

MANUAL DE REPARACION DE MOTOR SINOTRUK HOWO



2014 Chevrolet Silverado 2500HD

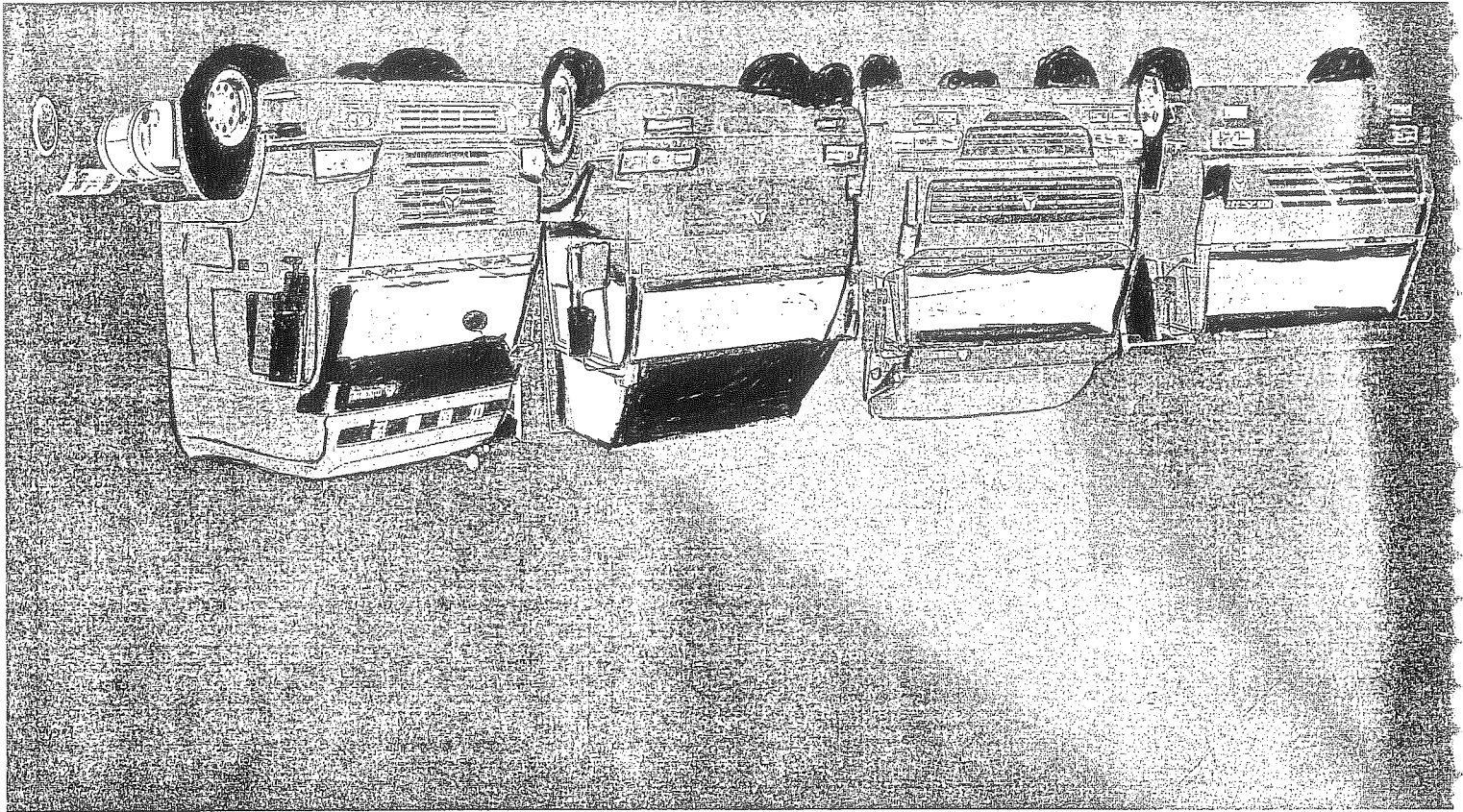
2014 Chevrolet Silverado 3500HD

2014 Chevrolet Silverado 4800HD

2014 Chevrolet Silverado 5500HD

2014 Chevrolet Silverado 6500HD

China National Heavy Duty Truck Group Co., Ltd



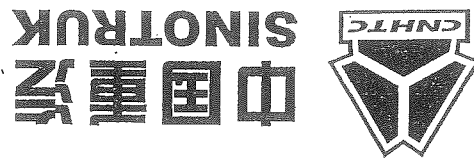
REPAIR MANUAL (A)

HOWO, STEYR, HUANGHE-PRINCE

中国重汽
SINOTRUK



China National Heavy Duty Truck Group Co., Ltd



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Foreword

SINOTRUK HOWO, STEYR, HUANGHE-PRINCE series Heavy Truck are Manufactured by China National Heavy Duty Truck Group Co., Ltd(SINOTRUK). This Manual is intended to Familiarize Repairman with the Technical Details and Constructions of these Trucks, and to Assist in the Necessary Maintenance and Repairwork Carried out on the Engine, Clutch, Gearbox, Transfer case, Propellershaft. This manual Consist of the Book A and the Book B.

This manual is for the Guidance as the Maintenance, Adjusting, Disassembly, Assembly, Repair and Common Troubles Removal of these main Assemblies on the SINOTRUK Trucks. We ask Repairman in the Service Center Appointed by SINOTRUK to read this Manual Thorough Again and Again, and to Closely Follow the Instruction for Maintenance and Repair.

The Following Must be Essential to Maintenance and Repairwork in the Service Center Appointed by SINOTRUK(CNHTC) :

1. Trained Repairman
2. Special Equipment, Test Bench and Special Tools
3. Genuine SINOTRUK Spare Parts

Standard Assemblies were used when Compiling this Manual which may Deviate from the Assembly to be Repaired with Reference to Method and Technical Specifications. We Remain the Right of Changing without Notice.

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China National Heavy Duty Truck Group Co., Ltd
CNHTC Shandong Import & Export Co., Ltd
November 30, 2005

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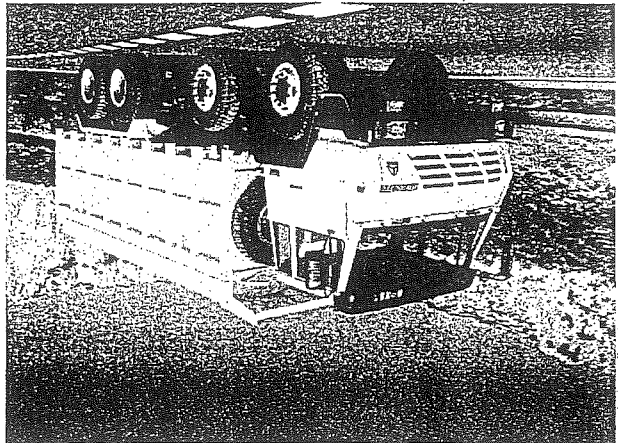
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CHAPTER 1 INTRODUCTION TO SINOTRUK PRODUCTS

1. SINOTRUK VEHICLE PRODUCT SERIES

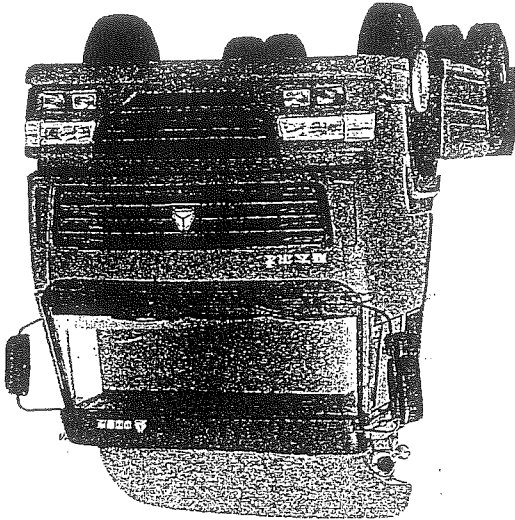
The principal types of vehicles manufactured and sold by SINOTRUK(CNHTC) include five series of heavy duty (HD) vehicle products, STEYR HD vehicle series, STEYR-KING HD vehicle series, HUANGHE Brand HUANGHE Prince HD vehicle series, special vehicle series and HOWO Brand vehicle series. Additionally, more categories of special vehicles and buses can be manufactured.

(1) STEYR Brand HD Vehicle



STEYR HD vehicle series was STEYR 91 series vehicle that was introduced from STEYR Truck Company in Austria and formally produced in nineties of last century. This series of vehicle type was internationally advanced series product by integrating the remarkable experience in matching design of whole vehicle and the advantages in technical research of engine, by borrowing the design experience from the major HD vehicle manufacturers in Europe, and by fully utilizing the perfect system for marketing and supply of auto parts, which was formed by professionalized production and labor division in internationalized cooperation. It is characterized by the following:

1. It is a series of vehicle types and with various varieties that can meet the requirements from various customers. The manufactured vehicle types are divided into the types of 4×2 , 4×4 , 6×2 , 6×4 , 8×4 , 8×8 series according to driving types. There are five grades of load carriage for individual vehicles from 16 t to 40 t, including 16 t, 19 t, 32 t (25 t as per China Regulations), 38 t (31



(2) STEYR-KING Series HD Vehicle

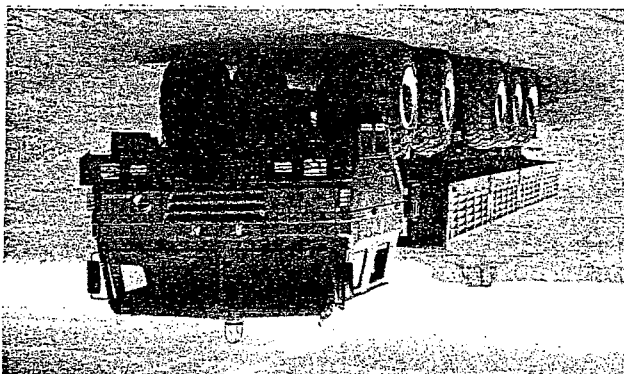
t as per China Regulations) and 40 t. The power horse from 266 to 420 can be selected according to the required power. The vehicles are mainly typed in van-type truck of general good, dumper, tractor, concrete mixer truck, military truck, large bus chassis and various special chassis. General and special chassis of STEYR vehicles are used for modification into various special vehicles. The high interchangeability provides extreme convenience for spare procurement and maintenance. Since STEYR series vehicles utilized the structural design of module combination. In all types of the vehicles, the interchangeability of the components and parts are very high so that the users of different types of vehicles, even the users who use a little amount, can acquire their spare parts in a very convenient way. 3. Many optional devices are available for the users. Due to different service conditions and different users' requirements for a same type of vehicle. Besides the basic equipment on STEYR vehicle, the user can select the required device through consultation with the sales department according to its demand.

4. It is characterized by good powerfulness, economy, riding comfort and relatively low operating cost.

5. The assemblies are advanced in performance, reliable in quality and long in service life.

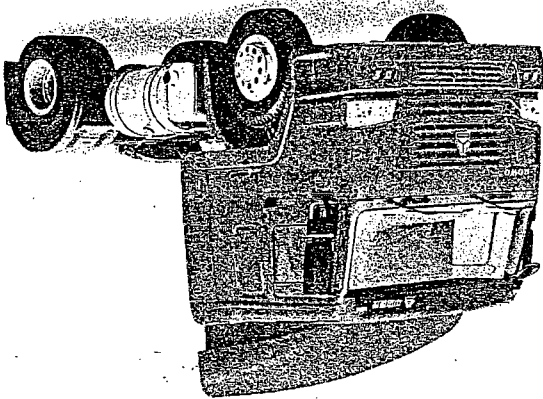
The HUANGHE Brand HUANGHE Prince series medium HD vehicles are the latest medium HD vehicles developed by integrating introduced and produced Germany MAN 2000 cab at a level of leading position in the world and based on the technical foundation of STEYR HD vehicles.

(IV) STEYR, HUANGHE Brand Special Series Vehicle



SINOTRUK(CNHTC) has developed and manufactured series special vehicles including 4 x 4, 6 x 6, 8 x 10 x 10 series according to the requirements set by oil field, construction site, military unit, etc, for the specific service environments

(V) HOWO Brand 7 Series HD Vehicle



As a manufacturer that has longest history in production of HD vehicle in China, SINOTRUK(CNHTC) relied on the leading strength of development of HD vehicles in the domestic field, applied the experience of successfully developing and manufacturing STEYR and STEYR-KING series vehicles, utilized the key advanced technologies in HD trucks in the world and independently developed in October 2004 a new generation of HD vehicle - HOWO HD truck 7 series, which reaches the modern international level and is characterized by independent brand, more advance performance and higher grade internal decoration.

SINOTRUK(CNHTC) closely followed the technical development of HD vehicles in the world, transferred the new technologies and new structures of the heavy vehicles to STEYR series on the technical bases of STEYR series vehicles and developed STEYR-KING series HD vehicles with more advanced performance, wider range of application, more reliable quality and more driving and riding comfort. It is characterized by the following:

1. The driver's cab is shaped with lifelike, in conformity of aesthetic view of modern people, with reduced air drag, with lighting and field of view meeting the safety requirements and internal decoration improved in all-round way.

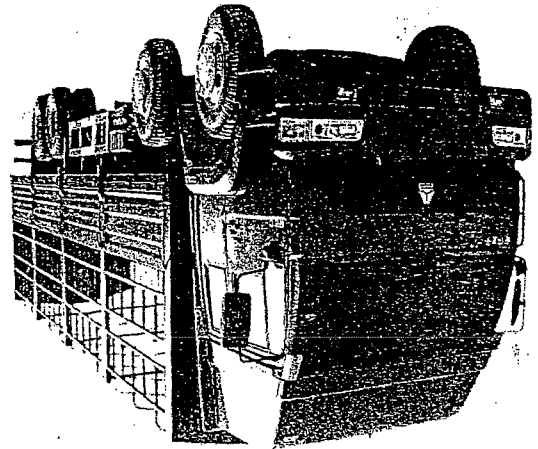
2. The engine can save energy and protect environment more effectively, with emission all up to EURO II and its power covering 420PS.

3. Power train adopted a lot of new structures, such as pull-type diaphragm clutch, end-face teeth flange connecting drive shaft, single-stage deceleration drive axle with even higher effectiveness.

4. The operating device has adopted new technologies so as to greatly increase the easiness and convenience, such as: steering operating system up-and-down and

5. A new design of instrument console is adopted and a build-in air conditioning system equipped so that it is solved that there is no way to install a build-in and high-efficiency air conditioning system reasonably in STEYR series.

(III) HUANGHE Brand HUANGHE Prince Series Medium HD Vehicle



HOWO series vehicle, in accordance with the design concept to maximize customer's value and based on the long-term and multi-angle research and cooperation with the international HD truck experts, enable our customers to actually realize its super operating functionalities, satisfactory internal and external decoration, good safety, good comfort, good operation ability, and good economy from fuel consumption to maintenance, and feel pride that "Ultra institute is worth the thing; and type selection is correct", when comparing with the other types of vehicles selected by the other customers.

HOWO HD truck 7 series has integrated the characteristics of the advance technologies in the world, used the advanced key assemblies and included reasonable technical connection. The layout of whole vehicle is fair and all its major assemblies are coordinated, uniformed, reliable and flexible. It has best powerfulness, reliability, economy and environmental amity and longest service life.

HOWO HD truck displays its unique leader quality with its external appearance of luxury, magnanimity, firmness and gracefulness and magnificence and beauty. And especially with its comfort, safety and convenience and other humanized concerning, HOWO reaches the international level of HD vehicles.

Launch of HOWO HD truck shows concentrically the enterprise business concept of SINOTRUK(CNHTC) to seek for maximization of customers' value uninterruptedly. It is mainly characterized by the following:

1. Driver's Cab

The driver's cab in HOWO HD truck series is the most successful embodiment in technical exchange and cooperation conducted with the international magnates of HD trucks in all aspects. There are different types of driver's cabs applicable to different purposes, high-roof cab (long-distance transportation), medium-length cab (medium-distance transportation) and short cab (engineering dumping). The cab is carefully designed for all its components, by using the art of molding, to integrate them into a perfect figure with luxurious and magnanimous shape. The internal space of the cab is up to 2.5 m wide. The integral structure is reasonable and compact. The sealing and seaming of each component is equal to the current international level. The primer and the face paint are produced on the latest paint spraying line that is independently developed by SINOTRUK(CNHTC). Cleaness, brightness, acid and alkaline resistance and firmness of the paint have already reached the level of HD trucks of the international brands.

Safety: The safety of HOWO HD 7 series cabs is extremely high since it meets the requirements in Sweden regulations (The prototype won the title "The Safest Cab in Europe", which are the strictest in the world. This is a very good guarantee to the safety of driver and passengers, and truly reflects SINOTRUK(CNHTC) maintenance to customer interest and concerning over the drivers and passengers. It is characterized by the following:

- The main body is a structure of rigid steel frame that is solid, firm and strong in resistance against shock and external force compression.
- The bodywork is welded and assembled on the fully automatic robotic production line and the operation is controlled fully by the modern programs.
- A roll restrictor for the cab is added.
- Powerful guards are equipped to prevent front collision and front under ride.
- The windscreen in front of the widest curved surface on the HD truck has a angle of field of view that is up to the European standard.
- The driver safety belt is of double-lock structure so that the safety margin is greatly increased.

Comfort: It is evaluated by the experts in the field that the comfort and human anti-fatigue indicator on HOWO HD truck 7 series have reached the international level.

- The cab on highway truck adopts the latest four-point full-floating air suspension of which the shock absorbing effect is as stable and comfortable as "playing" in a pleasure boat on water surface.
- The steering wheel is improved and made of soft plastic material used on the cars, which is in good texture. The cab can be adjusted forwards and backwards for an angle $\pm 5^\circ$ and upwards and downwards for a height of 25mm.

- All the vehicle types with above 290 HP are equipped with cooling and heating air conditioning equipment, which are electrically operated and can control the temperature automatically.
- The sleeping bed on HOWO HD truck is designed according to the figure of European and 600mm wide. The aluminum alloy framework, which is light and rigid, and of build-in wire net structure, can more effectively relax the fatigue, compared with the bed pad on other products.
- The upper-deck beds can be raised to and set at any angle.
- The ventilation system in cab is designed uniquely: ① A vent window is equipped to keep the air in cab fresh and clean in case the cab is in fully closed state. The cooling and heating channels may lead the air to the doors on both sides so that the glasses on the two sides can defogged quickly. Its good air circulation may eliminate the dust and peculiar smell.
- The cab is equipped with luxurious stowage compartment in large space. The on-board refrigerator is included in its basic configuration.
- The independently created silencer system has passed many rounds of experiments so that the silencing effect reaches the international standard for top HD trucks. The noise is obviously decreased so as to make the driver and passengers pleasant and comfortable.
- Humanization: The humanized design is based on current internationally used standards.
 - a. The artificially intelligent design is a most important form to reflect the competitive strength of product and technology and to protect the customer interest. The higher the intelligence is, the more its coverage to the whole vehicle, the higher the density of view points and control points, the more favourable it is for the driver to control the reliability and stability of the whole vehicle. HOWO HD trucks have an artificially intelligent technology that is created domestically and independently and reaches the international level. It is reflected by: 1) Control of water temperature and oil temperature of the engine, control of machine oil consumption and combustion; 2) Control of the electrical circuits in the whole vehicle; 3) Control of the load in air inlet and emission system; 4) Control of air pressure state in the whole vehicle; 5) control of fuel quantity and fuel line system; etc. All the control nodes can be displayed with different symbols on the LED display.
 - b. The seat is of latest design. It reflects the technical feature of SINOTRUK(CNHTC) patent. Not only its external appearance is as visually beautiful as that of HOWO HD truck, but also the principle of human engineering is fully utilized: 1) The seat cushion and back are equipped with electrically heating device; 2) Air bag is equipped on the high back at the waist portion so as to effectively support the waist; 3) The top part of high back may be adjusted to relax the fatigue in driver's shoulder and neck.
 - c. The reflector is designed according to comparison and reference with the most advanced vehicle types abroad, with electrical operation and electrical defogging optional. The rear view mirror, the right road mirror and front low view mirror are all wide in field of view to enable the driver to know the entire driving environment.
 - d. The unique structure to open and close the door, 90° maximum angle for door opening, two side door handles and two-stage stainless-steel anti-skid pedal enable to open the door and to access the vehicle more safely, more conveniently and in more humanized way.
 - e. Reading lights are located in many places in the cab. They are of luxurious design and good brightness to provide great convenience for reading and officing on board.
- The comfortable and humanized design is in line with the European HD trucks so as to enable HOWO 7 series to be a movable "HOME" and a graceful "OFFICE".
- 2. Engine
 - The engine is upgraded by using SINOTRUK(CNHTC) patent technologies, and its power is reasonably adjusted according to the grading. The power grading is more reasonable; covering broader, power more powerful, fuel consumption more economical, and emission cleaner. The most advanced technologies of STEYR engine used in HOWO series are characterized by:
 - The inlet and exhaust system is completely in line with the European HD trucks. The inlet and exhaust is even

HOWO HD truck 7 series vehicle frame is made of alloy steel with high strength. The width of the frame is modified according to the general international standard, with front wider and rear narrower (front 1000mm, rear 850mm). All the holes are punched with digital control so that their locations are extremely accurate. The height of the centre of

5. Vehicle Frame

and reliably. The service life of clutch in HOWO HD truck is up to the advanced international level. The clutch is operated easily synchronomesh transmission is good in performance and operates reliably. The flexible cable is characterized by free operation, freedom from throw-out of gear, freedom from hand hitting in shifting, short lever and soft and smooth control so that the vibration can not be transmitted to the cab. The all-heavy carrying load so as to enable the engine within the range of economical speed.

stable quality, wide range of transmission ratio, good capability of starting, climbing and off-road driving with and reaches the advanced international level. It is characterized by compact structure, large capacity of torque, heavy carrying load so as to enable the engine within the range of economical speed.

4. Transmission and Clutch

to prolong the service life.

- Q-Plus brake, a Meritor patented product, has stable, smooth and constant braking and thickened friction lining
- The ABS system and automatic clearance adjusting arm are optional.

strength requirements and improve its rigidity.

- Drive axle case in rectangular section is formed accurately in dimension and shaped regularly so as to meet the impact.

- Full floating axle has hard and strong surface that can bear fatigue impact, and elastic shaft that can absorb the
- The conical roller bearing has high load-carrying capability.

higher shock resistance.

- The precision-forged side gear and the planetary gear for differential have even greater strength and even transmission ratio by engine speed.

area, smoother and more stable in operation and lower in noise so as to meet the requirements for wide gear

- The hypoid bevel gear verified by Meritor Company is high in strength, longer in service life, greater in contact

easy operation and maintenance. All its performances reach or surpass the advanced international level.

HOWO axle is a central single-reduction axle and equipped with Meritor R180 final reduction gear. It is characterized

by simple and reliable structure, high torque bearing capability, long service life, high efficiency, fuel saving, and technical cooperation with the experts in Europe and in the United States, which won the "National Prize of Progress in Science and Technology in 2003".

HOWO drive axle is one of the biggest single-reduction axles in the world currently, and is the crystal of deep

3. Drive axle

- The exhaust emission meets the requirements in EURO II regulations.

efficiency at low speed and enable the board customers to reduce their operating cost in practical way.

- The Tipper truck is equipped with special engine. In connection with the feature that the engine of Tipper truck

reached the advanced international level per 100 km.

- The engine has high torque in wide area at low speed so that the fuel consumption is greatly decreased and the cylinder block to bear even higher bursting pressure.

● The key components and matching fittings of the engine pass over-load test so that the reliability of the whole engine is created greatly. Especially modification is done for the weak points of the cylinder block so as to enable smoother and the efficiency even higher so that the service life of the engine is greatly increased and the fuel consumption decreased in all-around way.

6. Electrics and Instrument

The instruments in HOWO HD truck 7 series adopt the types of instruments the same as those selected and used on European HD trucks. They do not easily cause fatigue to the eyes. All the operating switches have a good sense of vision and touch. The trouble rate is very low in the normal operation.

The intelligent master control system for electrical appliances is used.

The lighting combination for HOWO HD truck 7 series is redesigned completely. The front light combination is in beautiful shape and is perfectly integrated with the cab. The crystal light shade that is popularly used in the world is adopted with high brightness, strong penetration and very high service life (xenon light bulb for option). The front light bracket is rotary for convenience of maintenance. The rear light combination is compactly structured, reasonably designed and beautifully and gracefully integrated. The bracket is firm and stable due to multi-point connection.

HOWO HD truck 7 series has many independently developed technologies, such as:

The tire mudguard for rear axle can be opened from its top. The strong brush is installed in the guard, which may effectively reduce noise, brush off the mud, slurry and other additives and effectively protect the safety of the tire.

The medium-length cab is equipped with 2m long and 1.6m wide large cowl that can effectively decrease the resistance coefficient by 0.8 and save fuel with the best result.

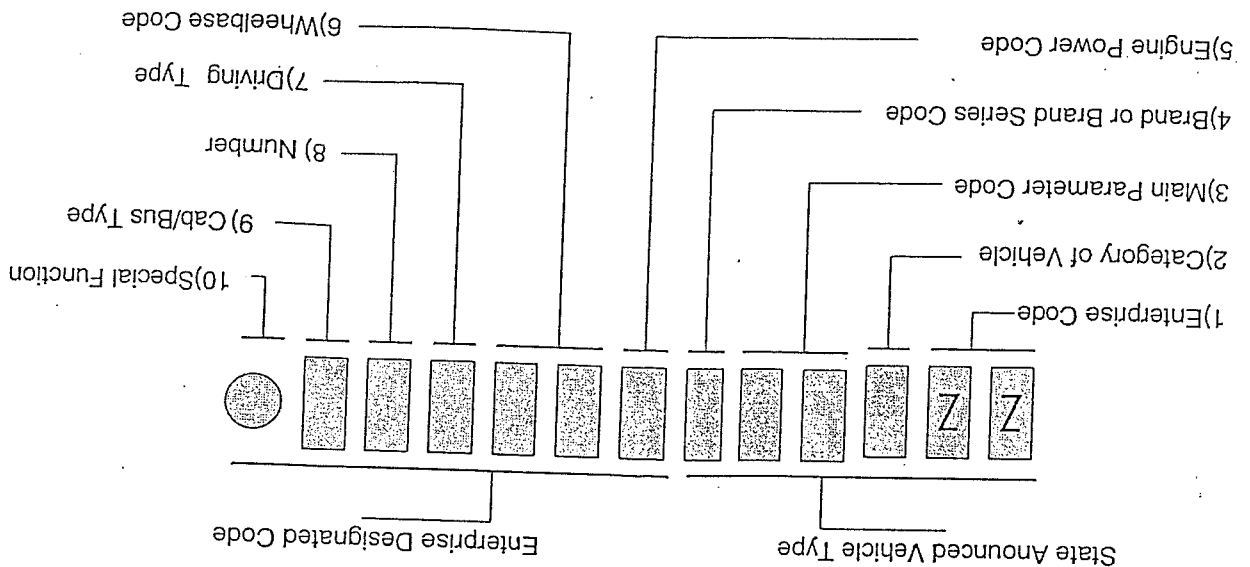
The highway vehicles, especially the tractors, are all equipped with rear side cowl, which is used to obviously decrease the drag coefficient by 0.4 to create a new fuel saving space for the customers.

On all the high-proof and medium-length cabs, large rear view windows, in the size of 600mm x 400mm, are opened, so as to enable the cab to have sufficient light and the driver to have increased rear view safety margin.

There are many driving types, such as 4 x 2, 6 x 2, 6 x 4, 8 x 4, 8 x 4 and 10 x 4, in HOWO HD truck 7 series. Various chassis with different wheelbases may be used to modify tractor, dumper, van, tanker and other types of special purpose vehicles.

II. Rule for SINOTRUK Product Numbering

1. SINOTRUK Product Type



For example: ZZ1233K4641 ZZ1312N4666F

2. SINOTRUK Special Vehicle Product Type

1. It is designed in line of European shape and follows the international trend.
STEYR-KING series cab is characterized by:

(i) Cab

III. Brief Introduction to the Assemblies of SINOTRUK Products

semi-high and extended cab with sleeper.
extended cab with sleeper, O – high-sided and covered cargo body, I – high-sided and covered cargo body with
X – HUANGHE brand new model of cab, Q – covered cargo body, Y – covered cargo body with semi-high roof and
extended cab with sleeper, V – high roof and extended cab with sleeper, U – high-sided and five-door cargo body,
military vehicle with semi-high roof and extended cab with sleeper, P – bucket van with semi-high roof and
sleeper, H. Military vehicle with semi-high roof and extended cab with sleeper, M – high-sided cargo body of
sleeper, B. high-sided cargo body with extended cab with sleeper, F. semi-high top and extended cab with
engine, T. Deutz engine military vehicle, W. extended cab with sleeper, A. military vehicle with extended cab with
double-deck bus chassis, D – urban tram chassis, N – dumper bucket cargo van, E – Deutz engine, K. Cummins
wheel, L – liquefied petroleum gas (LPG) used as fuel, C. compressed natural gas (CNG) used as fuel, S –
9) Cab/Cargo Body/Bus Category Code: J – military vehicle, G – high-sided cargo body, R – righthand steering

8) Cab/Bus Variant Serial No.

7) Driving type: 1.4 × 2 2.4 × 4 3.6 × 2 4.6 × 2 4.6 × 4 5.6 × 6 6.8 × 4 7.8 × 8 8.10 × 8 8.10 × 10 9.12 × 10

6) Wheel base Code: The distance between the central lines of adjacent steering axle and drive axle (dm).

5) Engine Power Series Code: G.180PS H (5) .200PS J.220PS K.240PS L.266~290PS N.310~336PS S.360~371PS V.420PS W.440PS X.460PS Y.480PS Z.500PS Q.560PS A.580PS

Vehicle 7: HOWO Series Vehicle

4) Brand or Branch Series Code: 1: HUANGHE Series Vehicle 2: STEYR Series Vehicle 6: STEYR-KING Series

categories 6 and 7, vehicle length.

3) Main Parameter Code: For vehicle Categories 1~5 and 9, the main parameter code is total mass (t); For vehicle

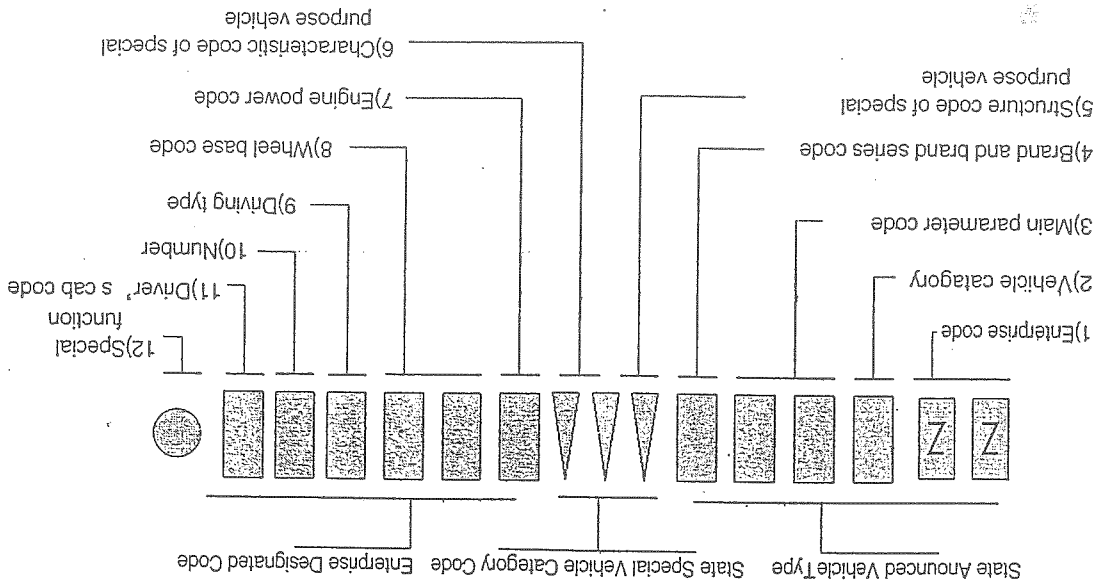
Semi-trailer, Special Semi-trailer

2) Vehicle Category Code: 1. Cargo Truck, 2. Off road, 3. Tipper, 4. Tractor, 5. Special Purpose, 6. Bus, 7. Car, 9.

1) Enterprise Name Code: SINOTRUCK logo.

3. Implications or Regulation of Each Code in Product Type Structure

For example, ZZ1312XXYN4646F ZZ1312CLXN4646F



2. There are two types of bumpers, high and low, 400mm height difference between them. The towing hook is skillfully arranged in the low grid.
 3. The headlight is shaped more gracefully and provides stronger intensity of illumination.
 4. The sun visor and sun shield are combined for use to provide the driver and passenger more safety and comfort.
 5. The new type of rear view mirror is free from blind area and provides a better rear view result.
 6. The cowl is styled more beautifully and in line of aerodynamics so as to greatly reduce the wind drag and enhance the economy of the whole vehicle.
 7. The low-sounding horn is equipped with stronger penetration and good alarm effect and sounds to 1.5km.
 8. Features of Internal Decoration in Cab:
 - (1) The instrument console is designed humanly and decorated with peach wood pattern.
 - (2) The steering wheel can be adjusted vertically and forward and backward to fit the driving habits of different drivers.
 - (3) There are two types of driver seat shock absorbing, mechanical and air spring.
 - (4) The air warming system adopts the car structure, in which the cooling and the warming systems are integrated. It is in line with European technical level. It is suitable to application in extremely cold region by using high-speed motor.
 - (5) It has the top distance of 1,850mm that is the maximum among the HD vehicles made in China, and is equipped with double-deck sleeper.
 - (6) The short-handle gearshift is adopted with comfortable sense of touch, easy operation and uneasy throw-out of gear and does not affect cab tilt.
 - (7) The advanced electric control system is available for operation. It uses digital circuit control with 24 V for power consuming device and 5V for control system. The vehicle-level integrating circuit and LED lighting are adopted with highly reliable signal. The trouble build-in test equipment (BITE) and alarm display are equipped. It can save the operating time of engine automatically and the chip may store the ex-work configuration and parameters.
 - (8) The rear suspension for cab adopts the structure of combination of spring and shock absorber, resulting in good shock absorbing effect. Rubber pad is used at the front tilt shaft.
 - (9) The air conditioning system is free from fluorene (F) and designed in sense of environmental protection, matches reasonably and performs reliably. The condensing pipelines are made of quality material, safe and reliable.
 - Feature of STEYR-KING Series Cab: With exception that the electric control system adopts the central distribution device which is different from STEYR-KING and the external appearance is kept at that of the imported vehicle type, the rest are basically the same as STEYR-KING cab.
 - Introducing the technologies of MAN L2000 for German Man Commercial Vehicle Company produces HUANGHE Prince series cab. Various control devices and instrument systems all adopt MAN technologies.
 - HOWO cab is independently developed by SINOTRUK and is characterized by the above-mentioned points which will not be repeated hereinafter.
 - (II) Engine
- SINOTRUK special WD615 engine: a mature 10L engine that is tested in the market for a long time. Fuel injector: a multiple orifice fuel injector with high pressure P type flange pump. Combustion chamber: a shallow w combustion chamber. Euro II injection pump adopts 7000 series pump manufactured by our group or Bosch pump, which has high reliability and high performance. The advanced fuel injection system decreases the specific fuel consumption greatly. Compared with the original STEYR engine, the average fuel consumption on the outer characteristic curve decreases by 5g/KW.h.
- Reinforced body structure is adopted. The small end of wedge connecting rod inherits the frame type main bearing structure of the original WD615 series Diesel engine and realizes no need of overhaul within 700,000 km. To adopt necking w combustion chamber, high piston ring, low swirl duct, high injection pressure fuel pump, multiple orifice

injector and high-efficiency supercharger with inlet air compensation improves the combustion process greatly and realizes low exhaust emission, low pollution and low noise. High throughput and strong adaptability. Most of parts and components to pass for convenience of generation renewal and maintenance.

SINOTRUK WD618 Diesel engine is a Diesel engine used on a new generation of 12L HD vehicle, which is developed by lengthening the stroke based on the mature technologies of STEYR WD615 Diesel engine, including three models: WD618.36, WD618.39 and WD618.42. The Diesel engine of this system continuously uses WD615 frame-type main bearing structure and adopts newly designed gear drive mechanism. In order to improve the bursting pressure and enhance the impact to the strength of the connecting rod piston, a small end of wedge connecting rod is designed. The high injection pressure P type flange injection pump, multiple orifice injector and high efficiency S3B supercharger are used for improvement of exhaust emission. Euro II emission standard can be met by changing the piston shaping line or by adopting post-emission treatment. Its advantages are high power, small volume, good economy, low emission, easy starting, etc.

(III) Clutch

SINOTRUK adopts two types of clutches, GF420 and $\Phi 430$. GF420 clutch is a coil spring clutch that is a mature clutch with maximum transmission torque currently. The hydraulic air booster operation system and mechanical air booster system improve the easy and stable operation of the clutch. They are matched with engines 266, 290 and 336PS.

The reinforced $\Phi 430$ inlet diaphragm clutch is pull type clutch. It is characterized by high transmission torque, stable operating performance, simple structure, compact axial dimension, long service life, etc. It is installed on and matched with engines 360 and 420PS.

(IV) Transmission

SINOTRUK HD trucks are equipped with two types of transmissions, one is the FAST transmission manufactured by Shanxi Fast Gear Co., Ltd. and the other is QJ transmission manufactured by Qijiang Gear Co., Ltd.

The FAST transmission has its unique twin intermediate shaft configuration and adopts double H shift mechanism. The main gearbox uses the traditional engagement sleeve and the auxiliary gearbox adopts inertia lock pin type synchronizer. It is characterized by compact volume, high transmission torque, high reliability, etc.

The QJ transmission is a three-shaft-mounted all-synchronmesh gearshift, which is manufactured by Chongqing Qijiang Gear Co., Ltd. based on the technologies introduced from German ZF Company. The reverse gear adopts engagement sleeve gearshift transmission. At present, SINOTRUK uses and installs S6-120 integral all-synchronmesh transmission and S5-111GP and S5-150GP main and auxiliary gearbox combined synchronmesh transmission.

(V) Propeller Shaft

SINOTRUK manufactures the propeller shaft by using the latest international technologies of propeller shaft products. It is characterized by structure in line with the world current, strong transmission torque, reliable operation, long service life, simplified process, convenience for mass production, low cost, easy installation and removal and convenient maintenance and service. As for connection, end face teeth connection is adopted so that the transmission torque is great, stable and reliable.

(VI) Drive Axle

SINOTRUK adopts hub reduction axle with STEYR technologies and produces HW1667 and HW1697 single-stage reduction axle for HD vehicle and M1249 and M1279 single-stage reduction axle for medium HD vehicle by using the technologies of American Meritor Company (American Meritor Company is the largest vehicle axle manufacturer in the world).

STEYR Drive Axle: The drive axle uses the real STEYR technologies and is upgraded in line of the situation in China. The section of axle housing is 130×150 mm. It is especially suitable to operate in bad conditions due to its advanced manufacturing process, quality material, really high quality and skillful structural configuration.

HOWO Drive Axle and Merriter Drive Axle: It adopts the real axle technologies of American Merriter and is characterized by simple and compact structure and convenient maintenance and service. The key parts and components are imported with high reliability and long service life. The advance process can ensure its high quality. It is especially suitable to highway transportation. It can effectively reduce the fuel consumption of the whole vehicle and increase the efficiency of transportation.

(VII). Front Axle

STEYR Front Axle Used on HD Vehicle: The rated axle load of STEYR front axle is 6.5 T. The axle load on good road surface is up to 8 T. It is suitable to special purpose vehicle and modified vehicle. The Elliot integral die forged I type beam is made of quality material and is graceful in external appearance and reliable in performance. The tire bolts is in unique structure and ensure safe operation. 5.5 T grade rigid front axle is used on medium HD vehicle.

(VIII) Suspension System

The equalizing suspension of dual drive axle is composed of longitudinal balance spring, bearing shaft, thrust bar, etc. Its maximum load is up to 32 T.

Single axle rear overhang is characterized by main and auxiliary spring structure, cylindrical shock absorber, stabilizer anti-roll bar, and high stability and smoothness of the whole vehicle.

The front overhang is characterized by multiple sheet spring structure, cylindrical shock absorber, stabilizer anti-roll bar and high smoothness.

(IX) Steering System

Two types of steering gears, ZF8095 and ZF8098, of German ZF Company, are used. The ZF steering structure is of rotary valve type and with compact structure so as to ensure stability and safety. The secondary steering shaft of 8 × 4 HD vehicle adopts roll-damping structure to ensure that there is no swing and no stuck-tight tire.

(X) Brake System

The brake system adopts direct press type master valve structure and has dual-circuit air pressure type main brake, spring-stored-energy type parking brake, emergency brake and exhaust brake and auxiliary brake to ensure that the brake system operates stably, reliably and safely.

(XI) Vehicle Frame

SINOTRUK adopts the frames of different structural forms, such as, constant-width trapezoid type frame, wide-front and narrow-rear frame, etc. The sectional height of the frame is 300mm or 243mm. The frames in different sizes and forms can be selected according to the requirements of vehicle type.

(XII) Electric System

STEYR, STEYR KING electric system, since 2004, adopts central distribution device to concentrically control the relays, fuses and on-board electrical appliances for convenience of maintenance and enhancement of reliability. HOWO electric system adopts the integrated control board. The embedded intelligent control software is used to apply intelligent control to various electric devices on the vehicle. And at the same time, it is also equipped with CAN bus control system to provide automatic bus test function and automatic failure display

IV. Main Technical Parameters for Various Series Typical Vehicle Types

For main technical parameters of STEYR-KING series typical vehicle types, see Table 1-1 ~ Table 1-6.

For main parameters of HOWO series typical vehicle types, see table 1-7 ~ Table 1-12.

Change for the data in these tables without prior notice.

Table 1-1

body		mid & rear axle		front wheel data		Front axle		frame		gearbox		performance data					Mass data										
Type dimension(lengthXwidthXheight) mm		Differential lock		Toe-in Φ		Rigid stub axle with double T-cross section		Section of Main frame Channel type243×80×8mm		Forward ratio 13.04;8.48;6.04;4.38;3.43;2.47;1.76;1.2 8.1.00 /12.42;8.26;6.08;4.53;3.36;2.47;1.81; 1.35;1.00		Reverse ratio 11.77/12.99		Type 5S-150GP/RT11509C		Distance in no power (speed =50km/h) (m) 830		Distance after braked (speed =30km/h) (m) ≤9.0		Train maximum total mass(Kg)		Towing gross weight (Kg)		Maximum total mass(Kg) 16000(19000)		Kerb Mass(Kg) 7020	
7300x2326x550		4.8		3~4.5mm		T-cross section		Channel type215×70×5mm		13.04;8.48;6.04;4.38;3.43;2.47;1.76;1.2 8.1.00 /12.42;8.26;6.08;4.53;3.36;2.47;1.81; 1.35;1.00		11.77/12.99		5S-150GP/RT11509C		830		≤9.0						16000(19000)		4320	
		Steyr two step reduction		1°				Ladder frame		13.04;8.48;6.04;4.38;3.43;2.47;1.76;1.2 8.1.00 /12.42;8.26;6.08;4.53;3.36;2.47;1.81; 1.35;1.00												6000		2700			
		Model/Type		Kingpin inclination		Camber angle		Section of assistant frame		13.04;8.48;6.04;4.38;3.43;2.47;1.76;1.2 8.1.00 /12.42;8.26;6.08;4.53;3.36;2.47;1.81; 1.35;1.00												10000(13000)					
		ratio		3°		1°		Channel type215×70×5mm		13.04;8.48;6.04;4.38;3.43;2.47;1.76;1.2 8.1.00 /12.42;8.26;6.08;4.53;3.36;2.47;1.81; 1.35;1.00												rear axle					
		Model/Type		Caster		Kingpin inclination		Channel type215×70×5mm		13.04;8.48;6.04;4.38;3.43;2.47;1.76;1.2 8.1.00 /12.42;8.26;6.08;4.53;3.36;2.47;1.81; 1.35;1.00												front axle					
		Steyr two step reduction		1°		1°		Channel type215×70×5mm		13.04;8.48;6.04;4.38;3.43;2.47;1.76;1.2 8.1.00 /12.42;8.26;6.08;4.53;3.36;2.47;1.81; 1.35;1.00												rear axle					
		4.8		3°		1°		Channel type215×70×5mm		13.04;8.48;6.04;4.38;3.43;2.47;1.76;1.2 8.1.00 /12.42;8.26;6.08;4.53;3.36;2.47;1.81; 1.35;1.00												front axle					
		Steyr two step reduction		1°		1°		Channel type215×70×5mm		13.04;8.48;6.04;4.38;3.43;2.47;1.76;1.2 8.1.00 /12.42;8.26;6.08;4.53;3.36;2.47;1.81; 1.35;1.00												front axle					
		4.8		3°		1°		Channel type215×70×5mm		13.04;8.48;6.04;4.38;3.43;2.47;1.76;1.2 8.1.00 /12.42;8.26;6.08;4.53;3.36;2.47;1.81; 1.35;1.00												front axle					
		Steyr two step reduction		1°		1°		Channel type215×70×5mm		13.04;8.48;6.04;4.38;3.43;2.47;1.76;1.2 8.1.00 /12.42;8.26;6.08;4.53;3.36;2.47;1.81; 1.35;1.00												front axle					
		4.8		3°		1°		Channel type215×70×5mm		13.04;8.48;6.04;4.38;3.43;2.47;1.76;1.2 8.1.00 /12.42;8.26;6.08;4.53;3.36;2.47;1.81; 1.35;1.00												front axle					
		Steyr two step reduction		1°		1°		Channel type215×70×5mm		13.04;8.48;6.04;4.38;3.43;2.47;1.76;1.2 8.1.00 /12.42;8.26;6.08;4.53;3.36;2.47;1.81; 1.35;1.00												front axle					
		4.8		3°		1°		Channel type215×70×5mm		13.04;8.48;6.04;4.38;3.43;2.47;1.76;1.2 8.1.00 /12.42;8.26;6.08;4.53;3.36;2.47;1.81; 1.35;1.00												front axle					
		Steyr two step reduction		1°		1°		Channel type215×70×5mm		13.04;8.48;6.04;4.38;3.43;2.47;1.76;1.2 8.1.00 /12.42;8.26;6.08;4.53;3.36;2.47;1.81; 1.35;1.00												front axle					
		4.8		3°		1°		Channel type215×70×5mm		13.04;8.48;6.04;4.38;3.43;2.47;1.76;1.2 8.1.00 /12.42;8.26;6.08;4.53;3.36;2.47;1.81; 1.35;1.00												front axle					
		Steyr two step reduction		1°		1°		Channel type215×70×5mm		13.04;8.48;6.04;4.38;3.43;2.47;1.76;1.2 8.1.00 /12.42;8.26;6.08;4.53;3.36;2.47;1.81; 1.35;1.00												front axle					
		4.8		3°		1°		Channel type215×70×5mm		13.04;8.48;6.04;4.38;3.43;2.47;1.76;1.2 8.1.00 /12.42;8.26;6.08;4.53;3.36;2.47;1.81; 1.35;1.00												front axle					
		Steyr two step reduction		1°		1°		Channel type215×70×5mm		13.04;8.48;6.04;4.38;3.43;2.47;1.76;1.2 8.1.00 /12.42;8.26;6.08;4.53;3.36;2.47;1.81; 1.35;1.00												front axle					
		4.8		3°		1°		Channel type215×70×5mm		13.04;8.48;6.04;4.38;3.43;2.47;1.76;1.2 8.1.00 /12.42;8.26;6.08;4.53;3.36;2.47;1.81; 1.35;1.00												front axle					
		Steyr two step reduction		1°		1°		Channel type215×70×5mm		13.04;8.48;6.04;4.38;3.43;2.47;1.76;1.2 8.1.00 /12.42;8.26;6.08;4.53;3.36;2.47;1.81; 1.35;1.00												front axle					
		4.8		3°		1°		Channel type215×70×5mm		13.04;8.48;6.04;4.38;3.43;2.47;1.76;1.2 8.1.00 /12.42;8.26;6.08;4.53;3.36;2.47;1.81; 1.35;1.00												front axle					
		Steyr two step reduction		1°		1°		Channel type215×70×5mm		13.04;8.48;6.04;4.38;3.43;2.47;1.76;1.2 8.1.00 /12.42;8.26;6.08;4.53;3.36;2.47;1.81; 1.35;1.00												front axle					
		4.8		3°		1°		Channel type215×70×5mm		13.04;8.48;6.04;4.38;3.43;2.47;1.76;1.2 8.1.00 /12.42;8.26;6.08;4.53;3.36;2.47;1.81; 1.35;1.00												front axle					
		Steyr two step reduction		1°		1°		Channel type215×70×5mm		13.04;8.48;6.04;4.38;3.43;2.47;1.76;1.2 8.1.00 /12.42;8.26;6.08;4.53;3.36;2.47;1.81; 1.35;1.00												front axle					
		4.8		3°		1°		Channel type215×70×5mm		13.04;8.48;6.04;4.38;3.43;2.47;1.76;1.2 8.1.00 /12.42;8.26;6.08;4.53;3.36;2.47;1.81; 1.35;1.00												front axle					
		Steyr two step reduction		1°		1°		Channel type215×70×5mm		13.04;8.48;6.04;4.38;3.43;2.47;1.76;1.2 8.1.00 /12.42;8.26;6.08;4.53;3.36;2.47;1.81; 1.35;1.00												front axle					
		4.8		3°		1°		Channel type215×70×5mm		13.04;8.48;6.04;4.38;3.43;2.47;1.76;1.2 8.1.00 /12.42;8.26;6.08;4.53;3.36;2.47;1.81; 1.35;1.00												front axle					
		Steyr two step reduction		1°		1°		Channel type215×70×5mm		13.04;8.48;6.04;4.38;3.43;2.47;1.76;1.2 8.1.00 /12.42;8.26;6.08;4.53;3.36;2.47;1.81; 1.35;1.00												front axle					
		4.8		3°		1°		Channel type215×70×5mm		13.04;8.48;6.04;4.38;3.43;2.47;1.76;1.2 8.1.00 /12.42;8.26;6.08;4.53;3.36;2.47;1.81; 1.35;1.00												front axle					
		Steyr two step reduction		1°		1°		Channel type215×70×5mm		13.04;8.48;6.04;4.38;3.43;2.47;1.76;1.2 8.1.00 /12.42;8.26;6.08;4.53;3.36;2.47;1.81; 1.35;1.00												front axle					
		4.8		3°		1°		Channel type215×70×5mm		13.04;8.48;6.04;4.38;3.43;2.47;1.76;1.2 8.1.00 /12.42;8.26;6.08;4.53;3.36;2.47;1.81; 1.35;1.00												front axle					
		Steyr two step reduction		1°		1°		Channel type215×70×5mm		13.04;8.48;6.04;4.38;3.43;2.47;1.76;1.2 8.1.00 /12.42;8.26;6.08;4.53;3.36;2.47;1.81; 1.35;1.00												front axle					
		4.8		3°		1°		Channel type215×70×5mm		13.04;8.48;6.04;4.38;3.43;2.47;1.76;1.2 8.1.00 /12.42;8.26;6.08;4.53;3.36;2.47;1.81; 1.35;1.00												front axle					
		Steyr two step reduction		1°		1°		Channel type215×70×5mm		13.04;8.48;6.04;4.38;3.43;2.47;1.76;1.2 8.1.00 /12.42;8.26;6.08;4.53;3.36;2.47;1.81; 1.35;1.00												front axle					
		4.8		3°		1°		Channel type215×70×5mm		13.04;8.48;6.04;4.38;3.43;2.47;1.76;1.2 8.1.00 /12.42;8.26;6.08;4.53;3.36;2.47;1.81; 1.35;1.00												front axle					
		Steyr two step reduction		1°		1°		Channel type215×70×5mm		13.04;8.48;6.04;4.38;3.43;2.47;1.76;1.2 8.1.00 /12.42;8.26;6.08;4.53;3.36;2.47;1.81; 1.35;1.00												front axle					
		4.8		3°		1°		Channel type215×70×5mm		13.04;8.48;6.04;4.38;3.43;2.47;1.76;1.2 8.1.00 /12.42;8.26;6.08;4.53;3.36;2.47;1.81; 1.35;1.00												front axle					
		Steyr two step reduction		1°		1°		Channel type215×70×5mm		13.04;8.48;6.04;4.38;3.43;2.47;1.76;1.2 8.1.00 /12.42;8.26;6.08;4.53;3.36;2.47;1.81; 1.35;1.00												front axle					
		4.8		3°		1°		Channel type215×70×5mm		13.04;8.48;6.04;4.38;3.43;2.47;1.76;1.2 8.1.00 /12.42;8.26;6.08;4.53;3.36;2.47;1.81; 1.35;1.00												front axle					
		Steyr two step reduction		1°		1°		Channel type215×70×5mm		13.04;8.48;6.04;4.38;3.43;2.47;1.76;1.2 8.1.00 /12.42;8.26;6.08;4.53;3.36;2.47;1.81; 1.35;1.00												front axle					
		4.8		3°		1°		Channel type215×70×5mm		13.04;8.48;6.04;4.38;3.43;2.47;1.76;1.2 8.1.00 /12.42;8.26;6.08;4.53;3.36;2.47;1.81; 1.35;1.00												front axle					
		Steyr two step reduction		1°		1°		Channel type215×70×5mm		13.04;8.48;6.04;4.38;3.43;2.47;1.76;1.2 8.1.00 /12.42;8.26;6.08;4.53;3.36;2.47;1.81; 1.35;1.00												front axle					
		4.8		3°		1°		Channel type215×70×5mm		13.04;8.48;6.04;4.38;3.43;2.47;1.76;1.2 8.1.00 /12.42;8.26;6.08;4.53;3.36;2.47;1.81; 1.35;1.00												front axle					
		Steyr two step reduction		1°		1°		Channel type215×70×5mm		13.04;8.48;6.04;4.38;3.43;2.47;1.76;1.2 8.1.00 /12.42;8.26;6.08;4.53;3.36;2.47;1.81; 1.35;1.00												front axle					
		4.8		3°		1°		Channel type215×70×5mm		13.04;8.48;6.04;4.38;3.43;2.47;1.76;1.2 8.1.00 /12.42;8.26;6.08;4.53;3.36;2.47;1.81; 1.35;1.00												front axle					
		Steyr two step reduction		1°		1°		Channel type215×70×5mm		13.04;8.48;6.04;4.38;3.43;2.47;1.76;1.2 8.1.00 /12.42;8.26;6.08;4.53;3.36;2.47;1.81; 1.35;1.00												front axle					
		4.8		3°		1°		Channel type215×70×5mm		13.04;8.48;6.04;4.38;3.43;2.47;1.76;1.2 8.1.00 /12.42;8.26;6.08;4.53;3.36;2.47;1.81; 1.35;1.00												front axle					
		Steyr two step reduction		1°		1°		Channel type215×70×5mm		13.04;8.48;6.04;4.38;3.43;2.47;1.76;1.2 8.1.00 /12.42;8.26;6.08;4.53;3.36;2.47;1.81; 1.35;1.00												front axle					
		4.8		3°		1°		Channel type215×70×5mm		13.04;8.48;6.04;4.38;3.43;2.47;1.76;1.2 8.1.00 /12.42;8.26;6.08;4.53;3.36;2.47;1.81; 1.35;1.00												front axle					
		Steyr two step reduction		1°		1°		Channel type215×70×5mm		13.04;8.48;6.04;4.38;3.43;2.47;1.76;1.2 8.1.00 /12.42;8.26;6.08;4.53;3.36;2.47;1.81; 1.35;1.00												front axle					
		4.8		3°		1°		Channel type215×70×5mm		13.04;8.48;6.04;4.38;3.43;2.47;1.76;1.2 8.1.00 /12.42;8.26;6.08;4.53;3.36;2.47;1.81; 1.35;1.00												front axle					
		Steyr two step reduction		1°		1°		Channel type215×70×5mm		13.04;8.48;6.04;4.38;3.43;2.47;1.76;1.2 8.1.00 /12.42;8.26;6.08;4.53;3.36;2.47;1.81; 1.35;1.00												front axle					
		4.8		3°		1°		Channel type215×70×5mm		13.04;8.48;6.04;4.38;3.43;2.47;1.76;1.2 8.1.00 /12.42;8.26;6.08;4.53;3.36;2.47;1.81; 1.35;1.00												front axle					
		Steyr two step reduction		1°		1°		Channel type215×70×5mm		13.04;8.48;6.04;4.38;3.43;2.47;1.76;1.2 8.1.00 /12.42;8.26;6.08;4.53;3.36;2.47;1.81; 1.35;1.00												front axle					

Table 1-2

body		mid & rear axle		front wheel data		Front axle		frame		gearbox		performance data		Mass data	
Type & dimension (lengthXwidthXheight)		Ratio		Toe-in		type		type		Forward ratio		Maximum speed (km/h)		Kerb Mass(Kg)	
7592x2326x550		4.8		3-4.5mm		Rigid stub axle with double T-cross section		Ladder frame		13.0;4.8;4.8;6.0;4.4;3.8;3.4;3.2;4.7;1.76;1.28;1.00		93		9100	
Differential lock		Model/Type		Caster		Channel type215x70x5mm		Section of Main frame		1/2.42;8.26;6.08;4.53;3.36;2.47;1.81;		Maximum grade ability (%)		Maximum total mass(Kg)	
		Steyr two step reduction		1°		Channel type243x80x8mm		Type		Reverse ratio		Fuel consumption (L/100km)		Train maximum total mass(Kg)	
				3°				SS-150GP/RT11509C		11.77/12.99		36		Towing gross weight (Kg)	
				1°				Distance after braked (speed =30km/h) (m)		Forward ratio		33		Maximum mass of each axle (Kg)	
								Distance in nopower (speed =50km/h) (m)		Type		93		Maximum mass of each axle (Kg)	
								Minimum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum gradient at parking brake%		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Capacity of fuel tank (L)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Accelerate time(gear ratio=1)(s)(20-70km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Minimum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
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								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
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								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
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								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
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								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
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								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
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								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
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								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
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								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
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								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
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								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
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								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)		55-150GP/RT11509C		93		Maximum mass of each axle (Kg)	
								Maximum speed in gear ratio=1(Km/h)							

Front axle		rear axle		front wheel data		gearbox		Frame		performance data				Mass data											
Rigid stub axle with double T-cross section		Differential lock		With axle,wheel differential lock		Toe-in		Reverse ratio		Section of assistant frame		capacity of fuel tank (L)		Distance in nopower (speed =50km/h) (m)		Minimum speed in gear ratio=1(km/h)		Max load capacity of fifth wheel(kg)		Maximum pull mass(t)		Maximum total mass(kg)		Mass in each axle (kg)	
		ratio		4.8		Caster		Forward ratio		Section of Main frame		Fuel consumption(l/100km)		Distance after braked (speed =30km/h) (m)		Maximum gradient at parking brake (%)		Train maximum total mass(kg)		Maximum mass of each		Maximum total mass(kg)		front axle	
		model		STERY rear axle		Kingpin inclination		1:00		Ladder frame		Distance after braked (speed =30km/h) (m)		Maximum grade ability (%)		Maximum speed (km/h)		Maximum turning circle (m)		Rear axle		18000(19000)		Rear axle	
Tire		wheel		8.5-20/8.0-20		Kingpin inclination		5:1.00		Channel type215×70×5(mm)		Distance in nopower (speed =50km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
		electric equipment		Batteries (V/Ah)		Caster		12.42;8.26;6.08;4.53;3.36;2.47;1.81;1.3		Channel type243×80×8(mm)		Distance after braked (speed =30km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
		Power of alternator		1000W		Kingpin inclination		12.42;8.26;6.08;4.53;3.36;2.47;1.81;1.3		Channel type243×80×8(mm)		Distance after braked (speed =30km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
wheel		Type for wire		Single line, negative grounded		Kingpin inclination		13.04;8.48;6.04;4.39;3.43;2.47;1.76;1.28		Ladder frame		Distance after braked (speed =30km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
		Volt		24V		Kingpin inclination		13.04;8.48;6.04;4.39;3.43;2.47;1.76;1.28		Ladder frame		Distance after braked (speed =30km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
		Type for wire		Single line, negative grounded		Kingpin inclination		13.04;8.48;6.04;4.39;3.43;2.47;1.76;1.28		Ladder frame		Distance after braked (speed =30km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
brake system		Trailer brake		3 - 4.5(mm)		Kingpin inclination		5:1.00		Channel type215×70×5(mm)		Distance in nopower (speed =50km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
		Auxiliary brake		3 - 4.5(mm)		Kingpin inclination		5:1.00		Channel type215×70×5(mm)		Distance in nopower (speed =50km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
		Engine exhaust brake		3 - 4.5(mm)		Kingpin inclination		5:1.00		Channel type215×70×5(mm)		Distance in nopower (speed =50km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
steering		Main brake		1°		Kingpin inclination		1:00		Ladder frame		Distance after braked (speed =30km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
		Spring energy air-cut-off brake		1°		Kingpin inclination		1:00		Ladder frame		Distance after braked (speed =30km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
		Two circuit brake		1°		Kingpin inclination		1:00		Ladder frame		Distance after braked (speed =30km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
clutch		Work pressure(kPa)		11.77/12.99		Kingpin inclination		5:1.00		Channel type215×70×5(mm)		Distance in nopower (speed =50km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
		Max oil pressure in oil pump(kPa)		11.77/12.99		Kingpin inclination		5:1.00		Channel type215×70×5(mm)		Distance in nopower (speed =50km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
		Ratio		11.77/12.99		Kingpin inclination		5:1.00		Channel type215×70×5(mm)		Distance in nopower (speed =50km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
cab		Model		11.77/12.99		Kingpin inclination		5:1.00		Channel type215×70×5(mm)		Distance in nopower (speed =50km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
		ZF8098		11.77/12.99		Kingpin inclination		5:1.00		Channel type215×70×5(mm)		Distance in nopower (speed =50km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
		Ratio		11.77/12.99		Kingpin inclination		5:1.00		Channel type215×70×5(mm)		Distance in nopower (speed =50km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
engine		Type		11.77/12.99		Kingpin inclination		5:1.00		Channel type215×70×5(mm)		Distance in nopower (speed =50km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
		WD615.62/WD615.87/WD615.69/WD615.47		11.77/12.99		Kingpin inclination		5:1.00		Channel type215×70×5(mm)		Distance in nopower (speed =50km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
		Displacement(L)		11.77/12.99		Kingpin inclination		5:1.00		Channel type215×70×5(mm)		Distance in nopower (speed =50km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
dimension data		Rated powerkW/(r/min)		11.77/12.99		Kingpin inclination		5:1.00		Channel type215×70×5(mm)		Distance in nopower (speed =50km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
		247/2200;273/2200		11.77/12.99		Kingpin inclination		5:1.00		Channel type215×70×5(mm)		Distance in nopower (speed =50km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
		1160/1300-1600		11.77/12.99		Kingpin inclination		5:1.00		Channel type215×70×5(mm)		Distance in nopower (speed =50km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
Dimensions		Maximum torqueNm/(r/min)		11.77/12.99		Kingpin inclination		5:1.00		Channel type215×70×5(mm)		Distance in nopower (speed =50km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
		1460/1300-1600		11.77/12.99		Kingpin inclination		5:1.00		Channel type215×70×5(mm)		Distance in nopower (speed =50km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
		196/2200;213/2200		11.77/12.99		Kingpin inclination		5:1.00		Channel type215×70×5(mm)		Distance in nopower (speed =50km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
Wheel base (mm)		Type		11.77/12.99		Kingpin inclination		5:1.00		Channel type215×70×5(mm)		Distance in nopower (speed =50km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
		WD615.62/WD615.87/WD615.69/WD615.47		11.77/12.99		Kingpin inclination		5:1.00		Channel type215×70×5(mm)		Distance in nopower (speed =50km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
		Displacement(L)		11.77/12.99		Kingpin inclination		5:1.00		Channel type215×70×5(mm)		Distance in nopower (speed =50km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
Track		Rated powerkW/(r/min)		11.77/12.99		Kingpin inclination		5:1.00		Channel type215×70×5(mm)		Distance in nopower (speed =50km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
		247/2200;273/2200		11.77/12.99		Kingpin inclination		5:1.00		Channel type215×70×5(mm)		Distance in nopower (speed =50km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
		1160/1300-1600		11.77/12.99		Kingpin inclination		5:1.00		Channel type215×70×5(mm)		Distance in nopower (speed =50km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
Dimensions		Maximum torqueNm/(r/min)		11.77/12.99		Kingpin inclination		5:1.00		Channel type215×70×5(mm)		Distance in nopower (speed =50km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
		1460/1300-1600		11.77/12.99		Kingpin inclination		5:1.00		Channel type215×70×5(mm)		Distance in nopower (speed =50km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
		196/2200;213/2200		11.77/12.99		Kingpin inclination		5:1.00		Channel type215×70×5(mm)		Distance in nopower (speed =50km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
Wheel base (mm)		Type		11.77/12.99		Kingpin inclination		5:1.00		Channel type215×70×5(mm)		Distance in nopower (speed =50km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
		WD615.62/WD615.87/WD615.69/WD615.47		11.77/12.99		Kingpin inclination		5:1.00		Channel type215×70×5(mm)		Distance in nopower (speed =50km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
		Displacement(L)		11.77/12.99		Kingpin inclination		5:1.00		Channel type215×70×5(mm)		Distance in nopower (speed =50km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
Track		Rated powerkW/(r/min)		11.77/12.99		Kingpin inclination		5:1.00		Channel type215×70×5(mm)		Distance in nopower (speed =50km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
		247/2200;273/2200		11.77/12.99		Kingpin inclination		5:1.00		Channel type215×70×5(mm)		Distance in nopower (speed =50km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
		1160/1300-1600		11.77/12.99		Kingpin inclination		5:1.00		Channel type215×70×5(mm)		Distance in nopower (speed =50km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
Dimensions		Maximum torqueNm/(r/min)		11.77/12.99		Kingpin inclination		5:1.00		Channel type215×70×5(mm)		Distance in nopower (speed =50km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
		1460/1300-1600		11.77/12.99		Kingpin inclination		5:1.00		Channel type215×70×5(mm)		Distance in nopower (speed =50km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
		196/2200;213/2200		11.77/12.99		Kingpin inclination		5:1.00		Channel type215×70×5(mm)		Distance in nopower (speed =50km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
Wheel base (mm)		Type		11.77/12.99		Kingpin inclination		5:1.00		Channel type215×70×5(mm)		Distance in nopower (speed =50km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
		WD615.62/WD615.87/WD615.69/WD615.47		11.77/12.99		Kingpin inclination		5:1.00		Channel type215×70×5(mm)		Distance in nopower (speed =50km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
		Displacement(L)		11.77/12.99		Kingpin inclination		5:1.00		Channel type215×70×5(mm)		Distance in nopower (speed =50km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
Track		Rated powerkW/(r/min)		11.77/12.99		Kingpin inclination		5:1.00		Channel type215×70×5(mm)		Distance in nopower (speed =50km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
		247/2200;273/2200		11.77/12.99		Kingpin inclination		5:1.00		Channel type215×70×5(mm)		Distance in nopower (speed =50km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
		1160/1300-1600		11.77/12.99		Kingpin inclination		5:1.00		Channel type215×70×5(mm)		Distance in nopower (speed =50km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
Dimensions		Maximum torqueNm/(r/min)		11.77/12.99		Kingpin inclination		5:1.00		Channel type215×70×5(mm)		Distance in nopower (speed =50km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
		1460/1300-1600		11.77/12.99		Kingpin inclination		5:1.00		Channel type215×70×5(mm)		Distance in nopower (speed =50km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
		196/2200;213/2200		11.77/12.99		Kingpin inclination		5:1.00		Channel type215×70×5(mm)		Distance in nopower (speed =50km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
Wheel base (mm)		Type		11.77/12.99		Kingpin inclination		5:1.00		Channel type215×70×5(mm)		Distance in nopower (speed =50km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
		WD615.62/WD615.87/WD615.69/WD615.47		11.77/12.99		Kingpin inclination		5:1.00		Channel type215×70×5(mm)		Distance in nopower (speed =50km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
		Displacement(L)		11.77/12.99		Kingpin inclination		5:1.00		Channel type215×70×5(mm)		Distance in nopower (speed =50km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
Track		Rated powerkW/(r/min)		11.77/12.99		Kingpin inclination		5:1.00		Channel type215×70×5(mm)		Distance in nopower (speed =50km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
		247/2200;273/2200		11.77/12.99		Kingpin inclination		5:1.00		Channel type215×70×5(mm)		Distance in nopower (speed =50km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
		1160/1300-1600		11.77/12.99		Kingpin inclination		5:1.00		Channel type215×70×5(mm)		Distance in nopower (speed =50km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
Dimensions		Maximum torqueNm/(r/min)		11.77/12.99		Kingpin inclination		5:1.00		Channel type215×70×5(mm)		Distance in nopower (speed =50km/h) (m)		Maximum speed (km/h)		Maximum gradient at parking brake (%)		Maximum pull mass(t)		Maximum mass of each		18000(19000)		Rear axle	
		1460/1300-1600		11.77/																					

Front axle		rear axle		front wheel data		gearbox		Frame		performance data				Mass data									
Rigid stub axle with double T-cross section		model		Toe-in		type		type		Minimum speed in gear ratio=1(km/h)		Maximum load capacity of fifth wheel(kg)		Kerb Mass(kg)		Mass in each axle		Dimensions		Wheel base (mm)		Track	
Differential lock		ratio		Caster		Forward ratio		Section of Main frame		Maximum gradient at parking brake (%)		Train maximum total mass(kg)		front axle		Length (mm)		width (mm)		height (no load)(mm)		front axle	
With axle, wheel differential lock		4.8		1°		00/12.42;8.26;6.08;4.53;3.36;2.47;1.81;1.3		Channel type 243×80×8(mm)		29;25.8;29		46;47.5;		rear axle		2480		1800		3730(with spoiler)		rear axle	
model		STEVR double rear axle		Kingpin inclination		13.04;8.48;6.04;4.39;3.43;2.47;1.76;1.28;1.00		Ladder frame		Maximum speed (km/h)		Maximum pull mass(t)		Wheel base (mm)		2925+1350		2925		2925+1350		2925+1350	
ratio		4.8		3°		55-150GP/RT11509C		Type		Distance in nopower (speed=50km/h) (m)		each axle (kg)		Approach angle (°)		15		15		15		Departure angle (°)	
Differential lock		With axle, wheel differential lock		Reverse ratio		Channel type 215×70×5(mm)		Section of assistant frame		Maximum grade ability (%)		Maximum mass of front axle		Minimum ground clearance (mm)		298		298		298		Front overhang (mm)	
11.77/12.99		5:1.00		Camber angle		13.04;8.48;6.04;4.39;3.43;2.47;1.76;1.28;1.00		Channel type 215×70×5(mm)		Distance after braked (speed=30km/h) (m)		Maximum mass of fifth wheel(kg)		Rear overhang (mm)		810		810		810		Rear overhang (mm)	
11.77/12.99		5:1.00		Reverse ratio		13.04;8.48;6.04;4.39;3.43;2.47;1.76;1.28;1.00		Channel type 215×70×5(mm)		Fuel consumption(l/100km)		Train maximum total mass(kg)		Distance from center of fifth wheel		2780		2780		2780		Distance from center of fifth wheel	
11.77/12.99		5:1.00		Reverse ratio		13.04;8.48;6.04;4.39;3.43;2.47;1.76;1.28;1.00		Channel type 215×70×5(mm)		Capacity of fuel tank (L)		Maximum load capacity of fifth wheel(kg)		Saddle height from ground (mm)		1369(no load)		1369		1369		Saddle height from ground (mm)	
11.77/12.99		5:1.00		Reverse ratio		13.04;8.48;6.04;4.39;3.43;2.47;1.76;1.28;1.00		Channel type 215×70×5(mm)		Distance in nopower (speed=50km/h) (m)		Maximum load capacity of fifth wheel(kg)		Type		WD615.62/WD615.69/WD615.47		WD615.62/WD615.69/WD615.47		WD615.62/WD615.69/WD615.47		Type	
11.77/12.99		5:1.00		Reverse ratio		13.04;8.48;6.04;4.39;3.43;2.47;1.76;1.28;1.00		Channel type 215×70×5(mm)		Distance in nopower (speed=50km/h) (m)		Maximum load capacity of fifth wheel(kg)		Displacement(L)		9.726		9.726		9.726		Displacement(L)	
11.77/12.99		5:1.00		Reverse ratio		13.04;8.48;6.04;4.39;3.43;2.47;1.76;1.28;1.00		Channel type 215×70×5(mm)		Distance in nopower (speed=50km/h) (m)		Maximum load capacity of fifth wheel(kg)		Rated powerkW/(r/min)		196/2200;213/2200		196/2200;213/2200		196/2200;213/2200		Rated powerkW/(r/min)	
11.77/12.99		5:1.00		Reverse ratio		13.04;8.48;6.04;4.39;3.43;2.47;1.76;1.28;1.00		Channel type 215×70×5(mm)		Distance in nopower (speed=50km/h) (m)		Maximum load capacity of fifth wheel(kg)		Maximum torqueNm/(r/min)		1100/1300-1600		1100/1300-1600		1100/1300-1600		Maximum torqueNm/(r/min)	
11.77/12.99		5:1.00		Reverse ratio		13.04;8.48;6.04;4.39;3.43;2.47;1.76;1.28;1.00		Channel type 215×70×5(mm)		Distance in nopower (speed=50km/h) (m)		Maximum load capacity of fifth wheel(kg)		Minimum fuel consumption g/(kWh)		1460/1300-1600		1460/1300-1600		1460/1300-1600		Minimum fuel consumption g/(kWh)	
11.77/12.99		5:1.00		Reverse ratio		13.04;8.48;6.04;4.39;3.43;2.47;1.76;1.28;1.00		Channel type 215×70×5(mm)		Distance in nopower (speed=50km/h) (m)		Maximum load capacity of fifth wheel(kg)		Seats		2seats		2seats		2seats		Seats	
11.77/12.99		5:1.00		Reverse ratio		13.04;8.48;6.04;4.39;3.43;2.47;1.76;1.28;1.00		Channel type 215×70×5(mm)		Distance in nopower (speed=50km/h) (m)		Maximum load capacity of fifth wheel(kg)		Type		STEVR-KING cab, Flat head, hydraulic		STEVR-KING cab, Flat head, hydraulic		STEVR-KING cab, Flat head, hydraulic		Type	
11.77/12.99		5:1.00		Reverse ratio		13.04;8.48;6.04;4.39;3.43;2.47;1.76;1.28;1.00		Channel type 215×70×5(mm)		Distance in nopower (speed=50km/h) (m)		Maximum load capacity of fifth wheel(kg)		Diameter of disc		Single disc dry type, Hydraulic operating with air assisted		Single disc dry type, Hydraulic operating with air assisted		Single disc dry type, Hydraulic operating with air assisted		Diameter of disc	
11.77/12.99		5:1.00		Reverse ratio		13.04;8.48;6.04;4.39;3.43;2.47;1.76;1.28;1.00		Channel type 215×70×5(mm)		Distance in nopower (speed=50km/h) (m)		Maximum load capacity of fifth wheel(kg)		Max oil pressure in oil pump(kPa)		13000		13000		13000		Max oil pressure in oil pump(kPa)	
11.77/12.99		5:1.00		Reverse ratio		13.04;8.48;6.04;4.39;3.43;2.47;1.76;1.28;1.00		Channel type 215×70×5(mm)		Distance in nopower (speed=50km/h) (m)		Maximum load capacity of fifth wheel(kg)		Work pressure(kPa)		784		784		784		Work pressure(kPa)	
11.77/12.99		5:1.00		Reverse ratio		13.04;8.48;6.04;4.39;3.43;2.47;1.76;1.28;1.00		Channel type 215×70×5(mm)		Distance in nopower (speed=50km/h) (m)		Maximum load capacity of fifth wheel(kg)		Main brake		Two circuit brake		Two circuit brake		Two circuit brake		Main brake	
11.77/12.99		5:1.00		Reverse ratio		13.04;8.48;6.04;4.39;3.43;2.47;1.76;1.28;1.00		Channel type 215×70×5(mm)		Distance in nopower (speed=50km/h) (m)		Maximum load capacity of fifth wheel(kg)		Parking brake		Spring energy air cut-off brake		Spring energy air cut-off brake		Spring energy air cut-off brake		Parking brake	
11.77/12.99		5:1.00		Reverse ratio		13.04;8.48;6.04;4.39;3.43;2.47;1.76;1.28;1.00		Channel type 215×70×5(mm)		Distance in nopower (speed=50km/h) (m)		Maximum load capacity of fifth wheel(kg)		Auxiliary brake		Engine exhaust brake		Engine exhaust brake		Engine exhaust brake		Auxiliary brake	
11.77/12.99		5:1.00		Reverse ratio		13.04;8.48;6.04;4.39;3.43;2.47;1.76;1.28;1.00		Channel type 215×70×5(mm)		Distance in nopower (speed=50km/h) (m)		Maximum load capacity of fifth wheel(kg)		Trailer brake		Single line, negative grounded		Single line, negative grounded		Single line, negative grounded		Trailer brake	
11.77/12.99		5:1.00		Reverse ratio		13.04;8.48;6.04;4.39;3.43;2.47;1.76;1.28;1.00		Channel type 215×70×5(mm)		Distance in nopower (speed=50km/h) (m)		Maximum load capacity of fifth wheel(kg)		Voltage		24V		24V		24V		Voltage	
11.77/12.99		5:1.00		Reverse ratio		13.04;8.48;6.04;4.39;3.43;2.47;1.76;1.28;1.00		Channel type 215×70×5(mm)		Distance in nopower (speed=50km/h) (m)		Maximum load capacity of fifth wheel(kg)		Power of alternator		1000W		1000W		1000W		Power of alternator	
11.77/12.99		5:1.00		Reverse ratio		13.04;8.48;6.04;4.39;3.43;2.47;1.76;1.28;1.00		Channel type 215×70×5(mm)		Distance in nopower (speed=50km/h) (m)		Maximum load capacity of fifth wheel(kg)		Batteries (V/Ah)		2*12/135		2*12/135		2*12/135		Batteries (V/Ah)	
11.77/12.99		5:1.00		Reverse ratio		13.04;8.48;6.04;4.39;3.43;2.47;1.76;1.28;1.00		Channel type 215×70×5(mm)		Distance in nopower (speed=50km/h) (m)		Maximum load capacity of fifth wheel(kg)		Wheel		8.5-20/8.0-20		8.5-20/8.0-20		8.5-20/8.0-20		Wheel	
11.77/12.99		5:1.00		Reverse ratio		13.04;8.48;6.04;4.39;3.43;2.47;1.76;1.28;1.00		Channel type 215×70×5(mm)		Distance in nopower (speed=50km/h) (m)		Maximum load capacity of fifth wheel(kg)		Tire		11.00-20,11.00R20		11.00-20,11.00R20		11.00-20,11.00R20		Tire	
11.77/12.99		5:1.00		Reverse ratio		13.04;8.48;6.04;4.39;3.43;2.47;1.76;1.28;1.00		Channel type 215×70×5(mm)		Distance in nopower (speed=50km/h) (m)		Maximum load capacity of fifth wheel(kg)		Pressure (kPa)		833±10		833±10		833±10		Pressure (kPa)	

STEVR ZZ4256M(N,S)2946F TRACTOR MAIN SPECIFICATION

Table 1-4

Table 1-5

body		mid & rear axle		front wheel data		front axle	frame		gearbox		performance data				Mass data																		
body dimension(lengthXwi dthXheight) mm	Type & dimension(lengthXwi dthXheight) mm	Differential lock	ratio	Model/Type	Φ	Type	Section of Main frame	Section of assistant frame	Forward ratio	Reverse ratio	Type	Distance after braked (speed =30km/h) (m)	Distance in nopower (speed =50km/h) (m)	Minimum speed in gear ratio=1(km/h)	Maximum gradient at parking brake%	capacity of fuel tank (L)	Fuel consumption (L/100km)	Maximum grade ability (%)	Maximum speed (km/h)	Minimum turning circle (m)	Kerb Mass(kg)	Mass in each axle(kg)	Maximum total mass(kg)	Maximum mass of each axle (kg)	Towing gross weight (kg)	Train maximum total mass(kg)							
	5400x2300x1000(1200,1300,1400,1500)	With axle,wheel diff,locks	5.73	Steyr two step reduction	3-4.5mm																						Rigid stub axle with double T-cross section	Channel type300x80x8mm	Channel type275x70x5mm	13.04;8.48;6.04;4.38;3.43;2.47;1.76;1.28;1.00	11.77/12.99	5S-150GP/RT11509C	830
wheel		electric equipment		brake system			steering		clutch		cab		engine				dimension data																
Tire	Type	Power of alternator	Voltage	Type for wire	Main brake	Parking brake	Auxiliary brake	Trailer brake	Work pressure (Kpa)	Maximum pressure in oilpump (Kpa)	Ratio	Model	Diameter of disc	type	seats	type	Rated power Kw/(r/min)	Maximum torque N.m/(r/min)	Rated fuel consumption g/(Kw.h)	Min fuel consumption g/(Kwh)	Type	Displacement (L)	Wheel base (mm)	Track width (mm)	Minimum ground clearance (mm)	Approach angle (°)	Departure angle (°)	Front overhang (mm)	Rear overhang(mm)				
	11.00-20, 12.00-20, 11.00R20, 12.00R20, 8.5-20/8.0-20																													Pressure(kpa)	833±10	8.5-20/8.0-20	2'12/135

Table 1-6

[illegible]

Table 1-7

body		mid & rear axle		front wheel data		Front axle	frame		gearbox		performance data				Mass data																				
body dimension(lengthXwidthXheight) mm	Type & 6250x2435x600	Differential lock	ratio	Mode /Type	Toe-in	Caster	Kingpin inclination	Camber angle	Type	Reverse ratio	Forward ratio	Type	Distance after braked (speed =30km/h) (m)	Distance in nopower (speed =50km/h) (m)	Minimum speed in gear ratio=1 (km/h)	Maximum gradient at parking brake%	capacity of fuel tank (L)	Fuel consumption (L/100km)	Maximum grade ability (%)	Maximum speed (km/h)	Minimum turning circle (m)	Train maximum total mass(Kg)	Towing gross weight (kg)	Maximum total mass(Kg)	Maximum mass of each axle (Kg)	Kerb Mass(Kg)	Mass in each axle(Kg)								
			4.8/4.22	Steyr two step reduction/Howo single reduction axle	3-4.5mm	1°	3°	1°	Rigid stub axle with double T-cross section	Channel type275x70x5mm	Channel type300x80x8mm	Ladder frame(1000front/850rear)	11.77/12.99	13.04;8.48;6.04;4.38;3.43;2.47;1.81;1.35;1.00	SS-150GP/RT11509C	≤9.0	830	20	20	200/350	26	46	90/102					20		16000(19000)	6000	7010	4430	2580	
wheel		electric equipment				brake system				steering		clutch		cab		engine				dimension data															
Tire	Type	Power of alternator	Batteries (V/Ah)	Type for wire	Main brake	Parking brake	Auxiliary brake	Trailer brake	Work pressure (Kpa)	Maximum pressure in oilpump (Kpa)	Ratio	Model	Diameter of disc	type	seats	Type	Rated fuel consumption g/(Kw.h)	Min fuel consumption g/(Kw.h)	Rated power Kw/(r/min)	Maximum torque	N.m/(r/min)	Displacement (L)	Type	number of pull pin	Rear overhang(mm)	Front overhang (mm)	Departure angle (°)	Approach angle (°)	Minimum ground clearance (mm)	Track width (mm)	Wheel base (mm)	Dimensions (mm)			
																																	Pressure(kpa)	Vol	Power of alternator
833±10	11.00-20 ,12.00-20 ,11.00R20 ,12.00R20	1000W	2*12/135	Single line, negative's with iron	Two circuit brake	Spring energy air cut-off brake	Engine exhaust brake		784	15000	22.4	ZF8098	Φ420mm	Single disc dry type coil-spring , Operating with air assisted	2seats	HOWO cab , Flat head, hydraulic lifting forward 55°		198	196/2200 or 213/2200	1100/(1300-1600)	1160/(1300-1600)	9.726	WD615.62 /WD615.87			2270	1500	20	16	314/298	1850	5000	8770	2496	2958

body		mid & rear axle		front wheel data			Front axle		frame		gearbox		performance data			Mass data																																																			
Type & dimension (lengthXwidthXheight) mm		Differential lock		Model/Type		Type		Section of Main frame		type		Reverse ratio		Forward ratio		Distance after braked (speed =30km/h)		Distance in nopower (speed =50km/h)		Minimum speed in gear ratio=1(Km/h)		Maximum gradient at parking brake%		Accelerate time(gear ratio=1)(s)(20-70km/h)		Capacity of fuel tank (L)		Fuel consumption (L/100Km)		Maximum grade ability (%)		Maximum speed (Km/h)		Minimum turning diameter (m)		Maximum total mass on fifth wheel(Kg)		Train maximum total mass(Kg)		Towing gross weight (Kg)		Maximum mass of each axle (Kg)		Maximum total mass(Kg)		Mass in each axle(Kg)		Kerb Mass(Kg)																			
9280x2435x600				4.8/4.22		HOWO single reduction driving axle		Steyr two step reduction		3-4.5mm		1°		3°		1°		Channel type275x70x5mm		Channel type300x80x8mm		Ladder frame(1000front/850rear)		11.77/12.99		13.04;8.48;6.04;4.38;3.43;2.47;1.76;1.28;1.00		1/2.42;8.26;6.08;4.53;3.36;2.47;1.81;		1.35;1.00		9.0		830		20		20		70		350		30		48		102/90		24												9450		4550		4900	
				Ratio		Model/Type		Type		Camber angle		Kingpin inclination		Caster		Toe-in		Section of assistant frame		Channel type275x70x5mm		Ladder frame(1000front/850rear)		Reverse ratio		Forward ratio		Distance after braked (speed =30km/h)		Distance in nopower (speed =50km/h)		Minimum speed in gear ratio=1(Km/h)		Maximum gradient at parking brake%		Accelerate time(gear ratio=1)(s)(20-70km/h)		Capacity of fuel tank (L)		Fuel consumption (L/100Km)		Maximum grade ability (%)		Maximum speed (Km/h)		Minimum turning diameter (m)		Maximum total mass on fifth wheel(Kg)		Train maximum total mass(Kg)		Towing gross weight (Kg)		Maximum mass of each axle (Kg)		Maximum total mass(Kg)		Mass in each axle(Kg)		Kerb Mass(Kg)							
9280x2435x600		Differential lock		Ratio		Model/Type		Type		Camber angle		Kingpin inclination		Caster		Toe-in		Section of assistant frame		Channel type275x70x5mm		Ladder frame(1000front/850rear)		Reverse ratio		Forward ratio		Distance after braked (speed =30km/h)		Distance in nopower (speed =50km/h)		Minimum speed in gear ratio=1(Km/h)		Maximum gradient at parking brake%		Accelerate time(gear ratio=1)(s)(20-70km/h)		Capacity of fuel tank (L)		Fuel consumption (L/100Km)		Maximum grade ability (%)		Maximum speed (Km/h)		Minimum turning diameter (m)		Maximum total mass on fifth wheel(Kg)		Train maximum total mass(Kg)		Towing gross weight (Kg)		Maximum mass of each axle (Kg)		Maximum total mass(Kg)		Mass in each axle(Kg)		Kerb Mass(Kg)							
9280x2435x600		Differential lock		Ratio		Model/Type		Type		Camber angle		Kingpin inclination		Caster		Toe-in		Section of assistant frame		Channel type275x70x5mm		Ladder frame(1000front/850rear)		Reverse ratio		Forward ratio		Distance after braked (speed =30km/h)		Distance in nopower (speed =50km/h)		Minimum speed in gear ratio=1(Km/h)		Maximum gradient at parking brake%		Accelerate time(gear ratio=1)(s)(20-70km/h)		Capacity of fuel tank (L)		Fuel consumption (L/100Km)		Maximum grade ability (%)		Maximum speed (Km/h)		Minimum turning diameter (m)		Maximum total mass on fifth wheel(Kg)		Train maximum total mass(Kg)		Towing gross weight (Kg)		Maximum mass of each axle (Kg)		Maximum total mass(Kg)		Mass in each axle(Kg)		Kerb Mass(Kg)							
9280x2435x600		Differential lock		Ratio		Model/Type		Type		Camber angle		Kingpin inclination		Caster		Toe-in		Section of assistant frame		Channel type275x70x5mm		Ladder frame(1000front/850rear)		Reverse ratio		Forward ratio		Distance after braked (speed =30km/h)		Distance in nopower (speed =50km/h)		Minimum speed in gear ratio=1(Km/h)		Maximum gradient at parking brake%		Accelerate time(gear ratio=1)(s)(20-70km/h)		Capacity of fuel tank (L)		Fuel consumption (L/100Km)		Maximum grade ability (%)		Maximum speed (Km/h)		Minimum turning diameter (m)		Maximum total mass on fifth wheel(Kg)		Train maximum total mass(Kg)		Towing gross weight (Kg)		Maximum mass of each axle (Kg)		Maximum total mass(Kg)		Mass in each axle(Kg)		Kerb Mass(Kg)							
9280x2435x600		Differential lock		Ratio		Model/Type		Type		Camber angle		Kingpin inclination		Caster		Toe-in		Section of assistant frame		Channel type275x70x5mm		Ladder frame(1000front/850rear)		Reverse ratio		Forward ratio		Distance after braked (speed =30km/h)		Distance in nopower (speed =50km/h)		Minimum speed in gear ratio=1(Km/h)		Maximum gradient at parking brake%		Accelerate time(gear ratio=1)(s)(20-70km/h)		Capacity of fuel tank (L)		Fuel consumption (L/100Km)		Maximum grade ability (%)		Maximum speed (Km/h)		Minimum turning diameter (m)		Maximum total mass on fifth wheel(Kg)		Train maximum total mass(Kg)		Towing gross weight (Kg)		Maximum mass of each axle (Kg)		Maximum total mass(Kg)		Mass in each axle(Kg)		Kerb Mass(Kg)							
9280x2435x600		Differential lock		Ratio		Model/Type		Type		Camber angle		Kingpin inclination		Caster		Toe-in		Section of assistant frame		Channel type275x70x5mm		Ladder frame(1000front/850rear)		Reverse ratio		Forward ratio		Distance after braked (speed =30km/h)		Distance in nopower (speed =50km/h)		Minimum speed in gear ratio=1(Km/h)		Maximum gradient at parking brake%		Accelerate time(gear ratio=1)(s)(20-70km/h)		Capacity of fuel tank (L)		Fuel consumption (L/100Km)		Maximum grade ability (%)		Maximum speed (Km/h)		Minimum turning diameter (m)		Maximum total mass on fifth wheel(Kg)		Train maximum total mass(Kg)		Towing gross weight (Kg)		Maximum mass of each axle (Kg)		Maximum total mass(Kg)		Mass in each axle(Kg)		Kerb Mass(Kg)							
9280x2435x600		Differential lock		Ratio		Model/Type		Type		Camber angle		Kingpin inclination		Caster		Toe-in		Section of assistant frame		Channel type275x70x5mm		Ladder frame(1000front/850rear)		Reverse ratio		Forward ratio		Distance after braked (speed =30km/h)		Distance in nopower (speed =50km/h)		Minimum speed in gear ratio=1(Km/h)		Maximum gradient at parking brake%		Accelerate time(gear ratio=1)(s)(20-70km/h)		Capacity of fuel tank (L)		Fuel consumption (L/100Km)		Maximum grade ability (%)		Maximum speed (Km/h)		Minimum turning diameter (m)		Maximum total mass on fifth wheel(Kg)		Train maximum total mass(Kg)		Towing gross weight (Kg)		Maximum mass of each axle (Kg)		Maximum total mass(Kg)		Mass in each axle(Kg)		Kerb Mass(Kg)							
9280x2435x600		Differential lock		Ratio		Model/Type		Type		Camber angle		Kingpin inclination		Caster		Toe-in		Section of assistant frame		Channel type275x70x5mm		Ladder frame(1000front/850rear)		Reverse ratio		Forward ratio		Distance after braked (speed =30km/h)		Distance in nopower (speed =50km/h)		Minimum speed in gear ratio=1(Km/h)		Maximum gradient at parking brake%		Accelerate time(gear ratio=1)(s)(20-70km/h)		Capacity of fuel tank (L)		Fuel consumption (L/100Km)		Maximum grade ability (%)		Maximum speed (Km/h)		Minimum turning diameter (m)		Maximum total mass on fifth wheel(Kg)		Train maximum total mass(Kg)		Towing gross weight (Kg)		Maximum mass of each axle (Kg)		Maximum total mass(Kg)		Mass in each axle(Kg)		Kerb Mass(Kg)							
9280x2435x600		Differential lock		Ratio		Model/Type		Type		Camber angle		Kingpin inclination		Caster		Toe-in		Section of assistant frame		Channel type275x70x5mm		Ladder frame(1000front/850rear)		Reverse ratio		Forward ratio		Distance after braked (speed =30km/h)		Distance in nopower (speed =50km/h)		Minimum speed in gear ratio=1(Km/h)		Maximum gradient at parking brake%		Accelerate time(gear ratio=1)(s)(20-70km/h)		Capacity of fuel tank (L)		Fuel consumption (L/100Km)		Maximum grade ability (%)		Maximum speed (Km/h)		Minimum turning diameter (m)		Maximum total mass on fifth wheel(Kg)		Train maximum total mass(Kg)		Towing gross weight (Kg)		Maximum mass of each axle (Kg)		Maximum total mass(Kg)		Mass in each axle(Kg)		Kerb Mass(Kg)							
9280x2435x600		Differential lock		Ratio		Model/Type		Type		Camber angle		Kingpin inclination		Caster		Toe-in		Section of assistant frame		Channel type275x70x5mm		Ladder frame(1000front/850rear)		Reverse ratio		Forward ratio		Distance after braked (speed =30km/h)		Distance in nopower (speed =50km/h)		Minimum speed in gear ratio=1(Km/h)		Maximum gradient at parking brake%		Accelerate time(gear ratio=1)(s)(20-70km/h)		Capacity of fuel tank (L)		Fuel consumption (L/100Km)		Maximum grade ability (%)		Maximum speed (Km/h)		Minimum turning diameter (m)		Maximum total mass on fifth wheel(Kg)		Train maximum total mass(Kg)		Towing gross weight (Kg)		Maximum mass of each axle (Kg)		Maximum total mass(Kg)		Mass in each axle(Kg)		Kerb Mass(Kg)							
9280x2435x600		Differential lock		Ratio		Model/Type		Type		Camber angle		Kingpin inclination		Caster		Toe-in		Section of assistant frame		Channel type275x70x5mm		Ladder frame(1000front/850rear)		Reverse ratio		Forward ratio		Distance after braked (speed =30km/h)		Distance in nopower (speed =50km/h)		Minimum speed in gear ratio=1(Km/h)		Maximum gradient at parking brake%		Accelerate time(gear ratio=1)(s)(20-70km/h)		Capacity of fuel tank (L)		Fuel consumption (L/100Km)		Maximum grade ability (%)		Maximum speed (Km/h)		Minimum turning diameter (m)		Maximum total mass on fifth wheel(Kg)		Train maximum total mass(Kg)		Towing gross weight (Kg)		Maximum mass of each axle (Kg)		Maximum total mass(Kg)		Mass in each axle(Kg)		Kerb Mass(Kg)							
9280x2435x600		Differential lock		Ratio		Model/Type		Type		Camber angle		Kingpin inclination		Caster		Toe-in		Section of assistant frame		Channel type275x70x5mm		Ladder frame(1000front/850rear)		Reverse ratio		Forward ratio		Distance after braked (speed =30km/h)		Distance in nopower (speed =50km/h)		Minimum speed in gear ratio=1(Km/h)		Maximum gradient at parking brake%		Accelerate time(gear ratio=1)(s)(20-70km/h)		Capacity of fuel tank (L)		Fuel consumption (L/100Km)		Maximum grade ability (%)		Maximum speed (Km/h)		Minimum turning diameter (m)		Maximum total mass on fifth wheel(Kg)		Train maximum total mass(Kg)		Towing gross weight (Kg)		Maximum mass of each axle (Kg)		Maximum total mass(Kg)		Mass in each axle(Kg)		Kerb Mass(Kg)							
9280x2435x600		Differential lock		Ratio		Model/Type		Type		Camber angle		Kingpin inclination		Caster		Toe-in		Section of assistant frame		Channel type275x70x5mm		Ladder frame(1000front/850rear)		Reverse ratio		Forward ratio		Distance after braked (speed =30km/h)		Distance in nopower (speed =50km/h)		Minimum speed in gear ratio=1(Km/h)		Maximum gradient at parking brake%		Accelerate time(gear ratio=1)(s)(20-70km/h)		Capacity of fuel tank (L)		Fuel consumption (L/100Km)		Maximum grade ability (%)		Maximum speed (Km/h)		Minimum turning diameter (m)		Maximum total mass on fifth wheel(Kg)		Train maximum total mass(Kg)		Towing gross weight (Kg)		Maximum mass of each axle (Kg)		Maximum total mass(Kg)		Mass in each axle(Kg)		Kerb Mass(Kg)							
9280x2435x600		Differential lock		Ratio		Model/Type		Type		Camber angle		Kingpin inclination		Caster		Toe-in		Section of assistant frame		Channel type275x70x5mm		Ladder frame(1000front/850rear)		Reverse ratio		Forward ratio		Distance after braked (speed =30km/h)		Distance in nopower (speed =50km/h)		Minimum speed in gear ratio=1(Km/h)		Maximum gradient at parking brake%		Accelerate time(gear ratio=1)(s)(20-70km/h)		Capacity of fuel tank (L)		Fuel consumption (L/100Km)		Maximum grade ability (%)		Maximum speed (Km/h)		Minimum turning diameter (m)		Maximum total mass on fifth wheel(Kg)		Train maximum total mass(Kg)		Towing gross weight (Kg)		Maximum mass of each axle (Kg)		Maximum total mass(Kg)		Mass in each axle(Kg)		Kerb Mass(Kg)							
9280x2435x600		Differential lock		Ratio		Model/Type		Type		Camber angle		Kingpin inclination		Caster		Toe-in		Section of assistant frame		Channel type275x70x5mm		Ladder frame(1000front/850rear)		Reverse ratio		Forward ratio		Distance after braked (speed =30km/h)		Distance in nopower (speed =50km/h)		Minimum speed in gear ratio=1(Km/h)		Maximum gradient at parking brake%		Accelerate time(gear ratio=1)(s)(20-70km/h)		Capacity of fuel tank (L)		Fuel consumption (L/100Km)		Maximum grade ability (%)		Maximum speed (Km/h)		Minimum turning diameter (m)		Maximum total mass on fifth wheel(Kg)		Train maximum total mass(Kg)		Towing gross weight (Kg)		Maximum mass of each axle (Kg)		Maximum total mass(Kg)		Mass in each axle(Kg)		Kerb Mass(Kg)							
9280x2435x600		Differential lock		Ratio		Model/Type		Type		Camber angle		Kingpin inclination		Caster		Toe-in		Section of assistant frame		Channel type275x70x5mm		Ladder frame(1000front/850rear)		Reverse ratio		Forward ratio		Distance after braked (speed =30km/h)		Distance in nopower (speed =50km/h)		Minimum speed in gear ratio=1(Km/h)		Maximum gradient at parking brake%		Accelerate time(gear ratio=1)(s)(20-70km/h)		Capacity of fuel tank (L)		Fuel consumption (L/100Km)		Maximum grade ability (%)		Maximum speed (Km/h)		Minimum turning diameter (m)		Maximum total mass on fifth wheel(Kg)		Train maximum total mass(Kg)		Towing gross weight (Kg)		Maximum mass of each axle (Kg)		Maximum total mass(Kg)		Mass in each axle(Kg)		Kerb Mass(Kg)							
9280x2435x600		Differential lock		Ratio		Model/Type		Type		Camber angle		Kingpin inclination		Caster		Toe-in		Section of assistant frame		Channel type275x70x5mm		Ladder frame(1000front/850rear)		Reverse ratio		Forward ratio		Distance after braked (speed =30km/h)		Distance in nopower (speed =50km/h)		Minimum speed in gear ratio=1(Km/h)		Maximum gradient at parking brake%		Accelerate time(gear ratio=1)(s)(20-70km/h)		Capacity of fuel tank (L)		Fuel consumption (L/100Km)		Maximum grade ability (%)		Maximum speed (Km/h)		Minimum turning diameter (m)		Maximum total mass on fifth wheel(Kg)		Train maximum total mass(Kg)		Towing gross weight (Kg)		Maximum mass of each axle (Kg)		Maximum total mass(Kg)		Mass in each axle(Kg)		Kerb Mass(Kg)							
9280x2435x600		Differential lock		Ratio		Model/Type		Type		Camber angle		Kingpin inclination		Caster		Toe-in		Section of assistant frame		Channel type275x70x5mm		Ladder frame(1000front/850rear)		Reverse ratio		Forward ratio		Distance after braked (speed =30km/h)		Distance in nopower (speed =50km/h)		Minimum speed in gear ratio=1(Km/h)		Maximum gradient at parking brake%		Accelerate time(gear ratio=1)(s)(20-70km/h)		Capacity of fuel tank (L)		Fuel consumption (L/100Km)		Maximum grade ability (%)		Maximum speed (Km/h)		Minimum turning diameter (m)		Maximum total mass on fifth wheel(Kg)		Train maximum total mass(Kg)		Towing gross weight (Kg)		Maximum mass of each axle (Kg)		Maximum total mass(Kg)		Mass in each axle(Kg)		Kerb Mass(Kg)							
9280x2435x600		Differential lock		Ratio		Model/Type		Type		Camber angle		Kingpin inclination		Caster		Toe-in		Section of assistant frame		Channel type275x70x5mm		Ladder frame(1000front/850rear)		Reverse ratio		Forward ratio		Distance after braked (speed =30km/h)		Distance in nopower (speed =50km/h)		Minimum speed in gear ratio=1(Km/h)		Maximum gradient at parking brake%		Accelerate time(gear ratio=1)(s)(20-70km/h)		Capacity of fuel tank (L)		Fuel consumption (L/100Km)		Maximum grade ability (%)		Maximum speed (Km/h)		Minimum turning diameter (m)		Maximum total mass on fifth wheel(Kg)		Train maximum total mass(Kg)		Towing gross weight (Kg)		Maximum mass of each axle (Kg)		Maximum total mass(Kg)		Mass in each axle(Kg)		Kerb Mass(Kg)							
9280x2435x600		Differential lock		Ratio		Model/Type		Type		Camber angle		Kingpin inclination		Caster		Toe-in		Section of assistant frame		Channel type275x70x5mm		Ladder frame(1000front/850rear)		Reverse ratio		Forward ratio		Distance after braked (speed =30km/h)		Distance in nopower (speed =50km/h)		Minimum speed in gear ratio=1(Km/h)		Maximum gradient at parking brake%		Accelerate time(gear ratio=1)(s)(20-70km/h)		Capacity of fuel tank (L)		Fuel consumption (L/100Km)		Maximum grade ability (%)		Maximum speed (Km/h)		Minimum turning diameter (m)		Maximum total mass on fifth wheel(Kg)		Train maximum total mass(Kg)		Towing gross weight (Kg)		Maximum mass of each axle (Kg)		Maximum total mass(Kg)		Mass in each axle(Kg)		Kerb Mass(Kg)							
9280x2435x600		Differential lock		Ratio		Model/Type		Type		Camber angle		Kingpin inclination		Caster		Toe-in		Section of assistant frame		Channel type275x70x5mm		Ladder frame(1000front/850rear)		Reverse ratio		Forward ratio		Distance after braked (speed =30km/h)		Distance in nopower (speed =50km/h)		Minimum speed in gear ratio=1(Km/h)		Maximum gradient at parking brake%		Accelerate time(gear ratio=1)(s)(20-70km/h)		Capacity of fuel tank (L)		Fuel consumption (L/100Km)		Maximum grade ability (%)		Maximum speed (Km/h)		Minimum turning diameter (m)		Maximum total mass on fifth wheel(Kg)		Train maximum total mass(Kg)		Towing gross weight (Kg)		Maximum mass of each axle (Kg)		Maximum total mass(Kg)		Mass in each axle(Kg)		Kerb Mass(Kg)							
9280x2435x600		Differential lock		Ratio		Model/Type		Type		Camber angle		Kingpin inclination		Caster		Toe-in		Section of assistant frame		Channel type275x70x5mm		Ladder frame(1000front/850rear)		Reverse ratio		Forward ratio		Distance after braked (speed =30km/h)		Distance in nopower (speed =50km/h)		Minimum speed in gear ratio=1(Km/h)		Maximum gradient at parking brake%		Accelerate time(gear ratio=1)(s)(20-70km/h)		Capacity of fuel tank (L)		Fuel consumption (L/100Km)		Maximum grade ability (%)		Maximum speed (Km/h)		Minimum turning diameter (m)		Maximum total mass on fifth wheel(Kg)		Train maximum total mass(Kg)		Towing gross weight (Kg)		Maximum mass of each axle (Kg)		Maximum total mass(Kg)		Mass in each axle(Kg)		Kerb Mass(Kg)							
9280x2435x600		Differential lock		Ratio		Model/Type		Type		Camber angle		Kingpin inclination		Caster		Toe-in		Section of assistant frame		Channel type275x70x5mm		Ladder frame(1000front/850rear)		Reverse ratio		Forward ratio		Distance after braked (speed =30km/h)		Distance in nopower (speed =50km/h)		Minimum speed in gear ratio=1(Km/h)		Maximum gradient at parking brake%		Accelerate time(gear ratio=1)(s)(20-70km/h)		Capacity of fuel tank (L)		Fuel consumption (L/100Km)		Maximum grade ability (%)		Maximum speed (Km/h)		Minimum turning diameter (m)		Maximum total mass on fifth wheel(Kg)		Train maximum total mass(Kg)		Towing gross weight (Kg)		Maximum mass of each axle (Kg)		Maximum total mass(Kg)		Mass in each axle(Kg)		Kerb Mass(Kg)							
9280x2435x600		Differential lock		Ratio		Model/Type		Type		Camber angle		Kingpin inclination		Caster		Toe-in		Section of assistant frame		Channel type275x70x5mm		Ladder frame(1000front/850rear)		Reverse ratio		Forward ratio		Distance after braked (speed =30km/h)		Distance in nopower (speed =50km/h)		Minimum speed in gear ratio=1(Km/h)		Maximum gradient at parking brake%		Accelerate time(gear ratio=1)(s)(20-70km/h)		Capacity of fuel tank (L)		Fuel consumption (L/100Km)		Maximum grade ability (%)		Maximum speed (Km/h)		Minimum turning diameter (m)		Maximum total mass on fifth wheel(Kg)		Train maximum total mass(Kg)		Towing gross weight (Kg)		Maximum mass of each axle (Kg)		Maximum total mass(Kg)		Mass in each axle(Kg)		Kerb Mass(Kg)							
9280x2435x600		Differential lock		Ratio		Model/Type		Type		Camber angle		Kingpin inclination		Caster		Toe-in		Section of assistant frame		Channel type275x70x5mm		Ladder frame(1000front/850rear)		Reverse ratio		Forward ratio		Distance after braked (speed =30km/h)		Distance in nopower (speed =50km/h)		Minimum speed in gear ratio=1(Km/h)		Maximum gradient at parking brake%		Accelerate time(gear ratio=1)(s)(20-70km/h)		Capacity of fuel tank (L)		Fuel consumption (L/100Km)		Maximum grade ability (%)		Maximum speed (Km/h)		Minimum turning diameter (m)		Maximum total mass on fifth wheel(Kg)		Train maximum total mass(Kg)		Towing gross weight (Kg)		Maximum mass of each axle (Kg)		Maximum total mass(Kg)		Mass in each axle(Kg)		Kerb Mass(Kg)							
9280x2435x600		Differential lock		Ratio		Model/Type		Type		Camber angle		Kingpin inclination		Caster		Toe-in		Section of assistant frame		Channel type275x70x5mm		Ladder frame(1000front/850rear)		Reverse ratio		Forward ratio		Distance after braked (speed =30km/h)		Distance in nopower (speed =50km/h)		Minimum speed in gear ratio=1(Km/h)		Maximum gradient at parking brake%		Accelerate time(gear ratio=1)(s)(20-70km/h)		Capacity of fuel tank (L)		Fuel consumption (L/100Km)		Maximum grade ability (%)		Maximum speed (Km/h)		Minimum turning diameter (m)		Maximum total mass on fifth wheel(Kg)</																			

Front axle		rear axle		front wheel data		gearbox		Frame		performance data				Mass data																			
Front axle type:Rigid stub axle with double T-cross section		model HW1667 single rear axle /STERY rear axle		ratio 4.22/4.42		Differential lock		Toe-in 3 - 4.5(mm)		Caster 1°		Kingpin inclination 3°		Camber angle 1°		Reverse ratio 11.77		Type QJ55-150GP		Forward ratio 13.04;8.48;6.04;4.39;3.43; 2.47;1.76;1.28;1.00		Forward ratio 11.77											
electric equipment		Type for wire Single line, negative grounded		Volt 24V		Power of alternator 1000W		Batteries (V/Ah) 2*12/135		wheel 8.5-20/8.0-20		Tire Type 12.00-20,12.00R20, 11.00-20,11.00R20		pressure (kPa) 833 ± 10		brake system		Main brake Two circuit brake		Parking brake Spring energy air cut-off brake		Auxiliary brake Engine exhaust brake		Trailer brake									
steering		Model ZF8098		Ratio 22.2-26.2		Max oil pressure in oil pump(kPa) 15000		Work pressure(kPa) 784		Type Single disc-dry type, Hydraulic operating with air assisted		Diameter of disc φ 420(mm)for WD615.62/87/69 φ 430(mm)for WD615.47		Section of Main frame Channel type300×80×8(mm)		Section of assistant frame Channel type275×70×5(mm)		Type Ladder frame (1000iron/850rear)		Distance in nopower (speed =50km/h) (m) ≥ 830		Maximum gradient at parking brake (%) 20		Minimum speed in gear ratio=1(km/h) 29		Distance after braked (speed =30km/h) (m) ≤ 9.0		Fuel consumption(l/100km) 32		Capacity of fuel tank (L) 350			
cab		Type HOWO cab, Flat head, hydraulic tilting forward 55°		seats 2seats		engine		Minimum fuel consumption g/(kW/h) 198;197;195		Rated powerkW/(r/min) 196/2200;213/2200 247/2200;273/2200		Maximum torqueNm/(r/min) 1100 /1300-1600 1160/1300-1600 1350/1300-1600 1460/1300-1600		Maximum speed (km/h) 102		Maximum grade ability (%) 59		Maximum gradient at parking brake (%) 20		Minimum speed in gear ratio=1(km/h) 29		Distance in nopower (speed =50km/h) (m) ≥ 830		Distance after braked (speed =30km/h) (m) ≤ 9.0		Fuel consumption(l/100km) 32		Capacity of fuel tank (L) 350					
dimension data		Wheel base (mm) 3500		Track front axle 2041/2022 rear axle 1850		Minimum ground clearance (mm) 260		Approach angle (°) 16		Departure angle (°) 42		Front overhang (mm) 1500		Rear overhang (mm) 1110		distance from center of fifth wheel to cab backplate mm 2010		saddle height from ground (mm) 1246(loaded)/1364(no load)		Type WD615.62/WD615.87/WD615.69/WD615.47		Displacement(L) 9.726		Rated powerkW/(r/min) 196/2200;213/2200 247/2200;273/2200		Maximum torqueNm/(r/min) 1100 /1300-1600 1160/1300-1600 1350/1300-1600 1460/1300-1600		Minimum fuel consumption g/(kW/h) 198;197;195		seats 2seats			
Kerb Mass(kg)		7180		Mass in each axle front axle 4600 Rear axle 2580		Maximum total mass(kg) 18000(19000)		Maximum mass of front axle 7000		Maximum mass of rear axle 11000(13000)		Maximum pull mass(kg) 38600		Train maximum total mass(kg) 10690(11690)		Minimum turning circle (m) 14.2		Maximum speed (km/h) 102		Maximum grade ability (%) 59		Maximum gradient at parking brake (%) 20		Minimum speed in gear ratio=1(km/h) 29		Distance in nopower (speed =50km/h) (m) ≥ 830		Distance after braked (speed =30km/h) (m) ≤ 9.0		Fuel consumption(l/100km) 32		Capacity of fuel tank (L) 350	

HOWO ZZ4187M(N,S)3211F TRACTOR MAIN SPECIFICATION

Front axle	Front axle type: Rigid stub axle with double T-cross section	Tire	Tire pressure (kPa)	Type	8.5-20/8.0-20	11.00-20, 11.00R20	12.00-20, 12.00R20	833 ± 10
rear axle	lock	Differential	ratio	model	HW1697 double rear axle	4.22	Side Ratio	2*12/135
front wheel data	Toe-in	Caster	Kingpin inclination	Camber angle	3 ~ 4.5(mm)	1°	3°	1°
gearbox	Reverse ratio	Forward ratio	type	frame	Section of assistant	Channel type 275 × 70 × 5 (mm)	Section of Main frame	Ladder frame (1000 front/850 rear)
performance data	Minimum speed in gear ratio=1 (km/h)	Maximum gradient at parking brake (%)	20	Maximum grade ability (%)	62	102	Distance in no power (speed = 50 km/h) (m)	≥ 830
Mass data	Kerb Mass (kg)	Mass in each axle (kg)	Front axle	Rear axle	4390	4830	Maximum turning circle (m)	22
dimension data	Wheel base (mm)	Track	width (mm)	height (no load) (mm)	3200+1400	2041/2022	1850	260
engine	Rated power kW/(r/min)	Maximum torque Nm/(r/min)	Minimum fuel consumption g/(kWh)	Type	WD615.62/WD615.87/WD615.69/WD615.47	9.726	Displacement (L)	196/2200; 213/2200
cab	seats	type	forward 55°	HOWO cab, Flat head, hydraulic tilting	2 seats	Single disc dry type, Hydraulic operating with air assisted	Diameter of disc	φ 420 (mm) for WD615.62/87/69
clutch	type	Diameter of disc	φ 430 (mm) for WD615.47	steering	Model	ZF8098	Ratio	22.2-26.2
brake system	Main brake	Two circuit brake	Spring energy air cut-off brake	Auxiliary brake	Trailer brake	Type for wire	Single line, negative grounded	24V
electric equipment	Power of alternator	1000W	Voltage	Type for wire	Single line, negative grounded	24V	Batteries (V/Ah)	2*12/135
wheel	Tire	Tire pressure (kPa)	Type	8.5-20/8.0-20	11.00-20, 11.00R20	12.00-20, 12.00R20	833 ± 10	

HOWO ZZ4257M(N,S)3241V TRACTOR MAIN SPECIFICATION

Table 1-10

[illegible]

HOWO ZZ3257M3641 TIPPER TRUCK CHASSIS MAIN SPECIFICATION

body		mid & rear axle		front wheel data			Front axle		frame		gearbox		performance data						Mass data												
Type	dimension(lengthXwi dthXheight) mm	Differential lock	ratio	Model/Type	Toe-in	Caster	Kingpin inclination	Camber angle	type	Section of Main frame	Reverse ratio	Forward ratio	type	Distance after braked (speed =30Km/h) (m)	Distance in nopower (speed =50Km/h) (m)	Minimum speed in gear ratio=1(Km/h)	Maximum gradient at parking brake%	capacity of fuel tank (L)	Fuel consumption (L/100Km)	Maximum grade ability (%)	Maximum speed (Km/h)	Minimum turning circle (m)	Train maximum total mass(Kg)	Towing gross weight (Kg)	each axle (Kg)	Maximum mass of front axle	Maximum total mass(Kg)	Mass in each axle(Kg)	Kerb Mass(Kg)		
7000X2300X1000(1200,1300,1400,1500)		With axle, wheel diff. locks	5.73	Steyr two step reduction	3-4.5mm	1°	3°	1°	Rigid stub axle with double T-cross section	Channel type275×70×5mm	11.77/12.99	13.04;8.48;6.04;4.38;3.43;2.47;1.76;1.28;1.00 1/12.42;8.26;6.08;4.53;3.36;2.47;1.81;1.35;1.00	55-150GP/RT11509C	≤9.0	830	21.3	20	200	32	48	75	23.2			rear axle	7000	31000(40000)	front axle	6010	10080	

HOWO ZZ3317M(N)3061 TIPPER TRUCK CHASSIS MAIN SPECIFICATION

Table 1-12

CHAPTER 2 ENGINE

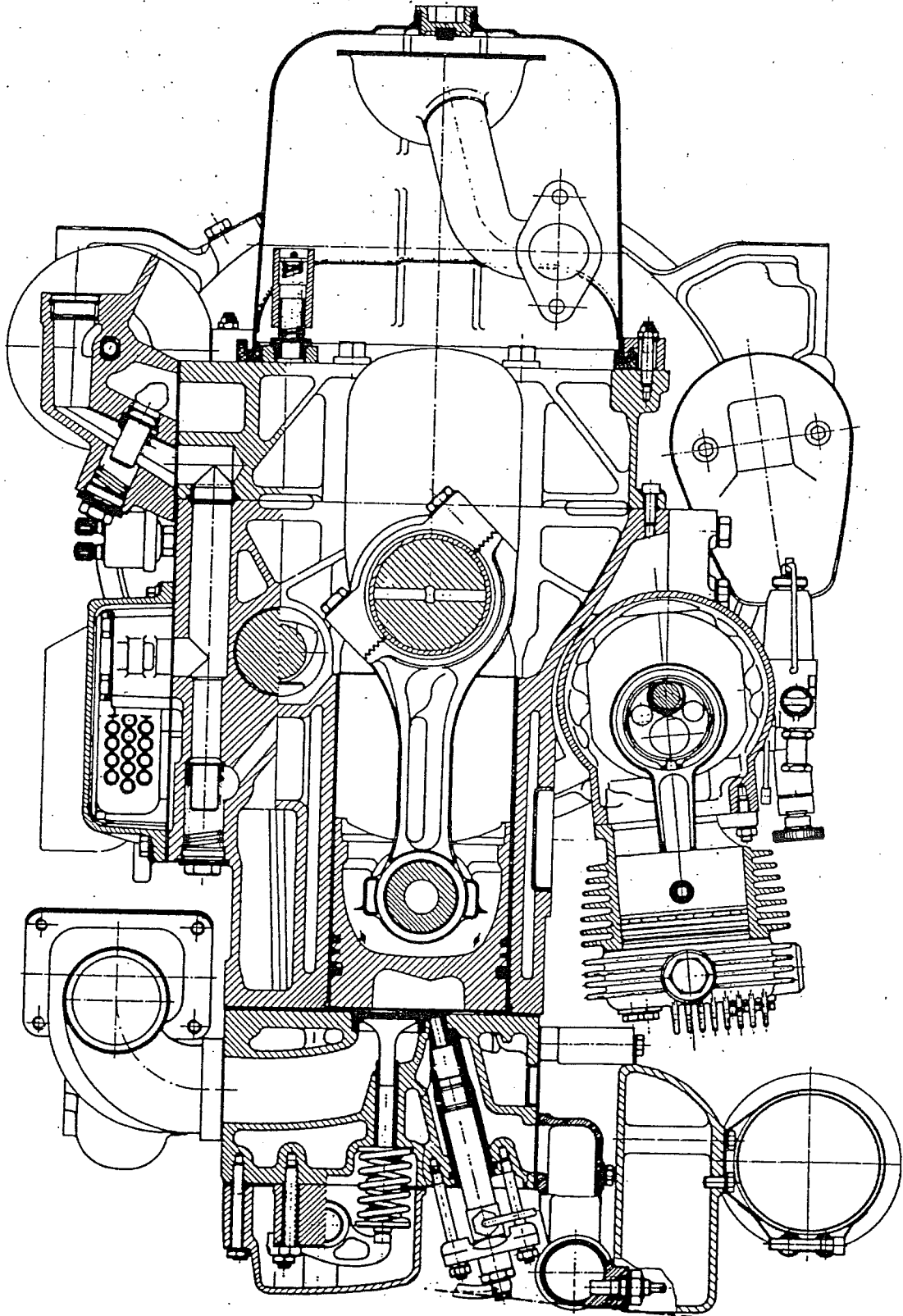
SECTION 1 GENERAL DESCRIPTION OF WD615 SERIES ENGINES MANUFACTURED BY SINOTRUK(CNHTC)

WD615 series engines are six cylinder, water-cooling, direct injection, in-line high-strengthened vehicle diesel engines adopting the manufacturing technique of 615 series engines of Austria Steyr Trucks Company integrated with the most advanced technique of diesel engine strengthening. With a total displacement of 9.726L, the engine is used for 16-40 tonnage Steyr, HOWO and Huanghe-Prince series heavy-duty trucks. The power range of the full series of the engines is 266-371HP, and their torque range is 1000-1460 Nm. The mode of air intake is charge inter-cooling. The engines are in different models with 240, 266, 290, 336, 371HP. The difference between into two types: one used for road vehicles and another for off-road all wheel drive vehicles. The difference between the two is that, the road vehicle diesel engine adopts high-position fan (the fan and the water pump are coaxial) and a single oil pump; and the off-road vehicle diesel engine adopts low-position fan (the fan and the crankshaft are coaxial) and duplex oil pump.

The best feature of WD615 series diesel engines is that the change of power is realized by adopting different mode of air intake and fuel injection system. WD615.00 is the basic model of the engine of the series. It is a natural aspirate engine. Its power is 200 HP, mounting an exhaust turbocharger on the basic model of WD615.00 engine increases the air intake of the engine immediately and the amount of fuel injection of the high-pressure fuel pump as well, that would increase the power of the engine without changing the structure of the engine very much, i.e. making it a WD615.61 engine with a power of 260 HP. WD615.64 engine is modified slightly on the basis of WD615.61. The modification reduced the maximum rotating speed of the engine with a sacrifice of partial power. The modification increased the maximum torque to meet the need of some kinds of vehicles (such as bus) for torque reserve. Such a diesel engines are called exhaust-turbocharged engine. The exhaust temperature of the engine is comparatively high and the metal parts of the supercharger are good in heat conduction, so the temperature of the air blown out of the supercharger is very high. The air expands at high temperature, which failed the ideal of increasing the power of the engine by increasing the amount of air intake due to the decrease of air intake in density. By cooling the hot air out of the supercharger, increasing the amount of air intake increased by increasing air density, and increasing the amount of fuel injection correspondingly at the same time, the power of the engine can be increased without varying the basic structural parameters of the engine. Air cooling is realized by an air radiator mounted in front of the engine radiator. This air radiator is called intercooler. This change has converted the engine into an inter-cooling WD615.62 engine with a power of 266 HP. The power of WD615.87 engine is 290 HP. By modifying the compression ratio of the supercharger and the poorly matched high-pressure fuel pump, the oil injector can increase the power of WD615.87 respectively to 336 HP (i.e. WD615.69) and 371 HP (i.e. WD615.47). WD615.62, WD615.87, WD615.69 and WD615.47 engines all can meet Euro II. Emission Standard. Therefore, except those parts directly related to the power performance such as fuel injection pump, oil injector, supercharger, etc., other fundamental structural parts of this series of engines such as cylinder block, crankcase, crankshaft, cylinder head, connecting rod, camshaft, timing gear, etc. are basically the same. Therefore, the general utilization of the parts for different models of engines in the series is as high as 85%. It is very good for maintenance, interchange of parts and stockpile of spares and has greatly facilitated the customers in the supply of parts.

Fig.2-1 and Fig.2-2 show structure of WD615 series engines. Fig.2-3, Fig.2-4, Fig.2-5, Fig.2-6 and Fig.2-7 are the characteristics curves of the engines of main models.

Fig.2-1 Structure of WD615 series diesel engines



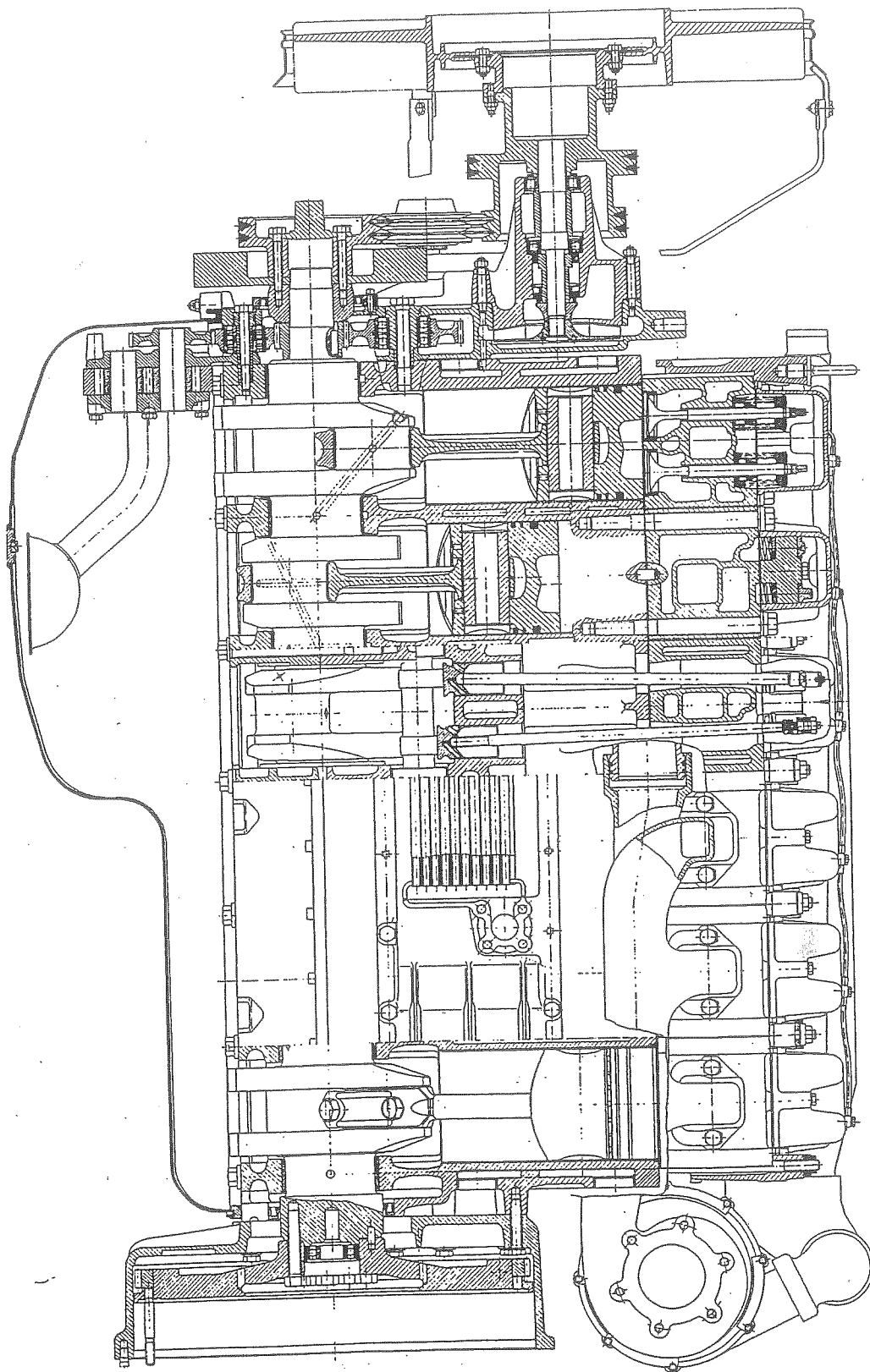
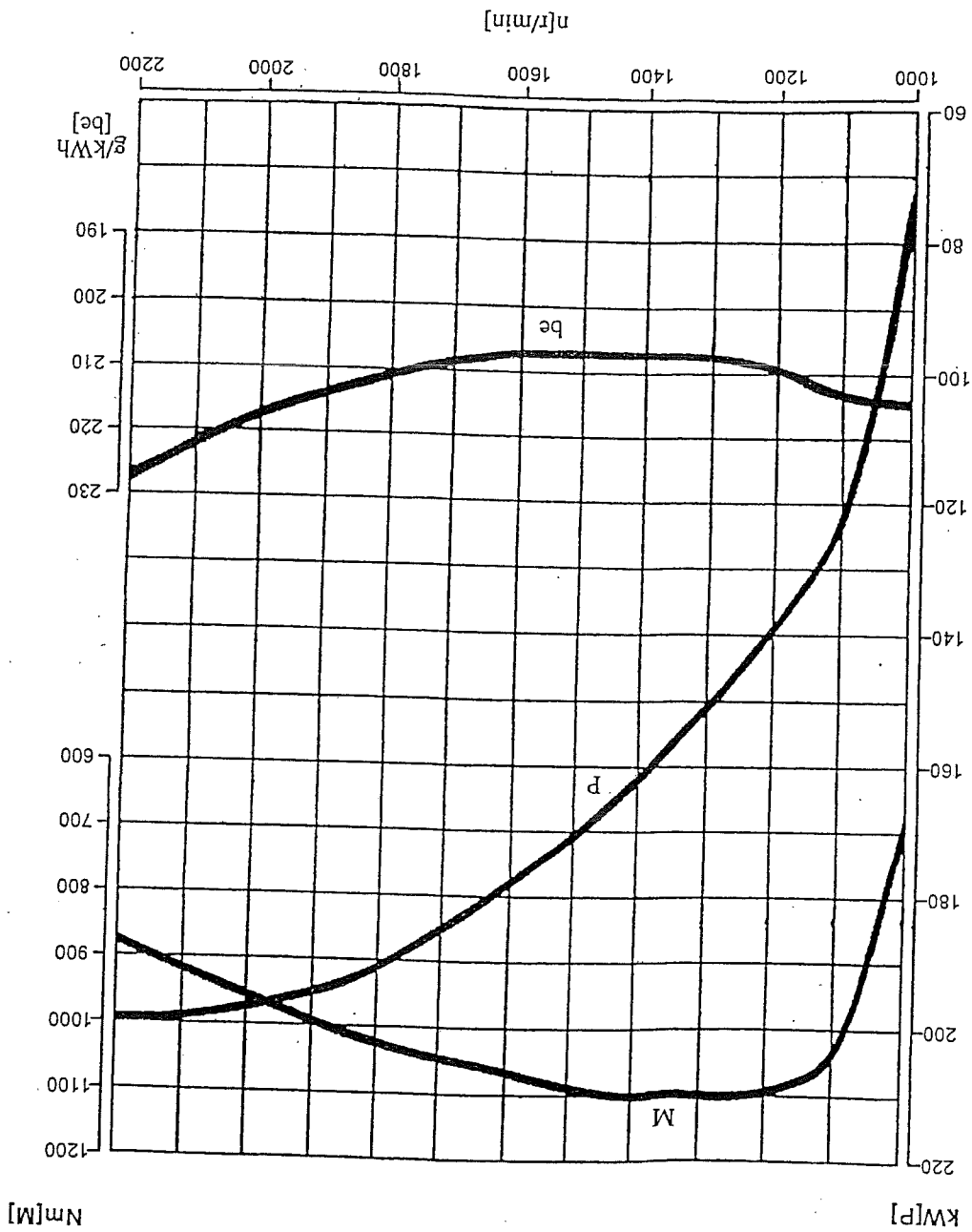


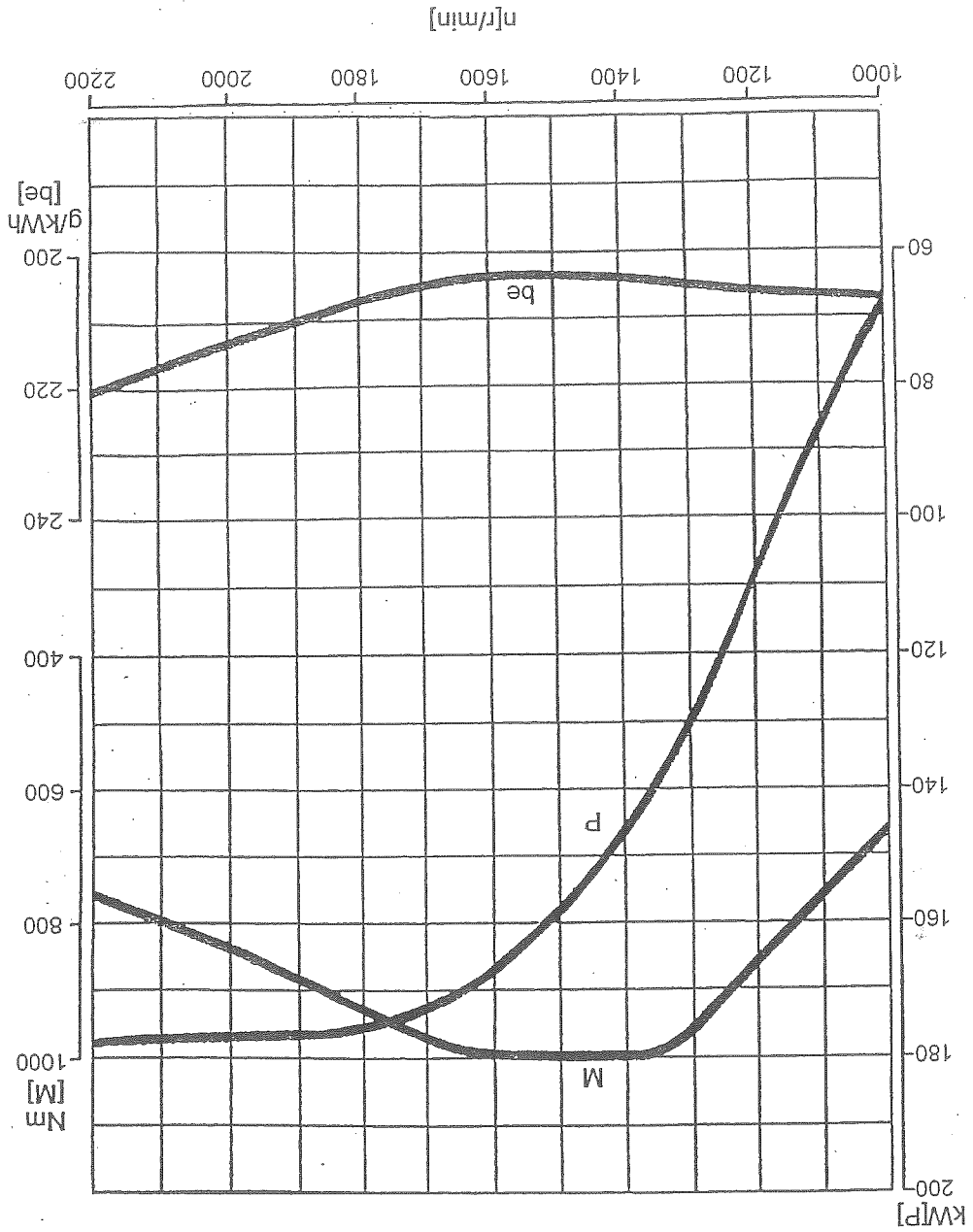
Fig.2-2 Structure of WD615 series diesel engines

Fig.2-3 Characteristics curves of 266 hp WD615.62 diesel engine



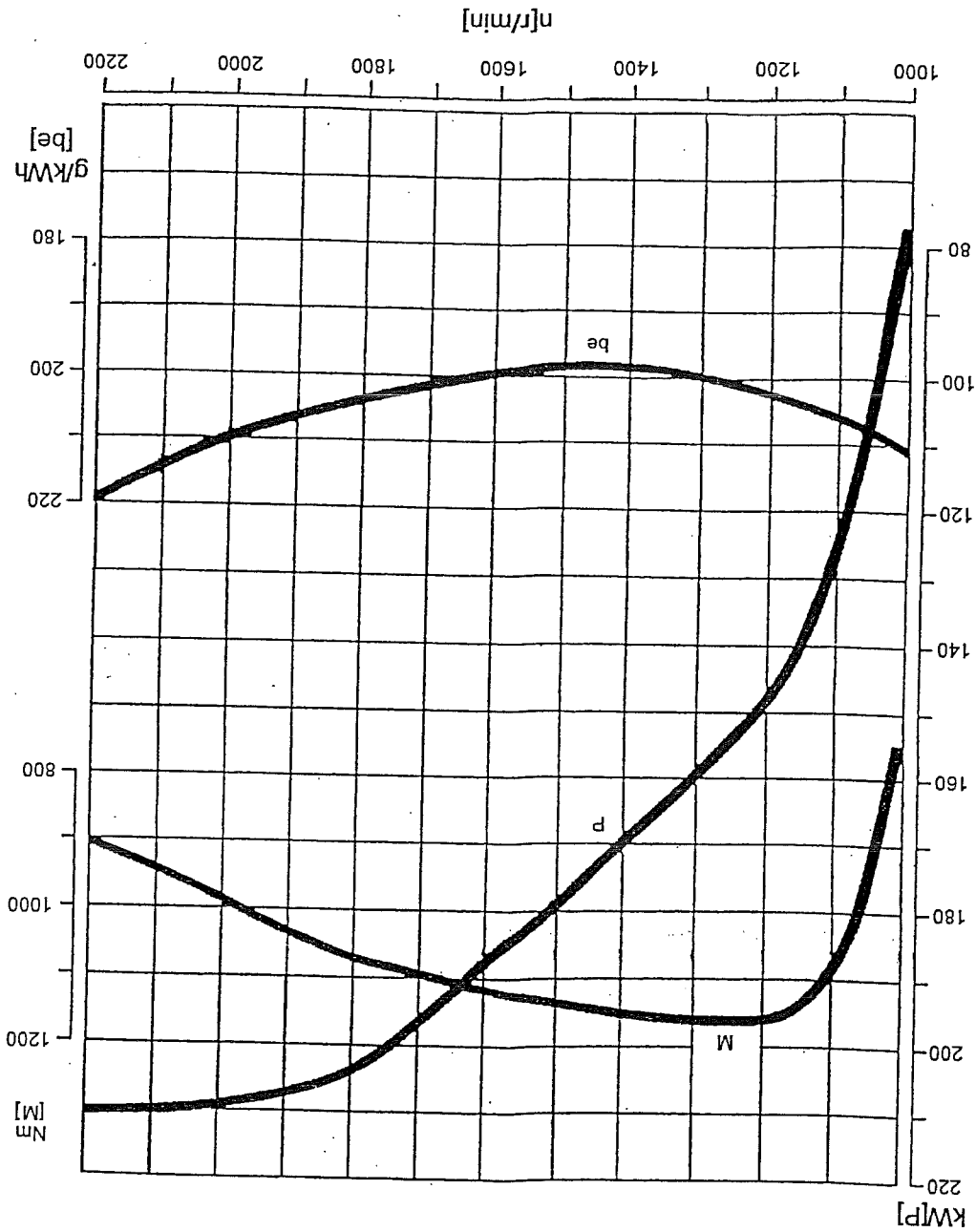
WD615.62

Fig.2-4 Characteristics curves of 240 hp WD615.64 diesel engine



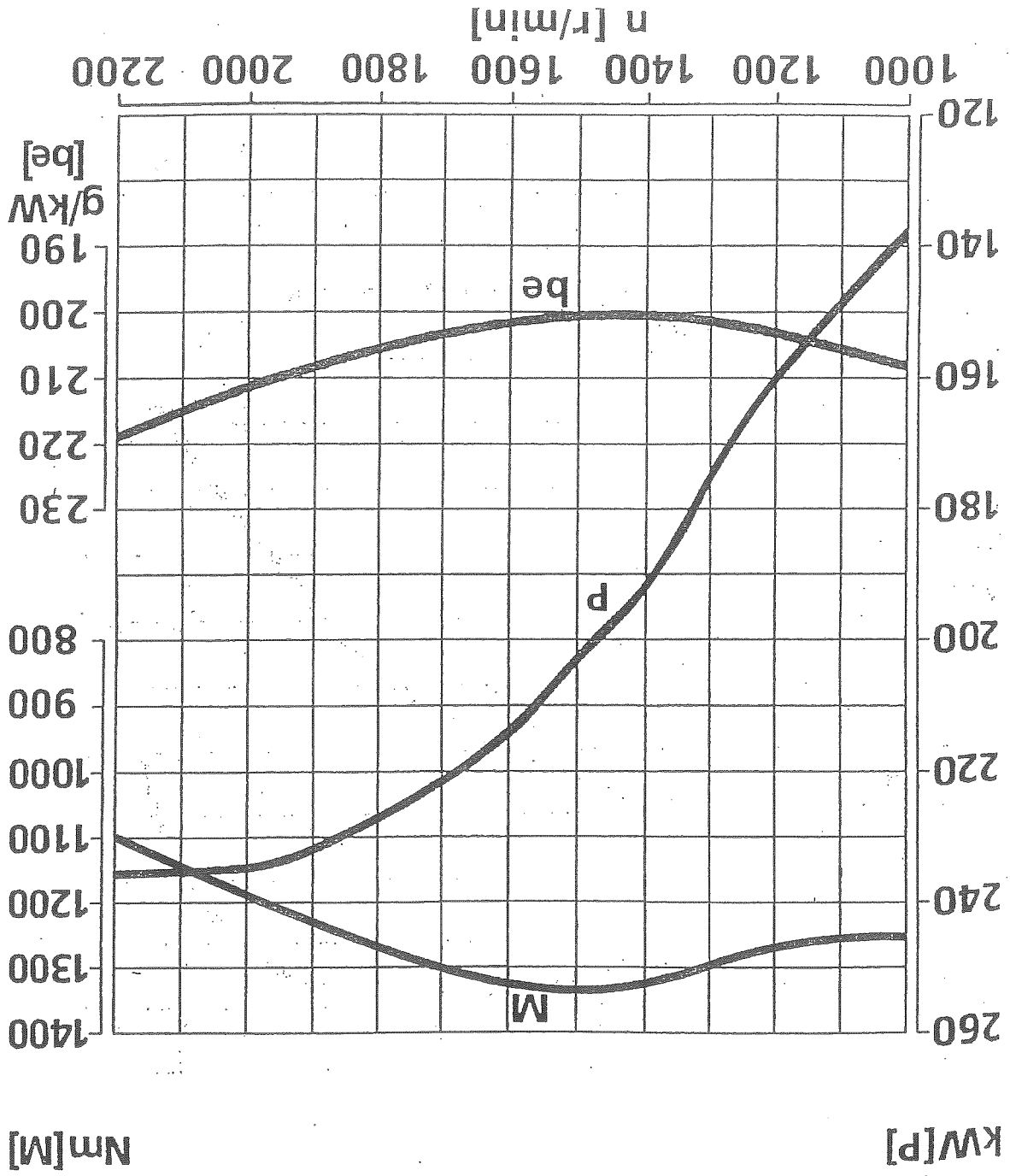
WD615.64

Fig.2-5 Characteristics curves of 290 hp WD615.87 diesel engine



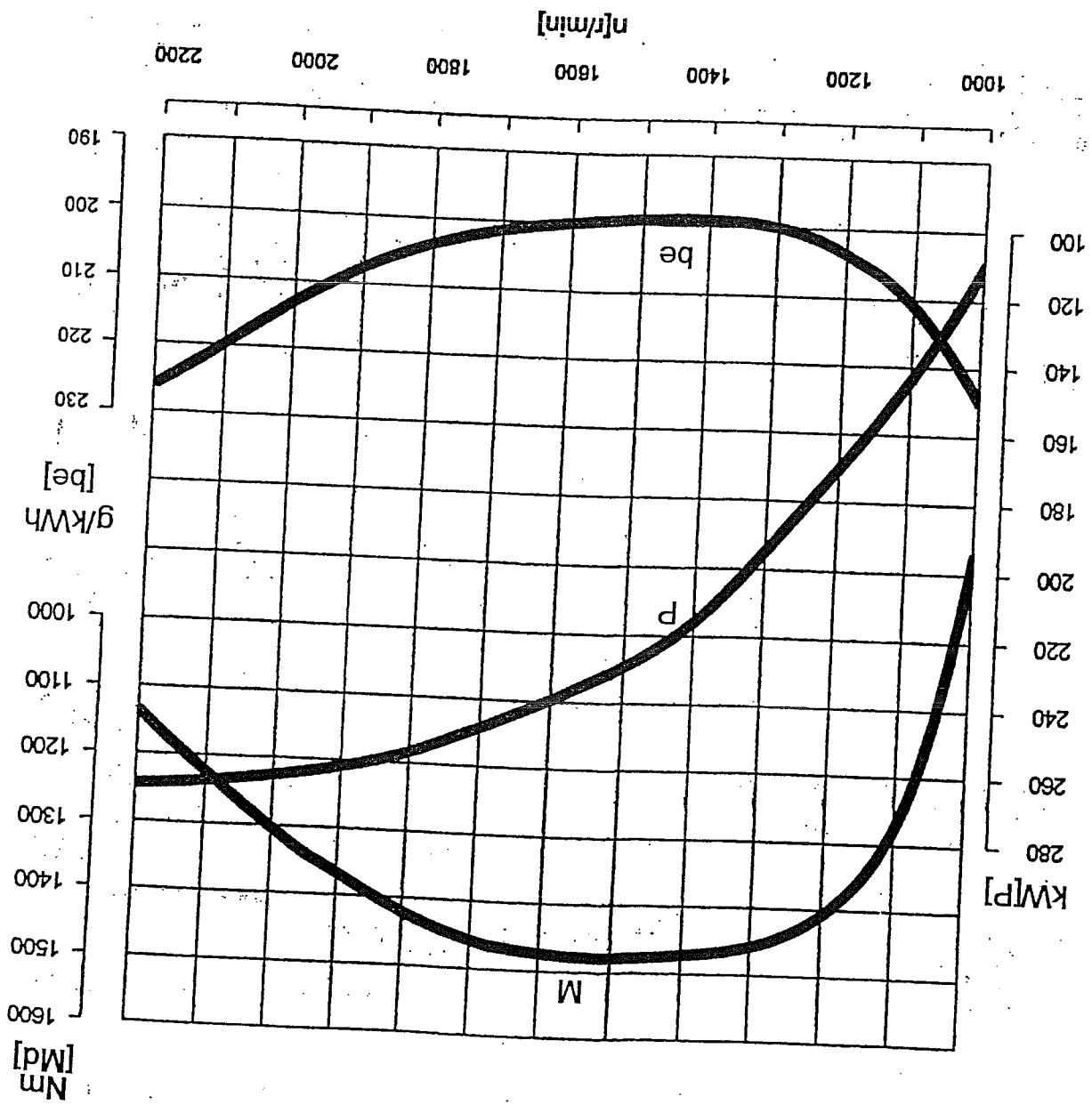
WD615.87

Fig.2-6 Characteristics curves of 336 hp WD615.69 diesel engine



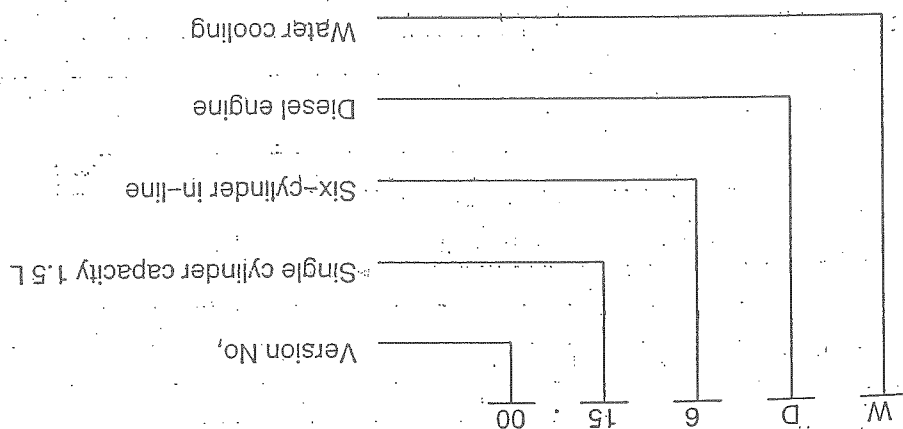
WD615.69

Fig.2-7 Characteristics curves of 371 hp WD615.47 diesel engine



WD615.47

The definition of the model of WD615 series diesel engines is as follows:



The basic performance parameters of the main models of WD615 series engines are given in Table 2-1, and the main technical specifications of the accessories are given in Table 2-2.

Ser. No.	Item	Engine model				
		WD615				
1	Rated power kW(ISO1585)	64	62	87	69	47
2	Rated rpm	2200	2200	2200	2200	2200
3	Max. torque Nm	1000	1100	1160	1350	1460
4	Max. torque rpm	1300-1600	1300-1600	1300-1600	1300-1600	1300-1600
5	Emission index	Euro II				
6	Number of cylinders	6				
7	Type	Four-stroke, water-cooling, in-line, direct-injection, dry-type oil cylinder				
8	Cylinder bore/stroke mm	126/130				
9	Displacement L	9.726				
10	Mean piston speed m/s	9.53				
11	Compression ratio	15.5:1				
12	Compression pressure kPa	>2000				
13	Mode of air intake	Inter-cooling				
14	Order of ignition	1-5-3-6-2-4				
15	Cold-state valve clearance mm	Intake 0.3 Exhaust 0.4				
16	Valve timing (valve clearance, with 0.3 intake/0.4 exhaust)	Intake valve opens 43° -39° before top dead center, Intake valve closes 61° -67° after top bottom dead center, Exhaust valve opens 76° -81° before top dead center, Exhaust valve closes 26° -34° after top bottom dead center				
17	Thermostat opening temperature °C	80 or 71				
18	Type of starting	Electric starting				
19	Type of lubrication	Pressure lubrication				
20	Lubricating oil capacity (oil pan) L	19				
21	Type of cooling	Water-cooling forced circulation				
22	Oil pressure kPa	350-500				
23	Oil pressure at idle speed kPa	≥100kPa				
24	Exhaust temp. after turbine °C	≥550				
25	Allowable longitudinal inclination	Long term 10/10 short term 30/30				
26	Allowable lateral inclination	Long term 45/5 short term 45/30				
27	Crankshaft rotating direction (looking from the free end)	Clockwise				
28	External dimension mm	Length				
		Width				
		Height				

Table 2-1 The main performance and technical parameters of WD615 series engines

Ser. No.	Name	Item Specification (parameter)	Model
1	Diesel filter	Type	Double-stage filter element
2	Water pump	Type	Centrifugal (centrifugal-chamber and timing gear chamber in one body)
		Rated rpm	2585
3	Oil pump	Type	Gear type (single stage pump for typical, two stage pump on special request)
		Rated rpm	1896
		Safety valve opening pressure kPa	1550 ± 150
4	Crankshaft vibration damper	Type	silicone oil
		outside diameter	Φ 280
5	Supercharger	Type	Exhaust turbine, vaneless, double-pear shaped, full-admission, long and short blades
		Model	GT42, K29, J90-2, GJ90B
6	Oil filter	Type	Screw-in, paper filter element, double barrel, parallel connection
		Type	Wax element composite
7	Thermostat	opening temp. °C	80 ± (71 ± 2)
		Full-open temp. °C	95(86)
8	Oil cooler	Type	plate-fin type
		By-pass valve opening pressure kPa	600 ± 36
		Pneumatic test pressure kPa	1500
		Type	DC, self-excitation
		Model	KB-24V 5.4kW
		Power kW	5.4
		Voltage V	24
9	Starter	Type	Rectifying and voltage regulating together
		Model	
		Power kW	750, 1000 and 1540
		Voltage V	28
		Type	Strengthened polyamide material, integral or silicone oil clutch
		outside diameter mm	620
		Max. unbalance of fan	30
11	Fan	Type	Single-cylinder, piston type, water-cooling
		Cylinder bore mm	90
		Stroke mm	46
		Piston total displacement cm³	293
		Working pressure kPa	850
		Max. pressure kPa	1000
		Ratio to engine speed	1.25
		Type of lubrication	Pressure lubrication
		Mode of working	Continuous
		Mass kg	12
12	Air compressor		

Table 2-2 Main technical specifications of accessories

SECTION 3 FEATURES OF STRUCTURE AND ASSEMBLY AND REPAIR

WD615 series diesel engines are typical high-strengthened vehicle diesel engines. Their structure, operating principle and method of assembly and maintenance/repair are basically the same as those of normally-strengthened diesel engines. The following description will be mainly focused on structural features and precautions in assembly and repair different from others.

1. Engine Body

The engine body is composed of cylinder block, crankcase, oil pan, cylinder head, timing gear case and flywheel casting. The cylinder block and the crankcase are made of high-strength gray cast iron and divided horizontally into the upper and lower parts from the centerline of the crankshaft. As shown in Fig. 2-8, WD615 diesel engine adopts an integral crankcase which together with the seven main bearing caps constitutes a highly rigid frame structure, hence increases the rigidity, reduces the noise and prolongs the service life of the engine body.

As shown in Fig. 2-8, the main bearing bores in the cylinder body and the crankcase are located and paired for machining by three $\phi 12\text{mm}$ locating pins, which has guaranteed the axiality and cylindricity of the seven $\phi 108+0.220$ main bearing bores ($\leq 0.05\text{mm}$). Therefore, when a cylinder block is to be replaced during maintenance/repair, the cylinder block and the crankcase must be replaced in pairs at the same time.

The cylinder block and the crankcase will be secured together by 14 M18 main bearing bolts as well as 24 M8 bolts. There is no gasket between the cylinder block and the crankcase. When assembling, apply some Loctite 510 sealant on their contacting surfaces as per Fig. 2-9. Then, tighten the main bearing bolts in the order as shown in Fig. 2-10 to their specified torque (first tighten them to 30 Nm, then to 80 Nm, and finally to 250+25 Nm). Finally, tighten the 24 crankcase fixing bolts.

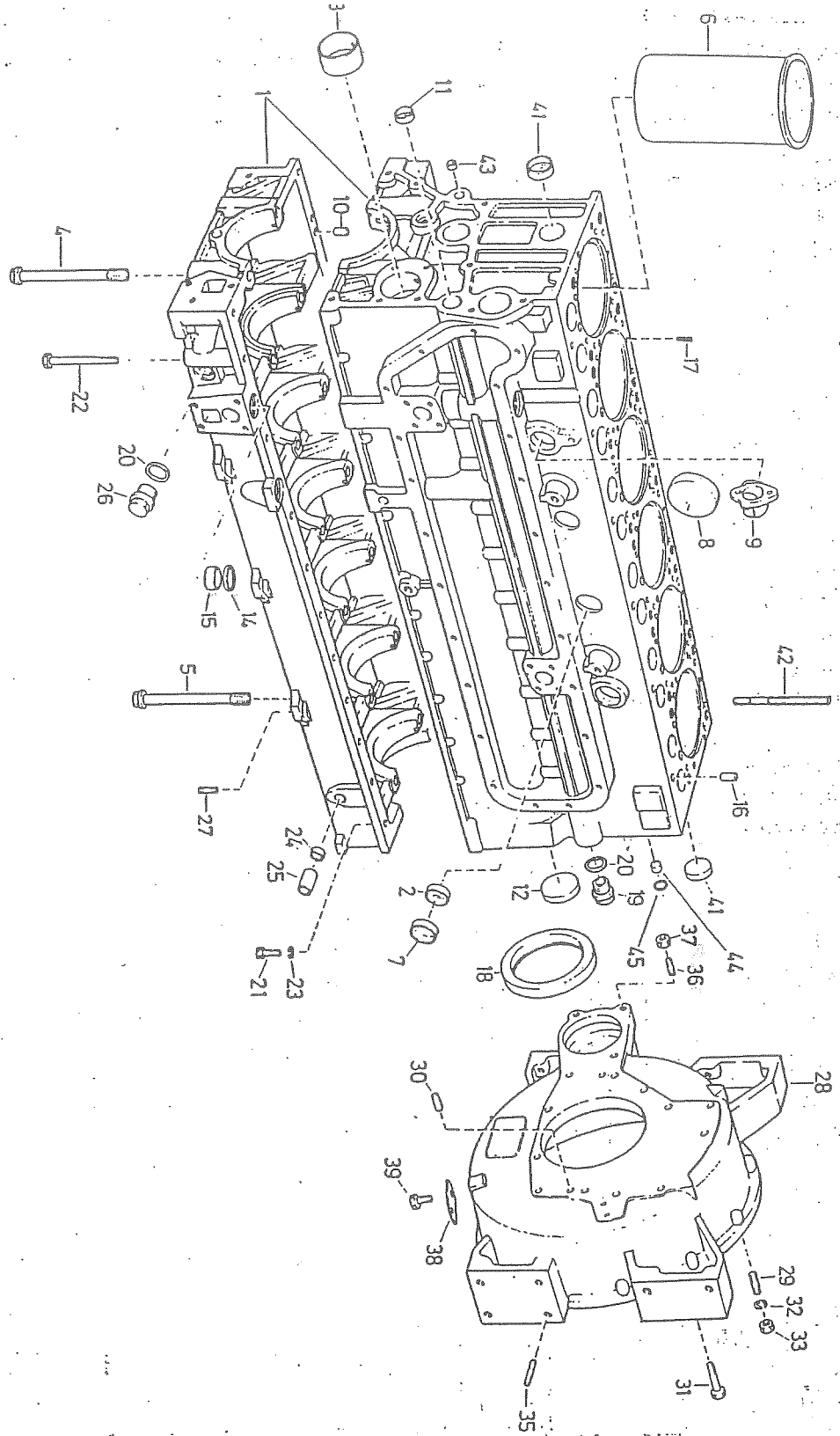


Fig. 2-8 Cylinder block, crankcase and flywheel casing

- 1.Engine body and crankcase 2,7.Bell-shaped plug 3.Camshaft bushing 4,5.Main bearing bolt 6.Cylinder sleeve 8.LH side bowl plug 9. Ventilation elbow 10.Cylindrical pin 11.oil passage bow plug 12.Rear end face bowl plug 14,15 Seal ring, sleeve, 16.Cylindrical pin 17.Elastic cylindrical pin 18.Real oil seal 19,20.Screw plug, washer 21,23.Hexagon socket head cap bolt, washer 24,25.Bowl plug, short oil return tube 26. Screw plug 27.Studbolt 28.Flywheel casing 29,30,32,33.Studbolt, spring washer, hex nut 31.Flywheel casing bolt 35.Studbolt 36,37.Studbolt, nut 38.Sight hole cover 39.Hex bolt 41.Bowl plug 42.Cylinder head, studbolt

The nonparallelism of the upper face and the lower face of the cylinder block should be ≤ 0.1 mm, and the unevenness of the surface within 100 mm length should be ≤ 0.03 mm (service limit is 0.05 mm). The height of the cylinder block is 363.75 ~ 363.85 mm with a service limit of 0.5 mm, and the conicity ≤ 0.02 mm. Seven main bearings on the cylinder block must be exactly the same, and the thrust bearing should be located on each side of the second main bearing. The cylinder sleeve is thin-wall and dry type made of high phosphorus iron. The thickness of the wall is 2 mm. The inner surface of the cylinder sleeve is specially treated into plane reticulate pattern, which may speed up fitting up and improve the efficiency of lubrication so as to increase its wear resistance. The cylinder sleeve and the bore hole are transition fit (bore hole $\phi 130 + 0.025/0$ mm, and cylinder sleeve $\phi 130 + 0.01/-0.008$ mm). During assembly, it is advisable to use clearance fit. Before assembly, use trichloroethylene to remove the grease on the contacting surfaces of the cylinder sleeve and the bore hole, and then apply some help of special tools. After the cylinder sleeve is pressed into the bore hole, the cylinder sleeve should be above the upper face of the cylinder block by 0.05 ~ 0.10 mm, and the out of roundness of the inner diameter of the cylinder sleeve should be smaller than 0.04 mm. When the cylinder and cylinder sleeve are overhauled, the diameters of the bore hole and the cylinder sleeve are permitted to be 0.5 mm larger than the standard diameter, i.e. the bore hole is allowed to be reamed to $\phi 130.525$ mm max.

The camshaft hole is at the right side of the cylinder block (looking forward), and there are altogether seven bearing journals. The magnitude of interference between the camshaft bushing and the shaft hole is 0.057 ~ 0.107 mm, and there is a oil orifice in the bushing. When assembling, be careful to align this oil hole with the oil passage hole in the cylinder block.

There is a $\phi 27$ mm run-through main oil passage at the right side of the mid part of the engine body (looking forward) used for lubricating the main bearing and the camshaft bearing. There is a secondary oil passage (it does not run through) connecting to a oil nozzle in each cylinder for cooling the piston, and lubricate the small end of the connecting rod and the piston pin. Attention should be paid to the locating pin when the oil nozzle is installed. There are 12 valve tappet holes in the engine body above the oil holes at the right side of the cylinder block. The fit clearance between the tappet and its hole is 0.025 ~ 0.089 mm, and the wear limit is 0.15 mm.

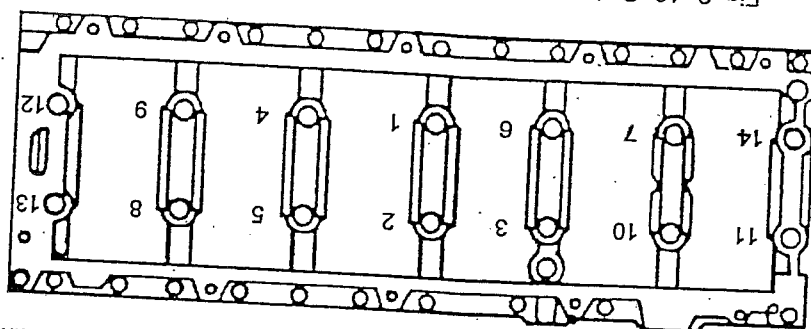


Fig. 2-10 Order of tightening crankcase main bearing bolts

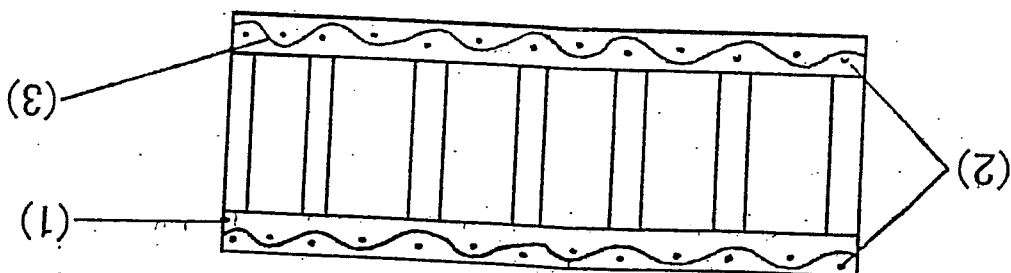
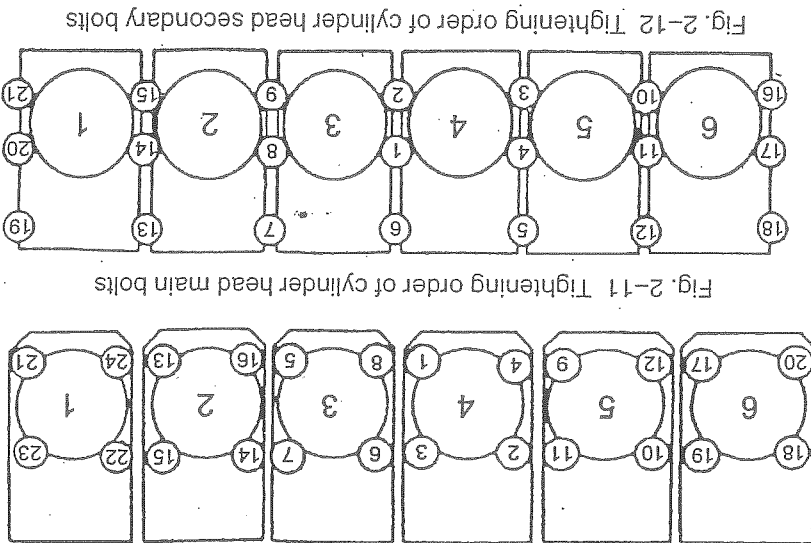


Fig. 2-9 Application of adhesive mating surfaces of cylinder block and crankcase

The tappet hole in the cylinder block meets the main oil passage at 4mm oil passage. It provide lubrication to the valve rocker arm and other mechanism through the hollow lifter. There is a chamber at the right side of the cylinder body (looking forward) for mounting oil cooler. In the cooling chamber, oil cooler element is installed to cool the oil. The oil cooler element is of pipe structure. Each cylinder of WD615 diesel engine uses one head. The cylinder head is made of nickel-chromium pearlite alloy cast iron and machined into a hexahedron. Each cylinder head is fixed to the cylinder block by means of four M16 main bolts, and the two adjacent cylinder heads at the front and rear ends each will be tightened by three M12 studbolts together with U-shaped plates, spherical washers and locking nuts. The order of tightening the cylinder head main and secondary bolts is as shown Fig. 2-11 and Fig. 2-12. The tightening method is as follows:

- After the cylinder heads are mounted and their exhaust side is made flush, first tighten all main and secondary bolts to 30 Nm in the order given.
- Tighten all secondary bolts to 100 Nm in given order.
- Tighten all main bolts to 200 Nm in given order.
- Turn all secondary bolts by 90° in given order.
- Turn all main bolts by 90° in given order.
- Turn all secondary bolts by 90° in given order, and check and make sure that the their torque is 120 ~ 160 Nm.
- Turn all main bolts by 90° in given order, and check and make sure that the their torque is 260 ~ 380 Nm. If unsatisfactory, the bolts must be replaced.
- It is allowed to use the cylinder head main bolts repeatedly for three times, and the secondary bolts for two times.



Each cylinder head has an air intake valve and an exhaust valve. There is a seat made of special cast iron for each valve. The seating angle of the intake valve is 110°, and that of the exhaust valve is 90°. As shown in Fig. 2-13, after assembly, the sinkage X of the intake valve should be 0.95-0.2mm and that Y of the exhaust valve should be 1.25 ± 0.18mm. Its maximum should not exceed 1.8mm. When exceeding 1.8mm, the bottom face of the cylinder head can be milled by 0.5mm. Two millings are allowed for 1mm in total. The valve seat and the cylinder head are fit by interference. They can be assembled by heating the cylinder head to 320°C or cooling the valve seat in liquid nitrogen.

The cylinder head is laid with oil nozzle copper sleeve. The cooling water after entering the cylinder head will pass the nose-bridge hot water jacket, then flows into the water outlet pipe through oil nozzle copper sleeve. It is extremely efficient for cooling the oil nozzle. The oil injector is mounted on the left side of the cylinder head. The included angle between the oil injector and the cylinder head plane is 75° , and the protrusion (C) of the tip of the oil nozzle from the cylinder head plane after assembling is $3.2 \sim 4.0$ mm.

In case of that the bottom face of the cylinder head has been milled by 0.5 mm (or 1 mm), in order to guarantee the protrusion of the oil nozzle tip, a 0.5 mm (1 mm) standard shim D must be used, as shown in Fig. 2-15a. Reuse of the cylinder gasket is permitted. However, care must be taken to guarantee the fitting position of the cylinder gasket, cylinder head and the cylinder block by means of locating pins. Apply some sealant within a $2\sim 3$ mm wide zone around the $\phi 8.5$ water passage in the cylinder gasket and around the lifter through hole respectively, so as to prevent the penetration of the cooling water and the oil.

As shown in Fig. 2-15, the timing gear case is made of high-strength gray cast iron. There is no locating pins between the timing gear case and the cylinder block. They are aligned with each other by the timing intermediate gear shaft "A" and the oil pump intermediate gear shaft "B". Therefore, when assembling the timing gear case, the timing intermediate gear shaft "A" and the oil pump intermediate gear shaft "B" should be tightened first (65 Nm), and the timing gear case fixing bolts. The air compressor, the steering boost pump and the water pump are all mounted on the timing gear case.

Fig. 2-14 Dimensional requirement on valve guide after fitting

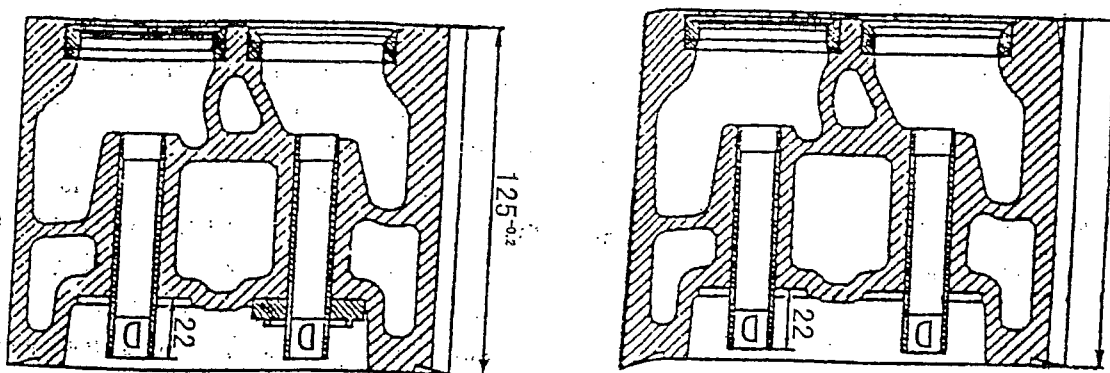
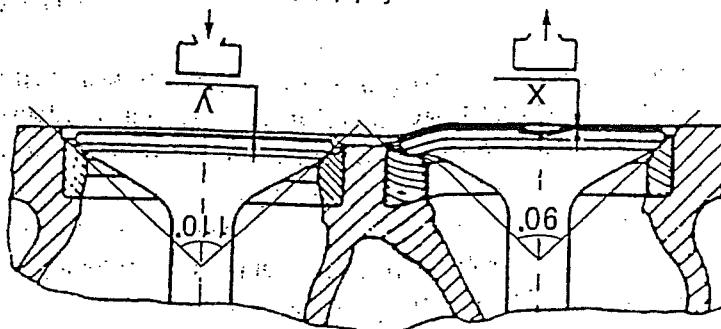


Fig. 2-13 Dimensions of air intake and exhaust valves



Valve guide can be replaced. After the valve guide is replaced, ensure that the valve guide is 22 mm higher than the cylinder head concave surface, as shown in Fig. 2-14.

16.

WD615 series diesel engines adopt conventional crankshaft and connecting rod mechanism, as shown in Fig. 2-

2. Crankshaft, Piston and Connecting Rod

acts as a shock damper.

V-shaped rubber seal is used between the oil pan and the engine body. It not only has good sealing effect but also

sealant should be applied on their contacting surfaces.

There are no gaskets between the timing gear case and the flywheel casing/cylinder block. In assembly, Lotite 510

° $\pm 5^\circ$ and make sure the final torque of 110 ~ 140 Nm is reached.

Tighten symmetrically the flywheel casing fixing bolts first to the torque of 40 Nm, and then turn the bolts by 120

Fig. 2-15a Protrusion of oil injector head

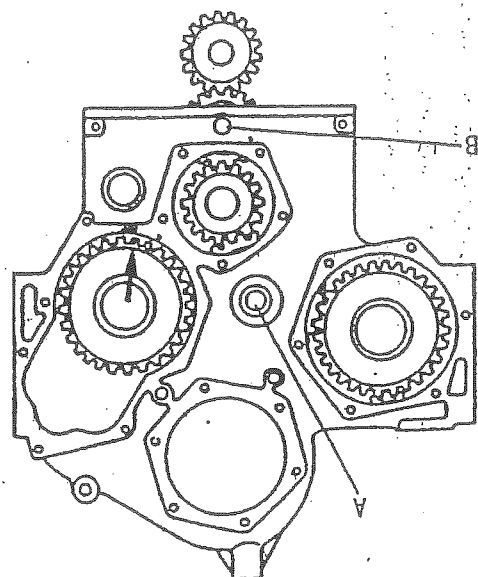
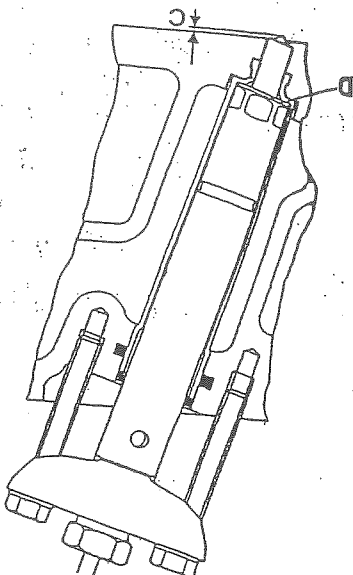


Fig. 2-15 Timing gear case

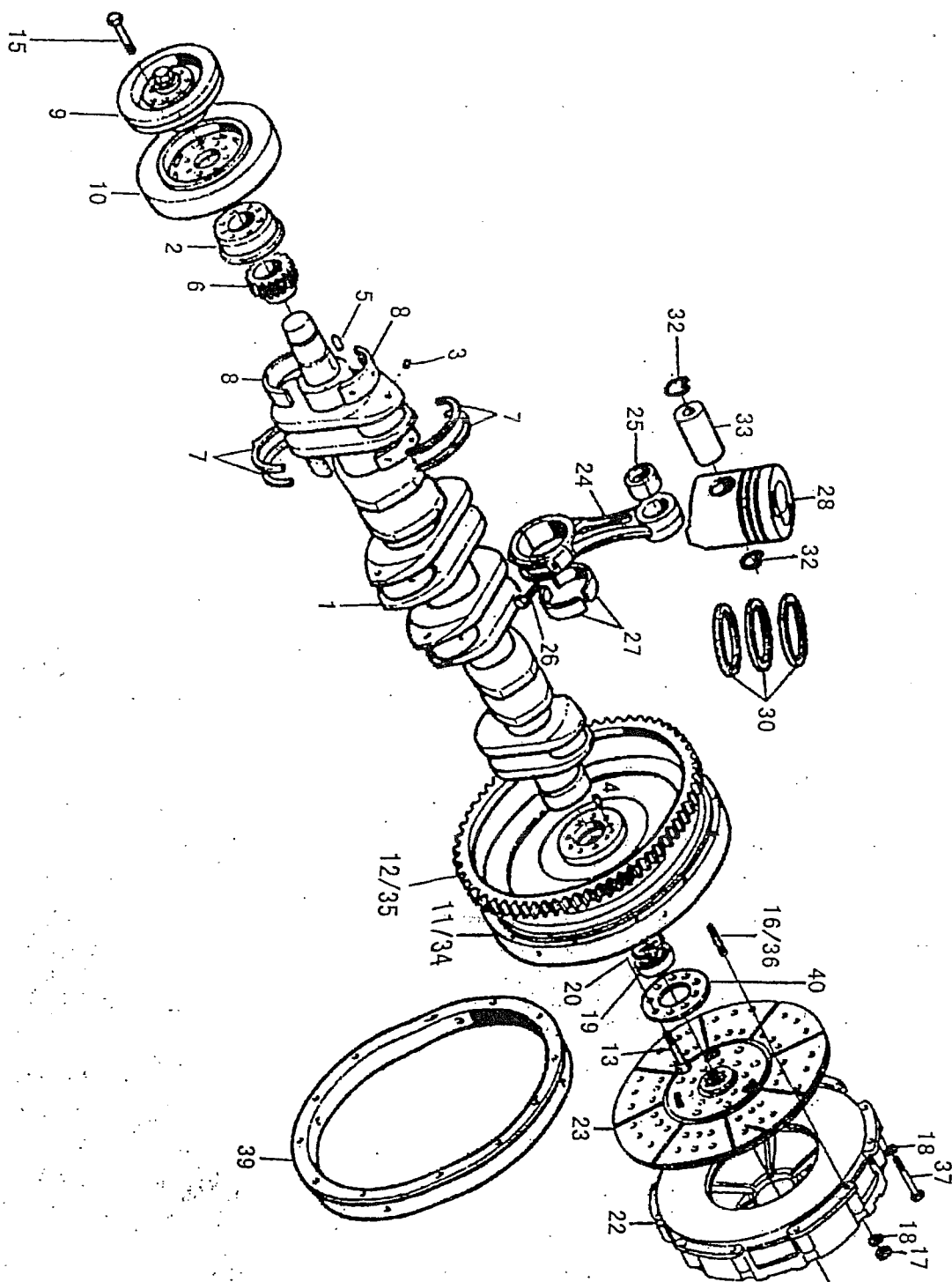


Fig.2-16 Crankshaft and connecting rod mechanism

1. Crankshaft 2. Flange 3, 4. Cylindrical pin 5. Flat key 6. Crankshaft gear 7. Thrust plate 8. Main bearing shell 9. Belt wheel 10. Shock absorber
- 11, 34. Flywheel 12, 35. Gear ring 13. Flywheel bolt 15. Hex bolt 16. Studbolt 19. Rolling bearing 20. Elastic collar for hole use 24. Connecting rod
25. Connecting rod bushing 26. Connecting rod bolt 27. Connecting rod bearing shell 28. Piston 30. Piston ring 32. Retainer 33. Piston ring 39. Spacer flange

WD615 engine uses die forging crankshaft. It has undergone special surface and soft-nitriding treatment. Hence, it has a very good wear resistance and a very good anti-fatigue layer.

The ellipticity of the crankshaft journal and the connecting rod journal should be $\leq 0.01 \text{ mm}$ with a service limit of 0.015 mm , and the conicity $\leq 0.01 \text{ mm}$ with a service limit of 0.015 mm . The eccentricity of the crankshaft intermediate journal relative to the two end journals (crankshaft bending) is 0.3 mm .

266 hp engine can use $\phi 260$ dia. silicon oil damper, and other high horse-power diesel engines can use $\phi 280$ dia. silicon oil dampers. At the front end of the crankshaft, a shock absorber fixing flange and crankshaft gear are mounted by thermal fit. For thermal fit, heat the crankshaft gear to 180°C , heat the fixing flange to 290°C , and then insert them into the crankshaft. The seven crankshaft bearing shells are made of steel-backed low-tin aluminum alloy of the same thickness. They are exchangeable. The thrust shoes are installed on both sides of the second main bearing. In assembly, the bearing shell bore and the journal dimensions must be measured. Choose proper main bearing shells to make the radial clearance of the main bearing $0.095 \sim 0.163 \text{ mm}$ with a service limit of 0.18 mm . The max. unbalance of the dynamic balance is $60 \text{ g} \cdot \text{cm}$. The axial clearance of the crankshaft is $0.052 \sim 0.255 \text{ mm}$ with a service limit of 0.35 mm . The bearing shell of the connecting rod is made of steel-backed low-tin aluminum alloy of the same thickness. The crankshaft and the flywheel are secured together by means of reinforced bolts. When installing the flywheel, first tighten the its bolts symmetrically to 60 Nm , then turn all the bolts by $90^\circ \pm 5^\circ$, and tighten them to a final torque of $230 \sim 280 \text{ Nm}$. Replace those bolts that failed to reach the final torque. The flywheel bolts can be used twice.

The piston is made of aluminum alloy, as shown in Fig. 2-17. There is a ω -shaped combustion chamber and intake and exhaust valve avoiding recesses. The combustion chamber volume is usually $87 \pm 0.75 \text{ ml}$, and its position is offset to the center of the piston. The compression clearance of the piston after installation is $A=1 \text{ mm}$.

$A=1 \text{ mm}$

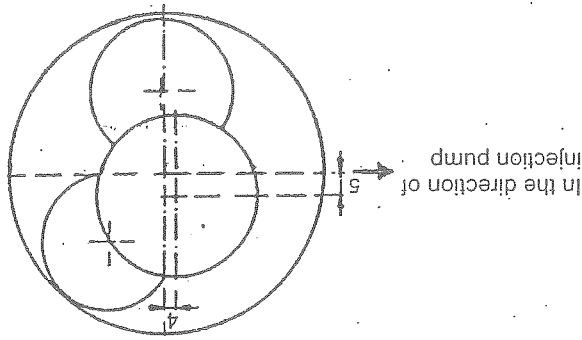
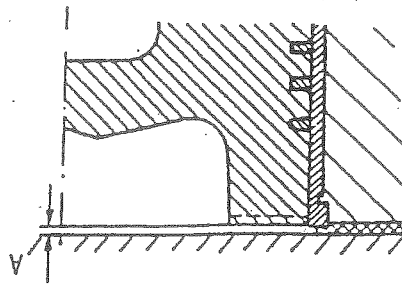


Fig. 2-17 Combustion chamber position and compression clearance

60mm with a wear limit of 1mm. The second air ring is a chrome plated tapered ring. Its height is 3mm, the annular gap is 0.07 ~ 0.102mm with a wear limit of 0.28mm, the opening gap is 0.25 ~ 0.40mm with a wear limit of 1.0mm. The cone angle of its single side outer ring face is $90^\circ \pm 5'$. There is a "TOP" assembly marking on the upper surface of each air ring. When assembling, the side with "TOP" marking must face up. The third ring is a oil ring with a spring cast iron bushing ring. The ring is 4mm high. Its both edge surfaces are chrome plated. Its annular gap is 0.05 ~ 0.075mm with a wear limit of 0.26mm. Its opening gap is 0.35 ~ 0.55mm with a wear limit of 1.0mm. When assembling the piston, care should be taken to check the side play between rings. The openings of the three rings must be staggered by 120° , and within 30° of the piston pin hole.

The diameter of the piston pin hole is $\phi 50\text{mm}$. The pin hole and the piston center should offset 1mm to the turning direction of the crankshaft. The piston pin and the piston hole/bushing are clearance fit. When assembling, the piston should be heated to over 80°C . The piston skirt is coated with 0.01mm thick graphite coating for the purpose of reducing friction.

There is a cut in the piston at the location corresponding to the oil nozzle in the secondary oil passage in the cylinder block. Its purpose is to avoid interference of the piston with the oil nozzle. The piston is cooled by oil sprayed by the oil nozzle.

The connecting rod with H-shaped cross-section is forged with No. 35 chrome molybdenum steel. The center distance of the big and small ends is 219mm. The big end is 46mm wide, and the small end is 41mm wide. The big end of the connecting rod is 45° domatic partition. The parting plane is 60° sawtooth located. The big end is secured by means of bolts made of No. 42 chrome molybdenum alloy steel. The connecting rod bolts are tightened by torque/rotation method (i.e. torque them to 120 Nm first, then turn them by $90^\circ \pm 5'$, confirm if the final torque reaches 170 ~ 250 Nm, and replace those with unsatisfactory torque). The connecting rod bolts can only be used once. Remember that the H-shaped cross-sectional connecting rod is solid and there is no center oil passage inside the connecting rod. The piston pin and the small end bushing are lubricated by oil flow through the oil hole in the small end of connecting rod in the end surface of the piston when the piston falls. The small end bushing is made of steel-backed pot metal. Its thickness is 2.5mm and has a T-shaped oil groove. The connecting rod bearing shell is made of steel-backed low-tin aluminum alloy of different thickness. Its surface has a coating of lead-tin-aluminum alloy in 0.015mm thickness and a coating of anticorrosion material in 0.002mm thickness. Scraping is not allowed for the main bearing shell and the connecting rod bearing shell. As shown in Fig. 2-19, the connecting rods are divided into 9 groups (C, D, E, F, G, H, J, K, L) by weight differing from one another by 29g. The connecting rod body and its bearing shell match marking and the weight group code will be impressed on the connecting rod and the side of the bearing shell respectively. The axial location of the connecting rod is realized by means of the half-round face of its big end. The width of the bearing shell is 2mm smaller than that of the big end. It not only reduced weight, but also decreased the machining accuracy of the bearing shell, hence reduced the cost of manufacture.

When assembling the piston and the connecting rod, pay attention to the direction of the connection of the piston and the connecting rod. The valve avoiding recess on the top of the piston should be at the right side of the cylinder block (looking forward). The 45° porting place must correspond to the right side of the cylinder block (looking forward), as shown in Fig. 2-19a. Match markings on the connecting rod body and its bearing shell seat must be checked. One engine must use connecting rods in the same weight group, or the operation of the engine might be unstable and the cylinder knocking may happen. The weight of pistons used by the same engine must not differ by more than 10g.

When assembling the crankshaft, the piston and the connecting rod, the clearance between the connecting rod bearing shell and the connecting rod journal must be kept within the specified range.

a. The hole diameter wear limit of the big end of the connecting rod is $\phi 88.035\text{mm}$, and that of the small end is $\phi 55.05\text{mm}$. b. The clearance between the connecting rod shaft and the connecting rod bearing shell is 0.028 ~ 0.08mm with a service limit of 0.1mm. c. The clearance between the piston pin and the bushing is 0.04 ~ 0.06mm with a service limit of 0.1mm. d. The clearance between the piston pin and the piston pin hole is 0.002 ~ 0.015mm

The cam form and the dimension of the camshaft of WD615 series diesel engines are as shown in Fig. 2-20. The camshaft has seven bearings and there are seven camshaft bearing bores in the cylinder block. The camshaft has seven bearings, which are pressed into camshaft bearing bushings with a magnitude of interference of $0.057 \sim 0.107$. There is a oil orifice in the crankshaft bushing corresponding to the slant oil passage in the main oil passage. When installing bushing, use a special tool to align the bushing oil orifice with the oil passage in the cylinder block. The inner diameter of the installed bushing is $\phi 60.01 \sim 60.06\text{mm}$, and the clearance between the bearing bushing and the camshaft journal is $0.04 \sim 0.12\text{mm}$. There is a 6mm wide locating groove between the first bearing of the camshaft and the shaft head. The locating retainer fixed to the engine body by two screws is inserted into the groove for axial location of the camshaft. The axial clearance of the camshaft is kept within $0.1 \sim 0.4\text{mm}$. The camshaft gear is coupled to the camshaft head by means of locating pin and four fixing screws. There is a timing mark line on one tooth of the camshaft gear for ensuring proper valve timing.

The rocker arm shaft and the rocker seat are an integral part. The intake rocker ratio is 1.64 and the exhaust rocker ratio is 1.36. The rocker arm shaft has no axial locating spring. The axial location of the rocker arm is realized by rotating mechanism, etc.

The valve mechanism is composed of camshaft, tappet, lifter and rocker arm, intake valve, exhaust valve, valve

3. Valve mechanism

Fig. 2-19 Connecting rod marking

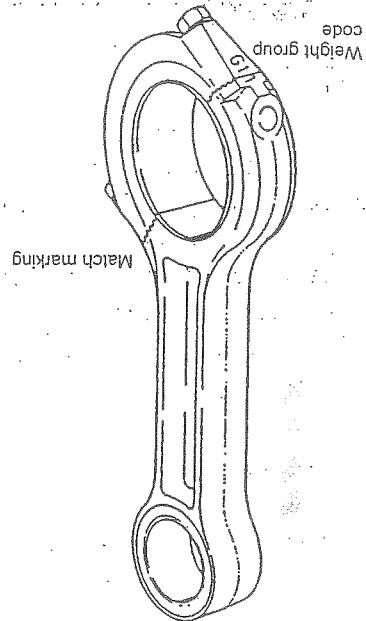


Fig. 2-19a Mounting position of the piston connecting rod

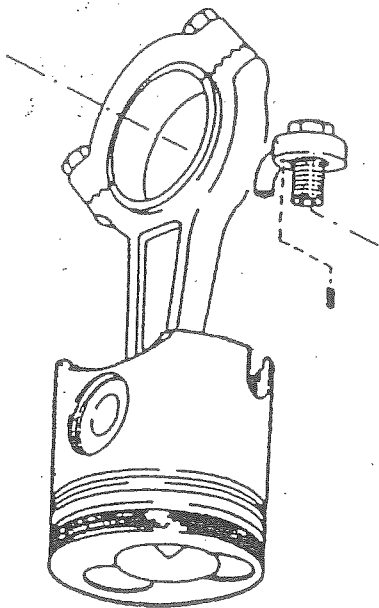
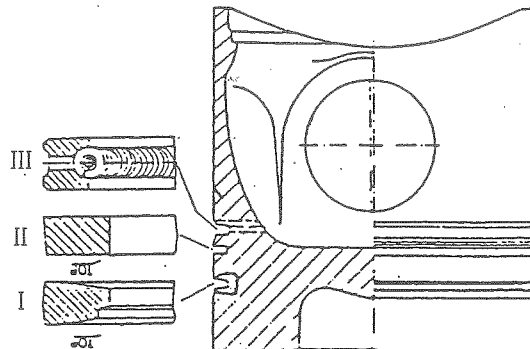


Fig. 2-18



with a service limit 0.03mm . e. the magnitude of interference between the connecting rod bushing and the small end of the connecting rod is $0.065 \sim 0.145\text{mm}$ with a service limit $0.083 \sim 0.118\text{mm}$.

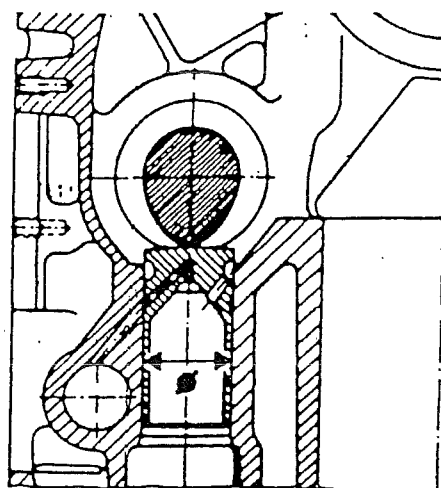


Fig. 2-20b Installation of tappet

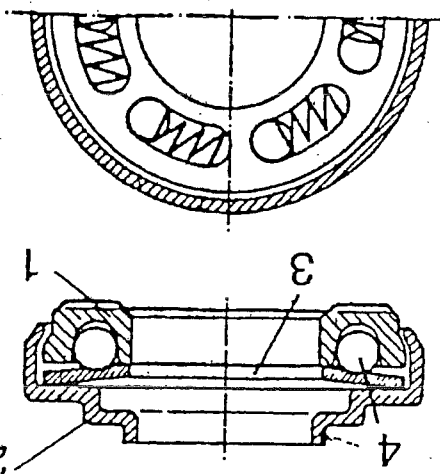


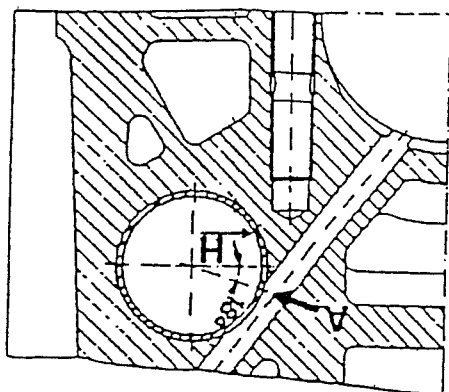
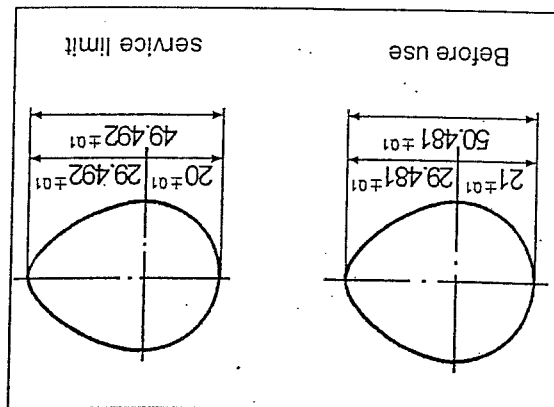
Fig. 2-20c Valve rotating mechanism

1. Valve spring seat 2. Spring seat 3. Disk spring 4. Steel ball

The intake valve is made of Nickel-Silicon copper steel. The exhaust valve is made of two materials by friction welding. The valve seat face is bead welded, and the valve stem is chrome plated. The valve rotating mechanism generates rotating motion between the valve and two valve seat surfaces on the cylinder head, so as to prolong the service life of the valve. The valve rotating mechanism is composed of a fixed spring seat (1) and a rotating spring seat (2). Between (1) and (2) are the steel ball (4) and the disk spring (3). When the valve opens, the disk spring is pressed flat, and the steel ball rolls along the slant track towards the center and moves the spring seat (2), making the valve turn slightly. For its structure, refer to Fig. 2-20c.

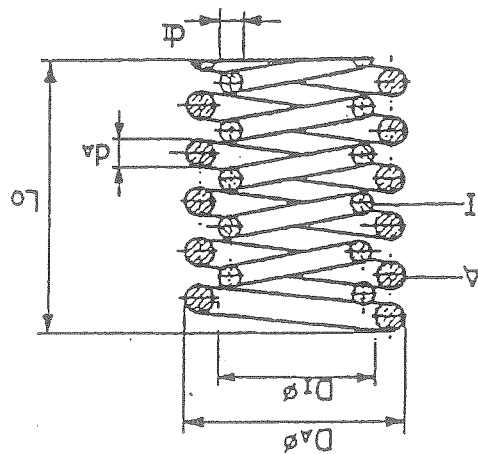
There are two ring grooves in the valve tappet. A $\phi 3$ mm slant hole in the upper ring groove is communicated with the main oil passage. Oil is supplied through the slant hole and the oil passage in the hollow lifter to the valve rocker arm, the rocker arm and the valve intermittently for lubrication. There is $\phi 5$ mm oil return hole in the lower ring groove.

Fig. 2-20 Cam form and dimensions



the side end surfaces of the high-precision cast iron valve housing cover. The fit clearance between the rocker arm shaft hole and the rocker arm shaft is $0.012 \sim 0.066$ mm with a service limit of 0.1 mm.

Intake valve	A	$L_o = 65$	Φ	$D_A = 39.8$	$d_A = 4.4$	I	$L_o = 59$	Φ	$D_I = 26.8$	$d_I = 2.9$
exhaust valve	A	$L_o = 69$	Φ	$D_A = 40$	$d_A = 4.5$	I	$L_o = 59$	Φ	$D_I = 26.8$	$d_I = 2.9$



Technical drawing of a mechanical part showing two views: a side view (top) and a front view (bottom). The side view shows a cylindrical part with a central hole of diameter 50 mm and a smaller hole of diameter 56 mm. The front view shows a cross-section with a 90-degree angle and a 110-degree angle. Dimensions are given in millimeters.

Side View Dimensions:

- Overall length: 148.0 ± 0.1
- Distance from left end to center of 56 mm hole: 4.7 ± 0.1
- Distance from center of 56 mm hole to center of 50 mm hole: 57.2 ± 0.2
- Distance from center of 50 mm hole to right end: 54.0 ± 0.5
- Radius of fillet: 1.8
- Radius of fillet: 4.0

Front View Dimensions:

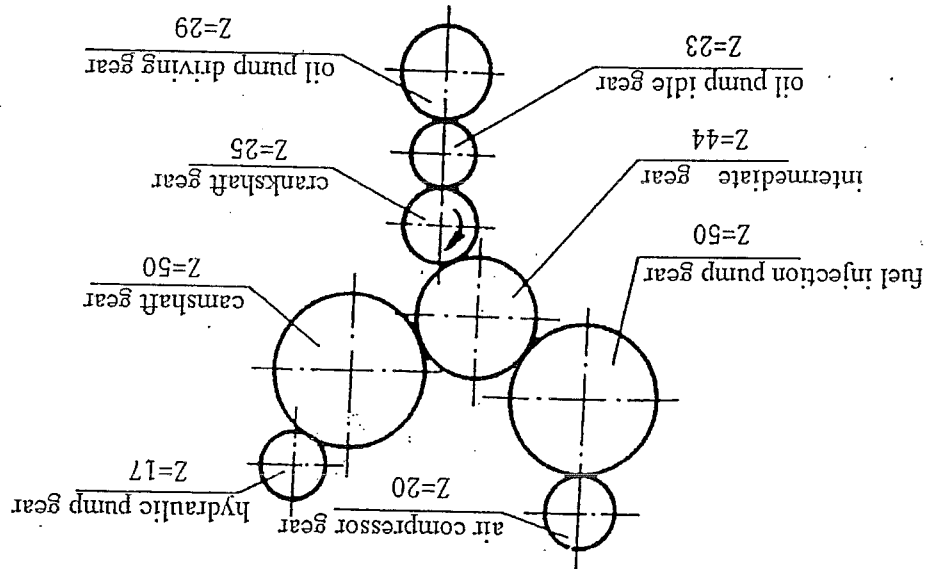
- Overall width: 13.6 ± 0.1
- Angle: 90°
- Angle: 110°

Technical drawing of a valve assembly. The drawing shows a vertical valve stem with a handle at the top. The handle has a circular end with a diameter of $\phi 1$. The stem has a diameter of ϕd at the bottom. The valve is labeled with 'Service limit A' and 'Valve stem dia.'. The drawing includes dimensions for the valve guide pipe ID and OD, and the valve guide pipe OD. The drawing is oriented vertically, with the handle at the top and the stem pointing downwards.

Valve dimension	Valve guide pipe ID	Valve guide pipe OD	Valve stem dia.	Service limit A	Intake valve	Exhaust valve
110°	11.0 ^{+0.018}	16.6 ^{+0.024}	10.97-10.98	1.6 mm	110°	90°
90°	11.0 ^{+0.018}	16.6 ^{+0.023}	10.965-10.975	1.6 mm	90°	110°

The crankshaft gear is heated to 180°C and then installed and keyed to the crankshaft. There is a fixing flange in the front of the crankshaft gear, used to fix the crankshaft belt pulley and the shock absorber. This flange is heated to 290°C and installed on the crankshaft. The crankshaft gear transmits its power to the oil pump gear through the

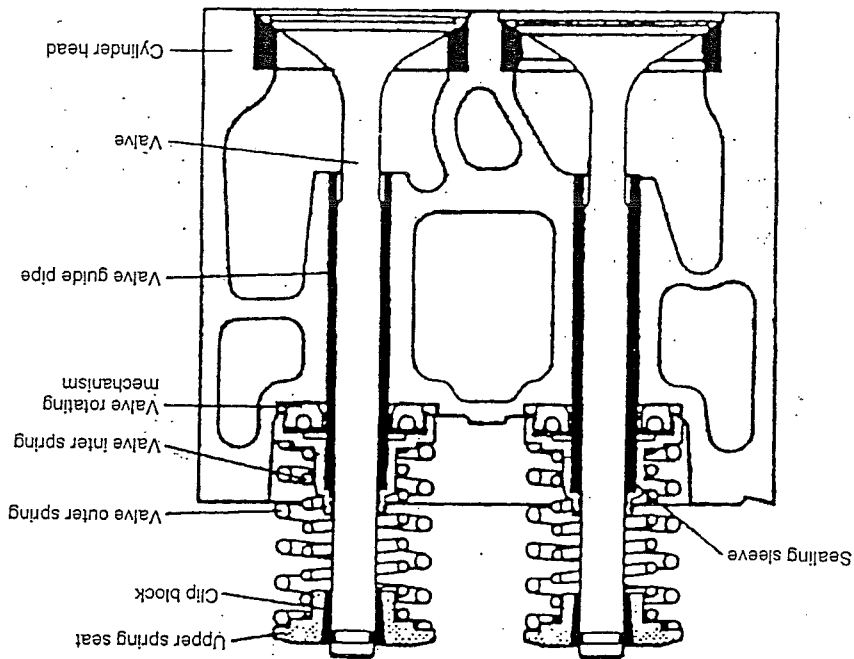
Fig.2-24 The timing gear drive



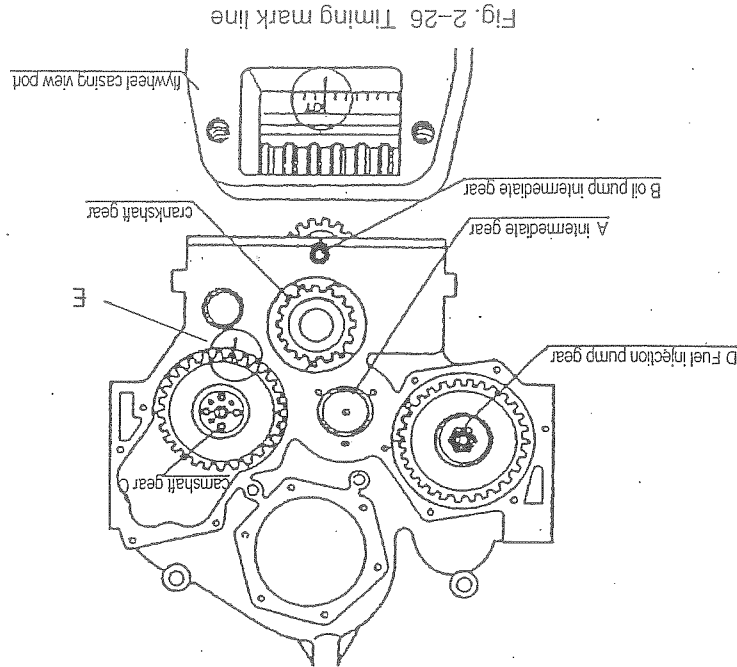
The timing gear drive is composed of 8 gears. The configuration of gears and the number of teeth of each gear are as shown in Fig. 2-24.

4. Timing Gear Drive

Fig. 2-23a Valve sealing

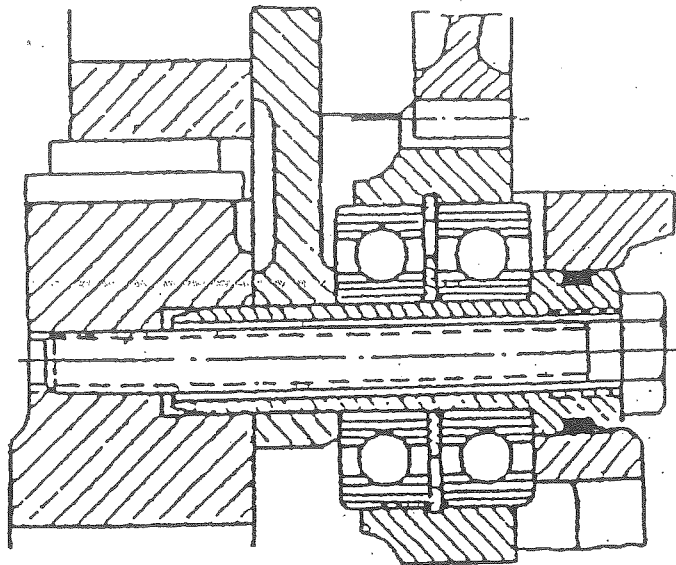


In order to guarantee that the oil does not enter the cylinder through valve stem and the valve guide pipe, seals are placed on the guide pipes of the intake and exhaust valves, as shown in Fig. 2-23a. The fitting clearance between the valve guide pipe and the valve stem is 0.02 ~ 0.048 for intake valve, and 0.025 ~ 0.053mm for exhaust valve. Their wear limit is 0.1mm. When exceeding the service limit, the valve guide pipe should be replaced timely.



The oil pump gear is heated to 240°C, and fit on the oil pump shaft with no key used. The crankshaft gear is coupled with the fuel injection pump gear via the timing intermediate gear and the camshaft gear. The timing intermediate gear is support in the timing gear case by means of the intermediate gear shaft sleeve (the shaft sleeve is fixed inside the timing gear case with support bolts) and the bearing. The camshaft gear is located by a Φ 8mm locating pin, and coupled to the camshaft head by means of four MSx20 bolts. When adjusting timing, set the first cylinder to its top dead center and make sure that the OT marking is aligned with the marking on the flywheel casing. It then indicates that the valve timing of the engine (i.e. the time when the intake and exhaust valves open and close) is guaranteed. When installing camshaft timing gear during the adjustment, make sure that the timing mark line on the camshaft timing gear is aligned with the timing mark line on the timing gear case, as shown at position E in Fig. 2-26.

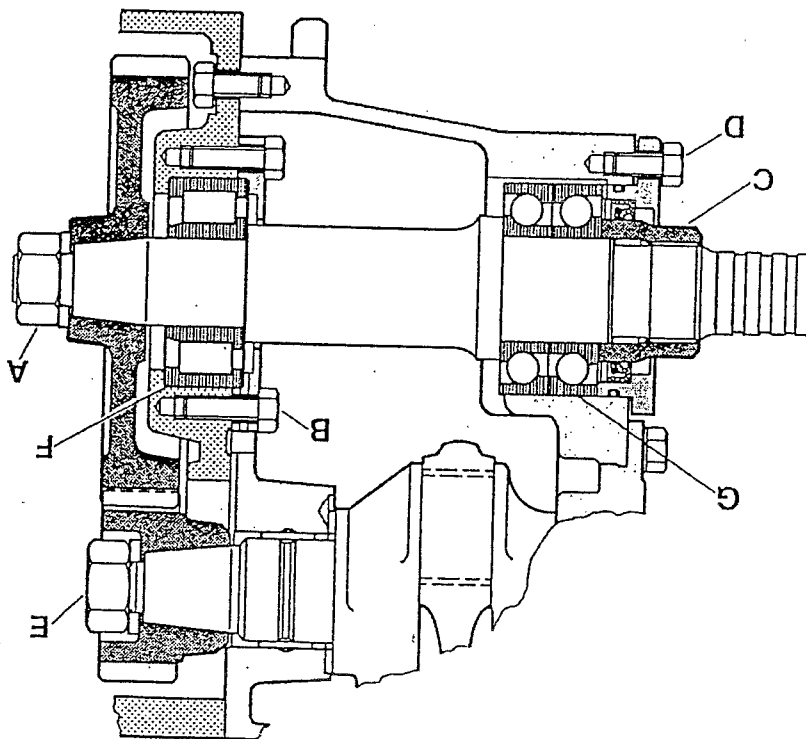
Fig. 2-25 Structure of oil pump intermediate gear



The oil pump intermediate gear is supported between the timing gear case and the cylinder block by means of the intermediate gear and two 303 bearings, as shown in Fig. 2-25.

The air compressor gear is also coupled to the crankshaft at high torque through a tapered hole and conical face with self-locking and without key. It is secured in the timing gear case by means of a suspension arm. The steering boost pump drive gear is keyed to the pump shaft, and secured in the timing gear case by means of a suspension arm. There are openings in the timing gear case at the location of the camshaft gear and the fuel injection pump drive gear. The camshaft gear and the fuel injection pump drive gear can be removed and installed through these openings with their covers removed. To replace the timing intermediate gear, you must first remove the camshaft gear, the camshaft axial locating plate, and all valve tappets from the camshaft, push in the valve tappets to the top of the cylinder block (separating the valve tappets from the camshaft), and finally take camshaft to the rearward direction of the diesel engine, withdraw the timing intermediate gear shaft, and finally take

Fig. 2-27 Assembly of fuel injection pump drive shaft



In Fig. 2-26, apply Lotite 242 sealant on fastening bolts at positions A, B, C and D. The tightening torques of the oil pump driving gear D are 60Nm, 32Nm, 300Nm and 350Nm respectively. The air compressor oil pump driving gear is coupled to the drive shaft through a tapered hole and conical face at high torque with self-locking and without key, and secured by a M18X1.5 nut, as shown in Fig. 2-27. It is characterized by simple assembly, proper injection timing and stepless adjustment. The Fuel injection pump driving shaft is supported by a cylindrical roller bearing at the side of the gearbox and by the biserial radial thrust bearing at the side of the air compressor crankcase. The cylindrical roller bearing is fixed in the gearbox by a cap. At the upper surface, a lubricating groove is milled (facing up). The inner race of the biserial radial thrust bearing is fixed on the shaft by a nut and the outer race is secured in the air compressor crankcase by a cover plate. When assembling, apply Lotite 242 sealant on bolts A, B, D and E, and tighten these bolts to 350Nm, 23Nm, 23Nm and 200Nm respectively. Apply Lotite 638 sealant on bolt C and tighten it to 150Nm. Apply Lotite 270 on the outer races of the bearing G. Apply Lotite 641 on the outer races of the bearing F. The two bearings are heated to 110°C and then installed.

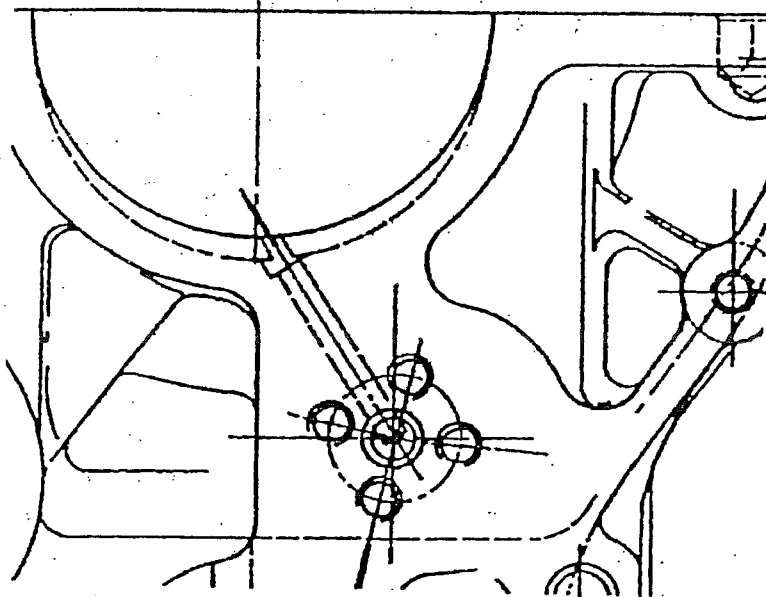
The air filter is of a double-element spiral-flow type. Air is sucked into the housing of the air filter. Under the centrifugal force generated by the spiral flow inside the cowl, large particles and impurities and dust in the air are thrown to the filter housing and fall into a dust collector. The collected particles and impurities and dust will be disposed manually. Fine dusts will pass together with the air and be filtered by the paper filter element and the felt safety element. Pure air after filtration will enter the engine. When the filter element and the safety element are too dirty and the vacuum inside the filter increases to a certain level, the switch of the air filter closes, illuminating the air filter indicator lamp on the instrument panel, and signaling the operator to clean the filter elements. As the filter element is dry outward-blow type, it is forbidden to soak clean the filter element and the safety element in solutions (such as gasoline). Before cleaning the filter with compressed air, check if the filter is damaged. Replace it if it is damaged. During operation, attention must be paid to the following two points: 1. The suction pipe in the front of the air filter is composed of two parts, and its upper half is a integral part of the driving cab, and its lower half is fixed

each other by means of steel sheet seal ring. of pipe with laminated wall and having two exhaust ports. The front and the rear exhaust manifolds are sealed from cylinders and another for the last three cylinders). The exhaust manifold used for the last three cylinders is a kind way type exhaust manifold, and the supercharged engine uses two exhaust manifolds (one for the first three cooling engines. There are also two kinds of exhaust manifolds: the natural aspirated engine uses simple straight-alloy. The intake manifold faces rearward for natural aspirated and supercharged engines and forward for inter-

The intake and exhaust systems differ as the form of intake is different. The intake manifold is made of aluminum

5. Intake and Exhaust Systems and Supercharger

Fig. 2-29 Local structure of the cylinder block intermediate gear portion



The radial clearance of the intermediate gear is 0.04 ~ 0.08mm, and the axial clearance is 0.15 ~ 0.25mm.

intermediate gear bearing, as shown in Fig. 2-29. In order to ensure reliable lubrication of the bearing, the timing intermediate gear shaft sleeve is lubricated under pressure. Therefore, as shown in Fig. 2-28, an oil passage leading to the timing intermediate gear bearing is opened in the first main bearing seat bore of the cylinder block. And at the same time, four bolt holes and a spindle locating hole are drilled in the end surface of the cylinder block at the corresponding positions for fixing the intermediate gear bearing, as shown in Fig. 2-29.

The timing gear case is sealed at the location of the intermediate gear by means of a end cover (9) and an O-ring (7). the engaging accuracy of the gears, decrease the possibility of occurrence of tooth knocking, and prolonge the service life of the intermediate gear.

on the chassis. There is open-type joint between the two halves. In operation, try to keep the joint out of the air filter, as this may increase the load of the air filter, and increase the opportunities of dust getting into the cylinder, speeding up the wear of the cylinder sleeve. 2. Although there is a sensor on the air filter and a filter blockage indicator lamp on the instrument panel, the operators should not rely on them absolutely due to the problem of their reliability, but check and clean the filter periodically, especially when operating in construction site or in a highly dusty environment.

The supercharger is made up of two parts: the turbine assembly and the pump impeller assembly. The exhaust from the engine blows the turbine together with the pump impeller to rotate at high speed, which in turn blows air into the intake manifold and increases the intake air pressure (air input). The boost pressure increases as the rotating speed rises. When the engine is at its rated speed (about 2,200 rpm), the speed of the rotor of the supercharger is as high as 70,000 ~ 100,000 rpm. The rotor shaft of the supercharger adopts full-floating bearing, i.e. there is a certain radial clearance between the shaft and the shaft sleeve, and the rotor shaft is floated by the lubrication oil under a given pressure. The pressure lubrication oil supplied by the main oil passage of the engine directly flows into the rotor shaft chamber of the supercharger and then back to the oil pan. There are seal rings on the turbine casing and the pump impeller casing respectively used to stop the lubricating oil of the rotor shaft from coming out, as shown in Fig. 2-30. Therefore, when replacing the supercharger, remember to add lubricating oil.

As the supercharger has the above-mentioned features, the following three points must be remembered during operation:

First, when the engine is started, apply load only after the oil pressure and the oil temperature become normal, especially in cold days, or the supercharger bearing and the seal rings might be pre-worn due to lack of lubricating

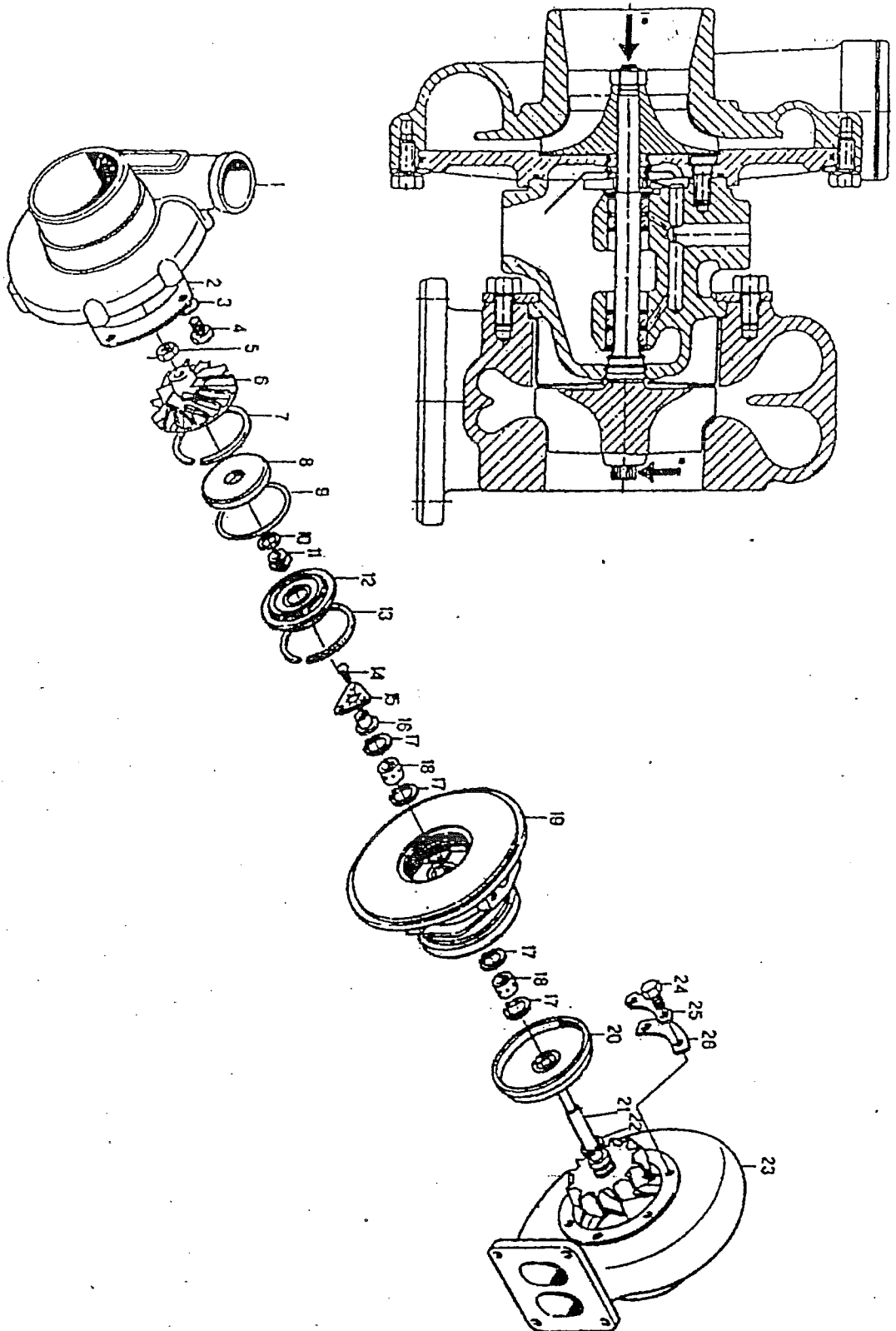
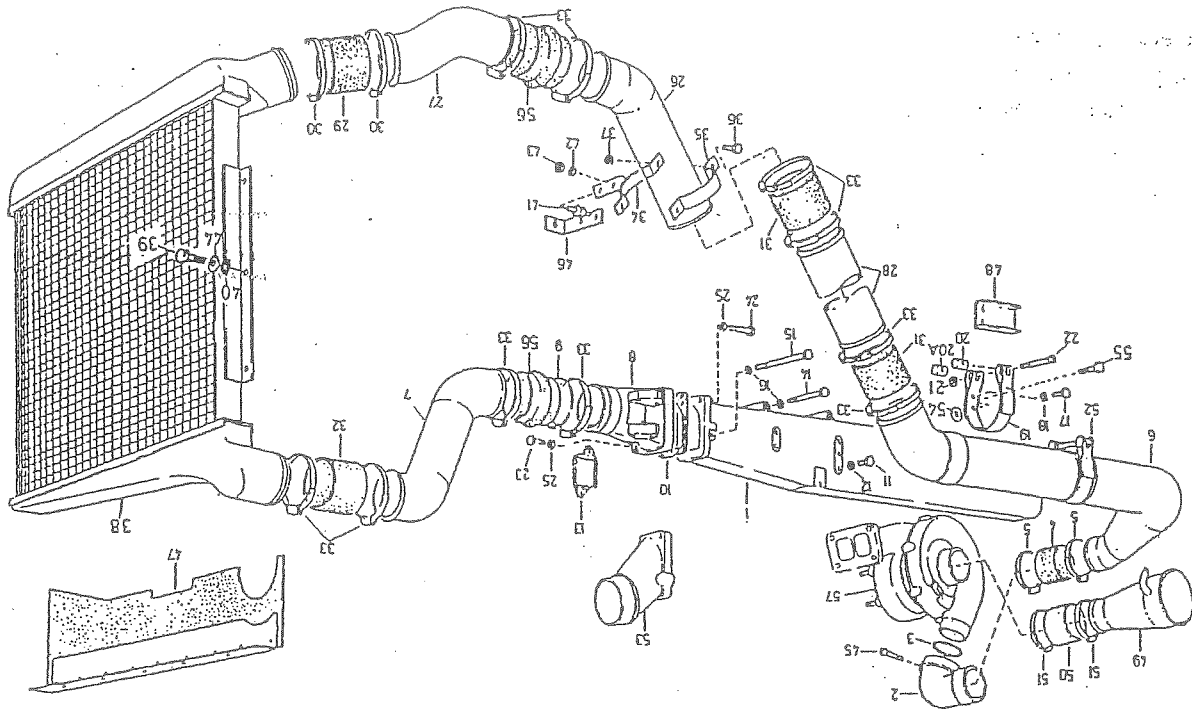


Fig. 2-30 Exhaust turbocharger

1. Air compressor casing 2. Air compressor hold-down plate 3. Locking washer 4. Hex bolt 5. Locking nut 6. Air compressor impeller
7. Aircilp 8. Air seal plate 9. O-ring 10. Air compressor end seal 11. Shaft seal 12. Oil deflector 13. Aircilp 14. Flat head screw 15. Thrust bearing 16. Distance fixing thrust sleeve 17. Floating bearing 18. Mild casing 19. Thermal baffle 20. Turbine parts 21. Turbine end seal ring 22. Turbine casing 23. Turbine casing lock piece 24. Hex bolt 25. Turbine casing hold-down plate 26. Turbine casing hold-down plate

Fig. 2-31 Component location of supercharging and inter-cooling system



oil.

Second, when shutdown the engine, first let the engine run at idle speed for 3-5 minutes to allow the rotating speed of the supercharger to decrease. Never advance the throttle abruptly before shutdown, as sudden increase of engine speed may accelerate the speed of the supercharger too much (70,000 ~ 100,000 rpm). If the engine is shutdown at this time, the oil pump stops running, and the oil circulation stops too. However, the supercharger rotor would continue to rotate at high speed under inertia force, and the rotor shaft, the bearing and the seal rings would be burnt due to lack of lubricating oil. The habit of advance the throttle abruptly during operation is fatal to the service life of the supercharger.

Third, when starting a engine parking for a long time, the supercharger must be pre-lubricated. This can be realized by removing the oil inlet pipe of the supercharger and fill a proper amount of clean oil into the oil inlet port. Otherwise, the engine would suffer from pre-wear due to lack of lubricating oil during initial starting. The phenomenon of pre-wear of the supercharger is oil leakage. During operation, if large amount of oil leakage is found from the intake or exhaust manifolds or the radial or axial clearance of supercharger rotor shaft is found exceeding their service limit, it indicates that the supercharger needs repair or replacement. The pre-wear of the supercharger normally results in decrease of engine power.

The primary inspection index for the exhaust turbocharger is the axial clearance and the radial play. Take T45 supercharger as an example, the radial play is 0.075 ~ 0.18mm and the axial clearance is 0.025 ~ 0.1mm. Superchargers used for engines of different powers are also different. When submitting a request to the spare supplier for a new supercharger, the model of the engine must also be clearly pointed out.

A disk valve and a control cylinder are mounted on the exhaust pipe of WD615 series diesel engines. They are used for engine shutdown and exhaust braking.

Engines with 266 hp or above are of inter-cooling type. The inter cooler is located in the front of the engine radiator, as shown in Fig. 2-31. As the supercharged air is cooled in the inter-cooler, the air entering the cylinder is low in temperature and high in density. As a result, the power is increased and fuel consumption lowered. As the temperature of inlet air is low, the thermal load of the engine is decreased, the temperature of the exhaust air is lowered and the amount of NO_x emission is reduced.

WD615 series diesel engines use conventional lubricating system. Fig. 2-32 is a diagram of lubricating system and Fig. 2-33 a diagram of oil circulation in the lubricating system.

6. Lubricating System

WD615 series diesel engines use conventional lubricating system. Fig. 2-32 is a diagram of lubricating system and Fig. 2-33 a diagram of oil circulation in the lubricating system.

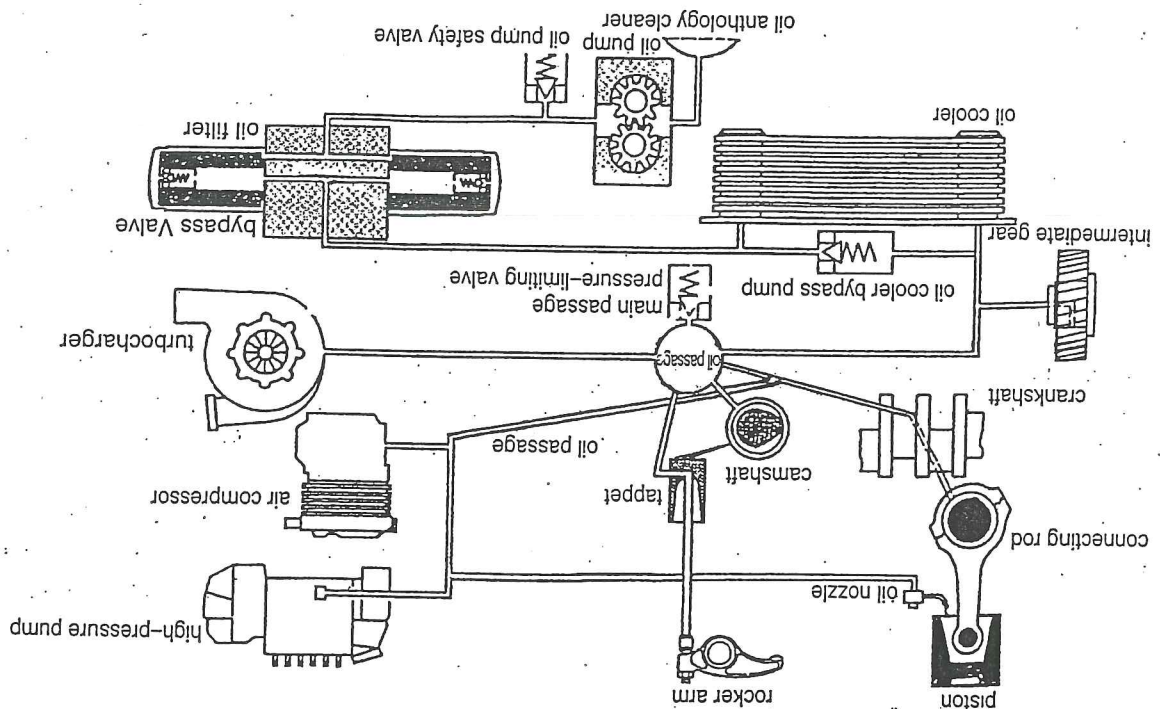


Fig. 2-32 Lubricating system

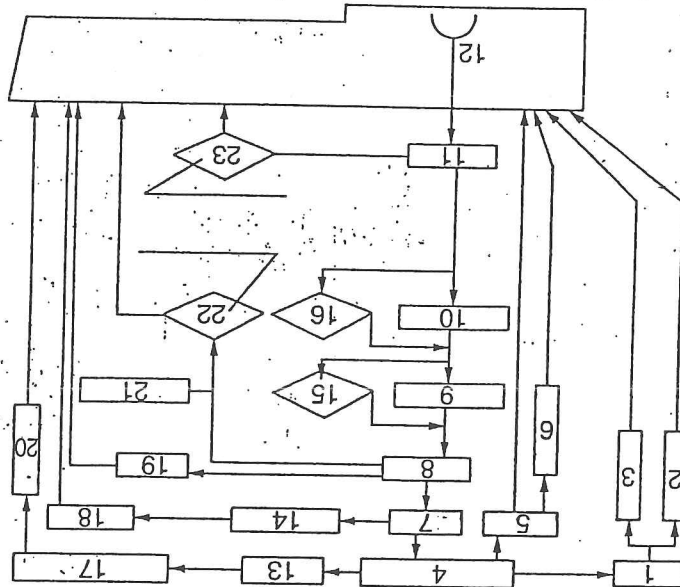


Fig. 2-33. oil circulation in lubricating system

1. secondary oil passage 2. fuel injection pump 3. air compressor 4. crankshaft main bearing oil passage 5. main bearing 6. connecting rod bearing 7. slant oil passage 8. main oil passage 9. oil cooler 10. oil filter 11. oil pump 12. oil pan 13. secondary oil passage 14. camshaft bearing 15. bypass valve 16. bypass valve 17. piston cooling oil nozzle 18. valve mechanism 19. supercharger 20. piston inner chamber 21. oil pressure sensor 22. main oil passage pressure-limiting valve 23. oil pump pressure-limiting valve

The oil pump sucks oil through the oil anthology cleaner in the oil pan and directly supplies it to a screw-in type oil filter through oil passage in the crankcase. The filtrated oil is fed to the oil radiator element at the right side of the cylinder block (looking forward) and cooled by cooling water. The cooled oil flows into the main oil passage in the cylinder block, and then further to the crankshaft journal and the connecting rod shaft journal for lubrication of the main shaft shell and the connecting rod shaft shell. The oil also flows from the main oil passage to the camshaft bushing for lubrication of camshaft bearing. With the intermittent opening between the oil passage orifice and the valve tappet, oil flows to the valve rocker arm shaft through the oil orifice in the valve tappet and the hollow valve lifter to lubricate the rocker arm shaft and the valve. The main oil passage is connected to the secondary oil passage on the left side of the cylinder block through an oil passage. oil is sprayed by an oil nozzle in each cylinder onto the top of the piston to cool the piston. When the piston falls, oil then flows into the piston pin bushing through V-shaped orifice in the small end of the connecting rod to lubricate the piston pin. The fuel injection pump, the air compressor and the supercharger are lubricated by oil coming from special supply pipes connected to the main oil passage. The timing gear is lubricated as follows:

Fig. 2-33c Mounting position of oil overflow valve

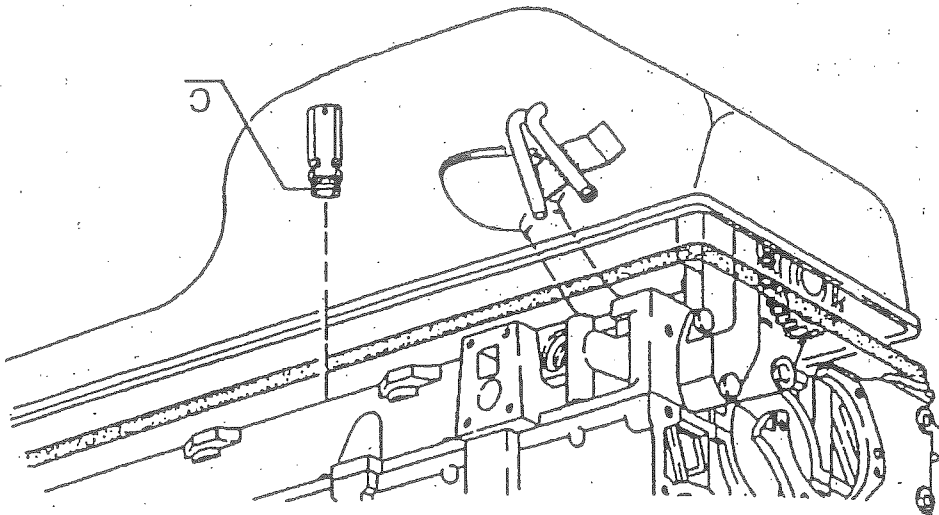


Fig. 2-33b Mounting valve of oil pump

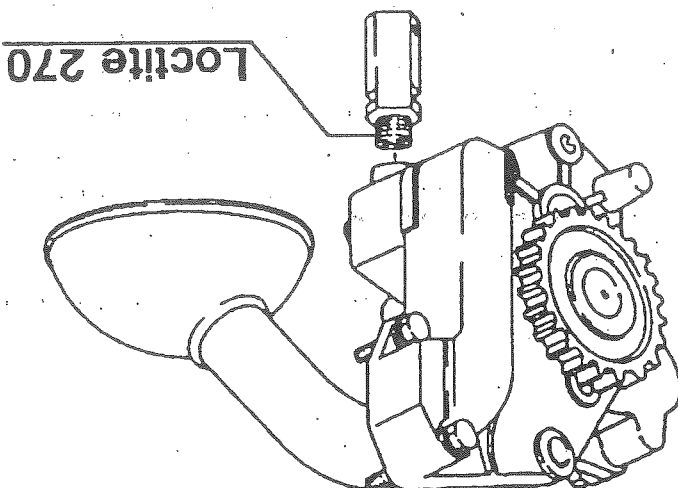
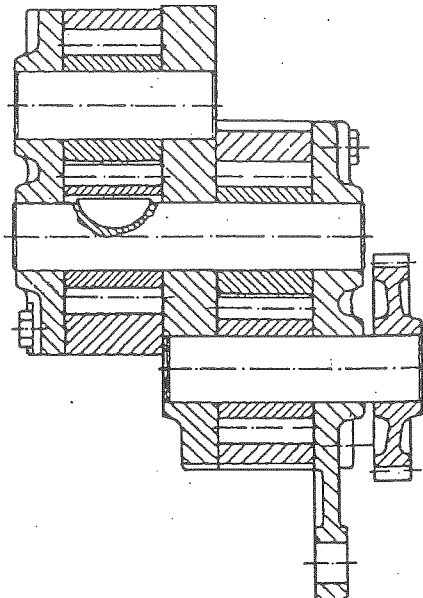


Fig. 2-33a Structure of gear pump



The oil pump is a gear pump with 45mm face width of tooth. See Fig. 2-33a. The fitting clearance between the gear shaft of the oil pump and the gear shaft seat bore is 0.04-0.08mm with a wear limit of 0.10mm, and the end clearance of the pump gear is 0.098-0.16mm with a wear limit of 0.20mm.

The area of heat dissipation of the tube-type oil radiator is 2,765 cm². The oil filter is of an integral screw-in structure. Replace it during service.

There is a safety valve on the oil pump. Its opening pressure is 15.5 ± 1.5 bars. See Fig. 2-33b. There is a pressure-limiting valve on the main oil passage in the cylinder block. Its opening pressure is 5.0 ± 0.5 bars. In order to prevent the oil filter from being blocked, a bypass valve with a opening pressure of 2.5 ± 0.175 bars is installed on the filter. There is also a bypass valve on the oil radiator whose opening pressure is 6 ± 0.36 bars. There is an overflow valve in the main oil passage of the cylinder block. Its opening pressure is 5 ± 0.5 bars, as shown in Fig. 2-33c. In order to guarantee safety, there is an oil pressure-sensing plug in the main oil passage. When oil pressure is below 0.25 ± 0.15 bars, an alarm indicator lamp will be illuminated.

Under normal operating temperature of the engine, the minimum oil pressure is 1 bar at idle speed and 3 bars at the rated rotating speed.

As for the double-stage oil pump assembly used on a cross-country vehicle, one of its pump will pump oil from the rear of the oil pan to the front of the oil pan. Another pump will pump oil from the front of the oil pan into the main oil passage.

7. Cooling System

WD615 series engines adopt an enclosed cooling system of conventional structure of modern strengthened diesel engine and with an expansion water tank, as shown in Fig. 2-34. Fig. 2-35 is a flow diagram of the cooling system.

The water pump is as shown in Fig. 2-35a.

On WD615 series engines, the water pump is mounted at the fore end of the engine. The volute casing of the water pump is above the timing gear case. The volute casing and the timing gear case are cast into one integral part. The water from the volute casing directly enters the water chamber at the right side of the engine body. The cold water flows across the oil cooler and flows into the interlayer of the cylinder sleeve through a passage hole at the lower right side of the engine body to cool the cylinder sleeve, and then enters the water chamber in the cylinder head through a water inlet hole to cool the cylinder head, and is finally discharged into the water exit pipe through a water exit hole in the cylinder head. There is a thermostat at the end of the exit pipe. The thermostat has two exits: one is communicated with the water tank and another connected to the water inlet of the water pump for minor circulation. When the temperature of the cooling water is 80°C, the thermostat begins to open. It comes to full open at the temperature of 95°C. And now, all cooling water will be cooled by the radiator and then pump into the engine body. When the cooling water temperature is low, the thermostat shuts off the above-mentioned passage. The cooling water enters the inlet port of the water pump directly, making the engine temperature rise quickly to the warm state of operation, and thus avoided cold scuffing and prolonged the service life of the engine. For engines operating on highlands and in hot regions, thermostats with an opening temperature of 71°C and full-open temperature of 85°C can be used so as to prevent the engine from overheating.

The oil chamber in the water pump is filled with approx. 120ml general vehicle-use lithium base grease. Periodical replenishment of the grease is required.

The function of the expansion tank is to replenish cooling water and to eliminate low-pressure vapor in the cooling system so as to suppress the generation of the phenomenon of vapor lock. The pressure inside the expansion tank should be maintained at 50 kPa. It must be higher than the engine and the radiator by 400mm.

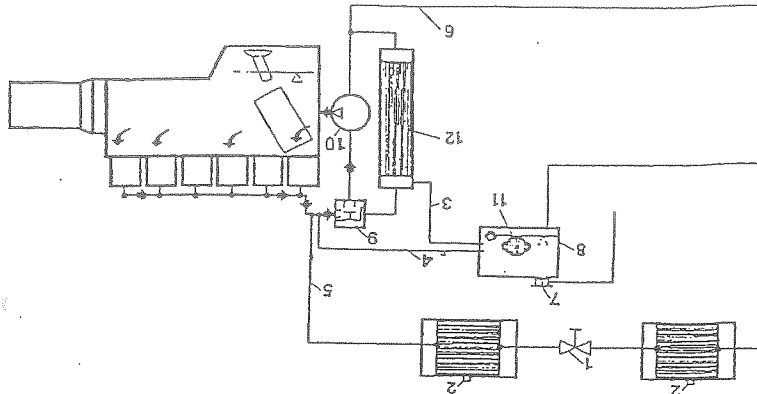
Caps of various water tanks must be kept intact and in good condition. Never leave them open. To maintain a 50kPa pressure inside the cooling system may increase the efficiency of cooling and make water unlikely to boil.

The plastic fan is die-cast from fiberglass strengthened PA6.

Fans can be driven by either positive driving or silicone oil clutch driving (i.e. viscous driving).

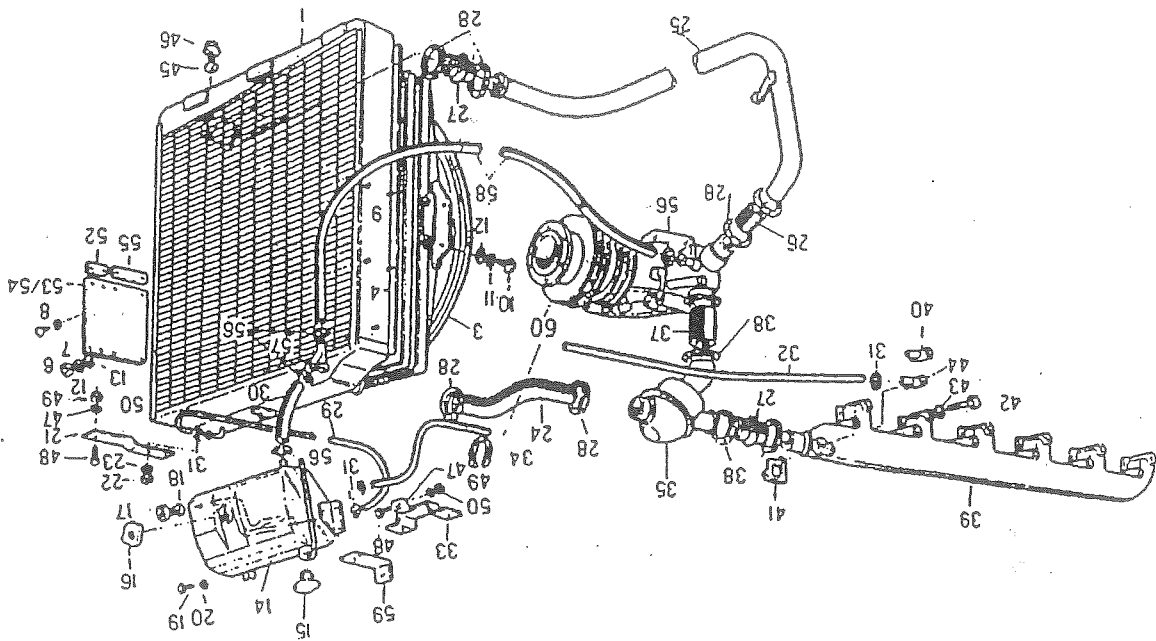
The operation of the silicone oil clutch fan is controlled by a bimetal temperature-sensing element. It is good in

Fig. 2-35 Water circulation in cooling system



1. Radiator 3. Cow 4. Rubber seal 5. Bracket 6, 7, 8, 10, 11, 12, 13. Bolt, washer, etc. 14. Expansion water tank 15, 16. Water tank cap 17. Water level indicator 18. Washer 19, 20. Fixing bolt 25. Water inlet pipe 26. Rubber union 35. Thermostat 39. Water exit pipe 60. Water pump

Fig. 2-34 Structure of cooling system



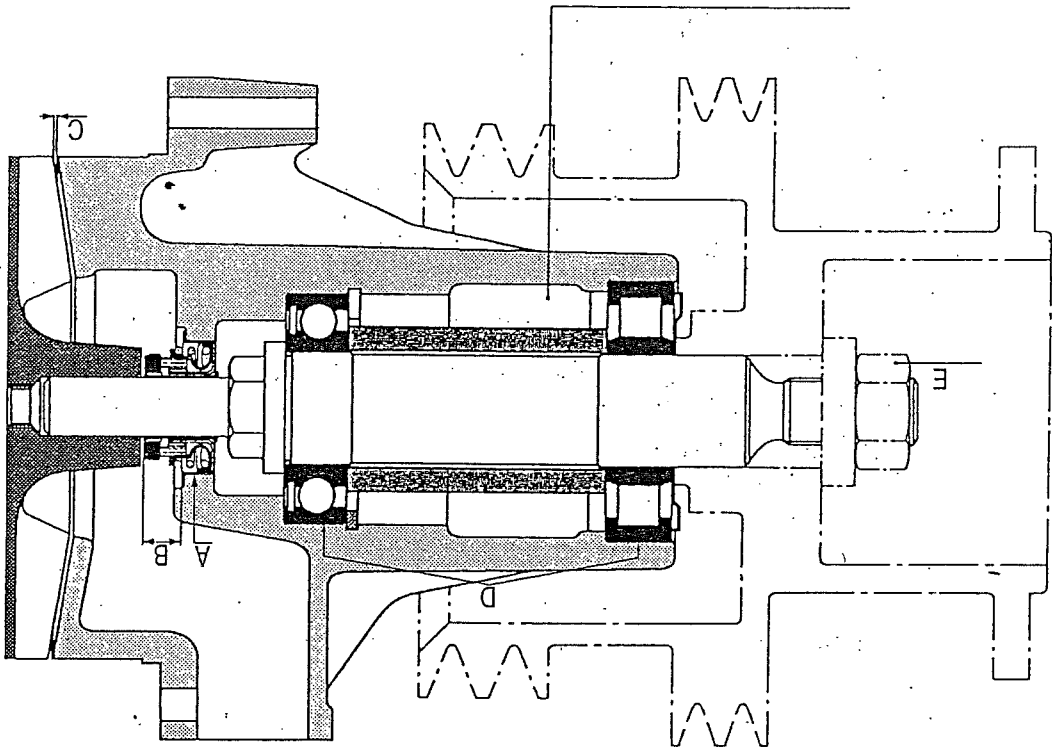
When the silicone oil clutch fan is removed, do not lay it horizontally, otherwise, silicone oil would leak out through the fit clearance of the sensor shaft.

energy saving, and more importantly, it can ensure diesel engine at a good hot state and is good to its operation and may prolong its service life. The primary principle of this fan is that, the engine drives the driving wheel in the clutch hub, the fan blades and the wheel hub are an integral part and there is a clearance between the driving wheel and the wheel hub. When this clearance is filled with silicone oil, the driving wheel can drive the hub to rotate; and when there is no oil in the clearance, the driving wheel would run idle (practically it can drive the fan to rotate at low speed). The bimetal probe is a valve to control the entry of the silicone oil into the working space, therefore, the operation of the fan is controlled by temperature. When the temperature of the air before the fan is below 40°C, the bimetal probe closes the silicone oil chamber valve. The driving wheel basically does not transmit power, and the fan rotates at a speed of 45% of the driving wheel speed. When the temperature is higher than 40°C, the silicone chamber valve opens, and silicone oil will fill up the working space. The fan speed now is 95% of the driving wheel speed.

8. Air compressor

WD615 series engines use single cylinder air compressors. For its structure, refer to Fig. 2-36.

Fig. 2-35a Water pump



1mm.

Water seal dimension B is reduced to 10.4mm. After the water pump impeller is pressed in, the dimension C is

Apply Loctite 572 to the location of water seal A.

The tightening torque for the fastening nut of the belt pulley is 130+20Nm.

Apply Loctite 641 sealant on bearing D.

sealed. A spring in the water seal makes the sliding ring stay against the sealing face.

The water pump is of backward curved vane centrifugal type. The liquid flows into the pump, and is driven by the rotating impeller and accelerated so that the cooling liquid has some energy. The water pump shaft is water

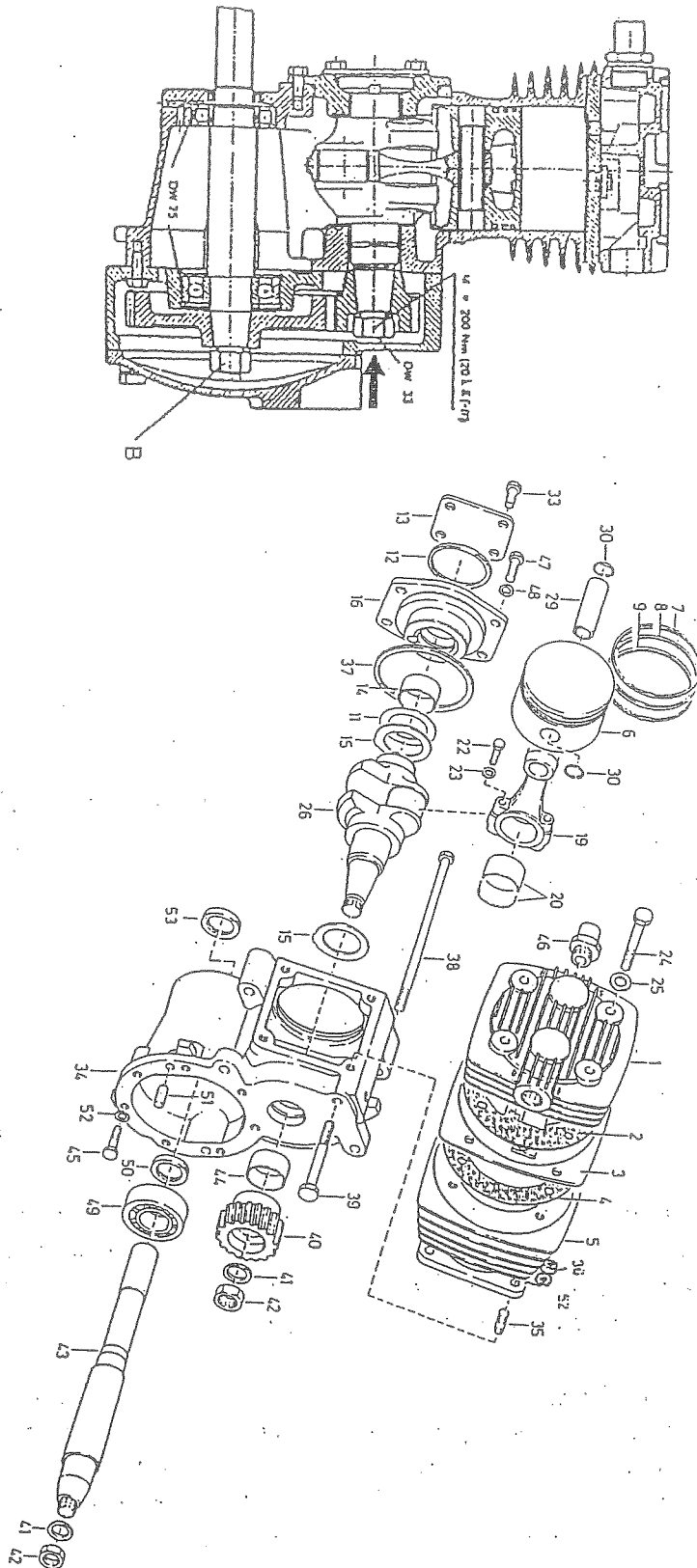


Fig. 2-36 Structure of air compressor

- 1.Compressor cylinder head 2、4.Shim 3、.Top cover 5.Cylinder sleeve 6.Piston 7、8、9.Piston ring 14、44: Main bearing shaft sleeve 16.Rear bear seat 19.Connecting rod 20. Connecting rod shaft shell 22、23.Connecting rod bolt washer 26.Crankshaft 29.Piston ring 30.Retainer 34.Crankcase 35.Fastening studbolt 36.Nut 38、39.Fastening bolt 40.Air compressor gear 41、42.Washer, nut 43.Drive shaft 49.Rolling bearing 53.Oil seal

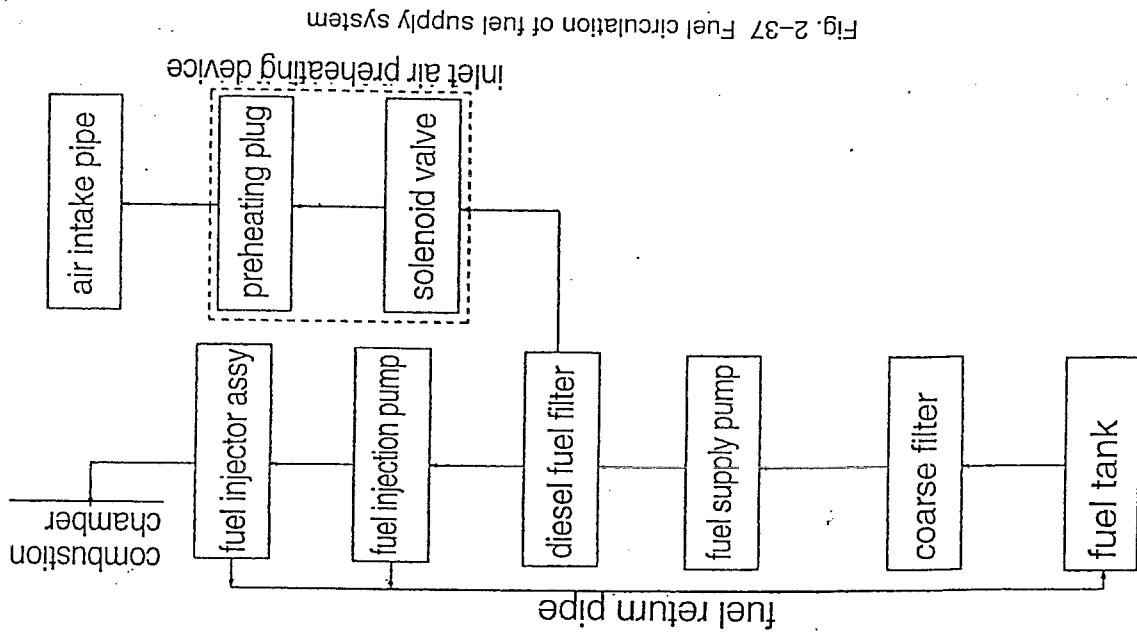


Fig. 2-37 Fuel circulation of fuel supply system

The Bosch P-type pump is a typical strengthened pump characterized mainly in compact structure and wide range of application. It adopts a fully-sealed pump body, plunger matching parts and suspension structure. Fuel injection timing is realized by means of adding or reducing the number of shims at the suspension sleeve. The amount of fuel supply is adjusted by rotating the suspension sleeve. The adjustment is easy and reliable. The amount of fuel supply of the P-type pump is adjusted by means of a pull rod slot and a ball engaging mechanism on the fuel supply control sleeve. The adjustment of fuel supply is flexible and reliable. In order to meet the requirement of high speed and high pressure of fuel injection, the plunger matching parts and the lifter are both forced lubricated. As for the structure of Bosch P-type pump, see Fig. 2-38.

9. Fuel injection system

The air compressor cylinder bore X stroke is 90 x 46mm, displacement 293ml, working pressure 8.33 bars and max. pressure 10 bars. The speed ratio of the air compressor to the crankshaft $i=1.25$, and the volumetric efficiency of the compressor $\eta_v=0.568$. The axial clearance of the crankshaft is 0.08 ~ 0.18mm. The intake and exhaust valves of the compressor are in reed structure. Apply Loctite sealant on the fixing nut of the drive gear, and tighten it to a torque of 200Nm. The compressor is force lubricated by oil supplied through a special pipe connected to the engine body. The lubricating oil comes from the main oil passage through oil pipe fixed on the cylinder block into the compressor to lubricate its bearings. After lubrication, oil then goes back to the scavenge oil pan from the timing gear case. Air entering the compressor has been filtrated by an air filter through a branch pipe at the front of the supercharger. The compressor is cooled by water coming through a pipe from the engine cylinder block to the compressor cylinder head. Water from the cylinder head then goes to the inlet of the engine water pump. Tighten cylinder head bolts to 50 Nm, Tighten connecting rod bolts to 14 Nm(box bead) and 25 Nm. The axial clearance of the crankshaft is kept within 0.08~0.18mm.

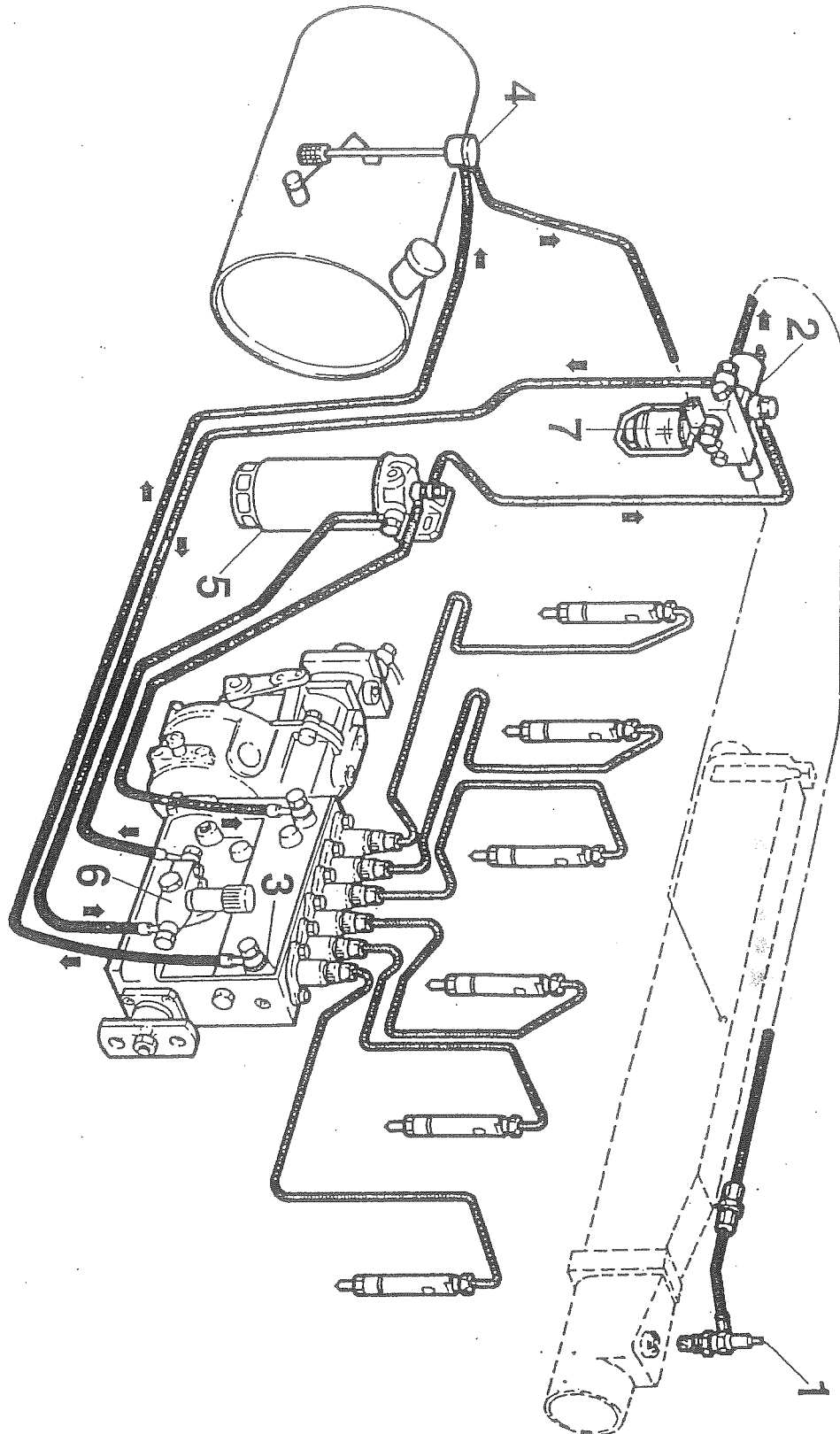


Fig. 2-37a Fuel supply system

1. Preheating plug 2. Solenoid valve 3. Overflow valve 4. Fuel tank 5. Fuel filter 6. Fuel supply pump 7. Fuel course filter

Fig. 2-38 Structure of German Bosch P-type pump

1. Nut 2. Adjusting shim of commencement of fuel supply 3. Steel sleeve flange 4. Leakage fuel return orifice 5. Plunger spring 6. Control sleeve 7. Lubricating oil injection port 8. Spring bottom seat 9. Roller body 10. Bottom cover 11. Oil delivery valve tightening cap 12. Oil delivery valve spring 13. Oil delivery valve gasket 14. Oil delivery valve 15. Pump body 16. Oil deflector bushing 17. Plunger 18. Pull rod 19. Camshaft

Definition of the type of Bosch pump:

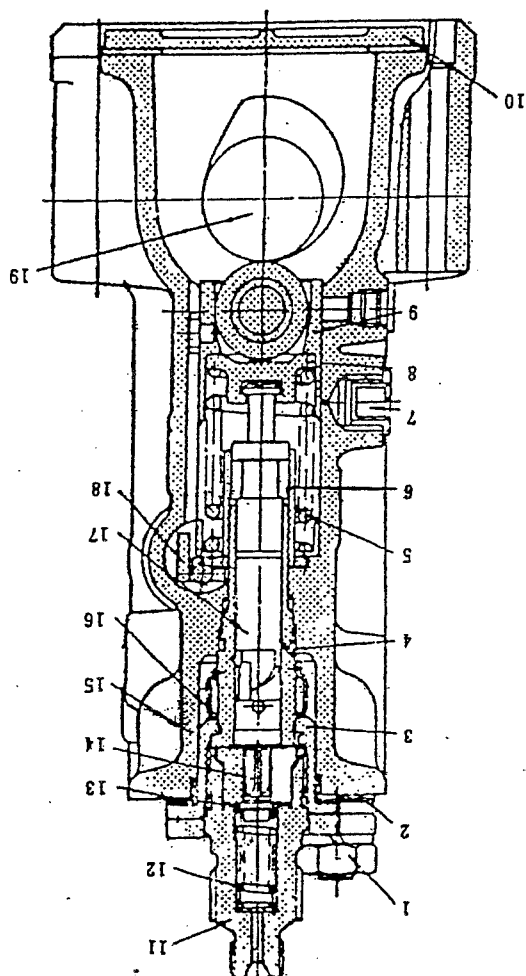
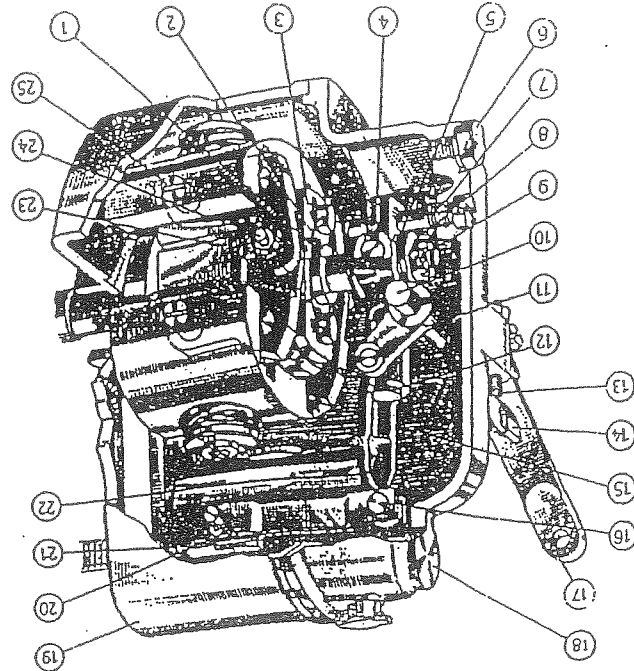
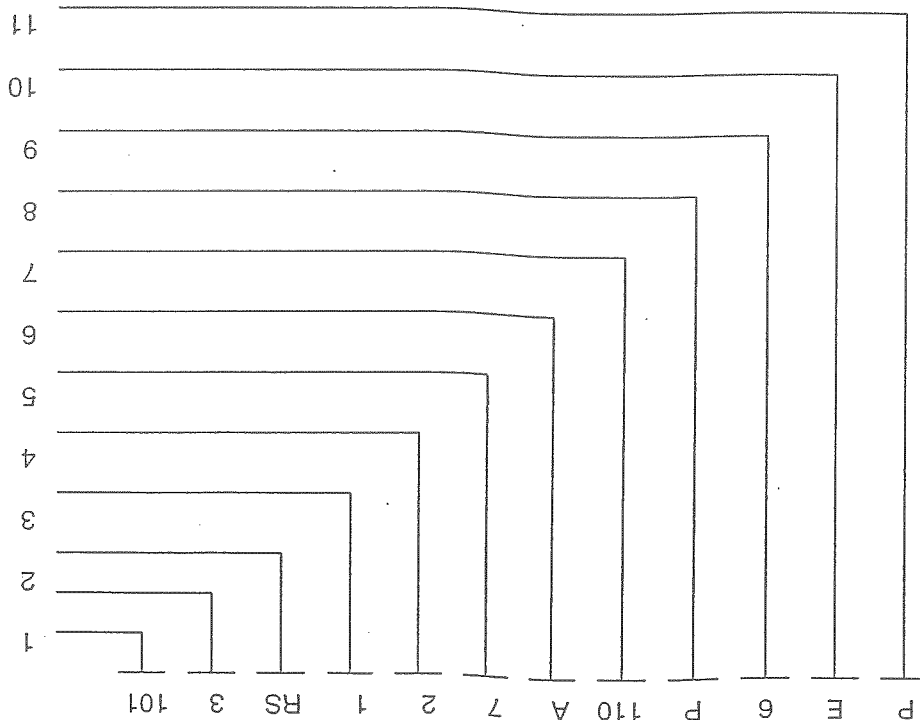


Fig. 2-39 Structure of RQ governor



1. Design code 2. With fuel feed pump mounting port 3. Fuel injection pump rotating direction code
4. Timing device mounting position code 5. Governor mounting position code 6. Fuel feed pump mounting form
code 7. Design code 8. Plunger diameter X10 (mm) 9. Fuel injection pump type (p) 10. Number of cylinders 11.
WD615 diesel engine uses two-speed governor or full-range governor (Euro II type) Bosch pump uses RQ two-
speed governor, as shown in Fig. 2-39. Its load control lever and floating lever are jointed by means of a sliding
sleeve. Their lever ratio is variable.



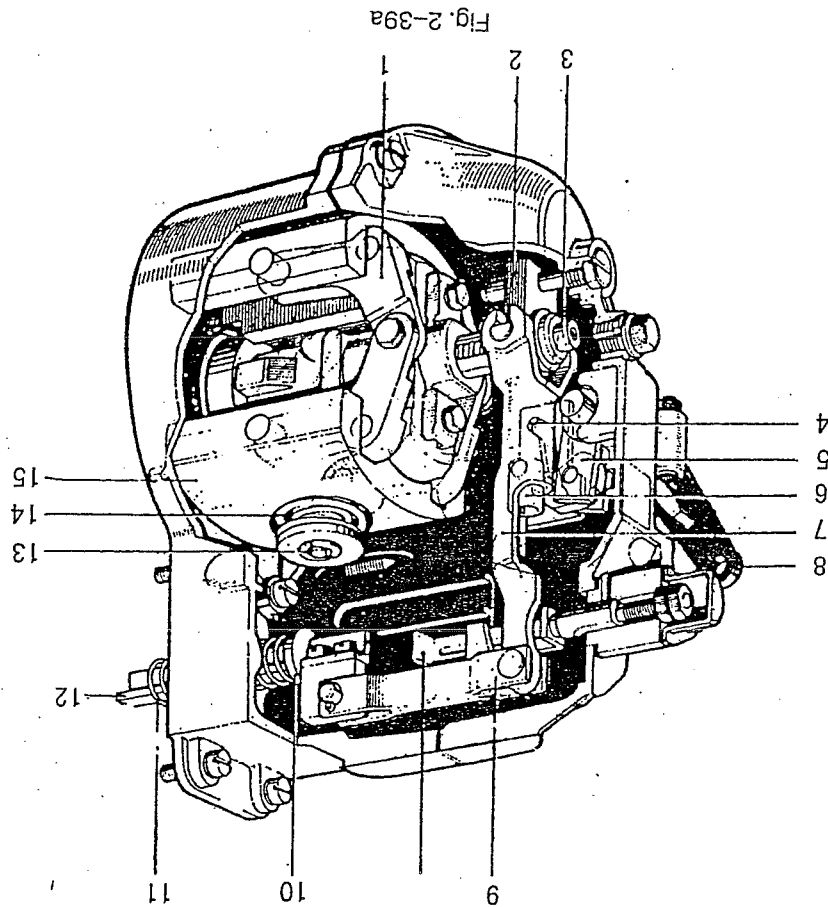


Fig. 2-39a

1. Slide 2. Locking steel cable 3. Angle lever bracket 4. Slide 5. Adjusting shim 6. Oil drain pipe plug 7. Support lever 8. Sliding sleeve nut 9. Lock pin 10. Control shaft 11. Control lever 12. Floating lever pin 13. Idle speed limiting bolt 14. Limiting stopper 15. Full-load limiting bolt 16. Coupling pin 17. Load control lever 18. Governor rear casing 19. Governor casing 20. Fuel supply coupling rod 21. Fuel supply gear rack 22. Floating lever 23. Angle lever 24. Lever shaft 25. Flyweight pin

At idle speed, the joint pivot of the load control lever and the floating lever is close to the mid position of the loading lever, and the upper and lower lever ratio of floating lever is 1.4:1. When the load control lever is at the full-load position, the joint pivot is close to the lower end of the floating lever, and the upper and lower lever ratio of floating lever is 2:1. The advantage of the variable lever ratio is: when operating at idle speed, as the rotating speed is comparatively low and the travel range of the idle speed adjusting gear rack is small. Small lever ratio can not only guarantee sufficient adjustment force, but also meet the requirement of the change of the idle speed gear rack. When operating at full-load and high-speed, as the flyweight has sufficient adjusting force, big lever ratio can not only ensure that the gear rack has sufficient travel, but also increase the speed governing rate with full load and at high speed and improve the sensitivity of the speed adjustment. The idle-speed, high-speed and correction springs of RQ governor are all fit in the flyweight.

As shown in Fig. 2-39a, the structure of the RQV governor is similar to that of RQ governor with some differences. In RQV, the speed adjustment spring is inside the flyweight. Within the specified range of speed adjustment, when the rotating speed increases, the flyweight will move outward continuously.

The controlled starting speed is related to various positions of the control handle. The movement of the control handle is transmitted to the floating lever via an elbow rocker arm and a guide, and then to the adjusting pull rod. The pivot of the floating lever can move in the sliding groove. The pivot is guided by a flat-face cam fixed on the rear casing of the governor, making the drive ratio vary between 1:1.7 and 1:5.9.

1. Angle lever 2. Slider 3. Spring supported telescopic shaft 4. Flat-face cam 5. Rocker 6. Guide 7. Floating lever 8. Control handle 9. Connecting fork full-load limiter 10. Spring holder 11. Balancing spring (clearance) 12. Fuel injection pump adjustment pull rod 13. Adjusting nut 14. Adjusting spring 15. Flyweight

In order to meet the matching requirement of the amount of the fuel supply and the amount of pressurized air of WD615 supercharger, a smoke limiter is installed on the governor used Bosch pump. The smoke limiter is actually a variable-travel gear rack limiter used to control the maximum fuel supply under various supercharging operating conditions. Fig. 2-40 shows a Bosch pump smoke limiter.

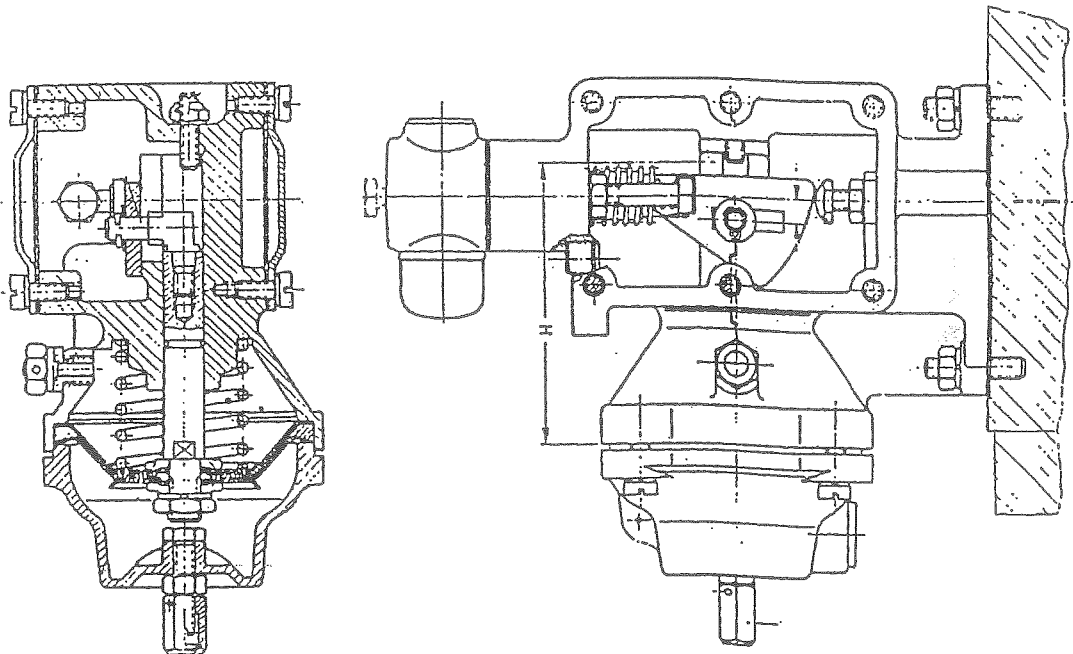


Fig. 2-40 Structure of Bosch pump smoke limiter

On Bosch injection pump, a starting enrichment device can be mounted. The enrichment device is actually a variable-travel gear rack limiter. When starting, pulling this limiter may obtain an amount of fuel supply for starting more than the amount of maximum full-load fuel supply.

The codification of type of Bosch governor is defined as follows:

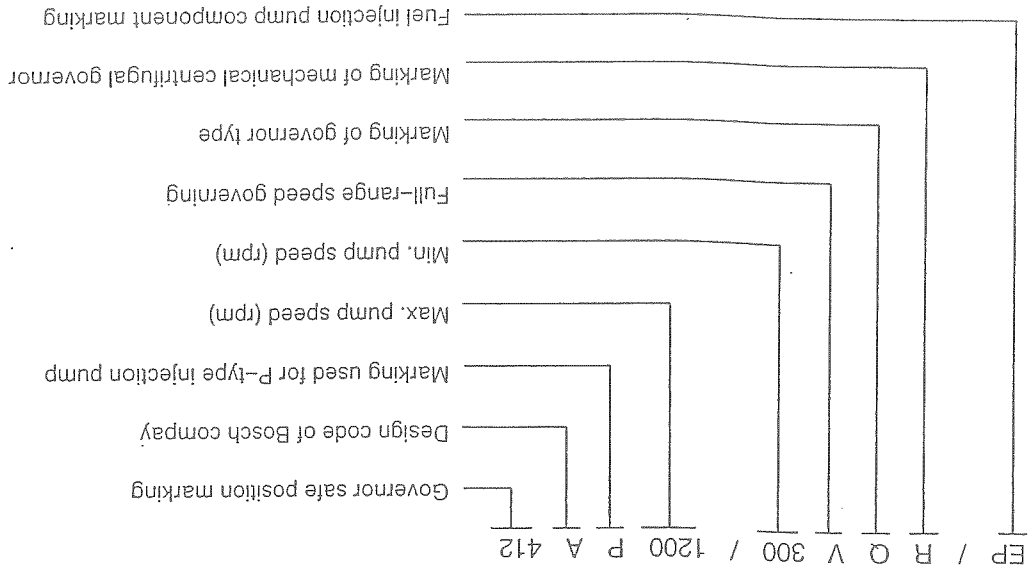


Fig. 2-42.

When starting the engine in winter seasons in cold areas, cold starting system must be used. There are two type of cold starting systems. One uses an intake manifold preheating system. The circuit of the system is shown in

10. Cold starting system

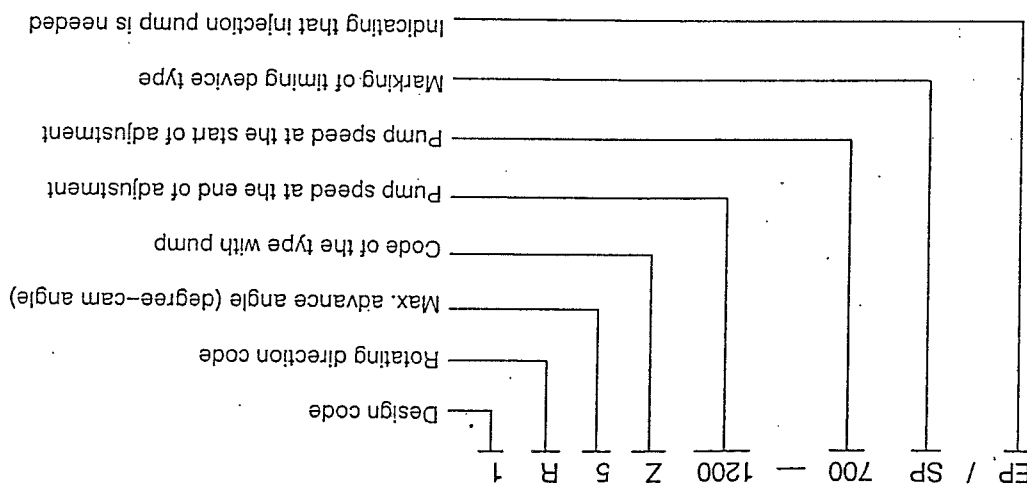
Fig. 2-41 Structure of Bosch injection pump



The structure of the fuel injector is as shown in Fig. 2-41.

The Bosch pump uses a plunger fuel supply pump. All fuel injectors are of multi-orifice direct injection type. The injection pressure is 30,000+800/0 kPa.

The Bosch pump uses a plunger fuel supply pump. All fuel injectors are of multi-orifice direct injection type. The



The codification of type of the timing device used on Bosch pump is defined as follows:

The fuel injection advance angle automatic adjusting device (timing device) used on WD615 series engines is of mechanical centrifugal type.

The preheating system is composed of preheating relay (1), solenoid valve (3), preheating plug (2), temperature sensor (4) and preheating indicator lamp.

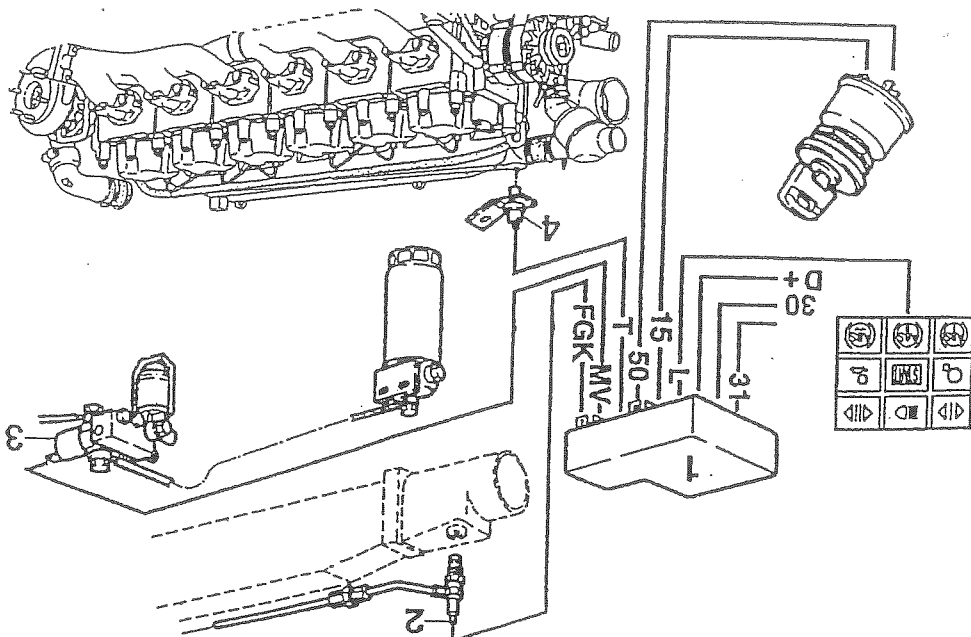
When the engine water temperature is below 23°C , turn the key switch to "Preheating" position. The relay (1) switches on the preheating plug (2) on the intake manifold, and the "START" preheating indicator lamp comes on. The lamp will flash after 50s, and now the operator may start the engine. Depress the start button, solenoid valve (3) is switched on, fuel is injected onto the burnt preheating plug and ignited, the start motor begins to run and drives the engine to rotate to preheat the coming air, and the engine is started rapidly. After the engine is started, the incoming preheating will last 1-2 minutes and stops itself. If the ambient temperature is above 23°C , turn the key switch to normal operation position, the indicator lamp comes on and goes off after 3s. The preheating plug now does not function, and the engine can be started directly. When the indicator lamp falls, the preheating device stops. If one or two preheating plugs is broken-circuited, the indicator lamp will flash for 15s and goes off, and the preheating device stops operating. Another method is to use a starting device with cold-start liquid. The cold-start liquid is a kind of explosive blended fuel mainly composed of ether. Spray a small amount of cold-start liquid into cylinder before starting to support low temperature combustion. It must be noted that the combustion of cold-start liquid is violent, therefore, when using it, the amount of spray must be kept under well control; never increase the speed and the load of the engine at once, otherwise, the life of the engine would be seriously shortened, and care should be taken to store the cold-start liquid safely.

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The cold starting system is an optional device, which will be mounted only on request.

and the load of the engine at once, otherwise, the life of the engine would be seriously shortened.

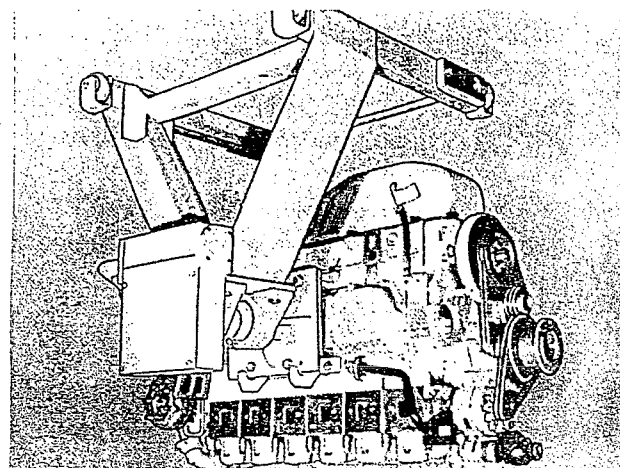
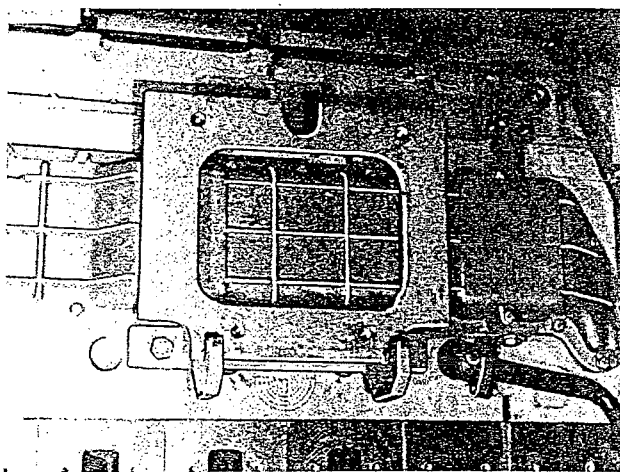
liquid is violent, when using it, the amount of spray must be kept under well control and never increase the speed cylinder before starting to support low temperature combustion. It must be noted that the combustion of cold-start liquid is a kind of explosive blended fuel mainly composed of ether. Spray a small amount of cold-start liquid into preheating device stops operating. Another method is to use a starting device with cold-start liquid. The cold-start



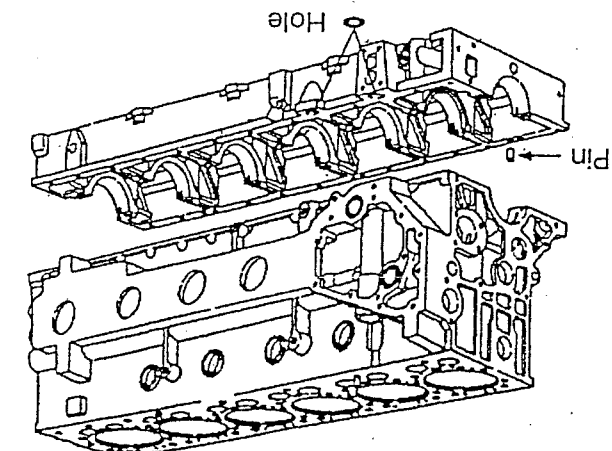
SECTION 4 ASSEMBLY AND DISASSEMBLY OF THE ENGINE

1. General Assembly of the Engine

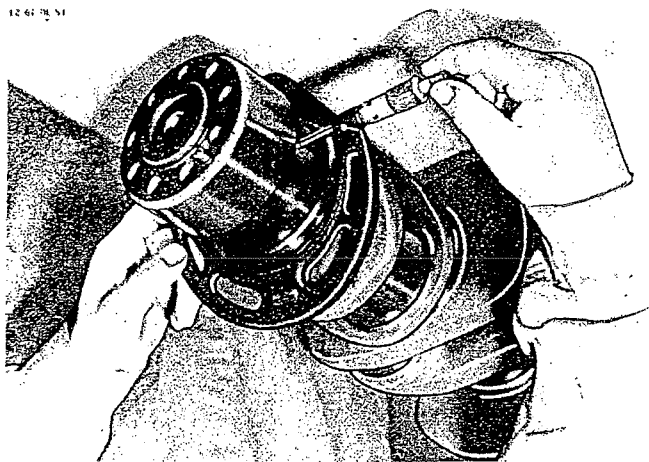
In maintenance, it is often necessary to disassemble and assemble some components, so the operators must be familiar with the procedures and requirements of disassembly and assembly of various components. The complete process of general assembly of the engine will be introduced as follows, and the procedures of disassembly will be the opposite of the assembly. The following descriptions will be presented in the form of illustrations.



1. The disassembly of the engine should be carried out on a turntable support.

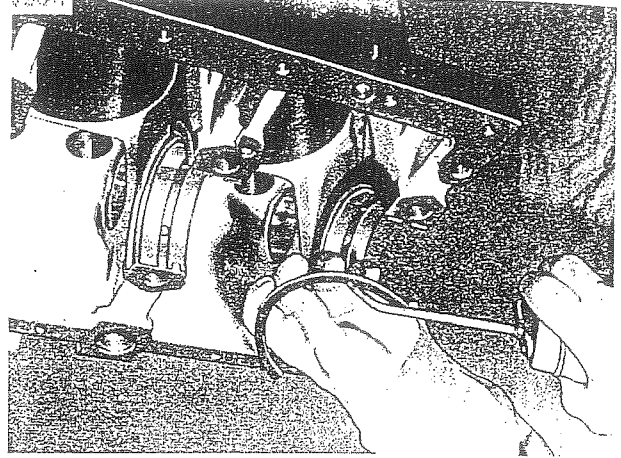


The engine body is composed of the cylinder block and the crankcase. They are located by three $\phi 12\text{mm}$ locating pins and communicated by two oil passages. 2. Before assembly, check and make sure that various holes of the cylinder block and the crankcase, the inner wall of the cylinder bore, main oil passages, secondary oil passages and various threaded holes are clean and free from any dirt, and that the cylinder block and the crankcase are free from cracks and sand blisters. Then use three M18x1.5mm bolts to fix the special hanger plate onto the cylinder block and the turntable support (with the upper face of cylinder facing downward). Properly install the oil nozzle of various cylinders with attention paid to the locating pins of the oil nozzle and the cylinder block.



3. Use an outside micrometer calipers to measure the diameters of various main shafts and connecting rod shafts, and record the result of measurement.

15 16 17 18 19 20 21

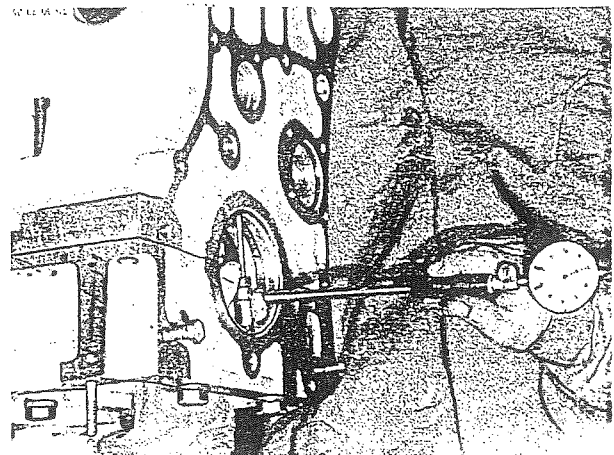


4. Install the crankshaft main bearing shells into the seating bores in the cylinder block and the crankcase (Note: the main bearing shell with oil groove is the upper shell installed into the cylinder body and that without oil groove is the lower shell installed into the crankcase). Assemble the crankcase and the cylinder block. Tighten the crankshaft bearing bolts to a torque of 250Nm. Use an inside micrometer calipers to measure the inner diameter of various shaft shells.

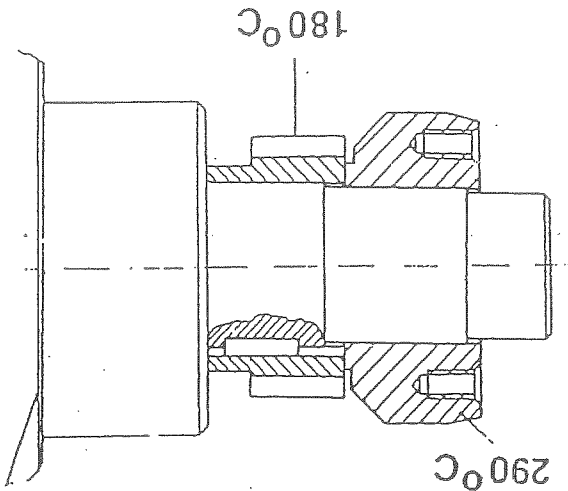
Choose appropriate shaft shells and make sure that the fit clearance between the shaft shell and the crankshaft main journal is within 0.095-0.163mm.

Although standard crankshaft and shells are used, measurement and verification must be made to make sure that the fit clearance between the journal and the bore is within the specified range. Crankshaft that was repaired and enlarged must be soft-nitriding and heat treated again.

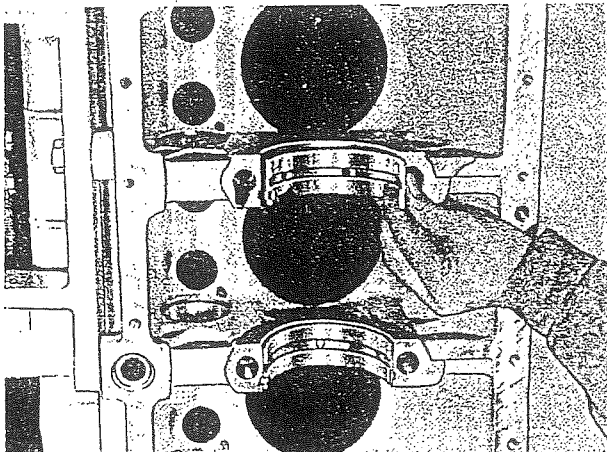
Before grinding the crankshaft, the dimensions of the main shaft shell and the connecting rod shell must be measured. The amount of grinding shall be determined according to the fit clearance specified.

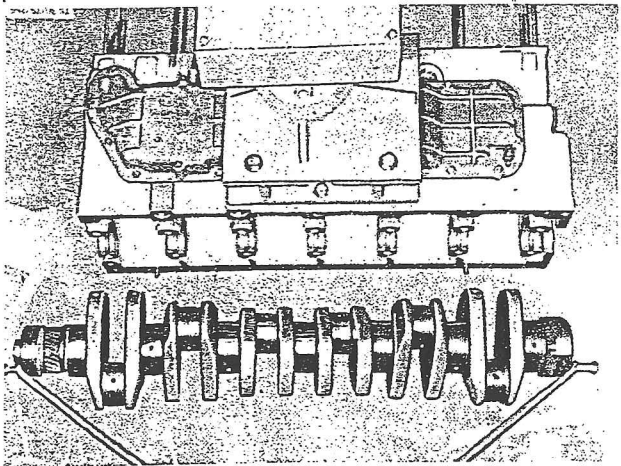


6. Heat the crankshaft gear to 180°C and the crankshaft flange to 290°C, and install them onto the crankshaft.

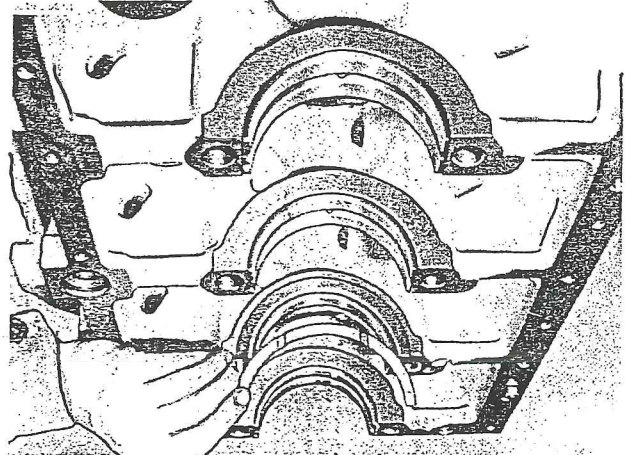


5. Remove the crankcase from the cylinder block, and place the crankshaft spacer gage between either side of the second main bearing and the wall of the cylinder block. Install the upper shell of the crankshaft on the cylinder block, and apply few drops of oil on each main shaft shell and spacer gage. (The side of the thrust spacer gage with oil groove faces outward to the thrust face of the crankshaft).

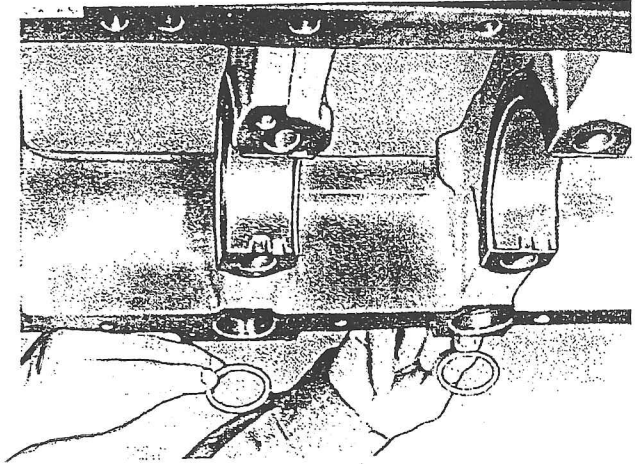




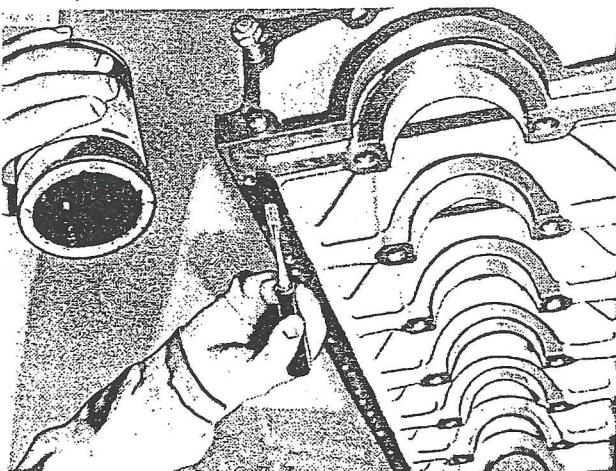
7. Place the crankshaft on the cylinder block shell.



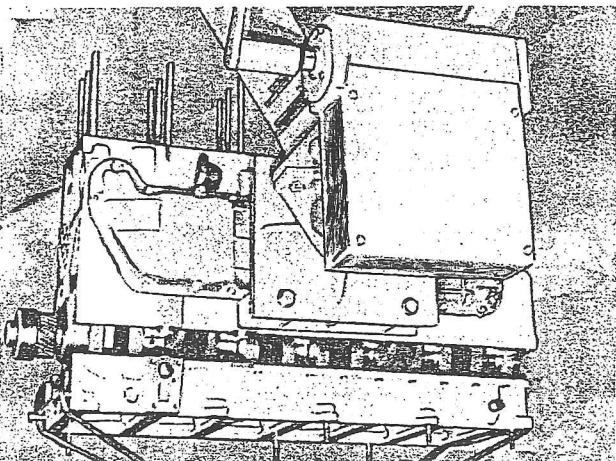
8. Place the crankshaft lower spacer gage in the side groove in the second bearing seat bore of the crankcase, and install the crankshaft lower shell on the crankcase. Apply few drops of oil on various crankshaft shells. (The side of the thrust spacer gage with oil groove faces the thrust face of crankshaft).



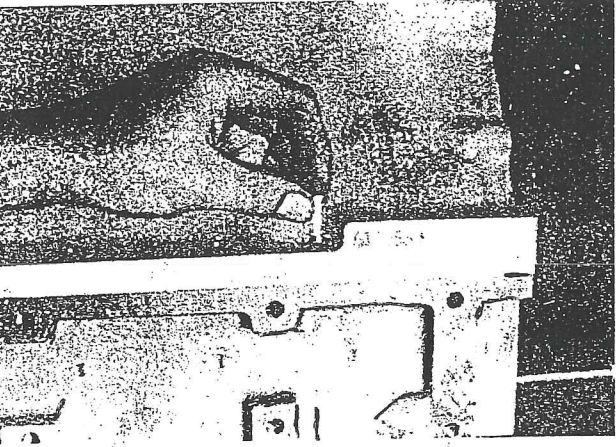
9. Install pipe unions in the two oil holes in the crankcase, and place O-rings on the pipe unions.



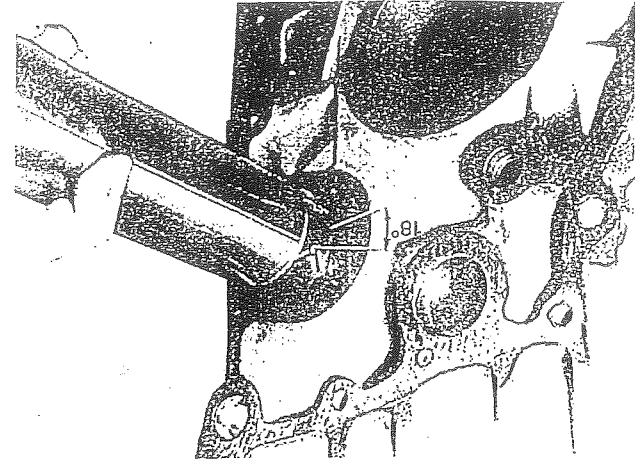
10. Apply Loctite 510 sealant on the contacting surfaces of both cylinder block and crankcase. (The sealant can also be applied in uninterrupted wire form on their contacting surfaces).



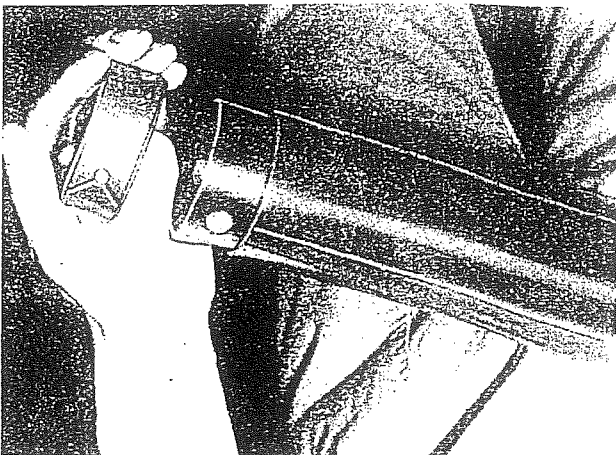
11. Fit the crankshaft and the crankcase in the cylinder block. (Assembly is carried out within 1 minute after sealant application).



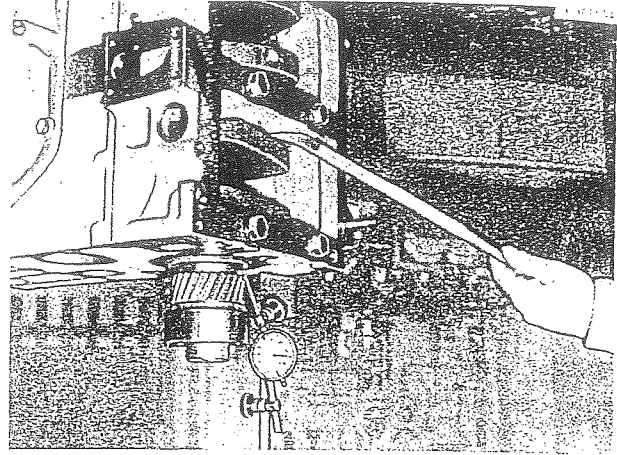
12. Drive in the locating pins of the crankshaft and the cylinder block.



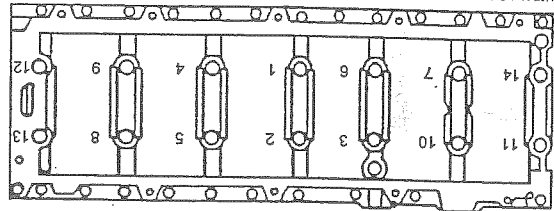
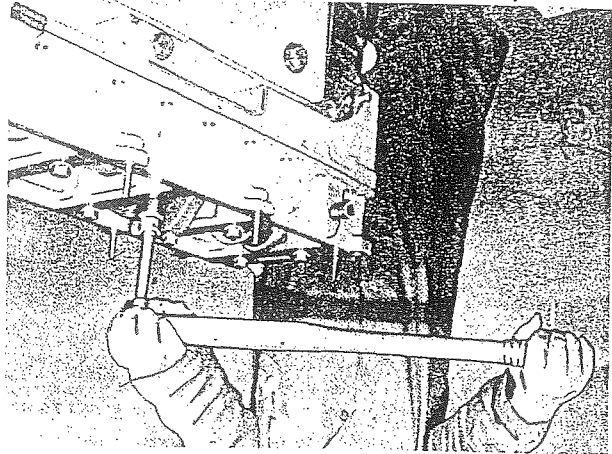
16. Install the camshaft bushing locating sleeve over a special filling rod. Check and make sure that the camshaft bearing seat bore in the cylinder block is free from any contamination and damage.



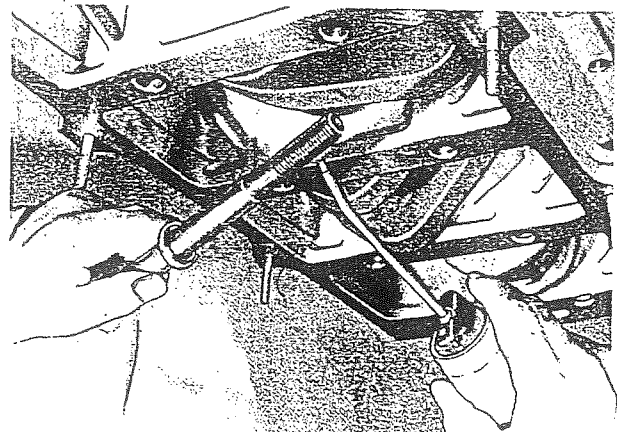
15. Use a magnetic dial gage holder to fix the dial gage frame on the end of the crankshaft, pry the crankshaft repeatedly, and measure and make sure that the axial clearance of the crankshaft is within a range of 0.052 ~ 0.255mm. Rotate the crankshaft and make sure that it runs freely without any jams.



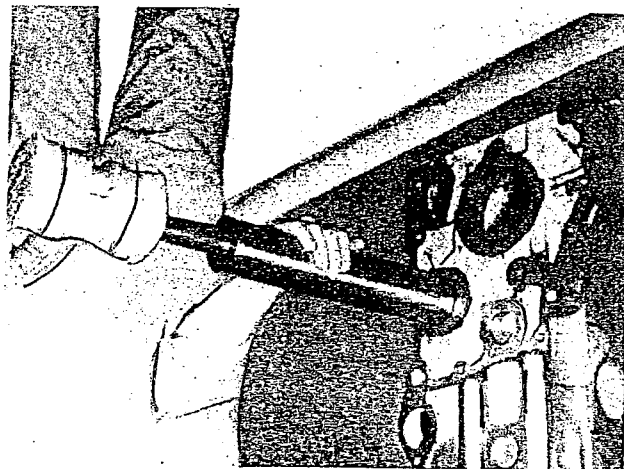
14. Screw in all the main bearing bolts. Pre-tighten these bolts to 30Nm, then tighten them to 80Nm, and finally to 250 + 25Nm. Then, tighten the twenty-four M8mm attachment bolt.



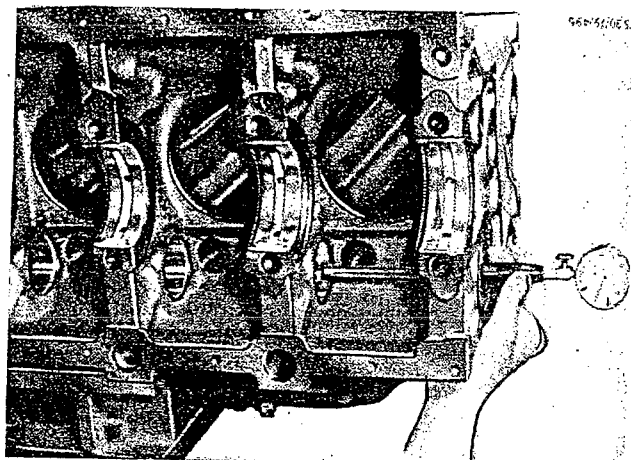
13. Apply a few drops of oil on the thread portion of various main bearing bolts.



17. In order to make sure that the camshaft bushing oil hole and the cylinder block oil hole are aligned, make a mark at the location of the oil passage on the cylinder block (offset the horizontal position by 18°).

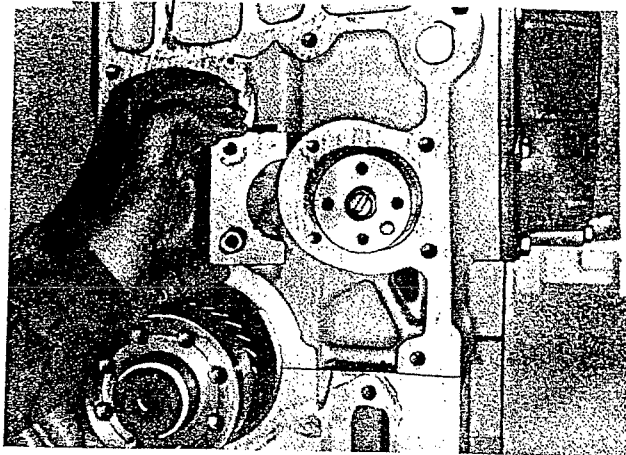


18. Measure and make sure that interference between the shaft hole and the bushing is $-0.057 \sim -0.107\text{mm}$, align the bushing oil hole with the assembly mark, and install all camshaft bushings into the shaft hole one by one from the inside to outside. Caution: The special fitting rod is not used to strike various bushings into the shaft hole, but insert the rod to the front edge of the shaft hole where a bushing is to be installed and then install the bushing.

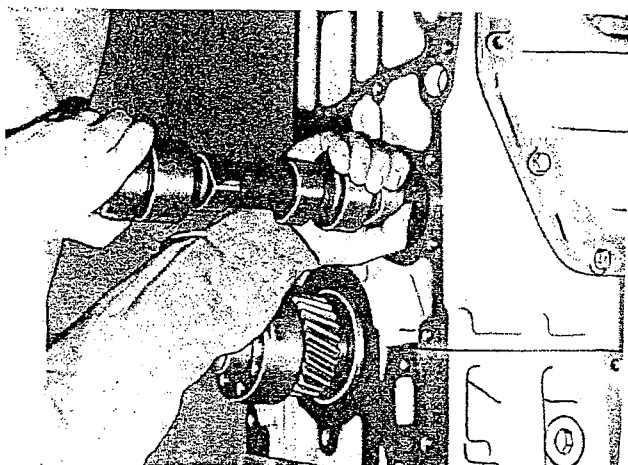


19. Check that various shaft hole bushings are fit firmly and that the oil passage and the oil hole are clear. Use an inside micrometer calipers to measure the inner diameter of various bushings and make record.

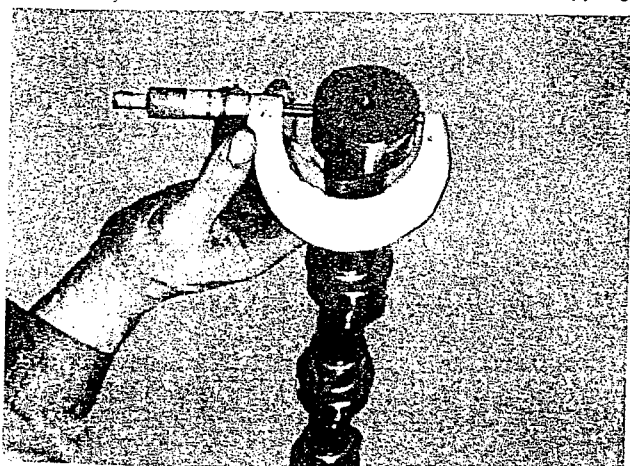
22. Check and make sure that the camshaft thrust groove, thrust baffle plate and the surface to mate with the cylinder block are free from damage and burrs. Insert

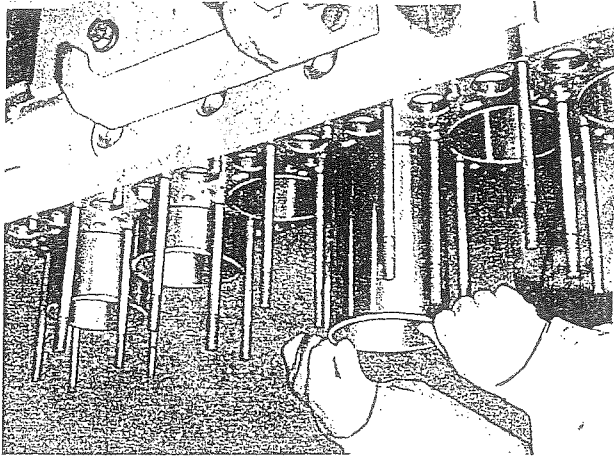


21. Smoothly insert the camshaft seat bore. Rotate the camshaft and make sure that it runs freely without any jams.

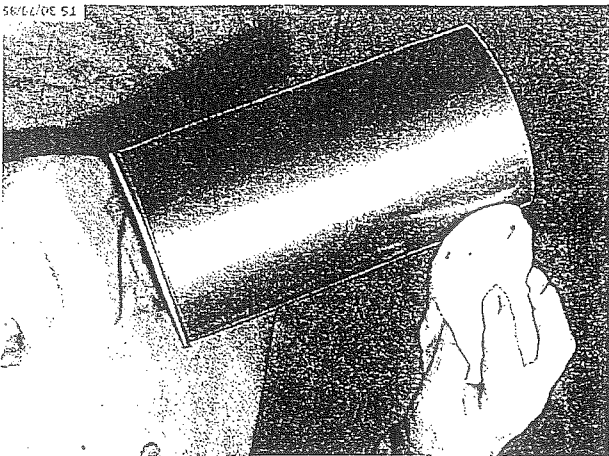


20. Use an outside micrometer calipers to measure the outer diameters of various bearings of the camshaft, and check if the clearance between the bushing and the camshaft journal is $0.04 \sim 0.12\text{mm}$. Apply some oil on various journals of the camshaft.

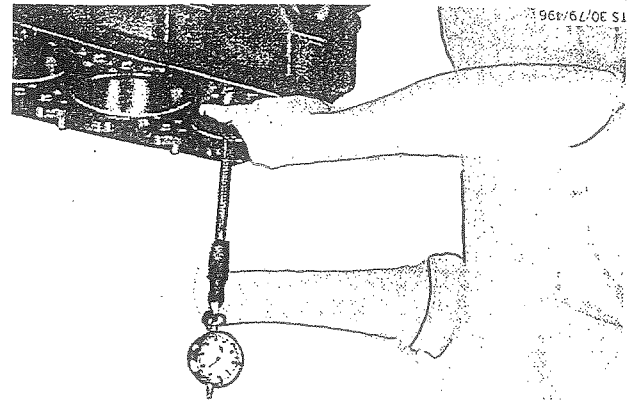
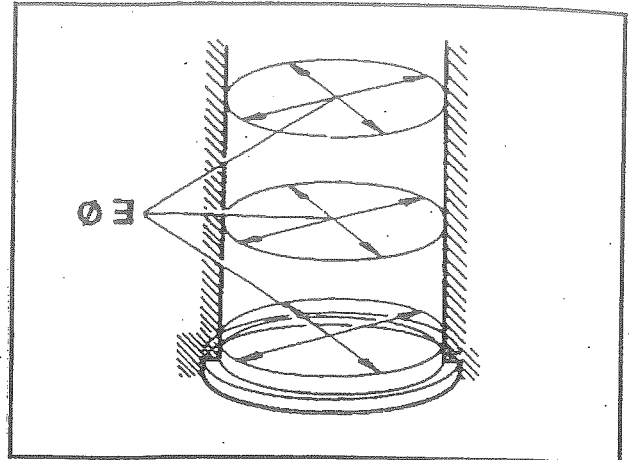




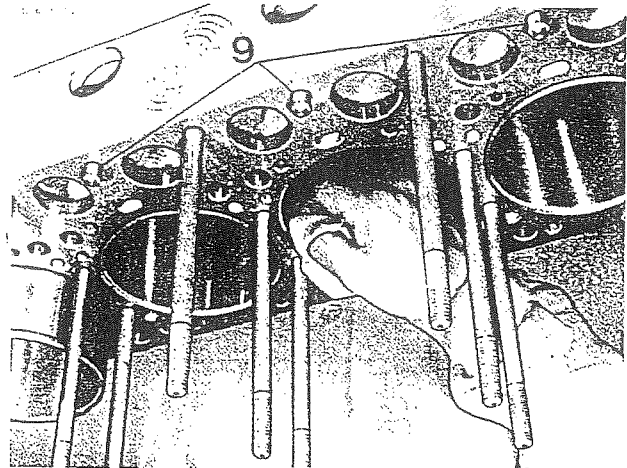
25. Use trichloroethylene cleaning solution to remove any oil stain on the surface of the cylinder sleeve, and then apply some molybdenum disulfide powder on the outer surface of the cylinder sleeve (never use engine oil).



24. Check and make that the cylinder block bore and stop port are clean and free from rust and damage. Use trichloroethylene cleaning solution to clean the cylinder bore and the stop port. Use an inside micrometer callipers to measure the dimensions at three locations and the out of roundness of the cylinder bore. Measure the outside diameter of the cylinder sleeve. The cylinder sleeve and the seat bore are allowed to have a transition fit (i.e. a 0.01 mm interference fit) or a clearance fit of $0 \sim 0.033$ mm.

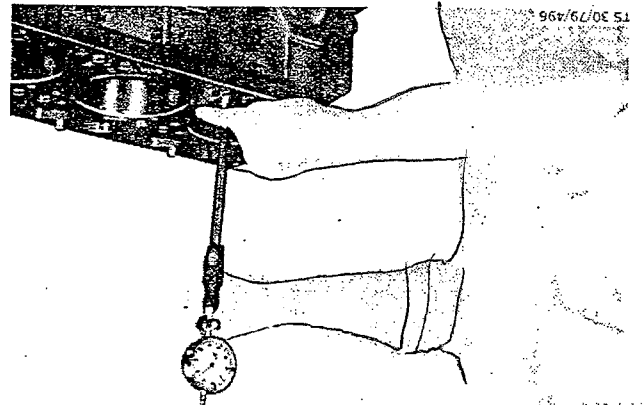
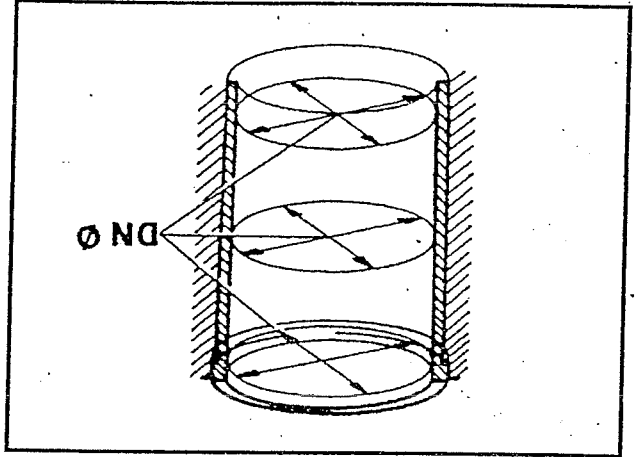


23. Crank the engine turntable support to a position below the crankcase. Apply some Loctite 262 sealant on the short thread end of the studbolt of the cylinder head. By using 50 Nm torque, screw the studbolt into the cylinder block, and make sure that the bolt is 180 ± 3 mm higher the plane surface of the cylinder block.

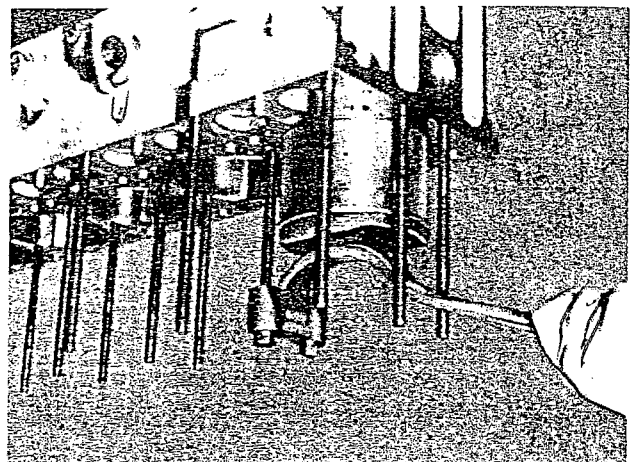


the thrust baffle plate into the thrust ring groove, and use two screws to fix the baffle plate on the cylinder block. Use a dial gage to check and make sure that the axial clearance of the camshaft is within $0.1 \sim 0.4$ mm.

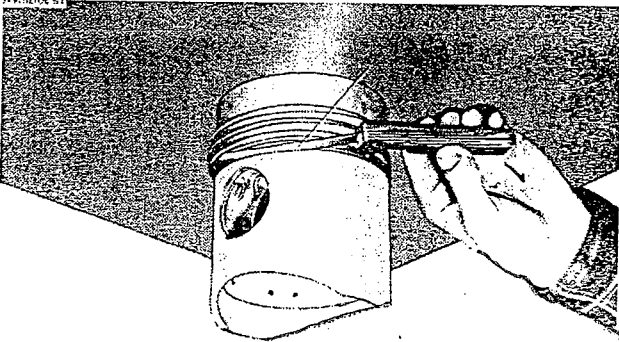
27. After the sleeve is pressed into the cylinder block, use an inside micrometer calipers to measure the inner diameter of the sleeve, and make sure that its out of roundness is within 0.04mm. The protrusion of the sleeve from the top place surface must be within 0.02 ~ 0.07mm.



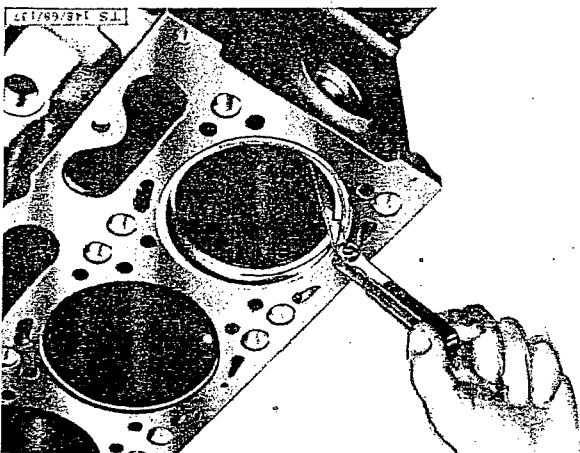
26. If the clearance is good, the cylinder sleeve can be lowered into the cylinder block manually or by tapping lightly by means of a special tool.



29. Install the piston rings into the piston ring grooves, and measure the side clearance of the piston ring grooves which should meet the following requirements:
Second gas ring side clearance: 0.07 ~ 0.12mm.
Third gas ring side clearance: 0.05 ~ 0.085mm.



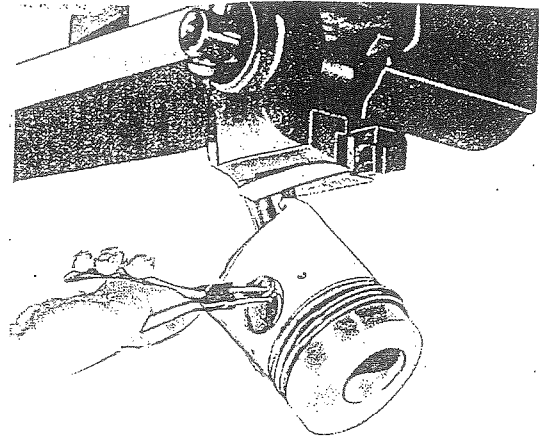
28. Install the piston rings into the cylinder sleeve, and measure the ring gaps of various piston rings which should meet the following requirements:
First gas ring gap: 0.4 ~ 0.6mm
Second gas ring gap: 0.25 ~ 0.4mm
Third gas ring gap: 0.35 ~ 0.55mm



30. Choose a connect rod of the same weight group, measure the inner diameter of various bushings and make record. Choose proper bearing shell so that the fit clearance between the shell and crankshaft connecting rod journal is within $0.059 \sim 0.127\text{mm}$.

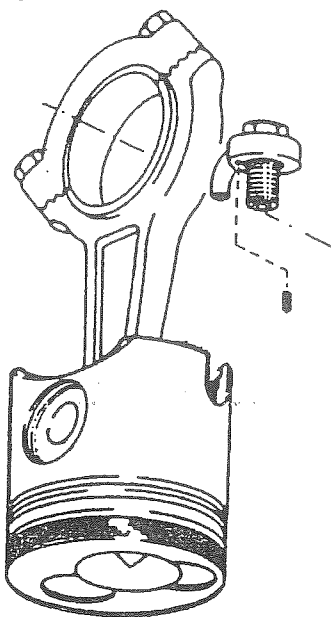


31. Press the bushing of the small end of the connecting rod into the shaft hole, and measure the inside diameter of the bushing, and the inside diameter of the piston pin bore and outside diameter of the piston pin, so as to ensure that the fit clearance between the connecting rod bushing and the piston pin is within $0.045 \sim 0.066\text{mm}$. The fit clearance between the piston pin bore and the piston pin should be within $0.003 \sim 0.013\text{mm}$. The connecting rod bushing can be reamed with special reamer to meet the requirement of fit clearance.

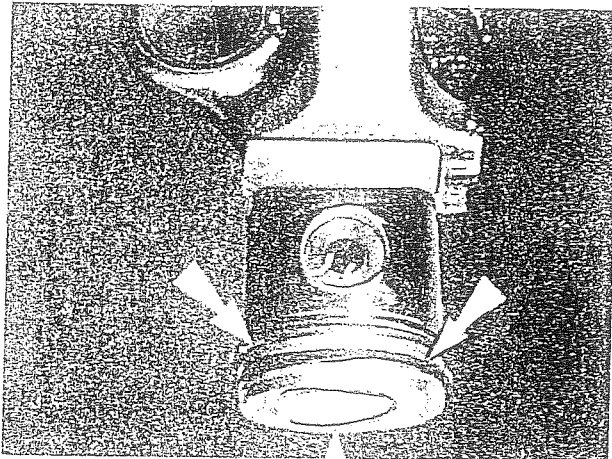


32. Install the piston ring into the piston ring groove. When installing, the side with "TOP" or up marking of the two gas rings must face up, and there is no

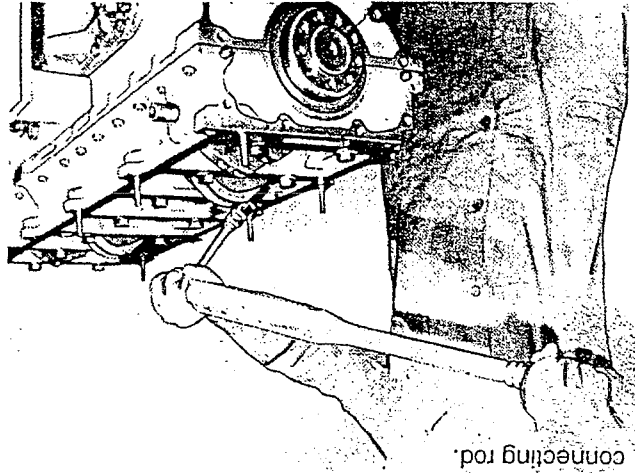
33. Put the piston assembly in a 80°C thermostatic oven for 10 minutes, take it out, immediately install the piston pin and the connecting rod, and install the locating clips in the locating grooves on both sides of the piston pin hole. Attention: the 45° cutting side of the big end of the connecting rod must face away from the recess of the oil nozzle on the piston.



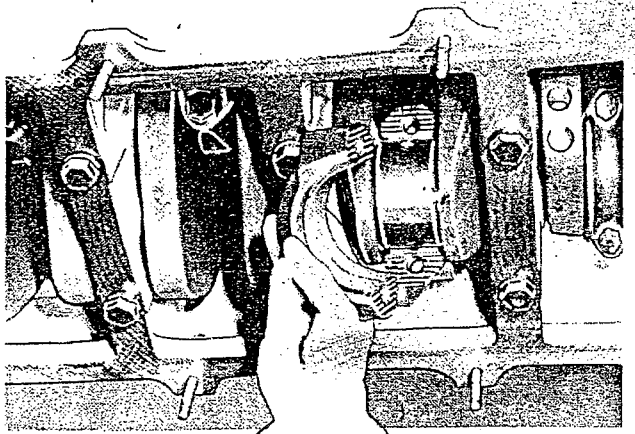
34. Set the piston rings with their openings offset one another by 120° , and away from the axial line of the piston pin by more than 30° . Apply some oil on the outer surface of the piston and the inner surface of the cylinder sleeve.



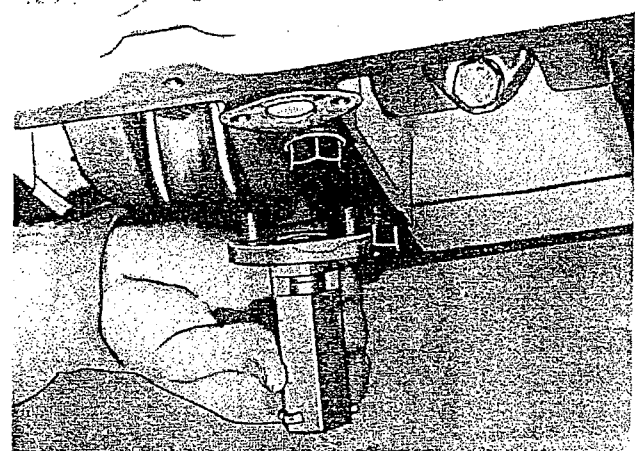
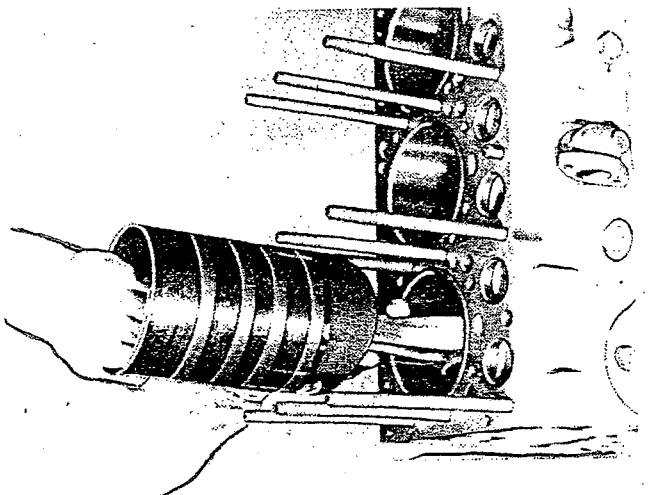
37. Tighten connecting rod bolts of various cylinders one by one, and check that the axial clearance of the connecting rod is 0.15 ~ 0.35mm. The sequence of tightening the connecting rod bolts is: first pre-tighten



36. Fit each connecting rod bearing shell to the

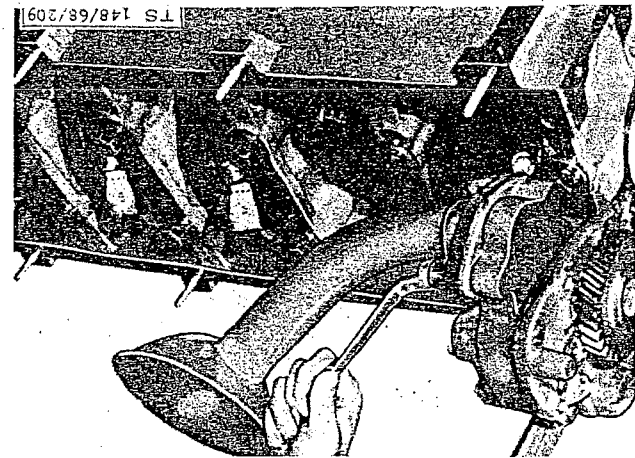


35. Use special tool and install all piston connecting rod mechanisms into various cylinder sleeves. Attention: the 45° cutting side of the big end of the connecting rod must face away from the side of engine fuel injection pump.

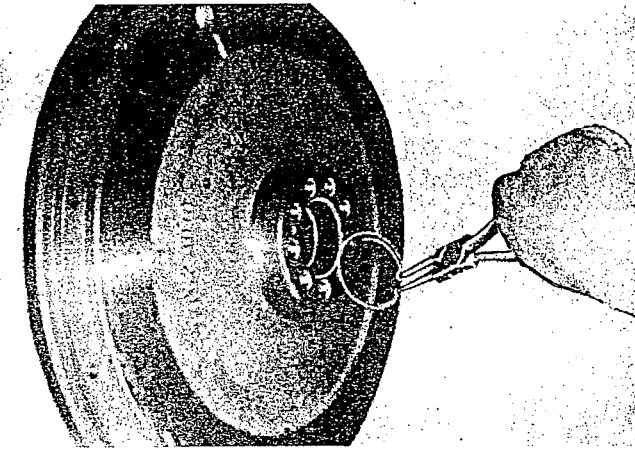


the bolts, then tighten them symmetrically to 120Nm, turn them in turn 90° ± 5°, and check if a final torque of 120 ~ 160Nm is reached. Replace those bolts that the final torque of 120 ~ 160Nm can not be reached. The connecting rod bolt can only be used once.

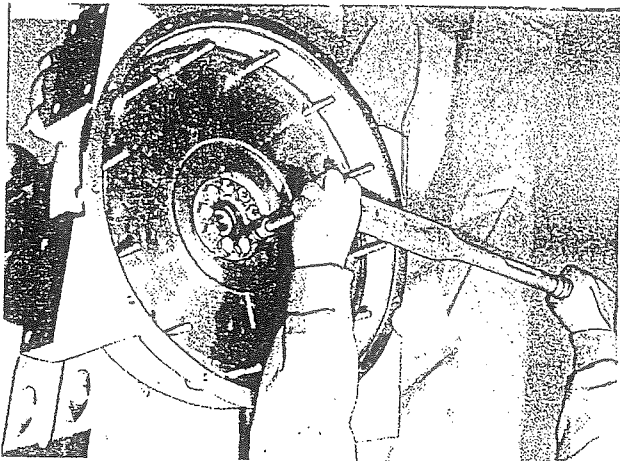
38. Install the oil pressure-adjusting valve in the crankcase oil passage.



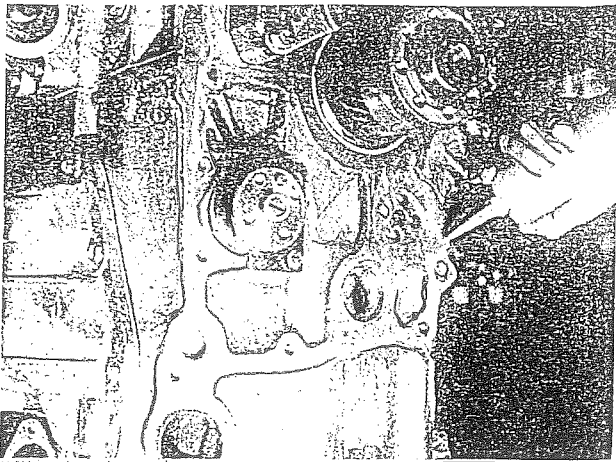
39. Install the oil pump on the crankcase. And rotate the oil pump and make sure that it runs without jamming.



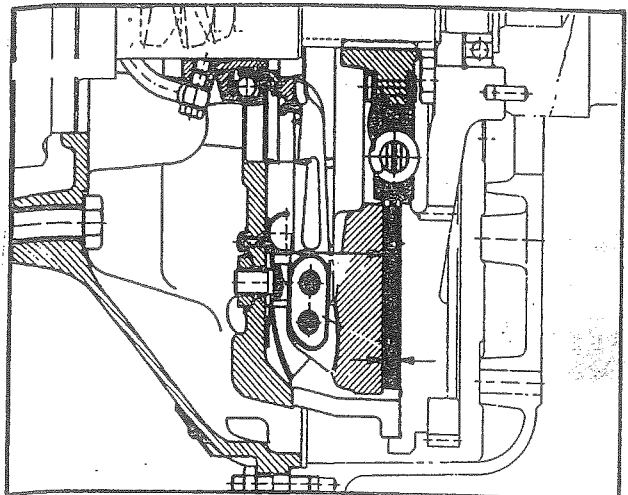
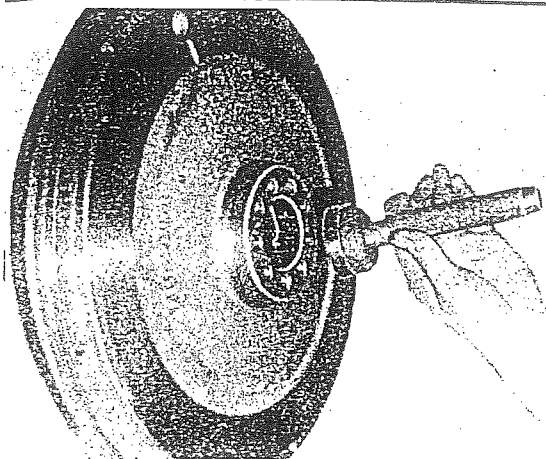
120° ± 5° symmetrically and make sure the final torque of 110 ~ 140 Nm is reached. Replace those bolts that failed to reach the specified final torque. These bolts can be used twice. Oil seal the crankshaft after installation:



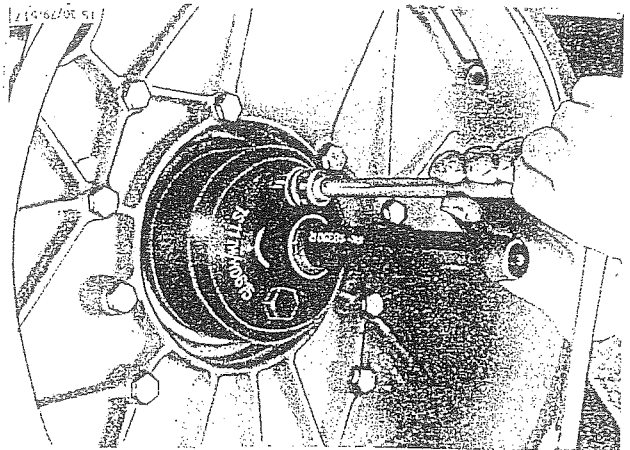
42. Install the flywheel. The flywheel and crankshaft end will be located by means of locating pins. Apply some Loctite 242 sealant on the threads of nine M14 x 1.5 bolts. Pre-tighten these bolts to 60Nm, and then turn the bolts by 180° ± 5° symmetrically and make sure the final torque of 230 ~ 280 Nm is reached. Replace those bolts that failed to reach the specified final torque. These bolts can be used twice. Rotate the flywheel and make sure that it runs without interference.



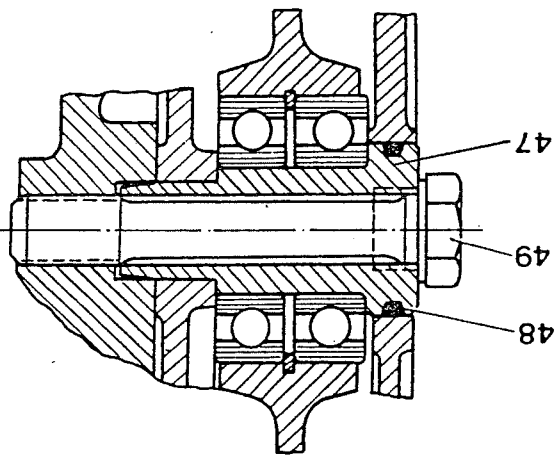
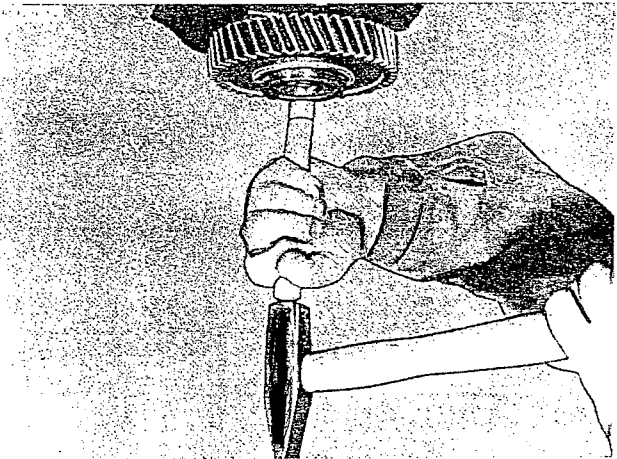
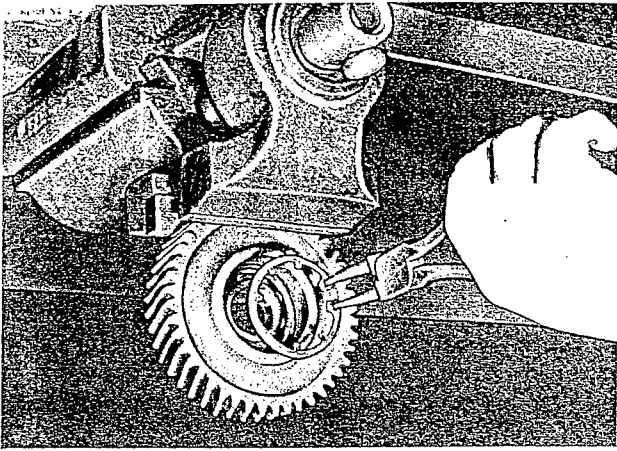
43. Apply some Loctite 510 sealant on the contacting surfaces of the timing gear and the engine body.



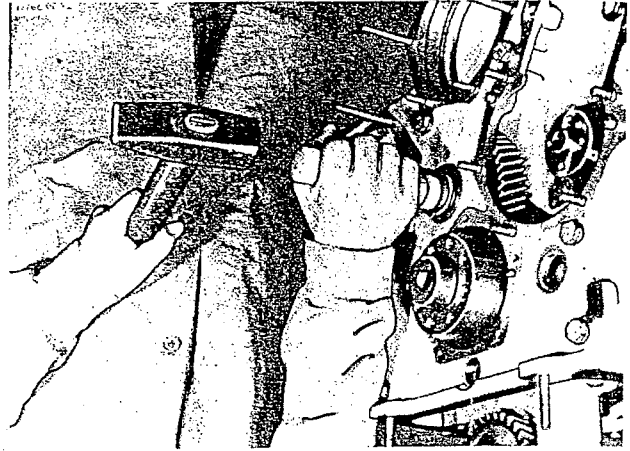
40. Put the bearing locating clip into the flywheel locating groove, and then install the center bearing into the front end of the flywheel shaft hole (between the crankshaft end and the clip).



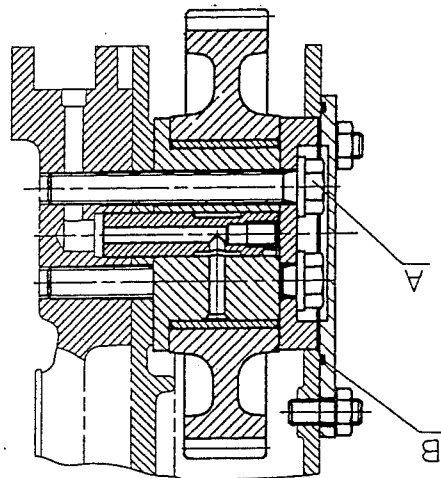
41. To install the flywheel casing: apply some Loctite 242 sealant on thirteen flywheel casing fixing bolts. Apply some Loctite 510 sealant on the contacting surfaces of the flywheel casing and the cylinder block. Pre-tighten the thirteen bolts to 40Nm, and then turn the bolts by



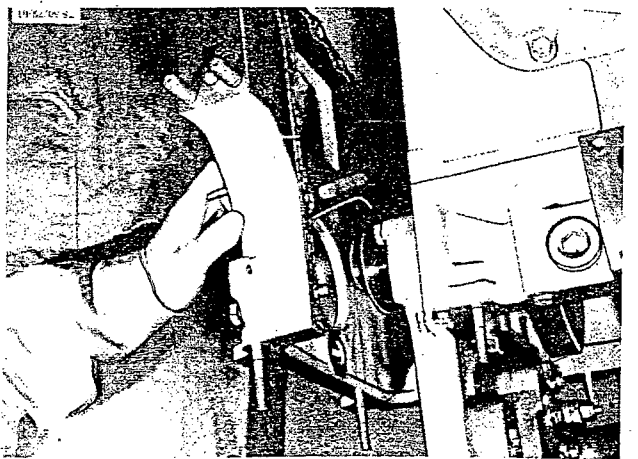
46. Remove the camshaft locating plate, lightly push the camshaft inward, and install the timing intermediate gear assembly to its mounting position through the camshaft gear window. Drive the intermediate gear shaft sleeve into the shaft holes in the timing house and the cylinder block. Then pull out the camshaft, and install the camshaft locating plate. Care must be taken not to pull the camshaft by too much force, as thus doing might pull the camshaft journal out of the bushing.

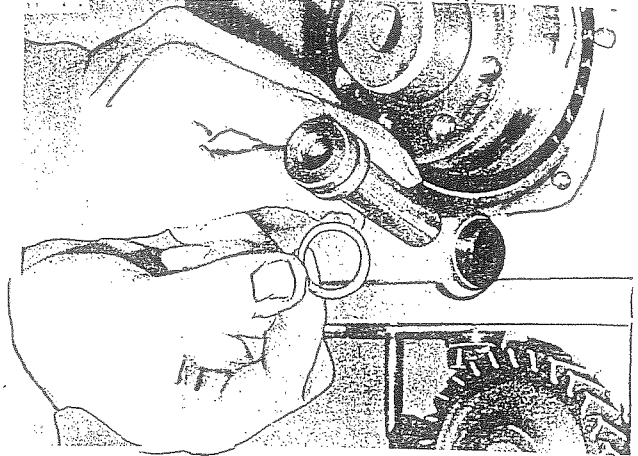


45. Install the intermediate gear assembly. The longer end of the intermediate gear faces the cylinder block. The radial clearance between the intermediate gear journal and the shaft sleeve is 0.04 ~ 0.08mm, and the axial clearance is 0.15 ~ 0.25mm. When installing the blanking cover, place the O-ring "B". Apply Loctite 242 sealant on bolt "A", tighten the bolt to 65Nm, and turn it by 90°. Bolt "A" can be used three times.

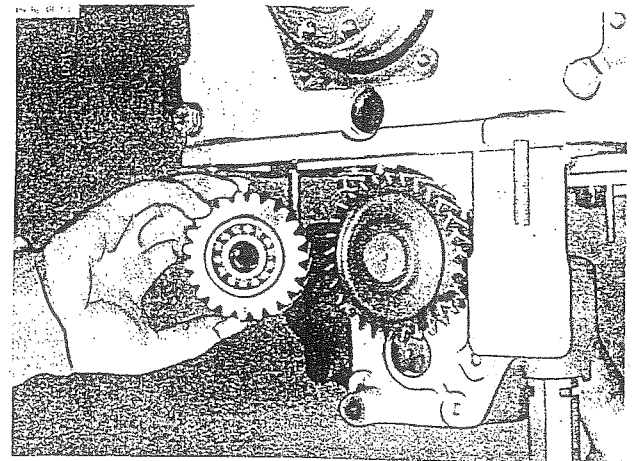


44. Use fixing bolts to secure the timing gear housing to the cylinder block, and lightly pre-tighten all the bolts.

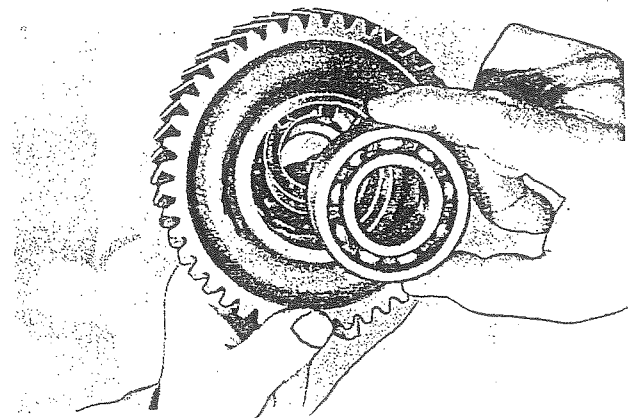




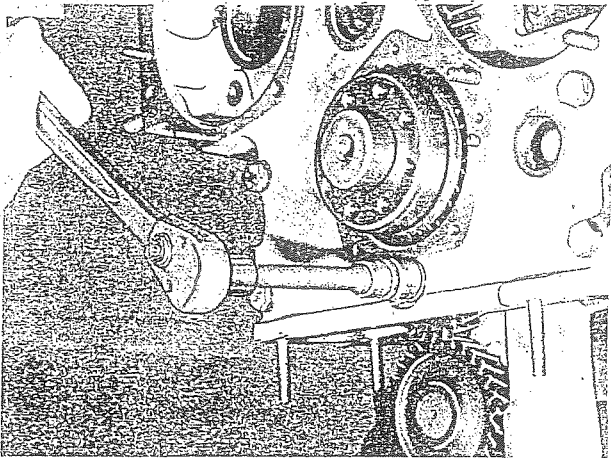
48. Install the oil pump until the its intermediate gear assy. is inside the timing gear house. Make sure that a shoulder of the gear is facing the cylinder block. Drive the intermediate gear shaft sleeve with O-ring into the timing house and the cylinder block shaft.



47. Assemble the oil pump intermediate gear assy.

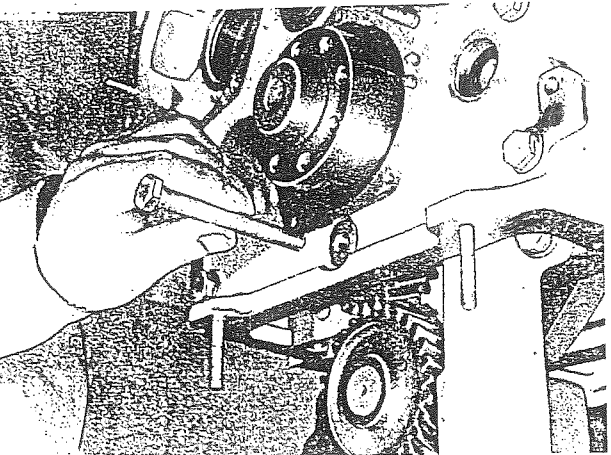


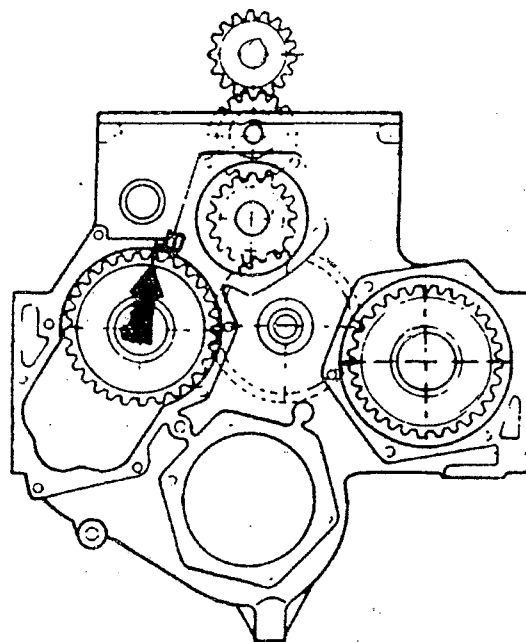
50. Tighten the oil pump intermediate gear fixing bolts.



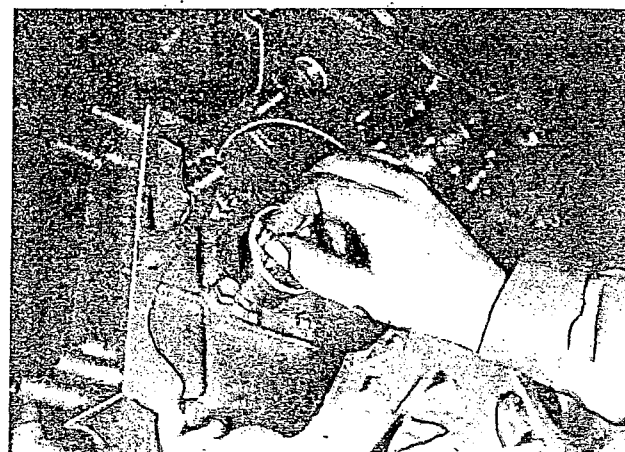
49. Install the timing intermediate gear and the oil pump intermediate gear fixing bolt to 180Nm and the oil pump intermediate gear fixing bolt to 60Nm. Finally, tighten all the bolts on the circumference of the timing house fixing it to the engine body.

When assembling, use the spindle to locate the bearing seat on the timing house and the cylinder block, install the bushing and the timing gear to their proper positions, and then use the bearing seat fixing bolt to secure the bearing cap and the bearing seat onto the cylinder block. Finally, fix the hold-down plate on the timing house.

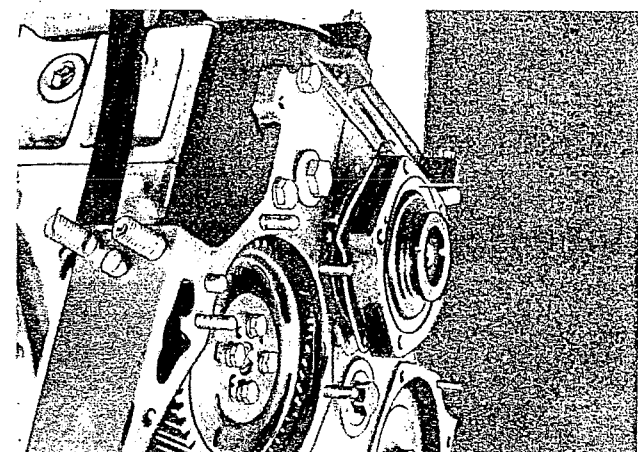
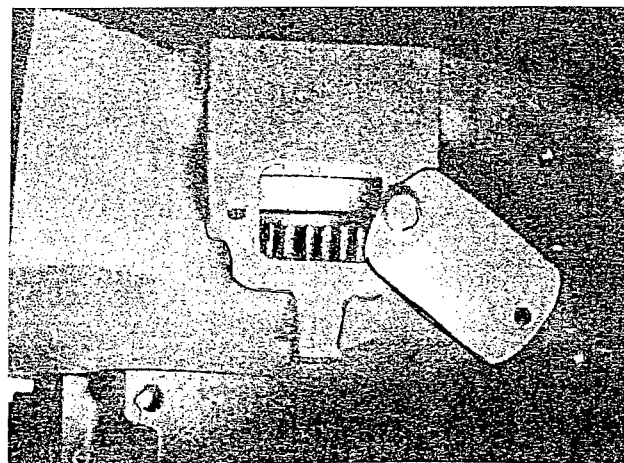




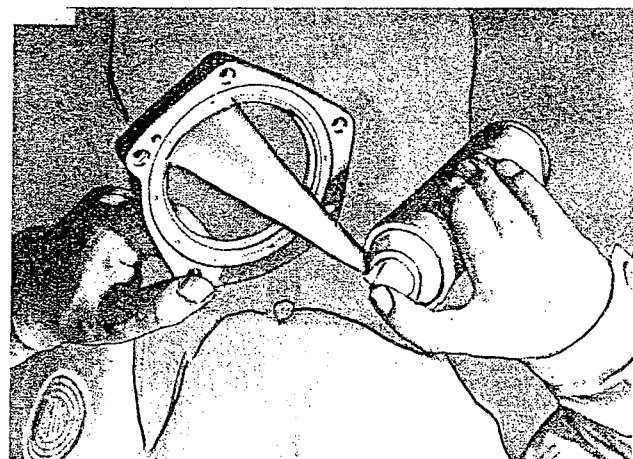
52. Install the camshaft gear locating pin.



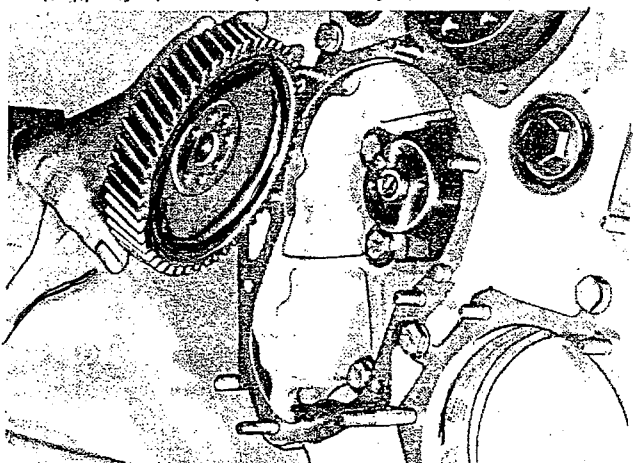
51. Crank the engine to the position of the top dead center of the first cylinder (the top dead center marking of "TOP" on the crankshaft flywheel is aligned with the mark line on the flywheel casing).

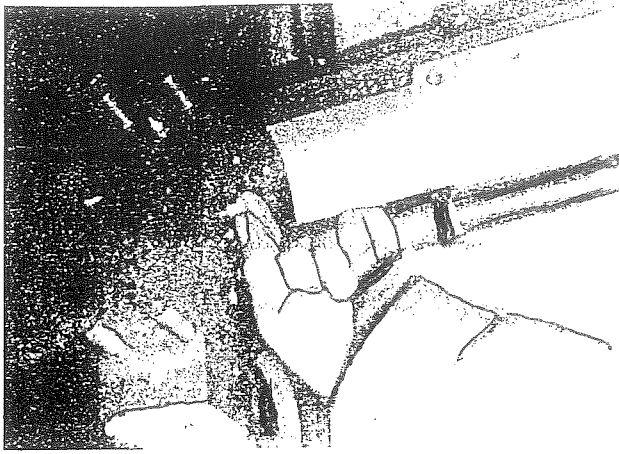


54. Install the front oil seal of the crankshaft into its seat, and then install the seat.

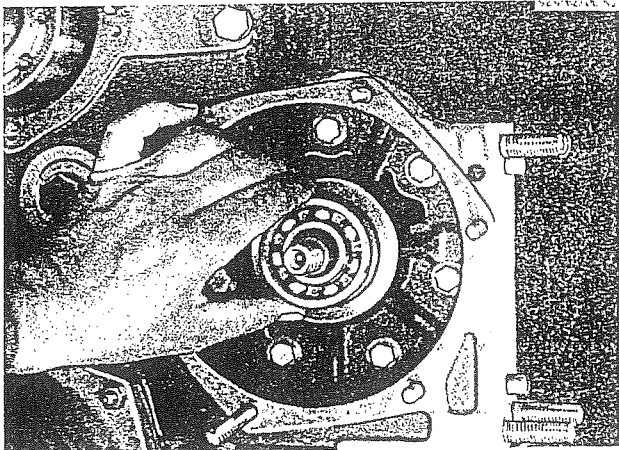
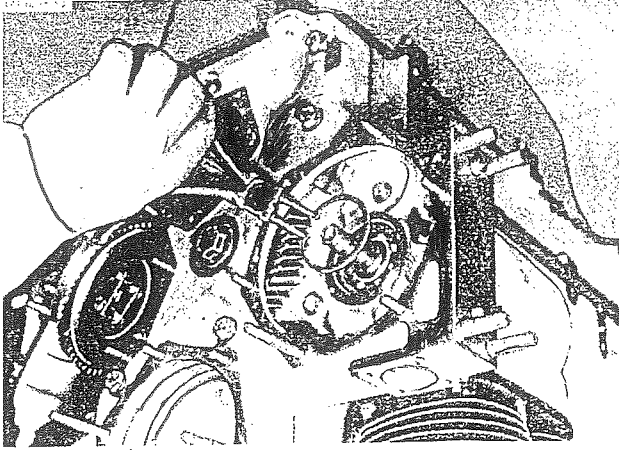


53. Install the camshaft gear on the camshaft with the timing mark line on the camshaft gear aligned with that timing mark line on the camshaft aligned with that on the timing house (to ensure the accuracy of valve timing). Apply Loctite 242 sealant on four fixing screws and tighten them to 32Nm.

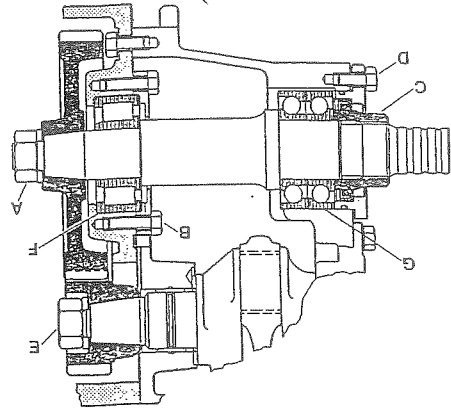
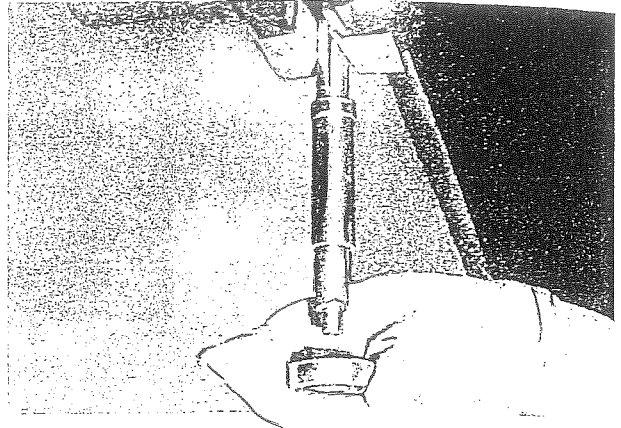




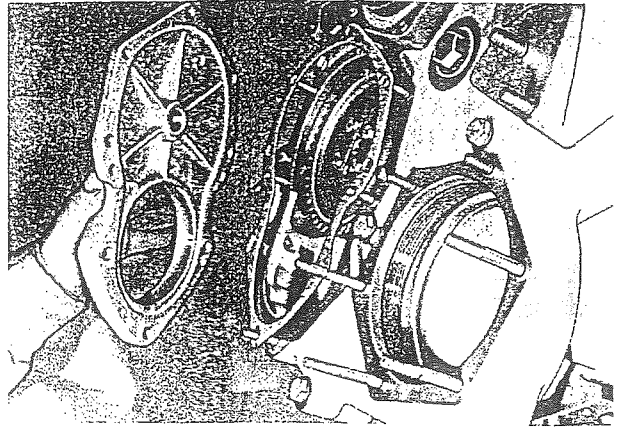
58. Insert the drive shaft into the timing house shaft hole, install the bearing to its position, and use four fixing bolts to secure the locating flange onto the timing house.



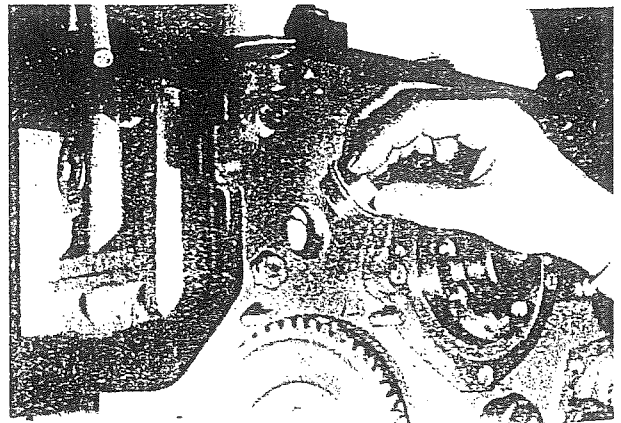
57. Install the fore and aft bearings of the drive shaft onto the shaft, and press them into the locating shaft sleeve. A Nut tightening torque is 35Nm. c Nut tightening torque is 150Nm, E Nut tightening torque is 20Nm. Apply Locilite 14 sealant on location F of outer race. Apply Locilite 270 sealant on location G. Apply Locilite 638 sealant on nut C. Apply Locilite 242 sealant on the remaining position q.

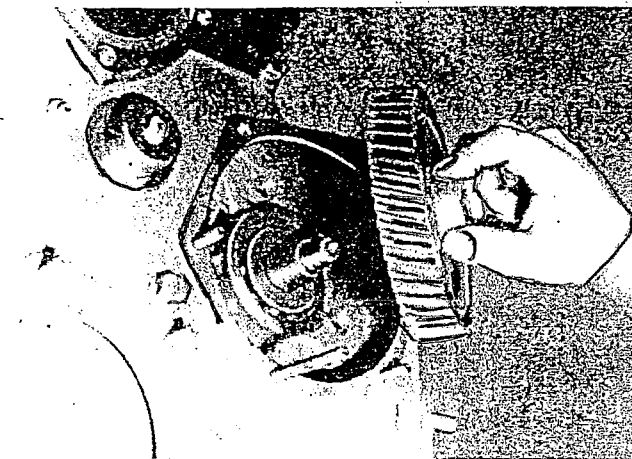


56. Install the camshaft gear gasket and cap.

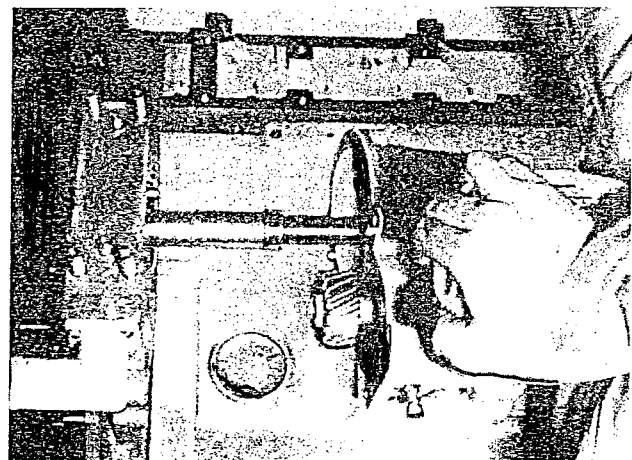


55. Install the timing house plug.

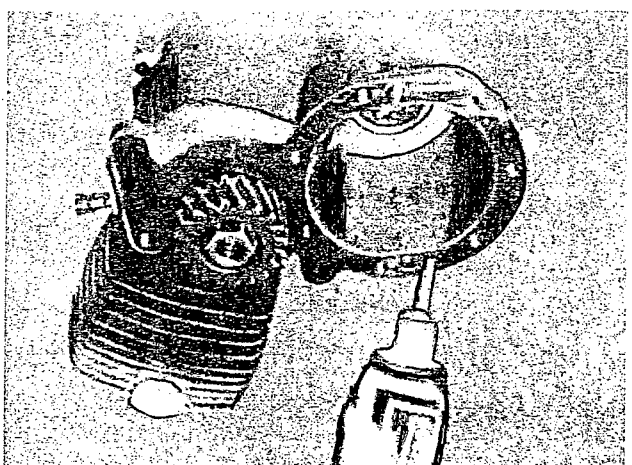




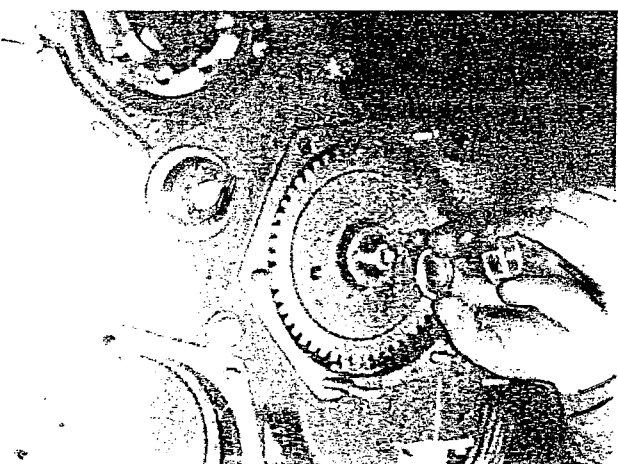
59. Install the locating pin of the air compressor crankcase.



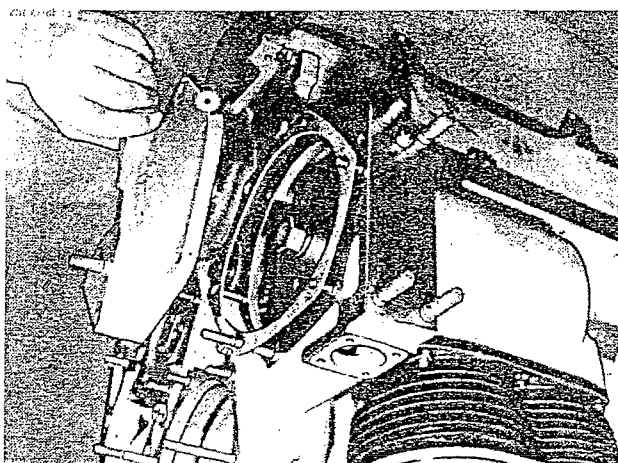
60. There is no gasket between the air compressor crankcase and the timing house. It is necessary to apply Loctite 510 sealant on the contacting surfaces and then to assemble the air compressor and the crankcase. Tighten the fixing bolts.



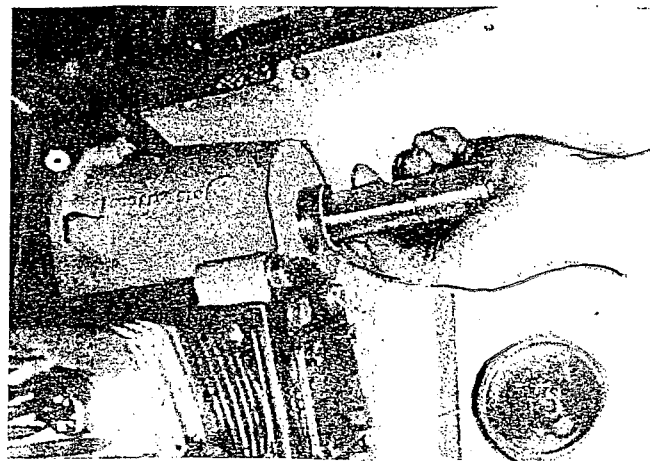
61. Install the fuel injection pump drive gear on the drive shaft, and tighten the fixing nut to 350Nm (with the thread applied with Loctite 242 sealant). Torque the air compressor gear to 200Nm.

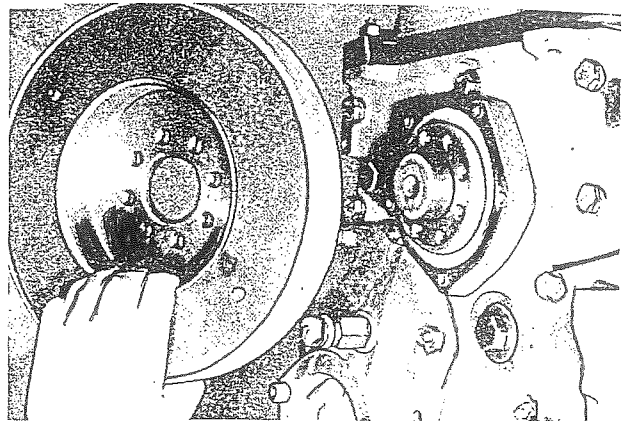
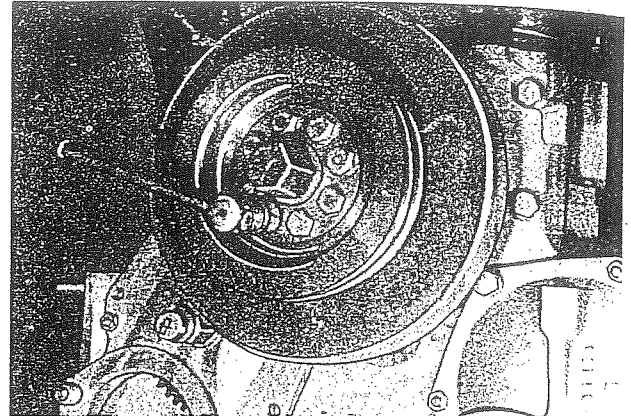


62. Install the drive gearbox gasket and cover.

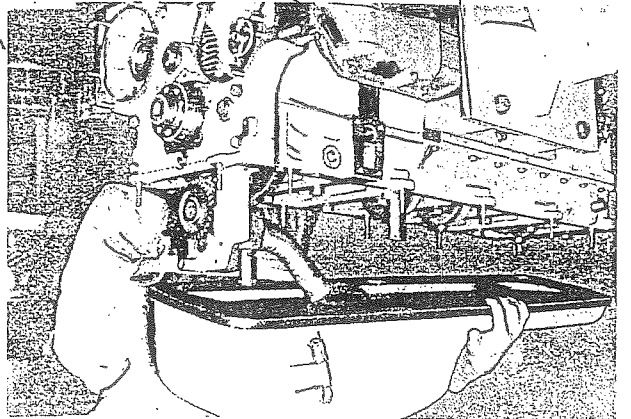


63. Install the oil seal of the air compressor crankcase.

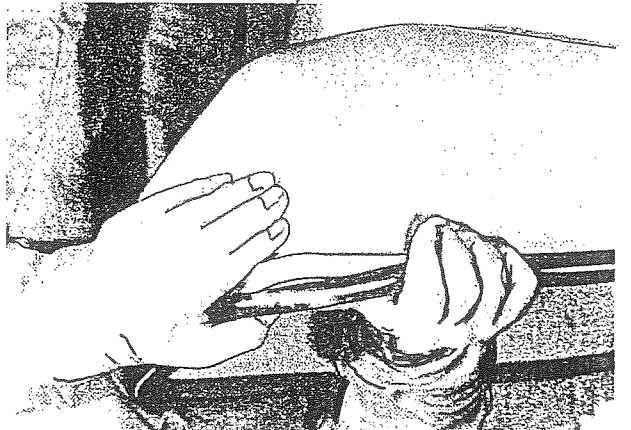




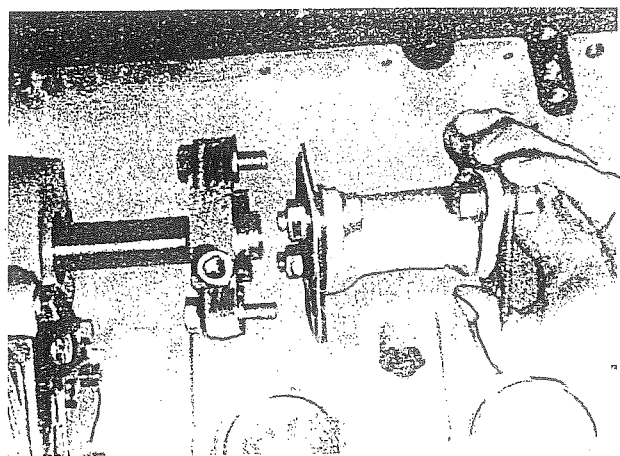
65. Install the oil pan on the crankcase.



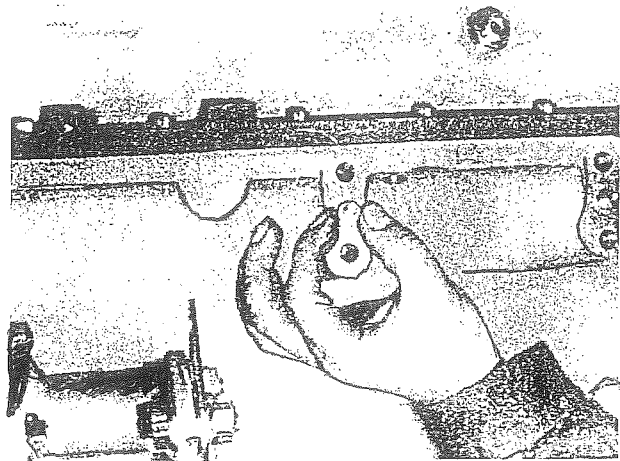
64. Install the V-shaped seal ring on the oil pan.



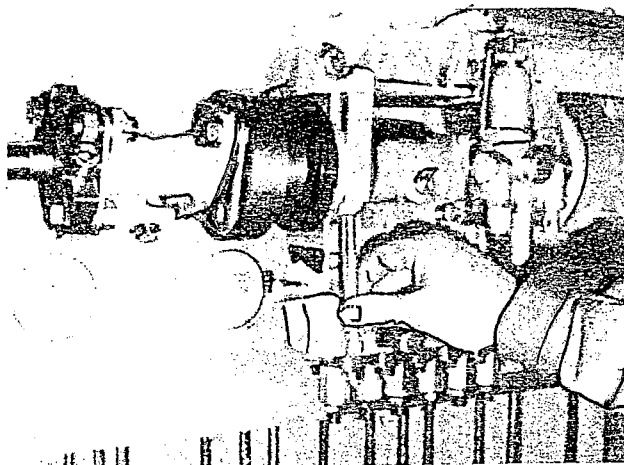
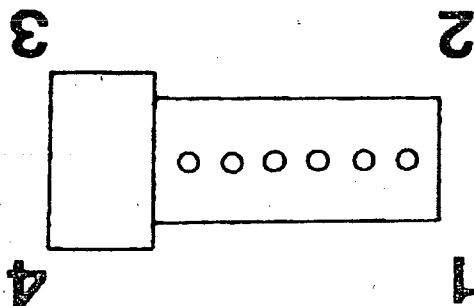
66. Secure the crankshaft vibration damper and the crankshaft belt pulley on the crankshaft by tightening their fixing bolt to 60Nm (with Loctite 242 applied).



67. Install the fuel injection pump drive flange and the drive sleeve. (Do not tighten the flange fastening bolt at this time).



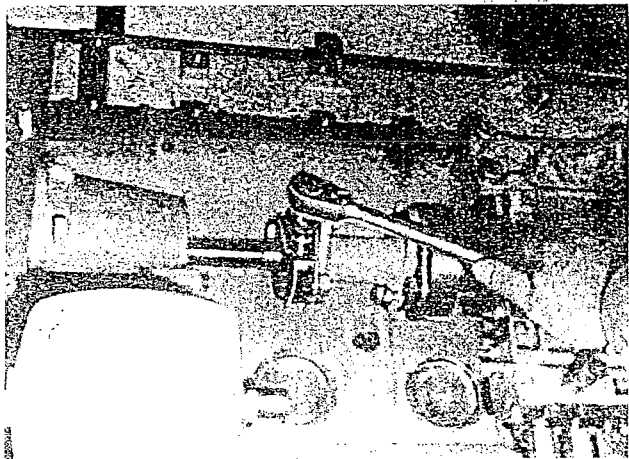
69. Install the fuel pump on its bracket, and secure it with four fixing bolts (with a torque of 32Nm) in the order as shown in the diagram.



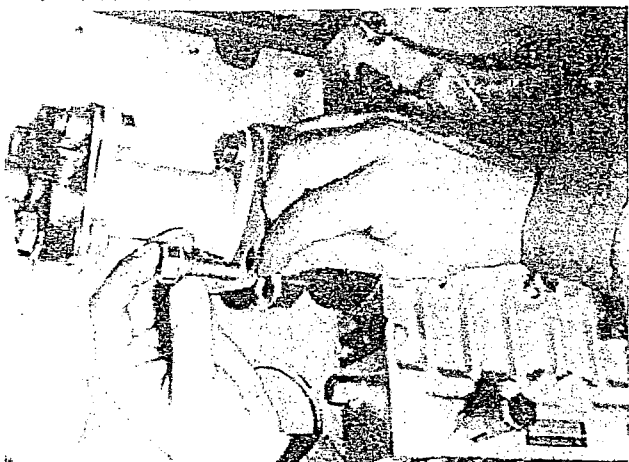
68. Install the fuel injection pump-bracket locating pin, and secure the bracket to the cylinder block by means of four fixing screws. Tighten these fixing screws to 80Nm in the order as given in the diagram.



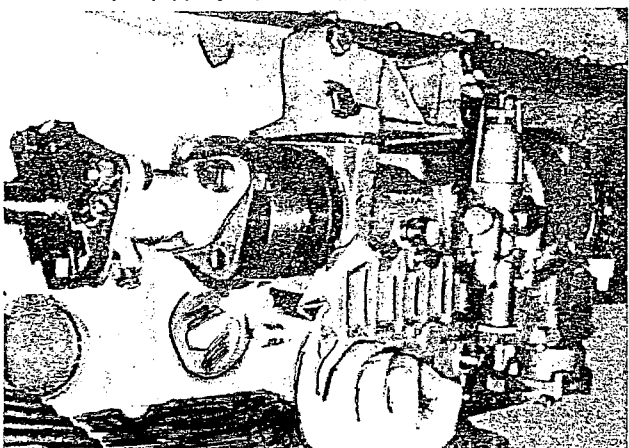
72. Rotate the engine flywheel in the direction of normal operation to the specified fuel injection advance angle prior to the position of the top dead center of the first cylinder, and tighten the drive flange fastening bolt to 110Nm.

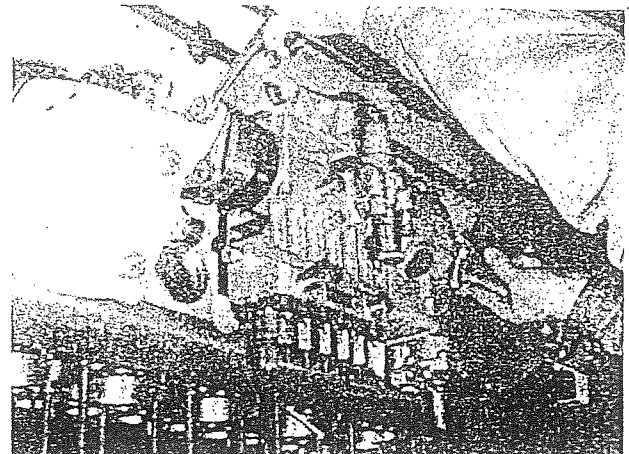


71. Connect the drive shaft sleeve to the fuel injection pump and tighten all coupling bolts.



70. Align the timing mark line on the fuel injection pump with that on the pump drive flange. Keep this position unchanged.



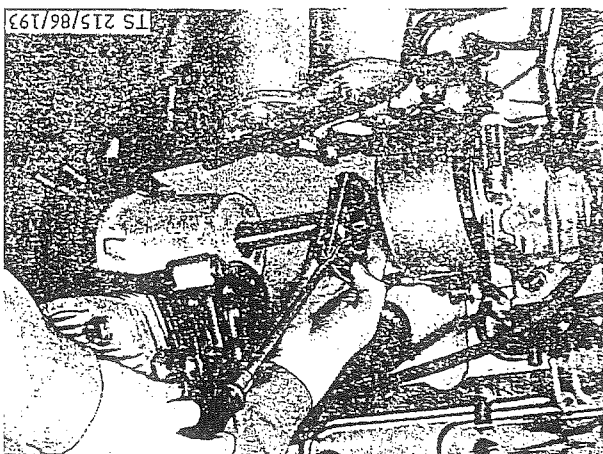


Before the cylinder head and the valve rocker arm are installed, the following method can be used to judge the top dead center of the first cylinder. Position the valve lifter in the six-cylinder intake valve tappet, rotate the engine in the direction of normal operation, and observe the movement of the six-cylinder intake valve lifter. When the valve lifter begins to move up, it indicates that the first cylinder is at the top dead center of compression.

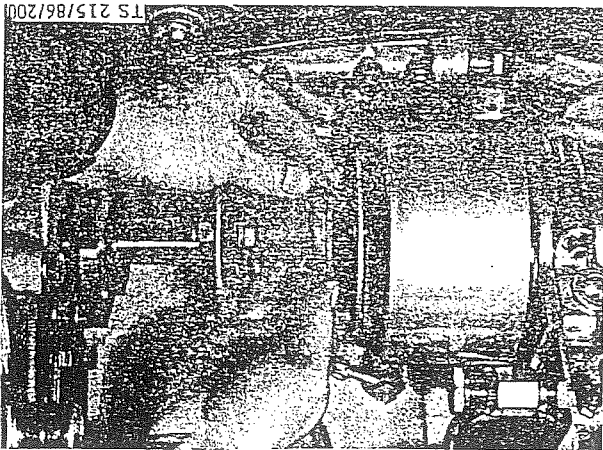
Now, rotate the engine flywheel by 40 degrees in the opposite direction of normal operation, then in the direction of normal operation to allow the mark line of the flywheel casing to align with the fuel injection advance angle mark line on the flywheel, and tighten the drive flange fastening bolt to the specified torque. The fuel injection advance angle of the engine is now guaranteed.

73. As for fuel injection pump without timing mark line, use a hand pump to pump fuel into the fuel injection pump to remove air inside the pump body. Connect a viewing pipe to the fuel outlet joint of the fuel supply branch pump of the first cylinder. Manually set the throttle the max. fuel supply position. Rotate the flywheel to the specified fuel injection advance angle prior to the position of the top dead center of the first cylinder. Slowly and intermittently rotate the fuel injection pump drive shaft in the direction of normal operation. When the level of the fuel in the viewing pipe begins to rise, tighten the drive flange fastening bolt to 110Nm. The fuel injection timing of the engine is now guaranteed.

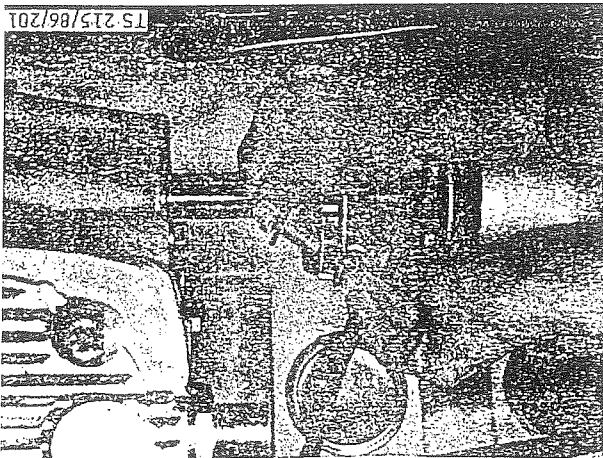
follows:



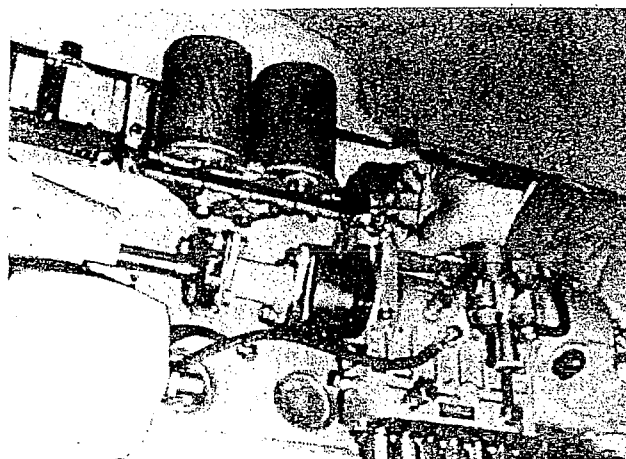
74. Install the drive flange over the fuel injection pump drive shaft.



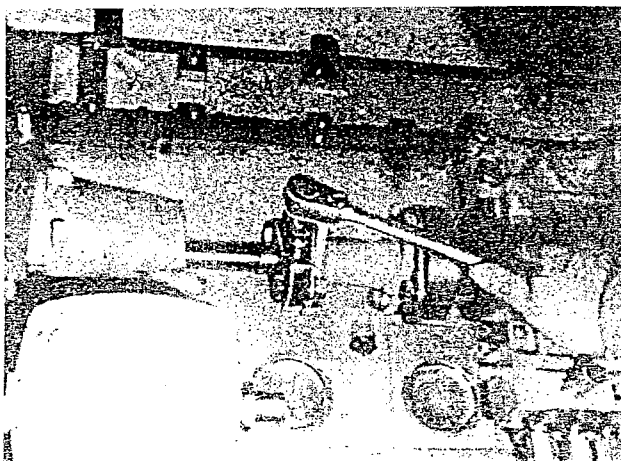
75. Connect the drive shaft sleeve with the timing device.



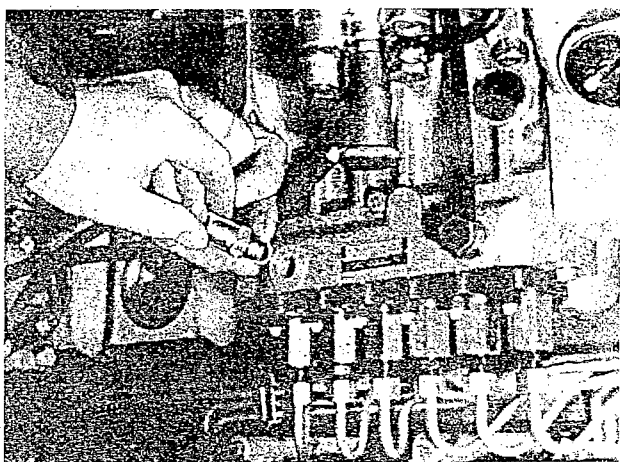
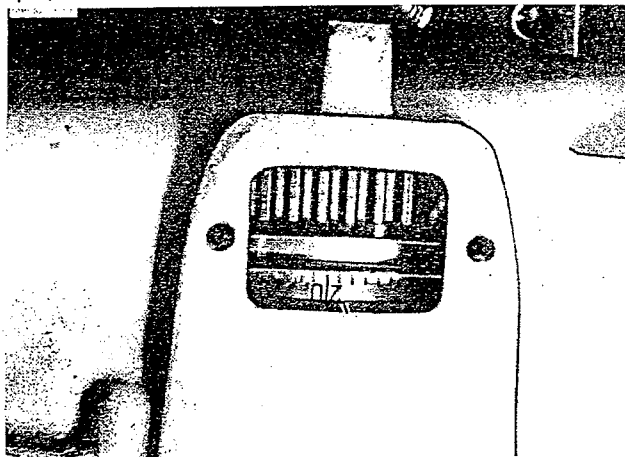
76. Install the elastic steel plate on the drive flange and the drive sleeve.



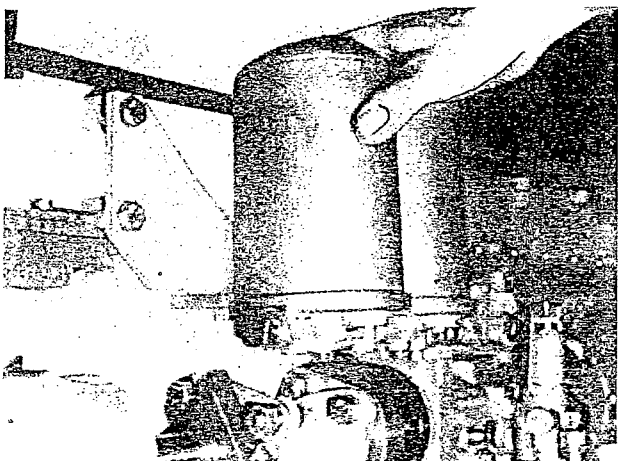
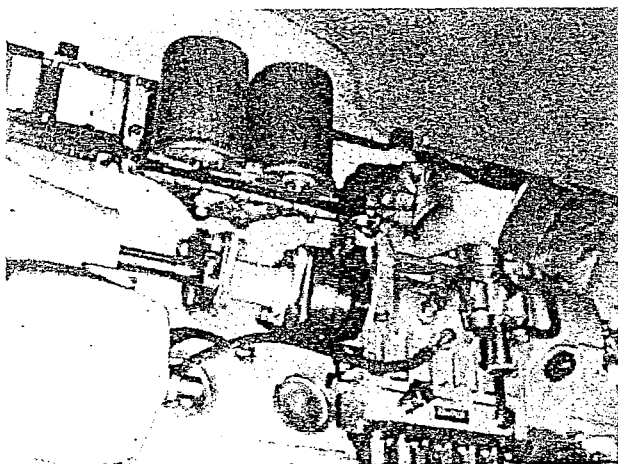
78. Place the fuel injection pump at the fuel injection starting position of the first cylinder, and tighten the flange fastening bolt to 110Nm.

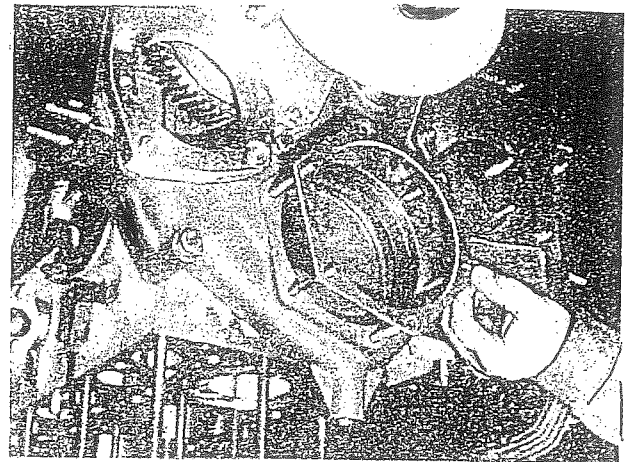


77. After the flange and the sleeve are connected, rotate the flywheel to the specified fuel injection advance angle prior to the position of the top dead center of the first cylinder.

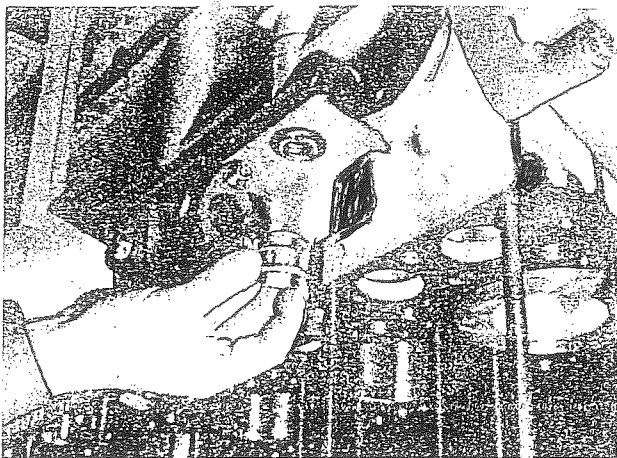
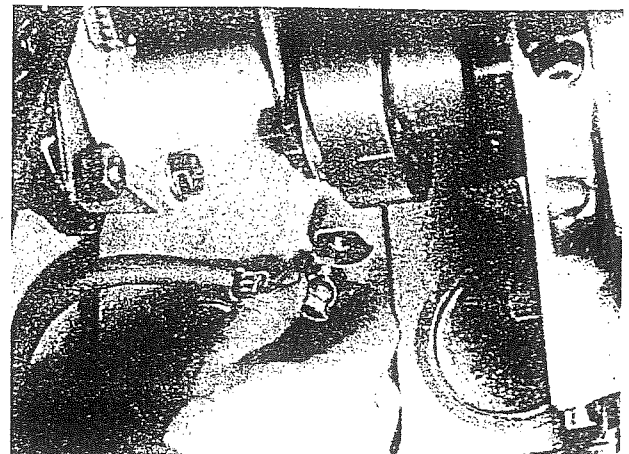
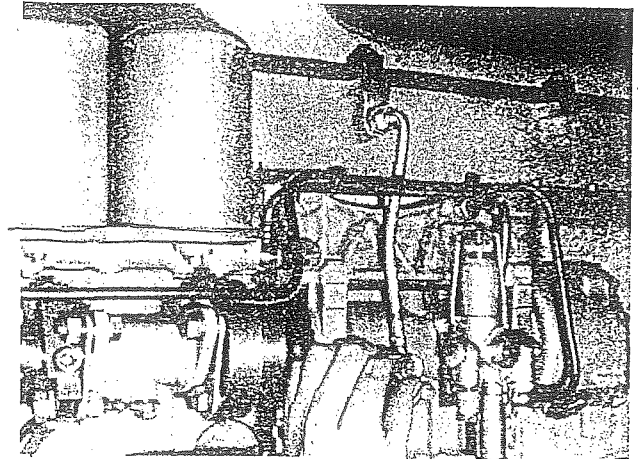


79. Connect various fuel supply pipes to the diesel fuel filter.

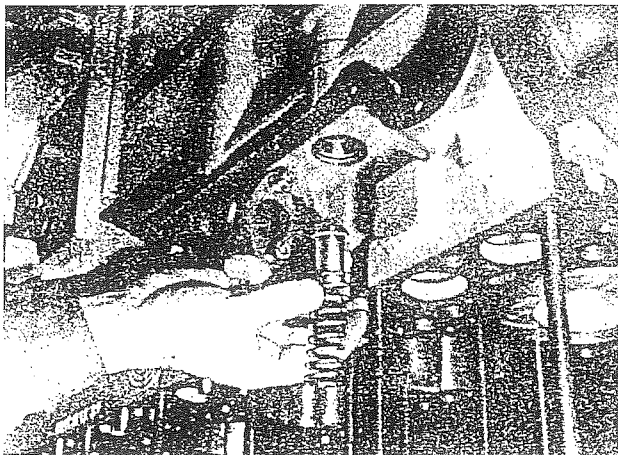




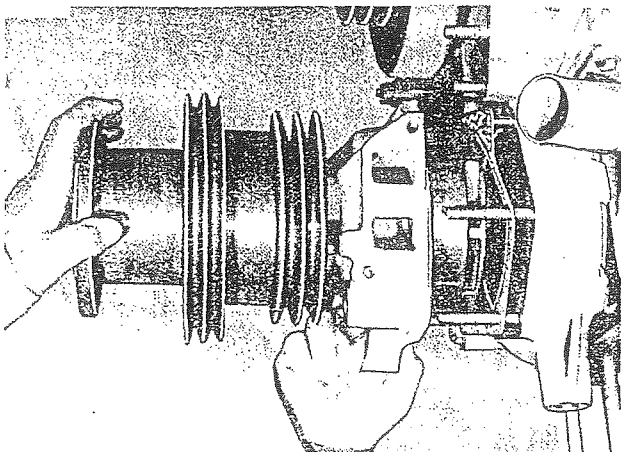
80. Connect the oil pipes of the air compressor to those of the fuel injection pump.

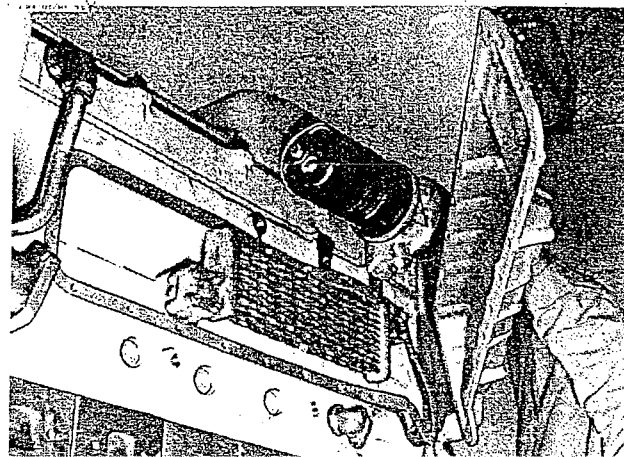


82. Position the bypass valve in the oil cooler, and then screw in the plug of the bypass valve.

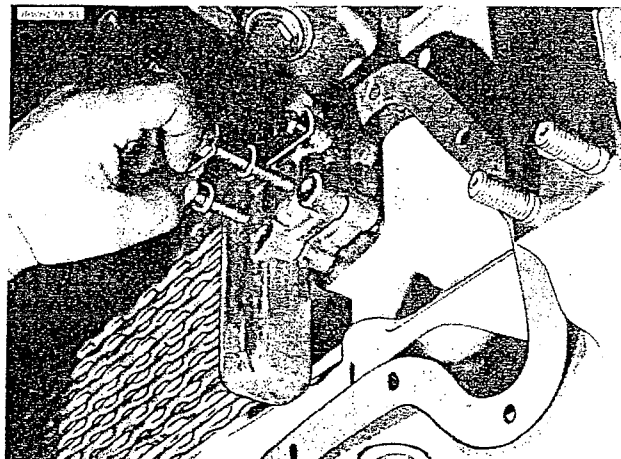


81. Install the water pump assy.

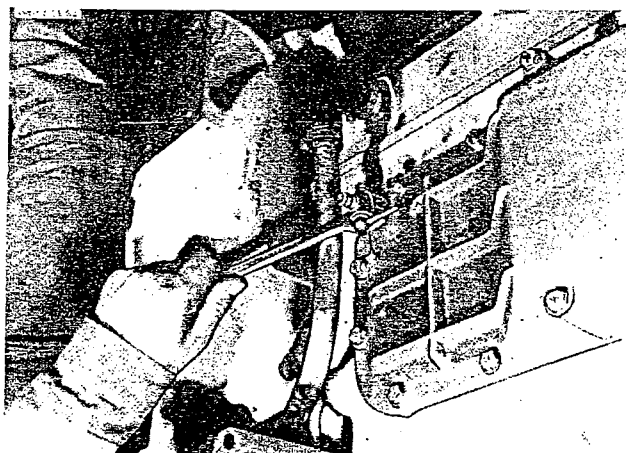




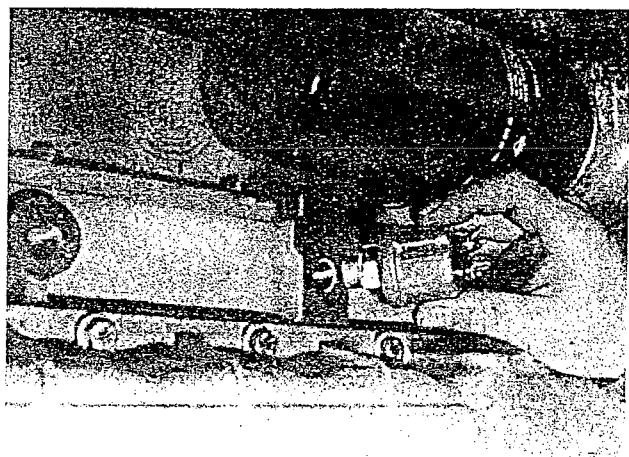
83. Install the oil radiator element and the gasket on the engine body. Take care to check and make sure that there is no leakage at the radiator element and its connectors.



84. Fit the oil cooler together with its gasket on the engine body, and tighten all the bolts. Install the water drainage plug or cock on the cooler cover.

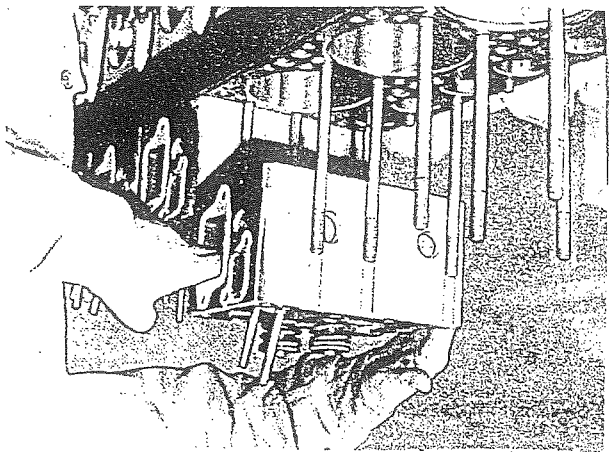


86. Install the oil pressure sensor.



85. Install the oil filter assy.

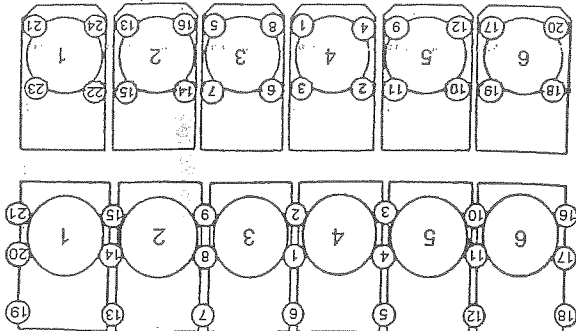
89. Fit the cylinder heads on the upper surface of cylinder block. The side with "TOP" marking faces up.



90. Install various cylinder head subassemblies on the cylinder. Be careful with the fitting direction of the cylinder head. (The side with valve should face the fuel injection pump side).

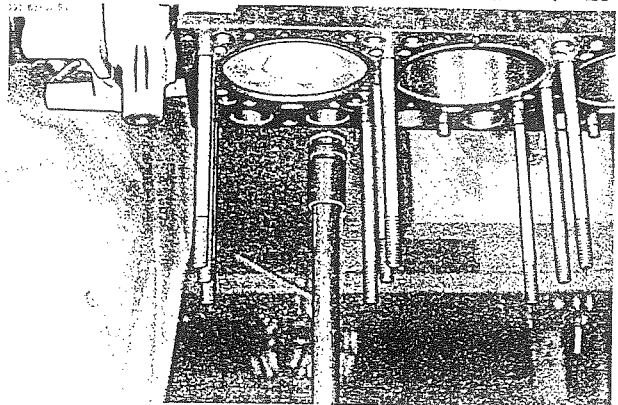
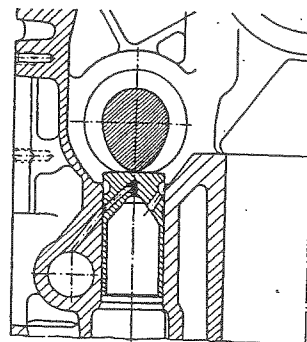


91. Preinstall the water pipe on the cylinder head (without gasket), and tighten the fixing bolts.

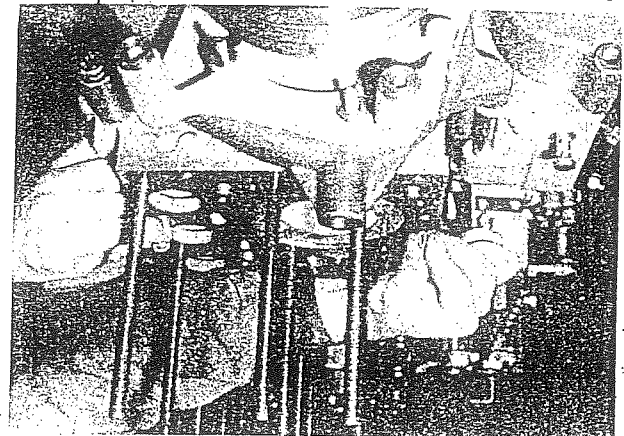


92. Install V-shaped hold-down block of the cylinder head main bolts and the secondary bolts.

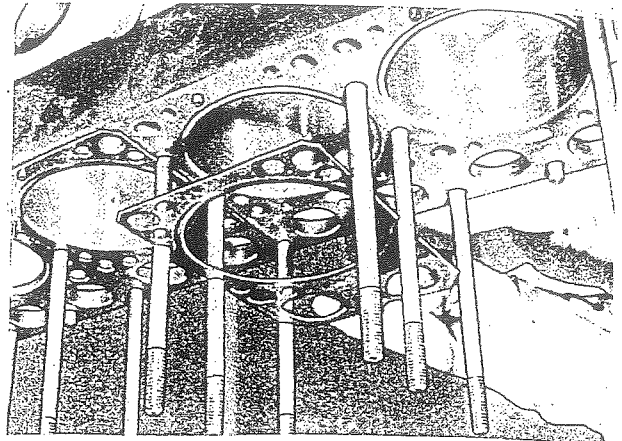
Pre-tighten the cylinder head secondary bolts (see Figure above) and the main bolts (below) in the order as shown in the above Figure to a torque of approx. 30Nm.

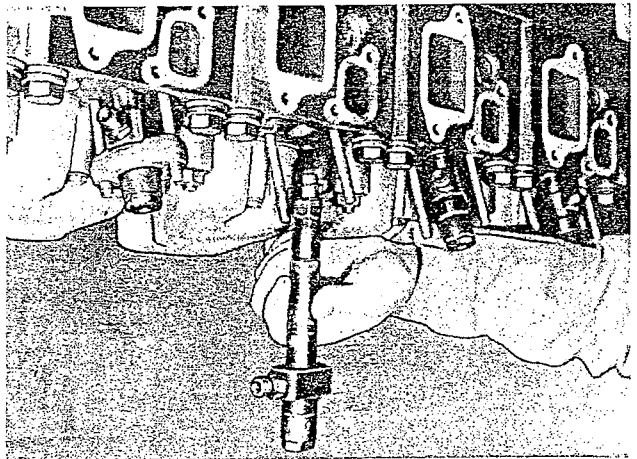
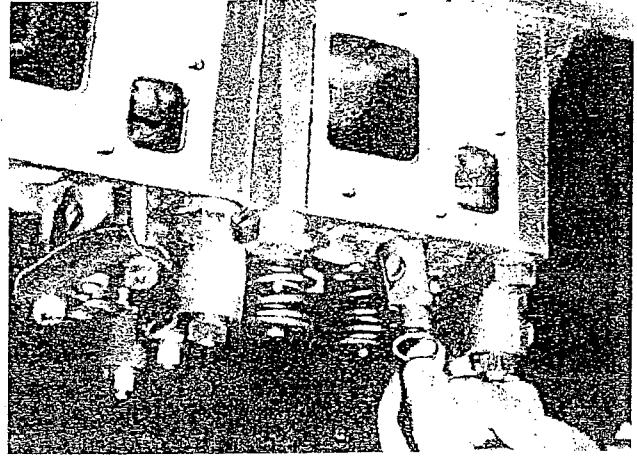


87. Install the twelve valve tappets into tappet bores to get in touch with the cams.

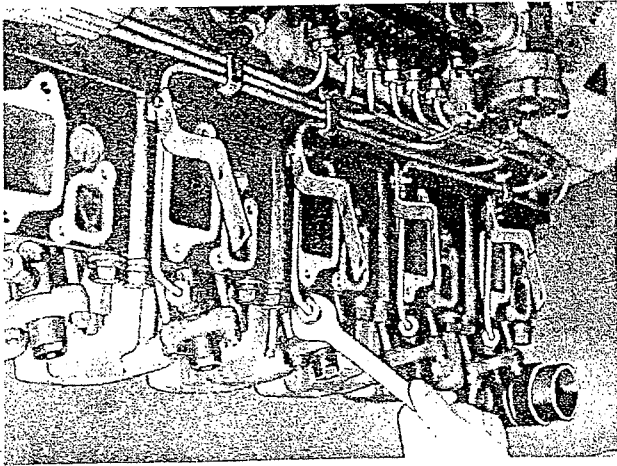


88. Install the locating pins of various cylinder heads on the upper surface of the cylinder block.

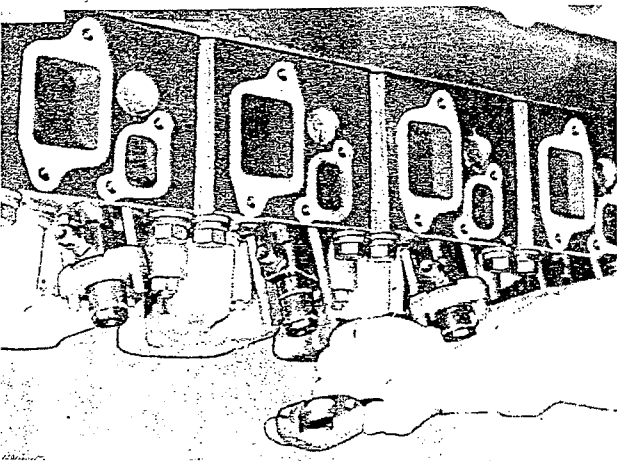
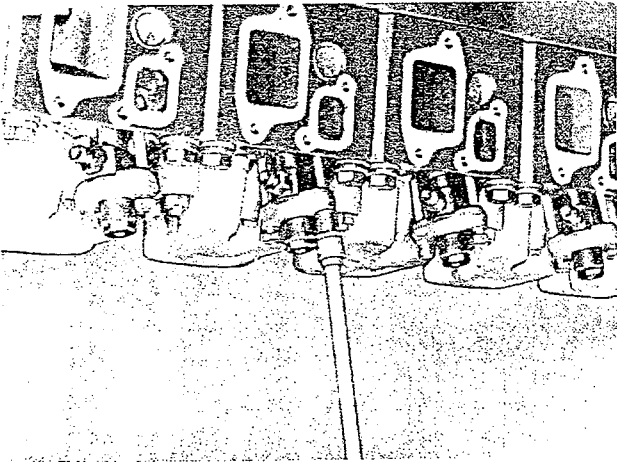


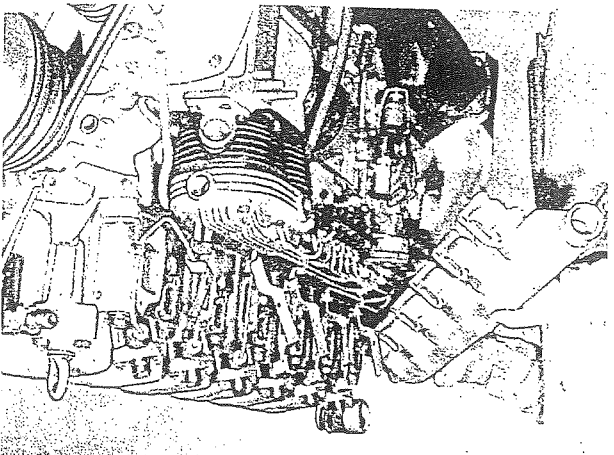


Tighten all secondary bolts to 100 Nm in the given order.
Tighten again all secondary bolts to 200 Nm in the given order.
Rotate all main bolts by 90° in the given order.
Rotate all secondary bolts by 90° in the given order.
Rotate again all secondary bolts by 90° in the given order, and make sure that a final torque of 120 ~ 160 Nm is reached. Replace those bolts that failed to reach the specified torque.
Rotate all secondary to a proper position in the given order, and make sure that a final torque of 240 ~ 340 Nm is reached. Replace those bolts that failed to reach the specified torque.
It is allowed to use the cylinder head main bolts repeatedly for three times, and the secondary bolts for two times.
Upon the completion of tightening all the bolts, remove the water pipes. Fit all the intake pipe gaskets of various cylinders.

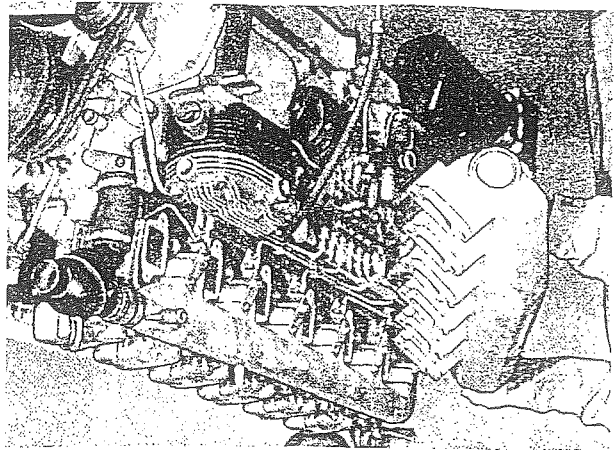


93. Install the fuel injector and the gasket into the cylinder head. Tighten all fuel injector fixing bolts to 25 Nm.

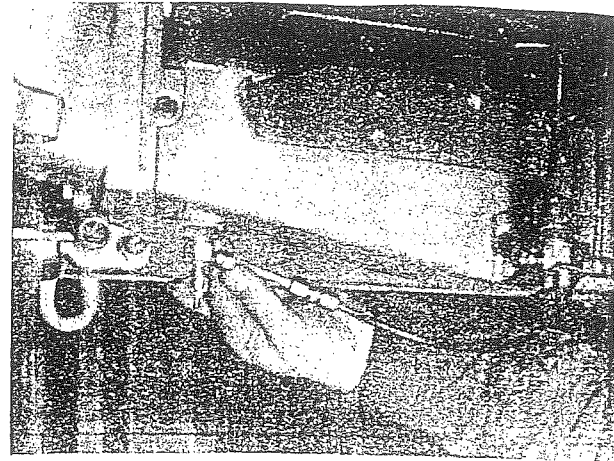




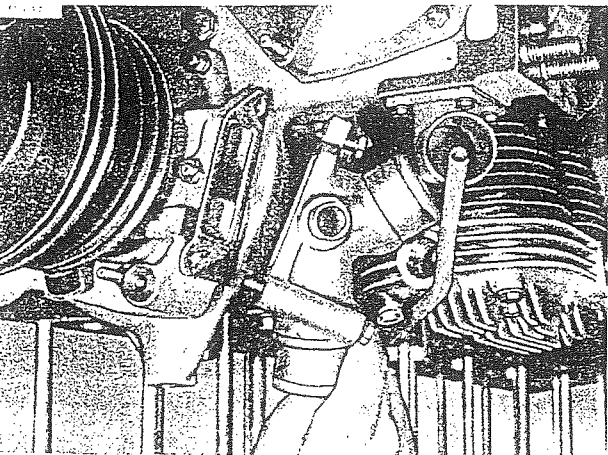
94. Install the high-pressure pipe and the water pipe. Tighten the water pipe fixing bolts.



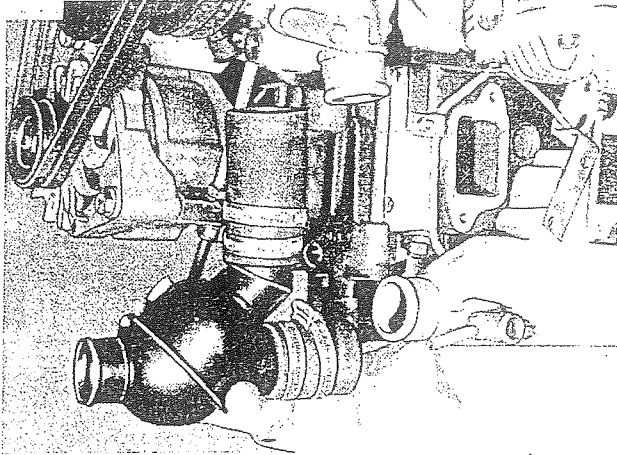
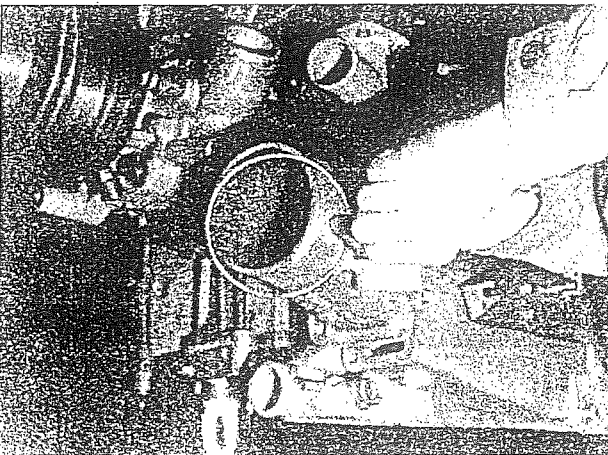
95. Install the engine intake duct, and tighten the duct fixing bolts.



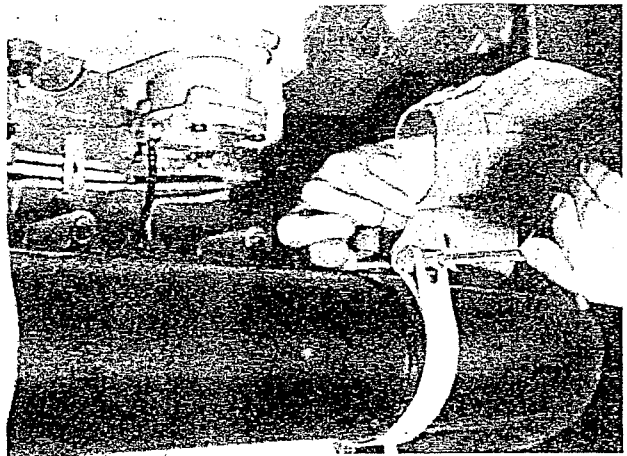
96. As for engine with pre-heater (optional), the solenoid valve, the preheating plug and the wires should well mounted and attached.



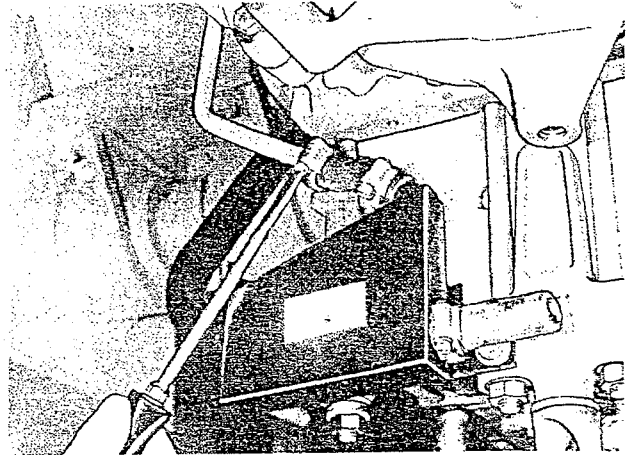
97. Attach the water diversion pipe and the air intake pipe connection tube. A seal ring should be fit on the intake pipe connection tube. (On the engine with supercharger, the intake manifold faces rearward, and on the inter-cooling engine, the intake manifold faces forward).



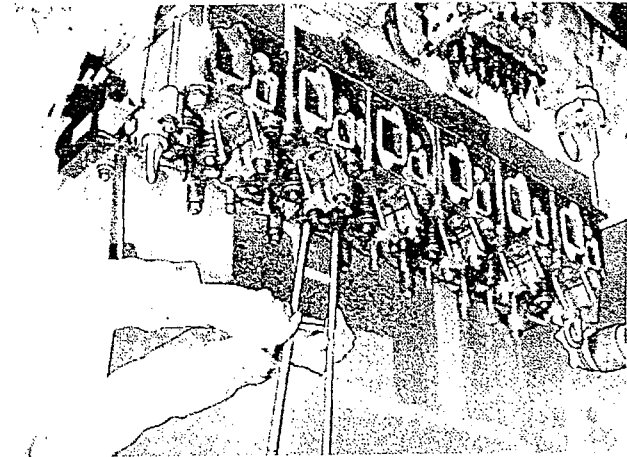
98. Install the thermostat.



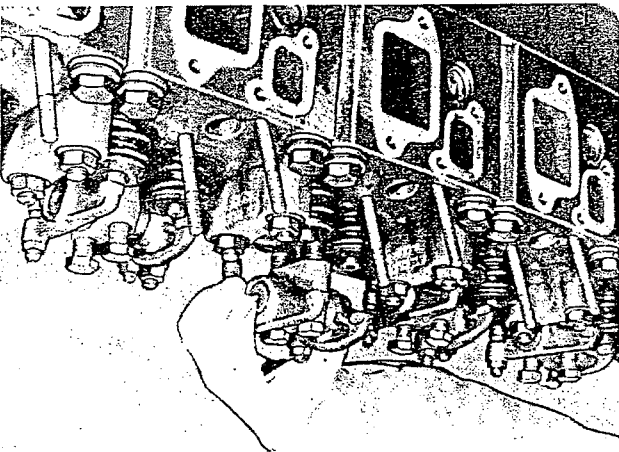
99. Connect the air pipes between the smoke limiter and the intake manifold (Bosch pump smoke limiter is at the fore end of the fuel injection pump). Connect and secure the intake pipe.



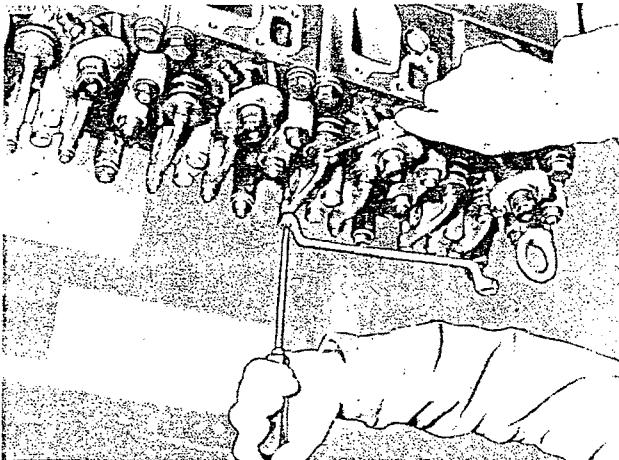
100. Install the oil-gas separator.



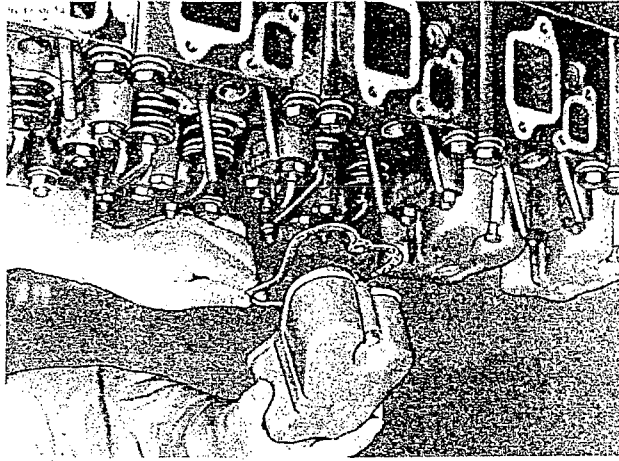
101. Insert the valve tappet.



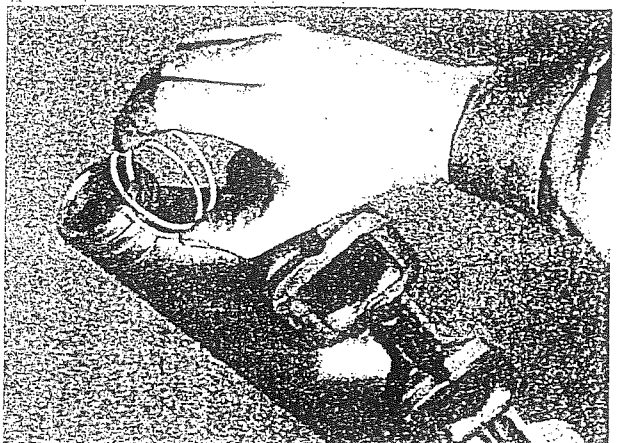
102. Install the valve rocker seat assy. Tighten the rocker seat fixing bolt to 100 Nm.



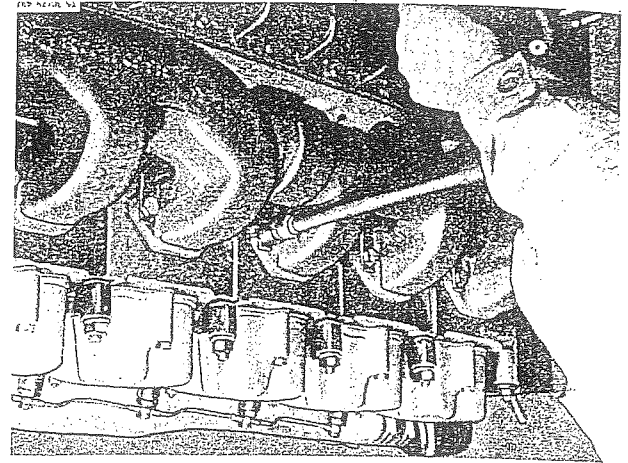
103. Adjust the valve clearance.
Intake valve clearance is 0.3mm.
Exhaust valve clearance is 0.4mm.



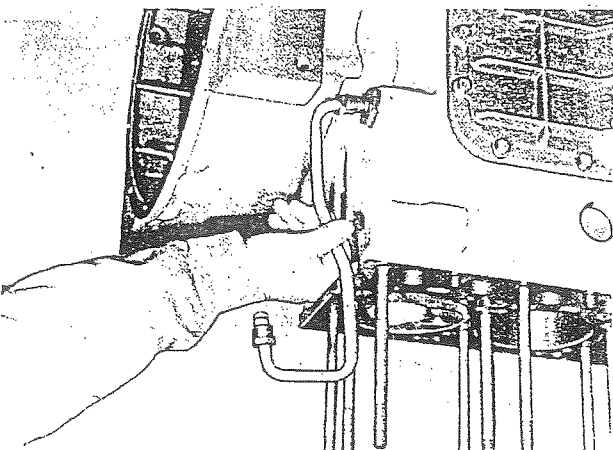
104. Properly install the valve chamber covers and the gaskets of various cylinder heads.



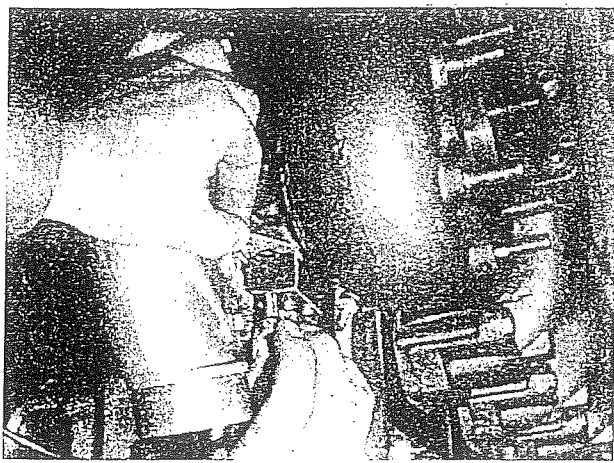
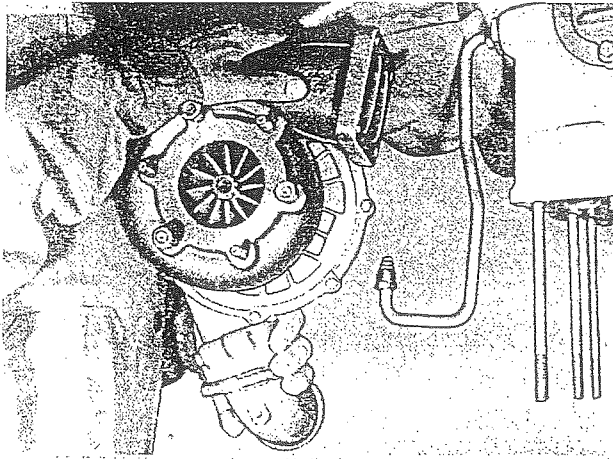
105. Install exhaust manifold sealing ring.



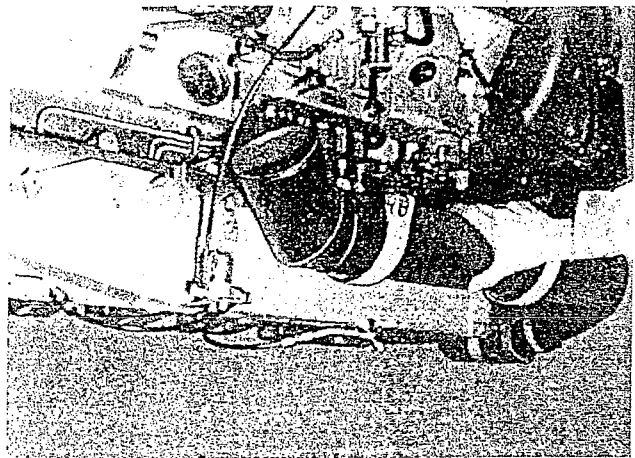
106. Install exhaust manifold and the gasket. Pre-tighten the thirteen exhaust manifold bolts to 5 ~ 50Nm, and then turn the bolts twice by 90° in tightening direction symmetrically and make sure that the final torque of 70 ~ 90 Nm is reached. The exhaust manifold fixing bolts can be used twice.



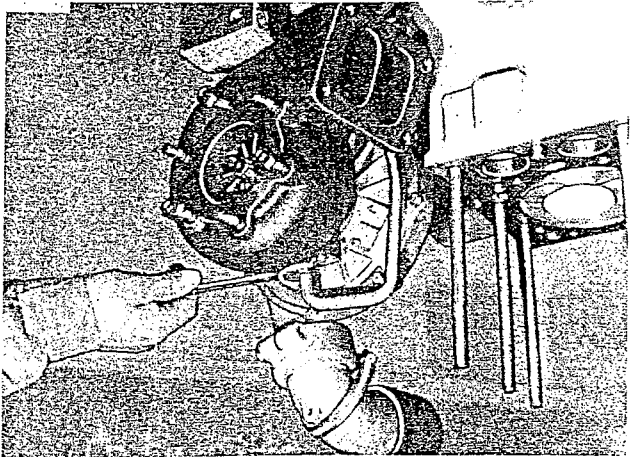
107. Attach the fuel supply pipes to the supercharger.



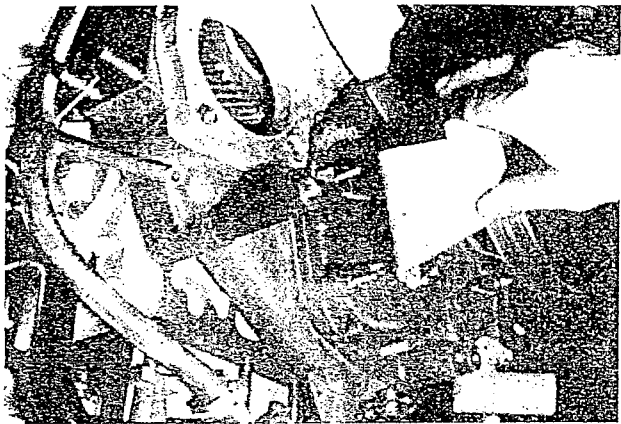
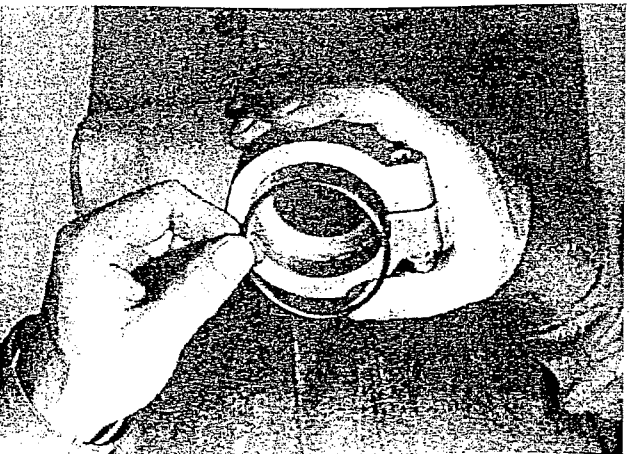
108. Install the supercharger and attach the oil supply pipe. Put a gasket at the pipe union.



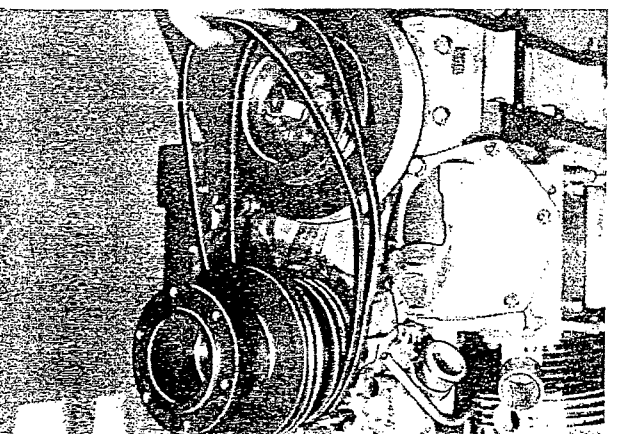
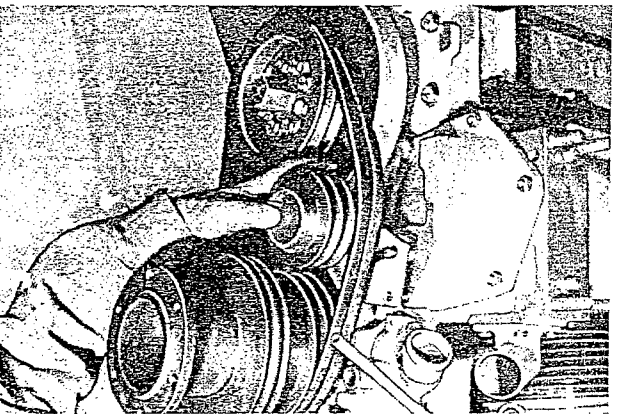
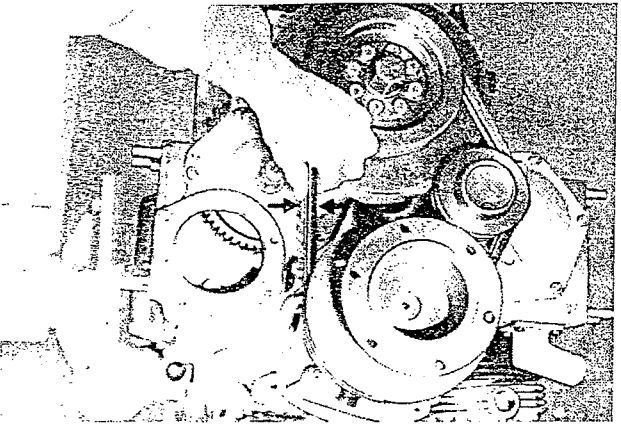
110. Connect the supercharger to the intake pipe.



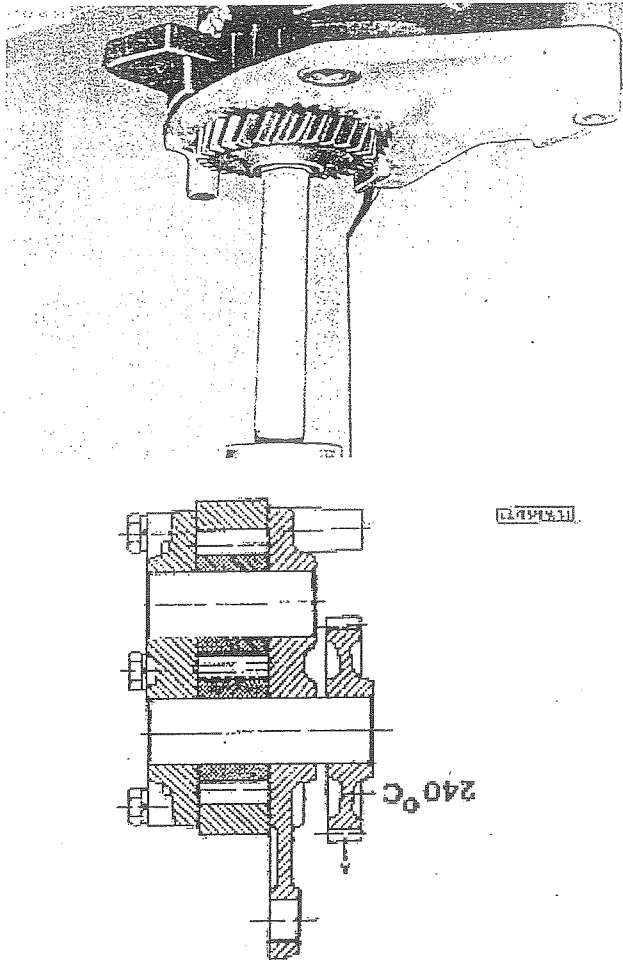
109. Fit the supercharger exhaust pipe seal ring.



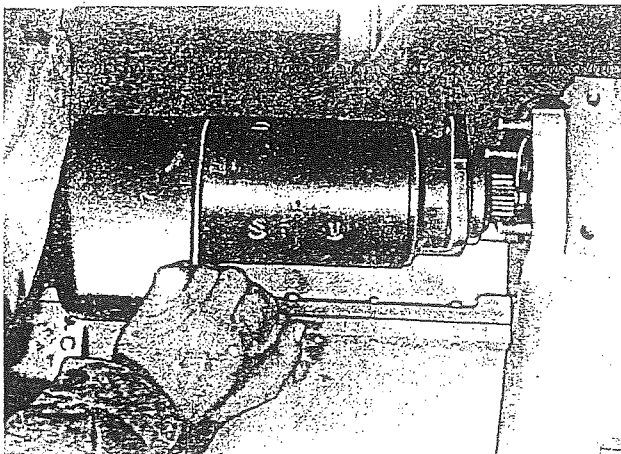
111. Install the tensioning pulley and the belt.



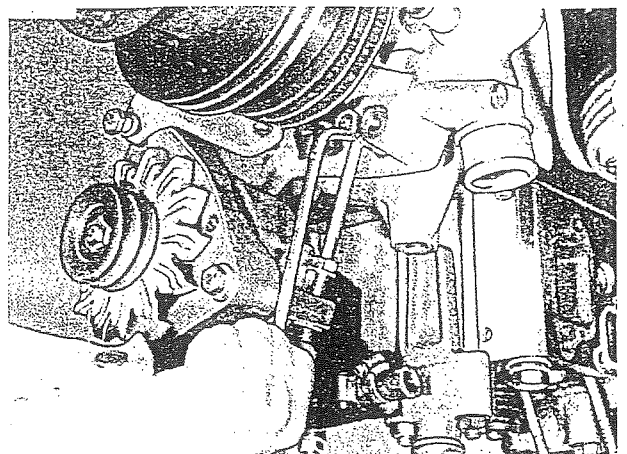
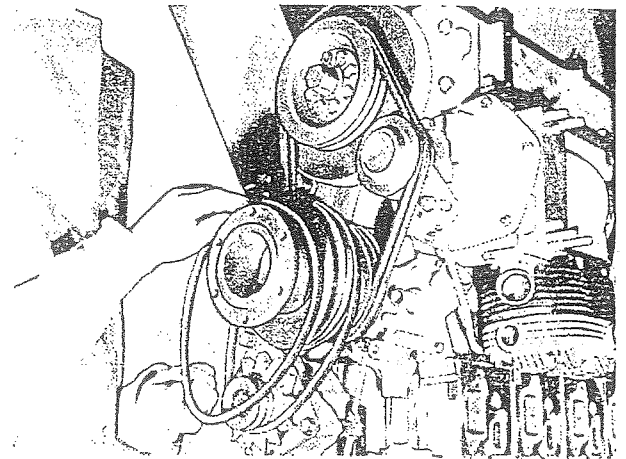
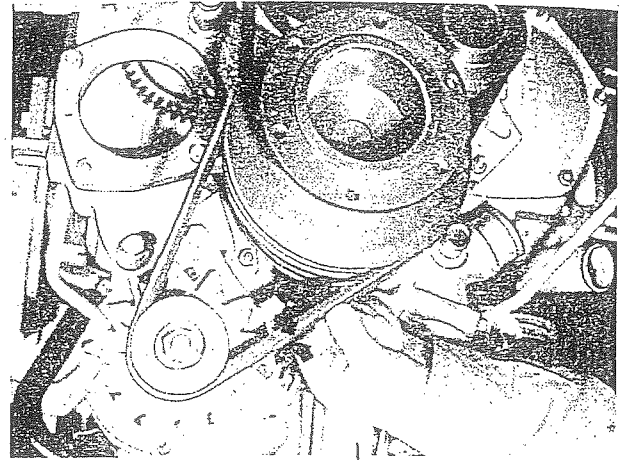
1. Fit (with no key used) the drive gear and the shaft of the gear pump by heating them to 240°C.



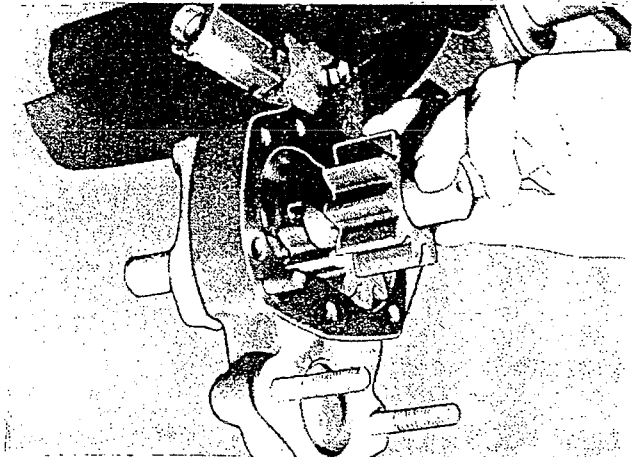
II. Assembling Various Subassemblies
(i) Oil Pump



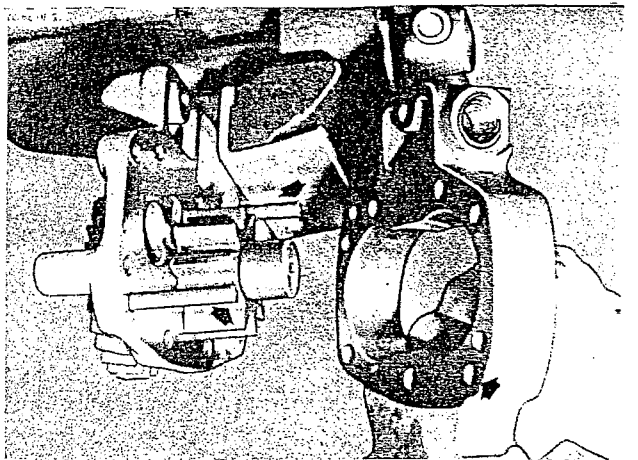
112. Install the generator bracket, the generator and the belt.



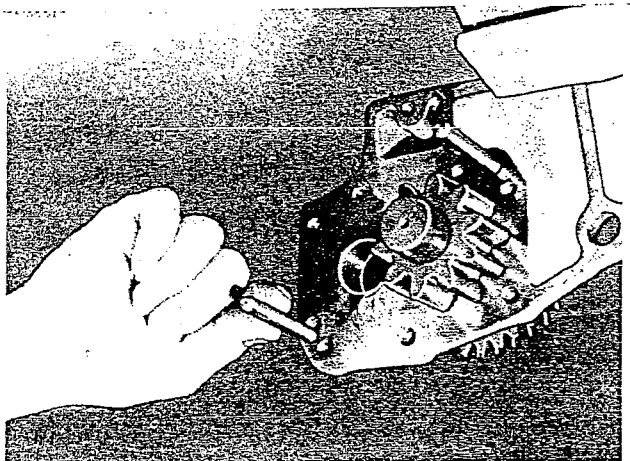
4. Apply engine oil on the gear and fit it into the pump body.



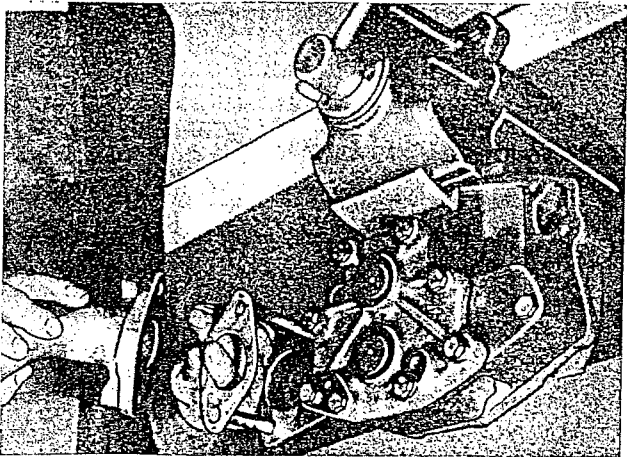
3. Fit the pump body to the pump housing.



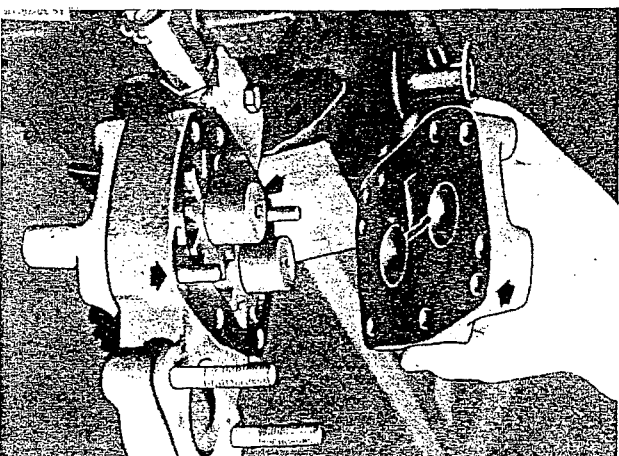
2. Install the locating pin on the pump body.

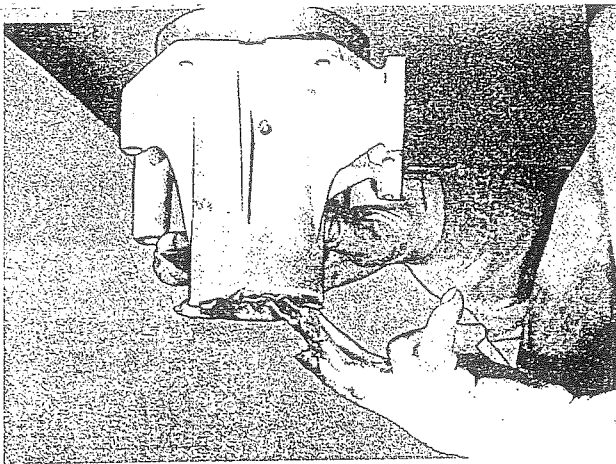


6. Tighten the pump cover fixing bolt.

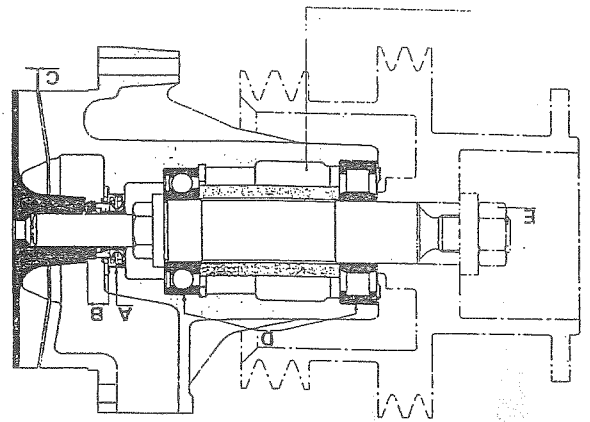
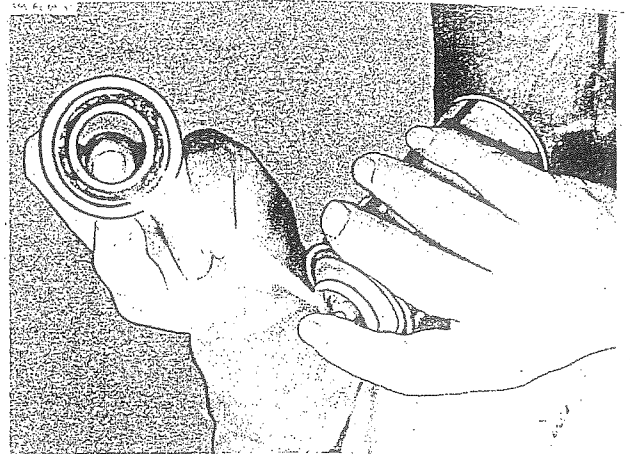
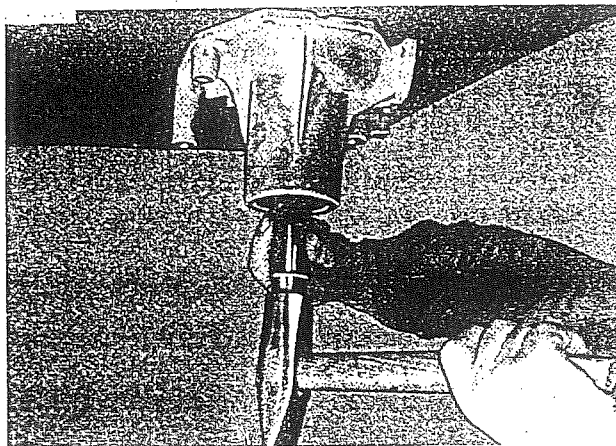
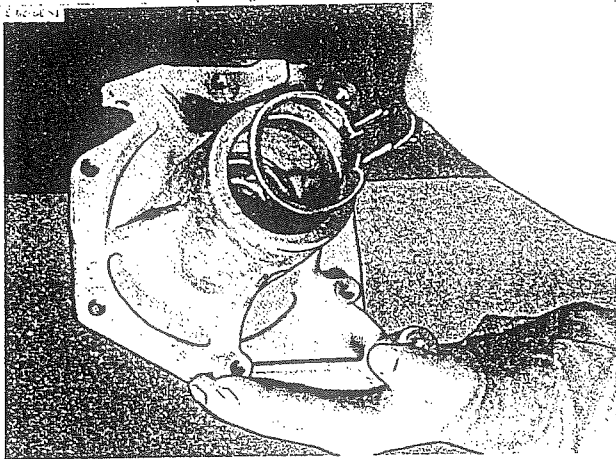


5. Fit the pump cover to the pump body.



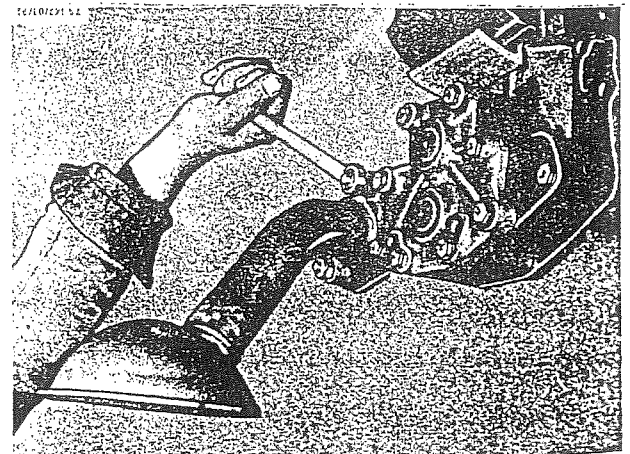


1. Fit the water pump bearing and secure it with a clip.

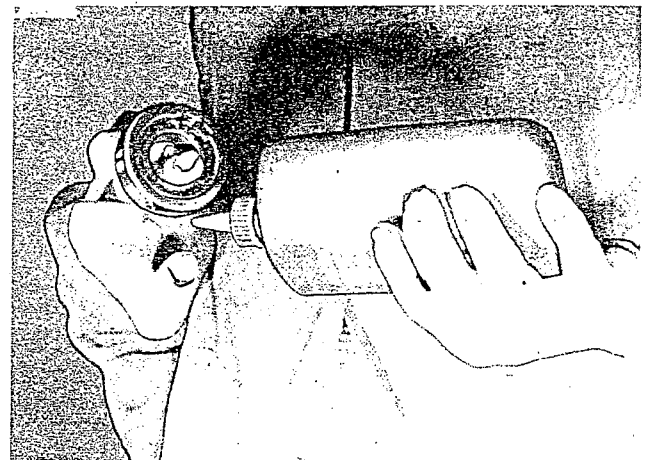
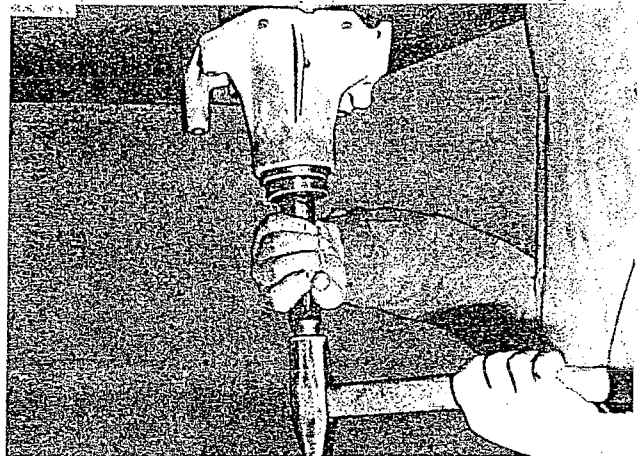


(II) Water Pump

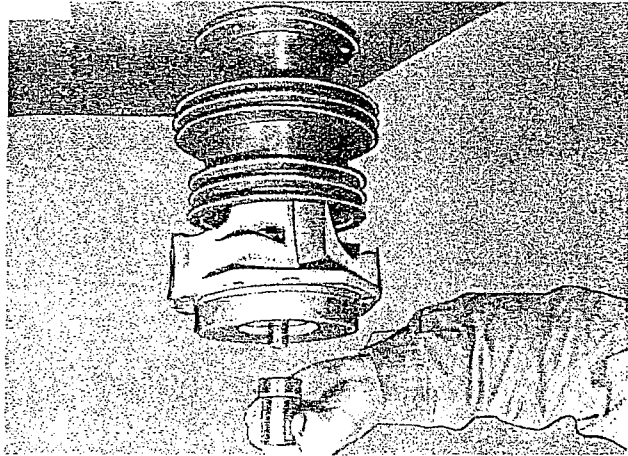
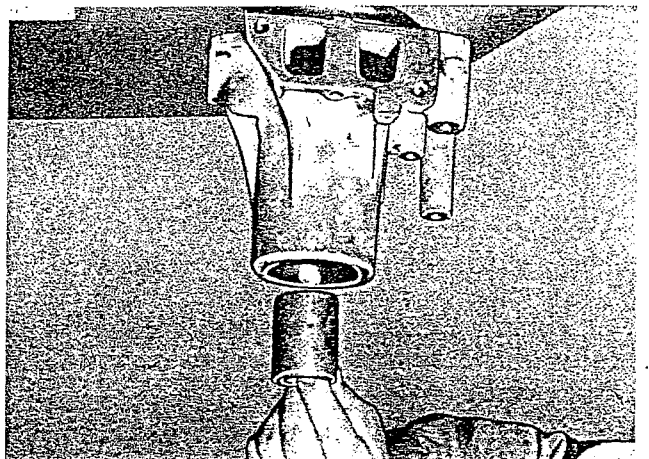
7. Place the oil anthology cleaner and the gasket on the pump body, and secure them with fixing bolts.



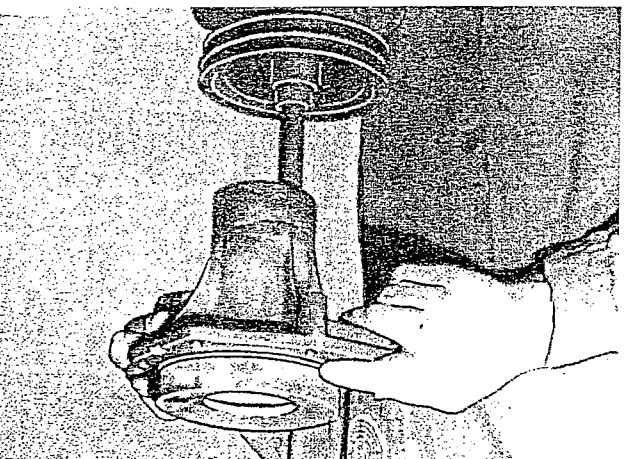
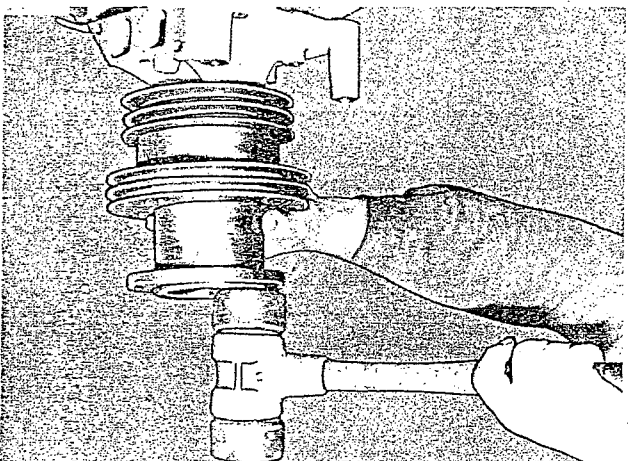
3. Apply Locite on the outer surface of bearings. Fit the outer bearing into the pump body.



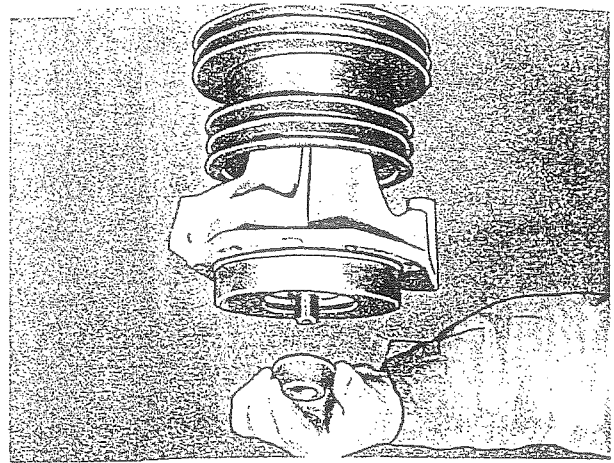
2. Coat with grease (lithium base), and fit it into the locating sleeve.



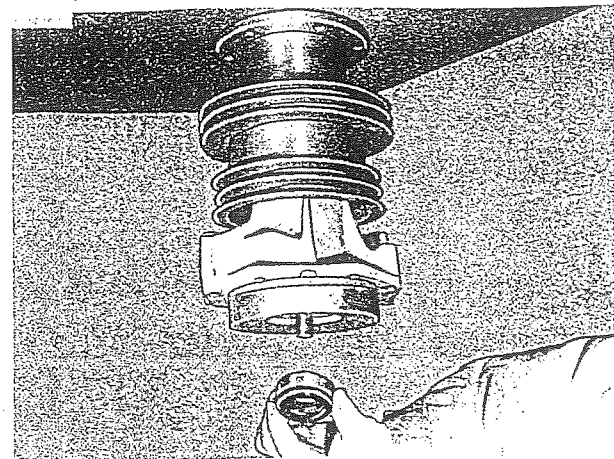
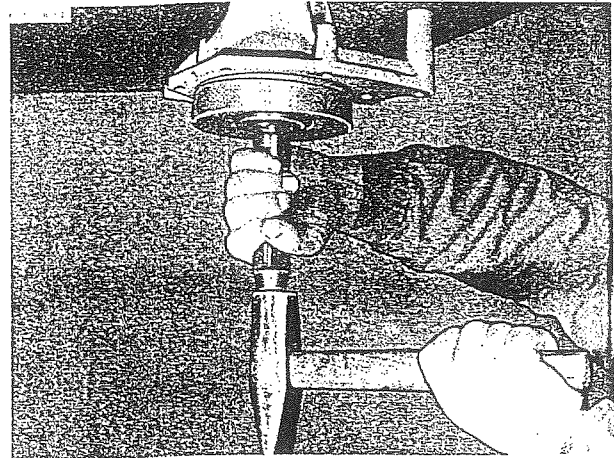
4. Fit the belt wheel and the shaft of the water pump. Then tighten the shaft nut to 130 ± 20 Nm.



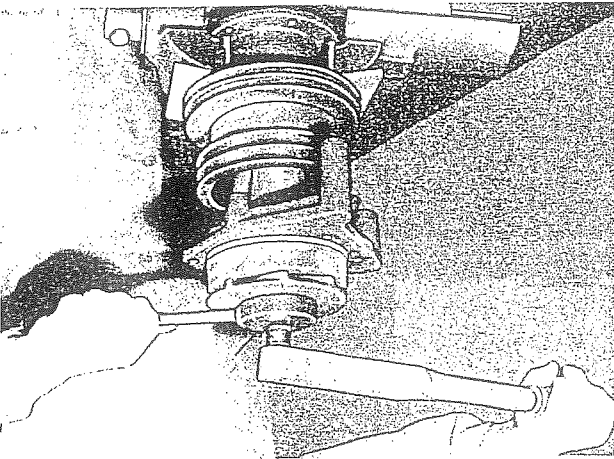
7. Apply Loctite 641 on the inner surface of the water seal ring, and insert it into the shaft.



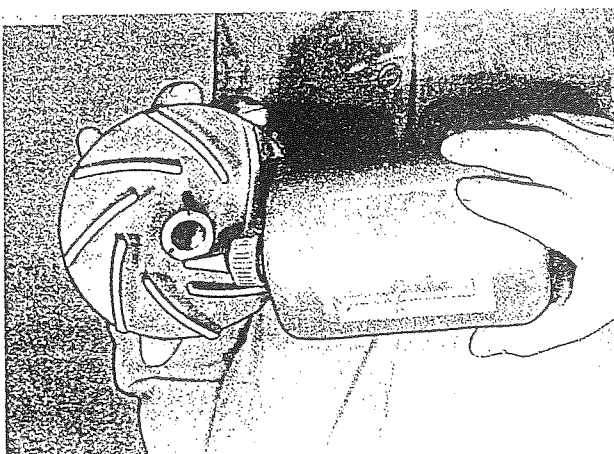
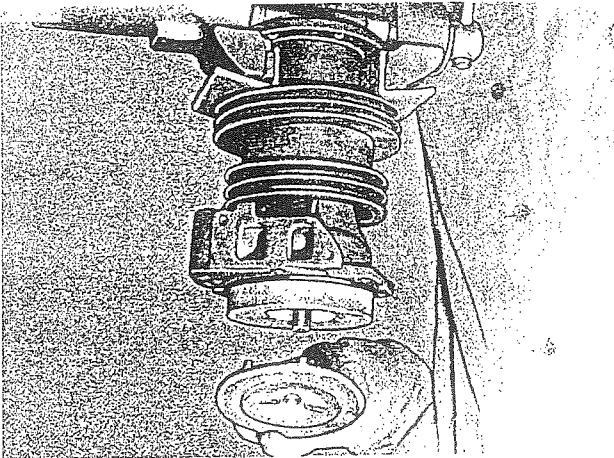
6. Install the water pump water seal.

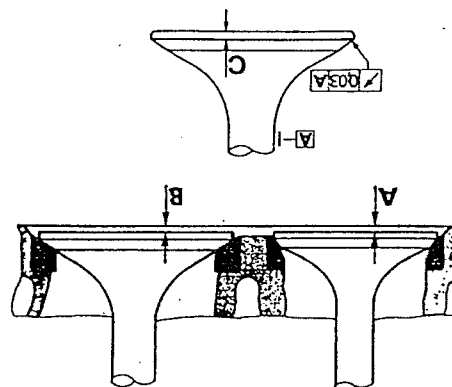


9. Tighten the impeller nut to 50Nm.
(iii) Installation of Valve

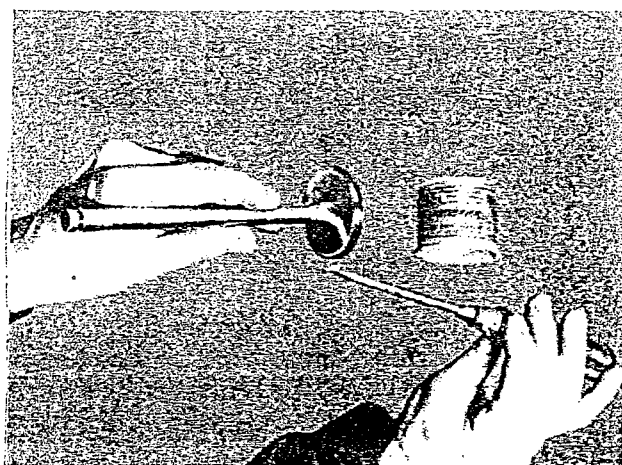
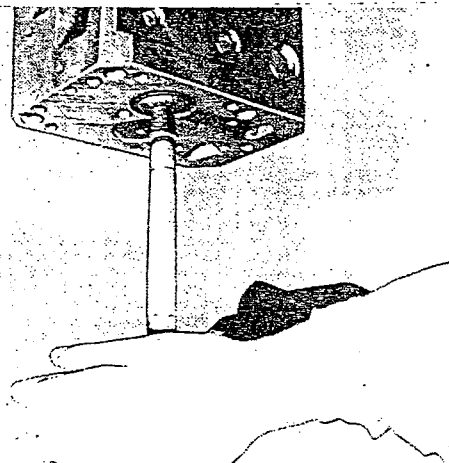


8. Apply Loctite 641 on the inner surface of the water pump impeller, and fit it on the shaft.

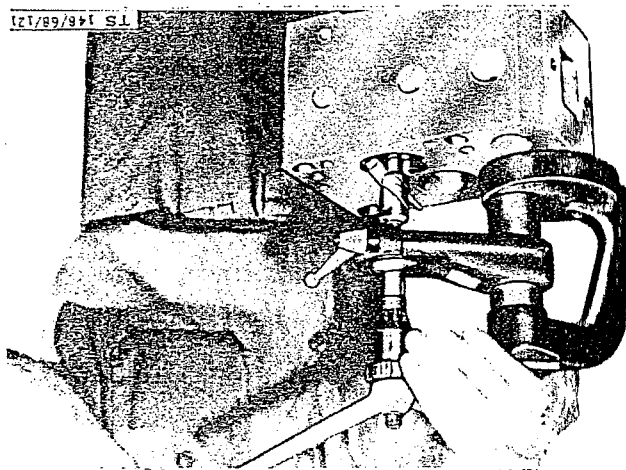




1. If the valve does not seal properly, lap it. And then check its airtightness. Apply some red lead oil or bearing oil on the conical surface of the valve. Put the valve into its seat, press and rotate it by several turns, and take out and observe the annular contacting zone. If the annular contacting zone is uninterrupted, it indicates that the tightness of the valve is good. Position the valve cap upside down to let the valve set to its position, pore some kerosene on the valve, and wait for 15 minutes. The valve is qualified if the level of the kerosene does not drop. Seriously worn valve seat must be reamed by means of a valve seat reamer before lapping.

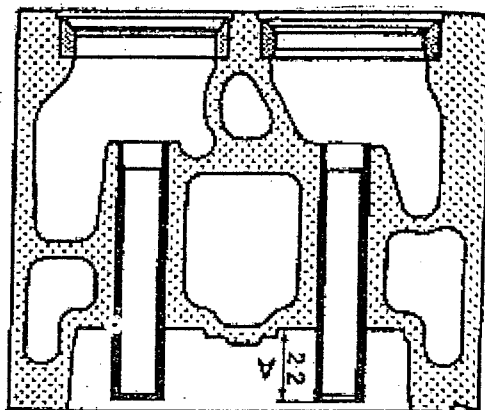


2. Place the valve into its seat, and measure the amount of falling of the valve and make sure it is within the specified limit:
 Intake valve $A = 0.95\text{mm}$.
 Exhaust valve $A = 1.25\text{mm}$.
 If the fall of the valve exceeds 1.8mm , check the thickness of the valve. Replace the valve if its thickness is out of tolerance. Otherwise, replace the valve seat.



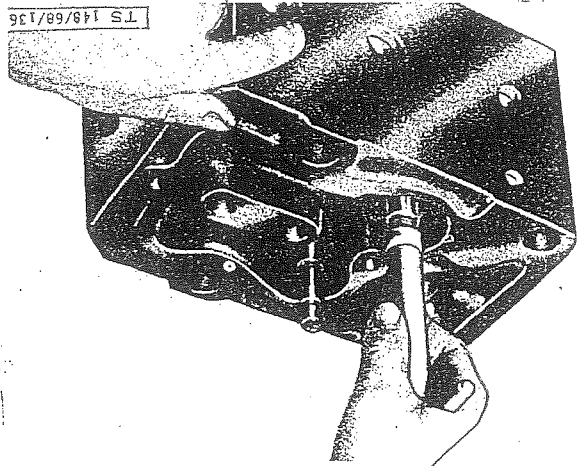
3. If a new valve seat is to be used, its opening must be reamed to the specified size.

New valve seat will be installed by the method of liquid nitrogen shrink fitting. The reamer shall be chosen according to the angle of the valve seat opening. After reaming, the seal band width of the intake valve port should be approx. 1.52mm , and that of exhaust valve port approx. 1.42mm . Lap the valves after reaming.

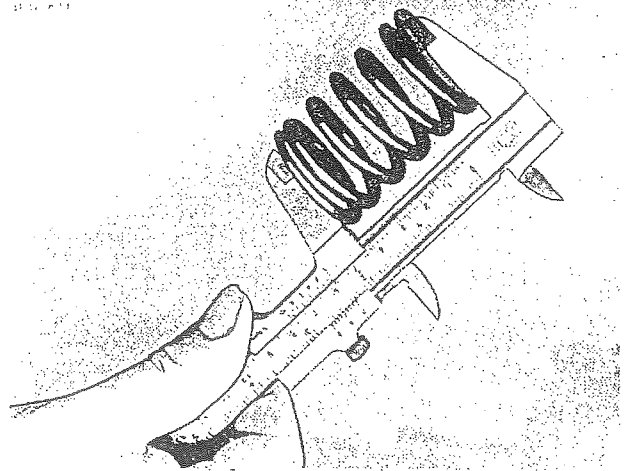


4. Clean the cylinder head valve guide seat and exterior surface. Press the valve guide into its seat bore, and finally ensure that the valve guide protrudes the bottom surface of the cylinder head valve by 22mm . Ream the inside diameter of the valve guide. The inside diameter of the valve guide is $\phi 11+0.018/0\text{mm}$.

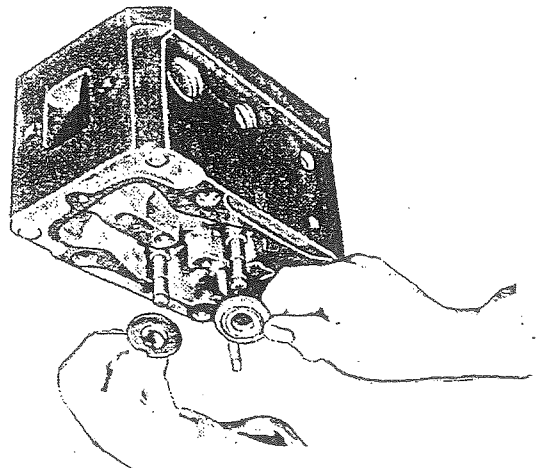
7. Install the valve guide oil seal on the valve guide.



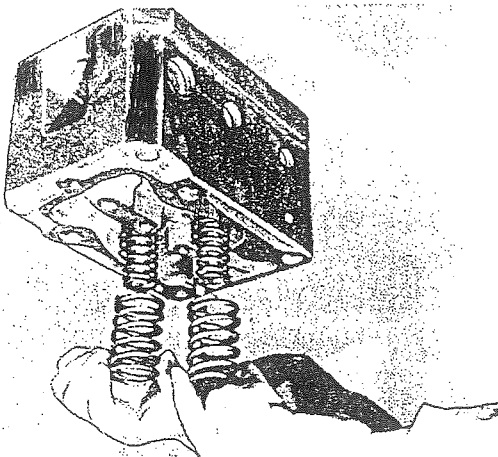
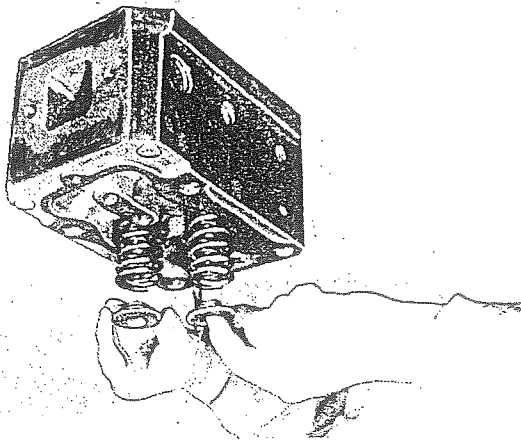
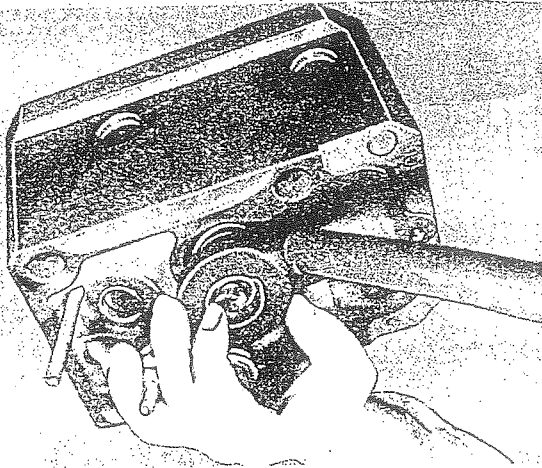
6. Check the free length of the valve spring.

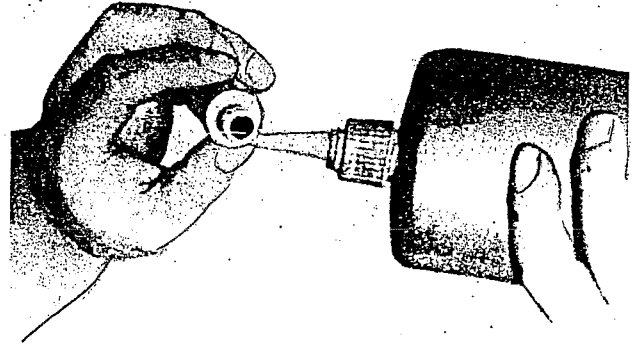


5. Install the valve rotating seat.

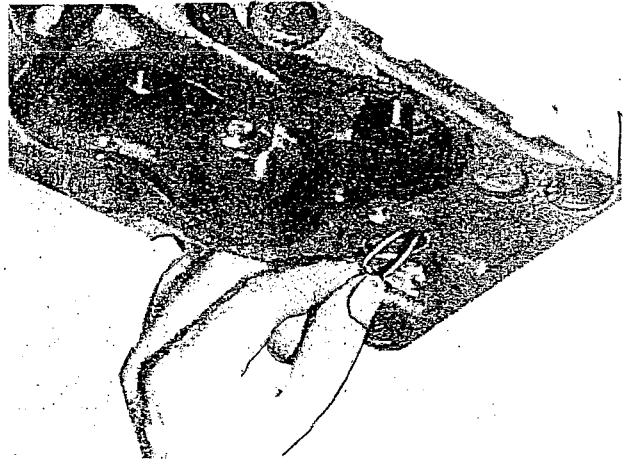


8. Install the inner and outer springs of the valve, and place the valve spring seat above the spring.



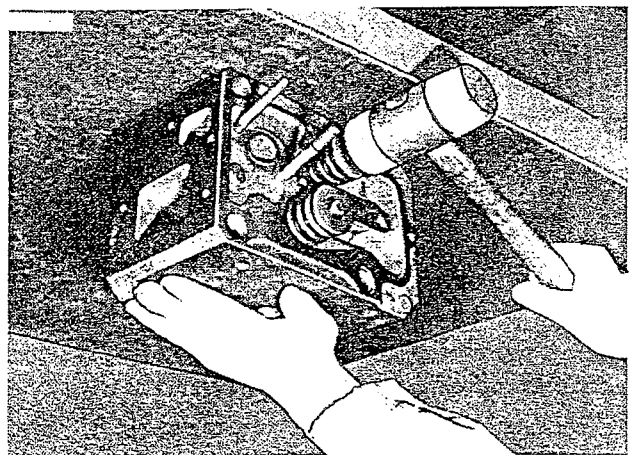


1. Install the fuel injector sleeve seal ring into the ring groove in the cylinder head.

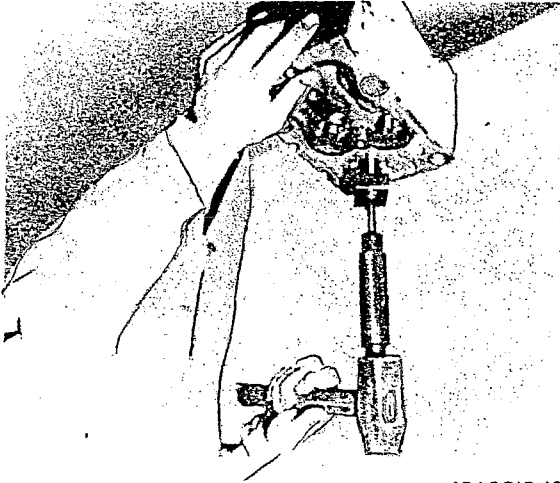


(IV) Installation of the Fuel Injector Sleeve

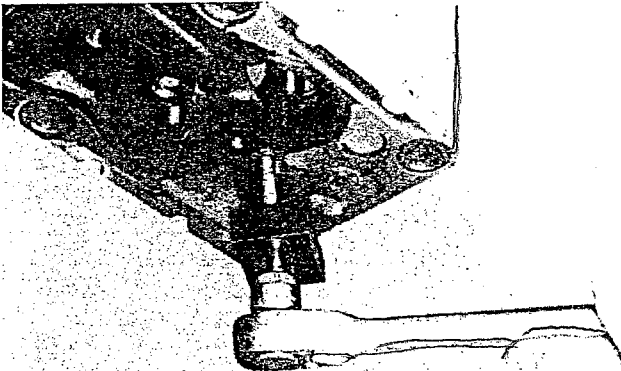
times to make the lock plate well secured. After installation, use a padded hammer and tap it several times to make the lock plate well secured. After properly assemble the spring and the valve seat, place the lock plate into the valve spring seat, and use a special tool to press down the valve spring.



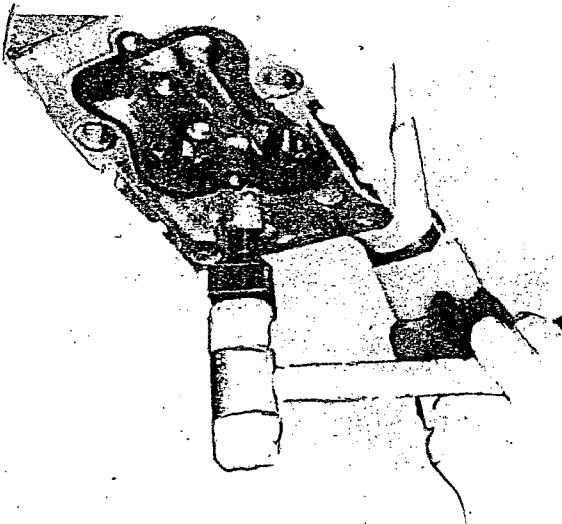
4. Insert a special support rod into the positioner, and use a padded hammer to drive in the support rod. The front end of the support rod will expand the head of the sleeve and firmly support on the cylinder head bore.



3. Tighten the hold-down bolt of the special positioner to 10Nm, allowing the positioner to press tightly on the injector sleeve.

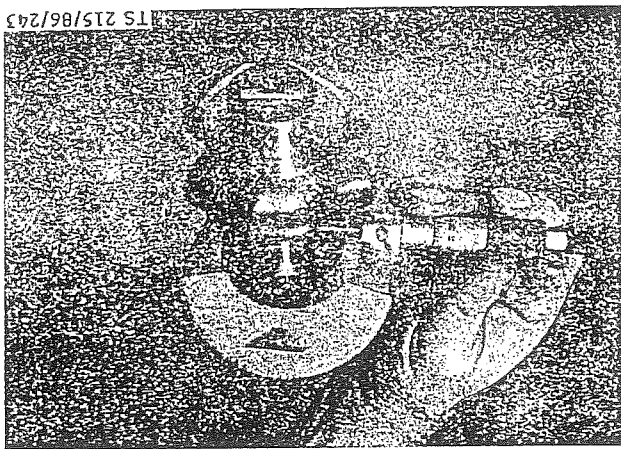


2. Apply some Loctite 620 sealant on the head of the fuel injector sleeve. Use a special positioner to drive the sleeve into the cylinder head seat bore.



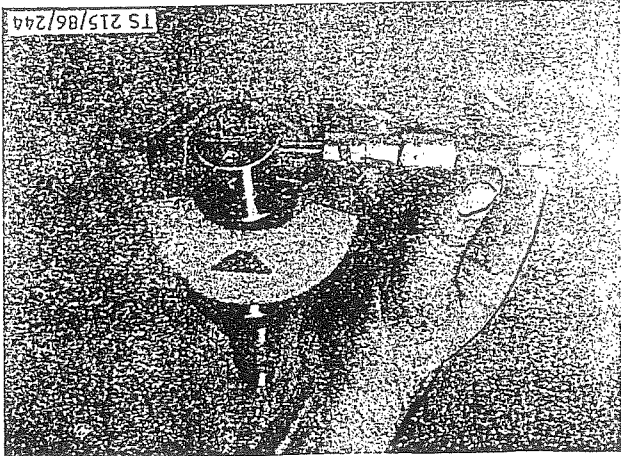
The bottom surface of the cylinder head is allowed to be ground twice. The amount of grinding each time is 0.5 mm. Max. amount of grinding is 1 mm. When the bottom surface of the cylinder head is ground, the thickness of the injector shim should be increased accordingly.

(V) Air Compressor



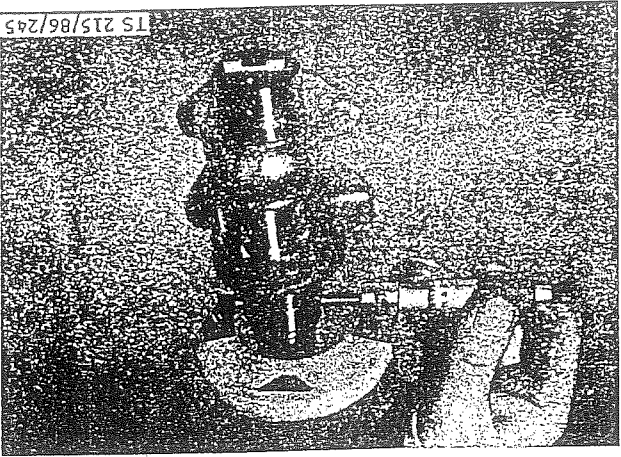
ITS 215/86/243

1. Measure the dimension of the crankshaft connecting rod journal and make a record.



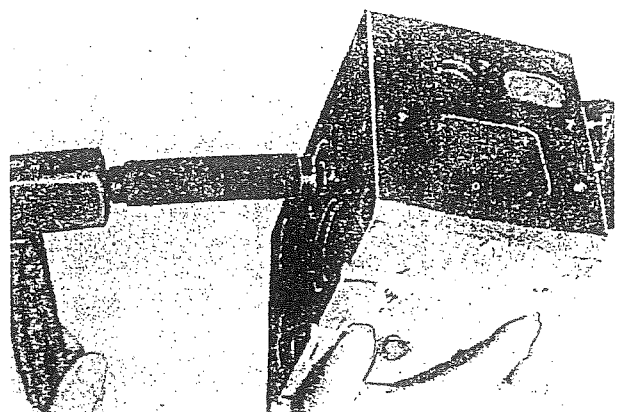
ITS 215/86/244

2. Measure the dimension of the crankshaft main journal and make a record.

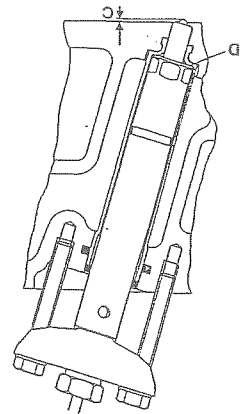
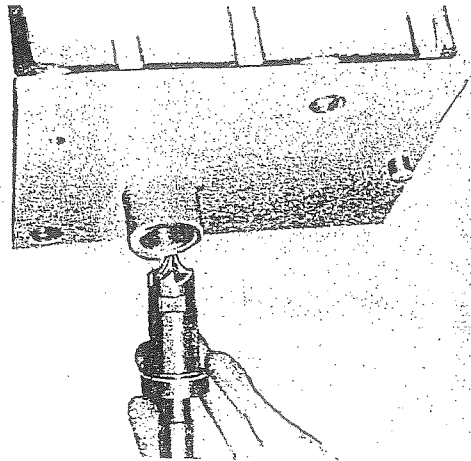


ITS 215/86/245

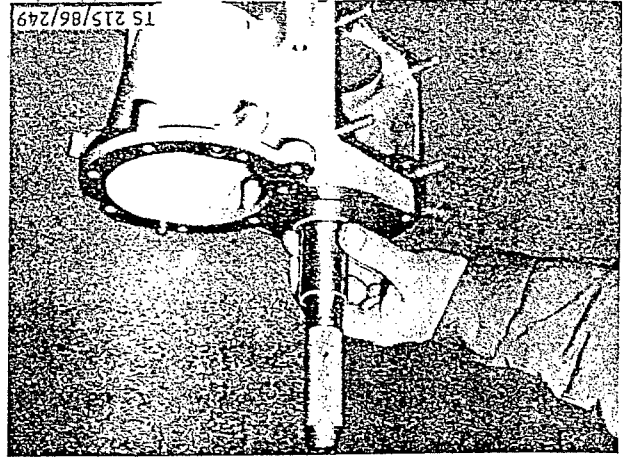
3. Measure the dimension of the input end main journal



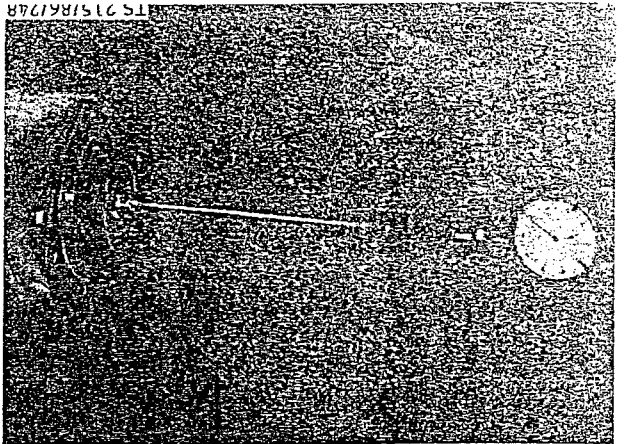
5. Using special reamer bracket and special reamer, ream the head of the sleeve flat. A drill can also be used to remove the protrusion of the sleeve head from the cylinder head surface.



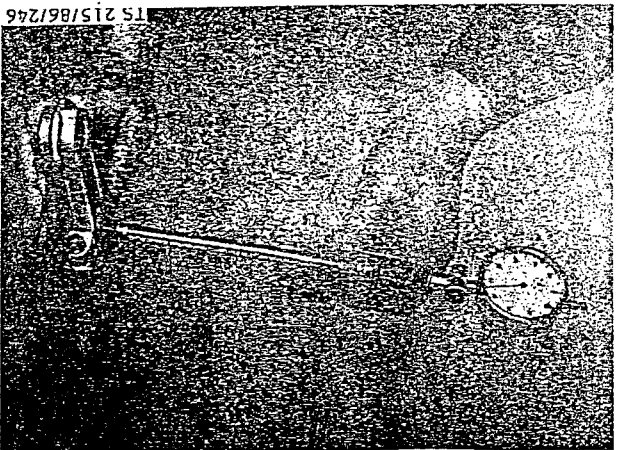
6. Install the fuel injector into the cylinder head, and choose copper shim D of proper thickness to make the protrusion A of the injector from the cylinder head surface within the specified limit.
C=3.2-4.0mm. The standard thickness of the injector shim is 1mm and 1.5mm.



5. Measure the inside diameter of the crankshaft bushing on the crankshaft axial head end cover and make a record. Make proper selection of the axial head and the journal of the crankshaft so that fit clearance between them is within 0.018 ~ 0.059mm.

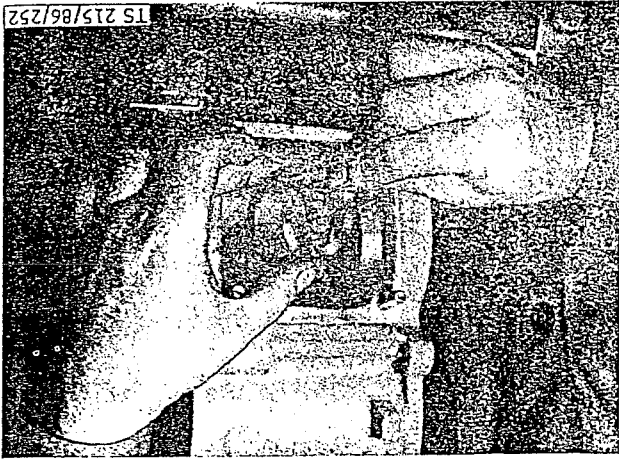


4. Measure the inside diameter of the connecting rod bearing shell and make a record. Make proper selection of the journal and bearing shell of the connecting rod so that their fit clearance between is within 0.018 ~ 0.059mm.

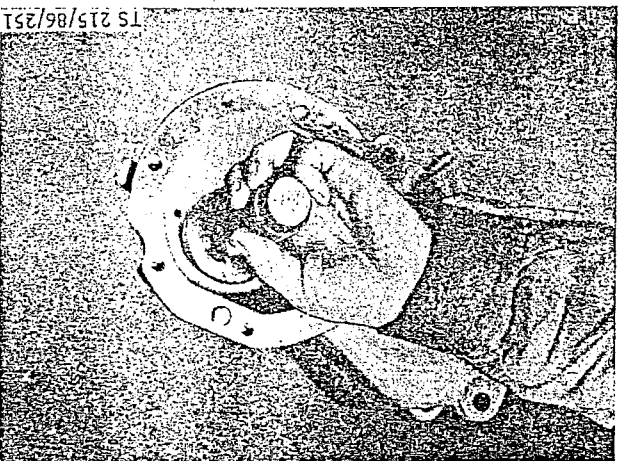


and make a record.

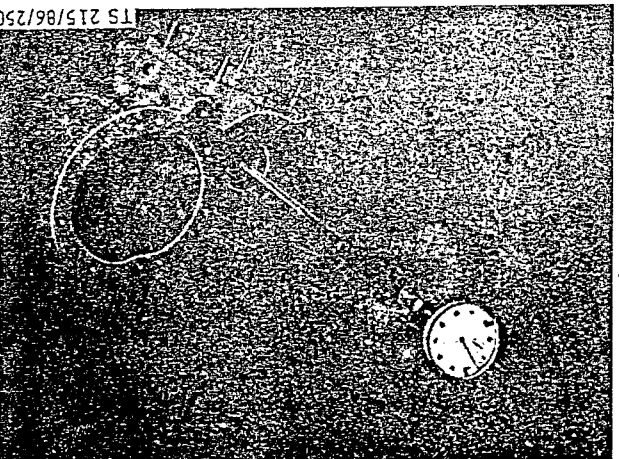
8. Install the axial clearance shim (thrust shim) of the input end.



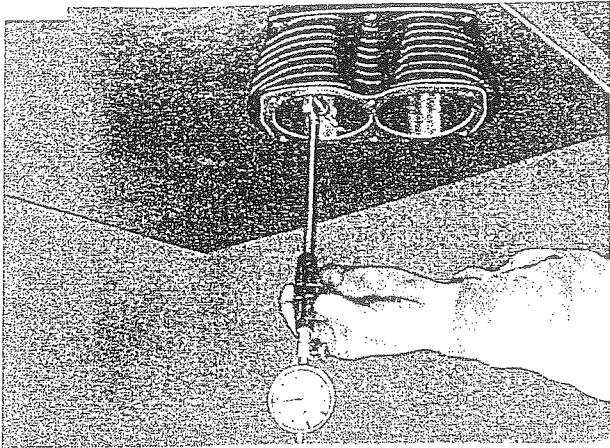
7. Install the oil seal of the air compressor into the fuel injection pump drive shaft hole.



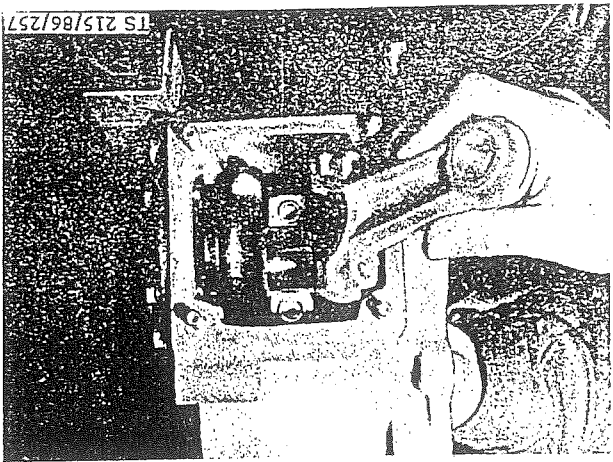
6. Press the crankshaft input end bushing into the crankcase, and measure the inside diameter of the bushing. The fit clearance between the bushing and the journal must comply with the requirement. Apply some engine oil on the inner wall of the bushing.



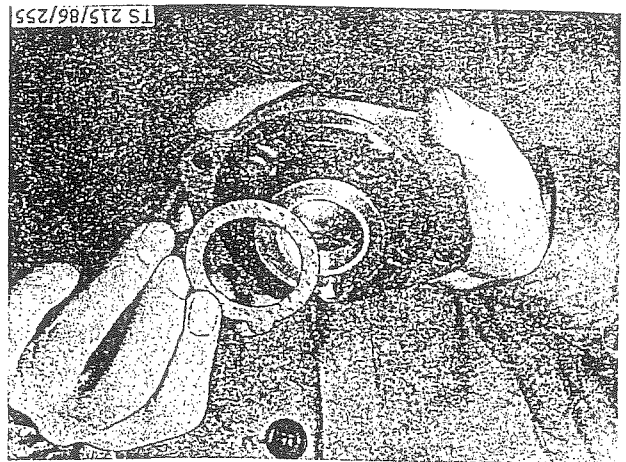
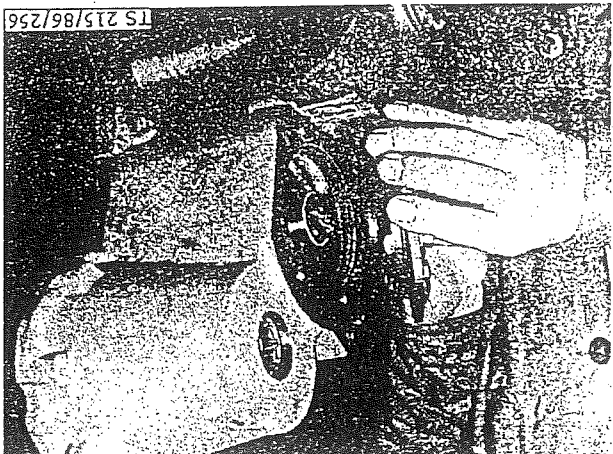
13. Measure the inside diameter of the air compressor cylinder sleeve and the outside diameter of the piston.



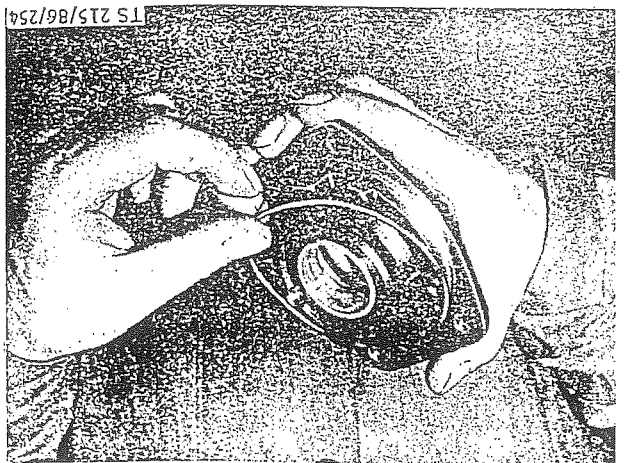
12. Install the connecting rod and the bearing shell on the crankshaft. The torque of the connecting rod bolt is 25Nm. (Apply some engine oil on the connecting rod bearing shell).



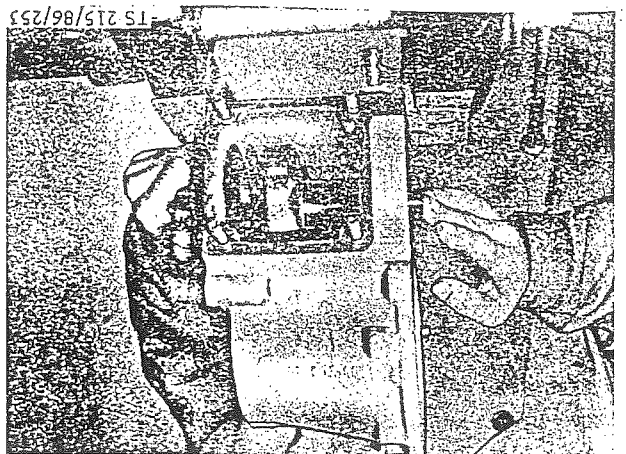
11. Install the axial head thrust shim on the axial head end cover, and then fit the axial head end cover on the crankcase. (Apply some engine oil in the shaft hole of the axial head end cover).

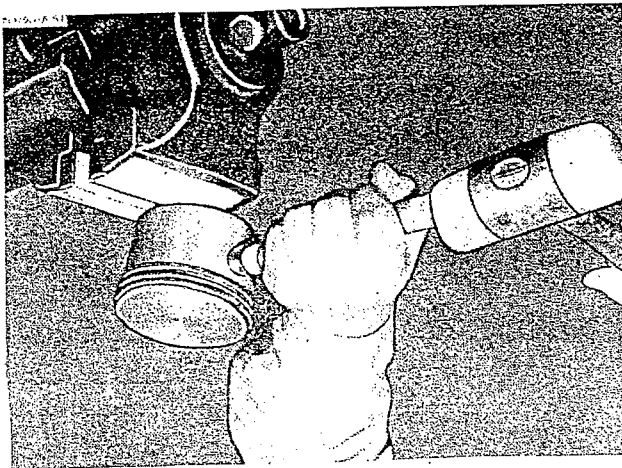


10. Install the O-ring into the axial head end cover.

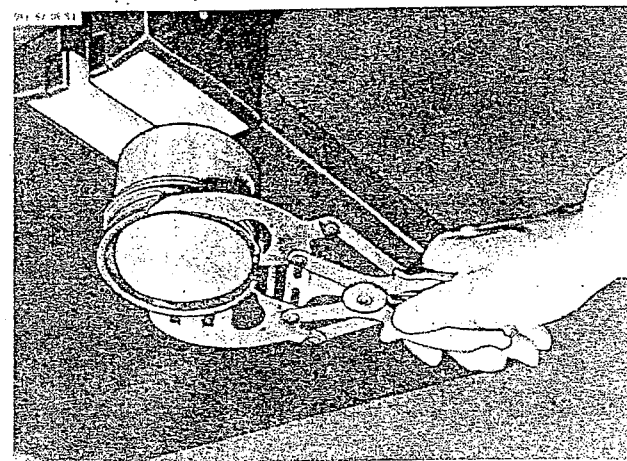


9. Install the crankshaft into the crankcase.

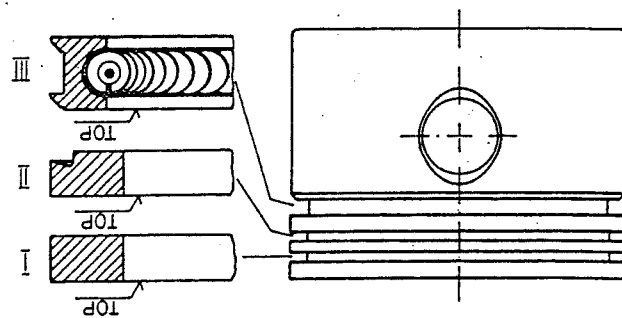




14. Using a pair of piston ring pliers, install the piston ring into the piston ring groove. The piston ring gaps will be offset each other by 120°.

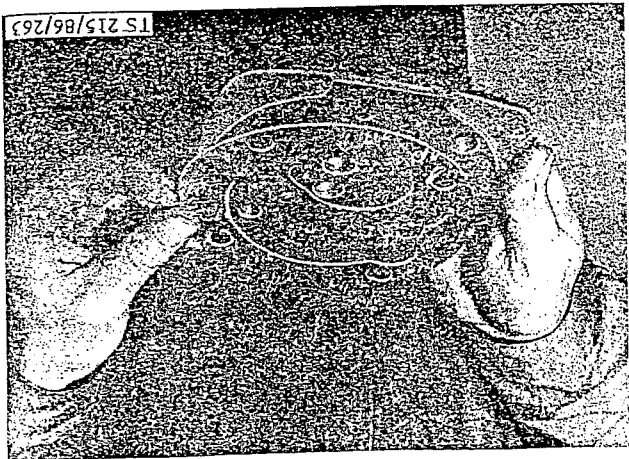


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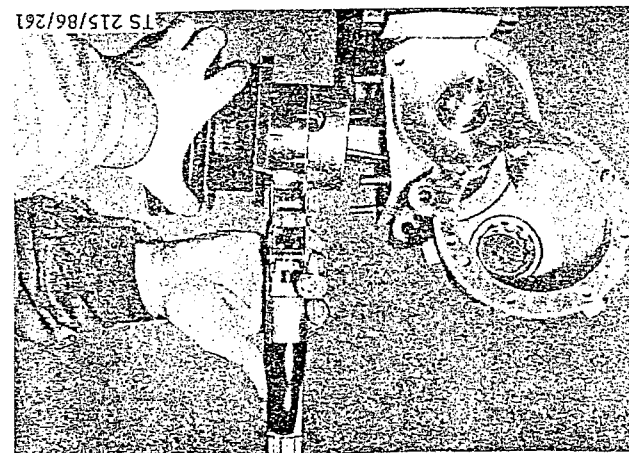


Choose proper piston and ensure that the fit clearance between the piston and the cylinder sleeve is within 0.105-0.115mm.

17. Install the valve body and the gasket into the upper end of the cylinder sleeve.

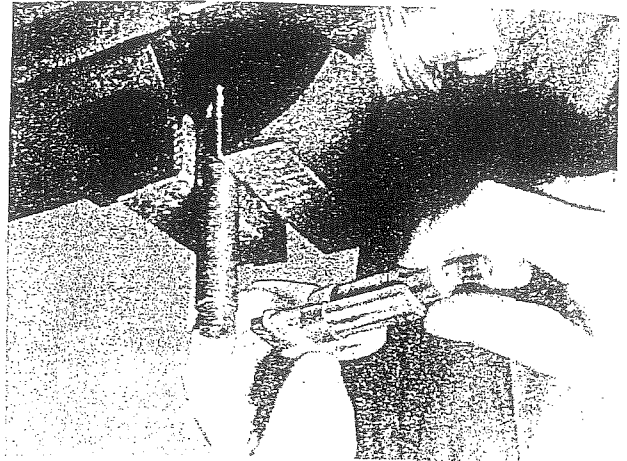


16. Using a special tool, install the cylinder sleeve into the piston, connect the cylinder sleeve fixing nut. (Apply some engine oil on the piston).



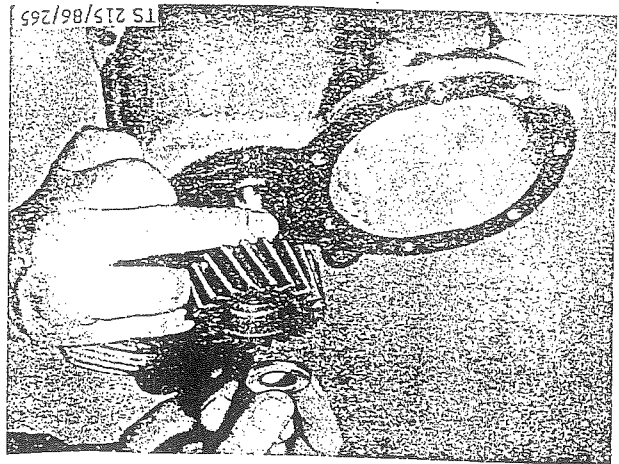
15. Connect the piston and the connecting rod, and fit the locating circlip. (Apply some engine oil on the piston pin hole and the inner wall of the connecting rod bushing).



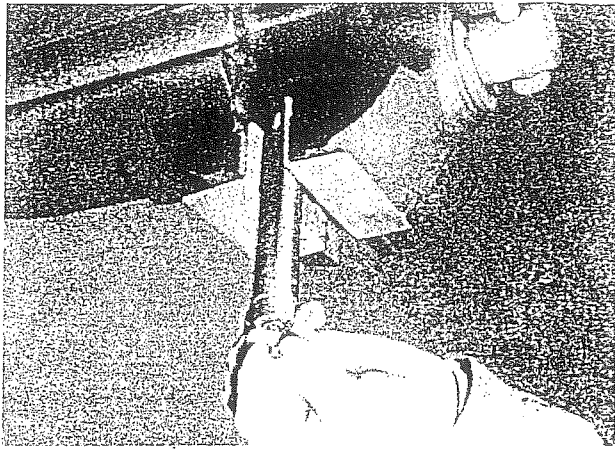
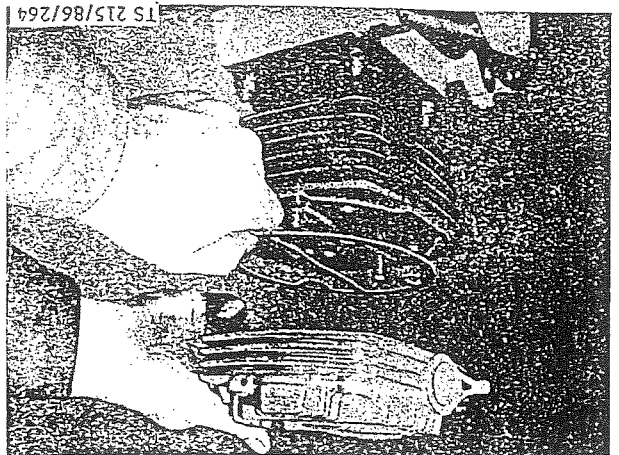


(VI) Fuel Injector

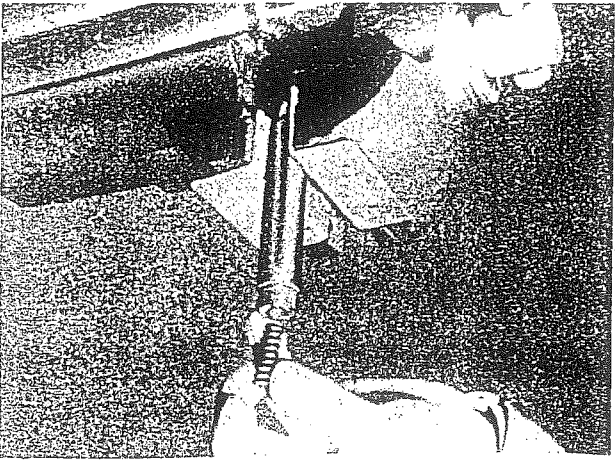
19. Install the drive gear on the crankshaft input end (the drive gear and the crankshaft are coupled with high-torque conical plane self-locking without use of keys). Apply Loctite 242 sealant on the thread and tighten the fixing nut to 200Nm.



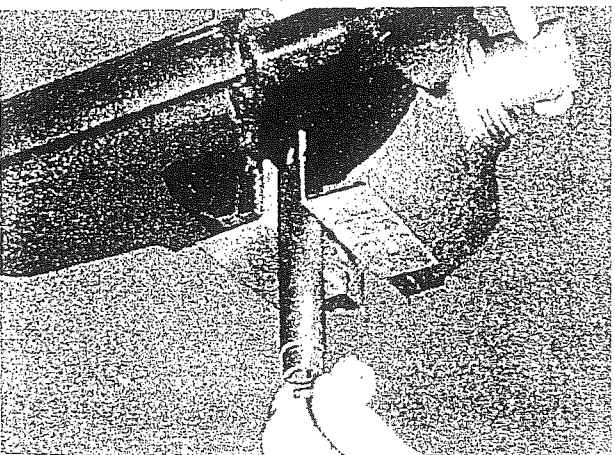
18. Install the cylinder head and the gasket on the cylinder block. Tighten the cylinder head bolt to 50 Nm.

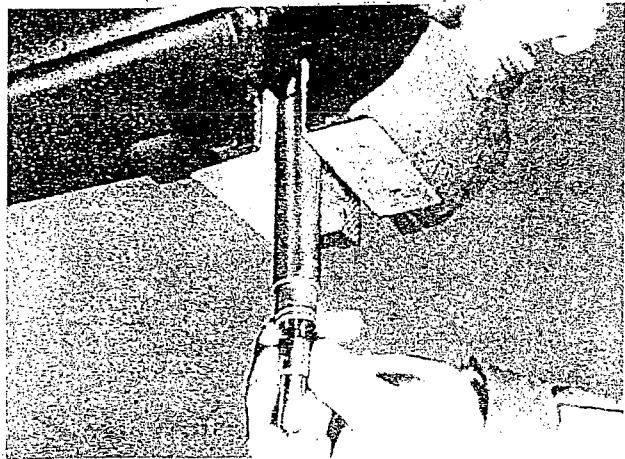


2. Install the fuel injector spring and the push rod.

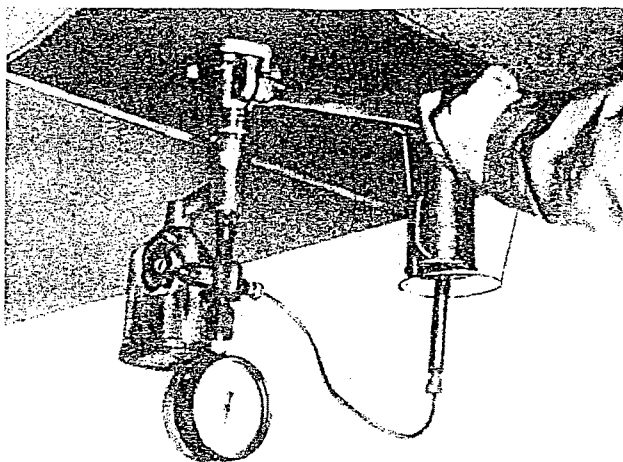
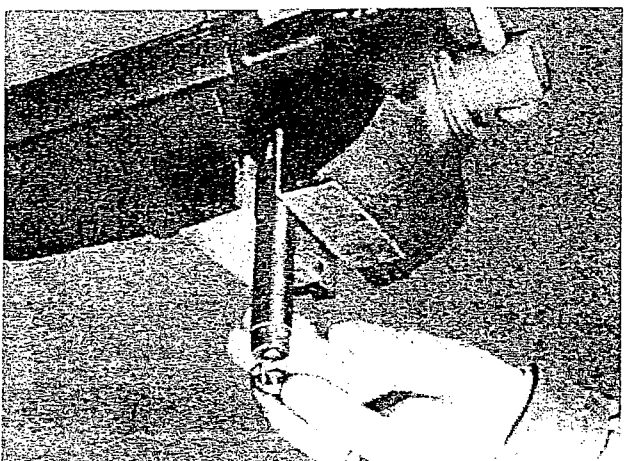
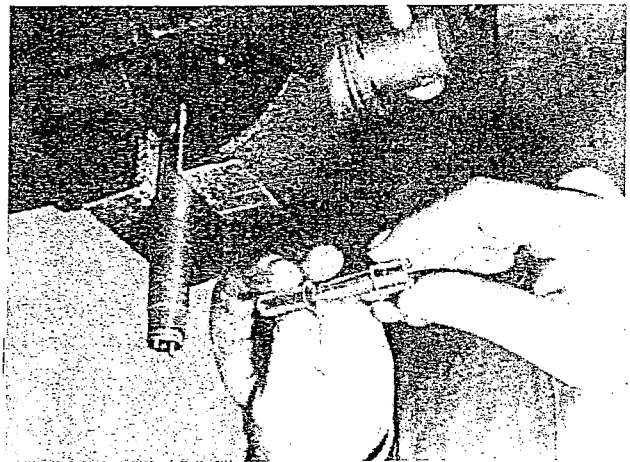


1. Install gasket of proper thickness into the fuel injector body.

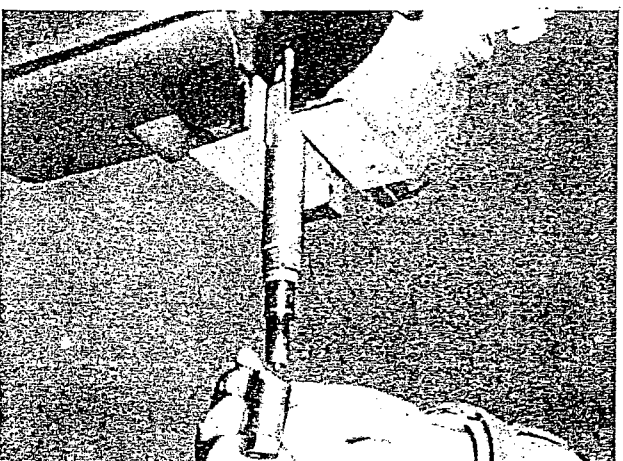




3. Install the hold-down plate into the injector body and the injection nozzle into the nozzle cage.



4. Install the injection nozzle into the injector body. Be careful with the direction of the locating pin. Then install the nozzle cap and screw it tight.



5. Check the opening pressure (3000Kpa) and fuel atomization of the fuel injector on the tester. If the fuel different thickness should be used.

SECTION 5 TIGHTENING TORQUE AND METHOD FOR MAIN BOLTS AND NUTS

For tightening torque of the main bolts and nuts of WD615 series engines, see Table 2-4, and for that of strengthening bolts, see Table 2-5.

Table 2-4 Tightening torque and Method for main bolts and nuts

Name of bolts	Tightening specifications		Torque after tightening	Extension (mm)	Times of use
	Tightening torque (Nm)	Angle of turn (degree)	Mini. torque (Nm)		
Main bearing bolt	250±25	2×90° ±5°	260	0.6~1.0	3
Cylinder head main bolt	200±10	2×90° ±5°	120	0.4~1.0	2
Cylinder head secondary bolt	90±10	2×90° ±5°	160	0.3±0.15	1
Connecting rod bolt	120	90° ±5°	170	0.2±0.1	2
Flywheel bolt	60±20	2×90° ±5°	230	0.1±0.15	2
Flywheel casing bolt	40±10	120±5°	110		
Oil pump idle gear shaft bolt	60±5				
Timing intermediate gear shaft bolt	180±20				
Cams shaft gear fixing bolt	32				
Exhaust pipe bolt	30±3	90°			
Rocker arm support	100±10				
Crankshaft pulley fixing bolt	60±5				
Injection pump fixing bolt	25	90°			

Note: All the thread support surfaces in the Table are working under the condition of lubrication.

For fit clearances and wear limits of the main parts of WD615 series engines, see Fig. 2-6.

SECTION 6 DIMENSIONS AND FIT CLEARANCES OF MAIN PARTS AND COMPONENTS

Surface state (μ total)		Zinc plating 0.125				Surface finish 0.14			
Strength grade	Original	6G	8G	10K	12K	6G	8G	10K	12K
	New W	6.9	8.9	10.9	12.9	6.9	8.9	10.9	12.9
Measuring dimensions		Metric common thread							
	M4	2.7		3.8	4.6	2.9		4.1	4.9
	M5	5.5		8	9.5	6.9		8.5	10
	M6	9.5		13	16	10		14	17
	M8	23		32	39	25		35	41
	M10	46		64	77	49		69	83
	M12	80		110	135	86		120	148.5
	M14	125		180	215	135		190	230
	M16	195		275	330	210		295	355
	M18	270		390	455	290		405	485
	M20	385		540	650	410		580	690
	M22	510		720	870	550		780	930
	M24	660		930	1100	710		1000	1200
	M27	980		1400	1650	1050		1500	1800
	M30	1350		1850	2250	1450		2000	2400
		Metric fine thread							
	M8 × 1	25	35	42		27	38	45	
	M10 × 1.25	49	68	82		52	73	88	
	M12 × 1.25	88	125	150		95	135	160	
	M12 × 1.5	83	115	140		90	125	150	
	M14 × 1.5	140	195	235		150	210	250	
	M16 × 1.5	210	295	350		225	315	380	
	M18 × 1.5	305	425	510		325	460	550	
	M20 × 1.5	425	600	720		460	640	770	
	M22 × 1.5	570	800	960		610	860	1050	
	M24 × 2	720	1000	1200		780	1100	1300	
	M27 × 2	1050	1500	1800		1150	1600	1950	
	M30 × 2	1450	2050	2500		1600	2250	2700	
μ total: refers to the total friction coefficient of the contact surface of the thread of bolt or nut.									
Caution: The tightening torque for bolts or nuts chrome plated or copper plated is lower than that of the bolts or nuts zinc 25%. The tightening torque of the selflocking nuts should be higher than the values given above.									
The tightening torque to screw the studbolt into the base material is half of the above value.									

Table 2-5 Tightening torque of general strengthening bolts (Nm)

Ser. No.	Name	Std. dimensions (hole/shaft)	Fitting nature	Clearance or interference	Wear limit
1	Main bearing shell and journal	$\Phi 100^{+0.095}_0 / \Phi 100^{+0.141}_0$	Clearance	0.095 ~ 0.161	0.17
2	Bearing seat and main bearing shell	$\Phi 108^{+0.022}_0 / \Phi 108^{+0.147}_0$	Interference	-0.103 ~ -0.147	
3	Thick. of main bearing shell	3.958 ~ 3.970	—		
4	Crankshaft and engine body locating pin	$46^{+0.05}_0 / 46^{-0.102}_{-0.205}$	Clearance	0.102 ~ 0.305	0.35
5	Connecting rod bearing shell and crank pin	$\Phi 82^{+0.105}_0 / \Phi 82^{+0.059}_{-0.02}$	Clearance	0.059 ~ 0.127	0.17
6	Crank pin and connecting rod big end	$46^{+0.1}_{-0.15} / 46^{+0.25}_{-0.25}$	Clearance	0.15 ~ 0.35	0.50
7	Connecting rod big end and bearing shell	$\Phi 88^{+0.022}_0 / \Phi 88^{+0.118}_{+0.105}$	Interference	-0.083 ~ -0.118	
8	Thick. of connecting rod bearing shell	2.97 ~ 2.979			
9	Connecting rod small end hole and bushing	$\Phi 55^{+0.3}_{+0.145} / \Phi 55^{+0.095}_{+0.145}$	Interference	-0.065 ~ -0.145	
10	Connecting rod bushing and piston pin	$\Phi 50^{+0.041}_0 / \Phi 50^{+0.025}_{-0.005}$	Clearance	0.025 ~ 0.046	0.10
11	Piston pin boss and piston pin	$\Phi 50^{+0.009}_0 / \Phi 50^{+0.003}_{-0.005}$	Clearance	0.003 ~ 0.013	0.025
12	Thickness of connecting rod bushing	2.75 ± 0.05	—		
13	Cylinder sleeve bore and piston skirt	$\Phi 126^{+0.025}_0 / \Phi 125.85$	Clearance	0.15	0.20
14	First gas ring gap value	0.40 ~ 0.60	—		1.5
15	Thickness of second gas ring and ring groove	$3^{-0.01}_{-0.022} / 3^{+0.06}_{+0.08}$			
16	Oil ring thickness and ring groove	$4^{+0.01}_{-0.25} / 4^{+0.06}_{+0.04}$	Clearance	0.05 ~ 0.085	0.26
17	Second gas ring gap value	0.25 ~ 0.40	—		1.5
18	Oil ring gap value	0.35 ~ 0.55	—		1.5
19	Engine body cylinder sleeve bore and cylinder sleeve	$\Phi 130^{+0.025}_0 / \Phi 134.5^{-0.01}_{+0.01}$	Interference	-0.01 ~ 0.033	0
20	Engine body opening and cylinder sleeve flange	$\Phi 134.5^{+0.10}_0 / \Phi 134.5^{-0.12}_{+0.10}$	Clearance	0 ~ 0.22	
21	Camshaft hole and bushing	$\Phi 65^{+0.030}_{+0.107} / \Phi 65^{+0.087}_{+0.107}$	Interference	-0.057 ~ -0.107	
22	Tappet hole and lifter	$\Phi 38^{+0.039}_0 / \Phi 38^{+0.050}_{-0.025}$	Clearance	0.025 ~ 0.089	0.15
23	Camshaft bearing and journal	$\Phi 60^{+0.06}_{-0.03} / \Phi 60^{+0.01}_{-0.06}$	Clearance	0.04 ~ 0.12	0.20
24	Valve guide and intake valve stem	$\Phi 12^{+0.018}_{-0.05} / \Phi 12^{-0.068}_{-0.05}$	Clearance	0.05 ~ -0.086	0.20
25	Valve guide and exhaust valve stem	$\Phi 12^{+0.030}_{+0.085} / \Phi 12^{-0.068}_{-0.05}$	Clearance	0.05 ~ 0.086	0.20
26	Cylinder head valve seat hole and intake valve seat	$\Phi 56^{+0.030}_{+0.085} / \Phi 56^{+0.066}_{+0.085}$	Interference	-0.036 ~ -0.085	
27	Cylinder head valve seat hole and exhaust valve seat	$\Phi 56^{+0.030}_{+0.085} / \Phi 56^{+0.066}_{+0.085}$	Interference	-0.036 ~ -0.085	
28	Intake valve sinkage	1.2 ~ 1.4	—		1.8
29	Exhaust valve sinkage	1.2	—		1.8
30	Rocker arm shaft hole and shaft	$\Phi 24^{-0.007}_{-0.040} / \Phi 24^{-0.073}_{-0.040}$	Clearance	0.012 ~ 0.066	
31	Oil pump gear and shaft	$\Phi 28^{-0.061}_{-0.041} / \Phi 28^{-0.013}_0$	Clearance	-0.028 ~ -0.061	
32	Oil pump end cover shaft hole and shaft	$\Phi 28^{+0.040}_{+0.075} / \Phi 28^{-0.013}_0$	Clearance	0.040 ~ 0.086	0.10

Table 2-6 Main fitting dimensions and clearances of WD615 series engines

Type of sealant	Parts with sealant applied
Locite 242 Action: anti-loosing	Timing gear housing bolt Tachometer coupling bolt Camshaft thrust shim bolt Intermediate gear shaft sleeve bolt Water pump impeller Water pump roller bearing seat Tensioning wheel bolt Filter seat bolt Oil cooler bolt Injection pump coupling bolt Intake pipe screw plug Air compressor bolt and nut Air compressor drive gear nut Intermediate gear shaft bolt
Locite 262 (red) anti-loosing	Cylinder head studbolt

Table 2-6 Application of sealant during assembly of WD615 series engines

SECTION 7 APPLICATION OF SEALANT DURING ENGINE ASSEMBLY

Ser. No.	Name	Std. dimensions (hole/shaft)	Fitting nature	Clearance or interference limit
33	Oil pump casing width and gear	$40^{+0.027}_{-0.050} / 40^{+0.002}_{-0.075}$	Clearance	0.052 ~ 0.102
34	Oil pump gear side clearance	0.098 ~ 0.16	—	
35	Water pump impeller and water pump shaft	M18 × 1.5		
36	Water pump belt pulley and water pump shaft	$\Phi 30^{+0.031}_{-0.044} / \Phi 30^{+0.015}_{-0.002}$	Interference	-0.033 ~ -0.059
37	Air compressor cylinder bore hole and piston	$\Phi 90^{+0.02}_{-0.09} / \Phi 90^{+0.01}_{-0.1}$	Clearance	-0.09 ~ 0.12
38	Air compressor piston ring groove and ring thickness	$2.5^{+0.039}_{-0.012} / 2.5^{+0.014}_{-0.012}$ $4^{+0.05}_{-0.02} / 4^{+0.02}_{-0.02}$	Clearance	0.014 ~ 0.059 0.02 ~ 0.07
39	Air compressor first piston ring gap value	0.25 ~ 0.40	—	1.5
40	Air compressor second piston ring gap value	0.25 ~ 0.40	—	1.5
41	Air compressor oil ring gap value	0.25 ~ 0.40	—	1.5
42	Air compressor axial clearance	0.10	—	0.25
43	Supercharger axial clearance K-28	0.16 (max)	—	0.16
44	Supercharger radial clearance K-28	0.46 (max)	—	
45	Air compressor connecting rod small end and piston pin	$\Phi 20^{+0.021}_{-0.007} / \Phi 20^{+0.013}_{-0.007}$	Clearance	0.007 ~ 0.041
46	Air compressor Connecting rod bearing shell and crank pin	$\Phi 35^{+0.005}_{-0.025} / \Phi 35^{+0.005}_{-0.041}$	Clearance	0.025 ~ 0.046
47	Air compressor piston and piston pin.	$\Phi 20^{+0.013}_{-0.007} / \Phi 20^{+0.013}_{-0.007}$	Clearance	0.007 ~ 0.033

Valve clearance can be checked and adjusted cylinder by cylinder or by the "method of two-step adjustment". The cylinder-by-cylinder adjustment is to rotate each cylinder to its top dead center, and adjust the intake and exhaust valves at the same time. The procedure is: rotate the flywheel in the direction of engine operation until when No.6 cylinder exhaust valve is fully closed and the intake valve just begins to open, adjust the clearance of the intake and exhaust valves of the first cylinder. As for a 6-cylinder diesel engine working in the sequence of cylinders 1-5-3-6-2-4, cylinders can be adjusted in pairs of cylinders 1 and 6, 2 and 5, and 3 and 4 using the

2. Check and adjustment of valve clearance

of the diesel engine can be guaranteed.

There are timing mark lines only on the camshaft gear and the timing gear housing. As long as the engine is rotated to the top dead center of the first cylinder (the first cylinder top dead center flywheel mark line "OT" is aligned with the mark line on the flywheel casing, and all of the intake and exhaust valves of the first cylinder are closed), and the mark line on the camshaft gear is aligned with the mark line on the timing gear housing, so that the valve timing

1. Check and adjustment of valve timing

SECTION 8 INSPECTION AND ADJUSTMENT OF MAIN MECHANISMS OF ENGINE

Parts with sealant applied	Locite 271 (red) anti-loosing	Main oil passage pressure-limiting valve and oil cooler bypass valve
Oil-gas separator elbow	Locite 609 (green) fastening	Warm air water inlet/outlet pipe unions
Bearing, oil pump drive shaft, intermediate gear	Locite 680 (green) fastening	Supercharger oil return pipe union
Cylinder head injection nozzle copper sleeve	Type of sealant	Parts with sealant applied
Supercharger lubricating pipe coupling bolt	Locite 569 (white) sealing	Oil pump lubricating pipe
Cylinder block and crankcase mating surface	Locite 510 (red) sealing	Engine body end surface
Air compressor and timing gear housing mating surface	504 (orange) synthetic rubber sealant/silicon resin sealant	Filter seat and crankcase mating surface
Air compressor rear oil seal	Anti-Size	Supercharger oil inlet flange
Exhaust pipe bolt, supercharger bolt	Molybdenum disulfide lubrication	Cylinder sleeve and engine block
Valve guide and cylinder head		Valve stem and guide

above adjusting method.

The two-step adjusting method is to put the No. 1 cylinder to its top dead center (No. 6 cylinder intake valve "nodes"), and adjust both intake and exhaust valves of cylinders 1, the exhaust valves of cylinders 5 and 3, and the intake valve of cylinder 4 and 2. Then rotate the flywheel by one full revolution, and adjust all the remaining valves.

3. Adjustment of fuel injection timing of the complete engine

First rotate the engine to the top dead center of the No. 1 cylinder. As for an engine with timing mark lines on the injection pump timing device and the pump casing, rotate the flywheel in the direction of the engine rotation to align the timing mark lines, and then observe the fuel injection advance angle through the viewing window in the flywheel casing and make sure it is satisfactory. If it is necessary to make any adjustment, rotate the flywheel in the opposite direction of engine rotation, and then rotate the flywheel slowly in the normal rotating direction until the fuel injection advance angle mark line is aligned with the flywheel mark line. Upon the completion of the adjustment, tighten and lock the drive flange fastening bolts to their specified torque. As the injection pump gear and the drive shaft are coupled by means of tapered hole and tapered shaft without the use of any keys, the injection timing can be adjusted steplessly by loosening the drive gear fastening nuts. Similarly, upon the completion of the adjustment, tighten and lock the nuts to their specified torque.

If there are no timing mark lines on the injection pump body and the timing device, the adjustment can be made by the "observation". That is, remove the No. 1 cylinder high-pressure pipe union from the injection pump, and lower the fuel level in the outlet pipe union of No. 1 cylinder by blowing. Manually set the injection pump load control lever (throttle lever) at the full-load (max. fuel supply) position. Rotate the flywheel in the same way as mentioned above, and observe the fuel level in the outlet pipe union of No. 1 cylinder. When the fuel level begins to rise, stop the flywheel immediately, and observe the flywheel mark line and make sure it complies with the requirement of the fuel injection advance angle. If it is necessary, conduct the adjustment in the same way as mentioned above. When using this method, it is better to rotate the flywheel intermittently, so as to make the fuel level at the start of injection pulsate distinctly. When check is repeated, care must be taken to first rotate the flywheel in the opposite direction by a given angle, and then rotate it in the normal rotating direction of the engine, so as to eliminate the erroneous effect of the side play of the timing gear on timing and guarantee the accuracy of injection timing.

4. Check and tester adjustment of fuel injection system

(1) Check and adjustment of fuel supply pump:

WD615 series diesel engines use piston-type fuel supply pump with manual fuel pump. The fuel supply pump is directly mounted on the casing of the fuel injection pump and its piston is driven by the fuel injection pump to move reciprocally to supply fuel.

The fuel supply pump needs the following checks:

- 1) Piston check. Check if the reciprocating movement of the fuel supply piston is flexible and free from jamming.
- 2) The check of manual fuel pump. When the screw rod of the manual fuel pump is loosened, the manual fuel pump rod will be pushed up under the action of the spring. If it fails to move up, it indicates that the manual fuel pump piston is jammed.
- 3) One-way tightness test. Check if the check valve is tightly sealed.

If the valve plug is not well sealed, apply some fine lapping compound on the valve plug and lap it on a flat glass surface repeatedly.

To check the fuel supply pump on the tester, the following requirement must be met:

- 1) With the rotating speed of the pump less than 700 rpm and the fuel outlet passage of fuel pump fully closed, the max. fuel supply pressure must not be lower than 3.5 Bar.
- 2) When the negative suction pressure of the fuel supply pump is not lower than 0.12 Bar (the fuel supply pump is 1 meter above the fuel tank), the inner diameter of the fuel inlet pipeline is 10 mm, the length of the fuel inlet pipeline is 2 m, and the fuel supply pressure is 1.5 Bar, the displacement of the fuel supply pump must not be lower than the following:

Before the fuel injector is disassembled for checking, it should be cleaned carefully to remove any exterior dirt and impurities so as to avoid scratching various precision mating surfaces of the injector during disassembly and reassembly. Pull out the needle valve out of the fuel injection nozzle, use a brush to clean the head of the needle valve in cleaning oil, and remove any carbon deposit from the head of the needle valve by a piece of wood stick. Use the brush to clean the hole of the needle valve in the valve seat. Use a special scraper to remove any carbon deposit from the inside of the needle valve. The stem of the special scraper must mate with the needle valve precisely so as to avoid scratching the mating surface of the valve seat bore when removing the carbon deposit. Use special steel cleaning needle to clean the spray orifice of the fuel injection nozzle.

The diameter of the steel needle should usually be 0.02-0.03 mm smaller than that of the spray orifice. In order not to damage the spray orifice, use thinner steel needle first and gradually increase the diameter of the needles. For

(4) Check and adjustment of the fuel injector

When the smoke limiter is tested on the tester, the air pressure should be gradually reduced from the maximum (0.7 Bar) to zero. The air pressure when it starts to function should be 0.50-0.60 Bar, and that when it stop functioning is 0.30-0.25 Bar.

Air pressure (Bar)	Lever travel (mm)
0.7	12.4-12.6
0.42	11.5-11.6
0.33	10.2-10.4
0	9.8-10.0

must conform to the following standards:

For example, the smoke limiter of the Bosch pump of WD615-67 engine tested on the fuel injection pump tester

pressure under a certain condition of the pump rotation.

(3) Check and adjustment of smoke limiter

In case of nonconformance, correction can be made by adjusting the spring shim or replacing the timing spring.

Pump rotating speed (rpm)	Advance angle (cam angle - degree)
Start to function 700 ± 50	0
800	1
900	2
1000	3
1100	4
1200	5

following standards:

result (obtained on the tester) of the timing device of the Bosch pump of WD615-67 engine should conform to the lubricated, the timing device should be character checked on the fuel injection pump tester. For example, the test curvature of the flyweight. If they are worn seriously, replacement must be made. After being assembled and shaft of the flyweight frame and the pinhole of the flyweight, and that of the spring pin on the flange and the For the fuel pump with the timing device, after the timing device is removed, check the wearing condition of the

(2) Check and adjustment of the timing device

pump at a speed of 80-100 cycles per minute, fuel should come out of the fuel outlet port within 30 seconds.

(3) With the fuel supply pump 1 m positioned above the fuel tank, the inner diameter of the fuel inlet pipeline being 10 mm, the length of the fuel inlet pipeline being 2 m, and the fuel supply passage fully open, crank the manual fuel

Pump rotating speed (rpm)	Displacement (l/m)
300	0.7
700	1.8
1200	2.0

example, to clean the spray orifice in 0.35 mm diameter, use a steel needle in 0.30 mm diameter first. Then use steel needle in 0.32 mm diameter. If the steel needle in 0.35 mm diameter is used, particular care must be taken. To clean the orifice, insert the steel needle into the orifice and rotate the needle back and forth. After cleaning by steel needles, use clean kerosene to wash and blow off any dirt out of the orifice with compressed air. Lubricate the fuel injection nozzle with light diesel fuel and rotate the needle valve back and forth repeatedly. Position the fuel injection nozzle upright, pull up the needle valve by one third, then release it, and check if the needle valve may fall to its seating position slowly and smoothly by its own weight. If it fails to do so, apply a small amount of high-grade lubricating oil with low viscosity on the needle valve and the valve seat bore in the fuel injection nozzle, and insert the needle valve into the hole in the injection nozzle and rotate it reciprocally to make it meet the requirement of smoothness.

Check the tightness of the needle valve and injection nozzle conical surface. If serious wear is found, you can smear a little precision aluminum oxide lapping compound (paste) on the conical surface of the needle valve and lap it against the injection nozzle valve seat. After lapping, wash it clean with clean kerosene. While lapping, care must be taken to avoid lapping compound getting onto the precision mating surfaces of the needle valve stem and the injection nozzle.

Check if there is any damage on the contacting surfaces between the injection nozzle seat and the fuel injector body, any rust and crack on the fuel injector spring, any sign of offset wear on the needle valve and inside the valve hole in the injection nozzle, and any serious wear on the contacting surfaces between the needle valve and the push rod and the contacting surfaces between the spring and the push rod. Replace if any damage or serious wear is found. Check the wear of the locating pin of the fuel injection nozzle.

When reassembling the fuel injector assembly, the following precautions should be taken:

1) Tighten the fuel injection nozzle cap to its specified torque, otherwise, it would result in poor atomization of the fuel injected.

2) When replacing new fuel injection nozzle matching parts, soak and clean the new matching parts in clean kerosene, and move the needle valve inside the injection nozzle reciprocally, so as to get the preserving oil out of the injection nozzle completely.

Upon the completion of all checks and reassembly, the following tests must be made:

1) Check and adjust the fuel injection pressure: set the fuel injector on the tester. Manually depress the handle of the tester for several times to remove the air inside the fuel pipeline, and flush again the inside of the fuel injector. Then manually depress the handle of the tester, and observe if the pressure of fuel injection is within the range of 300000+800kPa. If not, adjustment is needed. As for fuel injector of Type-A engine (as shown in Fig. 2-43A), the fuel injection pressure is adjusted by replacing spring shims of different thickness. And as for fuel injector of Type-B engine (as shown in Fig. 2-43B), the fuel injection pressure is adjusted by adjusting the fuel injection pressure adjusting screw. Upon the completion of the adjustment of fuel injection pressure, tighten the fuel injector locking nut, and then check again the initial pressure of the fuel injection. If unsatisfactory, readjust.

Plunger sliding test: as shown in Fig. 2-45, hold the plunger matching parts soaked with kerosene at an angle of 60° and the groove edge of the plunger, the plunger is cracked or deformed, or the plunger sleeve is cracked, the plunger matching parts must be replaced.

Exterior check: wash the plunger and its sleeve in clean kerosene or light diesel fuel, and check the mating surface of the plunger and its sleeve, especially the upper part and guiding portion of the plunger. If it is found that the surface of the plunger is seriously discolored (the worn surface is usually whitish), there is rust in the spiral groove or at the groove edge of the plunger, the plunger is cracked or deformed, or the plunger sleeve is cracked, the plunger matching parts must be replaced.

power performance of the diesel engine. So, the following checks must be made on the plunger matching parts: different fuel supply into various cylinders. Therefore, the wear of the plunger matching parts directly affects the unstable idle and flameout. When the wear of the plungers of various branch pumps is uneven, it would result in amount of fuel supply, lower the power of the diesel engine, and result in such faults as the difficulty in starting, the fuel injection starting time, advance the fuel supply terminating time, and at the same time, decrease the pump, wearing and scratching the plunger matching parts. The wearing of the plunger matching parts may delay there is a filter in the fuel system, it is unavoidable that some fine impurities would enter into the fuel injection The plunger and its sleeve are of precision matching parts with a fitting clearance of 0.001~0.003mm. Although

1) The check of the plunger matching parts.

After being disassembled, the injection pump should be checked systematically as follows:

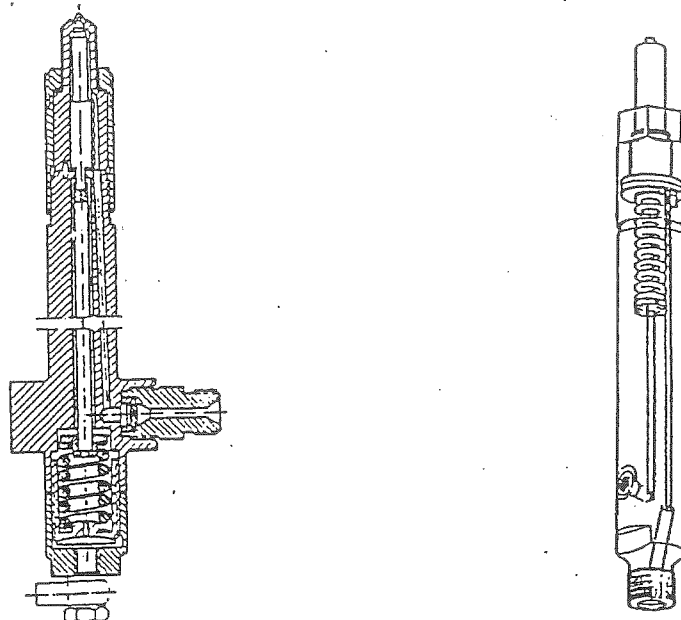
(5) The check of fuel injection pump.

indicates that the air tightness complies with the requirements.

time (usually 2 ~ 3s). If the fuel injector head does not leak fuel and there is no obvious drop in the pressure, it increase the pressure to 200 ~ 215 Bars (10 ~ 20 Bars lower than the nozzle opening pressure, and maintain some 3) The check of the tightness of the fuel injection nozzle. Actuate the handle of the fuel injector tester to slowly should be no fuel dripping from the fuel injector head or any fuel drops suspending from the fuel injector head.

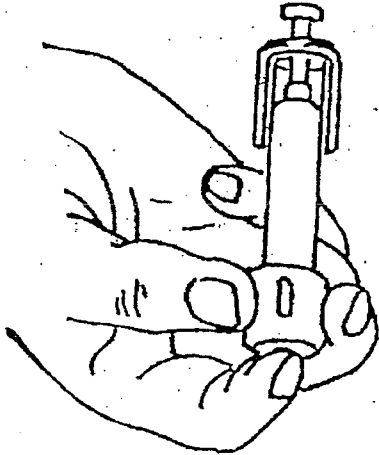
unsatisfactory. When the injection begins and terminates, there should be clear sound. After fuel injection, there fuel columns and any signs of unevenness of fuel spray density. Fuel beams in Details 1-5 in Fig. 2-44 are all mist, the mist beams sprayed from various orifices should be the same and uniform, and there should not be any observe the state of the fuel spray. The fuel should be sprayed in fine mist, there should be no large particles in fuel repeatedly the handle of the fuel injector tester in the maximum travel at the speed of 40-80 cycles per minute, and 2) Check of the spray status. It is advisable to use a stroboscope to check the state of the spray. Actuate

Fig. 2-43 Type-A Bosch fuel injector



Tightness test: as shown in Fig. 2-46, block the bottom port of the delivery valve with one of your fingers, press the valve plug downward, and then release it. If the valve plug automatically springs up, it means that the tightness

Fig. 2-46 Plunger tightness test



Sliding test: Set the delivery valve upright, pull up the valve by one third of its height, and release it, the valve should be able to slowly fall to its seating position by its own weight. Rotate the delivery valve to different position and repeat the above test. If there is sign of jamming, lap the delivery valve and its seat in pairs. However, be sure to apply the lapping compound on the guide rod, not up to the pressure reducing ring, and do not insert the pressure reducing ring into the valve seat for lapping.

Extorior check: Wash the fuel delivery valve in clean kerosene or light diesel fuel, and visually or by using a magnifying glass inspect the conical face of the fuel delivery valve. If it is found that the pressure-reducing ring is seriously worn (i.e. there is a clear and comparatively wider or deeper whitish wearing sign on the conical face of the fuel delivery valve), or there is obvious longitudinal scratches on the pressure reducing ring, then the delivery valve must be replaced. And at the same time, observe if there is any cracks or rust on the fuel delivery valve and its seat.

2) The check of the fuel delivery valve

The delivery valve has two pairs of contacting surfaces: one is for the precision matching and sealing of the pressure reducing ring and the valve seat bore. When the delivery valve is seriously worn, the sealing between the pressure reducing ring or the conical face would fail, which would lead to afterburning and fuel dripping, resulting in deterioration in burning and white smoke emission, and decrease of the engine power. When the problem is serious, piston knocking might occur. Therefore, the tightness of the fuel delivery valve must be checked.

The tightness check of the plunger matching parts: as shown in Fig. 2-46, block the upper port of the plunger by using your index finger to put the plunger at the position of its medium or maximum supply, and pull the plunger downwards (do not pull the plunger to block the fuel inlet hole). If your index finger can feel a force of suction, and when release the plunger, the plunger is able to return to its original position. It shows that the plunger complies to the requirements.

Fig. 2-44 Fuel atomization test

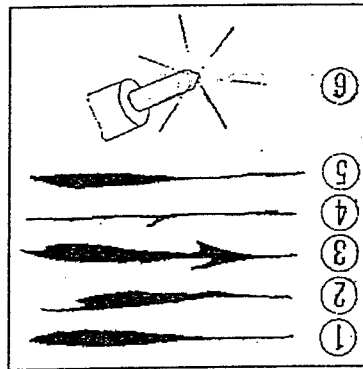
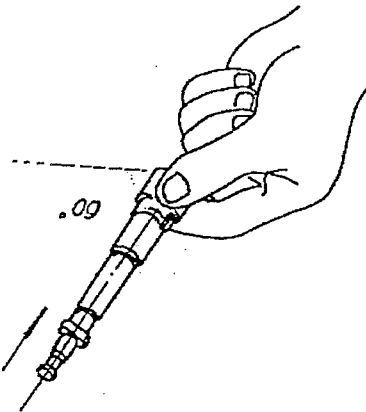


Fig. 2-45 Plunger sliding test



°, and pull the plunger out of its sleeve by two thirds, and when the plunger is released, the plunger should be able to slide into its sleeve by its own weight. Rotate the plunger to different position and repeat the above checks. If there is any jamming at some local position, apply some lapping compound on the plunger, insert the plunger into its sleeve, and lap the both the plunger and its sleeve in pairs. Lap them in reciprocal motion while rotating the plunger at the same time.

1) Preparation before test and adjustment.

Test conditions	Pump rotating speed (rpm)	Boost pressure (Bar)	Gear rack travel (mm)	Fuel supply (mm ³ /time)	Permitted difference between various cylinders (mm ³ /time)	Remarks
Test fuel: ISO4113 Fuel temp.: 40±5°C Fuel injector pressure: 172 -175 Bars Fuel supply pressure: 1.5 Bars High-pressure pipe: $\phi 6 \times \phi 1.5$ $\times 600\text{mm}$	1200	0.7	12.1~12.2	159.0~167.0	8.0	Reference
	300		5.8~6.0	9.5~20.5	7.0	
	700	0.7	12.5~12.6	163.0~171.0		
	700	0	9.8~9.9	117.0~125.0		
	100			236.0~274.0		Start fuel supply

67 (280 hp) engine

Table 2-7 The standard of the fuel injection of the PE6P110A721RS3101 Bosch pump of WD615-

of engine.

The following are the procedures of the tester adjustment with Bosch fuel injection pump on WD615-67 (280 hp) engine as an example. Table 2-7 lists the standard of test and adjustment of Bosch fuel injection pump of this type of engine.

The test conditions can be met, then the results obtained from the test must be corrected accordingly. In order to guarantee the accuracy of the test, all standards specified in the test conditions must be followed during the test and adjustment of the fuel injection pump. If some of the items are not satisfactory or the requirements of amount of fuel injection, therefore, the specifications of high-pressure fuel pipes must be given for the test.

beginning time of the fuel injection pump. Fuel pipes of different specifications have different influences on the expansion during the process of fuel supply, and the fuel injection of the injector would lag behind the fuel supply and the fuel injector must be in specified length, inner diameter and wall thickness. In pulsating operation, the high-pressure fuel pipe may generate fuel-pipe effect. That is to say, the fuel pipe may suffer from elastic expansion during the process of fuel supply, and the fuel injection of the injector would lag behind the fuel supply. The specifications of the high-pressure fuel pipe connecting the fuel injection pump by the fuel injection pump is. Therefore, the type and temperature of the test fuel are specified in the test conditions. In general, the greater the viscosity of the test fuel, the greater the amount of fuel supply by the fuel injection pump. And the viscosity of the test fuel has an indispensable influence on the amount of the fuel supply by the fuel injection pump. The fuel used for test and the fuel temperature determines the viscosity of the fuel injection pump is. Therefore, the fuel supply pressure must be specified in the test.

Fuel supply pressure. Low fuel supply pressure of the fuel injection pump has a great influence on the amount of fuel injection. In general, the higher the fuel supply pressure, the greater the amount of the fuel supply by the fuel injection pump is. Therefore, the fuel supply pressure must be specified in the test.

The opening pressure of the fuel injection nozzle. The injection pressure of the fuel injector has great influence upon fuel injection. Therefore, standard must be set for the injection pressure of the fuel injector during the test. It must be kept in mind that the fuel injection pressure specified in test conditions might not be the same as that required by actual operation.

after a certain number of operating cycles. The injection pressure of the fuel injector has great influence upon fuel injection. Therefore, standard must be set for the injection pressure of the fuel injector during the test. It must be kept in mind that the fuel injection pressure specified in test conditions might not be the same as that required by actual operation.

adjustment of various types of fuel injection pumps. These are the test conditions for the fuel injection pumps. Generally, the test conditions for the fuel injection pump tester include the following aspects:

Fit the fuel injection pump on the tester, and connect it with the drive shaft of the tester. As there is a smoke limiter on the fuel injection pump of the supercharged diesel engine, there must a pressure-adjustable air supply unit on the fuel injection pump tester, so that a specified air pressure can be supplied to the smoke limiter by the fuel injection pump during testing. Fit the measuring gage of the fuel supply gear rack on the fuel injection pump, and calibrate the gear rack travel to "Zero".

2) Adjustment of fuel supply timing

In order to guarantee accuracy of the fuel injection rate (law of injection) and to ensure the optimum operation of the diesel engine, the plunger lift (pre-travel of the plunger) of the fuel injection pump is fixed when various branch pumps of the fuel injection pump starts to supply fuel (the plunger begins to close the fuel inlet port), and the check and adjustment of the timing of the fuel supply of the fuel injection pump are just the check and adjustment of the pre-travel of the plunger. In other words, correct adjustment of the pre-travel of the plunger may ensure that the working zone of the cam is within the designed type curve of the pump, i.e. to guarantee that the fuel injection rate is within the designed range and the fuel supply timing of the fuel injection pump is correct. As for the fuel injection timing of the complete engine, it must be adjusted on the engine as mentioned above.

Table 2-8 The pre-travel of the plunger of the fuel injection pump of WD615.67 diesel engine

Engine model:	BOSCH pump	
	Pump type	Pre-travel (mm)
WD615 · 67/77	PE6P100A721 RS3101	2.75-2.95

The measurement of the plunger pre-travel must be made by means of special measuring set. There are two methods for measuring the plunger pre-travel: one is to measure the lift of the plunger by means of a measuring set, and another is to measure the lift of the tappet by means of the measuring set.

As shown in Fig. 2-48, disconnect the high-pressure fuel pipe connector from the branch pump of the first cylinder, remove the fuel delivery valve unit and the sealing washer, and then fit the measuring set on the fuel outlet connector of the branch pump. The measuring set is actually composed of a dial indicator fit on the fuel outlet pipe sleeve and an overflow pipe. After the measuring set is installed, let the gage pin of the dial indicator touch the top of the plunger directly. Open the low-pressure fuel supply pipe of the tester, rotate the camshaft to set the plunger at the bottom dead center (the bottom dead center of the plunger can be seen on the dial indicator), zero the pointer of the dial indicator, operate the load lever of the fuel injection pump to put the injection pump at its maximum fuel supply position, and fuel will flow out of the overflow pipe. Then, slowly rotate the camshaft in the operating direction of the fuel injection pump, stop the operation when the fuel flow from the overflow pipe of the measuring set. The value indicated by the dial indicator at this time is just the pre-travel of the plunger. If the value obtained is unsatisfactory, adjustment should be made.

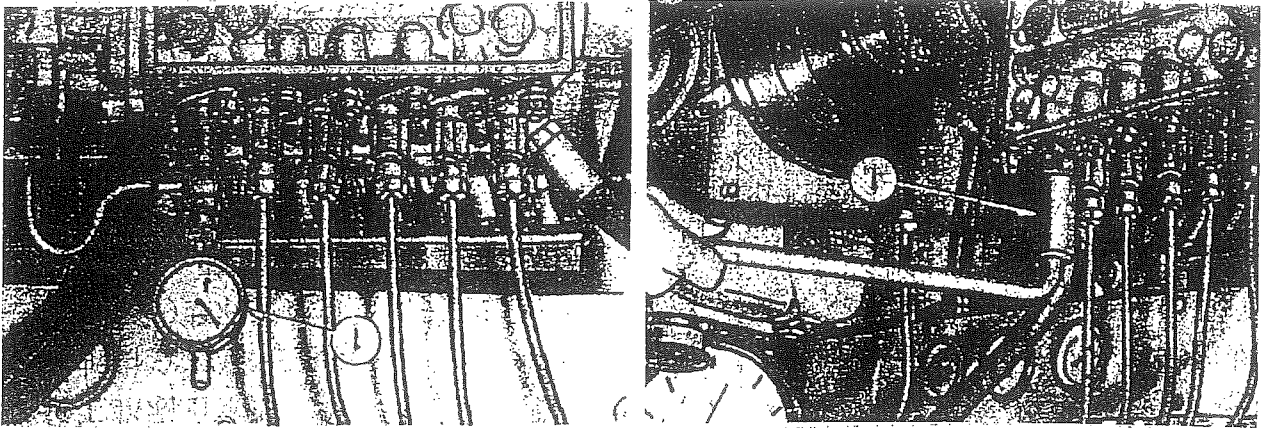


Fig. 2-48 Measure the pre-travel of the plunger by using the method of overflow

Using the same method, check and adjust the commencement of fuel supply of various branch pumps in the order of fuel supply of 1-5-3-6-2-4, making them supply fuel at the interval of $60^\circ \pm 0.5^\circ$ cam angle. Now the adjustment of the fuel supply timing of the fuel injection pump is completed.

The pre-travel of the plunger can also be measured by means of tappet lift measuring set. As shown in Fig. 2-51, fit the measuring set in the special measuring hole in the fuel injection pump (the measuring hole is usually located on the tappet of the first cylinder) with the measuring pin in contact with the upper edge of the tappet. Remove the fuel delivery valve of the branch pump of the first cylinder, start the tester to supply fuel to the fuel injection pump (or do not remove the delivery valve, but allow the fuel supply pressure to reach 25+2 Bars), set the fuel injection pump to its maximum fuel supply position, and now fuel will overflow from the branch pump. Rotate the camshaft to put the tappet of the plunger at the bottom dead center, zero the dial indicator, and then slowly rotate the camshaft in the direction of the normal operation of the pump. When the fuel flow from the branch pump stops (i.e. the plunger begins to close the fuel inlet port), observe the lift of the plunger as indicated by the dial indicator and make sure it meets the specification of the pre-travel. If unsatisfactory, make adjustment by adding or removing the timing shims. Upon the completion of the adjustment of the plunger of the first cylinder, use the same method and adjust the pre-travel of other branch pumps in the order of 1-5-3-6-2-4, making them supply fuel at the interval of $60^\circ \pm 0.5^\circ$ cam angle.

Fig. 2-49 Adjustment of fuel supply timing

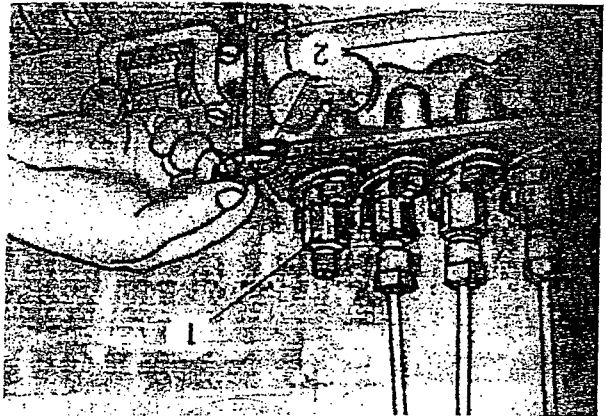
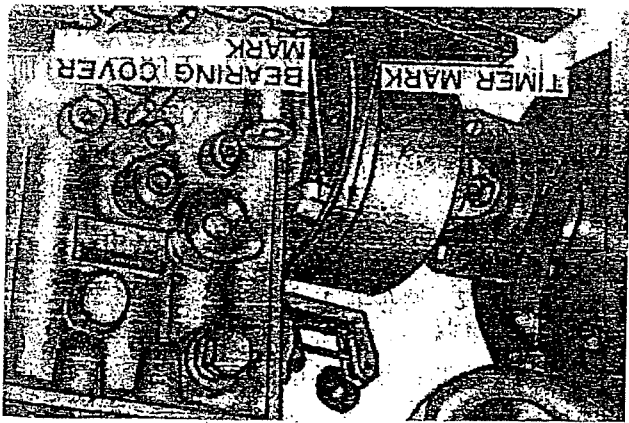


Fig. 2-50 Fuel supply timing scale lines



The adjustment of fuel supply timing is made through adding and reducing the number of timing shims. As shown in Fig. 2-49, remove the branch pump assembly. If the plunger pre-travel is smaller than the specified value, add timing shims below the flange of the branch pump, and vice versa. Make sure that the O-ring is intact when the branch pump is reinstalled. Upon the completion of the adjustment of the fuel supply timing of the branch pump of the first cylinder, put the pump at the position of starting fuel supply of the branch pump of the first cylinder (i.e. the position of the pre-travel of the plunger), as shown in Fig. 2-50, check and make sure that the fuel injection pump fuel supply timing scale lines are aligned properly. Otherwise, new aligned timing scale lines should be imprinted on the timing device and the fuel injection pump casing, for future check and adjustment of the fuel injection timing of the engine.

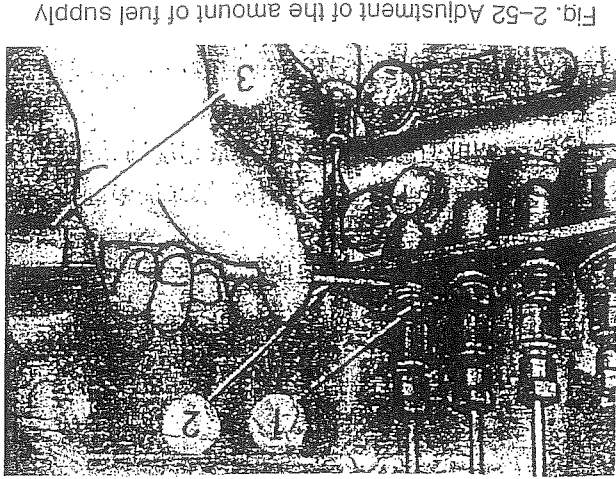


Fig. 2-52 Adjustment of the amount of fuel supply

As listed in Table 2-7, start the tester, adjust the rotating speed of the pump to 1200 rpm, apply an air pressure of 0.7 Bar on the smoke limiter, use the load control lever to control the fuel supply gear rack travel within 12.1 ~ 12.2 mm, and measure the amount of fuel supply of each branch pump which should be within the range of 159.0 ~ 167.0 ml/1,000 times, and make sure the maximum difference among various branch pumps in the amount of fuel supply does not exceed 8.0 mm³/time. If unsatisfactory, adjustment should be made. The adjustment of the amount of fuel supply is realized by rotating the plunger sleeve.

As shown in Fig. 2-52, each plunger sleeve can be turned by 10° relative to the pump body, which corresponding to the relative travel of 2.5 mm of the fuel supply gear rack. Therefore, before adjusting the amount of fuel supply of the branch pumps, the fixing screw on the branch pump flange should be loosened first. Use a screwdriver or a similar tool to tap lightly the branch pump flange to make it turn. Pay attention to the direction of increase or decrease in the amount of fuel supply while the adjustment is being conducted. After the adjustment of fuel supply is completed, tighten the flange fixing screw to the specified torque. The data in the first column of Table 2-7 is used to adjust the reference of the pump. The amount of fuel supply must meet the requirement under this working condition. The data in the following columns in the Table are used for checking the conformity of the amount of the fuel supply of the plungers. As there is some error in machining of the spiral shaped plunger, the amount of fuel supply of the fuel injection pump might be satisfactory under standard working conditions and the difference among various cylinders in the amount of fuel supply would

1) Adjustment of fuel supply

Fig. 2-51 The measuring set of plunger pre-travel

1. dial indicator 2. measuring pin 3. guide rod 4. measuring frame 5. tappet 6. measuring body

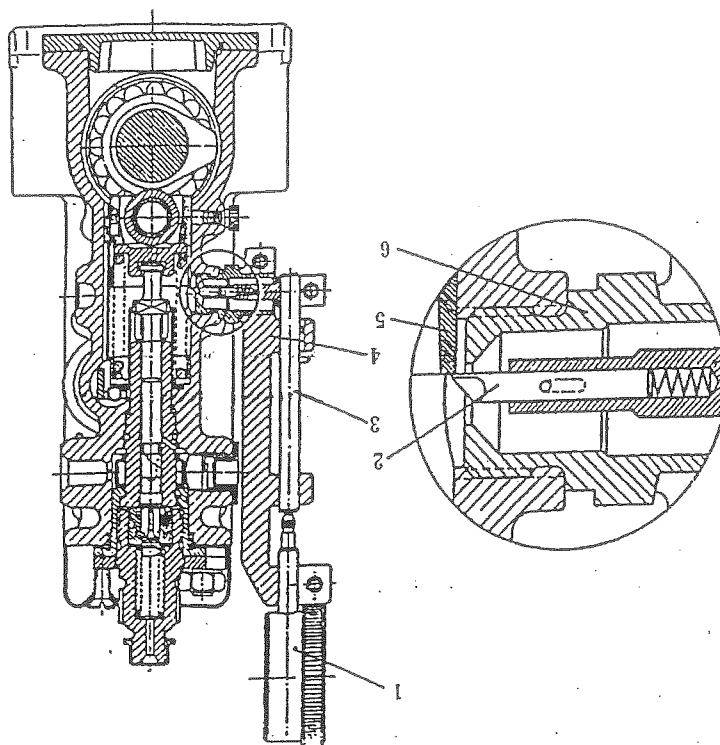


Table 2-10 Parameters for the adjustment of the governor of WD615-67 diesel engines

The methods for adjusting the RQ governor and the RDV full-range governor used on the Bosch Type-P fuel injection pump installed on WD615 series diesel engines are basically the same. The adjustment of the governor on the tester mainly includes: the adjustments of idle speed control, high-speed control and corrected fuel supply control. The test and adjustment will be explained with RQ300/1200PA412 governor fitted on Bosch fuel injection pump used by WD615-67 diesel engines as an example.

(7) Adjustment of the governor on tester

Sea level elevation (m)	Sea level	1,000-2,000	2,000-3,000	above 3,000
Coefficient of correction (%)	100	94	86	78

Table 2-9 Coefficient of correction for fuel supply of engines operating on highlands

For vehicles used on highlands, the fuel supply of the diesel engines will be corrected as per Table below:

Q – average fuel supply of various cylinders

Q_{min} – minimum fuel supply of the cylinder among various cylinders

where, Q_{max} – maximum fuel supply of the cylinder among various cylinders

$$\phi = (Q_{\max} - Q_{\min}) / Q \times 100\%$$

The unevenness ϕ of various cylinders can be calculated by the formula below:

injector on the tester. Thus, a optimum practical effect can be gained.

In practices, it is unable to guarantee absolute accuracy of the test of the fuel injector and the injection pump, and the error in these two devices would certainly increase the difference among various cylinders of the engine. In order to guarantee a good match of the fuel injector and the injection pump and obtain the optimum amount of fuel supply by various cylinders, check and calibrate the fuel injectors of various cylinders first, then use the calibrated and qualified fuel injector for the tester to calibrate the injection pump, and finally install all the fuel injectors and the injection pumps on the diesel engine with the same matching relationship between the injection pump and the fuel injector on the tester. Thus, a optimum practical effect can be gained.

After all adjustments are completed, check again the amount of fuel supply under the "reference" working conditions. In practical operations, the test site might be unable to meet the standard test conditions. In such cases, the standard data for the test and adjustment can not be used directly. By using a new fuel injection pump calibrated in its manufacturer, test the amount of fuel supply on the tester under the existing conditions and various specified working conditions (pump speed, gear rack travel, boost pressure, etc.), record the results, and use them as references for calibration of the pump. These reference data can only be used for pump calibration under the same conditions.

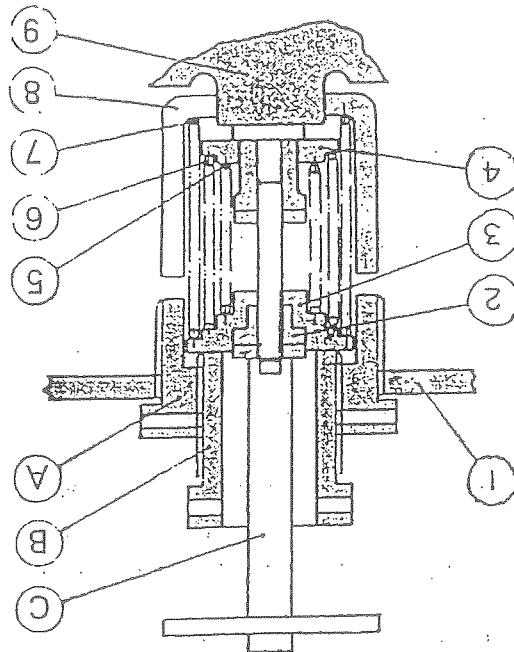
0 ~ 274.0 mm³/time.

Upon the completion of the adjustment of the amount of fuel supply under normal working conditions, adjust the pump speed to 100 rpm, set the load lever at full-load position (advance the throttle lever to the maximum fuel supply position), and adjust the gear rack limiter, so as to make the amount of the fuel supply of start reach 236.

are within the specified range under all the working conditions and that the diesel engines operate stably under all working conditions, but out of tolerance under other working conditions, then the plunger matching parts of this of fuel supply of a certain branch pump from other branch pump are satisfactory under the standard (reference) under various working conditions given in the Table. If the amount of fuel supply and the difference of the amount injection pump is adjusted under standard (full load) working conditions, check for fuel supply must be carried out unevenness of fuel supply by various cylinders would be out of tolerance. Therefore, after the fuel supply of the fuel be within the permissible range, and operating under other working conditions, the amount of fuel supply and the

Fig. 2-53 Adjustment of high-speed

1. Governor casing 2. Adjusting nut 3. Upper seat 4. Lower seat 5. Correction spring 6. High-speed spring 7. Idle speed spring 8. Flyweight 9. Flyweight body



If the rotating speed of the high-speed beginning to function does not comply with the above-mentioned specifications, as shown in Fig. 2-53, use the special tool to adjust the pre-tension of the high-speed spring. i.e., use the special tool (press sleeve B) to press the outer seat of the adjusting spring downward, and then use a box spanner to adjust the speed-adjusting nut 2. If the rotating speed of beginning to function is lower than the standard value, turn the nut towards the direction of tightening, and vice versa. When adjusting, attention should be paid that the adjusting nuts of the two flyweights are adjusted uniformly, i.e., to turn both nuts outward or inward by the same number of turns. Otherwise, internal force would be produced between the two flyweights and speed up the wear of the parts.

2) Adjustment of high-speed control. Turn on the tester, increase the pump speed to 1,240 rpm, and use the load control lever to set the gear rack at the location of 1.0mm of its travel. Keep the load control lever unchanged, increase the pump speed to 1,260 rpm. Then continue to increase the pump speed with the lever unmoved, the gear rack should begin to move towards the direction of decreasing fuel supply. When the pump speed reaches 1,325 ~ 1,355 rpm, the gear rack should withdraw to the location of 4.0mm of its travel. When the pump speed reaches 1,450 rpm, the gear rack should move back to the fuel shutoff position of 0 ~ 1.0mm of its travel.

1) Preparation prior to test. Recalibrate the "zero" position of the gear rack travel. Check if the maximum travel of the gear rack determined by the load control lever is satisfactory.

The type of governor: RQ300/1200PA412					
Load control lever at idle speed position	Idle speed control		High-speed control		
	Corrective control				
Pump rotating speed (rpm)	Gear rack travel (mm)	Pump rotating speed (rpm)	Gear rack travel (mm)	Pump rotating speed (rpm)	Gear rack travel (mm)
405-445	2.0	1245-1260	11.0	1200	12.0-12.1
300	5.8-6.0	1325-1355	4.0	1075	12.0-12.2
100	>7.5	1450	0.0-1.0	965	12.3-12.4
				600	12.4-12.5

WG I Group	Bad operation condition (severe winter, Hot summer, sandy or cross - country). Vehicles for short distance. Average annual mileage: up to 20000 Km
WG II Group	Vehicles in short and medium distance service. Average annual mileage: up to 60000 Km
WG III Group	Vehicles is long distance service. Average annual mileage: over 60000 Km

Table 2-11 Driving condition groups

II. Maintenance

1. Key points for running of engine
2. Starting time is not more than 15 seconds for every time. The time interval between two starting is not less than 30 seconds.
3. After starting, the engine must run at the idling speed for 3~5 minutes. Don't depress the accelerator violently before the oil pressure is higher than 2.0 bar and the temperature is higher than 60°C.
4. After the engine is out of ignition, operate it for 3~5 minutes at the idling speed, and then stop it. Don't depress the accelerator violently before stopping ignition.
5. Drive the first 3000 Km without a trailer and with only moderate loading of the engine, e.g. not over 70% rated total load.

SECTION 9 RUNNING AND MAINTENANCE OF ENGINE

If the rotating speed of the high-speed beginning to function complies with the requirements, but the adjusting rate does not meet the requirement (i.e. when the pump speed reaches 1,325 ~ 1,355 rpm, the gear rack is not at the location of 4mm of its travel), it is necessary to replace the high-speed spring of the governor. After the adjustment of the high-speed control is completed, adjust the full-load limiting screw to a position just touching the stop of the full-load control lever and fix it.

3) Adjustment of idle-speed control. Move the load control lever towards the direction of idle speed. When the pump speed reaches 300 rpm, the gear rack should be at the location of 5.8 ~ 6.0mm of its travel, and fix the load control lever at this position. Increase the pump speed to 405 ~ 445 rpm, the gear rack is at the location of 2.0mm of its travel. When the pump stops running completely, make sure that the gear rack is at the location of 7.5mm of its travel. If the result of the test does not comply with the standard, adjustment can be made by adding or reducing the number of the idle-speed spring shims or replacing the idle-speed spring. Upon the completion of the adjustment of the idle speed, adjust the idle-speed limiting screw to a position just touching the stop of the load control lever.

4) This type of governor has a correction spring, so the corrected fuel supply should also be calibrated. Set the load control lever at the full-load position, adjust the pump speed to 1,200 rpm, and check if the gear rack is at the location of 12.0 ~ 12.1mm of its travel. Lower the pump speed to 1,075 rpm, 965 rpm and 600 rpm, and observe if the gear rack is at the locations of 12.0 ~ 12.2mm, 12.3 ~ 12.4mm and 12.4 ~ 12.5mm of its travel respectively. If the rotating speed of the correction beginning to function does not comply with the requirement, it can be adjusted by using the adjusting shims of the correction spring. If the travel of the correction gear rack is unsatisfactory, it can be adjusted by adding or reducing the number of the travel adjusting shims on the correction spring seat.

● WD1, WD2, WD3, WD4 — 1, 2, 3, 4 class maintenance

● P — Routine inspection

Note: ● indicates that oil replacement is needed

	(WG I)	(WG II)	(WG III)	Generator oil grade
	Annual road mileage less than 2×10^4 km	Annual road mileage less than 6×10^3 km	Annual road mileage exceeding 6×10^3 km	AP I CD CF
First check	At road mileage of 1,000 ~ 1,500km	At road mileage of 1,500 ~ 2,000km	At road mileage of 1,000 ~ 2,500km	●
P	At the interval of 5,000km	At the interval of 1×10^4 km	At the interval of 1.5×10^4 km	●
WD1	At the interval of 1×10^4 km	At the interval of 2×10^4 km	At the interval of 3×10^4 km	●
WD2	At the interval of 2×10^4 km	At the interval of 4×10^4 km	At the interval of 6×10^4 km	●
WD3	At the interval of 4×10^4 km	At the interval of 8×10^4 km	At the interval of 12×10^4 km	●
WD4	At the interval of 8×10^4 km	At the interval of 16×10^4 km	At the interval of 24×10^4 km	●

Table 2-13 Replacement period in maintenance

● WD1, WD2, WD3, WD4 — 1, 2, 3, 4 class maintenance

● P — Routine inspection

Note: ● indicates that oil replacement is needed

	(WG I)	(WG II)	(WG III)
First check	At road mileage of 1,000 ~ 1,500km or 30~50h	At road mileage of 1,500 ~ 2,000km	At road mileage of 1,000 ~ 2,500km
P	At the interval of 5,000km or 150h	At the interval of 1×10^4 km	At the interval of 1.5×10^4 km
WD1	At the interval of 1×10^4 km or 300h	At the interval of 2×10^4 km	At the interval of 3×10^4 km
WD2	At the interval of 2×10^4 km or 600h	At the interval of 4×10^4 km	At the interval of 6×10^4 km
WD3	At the interval of 4×10^4 km or 1200h	At the interval of 8×10^4 km	At the interval of 12×10^4 km
WD4	At the interval of 8×10^4 km or 2400h	At the interval of 16×10^4 km	At the interval of 24×10^4 km

Table 2-12 Period in first check, routine inspection, maintenance

Maintenance specifications of the diesel engine	Note	First check	P	WD1	WD2	WD3	WD4
Replace oil of diesel engine(diesel engine uses CD or CF oil)(at least once a year)	●	●	●	●	●	●	●
Replace oil filter or element	●	●	●	●	●	●	●
Check and adjust valve clearance	●	●	●	●	●	●	●
Check opening pressure of injection nozzle	●	●	●	●	●	●	●
Replace fuel filter (inline type injection pump)	●	●	●	●	●	●	●
Clean fuel pump coarse filter	●	●	●	●	●	●	●
Check antifreezing fluid level and replenish	●	●	●	●	●	●	●
Replace antifreezing fluid	●	●	●	●	●	●	●
Tighten cooling pipe clamp	●	●	●	●	●	●	●
Tighten intake pipe, hose and flange connecting parts	●	●	●	●	●	●	●
Check the maintenance indicator lamp of the air filter	●	●	●	●	●	●	●
Clean the dust pocket of the air filter (excluding automatic dust exhaust type)	●	●	●	●	●	●	●
Clean the air filter main element	●	●	●	●	●	●	●
Replace the air filter main element	●	●	●	●	●	●	●
Replace the air filter safety element	●	●	●	●	●	●	●
After the main element has been cleaned for 5 times	●	●	●	●	●	●	●
Check and tighten the V-belt	●	●	●	●	●	●	●
Check the bearing clearance of the supercharger	●	●	●	●	●	●	●

Table 2-15 Maintenance specifications of the diesel engine

Ambient air temperature Use fuel with sulphur content of 0.5% (by mass)	A tropical or rigid climate (temperature often above +30°C or below -10°C)	B Use fuel with sulphur content of 0.5%-0.1%	C Use fuel with sulphur content of 1.0%-1.5%	Supercharged diesel engine	
				Oil replacement period	
				Severe condition A+C	
Normal conditions of use	WG I	WG I	WG I	5,000	10,000
	WG II	WG II	WG II	At the interval of 10,000km	At the interval of 10,000km
	WG III	WG III	WG III	30,000	30,000
Severe condition A	WG I	WG I	WG I	5,000	10,000
	WG II	WG II	WG II	5,000	10,000
	WG III	WG III	WG III	5,000	10,000
Severe condition B	WG I	WG I	WG I	5,000	1,000
	WG II	WG II	WG II	5,000	1,000
	WG III	WG III	WG III	10,000	15,000
Severe condition C	WG I	WG I	WG I	5,000	10,000
	WG II	WG II	WG II	5,000	10,000
	WG III	WG III	WG III	5,000	10,000
Severe condition A+B	WG I	WG I	WG I	5,000	7,500
	WG II	WG II	WG II	5,000	7,500
	WG III	WG III	WG III	5,000	10,000
Severe condition A+C	WG I	WG I	WG I	2,500*	5,000
	WG II	WG II	WG II	2,500*	5,000
	WG III	WG III	WG III	2,500*	5,000

Table 2-14 Diesel engine oil replacement period (depending upon oil consumption)

According to the result of the calculation as per formula above, the coefficient of intensification $K\phi$ of WD615.66, WD615.59, etc. supercharged inter-cooling diesel engine with power greater than 266hp has already exceeded 50. Therefore, CD or higher grade oil must be used, otherwise, failures such as pre-wear or burn of bearing shell may

AP1D, CF oil should be used when $K\phi > 50$.
AP1CB, CC oil should be used when $30 < K\phi < 50$.
In general, AP1CA oil should be used when $K\phi < 30$.

V --- Cylinder total volume (litre).

Where, M --- Diesel engine max. torque (kg/m);

$$Pe = \frac{M}{V \cdot 1.357} \text{ (kg / cm)}$$

S --- piston stroke (litre)

Where, N --- Diesel engine rated rpm

$$Cm = \frac{30}{N \cdot S}$$

Z --- Stroke coefficient (four-stroke diesel engine Z=0.5, and two-stroke diesel engine Z=1).

Cm --- Mean piston speed (m/s).

Where, Pe --- the mean effective pressure of the diesel engine (kg/cm²).

$$K\phi = Pe \cdot Cm \cdot Z$$

There are also many physical and chemical properties indicators for diesel engine oil. The number of the oil includes two indexes: oil strength (quality) grade index, and viscosity index. To select what number of diesel engine oil to be used depends on the integrated requirement of the engine on the two indexes mentioned above. Diesel engine oil is graded into AP1CA, CB, CC, CD, CF and etc. depending on their quality and strength according to the internationally accepted AP1 (American Petroleum Institute) standard. The higher the grade, the higher the strength and the better the quality of the oil is. The selection of the engine oil grade usually depends on the working strength and the severeness of the operating conditions of the diesel engine. The working strength of the diesel engine is represented by coefficient of intensification $K\phi$.

2) Diesel engine oil

There are many physical and chemical properties indexes for diesel fuel, but the most important ones are the cetane number which reflects the combustion property and the solidification point which represents the fluidity. The higher the cetane number, the better the combustion property is. The selection of the cetane number depends on the rotating speed of the engine. High-speed diesel engines for modern trucks normally use diesel fuel of hexadecane 40. The number of the diesel fuel represents its solidification point. According to their solidification point, the diesel fuel is numbered as 10, 0, -10, -20, -35, or even -50. No. -10 indicates that the solidification point of the diesel is minus 10 degrees. To select what number of diesel fuel to be used depends on the ambient temperature of use. In general, the number of the diesel fuel to be used should be 5-10°C lower than the temperature of use.

1) Fuel

WD615 series engines are comparatively advanced in the world in both power generation and economy, so they have some special requirements on the oil used by various mechanical parts. Misuse of oil may result in such serious failures as burning of bearing shell and break of shaft. So, it is very important to familiar with the requirement on oil and their use for each model of the engine.

3. Oil and antifreezing fluid for engine use

Note: ● indicates that maintenance is needed.

Maintenance specifications of the diesel engine	Note	First check	P	WD1	WD2	WD3	WD4
Check injection pump in a special workshop							●
Check and adjust the clutch travel and the steel cable condition		●	●	●	●	●	●
Adjust the idle speed		●					

SECTION 10 TROUBLESHOOTING OF THE ENGINE

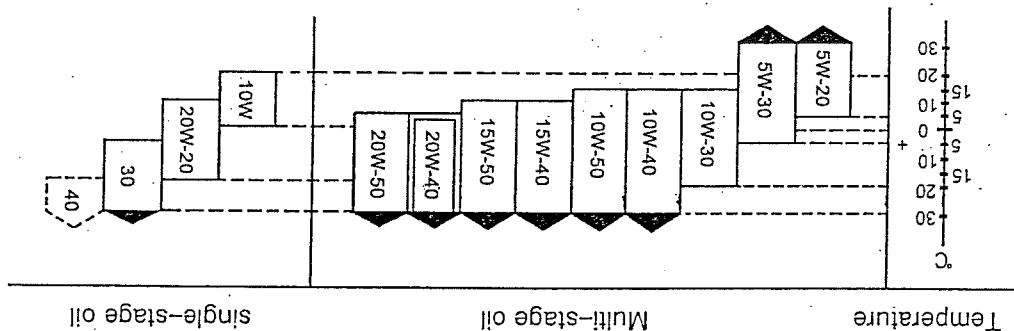
Recommended antifreezing fluids for all year around use by STEYR truck engines.

Most of antifreezing fluids used currently are ethylene glycol antifreezing fluids. Mixing the ethylene glycol with water at different volume ratio will make antifreezing fluids with different freezing points. The more ethylene glycol you put, the lower the freezing point of the antifreezing fluid is. Ethylene glycol antifreezing fluid is poor in volatility, and stable in performance. But it is somewhat corrosive. So, it is better to use long acting antifreezing fluids produced by well-known manufacturers. Because anticorrosive agent is added in such antifreezing fluid, you often find that the cooling components of the engine such as the water tank, pipes, especially the pipe unions and cocks made of aluminum are seriously corroded. This is probably the consequence of the use of unqualified antifreezing fluids. As the Ethylene glycol is poor in volatilization, as long as there is no leakage in the cooling system, there is need to replenish any antifreezing fluid in use. It is only necessary to replenish some demineralized water when the water in the water tank is found dropped below the specified level. Before winter is coming, it is preferable to take some sample of the antifreezing fluid for examination of its freezing point, so as to avoid the occurrence of the accident of cylinders frozen because of defective antifreezing fluid.

3) Antifreezing fluid

SINOTRUCK (China National Heavy Duty Truck Group Co. Ltd.) requires that the WD615 series supercharged inter-cooling diesel engines use grade API, CD or CF, No. SAE15W/40 diesel oil for both winter and summer use.

Fig. 2-54 Comparison between engine oil viscosity number and service temperature



2-54 shows a recommended relationship between oil number and temperature of use.

Selection of engine oil viscosity grade depends on the ambient temperature of use without strict requirement. Fig. SAE40.

SAE15W/40 (as an example), and complies with winter viscosity index of SAE15W and summer viscosity index of SAE40. Oil that can be used in both winter and summer is usually defined as the greater the viscosity of the oil is. The former are for winter use, and the latter for summer use. The bigger the number, on the basis of 90°C (210°F). The former are for winter use, and the latter for summer use. The bigger the number, graded as SAE5, 10W, 15W, 20W, etc., on the basis of -18°C (°F) viscosity index, and as SAE10, 20, 30, 40, etc. According to the internationally accepted SAE (US Society of Automotive Engineers) standard, engine oil is usually occur at a earlier time of use.

Ser. No.	Engine fails to start	Remedy
1.	Fuel supply system failure: (1) There is air in the fuel supply system (2) Fuel pipeline blocked (3) Fuel filter clogged (4) Fuel supply pump does not supply fuel or supplies fuel intermittently (5) The injector injects very little fuel or does not inject fuel, or injection pressure is too low (6) Injection pump failed (7) Improper valve timing or angle of fuel supply commencement Starting system failure: (1) Starting system is incorrectly wired or in poor contact (2) Battery capacity is insufficient (3) Starter brushes and the commutator are in poor contact (4) Starter run idle The engine can not be started with clutch pedal released, but can be started with clutch pedal stepped. 4. The compression pressure of the cylinder is insufficient: (1) Piston ring is worn excessively (2) Valve leaks 5. Engine lubricating oil viscosity too great, and the crankshaft is difficult to rotate when temperature is low 6. Fuel specifications is incorrect 7. Flywheel gear ring is loose 8. Air intake is difficult: (1) Air inlet blocked (2) Fuel filter clogged 9. Ambient temperature and engine temperature too low	(1) Check if the fuel pipe joint is loose and if the pipe is damaged. Loosen air bleed plugs on the fuel injection pump and the fuel filter, use a hand pump to suck fuel or pressurize the fuel tank to bleed the air in the fuel supply system. (2) Check if the pipeline is clear. (3) Wash fuel filter. (4) Check if there is air in the fuel inlet pipe. Otherwise, check and repair fuel supply pump. (5) Remove the fuel injector but with it still connected to the high-pressure fuel pipe, use the starter to rotate the crankshaft and drive the injection pump plunger. Observe the condition of fuel injection and atomization, remove it for check and readjustment if necessary. (6) Check the plunger and fuel delivery valve, and repair or replace the damaged parts. (7) Check and adjust. (1) Check the wiring condition and connect it properly. (2) Check battery capacity and recharge the battery. (3) Use fine sand paper to lap the commutator surface, blow off dust and replace brushes. (4) Check if the starter mounting and the friction clutch are normal. The engine can not be started with clutch pedal released, but can be started with clutch pedal stepped. 4. The compression pressure of the cylinder is insufficient: (1) Replace piston ring. (2) Check valve clearance, valve spring, and the tightness between the valve and the valve seat, lap the valve if the annular contacting zone is inconspicuous. Use specified lubricating oil. Use specified fuel. Reposition gear ring; replace flywheel and gear ring; spot weld gear ring on the flywheel. (1) Clean the clog. (2) Wash air filter. Correctly use cold starting system.

II. Engine Power Insufficient

Ser. No.	Failure cause	Remedy
1.	Valve spring is broken	1. Check and replace valve spring.
2.	Valve timing or fuel supply timing is incorrect	2. Calibrate the opening and closing angle and fuel supply advance angle of the intake and exhaust valves, check if the injection pump screw is loose, and tighten the screw if it is loose.
3.	Intake or exhaust valve clearance is incorrect	3. Check and adjust valve clearance.
4.	Cylinder compression pressure is insufficient, piston ring jammed, valve stem seized or inflexible	4. Clean, check and repair
5.	Engine is overheated (cooling system or lubricating system failed, water temperature is too high)	5. Check and cool.
6.	Carbon deposit in the engine is too much	6. Remove the cylinder head, remove the carbon deposit, and find out the reason of carbon deposit.
7.	Air filter is clogged	7. Wash the air filter, and check if its oil level is normal.
8.	Intake or exhaust pipe is clogged	8. Check the intake and exhaust pipes, and remove the accumulated dirt.
9.	There is air in the fuel supply system, or the system leaks fuel	9. Bleed the air from the fuel supply system by using the method mentioned above, and tighten or repair the fuel pipe joint
10.	Injection pump failed	10. Check the condition of wear, adjust the fuel injection pump, replace the plunger or fuel delivery matching parts if necessary, adjust the extra-low speed change of the Governor.
11.	Injection pump is clogged or in poor atomization	11. Check and adjust the injection pump, and replace the needle valve matching parts
12.	Cylinder head fuel injector seat hole leaks air;	12. Replace copper shim
	(1) Copper gasket contacting surface is damaged	(1) Replace copper shim
	(2) Copper gasket seat hole is not well cleaned	(2) Clean copper shim seat hole surface
	(3) The mating and pressure-bearing surfaces between the needle valve seat body and the injector body leaks	(3) Tighten injection pump needle valve fixing sleeve or lap the mating and pressure-bearing surface
13.	The joint between the cylinder head and the cylinder block leaks (its symptom is that, when changing rotating speed, there is a stream of airflow coming out from the gasket)	(1) Tighten the bolt to specified torque.
	(1) Cylinder head bolt is loose	(2) Check the mating surfaces of the cylinder head and the cylinder block; replace the cylinder gasket (do not use or repair the gasket that should be discarded), and plane the mating surface of the cylinder head or the cylinder block in necessary.
	(2) Cylinder gasket is damaged (leaks air or water)	(3) Check and repair
14.	(3) Cylinder head or cylinder block plane surface deformed	14. Remove any sticking substances and repair
	Intake or exhaust valve is stuck to valve guide	

Ser. No.	Fault signature	Cause	Remedy
1.	Silvery metal knocking sound can be heard from inside the cylinder	1. Fuel supply is too early.	1. Readjust the fuel supply timing.
2.	Deep and unclear sound can be heard from inside the cylinder	2. Fuel supply is too late.	2. Readjust the fuel supply timing.
3.	There is low and sharp sound while the engine is running. The sound is clear at high speed.	3. The mating between the piston pin and the connecting rod small end pin hole is too loose.	3. Replace the connecting rod small end bushing, so as to set the clearance within its specified range.
4.	Knocking sound can be heard when the engine is started. The sound becomes lower as the engine becomes warmer.	4. The clearance between the piston and the cylinder is too big.	4. Replace the piston or cylinder liner according to the state of the wear.
5.	When the engine is accelerated abruptly, clear knocking sound can be heard continuously. The sound remains unchanged when engine temperature changes.	5. The connecting rod bearing shell is too loose or clearance is too big.	5. Check the connecting rod bearing shell, and replace if necessary.
6.	While the engine is running at medium speed, deep knocking sound can be heard from the main bearing. The sound becomes more powerful when the rotating speed changes.	6. The crankshaft main bearing shell is too loose or clearance is too big.	6. Check the main bearing shell, and replace if necessary.
7.	When the engine is at idle speed, sharp and moving sound can be heard from the fore and aft end of the crankshaft.	7. The axial clearance at the rear end is too big due to wear of the thrust plate, resulting in fore and aft movement of the crankshaft.	7. Replace the thrust plate.

III. Engine generates abnormal noise

Ser. No.	Failure cause	Remedy
15.	Supercharger is damaged or burnt	15. Remove and check the supercharger, and replace if necessary.
16.	Intake manifold leaks air	16. Check for air leakage, replace seals.
17.	Exhaust manifold leaks air	17. Check for air leakage, replace seals.
18.	Inter-cooler leaks air	18. Check and repair the inter-cooler.
19.	Air intake system pipe fitting leaks air	19. Check for air leakage, replace seals.
20.	Exhaust system pipe fitting leaks air	20. Check for air leakage, replace seals.
21.	Smoke limiter air pipe leaks, diaphragm is damaged	21. Replace air pipe joint, check and repair seals, replace diaphragm
22.	Fuel quality is poor	22. Replace.
23.	Oil pan oil level is too high	23. Check oil stick, drain out excessive oil.
24.	Cylinder gasket leaks air	24. Check the compression pressure when engine is still hot, and replace the cylinder gasket
25.	Piston ring is worn or fractured, bearing shell clearance is too big	25. Replace the worn part
26.	Cylinder sleeve or piston is serious worn	26. Overhaul the engine

Ser. No.	Fault signatures and causes	Remedy
1.	Black smoke: (1) Fuel supply is too much, air is insufficient or load is too heavy. (2) Fuel injection by the injection pump to various cylinders is not even. (3) Injection pump is poor in injection. (4) Valves or piston rings are leaking. (5) Fuel injection is too late, part of the fuel is burning in the exhaust pipe. (6) Air intake is blocked or exhaust is under back pressure. (7) Fuel quality is poor. (8) The supercharging system is insufficient in pressure. (9) The supercharger is working abnormally. (10) Inter-cooler leaks air. (11) The action point of the smoke limiter is incorrect.	(1) Adjust the fuel supply and the valve clearance, and wash the air filter, or reduce the load. (2) Adjust the fuel supply to various cylinders, and make them balanced. (3) Check and repair the fuel injector. (4) Check the valve clearance, valve spring, valve sealing condition and the piston ring wearing condition. (5) Adjust the fuel supply advance angle. (6) Clean. (7) Replace. (8) Remedy the leakage. (9) Replace. (10) Remedy the leakage. (11) readjust.
2.	White smoke: (1) The injector leaks, the atomization is poor, injection pressure is low. (2) The engine is too cold. (3) There is water in the fuel. (4) The air filter is clogged, airflow is too high, the airflow level of oil in the oil pan is too much oil.	(1) Check the sealing condition of the needle valve matching parts and the injection pressure, replace the needle valve matching parts and adjust the injection pressure. (2) Check and repair the cooling system and improve the heat preservation of the engine. (3) Replace fuel or remove water in the fuel tank and air filter. (4) Check and clean the air filter, lower the oil in the oil pan to the specified level.
3.	Blue smoke: (1) The air filter is clogged, airflow is not smooth, or the level of oil in the oil pan is too high, the airflow brings in too much oil.	(1) Check and clean the air filter, lower the oil in the oil pan to the specified level.

IV. Abnormal smoke color of engine exhaust

When the engine is running under normal load, the exhaust smoke is generally in light-gray color. It is abnormal when the exhaust smoke is black, blue or white in case that the engine is lightly overloaded.

Ser. No.	Fault signature	Cause	Remedy
8.	Low and rhythmic sound can be heard from the engine cylinder head.	8. The valve spring is broken, the valve push rod is bent, or the lifter moving pairs are worn.	8. Replace the spring, push rod or lifter guide. Adjust the valve clearance.
9.	When the engine is running, powerful, smooth and rhythmic sound can be heard from the cylinder head.	9. The piston collides with the valve or the cylinder head.	9. Remove the valve chamber cover, and find out the cause of collision. Adjust the valve clearance, and if necessary, remove the cylinder head and find out the cause of collision against the cylinder.
10.	Abnormal sound can be heard from the linkage gearbox cover plate. When the engine is decelerated suddenly, impact sound can be heard.	10. The gear is worn excessively, the gear backlash is too big, or the gear is damaged.	10. Adjust the gear clearance, and replace the gear if necessary.

Ser. No.	Failure causes	Remedy
1.	Fuel is exhausted.	1. Refuel.
2.	There is air in the fuel supply system	2. Check if the fuel pipe joint is loose, pipe is fractured, and remedy the defects and remove air in the system.
3.	Fuel filter or fuel pipe is clogged.	3. Disassemble and wash the filter element, and clear the fuel pipeline.
4.	There is water in the fuel.	4. Replace fuel or remove water in the fuel tank and air filter.
5.	Fuel supply pump does not work.	5. Check the fuel supply pump and remove any trouble.
6.	The piston is seized (due to engine overheating or too small clearance between the piston and the cylinder liner).	6. Use a crowbar to rotate the crankshaft first, wait until the temperature drops, and check the cooling system, the piston and the cylinder liner, and remove any troubles found.
7.	Idle speed is too low.	7. Readjust.
8.	Ignition switch leaks.	8. Replace

VI. Unexpected engine flameout

Ser. No.	Failure causes	Remedy
1.	Antifreezing fluid is insufficient.	1. Replenish antifreezing fluid to specified level (check and adjust the specific gravity of the antifreezing fluid in the winter).
2.	Oil is insufficient.	2. Replenish oil to specified level.
3.	The engine is overloaded.	3. Reduce engine load for cooling.
4.	The radiator is clogged by scale deposition and its exterior is dirty.	4. Clean its interior and exterior.
5.	The water pump drive belt is loose, the water pumpage is too small.	5. Adjust the tightness of the belt or replace it.
6.	The thermostat is out function.	6. Check, repair or place the thermostat.
7.	The water pump impeller is damaged.	7. Replace the impeller.
8.	Silicone oil fan is defective.	8. Screw in the lock pin so as to lock the drive and driven discs of the fan, and return the silicone oil fan to the factory for repair.
9.	Water pipe is damaged, and air comes in.	9. Check and replace.

V. Engine overheating

Ser. No.	Fault signatures and causes	Remedy
3	(2) The piston ring is seized or excessively worn, its elasticity is poor, letting oil enter the combustion chamber. (3) The valve timing or fuel supply timing are incorrect. (4) The compression pressure is low, fuel burning is incomplete and the piston bulges the cylinder. (5) The piston ring and the cylinder liner are not well fit. (6) The piston ring gaps are not properly staggered. (7) Oil rings are out of function. (8) The seal ring and the thrust bearing of the supercharger are worn. (9) The oil return pipe is blocked.	(2) Wash the piston rings, and replace if necessary. (3) Check and adjust. (4) Check and repair the piston rings and cylinder liner. (5) Continue to fit in. (6) Adjust. (7) Replace. (8) Replace. (9) Wash or repair.

Ser. No.	Failure causes	Remedy
1.	Cylinder gasket is damaged.	1. Replace cylinder gasket.
2.	Cylinder head cracks (there is a lot of water in the exhaust gas, and water condensation makes the exhaust become white smoke).	2. Repair or replace cylinder head.
3.	There is air pocket in air cylinder block, and as a result, it leaks water.	3. Replace cylinder liner.

remedy the trouble.

When checking, take some oil and put it in a glass, leave the glass undisturbed for 1 hour, and see if there is any water settled at the bottom of the glass. If there is water, replace the oil or get rid of the water from the oil, and

milky foam.

The main reason is that there is cooling water entering the oil pan. The oil with water is characterized in yellowish.

IX. Oil pan oil level rises

Ser. No.	Failure causes	Remedy
1.	Oil temperature is too high: the engine is overloaded (with black exhaust smoke), or oil radiator is clogged.	1. Reduce the load or clear the oil radiator
2.	Inappropriate oil is used.	2. Use specified oil.
3.	Oil ring return hole is clogged by carbon deposit or the oil ring is jammed, and as a result, it lost the function of oil scrapping.	3. Clean carbon deposit or replace oil ring.
4.	The piston ring is stuck or worn too much against the cylinder liner, allowing oil to get in the combustion chamber and gas to come into the crankcase. Exhaust smoke is blue, and there is smoke coming out of the oil filler port and the ventilator of the crankcase.	4. Wash or replace piston ring, or replace piston and cylinder liner if necessary.

VIII. Oil temperature is too high, oil is too thin and oil consumption is too high

Ser. No.	Failure causes	Remedy
1.	Pressure is adjusted improperly.	1. Adjust pressure.
2.	Oil pump gear is worn.	2. Repair or replace oil pump.
3.	Oil pipeline leaks, or is clogged, fractured or broken.	3. Check and repair oil pipe, or replace if necessary.
4.	Oil pressure limiting valve spring is damaged, and the valve mating surface is not smooth.	4. Replace spring, lap the mating surfaces of the pressure limiting valve, adjust the pressure.
5.	Oil radiator or oil filter is clogged.	5. Clear the oil radiator, replace oil filter element.
6.	The joints of oil pressure and temperature sensors leak oil.	6. Check, repair or replace.

VII. Engine oil has no pressure, or pressure is too low or too high

1. Oil pan oil level.	1. Check the oil level and leakage, and replenish oil.
2. Main oil passage pressure-limiting valve is faulty.	2. Check, wash and repair the valve.
3. Oil anthology cleaner, oil passage, or connector gasket is blocked or fractured.	3. Check oil anthology cleaner and connector gasket, check if there is any foundry fault in oil passage and repair.
4. Oil number does not comply with the specification.	4. Use specified oil.
5. Oil pump inlet pipe leaks.	5. Check, repair or replace oil pipe and connector.
6. Cooling water or oil temperature is too high.	6. Check and repair the cooling system.
7. Oil filter resistance is too big.	7. Replace filter element.
8. Oil cooler is clogged.	8. Check and repair or replace.
9. Main oil passage is blocked.	9. Check and clear.
10. Bearing shell clearance is too big, or damaged.	10. Check and replace.
11. Parts are excessively worn and overhaul is needed.	11. Check the operating hours of the engine, and overhaul.

XII. Oil pressure is too low

1. Fuel is poor in quality, contains water or wax.	1. Check fuel system, and replace fuel.
2. Air leaks into fuel inlet.	2. Check the sealing of fuel pipe and joint, and remove air from the fuel.
3. Governor weight and spring are working abnormally.	3. Check and repair (by special factory).
4. Fuel supply is non-uniform.	4. Check and adjust (by special factory).
5. Injection nozzle atomization is unstable.	5. Check and repair.
6. Supercharger is surging.	6. Check and wash the air compressor flow passage, clear the fouling, and remove the carbon deposit from the inside of the exhaust turbine.
7. Supercharger bearing is damaged.	7. Replace.

XI. Unstable rotating speed

1. Air intake is blocked (air filter clogged).	1. Check and clear air filter and intake pipe.
2. Exhaust back pressure is too high.	2. Check and clear exhaust pipe and brake valve.
3. Fuel quality is poor.	3. Use specified fuel.
4. Fuel pipeline leaks.	4. Check and repair.
5. Fuel pipeline leaks.	5. Check and repair.
6. Injector is poor in atomization.	6. Check and adjust or repair.
7. The valve timing or fuel supply timing is incorrect.	7. Adjust the valve clearance and the fuel supply advance angle as specified.
8. The cylinder is hot and leaks.	8. Check compression pressure.
9. Bearing shell clearance is too big, and engine needs overhaul.	9. Check and overhaul.
10. Piston bulges the cylinder.	10. Replace cylinder liner, piston and piston rings.
11. The supercharging system is insufficient in pressure.	11. Check and remedy the leakage of the pipeline and the pipe connection.
12. The supercharger is working abnormally.	12. Check and replace the assembly.
13. Inter-cooler is damaged or leaks air.	13. Replace or repair.

X. Too much fuel consumption

1. Fuel quality is poor	1. Replace fuel.
2. Cooling water temperature is too low.	2. Check thermostat, and replace if necessary.
3. The valve timing or fuel supply timing is incorrect.	3. Check and repair or adjust.
4. Injector is poor in atomization.	4. Check and repair or adjust.
5. Injection pump is too much in pumpage.	5. Check and adjust (by special factory).
6. Shock absorber is damaged.	6. Check if there is any damage and the security of the fastening bolts, and replace damaged parts.
7. Valve leaks or poorly adjusted.	7. Remove, check and adjust the valve.
8. Gear clearance is too big or gear tooth is fractured.	8. Check and replace damaged parts.
9. Cylinder liner or piston are worn or scored.	9. Check and repair or replace.
10. Push rod is bent or fractured.	10. Replace.
11. Piston ring is fractured or worn.	11. Check and replace damaged parts.
12. Bearing shell is worn too much.	12. Check and replace the bearing shell.
13. Crankshaft thrust clearance is too big.	13. Replace the thrust plate.
14. Main bearing shell is eccentric.	14. Check and repair.
15. Crankshaft and its main driven shaft are not concentric.	15. Check the mounting bracket bolts and repair.
16. Parts are excessively worn and overhaul is needed.	16. Check mileage, and overhaul if necessary.
17. Supercharger is surging.	17. Clear the fouling from the air passage of the air compressor and the carbon deposit from the exhaust pipe.
18. Supercharger sealing ring is sintered.	18. Replace the assembly.
19. Supercharger bearing is damaged, rotating parts and fixed parts are scuffing with one another.	19. Replace the assembly.
20. Foreign matters entered the supercharger turbine or the air compressing impeller.	20. Replace the assembly.

XIV. Noise is too high

1. Air filter element is unqualified or damaged.	1. Check and replace the filter element.
2. Air intake pipe downstream the air filter leaks.	2. Check and repair, or replace the air pipe and sealing gasket.
3. Oil pan is low in oil level or has no oil.	3. Check oil level and leakage, repair and replenish oil.
4. Oil pipeline leaks.	4. Check and repair, or replace the oil pipe and sealing gasket.
5. Oil passage is blocked.	5. Clear the passage.
6. Oil number does not comply with the specification.	6. Use specified oil.
7. Piston ring is fractured or worn.	7. Replace the damaged piston ring.
8. Cylinder liner or piston are worn or scored.	8. Remove, check and repair, or replace the piston and cylinder liner.
9. Oil filter element is not replaced timely.	9. Replace as specified.
10. Parts are excessively worn and overhaul is needed.	10. Check mileage, and overhaul if necessary.
11. Crankshaft and its driven shaft are not concentric.	11. Check the mounting bracket and repair.
12. Cold-start liquid is injected too much.	12. Control the amount of each injection.

XIII. Parts wear too fast

Ser. No.	Failure causes	Remedy
1.	Rotating speed is unstable: (1) Fuel supply to various cylinders is not uniform (2) Fuel injector needle valve injection orifice is clogged by carbon deposit or drips fuel. (3) The weight pin is loose. (4) Plunger spring is fractured. (5) Delivery valve spring is fractured. Unstable or no idle speed: (1) The throttle control lever is released to its bottom position. (2) Idle speed spring is slightly seized. (3) Rotary sleeve and adjusting pull rod are slightly seized.	1. Rotate the pump body to adjust. (2) Clear the injector needle valve injection orifice or replace needle valve matching parts. (3) Replace pin. (4) Replace. (5) Replace. 2. (1) Check and repair. (2) Check and repair. (3) Check and repair.

XVI. Minor failure of injection pump rotating speed

Ser. No.	Failure causes	Remedy
1.	No fuel supply: (1) No fuel in the tank. (2) Fuel supply pump does not supply fuel. (3) Fuel filter or fuel pipe is clogged.	1. Refuel. (2) Check and repair fuel supply pump. (3) Wash or replace the fine filter element, and clear the fuel pipeline. (4) Remove air. (5) Replace. (6) Wash, lap or replace delivery valve set, and replace the valve gasket.
2.	Fuel supply is non-uniform: (1) There is air in the fuel supply system (2) Delivery valve spring is broken. (3) Delivery valve conical surface and pressure relief ring are worn. (4) Plunger spring is broken. (5) There are impurities in the plunger, which jam the movement of the plunger. (6) Fuel supply pump supply pressure is too low. (7) Fuel supply to various cylinders is not adjusted properly.	2. (1) Remove air. (2) Replace spring. (3) Lap or replace. (4) Replace plunger spring. (5) Check and adjust. (6) Check fuel supply pump and fuel filter. (7) Adjust.
3.	Fuel supply is insufficient. (1) Delivery valve leaks fuel. (2) Pipe connector leaks. (3) Plunger set is worn. (4) Incorrect installation. Fuel supply is too much: (1) Fuel injection of the injection pump to various cylinders is not properly adjusted.	3. (1) Lap or replace. (2) Check various connectors and repair. (3) Replace plunger set. (4) Reassembly and adjust. (2) Reassembly and adjust.
4.	(2) Incorrect installation.	(2) Reassembly and adjust.

XV. Injection pump minor failure

Ser. No.	Failure causes	Remedy
1	Too little or no fuel injection: (1) There is air in fuel line. (2) Injector needle valve is seized to valve body. (3) Needle valve and valve body fitting is too loose. (4) Fuel supply system leaks fuel seriously. (5) Fuel supply pump failed to supply fuel normally. Low injection pressure: (1) Adjusting screw is loose. (2) Pressure-adjusting spring force is insufficient or broken. (3) Needle valve is poor in sealing.	1. Remove air. (2) Wash and repair or replace. (3) Replace injector needle valve matching parts. (4) Repair and tighten various connector bolts. (5) Check and repair fuel supply pump. 2. Adjust injection pressure, and tighten. (2) Replace spring and adjust injection pressure. (3) Wash and repair or replace and adjust.

XVIII. Injector minor failure

Ser. No.	Failure causes	Remedy
1.	Fuel supply pump does not supply fuel. (1) Fuel supply pump filling valve and delivery valve is damaged or defective. (2) Fuel inlet connector leaks seriously. (3) Plunger spring is broken. Fuel supply by supply pump is insufficient: (1) Fuel supply pump filling valve is damaged. (2) Piston is worn. (3) Fuel inlet connector leaks air. (4) Filling valve and delivery valve is not well sealed. (5) Piston spring is poor in spring force.	1. Replace. (2) Repair and tighten. (3) Replace. 2. Replace. (1) Replace. (2) Replace. (3) Repair and tighten. (4) Lap or replace. (5) Replace.

XVII. Fuel supply pump minor failure

Ser. No.	Failure causes	Remedy
3.	Speed fluctuation: (1) Governor spring is deformed. (2) Weight shaft pin is worn and becomes loose. (3) Injection pump rotary sleeve and adjusting pull rod fitting is too loose. (4) Weight opening and closing distances are inconsistent. (5) Fit clearance of the adjusting pull rod, the connecting rod and the adjusting lever pins is too big. (6) Idle speed is improperly adjusted. (7) Sliding shaft and adjusting lever fitting is loose. (8) Governor and injection pump are loosely fit, and the axial clearance of the camshaft is too big.	3. Replace governor spring. (2) Replace shaft pin. (3) Reassembly and adjust. (4) Check and calibrate. (5) Replace pin. (6) Readjust. (7) Check, repair or replace. (8) Tighten the fixing nut, add shims and readjust.
4.	Runaway: (1) High-speed is adjusted too high. (2) Speed adjusting lever pin fell out. (3) High-speed spring is defective or broken. (4) Adjusting pull rod is seized. (5) Adjusting pull rod connecting rod pin fell out. (6) Plunger is seized.	4. Readjust the governor. (2) Repair and reassembly. (3) Repair, reassembly, and adjust. (4) Check and repair. (5) Check and repair. (6) Check and repair.

1. Battery voltage is low.	1. Recharge or replace battery.
2. Bearing bushing is worn.	2. Replace the assembly.
3. Brushes are in poor contact.	3. Clean brush surface or replace brushes.
4. Commutator is dirty or burnt.	4. Clean oil stain and grind the surface by means of sand paper, or replace the assembly.
5. Wire end is unsoldered.	5. Re-solder.
6. Switches are in poor contact.	6. Check and repair.
7. Clutch is worn and slipping.	7. Adjust the clutch working torque, or replace the assembly.

XX. Starting motor is not powerful

1. Battery is undercharged.	1. Check, recharge or replace battery.
2. Connecting wires are in poor contact.	2. Repair and tighten terminal posts.
3. Fuse is burnt.	3. Replace fuse.
4. Brushes are in poor contact.	4. Clean brush surface or replace brushes.
5. Starting motor is shorted.	5. Check and repair motor, or replace motor assy.

XIX. Starting motor does not operate

Ser. No.	Failure causes	Remedy
3	Too high injection pressure: (1) Adjustment is improper, pressure-adjusting spring force is too great.	3. (1) Readjust injection pressure.
4	(2) There is carbon deposit or dirt in the spray office. Needle valve matching parts leaks seriously: (1) Pressure-adjusting spring is broken (2) Needle valve matching parts seating face is damaged. (3) Needle valve matching parts are stuck or there is carbon deposit. (4) Needle valve matching parts fitting is loose. (5) Needle valve matching parts fixing sleeve is loose or deformed.	(1) Wash or repair. (2) Wash or replace needle valve matching parts. (3) Wash or replace needle valve matching parts. (4) Replace needle valve matching parts. (5) Tighten or replace fixing sleeve.
5	valve are contaminated or deformed. (6) Pressure-bearing surfaces of injector body and needle worn or burnt. (3) Needle valve matching parts, sealing conical surface is (2) Needle valve matching parts fit too tight or is seized. (1) Needle valve body is deformed or worn. Poor atomization, abnormal fuel injection sound: (1) Needle valve matching parts fixing sleeve is deformed.	(1) Replace needle valve matching parts. (2) Clean or replace. (3) Lap or replace needle valve matching parts. (4) Replace fixing sleeve. (5) Replace needle valve body.
6	(1) Spray office is clogged. (2) Needle valve matching parts seating face is excessively worn. (3) Needle valve matching parts are seized or there is carbon deposit. Needle valve matching parts surface is burnt or in blue color: (1) Cooling is poor, engine is too hot. (2) Injector is fit improperly, or fixing sleeve is too tight.	(1) Clean needle valve body. (2) Replace needle valve matching parts. (3) Clean or replace needle valve matching parts. (4) Check and repair cooling system. (5) Reassemble as specified.
7.		

WD618 diesel engines are made by China National Heavy Duty Truck Group Co. Ltd. (SINOTRUCK) with advanced manufacturing technologies introduced from Austria STEYR Trucks Company. The power of this type of the engine is increased by increasing its stroke from that (130mm) of WD615 to 155mm. The engine basically adopts the technology of WD615. So its structure will be introduced briefly. For more information, refer to the description of WD615 engine given above.

I. General

SECTION 11 GENERAL DESCRIPTION OF WD618 SERIES ENGINES

1. Generator is mounted improperly.	1. Repair.
2. Bearing is damaged.	2. Replace bearing.
3. Rotating part is in contact with the stationary part.	3. Repair or replace.
4. Rectifier tube is shorted.	4. Replace.
5. Stator coil is shorted.	5. Repair or replace.

XXV. Generator generates abnormal sound

1. Battery is shorted internally.	1. Repair or replace.
2. Voltage regulated by the regulator is too high.	2. Check and adjust.
3. Regulator is poorly grounded.	3. Repair.

XXIV. Generator over-charges the battery

1. Stator or rotor coil is about to be shorted or broken.	1. Repair or replace.
2. Brushes are in poor contact.	2. Repair.
3. Terminal posts are loose, and in poor contact.	3. Repair.
4. Voltage regulator is damaged.	4. Repair.
5. Voltage is improperly regulated.	5. Check and adjust.

XXIII. Charging current is unstable

1. Circuit is open or shorted, or connector is loose.	1. Repair.
2. Rotor or stator coil is locally shorted or opened.	2. Repair or replace the assembly.
3. Generator belt is loose.	3. Check and adjust the tension of the belt.
4. Generator rectifier tube is damaged, or brushes are in poor contact.	4. Repair.
5. Voltage regulated by the regulator is too low.	5. Adjust.
6. Regulator magnetic field coil or resistor wire is broken.	6. Repair or replace.
7. Battery electrolyte is insufficient, or battery is aged.	7. Add electrolyte, or replace battery.

XXII. Generator failed to charge the battery sufficiently

1. Circuit is open or shorted, or connector is loose.	1. Check the wires between the generator and the ammeter, and repair.
2. Rotor or stator coil is open, shorted or grounded.	2. Repair or replace the assembly.
3. Rectifying tube is damaged.	3. Replace the assembly.
4. Terminal post insulation is damaged, or wire is broken.	4. Repair.
5. Voltage regulated by the regulator is too low.	5. Repair.
6. Regulator contacts are burnt.	6. Repair or replace the assembly.

XXI. Generator does not generate electricity

3. Crankshaft

To compare with WD615, as the stroke of WD618 engine is increased, the height of the cylinder block is also increased from 363.8mm to 419mm. As a plate-fin type lubricating oil cooler is adopted, the structure of the oil cooler chamber in the cylinder block has been changed greatly, and the fuel and vapor separator is located at the top of the oil cooler chamber. This location is more reasonable. The width of the engine is increased from 352mm to 372mm. The main reason is that a thicker plate-fin type lubricating oil cooler is adopted. As the main journal of the crankshaft used in WD618 is increased, the main bearing bore is increased from 108mm to 110mm.

2. Cylinder block

① It adopts duplex thermostat. The two elements of the thermostat are located inside water pipe. The structure is more compact.
 ② The water pump is composed of the pump body, impeller and cover. The pump is fixed in the gear box and driven by gears.
 ③ It uses a special fan bracket. The center position of the fan is the same as that of WD615 engine.
 ④ The fuel injection pump is fixed onto the gear box by means of flange. To compare with WD615 engine, there is no the driving shaft in the fuel injection pump. The fuel injection pump is directly driven by gears via camshaft.
 ⑤ The air compressor is mounted on one side of the exhaust pipe in front of the gear box.

WD618 engine is developed on the basis of WD615 by increasing the stroke. Its overall configuration is similar to that of WD615 with the following differences:

III. Main structural features of WD618 diesel engines

Model	Rated power kW	Rotating speed rpm	Max. torque Nm	Rotating speed rpm	Min. fuel consumption g/kWh	Weight kg	Type of cylinder head
WD61836	265	2,200	1,500	1,300-1,600	198	905	2-valve*
WD61839	287	2,200	1,600	1,300-1,600	198	905	2-valve
WD61882	309	2,200	1,750	1,300-1,600	198	905	2-valve
WD61844	323	2,200	1,850	1,300-1,400	195	915	2-valve

Table 2-17 Performance parameters of WD618 diesel engines

Item	Cylinder bore mm	Stroke mm	Displacement L	Mode of air intake	Average piston speed m/s	Performance per litre kW/L	Compression ratio	Type of starting	Type of lubrication	Type of cooling	Lubricating oil capacity L
Model	126	155	11.6	Inter-cooling	11.36	22.8	16.5:1	Electric starting	Pressure lubrication	Water-cooling forced circulation	27
WD61836						22.8	24.7				
WD61839						26.6					
WD61882						27.8					
WD61844											

Table 2-16 Technical specifications of WD618 diesel engines

II. Main performance parameters and technical specifications, see Table 2-16 and Table 2-17

The rocker arm system of WD618 two-valve diesel engine is basically the same as that of WD615. But that of WD618 four-valve diesel engine differs greatly. A valve bridge is used to ensure that the two intake valves or two exhaust valves in the rocker arm system of WD618 four-valve diesel engine open at the same time. There are two types of valve bridges (different in structure). One is an all-in-one type with the top of the valve bridge in contact with the rocker head hardened; another type of the valve bridge is composed of two parts, i.e. a hard piece is fit on

7. Rocker arm system

The bearing of the intermediate gear shaft is sliding bearing which is lubricated by force.

6. The structure of intermediate gear shaft

thermostats to form water circulation.

from the rear end face of the head of No.6 cylinder. The two water flows flow separately to two independent drawn from the front end face of the head of No.1 cylinder, and water from No.4, No.5 and No.6 cylinders is drawn guarantee uniform water supply and appropriate water temperature, water from No.1, No.2 and No.3 cylinders is cylinder head. Both ends of connecting pipe are inserted and sealed into the water-crossing holes. In order to heads will be used instead of the water-crossing pipe. There is one 50mm water-crossing hole at either side of the There is no external water outlet pipe on WD618 four-valve engine. The connecting pipe between the cylinder pipe is set. The water-crossing pipe also functions to locate the cylinder head and the cylinder block.

crossing hole between the cylinder head and the cylinder block. Inside the water-crossing hole a water-crossing positioning the four intake valves and providing sufficient strength for the cylinder head. There is a 24mm water-of the cylinder head of WD618 four-valve engine have been changed greatly. The changes are made mainly for but the intake and exhaust passages are changed. The cooling water jacket and the intake and exhaust passages The main structure of the cylinder head of the WD618 two-valve engine is basically the same as that of WD615.

5. Cylinder head

chamber volume of WD618 four-valve engine is 106 ± 0.75 ml.

located at the center of the cylinder, hence the piston center is also at the center of the cylinder. The combustion combustion chamber volume and shape are different. As the center of the fuel injector of the four-valve engine is size of the piston skirt of the WD618 four-valve engine is exactly the same as that of the two-valve engine, but the engine, but the combustion chamber volume has been increased to 104.9 ± 0.75 ml (that of WD615 is 84 ml). The of the WD615 engines. The structure of the piston used on WD618 two-valve engine is similar to that of the WD615 420 hp, and the other used on four-valve diesel engines. The material of both types of pistons are the same as that WD618 engines have two types of pistons different in structure. One is used on two-valve diesel engines below (2) Piston

structural parameters are the same as those of WD615 engine.

between the holes in the big and small ends is increased to 253mm (that of WD615 engine is 219mm), and other engine, but the bolt length is increased from 60mm to 67.5mm. As the stroke is increased, the center distance of the connecting rod. The connecting rod bolt is still M14 $\times$ 1.5, and its material is the same as that of WD615 piston pin, the connecting rod bushing and the piston pin boss are lubricated by the slant structure of the small end The small end of the connecting rod of WD618 is wedge-shaped and has no lubricating orifice in the top. The

(1) Connecting rod

4. Piston and connecting rod

of the WD618 diesel engine crankshaft are the same as those of the WD615 engines. of lubrication, but also increased the strength of the crankshaft journal. Other structure parameters and the material experiment shows that the reduction of the number of the lubricating oil orifices can not only meet the requirement orifices in the main journal and connecting rod journal are reduced from 2 to 1. The result of calculation and 100mm to 104mm. The connecting rod journal is increased from 82mm to 83mm. The number of the lubricating oil dimensions and local structure of the crankshaft of WD618 engine are changed. The main journal is increased from In order to meet the requirement on the strength of the crankshaft as the power of the engine is increased, the

its top.

8. Cooling system

The cooling system of WD618 engine includes water pump, fan, thermostat, plate-fin type lubricating oil cooler, cooling water pipelines, etc.

(1) Water pump

The water pump is still located at the front end of the engine. As there are many accessories at the front end of the engine, the structure of the water pump has been changed a lot so as to facilitate the location of these accessories. The water pump casing of WD615 engine is located on the gear box. Its structure is rather compact. WD618 adopts a separate water pump. Water out from the pump flows into the engine body cooling water jacket through water passage in the gear box.

(2) Fan

The fan is driven by a belt. The fan bracket is fixed on the gear box. Changing the structure of the fan bracket may get different fan rotating speed and height so as to meet the requirements for cooling and installation. This kind of structure has also eliminated the impact of fan load to the water pump bearing.

(3) The structure of thermostat

The structure of the thermostat of WD618 two-valve engine differs from that of the four-valve engine. The lower housing of the thermostat of WD618 two-valve engine is forged together with the water outlet pipe, two same elements of the thermostat are mounted inside its lower housing, there is a water outlet pipe on the top cover of the thermostat, and the outlet pipe is connected to the water tank. Water out of No.1, No.2 and No.3 cylinder heads enters a thermostat, and water out of No.4, No.2 and No.6 cylinder heads enters another thermostat. The two thermostats are connected in parallel. The opening temperature of the thermostat is 79°C, full-open temperature is 90°C, and its minimum travel is 8mm.

(4) WD618 diesel engine cooling water passage

Water out of the water pump flows into the engine body through a long water passage in the gear box. It first cool the oil in the plate-fin type lubricating oil cooler, enter the cooling water jackets of various cylinders to cool the cylinder block, then enter the cylinder head through water-crossing hole to cool the cylinder head, and finally enter water pump or water tank through outlet pipe or water-crossing pipe for circulation.

9. Lubricating system

The lubricating system of WD618 diesel engine is basically the same as that of WD615 with the following features:
① In order to increase the cooling efficiency, The plate-fin type lubricating oil cooler more compact in structure is adopted.

② Main bearing shell and connecting rod bearing shell with grooves are adopted, that increased the reliability and prolonged the service life of the bearing shells.

③ The intermediate gear uses sliding bearing with pressure lubrication.

④ The water pump uses sliding bearing with pressure lubrication. The lubricating oil flow is secondary oil passage water pump fuel injection pump. The lubrication oil return pipe is removed. Oil flows back to the gear box through the flange face at the side of the fuel injection pump.

⑤ The structure of the oil pump is similar to that of WD615 diesel engine. The gear width of the oil pump is 53mm. However, its gear and shaft are of all-in-one structure.

⑥ In order to meet the requirements of cooling and lubrication, the capacity of the oil pan is 27L.

10. Fuel supply system

(1) Fuel injection pump drive system

As compared with WD615, the fuel injection pump drive system of WD618 has changed greatly. WD618 diesel engine uses a flange-mounted fuel injection pump, which is directly fixed on the gear box of the engine. The crankshaft gear drives the gear of the fuel pump via the intermediate gear. The angle of fuel supply commencement

(3) Features of fuel injection pump of WD618 diesel engines

WD618 two-valve diesel engine adopts conventional fuel injection pump (with DV) and conventional governor. The main structure of the fuel injection pump is the same as that of WD615 engine. WD618 four-valve diesel engine adopts fuel injection pump without delivery valve (RDV), and the governor is type RDV-K.

RDV fuel injection pump has the following three features: 1) It can guarantee higher fuel supply pressure; 2) The pressure inside the fuel pipe is comparatively low when fuel injection is stopped, and there is not secondary injection; and 3) In the fuel system using such fuel pump, there is no need to use a fuel injector return pipe.

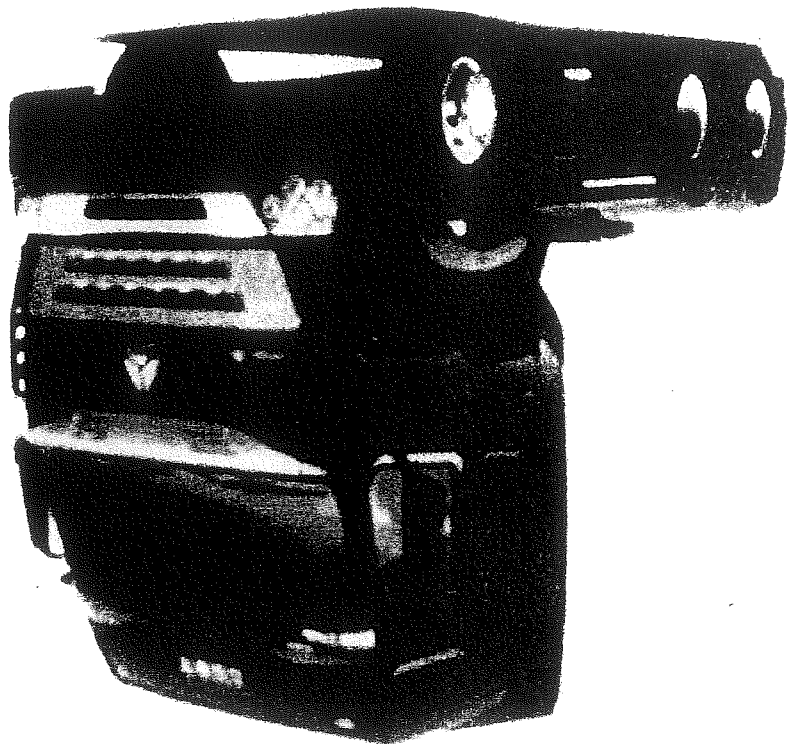
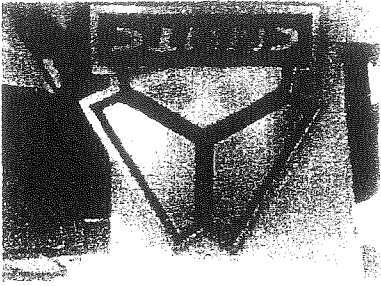
Item	Model	Type of fuel injection pump			
		PE6P120A	720RV17	429RP25	
Type of fuel delivery valve		2418552069	2418552063	2418552063	
Volume of fuel delivery valve mm ³		100	120	120	
Plunger diameter mm		12	12	12	12
Type of governor		RQ300/110PA V18461			
Pump end pressure Mpa		105	105	105	105
The opening pressure of the fuel injection nozzle Mpa		25	25	25	25
Fuel orifice size		7 × 0.282 × 155°			
High-pressure fuel pipe		φ 6 × 2	φ 6 × 2	φ 6 × 2	φ 6 × 2.25

Table 3 The main parameters of fuel supply system of WD618 diesel engines

The main parameters of fuel supply system are given in Table 3.

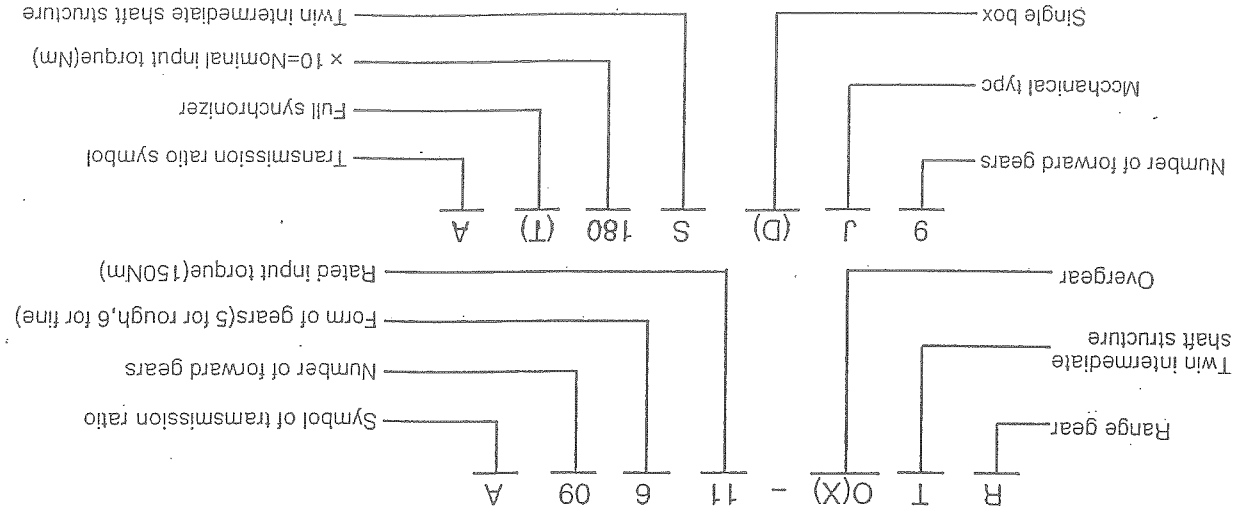
(2) Main parameters of fuel supply system

will be maintained by the scale lines on the locating pin and the gear. The drive system change is made on the following considerations: Firstly, in order to guarantee accurate angle of fuel pump of WD615 is composed of such elastic parts as drive shaft, coupling, etc. They can not guarantee that the angle of fuel supply commencement remain unchanged during the operation of the diesel engine. Besides, the air compressor in the drive system of WD615 engine is driven by the fuel pump gear and the compressor in operation is an impact load. This also exhibits some difficulty to guarantee the accuracy and steadiness of the angle of fuel supply commencement. As for the drive system of WD618 engine, the fuel pump gear drives the water pump gear. Because the load of the water pump is constant, there is no impact load, and it is good for ensuring the accuracy of fuel supply. Secondly, in order to meet the requirement of emission, the pump end pressure of the fuel injection pump of WD618 engine may reach 105Mpa. It is a big increase as compared with WD615 and the impact load is also increased remarkably. If we still adopt the driving form and structure of WD615, it would certainly result in deformation and unreliability of the elastic system.



MANUAL DE REPARACION DE Caja de Cambios SINOTRUK HOWO

Gearbox RT11509C is the basic form. Series of products with different input powers and different input torques



shaft and main shaft gears.

The FASTgearbox manufactured by Shaanxi Fast Gear Co., Ltd., with the technique introduced from American Eaton Company is an advanced rational product with complete series. FASTgearbox is a mechanical gearbox with high power, high torque and multi gear positions. It has introduced the design of combination of main box and auxiliary box and the design of single box with the structure of twin intermediate shaft drive and float-type main

SECTION 1 FAST GEARBOX

1. General

The heavy-duty vehicles made by China National Heavy Duty Truck Group Co., Ltd. (CNHTC)(SINOTRUCK) are now equipped with either of the following two kinds of gear boxes: one is the FASTgearbox manufactured by Shaanxi Fast Gear Co., Ltd. Shaanxi Fast Gear Co., Ltd., and the other is the QJ gearbox made by the Qijiang Gear Co., Ltd.

Transmission is a major unit assembly in the drive system of a vehicle. The complex operating conditions of a vehicle require that the driving force and speed of the vehicle should be able to vary within certain range. Transmission is the mechanism in the drive system that can change the torque and rotating speed. Its basic functions are as follows:

1. Changing the torque and speed transmitted from the engine to the driving wheel so as to meet the requirement of various driving conditions of the vehicle.
2. Realizing backward driving of the vehicle under the condition that the engine does not change its rotating direction.
3. Cutting off the power link of the engine with the drive system under the condition that the clutch engages.

CHAPTER 4 TRANSMISSION

Fig.4-1

The power transmission paths of the gears of FAST gearbox of twin intermediate shaft series are shown in

No.	Type	Climb	Transmission Ratio of the Gears											Mass	Fuel Consumption
			Low	1	2	3	4	5	6	7	8	Reverse	(kg)		
1	7DS100		9.20	5.43	3.54	2.53	1.82	1.33	1.00		8.49	255	13		
2	7DS100A		6.93	4.09	2.67	1.91	1.37	1.00	0.75		6.40	255	13		
3	7DS100B		8.17	4.82	3.14	2.09	1.44	1.00	0.82		7.54	255	12		
4	7JS100		10.63	7.04	4.63	3.36	2.09	1.38	1.00		10.58	255	12		
5	7JS100A		8.03	5.32	3.36	2.45	1.58	1.00	0.756		8.00	255	12		
6	8JS100B		11.40	7.94	5.63	4.06	2.81	1.96	1.39	1.00	11.35	255	12		
7	8JS118		11.40	7.94	5.63	4.06	2.81	1.96	1.39	1.00	11.35	255	12		
8	8JS118A		9.34	6.09	4.06	3.10	2.30	1.55	1.00	0.76	9.28	255	12		
9	RT11509C		12.42	8.26	4.53	3.36	2.47	1.81	1.35	1.00	12.99	270	13		
10	9JS180		12.65	8.38	4.57	3.40	2.46	1.83	1.34	1.00	13.22	300	12		
11	9JS180A		10.69	7.08	5.25	3.40	2.68	2.08	1.55	1.00	0.789	300	13		
12	8JS100T		10.31	7.33	5.09	3.77	2.73	1.94	1.35	1.00	10.26	255	13		
13	8JS130T		10.31	7.33	5.09	3.77	2.73	1.94	1.35	1.00	10.26	300	13		
14	8JS180T		10.31	7.33	5.09	3.77	2.73	1.94	1.35	1.00	10.26	300	13		
15	8JS100TA		8.12	5.77	3.77	2.98	2.15	1.53	1.00	0.79	8.08	255	13		
16	8JS130TA		8.12	5.77	3.77	2.98	2.15	1.53	1.00	0.79	8.08	300	13		
17	8JS180TA		8.12	5.77	3.77	2.98	2.15	1.53	1.00	0.79	8.08	300	13		

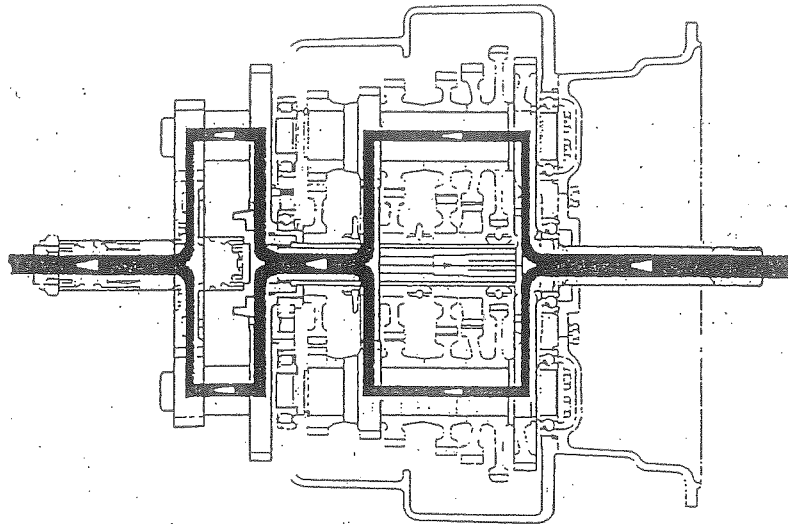
Table 4-2

Transmission Series	Rated Input Power (kW)	Rated Input Torque Nm	Maximum Input rpm
RT11509C series	265	1490	2600
7DS100.7(8)JS100(T) series	199	1000	2600
8JS118 series	220	1180	2600
8JS130T series	243	1300	2600
9JS180/8JS180T series	331	1800	2600

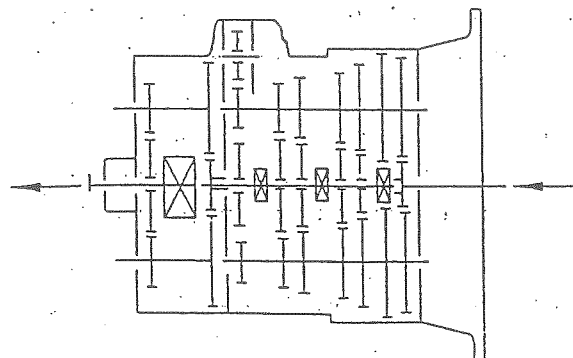
Table 4-1

For the primary performance of FAST gearbox of twin intermediate shaft series, see Tables 4-1 and 4-2.
have been developed to meet the requirements of various types of vehicles.

Fig. 4-1 Power Transmission Diagram of the Gears of FAST Gearbox



Low	1	2	4	3	5	6	8	Reverse
RT-11609B	RT-11609A	RT-11609E	RT-11609F	9JS180A	9JS180	9JS220A		
Low	1	2	4	3	5	6	7	8
Reverse								



II. Structural Features

FAST gearbox has an unique power transmission form and high torque. Now let's take the RT11509C gearbox as example to explain the structural features.

① FAST Gearbox RT11509C is made up of a forward main box with 5 forward gears and a reverse gear and a two-gear auxiliary box. Its outstanding feature is that both the main box and the auxiliary box adopted the twin intermediate shaft structure, which has changed the traditional single intermediate shaft structure and brought about a series of advantages. See Tables 4-1 and 4-2.

Power is inputted from the input shaft, and diffused to the two intermediate countershafts, then diffuses at the principal shaft to output. The principal shaft of the main box is just the input shaft of the auxiliary box. The auxiliary box repeats the power transmitting process of the main box. Finally, the power is outputted by the output shaft of the auxiliary box. Since each of the intermediate shafts only transmits half of the torque, this transmission form has improved the force applied on the gears, making the tooth width reduced by 40%, the axial length of the gearbox reduced, providing the drive system with convenience of power transmission.

② In order to make the gear of the principal shaft mesh correctly with the gears of the two intermediate shafts and distribute the load evenly, the gears of the principal shaft float radially on the principal shaft. The needle bearing between the bore of the gear and the principal shaft is abolished, making the structure greatly simplified and operating failure reduced. See Fig. 4-3.

The principal shaft adopts a float structure of swivel joint type. The journal of the principal shaft is inserted into the hole in the input shaft. There is a clearance of 1.12mm between the journal and the bore of the input gear. During operation, the radial forces applied by the gears of two intermediate shafts on the gear of the principal shaft are equal in magnitude and opposite in direction, they counteract each other. It makes the principal shaft only transmits the torque without bearing bending load. Thus the shaft can be made thinner. The force bearing condition of the bearing and the housing is improved.

③ Owing to the fact that the gear drive of the two intermediate shafts is more in equilibrium and the gears bear less force, straighttooth transmission is introduced, making the structure simplified.

④ Sliding joint sleeve is generally adopted in gear shifting in the main box, see Fig. 4-5. The joint sleeve is put on the principal shaft through involute splines. The movement of the joint sleeve makes the joint teeth on the joint sleeve mesh with the internal joint teeth of the gear on the principal shaft to transmit the power. There is the same taper angle of $\alpha = 35^\circ$ at the ends of the teeth of the joint sleeve and the internal joint teeth of the principal shaft gear. Since the principal shaft gear and the principal shaft are in floating position, the friction between the two taper angles offer synchronization at certain degree during gear shifting.

Synchronizer of inertia lockpin type is adopted in the auxiliary gearbox. Gear shifting is operated pneumatically. The structure of the synchronizer is as shown in Fig. 4-4. Three dowels 4 and 7 are riveted on the balking ring 2 of high gear and the balking ring 6 of low gear respectively. The sliding toothed sleeve 3 engages with the output shaft of the auxiliary gearbox through splines. The matrices of high gear balking ring and low gear balking ring are made of sintered iron basis powder metallurgy by forging. Non-metallic material with high friction performance is bonded on the internal conical surface high gear balking ring and external conical surface of low gear balking ring. There are corresponding external conical surface and internal conical surface between the driving gears and the reduction gears of the auxiliary gearbox.

Fig. 4-3 Schematic Diagram of Floating Structure of Principal Shaft
1. Principal shaft 2. Input shaft 3. Gear of input shaft 4. Driving gear of auxiliary gearbox

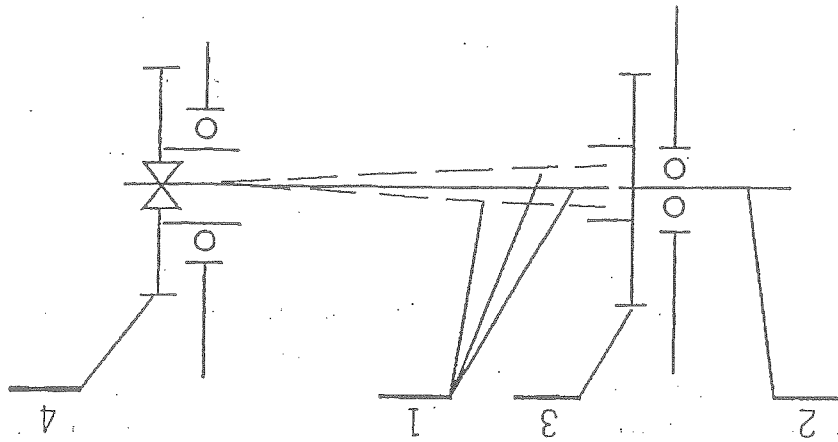
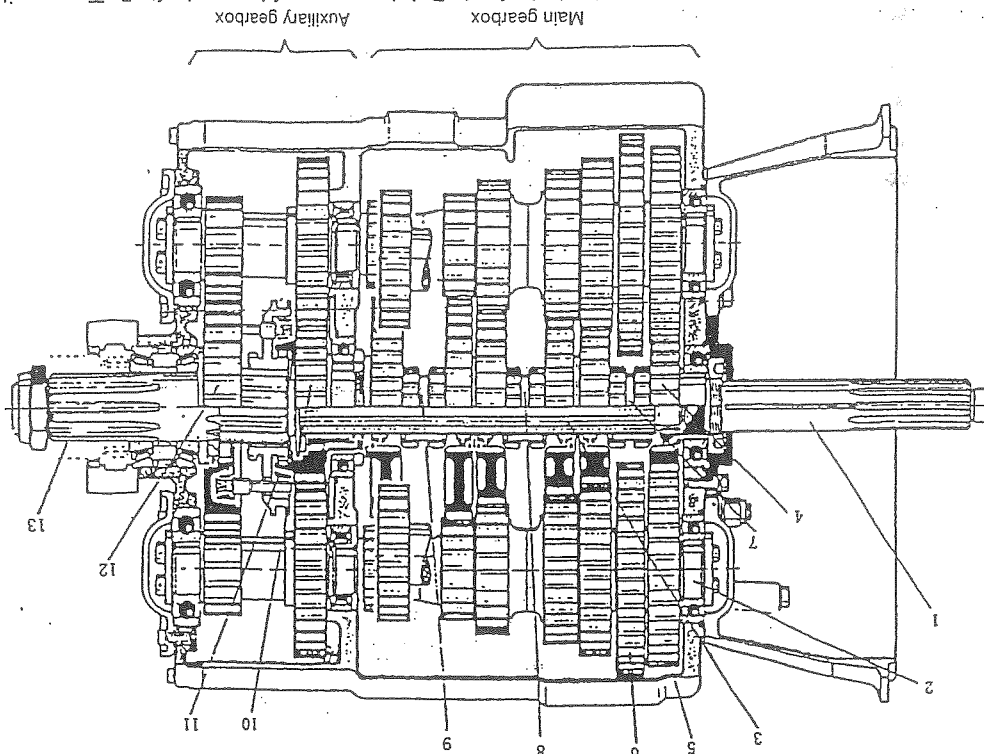
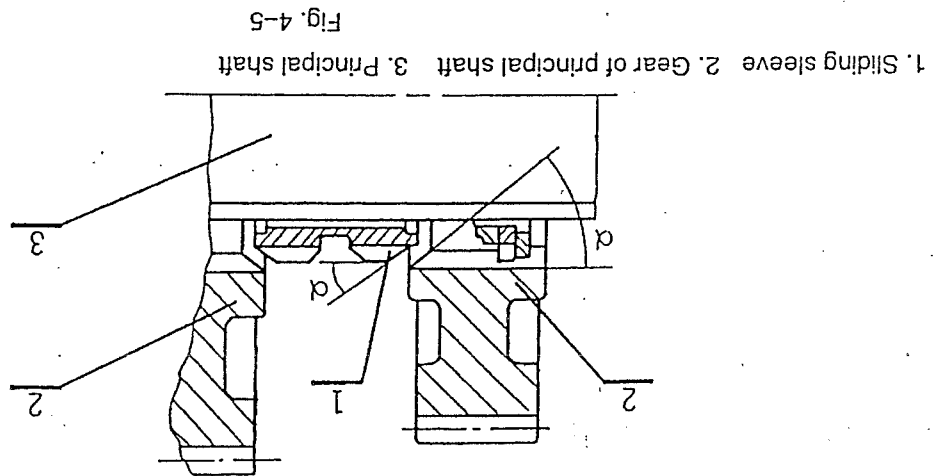


Fig. 4-2 Twin Countershaft Structure of FAST RT-11509C Gearbox

1. Input shaft 2. Intermediate shaft 3. Principal shaft 4. Driving gear of input shaft 5. Transmitting gear of intermediate shaft 6. Shaft-driven gear of the intermediate shaft 7. Sliding joint sleeves of 3rd and 4th gears (7th and 8th gears) 8. Sliding joint sleeves of 1st and 2nd gears (5th and 6th gears) 9. Sliding joint sleeves of reverse gear and creep gear 10. Driving gears on input shaft of auxiliary gearbox 11. Synchronizers of high and low gears 12. Gears of low gear 13. Output shaft

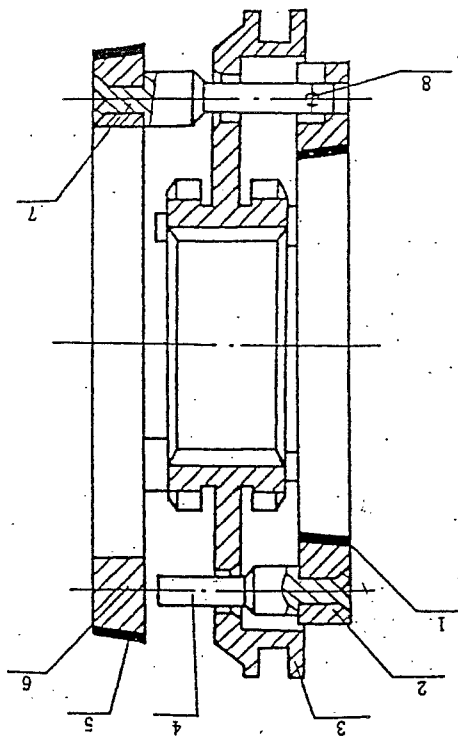




it will do if you pressed down the pedal to the position where you feel distinct resistance. reduced. The intermediate shaft brake is allowed to be used only in starting. When the clutch separates normally, force, they will soon stop moving after being braked. Thus the time for the driver to wait for engaging gear is the end of the gear tooth, and friction occurs between them. Since the gear and the shaft are rotating under inertial valve, pushing the piston to the braking gear of the countershaft. The braking surface of the piston leans against end. The pedal arm opens the clutch braking valve (a button valve). Compressed air flows into the clutch braking After pressing down the clutch pedal and overcoming distinct resistance that can be felt, press the pedal to the shaft braking device is consequently added, that is, the starting synchronizer. See Figs. 4-6 and 4-7.

Fig. 4-4 Synchronizer Assembly

1. High gear friction band 2. High gear synchronizing ring 3. Sliding toothed sleeve 4. High gear dowel 5. Low gear friction band 6. Low gear conical ring 7. Low gear dowel 8. Spring



The main box employs the gearbox control unit of the combination of "double H" gear shifting mechanism and gear shifting control mechanism of high and low gears of the auxiliary gearbox. See Figs. 4-8 and 4-9.

⑥ Control device

Fig. 4-7 Structure of Intermediate Shaft Brake

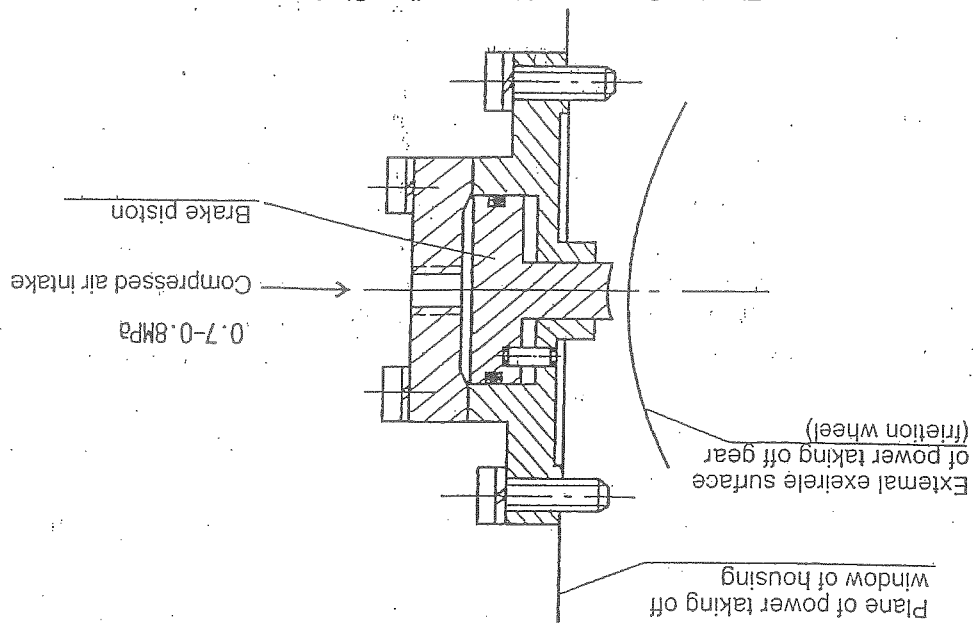
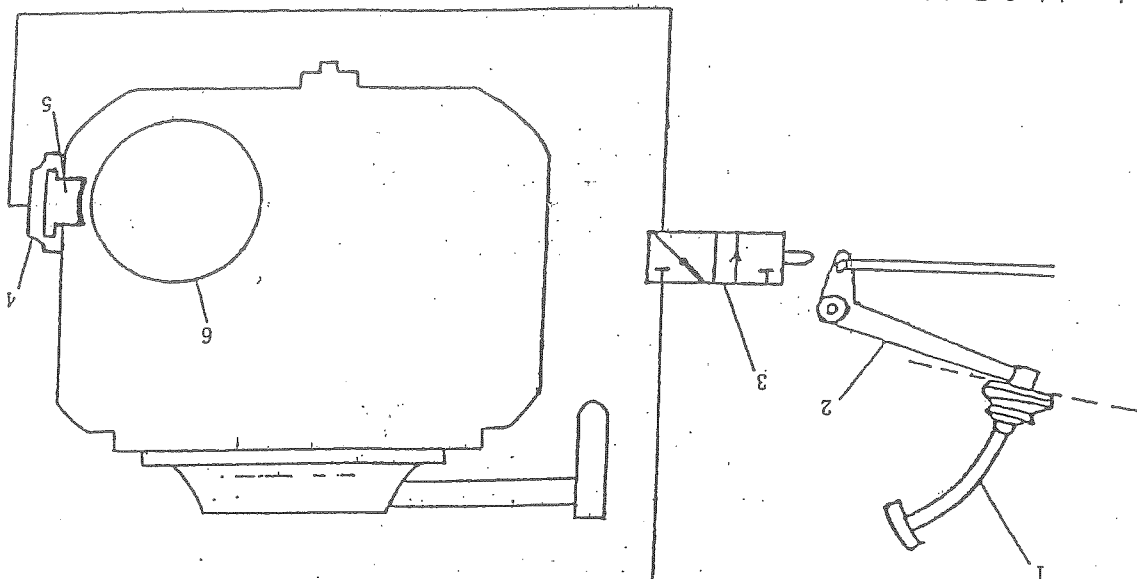


Fig. 4-6 Operation of Intermediate Shaft Braking Device

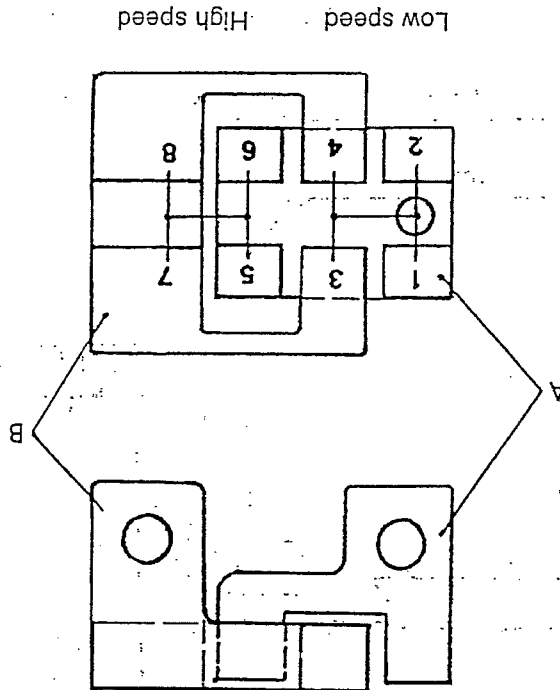
1. Clutch pedal 2. Pedal arm 3. Clutch brake control valve 4. Clutch brake valve 5. Piston 6. Auxiliary shaft brake gear



a) The double H gear shifting mechanism, as shown in Fig. 4-8, is one that in the gear shifting control unit, the gear shifting block for 1st-2nd gears (low speed) and 5th-6th gears (high speed) is made into one piece, and that for 3rd-4th gears (low speed) and 7th-8th gears is made into one piece. The 1st-2nd, 3rd, 4th, and 5th-6th, 7th-8th gears are simply arranged in an interlacing way, as shown in Fig. 4-8.

Two 3-way pneumatic valves (called double H gear shifting valve) are fitted in the gearbox cover. When they are, together with the deflector rod on gear shifting shaft, in the low gear section of 1st-2nd, 3rd-4th gears, the double H gear shifting valve supplies compressed air to Union 1 one low gear operating cylinder of the auxiliary gearbox gear shifting cylinder, and union 2 of high gear operating cylinder exhausts (See Fig. 4-10). The pneumatic valve of the low gear operating cylinder pushes the piston to draw back gear shifting shaft 5, controlling the sliding sleeve of the synchronizer to move backward to engage the low gear. When the deflector rod of the gear shifting shaft moves to the high gear position, the dummy club on the deflector rod pushes in the core of the double H gear shifting valve, making the air path of the valve changeover. At this moment, the double H gear shifting valve supplies compressed air to high gear operating union 2, and union 1 of low gear operating cylinder exhausts in turn. At this moment, piston 3 together with gear shifting rod 5 push forward, making the sliding sleeve engage with the high gear (direct gear).

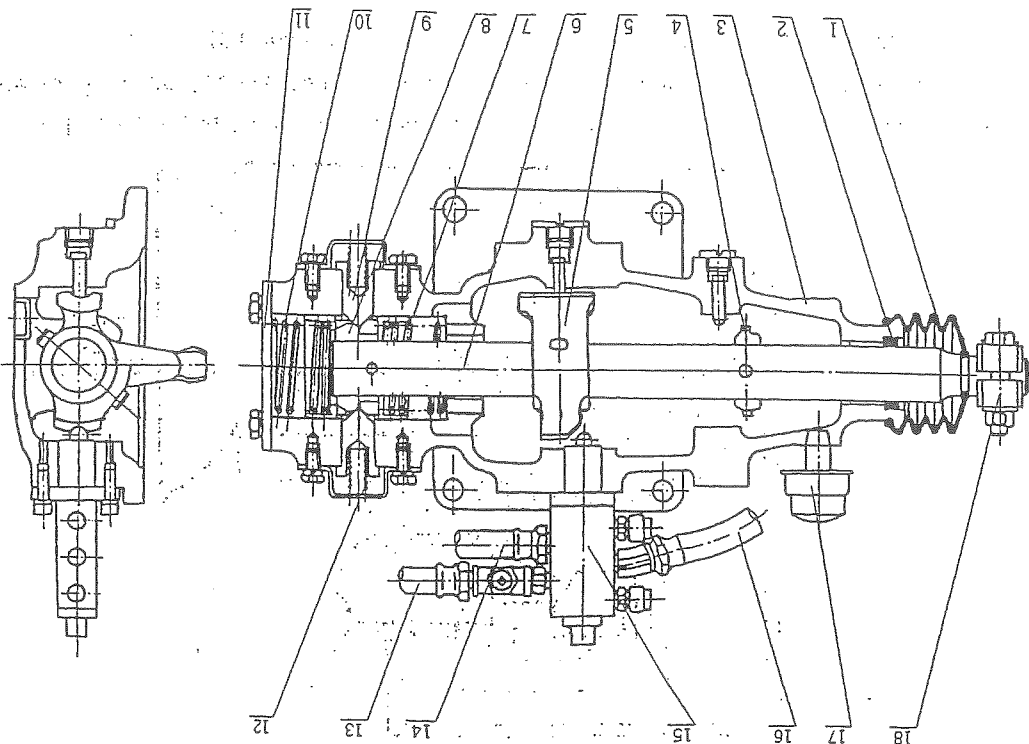
Fig. 4-8 Double H Gear Shifting Mechanism
A. Shifting block for 1-2(5-6), gears B. Shifting block for 3-4(7-8) gears



As shown in Figs. 4-8 and 4-9, when the gearbox is shifted to the 1st-2nd gears, it is the shifting block of the 1st-2nd gears that the shifting deflector rod pushes, the auxiliary gearbox is shifted to low gear, and the auxiliary gearbox is shifted to low gear. When the shifting deflector rod pushes the 3rd-4th gears, the shifting deflector rod pushes the shifting block of 3rd-4th gears, the auxiliary gearbox still engages with the low gear. When the gearbox is shifted to 5th-6th gears, the auxiliary gearbox is engaged with the high gears under the action of the double H gear shifting valve and the gear shifting cylinder. However, the shifting deflector rod of the main gearbox still pushes the shifting block of 1st-2nd gears at the 5th-6th gear position. In other words, the gearbox is pushed into the 1st gear from the 4th gear. Likewise, when the gearbox shifts to the 6th gear, the auxiliary gearbox engages with high gear, and the main gearbox engages with the 2nd gear, and the rest may be deduced by analogy. As shown in Fig. 4-8, two high and low gear positions of "H" shape, 1-2, 3-4 and 5-6, 7-8, are formed at the arranged gear positions of the shifting block. Hence it is called "double H" gear shifting mechanism.

Fig. 4-9 Sketch of Double H Control Unit

1. Dirt-proof boot 2. Oil seal 3. Housing of double H control unit 4. Control cam of reverse gear switch 5. Gear shifting block 6. Lateral gear shifting rod 7 & 10. Balancing springs 8. Locating ring 9. Locating plunger 11. Side board 12. Compression spring 13, 14 & 16 Air hoses 15. Double H pneumatic valve 17. Ventilation plunger 18. External gear shifting arm



As shown in Fig. 4-10, when the shifting block is at the low gear section, compressed air from the auxiliary passage goes through the pressure reducing valve in which the pressure is reduced to 4.1~4.4 bars, than it enters port 1 of the double H reversing valve. At this time, port 1 communicates with port 4, so the compressed

This system functions to bring the auxiliary gear box into the required gear section according to the lateral position of the shifting block.

b) The control system of the auxiliary gear box is mainly composed of the pressure reduction and filtering valve, the double H shifting valve and the shifting cylinder.

Fig. 4-11 Shifting Cylinder of High & Low Gears of Auxiliary Gearbox

1. Pneumatic union of low gear operation cylinder 2. Union of high gear operation cylinder 3. Gear shifting piston 4. O-ring 5. Gear shifting ring 6. O-ring 7. Gear shifting cylinder

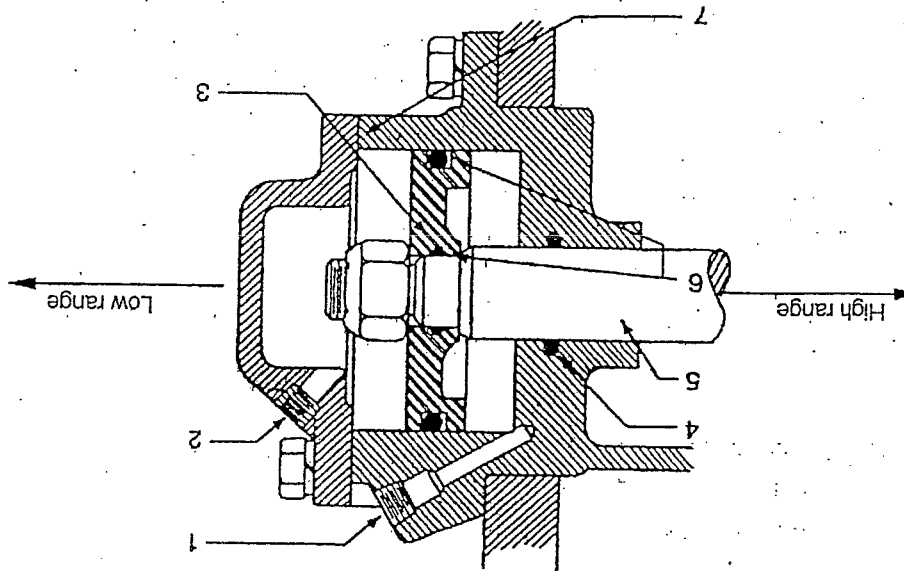


Fig. 4-10 Operational Principle of the Auxiliary Gearbox Control System

1. Gearbox 2. Pressure reduction and filtering valve 3. Double H changeover valve 4. Gear shifting cylinder of high and low gears 5. Piston 6. shaft of shifting fork 7. Gear shifting block 8. Gear shifting block

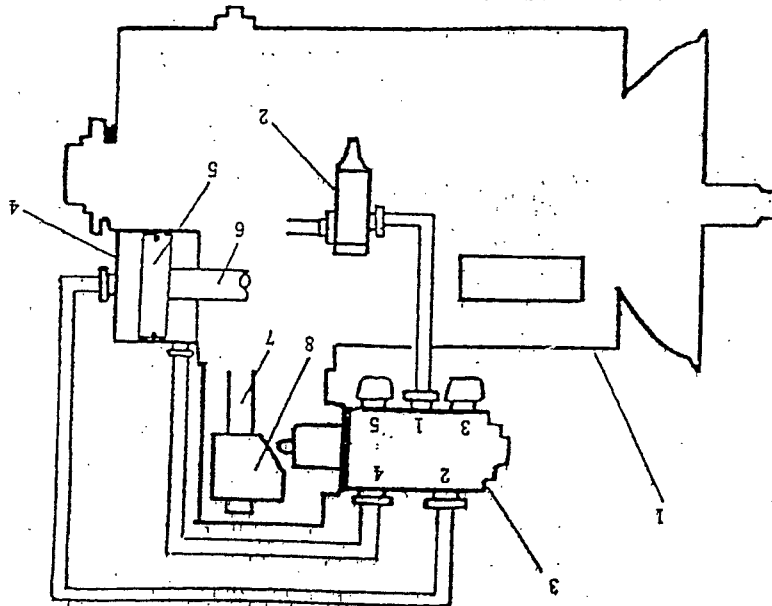
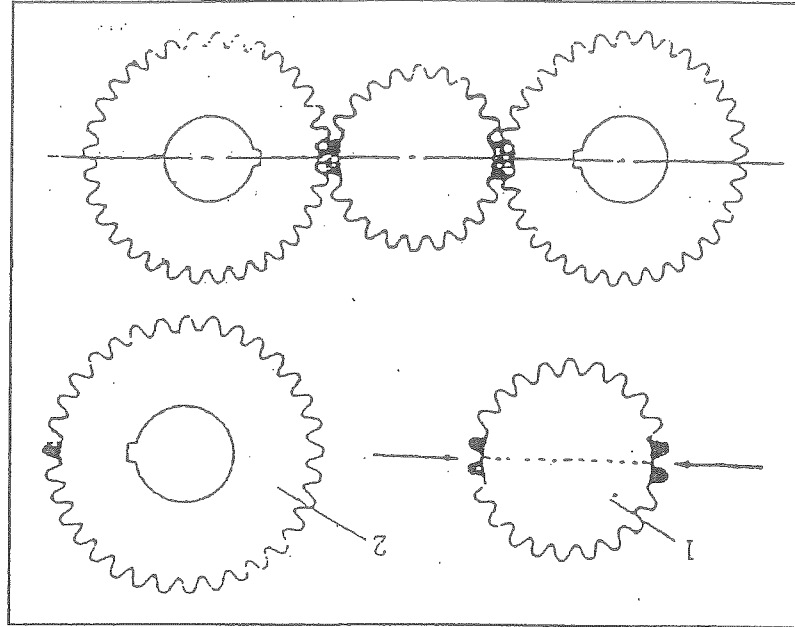


Fig.4-12 Sketch of Tooth Alignment of Gearbox with Twin Countershafts



The procedures of the operation are as follows:
a) Before assembling, make marks on any two adjacent teeth of the driving gear of the input shaft first. Then make marks on the two adjacent teeth on the opposite side which are symmetrical with the former two teeth. The number of teeth between the two marks should be equal. See upper-left of Fig. 4-12

Owing to the fact that both the main gearbox and auxiliary gearbox of the 'RAT' transmission employed the structure of twin intermediate shaft, when assembling the transmission after dismantling, it is imperative to make sure that all the gears on the two intermediate shafts mesh with the corresponding gears on the principal shaft simultaneously, and make the gears of the principal shaft locate on the center line of the principal shaft. To obtain this purpose, it is necessary to carry out tooth alignment to both the main gearbox and the auxiliary gearbox. Tooth alignment includes making marks on suitable teeth before assembling and making the teeth with marks mesh with each other in assembling.

1: Tooth Alignment and Procedures

III. Repair Features

that is, the 5th, 6th, 7th and 8th gears.
and 3rd-4th gears. Therefore, the high gears of the auxiliary gearbox make the transmission gain four more gears, the gear lever shifts to the 5th, 6th, 7th or 8th gear at high gear section, it still pokes the shifting shafts of 1st-2nd the auxiliary gearbox here is 1. Since the shifting block of the mechanical control unit has a special structure, when front of the piston is released through exhaust port 5 of the double H reversing valve. The transmission ratio of the synchronizer, it meshes into the output gear of the output shaft (the principal shaft) in the main gearbox. The air in shaft of shifting fork, the shifting fork and the sliding gear to move forward. After being synchronized by the and enters the shifting cylinder via the high gear pipe. The air pushes the piston forward, and the piston brings the shifting block pushes in the valve rod of the double H reversing valve, compressed air comes out from port 2 When the shifting block moves laterally rightward, the shifting shaft brings the shifting block to move axially, the auxiliary gearbox now is 3.35, rotating speed of the output shaft is reduced.

- b) Draw marks on the teeth, which is in line with the key way, of the driving gears of each intermediate shaft. See upper-right of Fig. 4-12.
- c) In assembling, make the teeth with marks mesh with each other. In this way, the gears of the principal shaft and the gears of the two intermediate shaft are ensured to mesh with each other simultaneously, and the gear of the principal shaft is made in alignment on the axle, as a result, it can transmit power correctly.
- The gear pair of the auxiliary gearbox that need tooth alignment differ with their types.
- Generally, the pair of gears at the back of the auxiliary box are selected to perform tooth alignment. The method of tooth alignment is the same with that of the main gearbox.
- 2. Key Points for Disassembling:**
- a) Bearings: It is necessary to clean them carefully, and apply lubricant on the bearings taken down. Seal and wrap them up for future use. Special extractor should be used when removing bearings.
- b) Unit Assemblies: When removing various assemblies, e.g. the second shaft, the intermediate shaft and the top head of the shifting fork lever, it is essential to put the parts on a clean worktable in the sequence of disassembling. By so doing, it will simplify the procedures of reassembling, and reduce the possibility of losing parts.
- c) Snap rings: Special purpose hand pliers should be used. The snap rings removed in this way can be used again.
- d) The first shaft can be removed independently, without the necessity of removing the intermediate shaft, the second shaft or the first shaft.
- e) Cleanliness: It is necessary to provide a clean site for working. It is important to prevent dust and foreign matters from entering into the unit. It is necessary to clean the exterior of the unit carefully before starting disassembling. Dust is a kind of abrasive. It can damage the bearings.
- f) Shock absorbing implement should be used when assembling by applying pressure on the parts such as the shaft and the housing. Don't apply pressure before the part is placed steady.
- 3. Inspection of the Wearing Parts**
- Before reassembling the transmission, it is necessary to check specific parts carefully so as to see if there is damage in the parts. Damaged parts should be replaced so as to ensure that the unit has a maximum service life after reassemble.
- a) Bearings
- 1) Wash all the bearings in clean solution. Check the steel balls, rollers and the bearing retainer for pockmark and flake. Replace the damaged parts.
- 2) Lubricate the undamaged parts and inspect the axial and radial clearances. Replace the bearings with great clearance.
- 3) Check the matching of the bearing with hole in the case. If the external ring can rotate freely in the hole, the case should be replaced.
- b) Gears
- 1) Check the tooth faces for pitting corrosion. The gears with pitting corrosion of its tooth face should be replaced.
- 2) Check all the mating gear teeth. All the gears should be replaced provided that the gears become conical and the engaging length is reduced due to the impacting in gearshift.
- 3) Check the gears for axial clearance. If a great clearance is found at a place, it is necessary to check the snap ring, washer, adjusting spacer of the gear and the gear's flange to see if there is too much wear.
- There should be an axial clearance of 0.13 to 0.30mm kept for the forward gear of the second shaft. And the clearance for the reverse gear should be 0.30 to 0.90 mm.

- c) Bearing sleeve
- 1) The annular sleeve must be replaced in case pitting corrosion, burn or too much wear occurs on them.
 - 2) The radial clearance and the clearance between the sleeve and the shaft should be only 1.12 mm.
- d) Splines
- 1) Check all the splines on the shaft for wear. If the sliding toothed sleeve, engaging flange and the clutch flange all deflect to the splines due to wear, the shaft should be replaced in such a case.
- e) Thrust washer
- Check the surface conditions of all the thrust washers. The washer should be replaced if there is scratch on them or the thickness is reduced.
- f) Gears of reverse gear and medium gear of reverse gear Check the wearing condition of the bearing sleeve according to the movement of the roller bearing.
- g) Parts of grey cast iron
- Check all the parts of grey cast iron for crack and damage. The damaged parts should be replaced or repaired. Large castings can be melting welded or blazed, but the thermal crack reduced should not stretch to the bearing hole and the joint surface of bolts.
- h) Release parts of clutch
- Check the release parts of clutch, shifting yoke and bearing bracket. Check the pedal shaft. Replace the parts with serious wear on their pressure bearing surfaces.
- i) Shifting top head
- 1) Check the contact surfaces of the shifting fork and the shifting block for wear. Replace the worn parts.
 - 2) Check the shifting fork for straightness accuracy. Align the warped parts in them.
 - 3) Check the shifting fork for excessive wear and replace the worn parts.
 - 4) Check the set screws of the shifting fork and shifting block. Tighten the loosened screws and fasten them with iron wire.
- 5) Check neutral notch on the shifting fork and see if the wear has made it disengage with the locking steel ball. If the place near the neutral notch has become saw-teeth shape, the shifting fork lever should be replaced.
- j) Gearlever
- 1) Check the spring tension on the gearlever. If the gearlever is too loose, replace the compression spring and washer.
 - 2) Check the central pivot pin or cotter pin of the top head and the corresponding mating hole in the gearlever for wear. Replace the worn parts.
- k) Bearing cap
- 1) Check the bearing caps for wear and replace the worn bearing.
 - 2) Check the bearing holes for wear. Replace the parts out of tolerance due to wear.
- l) Scavenge helical lines and oil seal
- 1) Check the scavenge helical lines on the front bearing cap. If oil-sealing function of the helical lines is damaged due to contacting with the first shaft, replace the cap. Check oil seal for damage and replace it in case of necessity.
 - 2) Check the oil seal for the axle on the odometer case. If the sealing action of the lip section fails, replace the sealing member.

- m) Synchronizer
- 1) Check the synchronizers of high and low gears for burrs and excessive wear at the uneven place and the contact surface.
 - 2) Check the dowel for excessive wear and degree of tightness.
 - 3) Check the synchronizers of high and low gears for excessive wear. Ablative synchronizer and gears of high and low gears with ablative contact surface should be replaced.
 - n) Sliding bush
 - 1) Check all the shifting forks and the grooves of the shifting forks on the sliding bush for excessive wear.
 - 2) Check the coupling teeth of the sliding bush and see if the zone of contact declines.
 - o) Front bearing cap
 - Check the inside lug of the front bearing cap, and observe the wearing condition due to the backward movement of the nut of the first shaft gear.
 - p) O-ring

Check all the O-rings for rupture and deformation. Replace them in case of necessity.

4. Key points for assembling

Make sure that the inside of the case and the caps has been well cleaned. The following precautions must be abided in the process of assembling.

- 1) Gaskets—New gaskets should entirely be used in reassembling. Insufficient gasket will cause oil leakage or declination of the bearing cap.

- 2) Screws—To prevent oil leakage, screw sealant must be applied to all the screws. Torsion moment should be performed according to corresponding values of the screws and nuts.

- 3) O-rings—Lubricate all the O-rings with lubricant.

- 4) Initial lubrication—In the process of assembling, all the thrust washers and splines on the shafts should be smeared with grease so as to prevent scratching and wearing.

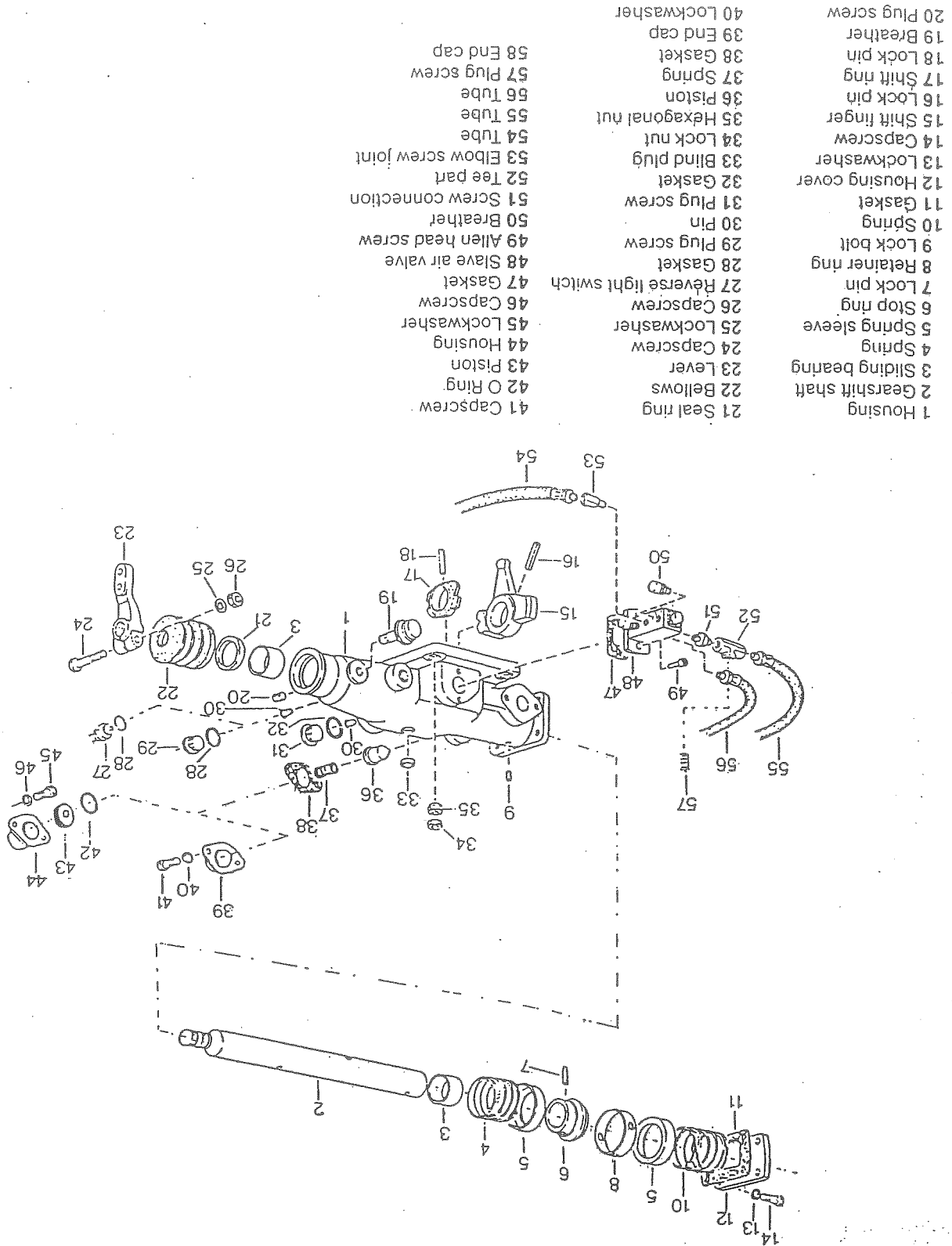
- 5) Axial clearance—Keep a axial clearance of 0.13 to 0.30 mm for the tooth wheel of the

second shaft forward gear. And the minimum clearance for the tooth wheel of the second shaft reverse gear should be 0.30 to 0.90 mm.

- 6) Bearings—It is recommended to use special tools in mounting the bearings. By using the special tool, force will be applied to the inner and outer rings simultaneously, thus the steel balls, the inner ring and the outer ring are prevented from being damaged, and concentricity of the bearing, the shaft and the hole is retained.

- 7) Tighten up the output flange with a torsion moment of 610 to 680 Newton meter (NM).

THE DOUBLE H SHIFTING UNIT

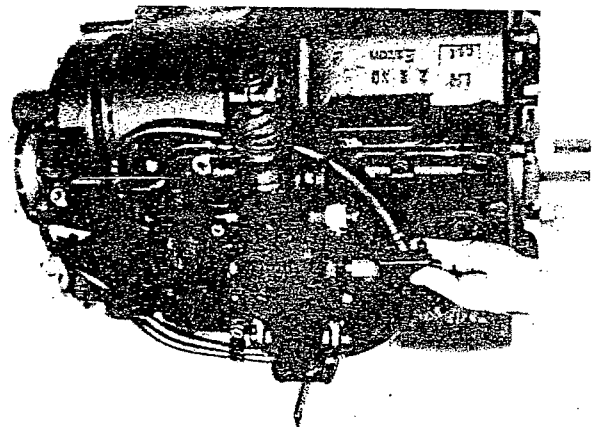


- 1 Housing
- 2 Gearshift shaft
- 3 Sliding bearing
- 4 Spring sleeve
- 5 Stop ring
- 6 Lock pin
- 7 Retainer ring
- 8 Lock bolt
- 9 Plug screw
- 10 Spring
- 11 Gasket
- 12 Housing cover
- 13 Lockwasher
- 14 Cap screw
- 15 Shift finger
- 16 Lock pin
- 17 Shift ring
- 18 Lock pin
- 19 Breather
- 20 Plug screw

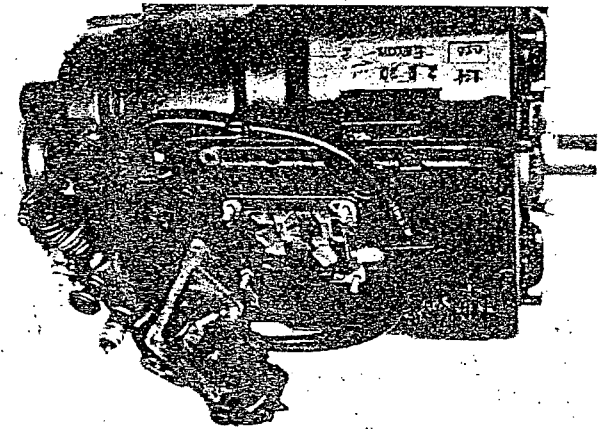
- 21 Seal ring
- 22 Bellows
- 23 Lever
- 24 Cap screw
- 25 Lockwasher
- 26 Cap screw
- 27 Reverse light switch
- 28 Gasket
- 29 Plug screw
- 30 Pin
- 31 Plug screw
- 32 Gasket
- 33 Blind plug
- 34 Lock nut
- 35 Hexagonal nut
- 36 Piston
- 37 Spring
- 38 Gasket
- 39 End cap
- 40 Lockwasher
- 41 Cap screw
- 42 O Ring
- 43 Piston
- 44 Housing
- 45 Lockwasher
- 46 Cap screw
- 47 Gasket
- 48 Slave air valve
- 49 Allen head screw
- 50 Breather
- 51 Screw connection
- 52 Tee part
- 53 Elbow screw joint
- 54 Tube
- 55 Tube
- 56 Tube
- 57 Plug screw
- 58 End cap

IV. Disassemble of IPAST- Transmission

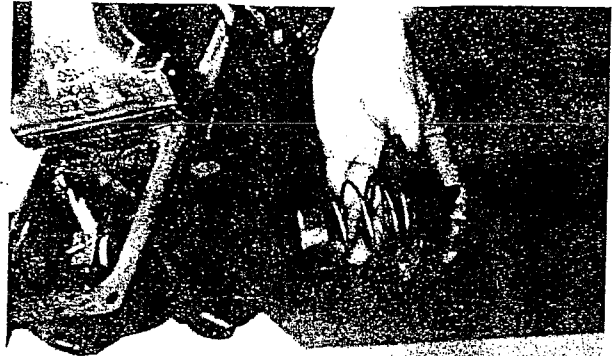
1. Remove the double H shifting unit



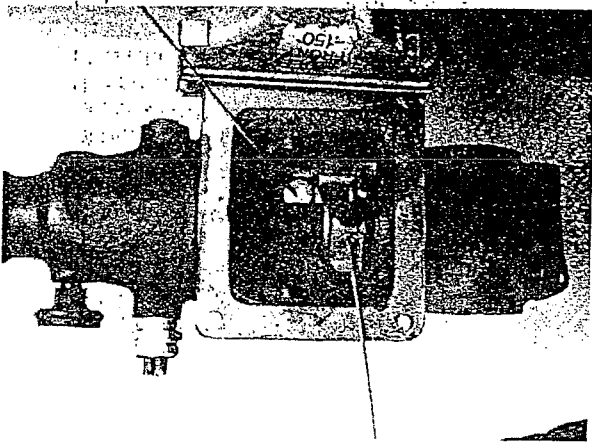
1. Remove double H shifting valve and air passages.



2. Remove shifting control mechanism.

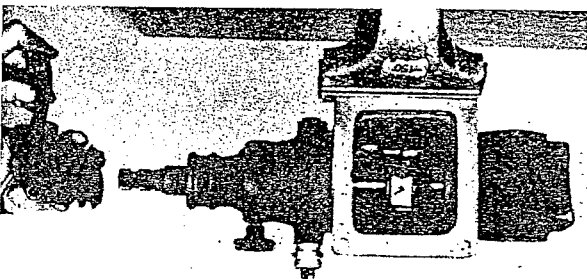


3. Remove rear cover and take out balance spring.

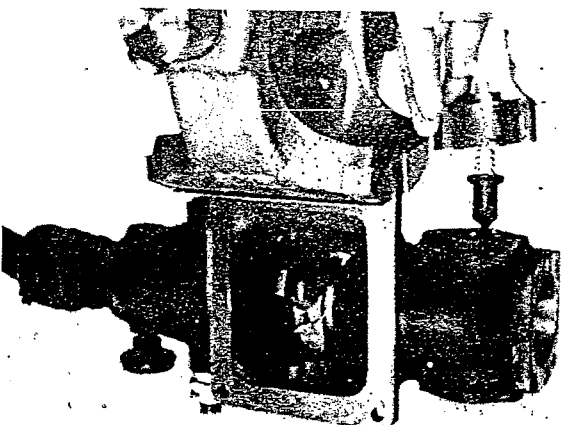


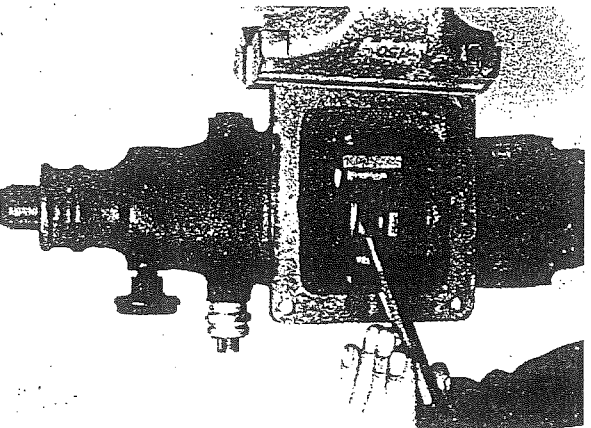
6. Tear down the locking wire and pullout the plug.

5. Remove the elbow arm and dust boot.

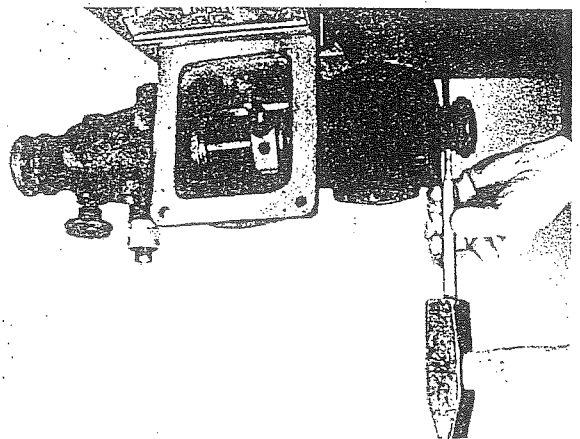


4. Take down the side covers, take out the spring and the locking pin.

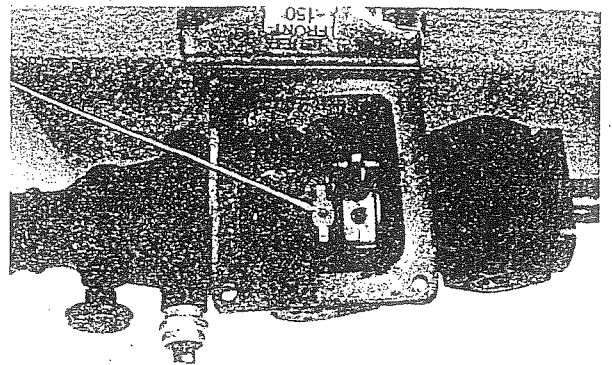




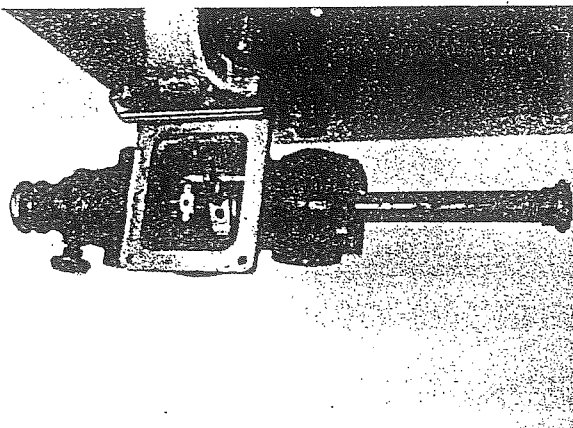
7. Punch out the straight pin.



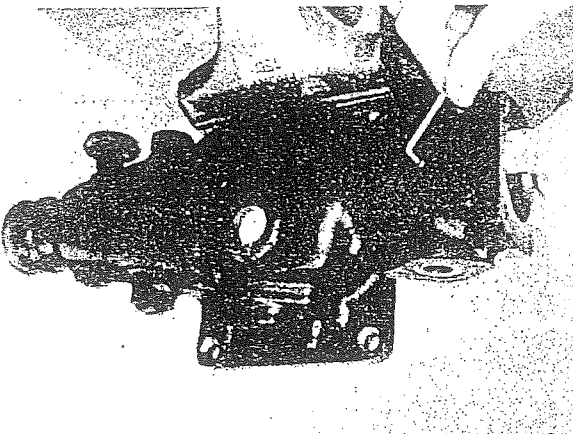
8. Punch out the locating pin of the shifting shaft.



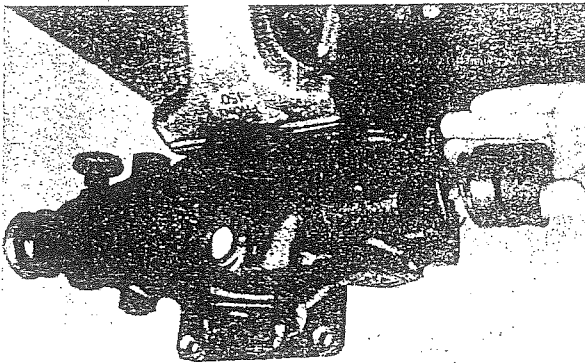
9. Pull out joint pin of reverse gear controller.



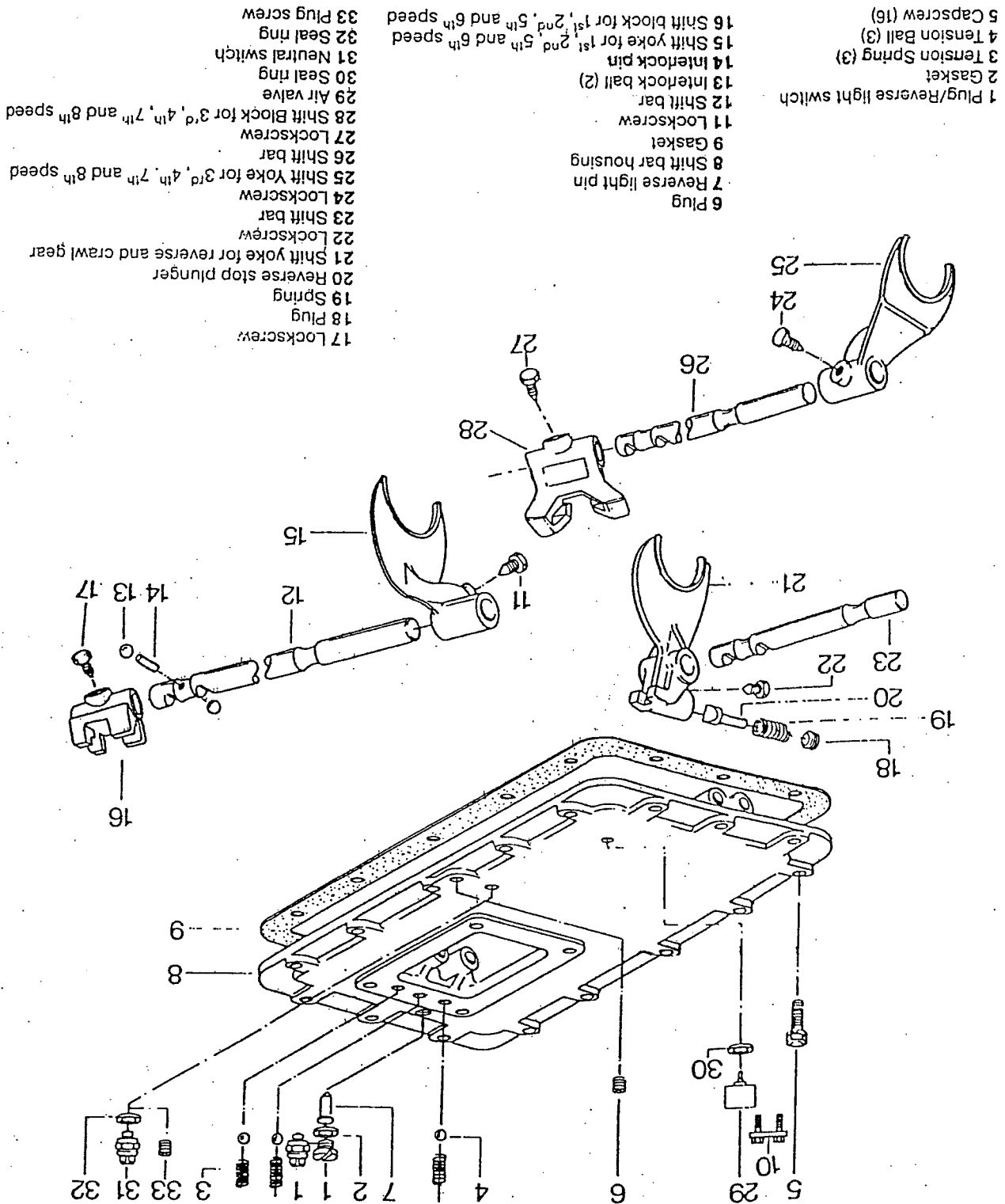
10. Remove shift shaft, take our shift block and reverse gear controller.



11. Remove the locking screw. Pay attention to safety.

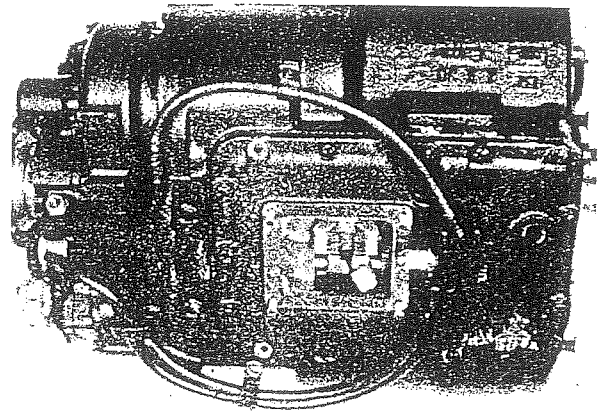


12. Take out spring seat, locate ring and spring.



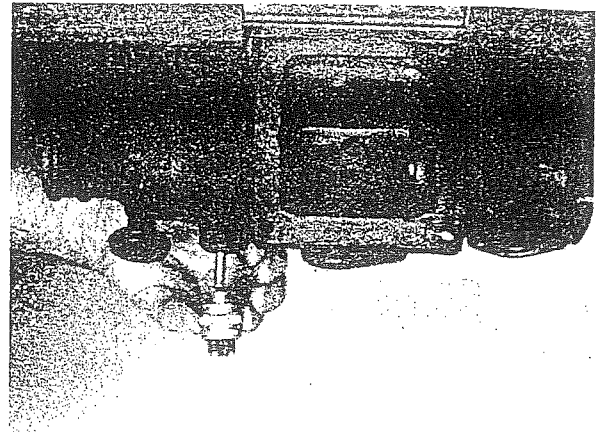
THE UPPER COVER

1. Transmission upper cover.



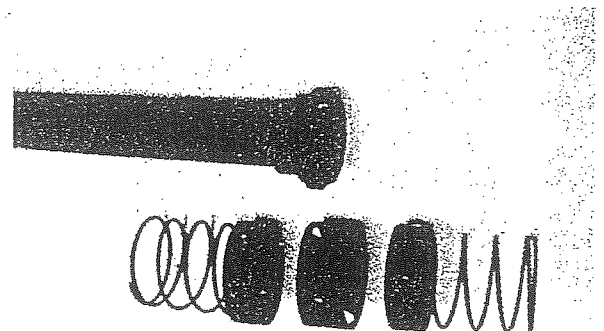
2. Removal of transmission upper cover

14. Remove the backup lamp switch and pivot shaft

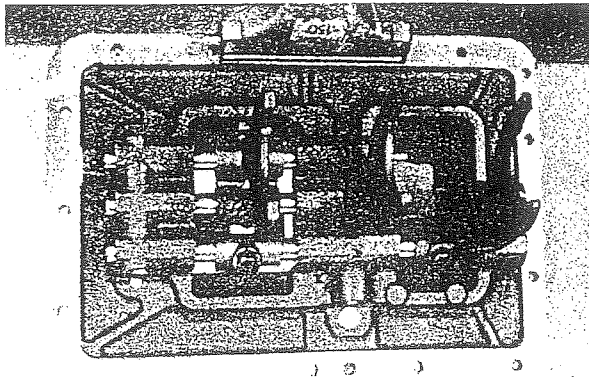


locating ring.

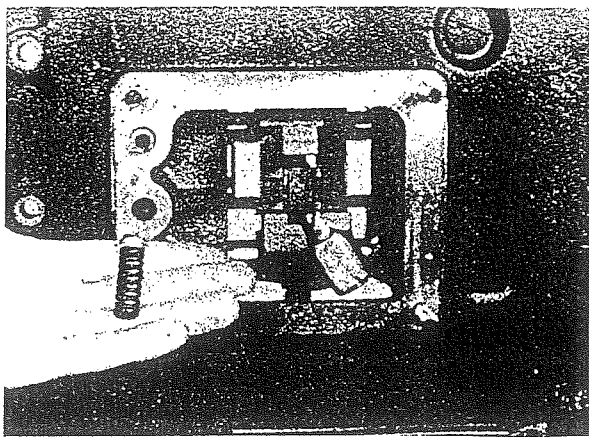
13. Sequence of spring, spring seat, spacer and



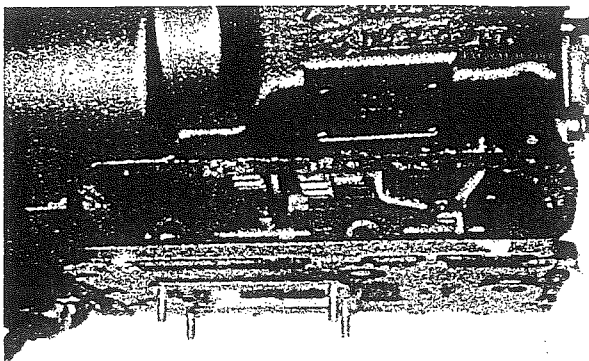
4. Hold the upper cover on bench vice.



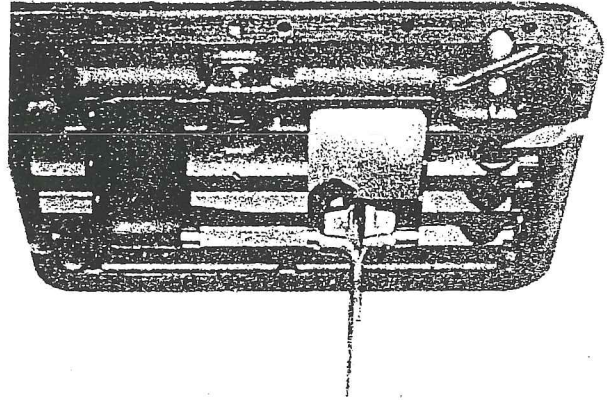
3. Take out gear position retainer spring and steel ball



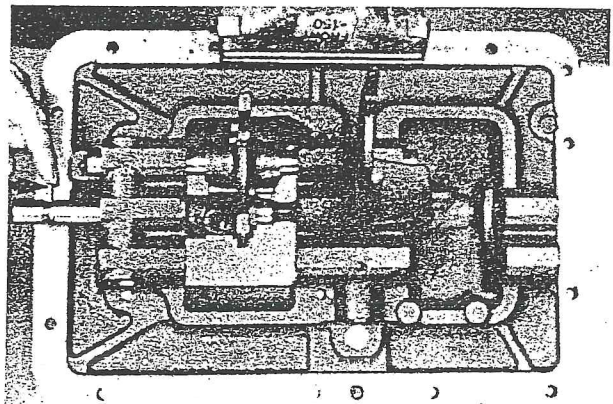
2. Remove the screws and the upper cover.



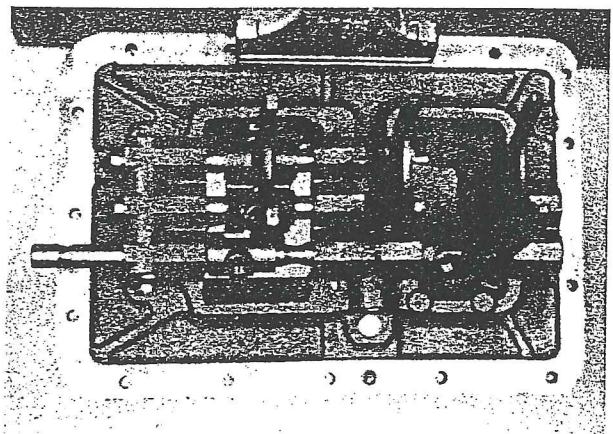
7. Take out the two interlocking steel balls (as shown by the arrow)



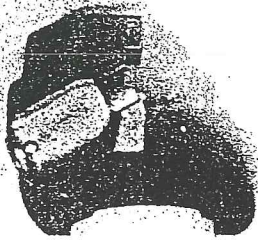
6. Remove set screws of 1&2 (5&6) gears, pull out shifting fork shaft, shifting fork and shifting block.



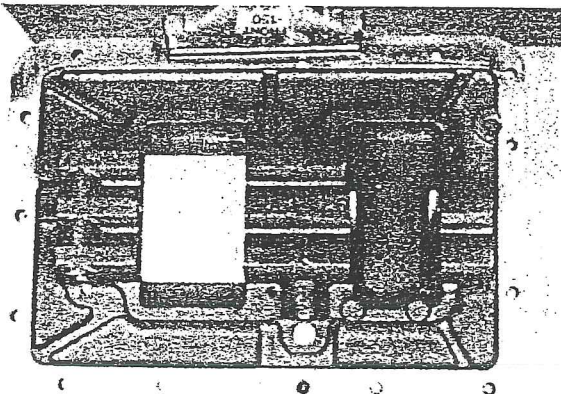
5. Remove set screws of 3&4 (7&8) gears, pull out shifting fork shaft, shifting fork and shifting block.



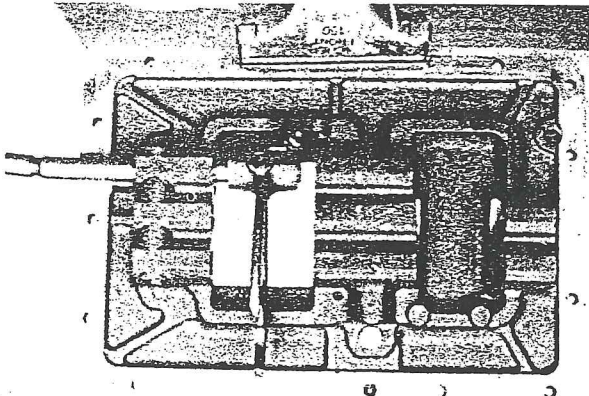
10. Remove the shifting yoke of reverse gear.

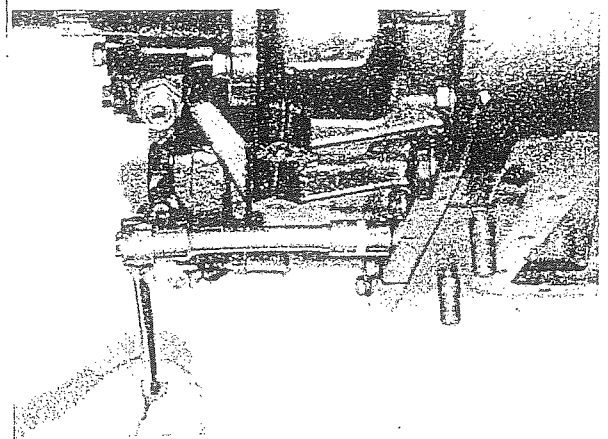
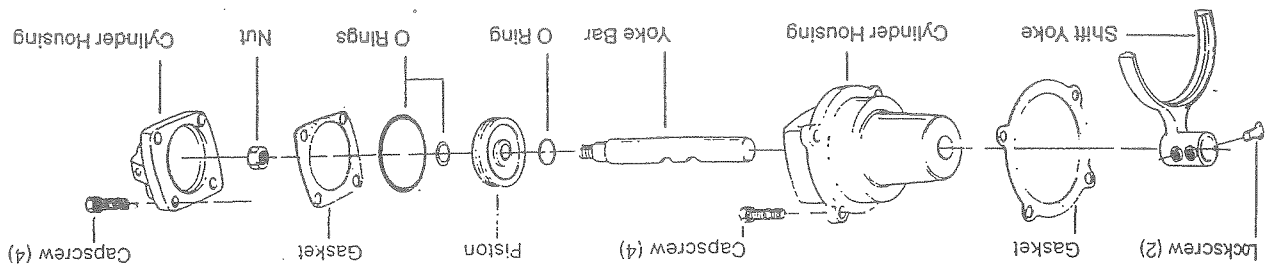


9. The upper cover of the transmission after dismantling.

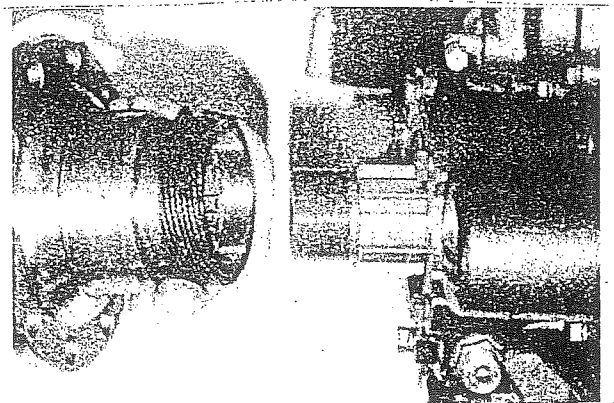


8. Remove set screws of low and reverse gears, pull out the shaft of shifting yoke and the shifting yoke.

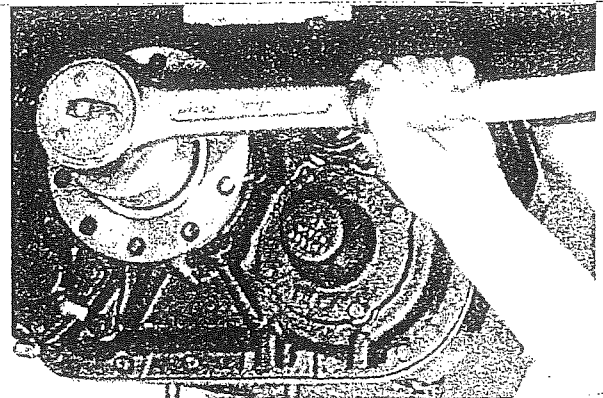




2. Remove the output flange, take out the worn wheel sleeve of odometer. Shift the auxiliary gearbox to low gear.

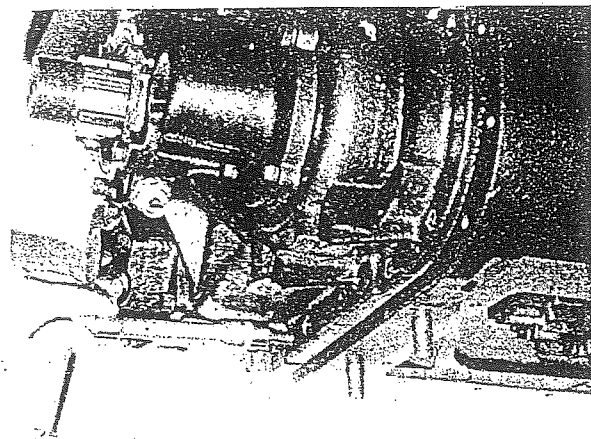


1. Shift the main gearbox to two gears simultaneously, remove the fixing nuts of output flange with special purpose spanner.

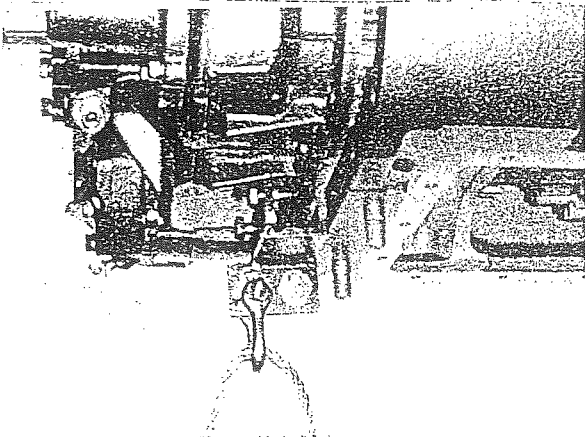


3. Removal of auxiliary gearbox

3. Remove the coupling bolts of the main and the auxiliary gearboxes.



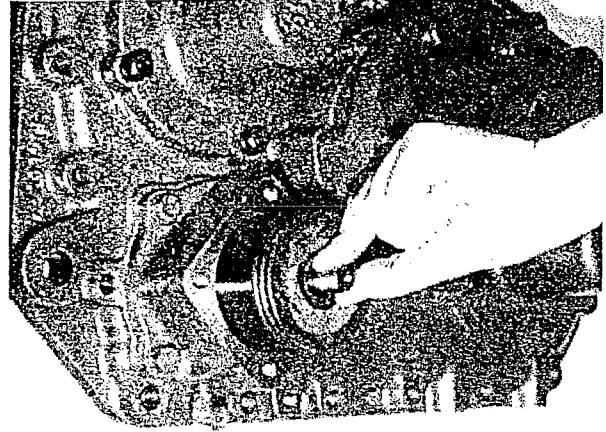
4. Push the auxiliary gearbox with 3 bolts by 13 mm.



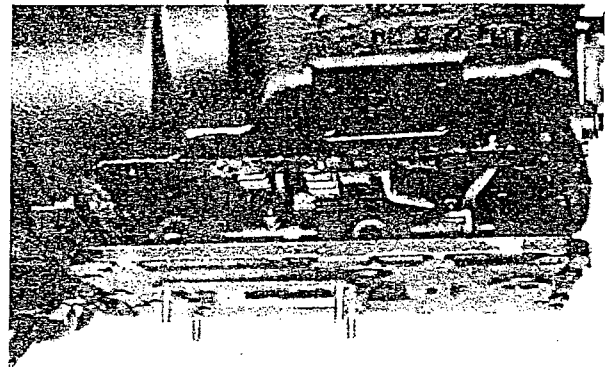
5. Set a hanger on the auxiliary gearbox. Lift the auxiliary gearbox with a loop wheel machine and move it laterally till the locating dowel of the main box separates with the auxiliary box.

4. Removal of shifting cylinder

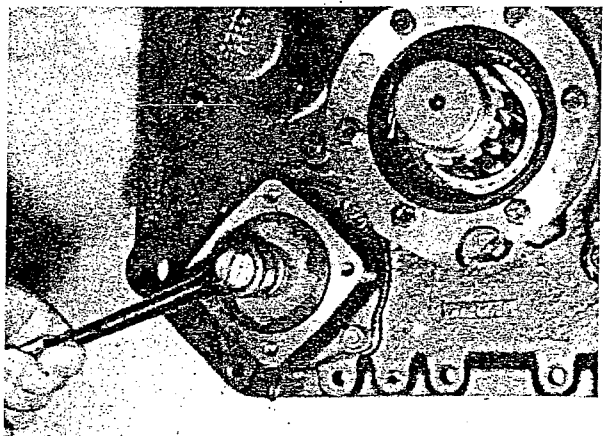
3. Push the piston rod out of the housing and take out the piston and the shifting yoke arm.



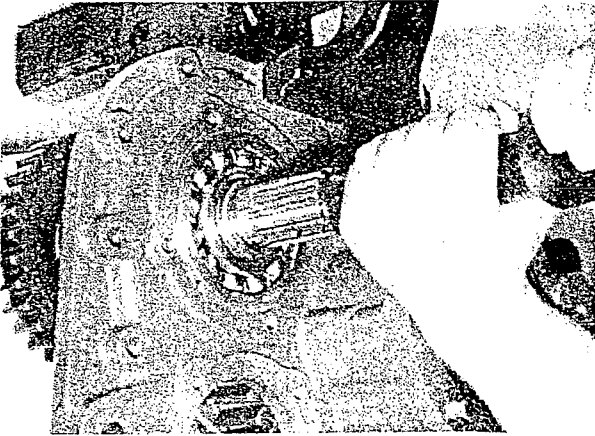
2. Break up the locking wire. Remove the fixing nuts of shifting yoke. Tap the shifting yoke shaft outward. Take off the shifting yoke from sliding sleeve of the synchronizer.



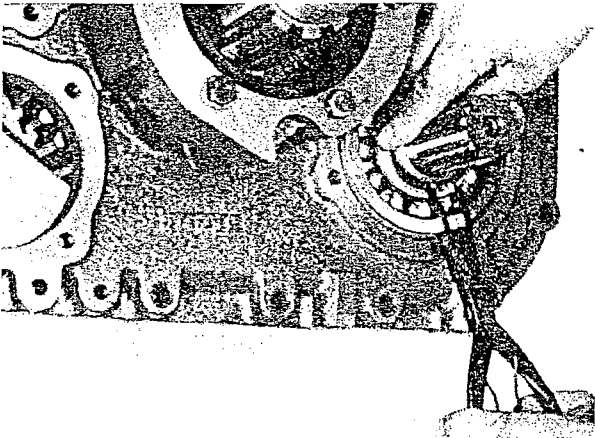
1. Remove the cover of the shifting cylinder. Remove the fixing nuts of piston rod.



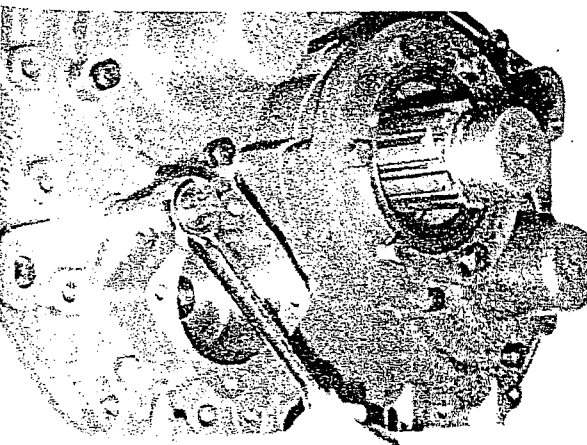
2. Gently tap the auxiliary shaft with a copper rod, make the countershaft come out of the housing with its gear. Then from the other side tap the bearing out of its sitting hole in the housing.



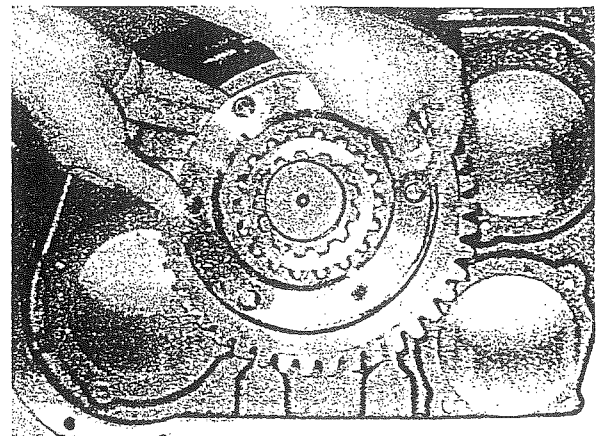
1. Remove the bearing caps of the two countershafts, take out locating circlip of the bearing inner race.



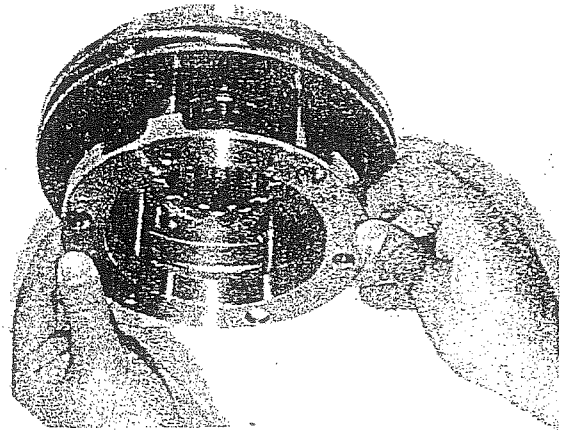
4. Remove the shifting cylinder body.
5. Removal of countershaft of auxiliary gearbox



6. Removal of auxiliary gearbox synchronizer

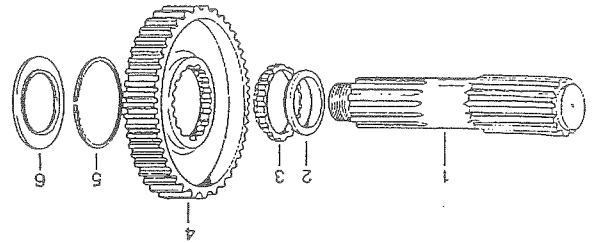


1. Pull synchronizer assembly outward to separate it from the output shaft.

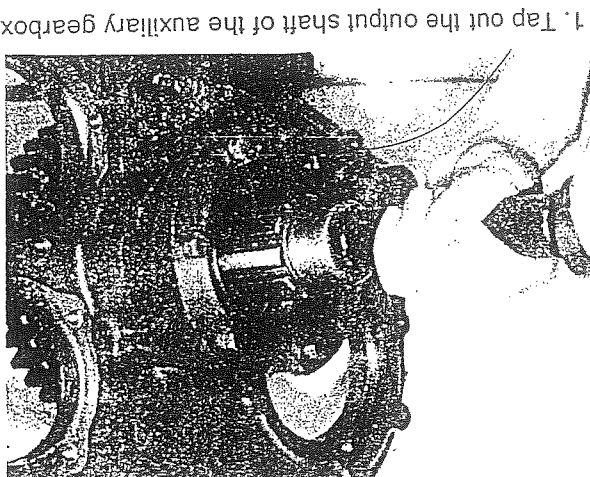


2. Pull out the conical ring of the high gear synchronizer from the low gear lockpin. Prevent the three compression springs from missing. Take out the sliding toothed sleeve of the synchronizer from the conical ring of the low gear synchronizer.

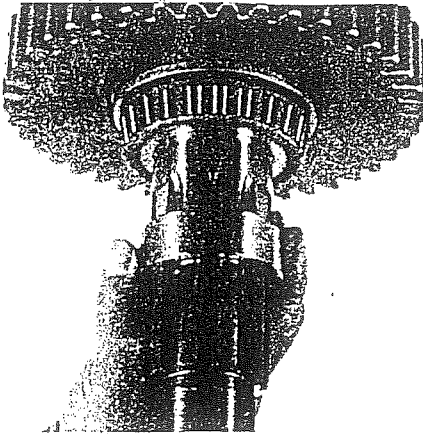
7. Removal of the output shaft of auxiliary gearbox



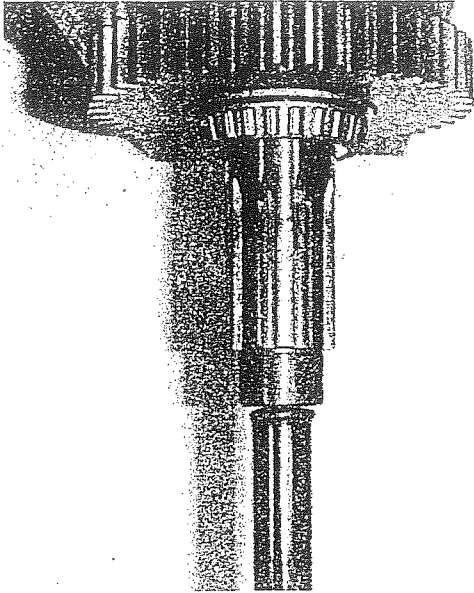
1. Output shaft 2. Stepped washer 3. Splined spacer 4. Low speed gear 5. Low speed snapping 6. Low speed gear rear washer



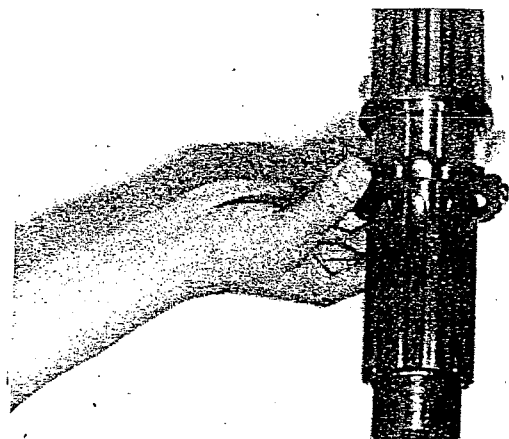
1. Tap out the output shaft of the auxiliary gearbox with a copper rod.



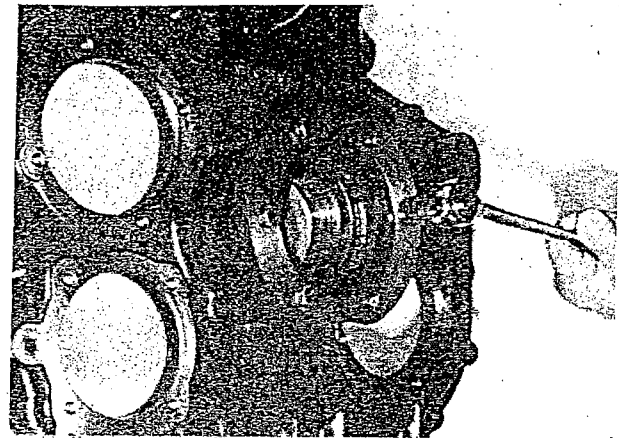
2. Take out the bearing inner race spacer from the output shaft.



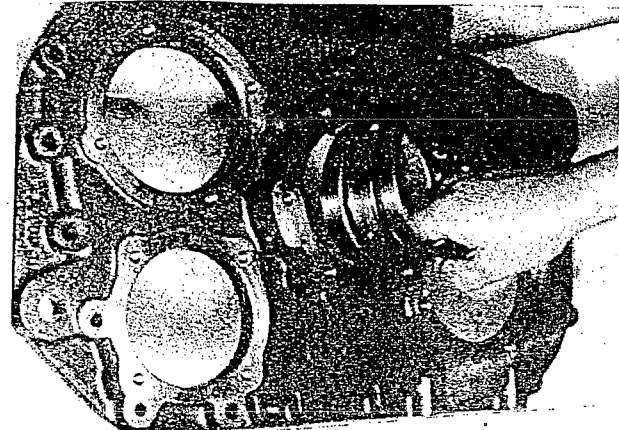
3. Press out the low speed gear from the output shaft with a pressing machine.



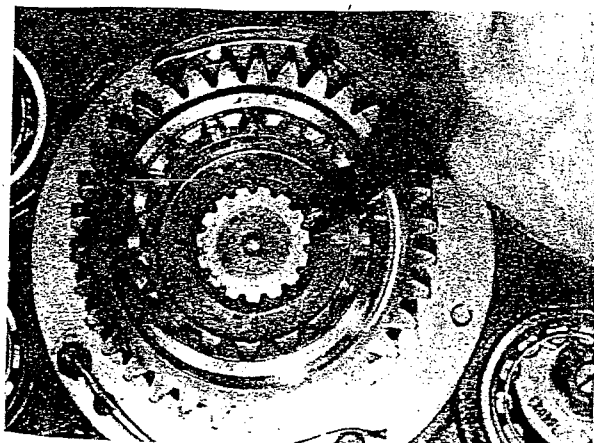
4. Take down the splines-underlay and washer from the output shaft.



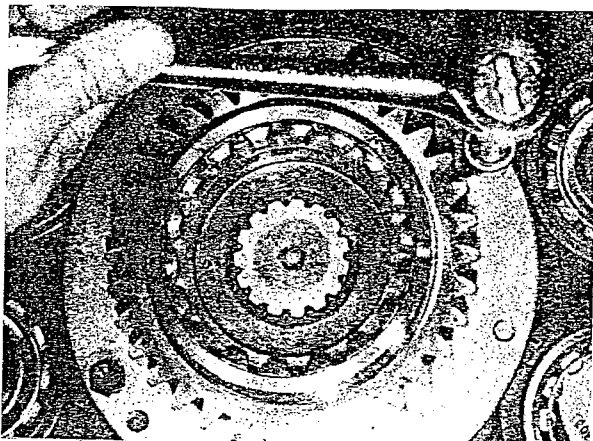
5. Remove the bearing rear cap. Replace the grease seal if needed. The grease seal may be removed.



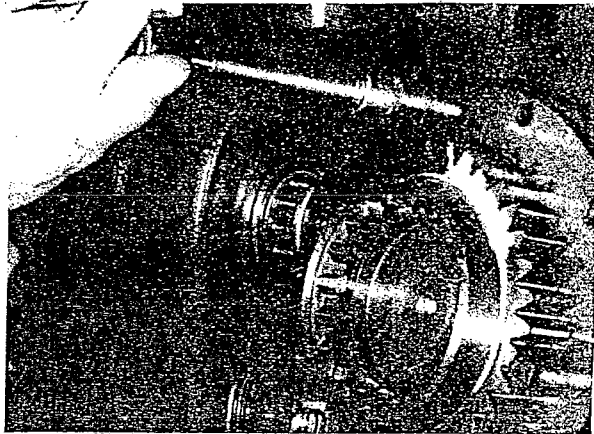
6. Remove the two conical bearing outer rings and spacers from the bearing holes.



8. Removal of output gear of the main gearbox

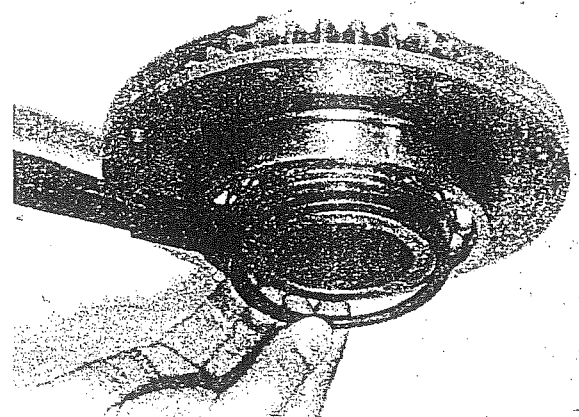


1. Take out the locating circlip on the output shaft of the main gearbox.

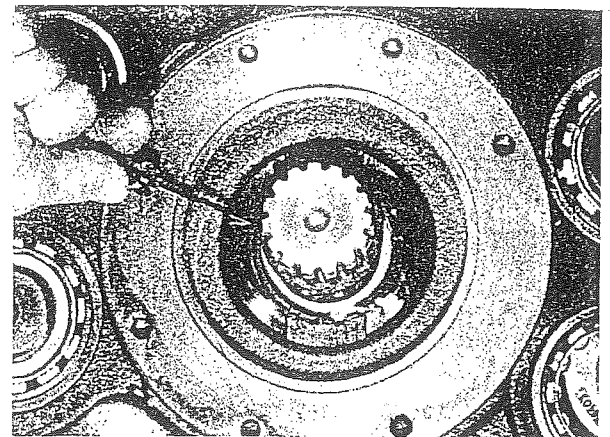


2. Shear up the locking wire and remove the fixing bolts on the supporting flange.

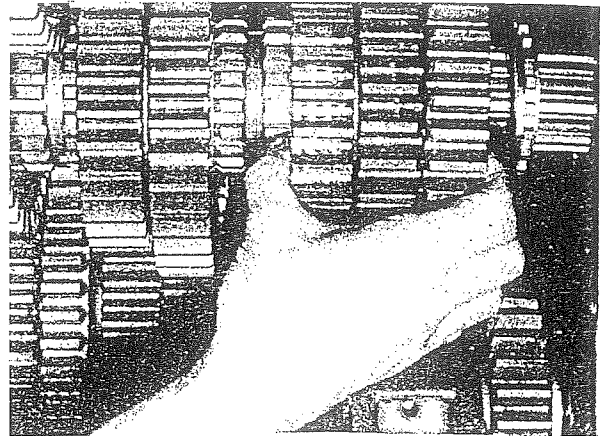
3. Push the flange out with 3 bolts.



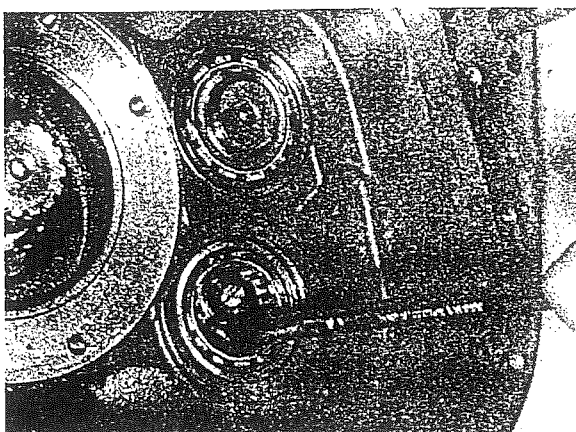
4. Remove the circlip on the output gear, press the gear out from the flange and the bearing.



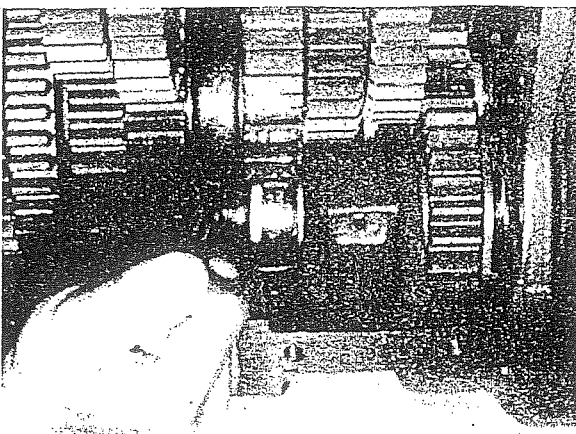
9. Removal of the left reverse intermediate gear of the main gearbox



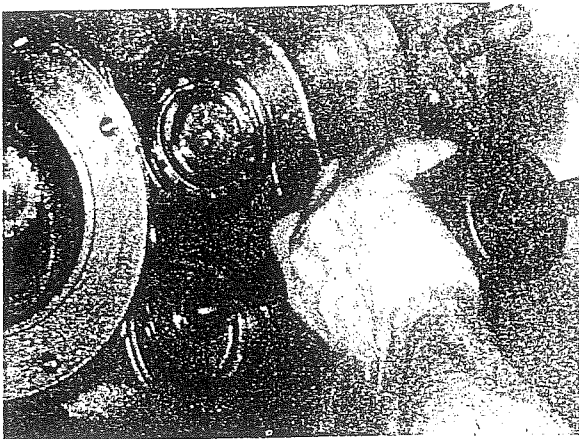
2. Move the reverse gear forward as much as possible to make it mesh with the reverse gear sliding sleeve.



3. Take down the bearing from the outside of the auxiliary shaft hole of the main gearbox.

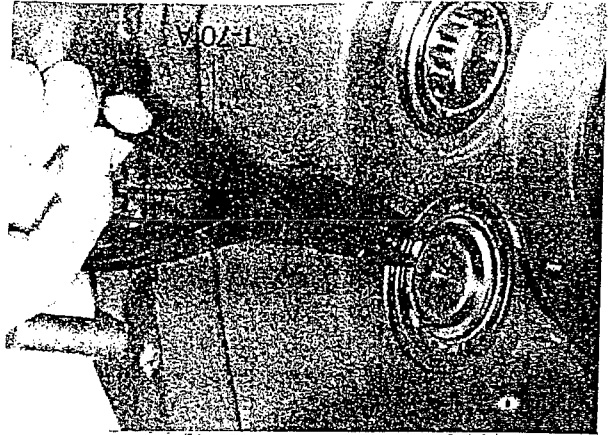


4. Remove the locking nut of reverse gear shaft and the washer.

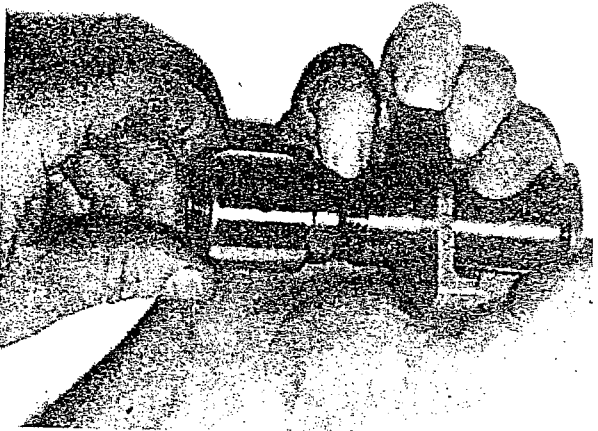


5. Screw out the screw plug on the reverse gear intermediate wheel, and put a reverse gear shaft extractor on the intermediate shaft to put out the reverse gear shaft.

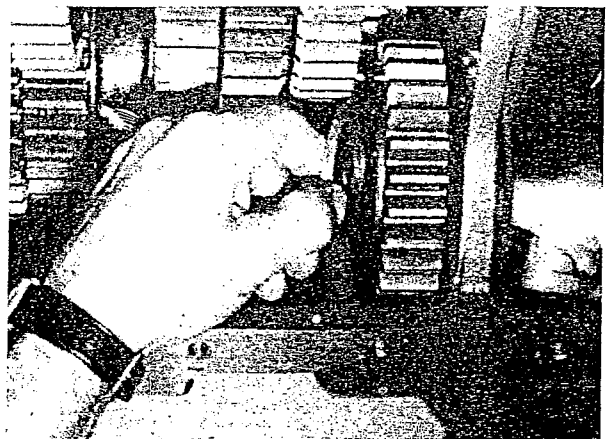
1. Take out the locating circlip of the auxiliary shaft rear bearing of the main box.



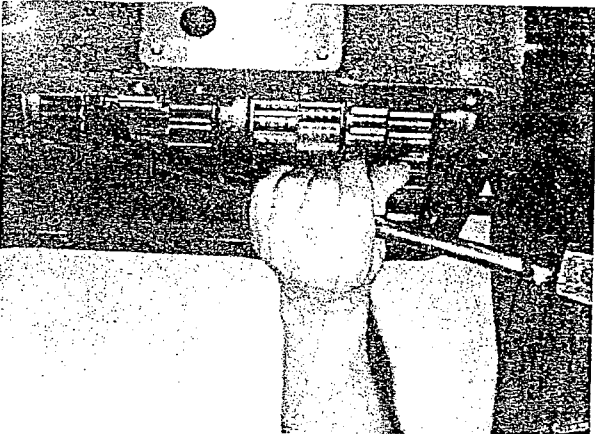
10. Removal of the second shaft of the main gear shaft.



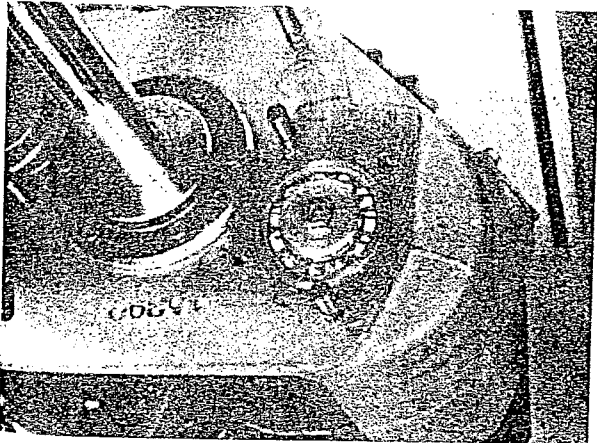
6. Take out the intermediate reverse gear and washer. Press out the bearing outer ring in the hole of the reverse gear shaft.



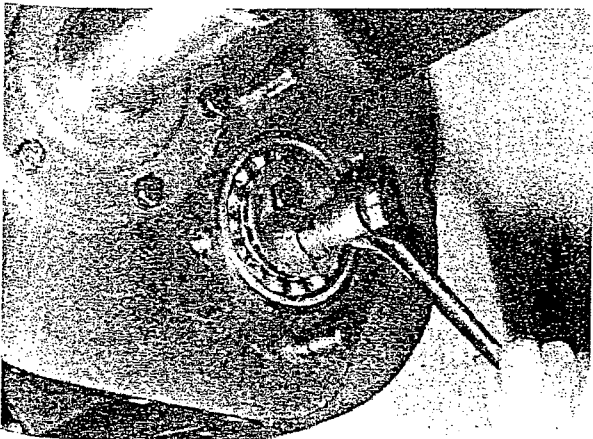
4. Knock the rear bearing of the auxiliary shaft out of the housing with a copper punch. Take care not to damage the bearing.



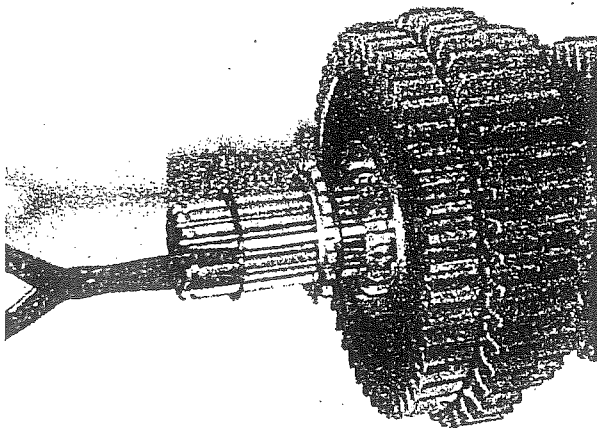
3. The front baffle of the auxiliary shaft is secured by a center bolt.



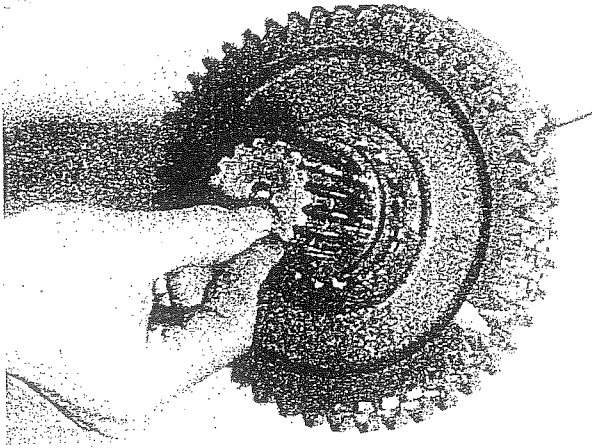
2. Remove the front locating baffle of the auxiliary shaft.



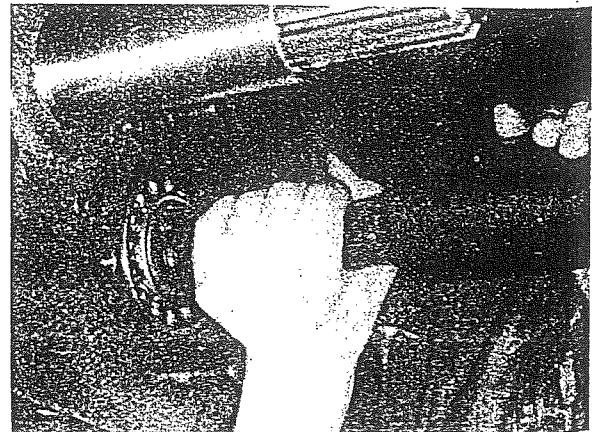
7. Make the reverse gear of the second shaft closely lean against the creep gear, and make the second shaft together with other gears move backward so as to let the front end of the second shaft separate from the first shaft. Uprill the whole second shaft and the gears and carry them out of the main box. The reverse gear now is in a free state, so attention should be paid not to let it slide out from the second shaft.



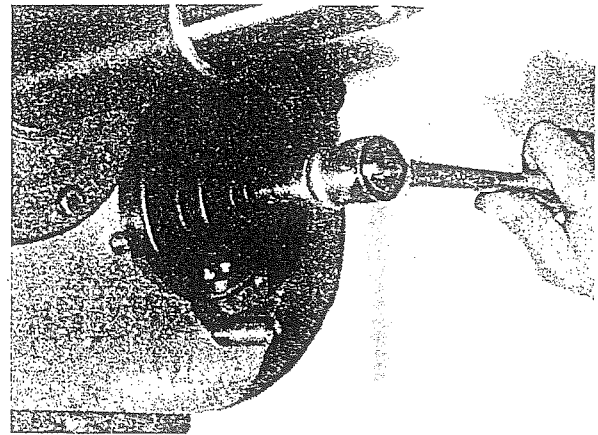
8. Take out the sliding bush from the front end of the second shaft, and take out the snap ring from the rear end.



9. Pull out the single key from the second shaft.



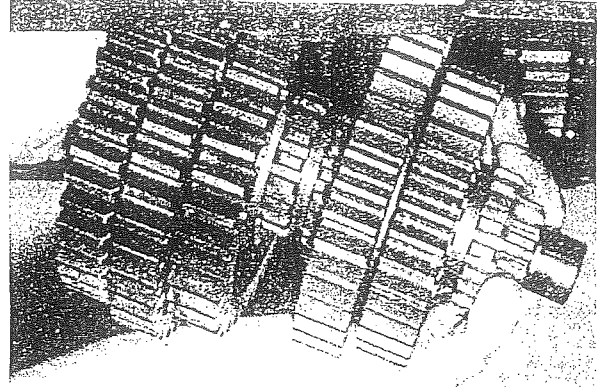
5. Knock the shaft rearward with a copper rod, making the auxiliary shaft move rearward.

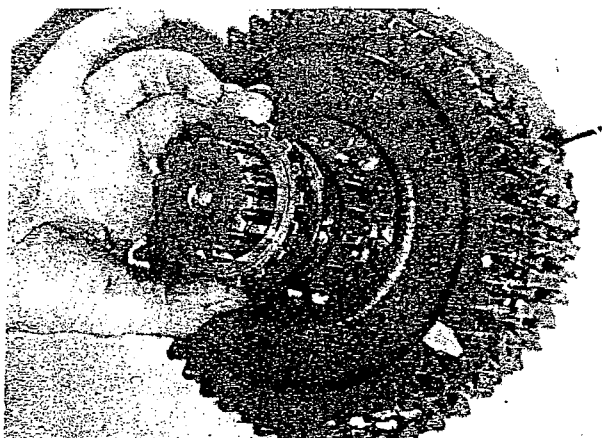


6. Then knock and move the auxiliary shaft forward, make the front bearing of the auxiliary shaft move out of the housing. Pull out the bearing with a special purpose extractor.

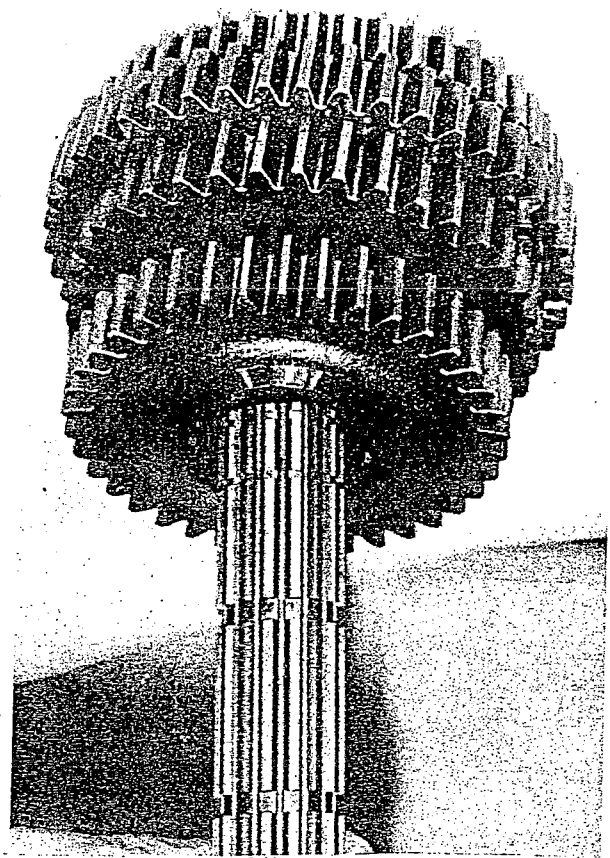
Lean the auxiliary shaft and its gears closely against the wall of the housing to make auxiliary shaft and its gear separate from the second shaft gear and get away as far as possible.

For this purpose, remove the brake unit of the clutch first.

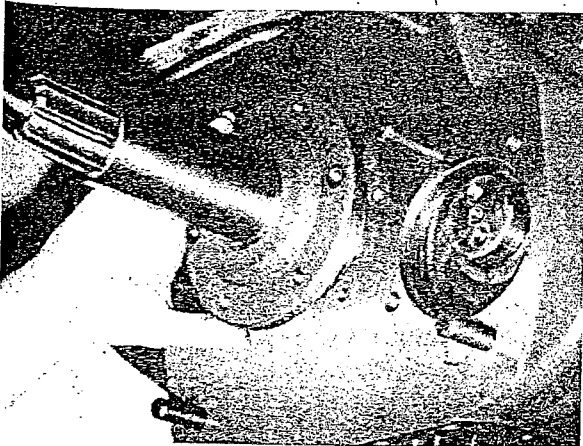




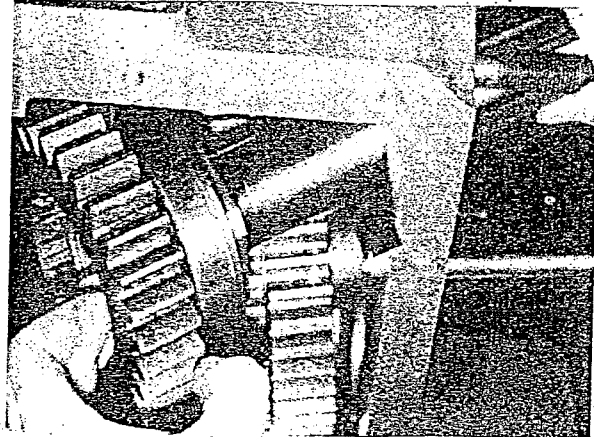
10. Take down the rear gear adjusting spacer and spline washer from the shaft.



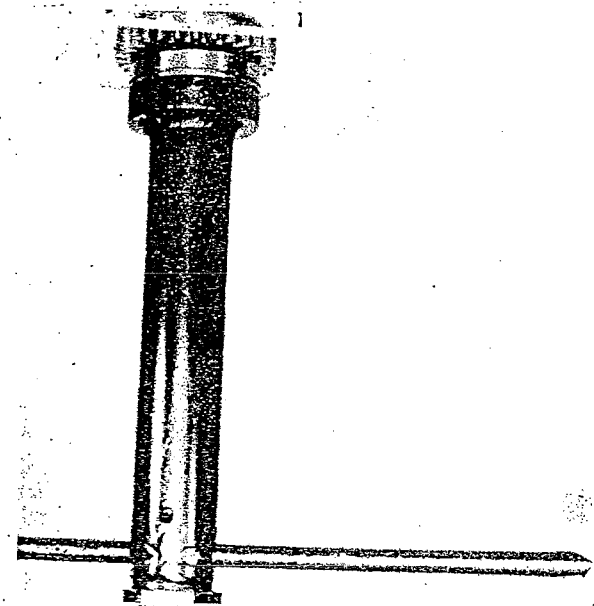
11. Point the front end of the second shaft upward and rotate it come-and-go. The gears will slide down from the second shaft and come out of the rear end of the principal shaft in the correct assembling sequence. Take out the snap rings from each gear if it is necessary.



11. Removal of the first shaft of the main box

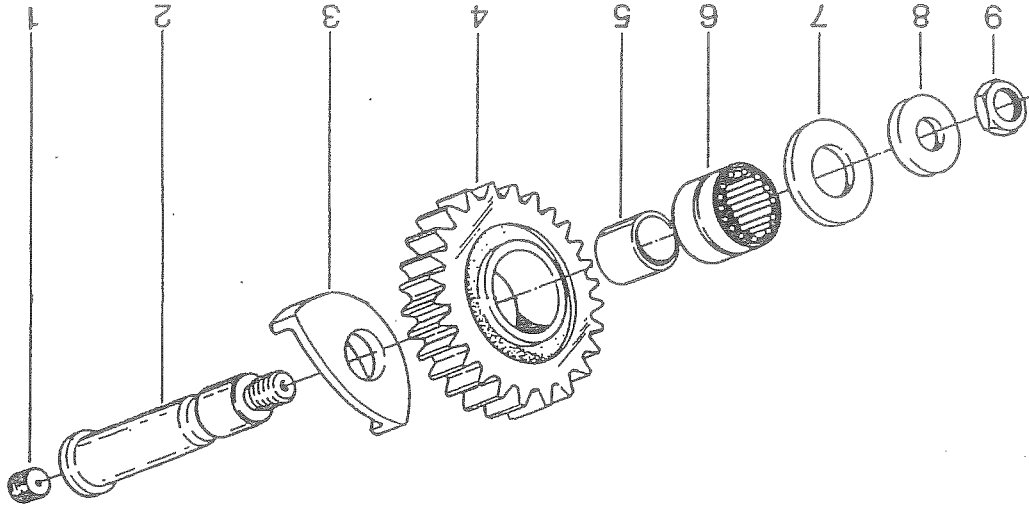


1. Remove the bearing cap of the first shaft.



2. Knock the first shaft forward to let the locating circlip of the bearing outer ring expose and remove the circlip. Then pull out the first shaft from the inside of the housing.

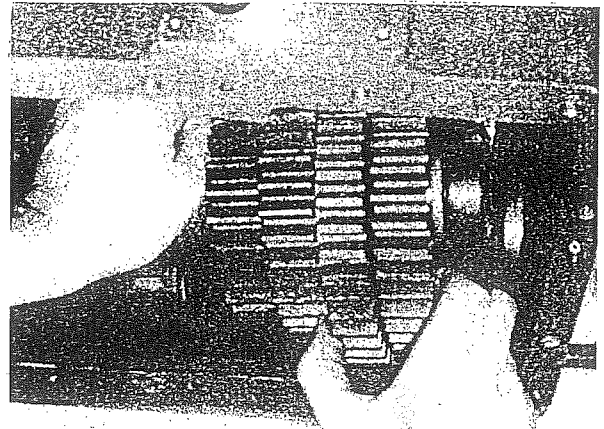
3. Remove the fixing nut of the first shaft bearing. Pay attention to that the nut is of left-hand thread.



(1). Assembly of the right reverse intermediate gear of the main box

III. Assembly of IFAST Transmission

1. Take out the auxiliary shaft from the gearbox.

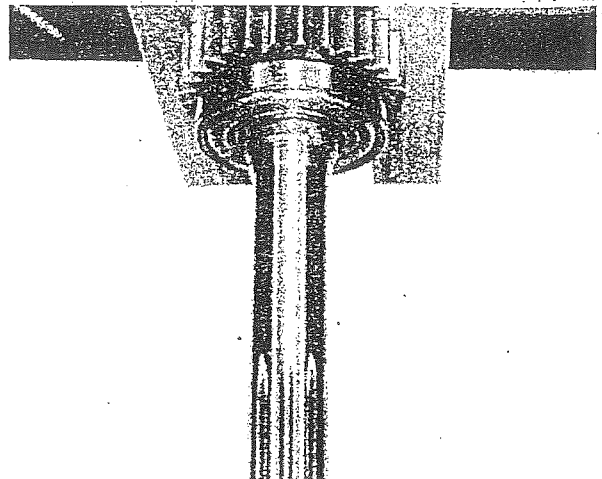


box

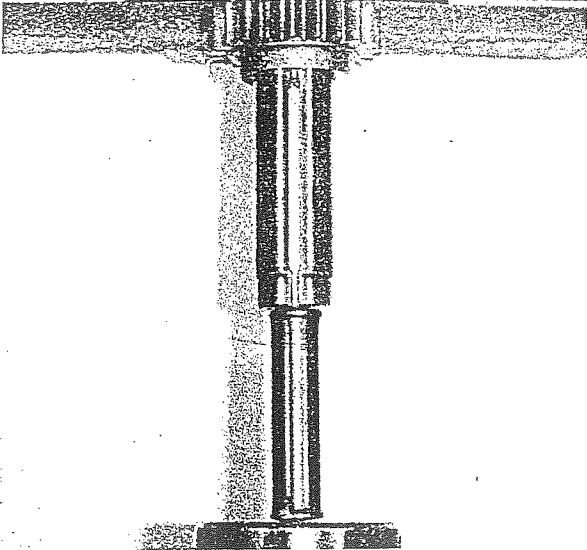
12. Removal of the countershafts in the main

separate from the first shaft.

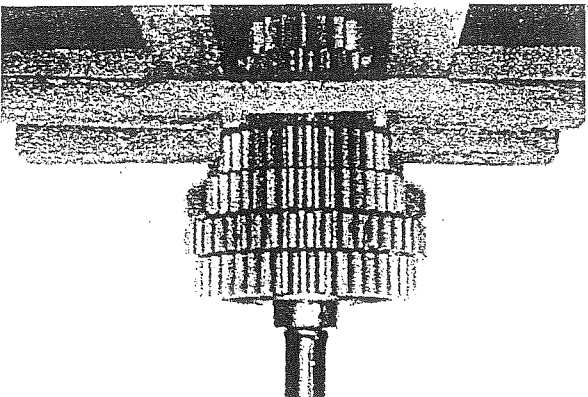
4. Press down the first shaft to make the bearing



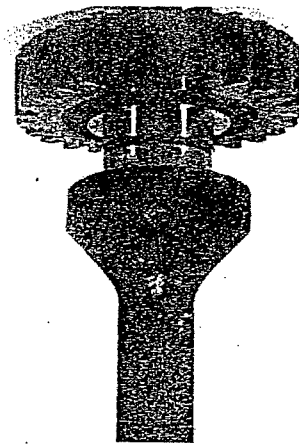
3. Then press out the other two gears one by one. Take out the long key and the half-roundkey in case of necessity.



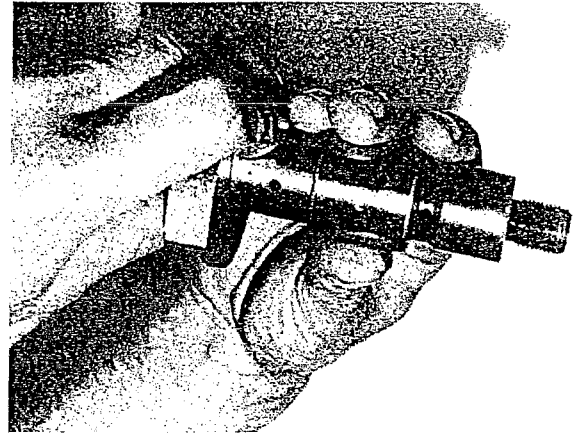
2. Press the four big gears out of the auxiliary shaft with a pressing machine of more than 20 tons.



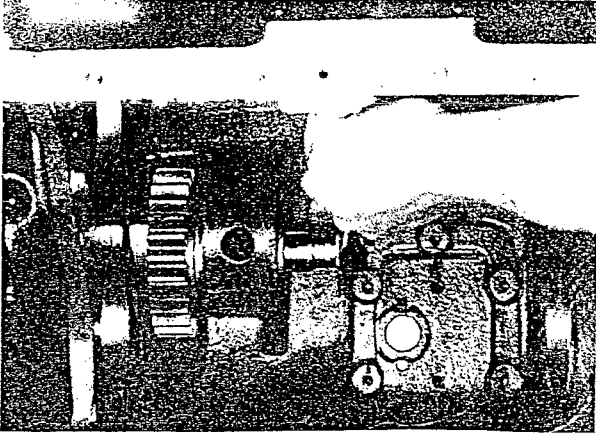
1. Faucet 2. Reverse intermediate gear shaft 3. Eccentric back plate 4. Reverse intermediate gear 5. Bearing inner race 6. Bearing outer ring 7. Thrust washer 8. Shield ring 9. Retaining nut
- Exploded View of Reverse Gear Structure
- Note: Before starting reassembly, make sure that the 3 magnetic discs in the bottom of the case are cleaned of any metal bits and if they are loose, attach them with adhesive to the housing floor.



1. Put the eccentric back plate and the bearing inner ring on the reverse intermediate gear shaft.



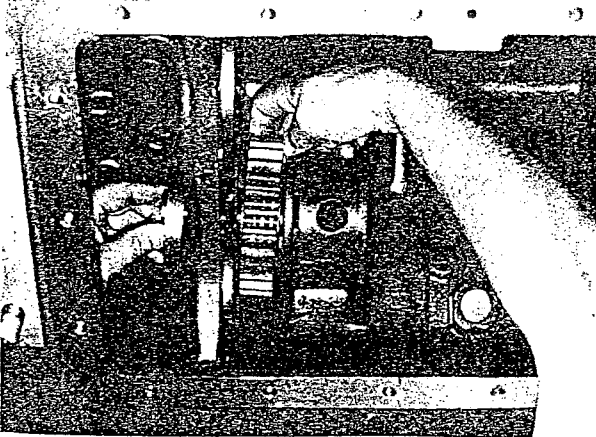
2. Press the bearing outer ring into the gear shaft hole.



4. Secure the reverse intermediate gear shaft with the locknut.

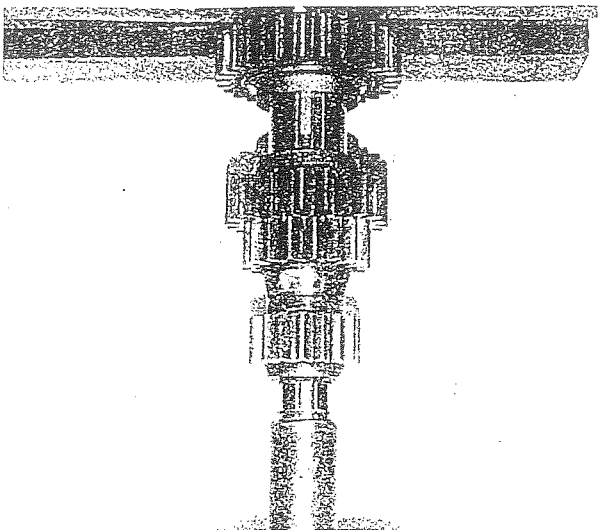


3. Set the reverse intermediate gear shaft component and the intermediate gear in the seat hole.

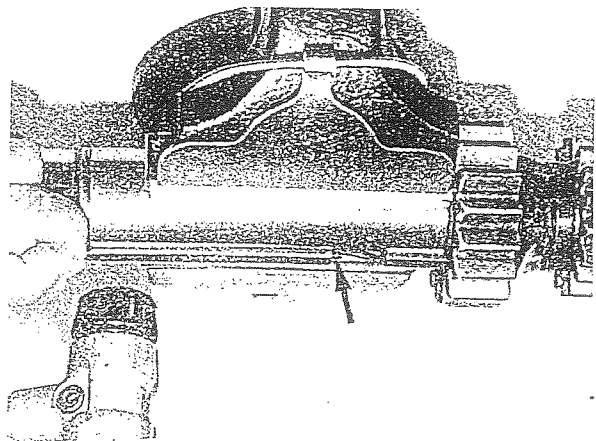


- (2). Assembling the counter shaft of the main box

2. Press the first-speed gear and second-speed gear onto the countershaft. The flange of the first-speed gear faces down while that of the second-speed gear faces up.

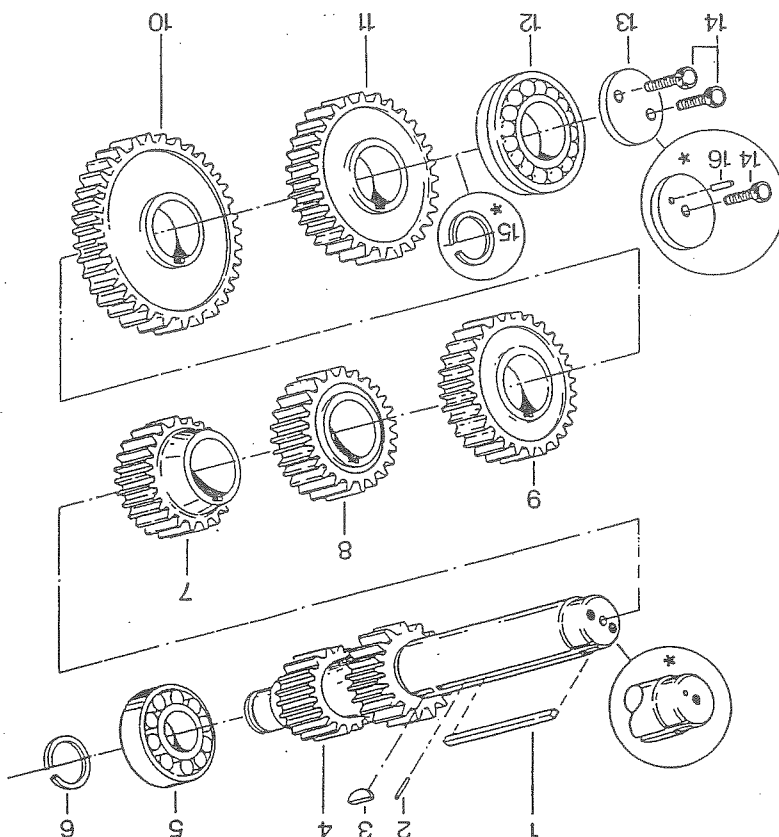


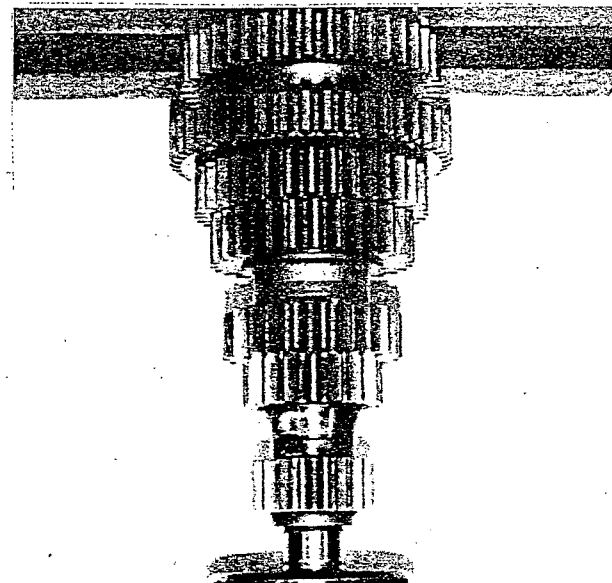
1. Install the dowel, the key and the woodruff key on the countershaft



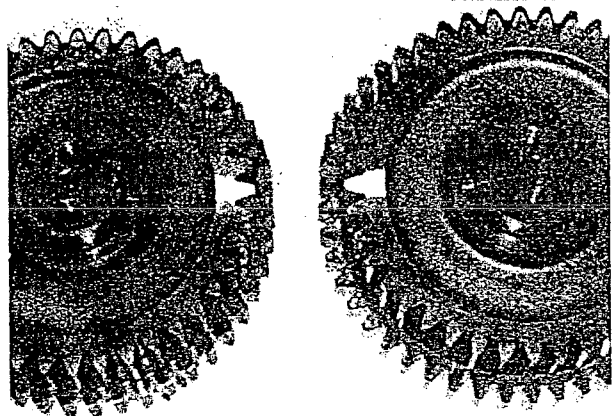
Exploded View of Counter Shaft Structure of Main box

1. Key 2. Pin 3. Woodruff key 4. Countershaft 5. Countershaft rear bearing 6. Snap ring 7. First-speed gear 8. Second-speed gear 9. Third-speed gear 10. Power taking-off gear 11. Counter shaft driven gear 12. Counter shaft front bearing 13. Baffle 14. Fixing whorl wheel 16. Dowel

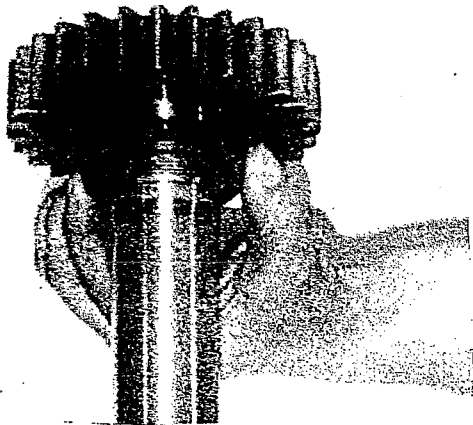




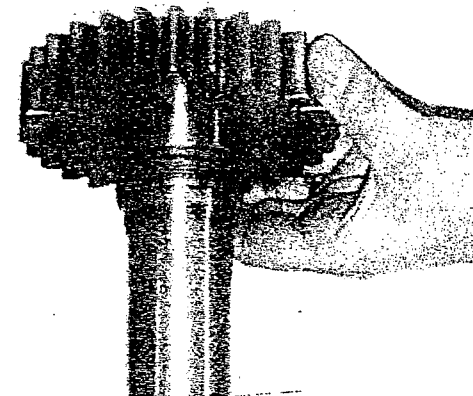
3. Press the third-speed gear, power takeoff gear and the driven gear of the countershaft onto the countershaft one by one. In installation, attention should be paid to that the flange of the third-speed gear should face down, the surface of the power takeoff gear with arc chamfer face up, while the flange of the driven gear faces up.



4. Make tooth alignment mark on the two driven gears of the countershaft for assembling. The teeth with marks should be in line with keyway of the countershaft.



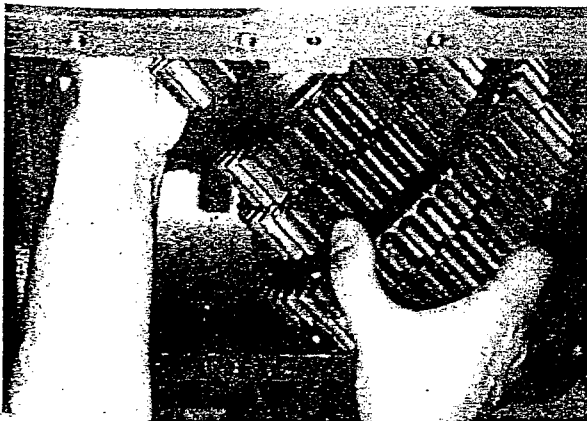
2. Set a spacer on the shaft and let it lean against the snap ring.



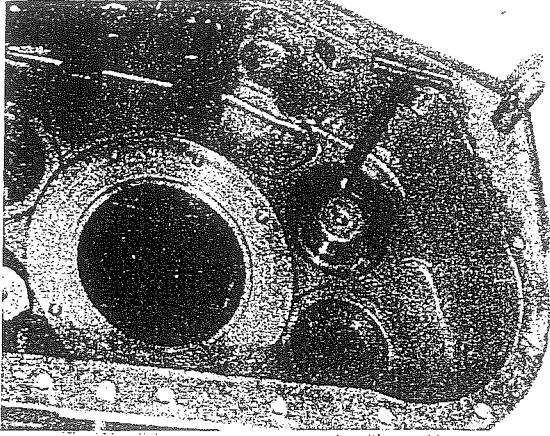
1. Put a snap ring on the inside of the first gear. Mount the first shaft gear onto the splined shaft, the side with snap ring should face forward.

(3). Assembling of the main box first shaft

5. Put the lower-left countershaft assembly into the seat hole in the housing. It should be noticed that the larger power takeoff gear is installed on the countershaft at the lower-left side. The bearings should not be installed now. Then mount the upper-right countershaft assembly. Likewise, the bearing are not to be installed temporarily.

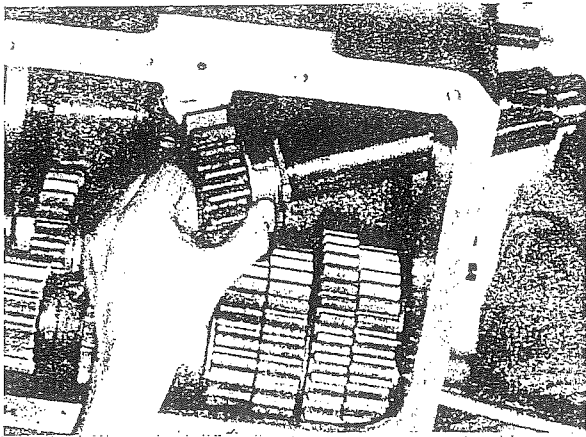


1. Support the front and rear shaft heads of the lower right countershaft with two special purpose bearers.

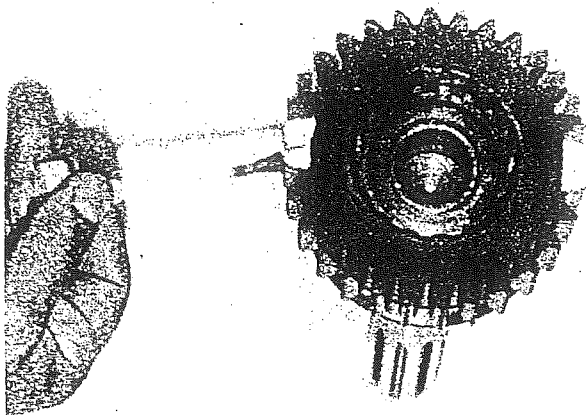


(4). Mounting the countershaft by tooth alignment bore of the first shaft. Fix the bearing with a circlip.

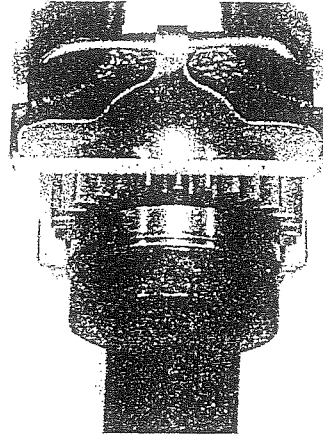
first shaft from inside to outside into the bearing saddle help of a crowbar. When room is made, install the 7. Poke the upper-right countershaft aside with the



6. Make marks on any two adjacent teeth of the first shaft gear, and then make marks on the symmetrical two teeth. Check the shaft lining and make sure that it is in the shaft and in intact condition.



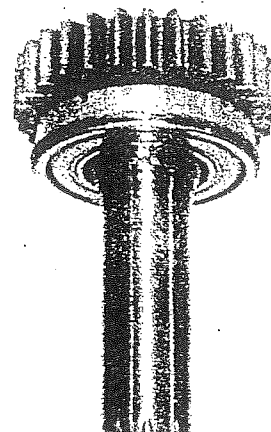
5. Screw the slotted nut on the shaft (left-hand threaded) with a torque of 340 to 410Nm. Then punch the lugs on the nut into the two grooves on the shaft so as to fix and lock the nut.

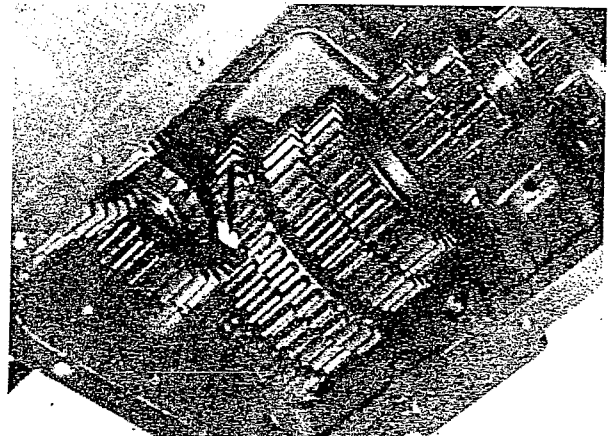


4. Clean the threads on the shaft and the inside of the slotted nut. Then smear locking sealant Locilite 242 on the inside of the

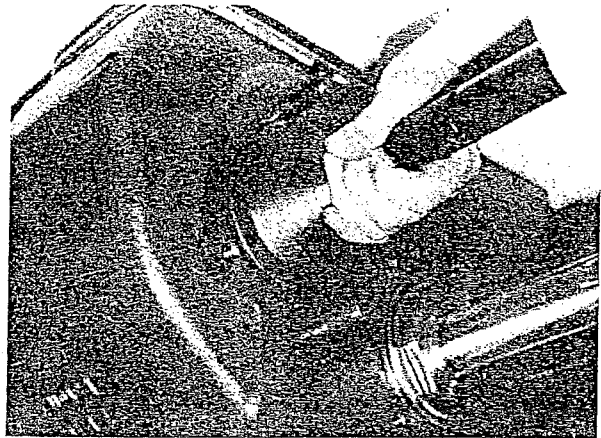


3. Press the bearing of the first shaft onto the shaft.

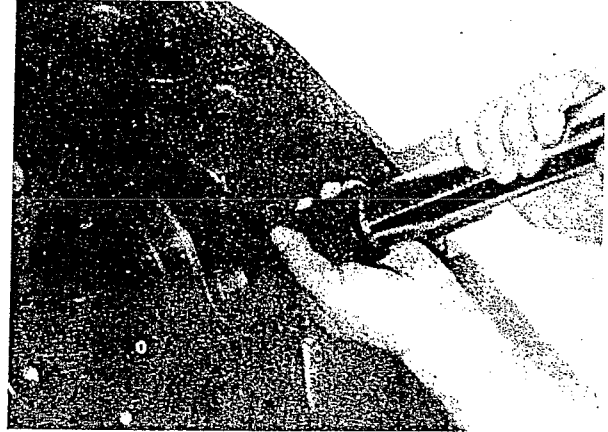




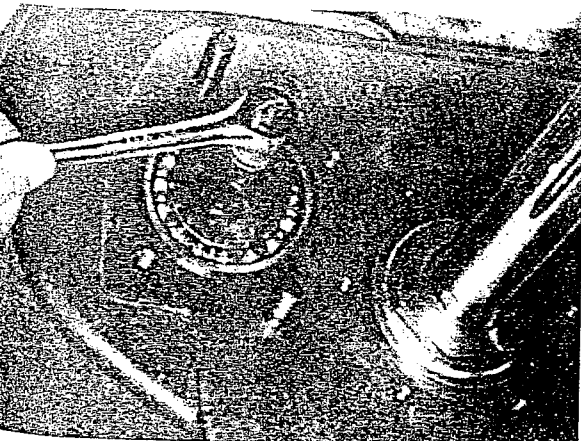
2. Rotate the countershaft to make the teeth with marks of the driven gear on this countershaft mesh with the teeth with marks of the driving gear on the first shaft.



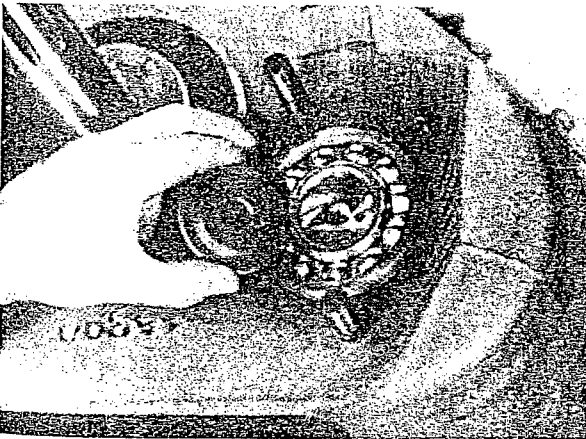
3. Dismount one of the bearers to install the front bearing of this countershaft.



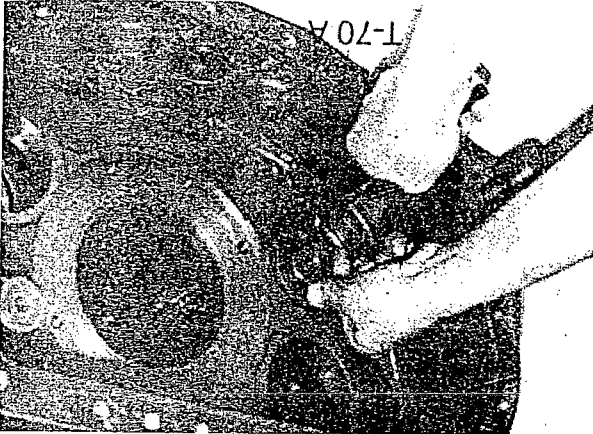
4. Remove the other bearer and install the rear bearing of the countershaft.



5. Install the front bearing baffle and two bolts of this countershaft, and lock it with wire.



6. According to the difference of the machine type, the bearing baffle can also be secured with a locating dowel and a bolt.



7. Install the locating circle of the rear bearing on this countershaft.
(5). Assembling of Second Shaft
Adjusting of the gear clearance of the second shaft.

obtain correct clearance:

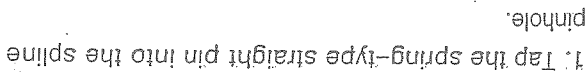
※※ Axial clearance of the reverse gear is adjusted

Put the snap ring into the reverse gear, put the spacer

Install the reverse gear and the driving gear of the

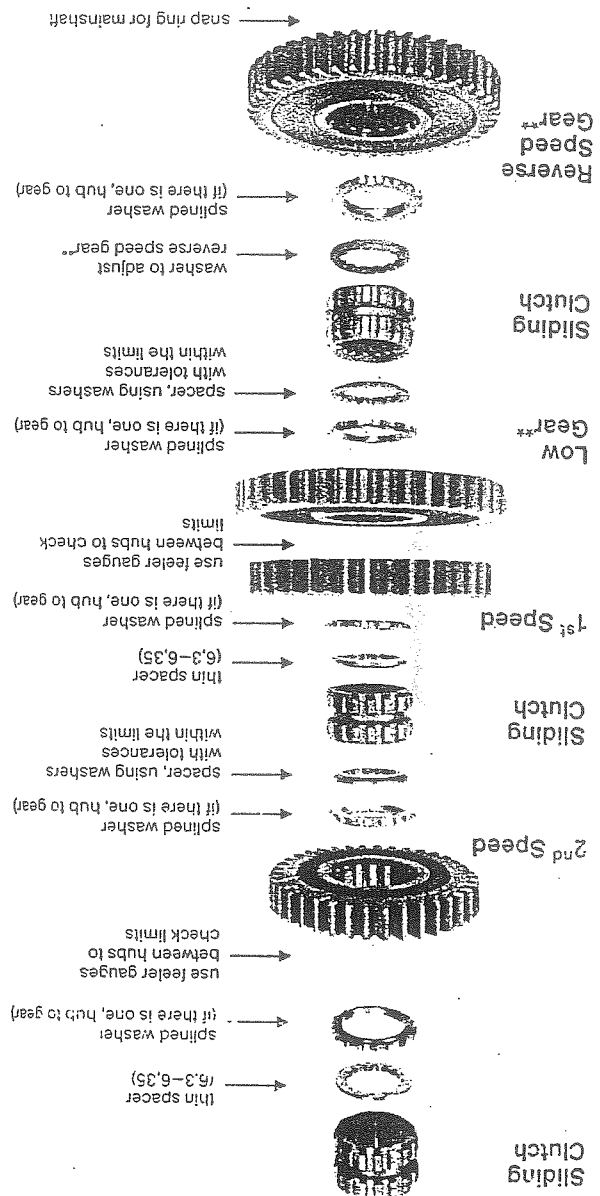
measure the clearance between the reverse gear and

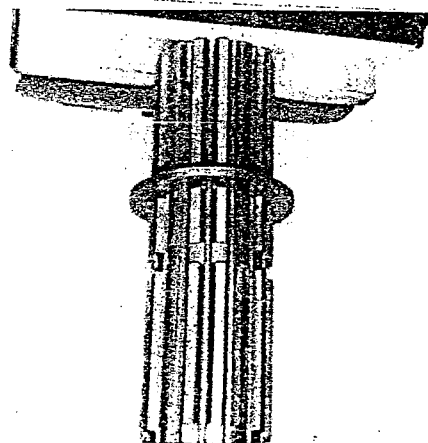
Replace the spacer in front of the reverse gear if



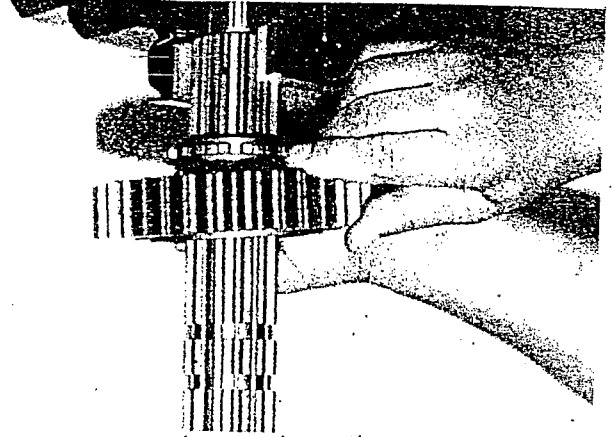
Reverse gear: 0.30 to 0.90 mm.

Forward gears: 0.13 to 0.30mm.



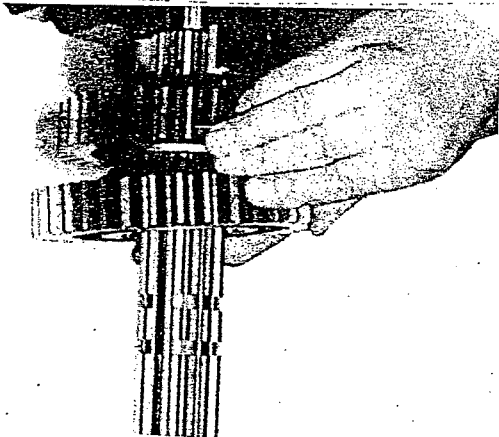


2. Clamp the second shaft on a jaw vice with the output end down. Put the washer of the third-speed gear in the lowest groove of the second shaft with its flat end down, and rotate the washer and lock it with single key. Note: When attaching the washer, see to it that the big notching on the internal spline is away from the keyway.

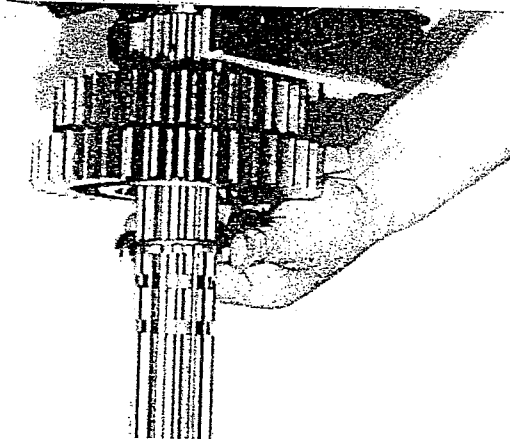


3. Attach the spline washer of the third-speed gear on the shaft and keep the spacer in position.

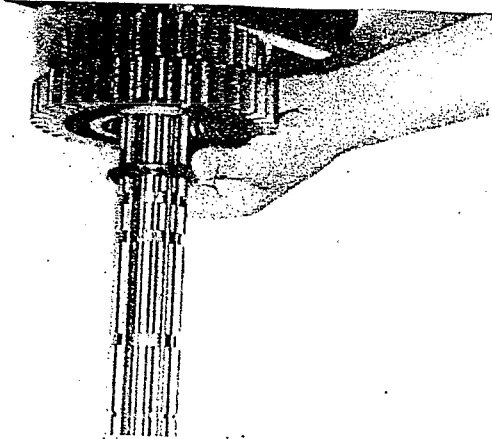
4. Put the third-speed gear on the spline washer with the joining teeth downside.



5. Put the second-speed gear on the third speed gear, the tooth face with arc chamfer upward.

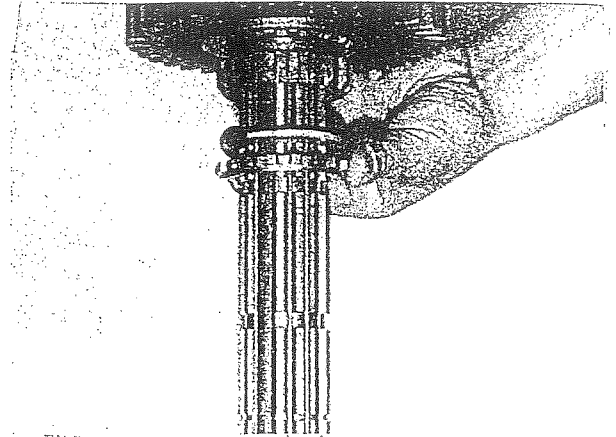


6. Put the spline washer into the second-speed gear with the flat end up.

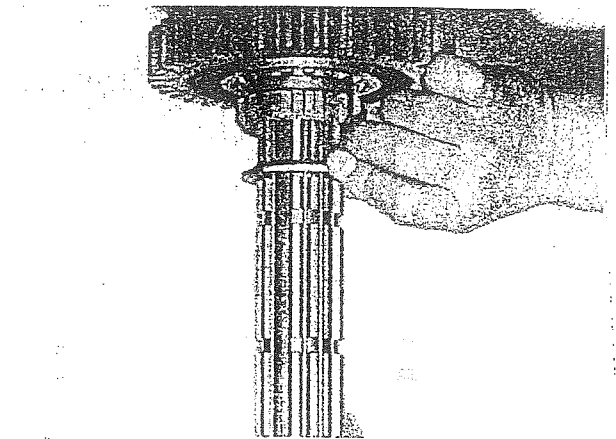


7. Take out the single key, put the adjusting spacer of the second-speed gear into the second-speed gear with the flat end down, rotate the washer to let the single key go in and lock the washer. The thickness of the washer should keep the axial clearance of the gear within a range of 0.13-0.3 mm. This clearance can be measured with feeler gauge at the gear flange.

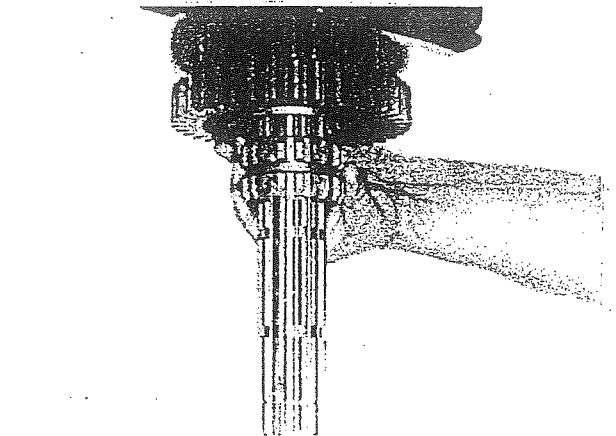
10. Put the spline washer on the shaft to hold the adjusting spacer, with the flat end downward.



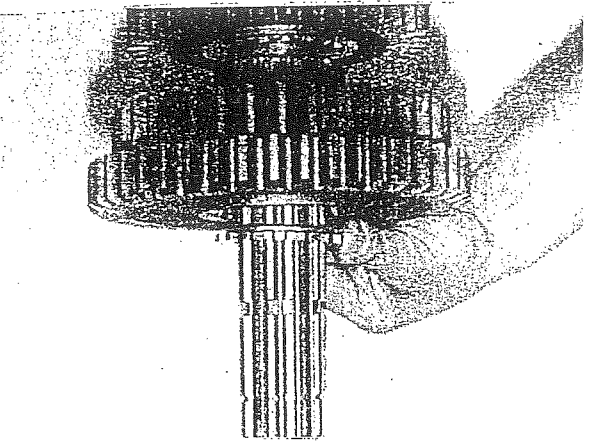
9. Take out the single key and put the adjusting spacer of the first-speed gear on the shaft, with the flat end up. Reattach the single key.



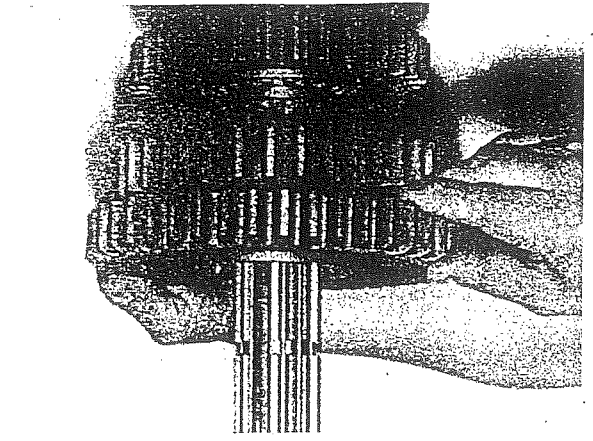
8. Put the engaging sleeve of 1-2 gear in the second shaft.



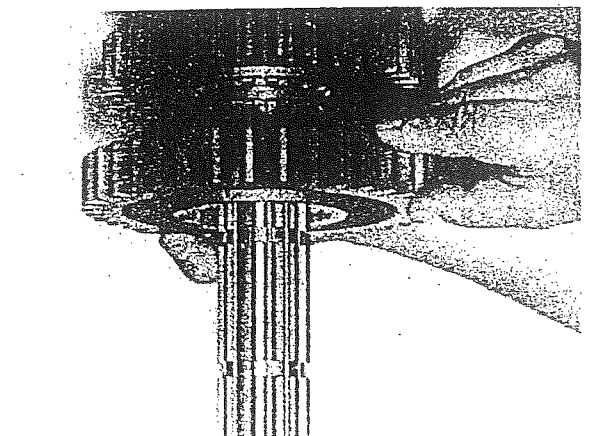
13. Put the spline washer in the flange of the low speed gear, with the flat end upward.

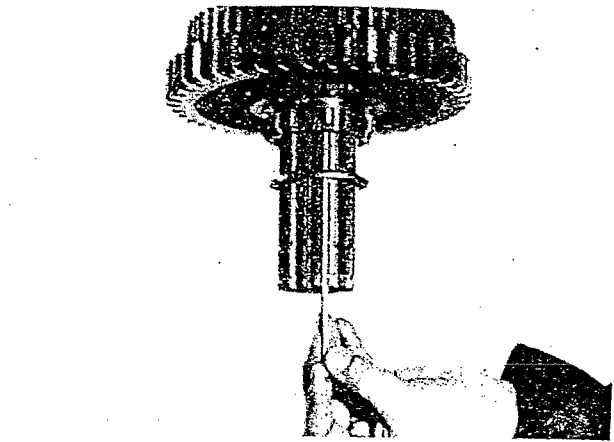


12. Put the low speed gear on the shaft, the tooth face with arc chamfer upward.

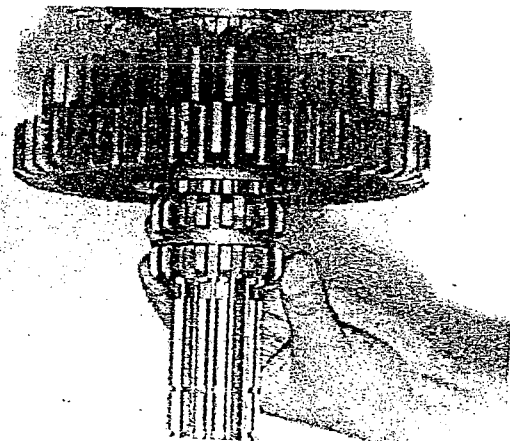


11. Put the first-speed gear on the shaft, the tooth face with arc chamfer upward.

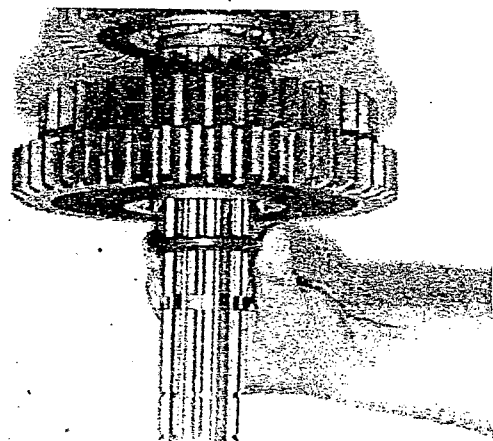




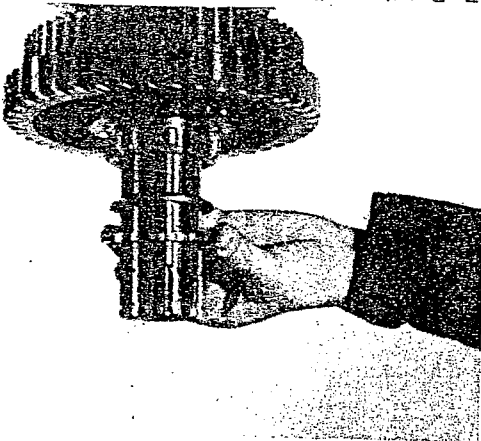
15. Attach the low gear and reverse gear sliding sleeves on the shaft, make the keyway of the sliding sleeve in line with the key on the shaft.



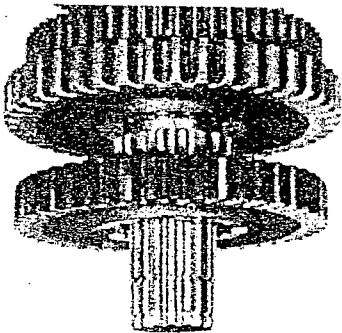
14. Take off the single key, put the adjusting washer into the low speed gear hole of the second shaft, with the flat end downward, rotate the adjusting washer and insert the single key again to position the adjusting washer. The thickness of the adjusting washer should ensure the axial clearance of the gear within the range of 0.13-0.3 mm.



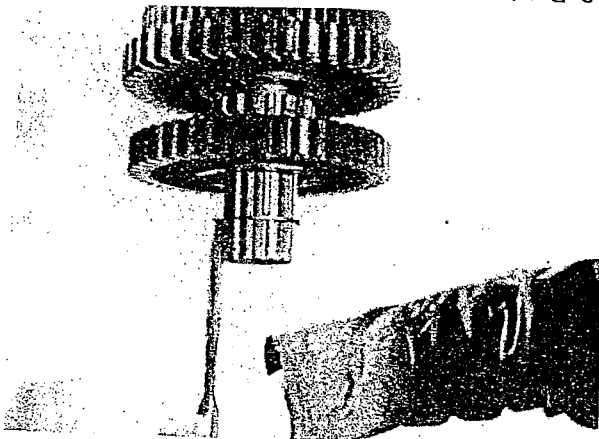
16. Take off the single key, attach the adjusting washer of the reverse gear, with the flat end upward. Insert the single key again:



17. Put the spline washer on the shaft to hold the adjusting washer. The flat end downward.

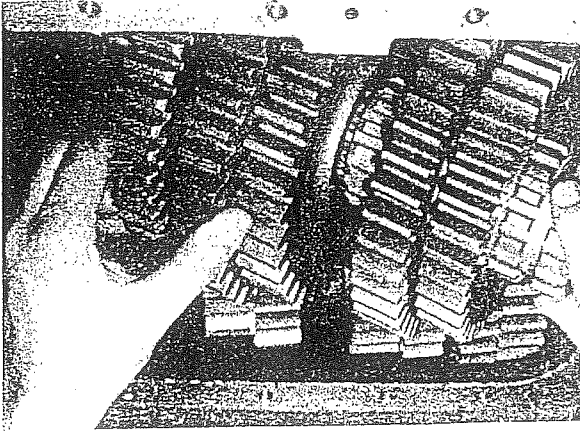


18. Put the reverse gear on the shaft, the tooth face with arc chamfer downward.

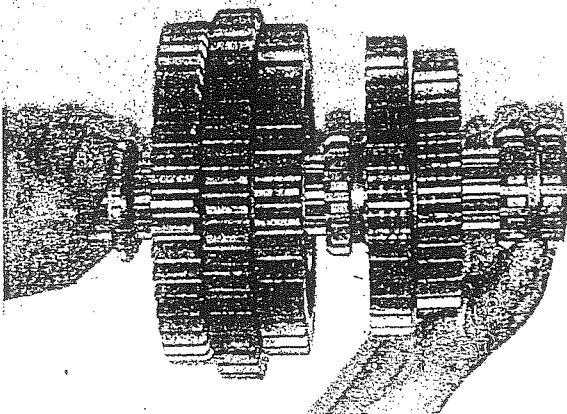


19. Put the snap ring into the second ring groove from the up side. The notching of the snap ring must be away from the keyway.

2. Push the auxiliary shaft inward to make it contact with the inner wall of the gearbox housing closely. Put the second shaft on the gearbox housing and lean against the reverse gear for positioning. Move the second shaft forward via the driving gear hole of the auxiliary box to set the shaft end in place in the bush of the first shaft and make all the gears of the second shaft mesh with those of the lower-left auxiliary shaft.

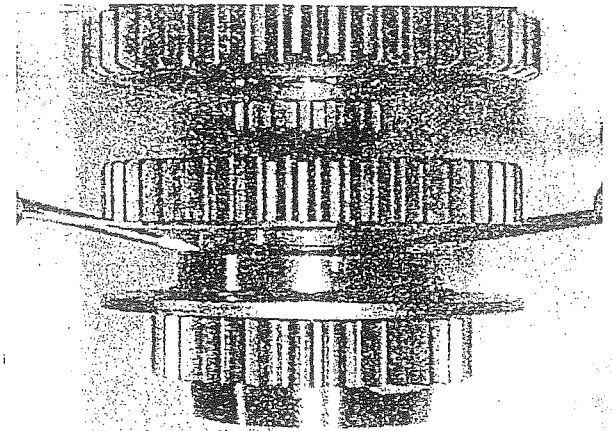


1. Take off the second shaft from the bench vice and put the sliding sleeve of the third and the fourth gears on the shaft.

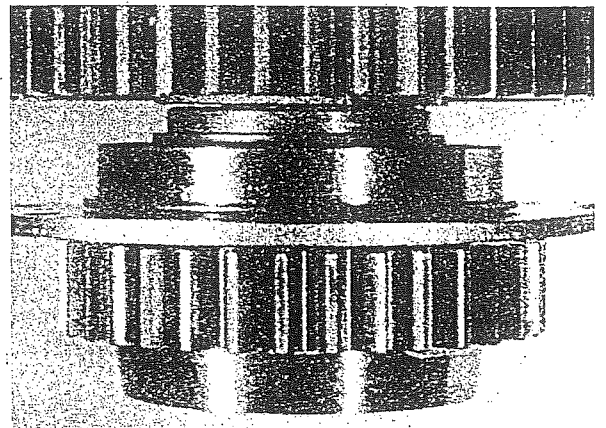


(6). Installing the second shaft

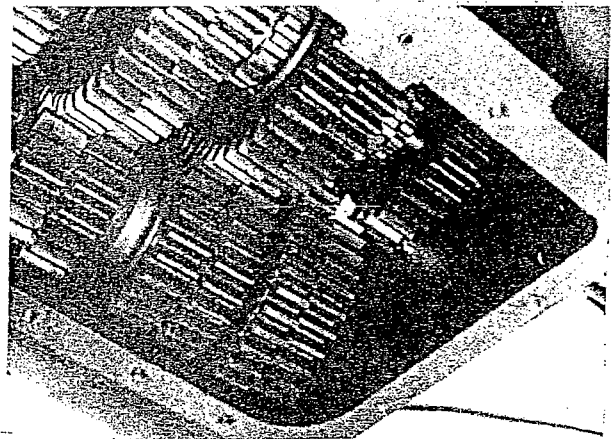
21. Insert 2 screw drivers between the driving gear of the auxiliary box and the reverse gear and poke them upward. Then check the clearance by inserting two feeler gauges between the flanges of the two gears. Replace the adjusting washer in case of necessity and remeasure the clearance.



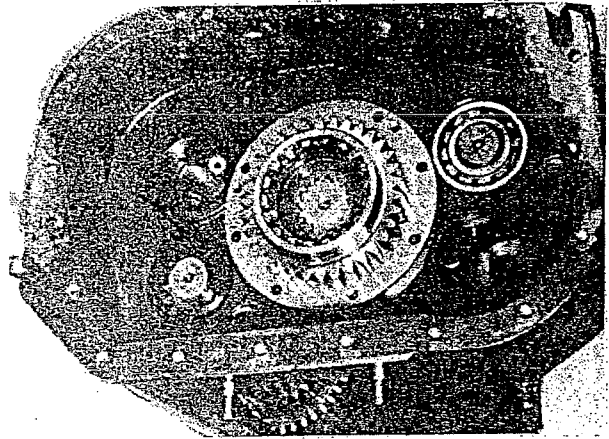
20. Attach the driving gear of the auxiliary box on the second shaft and lock it with the snap ring at the tail end of the second shaft.



(7). Installing the upper-right countershaft by tooth alignment



1. Under the precondition of ensuring the tooth alignment of the lower-left counter shaft gears, rotate the upper-right counter shaft, making the auxiliary shaft's driven gear teeth with marks mesh with the two marked teeth of the first shaft's driving gear.

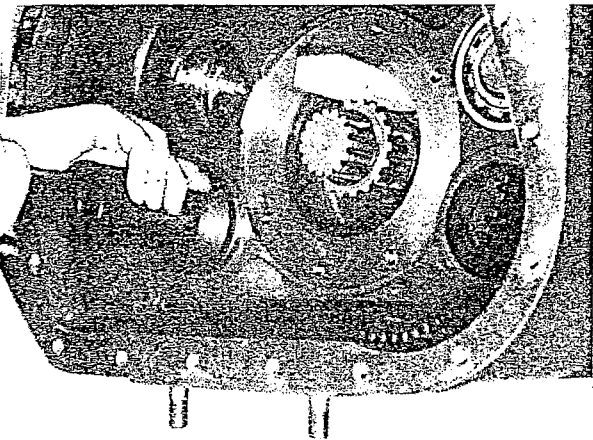


2. Put the output gear of the second shaft on the second shaft temporarily so as to center the second shaft. Meanwhile, center the rear end of the upper-right auxiliary shaft with a special bearer. At this time, all the gears on both of the auxiliary shafts should mesh with the gears of the second shaft simultaneously. If not, it shows that there is fault in the tooth alignment of the first shaft and the auxiliary shaft.

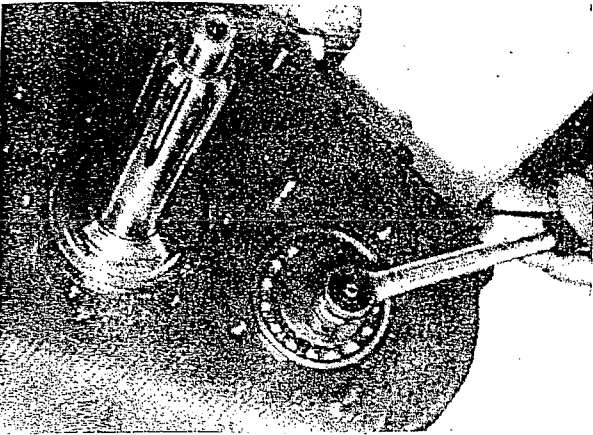
3. Mount the front bearing of the upper-right counter shaft.



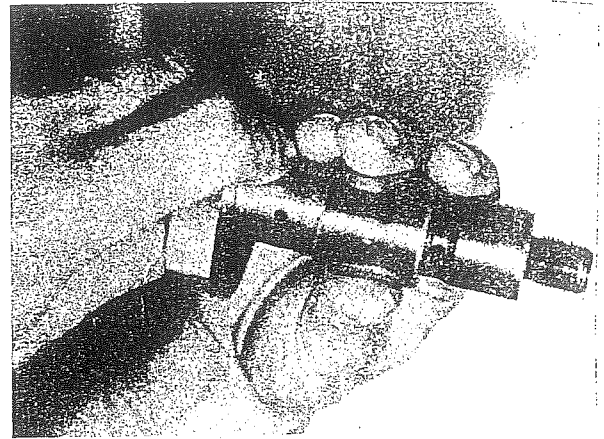
4. Take off the output gear of the second shaft, support the second shaft with a special purpose bearer, and mount the rear bearing of the upper-right counter shaft.



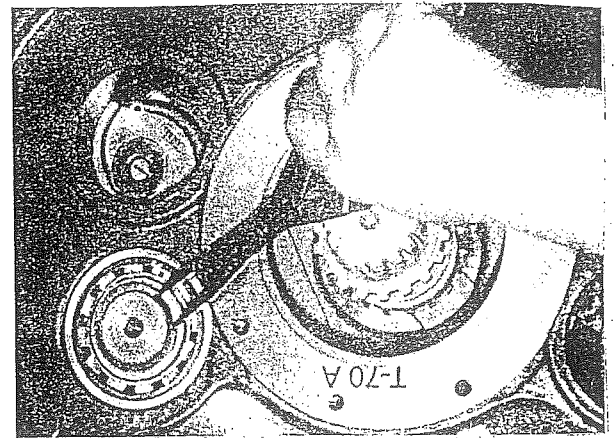
5. Mount the front bearing of the upper-right counter shaft and lock it with wire.



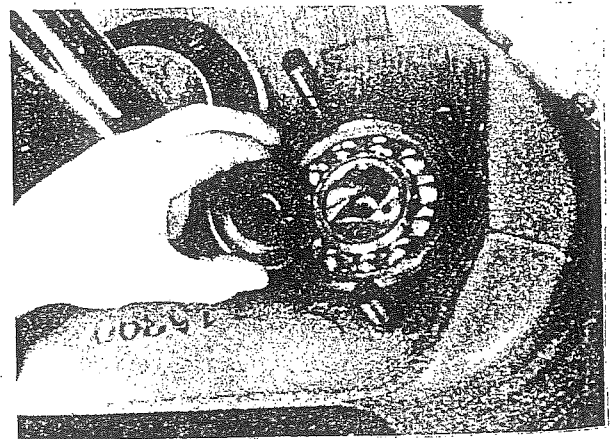
1. Fix the plug, eccentric back plate and the bearing inner race on the reverse gear shaft.



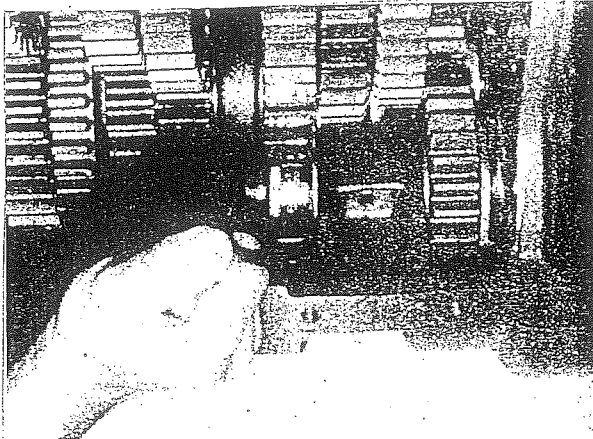
7. Set the circlip into the circular groove at the rear end of the auxiliary shaft.
(8). Installing the upper-right reverse intermediate gear



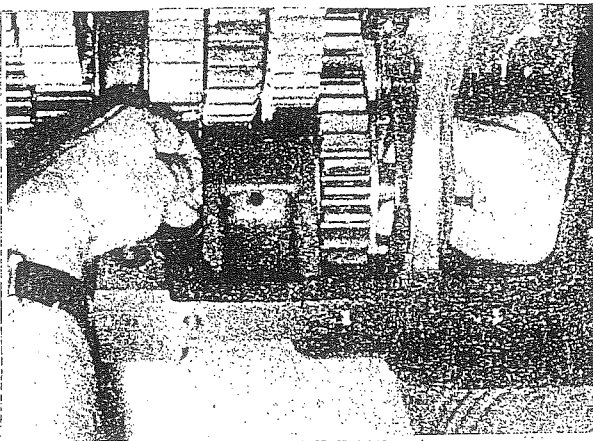
6. Owing to the variation of the machine types, the baffle can be secured with a dowel and a bolt.



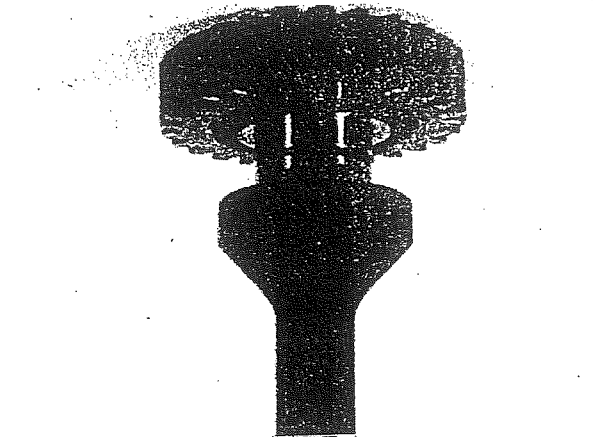
5. Install washers and nuts on the shaft and tighten them.



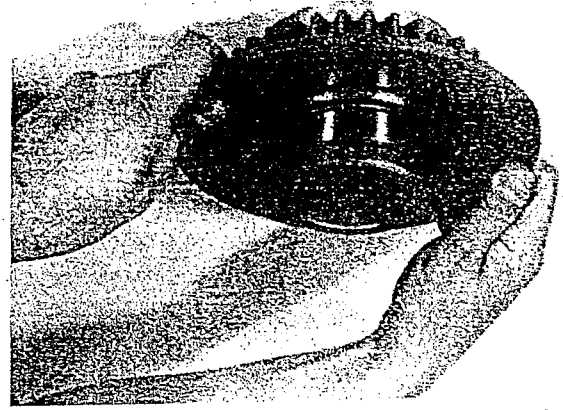
3. Set the reverse intermediate gear and the thrust plate in place in the housing hole. Attach the reverse intermediate gear shaft. Make sure that the bearing outer ring and the bearing inner ring are in alignment.



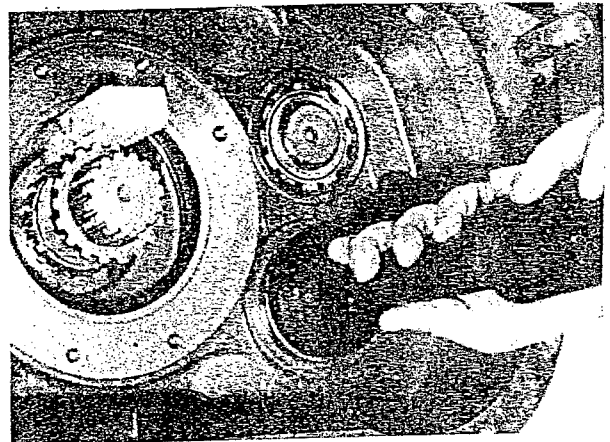
2. Press the bearing outer ring into the reverse intermediate gear.



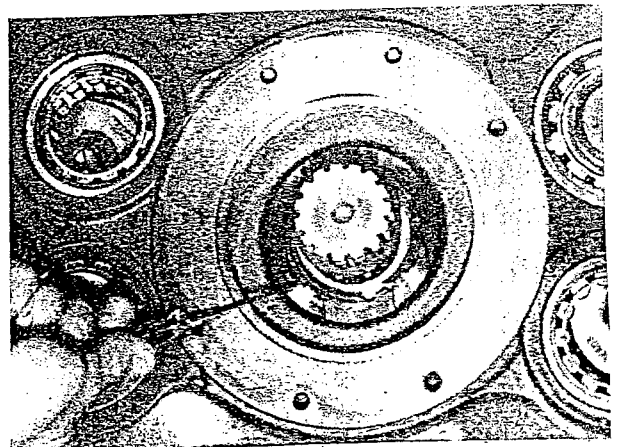
1. Set the locating disc on the driving gear with the flat side against the gear.



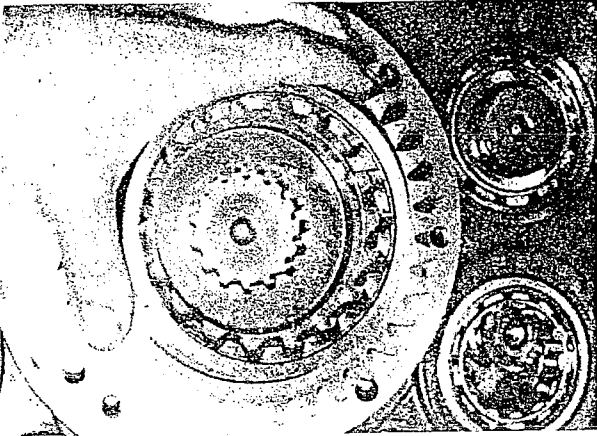
2. Mesh the reverse gear of the second shaft with the two reverse intermediate gears and put the snap ring on the inside of the reverse gear of the second shaft. (9). Installing the driving gear of the auxiliary box (output gear of the second shaft of main box)



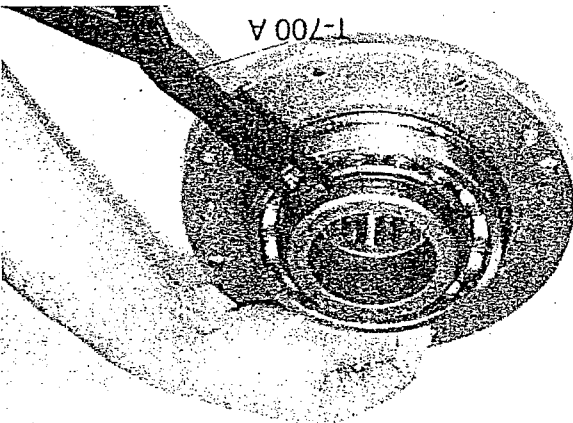
6. Seat the front bearing ring of the auxiliary boxes counter shaft in the housing hole of the reverse gear.



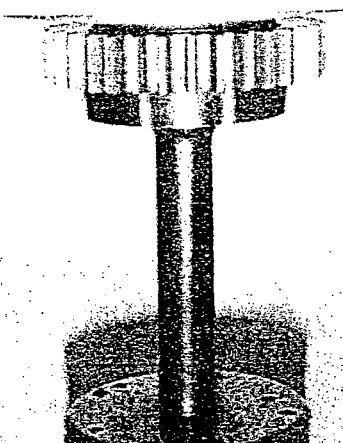
4. Put the driving gear of the auxiliary box over the splines of the second shaft, set the bearing in place in the housing rear hole.



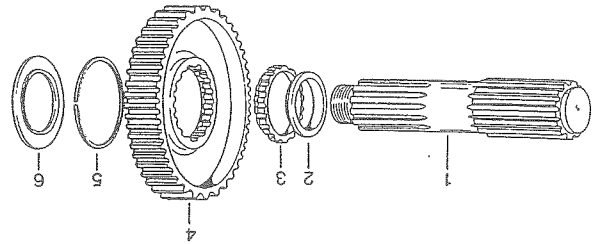
3. Set the snap ring into the circular groove in the circular bead of the gear.



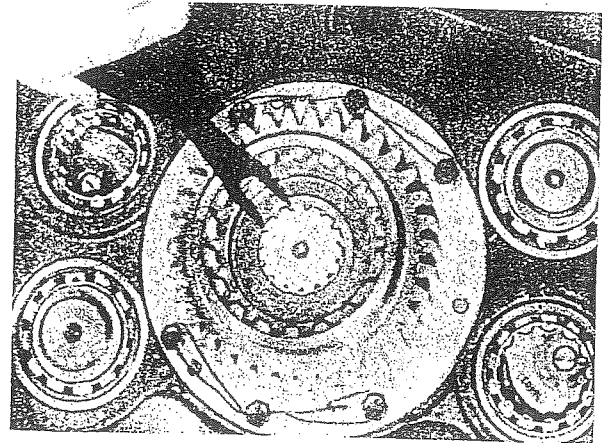
2. Press the bearing on the driving gear, the side of the snap ring upward.



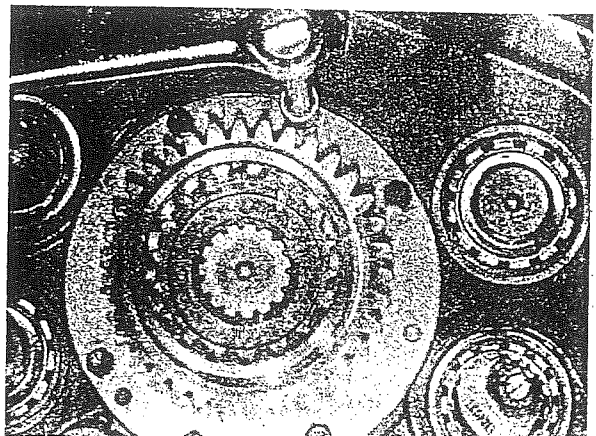
- Exploded View of the Output Shaft of Auxiliary Box
1. Output shaft
 2. Washer
 3. Spline washer
 4. Output gear
 5. Snap ring of the output gear
 6. Rear washer of reduction gear



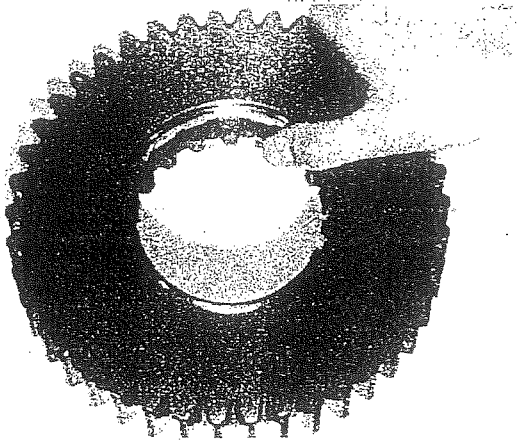
- (10). Attaching the output shaft of the auxiliary box
6. Set the snap ring into the circular groove in the second shaft.



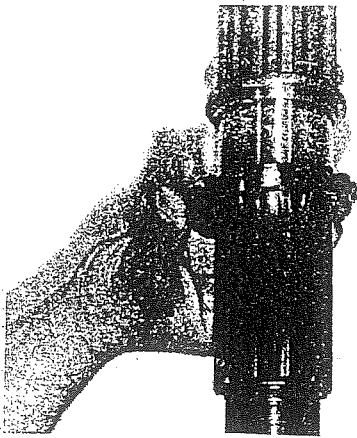
5. Secure the supporting disc and gear with 6 screws, and lock the screws with locking wire in two groups.



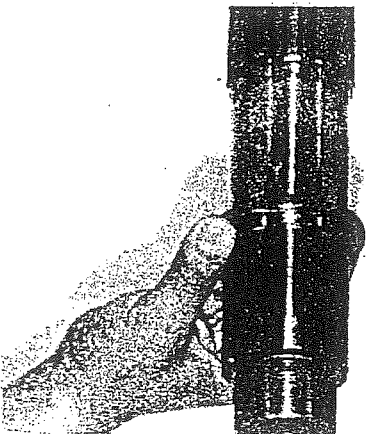
3. Put a circlip in the circular groove in the gear, attach the gear on the shaft and let it contact with the spline tightly. The flat end of the gear faces upward.



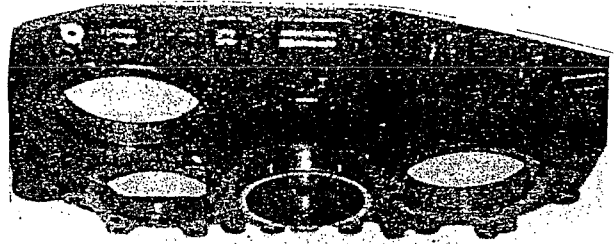
2. Put the spline sleeve into the shaft with the short axial diameter side upward.



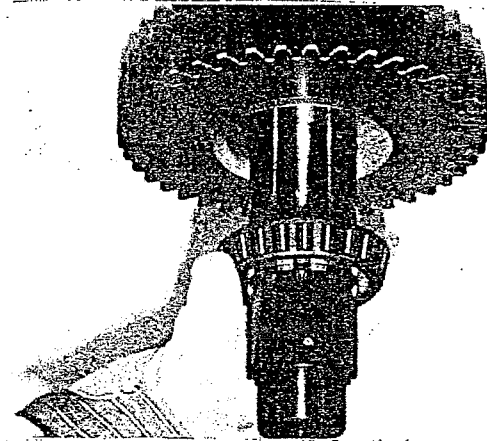
1. Put the output shaft on the workbench with the threaded end upward, place the washer in the shaft, the side with big circular bead downward while side with short axial diameter upward.



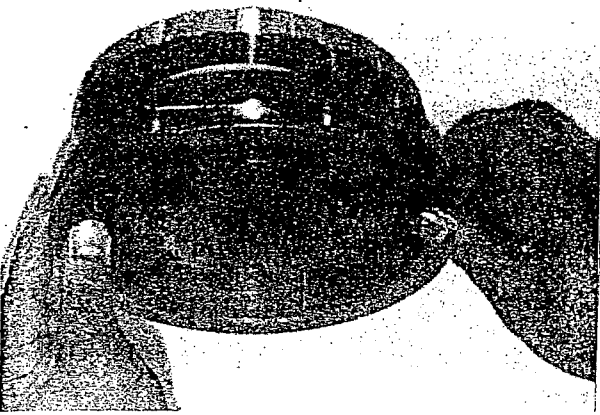
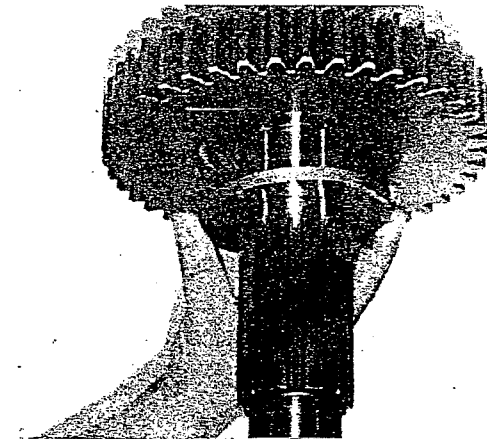
6. Put the outer ring of the front conical bearing in the housing hole. The conical surface must point downward.



5. Heat the inner ring of the front conical bearing to 130°C and attach it on the shaft, making it touch with the washer on the gear closely.



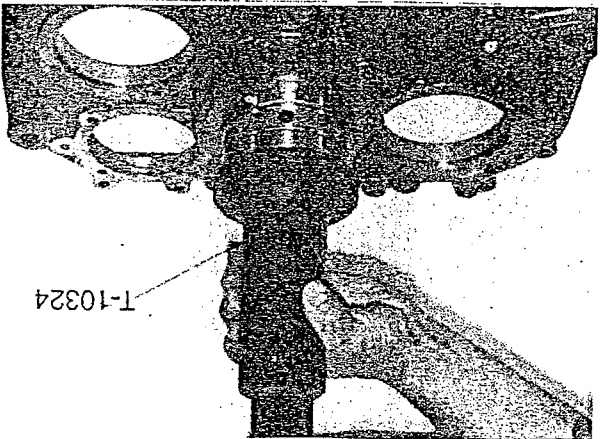
4. Put the washer over the shaft, the circular bead faces the gear and closely contacts with the gear.



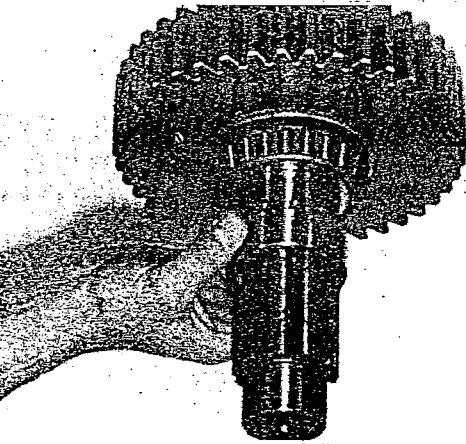
(11). Assembling the high and low gears synchronizer.

Note: The two conical bearings and spacers of the inner and outer rings are supplied in whole set. Therefore, when replacing them, they must be replaced in whole set.

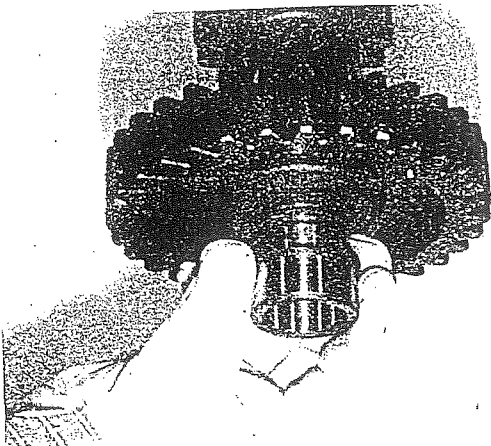
8. Tap gently the bearing outer spacer and the outer ring of the rear conical bearing into the housing hole, the circular bead side faces upward.



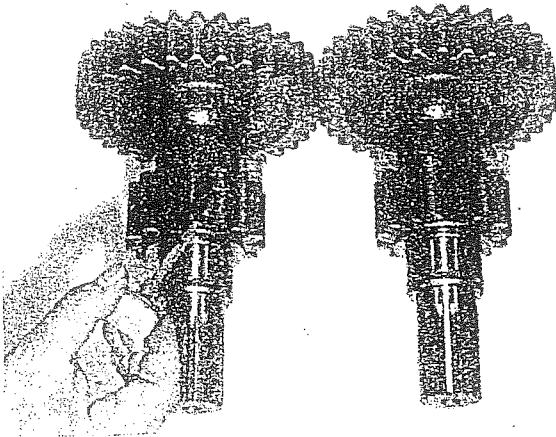
7. Install the spacer of the bearing inner ring on the shaft.



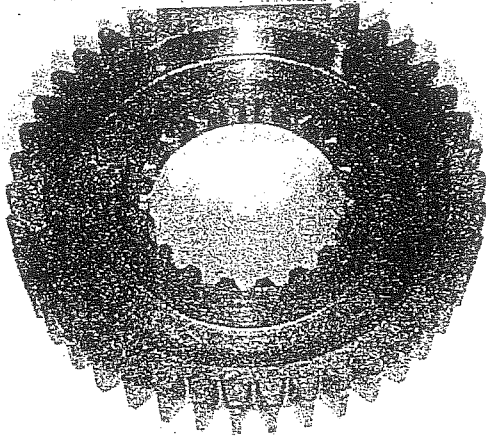
(12). Assembling the countershaft and output shaft of the auxiliary box



1. Put the bearing inner rings in the ends of the two counter shafts of the auxiliary box.

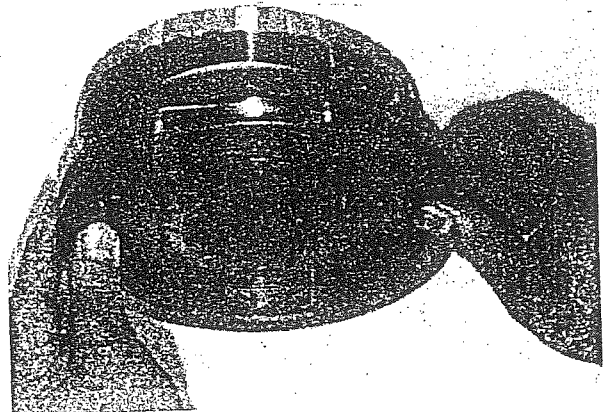


2. Mark the small gears of each intermediate shaft, on which letter "o" were printed.

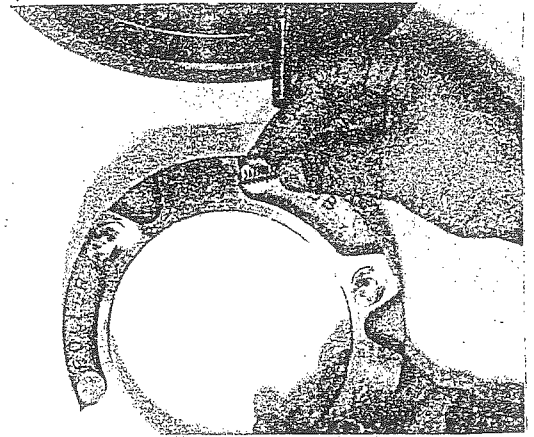


3. Make mark on any two adjacent teeth of the output gear and then make mark on the two teeth opposite to them.

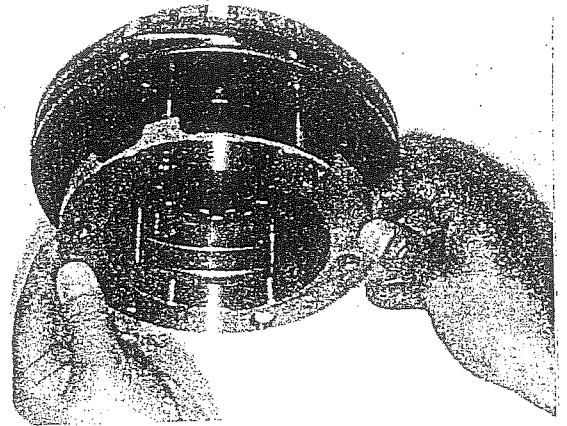
1. Put the sliding sleeve onto the dowel on the conical ring of the low gear synchronizer.



2. Put the 3 compression springs in the conical ring of high gear synchronizer.

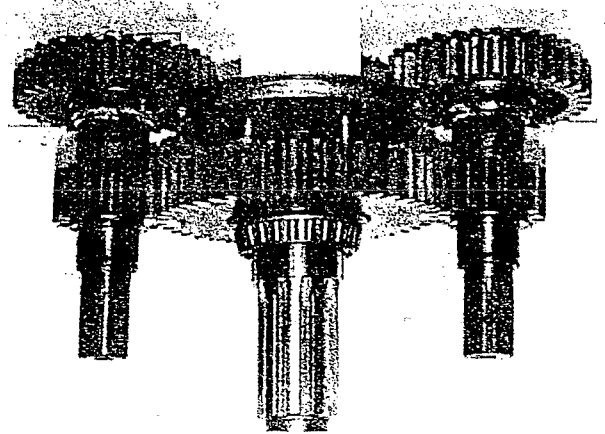


3. Put the conical ring of the high gear synchronizer on the dowel of low gear synchronizer conical ring.

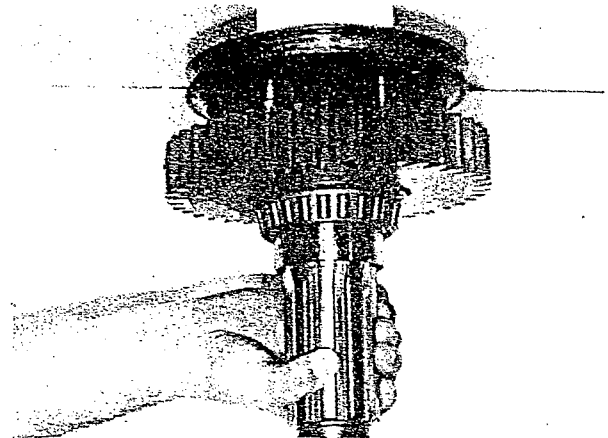


4. While compressing the springs, rotate and push conical ring of the high gear synchronizer downward to let the conical ring of the low gear synchronizer enter into the hole in the dowel.

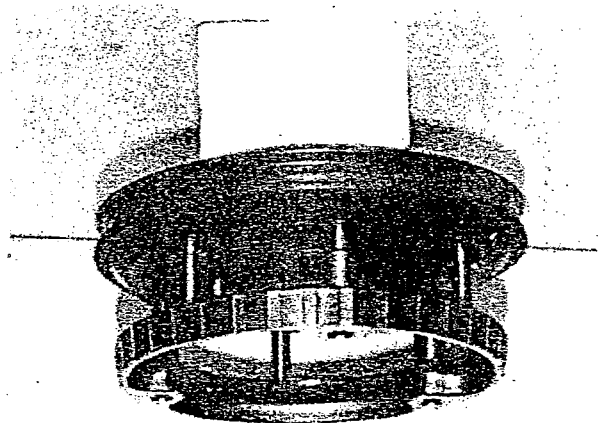
6. Let the two counter shafts touch closely against the output shaft. The two gears with marks on them of each countershaft must be located between the teeth with marks of the two output gears.



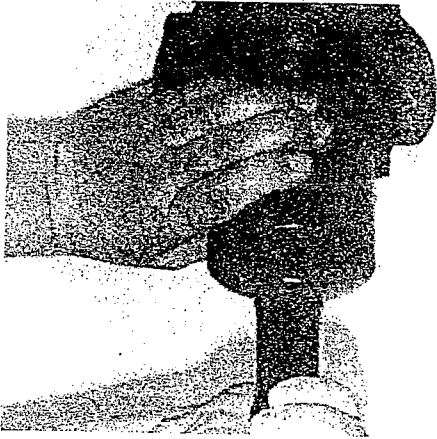
5. Put the output shaft on the synchronizer, let the keyway of the spline sliding sleeve on the shaft match with each other.



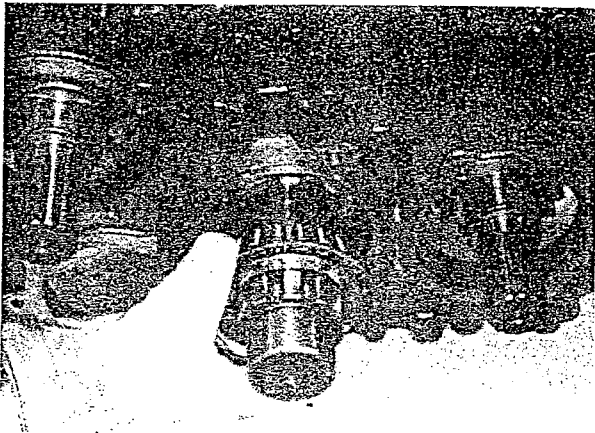
4. Put the synchronizer assembly on a block of wood with the thickness of about 50 mm. The conical ring of the high gear synchronizer faces down.



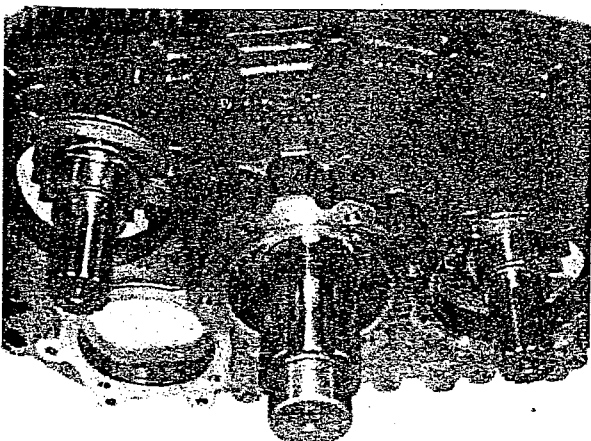
9. Install output shaft oil seal on the odometer casing, let the smooth side face up.



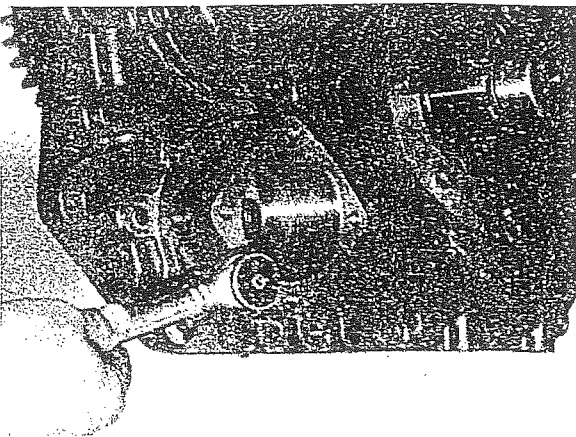
8. Heat the inner ring of the conical bearing and press it onto the output shaft.



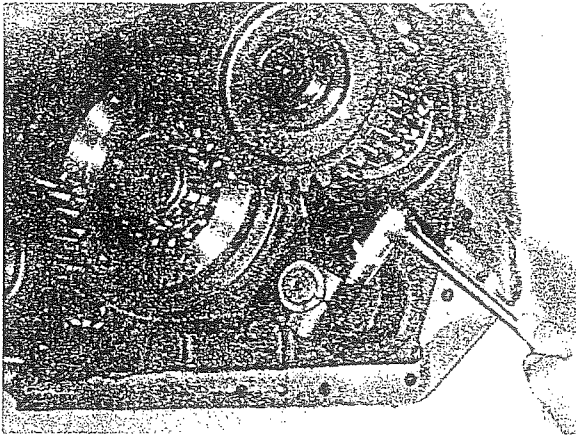
7. Put the auxiliary box on the output shaft with the up side down. The countershaft must line up with the bearing hole in the housing.



(13). Installing the high and low gears control cylinder



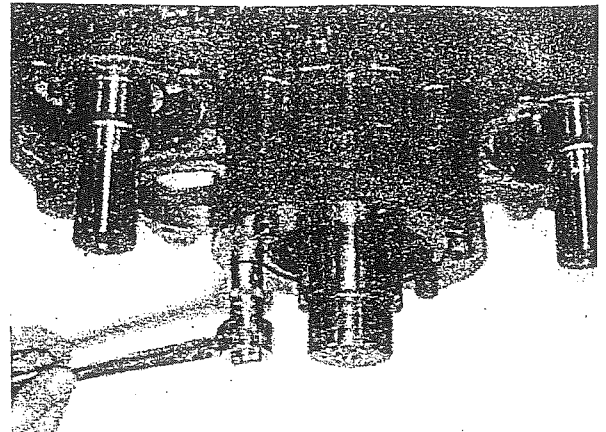
1. Mount the cylinder body and gasket on the auxiliary box housing and let the side with air pipe union face upward. The gasket should be coated with Loctite 501 surface sealant.



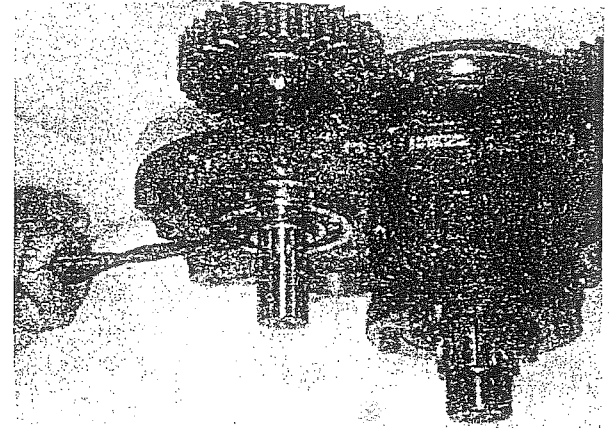
2. Attach the shifting yoke on the synchronizer sliding bush, insert the yoke lever in it and make it go through shifting yoke and the cylinder body. Secure the shifting yoke with two set screws and lock them up with wire.



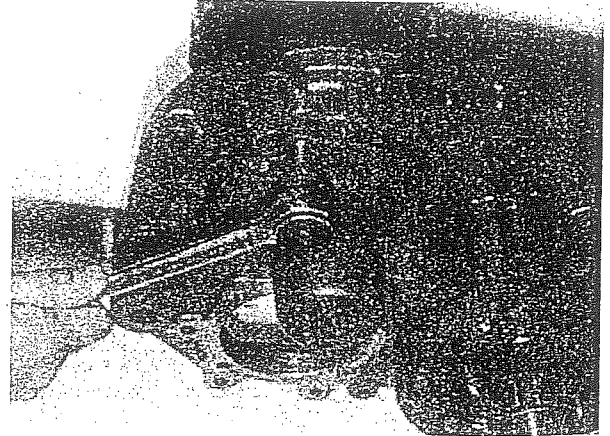
3. Set O-rings in the bore and outer ring of the piston.



10. Mount the odometer casing and gasket on the housing of the auxiliary box and fasten them. Smear Loctite510 surface sealant on the gasket.

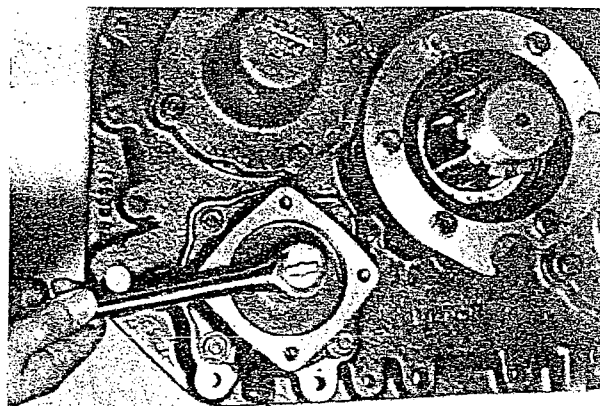


11. Mount the rear bearing on the countershaft, tap it into the housing hole with bearing installing tool, and attach the circlip.



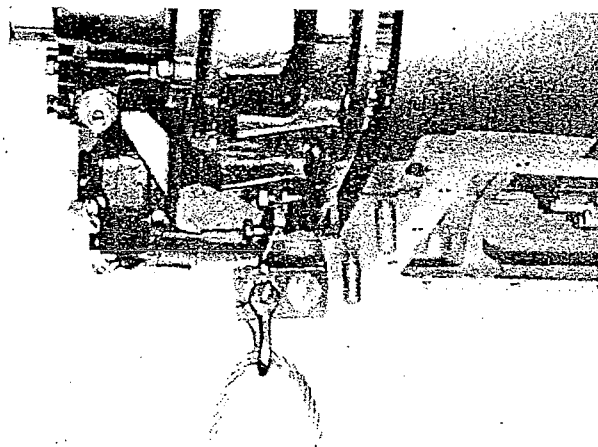
12. Fasten the rear bearing cap of the countershaft with the gasket. The gasket should be coated with Loctite510 surface sealant.

Coat the O-ring with thin layer of silicone grease before hand. Insert the piston on the shifting yoke lever and then put it into the cylinder. Let its flat end face out. Note: The shifting yoke is asymmetric. Screw must be installed from the down side.



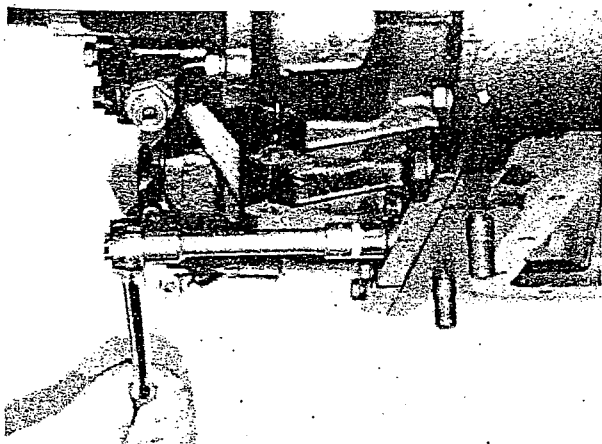
4. Fasten the piston with self-locking nut. Mount the shifting cylinder and gasket with the pipe union at the top. Coat the junction surfaces with Loctite 510 sealant.

(14). Hoisting the auxiliary box



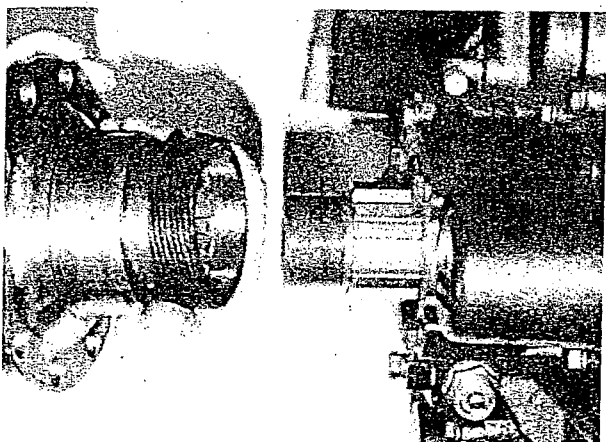
1. Set gasket on the junction surface of the auxiliary box housing. Attach a hoisting gear on the auxiliary box. Make the auxiliary box house align with the locating dowel on the main box. Both the auxiliary shafts should mesh with the driving gear, and the front end of each auxiliary shaft should insert into the bearing holes mounted in the bulkhead of the main box. Make the auxiliary shafts move smoothly toward the main box. Rotate the driving gear of the auxiliary box when it is necessary, so that the gears can mesh

correctly. When attaching the joint gasket, Loctite 510 sealant must be coated on both its sides.



2. Install the screws and tighten them up with the specified torque.

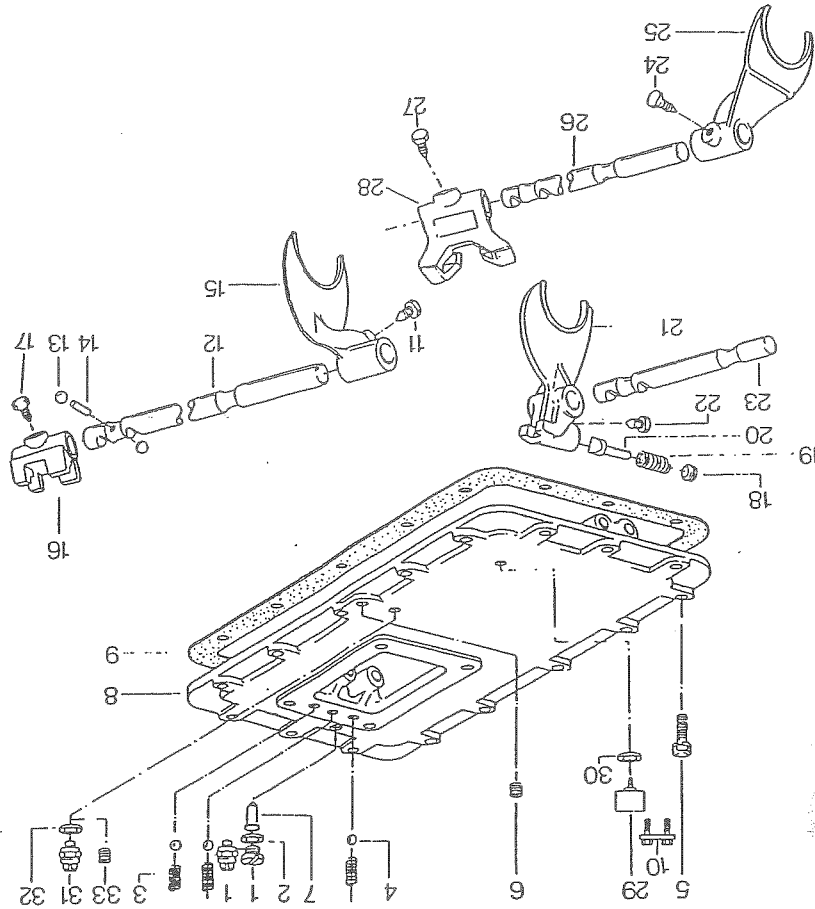
Note: The auxiliary box may also be installed in the vertical mode. Set the main box upright on a block of wood. Let the auxiliary box drop down with the help of sling chain of the hanger that attaches with the output shaft.



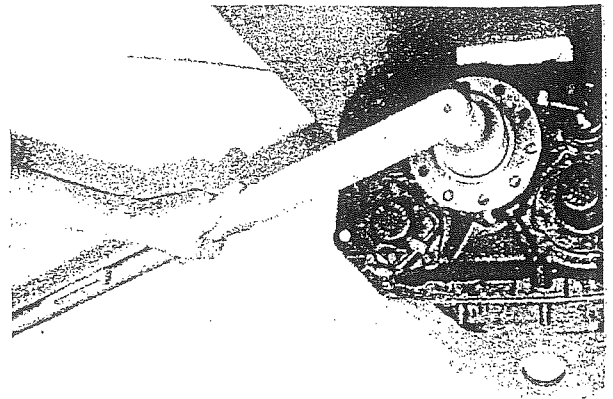
3. Mount the worm wheel or spacer on the shaft section of the flange disc. Put the flange disc over the spline of the output shaft. Remarks: When the auxiliary box is partially installed onto the main box, the synchronizer should be set at the low gear position at the beginning.

Exploded View of Gearbox Top Head Structure

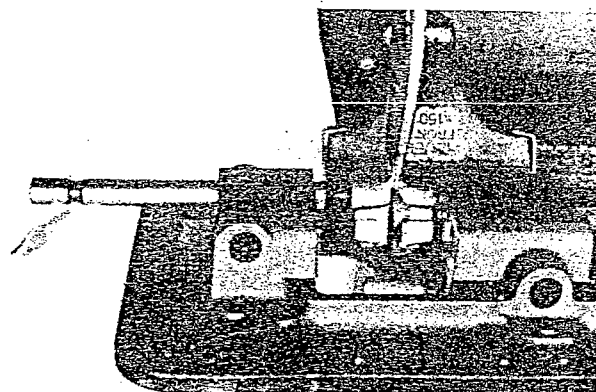
1, Plug screw/backup light switch 2, Gasket 3, Tension spring 4, Steel ball(3) 5, Screw(16) 6, Plug screw 7, Backup light dowel pin(option) 8, Top head 9, Gasket 10, Hex-screw bracket(option) 11, Set screw 12, Shifting yoke lever 13, Interlock steel ball 14, Interlock pin 15, Shifting yoke for 1st & 2nd gear, 5th & 6th gear 16, Shifting block for 1st & 2nd gear and 5th & 6th gear 17, Set screw 18, Plug screw 19, Spring 20, Plunger of reverse gear lock 21, Shifting yoke for low and reverse gears 22, Set screw 23, Shifting yoke lever 24, Set screw 25, Shifting yoke for 3rd & 4th gear and 7th & 8th gear 26, Shifting yoke lever 27, Set screw 28, Shifting block for 3rd & 4th gear and 7th & 8th gear 29, Pneumatic valve(option) 30, Neutral gear switch(option) 31, Sealing ring(option) 32, Sealing ring(option) 33, Screw



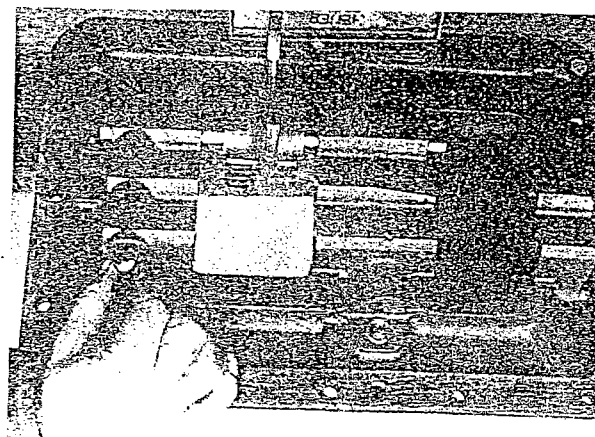
(15). Assembling the transmission top head



4. Shift the main box to two gears simultaneously and fasten the nut of the output shaft with the torque of 610~680Nm.

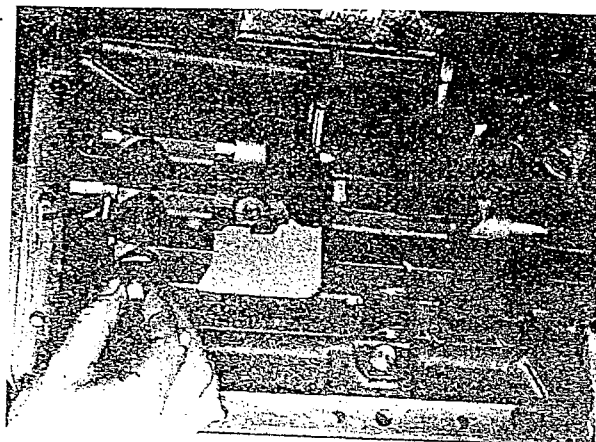


1. Mount the shifting yoke and shifting yoke lever of reverse/low gear. Attach and fasten the set screws.

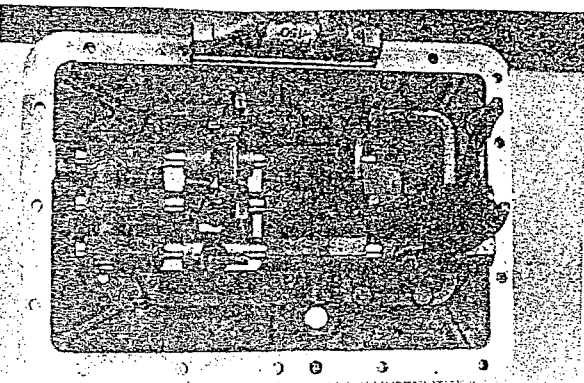


2. Install the shifting interlocking ball.

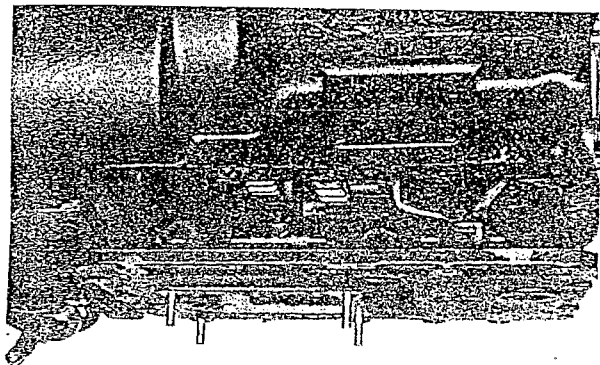
Note: All the notchings on the shifting yoke lever used for shift locking must face the top head.



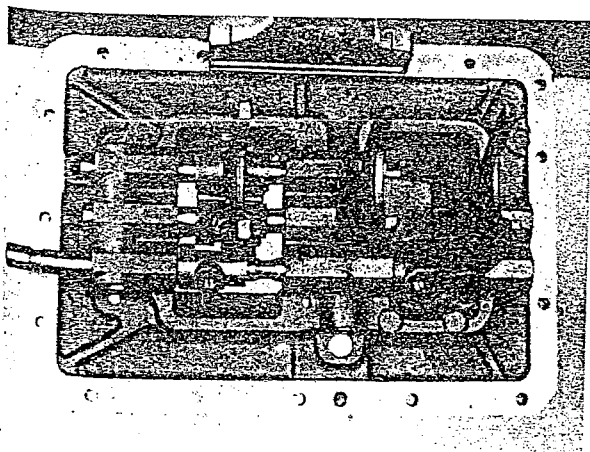
3. Install the shifting yoke, shifting block, shifting yoke lever and dowel of the 1st & 2nd gear (5th & 6th gear). Set the shifting interlocking steel ball and fasten the set screws.



5. Install and fasten the set screws.



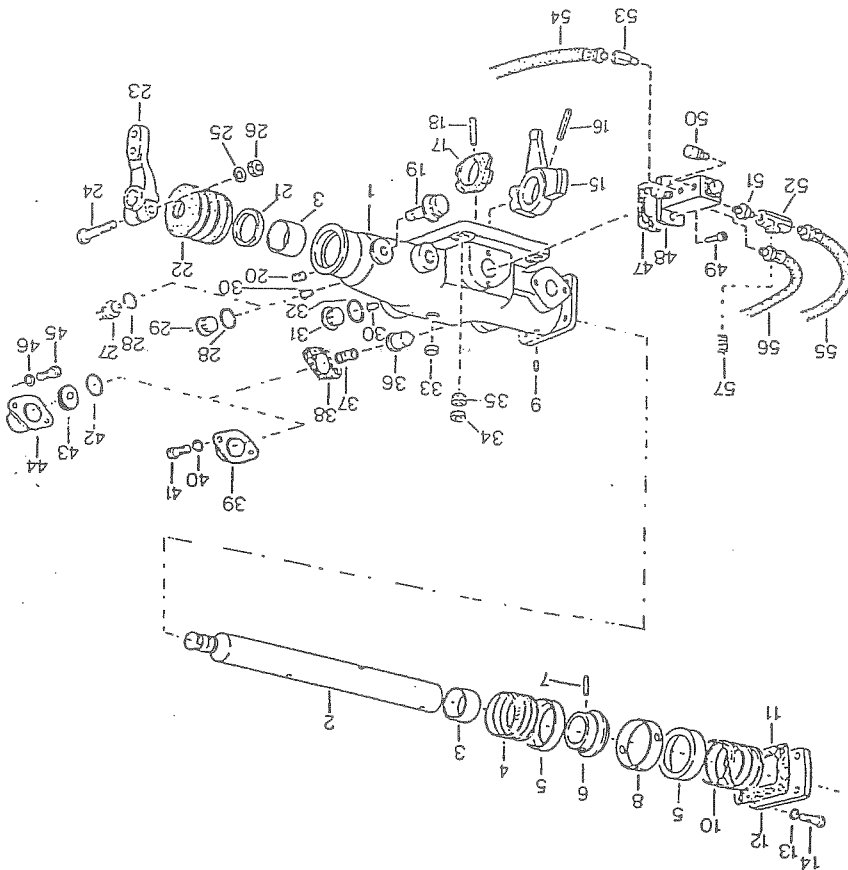
6. Mount the top head on the gearbox and fasten it.



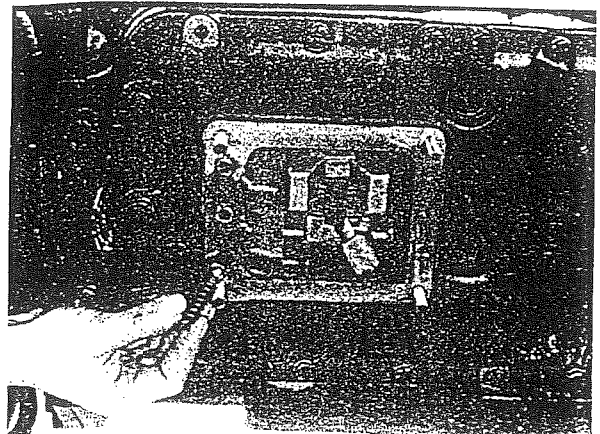
4. Install the shifting yoke, shifting block and shifting yoke lever of the 3rd & 4th gear (7th & 8th gear).

Exploded View of Double H Shifting Unit Structure

54, Air pipe 55, Air pipe 56, Air pipe 57, Screw plug 58, End cover
 49, Hexagon-socket head screw 50, Ventilation plug 51, Screwed union 52, Three way 53, Elbow joint
 Screw 42, O-ring 43, Piston 44, Cover 45, Screw 46, Spring washer 47, Gasket 48, Switching valve
 34, Lock-nut 35, Hex nut 36, Piston 37, Spring 38, Gasket 39, Cover 40, Spring extension ring 41,
 Backup light switch 28, Gasket 29, Screw 30, Pin 31, Screw(Neutral gear switch) 32, Gasket 33, Plug
 plug 20, Screw 21, Oil seal 22, Air bag 23, Shifting rocker 24, Screw 25, Spring washer 26, Nut 27,
 Shifting block 16, Cylindrical pin 17, Elastic cylindrical pin 18, Reverse gear switch control cam 19, Ventilation
 Spring spacer 9, Set bolt 10, Spring 11, Gasket 12, Housing cover 13, Spring washer 14, Screw 15,
 1, Housing 2, Shifting shaft 3, Sliding spring 4, Spring 5, Spring seat 6, Set collar 7, Elastic column 8,

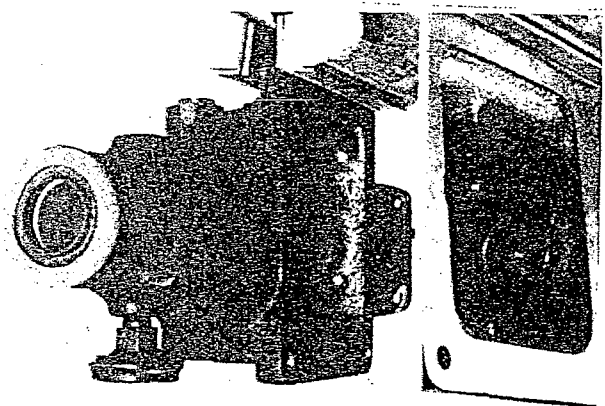


(16). Assembly of double H shifting mechanism

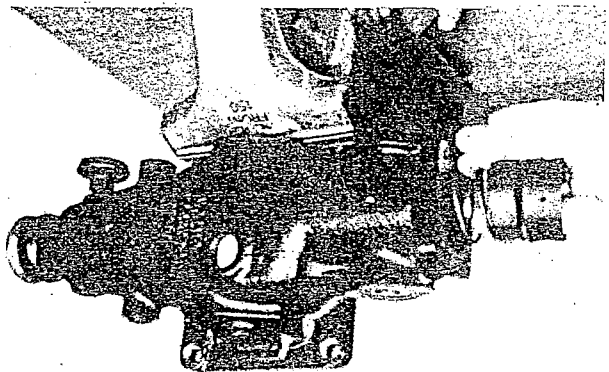


7. Self-locking steel ball and compression spring

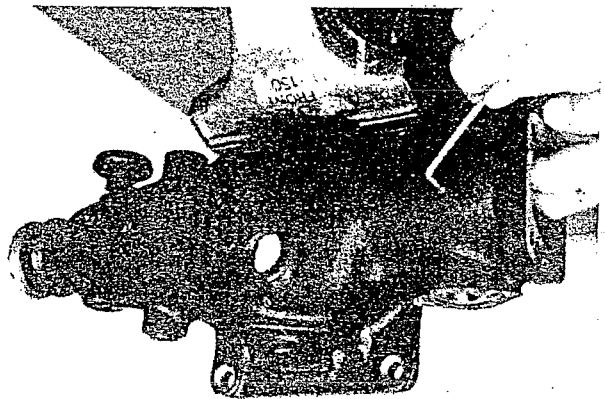
1. Mount the oil seal and bush.



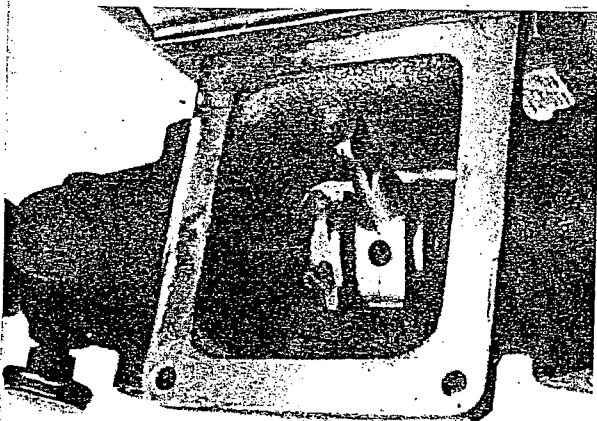
2. Install the spring, spring seat, spacer and locating ring.



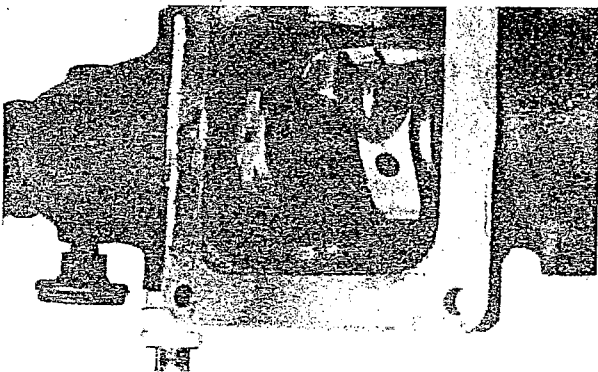
3. Compress the spring and fix the locating ring with a screw.



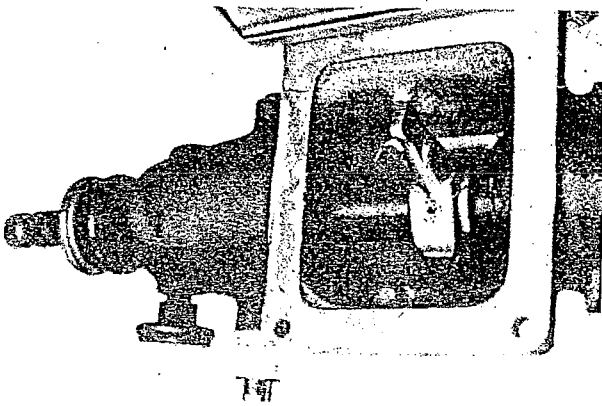
4. Install the shifting shaft, the shifting block and the shifting control block.

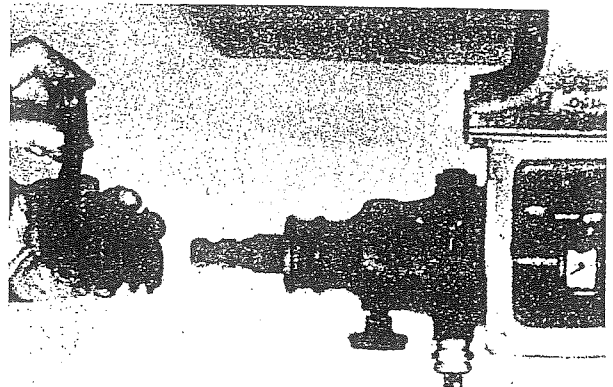


5. Fix the reverse gear control cam and the shifting shaft with the cylindrical pin. Install the reverse gear switch and pinle.

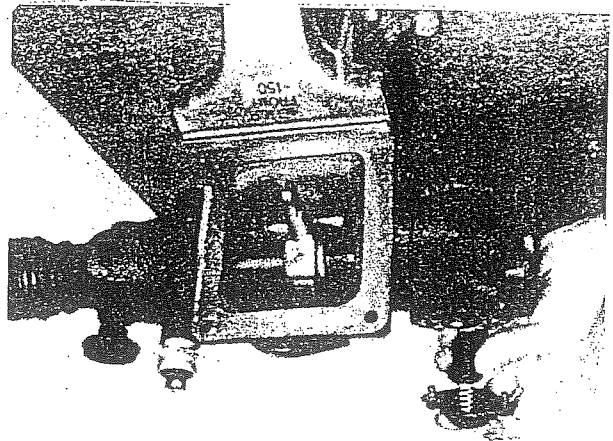


6. Secure the shifting block and the shifting shaft with the cylindrical pin and lock it with wire.

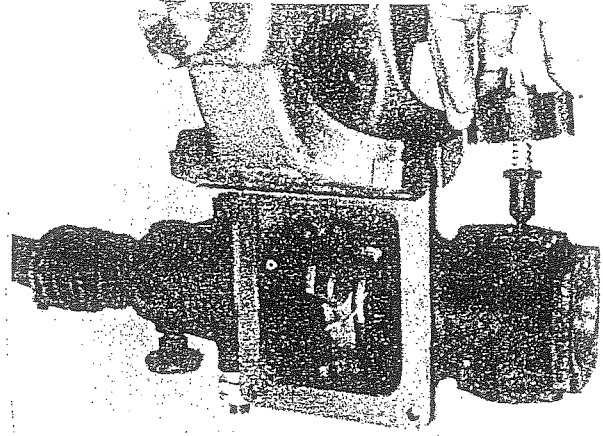




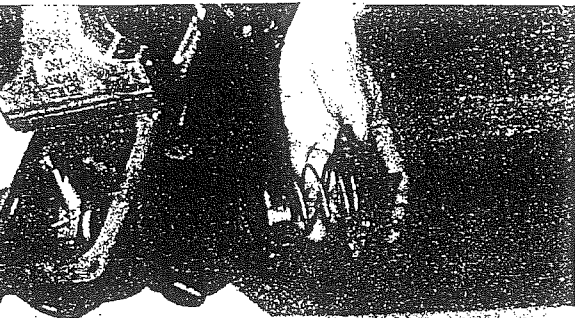
7. Install the shifting elbow arm and the dust proof boot.



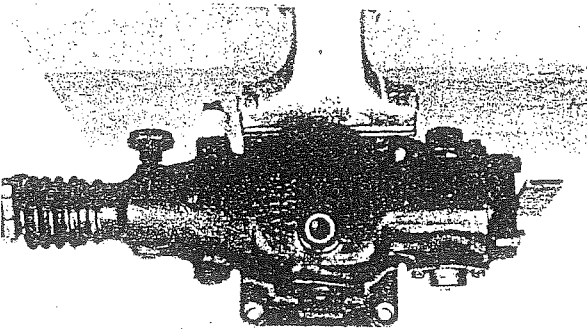
8. Install the position lock pin, spring and side cap.



9. Install the position lock pin, spring and side cap on the other side.



10. Install the rear spring and end cover.

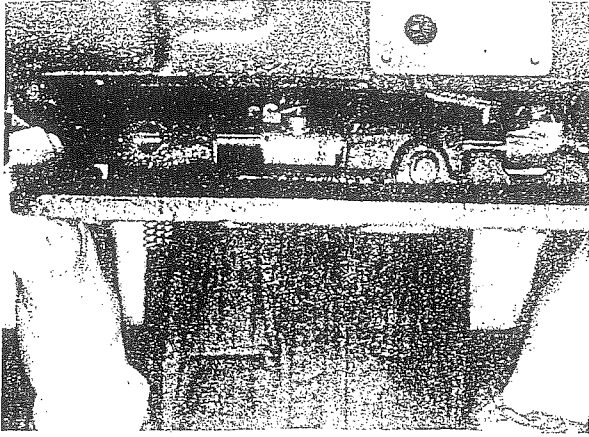


11. Tap the plug in.

IV. Direct Removal of the First Shaft from the Gearbox

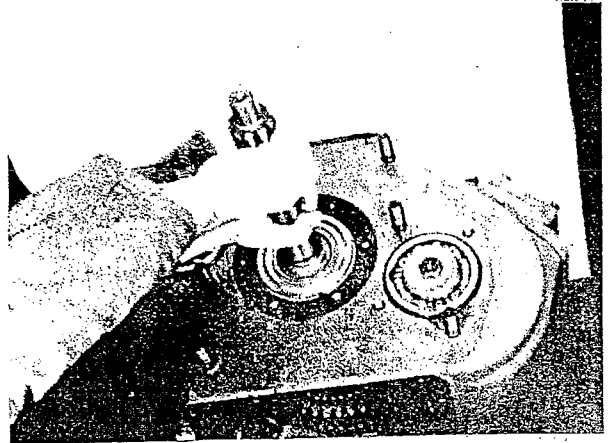
Under certain conditions, only the first shaft is needed to be removed for repair. It may be removed and installed with the following method:

1. Removal of the first shaft

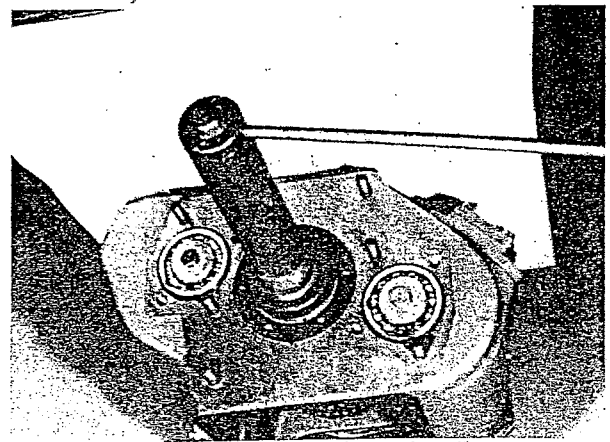


1. Remove the top head of the gear box.

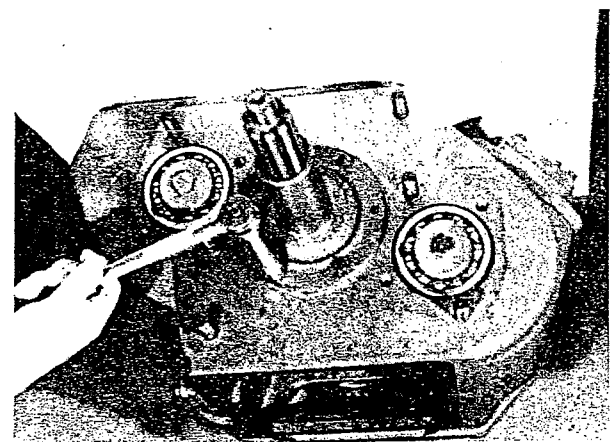
4. Move the first shaft forward.



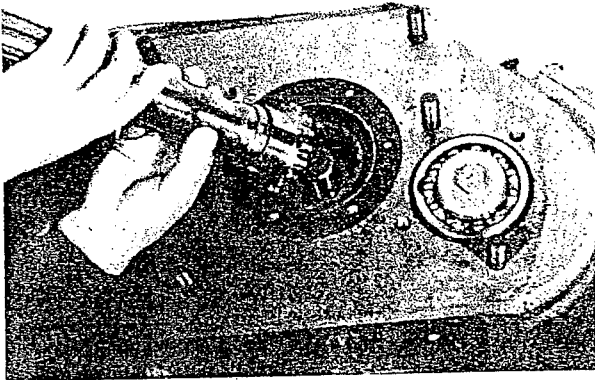
3. Remove the fixing nut of the first shaft. See to it that the nut is left-hand threaded.



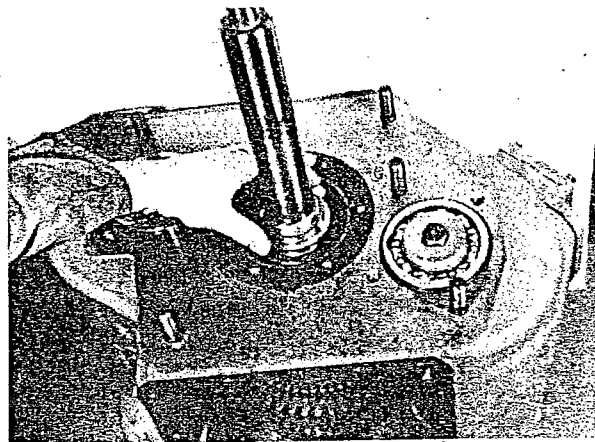
2. Take down the bearing cap of the first shaft of the transmission.



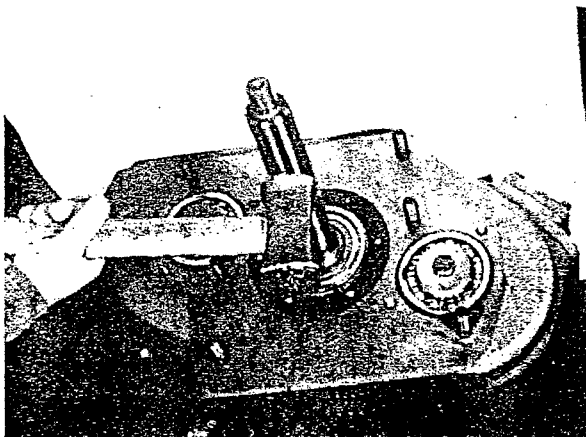
7. Take off the first shaft from the gearbox.



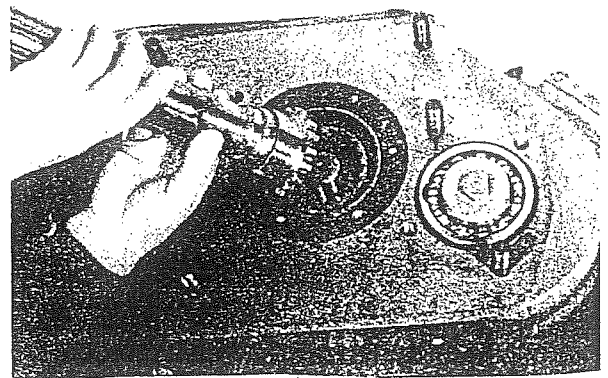
6. Take off the washer.



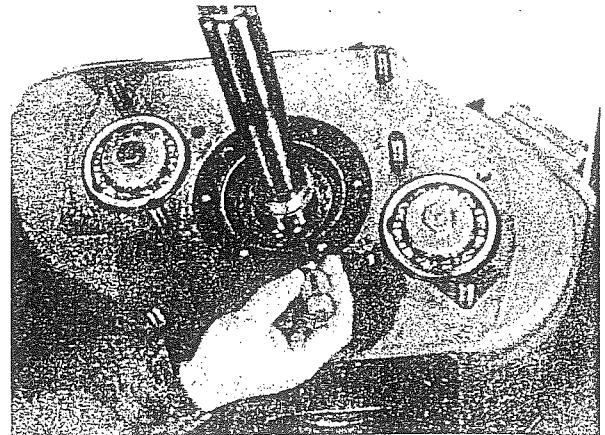
5. Knock at the first shaft from the top and bottom to make the bearing locating circlip move forward and take out the bearing with a special tool.



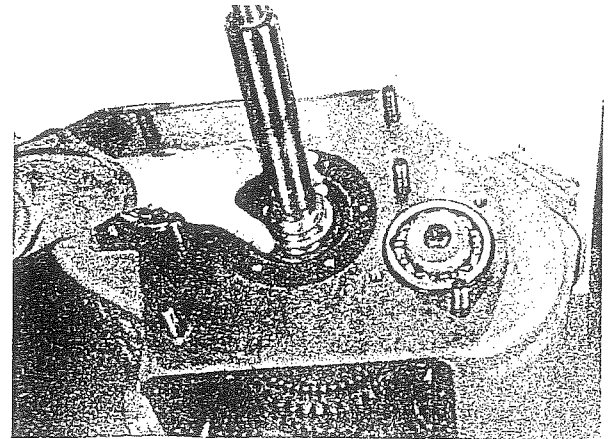
(2) . Assembling the first shaft



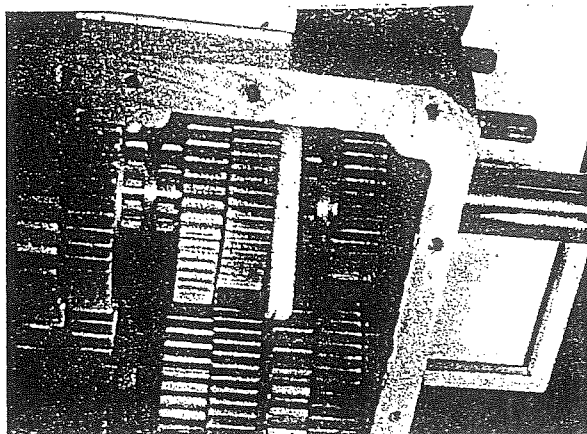
1. Put the new first shaft into the spline of the first shaft gear and make the circular groove of the snap ring at the inside of the first shaft gear just completely exposed, neither more nor less.



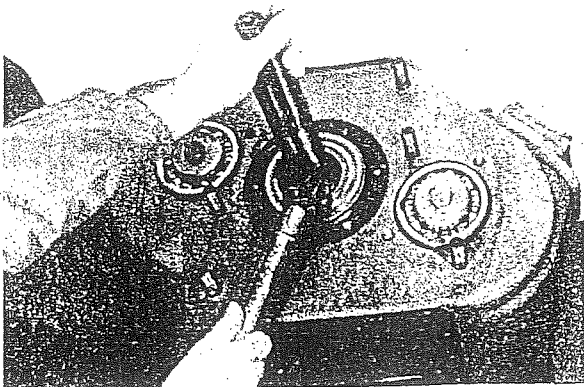
2. Put the snap ring on the inside of the first shaft gear.



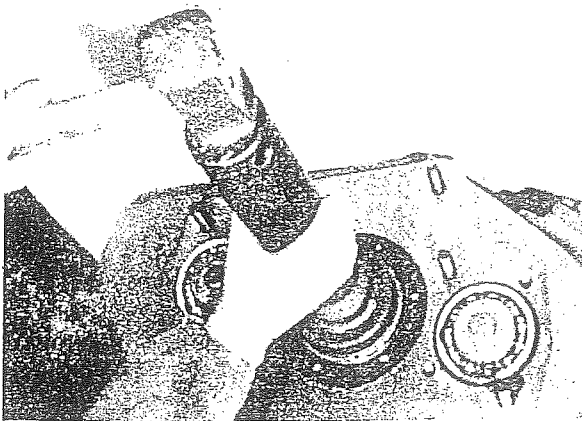
3. Put the washer over the first shaft.



4. Shift to the fourth gear and insert a piece of wood between the back of the sliding sleeve and the third-speed gear. By so doing, when mounting the bearing, it will keep the first shaft at a proper position so as to mount the bearing correctly:



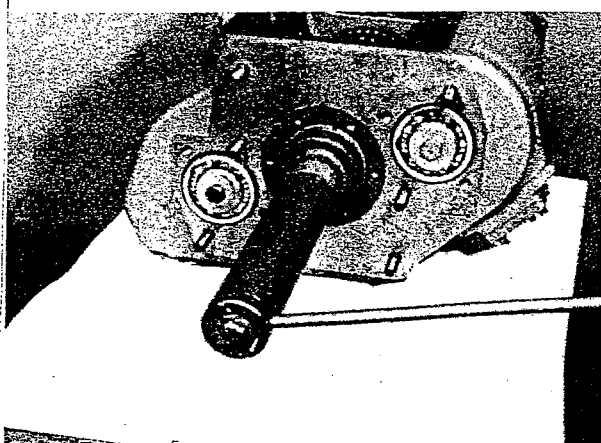
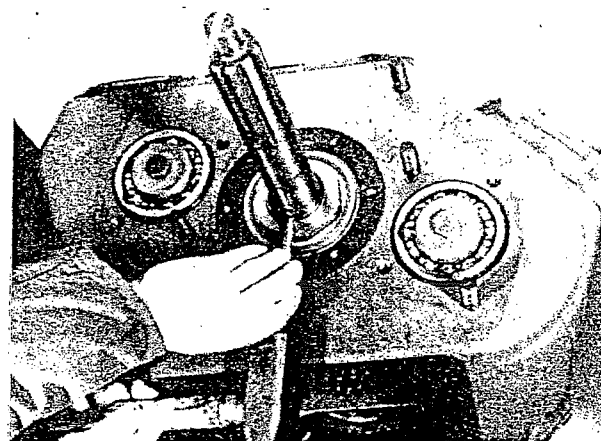
5. Mount the bearing.



6. Put the bearing of the first shaft gear on the shaft and mount it in the housing hole. At this time, the wood should be kept unmoved.

1. Tightening Moment for Bolts and Nuts
1. Refer to the indicating diagram I for threaded members tightening moment
1. All the 1/8" threaded members: 7~10Nm
4. Pneumatic valve
- 4-M6 screw: 10.8~16.2Nm.
5. Screw
- 4—M12 cast iron housing: 108~135Nm.
6. Clutch housing
- 6M16 × 1.5 nut
- Cast iron housing: 224 to 271Nm.
7. Studs
- 6M16 × 1.5; 244~271Nm
8. First shaft bearing cap
- 6~M10: 47~61Nm
9. Retaining ring of intermediate shaft front bearing
- 2-M16 × 1.5 screw: 122 to 162Nm
10. First shaft gear

- M54 × 1.5 left handed nut: 338 to 406Nm.
11. 5 set screws of the shifting yoke
- 5-M12 × 1.5 screw: 47.5 to 61Nm.
12. Gear shifting mechanism
- 4-M10 screw: 47.5 to 61Nm.
13. Top head
- 16-M10 screw: 47.5 to 61Nm.
14. Shifting yoke of auxiliary box
- 2-M12 × 1.5 screw: 67.5 to 88Nm.
15. Bracket of air cleaner
- 2-M10 screw: 47.5 to 61Nm.
- 15A. Adjusting valve
- 2-M6 screw: 10.8 to 16.2Nm.



7. Smear sealant on the thread of the nut and tighten it.
8. Punch the lugs of the nut and make them embedded in the two grooves on the shaft. Install the front cap of the bearing.
- Remarks: The above statement only suits to the replacement of the first shaft. If the first shaft gear is to be replaced, the main box section should be completely dismantled then.

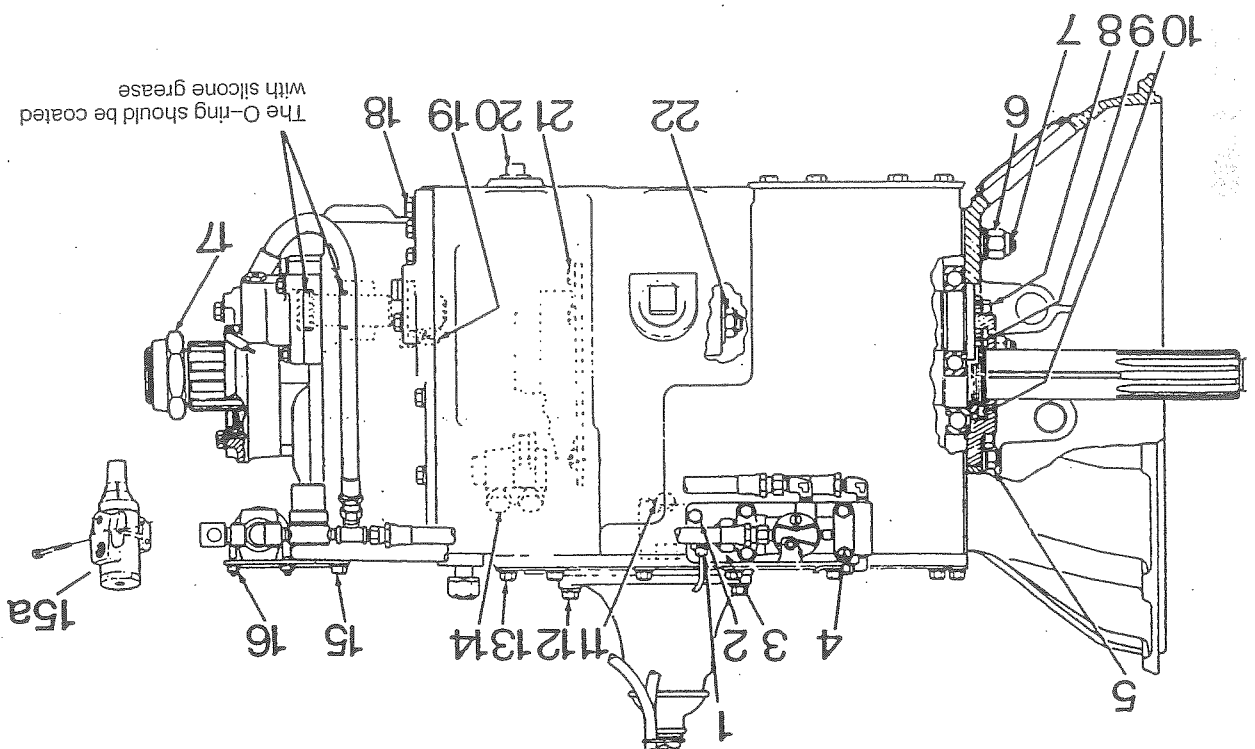


Fig. 4-13 Indicating Diagram of Threaded Member Tightening Moment I

1. Studs
- M16 bolt 81 Nm in minimum
2. Stud nut
- M16 nut 230 to 250 Nm.
3. Plug screw of air cleaner
- M8 plug screw: Plug screw 23 to 28.5 Nm.
4. Intermediate shaft rear bearing cap of auxiliary box
- 8-M10 screw: 47.5 to 61 Nm.
5. Filling plug screw
- 1/4" pipe thread: 81 to 101.5 Nm.
6. Lower power take off cap
- 8-M12 screw: 67.5 to 88 Nm.
7. cylinder cap of high speed gear
- 4 — 5/16" screw: 27 to 34 Nm.
8. Cock of combined type valve
- 5/8" thread: 54 to 67.5 Nm.
9. Cover
- 4 pieces of 5/16" screws: 27 to 34 Nm.
11. Plug screw
16. Air cleaner bracket
- 2-M6 nut: 13.5 to 20.3 Nm.
17. Flange nut of output shaft
- M50 × 1.5 screw: 609 to 677 Nm.
18. Auxiliary box housing
- 19-M10 screw: 47.5 to 61 Nm.
19. Shifting yoke of high speed gear
- M12 × 1.25 shifting yoke screw: 47.5 to 61 Nm.
20. Drain plug
- 3/4 pipe thread: 61 to 74.5 Nm.
21. Driving gear retaining ring of auxiliary box
- 6M10 screw: 47.5 to 61 Nm.
22. Reverse gear medium wheel shaft
- 2-M12 screw: 67.5 to 81 Nm.
- Plunger in the reverse gear shifting yoke
- Tighten the cock after installing the plunger and spring, then unscrew it by 1/4-1/2 turn.
- Gearlever
2. Refer to the indicating diagram of threaded members for tightening moment II

oil.
filled with SAE 85W/90(GL-5) heavy duty vehicle gear
1) Lubricant designation: The transmission should

1. Lubrication VI. Operation and Maintenance

5-M10 screw: 47.5 to 61Nm.

19. Odometer casing

1-M10 screw: 47.5 to 61Nm.

18. Odometer casing

1/2" pipe thread: 54 to 67.5Nm.

17. Plug screw

6M-10 screw: 24.5 to 31Nm

16. Transmission side access cover

4M-10 screw: 47.5 to 61Nm.

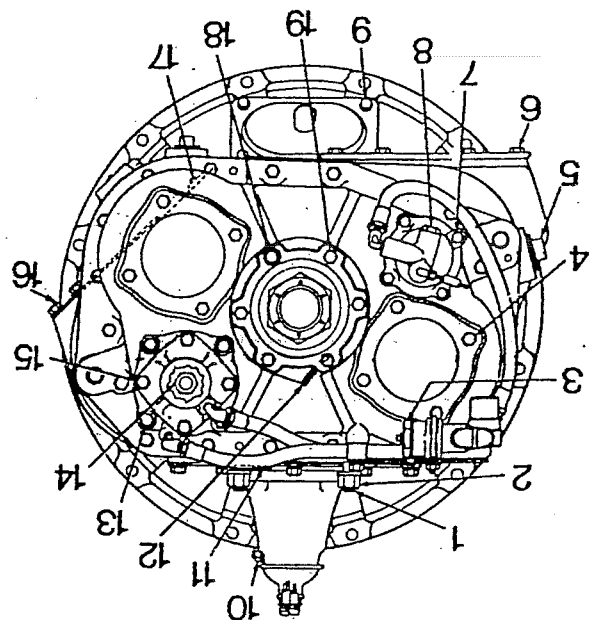
15. Cylinder head of range gear

5/8" nut: 95 to 115Nm.

14. Shifting yoke lever of range gear

Tightening Moment II

Fig. 4-14 Indicating Diagram of Threaded Members



4M-10 screw: 47.5 to 61Nm.

12. Cylinder housing of range gear

13/16" plug screw: 47.5 to 101.5Nm.

12. Plug screw of odometer housing

9/16" plug: 47.5 to 67.5Nm.

- 1) It operates at a running speed of lower than 32km/h continuously.
- 2) RPM of the engine is high.
- 3) Ambient temperature is high.
- 4) Whirlpool encircles the transmission.
- 5) The exhaust gas system is too much close to the transmission.
- 6) Operating at high power, excessive speed and

Any one of the following conditions will induce the operation temperature exceeding 120°C:
transmission will be reduced.
the lubricant deteriorated, and the life of the
the operation temperature exceeds 120°C, it will make
temperature is not permitted to exceed 120°C. When
During continuous operation of the transmission, its

e) Operating temperature

place.

It is not allowed to mix the oil of different brand and
different quality, otherwise chemical reaction may take

d) Add oil

shaft rotates reversely.

the oil will flood out of the housing when the main
However, it is forbidden to fill it excessively. Otherwise
angle of inclination of the transmission and its type.
to the mark. Definite amount of filling depends on the
Clean the surrounding of the oil filling plug, then screw
off the filling plug and fill the transmission with oil up

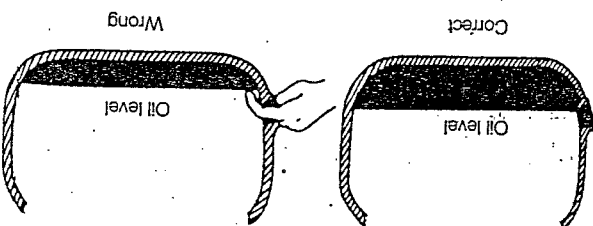
c) Fill the oil

drain plug on the bottom of the housing.

is running, the oil can be drained just by screw off the
After the transmission becomes hot when the vehicle

b) Drain the oil

Fig. 4-15 Oil Level



a) Make sure to line up with the oil level.

2) Correct oil level

friction will be induced between the piston and the auxiliary shaft brake gear, which will accelerate the wear and running, the pedal is never allowed to be pressed to the travel of intermediate shaft braking. Otherwise unnecessary intermediate brake control valve to make the brake unit operate. But when pressing the clutch to shift gears in pedal and close to the cabin bottom board. It is required to press the pedal to the bottom in starting to open the service life of the clutch brake unit. Clutch brake travel is the last section of travel under the operating travel of the

c) Correct use of the clutch brake can not only shorten the time for gear shifting in starting, but also prolong the removed. Long time coasting with neutral gear should be avoided in running. gear shifting or even damaging the gears. Therefore, when the vehicle is hauled, the driving shaft should be condition, and even the worse, it will cause axial looseness of the main shaft gears inducing the trouble of confused accelerates the wear of the spline washer and the location clip on the main gear in the insufficient lubrication rotate very slowly. Only the main shaft, driven by the rear wheel, rotates at high speed. The high rotating speed rotate ceaselessly in the running. But when the vehicle is hauled, the above-mentioned shafts do not rotate or b) Splashing lubrication is used in Fuller transmission, which requires the main shaft and the auxiliary shaft to clap the gear lever by force.

at will. When step up from the 4th gear to the 5th gear, or when step down from the 5th gear to the 4th gear, don't gear and the low gear during the running of the vehicle. In an other word, he should not move the gear lever laterally operation, it mainly means the driver should do his best to reduce the unnecessary changeover between the high inevitable. The synchronizer has certain service life. Correct operation can prolong its service life. By correct the synchronizer operates once in each changeover, and it is certainly worn for one time in each operation. It is shifting yoke and the synchronizer, it makes the gears mesh with each other after getting synchronized. Therefore, this: Compressed air controls the shifting cylinder, via the workpieces of the piston, the shifting yoke shaft, the a) The changeover between the high-speed gear and low-speed gear of the auxiliary gearbox is performed like

(2) Operation

- d) Lubricant should be changed at every 5000 km of running.
- c) Check the lubricant for oil level high and leakage when running every 10000 km, and make oil supplement timely.
- b) Oil must be changed when a new transmission operates for 2000~5000 km.

oil.

with the clutch engaged and the transmission at neutral position. Then drain the detergent thoroughly and fill in new diesel fuel or detergent. After putting in proper amount detergent, let the engine run for one minute at high speed a) Oil should be drained with the transmission in a hot oil state. After drain the oil, wash the transmission with light

3. Oil change

it will reduce the climb degree about 30 (5.5%). Low oil level will cause serious influence to the safe operation angle. If the oil level is 13 mm lower than the oil hole, transmission exceeds 120 long hours so as to guarantee a proper lubrication.

Oil pump or cooling component must be equipped to the transmission provided that the operation angle of the (expressed in degrees).

Operation angle indicates the angle of the transmission mounted on the chassis plus the climbing degree percentage If the operation angle of inclination of the transmission exceeds 120, abnormal lubrication phenomenon will occur.

temperature maintained below 120°C.

When falling across the above-mentioned conditions, cooling component may be used to make the operation

High operation temperature needs a frequent change of oil.

excessive load.

Transmission bearings often operate under the condition of high rpm and heavy load. The rolling elements and the roller tracks are subject to severe wear, flake off due to fatigue, burn and breaking up, inducing the increases of axial clearance and radical clearance. When the rpm changes, the load increases or the lubrication is poor, noise will be produced due to the impacting between the rolling elements and the roller tracks. Such noise will grow up

(1) The bearing noise

By "the transmission makes noises" it means it makes abnormal noises during its operation. Such noise is mainly caused by the looseness of the bearings due to wear and abnormal meshing of the gears. There are many moving parts in the transmission, and the noise produced by them is complex. Therefore, the tracing of noise trouble should be performed on the bases of the noise feature as well as the occasion when it occurs, so as to correctly analyze and judge the location where the noise is produced and the reason why it is produced.

1. Transmission noise

When the vehicle is running, the movable parts of the transmission often operate under the condition of high rpm and high load, and especially when running on complex road, gear position changes frequently. In the process of gear shifting, violent impacts occur between the gears and between the gear and the shaft in the transmission due to the change of relative movement among them, which will cause the wear of the elements in various parts. Especially, when the driver operates incorrectly, it will accelerate the wear of the members of the machine and even damage them. Therefore, trace the location of the trouble and remedy it timely, that is the key to prolong the life of the transmission.

VII. Troubleshooting and Remedy

h) When the vehicle runs down a slope, it is forbidden to change the position section of high gear and low gear.

life of the synchronizer.

synchronizer, then push the gearlever to the 5th gear. By so doing, it will ensure the gear shifting while prolong the the 5th gear section, it should wait for a while till the auxiliary box engages with the high gear position via the (g) When shifting from the 4th gear to the 5th gear (or from the 5th gear to the 4th gear), after the gearlever enters first, then shift the gear, so as to prevent the parts from being damaged.

f) When the vehicle is shifted to the lowest gear (climbing gear) or the reverse gear, the engine should be shut off section. When the vehicle is parked, the gearlever should be set at the neutral position at the low-speed section.

is 5th-6th gear neutral position in the high-speed section and 3rd-4th gear neutral position in the low-speed section. That (e) The gearlever has two neutral positions in the high-speed gear section and in the low-speed gear section. That switch and link up the two leads and after the engine is started, connect them back to the switch again.

after the engine stops and the engine cannot be started. In such a case, disconnect the two leads from the neutral restricts the mishandling of the driver. It should be noted that under certain conditions, a gear cannot be disengaged head of Fuller transmission. This switch breaks the starting circuit in case a gear is engaged, which effectively (d) In order to prevent the driver from starting the engine with gear engaged, a neutral gear switch in attached to the brake when shifting the gear in running.

cause premature worn out failure of the clutch brake unit. Therefore, it is forbidden to use the intermediate shaft pressing when the pedal is pressed to the hard point. If the pedal is pressed to below the clutch brake travel, it will the quickest gear shifting to start. When pressing the pedal for gear shifting in running, don't apply any more essentials are: Overcome the spring force and press the pedal to the bottom consciously in starting so as to try for When the pedal is pressed to the clutch brake travel, the driver will feel a hard point here. Correct operating bring about power loss. To solve this problem, a hard return spring is attached in the clutch brake control valve.

gradually, and when it is severe, the parallelism between the shafts will be spoiled, causing abnormal meshing of the gears, which will speed up the wear and subsequently causing a series of troubles like trip stop of the transmission, the gear noises. Therefore, when bearing noise occurs, in time tracing and remedy should be performed.

(2) Gear noise

Gear noise caused by the spoiling of the normal mesh clearance and mesh impression of the gears, severe wear of the gears, the change of the relative positions of centerlines of two gears and severe looseness of bearings. In the process of transmitting the power by the gears, the meshing surfaces are in a state of rolling friction and sliding friction. Due to the action of the pressure between the tooth faces, wear is inevitable, and light fatigue flake off on the tooth face is permitted. But when the time of use is too long, if the tooth faces are severely worn, the tooth face is burnt or the fatigue flake off becomes chip tearing, and very few teeth are broken, they will cause the increase of meshing clearance, poor meshing impression and loss of driving stability, inducing the noise of the transmission gears.

The variation of gear center position will make the clearance become great now and small then in the process of meshing. When the clearance is great, the impact load between the tooth faces increases, and noise is produced when the gears mesh; and when the clearance is small, the extrusion pressure between the tooth faces increases, noise will also be produced.

When checking and judging the trouble of gear noising, judge the position of the trouble and the cause that induces it on the basis of the noise feature and the occasion it occurs. The noise induced by excessive meshing clearance is a continuous one that has uniform rhythm; and the noise that induced by the damage of very few teeth has very clear rhythm and it rises with the increase of rotating speed. Generally speaking, noise occurs in the gear position in which the gear meshing clearance or meshing impression is in aberration. If noise occurs in neutral gear or all the gear positions, the meshing clearance or meshing impression of the constantly meshing gear is in aberration.

As for the gears of which the clearance increment is due to normal wear, and only light and uniform noise occur in operation, they can still be used. If there is nonuniform periodic noise, careful inspection should be made, and repair or replace them in case of necessity.

2. Transmission gear coming off

The phenomenon that during running the gearlever jumps back by itself back to the neutral position, the joining sleeve disengages its meshing position is called gear coming off. The first cause to this phenomenon is the formation of an axial force and the weakening of the function of locating device.

The concrete factors and location are as follows:

The teeth of the gear are worn into cones, producing axial force. Owing to the frequent contacting, collision and friction, the teeth of the gears or joint sleeve are worn unevenly in length, that is, the ends of the teeth that come into meshing first and leave meshing late in gear shifting are severely worn. With the elapsing of time, the teeth are worn into cones. When the worn teeth transfer torque one another, it makes the sliding gear leave meshing, causing gear coming off.

Looseness of the transmission gears and deformation of the housing will make nonparallelism of axes of the upper and lower bearing holes on the transmission housing increase, causing declination of the axis which breaks the normal meshing of the gears and increases the axial force. Tests have proved, when the rotating speed is 1450rpm, the axial force felt on the first gear shifting yoke of a new transmission is 0.9kg, when the nonparallelism of bearing seat axis in the transmission housing is 0.19 mm, the axial force is 5 kg, and when the nonparallelism increases to 0.34 mm, the axial force of the first gear increases by 13 times. Thus the possibility of gear coming off is greatly increased.

In the interlocking device, if the interlocking groove on the shifting yoke shaft, the capturing ball and the interlocking pin are severely worn, they will all make the interlocking device out of function. In gear shifting, it may make the two yoke shafts move together to engage into two gear positions. Furthermore, if the fixing screws are loose or fractured, the shifting pin on the shifting shaft is fractured, and the lower end and the groove on the shifting yoke guide are excessively worn, they will all make the gearlever wallor or disengage with the guide, causing confused gears. Besides, bending of shifting yoke shaft, burs on its end head and rust on yoke shaft will all keep the yoke shaft

The mechanical cause of confused gears is mainly due to the interlocking device failure. with operating process of transmission gear shifting, analyze them one by one so as to get a correct conclusion. operational causes. Judgement of the trouble should be made on the basis of the trouble phenomena in conjunction As for Fuller transmission, the cause of confused gears is complex, there are mechanical causes as well as

Confused gears means the transmission cannot shift to the required gear position while difficult gear shifting means the transmission cannot shift to the gear position smoothly or it is hard to disengage the gear position. As for Fuller transmission, the cause of confused gears is complex, there are mechanical causes as well as

3. Confused Gears and Difficult Gear Shifting of the Transmission

It may be repaired by welding or replaced.

too weak, to increase its elasticity and continue to use it. If the locating groove on the shifting yoke shaft is worn, allow to replace it, spacer of proper thickness may be added to the top end of the spring, the elasticity of which is worn severely. If the spring is fractured or its elasticity is too weak, it must be replaced. If the condition does not of the locating device is fractured or its elasticity is too weak, the locating ball and the groove on the yoke shaft are If the inspection shows there is no defect with the gear, the bearing and the shifting mechanism, check if the spring

Replace or repair them by welding when necessary.

the gearlever and the shifting yoke guide and between the shifting yoke and the yoke groove on the joint bush. move axially. If the above conditions are perfect, check if there is excessive clearance between the lower end of check if the teeth are worn into cones in length direction, whether the bearings are loose, the shaft and the bearing of the gearbox and check the meshing condition of the gear that comes off (at meshing position). If they mesh well, If gear coming off occurs at a certain gear position, push the gearlever into this gear position, remove the top head

Remedy to gear coming off:

Run on an uneven road with sags and crests to make the vehicle bump and oscillate. Check if there is gear coming off. is gear coming off.

When the vehicle runs up a slope or at high speed (50-60km/h) on a level road, apply brake gently to see if there medium or high speed, check if gear coming off occurs.

Apply a great alternative load on the gear by sudden acceleration and deceleration when the vehicle is running at Methods for checking gear coming off:

coming off.

too shallow or worn axlwise into a slot, they will all weaken the function of the locating device, causing gear If the locating ball is worn, the locating spring is too weak or fractured and the groove on the shifting yoke shaft is If there is a little of axial force, it will make the joint sleeve leave its meshing position, causing gear coming off. shift to its position, that is, the joint sleeve and the teeth of the gear fail to mesh in full length. In such a case, even guide and that between the shifting yoke and the yoke groove on the joint sleeve will all make the gear insufficiently Bending and deformation of the shifting yoke, excessive fit clearance between the lower end and the shifting yoke If the bearing locking circlip or the thrust washer on the back of the gear is loose or severely worn, it will bring about the play of the shaft or gear shaft, which tends to cause gear coming off.

away from axial movement or make axial movement difficult. If the pneumatic control system of the transmission runs into trouble, the phenomenon that there is only low gear without high gear or there is only high gear without low gear, that is, the high and the low gear positions cannot interchange, or gear shifting is delayed. Only when you are very familiar with the operational principles of the pneumatic control system, can you analyze such a trouble and find out the location of the trouble correctly. For trouble diagnosis of high & low gears changeover failure, see Fig. 4-16.

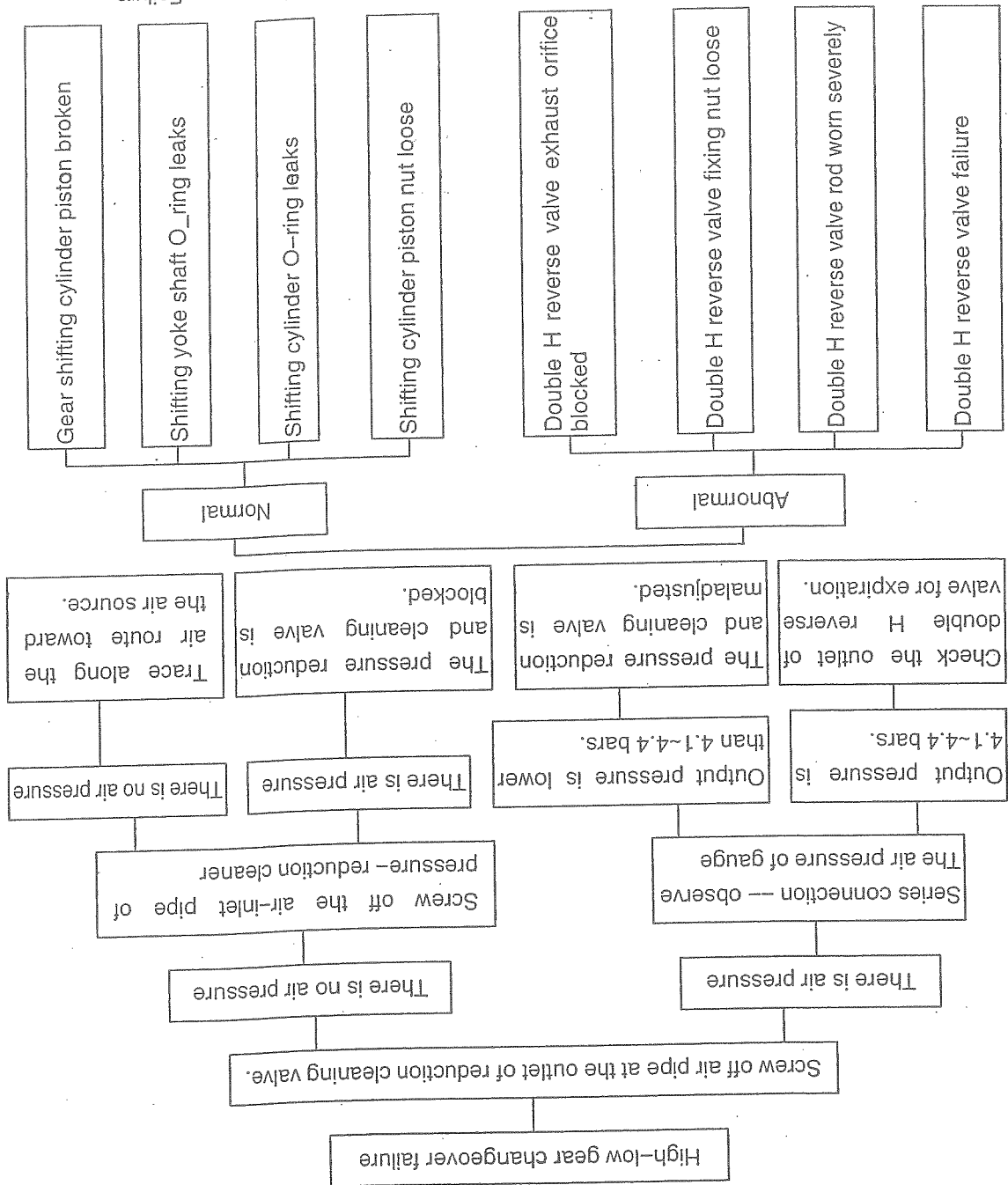


Fig. 4-16 Trouble Diagnosis Diagram of High & Low Gears Changeover Failure

4. Overheating of the transmission

Operating temperature of Fuller transmission should not be higher than 120°C for a long time. Overheating will

(3) Gear can't be shifted off

No.	Cause	Remedy
1	Defectiveness of pressure regulator valve	Replace
2	Air pipe and union loose and leak	Tighten and repair
3	Joining bush severely worn forming higher conicity	Replace
4	Gears not at aligned position	Adjust or Replace
5	Air pipe pressed flat, there is no air	Repair and Replace

(2) Gear coming off of auxiliary box

No.	Cause	Remedy
1	Shifting block worn	Replace
2	Joining sleeve is worn, forming higher conicity	Replace
3	Fork groove of joining sleeve severely worn	Replace
4	Front bearing inner ring of auxiliary box intermediate shaft falls off	Repair or Replace
5	Bearing damage	Replace
6	Bearing set clip severely worn or loose causing axial looseness of the shaft	Replace
7	Gear thrust washer severely worn causing axial looseness of gear	Replace
8	Shifting yoke bended or deformed	Replace
9	Locating ball worn or groove on shifting yoke shaft is too shallow and axially worn into slot	Replace
10	Stiffness of locating spring is too low or broken	Replace
11	Pulling rod interference	Adjust and repair
12	Engine bearer damaged	Replace
13	Engine and transmission not centered	Replace, adjust

(1) Gear coming off of the main box

5. Common troubles and Remedy

make the lubricant become thinner and deteriorated which will affect the lubrication effect and thus reduce the life of the transmission.

The possible causes for transmission overheating are as follows:

Gear meshing clearance is excessively short;

The axial clearance of gears is too small;

The bearing is too tight or damaged;

The gear turns on the shaft or is away from its aligning position;

Quality of the lubricant is poor or lubricants of different brands are used in a mixed state.

Over-speed and overload running of the vehicle, prolonged low-speed running (32km/h) can also make the transmission overheat.

Apart from the above-mentioned troubles of the transmission, there may be some other troubles such as the common oil leaking; they should all be checked and remedied.

No.	Cause	Remedy
1	Gear shifting block worn	Replace
2	Gears not at aligned position	Repair
3	Intermediate shaft brake does not work	Replace or repair
4	There is no intermediate shaft brake	Reinstall
5	Pulling rod obstruction	Repair
6	Maladjustment of pulling rod	Adjust
7	Maladjustment of clutch	Adjust

(7) Gear shifting noise

No.	Cause	Remedy
1	Neglected attaching of interlocking pin of ball	Repair
2	Main box key damaged	Replace

(6) Main box shifts to two gear positions simultaneously

No.	Cause	Remedy
1	Defectiveness with pressure regulating valve	Replace
2	Air route blocked or leaks	Replace
3	Double H changeover valve failure	Replace
4	Shifting cylinder piston broken	Replace
5	Seal ring of shifting yoke shaft failure	Replace
6	Shifting cylinder piston jamming	Replace
7	Nut of shifting cylinder piston loose	Tighten
8	Synchronizer spring damaged	Replace
9	Synchronizer damaged	Replace

(5) Gear shifting of auxiliary box jammed or unable to shift

No.	Cause	Remedy
1	Shifting yoke shaft banded	Replace
2	There are burrs on shifting yoke shaft	Repair
3	Locking spring too stiff	Replace
4	Gear shift mechanism housing broken	Replace
5	Gears not at aligned position	Adjust or Replace
6	Main shaft twisted	Replace
7	Pulling rod interference	Adjust
8	Clutch not thoroughly disengaged	Adjust
9	Engine bearer damaged	Replace

(4) Main box has difficulty in gear shifting

No.	Cause	Remedy
1	Main shaft twisted	Replace
2	Pull rod obstruction or maladjustment	Adjust or repair

No.	Cause	Remedy
1	Ventilation hole blocked	Remedy
2	Oil level too high	Drain oil
3	Casting defect with housing	Replace
4	Oil seal damaged	Replace
5	Screw is loose or neglected to install	Adjust, supplement

(11) Oil leaking

No.	Cause	Remedy
1	Gears not at aligned position	Replace or repair
2	Bearing damaged	Replace
3	Front bearing inner ring of auxiliary box intermediate shaft falls off	Replace
4	Oil level too low	Supplement
5	Oil level too high	Adjust
6	Quality of lubricant is poor	Replace
7	Transmission operation inclination angle too high	Replace, adjust
8	Fail to change oil in time	Replace
9	Different oil used in a mixed state	Replace

(10) Overheating

No.	Cause	Remedy
1	Engine bearer damaged	Replace
2	Improper tightening moment of output flange nut	Adjust
3	Improper installation of driving shaft	Adjust
4	Suspension worn	Adjust, Replace
5	Vehicle wheel unbalanced	Replace or adjust

(9) Vibration

No.	Cause	Remedy
1	Gears not at the aligned position	Repair or Replace
2	There are cracks or burs on gear	Repair or replace
3	Main shaft gear out of tolerance	Adjust or replace
4	Front bearing inner ring of auxiliary box intermediate shaft falls off	Reinstall
5	Bearing damaged	Replace
6	Oil level too low	Add oil
7	Quality of lubricant is poor	Replace
8	Oil changed not in time	Replace
9	Different oil used in mixed state	Replace
10	Engine running unsteadily	Replace

(8) Noise

(12) Main shaft washer burnt

No.	Cause	Remedy
1	Oil level too low	Replace or supplement
2	Incorrect hauling or coasting method	Change

(13) Input shaft spline worn or damaged

No.	Cause	Remedy
1	Starting with too high gear position	Change driving habit
2	Impulsion starting	Change driving habit
3	Clutch adjusted incorrectly	Replace, adjust
4	Clutch failure	Replace, adjust
5	Engine and transmission not centered	Adjust, replace
6	Driving shaft installed incorrectly	Adjust

(14) Clutch housing broken

No.	Cause	Remedy
1	Engine bearer damaged	Replace
2	Engine and transmission not centered	Replace

(15) Auxiliary box housing damaged

No.	Cause	Remedy
1	Driving shaft mounted incorrectly	Replace, adjust

(16) Synchronizer burnt

No.	Cause	Remedy
1	Defect with pressure regulating valve	Replace
2	Shifting yoke installed in reverse	Replace, adjust
3	Synchronizer spring damaged	Replace, adjust
4	Quality of lubricant is poor	Replace
5	Different oil used in mixed state	Replace

(17) Synchronizer damaged

No.	Cause	Remedy
1	Engine mount damaged	Replace
2	Tightening moment of the fixing nuts of output flange is incorrect	Adjust
3	Driving shaft installed incorrectly	Adjust
4	Suspension worn	Replace
5	Vehicle wheel unbalanced	Replace

(18) Main shaft twisted

No.	Cause	Remedy
1	Starting gear position too high	Change and improve driving
2	Pulse load	Change and improve driving

(19) Bearing burnt

No.	Cause	Remedy
1	Front bearing inner ring of auxiliary box intermediate shaft falls off	Replace, supplement
2	Oil level too low	Replace
3	Quality of lubricant is poor	Replace
4	Fail to change oil in time	Replace
5	Different oil used in mixed state	

VIII. Power take off

To meet the requirements of some special purpose vehicles, power take off unit can be installed in the power take off hatch at the left side of the bottom of the main box housing of "AST" transmission, taking off power from the power take off gear located between the intermediate driving gear and the third-speed gear. Power can also be taken off from the lengthened intermediate shaft of the auxiliary box at the rear end of the transmission, which is called "the rear power take off". This kind of power take off is most popularly used nowadays.

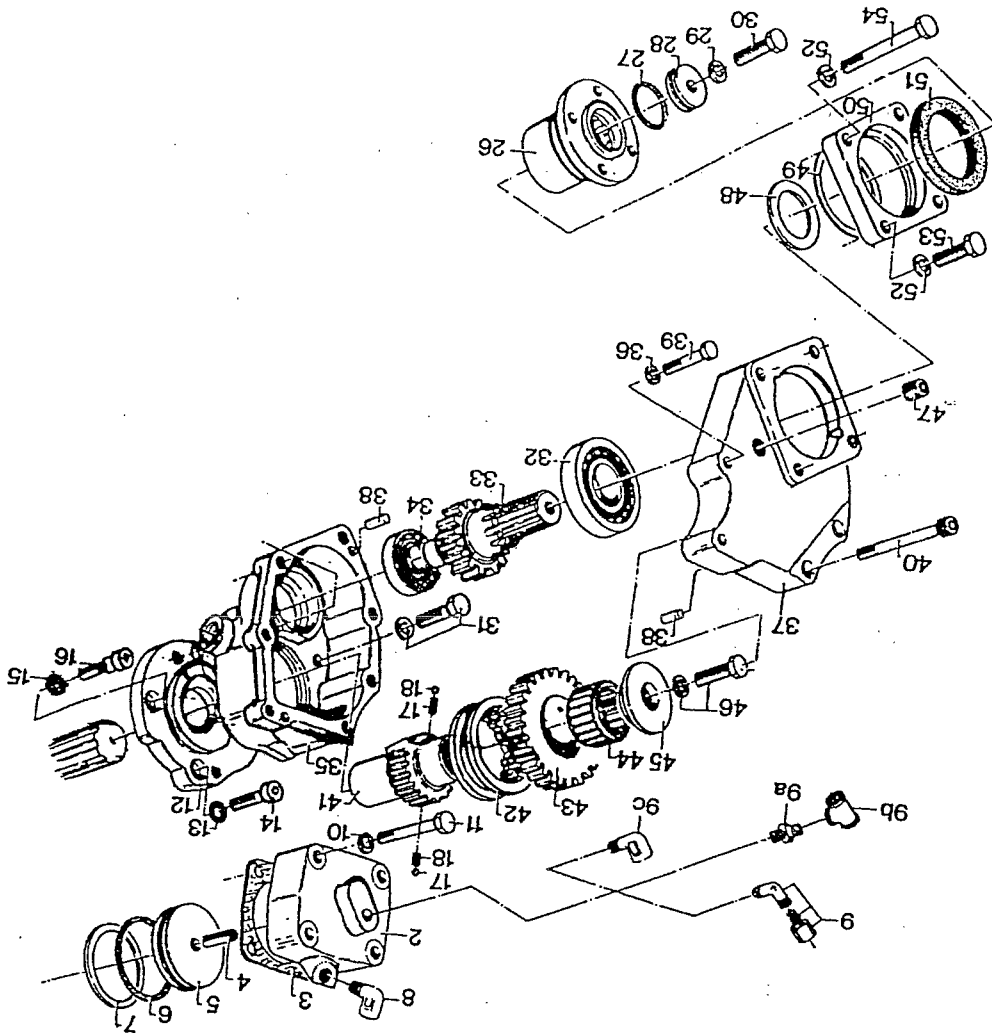
1. The rear power take off control adopt electropneumatic control, see fig.4-17. The rear power take off control is only required to remove the range gear cylinder head and add a neutral gear position. To solve this problem, it is structural diagram of neutral position cylinder, and the position shown in the Fig. 4-18 is the neutral gear position.

(1) Parking power take off

In Fig. 4-18, orifices A and B connect with low gear air pipe and high gear air pipe of the transmission respectively, they are joined with the double H valve, the air pressure is 4.1~4.4 bar. Orifice C is the compressed air inlet when the transmission is set at the neutral gear position (at the center), the air pressure is 7~8bar. In parking power take off, push the control handle of the transmission to the low gear section first. The low air pressure from the double H valve goes into the low gear chamber from orifice A, making the range gear cylinder piston 4 press tightly on the locating ring 6. Then depress the neutral switch control electro-magnetic valve, let the compressed air, the pressure of which is 0.7~0.8 bar, enter the neutral gear position cylinder 9 via orifice C. Owing to the pressure difference, the neutral gear position cylinder piston 11 moves leftward till it presses the locating ring 6, then it stops. In this way, the range gear cylinder piston 4 of the transmission is situated at the neutral position. Then press down the clutch pedal and depress the power take off switch, and shift the gearlever to a gear position of the 1 - 4 gears and release the clutch pedal. Parking power take off is realized.

If parking power take off is no longer to be used, it needs only to reset the switch. The compressed air in the neutral gear position cylinder will be exhausted to the atmosphere via the electro-magnetic valve.

Fig. 4-19



independently.

The cavity of the power take off unit does not communicate with that of the transmission, oil should be charged off, it automatically disengages the gear. For gear shifting mechanism, see Fig. 4-20.

QH50 power take off unit is of twin shaft structure, mounted behind the lengthened intermediate shaft of twin series transmissions, see Fig. 4-19, it employs unidirectional control to take power with gear shifted. When the air is cut

(2) Structure feature

Model of power	Output rotating direction and engine	Speed ratio	Installing position
QH50	The same	0.818	Lower-right corner
QH50A	The same	0.818	Lower-left corner

positioned power take off unit. Its performance parameters are as follows:

RAST Transmission can match with many kinds of power take off units. The widely used one is QH50 series rear-

(1) Technical parameter

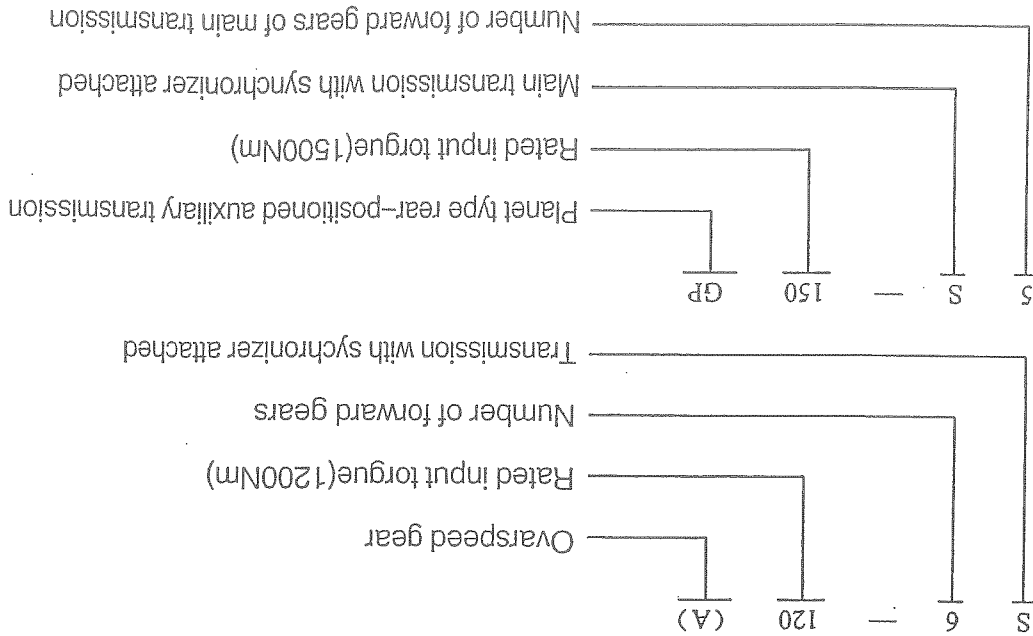
2. Rear Power Take Off

switch, and shift to the first or the second gear. Then running power take off is realized.

1. General

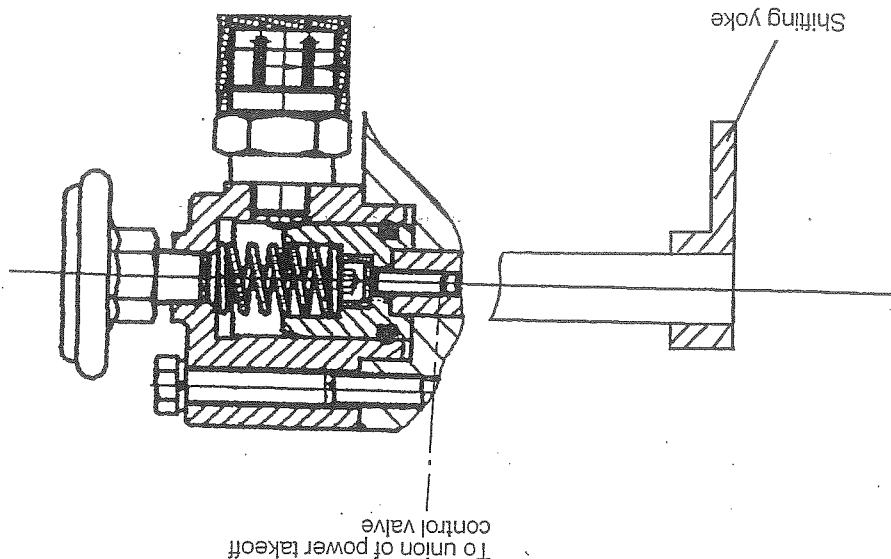
QJ transmission is a tri-axle type dead axle driving fully synchronized gear shifting mechanism manufactured by Chongqing Qijiang Gear Transmission Co. Ltd. with the technology introduced from German ZF Company. Joint sleeve drive is used for the reverse gear position. At present, China National Heavy Duty Truck Group Co., Ltd (SINOTRUCK) installs its trucks with transmission types S6-120, S5-111GP and S5-150GP, among which, S6-120 is an integral fully synchronized transmission, and the others are fully synchronized transmissions of main and auxiliary transmission combination type.

Symbols and significance of the transmission:



SECTION 2 QJ TRANSMISSION

Fig. 4-20



2. Transmission of Main Transmission and Auxiliary Transmission Combination

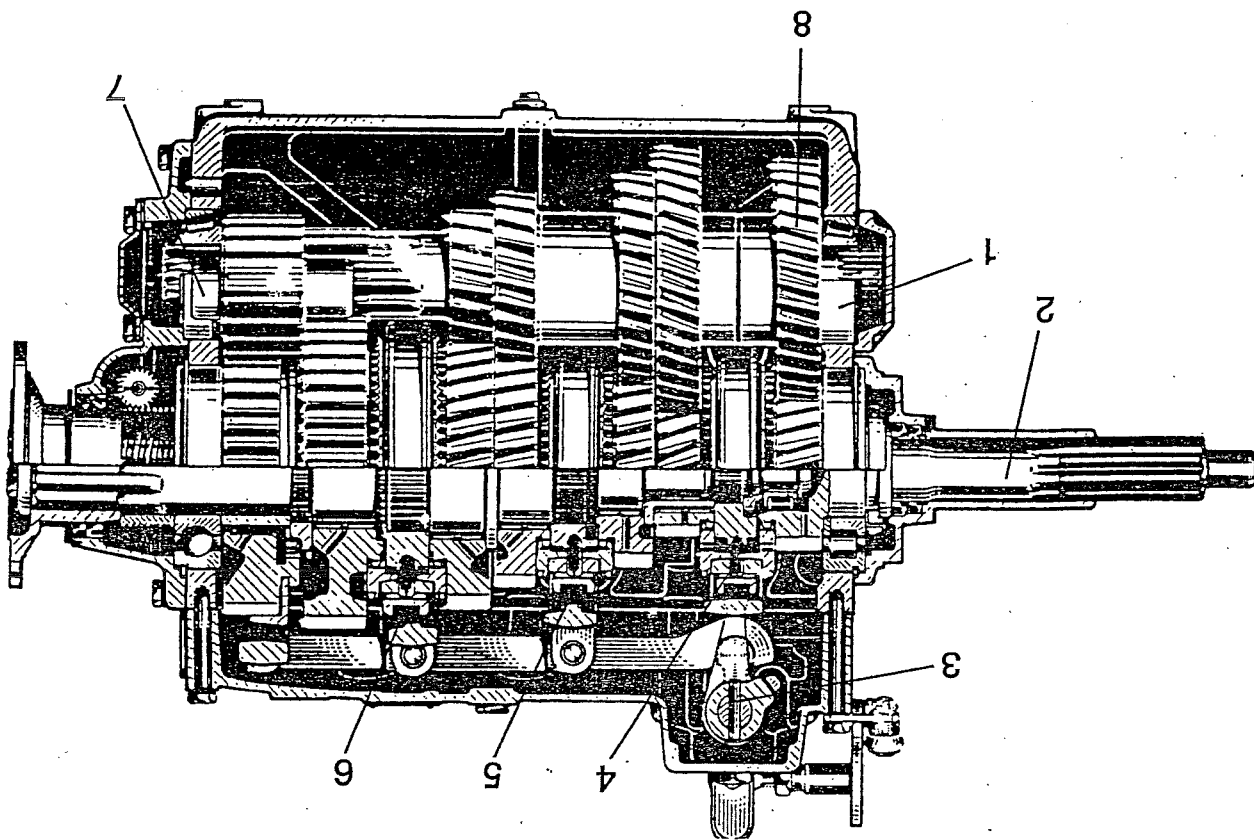
Dry Tank Oil Charge						13 Liters	
Total Weight						230kg	
S6-120 Speed Ratio	9.01	5.24	3.22	2.20	1.50	1.00	8.30
Gear Position	1	2	3	4	5	6	Reverse

Table 4-3

Speed ratio of this transmission is shown in Table 4-3.

1. Intermediate shaft 2. Input shaft 3. Gear shiffting shaft 4. The 5th and 6th gear synchronizer 5. The 3rd and 4th gear synchronizer 6. The 1st & 2nd gear synchronizer 7. Reverse gear shaft 8. Driving gear of intermediate shaft

Fig.4-21 Structure of S6-120 Transmission

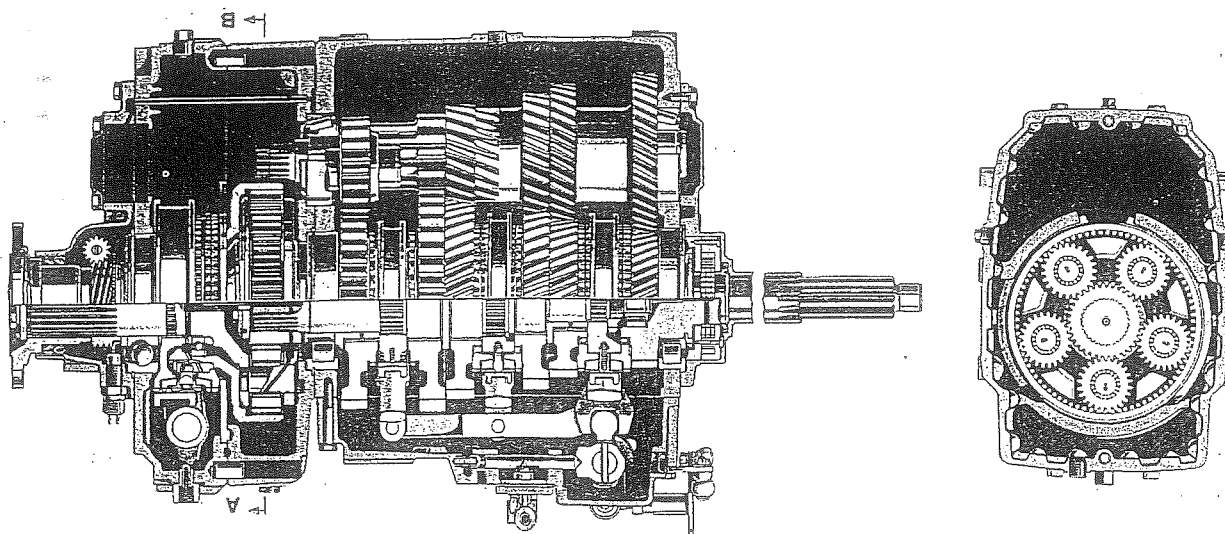


1. S6-120 Transmission

Transmission Type S6-120 is a tri-axle type dead axle drive transmission with 6 forward gears and a reverse gear. It employs pull rod type gearshift mechanism. Flexible shaft control mechanism can be optionally selected. In transmission S6-120, all the forward gears introduce synchronizer to shift the gear while the reverse gear uses joint sleeve to shift the gear. Power output can be attached to the rear end of the transmission auxiliary shaft. Many kinds of power take off units can be installed at the customer's option. Its front end can match with clutch housing No. SAE1 or No. SAE2. Gear shifting is manually operated, remotely or directly. The transmission assembly can be installed vertically, lying on its left side or on its right side. For detailed structure, see Fig. 4-21.

Transmission 5S-111GP consists of the 5-gear main transmission which is driven by the constantly engaged dead axle and has the creep gear, and the 2 geared auxiliary transmission which is engaged in NGW form and driven by a planet gear, as shown in Fig. 4-22. It has 9 forward gear positions and a reverse gear position, which is shifted by joint sleeve. The QJ-B locking-ring type synchronizer shifts all the forward gears. Power of the main transmission is output by the two-gear auxiliary transmission. The transmission has only one reverse gear.

Fig. 4-22 Structure of 5S-111GP Transmission



The structure of the main box of S6-120 Transmission is basically the same with that main gearbox of the 5S-111GP, 5S-150GP transmissions, The structure of the 5S-150GP is the same with the 5S-111GP. Therefore, the 5S-111GP transmission is taken as example to make the introduction.

II. Structural Feature

Model	Input Torque Nm	CR	Standard Transmission Ratio								Odometer Transmission Ratio	Total Weight	Dry Tank Fuelling Charge
			1 st gear	2 nd gear	3 rd gear	4 th gear	5 th gear	6 th gear	7 th gear	8 th gear			
4S-130GP	1300		13.15	9.37	6.71	4.4	2.99	2.13	1.52	1.00	16.91		
4S-130GP	1300			9.37	6.71	4.4	2.99	2.13	1.53	1.00	16.91		
5S-111GP	1100		13.04	8.48	6.04	4.39	3.43	2.47	1.76	1.28	11.77		
5S-150GP	1500		13.04	8.48	6.04	4.39	3.43	2.47	1.76	1.28	11.77		
1.545/2.0											13.0 liter		
											310 kg		

Table 4-4

Technical parameters are shown in Table 4-4.

4S-130GP is a mechanical fully synchronized combination transmission, with eight gear positions while 5S-111GP and 5S-150GP are mechanical fully-synchronized combination transmission with nine gear positions. They are composed of tri-axle dead axle drive main transmission and planet drive auxiliary transmission. They have eight or nine forward gear positions and a reverse gear position respectively. They employ "QJ" cirlet type inertial synchronizer, rotating shaft-pulling plate-shifting yoke gear shifting mechanism and "double H" control. They can match single rod and various types of soft shaft devices. Gear shifting is easy and reliable.

a) The first assembly, see fig. 4-24. The first shaft gears are made into one piece with the shaft. The first shaft is supported at two points. The spline journal at the front end of the first shaft is supported in the crank seat hole by a single-row annular ball bearing. Cylindrical roller bearing with great carrying capacity is used for the first shaft gear journal which is supported in the seat hole in the main transmission front wall. The bearing outer race is pressed firmly by the first shaft end cap. Spacer is set between the end cap 2 and the bearing outer race of the first shaft. Adding spacers may adjust axial clearance between the first shaft bearing and the front end locating surface, and reverse gear shaft assembly.

Gear mechanism is composed of the first shaft assembly, intermediate shaft assembly, second shaft assembly, (1) Gear mechanism:

Main components of the transmission: gear mechanism, control mechanism, housing, head and subsidiary device.

1. Main transmission

intermediate shaft spline.

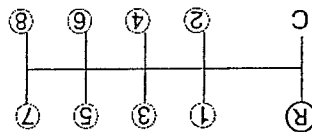
Power take off unit may be installed onto the rear part of the transmission, and the power is outputted through the which the engine is coupled through a universal joint separately.

The special requirement of the whole vehicle layout, a coupling of "double flange" structure may be provided with the transmission can match with SAE1 or SAE2. The clutch housing directly connects with the engine. Based on transmission under heavy load conditions.

Combined lubrication of the forced lubrication by internally meshed gear oil pump and the gear splashing lubrication is adopted so as to ensure a reliable lubrication of the moving parts such as the gears and bearings of the positions.

On the gear position scutcheon, the forward gears are arranged in "H-H" form, and thus it is called "double H" control. The gear shifting of the main transmission is operated manually. The changeover of high-low gear of the auxiliary transmission is done pneumatically "automatically" at the moment when manually shifting the gears it opens the pneumatic control valve. At the low gear section, the neutral gear position of the transmission is between the third and the fourth gear positions, while at the high gear section, it is between the fifth and the sixth gear positions.

Fig.4-23 Gear position layout of 5S-111GP Transmission(Double H)



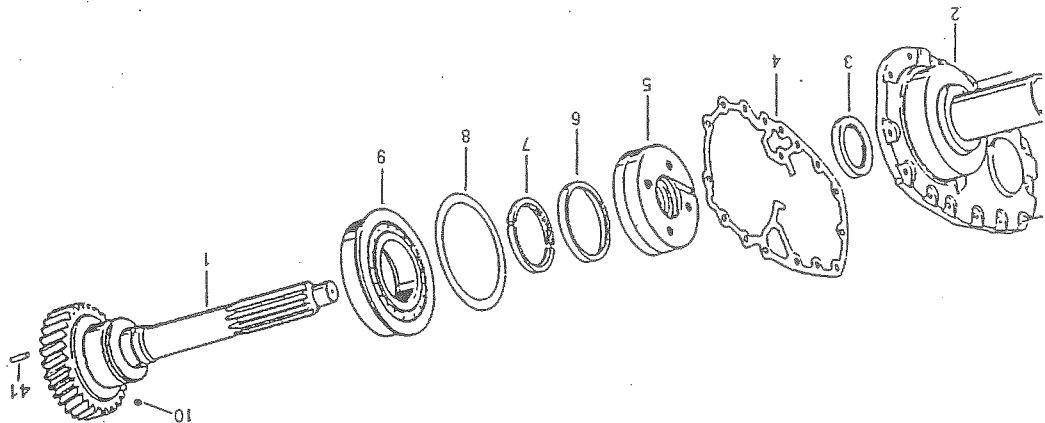
gear as shown in Fig. 4-23.

The creep gear and the reverse gear are structurally designed to lock the high gear of low transmission ratio to engage in. Only the low reverse gear of greater transmission ratio is reserved. Therefore, all the forward gears of the main transmission have two gear positions with the exception of the creep gear and the reverse gear. It is called the subsection type so as to distinguish it from the half-gear insert type combination. When the auxiliary transmission is shifted to the low gear section, the planet driving mechanism, via the 13 convex pins on the supporting plate, locks the supporting plate onto the front housing of the auxiliary transmission, the internal toothed ring is arrested from rotation, combines into the 1st, 2nd, 3rd, 4th and creep gears of 5S-111GP transmission with the 1st, 2nd, 3rd, 4th gears of the main transmission; when the auxiliary transmission is shifted to the high gear section, the three members of the planet drive, the central wheel, the planet gear ring and the planet carrier, link into one piece, and the rotation is directly transmitted, making up the 5th, 6th, 7th and 8th gears of the transmission with the 1st, 2nd, 3rd and 4th gears of the main transmission. For this kind of combination on the scutcheon, 1-4 gears are the low gear, arranged in H form; 5-8 gears are the high gear, also arranged in H form, C gear is creep gear as shown in Fig. 4-23.

The case of the internal gear oil pump 5 is attached in the case of the first shaft end cap 2 and localized by the locating pin. An oil pump driving pin 10 is set on the first shaft journal at a position relative to the oil pump. When end cap 2 is mounted together with oil pump 5 on the first shaft 1, driving pin 10 is just in the internal gear driving keyway of the oil pump rotor. Thus the rotating of the first shaft drives the internal gear pump to rotate to pump oil. The pump sucks in gear oil through the oil path in the casing and oil suction tube from the oil sup tank, then pumps it, via the first shaft oil path and second shaft oil pipe into the central oil canal to lubricate the needle bearings of all the second shaft gears and the planet gear driving mechanism of the auxiliary box. It is worth to point out that only when the first shaft driving box 10 rotates to the position where the first shaft lines up with the center of the auxiliary shaft and the driving pin faces up (if the gearbox rotates to the vertical position where the first shaft is at the top while the auxiliary shaft is at the bottom), can the notch on the oil pump casing align with the driving keyway on the

Fig. 4-24 Exploded View of First Shaft Structure

1. First input shaft 2. End cap of the first shaft 3. Oil seal of the first shaft 4. Washer 5. Internal gear oil pump
6. Locking ring 7. Semicircular locking ring 8. Spacer 9. Bearing of the first shaft 10 Driving pin of oil pump



Lubrication of the first shaft bearing: The transmission is mounted horizontally. It employs composition lubrication of forced lubrication and splash lubrication. Driven and stirred by the gears, lubricant splashes; it lubricates the first shaft bearings via the interspace among the gears, oil holes and oil duct in the front end cap and transmission housing. To lubricate the second shaft front bearing, the needle bearings of the second shaft, and the GP auxiliary transmission, the center hole in the first shaft gear is closed down, forming an oil store. A radial hole is drilled in the gullet of the chamber, it communicates with gear groove of the shaft. An oil hole is also machined in the gear center, and a jet pipe that communicates with the oil hole in the first shaft journal in which an inside engaged gear oil pump is attached. The driving pin of the oil pump in the first shaft journal brings the oil pump to rotate with the first shaft. The oil pump pressed lubricant to the jet pipe via the oil hole in the first shaft lever to lubricate the bearing on the second shaft and the GP auxiliary transmission.

The first shaft gear constantly engages with the intermediate shaft driving gear. The fourth speed gear synchronizing conical hub is installed at the place of the joint tooth at the front end of the first shaft gear. A spacer is fitted between the end of the first shaft gear and the fourth speed gear conical hub. This spacer is used to adjust the axial clearance between the first shaft and the second shaft to 0.6-0.9 mm.

positions away from the open slot of the semicircular locking rings to fix them.

collar 6 round the two semicircular locking rings punch four pits evenly along the edge of the retaining collar at four 02 mm. In order to ensure that the two semicircular locking rings will not escape in running, put a punched retaining dimension of which are properly selected and measured, tapped in the ring slot with advanced tightness of 0.01-0. axle surface of the first shaft journal. It is axially fixed by a semicircular locking ring 7, the specification and which should be 0-0.01 mm. The cylindrical roller bearing inner race of the first shaft is fixed on the corresponding

Fig 4-26 Counter shaft Structure of 5S-111GP Transmission

1. Front end cover 2. Gasket (between the transmission and the front end cover) 3. The countershaft with the creep gear and reverse gear toothed wheels attached 4. Conical roller bearing 5. Gasket (between the transmission and the auxiliary box) 6. Oil baffle (differ with structural types, mounted in the front housing of the auxiliary box) 7. Gasket (between the auxiliary box and the odometer) 8. Odometer case 9. Auxiliary box housing 10. Transmission housing 11. Duplicate gear for 1-2 gear or 5-6 gear 12. Duplicate gear for 3-4 gear or 7-8 gear 13. Conical roller bearing 14. Spacer 15. Circlip

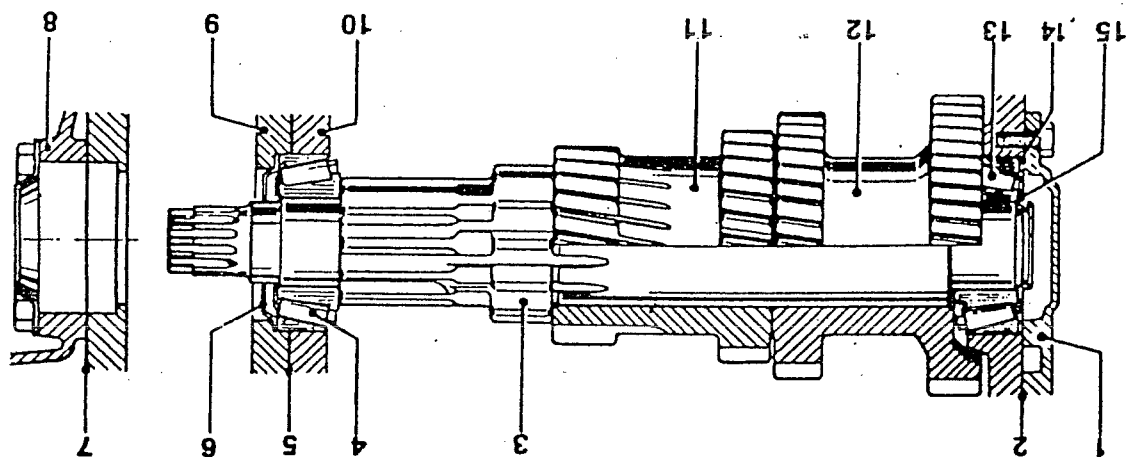
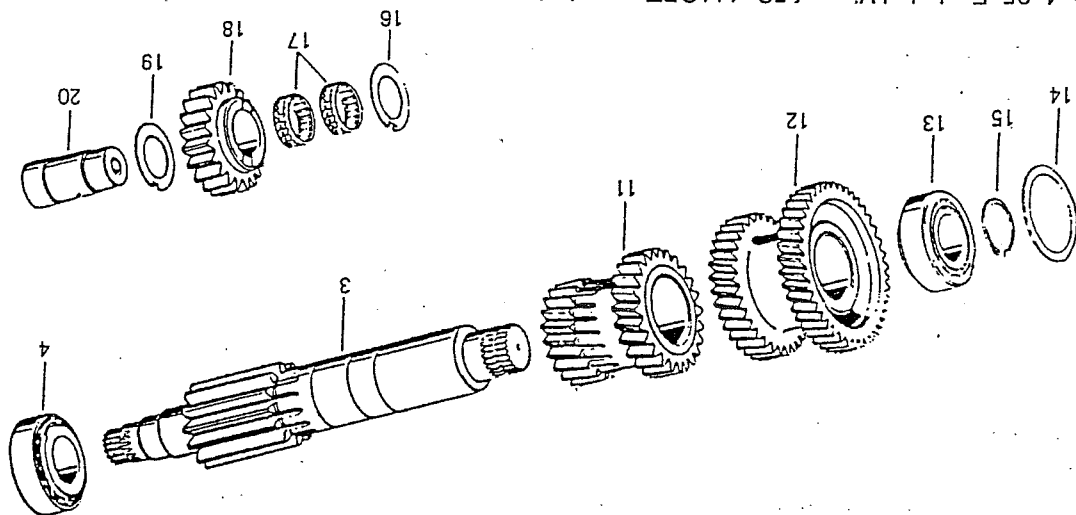


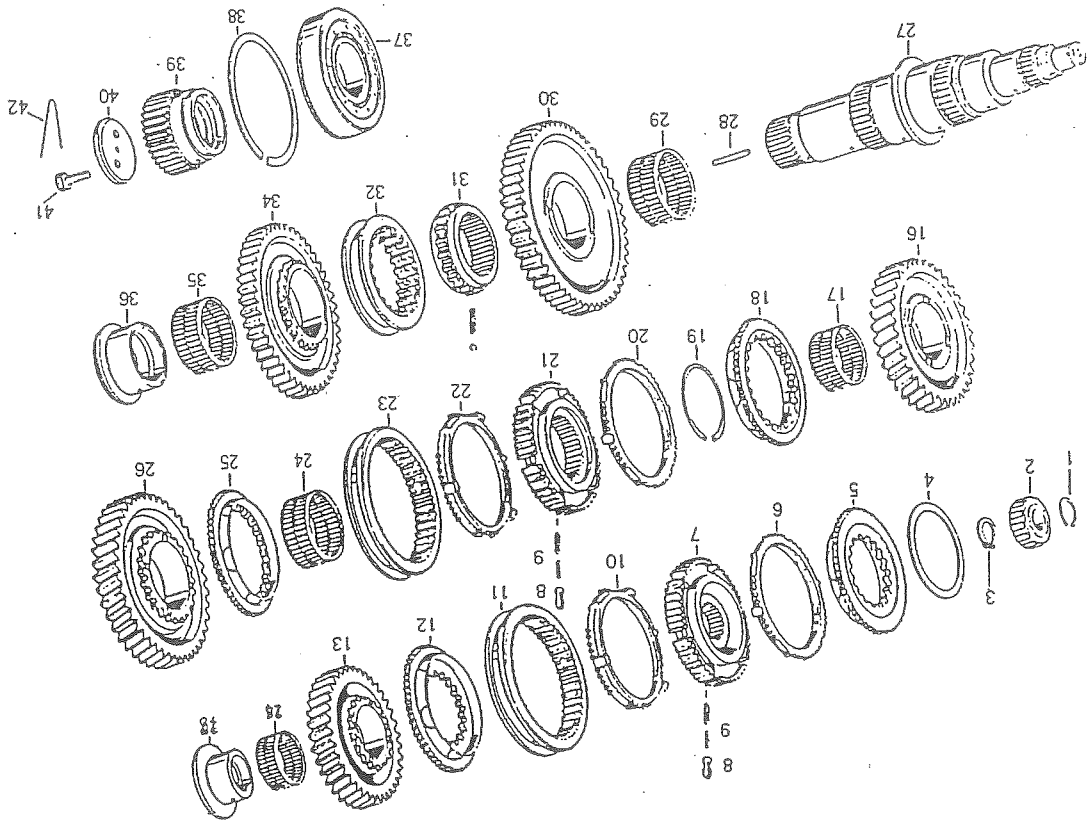
Fig. 4-25 Exploded View of 5S-111GP Transmission counter shaft and Reverse Gear countershaft



internal toothed wheel of the oil pump rotor, in other words, the first shaft end can be removed from the first shaft together with the oil pump. Otherwise driving pin 10 will not be in alignment with the oil pump notch, and subsequently, the end cap and the pump can not be removed from the first shaft. This point should also be noted when installing the first shaft and the first shaft cap.

There is a flange on the outer ring of the first shaft bearing. In assembling, the bearing flange should closely touch against the end surface of the gearbox housing, and the locating flange in end cap 2 should tightly press the end surface of bearing outer ring via the spacer. Make the bearing localized on the housing with an advanced tightness of 0-0.05 mm. The excircle of the first shaft oil seal 3 should be pressed tightly in the end cap with the inner circle lip surface inward round the shaft to seal up. When assembling the first shaft end cap, attention should be paid not to damage the oil seal lip surface. There is a gasket between the end cap and the gearbox housing. Surface sealant should be applied on it when assembling.

1. Circlip 2. Cylindrical roller bearing 3. Slotted nut 4. Spacer of the 4th speed gear synchronizer 5. The 4th speed gear (direct gear) synchronizing cone 6. The 4th speed gear synchronizing ring 7. Toothed seat of 3rd-4th speed gear synchronizer 8. Push block 9. Spring 10. 3rd speed gear synchronizing cone 11. 3rd-4th speed gear sliding sleeve 12. 3rd-4th speed gear synchronizing cone 13. Third speed gear 14. Third speed gear needle bearing 15. Third speed gear bearing axle bush 16. Second speed gear 17. Second speed gear needle bearing 18. Second speed gear synchronizing cone 19. Second speed gear synchronizing conical ring 20. Locating circlip of 1st-2nd speed gear synchronizing toothed seat 21. 1st-2nd speed gear synchronizing toothed seat 22. First speed gear synchronizing conical ring 23. 1st-2nd speed gear sliding sleeve 24. First speed gear needle bearing 25. First speed gear synchronizing cone 26. First speed gear 27. Second output shaft 28. Lubricating oil pipe 29.



b) Counter shaft assembly consists of the counter shaft, the 1/2 and 3/4 speed gear double gears and conical roller bearings. See fig. 4-25, 4-26.

The counter shaft uses a specially structured (no splines, no keyways) cylindrical stair-formed shaft. The creep gear, reverse gear, first speed gear and the second speed gear are integrated with the counter shaft. The spline teeth at both ends of the intermediate shaft are used to attach power take off unit or clutch brake. The 1/2 and 3/4 speed gears are dual gears. For 4S-130GP, the third speed gear and the fourth speed gear on the intermediate shaft are dual gears. Large magnitude of interference is employed. After being heated to 160-180°C and thermally insulated for certain time, it is attached onto the corresponding position on the intermediate shaft journal with a 60-ton pressing machine, thus the rigidity of the counter shaft assembly is intensified, and driving quality and carrying capacity are raised. Constantly engaged driving is practiced between the gears on the counter shaft and the corresponding gears on the first shaft, the second shaft and the reverse gear shaft respectively. The two ends of the counter shaft are supported on the transmission housing with two conical roller bearings. Spacer 14 is set between the outer race of the bearing at the counter shaft input side and the front end cap. Select a spacer with proper thickness to ensure the axial clearance of 0.12-0.15 mm for the counter shaft.

The second shaft assembly is supported at two points. Heavy duty short cylindrical roller bearings with high carrying capacity are used both the front and rear ends of the shaft. Front end of the second shaft is supported in the first shaft bearing hole, while its rear end is supported in the seat hole in the housing rear wall of the main housing and the bearing to regulate the bearing clearance. As shown in Fig. 4-22, the front output axle head of the second shaft is attached with a cylindrical roller bearing 3 without outer ring. This bearing is inserted into the gear shaft hole of the first shaft to support the input end of the second shaft. The output end of the second shaft is supported in the axle hole of the gearbox. The axial location of the second shaft is guaranteed by this bearing. The bearing outer ring is positioned on the gearbox housing by a retaining ring. There is an adjusting spacer in the front housing the auxiliary box. This spacer and the oil deflector ring press on the bearing outer ring, making the retaining

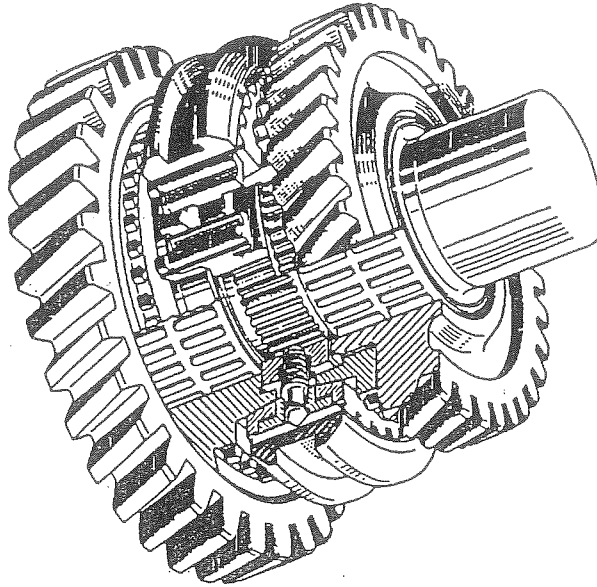
steel, conical friction surfaces are sprayed with molybdenum coating so as to lengthen its service life.

slots for neutral gear position. ⑤ The crucial shifting part the synchronizing ring is forged with low carbon alloy gear position, the interspaces between the internal teeth of the sliding sleeve are machined into trisected locating trisected 6 mm limiting steps. To ensure that the sliding sleeve can be kept at the central position at the neutral the synchronizing sliding sleeve is chamfered into a cone, the two ends of the internal teeth are sharpened into external conical surfaces of the conical hub so as to raise the friction force. ④ Besides that the included angle of thickness, the inside is narrow while the outside is wide. ③ Semicircular oil draining slots are machined on all the sliding sleeve and the conic hub are machined into the structure of inverted cone form along the direction of tooth the gear positions, prevent the sliding sleeve from escaping by itself causing gear come off, the joint teeth of the sleeve, synchronizing ring and conical hub are chamfered into closed angles. ② To increase the locking force at is specially processed: ① To increase the chance of sheathing, the joint teeth ends of synchronizing sliding hub, and interchangeable second/first gear conical hub. The synchronizer mounted on the second shaft assembly synchronizing sliding bushes, general-purpose and interchangeable fourth/third gear conical gear and second/first gear synchronizing rings (four pieces), 6 sets of synchronizing pushing blocks, two pieces of gear synchronizer assembly, among which 10 per cent are general purpose and interchangeable, the fourth/third bearings with retainers are mounted. On the second shaft mounted are the fourth/third gear and the second/first of various speed gears are mounted on the second shaft assembly, in the central hole of which double row needle reverse gear, short cylindrical roller bearing of the reverse gear joint bush, steel ball, joint bush, creep gear, following are mounted in turns: positioning spring of the reverse gear joint bush, steel ball, joint bush, creep gear, seat, the second gear front bearing, and elastic limiting ring. On the rear section from the shaft shoulder the synchronizing toothed seat and synchronizer assembly, elastic limiting ring of the third and fourth gear toothed bearing race and driving gear, bearing seat elastic limiting ring, the third gear and the second gear, the second gear the first and second gears, the synchronizer assembly of the first gear and the second gear, the second gear gear. From this journal the following are mounted in sequence: the first speed gear driving gear, the toothed seat of rear. The front section is from the front bearing of the second shaft to the journal near the second shaft first speed gear. The full length of the second shaft which divides the second shaft into two sections, the front and the two fifths of the full length of the second shaft are machined. There are splines at three places on the shaft. There is a big shaft step at the point of and oil duct are machined. There are splines at three places on the shaft. There are gears, and direct through oil hole c) The second shaft, as shown in Fig. 4-27, is a stepped shaft, on which there are gears, and direct through oil hole

Fig. 4-27 Exploded View of the Second Shaft of 5S-111GP Transmission

Creep gear needle bearing 30. Second shaft creep gear 31. Engaging toothed seat and spring of reverse gear and creep gear 32. Engaging sliding sleeve of reverse gear and creep gear 33. Second shaft reverse gear 35. Reverse gear needle bearing 36. Reverse gear bearing bush 37. Cylindrical roller bearing at the output end of the second shaft 38. Locating circlip of bearing outer race 39. Main box output gear (input sun gear of second box) 40. Gear baffle 41. Baffle fixing screw 42. Fixing screw locking wire

Fig. 4-28. Locking Ring Type Inertial Synchronizer



ring have an advanced tightness of 0~0.05 in the bearing hole.

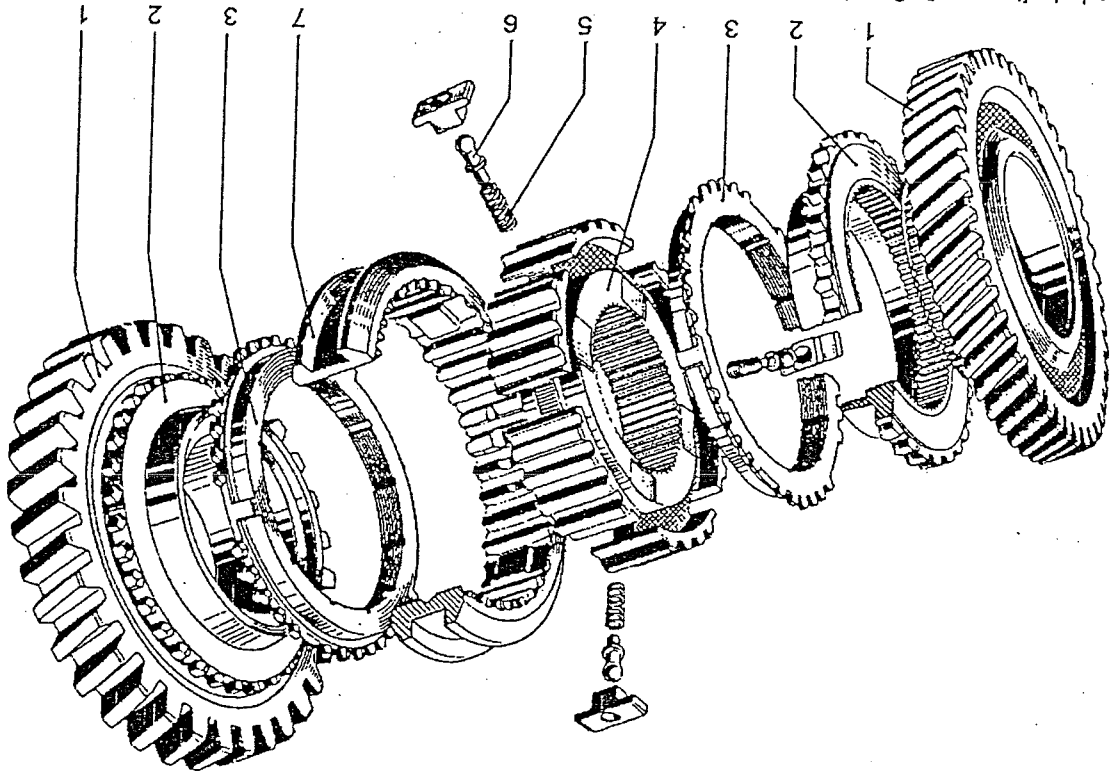
Adjusting spacer is also added between the fourth gear conical hub of the second shaft assembly and the first gear for adjusting the axial clearance between the first shaft and the second shaft to the range of 0.6~0.9 mm. The second shaft adopts integrated lubrication. Four lubricant slots are machined on each of the gears, which lead to the two end surfaces of the gears. All the operating gears are sheathed on the second shaft loosely via needle bearings and engage with the intermediate shaft gears constantly. When the transmission operates, lubricant is pressed in by the oil pump via the jet pipe on the first shaft, the oil hole and oil duct on the second shaft, oil pipe on the reverse gear shaft and the cast oil duct in the front case. Together with the splashed lubricant, it lubricates the gear bearings of the second shaft, thus reliable lubrication is ensured, driving quality of the transmission is improved and its service life is lengthened. Axial modification of the transmission gears and high power blasting of the tooth faces have raised the gear drive carrying capacity and reduced its operational engaging noise.

d) The reversing shaft assembly is made up of the reversing shaft, reversing gear, reversing gear needle bearing and reverse gear washer, see Fig. 4-25. The reversing shaft assembly is the assembly that changes the rotating direction of the transmission's driving gears to realize backup of the vehicle. The reversing shaft 20 is a cylindrical trapezium bare shaft. The reversing shaft has two supporting points. Interference fit is adopted to press the rear shoulder of the shaft into the transmission housing. The straight-toothed reversing gear is supported on the reversing shaft by two double row needle bearings with punched retainer. The two gear washers 16 and 9 are used to adjust the axial clearance of the gear. When assembling the reversing shaft, its big end should be 0.5 mm lower than the transmission housing.

The reversing gear constantly engages with tooth of the intermediate shaft and the gear on the second shaft. Since the three engaging gears are all straight-toothed gears, and in addition, there is processing position error with the three axle hole in the transmission housing and geometrical error in the manufacture of the intermediate shaft, when the vehicle is in reversing gear, the engaging noise of the gear's operation is somewhat higher than the other gear positions.

On the reversing shaft straight through oil hole is machine and jet pipe is attached. Oil duct is machined on the end surface of reversing gear. Integrated lubrication is introduced to lubricate the shaft, gears and bearings. Its performance is all right.

Fig. 4-29 Exploded View of ZF Inertial Locking-Ring-Type Synchronizer
1. Second shaft gear 2. Synchronizer cone 3. Synchronizing conical ring 4. Synchronizer toothed seat 5. Synchronizer spring 6. Pushing block 7. Synchronizer sliding sleeve

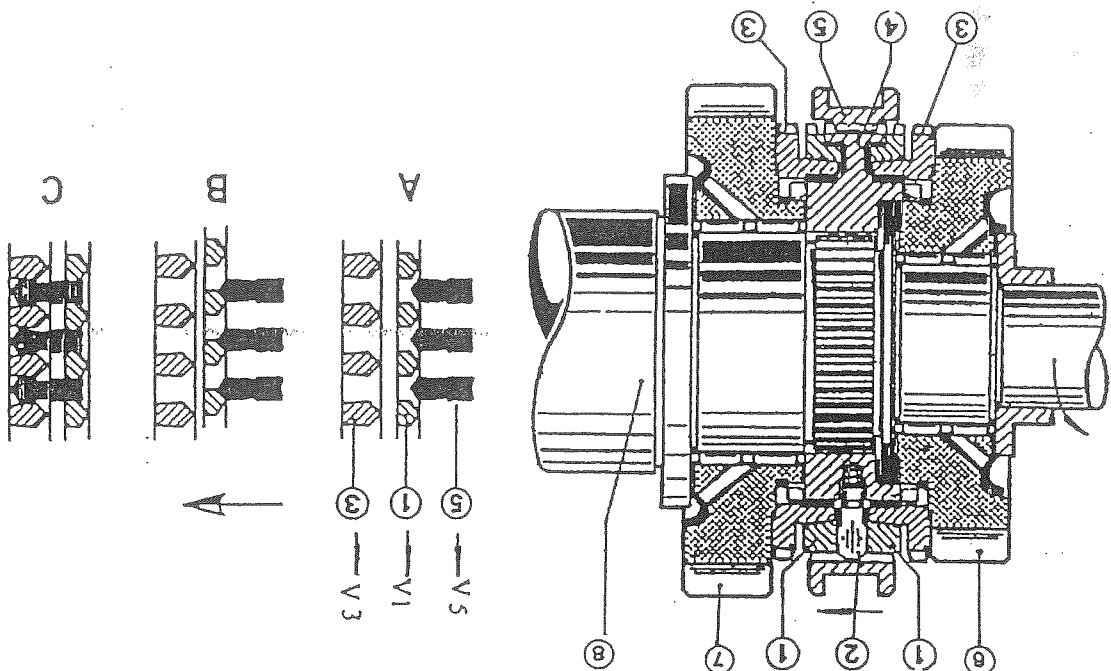


e) Gear engaging mechanism. As shown in Figs 4-28 & 4-29, the structure of inertial lock ring type synchronizer is adopted to the 1st-2nd (5th-6th) and 3rd-4th (7th-8th) gears while the common engaging sleeve structure is adopted to the creep and the reverse gears of the transmission. As shown in Fig. 4-33. As for the inertial lock type synchronizer, a synchronizer toothed seat 4 is attached on the second shaft between each two adjacent gear positions. It is connected with the second shaft spline and positioned on the shaft by a circlip and a slotted nut. There are six notches the toothed seat of the synchronizer, on the three symmetrical notches of the toothed seat 5 and three pushing blocks 6 are fitted. Engagement sliding sleeve 7 is sheathed on outer ring of the toothed seat of the synchronizer in the form of spline teeth. On the internal teeth of the sliding sleeve three grooves are machined at the positions corresponding to the pushing block 7. When shifting to the neutral gear position, sliding sleeve 7 aligns with the toothed seat 4, the pushing block is pushed by the spring into the grooves on the internal teeth of the sliding sleeve. There are two conical synchronizing rings 3 on the two sides of the toothed seat of the synchronizer. Friction material with high friction coefficient is cemented on the conical surface of the inner ring of cone 2 sheathes on short engaging teeth of the second shaft gear 1 through its internal teeth. There is an external conical surface with the same taper on the synchronizer 2 at the position corresponding to conical synchronizing ring. There are short spline teeth machined on the circumferences of the synchronizing cone and the conical synchronizing ring. When the sliding sleeve 7 is pushed into gear position, its internal spline teeth sheath the toothed seat 4, the conical synchronizing ring 3 and synchronizing cone 2 together. Thus the power transmitted by the gears of this gear position is delivered via the sliding sleeve 7 and the toothed seat 4 to the second shaft to output.

Now let's take the third and fourth speed synchronizer as example to explain the operational principle of the synchronizer. As shown in 4-30, suppose the gearbox is operating under the fourth gear working condition. The sliding sleeve is at the position on the left where it sheathes on the synchronizing conical ring and the synchronizing cone of the fourth gear. The power is now delivered to the second shaft via the fourth gear, the conical synchronizing ring, sliding sleeve and toothed seat to output. Since the second shaft gear is engaged constantly, all the gears rotate when the gearbox is in operation. Since the gearbox at this moment is at the fourth gear position, it is obvious that the rotating speed of the fourth gear is higher than that of the third speed gear. In other words, the rotating speed of the second shaft is higher than that of the third speed gear. When the sliding sleeve moves rightward to speed of the second shaft is higher than that of the third speed gear. When the sliding sleeve moves rightward to the neutral gear position, all the machine parts will rotate at their original speeds under the inertia force. There is an RPM difference between the sliding sleeve and the third gear synchronizing cone. It is hard to make engagement without a synchronizer. As shown in Fig. 4-30A, when sliding sleeve moves rightward, the recesses of its internal teeth pushes the pushing block which in turn pushes the conical synchronizing ring, making the internal conical surface of the conical synchronizing ring press onto the external conical surface of the synchronizing cone. Since the rotating speeds of the third speed gear and the synchronizing cone of the third gear are lower than the rotating speed of the sliding sleeve, as shown in Fig. 4-30B, the circumferential rotating speed V_3 of the third speed synchronizing cone is lower than that of the sliding sleeve, therefore, once the friction surface of the conical ring touches the friction surface of the cone, the synchronizing cone will force the conical synchronizing ring to reduce its speed. The bevel surface of the engaging teeth of the conical synchronizing ring pushes firmly against that of the internal engaging teeth of the sliding sleeve, making that the sliding sleeve locked at this position and stopped from moving further. As long as there is rpm difference between the toothed seat together with the sliding sleeve and the third gear and the third gear conical synchronizing ring, there would exist resistance of the engaging teeth on the conical synchronizing ring to the bevel surface of the sliding sleeve, and the sliding sleeve would not be able to engage with the synchronizing cone. The resistance of the engaging teeth of the conical synchronizing ring to.

Fig. 4-30 Principle of Inertial Locking-Ring-Type Synchronizer

1. Synchronizing conical ring 2. Pushing block 3. Synchronizing cone 4. Toothed seat 5. Sliding sleeve 6. Fourth speed gear 7. Third speed gear 8. Second shaft



The control mechanism functions to ensure that the sliding sleeve and the conical hub will fully engage so that the transmission will not walk out of mesh by itself, in shifting, it will not engage with two gear positions at the same

(2) Control Mechanism

Fig.4-33 Engaging Devices of Creeping Gear and Reverse Gear of Transmission 5S-111GP

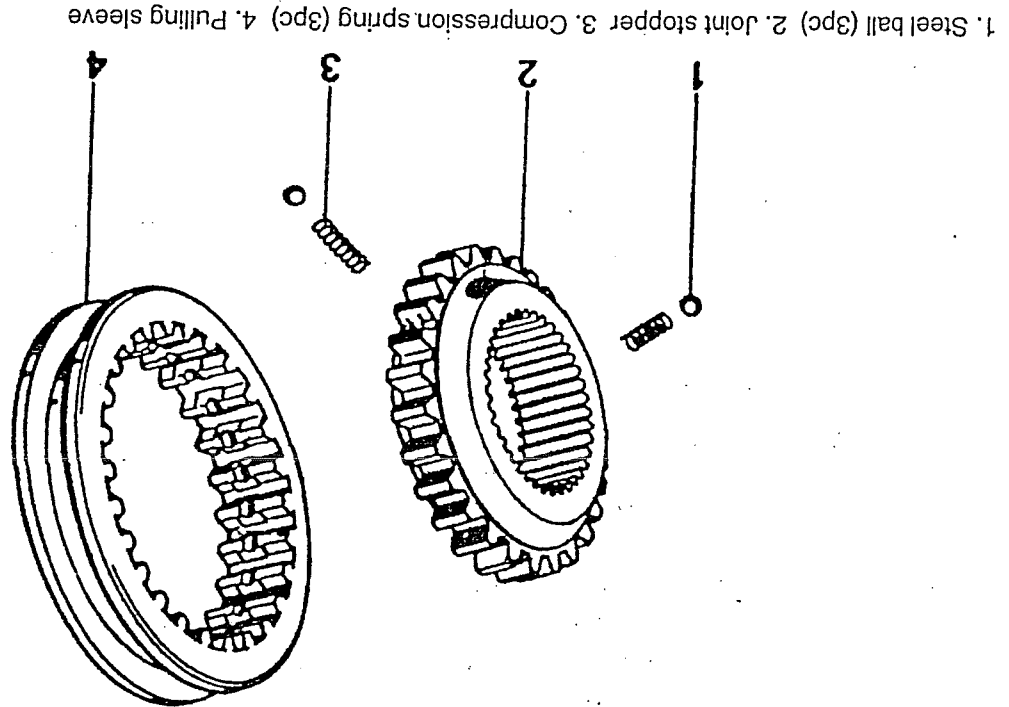
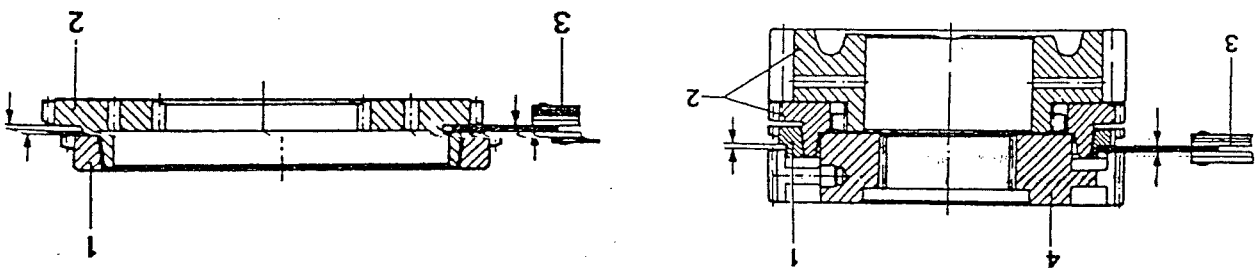


Fig. 4-31 Measurement of Synchronizer Clearance Fig. 4-32 Measurement of Limit of Wear of Synchronizer

1. Conical synchronizing ring 2. Synchronizing cone
3. Feeler gauge 4. Synchronizing toothed seat

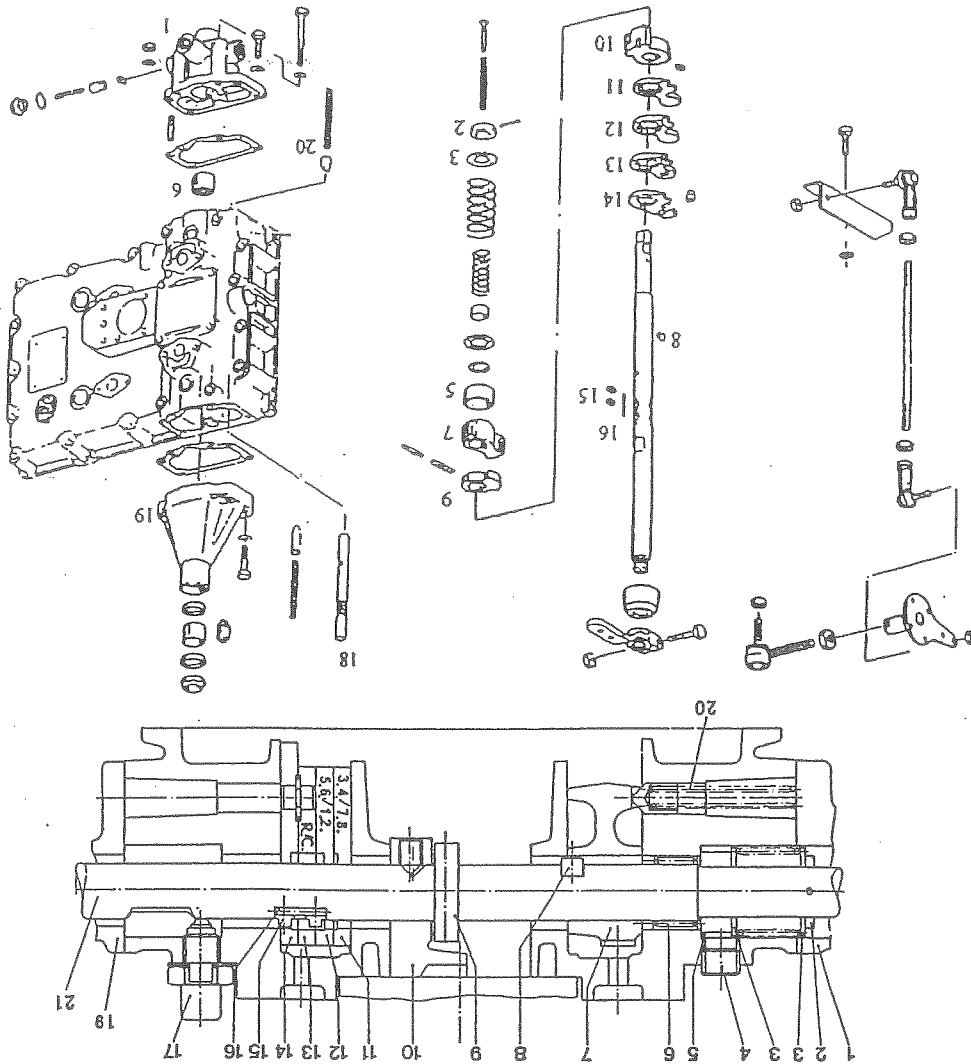


should be replaced with a new one.

conical ring. However, the maximum stock removal should not exceed 0.3 mm. Otherwise, the synchronizing ring If the clearance is less than 0.6 mm, other synchronizing ring should be selected, as shown in Fig.4-31. If the clearance is less than 0.6 mm, its upper limit is restricted by the friction margin of the synchronizer, the synchronizer clearance, i.e., the clearance between the synchronizing ring and the support surface of the synchronizing cone, and thus is shifted into the third speed gear position, as shown in Fig. 4-30C. In assembling, into the synchronizing toothed seat and push it rightward to engage with the external teeth of the third gear such a case can sliding sleeve overcome the acting force of the pushing block to press the pushing block same rotating speed with the synchronizing cone (i.e., being synchronized) under the action of friction, and only in the internal bevel surface of the sliding sleeve can disappear only after the conical synchronizing ring gets to the

Fig. 4-34 Gear Shifting Mechanism of Transmission 5S-111GP

1. End cap of shifting shaft 2. Check ring 3. Spring retainer 4. Screw plug 5. Spacer 6. Needle bearing 7. Gear position auto-locking block 8. Driving pin of auto-locking block 9. Interlocking shaft shifting block 10. Shifting block of high/low gear section lock 11. Shifting block of 3rd-4th (7th-8th) gear 12. Shifting block of 1st-2nd (5th-6th) gear 13. Shifting block of creep gear and reverse gear 14. Interlock shifting block 15. Driving pin 16. Driving pin needle roller 17. Reverse gear lock 18. Interlock shaft 19. End cap 20. Gear position lock pin and spring 21. Gear shifting shaft



exploded view of the control mechanism.

a) The gear shifting mechanism consists of six parts: the gear shifting device, the locating device, shifting reset valve, self-locking device, inter-locking device and the reverse-gear-booster; see Fig. 4-34-sectioned view and engaging with two gear positions and confused gear shifting.

The gear shifting mechanism is mounted on the transmission head. The shifting yoke mechanism employs the advanced single rotary shaft tie bar shifting yoke type mechanism, which can absolutely avoid return from the operating gear position back to the neutral position at any moment. The control mechanism can guarantee the driver to shift the transmission to operate at any required gear position at any moment, and prevent the transmission from shifting into reverse gear position by mistake. The control mechanism

Gear shifting shaft 21, mounted in the transmission head, can move axially and rotate. Driving shaft 15 that goes through the shifting blocks moves the shifting blocks 11, 12 and 13 of various gear positions separately making them swing fore and aft. The shifting linkage which is interlocked with the shifting block operates the shifting yokes of various gear positions, and via the sliding block mounted on the shifting yoke, it pushes the engaging sleeve to realize making gear engagement or breaking gear engagement.

① Gear shifting device is made up of the following parts: the transmission head, the gear shifting shaft, the gear shifting shaft seat, the gear shifting rocker arm, the rocker arm spherojoint, the joint plate, the driving pin, four pieces of shifting plates and two pieces of sheet-type tie bars.

The transmission head is a die cast of aluminum alloy with symmetrical structure. All the parts of the gear shifting device are assembled on the head. Subordinate members are also mounted on the head according to the requirement: the signal switches of neutral gear and reverse gear, the booster, gear selecting crank bar and bracket. The head can be assembled in the forms lying on the left side, lying on the right side or setting vertically, or with gear positions of I or II types. The head is fixed on the transmission through the 17 M10 bolt holes in the head. All the transmission heads of 5S-11 GP series transmissions are universal and interchangeable.

There are splines at one end of the gear shifting shaft. Six cylindrical shallow holes and two tapered shallow holes are machined on the cylindrical section of the shaft. Grooves are machined on the short cylindrical section of the splines. The other end of the splined shaft is manufactured into a stepped shaft with cross grooves. The gear shifting shaft is mounted on the transmission head and supported at two points. The shifting shaft seat positions the splined end of the shifting shaft. A dust cap and the shifting rocker arm are fixed at the splined end of the shifting shaft. Four needle rollers and four driving pins are attached in the cylindrical shallow holes. Four shifting plates are assembled on the driving pins. Owing to the difference of lying and forms of gear positions, the gear shifting shafts and the gear shifting plates are not interchangeable.

On the bare shaft from the top to the bottom the following parts are attached: air cam, the interlock shaft shifting block, the driving pin, the sectorial self-locking block, two groups of big and small return springs, the locating spacer, the inner race, two groups of return springs, the return spring retainer rings and the elastic pin.

The gear shifting shaft seat is used to support the gear shifting shaft. It is a die cast member of aluminum alloy. The shaft seat differs with the difference of the gear shifting shaft in length. The shaft seat is fixed onto the housing with 6 bolts. Two oil seals, an axle bushing and a dust-proof sealing are fixed in the bore of the shaft seat. On the shaft seat, a ventilation plug is also attached.

The gear shifting rocker arm is a cast steel product, which is fixed at the shifting spline section with M10 bolt. In the rocker arm, two or three tapered holes for mounting are machined. There are varieties of processing radii for the tapered holes, such as 45, 55, 65, 75 and 85 mm, measured from the center of the rocker arm shaft hole to the center of the conical hole. The mounting hole of the rocker arm is selected according to the gear shifting heaviness of the driver. If he requires a strong hand and feeling, select the hole smaller than 65 mm. Otherwise select the hole larger than 65 mm for assembling. Apart from the selection of mounting hole distance of the rocker arm, the gear shift rocker arm can determine the direction of the rocker arm tapered hole basing on the connecting direction and the difference in lying. In shifting, the angle that the rocker arm rotates to the right or to the left is 18° (there is about 2-3 mm free play in the circumference direction).

The spherojoint of the rocker arm is a connecting piece of the control rod system. It is connected with the control rod, the gear selecting crank bar and the gear shifting rocker arm respectively. It is generally a stamping weld part, and sometimes it is a cast part with the same performance. Two mounting holes for the gear selecting crank bar are machined in the lengthwise direction of the connecting plate. There are four groups of dimensions for the user to select the connecting plate. They are 47, 58, 65, 72, 80, 88, 103 and 122 mm respectively. Apart from the

Due to the vibration or other reasons, the sliding sleeve will move axially by itself to throw out of mesh, causing automatic gear coming off. To prevent the gear from coming off and ensure that the sliding sleeve is at fully engaged position without change, a self-locking device is attached in the transmission. The self-locker of the Q3 transmission is simple in structure and advanced in performance. All the gear positions share one self-locking device. The sectoral self-locking block is in sector shape, on its head part, a V-shaped groove is machined which is used to drive the neutral gear position signal light switch. Its lower part is in saddle hump shape. Three grooves are machined on the hump. The sectoral self-locking block is fixed on the gear shifting shaft, the driving pin on the gear shifting shaft brings it to swing right and left. The self-locking pin and the self-locking spring are pressed and sealed by the gear shifting shaft. Under the action of the spring, the self-locking pin sets in the three grooves of the sectoral self-locking block. The central groove is for the neutral position of the transmission. In the process of gear shifting, the gear shifting shaft rotates and compresses the self-locking spring, making the self-locking pin come out of the groove and then set in the adjacent self-locking groove, thus the gear shifting shaft and the sliding spring.

③ Self-locking device: It is composed of the sectoral self-locking block 7, self-locking pin 8 and self-locking fitting positions of the spring seats.

There are varieties of specifications of the return springs with different spring forces. The spring should be chosen according to the requirement of the whole vehicle. Different gear position layout can be realized by changing the fitting positions of the spring seats.

The gear shifting return valve is made up of two groups of different springs, big and small, and corresponding spring retainers and check rings. The two groups of big and small springs are assembled on the steps at the end of the gear shifting shaft and the return spring is locked on the gear shifting shaft by the check ring. Under the action of the return spring, the gear position returns to the neutral position automatically.

Shapes of the housing of gear section lock are different, but their functions are the same.

The gear section lock is a die cast of aluminum. It has a cross shaped appearance, and cross shaped shaft hole is machined in it. A roller unit is attached in the shaft hole, limiting the high and low gear section. Owing to the difference of the fitting positions of the gear shifting cylinder, some are positioned higher and others lower, the shapes of the housing of gear section lock are different, but their functions are the same.

is in the aisle of the 5th and the 6th gears.

of transmission locate in the aisle of the 3rd and the 4th gears, and for the 5th ~ 8th gears, the neutral gear position of transmission will be determined by the driving pins of the above mentioned parts, making the neutral gear the gear shifting plate will be determined by the driving pins of the above mentioned parts, making the neutral gear locating device is actuated by the control mechanism, the gear shifting shaft moves up and down. The position of shaft shifting block, the air controlling cam, the interlock shaft, the gear section lock and the housing. When the 2: Locating device: It consists of the crank bar subassembly, the driving pin, the gear shifting plate, the interlock tapped on this tie rod, which is used to actuate the signal switch.

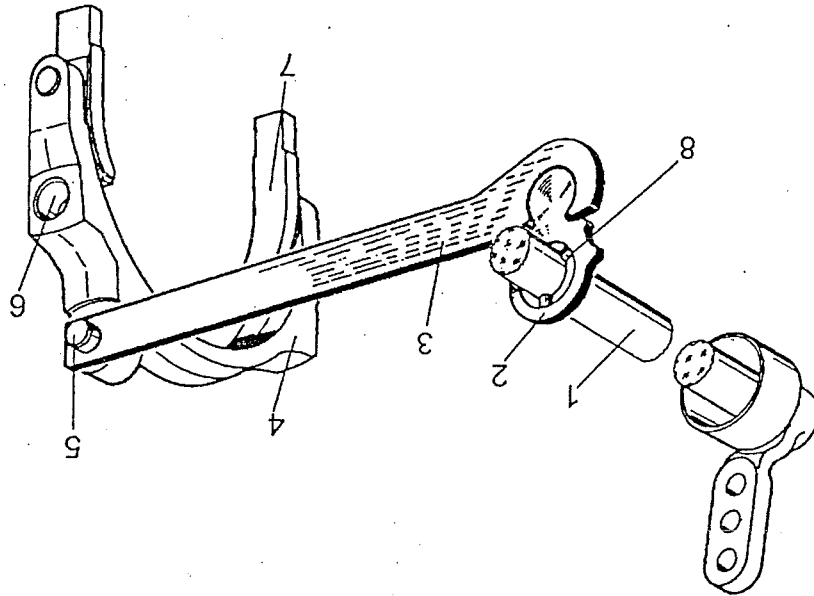
shifting of the 1st/2nd and 3rd/4th gears. The other tie bar (long) is used in creep gear and reverse gear. A flute is The gear shifting tie bars are steel stamped parts with their section in hook shape. They are used in the gear lying on the left or on the right, and for the transmissions with type I, gear position layout.

pin. The gear shifting plates are not interchangeable for the overgear and direct gear positions for the transmissions. Trisect 10mm grooves and 4mm limiting groove are machined on the gear shifting plate that is driven by the driving self-locking block.

shaft. They are used to drive the gear shifting plate. The other cylindrical driving pin is used to drive the sectoral Six driving pins, in the form of character "品", are attached on the corresponding positions of the gear shifting direction of the transmission and the layout of the gear positions.

position selection of the crank bar hole, there is also requirement on the mounting direction of the connecting plate. Its attaching direction should be determined on the basis of the difference of vehicle models, the lying

Fig. 4-35 Shifting Yoke Mechanism
1. Gear shifting shaft 2. Gear shifting block 3. Gear shifting linkage 4. Shifting yoke 5. Shifting yoke pin 6. Needle bearing in the supporting hole 7. Sliding block 8. Driving pin of the shifting block



b) Shifting yoke mechanism

offers the driver a distinct feeling so as to avoid mishandling.

shifting block of reverse gear, the gear shifting shaft jacks up the reverse gear lock. The resistance at this position gear lock are spring cotteners with great stiffness. When the gear shifting shaft is pushed to the position of the gear synchronization with the gear shifting shaft to perform gear position selection. Both the creep gear lock and the reverse gears is realized. The shifting block of the interlock shaft, which is mounted on the gear shifting shaft, moves in of the shaft. The bare section of the shaft blocks the other three gear shifting plates. Thus the interlocking between the The groove at this end can only allow one gear shifting plate that takes part in the gear shifting to swing in the groove interlock shaft, and the circular groove at the other end is set in the semicircular grooves of the four gear shifting plates. machined on the cylindrical interlock shaft. The groove at one end embeds the interlock shaft in the shifting block of the block of the interlock shaft is fixed on the gear shifting shaft with big and small elastic cylindrical pins. Two grooves are the shifting block of the interlock shaft is attached on the corresponding part of the gear shifting shaft. The gear shifting interlock mechanism of the transmission has advanced and reliable performance. The specific part of the mechanism, The yoke type can only lock the adjacent gear position; it cannot lock the gear positions that are not adjacent. The transmission is totally different with the traditional yoke type and interlock pin steel ball type interlocking mechanism. shifting plates that will not take part in the gear shifting will be automatically locked. The interlock mechanism of the in the system. After installing such a mechanism, the system can only make one shifting plate swing, while the other In order to put an end to the simultaneous engaging of two gear positions, an interlocking mechanism must be installed case is serious, it will damage the transmission assembly.

meshed gears stick each other. If the case is light, it will make all the drive stop and the engine flameout; if the different, and the transmission ratios are different, mechanical interference will inevitably take place, making the pushed to engage with two gear positions at the same time. Since the teeth numbers of the two gear positions are Without an interlocking device, the condition would occur that in the process of gear shifting, two shifting yokes are and interlock shaft:

④ The interlock device consists of the shifting block of the interlock shaft, big and small elastic cylindrical pins sleeve of the shifting yoke are locked axially, and the purpose of self-locking is achieved.

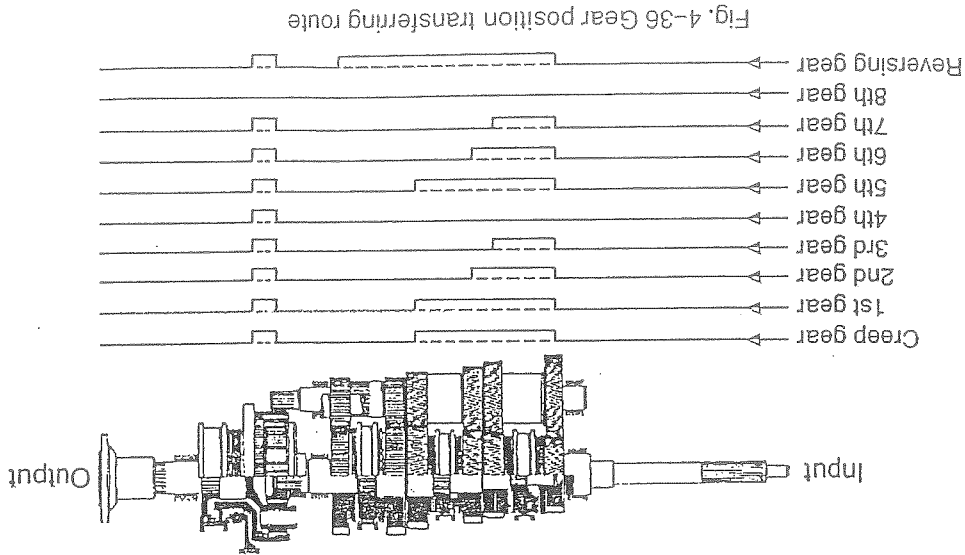


Fig. 4-36 Gear position transferring route

Under the action of the gear shifting mechanism, the shifting yoke moves the synchronizing sliding sleeve and the gear so that the gear that they mesh with is changed and different vehicle speed is realized. As shown in Fig. 4-35, the shifting yoke mechanism is composed of the shifting linkage 3, shifting yoke 4 and sliding block 7. The shifting yoke is supported in the transmission by two supporting bolts that are fixed on the two sides of the transmission housing. Needle bearings are attached in the supporting holes of the shifting yoke. The upper part of the shifting yoke is connected with the shifting linkage 3 via the shifting yoke pin 5. Its lower end is connected with two sliding blocks 7. When the gear shifting shaft rotates, via driving pin 8 it makes the shifting block 2 swing. It brings the shifting linkage 3 to move forward and aft, thus the shifting yoke 4 is made to swing. The sliding block 7 that is mounted on the shifting yoke will push the synchronizer sliding sleeve to move forward and aft to realize the making or breaking of a certain gear position. When installing the two supporting bolts of the shifting yoke, make sure to align the supporting hole of the shifting yoke with the supporting hole in the housing. Avoid damaging the needle bearing in the supporting hole when attaching the bolts. Finally, tighten up the bolts with a torsion moment of 200Nm. When removing or installing the transmission head, it is necessary to remove and install the shifting interlock mechanism according to the specified procedures.

(c) The gear shifting mechanism employs the single rotary shaft the bar shifting yoke type structure. The essential difference between this mechanism and the traditional yoke and slide rail type is that the process of gear shifting is divided into two steps: selecting the gear and shifting the gear. At the low gear section, the neutral gear is on the aisle of the 3rd and 4th gears. If the 1st and 2nd gears and the reverse gear are to be engaged, it is necessary to move the gear lever left and right. The rigid longitudinal tie that connects with the shaft seat bring the coupling board to rotate, the spheroid of the rocker arm and the shifting rocker arm that are connected with the coupling board drive the shifting shaft to move up and down. The driving pins attached on the shifting shaft determine the position of the shifting plate so as to determine the gear position.

Shifting the gear—When shifting the gear, move the gear lever forward and aft. The rigid longitudinal tie rod that connects with the shaft seat drives the connecting board that is linked with it; the spheroid and the shifting rocker arm bring the shifting shaft to rotate forward and aft. The driving pin fixed on the gear shifting shaft swings the shifting plate of the required gear position, bringing about the swinging of the shifting yoke of the shifting the bar which is connected with it. The sliding sleeve is made to move axially to sheath onto the conical hub and toothed seat of the corresponding gear position to realize the output of a certain gear position.

Gear position transferring route is as shown in Fig. 4-36.

(3) Oil pump

Crescent gear pump is employed to perform forced lubrication to the transmission so as to ensure a sufficient and reliable lubrication of the running gears and bearings under heavy load conditions. The driving pin fitted on the first shaft drives the oil pump, installed in the front cover. It sucks in the oil from the bottom of the transmission housing via the oil duct in the front cover. The oil is divided into two paths. One path of oil goes through the oil ducts in the first shaft and the second shaft to lubricate the bearings and gears on the second shaft and the GP auxiliary box. The other path of oil goes through the jet pipe fitted on the reverse gear shaft to lubricate the bearings on the reverse gear shaft and the gears on the intermediate shaft. This path of oil also lubricates the power take off in the rear cover through the oil pipe in the front cover of the auxiliary transmission.

(4) Incidental equipment

The neutral gear signal switch is designed to correctly show the neutral gear position. It is an electric element of reed contact point constant close structure. It has a high requirement on air tightness and heat resistance. It is attached at the corresponding position on the transmission cover and controlled by the sectorial self-locking block and pushing pin which are installed on the shifting shaft. In the process of gear shifting, the shifting shaft rotates, the self-locking block moves together, the V-shaped groove on the top of the sectorial self-locking block controls the lifting of the pushing pin. The pushing pin touches the contact point of the switch, making the light of the signal switch to display. The neutral gear signal switch is in parallel with the engine ignition switch. The engine can be started only when the transmission is at the neutral position. The neutral gear signal switch of  transmission is universal.

The reverse gear signal switch is a display specially installed for the correct engaging of reverse gear. It is an electric element of nonferrous metal reed contact point constant open structure. It has a high requirement on air tightness and heat resistance. It is attached at the corresponding position on the transmission cover and secured by two M15 screws. The turning on of the signal switch is controlled by the groove on the reverse gear the bar. During gear shifting, the shifting the bar moves, from the groove to the flat surface it triggers the signal switch to make the indicating light on. The reverse gear signal switches are universal, but they differ in their attaching positions.

2. The auxiliary transmission

The auxiliary transmission is composed of single planet wheel and single row planet mechanism that use the single row straight tooth NGW engaging mode. It has two gear positions and shifts the gear with lock ring type inertial synchronizer. The power is inputted by the sun wheel (the center gear), and outputted by the planet carrier. When the auxiliary transmission is at low gear position, the internal gear of the planet driving member is stationary without rotating. When the auxiliary transmission is shifted to high gear position, the three members driven by the planet link into one piece and transmits power directly.

The auxiliary transmission consists of the planet driving mechanism, the gear-shift mechanism, the self-locking mechanism, air-operated control mechanism, cover, housing and incidental equipment. See Figs. 4-36 and 4-37.

The second shaft of the main transmission is the input shaft of the auxiliary transmission. A sun gear is installed at the end of the second shaft. Five planet gears 3 are attached around the sun gear. The planet gears are fixed on the planet carrier 1. An integral annular gear 4 is engaged around the planet gears. The annular gear 4 is fixed with the toothed seats of the high and low gears into one piece via the splines.

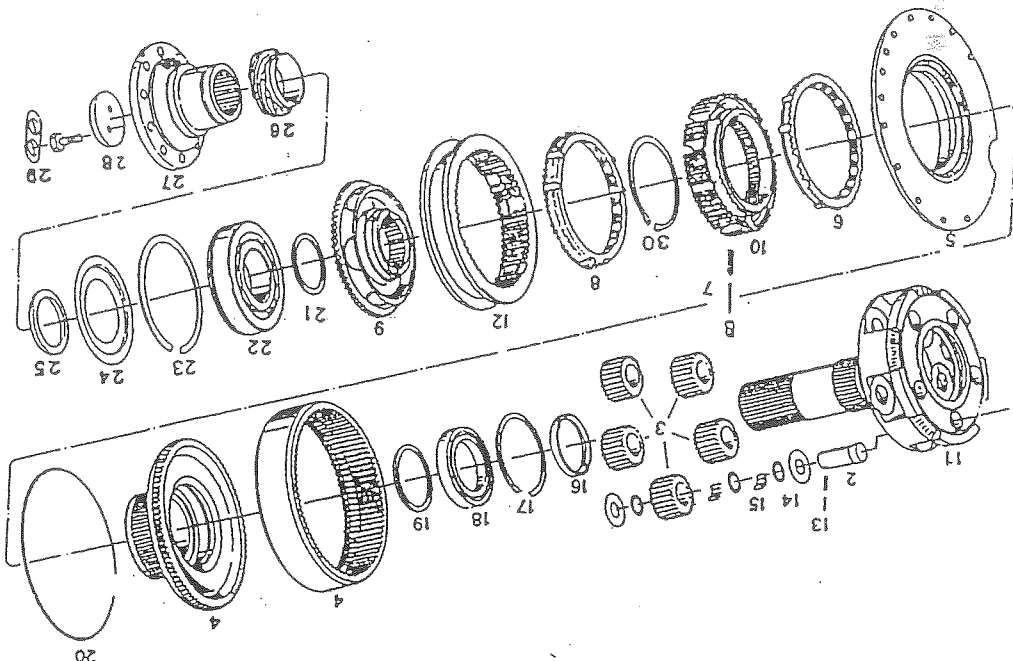
When the main gearbox is shifted to a forward gear, the second shaft rotates at certain rpm to output, that is to say, the sun gear 1 of the auxiliary box inputs at certain rpm. If the auxiliary box is shifted to the low gear, that is, the sliding sleeve of the synchronizer pushes leftward (as shown in Fig.4-37), making the toothed seat of the synchronizer which is fixed on the annulus ring engage with the conical ring which is fixed on the housing of the auxiliary box. Thus the annulus ring is made stationary. Since the sun wheel 15 is rotating, it makes the meshed planet gears 17 rotate all together. However, the annulus ring that meshes with the planet gears at the same time is stationary, the planet gears 17 are made not only to spin, but also revolve at a great reduction ratio, pushing the planet carrier 11 to rotate to output the power. If the tooth number of the sun gear of the auxiliary box is Z_1 , the tooth number of the annulus ring is Z_2 , then the gear ratio at the low gear position of the auxiliary box is $i = Z_2/Z_1 + 1$.

When the auxiliary box is shifted to the high gear position, the engaging sliding sleeve is pushed rightward to the position as shown in Fig.4-37, making the engaging toothed seat 10 to engage with the planet carrier. At this time, the toothed seat of the synchronizer makes the annulus ring integrate with the planet carrier, in other words, the sun wheel, planet gears, planet carrier and annulus ring of the planet gear mechanism are completely integrated, the planet carrier will rotate at the same speed of the sun wheel to output the power, making the auxiliary box output with the direct gear (high gear).

a. Planet driving mechanism

Fig.4-36 Exploded View of Auxiliary Transmission

2. Planet gear shaft 3. Planet gear 4. toothed ring 5. Low gear cone 6. Low gear conical synchronizing ring 7. Pushing block assembly of the synchronizer 8. High gear conical synchronizing ring 9. High gear synchronizing cone 10. Synchronizer toothed seat 11. Planet wheel carrier 12. Sliding sleeve 13. Planet wheel shaft pin 14. Axial locating washer of planet wheel shaft 15. Needle roller 16. Spacer 17. Circlip 18. Bearing 19. Adjusting washer 20. Circlip 21. Adjusting washer 22. Bearing 23. Circlip 24. Oil catch ring 25. Spacer 26. Odometer worm gear 27. Output flange 28. Baffle 29. Fixing bolts and locking plate 30. Circlip



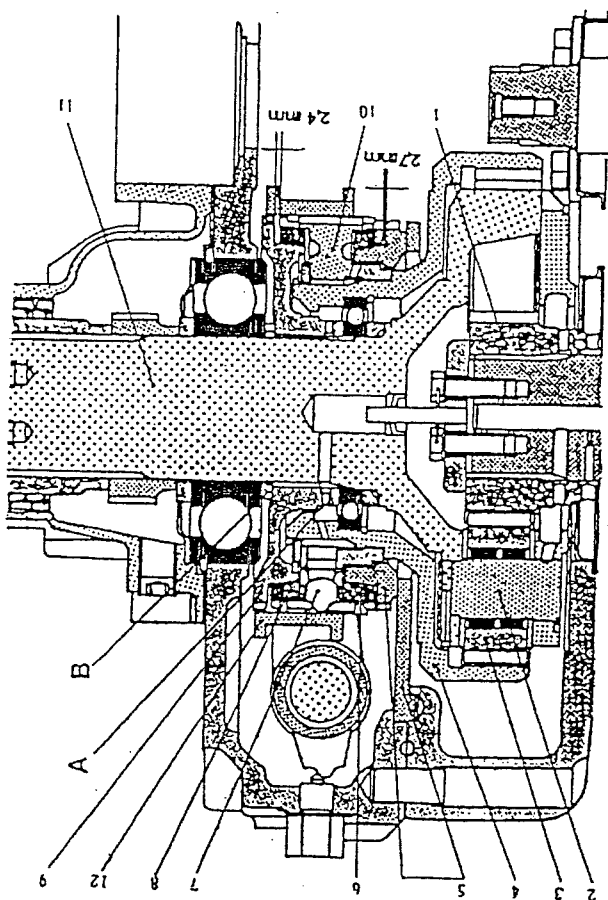
As shown in Fig. 4-38, in assembling, the annulus ring 4 with its bearing attached should be sheathed onto the planet carrier assembly 11. Care should be made to put a spacer between the bearing inner race and the shaft of the planet carrier and the inner conical surface of the spacer should face the front end of the planet carrier. Put the supporting disc, the low gear synchronizing cone 5, the conical ring 6, the synchronizing engaging toothed seat 10, the driving component 7, the high gear synchronizing ring 8 and the sliding sleeve 12 on the shaft of the annulus ring.

As shown in Fig. 4-37, there is an adjusting washer "A" between the bearing inner race of the annulus ring and the high gear cone 9 that is used to adjust the clearance between the high gear synchronizer cone and the conical ring. This clearance should be adjusted to 2.4 mm. There is an adjusting washer "B" between the high gear synchronizing cone 9 and the inner race of the auxiliary box rear housing bearing (output bearing) which is used to adjust the clearance between the low gear synchronizing cone and the conical synchronizing ring. This clearance should be

Fig. 4-37 Sectioned View of Auxiliary Transmission

- A. Washer for adjusting the clearance of high gear synchronizer
B. Washer for adjusting the clearance of low gear synchronizer

1. Sun gear 2. Planet gear shaft 3. Planet gear 4. Annulus ring 5. Support disc and low gear synchronizing cone 6. Low gear conical synchronizing ring 7. Driving component 8. High gear conical synchronizing ring 9. High gear synchronizing cone 10. Toothed seat of synchronizer 11. Output shaft of planet carrier 12. Sliding sleeve of synchronizer

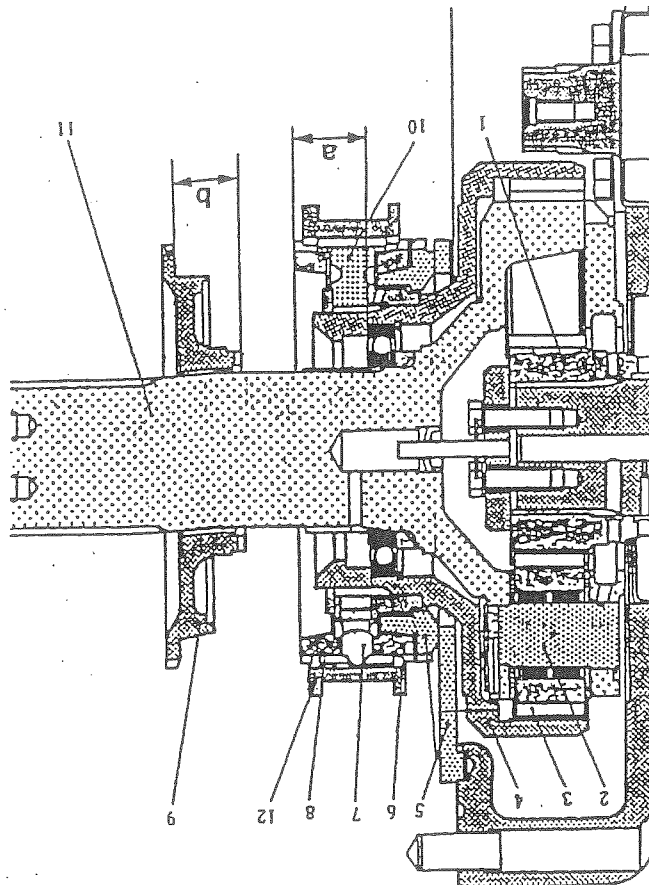


An oil pipe is inserted into the second shaft output side of the main box. The pressurized lubricant from the oil pump of the main box goes through this oil pipe and the oil duct in the planet carrier to lubricate the annulus ring bearing and the planet gear train.

Set the gearbox erect. Put the planet carrier and the annulus ring into the front housing of the auxiliary box, and set the supporting disc 5 at the relevant position in the auxiliary box front housing without any axial clearance. Insert two 2.7mm spacer gauges symmetrically between the low gear synchronizing cone 5 and the end face of the conical ring 6. Then cover the front housing with the rear housing of the auxiliary box (See to it that the gaskets of the front housing and the rear housing are attached). Fix the front and the rear housings with two fixing bolts. Measure the distance "c" from the end face of the rear housing to the internal end face of the high gear synchronizing cone with a depth gauge. Then measure the distance "d" from the end face of the locating circlip of the output shaft bearing to the end face of the bearing inner race (as shown in Fig. 4-39). In order to guarantee the low gear synchronizer clearance to be 2.7mm, the thickness of the adjusting washer (B) between the bearing inner race of the output shaft and the synchronizing cone 9 should be $b = c - d$ mm (as shown in Fig. 4-25). Remove the rear

Fig. 4-38 Adjusting of High Gear Synchronizer Clearance

1. Sun gear 2. Planet gears and shafts 3. Planet gear 4. Annulus ring 5. Supporting disc and low gear synchronizing cone 6. Low gear conical synchronizing ring 7. Driving component and spring 8. High gear conical synchronizing ring 9. High gear synchronizing cone 10. Engaging toothed seat 11. Planet carrier output shaft



the high gear synchronizing cone 9. Fix the synchronizing engaging toothed seat 10 on the shaft sleeve of the annulus ring without any axial clearance with a circlip of specified dimension. Measure the distance "a" from the external end face of the high gear conical synchronizing ring to the end face of the bearing inner race. Then measure the distance "b" from the external end face of the bearing inner race to the end face of the bearing inner race. To guarantee the clearance of the high gear synchronizer face of high gear synchronizing cone 9 to its inner end face. Choose a washer with proper thickness and set it between the bearing inner race and the high gear synchronizing cone 9. The thickness of adjusting washer A between the synchronizing cone 9 and the bearing inner race should be $b = (a - b) + 2.4$ mm. Choose a washer with proper thickness and set it between the bearing inner race and

It consists of the high and the low gears shifting blocks, the section position changeover valve, gear shifting cylinder and pneumatic pipes. See Fig.4-40.

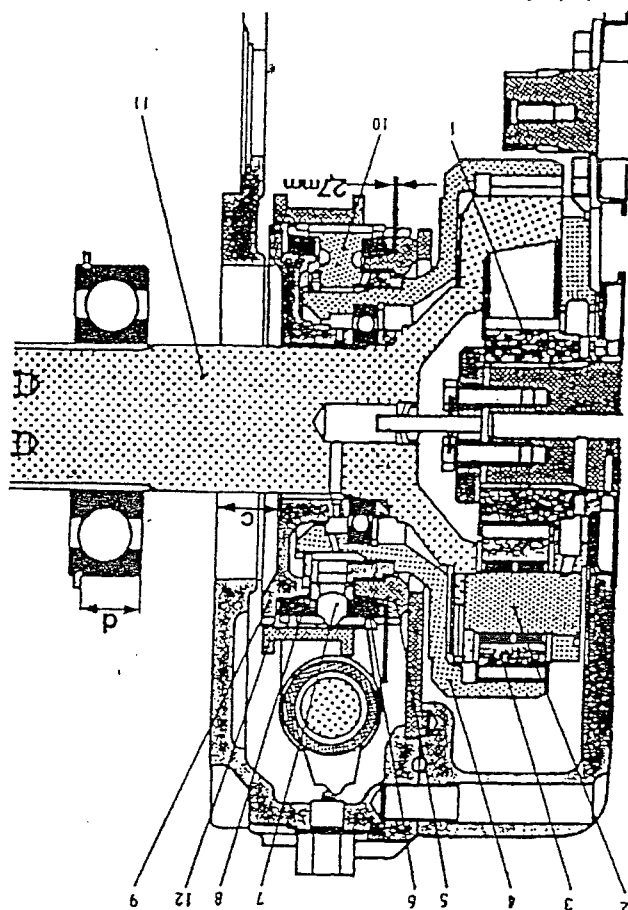
b) Pneumatic control mechanism

reverse order.

is of fluororubber, while the outer oil seal (part number: 99100290704) is of Buna-N rubber. Don't mount them in noticed that the inner oil seal and the outer oil seal differ in materials. The inner oil seal (part number: 99112220832) There are two oil seals installed on the end cap of the auxiliary box output shaft. When assembling, it should be

Fig. 4-39 Adjusting of Low Gear Synchronizer Clearance

1. Sun gear 2. Planet gear and shaft 3. Planet gear 4. Annulus ring 5. Supporting disc and low gear synchronizing cone 6. Low gear conical synchronizing ring 7. Driving component 8. High gear conical synchronizing ring 9. High gear synchronizing cone 10. Engaging toothed gear 11. Output shaft of planet carrier



thickness of the adjusting washer of the bearing outer ring.

the thickness of the gasket included). The value of the difference between the two added by 0.05mm is the distance from the internal block locating bead of the rear end cap to the end face of the end cap (with distance from the end face of the bearing outer ring to the end face of the auxiliary box rear housing and the 4-20, when installing the output end cap it is necessary to measure, under the condition of tight compression, the In order to ensure the fixation of the output shaft bearing on the housing without axial clearance, as shown in Fig. on the front housing again, set the adjusting washer of proper thickness between the bearing inner race of the output shaft and the conical ring 9, and set the output shaft bearing into the shaft hole.

housing and take away the two 2.7mm spacer gauges, mount the gasket and the rear housing of the auxiliary box

1. Pressure regulating valve
2. Air cylinder
3. Pressure reducing valve
4. Shifting valve of the high and low gears
5. Shifting cylinder of high and low gear

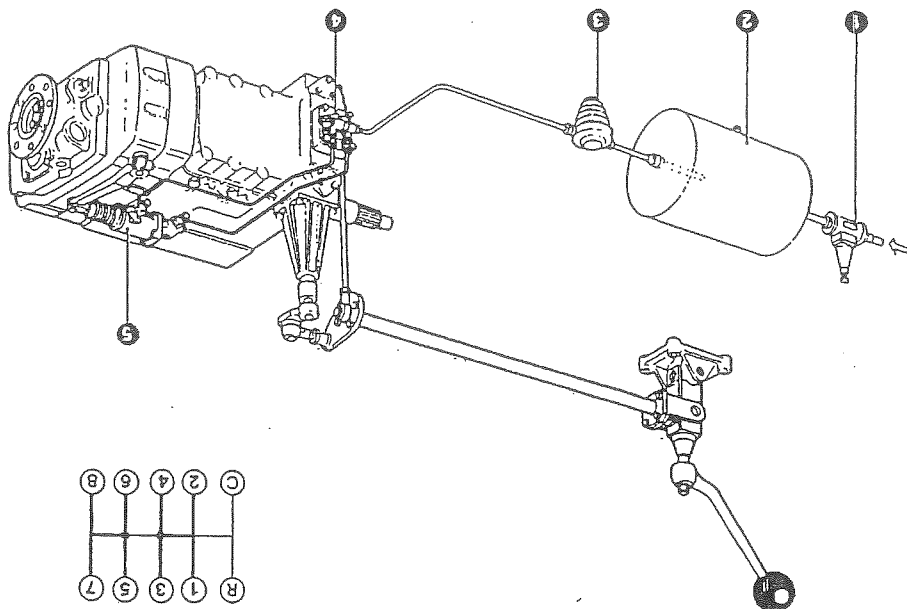


Fig. 4-40 Gear Shifting System External Structure of Transmission QJ5SS111GP

The driving block of high and low gears section lock assumes sectorial cambered surface. A shaft hole is machined in it. On the shaft hole two screw holes are machined for the fastening pins. On the sectorial arc surface, two arc grooves are machined, one is long and the other is short. It sheathes on the shifting shaft. When the main transmission is at the neutral gear position and the gear lever is operated, the shifting shaft moves up and down, the driving block of the high and the low gear section locks mounted on it will move with it together. Under the action of the section lock fitted at the end of the shifting shaft, it controls the opening of the air passage of the high and the low gears changeover valve, realizing the automatic changeover of high gear section and low gear section of the auxiliary transmission.

Gear section changeover valve: This is an important part of automatic changeover for the auxiliary transmission, in which an air inlet, two air outlets and two quick exhaust valves are machined. It is attached on the shifting block of the high and the low gear sections locks on the main transmission head. The air inlet is connected to the compressed air of the vehicle; the two air outlets are connected respectively to the two air inlets on the shifting cylinder mounted on the auxiliary transmission. When the air pressure of the vehicle reaches 6.5 bars and the main transmission is at the neutral gear position, under the action of the spring force one of the two air control pins falls into a groove on the shifting block of the high and the low gear section lock to open an air passage in the gear section valve, the compressed air flows into the shifting cylinder, at the same time one of the two quick exhaust valve on the changeover valve releases residual operating air. The compressed air pushes the two-way type shifting cylinder to change over the high and the low gear section. Meanwhile, the grooveless bright cambered surface of the shifting block of the high and the low gear section lock pushes upward to close the other air passage in the changeover valve, making the shifting cylinder only work in one gear position. When the main transmission is shifted to a gear position, as the shifting shaft revolves, the sectorial cambered surface of the shifting block of the high and the low gear section lock pushes upward to cut off the two air passages in the gear section changeover valve, making the compressed air not able to enter the shifting cylinder, and consequently, the parts are prevented from being damaged due to miss-shifting of the auxiliary transmission during the running of the vehicle.

Shifting cylinder: It is a traditional two-way action piston cylinder. There are two air inlets and two quick air exhaust

valves in the cylinder body. The shifting cylinder is mounted on the outside of the auxiliary transmission housing and connected with the shifting rocker arm of the auxiliary transmission via threaded hitch yoke. The two air inlets of the shifting cylinder are connected to the two air outlets of the changeover valve via air pipes respectively. The hitch yoke on the cylinder can adjust the engaging position of the high and the low gear position of the auxiliary transmission. The shifting cylinder can shift the gear normally only when the air pressure of the vehicle is above 6.5 bars.

c) Self-locking mechanism

Self-locking is conducted by the high and the low gear self-locking pins. This mechanism is of reed type structure, which is mounted at the relevant position of the auxiliary transmission rear housing. There is a washer under the self-locking pin that presses on the saddle-shaped hump of the high and the low gear position shifting block under the action of spring force (the pressure is generally 180-240N). In this way, the self-locking of the auxiliary transmission is realized.

d) Incidental equipment of the auxiliary transmission

The high and the low gear signal switch: This switch is an electric element of constant open contact type. It is attached on the front housing of the auxiliary transmission. There is an aluminum sealing washer between the switch and the front housing to prevent oil leaking. The shifting yoke that is mounted on the auxiliary transmission rear housing, which is reflected on the cab dash board showing the working condition, triggers the signal switch. Odometer driving mechanism: It is a device showing the total mileage of the vehicle. The mechanism is ingenious in design. It is classified into the first-stage drive and the second-stage drive mainly. The first-stage drive employs multi transmission ratios and two spiral directions. The second-stage drive can be grouped under two species, the electronic speed drive and the mechanical drive. The driving device of the mechanism is a small aluminum square box in which a pair of small gears are installed. The transmission ratio of the small gear is determined according to the difference of the bridge gear ratio, rolling radius of the tire, the first-stage drive of the odometer and the coefficient of the odometer. Under the condition that the main transmission ratio and the first-stage drive are unchanged, change the second-stage drive with different speed ratio to meet the requirement of the vehicle speed display. Basing on the fitting position, there are two types of second-stage drives, the straight headed and the elbow headed.

III. Fitting and Adjusting Data of the Transmission

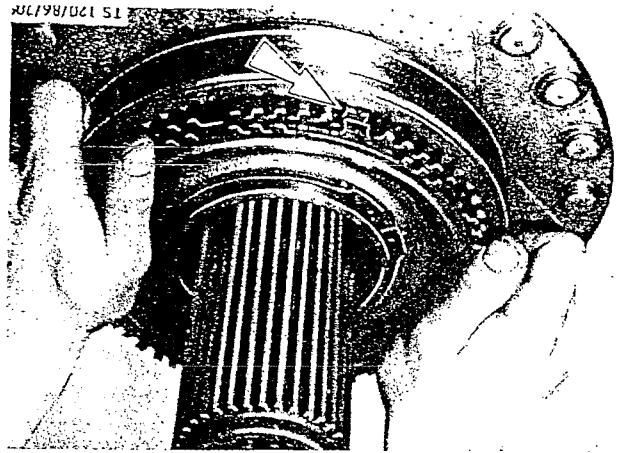
The fitting and adjusting data are classified into two groups: a. the data that the clearance is controlled by employing adjusting washers, retainer rings and screws after being measured with measuring tools. b. Inspection data indicates those that have been put into consideration and controlled when the part was designed and manufactured. The only thing to do in assembling is to examine the dimensions of the parts but not to adjust them.

No.	Item	Criteria
1	Axial clearance for the second shaft reverse gear	0.20-0.45 mm
2	Axial clearance for the second shaft first gear	0.20-0.40 mm
3	Axial clearance for the second shaft second gear	0.20-0.55 mm
4	Axial clearance for the second shaft third gear	0.20-0.40 mm
5	Axial clearance for the reverse shaft reverse gear	0.20-0.60 mm
6	Axial clearance for shifting plate on the shift shaft in the box cover	0.08-0.38 mm
7	Axial clearance for the self-locking cam on the shifting shaft in the box cover	0.1-0.3 mm
8	Distance from the needle bearing in the gear shifting cover to the end face of shaft hole	2-2.5 mm
9	Distance from the contact of diverter valve to the concave on the lock	≥ 0.2 mm

2. Fitting inspection data for QJ 5S-111GP, QJ 5S-150GP, QJ 4S-130GP

(1) Axial clearance for all the round column and annular ball bearings	0-0.10mm, advanced tightness of 0.05 mm is permitted
(2) Axial clearance for synchronizing toothed seat and elastic limiting retainer rings	0.02-0.05 mm
(3) Axial clearance for intermediate shaft	0.12-0.15 mm
(4) Axial clearance for shifting block in the sliding sleeve	0.20-0.50 mm, Wear limit clearance 1mm
(5) Clearance between the first shaft end face and the conical hub at the 4 th gear position of the second shaft	> 0.6 mm
(6) Distance from the shifting shaft needle bearing to the shaft hole end face	2+0.50 mm
(7) Wear limit clearance between synchronizing ring and conical hub	$> 0.8-1.2$ mm
(8) Axial advanced tightness clearance for the semicircular locating ring of the main box input shaft	0.01-0.02 mm
(9) Axial clearance between planet gear and planet carrier	0.2-1.3 mm
(10) Axial clearance for GP auxiliary box output shaft	0.6 mm
(11) Axial clearance for GP auxiliary box shifting shaft	0.1-0.5 mm
(12) Axial clearance for GP auxiliary box high gear synchronizing ring	$2.4^{+0.20}_{-0.01}$ mm
(13) Axial clearance for GP auxiliary box low gear synchronizing ring	$2.7^{+0.20}_{-0.01}$ mm
(14) Axial clearance for auxiliary box planet gear shaft	0.2-1.3 mm
(15) Axial clearance between shifting yoke roller of auxiliary box and the slide sleeve	1.5-1.7 mm

1. Adjusting data for QJ 5S-111GP, QJ 5S-150GP, QJ 4S-130GP



1. Disassembling of planet gear auxiliary box

N. Disassembling and Assembling of the Transmission

130-160°C

(3) Thermal fitting temperature for the dual gear of the 1st/2nd and 3rd/4th gear on the intermediate shaft:

(2) Thermal fitting temperature for synchronizing toothed seat : 120°C

screw : 85°C.

(1) Thermal fitting temperature for all ball bearing, conical bearing, short roller bearing, output flange and worm

5. Heating temperature of thermal fitting parts

No.	Item	Criteria
1	Axial clearance for the sixth gear	0.15-0.5 mm
2	Axial clearance for the fifth gear	0.15-0.5 mm
3	Axial clearance for the fourth gear	0.15-0.5 mm
4	Axial clearance for the third gear	0.15-0.4 mm
5	Axial clearance for the second gear	0.15-0.4 mm
6	Axial clearance for the first gear	0.15-0.45 mm
7	Axial clearance for the reverse gear	0.2-0.6 mm
8	Axial clearance for odometer shaft	>0.1 mm
9	Flank clearance for the teeth of odometer gear	0.1-0.2 mm

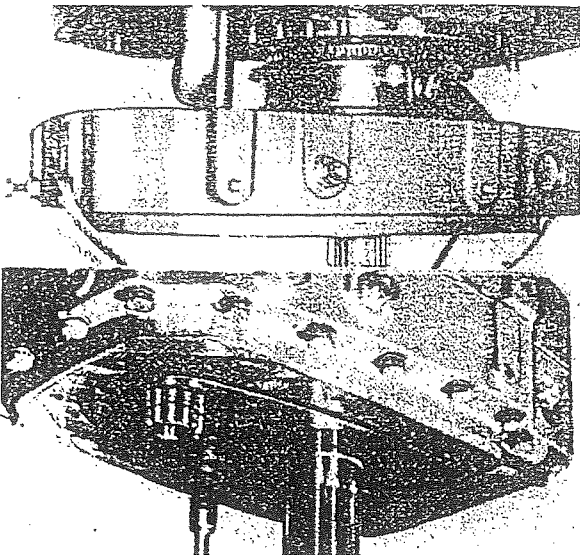
4. Fitting inspection data for S6-120

No.	Item	Criteria
1	Axial clearance for the bearings of the input and output ends	0, advanced tightness of 0.05 mm is permitted
2	Axial advanced tightness of the front semicircular lock ring of input shaft roller bearing	0.01-0.02 mm
3	Axial clearance for intermediate shaft	0.14-0.17 mm
4	Axial clearance for shifting block in the sliding sleeve	0.4-0.9 mm
5	Axial clearance for the shifting block in the shifting groove	0.4-0.9 mm
6	Axial clearance for the synchronizer	≥0.6 mm, wear limit if the distance from end face of synchronizer conical hub to the end face of lock ring ≥0.8 mm

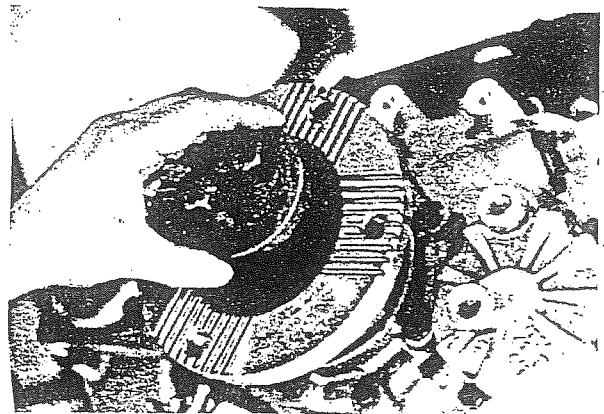
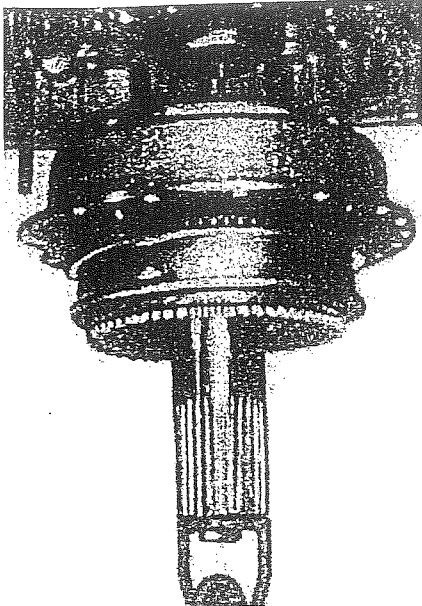
3. Adjusting data for S6-120

(1) Remove the high and the low gear shifting cylinder of the gearbox and the shifting rocker arm.

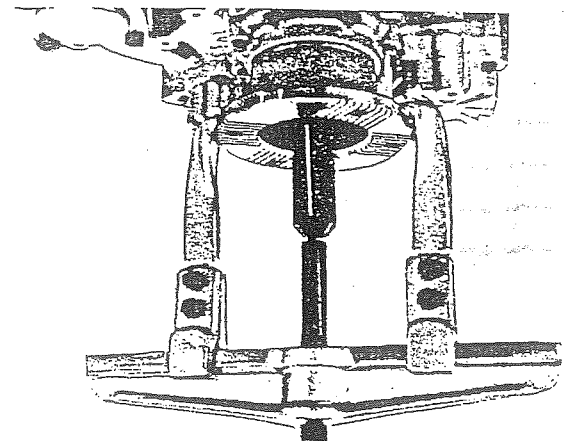
together with the worm wheel of the odometer from the output shaft.



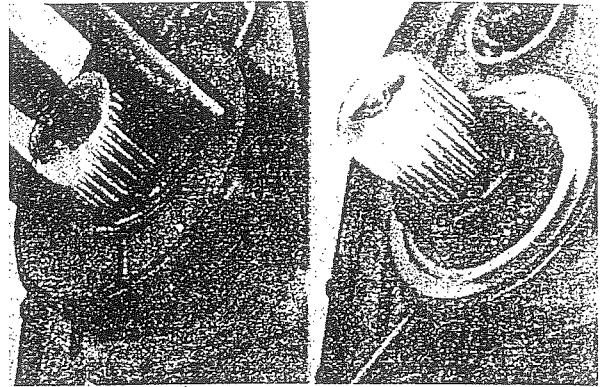
(4) Remove the fixing and connecting bolts on the rear housing of the auxiliary box, remove the bolts of the high and the low gear locating cotter on the rear housing of the auxiliary box. Put a fitting pry at a proper position to press the two halves of the housing open till the locating pin comes out completely. Then erect the gearbox with the auxiliary box up and fix two hanger bolts on the rear housing of the auxiliary box. Hang the rear housing up gently with a loop wheel machine, at the same time observe the high gear and the low gear shifting yokes, and make them pulled out smoothly from the sliding sleeve. Hang up the rear housing of the auxiliary box.



(2) Remove the two lock bolts on the fixing baffle of the auxiliary box output shaft flange, and remove the flange with an extractor.

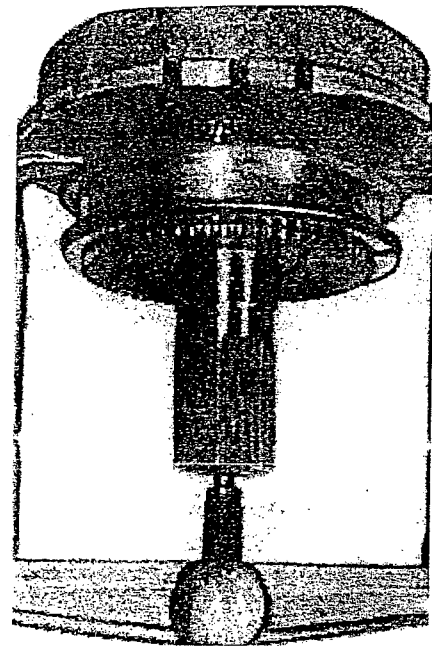


Remove the odometer shaft on the rear cover of the auxiliary box output shaft, and then remove the rear fixing bolts of the auxiliary box. Tap the rear cover gently with a soft hammer. Take care not to damage the oil seal of the output shaft. Remove the rear cover.

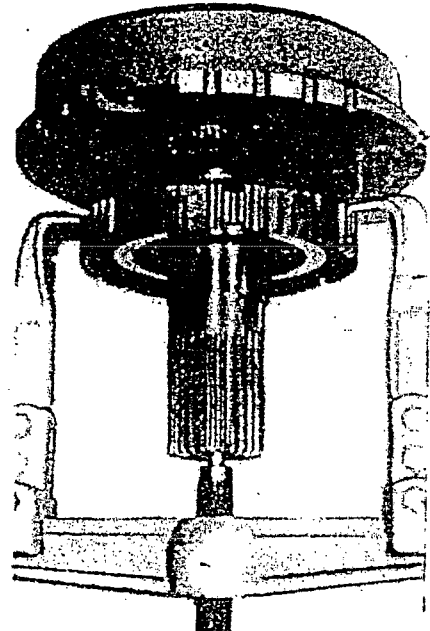


(3) Poke the locating circlip of the output shaft bearing out for a distance with a screwdriver and take the circlip away with callipers. Then put a special extractor round the bearing outer ring to extract the output bearing

(5) Use a special hanger to hang the output shaft of the auxiliary box together with the synchronizer assembly and the planet annulus ring out of the

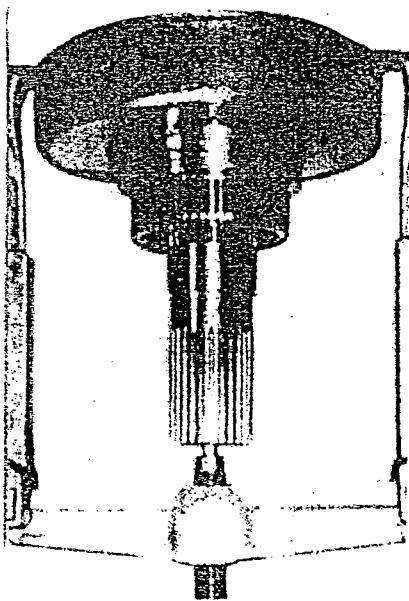


(6) Pull out the synchronizer sliding sleeve together with the high gear synchronizer cone with the help of an extractor. When pulling them out, care should be taken not to let the synchronizing driving block and the spring fly out causing lost. Keep the driving block and the spring properly.

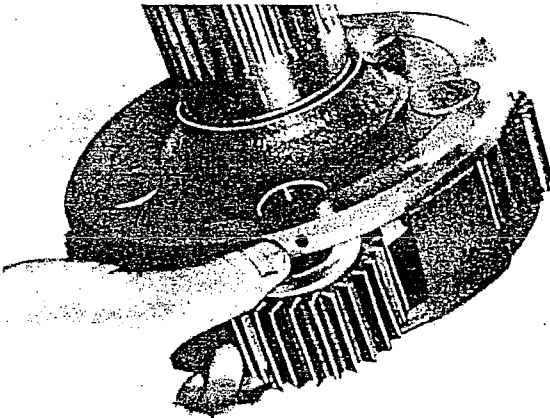


(7) Take out the circlip that fixed on the annulus ring.

Pull out the engaging toothed seat of the synchronizer from the annulus ring. Remove the low gear conical synchronizing ring and the synchronizing cone with a resisting device.

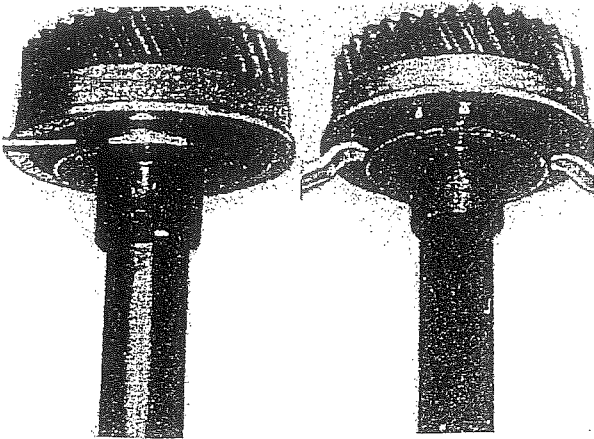


(8) Separate the annulus ring with the planet carrier by using a puller. Take out the locating circlip of the annulus ring inner bearing with circlip pliers. Tap the bearing out.



(9) Put the planet carrier on a special clamping fixture, tap out the five planet gears from the input side of the planet carrier with a punch, and take out the planet gears and thrust washer. Take out the needle bearing in the shaft hole of planet gear, clean and inspect it.

(6) Pry out the locking collar that fixes the semicircular locking ring with a pry. Take out the two semicircular



the box housing with a pry.

Pry out the input shaft together with the bearing from them properly so as to use them again in assembling. Take out the adjusting washers on the bearing outer ring of the input shaft and the auxiliary shaft and keep

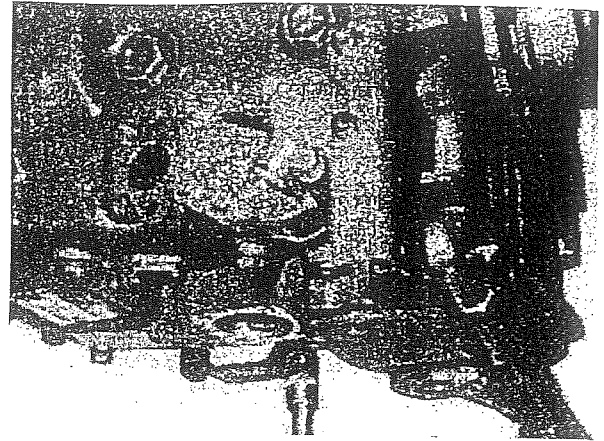
cover can not be pulled out. Otherwise, the front pin on the output shaft. The front cover can now be cover is at the same direction with oil pump driving so doing, the notch for the oil pump casting in the front centers of the input shaft and the auxiliary shaft. By shaft face up (on the perpendicular line from the input shaft (the first shaft) let the "O" mark on the (5) Remove the front fixing bolts of the gearbox. Rotate

gearbox. (4) Remove the supporting bolts of the 3rd-4th gear shifting yoke and pull out the shifting yoke from the pin and spring of the self locking block.

(3) Pull out the mobile gear selecting shaft, take out the shifting block of the interlock shaft and the locking sleeve of the synchronizer smoothly. (2) Pull out the mobile gear selecting shaft, take out

on the shift yoke should be pulled out from the sliding yokes out of the gearbox together (the sliding block the reverse gear shifting rods should lift the shifting shifting yoke and 1st-2nd gear, the creep gear and block should not separate from the 3rd-4th gear gearbox to hang up the box cover levelly. The shift the hanger on the diverter valve fixing hole of the and the reverse gear separate from the box body. Fix shifting yokes of the 1st-2nd gear, the creep gear of the 1st-2nd gears and reverse gear, making the

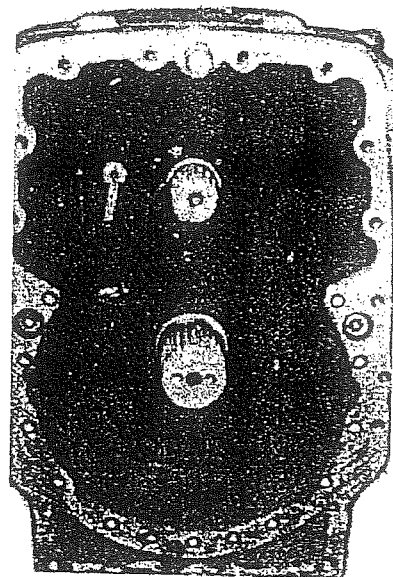
(1) Remove the diverter valve, the reverse gear switch and the neutral gear switch. (2) Remove the fixing bolts of the gearbox cover first. Then remove the supporting bolts of the shifting yokes



2. Disassembling the main gear box

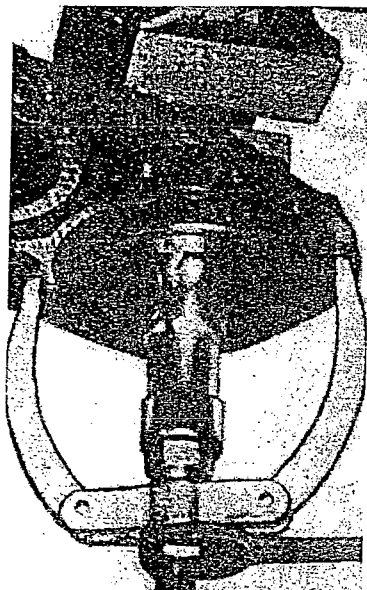
ring and the dust-proof ring should not be used again. the sliding block of the shift yoke for wear. The seal mechanism in the auxiliary box rear housing. Check (12) Disassemble the high and the low gear shifting front housing from the main box.

(11) Remove the fixing bolts of the auxiliary box front housing, tap the auxiliary box front housing gently to make it loose, and then separate the auxiliary box

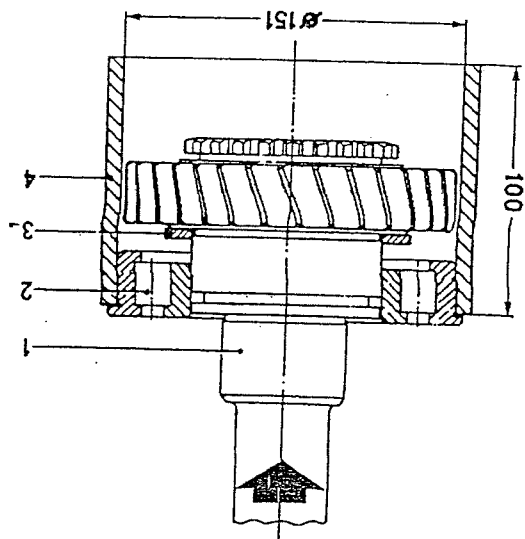


(10) Remove the two fixing bolts on the sun wheel baffle, take off the baffle and pull out the oil pipe. Remove the sun gear, which is fixed on the main box output shaft with a special puller. Remove the lubricant overflow pipe at the same time.

(8) Take out the input oil seal in the front cover and renew it if necessary.
Remove the output shaft (the second shaft)

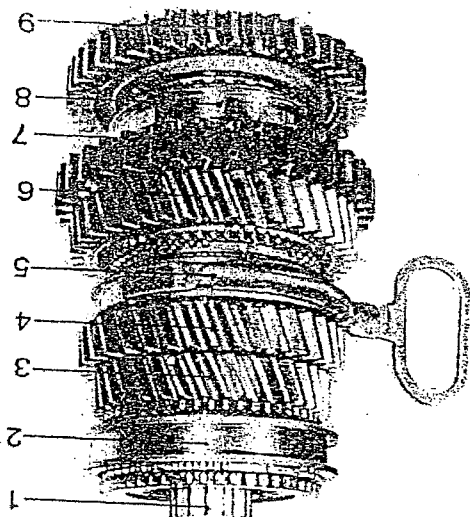


(7) Pull out the inner gear oil pump from the front end cover of the gearbox with an inner supporting type extractor.
The lubricant oil pump is supplied in unit assembly.

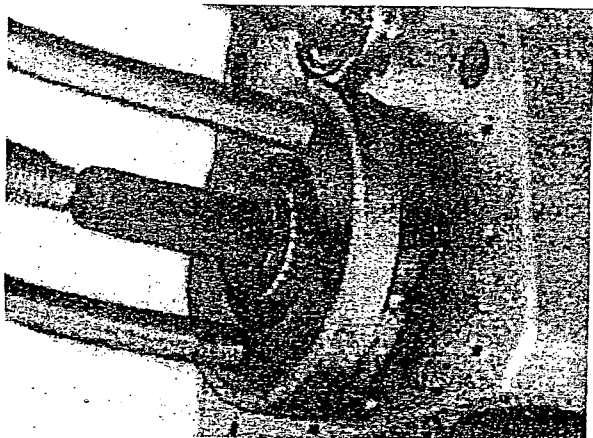


locking rings, which locate the bearing inner race. Hold the circular bead of the bearing outer ring with a special socket, as shown in the Fig., press out the output shaft from the bearing with a pressing machine, and take down the bearing retainer ring.

(10) Fix the hanger on the 1st-2nd gear synchronizing sliding sleeve as shown in the figure. Hang out the output shaft (the second shaft) slantways from the gearbox with slinging equipment. Clamp the output shaft firmly on the working bench upright with the input end up (take care not to damage the output shaft). Pull out the cylindrical roller bearing at the input end of the output shaft from the shaft with an extractor.

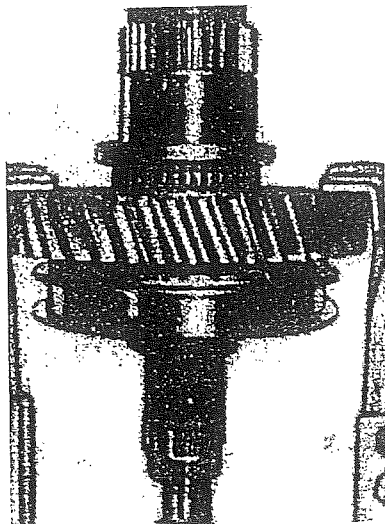
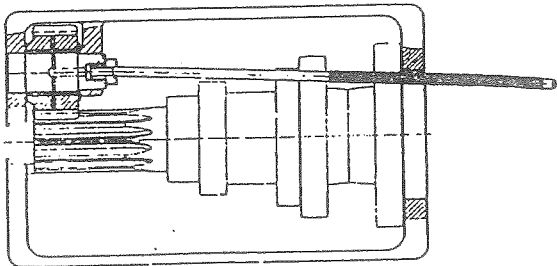


(9) Take out the bearing locating circlip of the output shaft (the second shaft) with circlip pliers and pull out the bearing from the output shaft (the second shaft) with a special extractor.

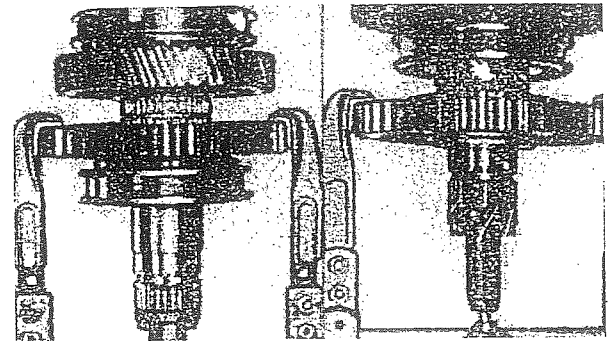


Remove the countershaft
Tap the input end of the countershaft toward its output
end gently with a soft hammer till the bearing outer
ring at the output end comes out from shaft hole in
the housing. Pull out the bearing inner race at the
output end of the auxiliary shaft with an extractor.
Hang the countershaft slantways with its input end
upward out of the housing. Tap the bearing outer ring
at the input end out of the seat hole in the box housing.

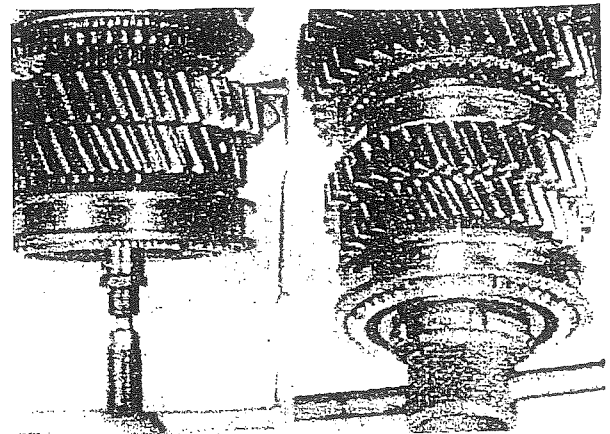
(13) Tap the front end of the jet pipe in the gearbox
housing gently with a soft hammer to separate the
two ends of the jet pipe from the holes in the reverse
gear shaft and in the front wall of the housing. Tap the
reverse shaft out from the input end with a long pole,
as shown in the figure. Take out the reverse gear, two
thrust plates and two needle bearings from the
housing.

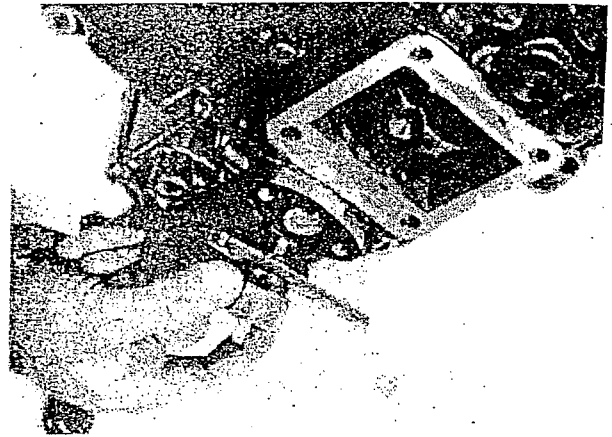


output shaft.
Take down the needle bearing that remains on the
extractor and pull reverse gear out of the output shaft.
end up. Hold the reverse gear with a three-jaw
extractor and pull reverse gear out of the output shaft.
(12) Reverse the output shaft upright with the output
the reverse gear from the output shaft (the second
Use the extractor again to pull out the creep gear and
the synchronizer component of the creep gear and
Reverse the output shaft again with the input end up.
Take out the fixing circlip of the 1st-2nd gear
synchronizer toothed seat with circlip pliers. Pull out
the first gear and the 1st-2nd synchronizer component
from the output shaft (the second shaft) with an
extractor. Take out the needle bearing of the first gear.

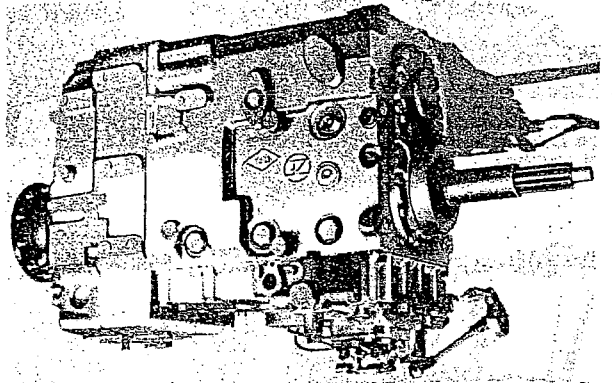


(11) Remove the slotted fixing nut of the 3rd-4th gear
synchronizing toothed seat. Pull out all the
synchronizer components of the second gear, the third
gear and the 3rd-4th gear with an extractor. Take out
the needle bearings in the second gear and the third
gear shaft holes.



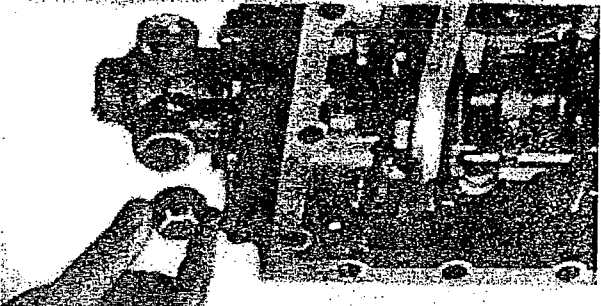
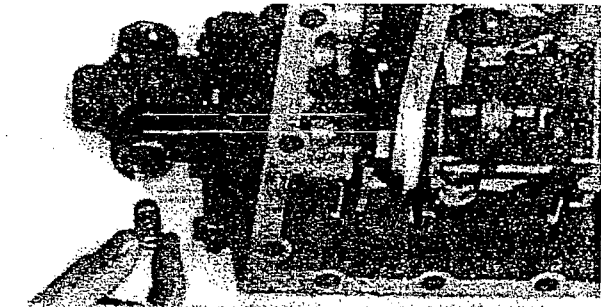
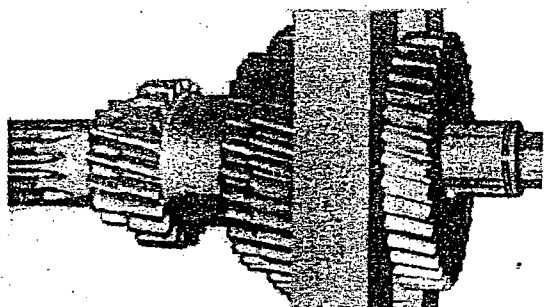
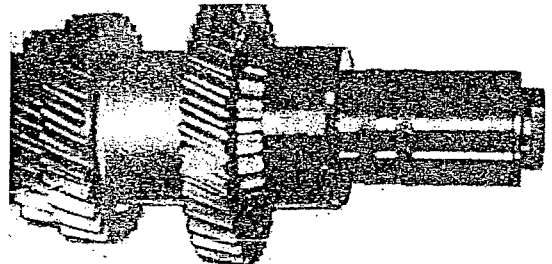


(1) Remove the high and the low gear selecting valve (double H shifting valve) from the gear box cover.

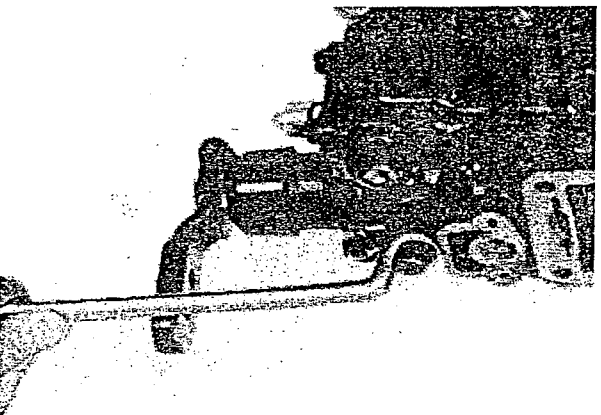


3. Removal of the gear shifting mechanism in the gear box cover
shaft with a pressing machine above 80 tons.

press out all the gears in turn from the intermediate the intermediate shaft with a special extractor. Then (14) Pull out the bearing inner race at the input end of



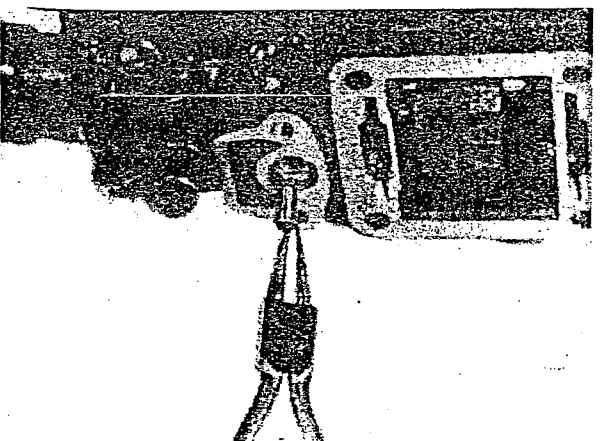
(3) Remove the locating bolt with locking plate.



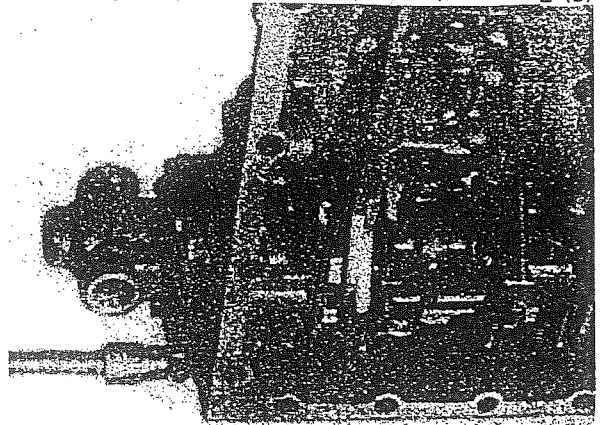
Remove the reverse gear light switch.

neutral gear switch with pliers.

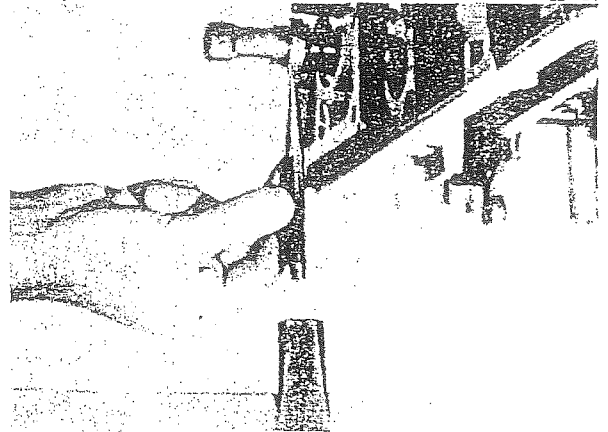
(2) Remove the neutral gear switch and the connecting plate. Put the gear selecting shaft away from the neutral gear position so as to take out the pin of the



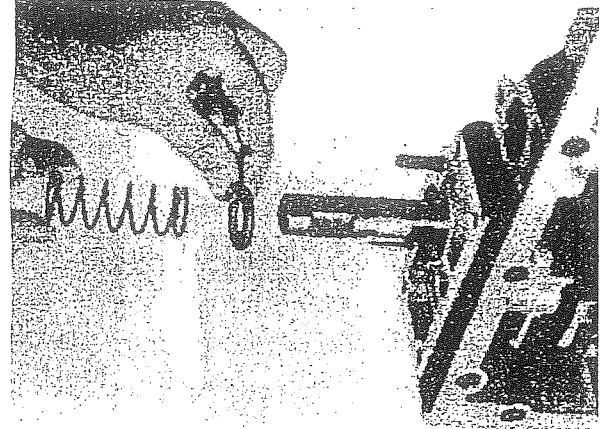
(4) Turn the gearbox cover over and clamp it horizontally on a bench vice. Remove the four screw plugs on the section position lock casing, and take out the four lock sleeves.



(5) Remove the section position lock casing. Take out the gear position lock pin and spring from the opening in the gearbox cover.

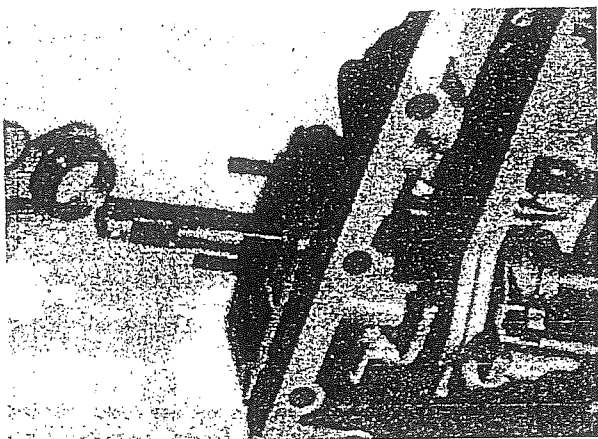


(6) Tap out the baffle elastic pin on the gear selecting shaft with a punch.

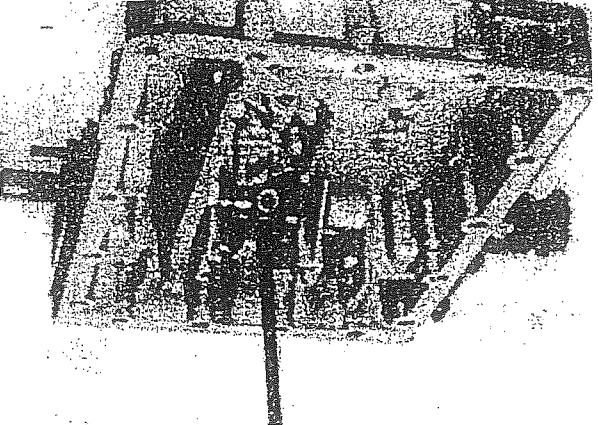


(7) Remove the spring retainer and spring from the gear selecting shaft.

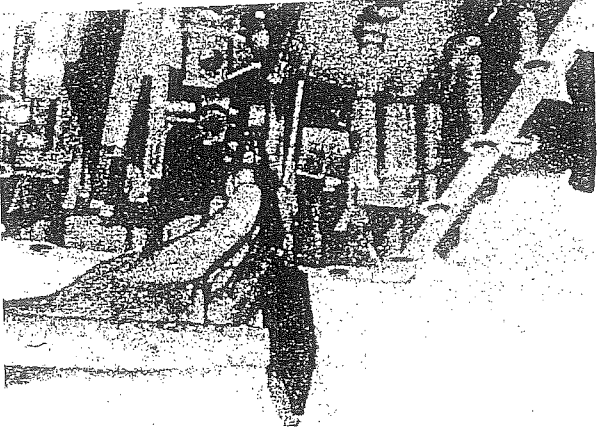
(8) Take out the spacer from the gear selecting shaft.

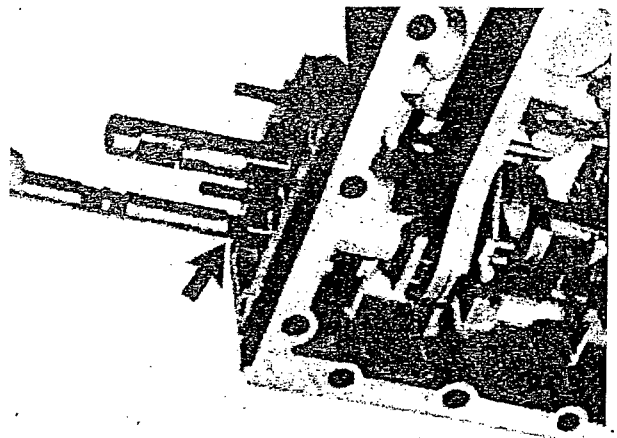


(9) Rotate the gear selecting shaft to a position where the socket spanner can approach the two fixing screws of the double H shifting cam and remove the cylindrical

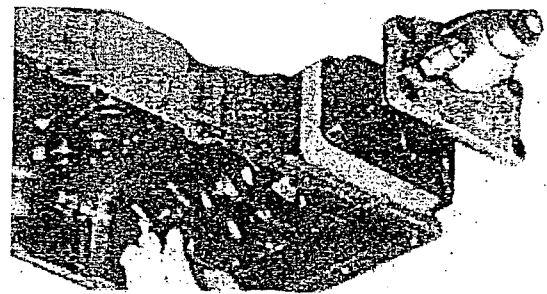
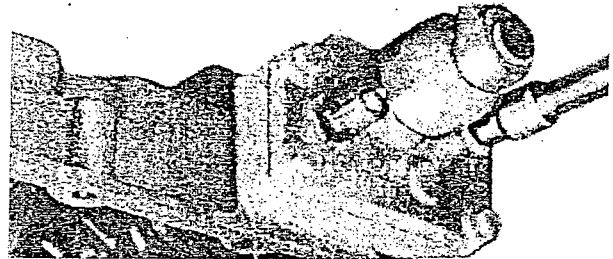


(10) Rotate the gear selecting shaft and tap out the elastic pin from the shifting block of the interlock shaft on the gear selecting shaft with a punch, so as to make the gear selecting shaft be able to rotate freely. Screw off the interlock shaft shifting block from the interlock shaft.

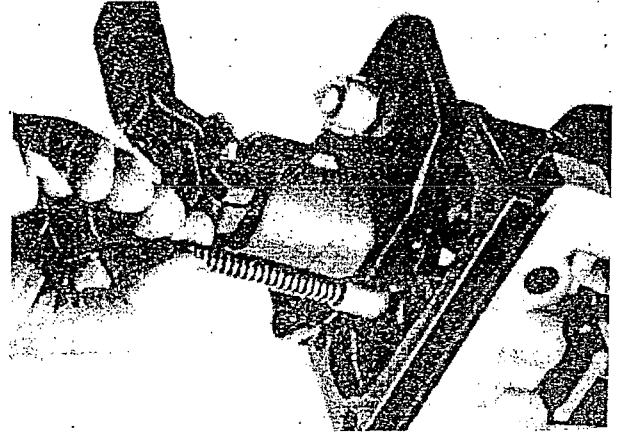




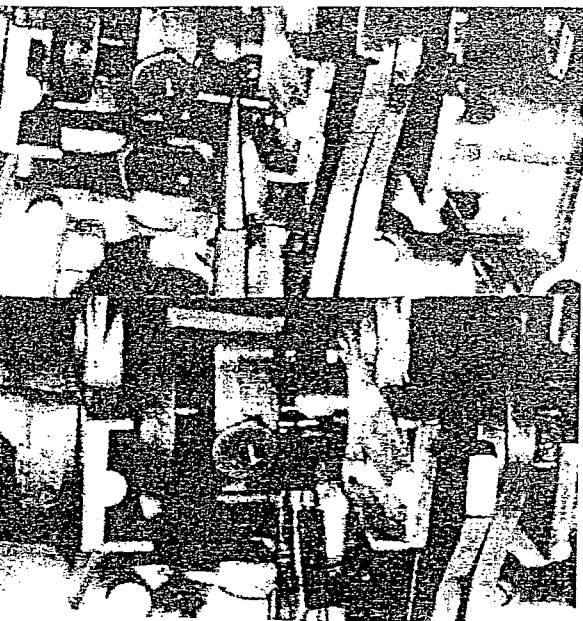
(11) Set the interlock shaft shifting block at the perpendicular position to loosen the interlock shaft. Take out the interlock shaft from the gearbox.



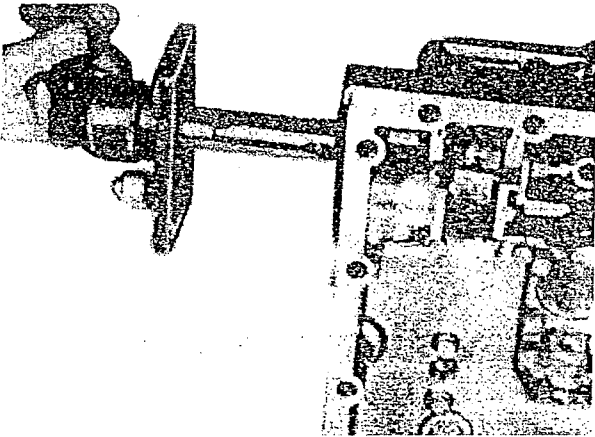
(12) Remove the gear selecting shaft casing.



(13) Rotate the gear selecting shaft casing and take out the reverse gear self-lock pin and spring from the inside of the gearbox cover.



(14) Pull the gear selecting shaft outward till the driving pins can be seen from between the partition on the box cover and the interlock shaft shifting block. (The self-lock block and the interlock shaft shifting block are at the perpendicular positions and the gear selecting shaft is at the neutral gear position). Take down the six driving pins (the figure at the top) and the three needle rollers (the figure at the bottom) from the gear selecting shaft with sharp nose pliers.

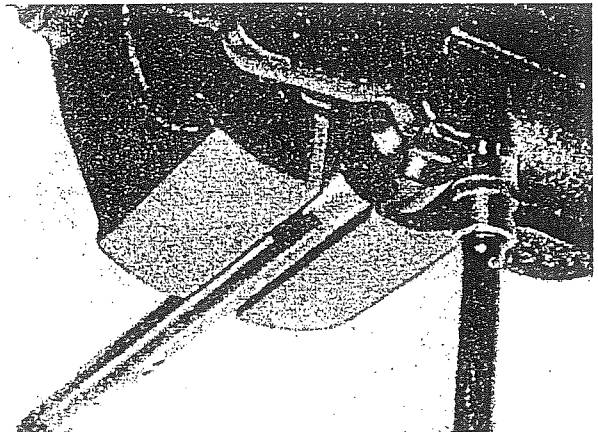
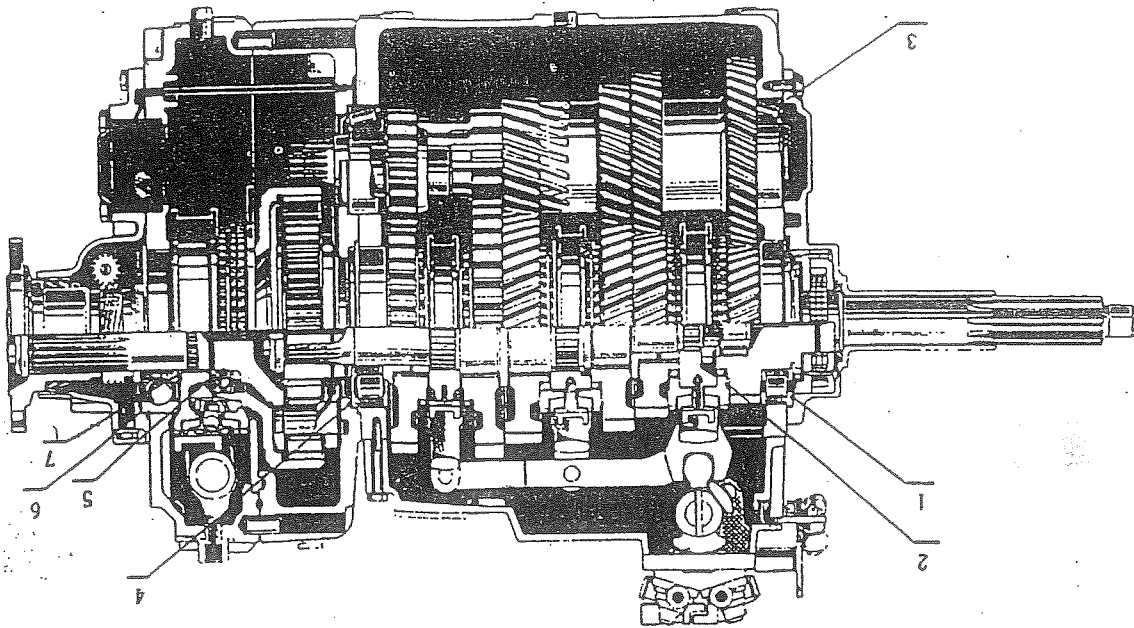


(15) Pull out the gear selecting shaft and gear selecting case together from the gear box. Take out the parts in the gearbox cover that have disconnected with the gear selecting mechanism (4shifting plates, driving block, interlock shaft shifting block, double H shifting cam and gear position locking block).

III. Assembly of the Gearbox

The assembly of the gearbox is divided into two parts, the assembly of the main gearbox and the assembly of the auxiliary gearbox. Basically, it is performed in the reverse procedures of the disassembly. Before assembling, take care to check whether the bearing, washers, the synchronizer components (especially the synchronizing cone and the conical ring), oil seals and adjusting washers meet the assembling criteria. If not, they should be replaced with new parts that meet the assembling criteria. As shown in the figure, the selection of the adjusting washers at all the locations has been explained clearly in the assembling procedures of the locations. It is necessary to perform the adjustment in light of the requirement.

In the figure: 1 — The washer for adjusting the axial clearance of the input shaft
2 — The washer for adjusting the clearance of the 3rd-4th gear synchronizer
3 — The washer for adjusting the axial clearance of the intermediate shaft
4 — The washer for adjusting the axial clearance of the output shaft
5 — The washer for adjusting the clearance of the auxiliary box synchronizer
6 — The adjusting washer of the auxiliary box output shaft
7 — The adjusting washer of the auxiliary box output shaft



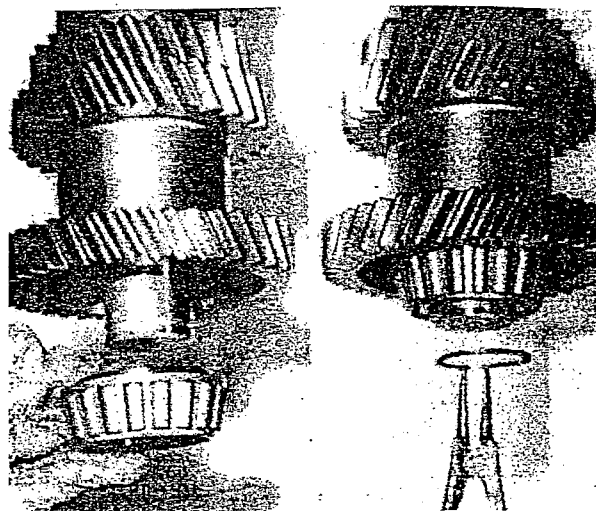
(16) Remove the gear selecting case from the gear selecting shaft. Make mark of the relative position between the swing arm and the gear selecting shaft, and remove the swing arm.

00769144033-1	2.1
00769144033-2	2.2
00769144033-3	2.3
00769144033-4	2.4
00769144033-5	2.5
00769144033-6	2.6
00769144033-7	2.7
00769144033-8	2.8
00769144033-9	2.9
00769144033-10	3.0
00769144033-11	3.1
00769144033-12	3.2

Washer thickness (mm)

Specification of the circlip commonly used

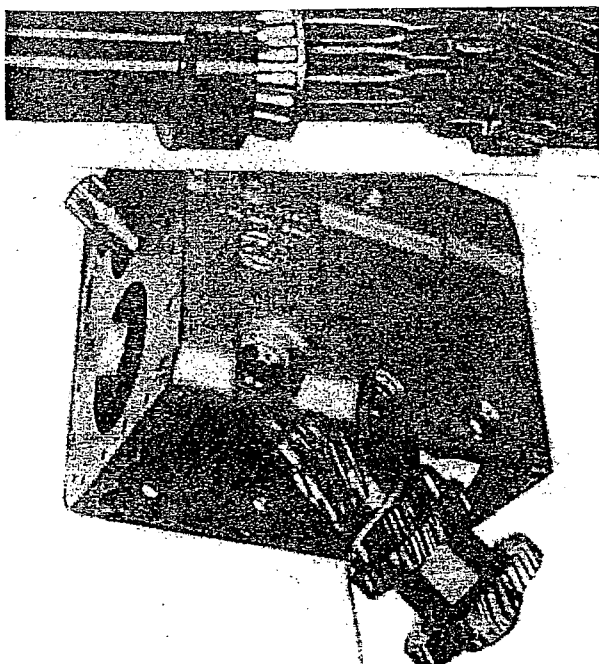
(1) Press all the countershaft gear on the intermediate shaft in sequence; make them lean against each other tightly without any axial clearance.
Clamp the intermediate shaft perpendicularly on the working bench (lead clamping board should be used). Heat the front tapered roller bearing to 80°C, press it on the shaft and make it contact with the gear shaft tightly without clearance. Choose circlip with proper thickness to fix the position of the bearing without clearance. Put the circlip into the circlip groove on the shaft.



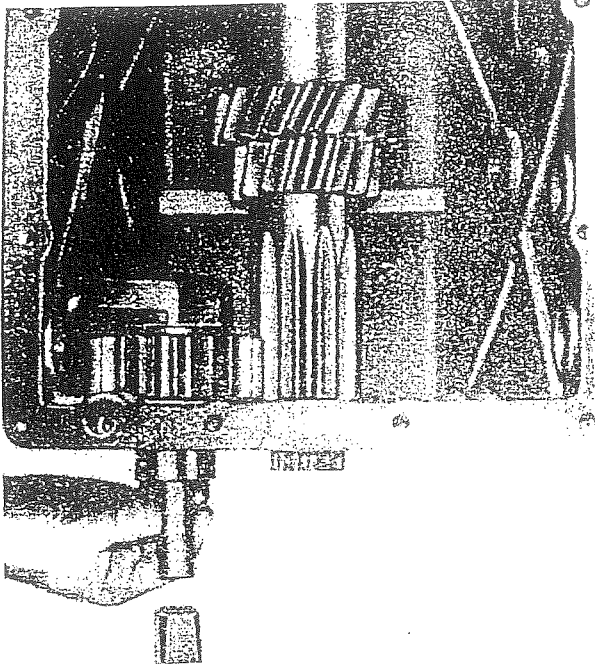
Assemble the countershaft

1. Assembling of the main gearbox

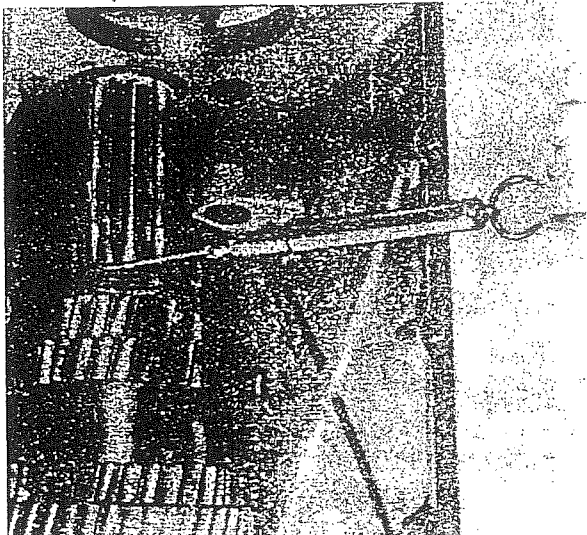
(2) Hang up the countershaft with a sling machine and put it into the box housing
slantways with the output end down (The oil sucking pipe has already been attached in the box housing). Move the countershaft toward the output direction and make the shaft attaching shoulder reach out the box. Heat the tapered roller bearing to about 80°C and press it tightly against the shaft shoulder. Then put the auxiliary shaft in the box housing at a correct setting position and attach the output side bearing outer ring. Attach the oil baffle disc of the bearing at the output end (rear end) of the auxiliary shaft in the relative bearing seat hole in the front housing of the auxiliary box (See to it that the smaller end of the oil baffle disc faces the output side). Preset auxiliary box front housing together with the gasket on the main box and fix them with part of the bolts temporarily.
Set the main box together with the front housing of the auxiliary box erect (the auxiliary box is at the bottom), and make the auxiliary shaft contact tightly against the oil baffle disc of the bearing seat hole in the auxiliary box front housing.



(5) Set the gearbox housing erectly with the input side down. Put a thrust washer on the reverse shaft seat



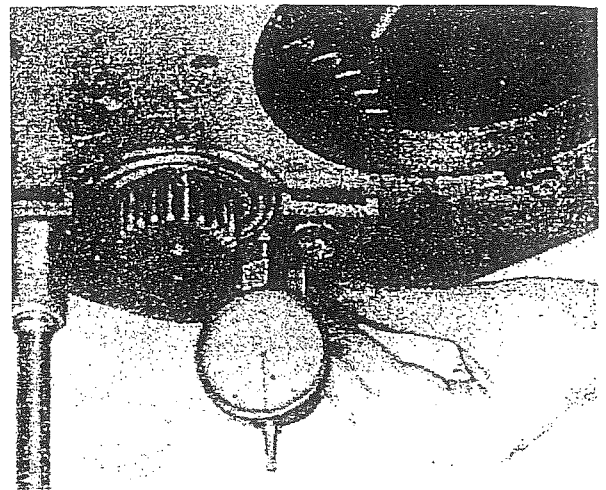
(4) Moment of torsion resistance of the auxiliary box may be determined with the following method: wind a thin rope on the intermediate shaft at the reverse gear portion for several turns. Tie a spring balance at the tail end of the rope; pull it evenly with hand to make the auxiliary shaft rotate. If the spring balance reads between 1.4~2.8kg, it corresponds to the moment of torsion resistance in the range of 5~10kg · cm. Remove the preset auxiliary box front housing, and use keep the selected adjusting washer properly, and use it when assemble the gearbox front housing.



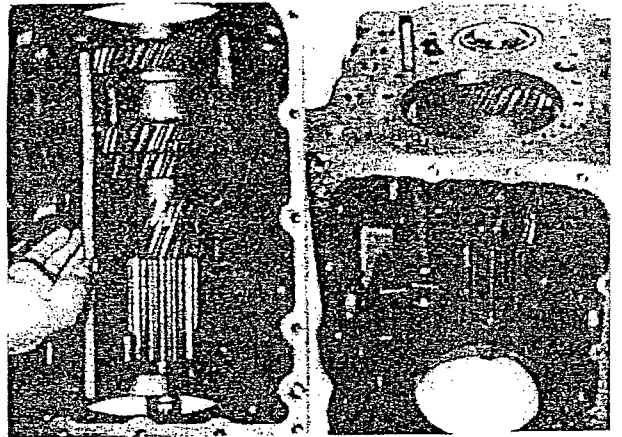
Factory part number	Washer thickness (mm)
1269140004-1	1.85
1269140004-2	1.90
1269140004-3	1.95
1269140004-4	2.00
1269140004-5	2.05
1269140004-6	2.15
1269140004-7	2.20
1269140004-8	2.25
1269140004-9	2.30
1269140004-10	2.35

Specification of the circlip commonly used

(3) Tap the bearing outer ring of the input end into the housing shaft hole. Press the bearing outer ring with two clamping board till the rotating resistance of the intermediate shaft reaches 5~10kg · cm. Measure the distance from the bearing outer ring to the end surface of the housing α . Then measure the thickness of the gasket of the gearbox front end cover b (Measure after the axial clearance of the intermediate shaft bearing to be within the range of 0.12~0.15mm, the thickness of the outer ring adjusting washer at the input end of the intermediate shaft should be : $(\alpha + b) - (0.12 \sim 0.15)$ mm.



and insert the bending tongue of the washer into the groove of the seat. Mount the reverse gear on which two needle bearings are attached carefully on the thrust washer and center it with the reverse gear shaft hole. Set the second selected thrust washer on the reverse gear and insert its bending tongue in the relative groove on the housing. Check the reverse gear for axial clearance with feeler gauge which should be in the range of 0.2-0.6mm. Tap the reverse gear shaft with its small end downward into the shaft hole with a soft hammer, till it is sustained firmly. See to it that the reverse gear shaft should not protrude beyond the junction plane of the housing.



(6) Check the oil hole of the jet pipe for blockage. Fix the oil pipe in the housing from the output side. Insert the front end of the pipe in the corresponding oil hole in the front wall. Rotate the oil pipe to make the jet orifice face the gear direction. Then insert the rear end into the hole in the reverse shaft. Tap the front end of the oil pipe gently with a soft hammer to make it enter the hole and keep level with the house junction plane.

Caution: The jet pipe should not protrude beyond the front end surface of the housing.

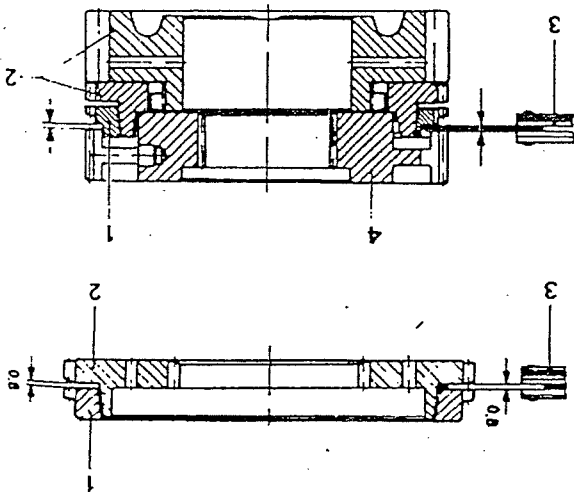
Assemble the output shaft of the main box (the second shaft)

The operation of the synchronizer should be checked first.

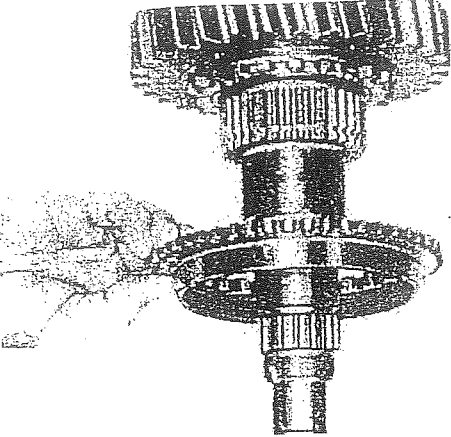
(7) The maximum wear limit of the synchronizing ring is 0.8mm. Set the synchronizing ring on the synchronizing cone with their centers aligned. Rotate the synchronizing ring to make the conical surface contact evenly. Check the clearance between the end surfaces of the synchronizing ring and the synchronizing cone at the corresponding positions on the circumferences with feeler gauge. The clearance should be greater than 0.8mm. If the clearance is less than 0.8mm, it is permitted to grind off the big conical surface by 0.3mm. If it is too much out of tolerance, the synchronizing ring should be replaced (the figure above).

Put the qualified synchronizing ring, conical synchronizing ring and synchronizing toothed seat on the corresponding gear, make the synchronizing toothed seat and the synchronizing cone touch the gear without any clearance. Measure the clearance between the end surfaces of the synchronizing seat and the conical synchronizing ring, which should be 0.6mm.

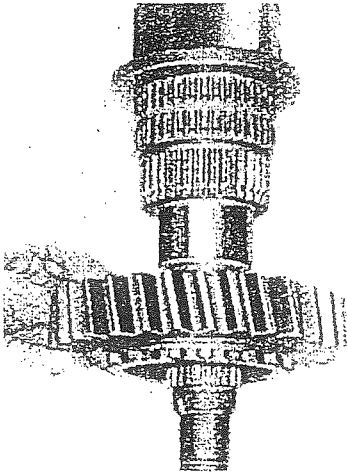
The measurement should be performed at multipoint in the circumference direction. Pairing marks should be engraved on the synchronizing cones and the conical synchronizing rings, which are up to the requirement through the inspection.



(12) Sheath the first gear-synchronizing cone on the engaging teeth of the first gear.

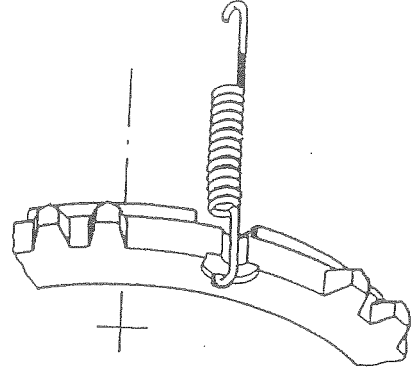


(11) Check the oil duct and oil holes of the output shaft (the second shaft) for passage through. Clamp the output shaft (the second shaft) on the working bench firmly with the input side up (see to it that special fixture should be used and the shaft surface of the second shaft should be kept away from Set the first gear needle bearing on the journal, mount the first gear on the needle bearing (with the engaging teeth up) and make it touch the shaft shoulder tightly. being damaged).



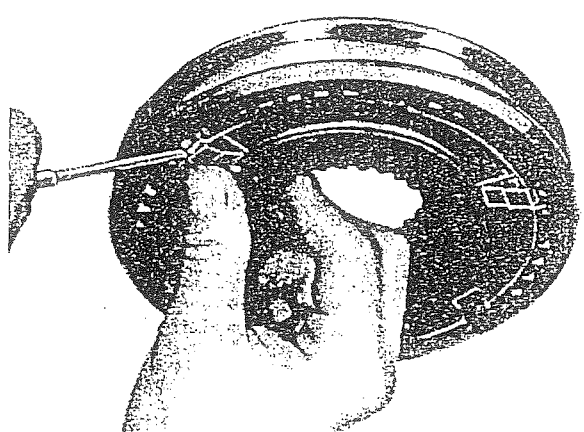
When fixing the synchronizer component on the output shaft (the second shaft), pay attention to pairing fitting requirement between the synchronizing cone and the conical synchronizing ring.

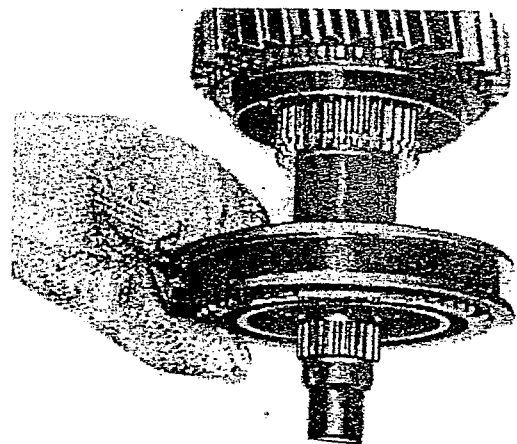
(10) The conical synchronizing rings have tension springs. Pass the three tension springs through the three notches on the synchronizing toothed seat and hook the springs on the flanking conical synchronizing rings.



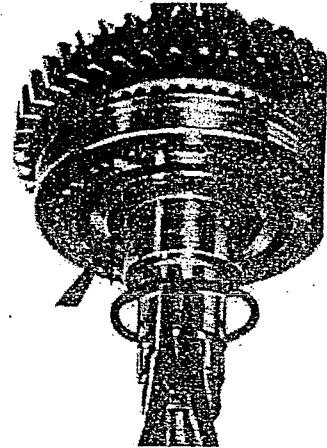
(9) Put the conical synchronizing rings flanking the synchronizing seat in the synchronizing seat (see to it that the six bosses on the conical synchronizing ring should be set correspondingly in the six notches of the synchronizing toothed seat.) Push the three driving blocks into the concaves of the sliding sleeve and press the synchronizer toothed seat into the sliding sleeve with a screw driver. Sheath the sych-engaging sliding sleeve on the synchronizing toothed seat and put the three concaves in the sliding sleeve in line with the three notches on the synchronizer toothed seat. Lift the synchronizing toothed seat a bit, set the driving block with inner and outer compression springs in the notch that corresponds with the concave of the sliding sleeve. Push the three driving blocks into the concaves of the sliding sleeve and press the synchronizer toothed seat into the sliding sleeve with a screw driver.

(8) Mount the sych-engaging sliding sleeve it should be noticed when mounting the sych-engaging sliding sleeve that the engaging sliding sleeves for the 3rd-4th gear and for the reverse gear are asymmetric, so they are direction free in mounting. There is an obvious chamfering bevel surface at one side of the synchronizing sliding sleeve for the 1st-2nd gear. When it is mounted, the chamfered side should face the rabbit of the synchronizing toothed seat.





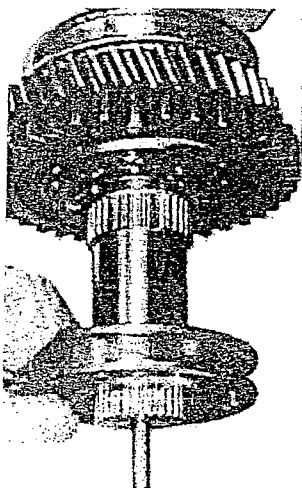
(13) Heat the 1st-2nd gear synchronizing toothed seat component to about 85°C and sheath it on the toothed seat spline of the output shaft (the second shaft) with the rabbet of the synchronizing toothed seat up. Make it contact with the shaft shoulder firmly and make sure that the toothed seat is free from axial clearance. Check again with feeler gauge whether the clearance of the first gear synchronizer is $\geq 0.6\text{mm}$. Check the axial clearance of the first gear with feeler gauge which should be within the range of 0.2~0.45mm, and in no load condition the gear should be able to run freely.



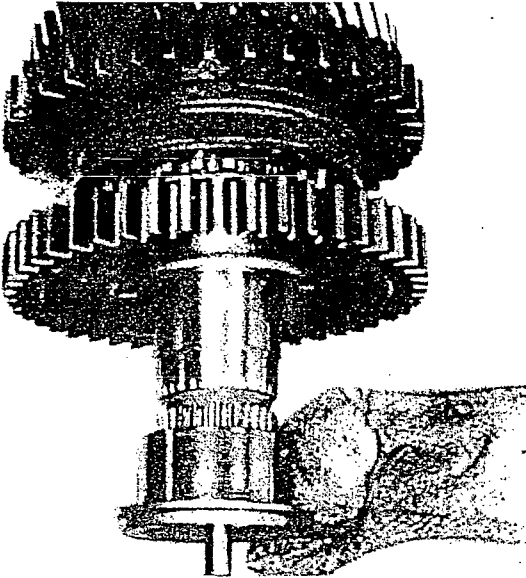
(14) Set the circlip in the corresponding circlip groove on the shaft shoulder of the synchronizing toothed seat. The axial clearance between the circlip and its groove should be 0.02~0.05mm. They are optional.

Factory part number	Washer thickness (mm)
115144034-1	2.3
115144034-2	2.4
115144034-3	2.5

Specification of the circlip commonly used



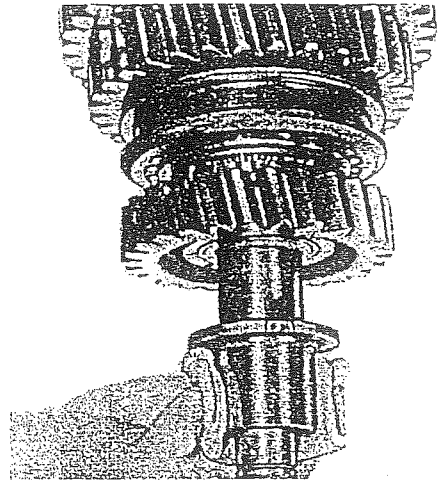
(15) Reverse the output shaft (the second shaft) and clamp it on the working bench with the output side up. Set the needle bearing on the creep gear shaft journal of the output shaft. Then fix the creep gear on the bearing (with the engaging teeth up) till they contact tightly in the axial direction. Heat the synchronizer toothed seat to 80°C, sheath it together with the sliding sleeve component on the spline shaft of the output shaft (the second shaft) and make it lean against the shaft shoulder tightly. Check the creep gear for axial clearance which should be within the range of 0.2~0.45mm.



Heat the third gear bearing lining to about 120°C and smear the third gear journal of the output shaft (the second shaft) with aluminium bisulfide ointment. Mount the lining with its circular bead facing down on the journal and make it contact with the shaft shoulder

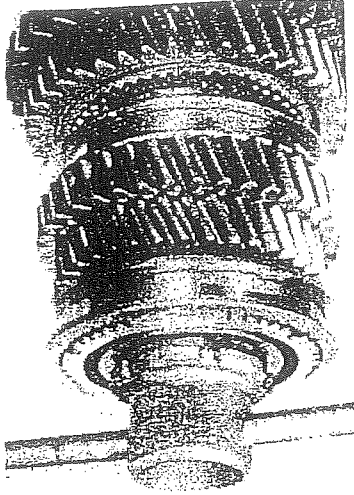
ring. Put the second gear-synchronizing cone, with its conical surface facing downward, under the first gear conical synchronizing ring. Set the needle bear at the position of the second gear journal of the output shaft (the second shaft), put the second gear (its engaging teeth facing down) in the needle bearing and make it engage and integrate with the conical synchronizing ring.

(17) Reverse the output shaft (the second shaft) and clamp the output side on the fixture with the input side up.



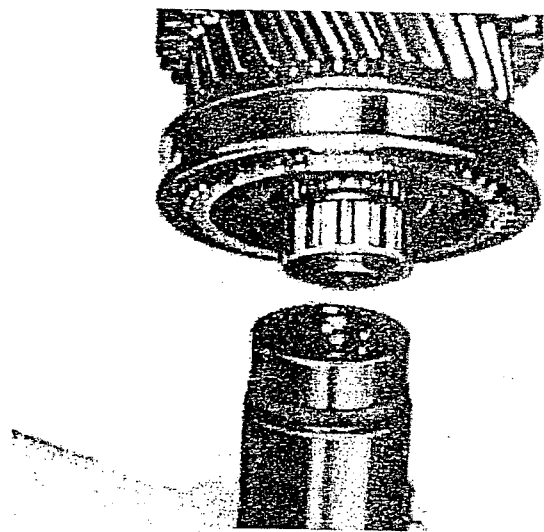
(16) Smear aluminium bisulfide ointment on the shaft journal of the output shaft (the second shaft) where the bearing race is mounted. Heat the reverse gear and needle bearing to about 100°C, sheath them on the bearing (the engaging teeth of the reverse gear face downward). Then put the bearing lining which has been heated to about 120°C in the needle bearings of the output shaft and reverse gear with the circular bead facing upward, and push the bearing lining forcibly till it touches the synchronizer toothed seat. The fitting process should be performed as quick as possible, otherwise the shaft will be heated which will cause fitting difficulty. Press the bearing lining and the shaft fully and ensure that there is no axial clearance. Check that the reverse gear can rotate freely and the axial clearance is within the range of 0.2~0.4 mm.

(18) Put the needle bearing of the third gear on the bearing lining and mount the third gear (with its engaging teeth facing up) till it contacts tightly in the axial direction. Place the third gear-synchronizing cone on the joint teeth. Heat the third gear synchronizing toothed seat to about 85°C. Sheath the synchronizing toothed seat and synchronizer sliding sleeve components on the splined shaft of the output shaft (the second shaft) and make them contact tightly in the axial direction (see to it that the synchronizer should be fitted with its internal conical surface facing up), and ensure that there is no axial clearance. Check the clearance of the third gear synchronizer. It should be 0.6 mm. The third gear should run freely and its axial clearance should be in the range of 0.2~0.4 mm.

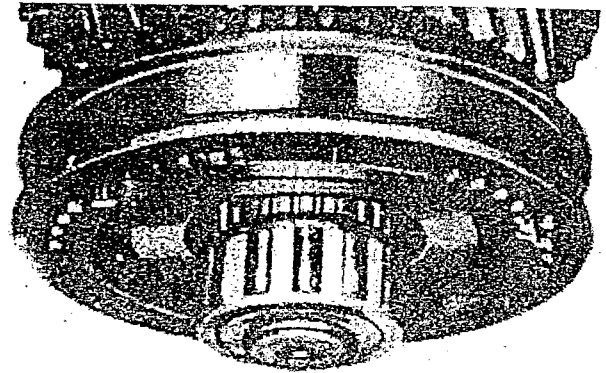
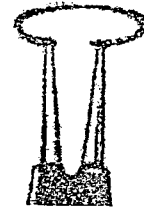


tightly, and ensure that there is no axial clearance. Check that the clearance of the second gear synchronizer is 0.6 mm, the second gear can rotate freely and its axial clearance is within the range of 0.2~0.55 mm.

(19) Screw the locking nut into the output shaft and tighten the nut on the 3rd-4th gear synchronizing toothed sea with the torsion moment of 250Nm. Lock it by caulking with a special tool (the threads should be coated with thread-locking glue).

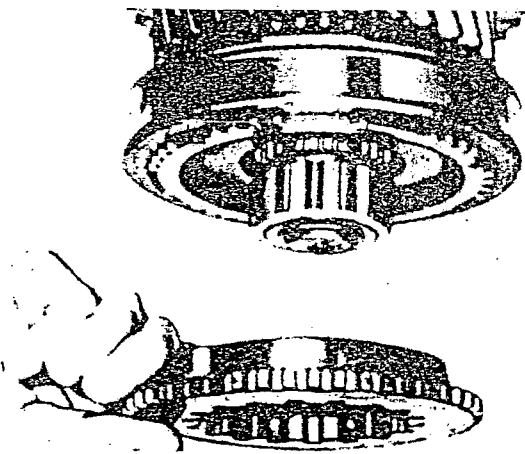


(20) Heat the cylindrical-roller bearing to about 85°C, sheath it on the head of the output shaft (the second shaft) and press it to the shaft shoulder tightly.

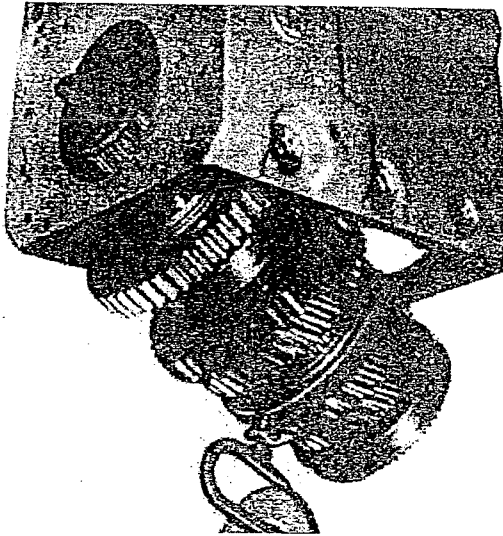


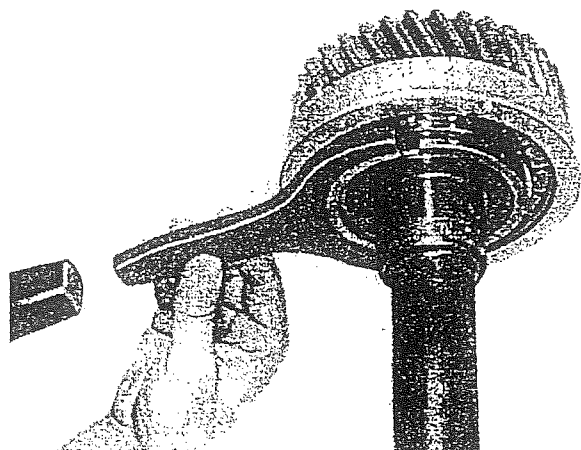
(21) Set the circlip in the circlip groove in front of the cylindrical-roller bearing with the help of circlip pliers.

(22) Set the fourth gear-synchronizing cone on the conical synchronizing ring (Pay attention to check the synchronizing cone for engagement before setting it. It should mesh the engaging tooth of the driving gear on the input shaft easily). Press the oil pipe into the central oil pipe in the output shaft tightly.



(23) Connect the special lifting tool on the 1st-2nd gear synch-engaging sliding sleeve, lift the output shaft (the second shaft) and put it into the gearbox. Make its gears and the gears of the auxiliary shaft at corresponding engaging positions. Hammer the output end bearing of the output shaft (the second shaft) into the bearing hole of the output journal in the gearbox, make the bearing inner race lean against the circular bead of the reverse gear bearing lining, and the bearing outer ring locating circlip lean against the junction plane of the gearbox housing tightly.





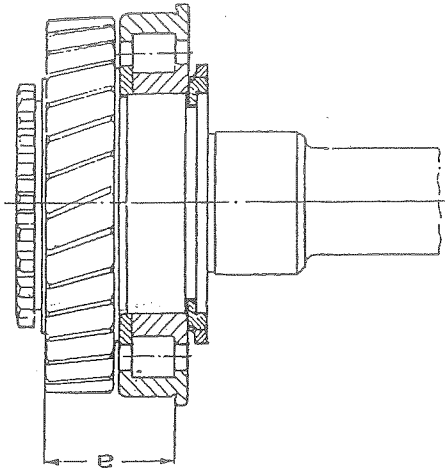
(26) Check the oil hole and oil duct of the input shaft (the first shaft) for passage clearness.

Heat the input shaft bearing to 85 °C, make the end bearing outer ring where there is a boss on it face the input shaft (the first shaft), lean against the driving gear tightly in the axial direction. Ensure that there is no axial clearance with the gear. Press the two tight-fit semicircular locating rings into the ring groove, then put the locking collar around the two semicircular rings, rivet the locking collar tight along the semicircular bevel surface with the caulking tool so as to avoid the movement of the locking collar.

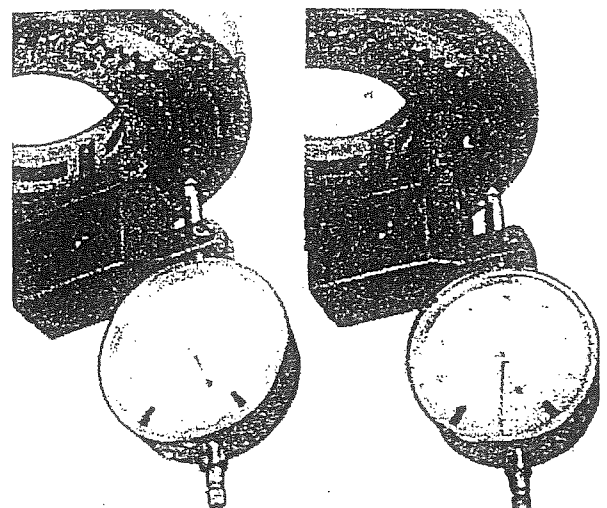
Specification of the circlip commonly used

Factory part number	Washer thickness (mm)
0769145010-1	4.10
0769145010-2	4.00
0769145010-3	3.90
0769145010-4	3.80
0769145010-5	3.70

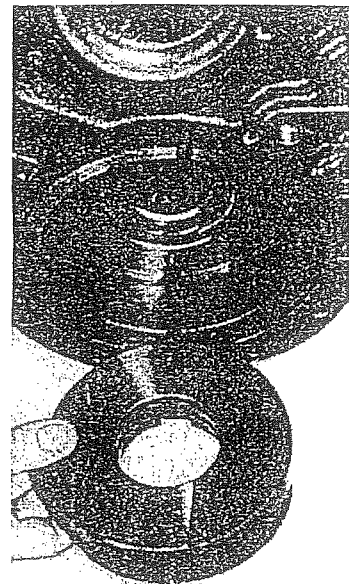
They are optional.



(24) Check whether the axial clearance of the inner and outer rotors of the oil pump within the range of 0.070~0.101 mm with a dial gauge. Replace them if the clearance is too large.



The oil pump is supplied only in unit assembly.



(25) Mount oil seal in the oil seal seat hole in the gearbox front cover with the lip of the oil seal facing the oil pump. Set the oil pump assembly in the front cover, and let the hex screw of the oil pump that protrudes out enter the blind hole on the front cover. Pay attention to its direction when mounting the oil pump and set it level without tilting.

Factory part number	Washer thickness (mm)
0769140115-1	2.4
0769140115-2	2.7
0769140115-3	3.0
0769140115-4	3.3
0769140115-5	3.6
0769140115-6	3.9
0769140115-7	4.2
0769140115-8	4.5
0769140115-9	4.8

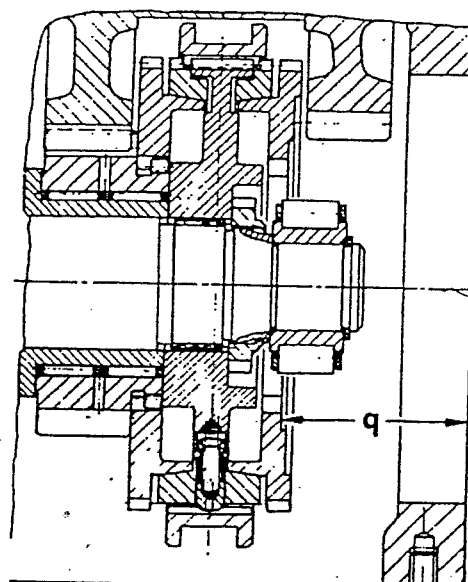
They are optional.

Specification of the circlip commonly used

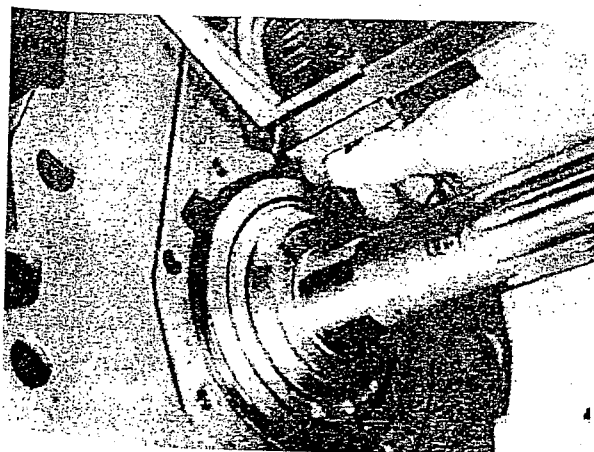
When measuring, it is imperative to make the bearing outer ring at the output end of the output shaft lean against the box housing tightly and make the fourth gear synchronizing cone level and press on the conical synchronizing ring without clearance.

$$s=b-a-0.6(\text{mm})$$

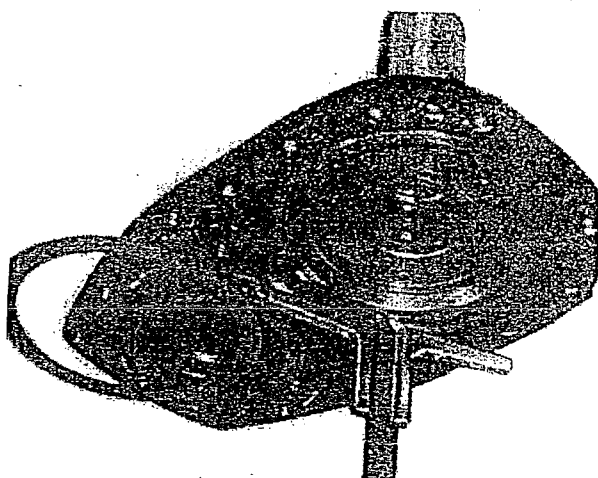
(27) In order to guarantee the axial clearance of the fourth gear synchronizer to be 0.6mm, it is necessary to adjust it with the adjusting washer between the end surface of the input shaft gear and the fourth gear-synchronizing cone. Measure the distance from the end surface of input shaft gear to the surface of bearing circular bead "a", and measure the distance from the front junction plane of the housing to the rabbet of the fourth gear synchronizing cone b. Then the thickness of the adjusting washer is:



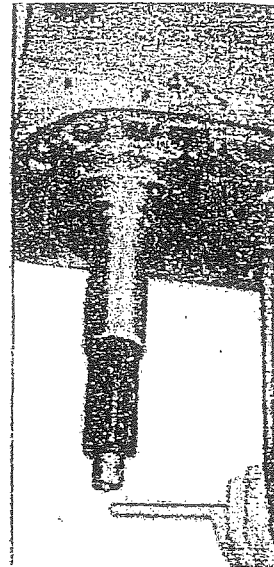
(28) Place the adjusting washer that has been selected on the rabbet plane of the fourth gear synchronizing cone (stick it with grease), put the input shaft (the first shaft) in the gearbox shaft hole, make the bearing circular bead contact with the junction surface of the housing tightly. When fitting, it is imperative to insert the front cylindrical-roller bear of the output shaft (the second shaft) into the shaft hole of the input shaft (the first shaft), meanwhile, insert the central oil pipe of the output shaft into the oil duct of the input shaft (the first shaft). Measure the distance from the circular locating bead of the input shaft bearing to the junction surface of the box housing "b".



(29) Place gasket on the front cover and measure the distance from the gasket to the locating rabbet of the input shaft bearing outer ring "a". To guarantee the axial clearance of the input bearing to be 0~0.05mm, an adjusting washer, the thickness of which is from (a-b) to (a-b-0.05) mm, should be applied between the locating surface of the front cover bearing and the bearing outer ring.



(30) Rotate the oil pump inner rotor to make the groove on the inner rotor in line with the groove on the pump cover. Rotate the input shaft to make the cylindrical roller (the "O" mark on the shaft end) be up, that is, on a perpendicular line which goes through the input shaft and the auxiliary shaft. At this position, sheath the front cover on the input shaft (the first shaft). It should be noticed that the cylindrical roller on the shaft would now insert into the notch on the oil pump rotor. Attach the front cover on the box body and tighten the fixing



They are optional.

Smear the adjusting washer that has been selected with grease and stick it tightly in the locating rabbit of the front input shaft bearing. Meanwhile, stick the locating adjusting washer of the intermediate shaft bearing on the intermediate shaft bearing outer ring with grease.

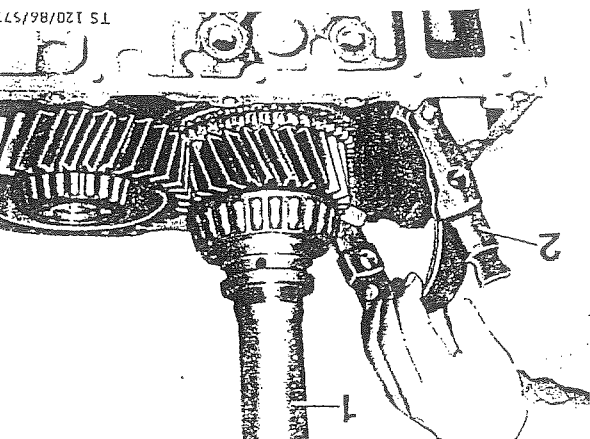
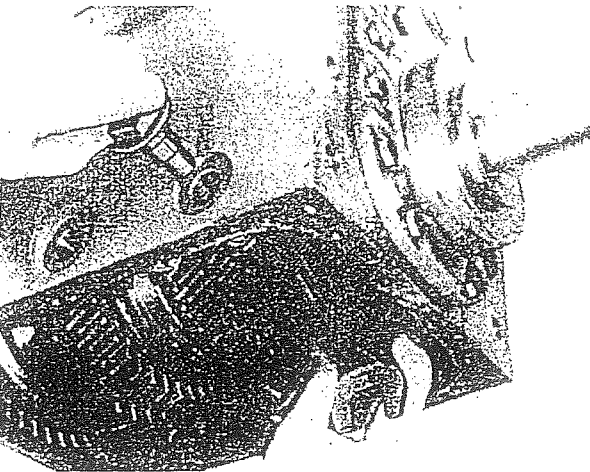
Coast the journal where the input shaft (the first shaft) mates with oil seal with a layer of molybdenum disulfide ointment. Smear the blind hole with grease, in which the cylindrical roller that drives the oil pump to rotate is mounted, and then set the cylindrical roll in the blind hole.

Factory part number	Washer thickness (mm)
0769140013-1	0.5
0769140013-2	0.6
0769140013-3	0.7

Specification of the circlip commonly used

(31) Fix the 3rd-4th gear shifting yoke component on the 3rd-4th gear synchronizer sliding sleeve, the supporting holes flanking the shifting yoke align with the supporting hole in the box housing. Set the supporting bolt, smeared with locking sealing glue, together with the washer in the supporting shaft hole and tighten it with a torsion moment of 200 Nm.

It should be noticed that in fitting, the 3rd-4th gear synchronizer sliding sleeve should be at the neutral gear position. And see to it that the supporting bolt should insert correctly in the needle bearing in the supporting shaft hole of the shifting yoke when the supporting bolt is attached.



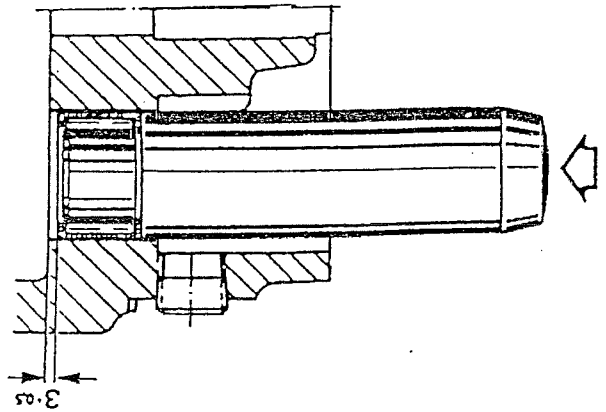
bolts evenly with the torsion moment of 49Nm (the thread should be coated with thread locking glue).

2. Assembling of gear shifting mechanism in gearbox top head

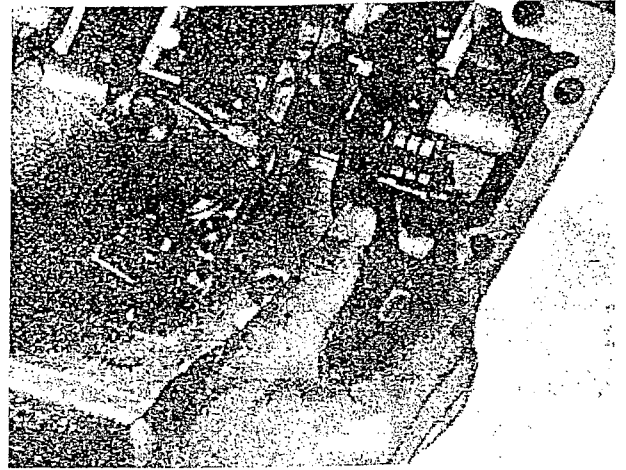
Assembling of gear shifting mechanism in gearbox top head is basically in reverse procedure of disassembling (See the section of removal of the gear shifting mechanism in the gearbox cover for detail). Pay attention to the following points:

When fix the swing arm on the gear selecting shaft, see to it that the assembling should be performed in light of the relative position mark engraved in

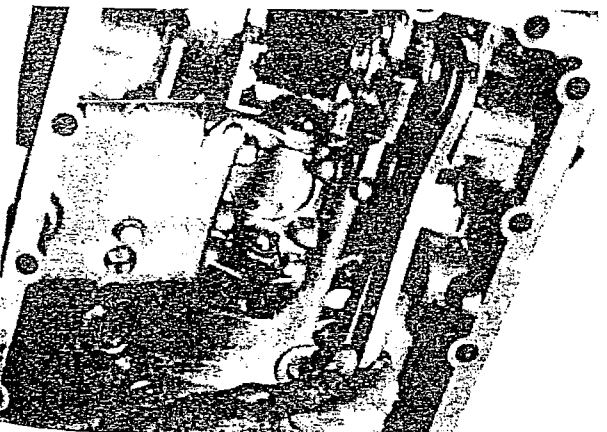
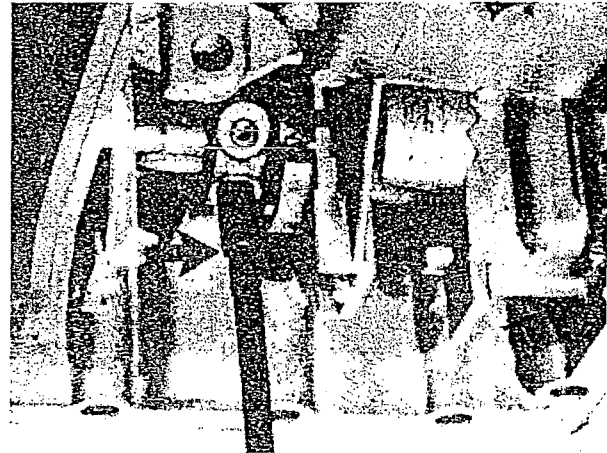
disassembling.

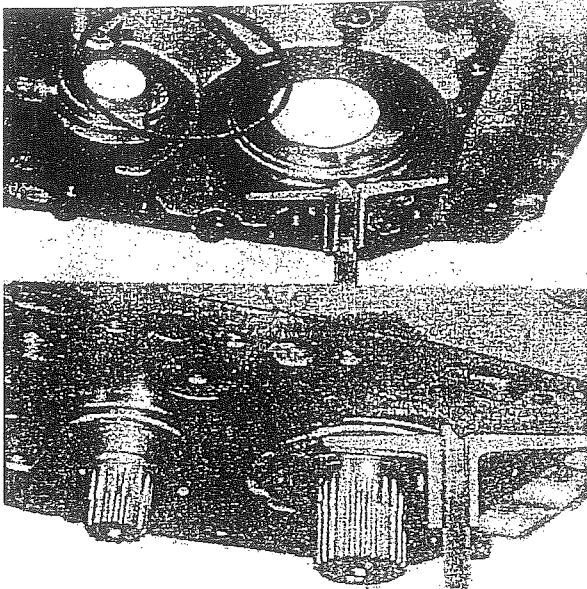


(1) If the supporting needle bearing of the gearbox gear selecting shaft is worn and needs replacement, press the new needle bearing in with special fixture, and there should be a clearance of $3+0.5\text{mm}$ from the end surface to the inner wall of the housing.



(2) When fixing the gear shifting plate, the self-locking block and double H shifting cam, pay attention to their mutual positions. Sheath the gear shifting pulld on their respective gear shifting plates and set the gear shifting plates at perpendicular positions. When fixing the gear selecting shaft, mount the driving pin and the driving pin with needle roller respectively and correctly on the gear selecting shaft. When mounting the driving pin, grease can be used to stick the needle bearing.





(5) Put the box cover gasket smeared with sealant on the junction surface of the box cover.

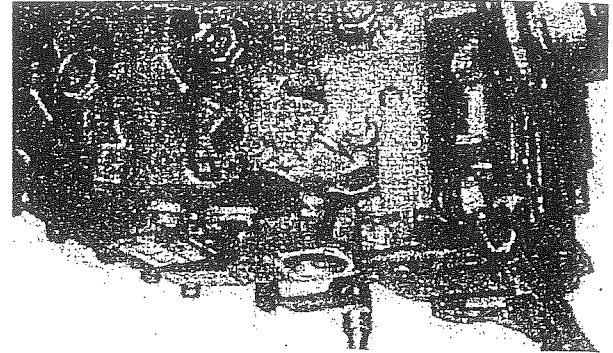
Set the 1st-2nd gear and the reverse gear synchronizer sliding sleeves at neutral gear position, shift the 1st-2nd gear and the reverse gear yokes to engage the shifting rods respectively, hang up the gearbox with a hanger, then put the sliding blocks of the 1st-2nd gear and the reverse gear shifting-yokes in their respective sliding sleeves, lower the box cover slowly, and move the shifting yokes fore and aft to make the supporting holes of the 1st-2nd gear and the reverse gear align with the support on the box housing. Screw in the supporting bolts smeared with thread locking sealant together with their washers respectively, and tighten them up with a torsion moment of 200Nm. (When attaching the supporting bolts, see to it that the stems of the bolts are inserted into the needle bearings in the yoke supporting holes correctly. Thread sealant is only smeared on the thread portion.)

Lower the 3rd-4th gear shifting plate correctly into the yoke head of the 3rd-4th gear, lower down the box cover and tighten up the connecting bolts of the box cover and the box body with a torsion moment of 49Nm.

By now the assembling of the main gearbox is finished.

3. Assembling of planet auxiliary box

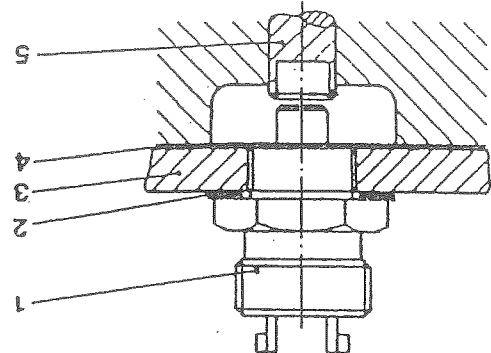
Erect the output shaft of the main box



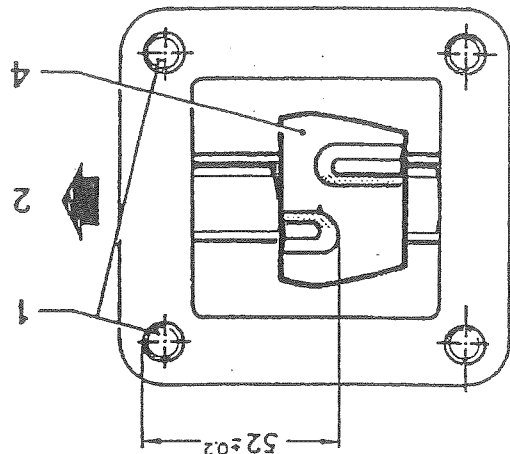
(4) After fixing the neutral gear switch on the gearbox cover, check it with a working lamp.

When the gear selecting shaft is set at the neutral gear position, the neutral gear switch should be on. And when it is set at any other gear positions, the switch should be off. Otherwise it should be adjusted with washers of different thickness.

Cover up the gearbox.



(3) The double H shifting cam should be located at such a position that when the gear selecting shaft is at low 3rd-4th gear neutral gear position, the edge of the long groove on the cam is 52 ± 0.2 mm away from the edge of the screw. This distance can be adjusted with two cylindrical fixing screws.



Put the locating circlip of the output bearing of the main box tightly against the junction surface of the housing. (As shown in the above figure) Measure the height of the bearing outer ring to the junction surface of the housing.

Put the oil baffle disc in the locating seat hole of the auxiliary box front housing. Place the sealing gasket of the junction surface between the main box and the auxiliary box on the junction surface of the auxiliary box front housing. Measure the height b of the gasket to the locating circular bead of the oil baffle disc shaft. (Note: The sealing gasket must be measured under the fully compressed condition).

The clearance from the locating circular bead of the oil baffle disc to the bearing outer ring of the main box output shaft is $(b-a)$.

To guarantee the axial clearance of the bearing to be in the range of $0 \sim 0.03$ mm, the thickness of the adjusting washer from $(b-a)$ to $(b-a+0.050)$ mm should be selected.

Specification of adjusting washer commonly used

Factory part number	Washer thickness (mm)
0769140003-1	0.20
0769140003-2	0.30
0769140003-3	0.50
0769140003-4	1.00
0769140003-5	1.25

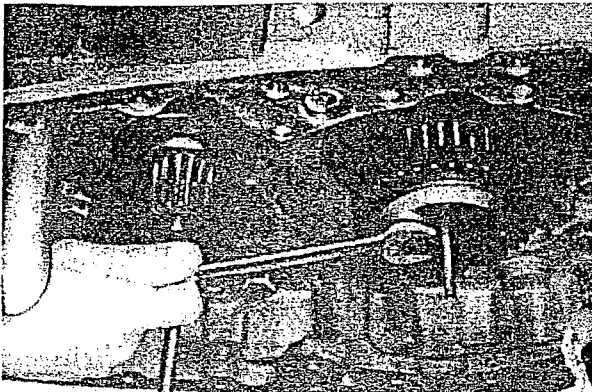
They are optional.

Smear the adjusting washer and the oil baffle disc with grease, and stick the washer and the oil baffle disc in the bearing seat hole in the auxiliary box front housing. Coat the junction surface of the main box and the auxiliary box front housing with plane sealant (if there is gasket, coat the gasket with plane sealant). Put the auxiliary box front housing on the main box, and tighten the M14 and M10 connecting bolts with torsion moment of 135 NM and 49 Nm respectively. (The bolts should be coated with thread locking sealant).

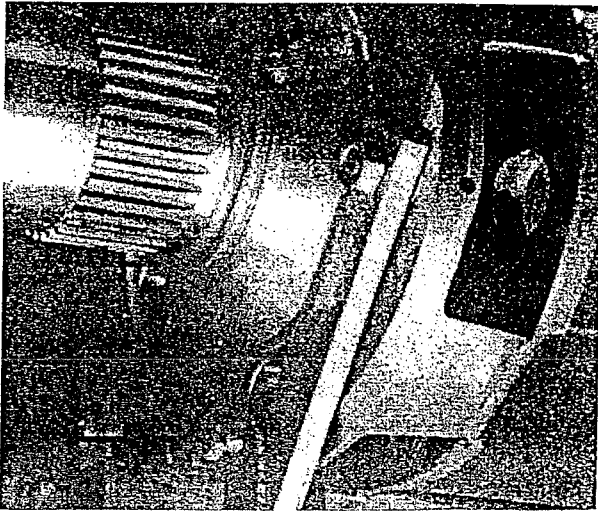
Insert the oil overflow pipe in the corresponding hole in the auxiliary box front housing and secure it with fixing bolts.



Set the sun gear which has been heated to about 100°C on the splined shaft of the main box output shaft with the wheel drum facing down, and make it touch the shaft shoulder tightly.

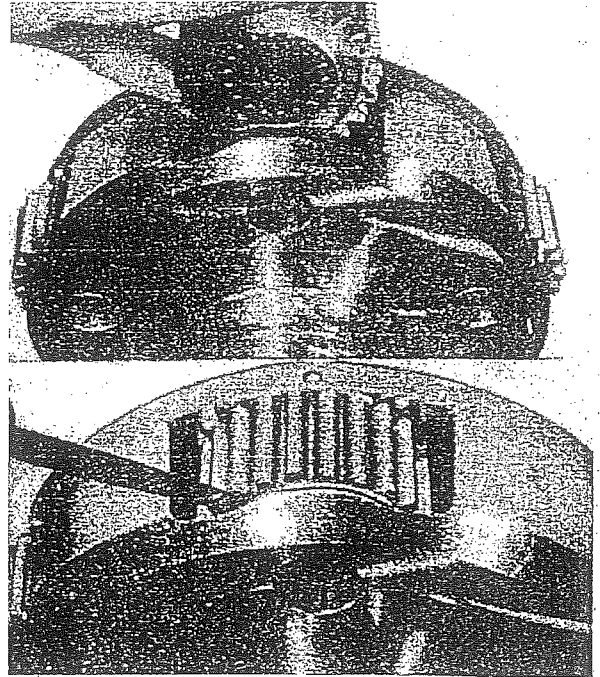


Let the shaft pass by the oil pipe toward the baffle and fix the sun gear on the main box output shaft with two fixing bolts with the torsion moment of 50 Nm. Lock the two fixing bolts with locking wire (The bolts should be coated with thread locking glue).

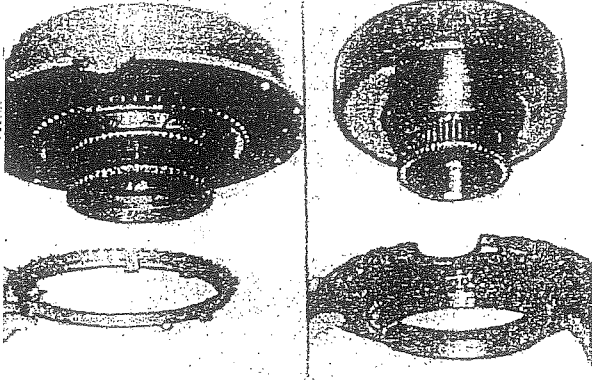


(1) Mount the planet gear pair:
When the planet gears are dismounted, the original locating rivets of the planet gears are damaged and cannot be used again in remounting. Therefore, it is necessary to reset the locating mechanism for the planet shaft. The concrete method is (as in the above figure): Drill a through hole in the wheel drum corresponding to each planet shaft with a special positioner. Remove burrs on both sides, and tap it into a threaded hole.
Grind a notch at the position opposite to the lubricating hole of the planet gear and corresponding to the locating threaded hole of the wheel carrier.
Put the planet gear on a flat board. Set 17 qualified needle rollers first in the shaft hole that has been coated with grease; insert the planet wheel shaft in to press the needle rollers to the race. Then set the last needle roller (the 18th needle roller) in the shaft hole, and pull out the planet wheel shaft carefully.

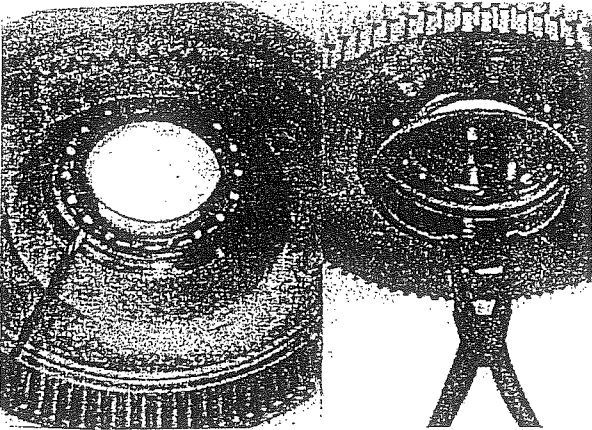
(2) Put a thrust washer and a copper washer on both the end surfaces of the planet gear, the thickness of the copper washer is $1 \pm 0.05\text{mm}$, and the application limit is 0.75mm .
Push the planet gear together with the thrust washer into the seat hole in the planet carrier. Check the axial clearance of the five planet gears with a feeler gauge, which should be in the range of $0.2 \sim 1.3\text{mm}$.



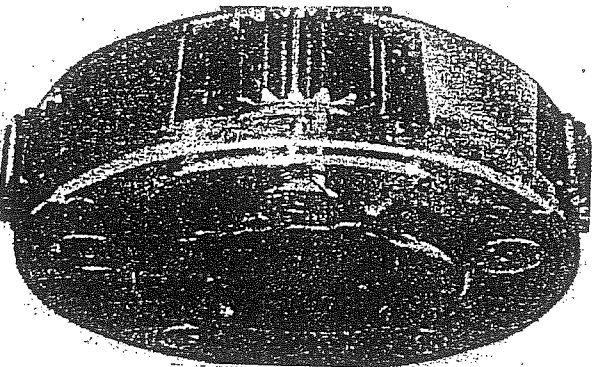
8. Set the supporting plate round the annulus ring;

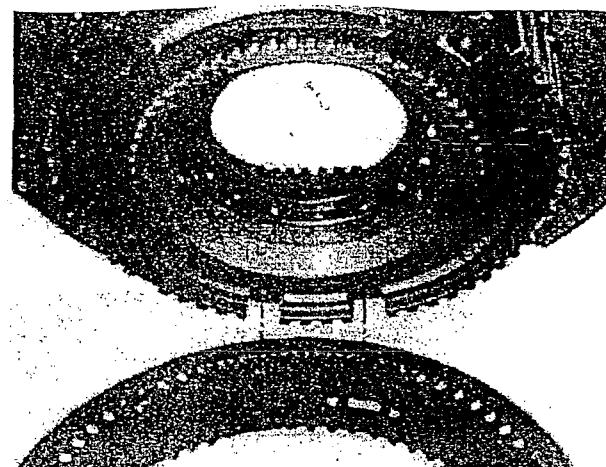


7. Put the bearing in the bearing seat hole of the annulus ring, and lock the bearing axially with a clip.
The radial clearance of a new bearing in the seat hole is $0 \sim 0.07\text{mm}$.



(3) Align the planet gear on which the needle bearing and thrust washer have been installed with the shaft hole of the planet carrier, mount it in the planet carrier with the small end of the planet wheel shaft facing the output end, and make the shaft end level with the end surface of the wheel carrier. Lock up the planet shaft by tightening the locking screw (coat it with thread locking glue).



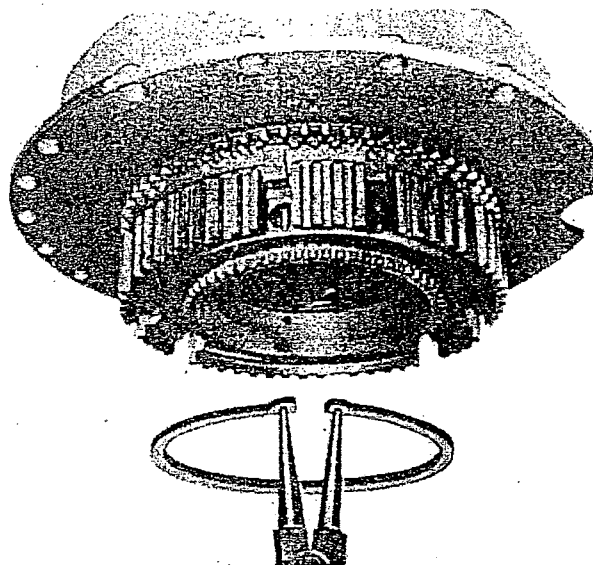


They are optional.

Factory part number	Washer thickness (mm)
0769144037-1	3.7
0769144037-2	3.8
0769144037-3	3.9
0769144037-4	4.0

Specification of the clip

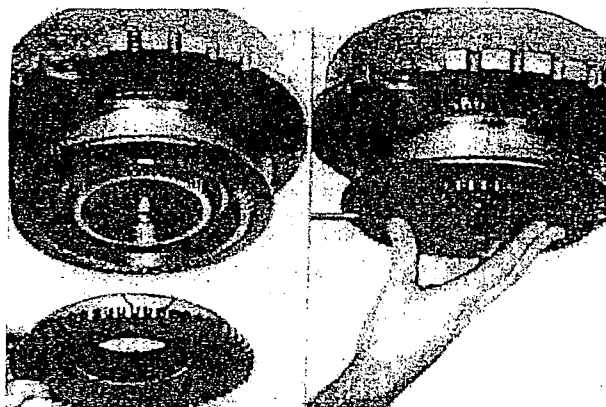
9. Heat the synchronizer engaging toothed seat properly, fix it on the annulus ring with its wheel drum facing downward, make the six notches align with the six bosses on the conical synchronizing ring, and set the locating clip in the circular groove without any axial clearance.



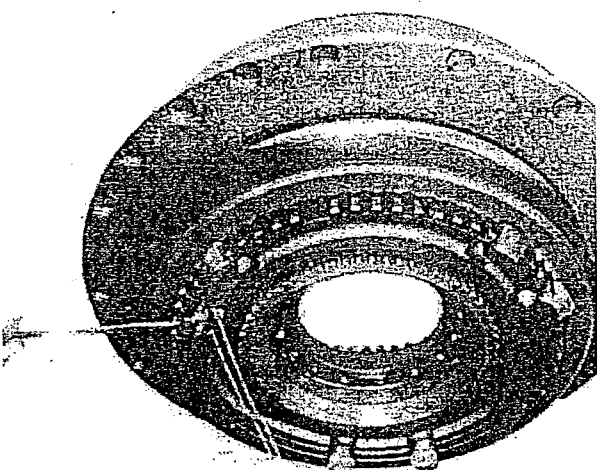
facing down.

connect the synchronizing cone and the supporting plate by the key tooth with the conical surface facing up. Put synchronizing ring on the synchronizing cone with the conical surface of the synchronizing wing

12. Select the adjusting washer (the adjusting washer



11. Put the six small springs in the six big springs, and place them together in the six synchronizing driving blocks. Put the driving blocks loaded with springs in the notch of the synchronizer-engaging block. Press the synchronizer driving block with a pry to make it go into the tongue (or concave) of the synch-engaging sliding sleeve. Set the engaging sliding sleeve at the middle neutral gear position. Set the high gear conical synchronizing ring on the engaging block, and make the six bosses align with the six notches of the engaging block.



engraved facing downward.

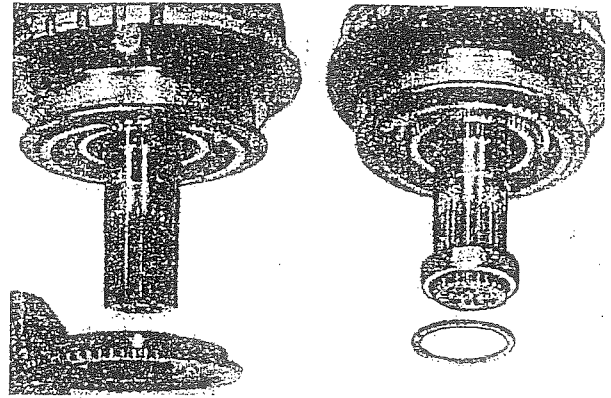
10. Make the grooves on the internal tooth of the synchronizer engaging sliding sleeve align with the six notches on the synchronizer engaging block, put the engaging sliding sleeve in the synchronizer engaging block and make it engage with the conical synchronizing ring under it. It should be noticed that the assembling should be performed with the side on which part number or other letter (for example, "B") is engraved facing downward.

between the bearing inner race of the annulus ring and the high gear synchronizing cone), put it between the bearing inner race of the annulus ring and the high gear synchronizing cone, make it free from axial clearance. Measure the clearance between the high gear synchronizing cone and the end surface of the conical synchronizing ring, which should be 2.4mm. The adjusting washer functions to guarantee the clearance of the high gear synchronizer within the given range.

Specification of adjusting washer commonly used

Factory part number	Washer thickness (mm)
0769140072-1	4.80
0769140072-2	4.70
0769140072-3	4.60
0769140072-4	4.40
0769140072-5	4.20
0769140072-6	4.00
0769140072-7	3.80
0769140072-8	3.60
0769140072-9	3.40
0769140072-10	3.20
0769140072-11	3.00

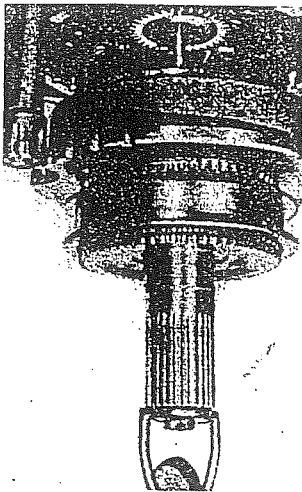
They are for option only.



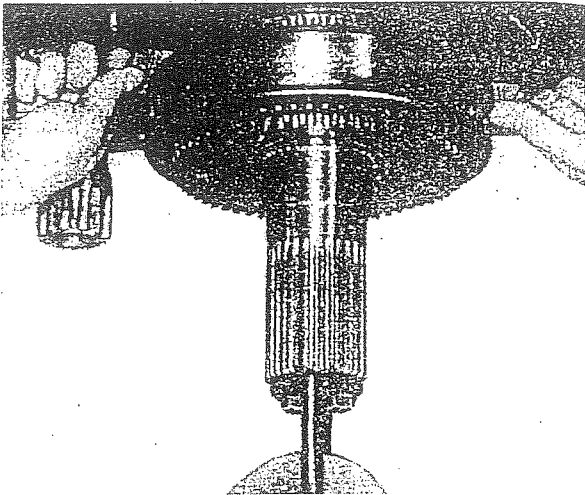
13. Set the spacer between the planet carrier and the annulus ring bearing on the shaft shoulder of the planet carrier (See to it that the chamfered side of the spacer faces the input end of the planet carrier). The sheath engage with the planet gears. Put the adjusting washer on the bearing inner race of the annulus ring. After heating the high gear synchronizing cone to 85 °C sheath it on the splined shaft of the planet carrier and

make it lean against the adjusting washer tightly to guarantee the synchronizing cone free from axial clearance.

Hang the planet gear component over the auxiliary box front housing, lower the planet carrier till the planet gears set in place of engaging with the sun wheel.

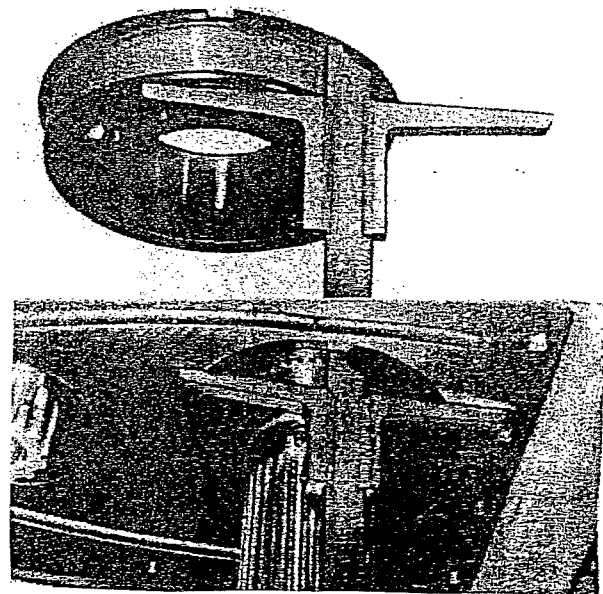


14. Make sure that the semicircular cantilever on the supporting plate points at the main box auxiliary shaft direction. Make the locating pin on the supporting plate go into the pin hole in the auxiliary box front housing. The supporting plate should be free from axial clearance and cling against the auxiliary box front housing tightly without axial clearance.



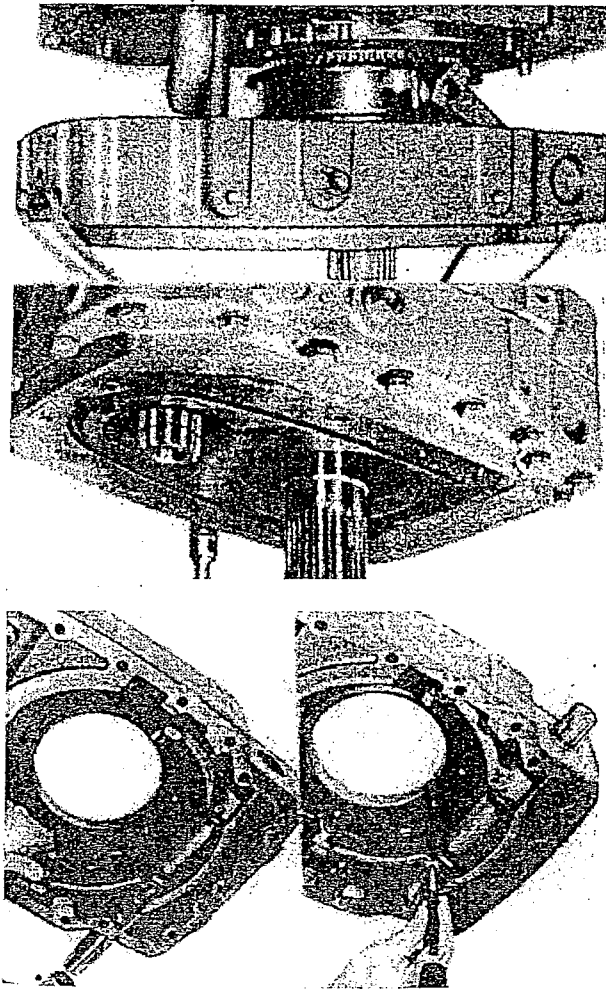
15. Hang up the planet carrier shaft on which the synchronizer assembly is installed to a proper height. Insert two feeler gauges the thickness of which is 2.7mm between the low gear synchronizing cone and the end surface of the conical synchronizing ring, and

lower the planet carrier to make the supporting plate lean against the auxiliary box front housing tightly without any clearance.



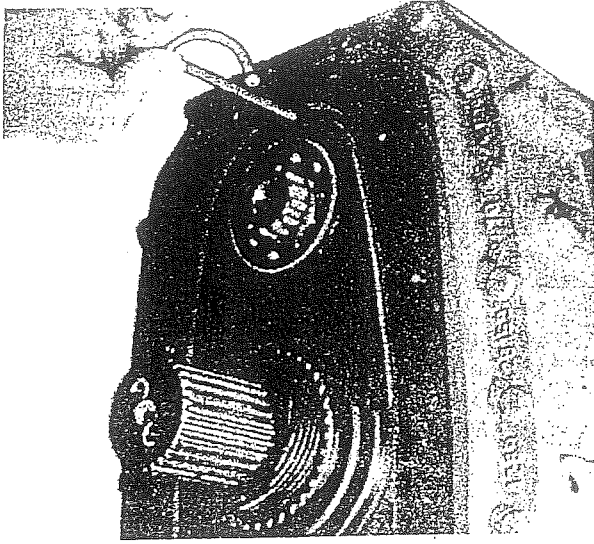
16. Cover the auxiliary rear housing on the front housing (Set gasket on it at the same time if there is). Fix two binding bolts on the symmetric positions of the housing and tighten them up. Measure the distance "b" from the end surface of the auxiliary box rear housing to the concave surface of the high gear synchronizing cone, where the adjusting washer is placed (Make sure that the high and the low gear synchronizing cone must lean against the adjusting washer of the annulus ring bearing and there is no axial clearance). Measure at two correspondent positions and take the mean value. Then measure distance "a" from the bearing end surface of planet carrier output shaft to the locating plane of the circlip. The thickness of the adjusting washer between bearing inner race and the concave surface of the synchronizing cone is now (b-a). This adjusting washer is designed to guarantee the clearance of the low gear synchronizer to be 2.7mm.

They are optional.
Remove the auxiliary box rear housing and take off the 2.7mm feeler gauges.
17. Attach the high and the low gear shifting yoke component of the auxiliary box on the auxiliary box rear housing.

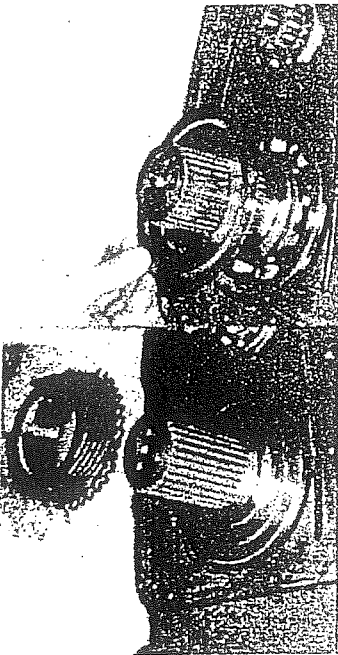


Specification of adjusting washer commonly used

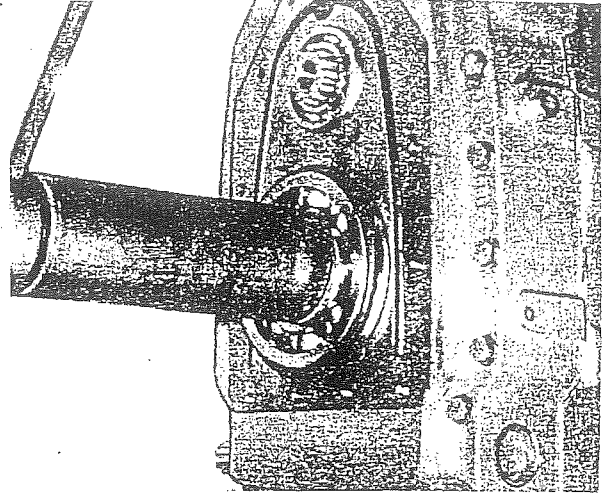
* Factory part number	Washer thickness (mm)
0769140186-1	4.60
0769140186-2	4.40
0769140186-3	4.20
0769140186-4	4.00
0769140186-5	3.80
0769140186-6	3.60
0769140186-7	3.40
0769140186-8	3.20
0769140186-9	3.00
0769140186-10	2.90



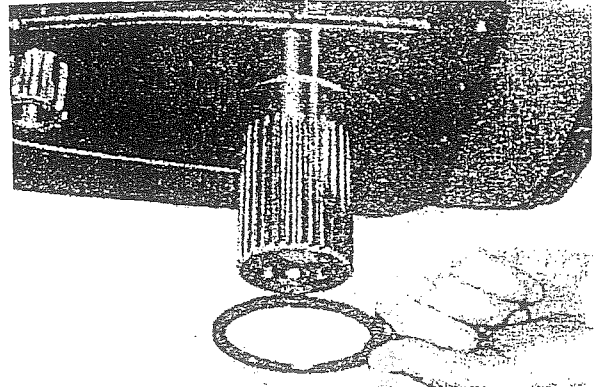
21. Push the spacer into the output shaft of the planet carrier to contact with the bearing inner race tightly. Stick the oil baffle disc on the bearing outer ring with grease (pay attention to the direction of the oil baffle ring. Make the protruding ring face the output end). Heat the worm wheel of the odometer to 85°C and press it on the output shaft to touch the spacer tightly.



20. Press the output shaft bearing with locating circlip into the auxiliary box rear housing till the bearing inner race touches the adjusting washer on the synchronizing cone. The locating circlip now touches the housing plane tightly.

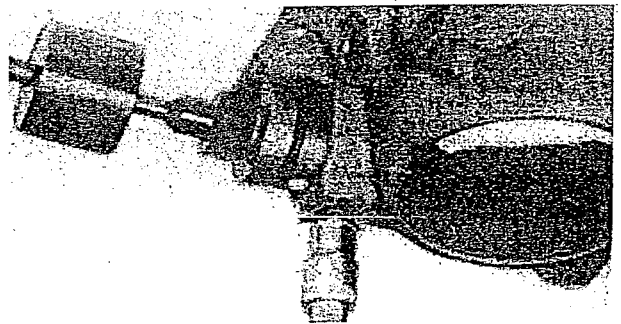


19. Place the adjusting washer that has been measured and selected as suitable on the concave surface of the high gear synchronizing cone (the washer must be higher than the external circumference plane of the synchronizing cone so as to guarantee the synchronizer clearance).

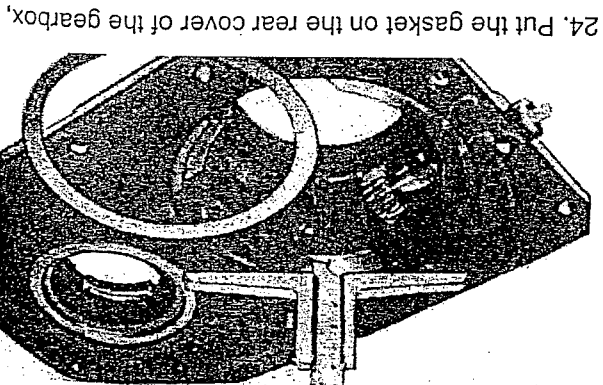
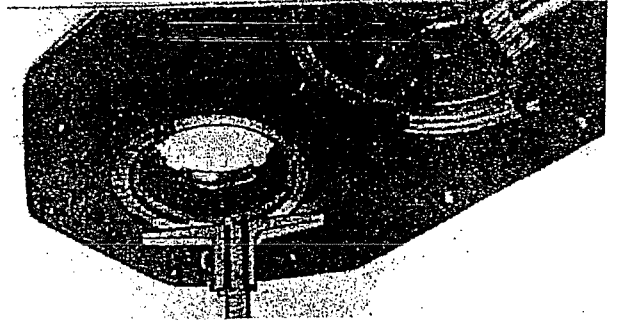
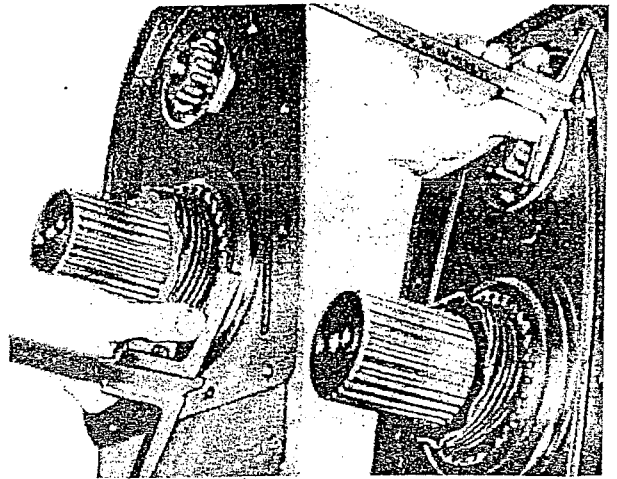


18. Smear plane sealant on the junction surfaces between the auxiliary box front housing and rear housing (or on the junction gasket). Hang the rear housing over the gearbox, and let the rear housing tile a little first. Move the shift yoke shaft to make the sliding block of the shifting yoke enter the circular groove of the engaging sliding sleeve of the synchronizer. Lower the rear housing slowly till the locating pin goes into the pinhole. Tap the pin portion of the rear housing with a soft hammer to make the auxiliary box rear housing clinging against the front housing tightly. Fasten the binding bolts coated with binding sealant with torsion moment of 49Nm, and tighten up the high and low gear locating pin installed on the auxiliary box rear housing with the torsion moment of 60Nm, and lock it with locking plate.

22. Push the oil pipe of the auxiliary box levelly into the oil hole in the rear housing till the front end of the oil pipe is pushed into the oil hole of the front housing. Check the condition of the O-ring.



23. Connect the odometer terminal to the rear cover of the gearbox and secure it with locking screws. Make the circlip of the output shaft bearing against the junction surface of the housing and measure the distance "b" from the oil baffle disc on the bearing outer ring to the junction surface of the housing.

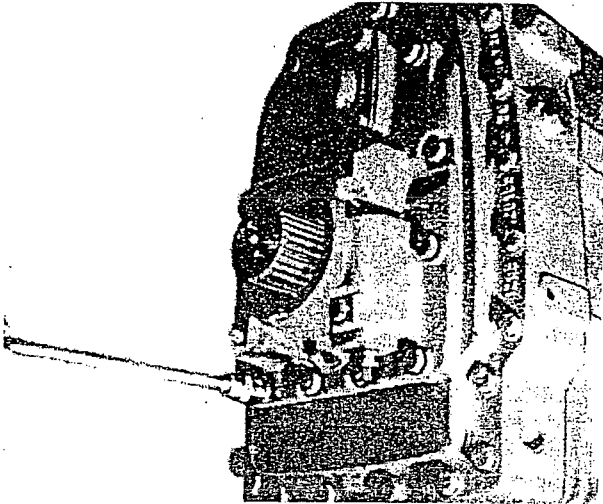


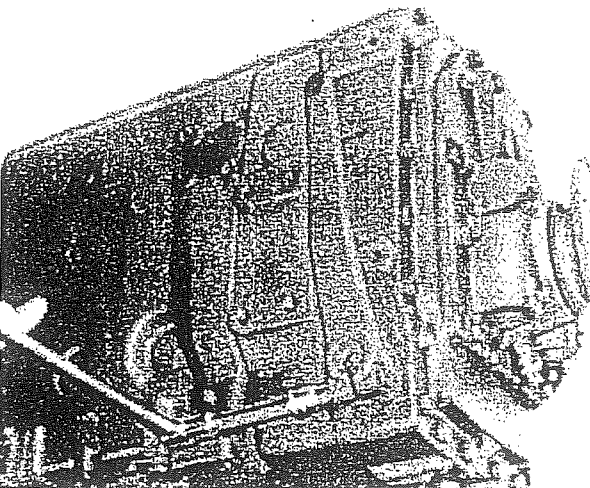
24. Put the gasket on the rear cover of the gearbox, and measure distance "a" from the gasket to the supporting surface of the bearing outer ring of the output shaft. The clearance between the bearing supporting surface and the oil baffle disc is now (a-b).

In order to ensure the axial clearance of the bearing to be 0-0.05mm, the thickness of the adjusting washer to be selected should be between (a-b) and (a-b+0.05) mm.

Factory part number	Washer thickness (mm)
0769140011-1	0.20
0769140011-2	0.30
0769140011-3	0.50
0769140011-4	0.60

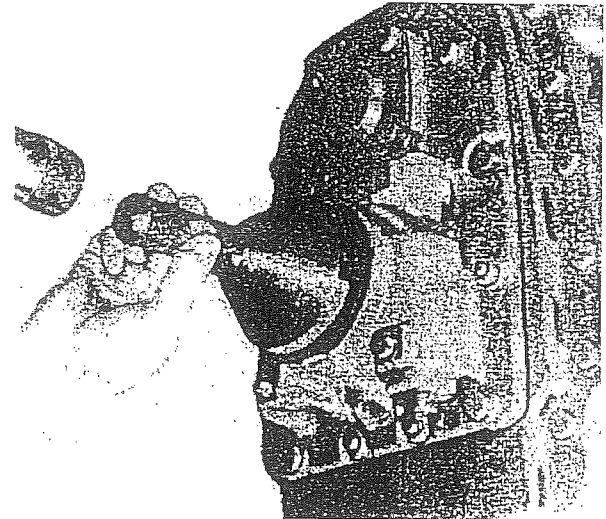
They are optional.





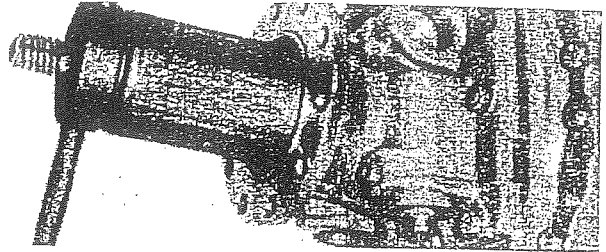
27. Attach the output flange that has been heated to 85°C on the output shaft with the special tool, and push it to the position where it contacts the worm wheel of the odometer tightly. See to it that the oil seal lip should be kept away from being damaged when it is attached. Secure the flange baffle with two fixing bolts (coated with thread locking glue), and lock them up with locking wire or locking plates.

28. Mount the high and the low gear shifting arm on the gear shifting shaft and secure it with locking bolts. Pay attention to the relative position between the gear shifting arm and the gear-shifting shaft. Align the notch on the gear-shifting with the "O" mark on the gear shifting shaft. Attach the shifting cylinder on the gearbox housing and connect it with the gear-shifting arm. Adjust the length of the push rod of the gear-shifting cylinder to make the travel for the high and the low gear position sufficient. Connect the border pipelines between the gearshift valve (section position valve) and the gear-shifting cylinder.



Tighten up the bolts of the power output rear cover with torsion moment of 86Nm.

25. Screw the stud coated with thread locking sealant in the housing with torsion moment of 15 Nm. Coat the junction surface between the housing and the gasket with plane sealant. Connect the gearbox rear cover to the rear housing of the auxiliary box with the shaft and the hole centered. Tighten up the bolts and nuts with torsion moment of 49 Nm.



26. Push the first internal oil seal of the output shaft to sufficient depth with special positioner to make the distance from the internal oil seal to the outer end of the rear cover up to 20+1.0mm, then push the second outer ring oil seal to the position where it contacts the internal oil seal tightly. Locking sealant may be coated on the outer ring of the oil seal. The lip points at the box body. It should be noticed that the inner oil seal differs with the outer oil seal in material. The inner oil seal is of fluororubber and the outer oil seal is of buna N. They are not interchangeable.

The user should strictly follow the operation and maintenance requirement and operate the transmission correctly and reasonably so as to extend the transmission's life. The following points should be followed:

(1) Adjust the transmission correctly, make it disengage thoroughly and engage totally.

(2) Make the engine lie in the economic rpm region (the green portion of the speed indicator). Do your best to use the high gear position, especially the direct gear and the 6th gear, so as to make full use of the engine power.

(3) Shift to high gear position when going down slope to make full use of the engine braking action.

(4) Put road condition in consideration in advance. Don't use braking and acceleration if unnecessary. Make full

VI. Transmission Operation and Maintenance

No.	Item	Torsion moment Nm
1	Tightening moment for main shaft slotted nut	250
2	Tightening moment for supporting bolts flanking the housing	200~220
3	Spherical hinge front locking nut M12 on supporting rod	72
4	Tightening moment for hex nuts M14 × 1.5 on gear selecting rocker arm spherical hinge	65
5	Tightening moment for the locking nut on gear selecting cylinder fork joint	60
6	Magnetic drain plug M24 × 1.5 on the housing	50
7	Oil filling plug and oil level limiting plug on housing	50
8	M24 × 1.5 on gear selecting cover	50
9	Two M10 hex bolts on main shaft	50
10	Tightening moment for M10 castle nut at spherical joint of supporting rod	49
11	M10 hex bolt and nut	49
12	Tightening moment for gas pipe fitting M12 × 1.5 of reversing cylinder	40
13	Tightening moment for hex bolt M8	25
14	Hex fixing bolt M8 of reversing cylinder	18
15	M10 × 1 castle nut at spherical joint of gear selecting rocker arm	15
16	M16 × 1.5 screw plug on gear selecting cover	10~15
17	Tightening moment for ventilation plug	10
18	Tightening moment for M5 hex bolt	6
Auxiliary box part:		
19	M14 hex headed and cylindrical headed bolts for fixing auxiliary box front housing	135
20	M12 hex bolt and hex nut on odometer case	86
21	M10 cylindrical headed bolt on the extended section of intermediate shaft	69
22	Tightening moment for locking plug of gear selecting mechanism	60
23	Tightening moment for the two hex bolts on output flange	60
24	Tightening moment for M24 × 1.5 screw plug on the housing (oil filling plug and oil level controlling plug)	50
25	Tightening moment for M24 × 1.5 magnetic oil drain plug on the housing	50
26	Tightening moment for the speed sensor	50
27	Tightening moment for fixing screw M10 × 1 on odometer case	25
28	Tightening moment for M10 stud at the output end	10~15

V. Tightening Torsion Moment for Main Bolts and Nuts

use of the vehicle inertia to run.

(5) Avoid overspeed and overloading.

(6) Avoid neglect of initial maintenance of the vehicle.

(7) Avoid running immediately after starting without temperature increase on site, before water temperature reaches initial starting temperature and air pressure reaches standard pressure.

(8) Avoid delayed shifting, that is, out-of-time gear shifting, to run at high speed with low gear position or to run at low speed with high gear position.

(9) Put an end to shifting by impacting; avoid gear shifting by sudden pushing and sudden pulling or by flapping.

(10) When shift to the reverse gear or creep gear, stop the vehicle first then shift the gear.

(11) Avoid coasting with neutral gear when running down slope.

Maintenance includes the following contents, routine maintenance and periodic maintenance.

a. Check the transmission for fixation and connection and check the control mechanism for operation:

Oscillation will occur due to road condition when the vehicle runs, which will make the connecting pieces of the housings of the transmission and the clutch, and carriage, engine, supports, driving shafts and output flanges become loose, therefore the fixing condition should be checked when the vehicle runs every 1200—1400km.

Series of troubles will gradually occur due to the deformation of the gears, shafts, bearings, and the button head of gear shifting mechanism and rocker arm during the operation of the transmission. It is imperative to check the control mechanism for operation in each time of maintenance. Because the control mechanism is exposed in the exterior, the lubrication is poor, and in addition, oil sludge and moisture will induce rust, which will make the spherical joint of the shifting arm breakdown, causing insufficient shifting of the gear or difficulty in gear shifting.

b. The sealing condition of the transmission:

Check the condition of the oil seals at the shaft ends of the first shaft and the output shaft, and the exterior of the housing and the cover. The oil seal lip will gradually become aged with the use, elasticity of the oil seal will reduce and the sealing action of the oil seal will weaken, thus oil leakage will occur, there will be lack of lubricant due to oil leakage, causing poor lubrication and accelerating the wear of the parts. It is recommended that oil should be renewed every 2000km of running.

c. Condition of ventilation plug:

Ventilation plug blockage often occurs due to its location and the existence of oil sludge. Owing to the poor ventilation of the plug, air pressure is developed in the operation of the transmission, causing oil leakage. It is recommended to check and dredge ventilation hole of the plug every 1000km of running.

d. Compressed air system:

Certain amount of condensed water will be formed in the compressed air system in different area and different weather. Therefore, the air tank should be drained every week, and in winter, it should be drained even every day. Otherwise, rust, water and other impurities will enter the valve and gear-shifting cylinder from the air tank, causing trouble and damage to the gear section changeover mechanism. Therefore, it is very important to clean the compressed air.

c. Lubrication

Refer to the part of FAST transmission.

VII. Trouble Judgement and Remedy

Cause	Remedy
1. Mechanical control device failure in the auxiliary transmission	Repair the control device of the auxiliary transmission.
2. Gas passage of the high and the low gear shifting valve is blocked or dirty.	Clean the gas passage.
3. Gas passage of operating cylinder is blocked or dirty, the piston is jammed	Check gas passage of operating cylinder, and the piston.
4. Driving rod of operating cylinder is loose or the jaw is loose.	Check the piston rod and the jaw. Adjust travel of piston rod.
5. The high and the low gear shifting valve leaks.	Check the sealing ring, piston and valve of the high and the low gear shifting valve. Replace it when necessary.
6. The operating cylinder leaks.	Check the rubber valve of operating cylinder, valve intake joint and piston sealing ring. Replace when necessary.
7. Synchronizer of auxiliary transmission damaged.	Repair or replace the synchronizer.

(2) Gear cannot be shifted when the vehicle is running. When the vehicle stops, only certain gear can be shifted in "high speed region" or "low speed region", and there is "quack" noise in shifting the gear.

Cause	Remedy
1. Ball bracket of gearlever and driving pin worn and loose.	Check mating condition. Replace spherical lining and pin in case of necessity.
2. Excessive wear of the driving rod joint and driving rod slot.	Check wearing condition. Replace if necessary.
3. Locating rod bolt getting loose or maladjusted.	Readjust and tighten up the bolt.
4. Shifting shaft rocker arm loose.	Fit rocker arm properly and tighten up bolts.
5. Driving pin on gear shifting shaft excessively worn or dropout.	Dismantle the transmission and check the driving pin. Replace it if necessary.
6. Excessive fit clearance between driving arm and connecting bar and between joint sleeve and sliding block of connecting bar and shifting yoke.	Dismantle transmission cover and check mating condition respectively.
7. Synchronizer bialk ring damaged.	Check transmission damage condition and transmission play. Replace the bialk ring if necessary.
8. Joint sleeve and conical disc damaged.	Replace joint sleeve and conical disc.
9. High and low gear shifting valve control cam worn excessively, or fixing bolt loose.	Check control cam. Replace it in case of excessive wear. If the fixing bolt is loose, adjust it in light of the method for adjusting the control cam of the high and the low gear shifting valve, then fix it.
10. Insufficient gas pressures or no pressure in the high and the low gear shifting valve.	Measure gas pressure of intake pipe of the high and the low gear shifting valve. It should be 0.7Mpa (about 7kg/cm ²).
11. Gas leakage or dirt on piston, sealing ring or membrane in the high and the low gear shifting valve.	Clean the high and the low gear shifting valve, or replace the assembly and damaged components.
12. Rubber valve of operating cylinder is dirty or damaged.	Clean or replace the rubber valve.
13. Poor airtightness of operating cylinder.	Replace piston sealing ring or piston.
14. Fork joint of operating cylinder piston rod is loose.	Adjust the travel of piston rod and fix the fork joint.

(1) Difficult to shift the gear

(3) Shifted gear is opposite to the pre-selected one:

Cause	Air pipes from the high and the low shift valve to the operating cylinder are connected reversely.
Remedy	Connect them in correct order.

(4) Unable to shift the gear:

Cause	1. Shifting shaft rocker arm is loose. 2. Spherical joint of locating rod is worn and loose. 3. Locating rod is maladjusted.
Remedy	Adjust the locating rod. The length of the locating rod is considered OK if the gearlever can smoothly shift to the reverse gear when the vehicle contorts to the right, and on the smooth road when shifting to the 7 th and 8 th gear, the gearlever does not scrape the seat cushion.

For other troubles, refer to FAST transmission.

During normal running on the road, no compressed air gets into the front drive gear cylinder, under the action of spring force, the gear piston returns to the position as shown in Fig.5-1, the shifting fork drives the engagement sleeve 14 to return to the position as shown in Fig. At this time, the power, through transfer box, is directly delivered to the rear drive axle by rear drive output shaft 13, drive flange 11 and propeller shaft, while the front drive axle is in disconnected state without load. When the vehicle is running on the slosh road

drive shaft 13, and another end is supported on the end cover by using bearing. left gear is also meshed to gear 13 of rear drive shaft. One end of front drive shaft 15 is inserted inside rear gear wheel shaft, its left and right gears are engaged respectively with gears 4 and 8, at the same time, the shaft can be engaged respectively with the driving gears 4 and 8. The intermediate shaft 18 is a double-link sleeve 6, which is coupled with the shaft and spline, can move leftwards and rightwards, so that the input 4 and 8 are installed on the input shaft 2, the two driving gears are sleeved on the shaft freely. A engagement transfer box, through short propeller shaft, is delivered to input shaft 2 from drive flange 1. Two driving gears As shown in Fig.5-1, the transfer case is composed of housing, 4 shafts and driving gears. The power of

1 VG1200 Transfer Case With out Interaxle Differential

The structure of VG1200 Type transfer box is basically the same as that of VG2000, now VG1200 Type transfer box is taken to brief the structure and operating principle.

SECTION 2 STRUCTURE OF TRANSFER CASE AND ITS OPERATING PRINCIPLE

Type	VG1200	VG1200	VG2000
Maximum input torque Nm	11770	11770	20000
Allowable maximum rpm	3000	3000	3000
First transmission ratio	1	1	1
Second transmission ratio	1.75	1.75	1.75
Lubricating oil volume(L)	4.5	Optional 1.22, 1.91	Optional 1.22
Weight (kg)	210	245	245

SECTION 1 TYPE AND TECHNICAL PARAMETERS OF TRANSFER BOX

For all wheel drive vehicle, a transfer box is added between transmission and drive axle, so that the power will be delivered respectively to the front drive axle and the middle and rear axles through transfer box. At the same time, in order to increase the low speed requirements during off-road running for full-wheel driving vehicles, the transfer box has a low speed gear. At present, VG1200 or VG2000 transfer box are installed for 4 × 4, 6 × 6 vehicles, and VG2000 transfer box is installed for 8 × 8 vehicles of SINOTRUCK.

CHAPTER 5 TRANSFER CASE

surface or in a grade climbing state with high drag (cross-country), driver presses down the "front drive" button, the front drive solenoid valve is energized and to be open, the compressed air goes to the geared cylinder 17 through solenoid valve, the piston is pushed by compressed air to move rightwards, and the engagement sleeve 14 is meshed with drive shaft 13 through shifting fork 13. At this time, the power, through power transfer box, is delivered to the front driving shaft 15 and rear driving shaft 13, and via front driving flange 16 and front propeller shaft, it is delivered to the front driving axle, through rear driving flange 11 and rear propeller shaft, is delivered to (middle) rear driving axle, thus realizing full wheel driving. It is worth to point out that, after the transfer case and front driving shaft are meshed, the front driving shaft and rear driving shaft becomes one. Therefore, there is no speed difference between front driving shaft and rear driving shaft at any moment. At any moment, its torque (power) is distributed equally to the front and rear. There are two steps for VG1200 Type transfer case. As shown in Fig.5-1, when the engagement sleeve 6 is pushed rightwards to mesh the low speed driving gear 8, the power will be delivered to the input shaft 2 from driving flange 1, to low speed gear 8 through the engagement sleeve 6, to the intermediate shaft 18 through meshed gears, then to the output shaft gear 13 through the left driving gears of intermediate shaft, thus to the front driving shaft. Because of two-stage speed reduction of the gear 8 with the right gear of intermediate shaft and the left gear of intermediate shaft with the gear 13 of the output shaft, thus the input is delivered to the output with a certain reduction ratio, realizing the low speed gear driving. When the engagement sleeve 6 is operated to move leftwards so that the input shaft 2 meshes with high speed gear 4, the power is delivered to the high speed gear 4 from the flange 1 and input shaft 2 through engagement sleeve 6, after that, directly to the output shaft gear 13 via the left gear of intermediate shaft 18, with transmission ratio $i=1$ of direct gear, and finally to the front, rear driving axles, thus realizing the high speed gear.

Generally speaking, under the highway running condition, the front drive is usually disengaged and the transfer case is engaged to direct gear, thus saving power and reducing the parts wearing. Under the off-highway cross-country running condition, it is necessary to engage the front drive. Only when cross-country drag is relatively big (for example grade-climbing), can the low speed gear be engaged. Fig.5-2 shows the power delivery diagrams in different operation conditions, in which A is the highway running condition, B is the off-highway running condition and C is off-highway low speed gear running condition.

There are three kinds of transmission ratio $i=1.22$, 1.75 and 1.91 for the low speed gear of VG1200 Type transfer case. Refer to Fig. 5-3 for teeth numbers of three transmission ratios. The commonly-used transmission ratio is 1.75 , the other two transmission ratios are optional for customers.

Fig. 5-2 Power delivery diagram

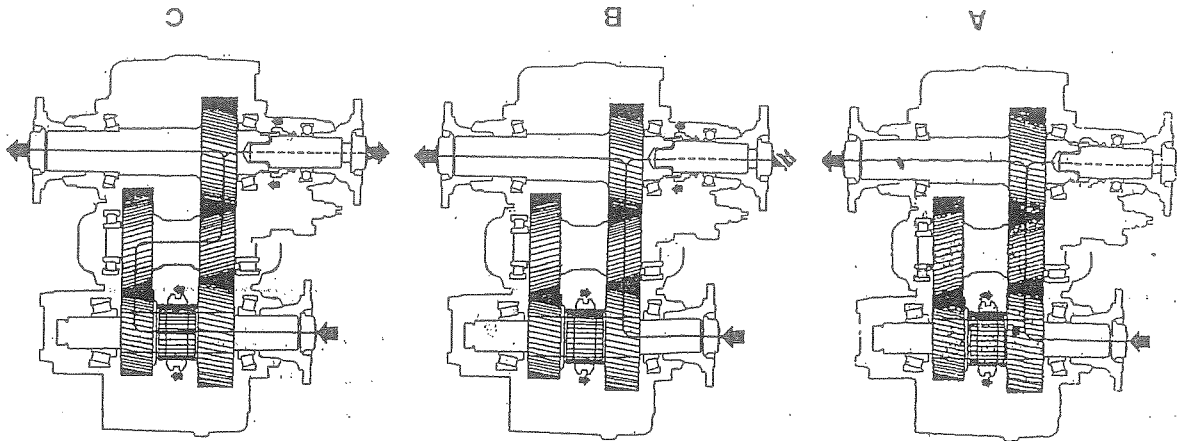
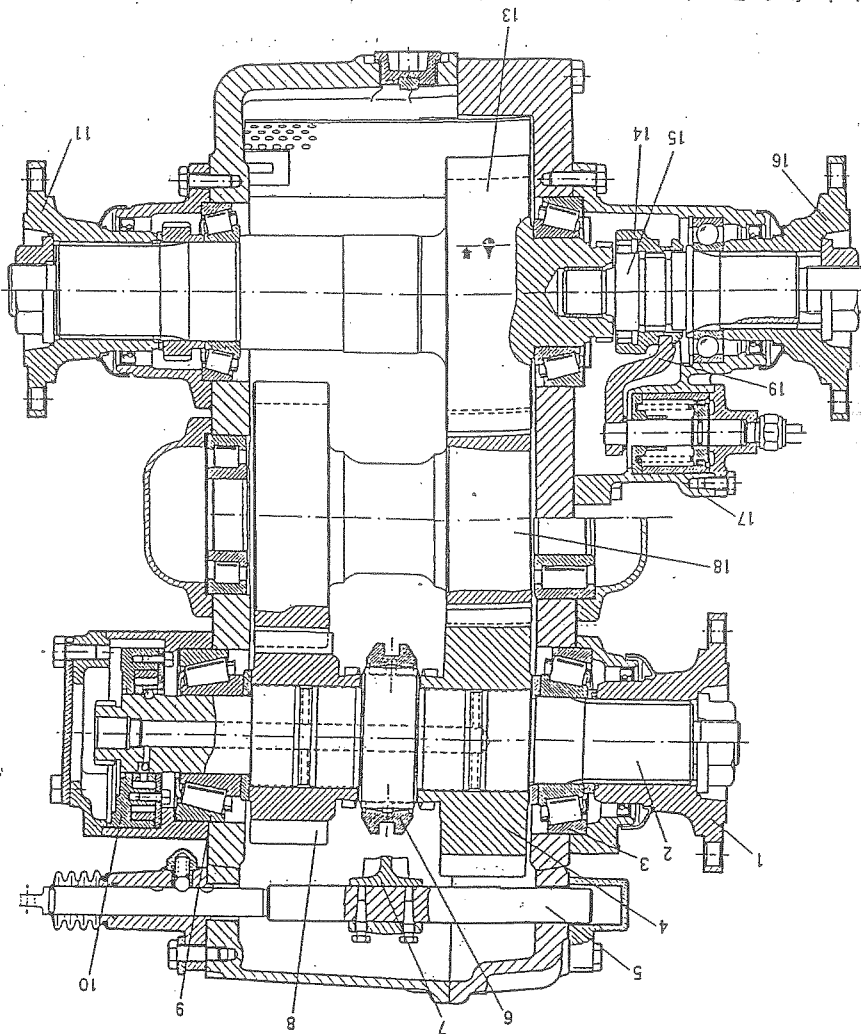


Fig. 5-1 VG1200 Type transfer case structure

1. Flange 2. Input shaft 3. Bearing 4. High speed gear 5. Shifting shaft 6. Engagement sleeve 7. Shifting fork 8. Low speed gear 9. Bearing 10. Oil pump 11. Rear driving flange 13. Output shaft gear 14. Engagement sleeve 15. Front driving shaft 16. Front driving flange 17. Front driving gear cylinder 18. Intermediate shaft



In order to solve this problem, a cylindrical planetary pinion differential can be added between the front and rear driving shafts for VG1200 Type transfer case. It not only plays a function of speed difference between front and rear shafts, but also distributes 1/3 power (torque) to the front shaft and 2/3 power to the rear shaft at any moment when the differential lock is not engaged. In this way the reasonable power distribution is realized, so it is also called a torque distributor.

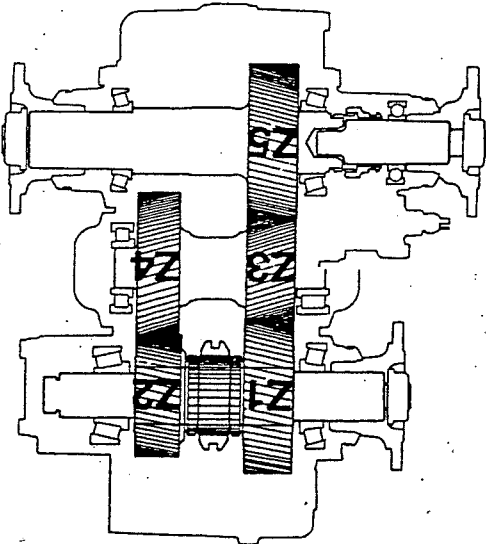
There is a big shortcoming for the transfer case with no interaxle differential: that is, before engagement and after driving, the front driving shaft and rear driving shaft have already become one rigid shaft, therefore there is not only no speed difference action between front shaft and rear shaft, but also the power will be distributed equally to the front and rear at any moment. Due to the distribution of vehicle axle load, generally the front driving shaft needs only 1/3 of total power. Therefore, this kind of transfer case causes waste of power, and is unable to bring into full play of engine power performances. At the same time, because there is no speed difference between the front and rear shafts, the wearing and damage of parts will be accelerated when running on uneven road surfaces.

II. VG1200 Transfer Case with Interaxle Differential

The lubrication mode of combined splash lubrication and pressure lubrication is adopted for VG1200 Type transfer case. An internal gear oil pump 10 is installed on the end of input shaft as shown in Fig. 5-1 and Fig. 5-7. The lubricating oil drawn from the bottom of transfer case mainly lubricate the shaft hole and shaft of two driving gears 4 and 8 through central input oil passage. In winter time, because the temperature is very low and oil viscosity is thick, the oil pump is hard to operate, and the lubrication condition at low temperature is rigorous. Therefore, for vehicle installed with such transfer case, at the beginning of running, it is necessary to transfer gradually from low speed running to high speed running, so that the vehicle can run at high speed after the oil temperature rises to normal.

Transmission ratio of low speed gear I	1.22	1.75	1.91
Z ₁	23	23	23
Z ₂	21	17	17
Z ₃	17	23	17
Z ₄	19	22	24
Z ₅	23	23	23

Fig.5-3 Teeth number of gear with various transmission ratios



1.22	1.75	Transmission ratio of low speed gear i
23	23	Z_1
23	17	Z_2
21	17	Z_3
19	22	Z_4
23	23	Z_5
28		Differential sun gear Z_6
18		Planetary gear Z_7
67		Ring gear Z_8
Interaxle differential transmission ratio $i=1.239$		

Fig. 5-4 shows the structure of VG1200 Type transfer case with cylindrical planetary pinion interaxle differential (torque distributor). As shown in Fig. 5-4, the power is delivered to the output shaft gear 3 from the intermediate shaft gear, while the gear 3 is also the planetary gear carrier, there are 5 planetary gears 5 around it. While the sun gear 4 of the planetary gear mechanism is integrated with the front driving shaft 2, and the ring gear 6 is integrated with the driving shaft 7. Thereout it plays a function of speed difference between the front shaft and rear shaft, so as to adapt to the needs of running on road surface.

At the same time, due to reasonable matching of the differential gear teeth numbers, at any moment 1/3 power is distributed to the front shaft and 2/3 power is distributed to the rear shaft, so as to adapt to the driving needs of axle load. The front driving shaft of this transfer case is normally engaged. Therefore it enhances the throughput performance of vehicle while not increasing the mechanical wearing.

When the vehicle is running on smooth or sloughy road and has slippage (for example, the front wheel slipping or rear wheel slipping). If the interaxle differential lock inside driving axles are engaged, however the vehicle still can not get out from the defective road, then the interaxle differential lock inside VG1200 transfer case needs to be engaged. As shown in Fig. 5-4, at this time the engagement sleeve 1 of differential lock is meshed with the planetary gear carrier 3 into one, that is, the driving shaft 2 and planetary gear carrier 3 becomes rigid one. At this time the whole planetary gear differential becomes an integrated one, it will no longer play a speed difference function, that is to say, the front driving shaft and rear driving shaft are becoming an integral one and the vehicle will be able to get out from defective road.

Fig. 5-5 shows the power distribution condition, in which diagram A is the condition that the differential is functioning, the 1/3 power is delivered to the front and 2/3 is delivered to the rear. Diagram B is the condition that the differential lock is engaged, at that time the front and rear driving shafts are becoming an integral one. The power will be distributed equally to the front and rear.

There are also two steps for this kind of transfer case: direct gear and low speed gear. There are two transmission ratios for low speed gear. Refer to Fig. 5-6 for different driving gear teeth numbers:

1. Engagement sleeve 2. Front driving shaft 3. Planet carrier 4. Sun gear 5. Planetary gear 6. Ring gear 7. Rear driving shaft

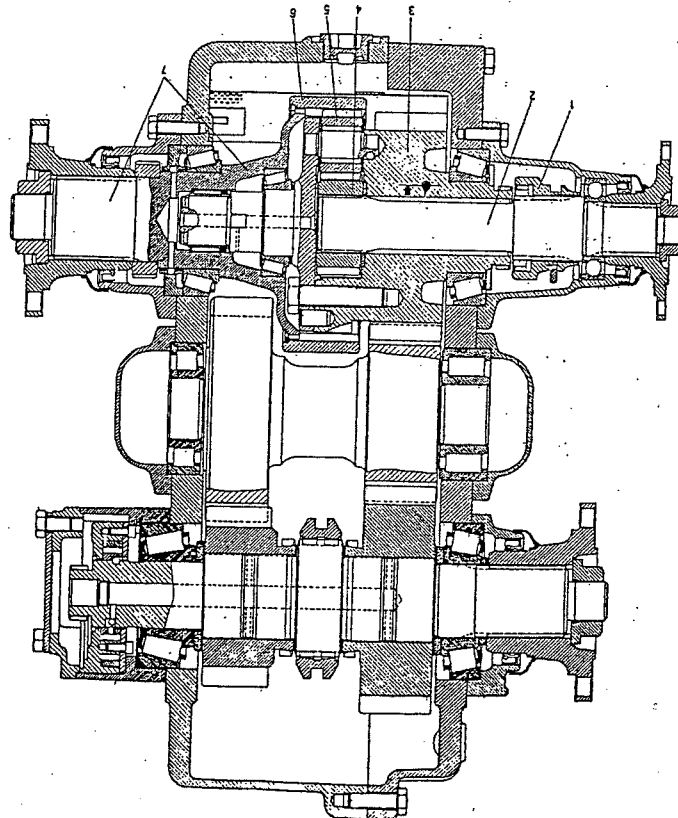


Fig. 5-4 Transfer case with interaxle differential

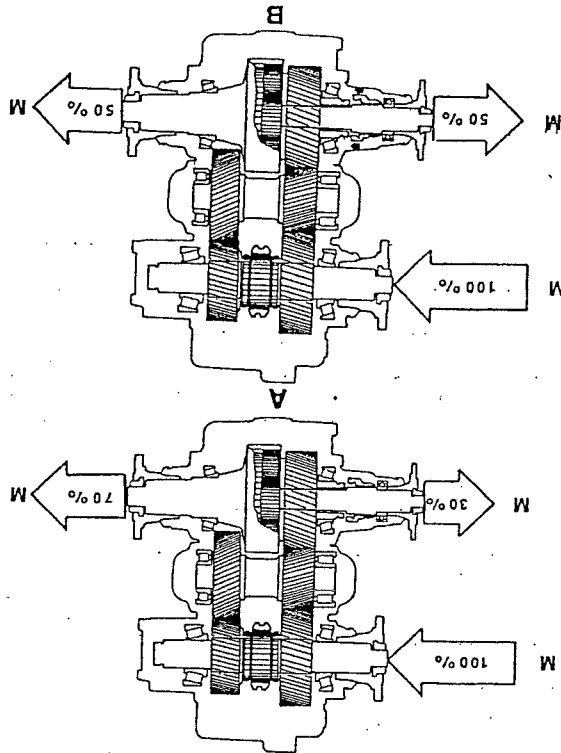


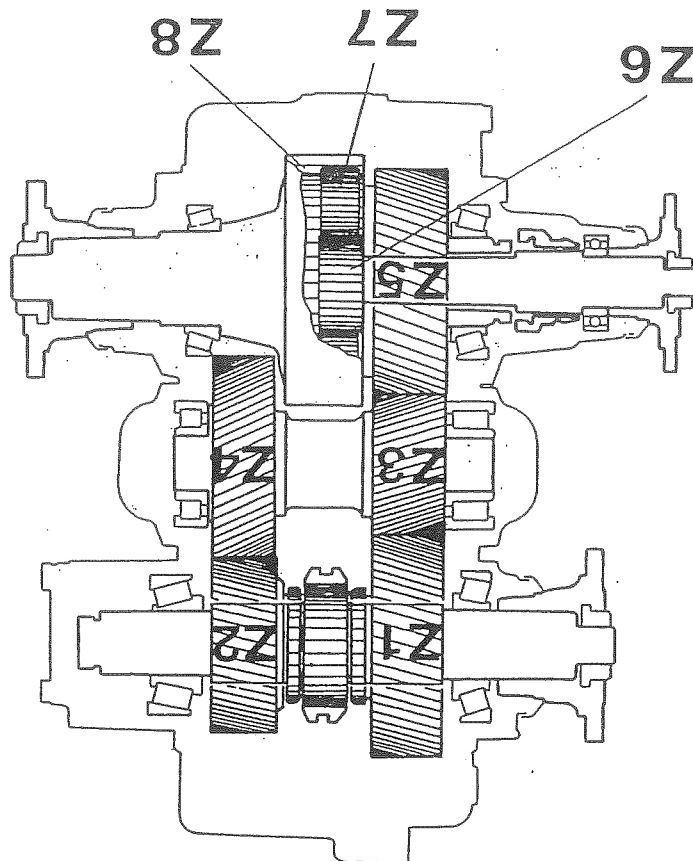
Fig. 5-5 Power distribution diagram

engagement sleeve and shifting fork.

2. High and low speed gears operations

1. Front Driving Engagement Operation

Fig. 5-6 Driving gear teeth numbers



- III. Assembling gluing and technique
- ① During assembling, the Loctite brand plane sealing compound should be applied to the plane joint. Loctite 242 sealing compound should be applied to the locking nut of input and output flanges.
 - ② After it is heated to 80°C, the bearing will be fitted onto shaft.

S/N	Contents	Standard value
1	Connecting bolts of front and rear covers of transfer case	110Nm
2	locking nut for input shaft flange	1,100Nm
3	locking nut for rear driving output flange	1,100Nm
4	locking nut for front driving output flange	650Nm
5	Bolts for cover plate of planet carrier	80-85Nm+120° ± 5°

II. Refer to Table below and Figs. 5-8 and 5-9 for the tightening force of main bolts and nuts.

S/N	Contents	Standard value
1	Pre-tightening force for the conical roller bearing of input shaft	0.05~1.0Nm
2	Axial clearance of conical roller bearing of intermediate shaft	0.3~0.5mm
3	Pre-tightening force for the conical roller bearing of output shaft	0.05~1.0Nm

I. For assembling and adjustment data, refer to Figs. 5-8 and 5-9 below:

SECTION 3 TECHNICAL DATA FOR MAINTENANCE AND ASSEMBLY

Fig. 5-7 Electrically-operated GV1200 Type transfer case

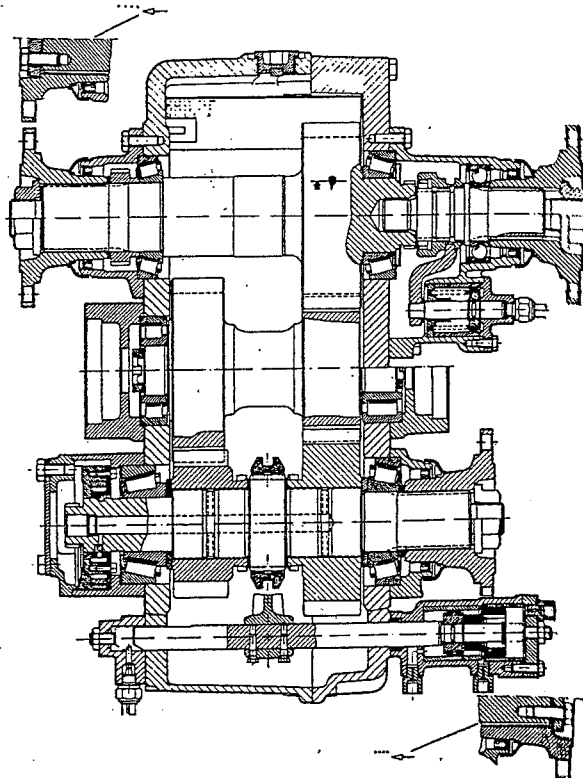
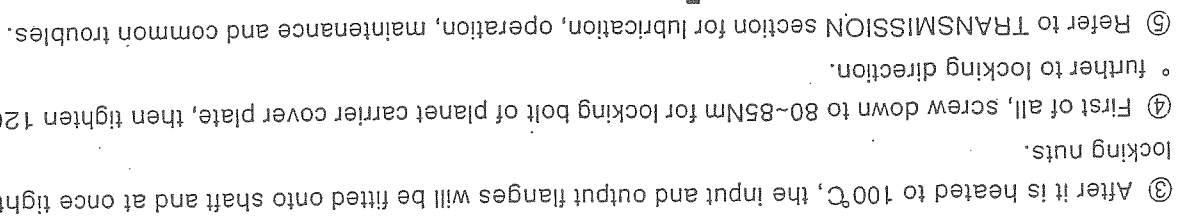


Fig. 5-8 Tightening torques for different positions (without interaxle differential)



③ After it is heated to 100°C, the input and output flanges will be fitted onto shaft and at once tighten the locking nuts.

SECTION 4 DISASSEMBLING AND ASSEMBLING

1. Disassembling

① Refer to Fig. 5-10 for disassembling of front cover section.

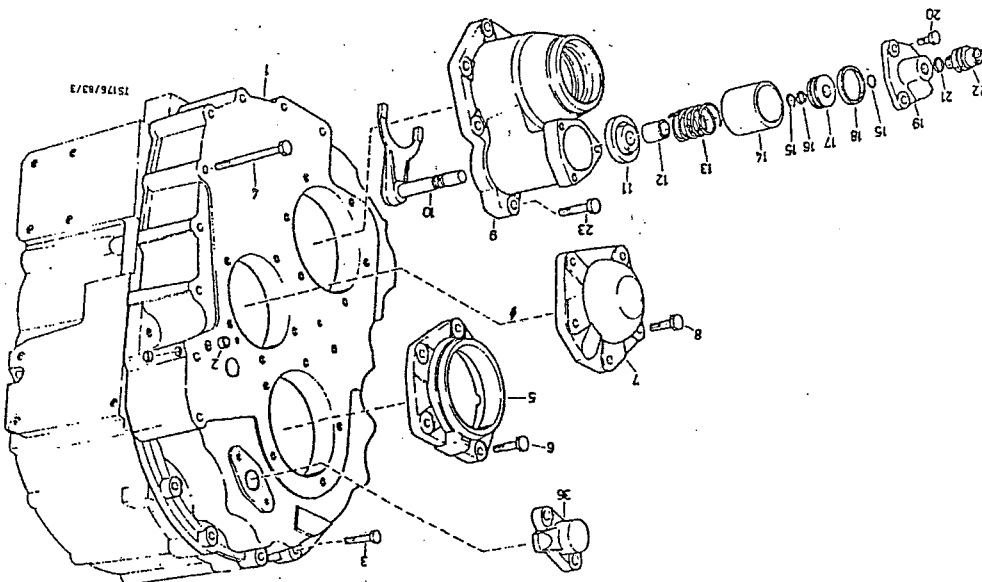


Fig. 5-10 Disassembling diagram of front cover

1. Front cover 2. Plug 3. Bolt 4. Bolt 5. Front bearing cover of input shaft 6. Bolt 7. Front bearing cover of intermediate shaft 8. Bolt 9. Front output shaft housing 10. Shifting fork 11. Gasket 12. Shaft sleeve 13. Spring 14. Sleeve 15. Clip 16. Sealing ring 17. Piston 18. Seal ring 19. End cover 20. Bolt 21. Seal ring 22. Front driving indicator switch 23. Bolt 36. Flange

② Refer to Fig. 5-11 for housing disassembling.

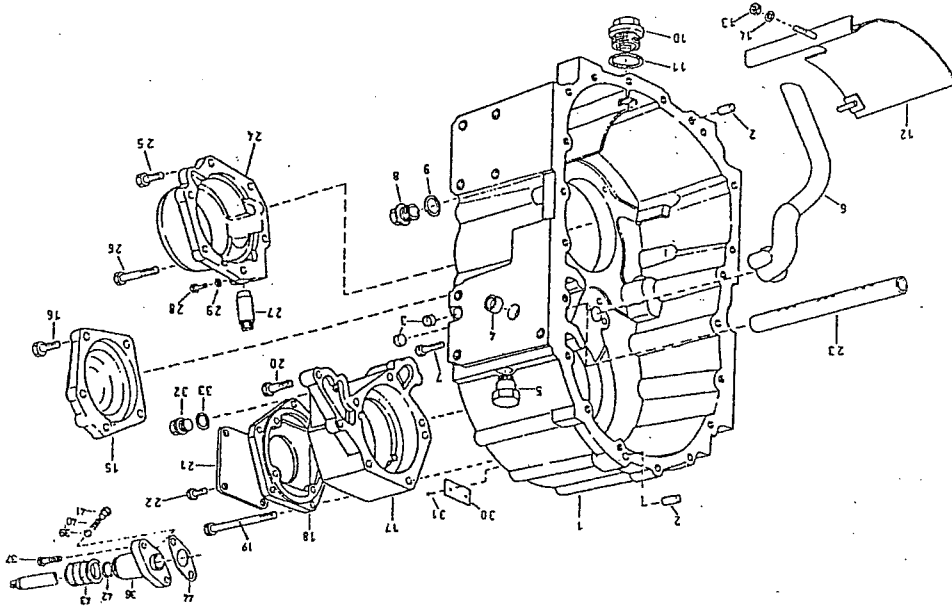
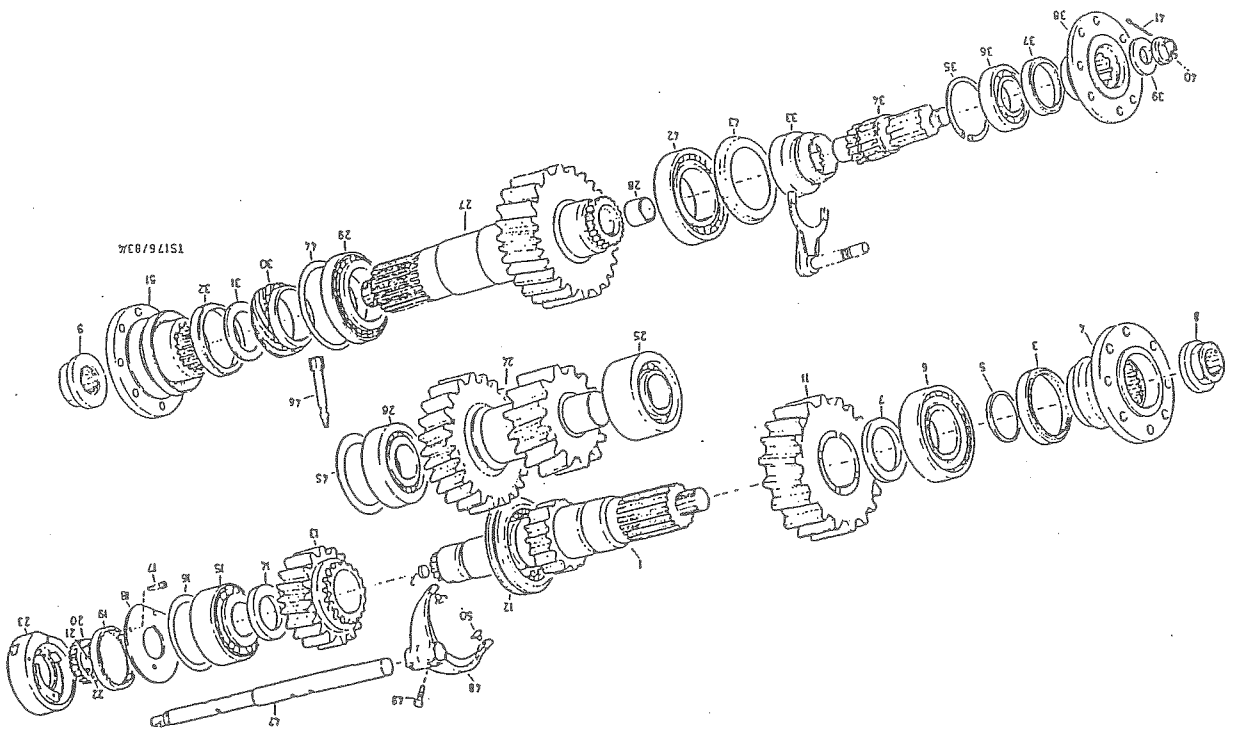


Fig. 5-11 Disassembling diagram of housing



③ Refer to Fig.5-12 for disassembling of driving gears.

1. Housing 2. Locating pin 3. Plug 4. Seal cover 5. Vent plug 6. Oil suck pipe 7 Bolt, 8 Screw plug, 9 Seal ring, 10 Magnetic screw plug, 11 Seal ring, 12 Oil baffle 13. Nut 14. Washer 15. Rear cover of intermediate shaft 16. Bolt 17. Rear cover of input shaft 18. End cover 19. Bolt 20. Bolt 21. Cover plate 22. Bolt 23. Injection pipe assembly 24. Cover of rear output shaft 25. Bolt 26. Bolt 27. Driven gear shaft sleeve of speedometer 28. Bolt 29. Spring washer 30. Nameplate 31. Slotted pin 32. Screw plug 33. Seal ring 36. Flange 37. Bolt 39. Steel lock ball 40. Spring 41. Screw plug 42. Seal ring 43. Dust cover 44. Adjusting washer

Fig. 5-12 Disassembling diagram of driving section

1. Input shaft 2. Seal cover 3. Oil seal 4. Input shaft flange 5. Washer 6. Conical roller bearing 7. Spacer 8. Nut 9. nut 11. Gear 12. Mating sleeve 13. Gear 14. Spacer 15. Conical roller bearing 16. Adjusting washer 17. Bolt 18. Cover plate 19. Oil pump tooth ring 20. Oil pump gear 21. Steel ball 22. Steel ball 23. Oil pump housing 24. Intermediate shaft 25. Roller bearing 26. Roller bearing 27. Output shaft 28. Shaft sleeve 29. Conical roller bearing 30. Drive gear of speedometer 31. Spacer 32. Shaft oil seal 33. Front drive mating sleeve 34. Front driving shaft 35. Clip ring 36. Ball bearing 37. Shaft oil seal 38. Front driving flange 40. Nut 42. Conical roller bearing 43. Washer 44. Adjusting washer 45. Adjusting washer 46. Driven gear of speedometer 47. Sliding rod 48. Shifting fork 49. Locking screw 50. Sliding block 51. Rear flange of output shaft

④ Refer to Fig.5-13 for disassembling of output shaft assembly with interaxle differential.

Fig. 5-14

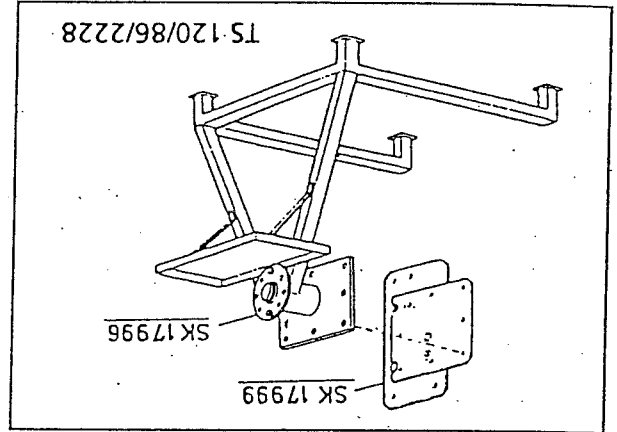
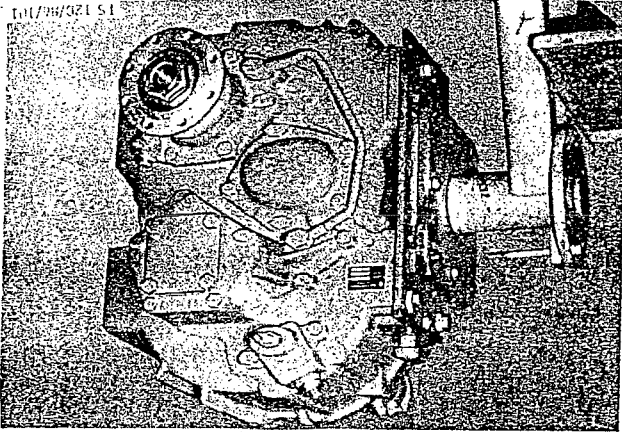


Fig. 5-15

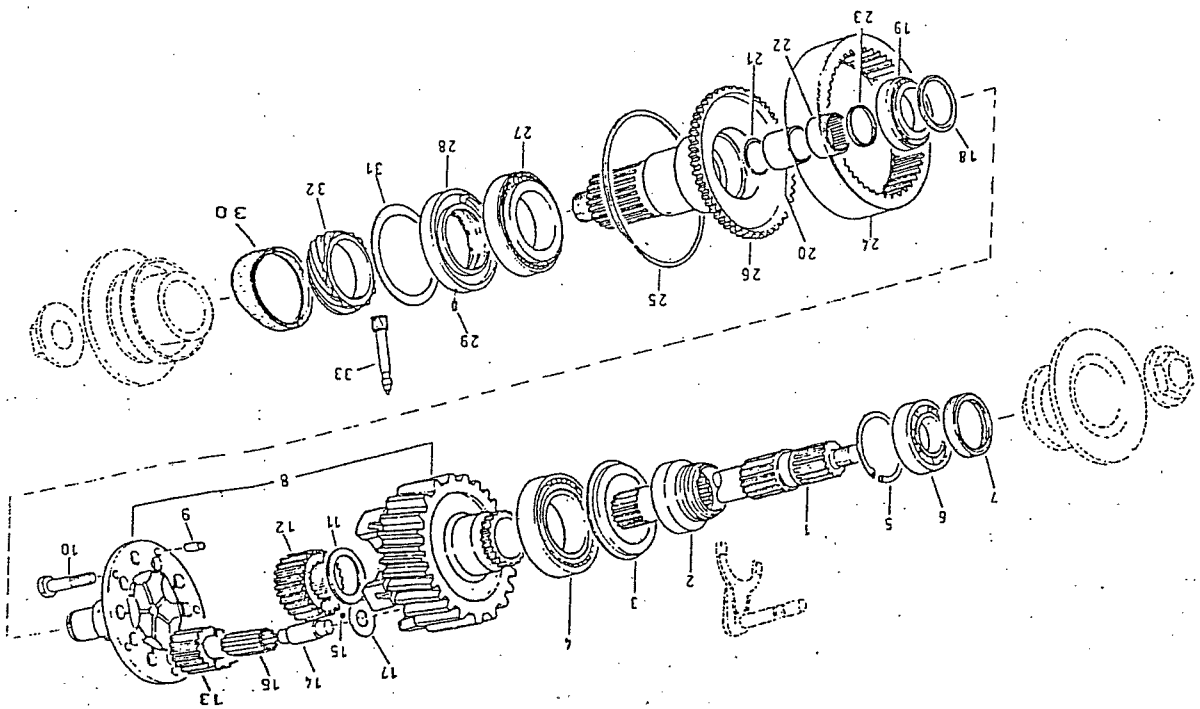


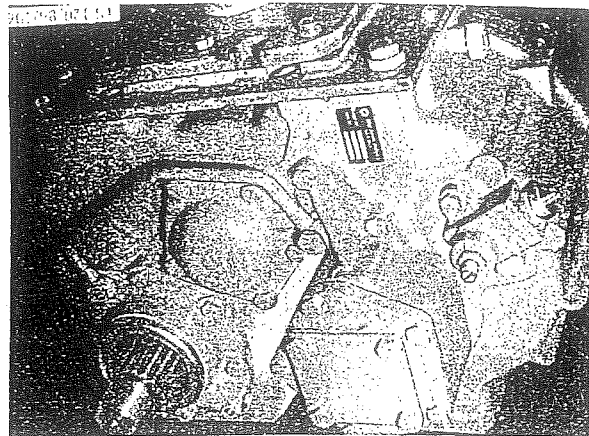
1. Use special tools to fix the transfer case on the workbench, refer to Fig. 5-14 and Fig 5-15.

II. Precaution of disassembling the transfer case

gear of speedometer
guide ring 29. Spring pin 30. Shaft oil seal 31. Adjusting washer 32. Drive gear of speedometer 33. Driven bearing 23. Seal ring 24. Tooth ring 25. Clip ring 26. Rear output shaft 27. Conical roller bearing 28. Oil Supporting washer 19. Conical roller bearing 20. Inner race of needle bearing 21. Clip ring 22. Needle Sun gear 13. Planetary gear 14. Planetary gear shaft 15. Steel ball 16. Needle bearing 17. Washer 18. 6. Ball bearing 7. Shaft oil seal 8. Planet carrier coupling 9. Locatin pin 10. Bolt 11. Thrust washer 12. 1. Front output shaft 2. Engagement sleeve of differential lock 3. Washer 4. Conical roller bearing 5. Clip

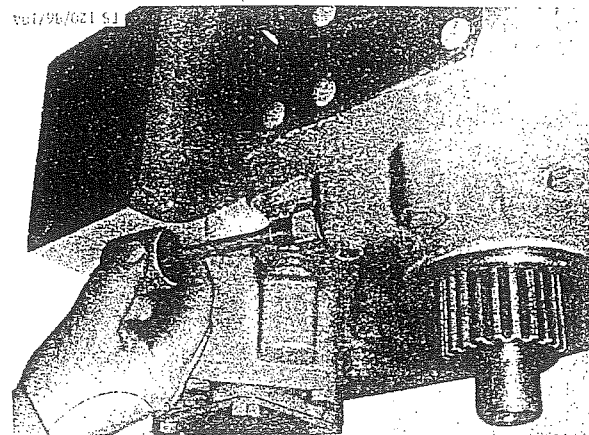
Fig.5-13 Disassembling of output shaft assembly with interaxle differential





3. Special tools should be used to disassemble the driven gear sleeve (part 27 in Fig. 5-11) of speedometer, see Fig. 5-17.

Fig. 5-17



2. Double-arm puller (see Fig. 5-16) should be used to disassemble flanges (part 4 and part 38 in Fig. 5-12).

Fig. 5-16

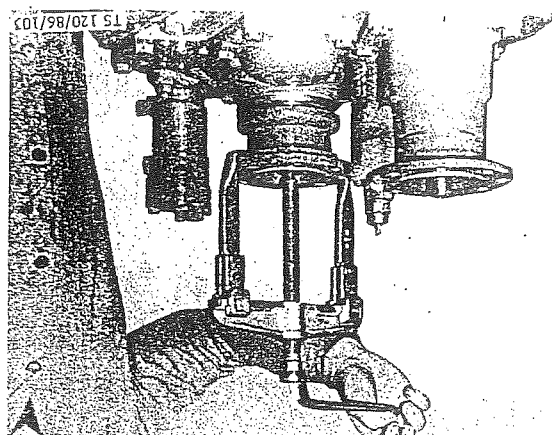
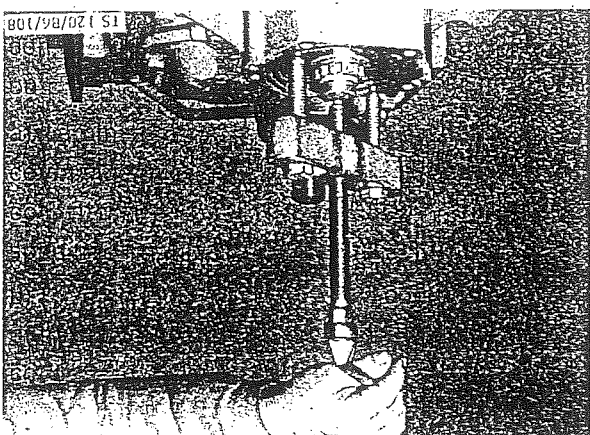


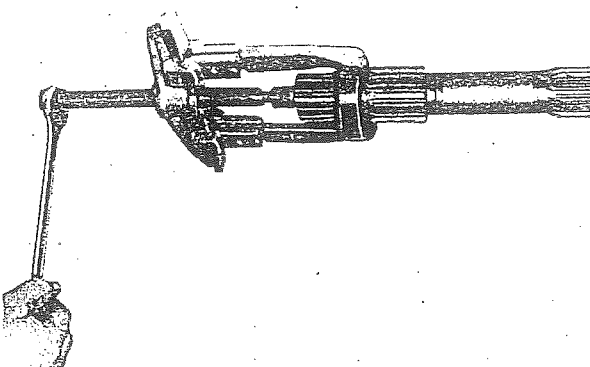
Fig. 5-18



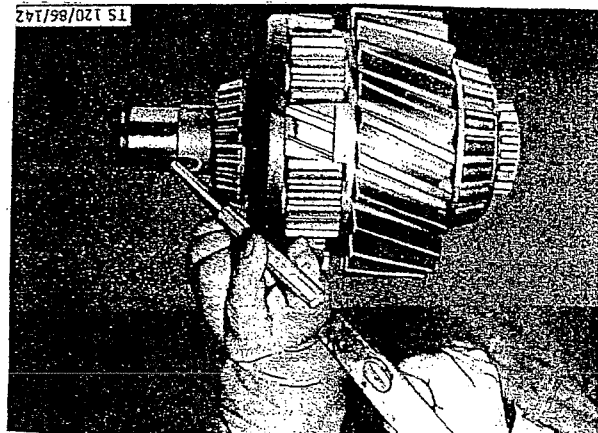
4. When dismantling the oil pump assembly (part 17 to part 23 in Fig. 5-12), the cover plate and end plate (part 21 and part 18 in Fig. 5-11) must be removed first. Turn the input shaft (part 1 in Fig. 5-12) to see the steel ball (part 22 in Fig. 5-12), then pull out the oil pump assembly by using puller and bolt (part 1 and part 2 in Fig. 5-18).

Fig. 5-19

TS 120/86/122

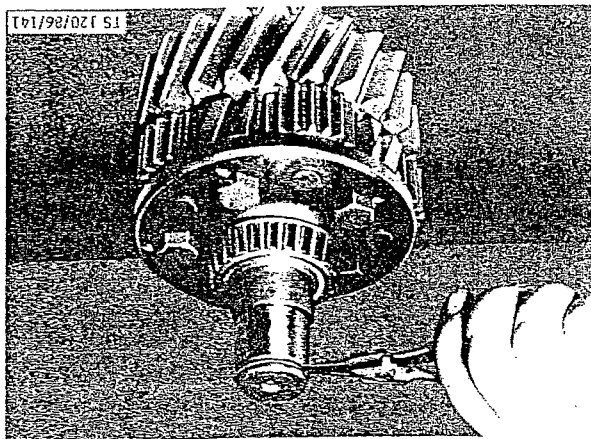


5. When removing the ball bearing (part 36 in Fig. 5-12, part 6 in Fig. 4-13) on the front output shaft, double-arm puller should be used to pull it out. See Fig. 5-19.



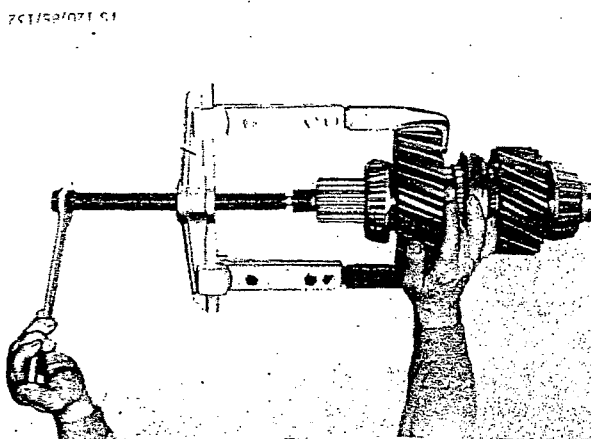
7. Refer to Fig. 5-12, when removing the inner race of roller bearing 26 from intermediate shaft 24, the puller (part 2 in Fig. 5-21) and special tool (part 3 in Fig. 5-21) should be used.

Fig. 5-21



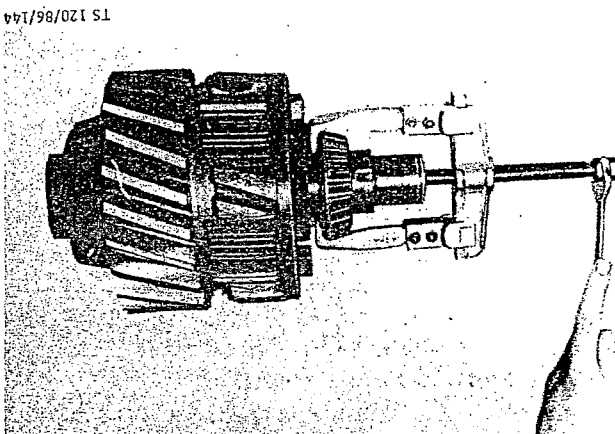
6. When dismantling the input shaft, the double-arm puller should be used to pull out parts 13, 14 and 15 in Fig. 5-12 (that is parts 1, 2 and 3 in Fig. 5-20). Use the same method to remove parts 6, 7 and 11 in Fig. 5-12.

Fig. 5-20



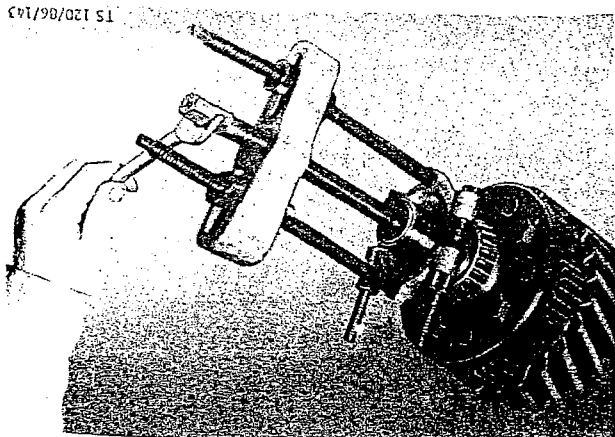
9. Refer to Fig. 5-13 and Fig. 5-22, when removing the inner race of conical roller bearing 19 from the coupling 8 of planet carrier, use the puller.

Fig. 5-23



8. Refer to Fig. 5-13, when removing the inner race 20 of needle bearing from the coupling 8 of planet carrier, first slightly tap out part 20, then use the puller (part 2 in Fig. 5-22) and special tool (part 3 in Fig. 5-22).

Fig. 5-22



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TS 120/86/144

TS 120/86/142

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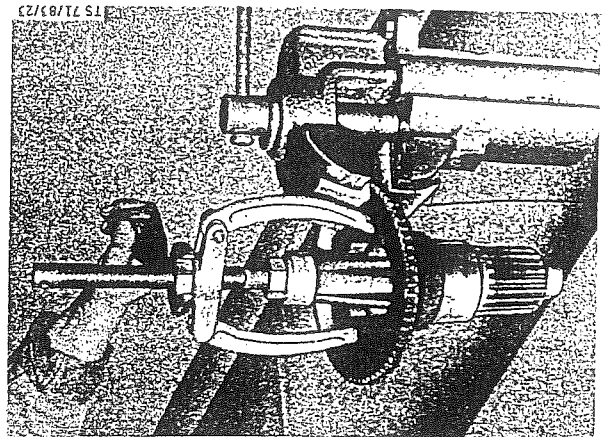


Fig. 5-24

11. Refer to Fig. 5-13, when removing bolt 10, a mark should be punched on the top of bolt (the bolt is allowed to be reused for one time). If there is already a mark, that bolt should no be used again.

12. Refer to Fig. 5-13, when removing the needle bearing 20 from rear output shaft, the puller (part 1 in Fig. 5-24) and the puller support (part 2 in Fig. 5-24) should be used.

2. Assembling and adjustment of transfer case

(1) Cleaning and inspection before assembling

① All parts must be cleaned thoroughly before assembling. Remove all oil stains, dust as well as all adhesive, sealing and locking agents. Ensure cleanliness, keep properly the cleaned parts to avoid them from being re-oiled and redusted.

② Check the housing parts for cracks and deformations. Check the friction surfaces of moving parts for cracks, corrosion, rust, pulling damage and overwearing. Especially the raceway and rollers of bearing, thread of gear surface connector. All parts with above-mentioned defects should not be re-used.

③ Generally speaking, oil seal, seal ring and other rubber parts and sealing parts should not be re-used.

④ Check the transfer case housing and cover hole for scar and overwear. Measure the hole size with micrometer and internal diameter dial indicator, refer to Fig. 5-26, the size scope is

A: 129.978~130.000
B: 119.978~120.000
C: 109.978~110.000
D: 124.978~125.000

(2) Precaution during assembling

① Before installed on the bearing journals, the inner race of various bearings must be oil-bathed to 80°C, then installed on position.

② All connecting bolts should be tightened according to specified torques, refer to Section III for concrete

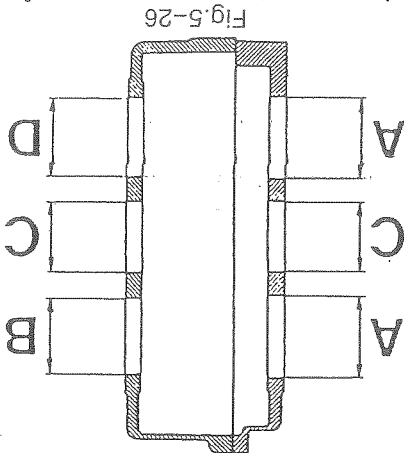
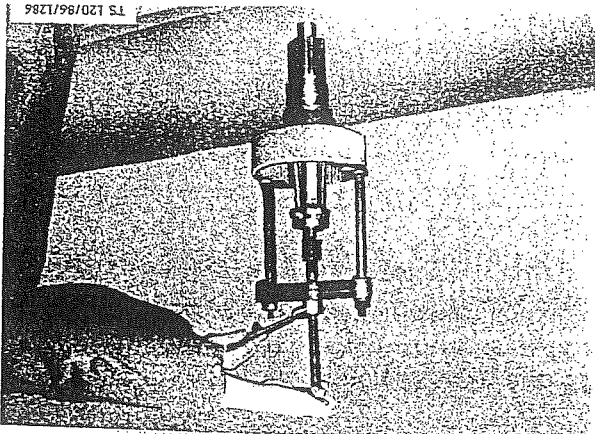


Fig. 5-26

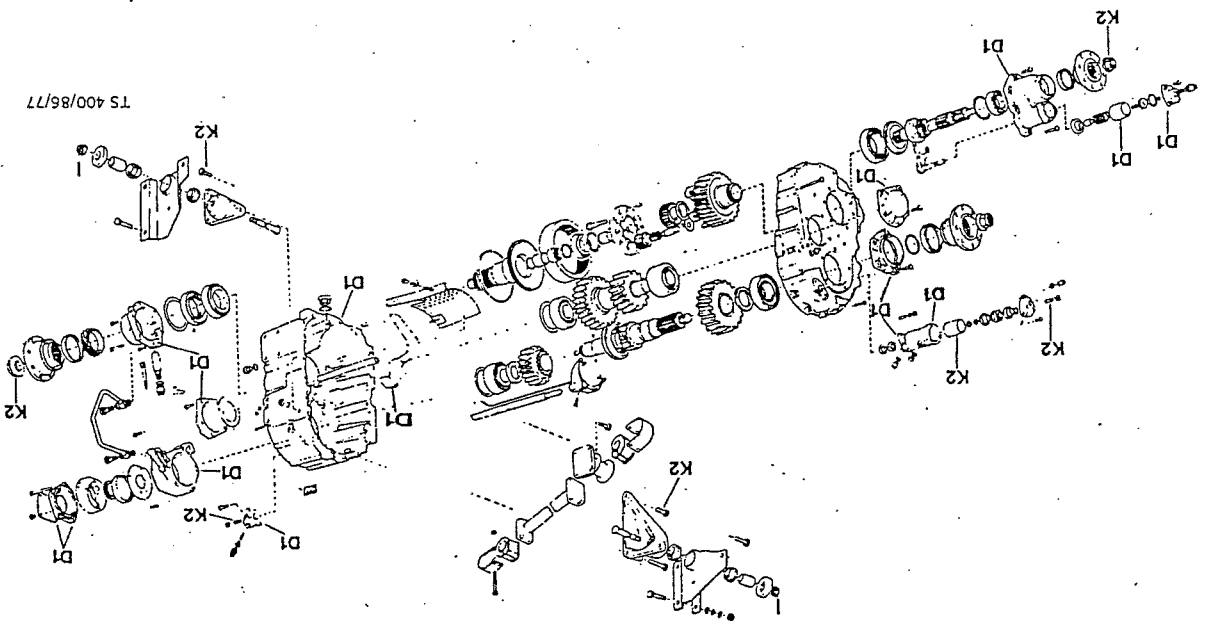
13. Refer to Fig. 5-13, when removing the outer race of conical roller bearing 19 from rear output shaft 26, the puller (part 2 in Fig. 5-25) and the puller support (part 1 in Fig. 5-25) should be used.

Fig. 5-25



- ensure no installation gap.
- bar to tap the input shaft, output shaft and outer race of bearing (parts 1, 15 and 27 in Fig. 5-12), so as to cover of input shaft (part 17 in Fig. 5-11) and the cover of rear output shaft (part 20 in Fig. 5-11). Use a soft in Fig. 5-10), turn over the workbench so as to make the housing cover face downward. Remove the rear c) Install the housing cover onto transfer case, do not apply the sealing compound, tighten the bolt (part 3 of transfer case (part 1 in Fig. 5-11), install the rear cover of input shaft (part 17 in Fig. 5-11) and rear input cover (part 24 in Fig. 5-11), install the bolts (parts 19, 20, 25 in Fig. 5-11) and tighten them. Install the input shaft assembly and output shaft assembly into the corresponding positions inside transfer case.
- b) Refer to Fig. 5-12, install the outer races of conical roller bearings 15 and 29 into the corresponding holes specified torques.
- a) Tap the outer races of conical roller bearings 6 and 42 in Fig. 5-12 into the corresponding holes of front cover. Install the front bearing cover 6 of input shaft and front output shaft housing 9 in Fig. 5-12 into corresponding positions, however do not apply the sealing compound, tighten the bolt 8 and bolt 23 to output shaft, i.e., to determine the thickness of washers, its method is as follows:
- After installation of the input shaft assembly, output shaft assembly and intermediate shaft assembly and before putting them into their housings, it is necessary to adjust the pre-tightening forces of one pair of conical roller bearings at two ends of input shaft and that of one pair of conical roller bearings at two ends of output shaft, i.e., to determine the thickness of washers, its method is as follows:
- ④ Adjustment of bearing pre-tightening force

Fig. 5-27



- adhesive.
- ③ For positions where sealing compound and adhesive agent are used during repair of VG1200 transfer case, refer to Fig. 5-27. In the diagram, D is Loctite 510 plane sealing compound, K 2 is Loctite 242 thread-locking torque values. Caution: the fixing bolts of planet carrier should be tightened to 80Nm, then tightened 120° further. Refer to Section III for pre-tightening torque or axial clearance of various bearings.

e) Refer to Fig. 5-30, from input end, measure the pre-tightening moment of input shaft bearing to be 0.5~1Nm, the spring balance pulling force is 13 ~ 34N. From the rear output end, measure the pre-tightening moment of bearing to be 0.5~1Nm, the spring balance pulling force is 15~30N. If the measured pre-tightening moment is beyond the specified scope, it can be adjusted by using adjusting washers 16 or 44.

f) After the pre-tightening force of bearing is well adjusted. Remove the above-mentioned parts and assemblies, keep the set adjusting washers, restart installation one step after another.

g) During installation of intermediate shaft, refer to the method described in this paragraph, measure the thickness X3 of adjusting washer (part 45 in Fig. 5-12), then add 0.3 ~ 0.5mm, the thickness specifications of washer 45 are 0.1, 0.2, and 0.5mm respectively.

Fig. 5-30

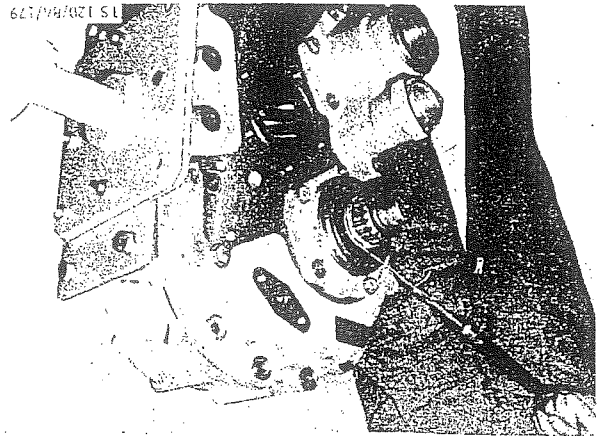
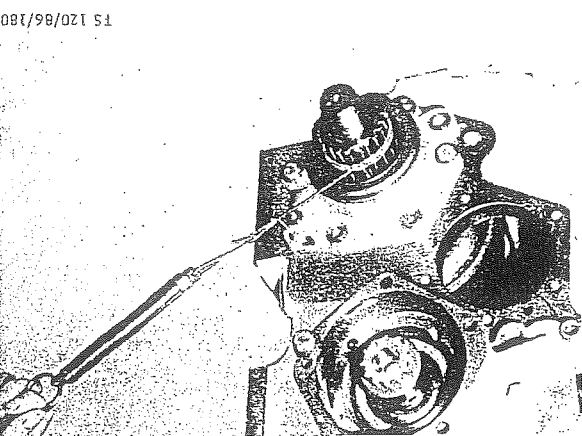


Fig. 5-31



d) Measure the height A1 of protrusion of bearing (part 29 in Fig. 5-12) outer race from transfer case (see Fig. 5-28), and measure the depth B1 of groove (see Fig. 5-29) in which the outer race of bearing on the rear output shaft housing (part 24 in Fig. 5-11). Calculate the thickness of adjusting washers $X1=A1-B1$, 0.1, 0.15, 0.2, 0.4 and 1.0mm of thickness specifications for the adjusting washer can be selected.

Use the same method to measure the total thickness X2 of adjusting washer C (part 16 in Fig. 5-12) of input shaft bearing. Install the adjusting washer 44 with total thickness of X1 and adjusting washer 16 with total thickness of X2, install the rear cover of input shaft (part 17 in Fig. 5-12) and output shaft cover (part 24 in Fig. 5-12), tighten the lock bolts 19, 20 and 5 to specified torques.

Fig. 5-28

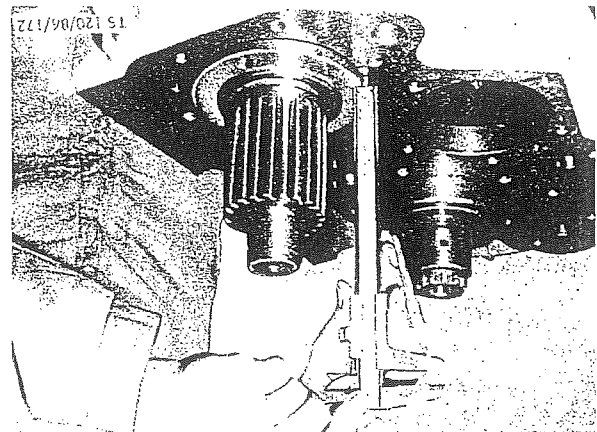
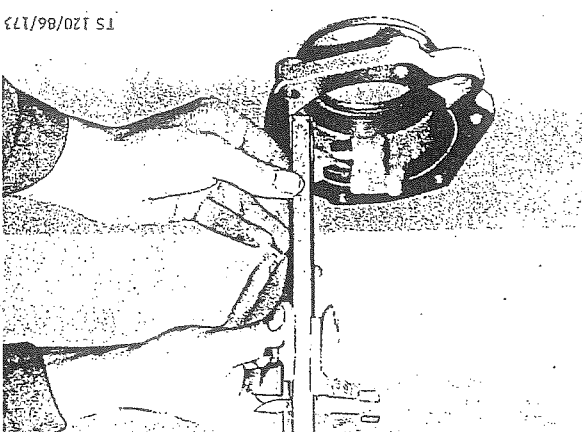


Fig. 5-29



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