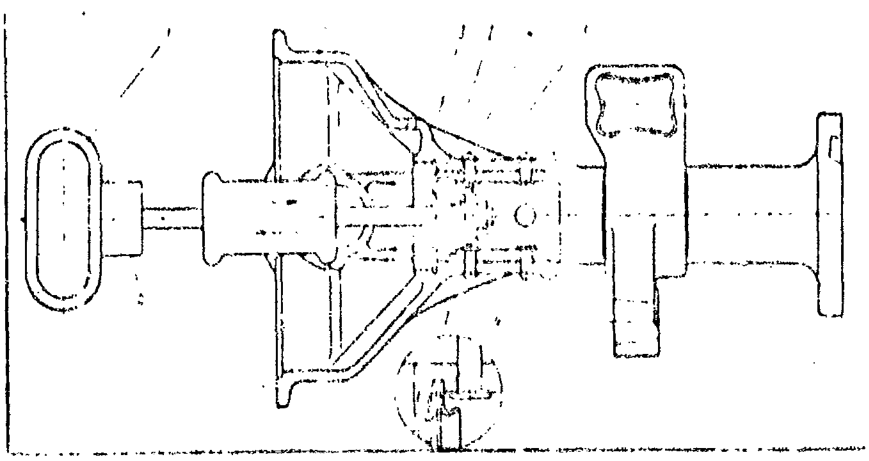


Plate 10 44. Pressing the seal out of the housing recess:
1) handle 2) movable weight 3) weight guide 4) seal 5) support plate 6) stop

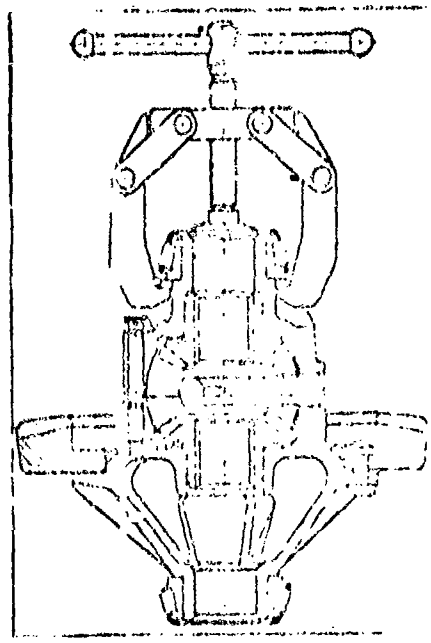


Plate 10-45. Pressing the bearing off the differential box cup

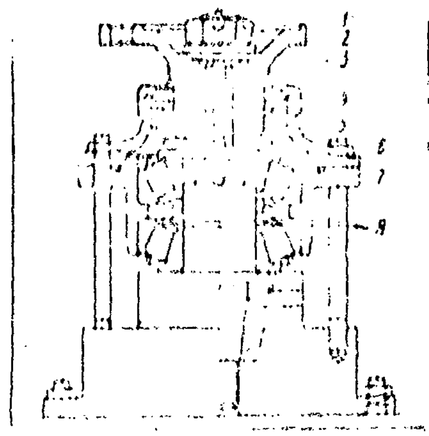


Plate 10-46. Installing the bearing carrier in assembly with the pinion gear shaft

Removal and disassembly of the bevel pinion gear shaft. For removal of the bearing carrier in assembly with the bevel pinion gear shaft, it is necessary to unscrew bolts 30 (see Plate 10-3) and, using the puller bolts, remove the bearing carrier assembly and adjusting gaskets 6. Remove stop ring ring 15 (see Plate 10-5) and press bearing 14 off the journal.

Install the bearing carrier in assembly with the bevel pinion gear shaft in the device (Plate 10-46), fasten it, and conduct the disassembly. Unpin nut 1 fastening the flange, and unscrew it. Remove support washer 2 and flange 3, tapping on it with a hammer. If the flange fits tightly on the splines, it must be removed with a 20P-7968 puller. Release the housing from its fastening, remove cover 6 by pressing it out of its recess with the two puller bolts, remove packing ring 7 from its circular groove, and remove support washer 5. If necessary, press seal 4 out of its recess in the cover with a mandrel.

Set the bearing carrier under a press, and press out the pinion shaft in assembly with the rear bearing. Remove the front bearing from the carrier, and remove the adjusting washers 8 from the shaft. Press the rear bearing off the shaft journal.

Press the outer bearing race out of the carrier with a 20P-7968 puller (Plate 10-47) using a special 20K-101 fitting.

In both cases, the outer bearing races are pressed out only if they are worn or damaged, and it is necessary to replace the bearings.

Disassembly of the rear and middle drive axles. Remove the brake chambers, withdraw the half-shafts, unscrew the nuts fastening the housing to the cover, separate the cover from the housing, remove the gasket, and withdraw the differential in assembly with ring gear. Unscrew the pinion gear shaft bearing carrier bolts and, using the puller bolts, remove the bearing carrier assembly and the adjusting gaskets.

Disassembly of the bevel pinion gear unit and differential is the same as disassembly on the front axle.

For disassembly of the balancing suspension, see Chapter 17. If there are cracks on axle parts, the parts hould be replaced.

Loosened rivets fastening the half-shaft jacket should be cut and new ones installed.

The beveled ring gear and pinion are paired, and this condition should be maintained.

If there is wear on the journals of the spindles, half-shafts, and ball supports above the allowable dimensions, the worn out parts are replaced.

Requirements for gears and half-shafts of the ZIL-157K motor vehicle drive axles are similar to the requirements for the rear axle on two-axle motor vehicles.

Assembly of the drive axle. Assembly of the bearing carrier with the pinion shaft. Press the outer bearing races into the carrier (interference, 0.025-0.075 mm). Press the rear bearing onto the pinion journal shaft until it rests against the face of the gear (interference, 0.015-0.047 mm).

Connect the pinion shaft with the bearing housing and mount the two adjusting washers on the shaft. Install the front bearing on the shaft. The bearing fits with a clearance of 0.008-0.035.

Install the pinion gear shaft in assembly with the carrier in a device (see Plate 10-46). Lay packing ring 7 in the circular slot, mount support washer 5, install cover 6, aligning the fixing pin of the housing with the hole in the cover, and fasten the shaft carrier with the cover in the device. Install flange 3 on the splines of the shaft, mount support washer 7 and, screwing on the nut, tighten it until it is firm. Tightening moment is 20-25 kg meters. Remove the bearing carrier from the shaft in assembly, fasten it in a vise, and check bearing tightness with a dynamometer. With properly tightened bearings, the pinion gear shaft must rotate due to the action of a moment of 6-14 kg cm, which corresponds to a force of 0.9-2.3 kg applied at the flange at one of its four holes. The method of checking is shown in Plate 10-22, b.

If the torque moment is less or greater than that required, it is necessary to disassemble the pinion housing, change the adjusting washer 8 (Plate 10-46), assemble it again, and check the moment of gear shaft rotation in the bearings. The adjusting gaskets are put out in the following thicknesses: 7.25, 7.30, 7.40, 7.50, 7.60, 7.70, 7.80, and 7.85 mm.

After finishing assembly and adjusting, press the bearing onto the journal of the tail part of the gear (interference 0.040-0.015 mm) and fasten the bearing with a stop ring (the bearing outer race is installed in the housing with a clearance of 0.038 mm or an interference of 0.005 mm).

After assembling and adjusting the bearing carrier assembly, it is recommended that it be spun for a period of one minute at a shaft speed of 200 rpm. After this, shaft rotation in the bearings is again checked with a dynamometer. It must rotate under action of a moment of 6-14 kg cm.

Assembly of the differential. Before assembly, the parts are rubbed with a dry soft cloth. During assembly, the assembled parts should be coated with transmission lubricant.

Press the bearings onto the differential box cup journals (see Plate 10-35).

Install support washer 12 and half-shaft gear 13 in the left cup 10 (see Plate 10-4).

Mount the support washers and differential pinions on the cross, and install the cross assembly in the left differential cup.

Mount the support washer on the second half-shaft gear, set the gear in the right cup, and install the unit on the left cup, aligning the hole with the bolts in both cups. Screw the bolts in and tighten them. Torque moment is 9.0-11 kg meters.

Check the proper assembly of the differential. Insert a leaf gauge 0.8 mm thick between the supporting surface of half-shaft gear 13 and support washer 12. In this operation, the gears must be rivoted.

The half-shaft gears and differential pinions in an assembled differential must rotate easily. Tight rotation of the gears or their binding is not allowed. After checking the differential, tie off bolts 2 with safety wire 15. The ends of the wire are bent into a lock as shown in Plate 10-4.

Install the assembled differential on the supports of a device by its bearings (Plate 10-40) and, turning it by hand, check oscillation along the lower face of the ring gear. Allowable oscillation is no greater than 0.16 mm.

Assembly of the ball support (left and right). If the support ring 17 is worn (see Plate 10-7), it must be replaced. The ring fits with an interference of 0.03 ... 0.21 mm. Lay the ball support with the king pins in assembly in the body of the turning spindle. Set the ball support in assembly with the body in device 1 (Plate 10-49), guiding the king pin onto support 2.

Plate 10-47. Pressing the pinion shaft bearing outer race from the carrier:
1) screw 2) link 3) grip 4) tip 5) 2DK-101 puller fitting 6) body

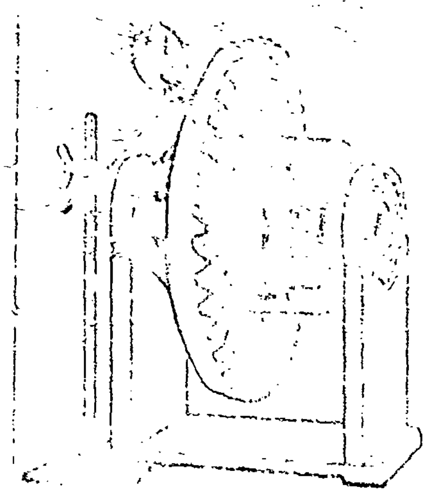


Plate 10-48. Checking differential ring gear oscillation

Plate 10-49. Pressing bearings onto the ball support king pins:
1) device 2) support 3) body 4) ball support 5) bearing 6) mandrel

Set bearing 5 on the face of the king pin, place mandrel 6 on the bearing and press it onto the kingpin. Install the outer race and press it into the recess in the turning spindle body.

Turn the ball support in assembly with the body in the device, press the other bearing onto the king pin, and press the outer ring into its recess in the body.

The bearings fit on the king pin journals with an interference of 0.002-0.027 mm, and the outer races fit into their recesses in the body with a clearance of from 0.045 mm to zero.

Screw in the cover fastening studs with a stud turner, install the support ring 5 (see Plate 10-7), the adjusting gaskets 9 and 16 in the lower bearing recess, mount covers 7 and 14 on the studs, mount the split conic bushings 12 on the studs, mount spring washers, and screw on the nuts, tightening them until they are firm. The tightening moment of the nuts is 12-15 kg meters. During tightening of the cover nuts, it is necessary to turn the housing so that the bearing rollers are distributed around the races properly.

Check bearing tightness with a dynamometer (Plate 10-50). If the force applied to the opening in the turning spindle necessary for its rotation is within the limits of 2.25-2.75 kg, the moment for rotation of the spindle is 0.45-0.55 kg meters, and bearing adjustment is not required in this case. If the required force moves outside the indicated limits, it is necessary to change the thickness of the set of gaskets 9 and 16 (see Plate 10-7) in a larger or smaller direction, so that the thickness of the gasket set pack between the upper and lower covers must not differ by more than one 0.05 mm thick gasket. In the selected gasket packet, there must be thicknesses of: 0.1, 0.2, 0.5, and 0.05 mm. In each packet must be two thin ones, 0.05 mm thick, and one thick one, 0.1 mm thick.

Having finished adjustment of bearing tightness, place the rubber packing 4 in its slot, set seal 2 on the ball support, and fasten it with bolts 3 and spring washers.

Screw the adjusting support screw into the hole in the ball support body and adjust the angle of turn, which must be 28-29°, with it, so that the bolt head rests against the ball support. Sold the support bolt to the body with brass solder. Assemble and adjust the right ball support of the front drive axle in the same manner.

Installation of the ball support. Set the axle housing and the half-shaft jacket so that the half-shaft jacket is pointed upward, and screw the studs (in case they are replaced) into the holes in the flange to half their depth.

Install the turning spindle by the ball support bearing surface into the hole in the half-shaft jacket so that the turning arm of the ball support body is directed toward the pinion gear flange and the ball support flange holes are aligned with the studs in the half-shaft jacket flange.

Press the bearing surfaces of the ball support into the hole in the half-shaft jacket until the ball support flange is seated. The bearing surface fit is accomplished from a clearance of 0.049 mm to zero interference. Install spring washers on the studs, screw on the nuts, and tighten them until they are seated. Nut torque moment is 12-15 kg meters.

Connect the right ball support to the half-shaft jacket in the same manner as the left one. If there is wear in the ring gear support plate, it should be replaced with a new one. Thickness of the plate must be 5.38-5.50 mm.

The spindle. If there is wear on the support ring and bushings, they must be replaced with new ones. The ring should be fit with an interference of 0.03-0.21 mm, and the bushing should be fit with an interference of 0.09-0.21 mm.

Assembly of the front axle half-shaft ball joint. Parts of the ball joint are shown in Plate 10-51, a. For assembly, fasten the inner half-shaft into a device or in a metal working vise, and connect it with the stub axle. Select the balls beforehand, using a technological ball with a flat surface placed in the center sphere of the assembled parts. Then, sequentially, one driving ball at a time, install the balls in any of the four recesses (Plate 10-51, b). The stub axle must be easily movable during this operation. The last locking driving ball is installed in the recess only after coincidence of its formed surface with the flat on the technological ball.

Having assembled the stub axle with the inner half-shaft, check the operation of the ball joint with a dynamometer, turning the stub axle by an angle of 10-15° in three directions: in the plane I-I, in the plane II-II, and in the plane III-III (Plate 10-51, b).

Plate 10-50. Checking the tightness of the turning spindle king pin bearings

Plate 10-51. Assembly of the front axle half-shaft ball joint:
a) ball joint parts b) installation of the balls in joint recesses c) diagram for checking the assembled joint
1) stub axle 2) running paths of the balls 3) inner half-shaft 4) center ball spherical recess 5) center ball 6) driving balls 7) dynamometer

The moment necessary for turning the stub axle by an angle of 10-15° must be within the limits of 2.0-8.5 kg meters.

The difference between the maximum values of the turning moment in the three planes must be no greater than 1.5 kg meters. After turning the stub axle by an angle greater than 10-15°, a decrease in the turning moment to zero is allowed. While the stub axle is being turned, there must be no binding of the balls.

The assembled half-shafts should be checked on a stand at 30 rpm with a load of 80 kg meters, and with the stub axle being turned relative to the inner half-shaft by an angle of no less than 30° to one side and to the other. During this operation, there must be no catching between the driving balls and the center ball, or catching between the two shafts.

If the requirements listed above are not satisfactorily performed, the joint must be disassembled, and the driving (lateral) balls of the joint must be replaced with ones of larger dimensions, if the moment required for turning the stub axle is less than that indicated, or must be replaced with ones of samller dimensions if the moment required is greater than that indicated. The balls range in diameter from 34.83-35.010 mm, and are divided into nine groups, differing by 0.02 mm in dimensions.

Having finished selection of the balls, remove the technological ball with the flat from the central recess, and replace it with the central ball (central ball diameter is 31.50-32.00 mm), and assemble the joint with the newly selected driving balls.

In installation of the fourth power ball, draw out and turn the stub axle to an angle which allows insertion of the fourth driving ball. Release the inner half-shaft, insert the stub axle in the vise and, with a smooth force applied by hand to the end of the inner half-shaft, turn it into the straight position.

If assembly is accomplished using drive balls from various groups according to diameter, these drive balls must again be placed in their previous recesses during exchange of the center ball.

If necessary, repeat the check on the operation of the assembled half-shaft ball joint. When the stub axle is turned by hand, there must not be any noticeable binding of the balls in the joint.

See Chapter 15 for assembly of the wheel hub and Chapter 16 for installation of the brake drum.

Overall assembly of the front drive axle. It is recommended that the axle be assembled on a GARO model 689-00-00 stand (see Plate 10-25). In case no such stand is available, the axle may be assembled on a bench.

Install the axle housing and screw the two auxiliary pins into the holes in the flange, mount adjusting gaskets of 1.6 mm overall thickness on the pins. In this operation, there must be no less than two gaskets 0.2 mm thick, and no less than two gaskets 0.1 mm thick in the gasket set.

The gaskets must not have nicks or creases from sharp bending.

Installation of the pinion gear shaft. Install the pinion gear shaft in assembly with its bearing carrier in the front axle housing so that the pin in the pinion shaft bearing housing goes into the hole in the axle housing flange.

Screw the auxiliary studs out of the holes in the flange. Placing spring washers beneath the bolt heads, screw the bolts fastening the pinion shaft bearing housing to the holes in the flange. (Torque moment is 3.5-5.0 kg meters.) Installation of the differential. Coat the working edges of the rubber cups in the half-shaft jackets with consistent type grease, and install the differential assembly in the front axle housing, checking to see that the paired pinion and ring gear have the same unit serial number.

Smear the assembly surface of the housing cover with grease, and install the gasket, aligning the holes in the gasket and the holes in the cover. Install and connect the cover to the housing so that the areas for fastening the front springs are located in the same plane, and the holes in the cover and axle housing are aligned. Install the bolts, whose heads must be located on the side of the housing, install spring washers, screw on the nuts, and tighten them with a wrench. The moment for nut tightening must be 5.0-6.5 kg. The two bolts screwed into the housing body are pinned with safety wire.

Check the installation and assembly of the axle mechanism by rotating the pinion gear manually by the shaft flange. There must be no catching of the gears or differential box on the housing and support plate when the pinion gear is turned.

Adjustment of the clearances and engagement of new final drive bevel gears. With the proper selection of adjusting gaskets installed with the pinion gear housing flange, the lateral clearance between the teeth must be 0.1-0.5 mm at the wide part of the tooth, which will correspond to a pinion gear shaft flange rotation of 0.25-1.00 mm with the installation of an indicator rod on the flange along the diameter where the bolt hole is located. The method of checking the clearance with an indicator is shown in Plate 10-52.

In a case where the clearance between the gear teeth does not correspond to the value 0.1-0.5 mm, it is necessary to perform adjustment by means of changing the thickness of the gasket set installed beneath the bearing carrier flange of the pinion gear shaft. In this operation, one thin gasket, 0.1 mm or 0.2 mm, should first be installed or removed. After each decrease or increase in the adjusting gasket set thickness, the bearing carrier should be fastened on and the clearance between the gear teeth checked by the method shown in Plate 10-52.

Having ensured that the clearance between the bevel gear teeth corresponds to that established, it is still necessary to check the engagement of the gear teeth on their spot of contact, which must be located on the working convex side of the tooth profile (Table 10-3).

For checking the position of the contact spot, it is necessary to disconnect the cover, withdraw the pinion gear shaft assembly from the housing, apply a thin layer of paint on the working part of the teeth, and again install the assembly in place. Turn the pinion shaft by several revolutions, rotating the flange by hand, after which the pinion gear shaft is removed and the position of the contact spot checked on the teeth. The spot of contact on the teeth of a new ring gear must have a length of 28-35 mm and be removed from the narrow end of the tooth by 3-6 mm, from the wide end of the tooth by no less than 5 mm, and from the top of the tooth by no less than 1 mm.

The position and size of the spot is adjusted by moving the engagement of the gears, changing the thickness of the set of adjusting gaskets beneath the flange of the pinion gear bearing carrier.

In order to move the pinion gear away from the ring gear, it is necessary to increase the thickness of the gasket set, adding one thin gasket, 0.1 mm in thickness, each time and, conversely, so as to bring the pinion gear nearer to the ring gear, it is necessary to remove the same amount of thickness. After each change in the gasket set thickness, the pinion gear shaft bearing carrier is again installed in place, and the amount and position of the spots of contact are checked by turning the gears.

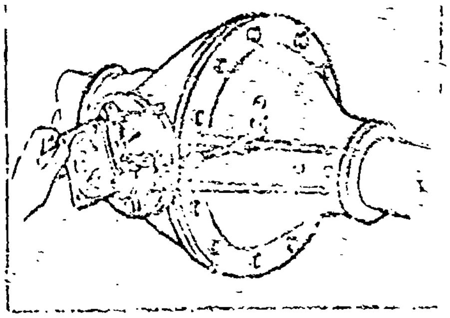


Plate 10-52. Method of checking the clearance between the drive axle final drive gear teeth of a ZIL-157K motor vehicle

The axial clearance (slack) of the ring gear depends on the fit of the differential bearings, whose preliminary fit was provided during assembly of the precision dimension parts and installation of the 0.15-0.25 mm thick gasket on the assembly surface between the housing and the drive axle cover.

The fit of the differential bearings in an assembled new drive axle must be within the limits of from interference of 0.5 mm to clearance of 0.09 mm. The axial clearance 0.09 mm is also the maximum axial slack in a ring gear in assembly with the differential. The axial clearance of the ring gear shaft may be measured with a leaf gauge by inserting it between the ring of the ring gear and the copper plate riveted to the axle housing cover. This slack may be measured with an indicator, setting its knife against the toothed ring of the ring gear. While measuring this slack, the pinion gear shaft in assembly with the bearing carrier must be removed from the drive axle housing.

During the process of operation of the drive axle, the axial clearance in the ring gear is allowed to increase to 0.2 mm. In connection with the fact the that the differential bearings are not adjusted, the axial clearance in the ring gear may be decreased by replacing the gasket on the assembly surface between the housing and the cover with a thinner one, or by replacing the worn out differential bearings with new ones.

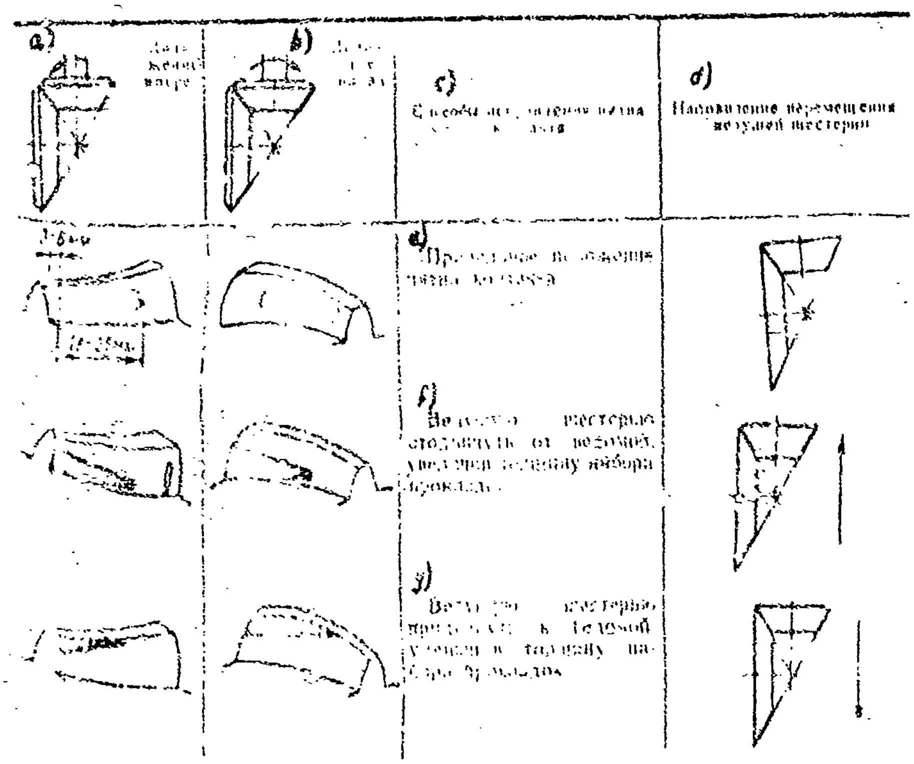


Table 10-3. Position of spots of contact for assembly of the final drive gears in three-axle motor vehicles

Key: a) movement forward
b) movement backward
c) method of correcting the spot of contact
d) direction of pinion gear movement
e) Correct position of the spot of contact
f) Move the pinion gear away from the ring gear, increasing the thickness of the gasket set
g) Move the pinion gear closer to the ring gear, decreasing the thickness of the gasket set

Installation of the half-shafts. Screw the spindle fastening studs into the ball support body (if they were unscrewed).

Install the stub axle and inner half-shaft assembly into the half-shaft jacket of the axle, having previously applied type AM grease (Universal GOST 5730-51) in the half-shaft ball joints and the space in the body.

Installation of the spindles, brake units, wheel hubs, and air supply heads. Install the spindles in assembly with the ball joint stub axles, install the backing plate assembly on its studs, mount the ring with its seal in assembly on the stud after servicing the seal with liquid oil. Install the return spring hooks on the two studs, mount the spring washers on the studs, screw nuts onto them, and tighten them with a wrench. (Torque moment is 3.6-4.8 kg meters.)

Install the spreader cams, adjusting levers, brake shoes, and brake chambers. Install the wheel hub and adjust the wheel bearings. Install the air supply head and hubcap. See Chapter 16 for assembly and adjustment of the brakes, and Chapter 15 for installation of the wheel hubs and adjustment of the bearings.

Installation of the half-shaft flange. Install the gaskets and half-shaft flange on the hubcap studs, install spring washers on the studs, screw nuts onto them and tighten them (tightening moment is 3.5-5.0 kg meters).

Screw the puller bolts into the threaded holes in the half-shaft flange, having previously mounted stop nuts on the bolts, and tighten the bolts and stop nuts until they are seated.

Assembly of the components and overall assembly of the rear and middle drive axles are similar to assembly of the front axle, with the exception of the ball support and half-shafts. Therefore, during assembly and adjustment of the rear and middle drive axles, it is necessary to be guided by the information presented for the front axle.

Testing of drive axles. The assembled drive axles must be serviced and checked on the stand or during a run.

While being checked on a stand, the pinion gear shaft must have a rotation speed of 1000 rpm. Checking must take place with reversing and braking for a period of 7-10 minutes.

The following are not permissible: sharp noises of the final drive gears, and knocks and sharp noises from the differential with one brake drum being braked; catching of the rotating parts on the stationary ones (for instance, catching of the ring gear and differential cups on the housing and axle cover, catching of the brake drum on the backing plate and the brake shoes, catching of the half-shaft ball joints on the ball support of the rotating spindle, etc.); heating in the places where the pinion gear shaft bearings and differential bearings are located in the housing and housing cover, and also in the places where the wheel hub bearings are installed; heating of the brake drum and ball supports (checking is done with touching by hand); oil leaks through the seals and connections; catching of the ball joints either with the turning spindles in the straight position or in the extreme angles of right and left turn.

Installation of the drive axles in the motor vehicle. Raise the front part of the motor vehicle frame with the hoist mechanism and roll the front axle beneath the frame. Install the spring ends in their rubber cushions, bring them into the brackets, close them with their cups, and tighten the bolts.

Lower the motor vehicle frame. Raise the rear portion of the motor vehicle frame, roll the paired middle and rear axles underneath the frame and lower the frame onto the suspension pads, guiding the studs into the holes in the pad flanges.

Screw nuts onto the studs and tighten them with a wrench until they are seated. Connect the upper torque rod to the bracket on the frame.

Connect the flexible hoses to the brake chambers, to the air supply unit tee, and to the spindle flanges. Connect the propellor shafts to the flanges of the spindle gear shafts of the front, middle, rear axles, and to the intermediate propellor shaft support. Lower the motor vehicle frame.

The ZIL-131 motor vehicle

Removal of the front, middle, and rear axles from the ZIL-131 motor vehicle is similar to the removal of the drive axles from a ZIL-157K motor vehicle.

Disassembly of the front drive axle. Plate 10-11 shows the front drive axle. Dissassembly of the front axle should take place on a GARO model 689-00-00 stand (see Plate 10-25). If such a stand is not available, disassembly may take place on a bench. The recommended procedure for disassembling the front axle is as follows.

Removal of the half-shaft. Remove valves 5 (Plate 10-11). Unscrew the nuts fastening the splined flange 7 of the half-shaft and remove it by the puller bolts, screwing them into the holes in the flange. Remove the gasket.

Unscrew the stop nut 6 with a special wrench, and remove the lock washer 8. Unscrew nut 3 fastening the hub bearings and, lightly tapping on the hub 1 with a hammer, remove it with the brake drum and outer bearings. See Chapter 15 for disassembly of the wheel hub. Remove the brake adjusting levers, bracket 16, and spreader cams. Unscrew fitting 13 with the hose from air supply head 27. Remove the brake chambers and brake mechanism. See Chapter 16 for brake disassembly. Remove spindle 2, for which the nut fastening the spindle to the body should be unscrewed, screw M12 dimension bolts into the threaded holes in the spindle flange, and disconnect the spindle from the body with them. The spindle assembly is shown in Plate 10-20. The spindle must be removed very carefully, attempting not to damage the air supply head seals. If necessary, remove the outer race with the rollers of wheel hub bearing 11 from the spindle with a puller (see Plate 10-11). For removal of the air supply head 3 (see Plate 10-20), it is necessary to unscrew the bolts and remove stop ring 5 of the spindle, and then remove the head. Remove the inner half-shafts 19 in assembly with the stub axle (see Plate 10-11) from the axle rail. The half-shaft assembly is shown in Plate 10-18. For removal of the second inner half-shaft, the same operation should be performed.

Removal and disassembly of the reduction gear. Disconnect and remove the steering tie rod. Turn the front axle so that the supporting flange of the reduction gear is in the horizontal position, and the bevel pinion gear shaft flange is directed upward. Unscrew the bolts fastening the reduction gear to the front axle housing. Besides the exterior bolts, the reduction gear is fastened to the axle housing with two more bolts located inside the reduction gear carrier. In order to unscrew these bolts, it is necessary to remove cover 24 (Plate 10-11). Having unscrewed the bolts, again fasten the cover on the reduction gear carrier. Install a bracket on the final drive reduction gear flange, and remove the reduction gear from the front axle housing with a hoist. The method of removing the reduction gear is shown in Plate 10-53. Carefully remove the sealing gasket from the housing. Disassembly of the reduction gear takes place on a stand or on a bench.

Removal and disassembly of the bevel pinion gear shaft. Unscrew bolts 16 (Plate 10-14) fastening the cover and pinion gear shaft bearing carrier to the reduction gear housing. Remove the shaft in assembly with pinion gear 24, carrier 21, and bearings 22, from the reduction gear housing with M12 X 1.75 bolts, which are screwed into the threaded holes in the flange of carrier 21. Remove the adjusting gaskets 15.

For disassembly of the bevel pinion gear shaft, fasten it in a metal working vise. Remove stop ring 1 (see Plate 10-15) of the front bearing of the bevel pinion gear shaft with a screwdriver and hammer. Remove front bearing 2 with a puller. Unpin nuts 11 fastening flange 9. Then, preventing the flange from turning with a bar, unscrew the nut fastening the flange. Remove support washer 10 and the flange, tapping on it with a hammer. If the flange fits tightly, use a 20P-7968 puller. Remove cover 8 with its seal, packing gasket, and supporting oil-deflecting washer 13. In case the seal in cover 8 is damaged, it may be pressed out of the body with a hammer and mandrel.

For removal of shaft 3, it is necessary to install the pinion gear shaft in assembly on the support of a press, and press out the shaft as shown in Plate 10-54. Set carrier 6 (Plate 10-15) on its flange on a support, as shown in Plate 10-55, and with a mandrel and hammer (or press), press the bevel pinion gear shaft together with the inner races of the front tapered bearing 5 (see Plate 10-15) out of carrier 6. Remove the inner race in assembly with the rollers of the rear tapered bearing. Remove adjusting washers 7. Press the inner race with the rollers of the front tapered bearing off the bevel pinion gear shaft. Press the outer races of the bearings out of the carrier with a 20P-7968 puller, using a 20K-101 fitting (Plate 10-56). The outer races of the pinion gear bearings are pressed out of the carrier only in the presence of wear above the allowable amount, or if the races are damaged.

Removal and disassembly of the differential. Bend the locking plates away from the heads of bolts 2 (see Plate 10-14) fastening stop 3, unscrew the bolts and remove the locking plates and adjusting nut stops.

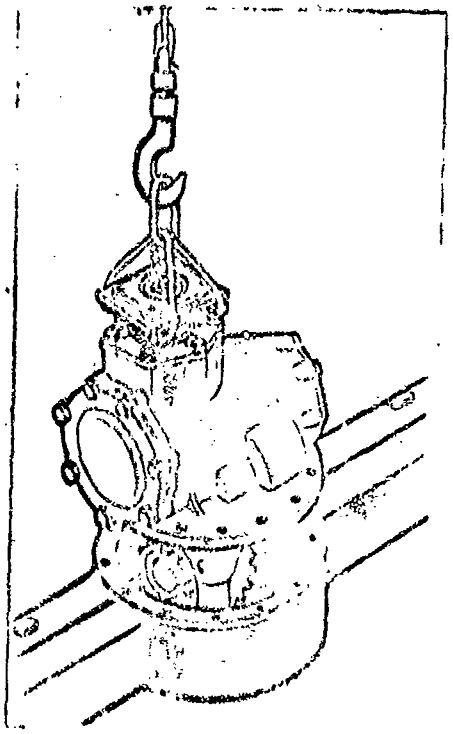


Plate 10-53. Removal of the reduction gear from the front axle rail

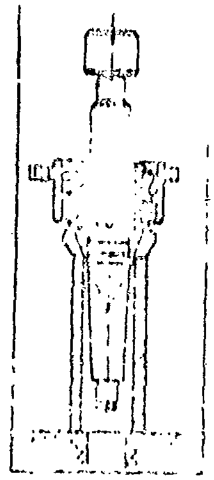


Plate 10-54. Pressing the shaft out of the bevel pinion gear

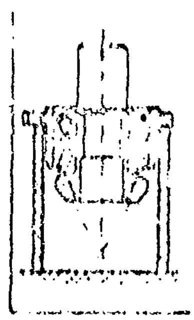


Plate 10-55. Pressing the bevel pinion gear out of the bearing carrier

Unpin and unscrew nuts 34 fastening the covers 33 of the differential box cup bearings with an angular socket wrench, mark the covers 33 and remove them, mark and remove both adjusting nuts 4, and remove the differential together with its bearings. If necessary, unscrew the studs with a stud turner, having previously pulled out the pins. If the studs remain in place, it is recommended that bearing covers 33 be installed in place and have their nuts tightened. If necessary, press the bearings out of the differential box cups, without disassembling the differential. The method of pressing the bearings out with a 20P-7968 puller, using a 20K-992 fitting and a 20K-103-2 ring is shown in Plate 10-57.

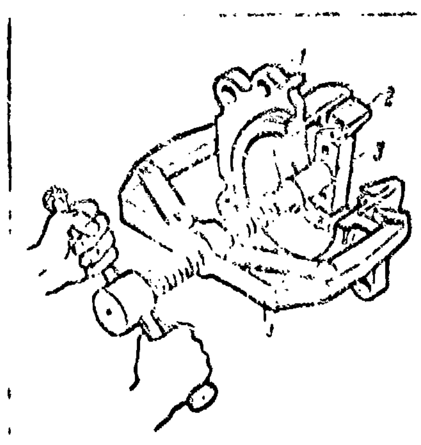


Plate 10-56. Pressing the outer bearing races of the spindle pinion gear shaft out of the carrier with a 20P-7968 puller:
1) bearing carrier 2) bearing outer race 3) puller fitting 4) puller

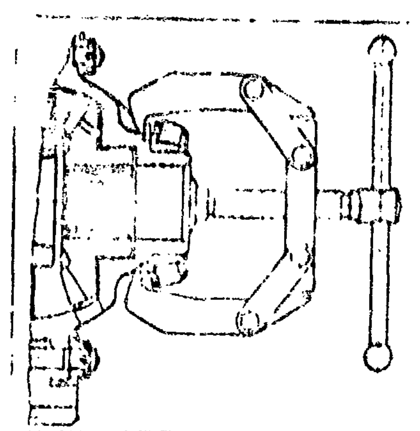


Plate 10-57. Removal of bearing from differential cup

For disassembly, the differential should be set in a vise, clamped by the rim of the ring gear. Unpin and unscrew the nuts from the bolts fastening the differential box cups and the ring gear. Mark the relative positions of the cups with a punch, since the recesses for the differential cross in the differential box are machined with the unit in assembly. During disassembly, the unity of the differential cups should be maintained. Remove any cup 2 (see Plate 10-17) of the differential together with one of the half-shaft gears 7 and support washer 6. Remove cross 3 with differential pinions 5 and differential pinion support washers 4. Remove the half-shaft gear with its support washer from the other differential cup. Remove the ring gear 1 from the differential cup with a copper mandrel and hammer.

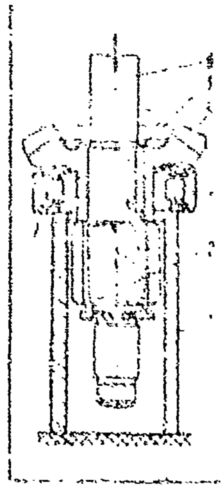


Plate 10-58. Pressing the cylindrical driving gear off the driven bevel gear: 1) support 2) cylindrical driving gear 3) bearing 4) driven bevel gear 5) key 6) mandrel 7) spacing ring

Removal and disassembly of the cylindrical driving gear shaft. Unscrew the bolts fastening cover 7 (see Plate 10-14) and recess 10 of the double tapered bearing for the driving cylindrical gear shaft. Remove the cover and sealing gasket. Block the shaft of the cylindrical driving gear to prevent it from rotating. Unscrew nut 9 tensioning the inner race of the double tapered bearing 8. Remove the support washer, unscrew the bolts, and remove cover 27 with its sealing gasket. Using a mandrel and hammer, press the shaft in assembly with the driving cylindrical gear 14, the driven conic gear 25, bearing 26, and the inner race of double bearing 8 out of the recess 10 and out of the carrier 6 (from the side of the cylindrical gear).

Pull the other inner race of bearing 8 and adjusting ring 13 from recess 10. Mark the inner races of bearing 8 and the adjusting ring 13 in the positions that they were in during assembly. Press the remaining inner race with the rollers of double bearing 8 from the driving cylindrical gear shaft.

For removal of the driven bevel gear from the driving cylindrical gear shaft, it is necessary to set this unit on support 1 (Plate 10-58), and press the shaft of driving cylindrical gear 2 from the receptacle in driven bevel gear 4. Drive out the key 5. Press off the cylindrical roller bearing 3 and spacing ring 7 with the driven bevel gear 4.

Withdraw the recess for the double tapered bearing from the reduction gear housing with M12 X 1.75 puller bolts. Remove the adjusting gaskets and press the outer race 3 (Plate 10-59) of the roller bearing out with mandrel 4. During this operation, support 1 must be placed beneath the receptacle.

Removal and disassembly of the ball support. To separate the ball support 20 (see Plate 10-11) from front axle housing 25, it is necessary to unscrew the nuts, remove the washers, and press the fitting band of the ball support out of the housing with puller bolts, which are screwed into the threaded holes in the flange of the ball support.

If the half-shaft seal is not in proper condition, it must be pressed out of the ball support with a 20P-7968 puller (Plate 10-60) together with the seal ring. Remove the consistent grease from the turning spindle body, and wash the body with degreasing solution. Unscrew nuts 9 (see Plate 10-19) fastening the cover with the rotating spindle lever, and nuts 19 on lower cover 2 of the king pin bearing. Remove the washers, and, lightly tapping with a hammer, remove the conic bushings 6 from the studs, and then remove the cover with the turning spindle lever and lower king pin bearing cover.

Remove the adjusting gaskets 5 and, unscrewing the bolts fastening the seal, remove packing ring 11 together with seal 12 in assembly. Remove the rubber plug 17 from the slot in turning spindle body 4. Unscrew the studs from the flanges of the turning spindle body. Set the turning spindle body with the ball support on a support and press out the bottom bearing outer race with a mandrel. Press the inner race of the bearing off the bottom king pin of the ball support.

To separate the ball support from the turning spindle body, it is necessary to turn the ball support, directing the lower king pin into the slot, and pull the ball support out of the body together with the inner race of the upper king pin bearing (see Plate 10-42). Press the inner race of the upper bearing on the king pin journal with a 20P-7968 puller and 20K-105-2 ring, or with another similar puller. The outer race of the bearing is removed from the rotating spindle body with a hammer and mandrel.

Disassembly of the rear and middle drive axles. Remove the brake chambers, pull out the half-shafts, remove the wheel hubs and brake mechanism, remove the spindles, and withdraw the reduction gears. Disassembly and removal of the parts and components mentioned above are similar to disassembly of the front drive axle, with the exception of the disassembly of the reduction gear. Removal and disassembly of the differential and driving cylindrical gear shaft is identical in all reduction gears of the three drive axles. Reduction gears differ only in construction of the bevel pinion gear shafts. In order to remove the bevel pinion gear shaft of the rear axle reduction gear, it is necessary to lock the splined flange or ring gear, and, unpinning the nut, unscrew it and remove the washer and flange. If necessary, use a puller.

Unscrew the bolts fastening the rear bearing cover of the bevel pinion gear. Remove the cover with its sealing gasket. Using the puller bolts screwed into the bearing flange, press the cup in assembly with the shaft and gear out of the reduction gear body. Further disassembly is similar to disassembly of the bevel pinion gear shaft of the front axle. Removal and disassembly of the bevel pinion gear of the middle axle reduction gear is the same as that for the rear axle.

If there are cracks on axle parts, the parts should be replaced. Damaged threads on the spindle and other parts of the axles are not allowed to cover more than two turns.

If the half-shaft journals, ball supports, and journals of the spindles for the seals are worn above the allowable dimensions, the worn-out parts are replaced. If the journals of the spindles, shafts, and reduction gears for the bearings are worn more than the allowable dimensions, the worn-out journals may be renewed. If there are breaks, twisting, or bends in the half-shafts, the shafts should be replaced. Allowable oscillation of the half-shaft at the half-shaft seal and air supply head seal is no greater than 0.1 mm. Oscillation of the flange of a new half-shaft is allowed to be no greater than 0.8 mm, and allowable oscillation of the flange without repair is no greater than 0.15 mm. The driving and driven conic gears of the reduction gear are paired according to contact spot, noise, and lateral clearance. If either one of the paired gears is repaired, the gears should not be used except with each other. During replacement, it is necessary that both gears be replaced together.

Assembly of the front axle. Before assembling the front drive axle, the parts must be washed in degreaseng solution, blown off with compressed air, and checked in accordance with their technical requirements.

During assembly of axles, it is necessary to ensure the tightness of components needed for the motor vehicle to ford streams. All connecting flanges and sealing gaskets must be coated with sealing paste (VTU MKhT 3336-62) during assembly.

Before their installation, steel adjusing gaskets must be washed and coated with spindle oil (GOST 1642-50).

Thin adjusting gaskets must be installed on both sides of the gasket set.

The control drain hole in the ball support is coated with type UN-25 paste before its installation in place.

Before installation of the half-shafts into place, the half-shaft journals for the seal and for the air supply head must be coated with 1-13c (VTU NPS-58) or YaNZ-2 (GOST 9432-60) lubricant.

The inner hollow of the half-shaft seal ring must be serviced with the same lubricant.

Before installation of the turning spindles, the working surfaces of the collar and surfaces of the centering holes in the air supply head must be coated with a thin coat of the same lubricant. The inner hollow of the air supply head must be serviced with lubricants, but the hole for the fitting must be free of lubricant.

The journals on the stub axle of the ball joint for the air supply head and for the bronze bushing must also be lubricated.

The space between the air supply head and the protective bushing, the space between the inner half-shaft seal and the support collar on the rear and middle axle housings, and also the space between the spindles and the [illegible]e must be filled with the same lubricant.

When [illegible] spindles are installed in place, it is necessary to ensure the proper p[illegible] of the holes for the air supply formed in the spindle journals.

A[illegible] of the front axle reduction gear should be accomplished on a stand or on [illegible]h. Press the outer races of the front and rear bearings 5 into hous[illegible] (see Plate 10-15) with a mandrel until they rest against the housing fi[illegible] [illegible]erference is 0.025-0.075 mm).

[illegible]nt the inner race of front bearing 5 on the shaft of driving gear 4 a[illegible] [illegible]ess it with a mandrel or press until it rests against the face of the gear [illegible]terference is 0.019-0.048 mm).

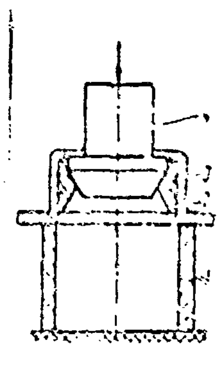


Plate 10-59. Pressing the outer race of the double tapered bearing out of its recess:
1) support 2) recess 3) outer bearing race 4) mandrel

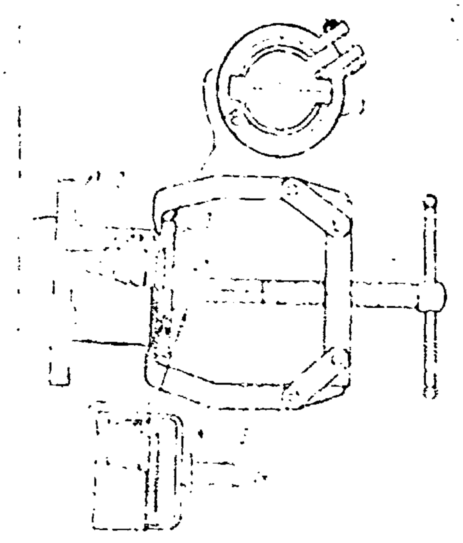


Plate 10-60. Method of pressing out half-shaft seal:
1) turning spindle body 2) half-shaft seal 3) puller auxiliary ring 4) puller support bracket 5) screw

Mount the bevel pinion gear 4 in assembly with the inner race and rollers of the front bearing on shaft 3 with a mandrel and press, and press them on until they rest against the shaft fillet. A clearance of 0-0.44 mm is allowed in the fit.

Press bearing 2 onto the journal on the front end of the pinion gear shaft until it rests against the face of the shaft (interference is 0.015-0.040 mm). Install stop ring 1 on the shaft with a screwdriver and hammer. Set the shaft in a device (Plate 10-61) in the vertical position with the splined end up. Mount the adjusting washers 7 and carrier 6 in assembly with the outer races of the bearings on the pinion gear. Install the inner race with the rollers of the rear bearing with a hammer and mandrel until the race rests against the adjusting washers (fit from interference of 0.003 mm to clearance of 0.052 mm).

Mount the oil deflecting washer 13 on the shaft with glue on face P. Mount the sealing gasket and cover 8 with its seal in assembly on the housing. Install flange 9 with the deflectors on the splines of the shaft, and press them until they are seated (fit with a clearance from 0-0.67 mm). Install the support washer 10 and fasten the flange with nut 11. The torque moment on the nut must be 20-25 kg meters. Remove the unit from the device.

Install the bevel pinion gear shaft in a vise, lightly press in the bearing carrier, and check the preliminary interference of the bearings.

The tapered roller bearings of the bevel pinion gear shaft are adjusted with a small amount of preliminary interference, and axial clearance is not allowed. The moment of torque necessary to rotate the shaft in the bearings must be within the limits of 0.08-0.16 kg meters, which corresponds to a force of 2.2-4.5 kg applied at the flange hub for the first, middle, and rear drive axles. The method of checking is shown in Plate 10-22, c.

Measure the torque moment required for continuous smooth rotation in one direction after no fewer than five full rotations of the shaft. The bearings must be lubricated with transmission oil during this operation.

While the rotation moment of the bevel pinion gear of the front (middle) axle is being checked, bearing cover 20 (see Plate 10-14) must be moved away so that the centering projection of the reduction gear housing 6 goes into the recess in the cover and the seal does not form resistance to rotation of the gear shaft.

Adjustment of the preliminary tightness of the bearings on the pinion gear shaft should be adjusted with a selection of adjusting washers having the required thickness. Two of these are installed between the faces of the bearing inner races.

The factory puts out adjusting washers having thicknesses of: 7.25, 7.40, 7.50, 7.60, 7.70, 7.80, and 7.85 mm.

After final adjustment of the bearings has been completed, the nut fastening the pinion gear flange must be tightened and pinned. Torque moment for tightening the nut must be 20-25 kg meters. While tightening the nut, turn the pinion gear shaft so that the bearing rollers occupy the proper positions between the beveled surfaces of the rings.

After assembly and adjustment of the shaft, it is recommended that the pinion gear in assembly with its housing and bearings also be set in a device and turned for a period of one minute with a shaft speed of 200 rpm. After this turning, the moment for shaft rotation in the bearings is again checked with a dynamometer. It must be within the limits of 0.08-0.16 kg meters.

Assembly of the cylindrical driving gear and ring gear. Install bearing 2 on the journal of the ring gear 1 (see Plate 10-16), and press the bearing until it rests against the face of the gear with a mandrel and press (interference is 0.003-0.038 mm). Install spacing ring 4 on the journal of the ring gear with a hammer until it rests against the face of the bearing (from a clearance of 0.197 mm to interference of 0.023 mm). Press key 3 into the keyway in the driving cylindrical gear journal. To ease fitting, it is recommended that the ring gear in assembly with its bearings be previously heated in oil to 120°C and pressed onto the shaft journal while hot with a mandrel and press until they rest against the face of cylindrical gear 5 with an interference of 0.033-0.087 mm. After assembly, the outer race of the bearing must rotate freely.

Assembly of the differential. Before assembling the parts of the differential, it is necessary to rub them off with a soft cloth and lubricate the assembly surfaces with transmission oil. The recommended order of differential assembly is as follows.

Set the differential box cup on a plate or bench. Install the bearing inner race with the rollers on the cup journal, and press it with a mandrel until it rests against the face of the cup (see Plate 10-35) with an interference of 0.010-0.045 mm. Assembly of the other differential cup is performed in a similar manner.

Install one of the differential box cups on the support on a bench. Install the ring gear 1 (see Plate 10-17) on the differential box cup. Insert support washer 6 and half-shaft gear 7 in the cup (clearance from 0.065-0.165 mm). Mount the four differential pinions 5 with their supporting spherical washers 4 on the journals of cross 3. The differential pinions must be installed on the journals of the cross with a clearance of from 0.050-0.105 mm. Lay the cross in assembly with the differential pinions on the differential box cup. The cross journals have a fit in the cup with a clearance of up to 0.05 mm, or an interference of up to 0.01 mm.

Lay the other half-shaft gear with its support washer on the differential pinions. Install the second differential box cup, aligning the marks made with a punch during disassembly. Insert the bolts into the holes in the differential box cup, aligning them with the holes in the ring gear. Screw the nuts onto the bolts and tighten them with an angular socket wrench. Torque moment on the nuts must be 12-14 kg meters.

Check the correctness of the differential assembly. Insert a leaf gauge between the supporting face of the half-shaft gear and a support washer opposite each of the four openings in the differential box cup. The clearance must be within the limits of 0.05-1.2 mm for each side. Deviation of the clearance for one gear must not be greater than 0.2 mm. The differential pinions and half-shaft gears must turn easily. Tight rotation of the gears or their binding is not allowed. After checking, the nuts fastening the differential box cups must be pinned.

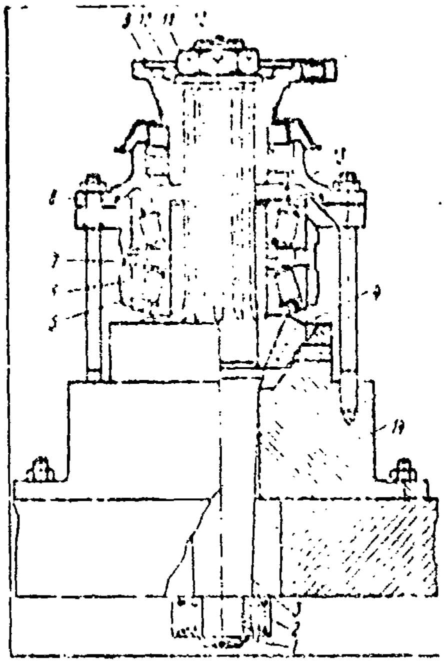


Plate 10-61. The bevel pinion gear in assembly with the bearings, installed in a device for assembly and disassembly:
1) stop ring 2 and 5) bearings 3) shaft 4) gear 6) bearing carrier 7) adjusting washer 8) pinion gear bearing carrier cover 9) flange 10) washer 11) nut 12) cotter key 13) oil-deflecting support washer 14) device

Assembly of the reduction gear. Install the driven bevel gear and driving cylindrical gear (see Plate 10-16) in the recess in housing 6 (see Plate 10-14) of the reduction gear. The fit of the outside roller bearing race is accomplished with a clearance from 0-0.058 mm. Install the outer race of the bevel tapered bearing 8 in recess 10 of the driving cylindrical gear with a clearance from 0-0.05 mm. Assemble the inner races of the bevel tapered roller bearing, installing an adjusting ring between them. Before assembly, the bearings must be lubricated with transmission oil. Lay the adjusting gaskets on the flange of the recess.

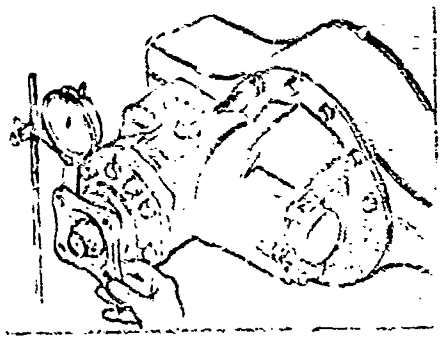


Plate 10-62. Measuring lateral clearance between bevel gear teeth

Install the assembled recess with its double bearings in housing 6, guiding the hole of the inner bearing race onto the journal of the driving cylindrical gear shaft. Press the inner bearing race onto the shaft journal with a mandrel and hammer until it is seated. The fit of the bearing recess in the reduction gear housing is accomplished with a clearance from 0-0.08 mm. The fit of the double bearing on the shaft journal is accomplished from clearance of 0.027 mm to interference of 0.002 mm.

Mount the support washer on the end of the shaft and, screwing on the nut, tighten it (moment is 20-25 kg meters).

The double roller bearing 8 of the driving cylindrical gear shaft is put out by the manufacturing plant with selected adjusting rings 13, and therefore requires no additional adjustment. The parts of this bearing are not interchangeable, and therefore changing parts from one bearing to another is not allowed. The inner race of the bearing, which has the letter V stamped on its face, must be installed on the side of the stamped face of the outer race.

Install cover 7 with its gasket and fasten it with bolts. The bearing recess is simultaneously fastened.

After mounting the adjusting gaskets 15 on the flange of housing 21 (see Plate 10-14), install the assembled bevel pinion gear shaft (see Plate 10-15) in the reduction gear housing. Fasten housing 21 in assembly with the cover with bolts. The front bearing 28 of the bevel pinion gear shaft is installed in its recess with a fit from clearance of 0.037 mm to interference of 0.006 mm. The bevel pinion gear shaft bearing housing is installed in the reduction gear housing recess with a clearance from 0-0.067 mm.

The bevel pinion gear 24 and driven gear 25 of the reduction gears are matched as a unit at the factory according to spot of contact and lateral clearance in the engagement. They are lapped together, and stamped with a unit serial number. During the process of the motor vehicle's operations, the gears are worn in, and therefore, if it is necessary to replace one of the gears, simultaneous replacement of both of them is recommended. Newly installed bevel gears must have the same unit serial number.

When the new bevel gears of the reduction gear are installed, they must be adjusted according to point of contact and according to lateral clearance in their engagement.

The point of contact on the pinion gear may reach the top edge of the tooth. The methods for correcting the point of contact and achieving the proper gear engagement are presented in Table 10-3.

The point of contact is marked by applying a thin layer of paint on several teeth of the driven gear and rotating the pinion gear shaft in both directions, simultaneously braking the driven gear by hand.

The lateral clearance between the teeth of the pinion and driven bevel gears must be within the limits of 0.15-0.40 mm at the wide part of the tooth, which corresponds to a rotation of the bevel pinion gear shaft flange by an amount of 0.16-0.48 mm, measured at the radius of the bolt hole on the flange with the driven gear remaining stationary (Plate 10-62). For the middle axle reduction gear, the measurement is taken on the smaller flange. It is necessary to check the lateral clearance on no fewer than four teeth of the driven gear, located at equal distances from the circumference.

When new gears are installed in the reduction gear, it is necessary to install adjusting gaskets 15 (see Plate 10-14) having 2 mm total thickness beneath the flange of the pinion gear shaft bearing carrier. After this, adjust the lateral clearance, moving the driven bevel gear by changing the number of gaskets 12 beneath the flange of bearing recess 10 of the driven gear shaft, and then check the point of contact. If a proper point of contact is not achieved as a result, it is necessary to move the bevel gears as shown in Table 10-3, changing the number of gaskets beneath the flanges of the pinion gear shaft bearing carrier and driven gear bearing recess.

After finally adjusting the point of contact, no fewer than two gaskets 0.1 mm thick must be installed in each gasket set. Thin gaskets must be located on both sides of the gasket set to attain a tight hermetic connection.

The bolts fastening the carrier, recess, and covers of the bearings must be tightened after final adjustment (tightening moment is 6-8 kg meters). If the gears have an increased lateral clearance in their engagement as the result of tooth wear, they should not be adjusted, since this would spoil their proper engagement. The bevel gears must work until they are fully worn without additional adjustment.

When installation of the reduction gear components and adjustment of the gear engagement have been completed, it is necessary to install the differential.

If the studs fastening the differential bearing covers have been replaced, they must be screwed into the reduction gear housing, tightened (moment is 22-25 kg meters), and then pinned.

Mount the outer races on the rollers of differential box cup 5 (see Plate 10-14) and install the differential in the reduction gear housing, guiding the outer races of both bearings 5 into the recess in the housing. Install differential bearing cover 33 and adjusting nut 4, aligning their threads. If the cover does not sit in place, this means that the adjusting nuts are cross-threaded and they must be corrected on the threads. Installation of the covers with excessive force may lead to damage of the housing, covers, and adjusting nuts. After installation of the bearing covers, it is necessary to screw nuts 34 fastening the covers until they are seated and, after this, loosen them enough so that adjusting nuts 4 can be turned. Adjusting nuts 4 must be installed so that the ring gear occupies a position which is symmetrical in relation to its driving gear.

The differential bevel roller bearings must be adjusted with a small amount of preliminary tightness. For this, the adjusting nuts must first be set so that the differential has a lateral movement not exceeding 0.01 mm. The amount of lateral movement must be checked with an indicator installed opposite the ring gear rim and fastened on the bearing cover.

After this, tighten each adjusting nut by one slot, lock them in this position with stop 3, and tighten the stop. Tighten the nuts 34 fastening the bearing covers (moment is 17-19 kg meters) and pin them.

While adjusting the bearings, it is necessary to turn the differential several times so that the bearing rollers occupy their correct position between the beveled surfaces of the rings. Before assembly, the bearings must be lubricated with transmission oil.

Check the operation of the reduction gear, turning the pinion gear shaft flange by hand. During this operation, the gears must turn freely without binding or catching on the reduction gear housing.

Before assembling the ball support, it is necessary to check the usability of the support washers 14 (see Plate 10-19). If the washers are worn, they must be replaced. The washers fit into the ball support turnings with an interference of 0.105-0.225 mm. If necessary, replace the half-shaft seal (see Plate 10-60). The new seal is pressed into its ring with a mandrel and hammer (interference is 0.05-0.45 mm). The ring in assembly with the seal is pressed into the ball support recess (interference is 0.015-0.135 mm). The order of assembly is as follows. Set the ball support assembled with the king pins in the turning spindle body. Set the ball support in assembly with the body in a device (see Plate 10-49). Set the bottom king pin on support 2. Mount the inner race of bearing 5 on the top king pin and press it onto the king pin with mandrel 6 until it rests against the face with an interference of 0.003-0.032 mm. Install the outer race in the top hole of the rotating spindle body, and fit it in the body with a hammer and mandrel, with a clearance of from 0-0.05 mm. Turn the ball support together with the turning spindle body in the device, and press the inner race of the other bearing on the king pin and the outer race into the body hole by the indicated method. Screw the cover fastening studs into the turning spindle body. Lay the adjusting gaskets on the face surface of the body. Install the bottom and top covers on the studs, and mount the conic split bushings and spring washers on the studs. Screw on the nuts and tighten them until they are seated. The tightening moment of the nuts must be 16-18 kg meters. Check rotation of the king pins in the ball support bearings, and if necessary adjust them.

The turning spindle king pin bearings of the front drive axle are adjusted with a preliminary tightness. The torque moment necessary for smooth turning of the turning spindle body must be 0.5-0.6 kg meters, which corresponds to a force of 2.0-2.4 kg applied at a hole in the turning arm for the steering tie rod (Plate 10-63). During this operation, the bearings must be lubricated (see the lubrication chart).

Axial movement of the bearings is not allowed. The absence of axial movement may be checked with an indicator installed on the face of the lower king pin with a plug screwed into the cover. Using a jack or lever, move the rotating spindle upward, during which the movement of the indicator hand will show the presence of axial movement in the bearings. In order to eliminate axial movement, it is necessary to remove the required number of adjusting gaskets from beneath the lower cover, since the lower bearing is usually worn more severely. If it becomes clear during disassembly that wear of the bearings is identical, it is necessary to remove an identical number of gaskets from beneath the upper and lower covers. If the lower king pin bearing is severely worn, it is recommended that the bearings be switched from place to place. In this case, the adjusting gaskets must be removed from beneath the upper cover.

During installation of new bearings, it is necessary to measure their assembly height (from the support face of the outer race to the support face of the inner race). The overall thickness of the gasket set installed on the side of the large bearing must be larger by the amount of the difference in the bearings' assembly heights. If this rule is not observed, installation of adjusting gaskets may lead to a loss in alignment between the rotating spindle body and the ball support.

After final adjustment of new bearings, no less than ten gaskets 0.1 mm in thickness must be included in each of the gasket sets. Two gaskets 0.05 mm thick and one gasket 0.1 mm thick must be installed in the gasket set on the side of the turning spindle body, and the remaining thin gaskets are installed on the side of the cover or steering linkage turning arm to attain a tight, hermetic connection.

During the process of adjustment, it is necessary to turn the turning spindle body several times so that the bearing rollers occupy their correct position between the races of the bearings.

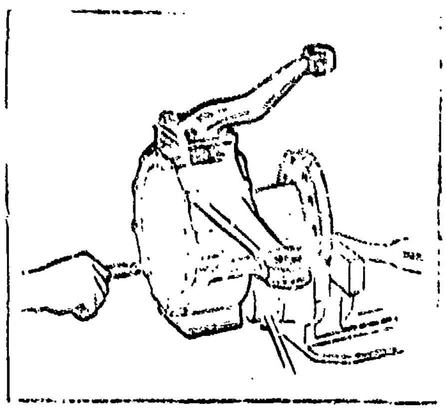


Plate 10-63. Checking the preliminary tightness of turning spindle king pin bearings

After adjustment of the ball support bearings is completed, install the rubber plug in the slot in the turning spindle body, mount the seal on the ball support, and fasten its ring with bolts, previously placing spring washers beneath the bolt heads. Screw the adjusting bolt into the hole in the turning spindle body and adjust with it the angle of turn, which must be within the limits of 29-30°. In this, the bolt head must rest against the ball support. When adjustment is completed, braze the support bolt to the turning spindle body.

Assembly of the front axle half-shaft joint. Before assembling the parts of the joint, it is necessary to rub them off with a clean, soft cloth, and lubricate them (see the lubrication chart). Assembly of the joint takes place in the following order. Fasten the inner half-shaft 3 (see Plate 10-51) in a device or in a metal working vise. Connect the stub axle with the inner half-shaft (see Plate 10-51, b). Select the drive balls 6, using the installation ball with the flat. For this, place it in the center sphere of the assembled parts. Sequentially install the balls (one at a time) in the four recesses with the stub axle being lightly rocked back and forth. The final, locking ball is installed in its recess only after its formed surface coincides with the flat on the installation ball. After assembly, check the operation of the joint with a dynamometer, turning the stub axle by an angle of 10-15° in three directions: in plane I-I (see Plate 10-51) of the spindle; in plane I-II of the half-shaft, and in plane III-III of the two opposite balls. The moment necessary to turn the stub axle by an angle of 10-15° must be within the limits of 3-9 kg meters, which will correspond to a force of 10-30 kg.

The difference between the largest moments of turning in the three planes must be no greater than 1.5 kg meters, which will correspond to a force of 5 kg. After turning the stub axle at an angle greater than 10-15°, the turning moment is allowed to decrease to zero. When the axle is turned by hand, there must be no noticeable binding of the balls.

The assembled half-shaft should be checked on a stand at 30 rpm with a load of 100 kg meters, and the stub axle of the joint should be turned at an angle no less than 31° to one side and the other, relative to the inner half-shaft. During this operation, there must be no knocks or gritting, binding of the drive balls on the central ball, or grinding of the joint parts on the half-shaft.

In a case where the cited defects appear, the joint is disassembled and the driving balls are changed, using a larger dimension if the moment required for turning the stub axle is smaller than that indicated, or a smaller dimension if the moment for turning is larger than that indicated. The driving balls range in diameter from 42.757-42.947 mm, and are divided into nine groups, differing according to dimensions by 0.02 mm. The dimensions of the balls according to groups are represented in Table 10-8.

After selection of the balls is completed, it is necessary to disassemble the joint. Pull out the selected driving balls and the installation ball with the flat. Insert a central ball in its place, and assemble the joint with the newly selected driving balls. The diameter of the center ball is equal to 41.25-41.30 mm. During installation of the fourth driving ball, the stub axle is pulled out and turned at an angle allowing the fourth ball to slip into place. When assembly is finished, it is necessary to turn the stub axle until it is aligned with the inner half-shaft and remove it from the vise. If the joint is assembled with driving balls from various groups according to diameter, these driving balls must again be installed in their former recesses when the central ball is exchanged. If necessary, repeat the operational check of the assembled half-shaft ball joint.

Assembly of the front axle turning spindle. The spindle assembly is shown in Plate 10-20. If worn-out bushing 2 was pressed off the spindle, a new bushing replacing it is pressed on with an interference of 0.09-0.21 mm. The new bushing should first be smoothed out to a dimension of 52.95-53.01 mm, and then machined with a reamer to a dimension of 53.4-53.6 mm. Install air supply head 3 in the spindle recess in assembly. Insert fitting 4 in assembly with its seal in the hole in the spindle, and screw it into the body of the air supply head. If support washer 6 is worn out above the allowable dimension, a new support washer is pressed into support ring 5 with an interference of 0.03-0.21 mm and rolled into the slots in the support ring. Install the ring in assembly with its support washer on the face of the spindle and fasten it with bolts. Place stop washers beneath the bolt heads before this is done. After the bolts are tightened down firmly, they are blocked with the washers (bent up against the bolt flats and ring). After replacement, machine the face of support washer 6 to a dimension of 2.15-2.25 mm.

If the inner race of the wheel hub inside bearing has been removed from the spindle, it should be again pressed onto the spindle journal until it rests against the fillet.

Assembly of the ball support with the front axle housing. Screw the studs halfway into the holes in the front axle housing 25 (if they were unscrewed) (see Plate 10-11). Connect the ball support body with the axle housing in such a way that the turning arm connected with the steering tie rod is directed toward the side of the flange on the final drive pinion gear shaft. Align the holes in the ball support flange with the studs on the axle housing flange. Press the journal of the ball support into the hole in the axle housing flange until it seats with the axle housing flange, with a fit from clearance of 0.05 mm to interference of 0.02 mm.

Install spring washers on the studs, screw nuts onto them, and tighten them until they are seated (torque moment is 16-18 kg meters). Apply fresh grease inside the ball support (see lubrication chart).

Assembly of the front axle is conducted on a stand. Assemble the front axle in the following order. Set the axle housing on the stand. Lay the sealing gasket on the face of the large housing flange, and install the reduction gear assembly (see Plate 10-14) in the recess in the axle housing. Fasten the reduction gear housing to the axle housing with the exterior bolts and the two bolts on the inside, first installing spring washers beneath the bolt heads. The torque moment on the bolts is 9-11 kg meters. Install side cover 24 (see Plate 10-11) of the reduction gear housing with its sealing gasket, and fasten it with bolts. Screw the studs into the turning spindle body if they were unscrewed during disassembly. Install the inner half-shaft 19 in assembly with the stub axle in the ball support and axle housing in such a way that you do not damage the seal, and so that the splined end of the inner half-shaft goes into the splined hole in the half-shaft gear. The fit in the splined connection has a clearance of 0.035-0.235 mm. Install spindle 2 in assembly with the stub axle, guiding the holes onto the studs of the turning spindle body in such a way that hole 2 (Plate 10-64, b) for air supply to the front axle spindle journal is in the proper position.

Install the spindle by its centering collar in the hole in the ball joint body with a mandrel and hammer, attaining fit from clearance of 0.96 mm to interference of 0.024 mm. Install the brake backing plate 30 in assembly (see Plate 10-11) on the studs, and mount the ring with the outside seal 12 in assembly on the studs after servicing the seal in oil. Mount spring washers on the studs, screw nuts on them, and tighten them with a socket wrench (moment is 5.5-6.0 kg meters). Screw fitting 13 with its hose into the air supply head. Install the spreader cams, adjusting covers, brake shoes, and chambers. Install wheel hub 1 and bearing 9, screw on nut 3 fastening the bearing, install lock washer 8, and tighten stop nut 6. Adjust the wheel hub bearings. For installation of the wheel hubs and adjustment of the bearings, see Chapter 15. For installation and adjustment of the brakes, see Chapter 16.

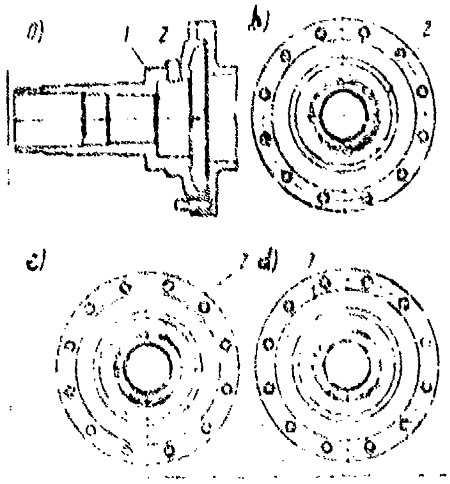


Plate 10-64. Diagram of location of the holes in the spindle for air supply to the drive axle tires of the ZIL-131 motor vehicle a) longitudinal section of spindle b) for front axle c) for middle axle d) for rear axle
1) spindle 2) hole in spindle for air supply

Mount the gasket on the hub studs and then mount splined half-shaft flange 7, previously fitting it onto the splines of the stub axle. The fit at the splined connection is with a clearance of 0.035-0.205 mm. The splines must be lubricated with the grease used in packing the wheel hubs. Install spring washers on the studs, screw nuts onto them, and then tighten them (moment is 7 9 kg meters). Insert valve 5 and fasten it to the half-shaft flange.

Assembly of the rear and middle drive axles is similar to assembly of the front drive axle.

Adjustment of the bearings and gears of the middle and rear axle reduction gears is similar to adjustment of the reduction gear bearings in the front drive axle. During assembly of the bevel pinion gear shaft of the axle reduction gear, the support washer for the inner race of the roller bearing should be installed with the stamp C on its face. This shows that the washer is equipped with an oil-slinging passage with a right-hand spiral. It is necessary to remember that when the motor vehicle is moving forward, the convex side of the tooth for the middle and rear axles and the concave side of the tooth for the front axle is the tooth's working side in the driven bevel gear. The spindles of the middle and rear axles should be installed according to Plate 10-64, c and d.

Testing drive axles. The assembled rear, middle, and front axles must be checked on a stand or with a run of the motor vehicle. The tested axle must satisfy the same requirements as the axle on a ZIL-157K motor vehicle.

The absence of binding in the joints of the front axle must be checked with the turning spindle set in the straight position, and also when they are at the extreme turning angles to the right and left.

Before installing the drive axles in the motor vehicle, it is necessary to assemble the wheels and fasten them onto the axles. Install the springs on the front axles, and on the middle and rear axles, first connect the balancing suspension, and then install the springs.

For installation of the axles, first raise the front part of the motor vehicle frame with a hoist mechanism and roll the front axle beneath the frame. Connect the front and rear ends of the springs to the frame brackets. Install the shock absorbers and lower the front part of the frame. Raise the rear part of the frame, roll the rear drive axle carriage together with the balancing suspension beneath the frame, and lower the frame onto the brackets of the balancing suspension. Insert the bolts fastening the balancing suspension brackets to the longitudinal rails and frame cross members, screw on and tighten the nuts until they are firm, and release the motor vehicle frame.

Connect the flexible hoses to the brake chambers, the hoses for air supply to the tires, the longitudinal steering rod and the propeller shafts of the front, middle, and rear axles.

Dimensions of parts

Dimensions of parts are presented in Tables 10-4, 10-5, 10-6, 10-7, and 10-8.

Table 10-4. Basic dimensions of rear axle parts of the ZIL-130 motor vehicle, mm

Dimension	Nominal	Allowable without repair
	Rear axle housing (cast)	
KCh 35-10 iron (GOST 1215-59).		
Diameter of hole for first half-shaft tube journal	74.92-74.96	74.98
Diameter of hole for second half-shaft tube journal	73.00-73.12	73.14
Diameter of hole for third half-shaft tube journal	72.00-72.12	72.14
Diameter of hole for fourth half-shaft tube journal	71.00-71.12	71.14
Diameter of housing journal for rear axle hub seal	93.20-93.50	93.10
	Rear axle housing (welded)	
Type 20 steel (GOST 1050-60).		
Diameter of journal for wheel hub inner roller bearing race	84.925-84.960	84.90
Diameter of journal for wheel hub outer bearing race	74.94-74.97	74.92
Diameter of journal for wheel hub inner bearing seal ring	93.060-93.085	93.04
Diameter of threads for wheel hub outer bearing fastening nut	M72 X 2, class 2	--
	Half-shaft tube	
Type 45 steel (TU 78-85); hardness--HB 235-321 used only with the cast rear axle housing.		
Internal tube diameter	56.5-58.5	--
Diameter of half-shaft tube journals for roller bearing race	74.94-74.97	74.92
Diameter of tube journals for rear axle housing:		

[Table 10-4, continued]

First	74.94-74.97	74.92
Second	73.165-73.225	73.145
Third	72.165-72.225	72.145
Fourth	71.165-71.225	71.145
Diameter of threads for wheel hub outer bearing fastening nut	M72 X 1.5, class 2	--
	Reduction gear housing and its cover	
KCh 35-10 iron (GOST 1215-59).		
Diameter of hole for pinion gear shaft roller bearing	140.018-140.060	140.10
Diameter of hole for housing cover	135.00-135.04	135.06
Diameter of hole for differential roller bearing	130.00-130.04	130.08
Diameter of threads for reduction gear housing cover fastening bolts	M12 X 1.75, class 2	--
Diameter of threads for fastening bevel pinion gear shaft bearing housing	M12 X 1.75, class 2	--
Diameter of hole in left cover for bearing	109.941-109.976	109.985
Diameter of hole in right cover for bearing	119.941-119.976	119.985
Diameter of journal in left and right covers	134.845-134.900	134.81
	Bevel pinion gear shaft carrier	
KCh 35-10 iron (GOST 1215-59).		
Diameter of hole for large roller bearing	139.932-139.972	139.99
Diameter of hole for small roller bearing	109.941-109.976	109.99

[Table 10-4, continued]

Bevel pinion gear

Number of teeth--13; 30KhGT steel (GOST 4543-61); hardened layer depth--1-1.4 mm; hardness of surface layer--HRC 56-62.

Diameter of larger journal for roller bearing	65.003-65.023	64.9
Diameter of smaller journal for roller bearing	49.985-50.004	49.97
Length of gear teeth	42.66-43.00	--
Thickness of splined teeth	6.94-6.99	6.85

Front bearing cover

KCh 35-10 iron (GOST 1215-59).

Diameter of cover recess for seal	93.00-93.07	93.2
Diameter of cover journal for hole in pinion gear shaft bearing carrier	109.86-109.95	109.70

Bevel pinion gear shaft flange

Type 45 steel (GOST 1050-60); depth of case hardened layer--1.0-2.5 mm; hardness--HRC 56-62.

Diameter of flange journal for seal	61.94-62.00	61.80
Diameter of holes for bolts	14.24-14.36	15.00
Width of grooves in flange splined portion	7.00-7.05	7.2

Differential box cup

Type 6 steel (GOST 380-60).

Diameter of hole for half-shaft gear journal	75.00-75.06	75.20
Diameter of journal for roller bearing	75.01-75.03	75.00
Diameter of hole for differential cross pins	28.02-28.05	28.10

[Table 10-6, continued]

Diameter of hole for compression bolts	14.24-14.36	14.8
Diameter of turning end cup for ring gear:		
Inner	198.004-198.335	197.97
Outer	249.7-250.0	--

Ring gear

35 PP steel; depth of case hardened layer--1-2.5 mm; hardness of surface layer--HRC 58-63; number of teeth--47.

Diameter of fitting hole for differential cups	198.000-198.027	198.03
Teeth length	70	--
Tooth thickness (Measured at height of 3.42 mm)	8.2	7.7

Differential cross

18KhGT steel (GOST 4543-61); depth of hardened layer--0.8-1.2 mm; hardness of surface layer--HRC 56-62

Diameter of cross journal	28.00-28.03	27.97

Differential pinion

25KhGT steel (ChMTU TsNIIChM 561-61); depth of hardened layer--0.9-1.3 mm; hardness--HRC 58-65; number of teeth--11.

Diameter of hole for cross journal	28.060-28.105	28.15
External diameter of bushing	29.67-29.70	--
Internal diameter of bushing	28.060-28.105	28.15

Half-shaft gear

18KhGT steel (GOST 4543-61); depth of hardened layer--1-1.4 mm; hardness--HRC 56-62; number of teeth--22.

Diameter of gear journal	74.895-74.935	74.75

[Table 10-4, continued]

Driven bevel gear

Number of teeth--25; 30KhGT steel (GOST 4543-61); depth of hardened layer--1-1.4 mm; hardness of surface layer--HRC 56-62.

Tooth length	39.83-40.00	--
Diameter of hole for rivet	10.2	10.5
Diameter of hole for driving cylindrical gear	110.000-110.054	110.08

Driving cylindrical gear

Number of teeth--14; 20KhNM steel (GOST 4543-61); depth of hardened layer--0.9-1.3 mm; tooth surface hardness--HRC 54-62.

Diameter of larger journal for roller bearing	54.982-55.005	54.97
Diameter of smaller journal for roller bearing	49.985-50.004	49.97
Diameter of support surface for driven bevel gear	110.070-110.095	110.07
Tooth length	75	--
Tooth thickness	10.3	--
Diameter of hole for rivets	10.2	10.5

Half-shafts

45 RP steel (GOST 1063-63); depth of case hardened layer--6.0 mm; hardness--HRC 52-60; number of holes for hub studs--12 (6.5 mm in diameter).

Length of left and right half-shaft (along the flanges)	1005-1011	--
Diameter of hole for hub studs	16.5	17.0
Tooth width on half-shaft splined portion	6.17	5.90
Diameter of threads in holes for puller bolts	M12 X 1.75, class 2	--

Table 10-5. Basic dimensions of the drive axle parts of the ZIL-157 motor vehicle, mm

Dimension	Nominal	Allowable without repair
Housings and covers		
KCh 35-10 wrought iron (GOST 1215-59).		
Diameter of hole for differential box roller bearing	109.941-109.976	110.000
Diameter of hole for pinion shaft rear roller bearing	61.95-61.98	62.00
Diameter of hole for pinion shaft bearing carrier	98.50-98.57	98.60
Axle half-shaft jacket		
Type 45 steel (102P X 16P, tube, GOST 8732-58 and GOST 8731-58); hardness--HB 197-229.		
Diameter of hole for seal in front, middle, and rear drive axles	80.00-80.06	80.20
Diameter of hole in jacket for ball support journal of front axle	70.000-70.046	70.080
Diameter of turning in half-shaft jacket flange in middle and rear drive axles for spindle	160.000-160.063	160.120
Spindle		
40Kh steel (GOST 4543-61); depth of case hardened layer--1-3.5 mm; hardness--HRC 50-62.		
Diameter of journal for wheel hub outer bearing	74.94-74.97	74.92
Diameter of journal for wheel hub inner bearing	79.94-79.97	79.92
Diameter of journal in spindle for air supply head seal	67.94-68.00	67.8[illegible]

[Table 10-5, continued]

Diameter of journal in spindle for inner hub seal	94.86-95.00	94.70
Diameter of journal in spindle for hole in turning spindle body	159.982-160.022	159.950
Diameter of threads for wheel hub outer bearing fastening nuts	M72 X 1.5, class 2	--
	Turning spindle body	
KCh 35-10 iron (GOST 1215-59).		
Diameter of hole for king pin bearing	72.00-72.03	72.05
Diameter of hole for spindle	160.000-160.063	160.120
Diameter of hole for turning spindle body bushing	25.000-25.033	--
	Spindle ball support	
40KhN steel (GOST 4543-61); hardness--HB 229-269.		
Diameter of support journal for half-shaft jacket	69.97-70.00	69.94
Diameter of turning for half-shaft support washer	65.00-65.12	65.3
Diameter of hole for king pin:		
First grip	38.000-38.027	--
Second grip	38.500-38.527	--
	King pin	
40Kh steel (GOST 4543-61); hardness--HRC 35-42.		
Diameter of king pin journal for inner bearing race	30.002-30.017	29.98
Diameter of king pin journal for ball support:		
First group	38.035-38.052	--
Second group	38.535-38.552	--

[Table 10-5, continued]

Bearing carrier

KCh 35-10 iron (GOST 1215-59).

Diameter of hole for front and rear bearings	99.925-99.960	99.980
Diameter of hole for bearing carrier fastening bolts	12.5	12.8

Bevel pinion gear

20Kh2N4A steel (GOST 4543-61); depth of hardened layer--1.2-1.6 mm; hardness--HRC 58-6[illegible]; number of teeth--6.

Diameter of journal for rear bearing	45.018-45.035	45.00
Diameter of journal for front bearing	44.965-44.980	44.95
Diameter of tail journal for bearing	25.015-25.030	25.0
Gear tooth length	45.0	--
Gear tooth thickness (measured at height of 9.85 mm)	13.46	13.2
Tooth thickness of gear splined portion	5.925-5.975	5.85
Diameter of threads	M24 X 1.5, class 2	--

Bearing carrier cover

KCh 35-70 iron (GOST 1215-59).

Diameter of hole in cover for seal	82.00-82.07	82.25

Pinion gear shaft flange

Type 45 steel (GOST 1050-60); depth of case hardened--1.5-1.3 mm; hardness--HRC 54-62.

Diameter of flange journal for seal	54.88-55.00	54.70
Groove width on flange splined portion	6.00-6.05	6.10
Diameter of holes for fastening bolts	14.24-14.36	[illegible]

[Table 10-5, continued]

Differential box cup

KCh 35-10 wrought iron (GOST 1215-59).

Diameter of journal for roller bearing	65.01-65.03	64.99
Diameter of recess for half-shaft gear journal	58.000-58.046	58.10
Diameter of holes for differential cross pins	22.150-22.175	22.20
Diameter of spherical surfaces for differential pinion washers	119.60-119.690	119.80
Diameter of holes for tension bolts	12.12-12.24	12.60

Driven bevel gear

20Kh2N4A steel (GOST 4543-61); depth of hardened layer--1.2-1.6 mm; hardness of surface layer--HRC 58-65; number of teeth--40.

Tooth length	44.2	--
Tooth thickness (measured at height of 2.52 mm)	5.94	5.70
Diameter of hole for gear fastening bolts	11.5	11.7

Differential cross

20Kh2N4A steel (GOST 4543-61); depth of hardened layer--1.0-1.4 mm; hardness--HRC 58-65.

Diameter of cross journal	22.125-22.175	22.0

Differential pinion

Number of teeth--11; 12KhNZ steel (GOST 4543-61); depth of hardened layer--0.9-1.3 mm; hardness--HRC 58-65.

Tooth length	12.0	--
Tooth thickness (measured at height of 5.67 mm)	8.05	7.8
Diameter of holes for cross journals	22.25-22.295	22.40

[Table 10-5, continued]

Half-shaft gear

Number of teeth--20; 12Kh2N4A steel (GOST 4543-61); depth of hardened layer--0.9-1.3 mm; hardness--HRC 58-65.

Diameter of gear journal for hole in differential box	57.895-57.935	57.85
Gear tooth length	19.0	--
Gear tooth thickness (measured at height of 3.85 mm)	7.63	7.40
Width of groove in gear splined portion	4.43	4.5

Rear and middle drive axle half-shafts

40KhGTR steel (ChMTU TsNIIChM 974-63); hardness--HB 388-444.

Diameter of half-shaft journal for seal	44.4-44.5	44.2
Tooth thickness of half-shaft splined portion	4.17-4.25	4.0
Half-shaft length:		
Left rear axle	1051	--
Right rear axle	972	--
Left middle axle	887	--
Right middle axle	1137	--

Front axle half-shaft

20Kh2N4A steel (GOST 4543-61); hardened layer depth--1.2-1.6 mm; hardness--HRC 58-65.

Inner half-shaft length:		
Right	953.5-954.5	--
Left	463.5-464.5	--
Stub axle length (right and left)	373.45-375.0	--
Diameter of stub axle journal for spindle bushing	47.9-48.0	47.8
Diameter of inner half-shaft journal for seal	44.4-44.5	44.2
Tooth width of inner half-shaft splined portion	4.17-4.25	4.0
Tooth width of stub axle splined portion	3.60	3.4

[Table 10-5, continued]

Diameter of center ball	31.50-32.00	--
Diameter of drive balls	34.87-35.010	--

Front axle half-shaft splined flange

40Kh steel (GOST 4543-61); hardness--HB 241-270.

Diameter of flange journal for hubcap	110.43-110.50	110.40
Groove width of flange splined portion	3.64	3.7
Diameter of holes for flange fastening bolts	12.5	12.8

Table 10-6. Diameter of half-shaft ball joint driving balls of the ZIL-157K motor vehicle, mm

a Группа	b Диаметр
I	34,83-34,85
II	34,85-34,87
III	34,87-34,89
IV	34,89-34,91
V	34,91-34,93
VI	[illegible]-34,95
VII	[illegible]-34,97
VIII	[illegible]
IX	[illegible]

Key: a) Group
b) Diameter

Table 10-7. Basic dimensions of drive axle parts of the ZIL-131 motor vehicle, mm

Dimension	Nominal	Allowable without repair
	Drive axle housings	
Type 35 steel (GOST 1050-60).		
Diameter of hole for reduction gear housing	315.00-315.34	315.50
Diameter of hole for front axle ball support journal	8[illegible]0-88.035	88.060
Diameter of turning in middle and rear axle housing flange for spindle journal	183.000-183.045	183.080
	Spindle	
40Kh steel (GOST 4543-61); depth of case hardened layer--1.0-3.5 mm; hardness--HRC 56-62, hardness of non-case hardened surfaces--HB 229-255.		
Diameter of journal for drive axle housing	182.977-183.024	182.945
Diameter of journal for wheel hub outer bearing	74.94-74.97	74.92
Diameter of journal for wheel hub inner bearing	79.94-79.97	79.92
Diameter of spindle journal for wheel bearing inner seal	114.86-115.00	114.60
Inner diameter of front axle spindle bushing	53.4-53.6	54.00
Diameter of threads for wheel hub outer bearing fastening nuts	M72 X 1.5	--
	Spindle ball support	
Type 45 steel (GOST 1050-60); hardness--HB 217-255.		
Diameter of support journal for front axle housing	87.985-88.020	87.95
Diameter of turning for inner half-shaft support washer	74.00-74.06	74.30

[Table 10-7, continued]

Diameter of hole for king pin	42.000-42.027	--

King pin

40Kh steel (GOST 4543-61); hardness--HRC 35-41.

Diameter of king pin journal for inner bearing race	40.00 -40.020	39.985
Diameter of kign pin journal for ball support	42.035-42.052	--

Rotating spindle body

KCh 35-10 iron (GOST 1215-59).

Diameter of hole for spindle journal	183.000-183.073	183.100
Diameter of body hole for king pin bearing outer race	90.000-90.035	90.055

Reduction gear housing

KCh 35-10 iron (GOST 1215-59).

Diameter of hole for recess for driving cylindrical gear shaft bearing	105.000-105.035	105.050
Diameter of hole for driven conic gear-shaft roller bearing	150.000-150.040	150.060
Diameter of hole for differential roller bearing	125.000-125.040	125.060
Diameter of hole for bevel pinion gear shaft bearing carrier	125.000-125.040	125.060
Diameter of reduction gear housing fitting belt	314.785-315.000	314.600
Diameter of hole for middle and rear axle bevel pinion gear-shaft roller bearing	90.000-90.035	90.060

[Table 10-7, continued]

Diameter of hole for front axle bevel pinion gearshaft roller bearing	61.949-61.979	62.000

<u>Driving cylindrical gearshaft bearing recess</u>

KCh 35-10 iron (GOST 1215-59).

Diameter of hole for outer race of driving cylindrical gearshaft double tapered bearing	90.000-90.035	90.060
Outer fitting diameter of recess in reduction gear housing	104.977-105.000	104.960

<u>Bearing carrier for bevel pinion gearshaft</u>

KCh 35-10 iron (GOST 1215-59).

Diameter of hole for outer race of tapered bearings	109.925-109.960	109.980
Exterior fitting diameter of carrier	124.973-125.000	124.950

<u>Front axle bevel pinion gearshaft</u>

40Kh steel (GOST 4543-61); depth of case hardened layer--1.5-4 mm; hardness--HRC 45-62; hardness of non-case hardened surfaces--HRC 28-33.

Diameter of journal for roller bearing	25.015-25.030	25.000
Diameter of journal for bevel pinion gear	45.983-46.000	45.965
Exterior diameter of shaft along splines	44.983-45.000	44.965
Thickness of spline tooth	6.940-6.990	6.850
Diameter of threads for flange fastening nut	M33 X 1.5, class 2	--

<u>Bevel pinion gearshaft of middle and rear axle reduction gears</u>

40KhGTR steel (ChMTU TsNIIChM 974-63);hardness--HRC 42-48.

Diameter of journal for roller bearing	49.992-50.008	49.975

[Table 10-7, continued]

Diameter of journal for bevel pinion gear	45.983-46.000	45.965
Exterior diameter of shaft along the splines for	44.983-45.000	44.965
Thickness of spline tooth	6.940-6.990	6.850
Diameter of threads for flange fastening nut	M33 X 1.5, class 2	--

Bevel pinion gear

Number of teeth--11; 20Kh2N4A steel (GOST 4543-61); depth of hardened layer--1.2-1.6 mm; surface hardness--HRC 60-65; core hardness--HRC 35-45.

Diameter of journal for front tapered roller bearing inner race (at a length of 27 mm)	60.019-60.033	60.000
Diameter of journal for rear tapered roller bearing inner race (at a length of 40 mm)	59.968-59.988	59.950
Diameter of hole for shaft journal	46.000-46.027	46.045
External diameter of spline hole	45.34-45.50	45.70
Width of spline groove	7.00-7.05	7.14
Thickness of gear teeth (measured at height of 10.13 mm)	11.38	11.10

Bevel pinion gear shaft flange

Type 45 steel (GOST 1050-60); depth of case hardened layer--1-2.5 mm; surface hardness--HRC 56-62.

Diameter of journal for seal	61.94-62.00	61.75
External diameter of splined hole	45.00-45.05	45.07
Width of spline groove	7.00-7.05	7.15
Diameter of holes for bolts	14.24-14.36	15.00

[Table 10-7, continued]

Driven bevel gear

Number of teeth--19; 20Kh2N4A steel (GOST 4543-61); depth of hardened layer--1.2-1.6 mm; surface hardness--HRC 60-65; core hardness--HRC 35-45.

Diameter of journal for bearing	70.003-70.023	69.985
Diameter of hole for shaft journal	48.000-48.027	--
Tooth length	33	--
Gear tooth thickness (measured at height of 5.24 mm)	8.52	8.25

Driving cylindrical gear

Number of teeth--12; 20KhNM steel (TU KO 8-64); depth of hardened layer--1-1.4 mm; surface hardness--HRC 60-64; core hardness--HRC 30-42.

Diameter of journal for driven bevel gear	48.060-48.087	--
Diameter of journal for inner race of tapered roller bearings	39.973-39.990	39.955
Tooth length	70	--
Tooth thickness (measured at height of 5.97 mm)	9.39-9.34	9.14
Diameter of threads for nut	M36 X 1.5, class 2	--

Ring gear

Number of teeth--51; 30KhGT steel (GOST 4543-61); depth of hardened layer--1-1.4 mm; surface hardness--HRC 60-65; core hardness--HRC 35-45.

Diameter of fitting hole for differential box cups	190.000-190.027	--
Tooth length	65	--
Tooth thickness (measured at height of 3.24 mm)	7.625-7.675	7.42

Differential cup

KCh 35-10 iron (GOST 1215-59).

[Table 10-7, continued]

Diameter of journal for roller bearing	70.01-70.03	69.99
Diameter of hole for half-shaft gear journal	75.00-75.06	75.12
Diameter of holes for differential cross journals	28.02-28.05	28.08
Diameter of differential pinion washer spherical surfaces	160.7-160.9	161.4
Diameter of holes for tension bolts	14.24-14.36	14.5

Differential cross

25 KhGT steel (ChMTU TsNIIChM 761-62); depth of hardened layer--1-1.4 mm; surface hardness--HRC 56-62.

Diameter of cross journals	28.00-28	27.98

Differential pinion

Number of teeth--11; 25 KhGT steel (ChMTU TsNIIChM 761-62); depth of nitrided layer--0.8-1.1 mm; surface hardness--HRC 58-65; core hardness--HRC 35-45.

Internal diameter of hole in pinion bushing for cross journal	28.060-28.105	28.15
Thickness of pinion tooth (measured at height of 6.68 mm)	10.57-10.72	10.35

Half-shaft gear

Number of teeth--22; 18KhGT steel (GOST 4543-61); depth of hardened layer--1-1.4 mm; surface hardness--HRC 56-62; core hardness--HRC 30-45.

Diameter of gear journal for hole in differential cup	74.895-74.935	74.75
Tooth thickness (measured at height of 5.1 mm)	8.65-8.50	8.25
Width of spline groove	5.367-5.452	5.65

Rear and middle drive axle half-shafts

45RP steel (VTU 1063-63); depth of case hardened layer--6 mm; surface hardness--HRC 52-62.

[Table 10-7, continued]

Half-shaft length along the flanges:		
Left	895	--
Right	1189	--
Spline tooth thickness	5.217-5.332	5.000
Diameter of holes for hub studs	12.5	13.0
Diameter of threads in holes for puller fastening bolts	M10, class 3	--
Diameter of journal for air supply head seal	52.88-53.00	52.7
Diameter of journal for half-shaft seal	49.9-50.0	49.7

Inner half-shafts and stub axles of the front drive axle

70KhGNTR steel (ChMTU TsNIIChM 1235-6' depth of hardened layer--1.2-1.6 mm; surface hardness--HRC 58-65.

Length of stub axle to face of head	238	--
Length of inner half-shaft to face of head:		
Right	750	--
Left	590	--
Diameter of inner half-shaft journal for seal	49.9-50.0	49.7
Diameter of stub axle journal for air supply head seals	52.88-53.00	52.7
Spline tooth thickness on stub axle and inner half-shaft	5.217-5.332	5.000
External diameter of stub axle along splines	49.950-49.975	49.90

Splined flange of front axle stub axle

40Kh steel (GOST 4543-61); hardness--HB 241-269.

Diameter of centering collar for wheel hub	130.92-131.00	130.90
Width of spline grooves along arc of divided circumference	5.367-5.422	5.600
Diameter of holes for flange fastening bolts	12.5	13.0

[Table 10-7, continued]

External diameter of splined hole	50.000-50.027	50.060
	Ball joint balls	
Diameter of central ball	41.250-41.300	--
Diameter of driving balls	42.767-42.947	--

Table 10-8. Diameter of half-shaft ball joint driving balls of the ZIL-131 motor vehicle, mm

a. Группа	b. Диаметры
I	42,767–42,787
II	42,787–42,807
III	42,807–42,827
IV	42,827–42,847
V	42,847–42,867
VI	42,867–42,887
VII	42,887–42,907
VIII	42,907–42,927
IX	42,927–42,947

Key: a) Group
b) Diameters