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Automobile Mechanic

ISCO: 8—43.20

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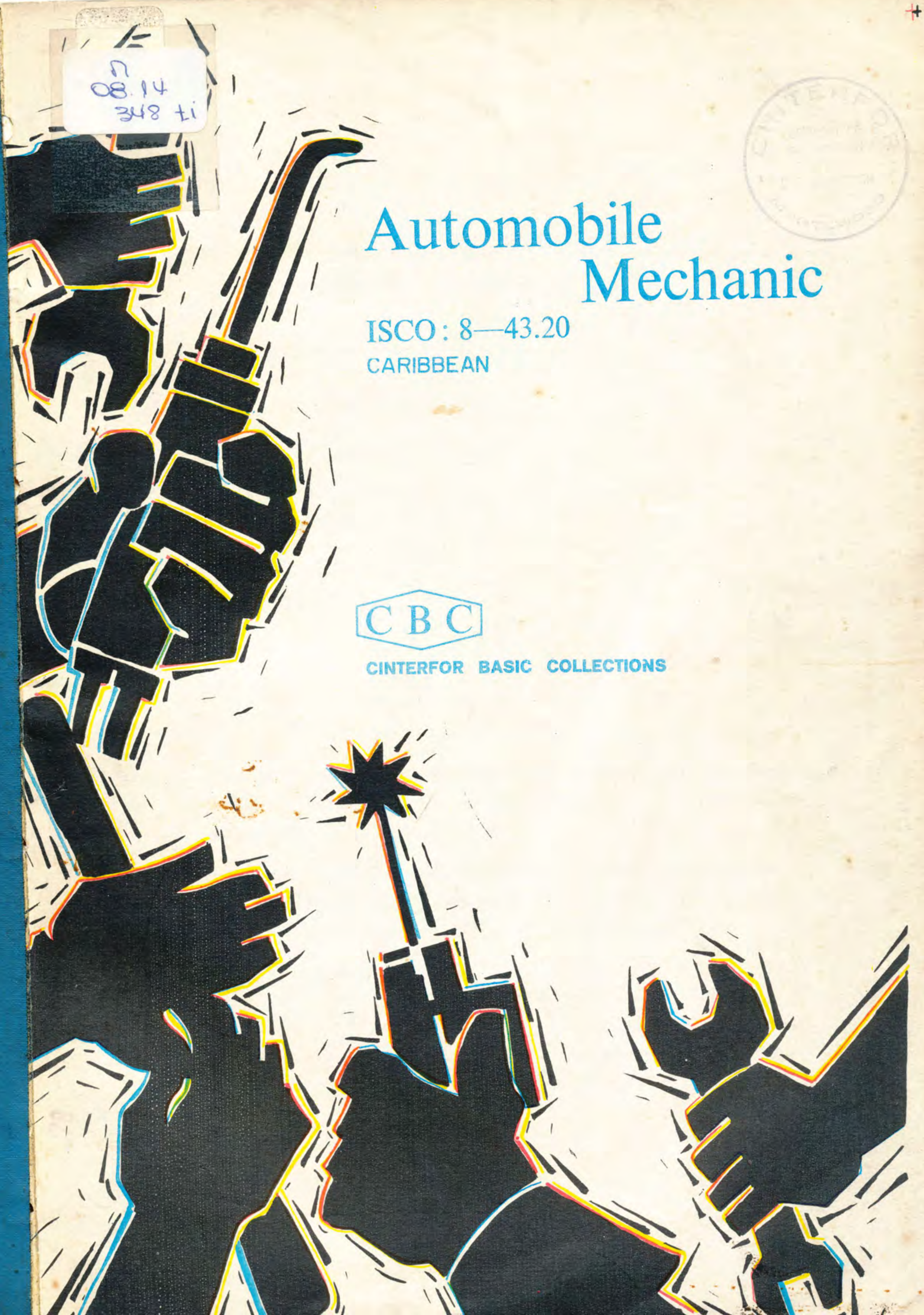

CBC

CINTERFOR BASIC COLLECTIONS

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DESCRIPTION OF THE CBC

FIELD OF APPLICATION OF THE CBC FOR AUTO-MECHANICS:

The operation and technological information sheets contained in this CBC for auto-mechanics, are applicable to the preparation of the instructional material in teaching the work-shop practices of the following occupation;

8.43.20 AUTO-MECHANICS

Repair, maintain and service automobiles and other vehicles with similar engines:

> Examine the vehicle to determine the nature, seriousness and cause of the defects; determine the work that is to be done with the aid of sketches and technical manuals; remove the engine, the transmission lines, the differential or other parts that need examining; repair or substitute parts like pistons, connecting rods, gears, valves, bearings, contact points and gaskets, as well as spark plugs and other accessories; change the brake lining and adjust it; change the bearings of the steering, and do whatever other repairs are necessary; adjust the idling speed of the engine by advancing or retarding the ignition, carburettor valves and the transmission lines; on completion of all this, test the vehicle in the work-shop or on the road.
>
> The student may specialize in the repairing of one type of automobile engine, such as diesel engines, and can be designated accordingly.

NOTE: The following complementary tasks have been incorporated to the previous ones for the purposes of this CBC:

Removing and replacing the electrical circuit.
Repairing and servicing the mechanical parts of the electrical circuit.
Checking and charging the battery.

The material can also be used for the instructions on partial aspects corresponding to the occupations belonging to the group 9-85 "Motor Vehicle Drivers".

OPERATIONS

This CBC includes the majority of operations involved in auto-mechanics but, owing to the unlimited number of operations and considering the variations due to the difference of component parts in different models and makes of vehicles, a fixed type of vehicle will be used as reference. This vehicle should have a gasoline 6-cylinder engine, mechanical transmission, three gears and a hydraulic braking system. In the composition of this CBC, an exception has been introduced, i.e. grouping the OS's in the specialisation blocks as was defined in pt. 4.3 page 13 of the normative document (2nd edition).

It was also thought useful to include operations which, although not strictly belonging to this occupation, complement it and facilitate its use. This is the case with operations in Block 9 of the electrical system.

It should be noted however that other CBC's on automobiles are being developed in which specialisation sections, such as electricity, upholstering, coating and painting,diesel engines etc., are being dealt with.

TECHNOLOGICAL INFORMATION

With regard to the TIS's, the same exception that was made with the OS's may be applied here, as in this first CBC it was practically impossible to classify and codify the technological information. As a result the indexes VII and VIII suggested in the normative document have not been included. Later in preparing other related CBC's, the missing classification and indexes may be put in.

INDEXES

OPERATION SHEETS

SPECIALISATION BLOCKS (*)

Grouping of operations for AUTO MECHANICS

CHARACTE-RISTICS	Title of block
AM-1	Braking System
AM-2	Suspension and Steering System
AM-3	Transmission System
AM-4	Engine Cooling System
AM-5	Engine Lubrication System
AM-6	Engine Fuel System
AM-7	Engine Distribution System
AM-8	Engine Block Unit System
AM-9	Engine Electrical System

(*) *Specialisation blocks:* this subdivision applies to occupations that may be taught in individual sections virtually independent of each other. It is particularly useful for grading operations in order of increasing difficulty, which order is observed within each block, but could not be maintained for operations in different blocks.

I OPERATIONS grouped in specialisation blocks and arranged by REFERENCE numbers.
Occupation: AUTO-MECHANICS.

Ref.	Name of Operation

BRAKING System (AM-1)

01/AM-1	Removing and replacing wheels
02/AM-1	Removing and replacing lines and tubings
03/AM-1	Preparing tubings
04/AM-1	Bleeding the braking system
05/AM-1	Removing and replacing the foot pedal unit
06/AM-1	Disassembling and reassembling brake master cylinder
07/AM-1	Disassembling and reassembling wheel hubs
08/AM-1	Disassembling and reassembling brake wheel unit
09/AM-1	Disassembling and reassembling hand brake
10/AM-1	Changing brake lining (riveted)
11/AM-1	Changing brake lining (bonded)
12/AM-1	Machining brake drums and discs
13/AM-1	Disassembling and reassembling brake disc unit

SUSPENSION AND STEERING System (AM-2)

01/AM-2	Removing rear suspension leaf spring unit
02/AM-2	Disassembling and reassembling spring unit
03/AM-2	Replacing rear suspension spring unit
04/AM-2	Disassembling independent front suspension of coil springs
05/AM-2	Inspecting independent front suspension of coil springs
06/AM-2	Reassembling independent front suspension of coil springs
07/AM-2	Balancing wheels

I OPERATIONS grouped in specialisation blocks and arranged by REFERENCE numbers.
Occupation: AUTO-MECHANICS (cont.)

Ref.	Name of the Operation
08/AM-2	Removing mechanical steering unit
09/AM-2	Disassembling mechanical steering box
10/AM-2	Inspecting parts of mechanical steering unit
11/AM-2	Reassembling mechanical steering box
12/AM-2	Replacing mechanical steering unit
13/AM-2	Aligning steering

TRANSMISSION System (AM-3)

01/AM-3	Changing the universal joints of the propeller shaft
02/AM-3	Removing gear box
03/AM-3	Replacing gear box
04-AM-3	Removing clutch
05/AM-3	Replacing clutch
06/AM-3	Disassembling and reassembling clutch pressure plate
07/AM-3	Removing differential unit
08/AM-3	Replacing differential unit
09/AM-3	Disassembling gear box
10/AM-3	Reassembling gear box
11/AM-3	Disassembling differential unit
12/AM-3	Checking components of differential unit
13/AM-3	Reassembling differential unit

I OPERATIONS grouped in specialisation blocks and arranged by REFERENCE numbers.
Occupation: AUTO-MECHANICS (cont.)

Ref.	Name of the Operation

Engine COOLING System (AM-4)

01/AM-4	Removing and replacing radiator
02/AM-4	Removing and replacing thermostat
03/AM-4	Changing water core plugs
04/AM-4	Removing and replacing water pump
05/AM-4	Disassembling and reassembling water pump

Engine LUBRICATING System (AM-5)

01/AM-5	Changing oil filter
02/AM-5	Removing and replacing ventilation system
03/AM-5	Removing oil pump
04/AM-5	Disassembling and reassembling oil pump
05/AM-5	Replacing oil pump

Engine FUEL System (AM-6)

01/AM-6	Removing and replacing gasoline tank
02/AM-6	Disassembling and reassembling gas pump
03/AM-6	Removing and replacing carburettor
04/AM-6	Disassembling and reassembling carburettor
05/AM-6	Adjusting carburation

Engine DISTRIBUTION System (AM-7)

01/AM-7	Removing and replacing intake and exhaust manifolds
02/AM-7	Removing cylinder head

I OPERATIONS grouped in specialisation blocks and arranged by REFERENCE numbers.
Occupation: AUTO-Mechanics (cont.)

Ref.	Name of the Operation
03/AM-7	Replacing cylinder head
04/AM-7	Disassembling and reassembling hydraulic valve lifters
05/AM-7	Checking cylinder head, valves and valve seatings
06/AM-7	Grinding valves and valve seatings

Engine BLOCK System (AM-8)

01/AM-8	Removing engine
02/AM-8	Replacing engine
03/AM-8	Removing connecting rods and pistons
04/AM-8	Replacing connecting rods and pistons
05/AM-8	Removing and replacing camshaft
06/AM-8	Removing and replacing crankshaft
07/AM-8	Checking camshaft
08/AM-8	Checking connecting rods, pistons and rings
09/AM-8	Checking block

Engine ELECTRICAL System (AM-9)

01/AM-9	Cleaning and checking battery
02/AM-9	Charging battery
03/AM-9	Cleaning and gapping spark plugs
04/AM-9	Disassembling and reassembling generator
05/AM-9	Disassembling and reassembling starting motor
06/AM-9	Checking ignition system
07/AM-9	Removing and replacing distributor
08/AM-9	Disassembling and reassembling distributor
09/AM-9	Testing distributor

III Corresponding table between OS and TIS directly connected.
Tentative distribution into instruction units.
Occupation: Auto-Mechanics.

OPERATION SHEETS -OS-		TECHNOLOGICAL INFORMATION SHEETS - TIS -	
Ref.	Name of Operation	Ref.	Title of Subject
BRAKING System (AM-1)			
01/AM-1	Removing and replacing wheels	-	-
02/AM-1	Removing and replacing lines and tubings	020	Braking system
03/AM-1	Preparing tubings	-	-
04/AM-1	Bleeding braking system	021	Hydraulic brakes (bled)
		022	Brake fluid
05/AM-1	Removing and replacing foot pedal system	-	-
06/AM-1	Disassembling and re-assembling brake master cylinder	023	Brake master cylinder
07/AM-1	Disassembling and re-assembling wheel hubs	024	Drum brake
08/AM-1	Disassembling and re-assembling brake wheel unit	025	Brake wheel cylinders
09/AM-1	Disassembling and re-assembling hand brake	026	Parking brake
10/AM-1	Changing brake lining (riveted)	027	Brake lining
		028	Brake lining (fixing and machining)
11/AM-1	Changing brake lining (bonded)	-	-
12/AM-1	Machining brake drums and discs	029	Drums and discs (machining)
13/AM-1	Disassembling and re-assembling brake disc unit	030	Disc brake

III Corresponding table between OS and TIS directly connected.
Tentative distribution into instruction units.
Occupation: Auto-Mechanics (continued).

OPERATION SHEEETS -OS-		TECHNOLOGICAL INFORMATION SHEETS -TIS-	
Ref.	Name of Operation	Ref.	Title of Subject

SUSPENSION and STEERING System (AM-2)

01/AM-2	Removing rear suspension leaf spring unit	031	Suspension systems
		032	Rear suspension leaf springs
		033	Shock absorbers
03/AM-2	Replacing rear suspension spring unit	-	-
04/AM-2	Disassembling independent front suspension of coil springs	034	Independent front suspension (coil spring)
05/AM-2	Inspecting independent front suspension of coil springs	-	-
06/AM-2	Reassembling independent front suspension of coil spring	-	-
07/AM-2	Balancing wheels	035	Steering systems
		036	Wheels (rims, tyres and inner tubes)
08/AM-2	Removing mechanical steering unit	037	Mechanical steering
09/AM-2	Disassembling mechanical steering box	-	-
10/AM-2	Inspecting parts of mechanical steering unit	-	-
11/AM-2	Reassembling mechanical steering box	-	-

III Corresponding table between OS and TIS directly connected.
Tentative distribution into instruction units.
Occupation: Auto-Mechanics (continued).

OPERATION SHEETS -OS-		TECHNOLOGICAL INFORMATION SHEETS -TIS-	
Ref.	Name of Operation	Ref.	Title of Subject
12/AM-2	Replacing mechanical steering unit	-	-
13/AM-2	Aligning steering	038	Steering Geometry

TRANSMISSION System (AM-3)

01/AM-3	Changing universal joints of propeller shaft	039	Transmission systems
		040	Drive shaft
02/AM-3	Removing gear box	041	Gear-box
03/AM-3	Replacing gear box	-	-
04/AM-3	Removing clutch	042	Mechanical clutch
05/AM-3	Replacing clutch	-	-
06/AM-3	Disassembling and reassembling clutch pressure plate	-	-
07/AM-3	Removing differential unit	043	Differential housing and half-axles
08/AM-3	Replacing differential unit	-	-
09/AM-3	Disassembling gear box	-	-
10/AM-3	Reassembling gear box	-	-
11/AM-3	Disassembling differential unit	044	Differential unit
12/AM-3	Checking components of differential unit	-	-
13/AM-3	Reassembling differential unit	-	-

ENGINE COOLING System (AM-4)

01/AM-4	Removing and replacing radiator.	045	Internal Combustion engine
		046	Cooling systems
		047	Radiator

III Corresponding table between OS and TIS directly connected.
Tentative distribution into instruction units.
Occupation: Auto-Mechanics (continued).

OPERATION SHEETS -OS-		TECHNOLOGICAL INFORMATION SHEETS -TIS-	
Ref.	Name of Operation	Ref.	Title of Subject
02/AM-4	Removing and replacing thermostat	048	Thermostat
03/AM-4	Changing water core plugs	-	-
04/AM-4	Removing and replacing water pump	049	Water pump
05/AM-4	Disassembling and reassembling water pump	-	-

ENGINE LUBRICATION System (AM-5)

01/AM-5	Changing oil filter	050	Lubrication systems
		051	Oil filter
02/AM-5	Removing and replacing ventilation system	052	Crankcase
03/AM-5	Removing oil pump	053	oil pump
04/AM-5	Disassembling and reassembling oil pump	-	-
05/AM-5	Replacing oil pump	-	-

ENGINE FUEL System (AM-6)

01/AM-6	Removing and replacing gasoline tank	054	Fuel systems
		055	Fuel tank
02/AM-6	Disassembling and reassembling gasoline pump	056	Gasoline pump
03/AM-6	Removing and replacing carburettor	057	Carburettor
04/AM-6	Disassembling and reassembling the carburettor	-	-

III Corresponding table between OS and TIS directly connected.
Tentative distribution into instruction units.
Occupation: Auto-Mechanics (continued).

OPERATION SHEETS -OS-		TECHNOLOGICAL INFORMATION SHEETS -TIS-	
Ref.	Name of Operation	Ref.	Title of Subject
05/AM-6	Adjusting carburation	058	Exhaust gas analyzer
		059	Tachometer

Engine DISTRIBUTION System (AM-7)

01/AM-7	Removing and replacing intake and exhaust manifolds	060	Distribution systems
		061	Intake and exhaust manifolds
02/AM-7	Removing cylinder head	062	Cylinder head
03/AM-7	Replacing cylinder head	-	-
04/AM-7	Disassembling and reassembling hydraulic valve lifters	063	Valve lifters
05/AM-7	Checking cylinder head, valves and valve seatings	064	Valves
06/AM-7	Grinding valves and valve seatings	065	Valves and valve seats (refaced)

ENGINE BLOCK System (AM-8)

01/AM-8	Removing engine	066	Engine block unit
02/AM-8	Replacing engine	-	-
03/AM-8	Removing connecting rods and pistons	067	Connecting rods, pistons, and rings
		068	Connecting rods and pistons (tools and control equipment)
		069	Cylinder ridge cutter
04/AM-8	Replacing connecting rods and pistons	-	-
05/AM-8	Removing and replacing camshaft	070	Camshaft
06/AM-8	Removing and replacing crankshaft	071	Crankshaft

III Corresponding table between OS and TIS directly connected.
Tentative distribution into instruction units.
Occupation: Auto-Mechanics (continued).

OPERATION SHEETS -OS-		TECHNOLOGICAL INFORMATION SHEETS -TIS-	
Ref.	Name of Operation	Ref.	Title of Subject
07/AM-8	Checking camshaft	-	-
08/AM-8	Checking connecting rods, pistons and rings	-	-
09/AM-8	Checking block	072	Block

Engine ELECTRICAL System (AM-9)

01/AM-9	Cleaning and checking battery	073	Electric system
		074	Battery
02/AM-9	Charging battery	075	Battery (testing instruments)
		076	Battery (chargers)
03/AM-9	Cleaning and gapping spark plugs	077	Spark plugs (cleaning and testing machine)
04/AM-9	Disassembling and reassembling generator	078	Generator
05/AM-9	Disassembling and reassembling starter motor	079	Starter motor
06/AM-9	Checking ignition system	080	Ignition system (distributor, condenser, coil and spark plugs)
		081	Stroboscopic light
07/AM-9	Removing and replacing distributor	-	-
08/AM-9	Disassembling and reassembling distributor	-	-
09/AM-9	Testing distributor	082	Distributor (testing machine)

INDEXES

TECHNOLOGICAL INFORMATION

SHEETS

(of the occupation)

III Corresponding table between OS and TIS directly connected.
Tentative distribution into instruction units.
Occupation: Auto-Mechanics (continued).

General Technological Information sheets not directly connected to Operation Sheets. (They can be included in any instruction units as seen fit by the programmer).

Ref.	TITLE OF THE TECHNOLOGICAL SUBJECT
001	Spanners and wrenches
002	Pliers (types and their applications)
003	Punches (types and their applications)
004	Cutter, flaring bit and pipe benders
005	Screw extractors (types and applications)
006	Torque wrenches
007	Cleaning materials
008	Gasoline
009	Lubricants (oils and greases)
010	Gaskets
011	Tubings
012	Lock rings
013	Ball-bearings
014	Lubrication Equipment
015	Lifting equipment
016	Air compressors
017	Dynamometers (spring)
018	Gauges
019	Automotive vehicles

NOTE: TIS's such as those of Tools, Instruments, Materials, and Equipment can be included as well.

For that, the indexes corresponding to occupations of General Mechanics should be consulted.

V TECHNOLOGICAL SUBJECTS TABLED with REFERENCE NUMBERS for AUTO-MECHANICS.

Ref.	TITLE OF TECHNOLOGICAL SUBJECT	
001	Spanners and wrenches	
002	Pliers (types and their applications)	
003	Punches (types and applications)	
004	Cutter, flaring bit and pipe benders	
005	Screw Extractors	
006	Torque Wrenches	
007	Cleaning Materials (liquids, tools and equipment)	
008	Gasoline	
009	Lubricants (oils and greases)	
010	Gaskets	
011	Tubings	
012	Lock rings	
013	Ball-bearings (types and their applications)	
014	Lubrication equipment	
015	Lifting equipment	
016	Air compressor	
017	Dynamometers (spring)	
018	Gauges	
019	Automotive vehicles	
020	Braking system	
021	Hydraulic brakes (bled)	
022	Brake fluid	
023	Brake master cylinder	

V TECHNOLOGICAL SUBJECTS TABLED with REFERENCE NUMBERS for AUTO-MECHANICS.

Ref.	TITLE OF TECHNOLOGICAL SUBJECT	
024	Drum brake	
025	Brake wheel cylinders	
026	Parking brake	
027	Brake Lining	
028	Brake lining (fixing and machining)	
029	Drums and discs (machining)	
030	Disc brake	
031	Suspension systems	
032	Rear suspension leaf springs	
033	Shock absorbers	
034	Independent front suspension (coil spring)	
035	Steering systems	
036	Wheels (rims, tyres and inner tubes)	
037	Mechanical steering	
038	Steering geometry	
039	Transmission systems	
040	Drive shaft	
041	Gear-box	
042	Mechanical clutch	
043	Differential housing and half-axles	
044	Differential unit	
045	Internal combustion engine	
046	Cooling systems	

V TECHNOLOGICAL SUBJECTS TABLED with REFERENCE NUMBERS for AUTO-MECHANICS.

Ref.	TITLE OF TECHNOLOGICAL SUBJECT	
047	Radiator	
048	Thermostat	
049	Water pump	
050	Lubrication systems	
051	Oil filter	
052	Crankcase	
053	Oil pump	
054	Fuel systems	
055	Gasoline tank	
056	Fuel pump	
057	Carburettor	
058	Exhaust gas analyser	
059	Tachometer	
060	Distribution systems	
061	Intake and exhaust manifolds	
062	Cylinder head	
063	Valve lifters	
064	Valves	
065	Valves and valve seats (refaced)	
066	Engine block unit	
067	Connecting rods, pistons and rings	
068	Connecting rods and pistons (tools and control equipment)	
069	Cylinder ridge cutter	

V TECHNOLOGICAL SUBJECTS TABLED with REFERENCE NUMBERS for AUTO-MECHANICS.

(continued)

Ref.	TITLE OF TECHNOLOGICAL SUBJECT	
070	Camshaft	
071	Crankshaft	
072	Block	
073	Electrical system	
074	Battery	
075	Battery (control instruments)	
076	Battery (chargers)	
077	Spark plugs (cleaner and tester)	
078	Generator	
079	Starter motor	
080	Ignition system (distributor, condenser coil and spark plugs)	
081	Stroboscopic light	
082	Distributor (testing machine)	

FOREWORD:

1) The following sheets will be used as a pattern for printing masters or stencils for office offset machines or mimeographs or other types of duplicators.

2) It is useful to recheck the sheets before printing the masters so that the weak lines may be retouched with either an ordinary pencil or drawing ink as well as to cover stains and imperfections with "gouache" (white tempera).

3) The additions that have to be made to the sheets, such as local codes etc., can be written on white paper blocks and stuck to their corresponding positions. The same procedure is adequate for correcting any other errors.

OPERATION SHEETS

Among the most common operations that a mechanic does, is the operation of removing and replacing wheels. This operation consists of removing them from their places and replacing them. It is an important one because it is done on a series of jobs, such as the rotation of the tyres, wheel alignment, repairing of the transmission, suspension, brakes and chassis.

METHOD OF EXECUTION:

1st step - *Place the vehicle* in the position in which it is going to be worked on.

SAFETY MEASURE:
MAKE SURE THAT THE FLOOR IS CLEAN SO AS TO PREVENT ACCIDENTS.

2nd step - *Take off the hub caps* with a lever or a pry bar.

3rd step - *Loosen the nuts* that fasten the wheels, one turn with a wheel spanner.

4th step - *Raise the front part of the vehicle* on to the axle-stand (or dumb jack) thus:-

a) Place the wedges against the rear wheels.

b) Put a jack under the centre of the front part of the chassis (fig. 1), and lift the vehicle to a height that allows the axle-stand (or dumb jack) to be fitted under it.

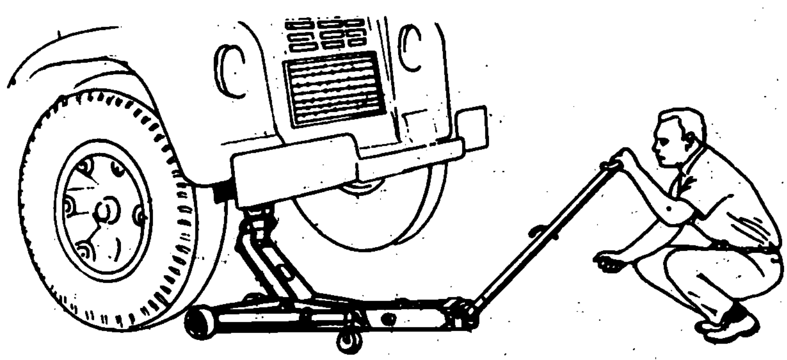

Fig. 1

REMARKS

1) Use a jack that is suited to the weight of the vehicle.

2) Choose axle-stands (or dumb jacks) best suited to the weight of the vehicle and which are tall enough to comfortably and safely work with.

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c) Place the axle-stands under suitable parts of the chassis, *one on each side.*

d) Lower the vehicle slowly until it rests on the axle-stands (or dumb jacks) and remove the jack.

NOTE:
Get aid in lowering the vehicle. This way you may guide the vehicle on to the axle-stand (or dumb jack) correctly and ensure that the wheels do not touch the floor.

SAFETY MEASURE:
ON LOWERING THE VEHICLE RECHECK THE POSITION OF THE WEDGES SO AS TO AVOID SLIPPING OR DROPPING OF THE VEHICLE.

5th step - *Raise the back part of the vehicle* on to the axle-stand thus:-

a) Remove the wedges from the rear wheels.

b) Place a jack under the centre of the axle-housing of the vehicle and raise the vehicle enough to give clearance for the axle-stand (or dumb jack).

c) Place the axle-stand under a suitable part of the chassis or axle-housing, *one on each side.*

d) Lower the vehicle slowly until it rests on the axle-stand (or dumb jack) (fig.2) and remove the jack.

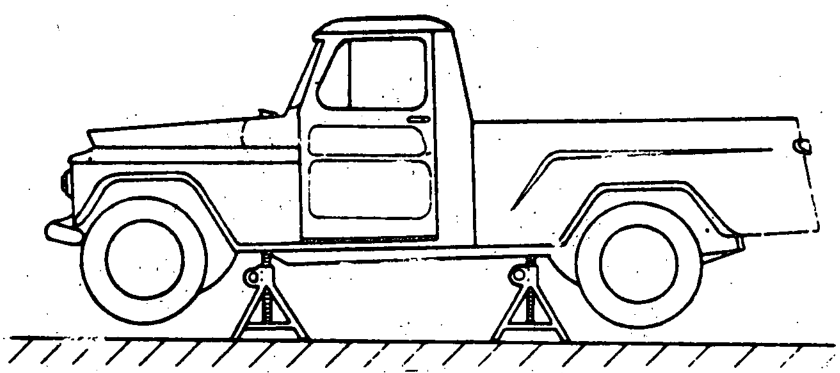

Fig. 2

6th step - *Remove the nuts* with a wheel spanner and remove the wheels.

SAFETY MEASURE:
CHOOSE THE MOST SUITABLE POSITION SO AS TO PREVENT SCRAPING, DROPPING AND DAMAGES IN GENERAL.

7th step - *Replace the wheels thus:-*

a) Place the wheels in their positions and replace the nuts.

b) Turn the nuts manually until they are fixed in their positions.

c) Use a wheel spanner to tighten the nuts.

8th step - *Remove the vehicle* from the front axle-stands (or dumb jacks) on to the ground thus:-

a) Raise the vehicle with the jack until the axle-stands can be removed.

b) Remove the axle-stands (or dumb jacks).

c) Lower the vehicle slowly and remove the jack.

SAFETY MEASURE:

WHEN LOWERING THE VEHICLE MAKE SURE THAT THERE ARE NO PERSONS OR TOOLS BELOW IT.

d) Place wedges under the front wheels.

9th step - *Lower the vehicle* from the rear axle-stands (or dumb jacks) on to the ground by repeating the previous step.

10th step - *Tighten the nuts* in the order indicated in Fig. 3 with a suitable torque wrench.

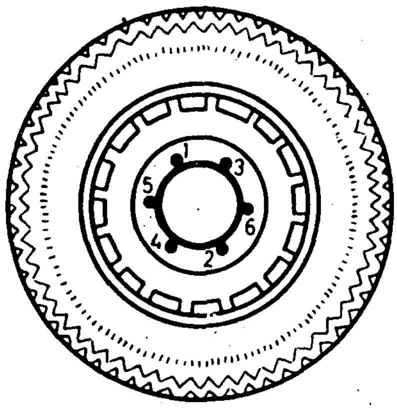

Fig. 3

NOTE:

Replace the hub caps forcing them with a hard push.

When overhauling the hydraulic braking system, the removing and replacing of tubings and lines is done to enable their replacement or repair. This operation is done when these parts are in bad shape or they obstruct the removal of another part, for example, the suspension system of the vehicle.

METHOD OF EXECUTION:

1st step - *Place the vehicle* on the pit or lift (or hoist) and wedge the wheels if necessary.

NOTE:
Use a mirror in front the pit to enable the guiding of the wheels, into their positions (fig.1).

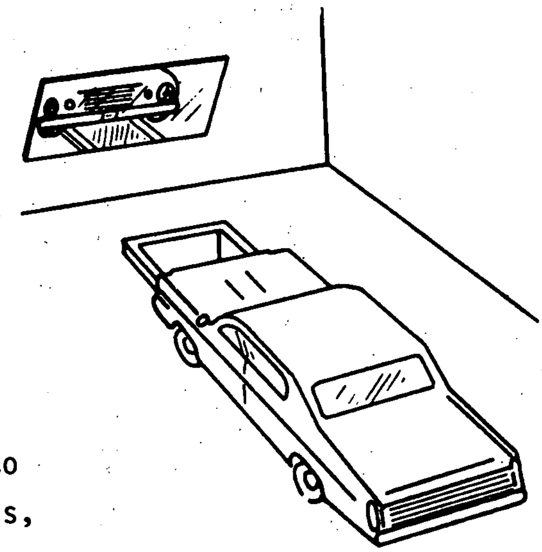

Fig. 1

SAFETY MEASURE:
MOVE THE VEHICLE SLOWLY SO AS TO PREVENT THE VEHICLE FROM FALLING INTO THE PIT.

2nd step - *Remove the lines and tubings* from the hydraulic system, thus:-

a) Disconnect the fixtures of the lines, using a back-up spanner and another spanner to turn (fig. 2).

SAFETY MEASURE:
AVOID THE SPILLAGE OF BRAKE FLUID INTO YOUR EYES.

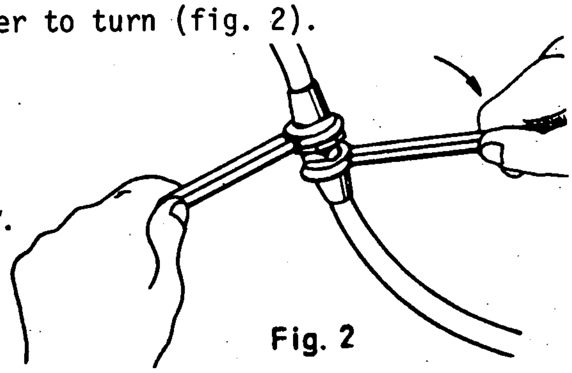

Fig. 2

b) Remove the retaining clips from the lines with the aid of a pliers or suitable tool and a hammer.

SAFETY MEASURE:
AVOID KNOCKING YOUR HANDS WHEN REMOVING THE RETAINING CLIPS.

c) Remove the clamps that secure the tubings.

3rd Step - *Clean and blow, inside and outside tubings and lines using alcohol-based fluid and compressed air.*

SAFETY MEASURE:
DO NOT ALLOW THE CLEANING LIQUID TO COME IN CONTACT WITH THE SKIN.

4th Step - *Replace the tubings and lines of the hydraulic system, thus:-*

a) Install the lines into the vehicle, securing them with their retaining clips.

b) Connect the lines or tubings to the wheel cylinders.

c) Connect the tubings to the lines, using a spanner and a back-up spanner.

d) Put on the clips of the lines using a plastic hammer.

This operation consists of flaring the ends of the tubings and giving them the right shape for installing them into the vehicle with the aim of substituting faulty tubings and to ensure air-tightness in their ends. This is done when cracks or liquid losses occur in the tubings or connections.

METHOD OF EXECUTION:

1st step - *Select the tubing*, thus:-

a) Measure the diameter of the tubing with vernier calipers.

b) Measure the length of the tubing.

NOTE:
Check whether the material of the tubing meets the manufacturer's specifications.

2nd step - *Cut the tubing thus:-*

a) Place the cutter on the tubing (fig. 1).

b) Cut the tubing in a progressive way so as to avoid its deformation.

c) Remove any burrs from the tubing (fig. 2).

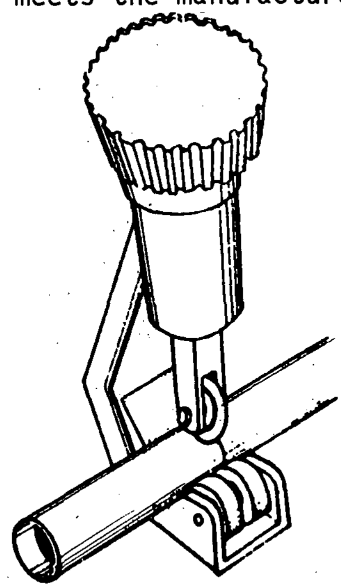

Fig. 1

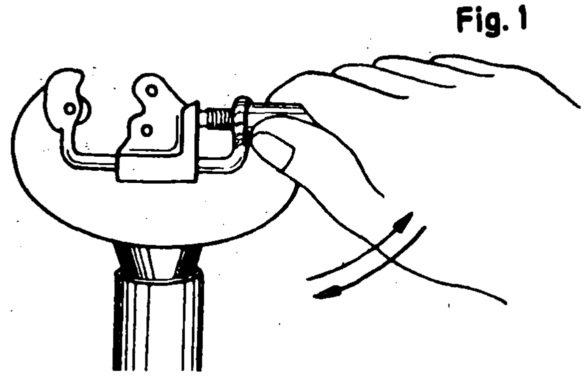

Fig. 2

SAFETY MEASURE:
TAKE CARE NOT TO DAMAGE YOUR HAND WITH THE EDGE OF THE TOOL OR WITH THE EDGES OF THE CUT TUBING.

3rd step - *Flare the end of the tubing thus:-*

a) Place the tubing between the flaring bars.

b) Place the fixtures on to the tubings.

c) Install the flaring tool on to the tubing.

NOTE:
Choose the correct size flaring tool to fit the diameter of the tubing.

d) Flare the end of the tubing (fig. 3).

NOTE:
Make sure that the flared end is the same measurement as was specified.

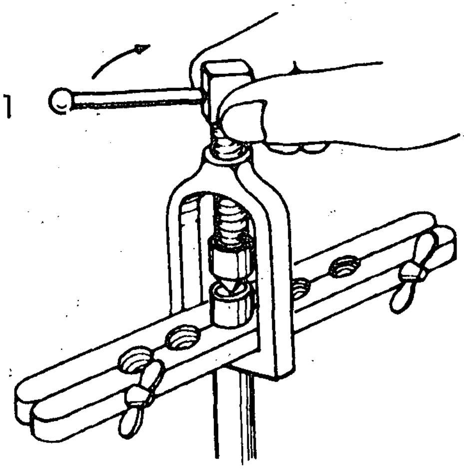

Fig. 3

4th step - *Bend the tubing* using as a reference the original tubing of the vehicle. Use the mechanical bender (fig. 4) if it is necessary.

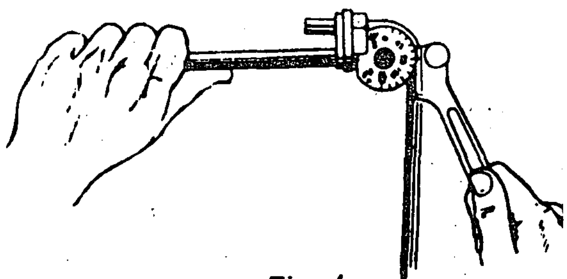

Fig. 4

This operation of bleeding the brakes allows the removal of the air that has entered into the hydraulic system, while repairing or servicing. This is done after the replacement of the tubings, and lines, and repairs such as changing the rubbers of the wheel cylinders, and of the brake master cylinder, or when the cylinder reservoir is empty.
On doing this, one should ensure that there is no air in the system, as the safety of the brakes depends on this condition.

METHOD OF EXECUTION:

1st Step - *Put the fluid in the brake system, thus:-*

a) Remove the cover from the brake master cylinder.

b) Fill the reservoir of the cylinder with fluid and place the cover of the master cylinder on, provisionally.

NOTE:

1) Prevent the fluid from falling onto the paint or upholstery of the vehicle.

2) Use fluid according to manufacturer's instructions.

SAFETY MEASURE:

AVOID STRIKING YOUR HANDS WHEN REMOVING THE COVER OF THE BRAKE MASTER CYLINDER.

2nd Step - *Remove the air from the system thus:-*

a) Connect a hose between the bleeder and the receptacle for receiving the fluid (fig. 1), on the wheel that is farthest away from the master cylinder.

b) Make the pressure within the system build up by repeatedly pumping the brake pedal.

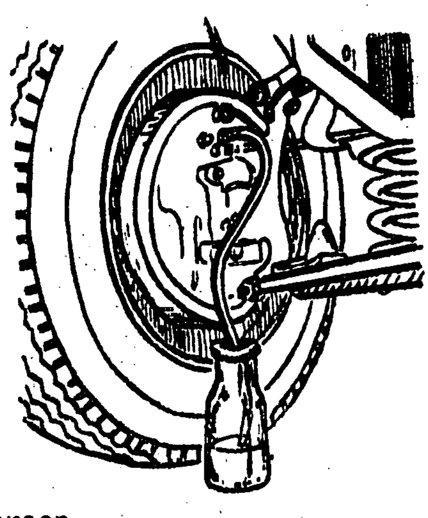

Fig. 1

NOTE:

Do this step with the aid of another person.

c) Slacken the bleeder of the braking cylinder.

d) Ensure that the fluid with the air bubbles comes out into the receptacle.

NOTE:
The presence of bubbles indicates that the air is being removed (fig. 2).

FLUID WITH AIR

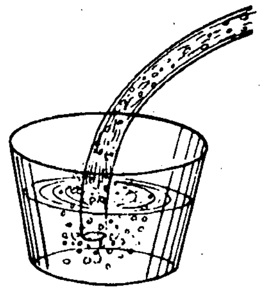

Fig. 2

e) Refill the brake master cylinder with fluid.

f) Repeat (b), (c), (d) and (e) until only fluid comes out of the bleeder.

NOTE:
Repeat the whole step with each wheel.

3rd step - *Check the travel of the pedal.*

NOTE:
If there is too much travel of the pedal, repeat the whole process of bleeding.

The efficient running of the control system of the hydraulic brakes depends, largely, on the fitting of the bushings and joints on the pedals, for which reason it is important to check these elements in any general repairing of the brakes.

METHOD OF EXECUTION:

1st step - *Remove the pedals* thus:-

a) Remove the return spring from the pedal using a pliers. (Fig. 1)

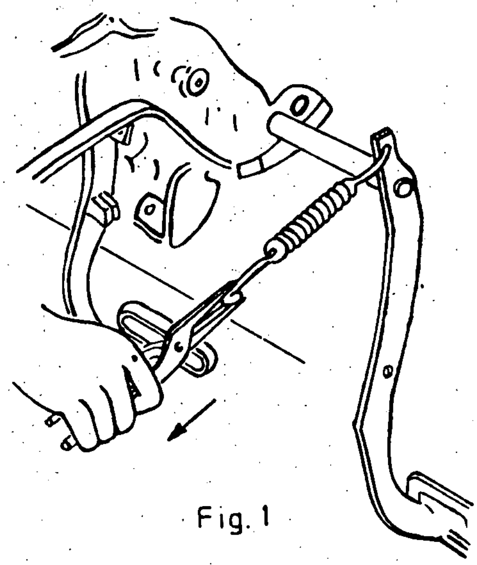

Fig. 1

SAFETY MEASURE:

BEWARE OF THE END OF THE SPRING INJURING YOUR HANDS.

b) Remove the rods that operate the master cylinder, taking out the cotter pins and bolts.

c) Take off the lock from the clevis pin of the pedals, and remove the pin, using a bronze drift punch.

NOTE:

When the lock is removed make sure that it does not spring off.

d) Remove the pedals.

2nd step - *Clean the disassembled parts.*

3rd step - *Check the disassembled parts* thus:-

a) Measure the bushings and bolts with a vernier caliper to determine the extent of wear so as to make the necessary replacements.

b) Check the springs, bolts and operating rods.

4th step - *Replace the pedals* thus:-

a) Position the pedals.

b) Replace the clevis pin of the pedals.

c) Replace the lock of the clevis pin of the pedals.

d) Replace the operating rods of the master cylinder.

e) Replace the return springs of the pedals.

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5th step - *Lubricate the joints,* while moving the pedals to check their travel.

6th step - *Adjust the play in the brake pedal,* thus:-

a) Loosen the lock nut from the adjuster of the rod of the master cylinder. (fig. 2).

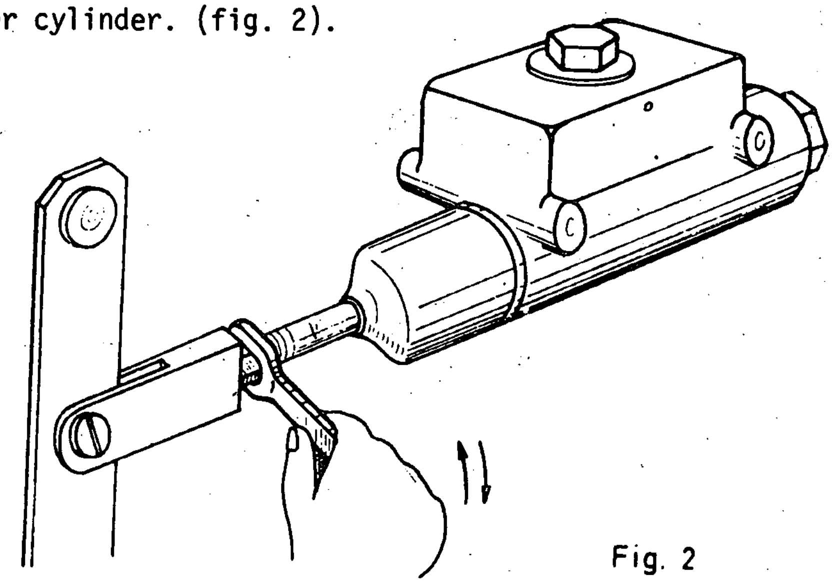

Fig. 2

b) Lengthen or shorten the adjusters depending on the play in the pedal.

c) Tighten the lock nut on the adjuster of the rod.

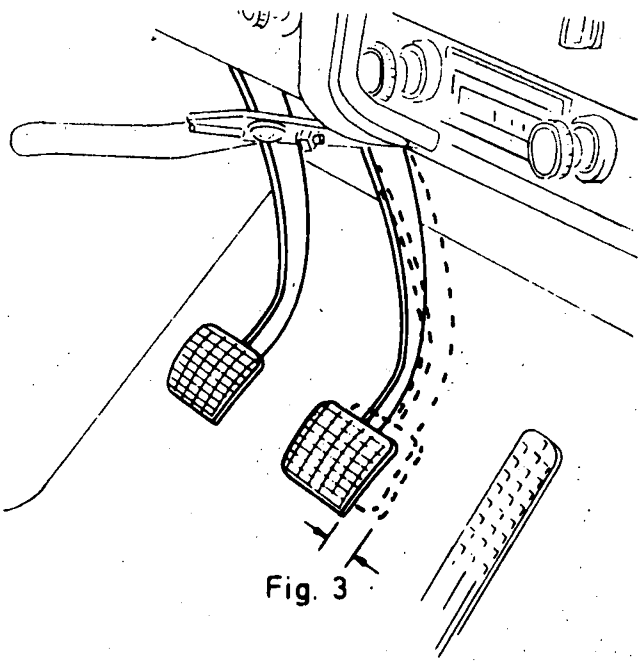

Fig. 3

Disassembling and reassembling of the brake master cylinder is an operation that a mechanic does frequently, owing to the heavy work to which it is subjected and the resulting continuous wear to its components.
This should be done every time that a general repair to the brakes is done, or in preventive maintenance of them, and consists of dismantling, cleaning, inspecting, changing and replacing its parts.

METHOD OF EXECUTION:

I TO DISASSEMBLE BRAKE MASTER CYLINDER

1st Step - *Remove the Brake Master Cylinder, thus:-*

a) Disconnect the outlet tubing from the master cylinder.

b) Disconnect the electric cables of the "STOP" light unit.

OBSERVATION
Isolate the cables so as to prevent short-circuiting.

c) Remove the securing screws from the cylinder and remove the latter from the vehicle.

2nd Step - *Clean the outside surface of the cylinder, thus:-*

a) Take off the cover from the reservoir and empty it.

b) Remove the dust cover.

c) Clean the body of the cylinder.

3rd Step - *Remove the internal parts of the cylinder, thus:-*

a) Hold the cylinder in a bench vice.

OBSERVATION
Use soft metal jaws so as to prevent damage to the body.

b) Remove the circlip while pushing down the piston to prevent it from jumping, because of the tension in the spring and, once the circlip has been withdrawn, release it slowly. (Fig. 1).

c) Remove the piston, the rubber, the spring and the valve.

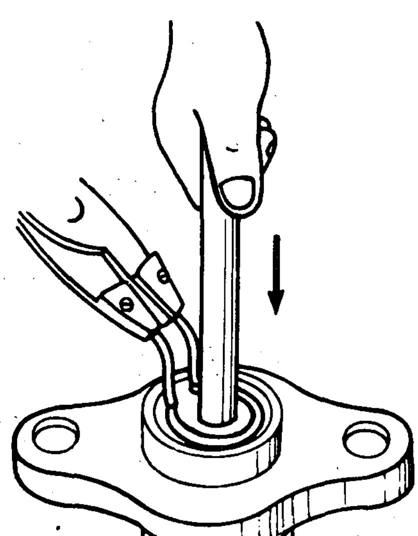
FIG. 1

4th Step - *Clean the disassembled parts, thus:-*

a) Clean all the parts and the interior of the body of the master cylinder with alcohol.

b) Dry all the parts with compressed air.

II TO REASSEMBLE BRAKE MASTER CYLINDER

1st Step - *Inspect all the parts of the cylinder, thus:-*

a) Make sure that the surfaces of the cylinder and piston are not scratched.

OBSERVATION

If there are small scratches on the interior of the cylinder, polish it with fine water-proof paper.

b) Make sure that the charge and discharge ports of the cylinder are clean.

OBSERVATION

Do not attempt to clean the ports with metallic material as this may enlarge them.

c) Check the play between the piston and cylinder according to the manufacturer's specifications (fig. 2).

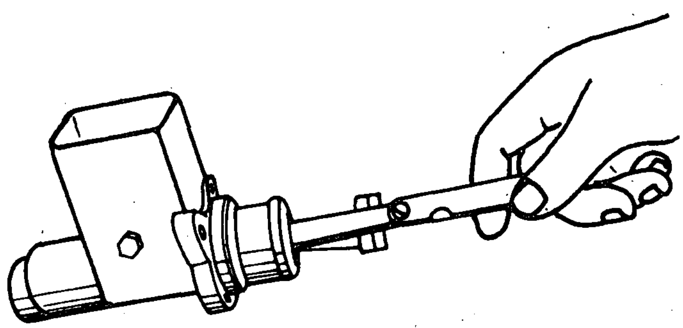

Fig. 2

OBSERVATION

Replace the rubbers every time that the master cylinder is disassembled, after they have been used.

2nd Step - *Replace the parts into the master cylinder, thus:-*

a) Lubricate the interior of the cylinder and all its parts with the same fluid that is to be used in the system.

OBSERVATIONS

1) Make sure that your hands are free of grease and dust.
2) Use a perfectly clean container to store the parts.

b) Replace the secondary rubber on the piston (fig. 3).
c) Hold the body of the master cylinder in a bench vice.
d) Replace the parts in the order indicated (fig. 4).

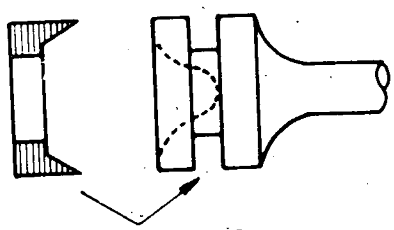

Fig. 3

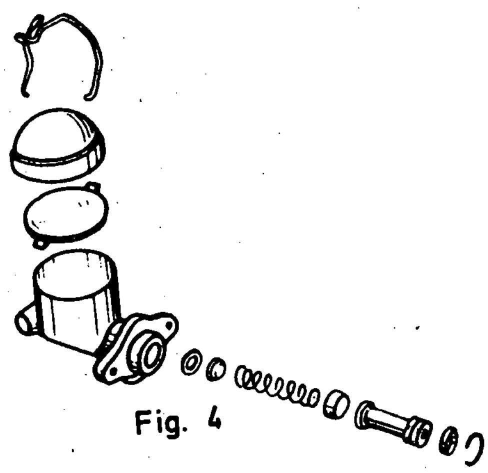

Fig. 4

OBSERVATION

To install the circlip or snap ring push the piston until the groove of its housing is uncovered.

3rd Step - *Check the working of the master cylinder, thus:-*

a) Place the master cylinder in the vice in the same position where it works when in the vehicle.
b) Fill the master cylinder reservoir with brake fluid.
c) Activate the piston until fluid flows out of the discharge port of the master cylinder.
d) Cover the discharge port and activate the piston so as to build up the pressure within the master cylinder.

OBSERVATION

Use plugs to seal the discharge port.

e) Make sure that the fluid does not come out of the rear part of the master cylinder.

4th Step - *Replace the master cylinder, thus:-*

a) Replace the brake master cylinder into the vehicle and secure it there by means of its screws.

b) Connect the outlet tubing of the brake master cylinder.

c) Connect the electric cables of the stop light unit.

OBSERVATION

Take care not to ground the cable so as to avoid short-circuiting.

It is an operation that is done periodically, in the maintaining of the hubs or when service to the brakes, suspension or steering is to be done. It consists of removing the hubs from the vehicle to check their physical state and that of their components and to be able to replace them in good working condition.

METHOD OF EXECUTION

I TO DISASSEMBLE WHEEL HUBS

1st Step - *Lift the vehicle and place it on dumb jacks.*

2nd Step - *Remove the wheels.*

3rd Step - *Remove the wheel hub from the spindle, thus:-*

a) Remove the grease cap, split pin and nut from the end of the spindle.

b) Pull the drum, approximately 2 cms. outwards, then push it back inwards and remove the washer and the outer bearing of the hub. (fig. 1).

OBSERVATION

Avoid dropping the bearings or interchanging them.

c) Remove the hub and place it on the work bench.

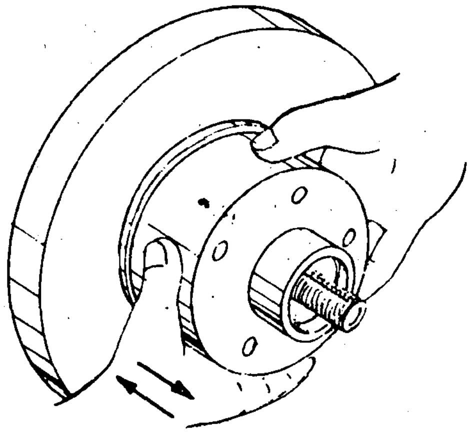

Fig. 1

4th Step - *Dismantle the components of the hubs, thus:-*

a) Remove the seal and inner bearing of the hub (fig. 2).

b) Remove the bearing races, using a bronze drift punch.

OBSERVATION

Hit each side of the bearing race alternately so that it comes out straight and does not damage the seating.

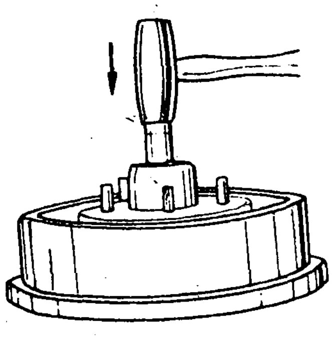

Fig. 2

5th Step - *Clean the parts, thus:-*

a) Wash the parts with a solvent and a brush.

b) Dry the parts with compressed air.

OBSERVATION

Do not spin the bearings so as to avoid damage.

II TO REASSEMBLE WHEEL HUBS

1st Step - *Inspect the parts, thus:-*

a) Check visually, that the bearing races are not broken or chipped on their rolling surfaces.

b) Make sure that the rollers are not chipped and that the bearing cage is not broken.

c) Check the threads of the wheel studs.

d) Make sure that the hub does not have distortions, cracks or fractures.

e) Check the groove of the axle head, the bearing races and the seal.

f) Check the nut of the axle head and the grease cap.

2nd Step - *Re-assemble the parts of the bearings, thus:-*

a) Install the bearing races with the aid of a bronze drift punch.

OBSERVATION

Make sure that the race enters straight.

b) Lubricate the bearings.

OBSERVATION

Use the specified grease.

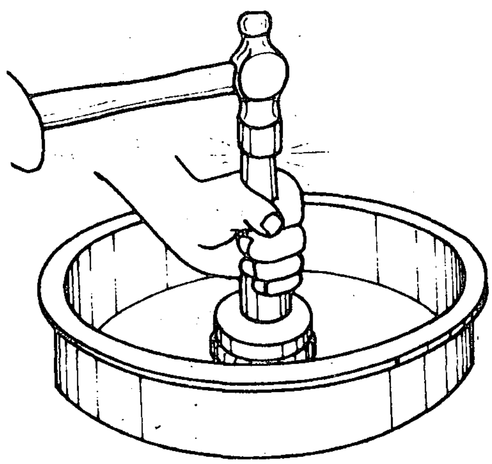

Fig. 3

c) Replace the inner bearing onto the race and replace the seal. (fig. 3).

OBSERVATION

Make sure that the seal is correctly replaced and that it is not deformed.

3rd Step - *Replace the wheel hub onto the spindle, thus:-*

a) Replace the hub and the outer bearing on the spindle.

OBSERVATION

Take care not to damage the seal.

b) Replace the washer and the nut, and preload the bearings.

OBSERVATION

Stick to the specifications when adjusting the bearings.

c) Replace the splitpin and the grease cap.

4th Step - *Replace the wheels.*

5th Step - *Lower the vehicle.*

Preventive maintenance of the braking system, so important in driving, makes it periodically necessary to take apart all the parts of the brake wheel units with the object of checking the state of these parts and for their subsequent cleaning and repair.
In doing this operation the mechanic should confine himself strictly to the specifications laid down by the manufacturers.

METHOD OF EXECUTION

I TO DISASSEMBLE BRAKE WHEEL UNIT

1st Step - *Remove the wheels and drums, thus:-*

a) Position and raise the vehicle .

b) Remove the wheels.

c) Close the adjusters of the brake shoes and remove the drums (Fig. 1).

OBSERVATION
Avoid stepping on the brake pedal when the drums have been removed.

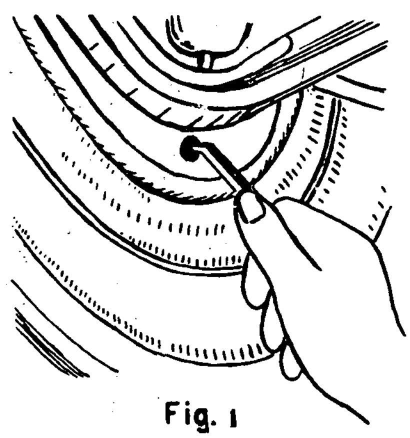
Fig. 1

2nd Step - *Remove the brake shoes, thus:-*

a) Remove the return springs of the brake shoes (fig. 2).

SAFETY MEASURE
AVOID DAMAGING YOUR HANDS WHEN REMOVING THE SPRINGS.

b) Remove the locks of the springs.

c) Push in the pistons of the brake cylinders with a spring clamp. (fig. 3).

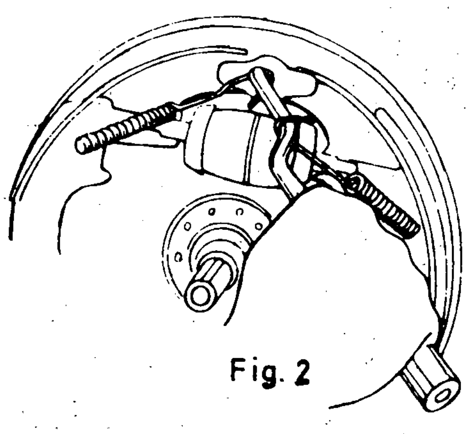
Fig. 2

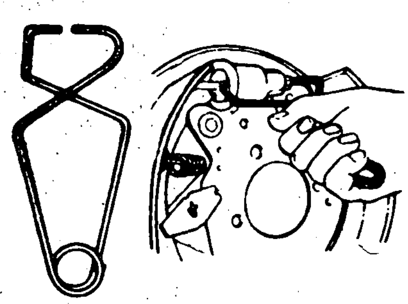
Fig. 3

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d) Disconnect the control cable of the hand brake, by pressing the spring forward and lifting the cable so as to unhook it.

e) Remove the brake shoes.

3rd Step - *Remove the brake cylinders, thus:-*

a) Disconnect the lines and tubings.

b) Remove the securing screws and remove the cylinders.

SAFETY MEASURE

AVOID SPILLING THE BRAKE FLUID ON TO THE GROUND.

4th Step - *Dismantle the brake cylinders, thus:-*

a) Remove the push rods and the dust covers.

b) Remove the pistons, rubbers and springs.

OBSERVATION

Repeat this step for each cylinder, placing the parts in separate containers so as to prevent mixing up.

5th Step - *Clean the disassembled parts, thus:-*

a) Clean the parts of the cylinder with alcohol and a brush.

b) Dry them with compressed air.

II TO REASSEMBLE BRAKE WHEEL UNIT

1st Step - *Inspect the dismounted parts, thus:-*

a) Make sure that the surfaces of the cylinders and pistons are free of scratches.

OBSERVATION

If there are small scratches on the cylinders, polish them with fine water-proof paper.

b) Check the play between pistons and cylinder with a feeler gauge according to manufacturer's specification. (fig. 4).

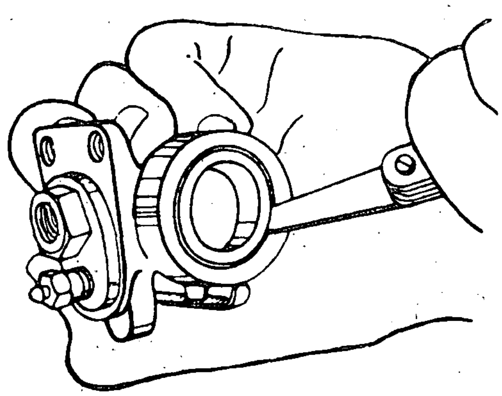
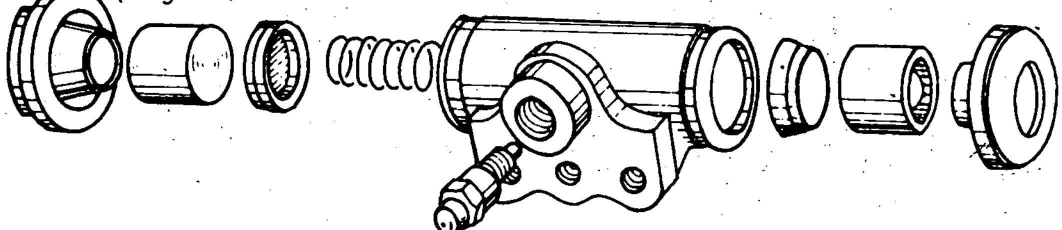


Fig. 4

2nd Step - *Assemble the brake cylinders, thus:-*

a) Lubricate the cylinders and other parts with the same brake fluid that is to be used in the system.

b) Replace the spring, the rubbers, pistons and dust covers (Fig. 5).



c) Use the spring clamp to hold the pistons and rubbers.

3rd Step - *Replace the wheel cylinders, thus:-*

a) Replace the cylinders on the brake backing plate, securing them with their screws.

b) Reconnect the lines and tubings.

4th Step - *Replace the Brake Shoes, thus:-*

a) Re-assemble the brake shoe unit, adjuster, and bottom spring. (fig. 6).

OBSERVATION
Lubricate the thread of the adjuster.

b) Replace the push rods of the brake shoe into the cylinder.

c) Replace the brake shoe unit on the plate. (fig. 7).

OBSERVATION
Lubricate the sliding supports of the brake shoes.

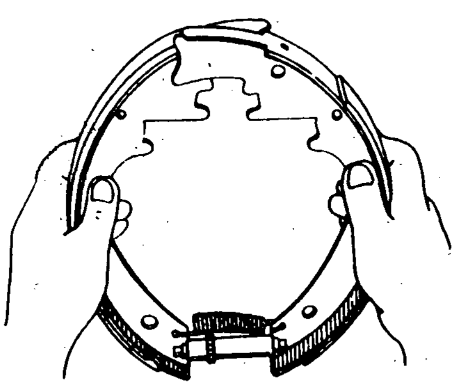


Fig. 6

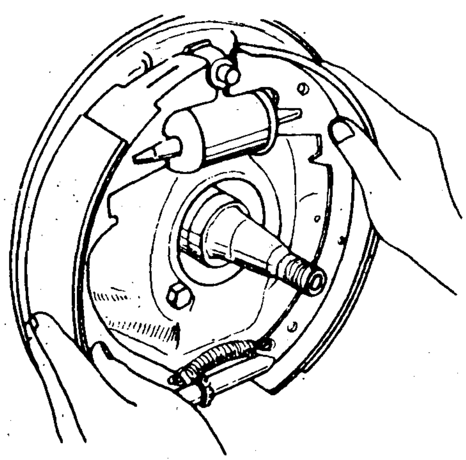


Fig. 7

d) Install the hand brake operating lever link with its spring and connect the control cable to the operating lever (fig. 8).

e) Replace the brake shoe locks .

f) Replace the anchor pin plate and the retracting springs. (fig. 9).

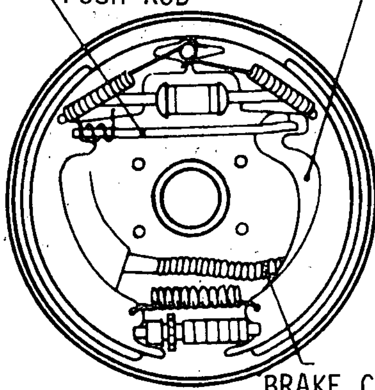


Fig. 8

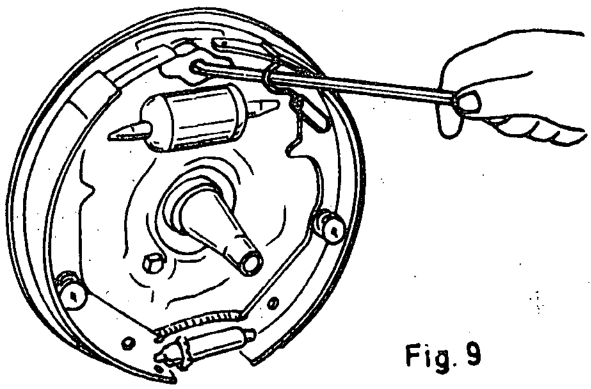


Fig. 9

OBSERVATION

Avoid deforming the hooks of the spring or stretching them more than necessary to hook them.

g) Remove the spring clamp that was used to hold the brake cylinder pistons.

5th Step - *Replace the drums and wheels.*

OBSERVATION

When replacing the drums, close the adjuster of the brake shoes.

6th Step - *Adjust the brake shoes of the brake wheels, thus:-*

a) Open the adjuster until the wheel is locked.

b) Close the adjuster until the wheel spins freely.

7th Step - *Lower the vehicle and tighten the wheels again.*

8th Step - *Bleed the system.*

CBC

OPERATION: DISASSEMBLING AND REASSEMBLING THE HAND BRAKE

Owing to the importance of the hand brake, each time that the mechanic repairs the braking system, he should remove, check, replace and adjust the components of this auxiliary mechanism. This operation also becomes necessary when the mechanism is stuck or when, having been adjusted, it does not work efficiently.

METHOD OF EXECUTION:

I TO DISASSEMBLE THE HAND BRAKE

1st step - *Remove the hand brake operating lever,* thus:-

OBSERVATION:
Before commencing the step, make sure that the lever is released.

a) Disconnect the intermediate cable (fig. 1).
b) Remove the screws which hold the operating lever and remove the lever.

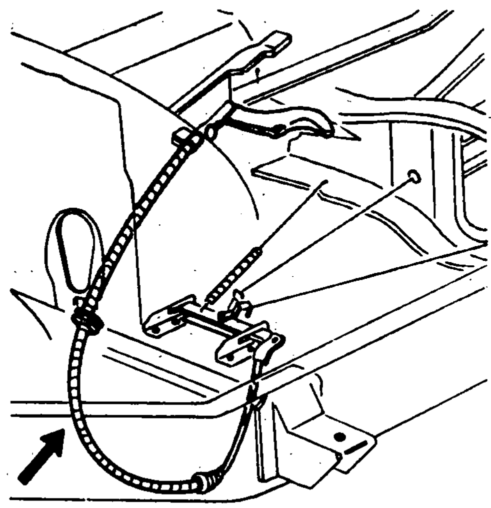


Fig. 1

SAFETY MEASURE:
Owing to the awkward position of the lever, work carefully so as to avoid damage to your hands and head.

2nd step - *Remove the intermediate cable and the relay lever,* thus:-
a) Remove the retaining clips from the intermediate cable.
b) Remove the bolt that joins the intermediate cable to the relay lever and remove the cable.
c) Disconnect the retracting spring from the relay lever.
d) Remove the bolt which joins the operating cables to the relay lever and remove the latter (fig. 2).

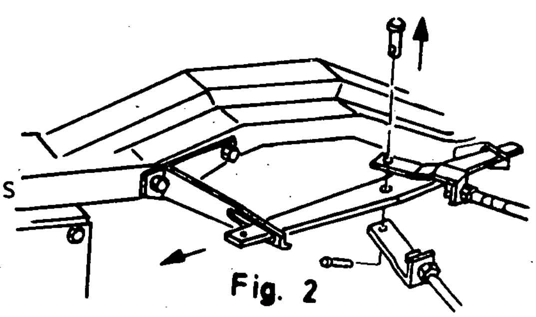


Fig. 2

3rd step - *Raise the vehicle,* remove the rear wheels and brake drums.

4th step - *Remove the control cables,* thus:-

a) Disconnect the control cables from the operation lever of the brake shoes.

b) Remove the securing screws of the housing of the control cables and remove the housing.

5th step - *Clean the dis-assembled parts,* thus:-

a) Dip the parts into a container with solvent, using a brush to finish cleaning them.

b) Blow with compressed air until the rest of the solvent is eliminated.

II TO REASSEMBLE HAND BRAKE

1st step - *Check the parts* and lubricate them, thus:-

a) Make sure there is free play among the cables within their housing.

OBSERVATION:
If there is restriction to the free play of the cables because of rusting, use a penetrating liquid.

b) Make sure that the housings are not bent or squeezed.

c) Make sure that there are no cut wires in the visible part of the cables, and that the ends, terminals, bolts and adjusters are not worn.

d) Lubricate the parts, distributing the lubricant in the housing by sliding the cable back and forth until it moves freely.

e) Make sure that the ratchet of the operating lever functions when operated.

2nd step - *Replace the control cables,* thus:-

a) Position the cables in their places and replace the securing screws onto the housings.

OBSERVATION:
Ensure that the housings will not rub against other parts of the vehicle.

b) Reconnect the control cables to the operation levers.

3rd step - *Replace the drums and the wheels.*

4th step - *Replace the relay lever* and the intermediate cable, thus:-

a) Replace the relay lever and the bolt that connects the control cables to it, and reconnect the return spring.

b) Position the intermediate cable and place its connecting bolt onto the intermediate lever.

c) Replace the retaining clips of the intermediate cable.

5th step - *Replace the hand brake control lever,* thus:-

Position the lever and replace its securing screws.

6th step - *Adjust the hand brake,* thus:-

OBSERVATION:
Before commencing this step make sure that the lever is in the brake free position.

a) Loosen the adjusting lock nut.

b) Pull the cable, while adjusting the adjuster nut, until the wheel is locked.

c) Loosen the adjuster until the wheel moves freely and tighten its locknuts.

d) Repeat this step with the other wheel.

e) Check its running, by operating the control lever.

7th step - *Lower the vehicle* and tighten the wheels.

This consists of replacing the brake shoe linings, securing them with rivets to the shoes, when they are worn, greased, crystallised or when they have completed the mileage recommended by the manufacturer.

METHOD OF EXECUTION

NOTE:
In order to avoid uneven braking, the relining of the brakes should always be done to all four wheels.

1st step - *Remove the brake shoe lining,* thus:-

a) Remove the rear brake shoes, and the operating lever of the hand brake.

b) Remove the securing rivets of the brake lining with a punch and a hammer or a riveting machine.

2nd step - *Clean the brake shoes.*

OBSERVATION:
To clean the shoes, remove the rust with a small metal brush and use the recommended solvent.

3rd step - *Inspect the shoes* (fig. 1), thus:-

a) Check the state of the holes.

b) Check the surface of the shoes that supports the brake lining.

c) Check the anchor points of the shoes.

d) Check the lining of the rib of the shoes.

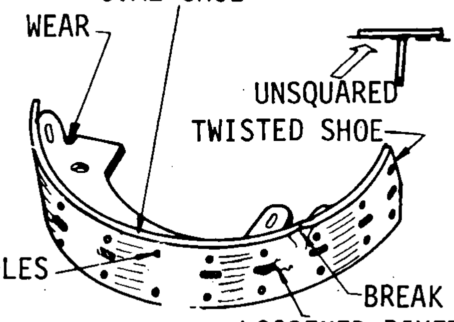


Fig. 1

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4th step - *Replace the brake lining,* thus:-

OBSERVATION:
Clean your hands and tools for this step.

a) Select the appropriate type of lining as specified by the manufacturer.

b) Measure and cut the lining, if rolls of lining are being used.

SAFETY MEASURE:
AVOID DAMAGING YOUR HANDS WITH THE SAW BLADE AND THE METAL MESH OF THE BRAKE LINING.

c) Fix the brake lining to the shoe by means of a clamp.

d) Drill and level the brake lining, using the special conical drill bit of the riveting machine.

OBSERVATIONS:
1) On chamfering the brake lining, do it to the level recommended by the manufacturer.
2) In some cases, the lining is already made for direct installation.

e) Select the appropriate type of rivets.

f) Rivet the brake lining to the shoe.

g) Rivet first the centre and then outwards as in (fig. 2).

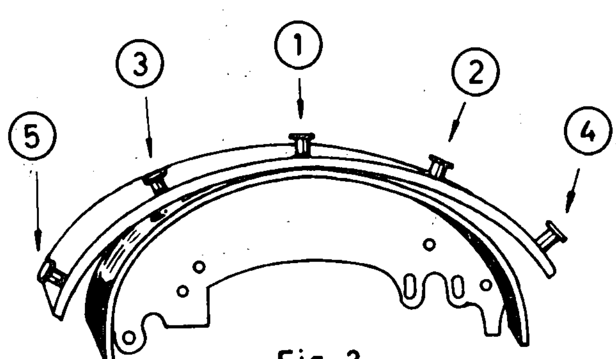


Fig. 2

5th step - *Grind the brake lining,* thus:-

a) Put the shoe into the grinding machine.

OBSERVATION:

Follow the instructions given with the brake lining grinder.

b) Adjust the machine to suit the diameter of the drum.

c) Grind the working surface of the brake lining (fig. 3).

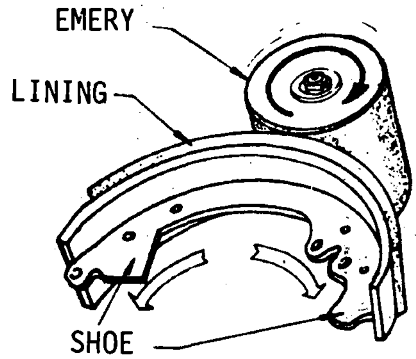


Fig. 3

SAFETY MEASURE:

AVOID INHALING THE DUST PRODUCED WHEN GRINDING.

AVOID ACCIDENTS WITH THE WHEELS OF THE GRINDER.

d) Chamfer the brake lining at its ends (fig. 4).

e) Remove the shoe from the grinder.

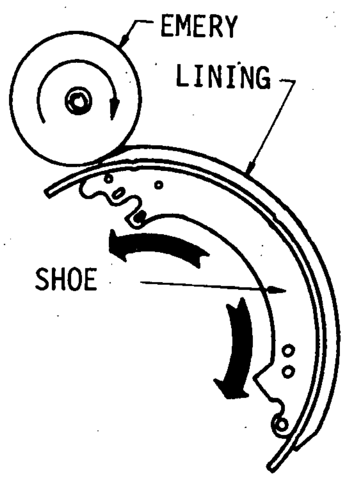


Fig. 4

This operation's objective is the replacement of the brake lining of the shoes and bonding it to them by means of a special adhesive. It is done when the lining has deteriorated or when its recommended time use has elapsed. It has to be done with maximum order and cleanliness to obtain an effective bonding job.

METHOD OF EXECUTION:

1st step - *Remove the brake lining* from the shoes, thus:-

a) Burn the adhesive from the brake lining, by placing the shoes in the bonding machine.

OBSERVATION:
Heat the oven to the temperature suggested by the manufacturer.

SAFETY MEASURE:
USE ASBESTOS GLOVES TO AVOID BURNING YOUR HANDS.

b) Remove the brake lining (fig. 1).

OBSERVATION:
Let the shoe cool to room temperature or cool it with compressed air.

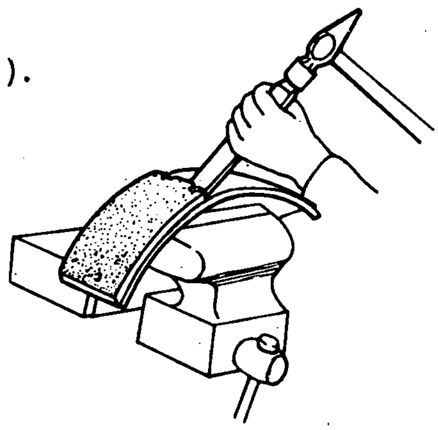


Fig. 1

2nd step - *Clean the shoes.*

3rd step - *Inspect the shoes.*

4th step - *Replace the brake lining* on to the shoes, thus:-

a) Measure and cut the brake lining.

OBSERVATION:
Select the appropriate type of lining for the bonding job.

b) Polish the surface of the shoes with sand paper or a wire brush.

OBSERVATION:
Don't touch the surfaces of the shoes and lining with dirty hands as this can damage the bonding job.

c) Put the adhesive on the shoe and lining with a brush and leave it to dry, sticking strictly to the manufacturer's specifications.

d) Use the press to hold the shoe-lining unit and place stops on the ends to prevent deformation (fig. 2).

OBSERVATION:
Make sure that the pressure produced by the press is uniform all over the surface of the lining.

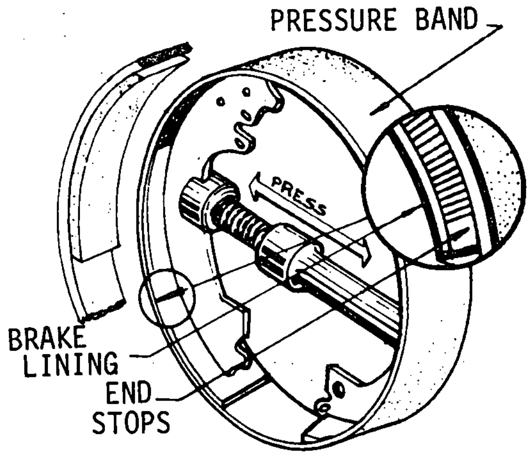


Fig. 2

5th-Step - *Bond the brake lining, thus:-*

a) Heat the oven to the temperature indicated by the manufacturer.

b) Place the shoe-lining unit in the oven.

c) Remove the shoe-lining unit from the oven, once the indicated time has elapsed.

OBSERVATION:
Let the shoe-lining unit cool to room temperature or cool it with compressed air.

d) Remove the press from the shoe-lining unit.

SAFETY MEASURE:
AVOID BURNING YOURSELF WHEN REMOVING THE SHOE-LINING UNIT FROM THE OVEN.

6th Step - *Grind and chamfer the brake lining.*

OBSERVATION:
The grinding and chamfering of the brake lining should be treated as in the riveting.

The operation of machining brake drums and discs consists of removing material from the working surface so as to restore them to working conditions.
This is done when these parts are scratched or deformed.

METHOD OF EXECUTION:

I TO MACHINE THE BRAKE DRUM

1st Step - *Remove the bearings of the hub.*

2nd Step - *Clean the drum and hub with solvent and dry with compressed air.*

3rd Step - *Inspect the drum, thus:-*

a) Check the state of the surface of the drum that comes into contact with the brake lining for crystallisation, scratches or surface cracks.

b) Measure the diameter of the drum to determine the out-of-roundness, its taper state or deformations, using a drum gauge and bearing the specifications in mind (fig. 1).

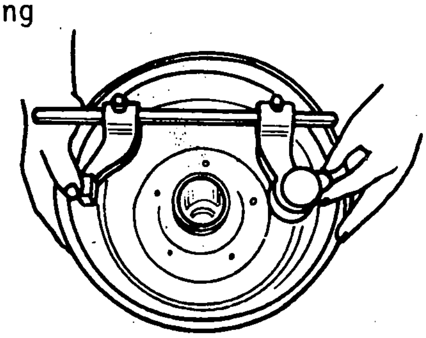


Fig. 1

4th Step - *Put the drum in the machine, thus:-*

a) Select the spindle, cone and spacers depending on the type of drum.

OBSERVATION:
For drums without hubs, special adapters suited to the machine, should be used.

b) Position and fix the spindle in the machine.

c) Place the inner cone on the spindle in the machine, as well as the drum, outer cone, spacers, washer and nut and tighten the unit.

d) Place a spring or an elastic band around the drum so as to avoid vibrations (fig. 2).

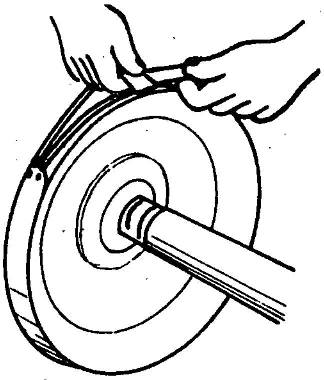


Fig. 2

5th Step - *Machine the drum, thus:-*

a) Select the cutting instrument.

b) Mount the cutting instrument (fig. 3).

c) Start the machine, bring the cutting instrument nearer and adjust the cutter.

d) Take the cut from inside to outside the drum.

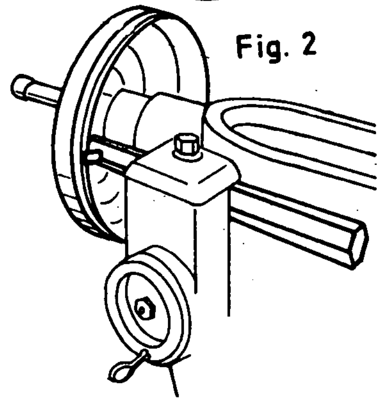


Fig. 3

OBSERVATION:
Repeat (d) until eliminating the uneveness of the drum and ensure that the measurements are within the specified limits suggested by the manufacturer.

e) Do the polishing cut, with the drum spinning at a high speed and without advancing the cutting tool too much.

f) Do the final polishing with an emery cloth, applying it with one's hand while the machine is in operation (fig. 4).

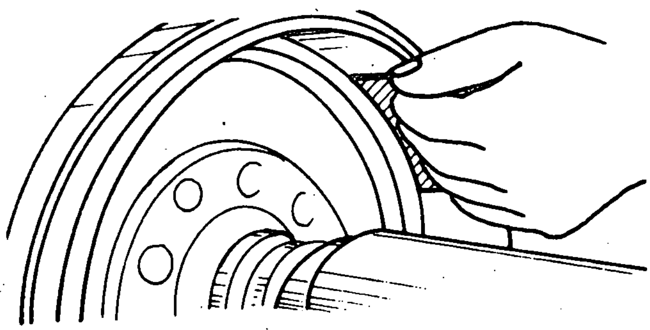


Fig. 4

6th Step - *Remove the drum from the brake drum refacing machine.*

II TO MACHINE THE BRAKE DISC

1st Step - *Clean the Brake disc.*

2nd Step - *Inspect the disc, thus:-*

a) Check the state of the surfaces of the brake pads which come into contact with the disc. Also check for crystallisation, scratches or surface cracks.

b) Measure the thickness of the disc to determine the extent of wear, with a vernier caliper.

3rd Step - *Mount the disc in the brake disc cutting machine.*

4th Step - *Machine the disc (fig. 5).*

OBSERVATIONS:

1) Bear the manufacturer's instructions in mind when mounting the equipment, cutting and in the final polishing.

2) Cut from the inner diameter to the outer one.

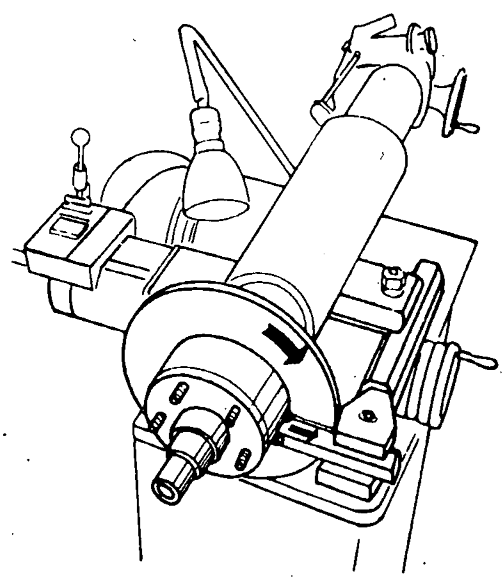


Fig. 5

This operation consists of removing and replacing the different parts of this type of brake so as to permit its cleaning, repairing, or replacing. This is done when the said parts have deteriorated or when a general servicing to the system is done.

METHOD OF EXECUTION:

I TO DISASSEMBLE BRAKE DISC UNIT

1st Step - *Remove the caliper from the brake disc, thus:-*

a) Raise the vehicle and remove the wheels.

b) Disconnect the line and remove the retaining clip.

OBSERVATION:
Cover the end of the line so as to prevent the system from leaking.

c) Remove the securing screws of the unit and put them away.

d) Clean the exterior of the unit with compressed air.

2nd Step - *Disassemble the caliper of the brake disc, thus:-*

a) Place the caliper in a bench vice, using soft metal jaws.

b) Remove the inspection cover of the caliper and remove the interconnecting tubing.

c) Remove the retaining clips and bolts from the braking plates.

d) Remove the braking pads (fig.1) and mark them so as to facilitate indentification later.

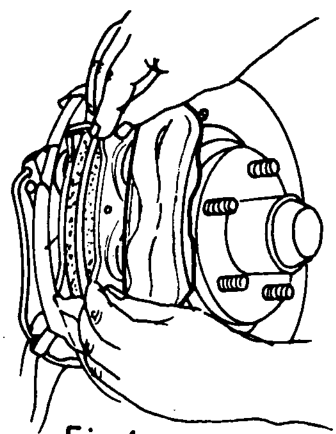


Fig. 1

OBSERVATION:
Avoid dirtying the pads or greasing them.

e) Remove the screws that hold the housings (fig. 2) and separate them.

f) Remove the dust covers (fig. 3).

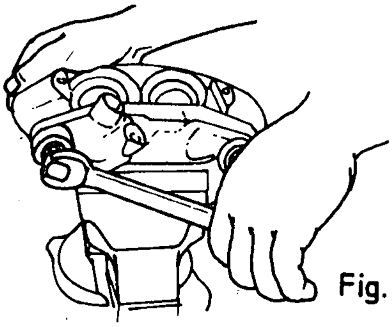


Fig. 2

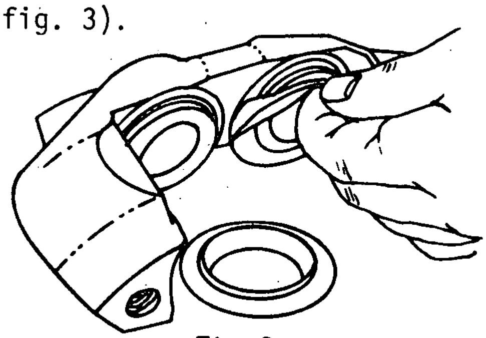
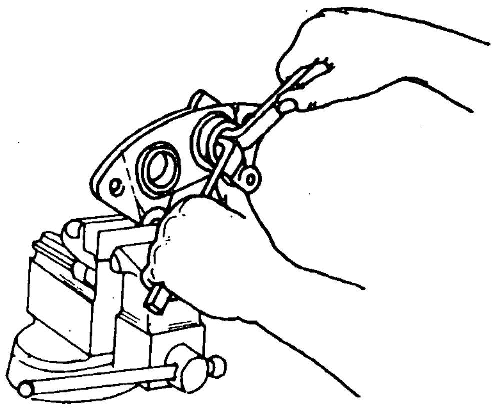


Fig. 3

g) Remove the pistons of the hydraulic system (fig. 4).



OBSERVATION:

Fig. 4

Mark the pistons so that they may be identified, taking care not to do so on the working surfaces.

h) Remove the seals from the cylinders with a fibre or a soft metal point (fig. 5).

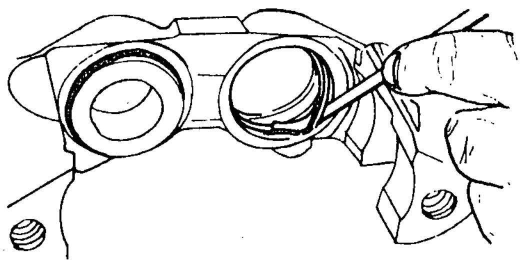


Fig. 5

3rd Step - *Clean all the parts.*

II TO REASSEMBLE BRAKE DISC UNIT

1st Step - *Inspect the parts, thus:-*

a) Make sure that the housings of the brake calipers are not worn or deformed.

b) Make sure that the retaining clips are not broken or overstrained.

c) Check that the wear to the pads does not exceed the extent recommended by the manufacturer.

d) Check the state of the cylinders and pistons making sure that they are not scratched, pitted or worn.

e) Check the state of the surface of the disc , making sure that it is not scratched, crystallised or running out. (fig. 6).

f) Ensure that the thickness of the disc is in accordance with the specifications.

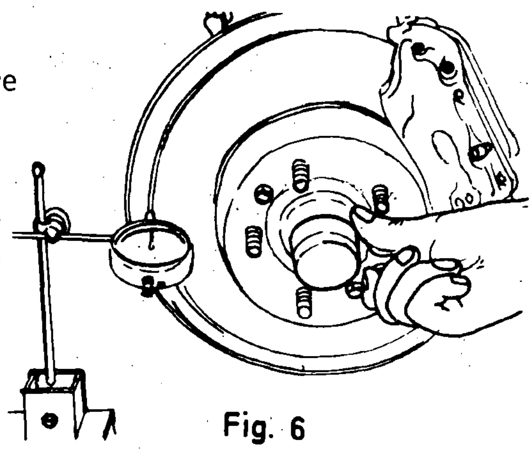


Fig. 6

OBSERVATION:

If the disc is grooved, grind it.

2nd Step *Reassemble the caliper of the brake disc, thus:-*

a) Install the seals into the cylinders (fig. 7).

b) Install the pistons into the cylinders (fig. 8).

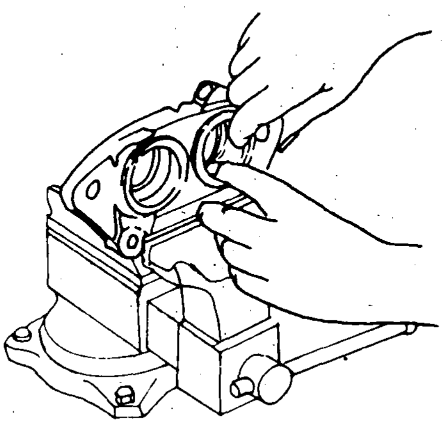


Fig. 7

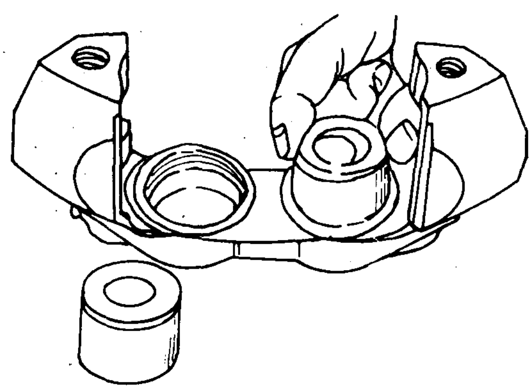


Fig. 8

OBSERVATION:

Pay attention to the position markers of the pistons allocated when the unit was dismantled.

c) Replace the dust covers of the pistons.

d) Join the housings and replace the securing screws, tightening them to the torque specified.

e) Install the interconnecting tubing.

3rd Step - *Replace the Brake Disc Caliper, thus:-*

a) Place the caliper in position and replace the securing screws, tightening them to the specified torque.

b) Place the braking pads in their position (fig. 9) and replace the retaining clips and bolts.

c) Reconnect the line and replace the clips.

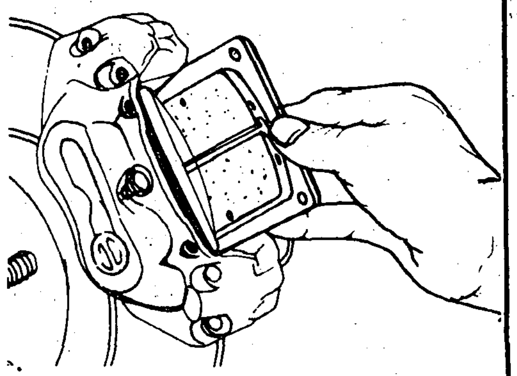


Fig. 9

4th Step - *Bleed the hydraulic system.*

OBSERVATION:
Make sure that all the air in the system has been removed by checking the travel of the pedal.

5th Step - *Check the unit, thus:-*

a) Check the clearance between the brake pads and the disc, making sure that it is within specifications (fig. 10).

b) Replace the inspection cover.

c) Replace the wheels and lower the vehicle.

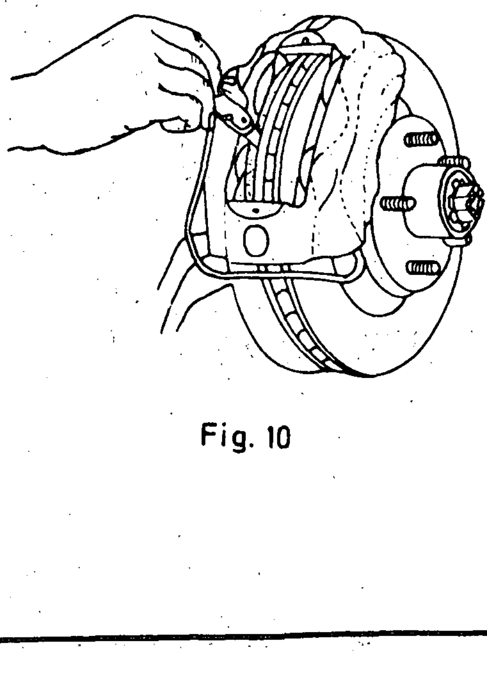


Fig. 10

On doing this operation the mechanic checks and makes the necessary replacements of the defective components of the rear suspension system.
This is done periodically to detect the faults before they cause an accident or prematurely wear the other system connected to it.

METHOD OF EXECUTION

1st Step - *Place the vehicle in its working position.*
2nd Step - *Jack the vehicle onto dumb jacks, supporting it on its frame.*
3rd Step - *Remove the rear wheels.*
4th Step - *Remove the shock absorbers, thus:-*

a) Remove the nuts that hold the shock (fig. 1).
b) Remove the shock with the aid of a lever.

5th Step - *Remove the spring system, thus:-*

a) Place a jack under the lower part of the differential housing.

OBSERVATION
Do not lift the rear axle housing, just support it.

b) Remove the nuts from the "U" bolts of the spring system (fig. 2).

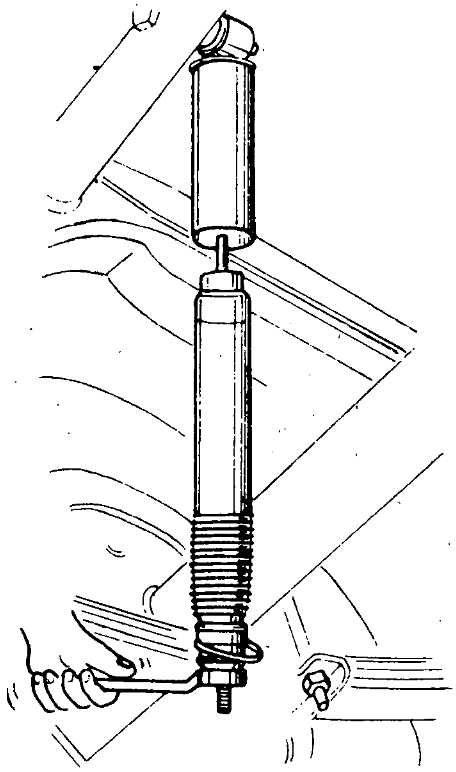


Fig. 1

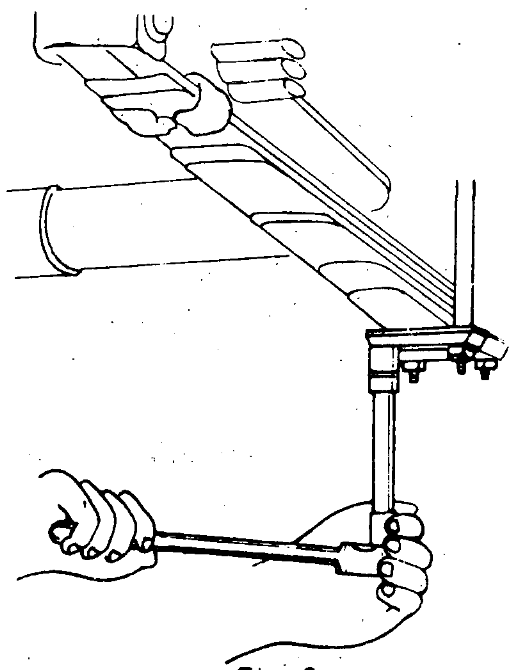


Fig. 2

c) Remove the plate and the "U" bolts of the spring system.

d) Put dumb jacks under the rear axle housing and remove the jack.

e) Remove the nuts and plates of the shackles (fig. 3).

f) Remove the shackles (fig. 4).

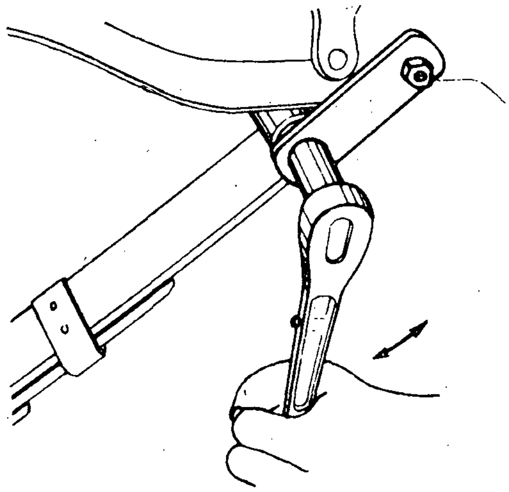


Fig. 3

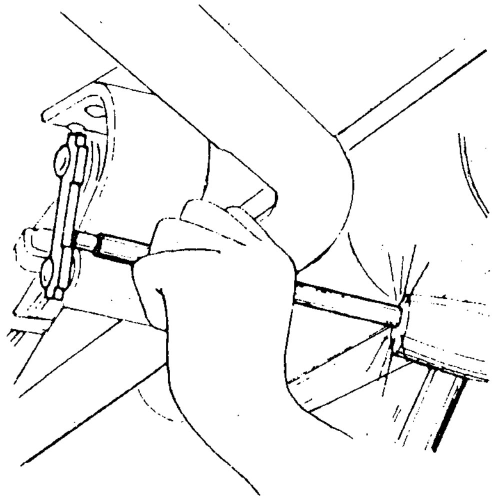


Fig. 4

OBSERVATION:

Seek aid to sustain the spring system while you remove the shackles.

SAFETY MEASURE:

MAKE SURE THAT THE SPRING SYSTEM IS FREE OF TENSION. IT CAN SPRING OUT WHEN REMOVING THE SHACKLE.

g) Remove the nut and front shackle pin (fig. 5).

OBSERVATION:

Seek aid to sustain the spring system while you remove the shackle pin.

h) Remove the spring system.

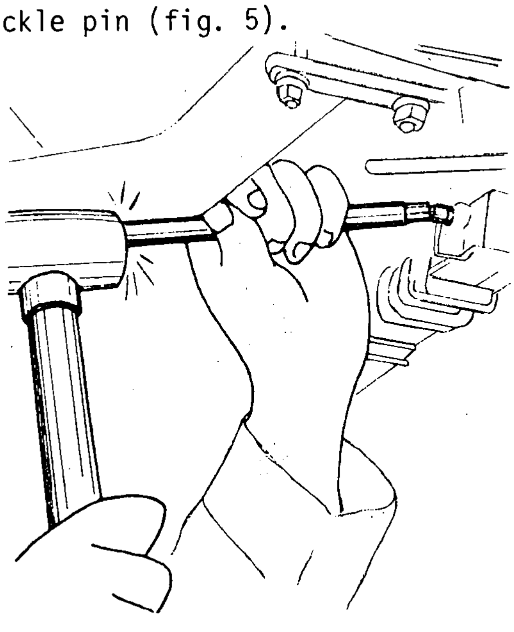


Fig. 5.

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6th Step - *Clean and inspect the parts of the rear suspension, thus:-*

a) Clean the parts using a wire brush to remove the dirt and then wash them with solvent.

b) Inspect the condition of the shocks by moving them with your hands (fig. 6).

c) Inspect the shackle bolts and the rubbers of the shock.

d) Check the U-bolts of the spring system, chase the threads and lubricate them with oil.

e) Check the free-play of the shackle bolts of the spring, using a feeler gauge, chase their threads and lubricate them with oil.

f) Inspect the rubber stops.

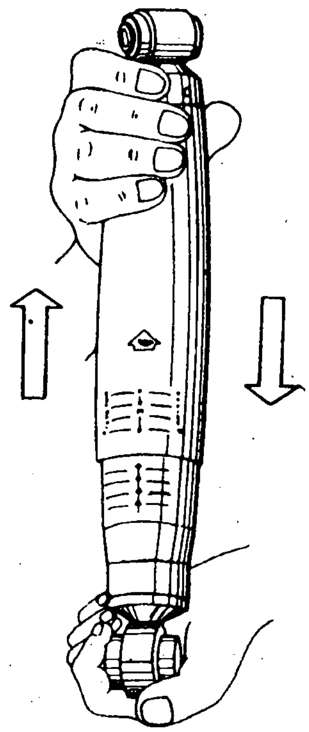

Fig. 6

This operation consists of separating the leaves which make up the spring assembly. This is done frequently to replace the broken leaves or the worn ones, to repair the "U" bolts, change the centre bolt and when giving it its periodical maintenance.

METHOD OF EXECUTION:

I TO DISASSEMBLE THE SPRING UNIT

1st Step -*Hold the spring system in a bench vice (fig. 1).*

2nd Step -*Remove the bolts from the clamps of the leaves of the spring assembly.*

3rd Step -*Remove the centre bolt, thus:-*

a) File the riveted part of the bolt.

b) Hold the head of the bolt with a vice grip pliers and remove the nut and bolt.

4th Step -*Remove the spring assembly from the bench vice.*

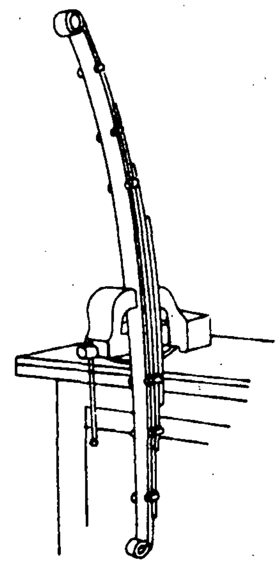

Fig. 1

SAFETY MEASURE:

OPEN THE CLAMP SLOWLY SO AS TO PREVENT THE LEAVES FROM SPRINGING OUT AND CAUSING AN ACCIDENT.

5th Step -*Separate the leaves using a lever, if necessary.*

6th Step -*Clean the leaves and wash them with solvent.*

7th Step -*Inspect the parts of the spring assembly thus:-*

a) Check the leaves of the assembly and change those that are not within the specifications in length and curvature.

b) Rivet the clamps that are loose and replace those that are broken.

c) Inspect the bushings and shackle bolt, replace them if they are not the specified type.

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II TO REASSEMBLE THE SPRING UNIT

1st Step -*Grease the leaves of the spring assembly with graphite grease.*

2nd Step -*Arrange and place the leaves on a guide bolt.*

3rd Step -*Place the spring unit in a bench vice and slowly tighten the bolt.*

OBSERVATION:
Keep the leaves aligned and centred when tightening the clamp.

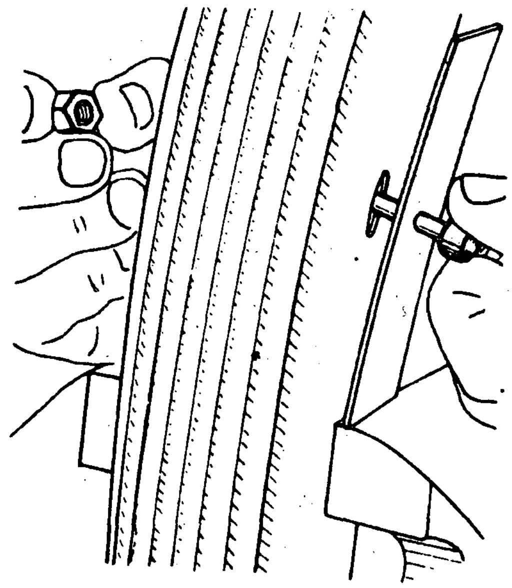

Fig. 2

4th Step -*Replace the guide bolt by the centre bolt and replace the nut (fig. 3).*

OBSERVATION:
The centre bolt should be a new one.

5th Step -

a) Tighten the nut and cut the centre bolt about 5mm from the nut with a hacksaw (fig. 3).

b) Rivet the top of the bolt with a hammer.

6th Step -*Attach the bolts to the clamps of the leaves of the spring unit.*

7th Step -*Remove the spring unit from the vice and place it on a bench.*

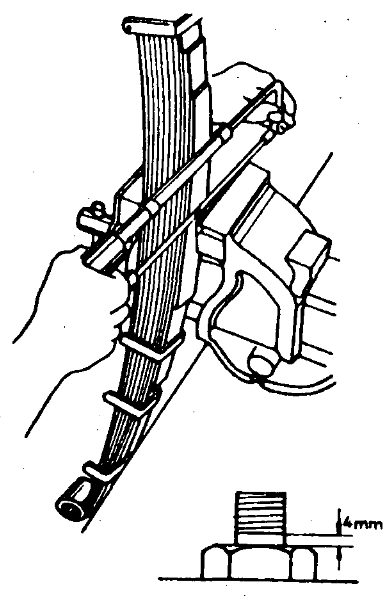

Fig. 3

It consists of replacing the parts that comprise the rear suspension after they have been repaired. This guarantees a good shock absorbing system and handling of the vehicle.

METHOD OF EXECUTION:

1st Step - *Replace the spring unit, thus:-*

a) Place the spring unit in its front hanger with its bolt (fig. 1).

OBSERVATION:
Seek aid to centre the spring unit in its position while you place the bolt with its nuts and washers.

b) Install the shackles (fig. 2).

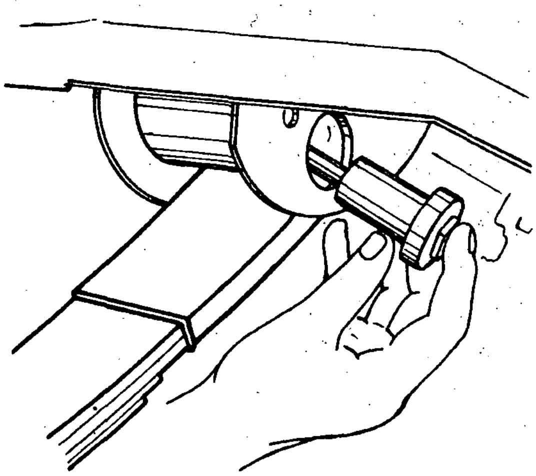

Fig. 1

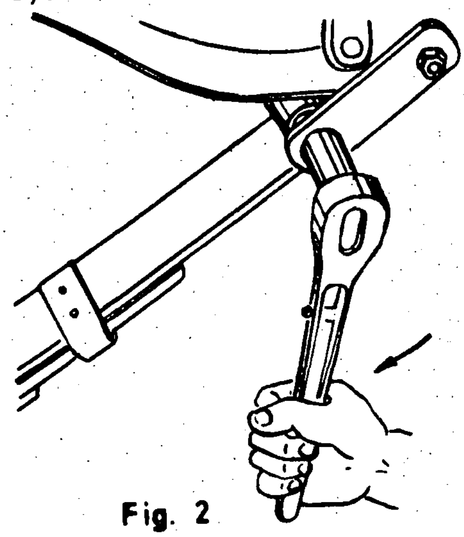

Fig. 2

OBSERVATION:
Seek aid to centre the unit while you replace the shackles and its linkage and nuts.

2nd Step - *Lower the rear axle housing, thus:-*

a) Position a jack and support the rear axle housing.

b) Remove the dumb jacks, lower the rear axle housing and remove the jack.

OBSERVATION:
Check that, on lowering the axle housing, the heads of the centre bolts of the spring units remain in their positions.

3rd Step - *Hold the rear axle housing, thus:-*

a) Install the "U" bolts.

b) Replace the "U" bolt plate of the unit and tighten the nuts (fig. 3).

OBSERVATION:
The tightening of the nuts of the "U" bolts should be done gradually to the indicated torque, according to the specifications.

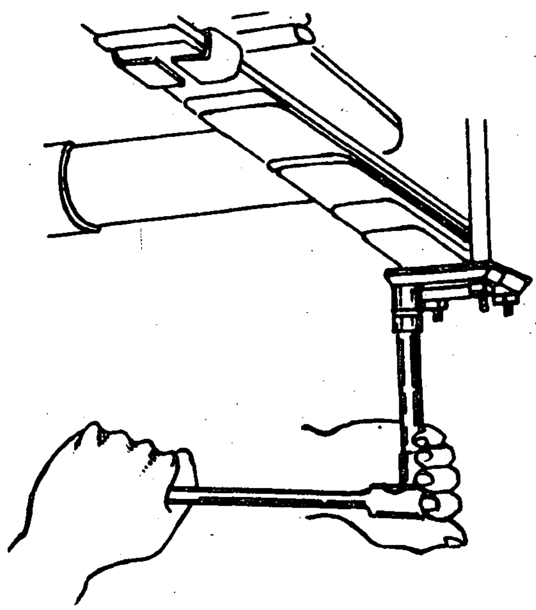

Fig. 3

4th Step - *Install the shock absorbers.*

5th Step - *Replace the rear wheels.*

6th Step - *Lower the vehicle.*

7th Step - *Tighten the nuts of the wheels and replace the hub-caps.*

Because of its construction and working characteristics, this type of suspension is one of the parts that should be periodically inspected with the object of obtaining safety, smoothness and stability in handling, for which reason the component parts should be removed.

METHOD OF EXECUTION:

1st Step *Position the vehicle and support the front part of the chassis on dumb jacks.*

2nd Step - *Remove the front wheels and remove the drums.*

3rd Step - *Remove the hub.*

4th Step - *Remove the nuts and remove the back plate, attach the back plate to the chassis with a hook.*

5th Step - *Remove the shock absorbers.*

6th Step - *Remove the bolts and disconnect the stabilizing bar.*

7th Step - *Disconnect the end of the steering bar from the steering spindle arm. (Fig. 1).*

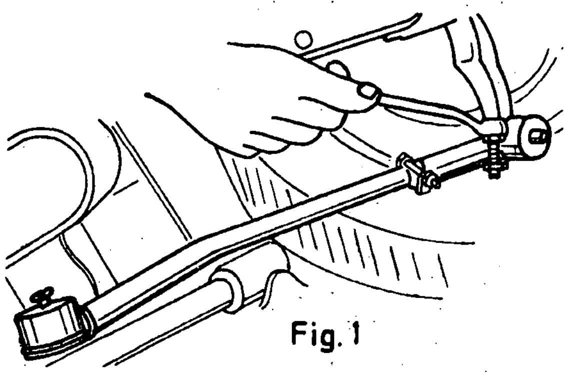

Fig. 1

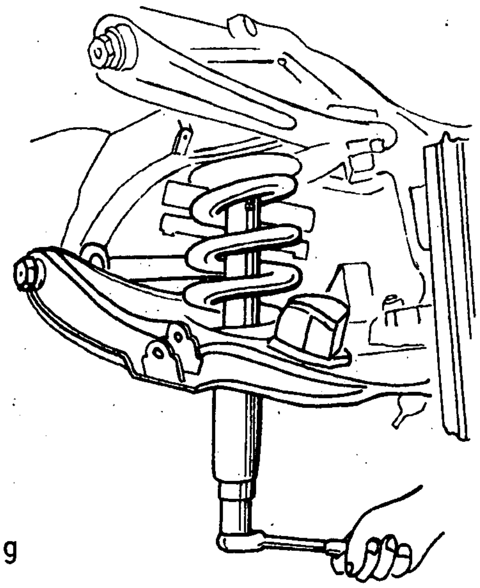

Fig. 2

8th Step - *Disconnect the lower ball joint, thus:-*

a) Install the coil spring compressor and compress the spring (fig. 2.).

b) Remove the bolts of the ball joints.

c) Turn the ball joint nuts 6 turns to the left.

d) Loosen the ball joint using the recommended tool (fig. 3).

e) Remove the nut and disconnect the lower ball joint.

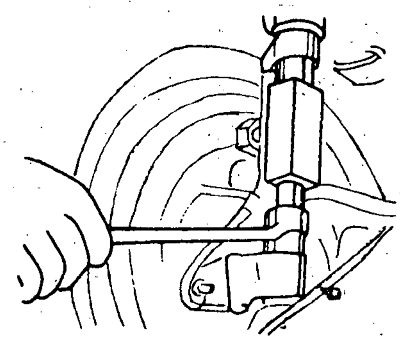

Fig. 3

9th Step - *Slowly loosen the coil spring compressor, remove it and remove the spring.*

SAFETY MEASURE:
LOOSEN SLOWLY TO AVOID THE SPRING EXTENDING VIOLENTLY OR SPRINGING FROM THE COMPRESSOR.

10th Step -*Disconnect the upper ball joint and remove the steering spindle arm.*

11th Step -*Remove the nuts of the clamps of the lower suspension arm and then remove the arm.*

12th Step -*Remove the upper suspension arm from its anchor bolts.*

OBSERVATION:
Avoid mixing up the adjusting shims and mark them according to their corresponding places.

13th Step -*Remove the bushings and suspension arm pivots (fig. 4).*

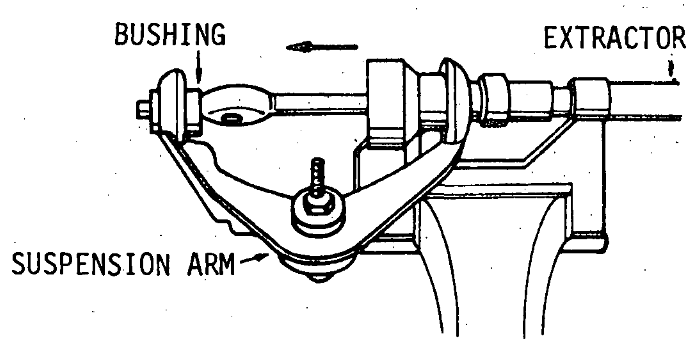

Fig. 4

CBC	**OPERATION:** INSPECTING INDEPENDENT FRONT SUSPENSION OF COIL SPRINGS	**REF.** OS 05/AM-2	1/1
		Caribbean	

Owing to the great importance placed on the safety and comfort aspects of a vehicle, and as this system is connected to the braking and steering systems, the parts of the unit should be subjected to a rigorous inspection, whether visual or with instruments to detect the faults in the parts every time that the unit is disassembled for repairing.

METHOD OF EXECUTION:

1st Step - *Inspect the coil springs, thus:-*

a) Check the length of the springs according to specifications.

b) Make sure that they are not cracked, broken or deeply rusted.

c) Make sure that their spiral twists are not damaged.

d) Check its squareness.

e) Inspect its housing and rubber insulators.

2nd Step - *Check the suspension arms, thus:-*

a) Make sure that they are not cracked, broken or twisted.

b) Check the bushing of the bolts on the suspenion arms.

c) Inspect the ball joint housing.

3rd Step - *Check the pivots, bushings, and ball joints of the suspension arms. (fig. 1).*

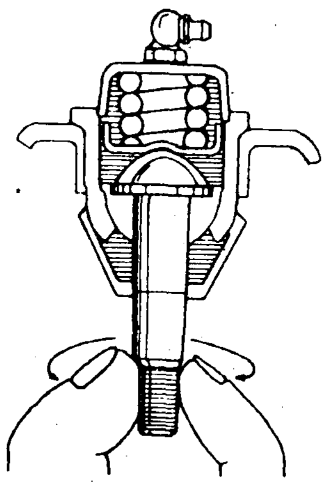

Fig. 1

4th Step - *Inspect the securing holes of the suspension arms.*

5th Step - *Inspect the rubber stops.*

6th Step - *Check the steering spindles, thus:-*

a) Check the bearings housing.

b) Check the race of the grease retainer.

c) Check the grooves of the axle head.

d) Make sure that they are not twisted, cracked or broken.

7th Step - *Check the shock absorbers.*

8th Step - *Check the hubs.*

For the suspension to attain a safe working condition, its parts should be assembled, with the manufacturer's specifications in mind, and after the faulty parts have been repaired or replaced.

METHOD OF EXECUTION:

1st Step - *Install the bushings and pivots in the suspension arms, thus:-*

a) Hold the suspension arm in a bench vice.

b) Replace the pivot.

c) Install the bushings (fig. 1).

d) Make sure that the pivot of the suspension arm remains centred (fig. 2).

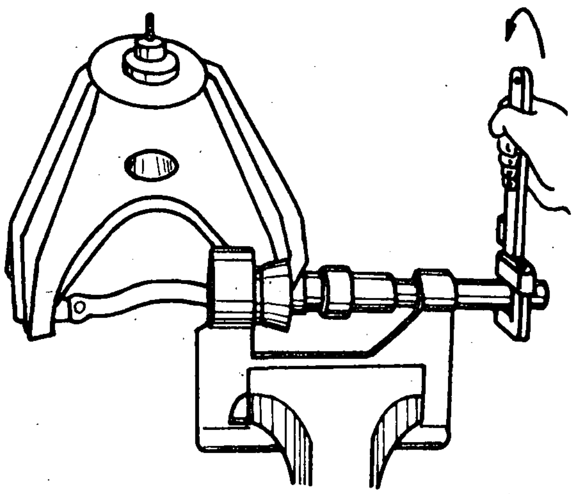

Fig. 1

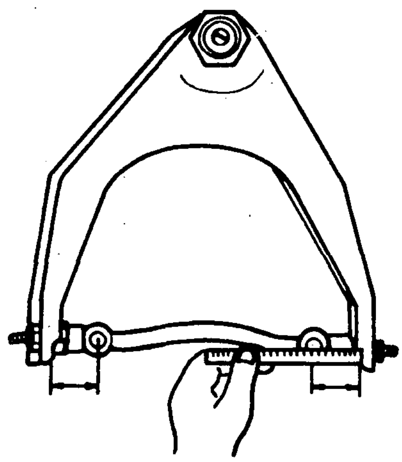

Fig. 2

2nd Step - *Place the hub on a bench vice.*

3rd Step - *Install the suspension arms, thus:-*

a) Replace the upper suspension arm.

OBSERVATION:
Place the adjusting shims of the steering arms in the same position that they occupied when they were removed.

b) Tighten the nuts alternately to the torque specified.

c) Install the lower suspension arm.

d) Tighten the clamps alternately and give it the specified torque.

4th Step - *Assemble the steering spindle to the upper ball-joint, thus:-*

a) Install the steering spindle into the upper ball-joint.

b) Replace the nut of the ball-joint and tighten it to the specified torque.

c) Install the split pin of the nut and secure it.

5th Step - *Install the coil spring, thus:-*

a) Install the coil spring in the housing of the lower suspension arm.

OBSERVATION:

Make sure that the coil spring is properly centred in its housing.

b) Install the spring compressor (fig. 3).

c) Compress the spring slowly until the lower ball-joint is connected to the steering spindle.

d) Replace the nut and tighten to the specified torque.

e) Put in the split pin of the nut and secure it.

f) Slowly loosen the spring compressor and remove it.

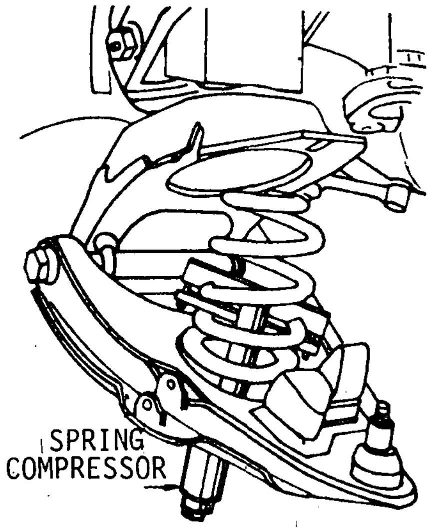

Fig. 3

OBSERVATION:

Check the positioning of the spring in its housing.

6th Step - *Install the shock absorber.*

7th Step - *Replace the stabilizing bar and the ends of the bar to the steering spindle.*

OBSERVATION:

Tighten to the specified torque and secure the nut with split pins.

8th Step - *Replace the back plates, tightening the nuts alternately to the specified torque.*

9th Step - *Replace the hub.*

10th Step - *Replace the brake drums and the wheels.*

11th Step - *Lower the vehicle and tighten the wheel nuts.*

The wheels, like all other rotating parts, need to be balanced. For this reason BALANCING is done. This consists of dynamically and statically balancing the wheels adding lead conterweights.
This should be done every time the tyres are changed, and when aligning the steering or when there appears to be vibration in the steering system of the vehicle.

METHOD OF EXECUTION:

I DYNAMIC BALANCING

NOTE:
Follow the manufacturer's instructions for the correct use of the balancing machine.

1st Step - *Mount the wheels on the balancing machine, thus:-*

a) Remove the counterweights from the wheels.

b) Carefully clean the wheel using a brush and water to remove foreign matter.

OBSERVATION:
This is done to avoid mistakes, or to prevent them from unfastening during the process of dynamic balancing.

c) Select the flange of the machine that corresponds to the wheel.

d) Mount the flange onto the hub of the machine (fig. 1).

e) Fix the wheel to the flange (fig. 2).

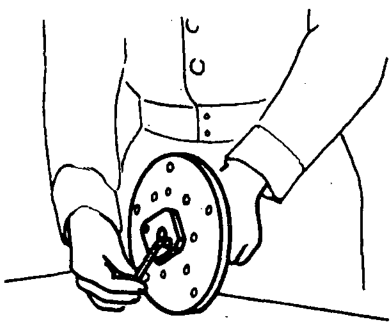

Fig. 1

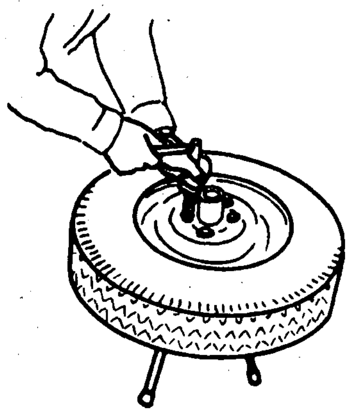

Fig. 2

f) Mount the unit on the axle of the machine (fig. 3).

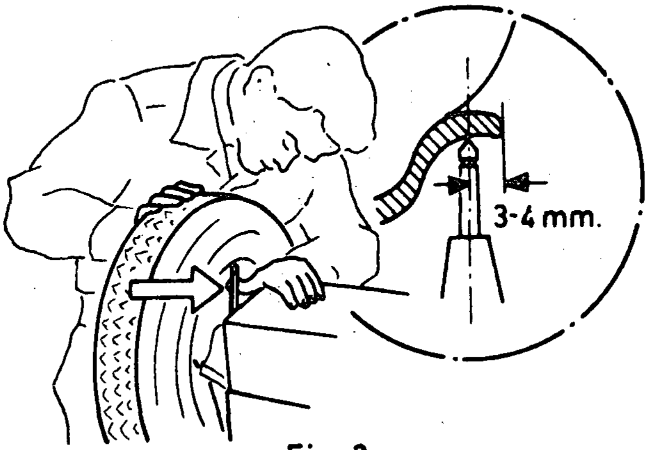

Fig. 3

g) Squeeze the hub with your hand.

2nd Step - *Check the balance of the wheel, thus:-*

a) Start the machine.

b) Stop the machine, take the reading of the counterweight and locate the position where it is going to be fitted (fig. 4).

c) Select the counterweight indicated by the machine and fit it on (fig. 5).

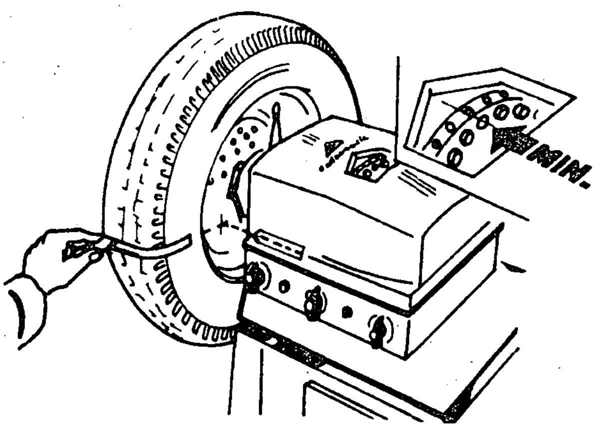

Fig. 4

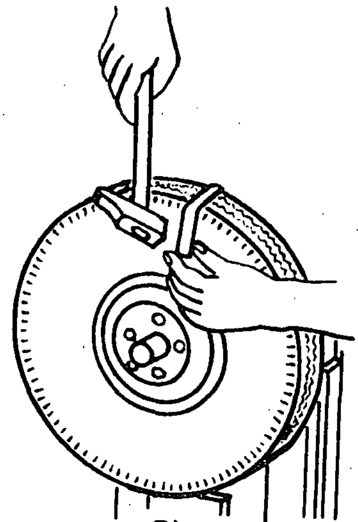

Fig. 5

OBSERVATION:
Check the fitting of the counterweights to prevent them from unfastening.

3rd Step - *Check the dynamic balancing by repeating Step 2.*

II STATIC BALANCING

1st Step - *Locate and position the counterweights, thus:-*

a) Spin the wheel slowly and wait for it to stop.

b) Mark the tyre with chalk where the meter indicates it (fig. 6).

c) Tentatively select a magnetic weight and place it in the inside of the tyre where the chalk mark indicates, then turn the wheel 90^{0} and observe if it maintains this position (fig. 7).

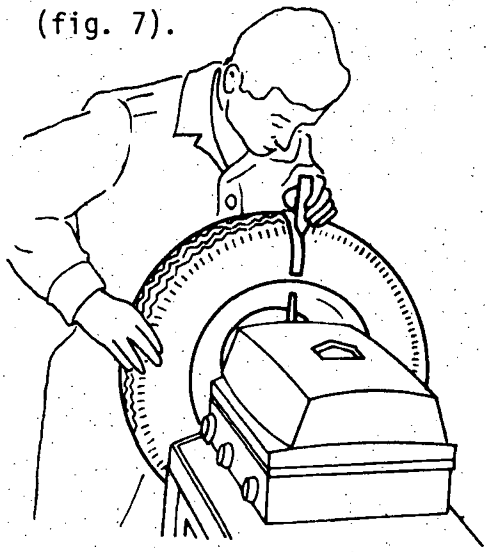

Fig. 6

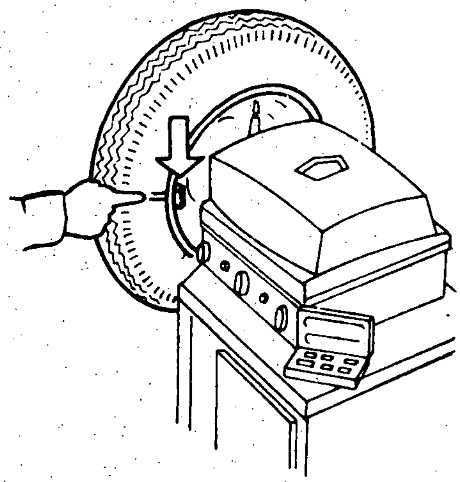

Fig. 7

d) Remove the magnetic weight and replace it with an equivalent lead counterweight (fig. 8).

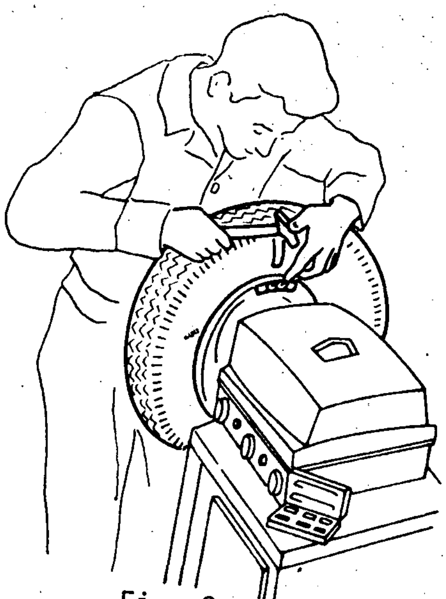

Fig. 8

2nd Step - *Remove the wheel from the balancer, thus:-*

a) Loosen the hub and remove the wheel.

b) Remove the bolts from the wheel and remove the flange with the hub.

c) Remove the bolts from the hub and separate it from the flange.

This operation is done when the steering is faulty and vibrating or premature wear to the tyres exists. To correct these faults it is necessary to disassemble the steering unit components to inspect, adjust and repair them.

METHOD OF EXECUTION:

1st Step - *Position the vehicle over a pit.*

2nd Step - *Remove the steering wheel, thus:-*

a) Disconnect the ground cable of the battery.

b) Remove the horn button.

c) Remove the screws which hold the horn button plate and remove it.

d) Remove the nut of the steering shaft.

e) Position the extractor and remove the steering wheel (fig. 1).

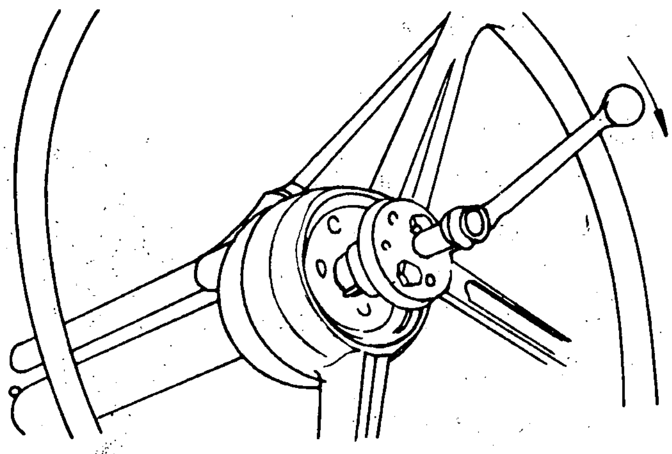

Fig. 1

OBSERVATION:
It may be necessary, as the extractor is tightened, to hit the top of the extractor screw with a hammer.

f) Remove the spring of the steering shaft.

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3rd Step - *Remove the steering column, thus:-*

a) Remove the securing screws of the gear selector lever.

b) Disconnect the cable from the horn.

c) Remove the screws from the bracket of the gear selector box (fig. 2).

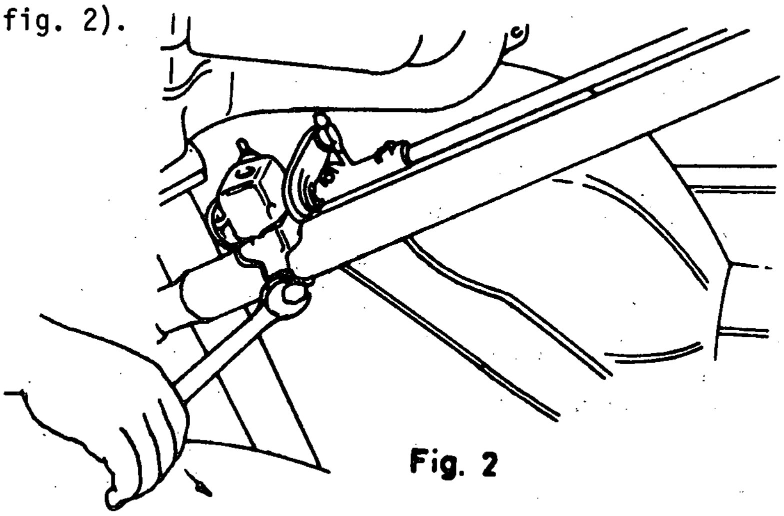

Fig. 2

d) Remove the nut, place the extractor and disconnect the intermediate rod from the end of the pitman arm.

e) Remove the nut from the pitman arm, install the extractor and remove the pitman arm (fig. 3).

OBSERVATIONS:

1) If the pitman arm is not marked with the sector, make one so as to enable it to be replaced in the same position.
2) It may be necessary to hit the top of the extractor screw with a hammer, while the pitman arm is being extracted.

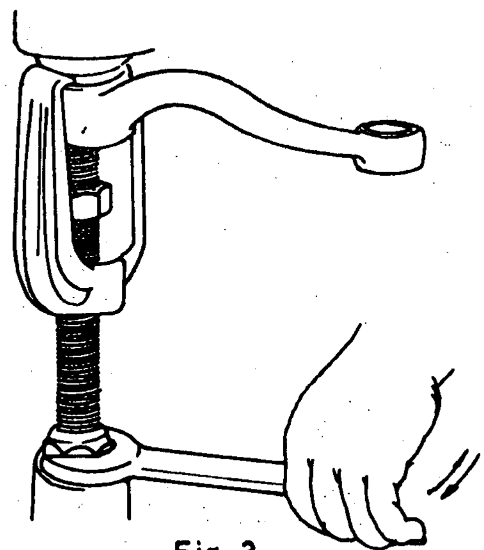

Fig. 3

f) Remove the clamp from the steering column to the panel.

g) Remove the screws which hold the steering box to the chassis.

h) Remove the steering column, removing it from the chassis, taking it out from under the vehicle.

4th Step - *Remove the steering rods and joints, thus:-*

a) Remove the nuts, position the extractor and remove the idler arm from the idler shaft.

b) Disconnect the intermediate rod from the idler arm.

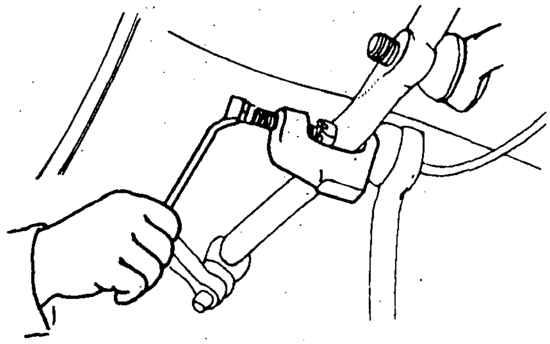

Fig. 4

c) Remove the anchor bolts and remove the intermediate rod from the chassis.

d) Place the idler arms in a bench vice with soft metal holders.

e) Loosen the clamps from the ends of the rods.

f) Remove the ends from the rods.

g) Remove the shaft from the intermediate rod (fig. 5).

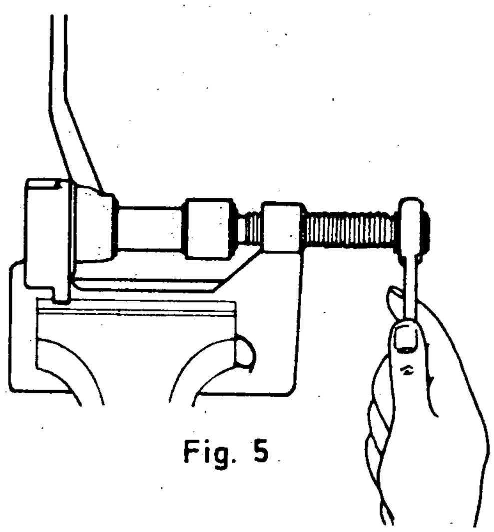

Fig. 5

This operation consists of disassembling the parts that make up the steering box, the principal component of the steering mechanism, to inspect, adjust or change the defective parts.

METHOD OF EXECUTION:

1st Step - *Remove the sector, thus:-*

a) Place the steering box in a bench vice; position the soft metal holder and tighten it, not so tight as to deform it.

b) Remove the lock nut from the adjusting screw of the sector (fig. 1).

c) Remove the bolts from the cover of the sector.

OBSERVATION:
Place a tray to collect the oil from the steering box.

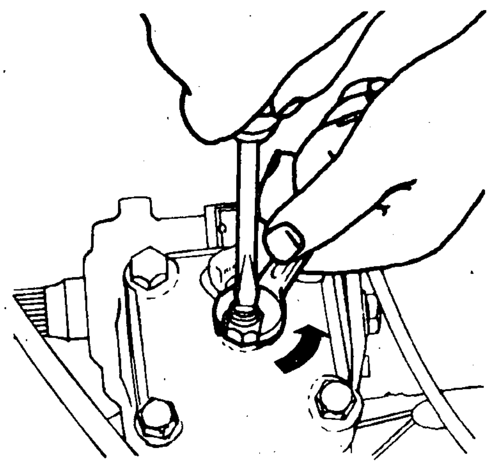

Fig. 1

d) Turn the adjusting screw of the sector clockwise and remove the cover.

e) Centre and remove the sector (fig. 2).

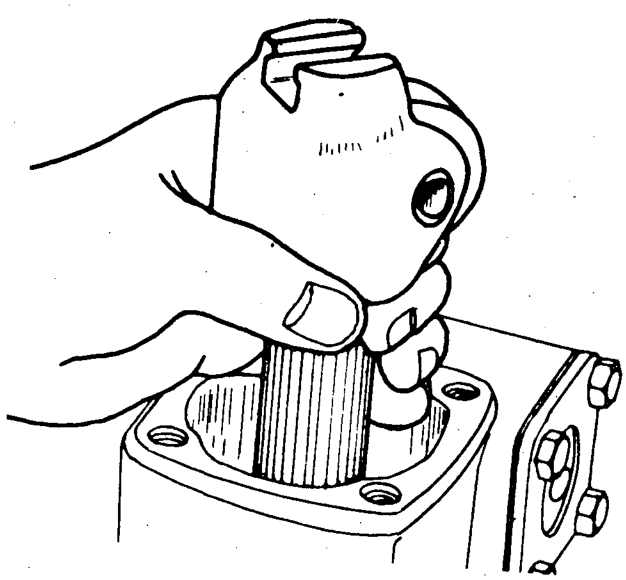

Fig. 2

2nd Step - *Remove the worm shaft, thus:-*

a) Remove the bolts from the lower cover of the steering box and remove it.

OBSERVATION:
Take care not to damage the adjustment shims on removing the cover.

b) Remove the adjustment shims from the worm shaft.

OBSERVATION:
Store the shims in a box so as to prevent damage to them or their misplacement.

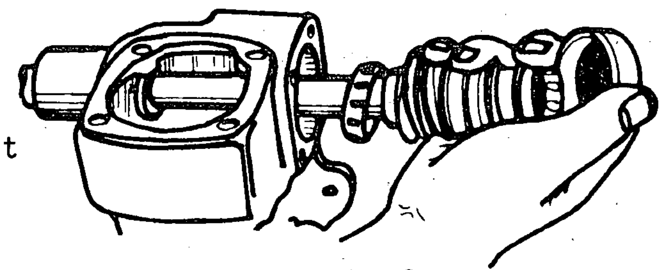

Fig. 3

c) Remove the worm shaft (fig. 3).

3rd Step - *Remove the seal and bushings from the sector.*

4th Step - *Remove the cups and bearing from the worm shaft housing (fig. 4).*

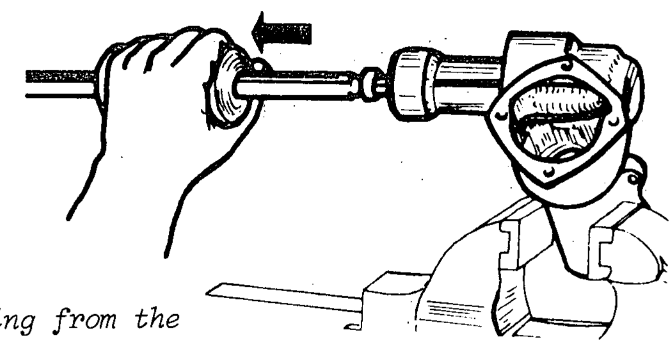

Fig. 4

5th Step - *Remove the upper bearing from the steering shaft with an extractor.*

6th Step - *Wash the metal parts with a solvent and dry them with compressed air.*

7th Step - *Clean the seal and bearing of the steering shaft with oil and a towel.*

8th Step - *Lubricate the bearings.*

Inspection either visual or with the aid of instruments, of the parts of the steering system, is done with the objective of detecting the defects or wear caused by its use, so as to make the necessary replacements and adjustments.

This operation is done every time the steering unit is disassembled or when it is faulty.

METHOD OF EXECUTION:

1st Step - *Check the steering wheel, thus:-*

a) Check the splines of the steering wheel.

b) Make sure that it is not twisted, broken or out of centre.

2nd Step *Inspect the steering column, thus:-*

a) Check the spring and the upper bearing of the steering column.

b) Place the steering shaft on the surface table and check with a dial indicator to see if it is twisted.

3rd Step - *Check the parts of the steering box, thus:-*

a) Visually check that the worm shaft is not pitted or worn.

b) Check the extent of wear to the bearings and cups of the worm axle.

c) Make sure that the sector is not deformed, worn or pitted and that its splines are not worn, or its threads in bad shape.

d) Check the wear to the bushings and the oil seal of the sector.

e) Make sure that the steering is not cracked, deformed or worn in the cup housings.

f) Make sure that the adjustment shims are not deformed or broken.

4th Step - *Make sure that the splines of the pitman arm are not deformed or worn.*

5th Step - *Make sure that the steering rods are not twisted and their splines and clamps not deformed or broken.*

6th Step - *Inspect the intermediate rod. Check to see that it is not deformed or that its bushings are not worn.*

7th Step - *Check the wear at the ends of the bars by spinning them with your hands (fig. 1).*

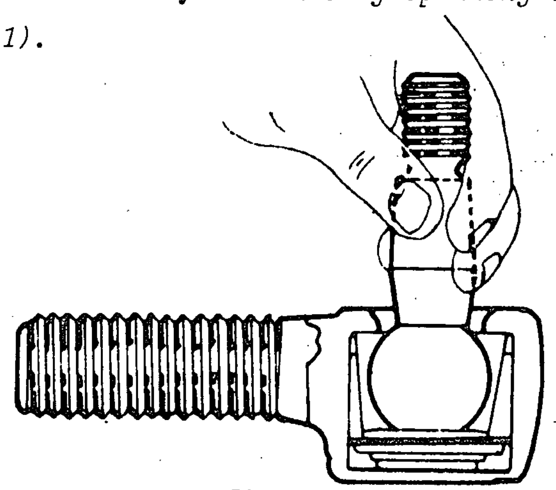

Fig. 1

To attain maximum durability and efficiency of the parts which make up the steering box, they should be assembled following the technical method prescribed by the manufacturers. This operation is done after the parts have been repaired or changed.

METHOD OF EXECUTION:

1st Step - *Place the steering box in a bench vice.*

2nd Step - *Install the upper bearing of the worm shaft, using a soft drift punch and a hammer.*

3rd Step - *Replace the worm-sector unit into the steering box, thus:-*

OBSERVATION:
Lubricate the parts of the steering box with the lubricant indicated by the manufacturer.

a) Install the cups of the worm shaft.

b) Replace the bushings and the seal of the sector (fig. 1).

c) Lubricate and replace the bearings of the worm shaft.

d) Install the worm shaft into the steering box.

e) Adjust the preloads of the bearings of the wormshaft in accordance with the manufacturer's specifications.

f) Replace the adjustment screw in the sector-cover.

g) Totally tighten the adjustment screw in the cover of the sector, then slacken four (4) turns approximately.

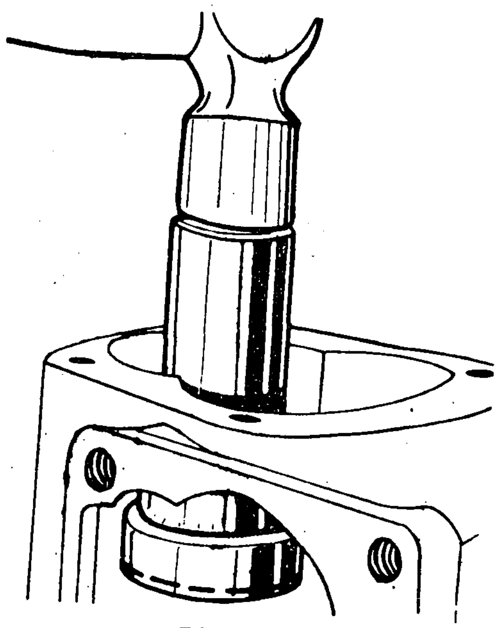

Fig. 1

h) Put adhesive on the gasket of the cover of the sector and replace it.

i) Replace the sector-cover unit and tighten the bolts to the specified torque.

OBSERVATION:
If the sector does not enter, turn the worm shaft slowly.

4th Step - *Adjust the play between the sector and worm shaft to the specifications suggested by the manufacturer by means of the adjustment screw (fig. 2).*

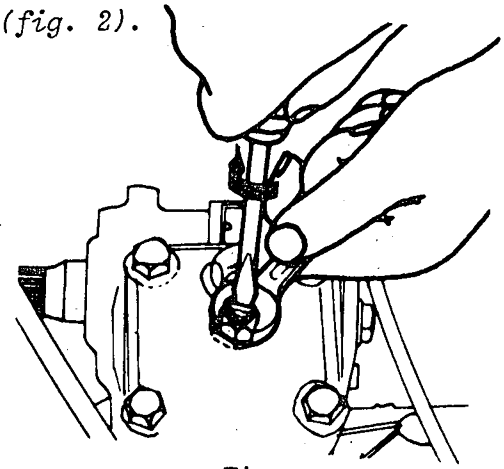

Fig. 2

5th Step - *Remove the steering box from the bench vice and place it on the work bench.*

The reassembling of the parts which make up the mechanical steering unit is done every time it is removed or disassembled with the object of inspecting or repairing it and consists of installing the parts, following the technical method of assembling and adjusting the unit.

METHOD OF EXECUTION:

1st Step - *Place the vehicle over a pit.*

2nd Step - *Replace the steering box, thus:-*

a) Slide the steering column into its housing in the vehicle and give a preliminary tightening to the securing bolts of the steering box.

b) Replace the securing clamps of the steering column and tighten its bolts.

c) Tighten the securing bolts of the steering box to the specified torque.

3rd Step - *Replace the gear lever, thus:-*

a) Replace the securing bolts of the gear lever.

b) Install the gear lever clamp, adjust the travel of the lever and tighten its securing bolts.

4th Step - *Connect the horn cable.*

5th Step - *Replace the pitman arm, thus:-*

a) Install the pitman arm, using the reference marks as a guide.

b) Replace the lock washer and nut of the pitman arm and tighten to the specified torque.

6th Step - *Install the steering wheel, thus:-*

a) Replace the steering wheel spring.

b) Place the steering shaft in the middle of its total rotation, and install the steering wheel, guiding yourself by the reference marks.

c) Replace the horn plate and install the adjusting screws.

d) Install the button of the horn.

7th Step - *Replace the joints and steering rods, thus:-*

a) Replace the steering ends and leave them centred (fig. 1).

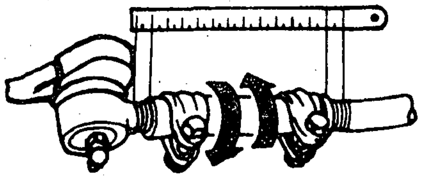

Fig. 1

b) Install the intermediate arm bushings (fig. 2).

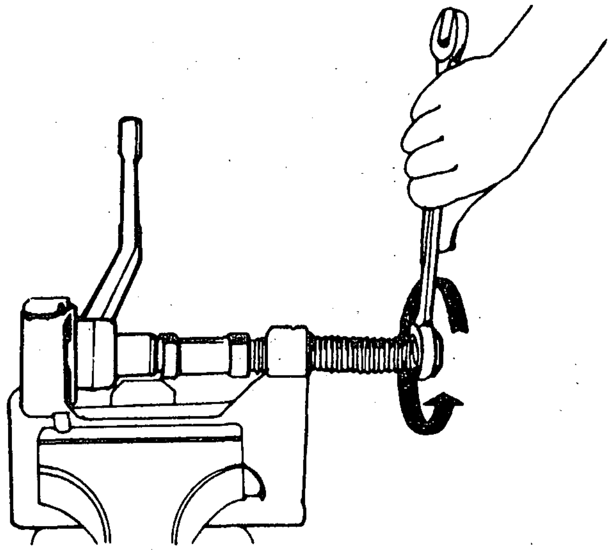

Fig. 2

c) Replace the intermediate arm.

d) Reconnect the steering ends and tighten the nut to the torque specified, securing it with a splitpin.

8th Step - *Reconnect the ground cable of the battery.*

9th Step - *Lubricate the steering system in accordance with the manufacturer's specification.*

With the aim of attaining the utmost stability of the steering system, and the maximum durability of its parts, the steering angles should be periodically checked. This consists of adjusting the caster, camber and toe-in or toe-out.
This operation should be done everytime that the suspension or steering systems are being repaired, as well as in controlling the vibrations in the steering or when there is premature and abnormal wear to the tyres.

METHOD OF EXECUTION:

1st Step - *Position the vehicle, thus:-*

a) Place the vehicle on a pit on top the alignment platform (fig. 1).

b) Make sure that the air pressure in the tyres is in accordance with the manufacturer's specifications.

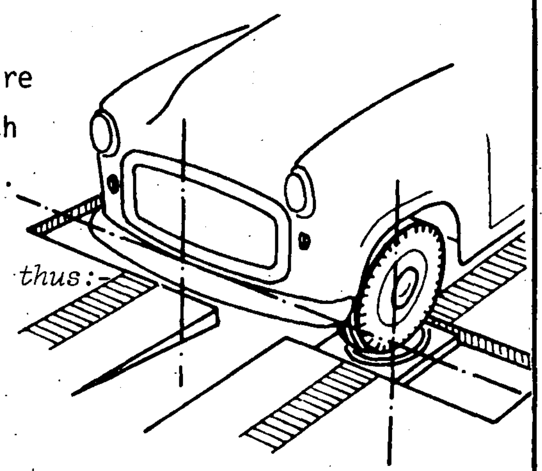
Fig. 1

2nd Step - *Check the wear to the front line, thus:-*

a) Lift the vehicle with a jack under the front small cross member.

b) Check the play in the bearings of the hubs of the front wheels, by moving the wheel inwards and outwards alternately, holding it on top and bottom (fig. 2).

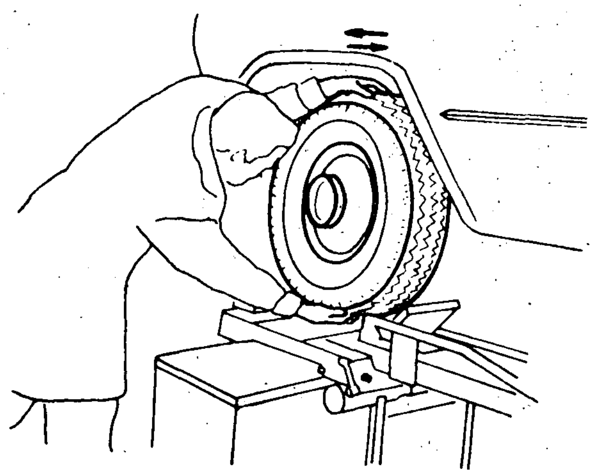
Fig. 2

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c) Check the wear to the parts of the steering, by moving the wheel inwards and outwards alternately, from the outer central part of the tyre (fig. 3).

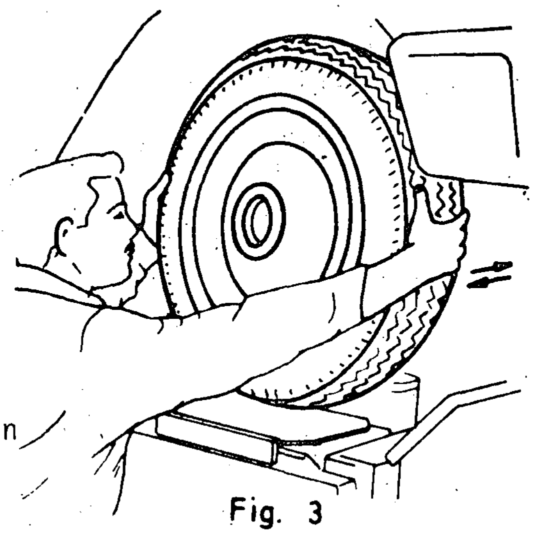

Fig. 3

d) Check the play of the ball joints by placing a lever between the tyre and the platform, and moving it up and down (fig. 4).

e) Visually check the shock absorbers, coil springs and stabilizing bar.

f) Lower the vehicle.

g) Move the vehicle up and down by pushing the bumper, so that the suspension remains level in its normal position.

h) Check the distance between axles (fig. 5).

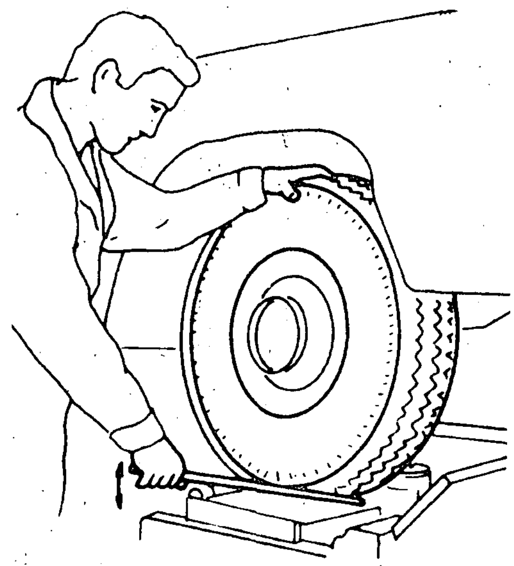

Fig. 4

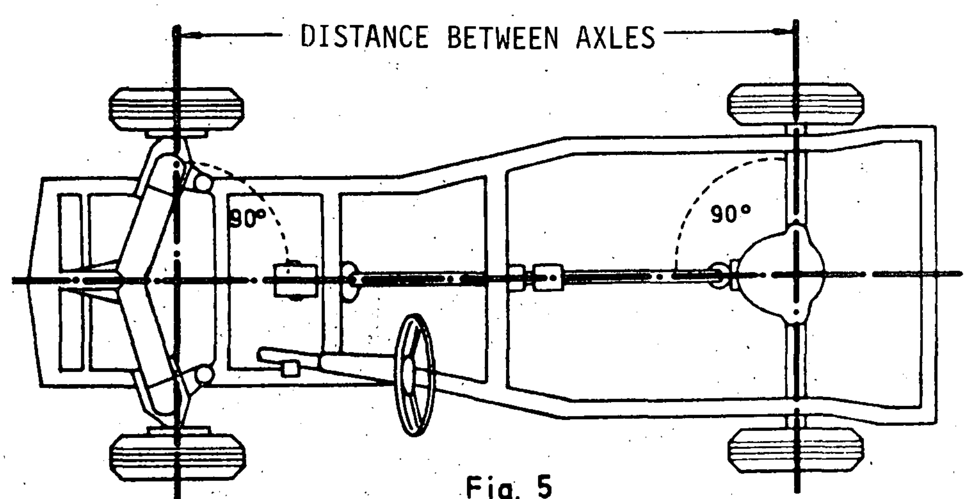

Fig. 5

3rd Step - *Install the equipment on the front wheels.*

OBSERVATION:
Follow the instructions of the manufacturer of the equipment.

4th Step - *Adjust the caster angle, thus:-*

a) Position the equipment for measuring the caster angle.
b) Read off the caster angle indicated on the aligner and check to see if it corresponds to the specifications of the manufacturer of the vehicle.
c) Loosen the securing bolts of the upper suspension arm.
d) Adjust the caster angle by placing or removing shims in each securing bolt of the upper suspension arm.
e) Tighten the bolts of the upper suspension arm to the torque specified by the manufacturer.
f) Check the caster angle.

OBSERVATION:
Repeat (c), (d) and (e) until obtaining the reading indicated by the manufacturer of the vehicle.

5th Step - *Regulate the camber angle, thus:-*

a) Position the equipment for measuring the camber angle.
b) Read off the camber angle appearing on the aligner and check it against that specified by the manufacturer of the vehicle.
c) Loosen the securing bolts of the suspension arm.
d) Adjust the camber angle by placing or removing the same number of shims of equal thickness in each securing bolt of the upper suspension arm.
e) Tighten the bolts of the suspension arm to the torque specified by the manufacturer.
f) Check the camber angle.

OBSERVATION:
Repeat (c), (d), and (e) until obtaining the reading indicated by the manufacturer.

g) Check the caster angle to see if it has varied as a result of adjusting the camber angle.
h) Remove the equipment of the front wheels.

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6th Step - *Adjust the toe-in, thus:-*

a) Position the rod and measure the distance between the front part of the tyres. (fig. 6).

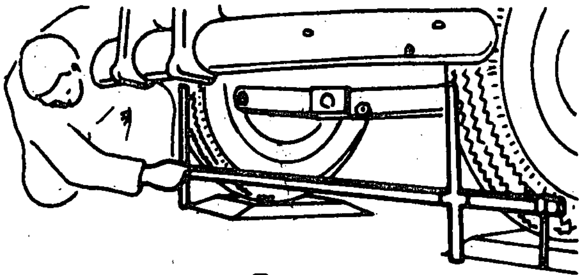

Fig. 6

b) Remove the rod to the rear end and see whether the difference in the reading is that indicated by the manufacturer of the vehicle.

OBSERVATION:
If it is necessary to make adjustments, proceed as indicated.

c) Loosen the clamps of the ends of the steering rod.
d) Turn the steering rod to screw it into, or unscrew it from the end (fig. 7), until the reading indicated by the manufacturer is obtained.
e) Tighten the clamps of the steering ends.
f) Check the toe-in.

OBSERVATION:
To adjust the toe-out, proceed in the same manner.

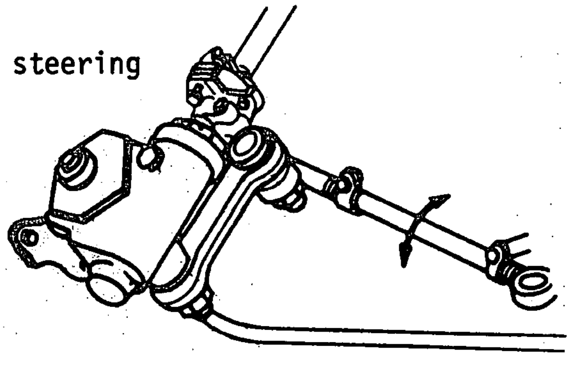

Fig. 7

7th Step - *Centre the steering wheel, thus:-*

a) Move the vehicle backward and forward, in a straight line, so that the steering wheel may take its normal position.

OBSERVATION:
If the wheel does not remain centred, proceed as indicated.

b) Centre the steering wheel.
c) Loosen the clamps from the steering ends.

d) Screw or unscrew each intermediate rod, an equal number of turns, until the wheels are correctly aligned and the steering centred.

e) Tighten the clamps of the steering ends.

f) Check the centring of the steering by moving the vehicle backwards and forwards.

OBSERVATION:

If it does not remain centred, repeat (c), (d), and (e), until the steering wheel remains centred.

g) Check the toe-in.

The auto mechanic changes the universal joints of the propeller shaft when they are worn. For this reason, it is necessary to remove the propeller shaft, an operation that is also needed when repairing the gear box, the clutch or the differential.

METHOD OF EXECUTION:

1st Step - *Position and lift the vehicle,* on a *pit or with a lift.*

PRECAUTION:

PLACE THE WEDGES UNDER THE VEHICLE TO PREVENT IT FROM SLIPPING.

2nd Step - *Remove the propeller shaft thus:-*

a) Remove the bolts from the joint, removing the nuts.

b) Lower and pull the propeller shaft towards the rear end of the vehicle so that the sliding yoke slips off the output shaft of the gear box.

OBSERVATION:

Use a lever to remove the propeller shaft from its housing, if necessary. Avoid dropping the bearings and losing their rollers.

3rd Step - *Remove the joints thus:-*

a) Hold the propeller shaft in a bench vice.

b) Remove the circlips (Fig. 1), using pliers.

c) Extract the bearings, using a press or extractor (Fig. 2) and remove the joint.

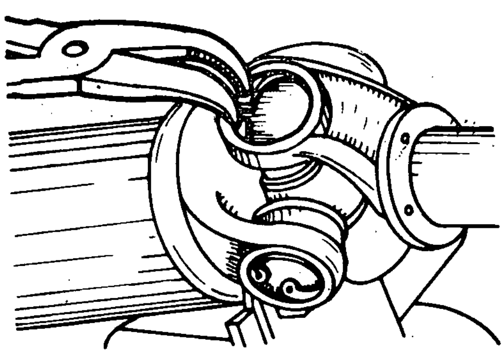

Fig. 1

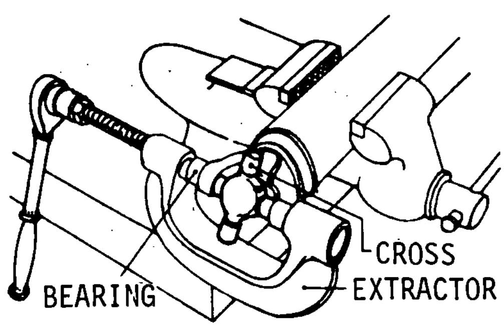

Fig. 2

OBSERVATION:

Remove the grease nipple if it obstructs the removal of the joint.

4th Step - *Replace the joints, thus:-*

a) Place the joint on the propeller shaft.

b) Project one end of the joint and install the bearing.

OBSERVATION:
Make sure that the rollers of the bearings maintain their position and that these remain centred.

c) Remove the bearing from its housing using a press until the circlip groove is in sight.

d) Install the circlip.

e) Place the other bearing and repeat c and d.

OBSERVATION:
While pressing the bearings onto the joints, make sure that they are free to move.

5th Step - *Couple the propeller shaft onto the gear box, thus:-*

a) Place the bearing in the housings of the sliding yoke and secure them with clamps.

b) Install the nuts and tighten them to the specified torque.

6th Step - *Lubricate the joints.*

This is the operation that the mechanic does when he has to check or repair the gear box or in removing other mechanisms, such as the clutch or the motor.

METHOD OF EXECUTION:

1st Step - *Position the vehicle over a pit or a lift.*

2nd Step - *Remove the drain plug of the box and remove the oil, using a clean container.*

SAFETY MEASURE
AVOID SPILLING OIL ON THE GROUND.

3rd Step - *Disconnect the speedometer cable from the gear box.*

4th Step - *Disconnect the control rods from the gear box, removing the securing bolts, flat washers and the springs that hold the rods to the gear lever.*

5th Step - *Remove the propeller shaft.*

6th Step - *Remove the gear box, removing the screws that secure it to the clutch housing, thus:-*

a) Move the gear box backwards until the main shaft comes out of the clutch plate.

b) Raise the motor with a lift, if necessary.

OBSERVATION:
Seek aid when removing the gear box.

CBC

OPERATION: REPLACING GEAR BOX

REF OS 03/AM-3 | 1/1

Caribbean

It is the operation done in installing the gear box into the vehicle, making all its respective connections.
This operation is done also when assembling the transmission when it has been removed for repairs and when the engine or the clutch mechanism has been removed.

METHOD OF EXECUTION:

1st Step - *Position the gear box, thus:-*

a) With the aid of a guide, centre the clutch disc, (fig.1), if necessary.

b) Centre the box, with the object of aligning the primary shaft grooves, to the clutch disc splines.

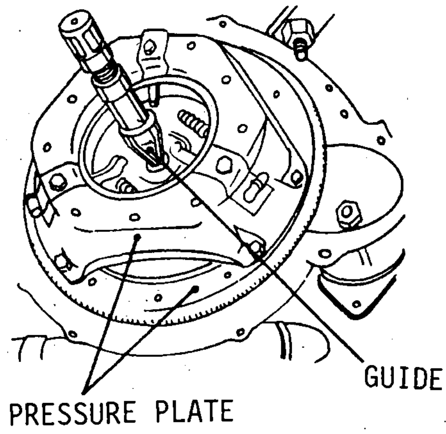

Fig. 1

c) Push the box until it rests on the face of the clutch housing, place the fastening bolts, and tighten to the specified torque.

2nd Step - *Make the connections on the box, connecting the spindles to the gear levers and the speedometer cable.*

3rd Step - *Replace the propeller shaft.*

4th Step - *Put oil in the gear box, thus:-*

a) Remove the plug and insert the hose from the lubricating equipment.

OBSERVATION:
Make sure that the drain plug is tightly fixed.

b) Pour in oil until it reaches to the level of the plug.

c) Replace and tighten the plug.

CBC

OPERATION: REMOVING CLUTCH

This is done with the object of disassembling the parts of the system so that repairs may be made to the clutch unit or such other parts as the flywheel, and the ring gear of the flywheel.

METHOD OF EXECUTION:

1st Step - *Position the vehicle on a pit or a lift.*

2nd Step - *Remove the propeller shaft.*

3rd Step - *Remove the gear box.*

4th Step - *Remove the clutch, thus:-*

a) Remove the lower cover of the housing of the clutch.

b) Remove the return spring from the clutch release lever.

c) Slip out the bearing support from the link and remove it.

d) Position a guide shaft so as to prevent the disc and pressure plate from falling.

e) Remove the fastening bolts that hold the pressure plate to the flywheel.

OBSERVATION:
If you are going to use the same pressure plate put a mark on its cover and another on the flywheel so as to enable you to install it in the same position.

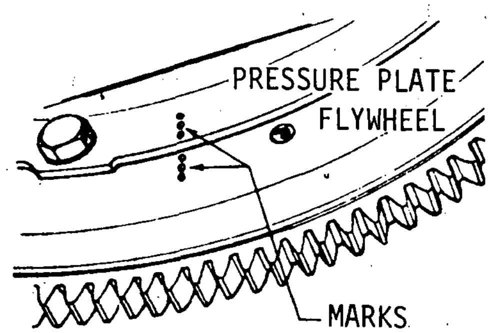

Fig. 1

f) Remove the guide shaft and remove the pressure plate and the disc through the opening of the lower part of the clutch housing.

5th Step - *Remove the link from its housing.*

This is the operation of installing the clutch unit onto the flywheel of the motor as the final stage in its repairing.

METHOD OF EXECUTION:

1st Step - *Install the clutch release lever.*

2nd Step - *Install the clutch unit, thus:-*

OBSERVATION:
Clean the flywheel, if there is oil or grease on it.

a) Position the clutch disc and the pressure plate on the flywheel, centring the disc with a guide bolt.
b) Line up the holes of the pressure plate cover with those of the flywheel and replace the bolts, tightening them to the specified torque alternately (fig. 1).

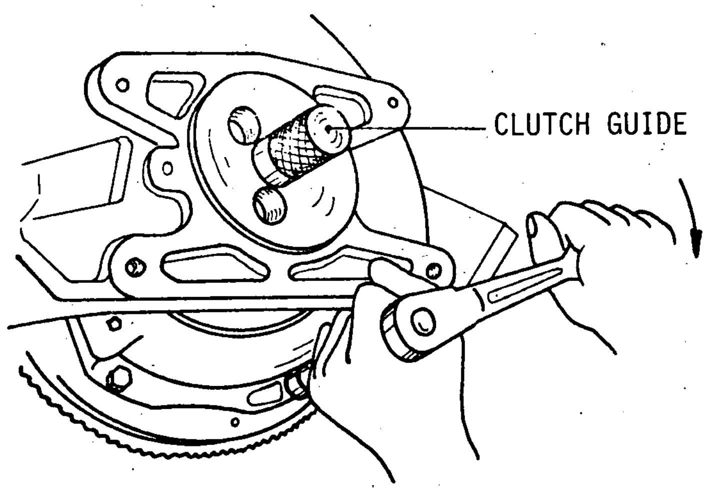

Fig. 1

c) Remove the guide from the centre of the disc.

3rd step - *Install the sleeve and centre it.*

4th Step - *Install the clutch release rod on the end of the release lever and reconnect the return spring.*

5th Step - *Replace the gear box.*

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6th Step - *Replace the propeller shaft.*

7th Step - *Adjust the play in the clutch pedal, thus:-*

a) Push the pedal to observe its free movement (fig. 2).

b) Adjust the clutch rod (fig. 3) until obtaining the clearance recommended by the manufacturer.

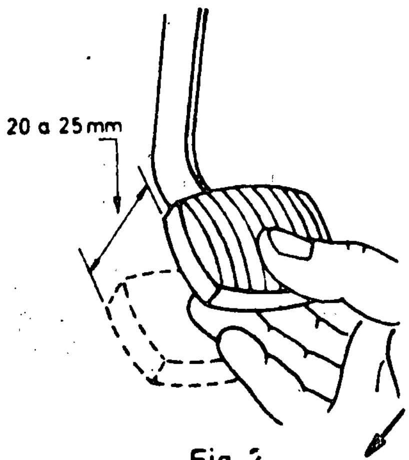


Fig. 2

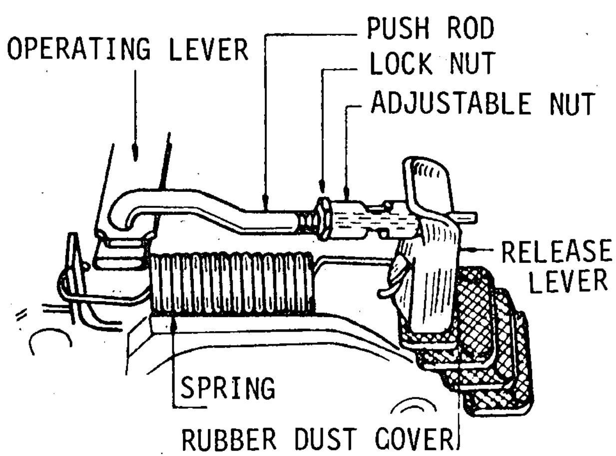


Fig. 3

This is done to check and repair the distinct parts of the pressure plate, an operation which is intended to accomplish a good coupling between the engine and the transmission system.

METHOD OF EXECUTION:

1st Step - *Remove the cover of the clutch pressure plate (fig. 1), thus:-*

a) Place the clutch pressure plate onto a hydraulic press.

b) Place the pressure plate on a wooden support (a) of the same diameter as the pressure plate (b) and under another piece of wood.

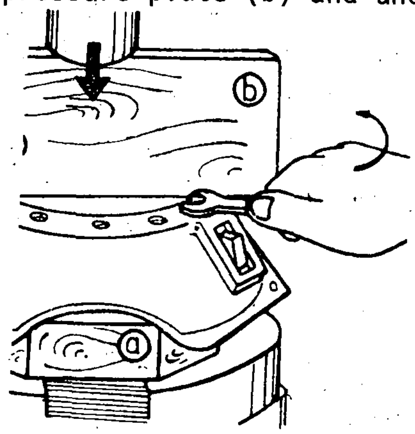


Fig. 1

c) Apply pressure to the cover of the pressure plate.

d) Remove the adjusting nuts (c).

e) Release the pressure to the hydraulic press and move the nut.

2nd Step - *Inspect the parts of the pressure plate, thus:-*

a) Check the wear to the supports and bolts of the clutch levers.

b) Check the contact surface of the pressure plate.

c) Check the tension in the springs (fig. 2) against the manufacturer's specifications.

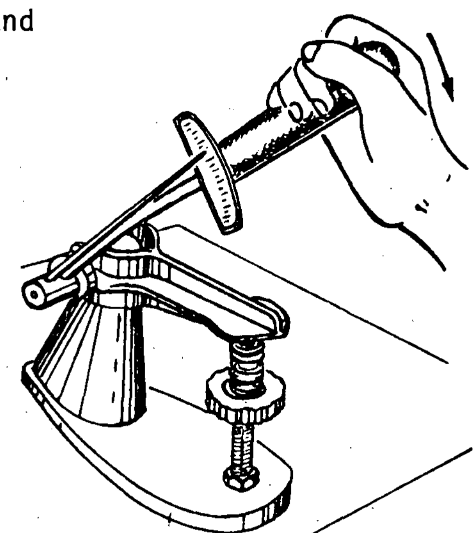


Fig. 2

3rd Step - *Assemble the pressure plate, thus:-*

a) Place the pressure plate on top the hydraulic press. Install the levers, bolts, springs and cover.

b) Apply pressure to the cover, centred over the adjusting bolts.

c) Replace the securing nuts and secure the cover of the clutch.

4th Step - *Adjust the pressure plate, thus:-*

a) Place the clutch disc on the flywheel and mount the pressure plate, tightening its securing bolts to the specified torque.

b) Adjust the clutch release levers, checking their height with a depth gauge template (fig. 3) according to the manufacturer's specifications.

c) Tighten the adjusting nuts.

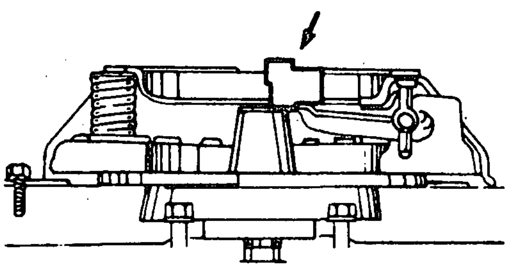


Fig. 3

CBC

OPERATION: REMOVING DIFFERENTIAL UNIT

REF. OS 07/AM-3 | 1/1

Caribbean

The operation consists of removing the differential unit from the vehicle. This is done when the differential mechanism needs repairing.

METHOD OF EXECUTION:

1st Step - *Position and lift the vehicle.*

2nd Step - *Remove rear wheels and drums.*

3rd Step - *Remove the propeller shaft.*

4th Step - *Drain the differential mechanism.*

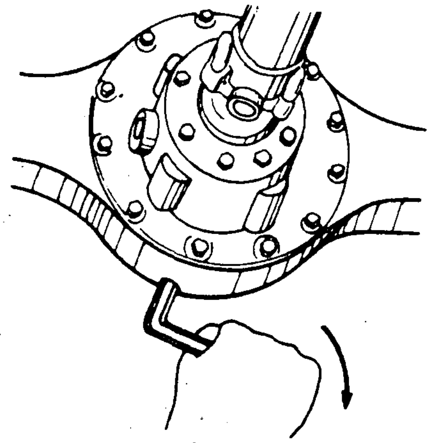


Fig. 1

OBSERVATION:
Collect the oil with a clean tray.

PRECAUTION:
PROTECT YOUR EYES FROM FALLING FOREIGN PARTICLES.

5th Step - *Remove the semi-floating axles, thus:-*

a) Remove the bolts from the retaining plate of the semi-axle.
b) Install the extracting tool to the semi-axle (fig. 2).
c) Remove the semi-axle from the housing, avoiding oil spillage on the floor.

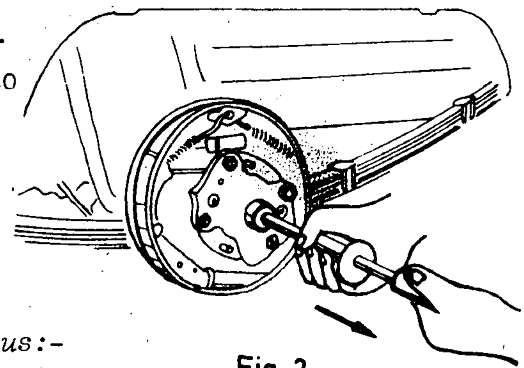


Fig. 2

6th Step - *Remove the differential unit, thus:-*

a) Remove the retaining bolts of the differential unit.
b) Remove the differential unit.

OBSERVATION:
If it is stuck, use a lever to remove it and seek aid if necessary.

This is the phase where the differential unit is installed into the housing. It is done after checking, changing and adjusting its parts.

METHOD OF EXECUTION:

1st Step - *Check the state of the semi-floating axles, thus:-*

a) Clean the half axle shafts to facilitate location of possible cracks or wear.

OBSERVATION:
Do not clean the sealed bearings with solvent so as to prevent the liquid from penetrating and damaging it.

b) Inspect the splines at the end of the axle to see whether they are deformed or worn.

c) Visibly and manually inspect the surface of the axle where it makes contact with the oil seal.

2nd Step - *Check the state of the bearings, thus:-*

a) Move the outer race of the bearing from side to side and observe whether there is any play in its oil deflector.

b) Slowly turn the outer part of the bearing so as to detect "skips" that may have been caused by surface cracks or dirt in the internal parts.

3rd Step - *Replace the differential unit, thus:-*

a) Install a new gasket between the differential unit and the housing.

b) Install the unit into its place in the housing.

OBSERVATION:
Seek aid, when installing the unit.

c) Replace the bolts and tighten them to the specified torque.

4th Step - *Replace the semi-axles, thus:-*

a) Introduce the half axle shaft into the cover of the differential, turning it slowly so that its splines enter the axle side gear and push it until its bearing is completely housed in the cover.

b) Install the retaining plate of the half-axle shaft with its bolts or nuts and tighten to the specificed torque.

c) Replace drums and wheels.

d) Replace the propeller shaft.

e) Refill the unit with oil until it reaches the level of the filling cap.

This is the operation that the mechanic should do when he has diagnosed some imperfection in the operation of the gear box.
It consists of disassembling all the component parts of the gear box, so as to repair, replace or check them.

METHOD OF EXECUTION:

1st Step - *Remove and disassemble the cover of the gear mechanism unit, thus:-*

a) Remove the securing bolts from the cover and remove it from its position (fig. 1).

b) Remove the shifter forks.

c) Remove the gear shift levers from the cam and shaft assembly.

d) Remove the bolts from the cam and shaft assembly.

e) Pull the cams until the shafts come out of their bushing in the cover.

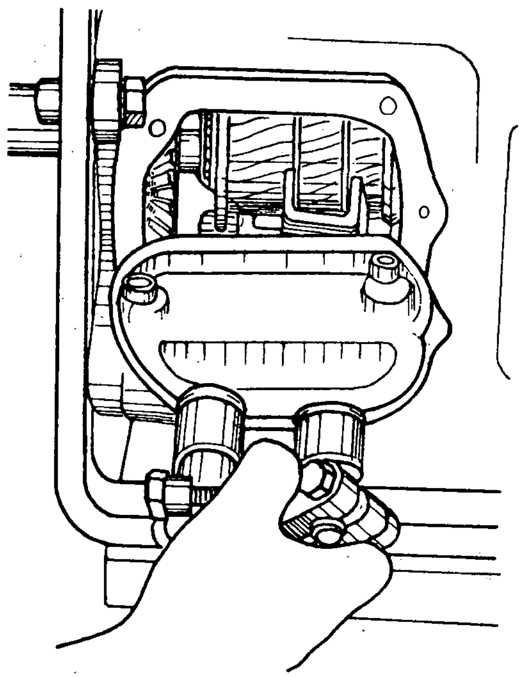


Fig. 1

OBSERVATION:
Hold the interlocking spring and interlock balls of the cams when removing them so as to prevent them from springing.

2nd Step - *Remove the main shaft, thus:-*

a) Remove the bolts that hold the rear cover to the body of the box.

b) Turn the cover until it uncovers the bolt of the intermediate shaft.

c) Remove the bolt of the counter shaft. Then remove the shaft by tapping its front part with a bronze or aluminium drift punch (fig. 2).

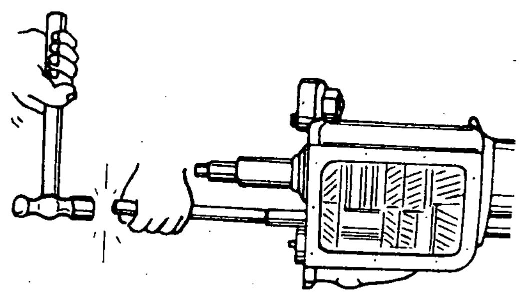


Fig. 2

d) Remove the shaft with the purpose of letting the counter gears fall to the bottom.

e) Remove the extension housing and the main shaft unit from the box (fig. 3).

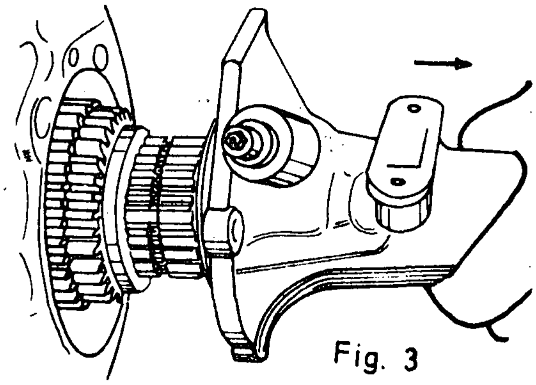


Fig. 3

3rd Step - *Remove the input shaft, thus:-*

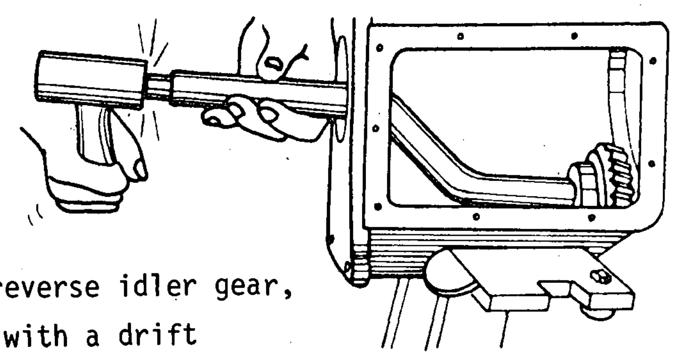
a) Remove the bolts which secure the cover of the bearing of the main shaft and remove it.

b) Remove the input shaft through the front part of the box.

OBSERVATION:
If the input shaft is stuck, tap it out with a plastic hammer.

4th Step - *Remove the counter gears and the reverse idler gear, thus:-*

a) Remove the counter gears and washers from the bottom of the box.



b) Take out the reverse idler gear, tapping its shaft with a drift punch (fig. 4).

Fig. 4

5th Step - *Disassemble the output shaft unit, thus:*

a) Remove the snap ring (fig. 5) which holds the shaft to the cover and remove it by tapping the grooved part of the shaft with a plastic hammer.

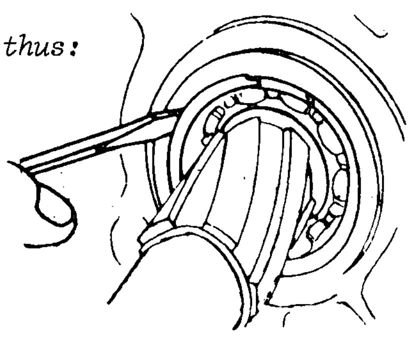


Fig 5

b) Hold the shaft in a vice with bronze jaws and remove the retaining clip of the synchronizer (fig. 6).

c) Remove the synchronizer unit and the second and first gear wheels from the output shaft.

d) Remove the retaining clip and remove the speedometer drive gear.

e) Remove the bearing by using an extractor (fig. 7).

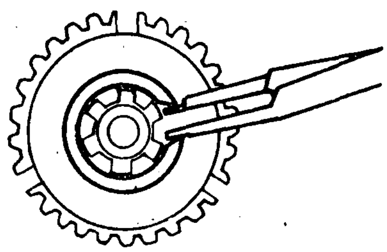


Fig. 6

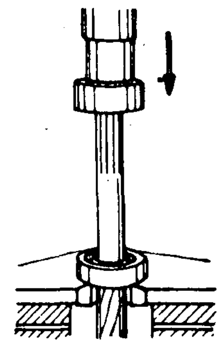


Fig. 7

6th Step - *Disassemble the synchronizer unit, thus:-*

a) Push the hub of the synchronizer from the sleeve and remove the blocking rings.

b) Remove the springs from each end of the hub.

7th Step - *Remove the bearing of the input shaft, thus:-*

a) Remove the snap ring from the bearing.

b) Remove the bearing from the shaft by using an extractor (fig. 8) and remove the oil deflector.

8th Step - *Clean the parts of the box with solvent and dry them with compressed air.*

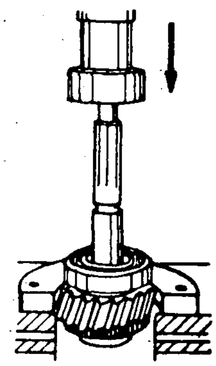


Fig. 8

OBSERVATION:

When drying the bearings do not spin them with the air jet.

This operation consists of reassembling and checking the parts of the gear box. The mechanic should do it every time that he has inspected or replaced one of the components of this mechanism.

METHOD OF EXECUTION:

1st Step - *Inspect the components of the box, thus:-*

a) Examine the casing of the box so as to detect cracks, holes, wear and other damage.

b) Check all the gears to see if they are worn or if the teeth are cracked or chipped.

c) Check the state of the shafts to see whether they are worn at their supports or by the splines.

d) Check the wear to the components of the synchronizer unit.

2nd Step - *Assemble the synchronizer unit, thus:-*

a) Install a synchronizer ring in each end of the hub.

b) Install the inserts(or dogs).

c) Install the springs.

d) Slip on the hub to the splines of the sleeve and centre it.

3rd Step - *Reassemble the output shaft unit, thus:-*

a) Replace the bearing on the shaft by using a press until it is secured in place (fig. 1).

b) Install the securing bolt of the speedometer gear and tighten it.

c) Replace the retaining clip of the gear wheel of the speedometer.

d) Install the first gear into the splines of the shaft.

e) Install the second gear.

f) Install the synchronizer unit and replace the retaining clip (fig. 2).

g) Install the output shaft cover and secure it with its snap ring.

h) Replace the oil retainer.

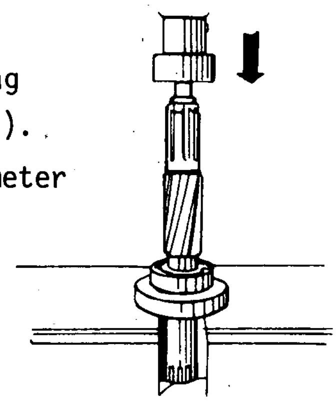


Fig. 1

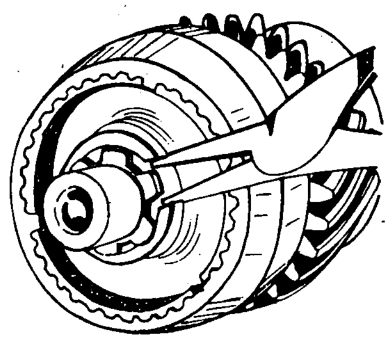


Fig. 2

4th Step - *Assemble the input shaft unit, thus:-*

a) Install the oil deflector.

b) Install the bearing and squeeze it until it remains secured in its position.

c) Replace the snap ring.

d) Place the needle rollers in the recess of the input shaft and stick them with grease.

5th Step - *Assemble the counter gears, thus:-*

a) Put the roller bearings spacer in position, and centre it within the counter gears.

b) Install the rollers and the thrust washers in their position and cover them with grease.

c) Insert an assembly dummy shaft into the counter gears.

6th Step - *Mount the reverse idler gear and place the counter gears into the box, thus:-*

a) Position the reverse idler gear in its housing and replace the shaft securing it in its position.

b) Stick and centre the spacer washers of the counter gears with grease inside the case of the box.

c) Place the counter gear into the box and let it rest on the bottom.

7th Step - *Mount the input shaft and the output shaft, thus:-*

a) Replace the input shaft, by tapping it with a hammer until the bearing is fixed in its housing.

b) Install the cover of the bearing with a new gasket and tighten the bolts to the torque specified.

OBSERVATION:
When installing the cover of the bearing make sure that the oil duct coincides with the vent on the box.

c) Introduce the output shaft unit until its end rests on the input shaft bearing and the rear cover.

8th Step - *Reassemble the counter shaft, thus:-*

a) Turn the rear cover until it uncovers the bore of the bolt of the counter shaft.

b) Lift the counter gear and introduce its shaft through the rear part, pushing the assembly tool until it comes out.

c) Install the lock of the shaft of the counter gear

d) Align the extension housing, install its screws and tighten to the specified torque.

9th Step - *Assemble the gear mechanism in the cover, thus:-*

a) Install one of the cams in the cover and put the securing bolt onto it.

b) Assemble the securing unit and install it in its housing.

c) Install the other cam and secure it.

d) Install the gear levers and the shifter forks.

10th Step -*Mount the cover of the gear box, thus:-*

a) Place a new gasket on the casing.

b) Replace the cover making sure that the shifter forks fit into the slots of their corresponding synchronizers.

c) Hold the cover, provisionally, with two bolts and check the working of all the gears in the box.

OBSERVATION:

In the event of encountering difficulty in engaging the gears, spin the main shaft with your hand.

d) Replace all the securing bolts of the cover and tighten to the specified torque.

This is the operation done when a fault has been discovered which affects one or more parts of the differential unit. It consists of removing all the integral parts of the unit.

METHOD OF EXECUTION:

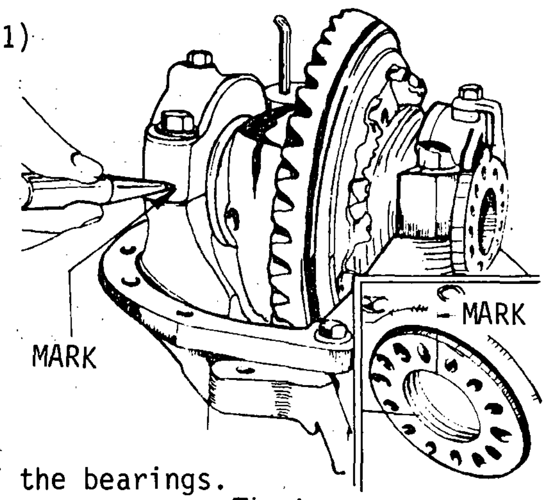
1st Step - *Remove the differential cage, thus:-*

a) Place the unit in a bench vice.

b) Mark the bearing caps (fig. 1) the housing of the unit, and the adjustment nuts.

c) Remove the locks of the adjustment nuts.

d) Remove the bearing caps and adjustable nuts and bolts.



OBSERVATION:
Avoid interchanging the races of the bearings.

Fig. 1

e) Remove the crown wheel and differential cage.

2nd Step - *Disassemble the differential cage, thus:-*

a) Hold the unit in a vice.

b) Remove the bolts from the crown wheel.

c) Tap the crown wheel with a plastic hammer, until it comes out of its housing.

d) Remove the securing nut from the pinion shaft and with a drift remove the shaft.

e) Remove the side gears, pinion gears and their thrust washers.

f) Extract the side bearings from the differential cage with an extractor (fig. 2).

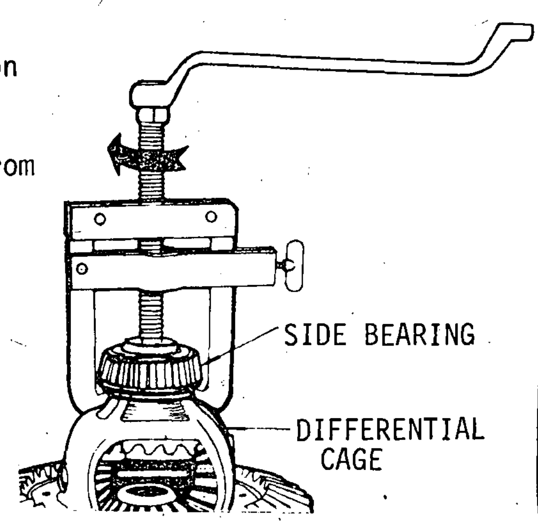


Fig. 2

3rd Step - *Disassemble the drive pinion and remove its bearings, thus:-*

a) Remove the drive pinion, its spacer and nut.

b) Remove the oil retainer and the front bearing.

c) Remove the bearing races from the cover of the differential (fig. 3).

d) Remove the bearing of the drive pinion using an extractor (fig. 4).

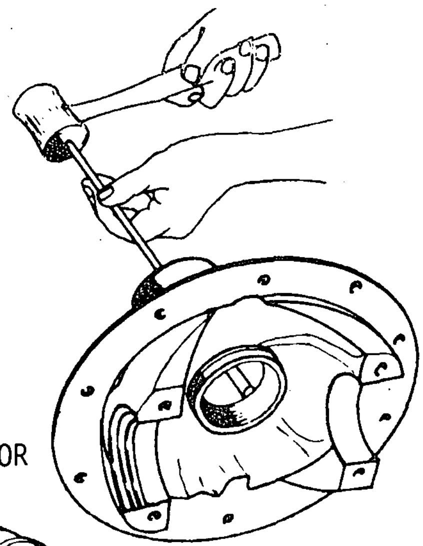


Fig. 3

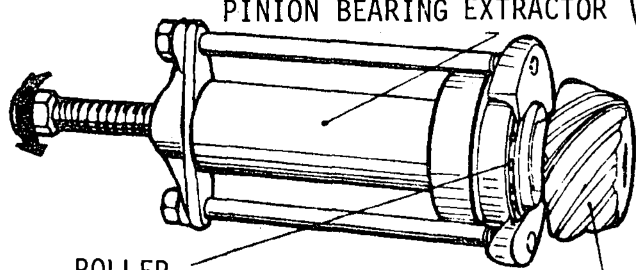


Fig. 4

OBSERVATION:

Keep the drive pinion spacers for future reference or for replacing.

TECHNICAL VOCABULARY

Pinion gear	-	Spider gear; or planet gear
Transmission	-	Gear box

This operation demands, from the mechanic that is going to do it, an understanding of the diverse parts that are to be checked. This should be done as soon as the parts have been completely cleaned. It consists of observing the parts, both visually and manually, to see whether they can be used in reassembling the unit.

METHOD OF EXECUTION:

1st Step - *Visually and manually check the differential carrier, thus:-*

a) Check to see if there are cracks or deformations.

b) Make sure that the bearing housings and the lock are not worn.

c) Check to see if the threads of the bolts and nuts of the carrier and bearing caps and adjustment nuts are damaged.

2nd Step - *Check the bearings.*

3rd Step - *Visually and manually check the crown wheel and pinion, thus:-*

a) Make sure that the teeth of the crown wheel and the pinion are not chipped, broken or worn.

b) Check to see that the bearing housing of the pinion is not worn or that it does not present head fusion.

c) Make sure that the splines of the pinion are not worn or deformed and check the play by using the pinion flange (fig. 1).

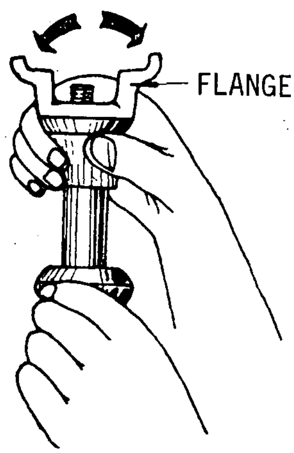


Fig. 1

4th Step *Check the differential case, thus:-*

a) Visually check the wear to the seatings of the bearings.

b) Visually and manually check the wear to the seatings in the differential cage and pinion gears.

c) Check the wear to the seatings of the side gear bores.

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d) Check the state of the surface of the seating of the cage with the crown wheel (fig. 2) with a dial indicator.

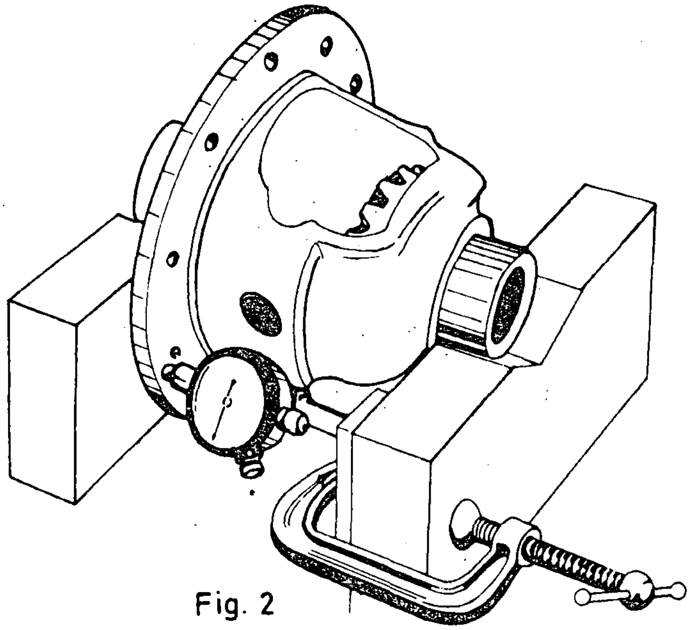


Fig. 2

e) Make sure that the splines, teeth and washers of the side gears and pinion gears are not damaged or worn by checking the play between the bolt and the respective half-axle.

f) Check the contact surfaces of the pinion shaft to see if they are worn or have surface cracks.

This operation forms part of the process of repairing the differential unit and consists of installing its component parts.

METHOD OF EXECUTION:

1st Step - *Reassemble the drive pinion, thus:-*

a) Position the depth spacers and install the rear bearing (fig. 1).

b) Replace the bearing races of the drive pinion into the carrier of the unit.

c) Install the drive pinion, the spacer, the front bearing, the pinion flange and tighten to the specified torque.

d) Check the height of the drive pinion using the recommended calibrators and procedure.

e) Check the preload of the bearings (fig. 2).

OBSERVATION:

If there is a variation to the established preload, correct it by adding or removing spacers.

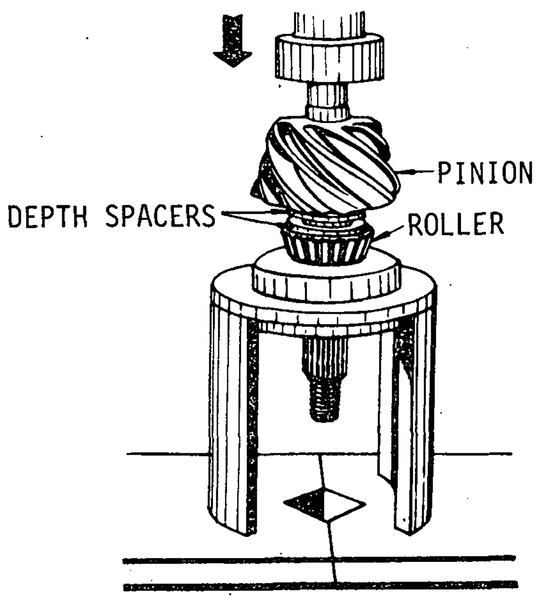


Fig. 1

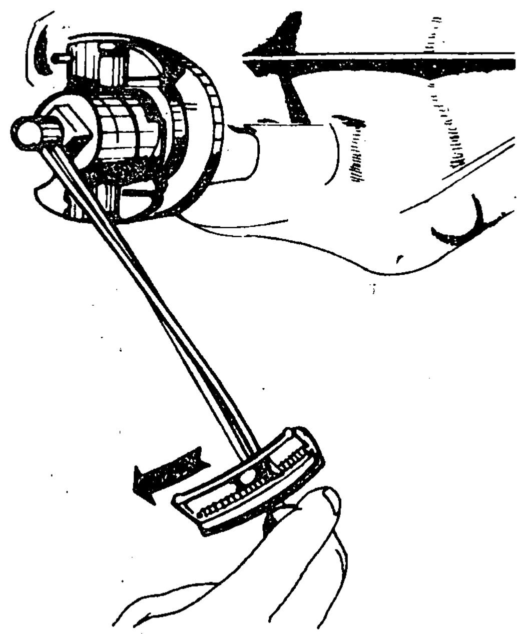


Fig. 2

f) Remove the flange, install the lock, replace the flange and tighten to the torque specified.

2nd Step - *Assemble the differential cage thus:-*

a) Install the crown wheel into the differential cage, tighten the bolts to the recommended torque in the manner indicated in (fig. 3).

b) Replace the pinion gears, side gears and shaft and install the lock.

c) Install the side bearings of the cage (fig. 4).

OBSERVATION:
Use a hydraulic press.

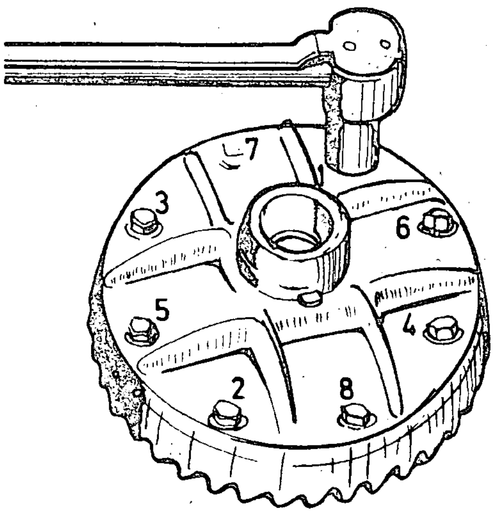


Fig. 3

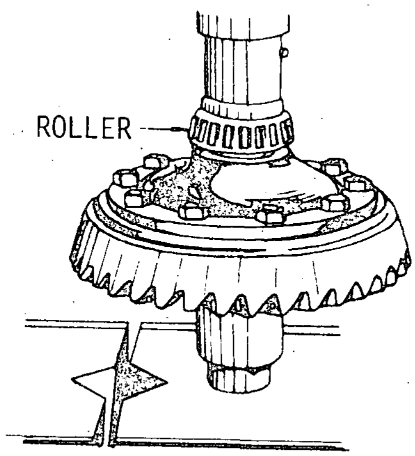


Fig. 4

3rd Step - *Replace the differential cage thus:-*

a) Replace the external races of the bearings and install the cage into the differential carrier (fig. 5).

b) Install the caps and bolts and adjustment nuts.

c) Tighten alternately the adjustment nuts so as to centre the races of the side bearings (fig. 6).

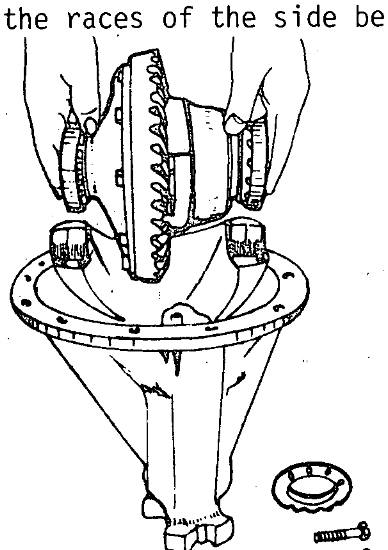


Fig. 5

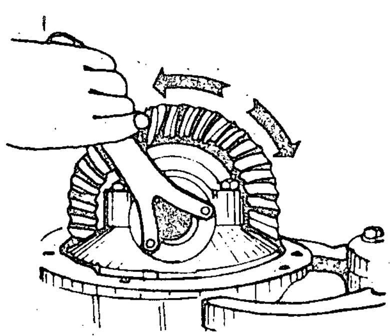


Fig. 6

d) Check the side play of the crown wheel by using a dial indicator (fig. 7).

e) Adjust the play between the crown wheel teeth and the pinion by moving the crown wheel sideways (fig. 8).

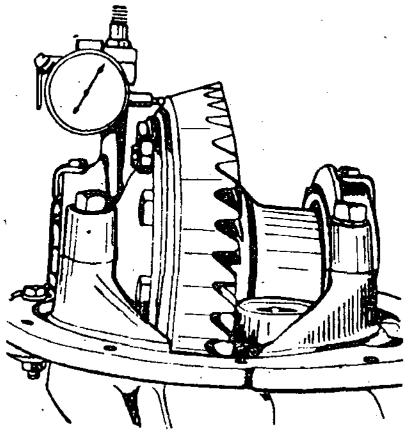


Fig. 7

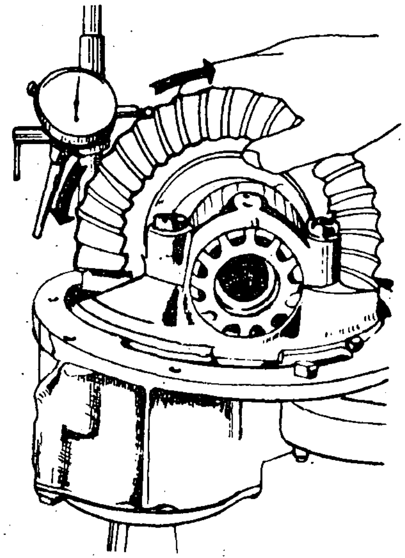


Fig. 8

f) Tighten the bolts of the covers to the recommended torque.

g) Check the seatings between teeth.

OBSERVATION:

Use a colouring element on the teeth of the crown wheel so as to pinpoint the contact zone.

h) Install the locks of the adjustment nuts.

This is the process designed to remove and replace the radiator of the vehicle when it is necessary to repair parts of the cooling system or other parts of the engine. This operation is important because it ensures an effective running of the cooling system.

METHOD OF EXECUTION

1st Step - *Drain the cooling system, thus:-*

a) Press, turn and remove the radiator cover (fig. 1).

SAFETY MEASURE:

IF THE ENGINE IS AT WORKING TEMPERATURE, TURN THE COVER TO THE FIRST POSITION, THEREBY ALLOWING THE STEAM TO ESCAPE. THIS PREVENTS POSSIBLE BURNS.

b) Open the taps of the engine and radiator (fig. 2).

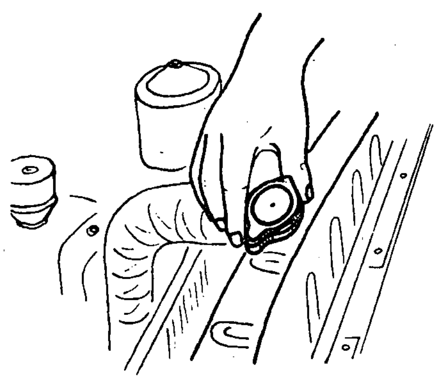


Fig. 1

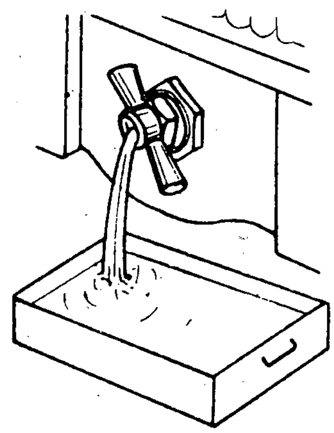


Fig. 2

OBSERVATIONS:

1. Use containers to catch the water.
2. Remove the tap if the water does not flow.

2nd Step - *Remove the hoses of the radiator and engine, thus:-*

a) Loosen the hose clamps (fig. 3).

b) Remove the hoses (fig. 4).

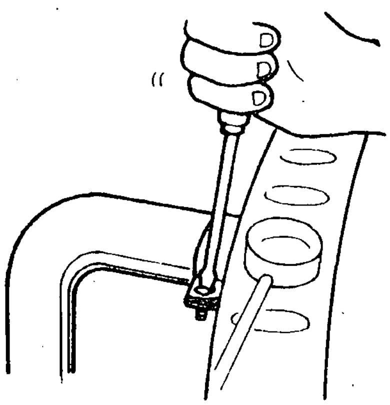


Fig. 3

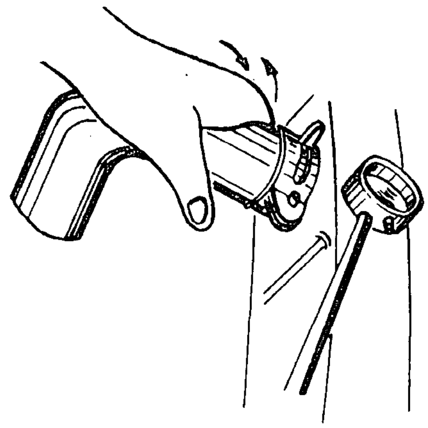


Fig. 4

3rd Step - *Remove the radiator from the vehicle, thus:-*

a) Remove the securing bolts of the radiator.

b) With both hands, sustain the radiator and raise it progressively until removing it from its base of support.

OBSERVATION:
Avoid hitting the radiator panel onto the ventilator fan.

4th Step - *Install the radiator into the vehicle, thus:-*

a) Replace the radiator on its base of support, making sure of not damaging it.

b) Install the securing bolts and tighten them.

5th Step - *Install the hoses of the engine and radiator and close the taps.*

6th Step - *Fill the cooling system with water.*

7th Step - *Start the engine, and inspect for possible water leaks and turn off the engine.*

OBSERVATION:
Refill the radiator with water, if necessary.

It is the action of removing, checking and replacing the thermostat of the engine, so as to check its effectivity, according to the manufacturer's specification. On checking it one may maintain the normal operating temperature of a cooling system.

METHOD OF EXECUTION:

1st Step - *Remove the thermostat from the engine, thus:-*

a) Remove the securing bolts from the cover of the thermostat.

b) Remove the cover and the thermostat.

c) Clean the seating of the base of support, the cover of the thermostat and check for deformation.

2nd Step - *Check the working conditions of the thermostat, thus:-*

a) Place the thermostat into a container with water.

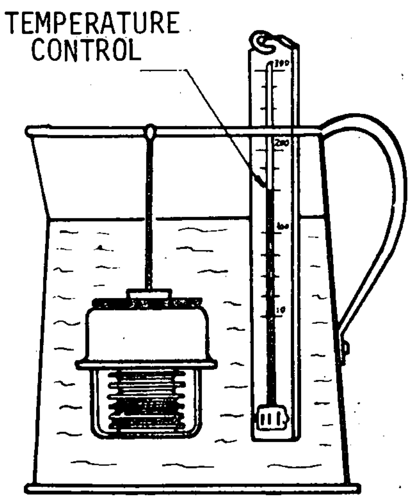
b) Heat the water in the container.

c) Check the opening and closing of the thermostat (fig. 1), according to the temperature specified by the manufacturer.

SAFETY MEASURE:

AVOID BURNING YOURSELF WITH THE HOT WATER.

3rd Step - *Install the thermostat (fig. 2), thus:-*



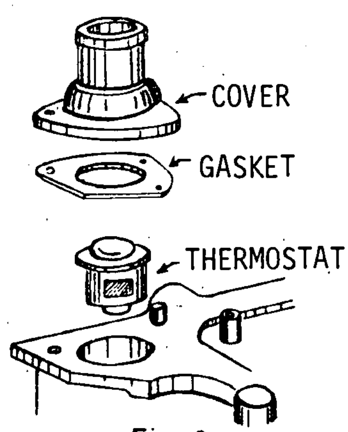


Fig. 2

a) Replace the greased gasket onto the cover.

b) Replace the thermostat in its housing and make sure it is correctly seated.

c) Install the cover of the thermostat and replace the bolts, tightening them to their corresponding torque.

This operation consists of replacing the plugs. This is done when they are defective or when cleaning the cooling system, the engine having been disassembled. By this means, we may prevent overheating the engine as a result of loss of the water.

METHOD OF EXECUTION

1st Step - *Remove the plugs from the engine, thus:-*

a) Puncture the plug in the centre with a punch (fig. 1).

SAFETY MEASURE:
AVOID HITTING YOUR HANDS.

b) Place a lever into the hole and extract the plug (fig. 2).

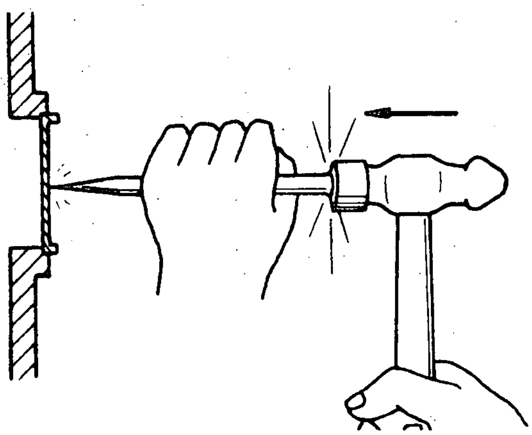


Fig. 1

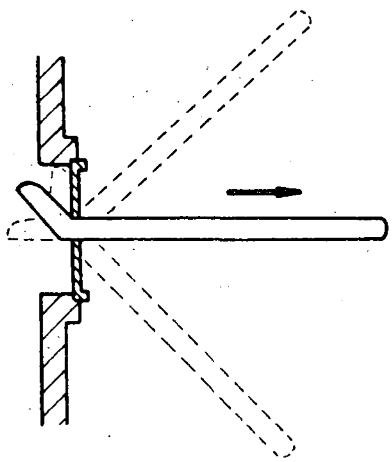


Fig. 2

2nd Step - *Clean the water duct and seatings of the plugs, by using a scraper.*

OBSERVATION:
Eliminate all rust and crustings.

3rd Step - *Place the plugs in the engine, thus:-*

a) Coat the seatings with adhesive.

b) Install the plugs by tapping their edges with a bronze drift (fig. 3)

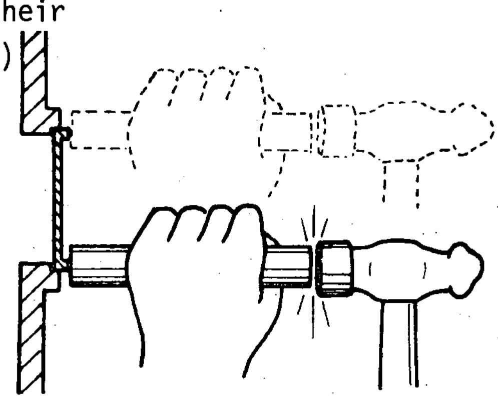


Fig. 3

It consists of removing and replacing the water pump of the engine so as to renew it, change its parts, or as part of the process of repairing the engine. The water pump forms part of the cooling system and is the part designed to maintain the constant circulation of the water.

METHOD OF EXECUTION:

1st Step - *Drain the cooling system and remove the hoses.*

2nd Step - *Remove the fan belt, thus:-*
a) Loosen the adjustment bolt of the generator.
b) Remove the fan belt.

3rd Step - *Remove the water pump, thus:-*
a) Remove the securing bolts of the pump.
b) Remove the pump from the engine removing the body if necessary.

4th Step - *Clean the external part of the pump with a brush and solvent. Remove the remains of the gasket.*

5th Step - *Replace the water pump into the engine, thus:-*
a) Replace the gasket coated with adhesive.
b) Install the pump with its respective bolts and tighten to the specified torque.
OBSERVATION:
Tighten the bolts gradually.

6th Step - *Install the fan belt, giving it its specified tension (fig. 1) and tighten the securing bolts of the generator.*

7th Step - *Reconnect the hoses and refill the cooling system with water.*

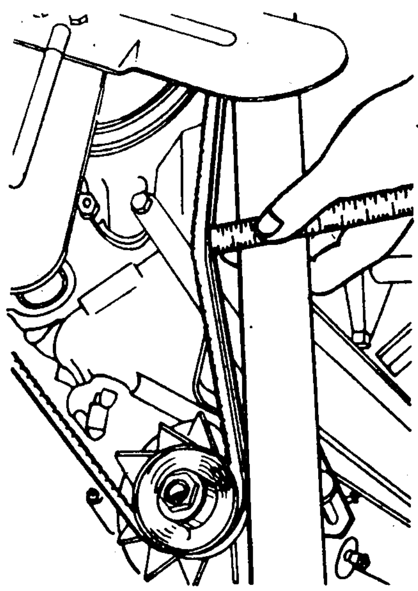


Fig.1

This is the phase in the repairing which enables the removal of the parts of the pump with the purpose of checking and changing the parts whenever necessary, so as to attain an efficient cooling system.

METHOD OF EXECUTION:

1st Step - *Remove the rear cover by removing the screws.*

2nd Step - *Remove the fan hub.*

OBSERVATION:
Use a bench vice and remove the hub with a 3-lêg extractor (fig. 1).

3rd Step -*Remove the impeller shaft, thus:-*

a) Remove the lock.
b) Remove the impeller shaft.

OBSERVATION:
Use a cylindrical drift and a press (fig. 2). Do not pound the body or the impeller of the pump, so as to prevent damaging either of the parts.

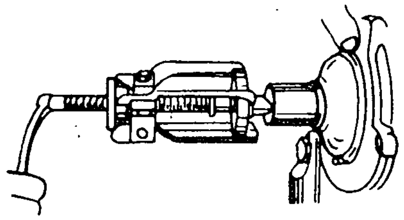


Fig. 1

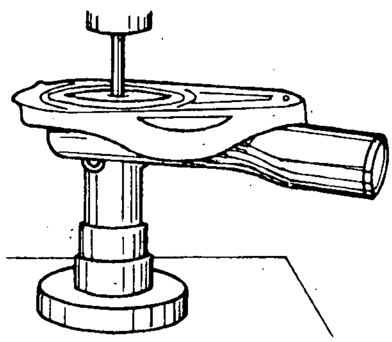


Fig. 2

c) Remove the impeller.
d) Check the water seal.

4th Step -*Check the parts, thus:-*

a) Check the water seal and its seating in the body of the pump.
b) Check the bearing on the shaft.
c) Check the squaring of the pulley.

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5th Step - *Replace the impeller shaft, thus:-*

a) Install the water seal.

b) Cover the contour of the bearing with grease and install it it into the pump housing by using pressure from a press.

c) Slowly press the impeller shaft into the pump housing, until it rests on its base (fig. 3).

d) Install the lock.

e) Install the hub by using a press (fig. 4).

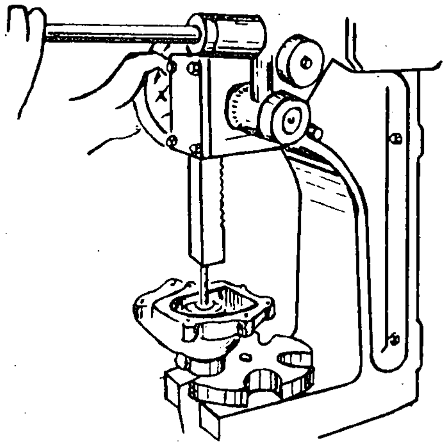


Fig. 3

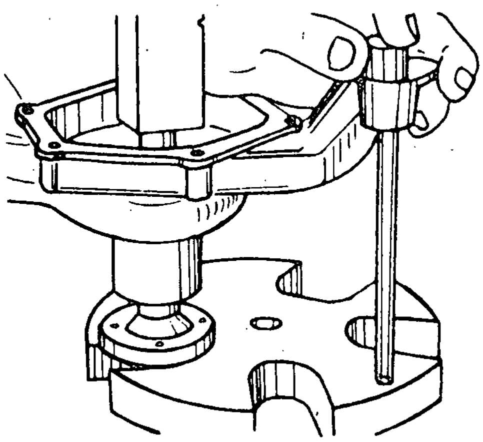


Fig. 4

6th Step -*Replace the impeller using a press to force it (fig. 5).*

OBSERVATIONS:

1) Avoid applying pressure to the part of the pump that is out of centre, so as to avoid breaking the impeller or the body.

2) Check the distance between the the impeller and the body in accordance with the manufacturer's specifications.

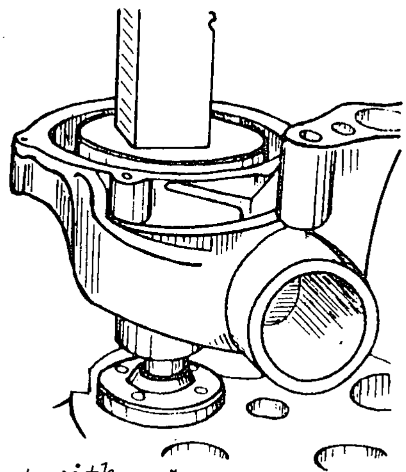


Fig. 5

7th Step -*Replace the rear cover and cover the gasket with grease or adhesive so as to obtain a good seal and air-tightness.*

The filter is an element that is replaced when changing the oil or when replacing other parts of the lubrication system.

The changing of this part should be done as frequently as determined by the manufacturer's specifications.

This process enables maintaining the oil free from abrasives and impurities.

METHOD OF EXECUTION:

1st Step -*Remove the oil filter from the engine, loosening it with a lever wrench (fig. 1).*

OBSERVATION:

Avoid spilling oil on the floor by positioning a container.

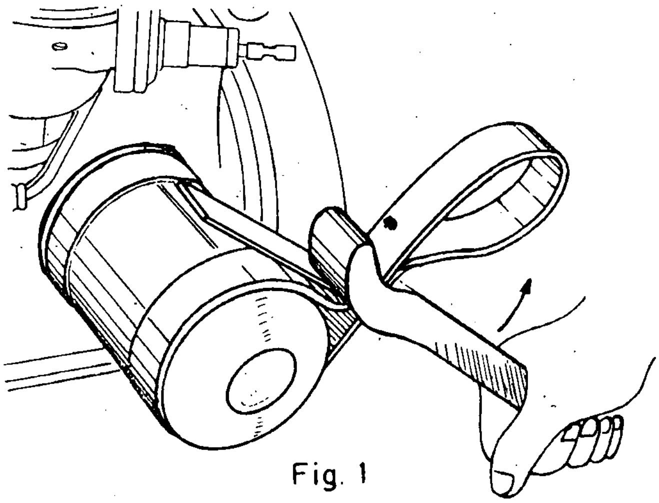


Fig. 1

2nd Step - *Clean the base of the filter with a piece of cloth.*

3rd Step - *Apply an oil film to the seat of the new filter.*

OBSERVATION:

Avoid wetting the seal with *solvent.*

4th Step - *Place the new filter into the engine and tighten according to the manufacturer's specifications.*

5th Step - *Turn on the engine, stop it and check the oil level of the engine by means of its dip stick, refilling it if necessary.*

OBSERVATION:

Check for oil leaks and correct the deficiencies, increasing the torque if necessary.

CBC

OPERATION: REMOVING AND REPLACING VENTILATION SYSTEM

To maintain the lubricating oil conditions and the internal pressure of the engine, the ventilation of the crank-case should be periodically checked.

METHOD OF EXECUTION:

1st Step - *Remove the hose of the ventilation system by loosening its clamp.*

2nd Step - *Remove the air filter from the carburettor by loosening the clamp of the filter.*

OBSERVATION:
Avoid spilling the oil from the filter.

3rd Step - *Remove the upper oil filling cover (fig. 1).*

4th Step - *Clean the inside and the outside of the oil filling cover, ventilator hose, reservoir, and the air filter unit by using solvent and compressed air.*

Fig. 1

5th Step - *Replace the ventilation system of the crank-case, thus:-*

a) Replace the upper oil filling cover.
b) Install the air-filter deposit, securing it with its clamp.
c) Put oil in the reservoir of the filter up to the level indicated.
d) Replace the ventilation hose and tighten its clamps.

NOTE:
In ventilation systems equipped with paper filters, the cleaning of the filter is done with compressed air at a low pressure (fig. 2).

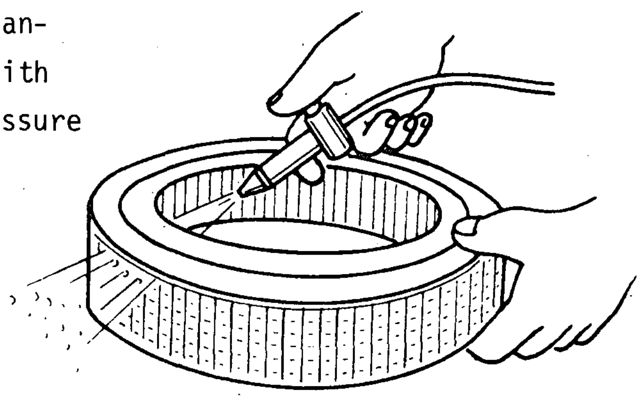


Fig. 2

It is the operation of removing the oil pump from the engine so as to check and repair this unit, which is the principal part of the lubrication system. The durability of the component parts of the engine depends on the mechanical state of the oil pump.

METHOD OF EXECUTION

1st Step - *Drain the lubrication system, thus:-*

a) Position a container and remove the drain plug of the crankcase.

OBSERVATION:
Use a clean container and avoid spilling oil on the floor.

b) Remove the dipstick from the oil level.

c) Replace the drain plug and remove the container with oil.

2nd Step - *Remove the crankcase thus:-*

a) Remove the securing screws of the crankcase to the block.

b) Remove the crankcase by using a lever if necessary.

SAFETY MEASURE:
PROTECT YOUR EYES FROM FALLING PARTICLES.

3rd Step - *Remove the oil pump, thus:-*

a) Remove the screw from the bracket of the tube.

b) Remove the screws that secure the pump to the block and remove the pump by pushing it downward.

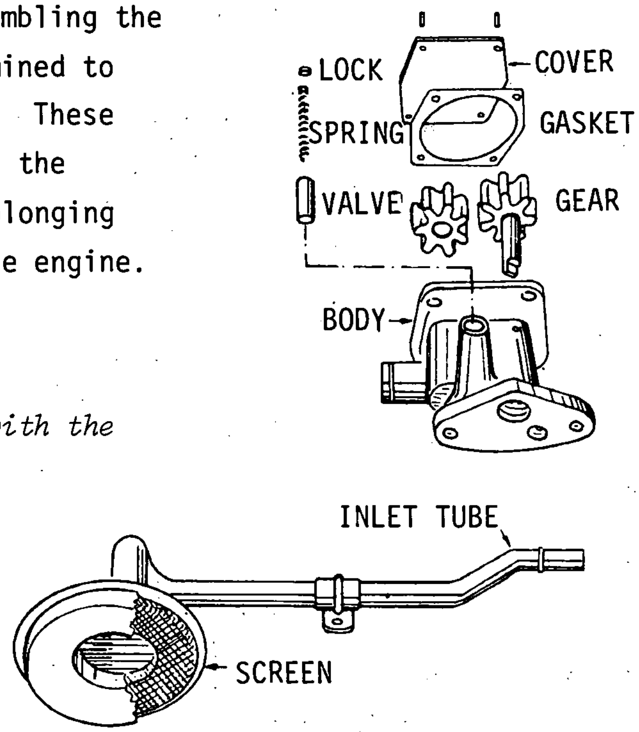
4th Step - *Clean the crankcase and the support surface of the block, scraping off the remains of the gasket.*

SAFETY MEASURE:
PROTECT YOUR EYES WHEN SCRAPING THE REMAINS OF THE GASKET.

5th Step - *Wash the crankcase with a brush and solvent; dry with compressed air.*

SAFETY MEASURE:
AVOID HAVING A FLAME ABOUT WHEN USING SOLVENT.

This operation consists of disassembling the unit so that the parts may be examined to assess the wear to them, (fig. 1). These confirmations are necessary due to the task that the pump performs in prolonging the life of the mobile parts of the engine.



METHOD OF EXECUTION:

1st Step - *Remove the inlet tube with the filter from the pump.*

Fig. 1

2nd Step - *Remove the cover of the pump by removing the securing screws.*

3rd Step - *Remove the gear wheels from the pump body.*

4th Step - *Remove the regulating valve, taking off the lock.*

5th Step - *Clean the parts with solvent and blow with compressed air.*

6th Step = *Check the parts of the oil pump, thus:-*

a) Examine the body of the pump to determine wear and deformation.

b) Check the tolerance between the gear wheel teeth and the body (fig. 2).

OBSERVATION:
Consult the specification of the manufacturer.

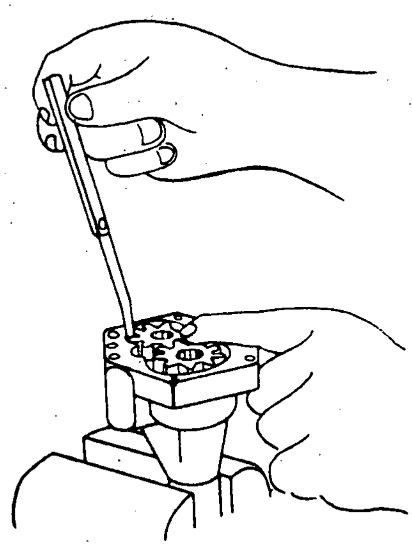


Fig. 2

c) Check the height of the gears and check its clearance (fig. 3).

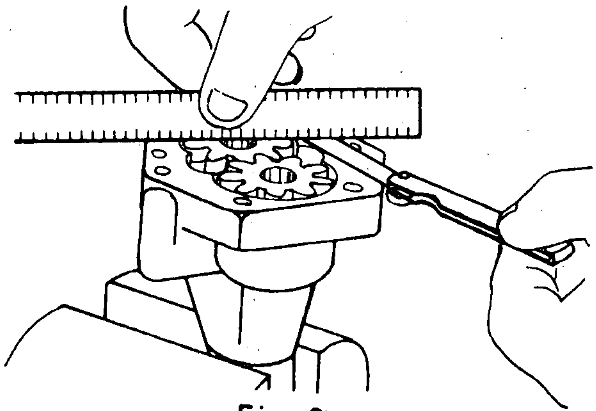


Fig. 3

d) Check the inlet tube and the screen filter.

7th Step - *Assemble the oil pump, thus:-*

a) Lubricate and install the gear wheels into the body of the pump.

b) Replace the gasket, the cover and tighten the screws to the specified torque.

OBSERVATION:
Make sure that the gasket is of the thickness specified.

c) Install the regulating valve, securing it with its lock.

d) Replace the inlet tube with the screen filter in the body of the pump.

8th Step - *Check the working of the pump, thus:-*

a) Prime the pump, filling it with oil through the inlet tube.

b) Submerge the inlet tube into a container with oil.

c) Turn the shaft of the pump until oil is expelled through the outlet tube.

It is an operation that consists of installing the oil pump in its respective base. This is done each time that it is removed for replacements, checking its parts or as a preliminary step to other repairs to the engine.

METHOD OF EXECUTION:

1st Step - *Install the oil pump in the engine, thus:-*

a) Position the pump on the block with its respective screws and tighten to the specified torque.

b) Centre and position the shaft of the pump in its respective housing.

c) Centre the inlet tube and secure it to the body by means of its bracket.

2nd Step - *Install the crankcase, thus:-*

a) Check the flatness of the crankcase.

b) Stick the gasket with adhesive to the crankcase.

OBSERVATION:
If the gasket is too small, submerge it in warm water until it is long enough.

c) Put lubricant grease onto the surface of the gasket that faces the block.

d) Place the crankcase onto the block and screw it on.

OBSERVATION:
Tighten the screws alternately and progressively.

3rd Step - *Refill the crankcase with oil, thus:-*

OBSERVATION:
Check and tighten the drain plug of the crankcase.

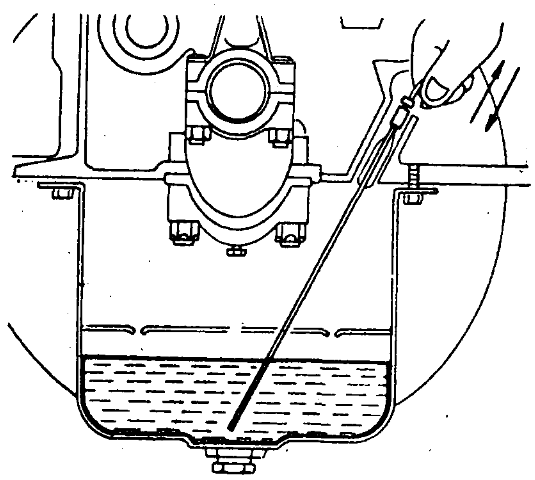


Fig. 1

a) Refill with the oil recommended by the manufacturer.

b) Check the oil level by means of the dipstick (fig. 1).

4th Step - *Check the lubrication system, thus:-*

a) Start the engine.

OBSERVATION:
If when starting the engine, it does not build pressure in the first instance, according to the specifications, stop the engine.

b) Stop the engine and check the oil level of the engine, refilling if necessary.

The gasoline used in automobiles is likely to be exposed to and receive impurities; as a result, it is necessary to remove the tank of the vehicle so as to check and clean it, so ensuring a clean supply of gasoline for the needs of the engine.

METHOD OF EXECUTION:

1st Step - *Remove the drain plug and empty the gasoline in a container with a cover.*

SAFETY MEASURE:
AVOID THE PRESENCE OF FLAMES OR ELEMENTS WHICH MAY IGNITE THE GASOLINE.

2nd Step - *Remove the tank from the vehicle, thus:-*

a) Remove the connection cable from the gas gauge.
b) Loosen the clamps and remove the hose from the tank.
c) Disconnect the outlet line of the gas from the tank.
d) Loosen the securing clamps and remove the tank.

OBSERVATION:
If necessary, seek aid to hold the tank.

3rd Step - *Remove the gas gauge.*

OBSERVATION:
Avoid hitting the gauge so as not to damage it and alter its accuracy.

4th Step - *Clean the gas tank, thus:-*

a) Replace the drain plug and put in the necessary gas for cleaning.

OBSERVATION:
Use a chain to remove the impurities stuck on the inside of the tank.

b) Shake the tank (fig. 1).

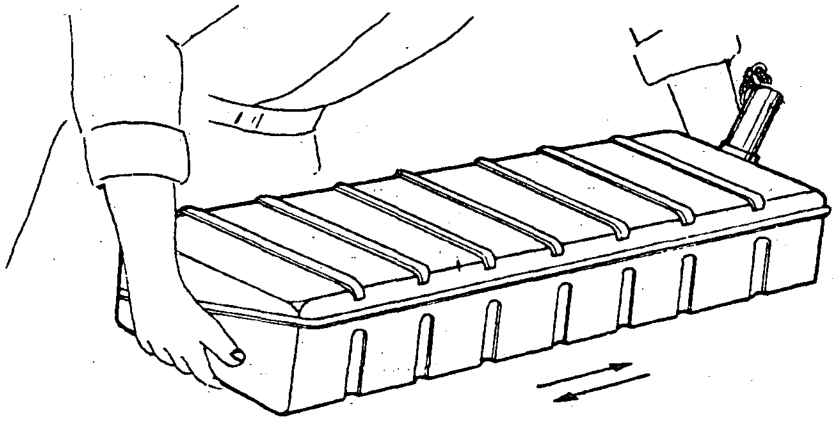


Fig. 1

SAFETY MEASURE:

VAPOURISED GASOLINE IS VERY INFLAMMABLE. AVOID A NAKED FLAME.

c) Clean as many times as necessary until the tank does not let off any foreign particles.

5th Step - *Replace the gas tank, thus:-*

a) Install the gas gauge with its gasket.

b) Replace the tank in its position.

OBSERVATION:

Seek aid when supporting the tank, if necessary.

c) Install the clamps of the tank and tighten the nuts.

d) Install the gas outlet line.

e) Install the filling hose and tighten the clamp.

f) Connect the cable to the gauge.

g) Refill the tank with gasoline.

The process of disassembling and reassembling the gas pump consists of removing and replacing the parts that comprise it, so as to check them with the purpose of replacing those that are deficient.

By this means, an effective delivery of gas to the carburettor is ensured, thus maintaining a good running engine.

METHOD OF EXECUTION:

1st Step - *Remove the gas pump from the engine, thus:-*

a) Disconnect the inlet and outlet gas lines from the pump.

OBSERVATION:
Avoid spilling gas on the floor.

b) Loosen the screws, remove the pump and its gasket.

c) Clean the surface of the seating of the pump in the engine.

2nd Step - *Separate the bodies of the pump, thus:-*

a) Clean the outside of the pump with solvent and a brush.

b) Place the pump in a bench vice and mark both bodies so as to pin-point its positioning (fig. 1).

c) Separate the bodies, removing the screws.

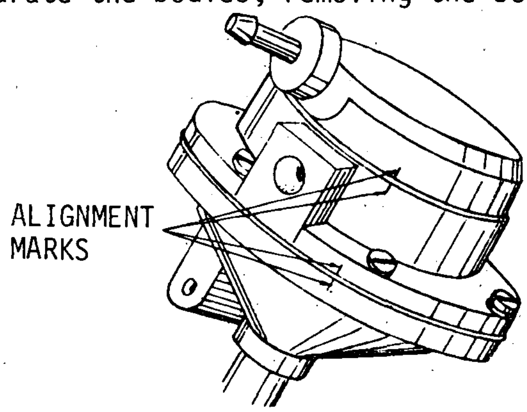


Fig. 1

OBSERVATION:
Use a plastic hammer, if necessary.

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3rd Step - *Remove the parts of the upper body of the pump, thus:-*

a) Remove the cover and filter.

b) Remove the valves by removing the securing plate (fig. 2).

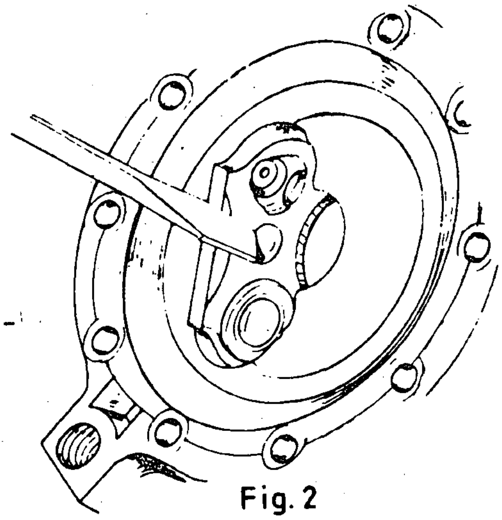

Fig. 2

4th Step - *Remove the parts of the lower body of the pump, thus:-*

a) Remove the diaphragm by compressing the spring so as to dislodge the stem from its operating lever (fig. 3).

b) Remove the oil seal.

c) Remove the bolt and take out the lever, the rocker arm (fig. 4) and the rocker arm spring.

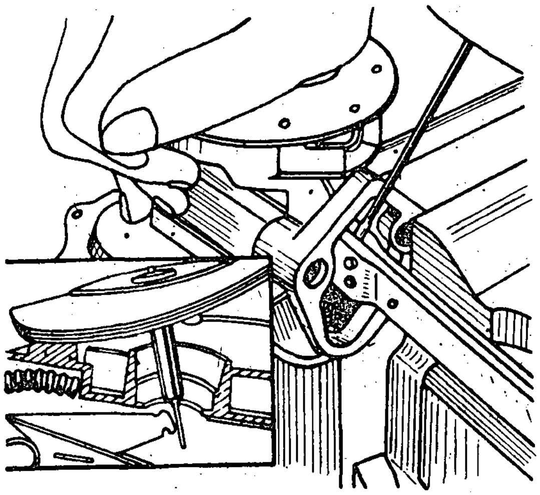

Fig. 3

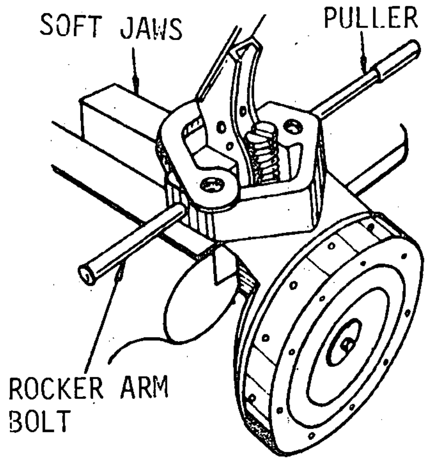

Fig. 4

SAFETY MEASURE:

TAKE CARE THAT THE SPRING DOESN'T JUMP OUT.

5th Step - *Clean and inspect the parts, thus:-*

a) Clean the metallic parts and blow out the ducts with compressed air.

b) Check the bodies of the pump for cracks and deformities.

c) Inspect the rocker arm, lever, and bolt for wear or deformities.

d) Check the diaphragm for breaks, porosity or dilations.

e) Check the valves and their seatings.

6th Step - *Install the parts of the lower body, thus:-*

a) Place the pump in a bench vice.

b) Replace the lever and the rocker arm and insert the bolt.

c) Replace the rocker arm spring.

SAFETY MEASURE:

TAKE CARE TO PREVENT THE SPRING FROM JUMPING.

d) Replace the oil seal.

e) Install the spring and the diaphragm (fig. 3).

7th Step - *Install the parts of the upper body, thus:-*

a) Replace the valves and secure them with the plate.

b) Replace the filter and the cover of the upper body.

8th Step - *Assemble the bodies of the pump, thus:-*

a) Place the lower body in a bench vice.

OBSERVATION:
Use soft metal jaws.

b) Mount the upper body, lining up the bodies so that the marks coincide.

OBSERVATION:
Centre the diaphragm and line it up with the bodies so that the holes coincide.

c) Replace the screws and tighten alternately.

9th Step -*Check the pump (fig. 5).*

SAFETY MEASURE:
AVOID THE PRESENCE OF FIRE OR ELEMENTS WHICH MAY IGNITE GASOLINE.

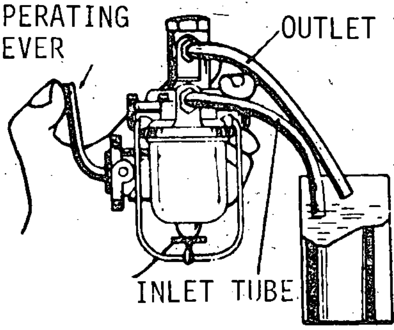

Fig. 5

10th Step -*Replace the pump in the engine, thus:-*

a) Put adhesive on to the gasket and place it on the pump.

b) Replace the pump and secure it with the screws.

OBSERVATION:
Make sure that the rocker arm of the pump is seated on the eccentric of the camshaft.

c) Reconnect the gas lines.

It is the operation designed to remove and install the carburettor so as to repair and check it, or as a step in repairing other parts of the engine. It is done, also, in removing the intake manifold, removing the cylinder head or disassembling the engine.

METHOD OF EXECUTION:

1st Step - *Remove the air filter from the carburettor.*

OBSERVATION:
If the filter is an oil bath type, place it on a flat place, on its base, so as not to spill the oil.

2nd Step - *Remove the carburettor, thus:-*

a) Disconnect the cables from the choke and the manual accelerator.

b) Disconnect the vacuum line to the distributor.

c) Disconnect the fuel intake line.

d) Disconnect the operating lever of the accelerator.

e) Loosen the securing nuts, remove the carburettor and its gasket.

OBSERVATION:
Cover the carburettor housing in the intake manifold (fig. 1), so as to prevent the entrance of foreign matter.

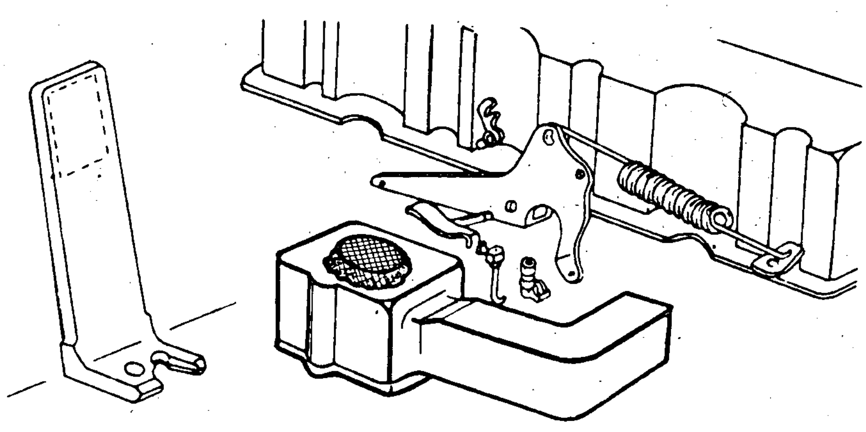

Fig. 1

3rd Step - *Clean the outside of the carburettor, using a tray with solvent, a brush and compressed air.*

SAFETY MEASURE:
AVOID THE PRESENCE OF FIRE OR ELEMENTS THAT CAN CAUSE THE IGNITION OF THE SOLVENT.

4th step - *Replace the carburettor, thus:-*

a) Install the gasket on the manifold, making its holes coincide with those of the carburettor.

b) Install the carburettor, tightening the nuts.

c) Reconnect the fuel intake line.

d) Reconnect the vacuum line to the distributor.

e) Install the choke and throttle, adjusting their openings.

f) Install the accelerator mechanism, adjusting the opening of the throttle valve.

5th Step - *Place the air filter on the carburettor.*

This consists of disassembling the carburettor so as to clean and check it and regulate its different parts.

After a certain mileage, it is necessary to replace the parts of the carburettor, which makes this operation important.

METHOD OF EXECUTION:

I TO DISASSEMBLE THE CARBURETTOR

1st Step - *Remove the parts of the upper body of the carburettor (fig. 1), thus:-*

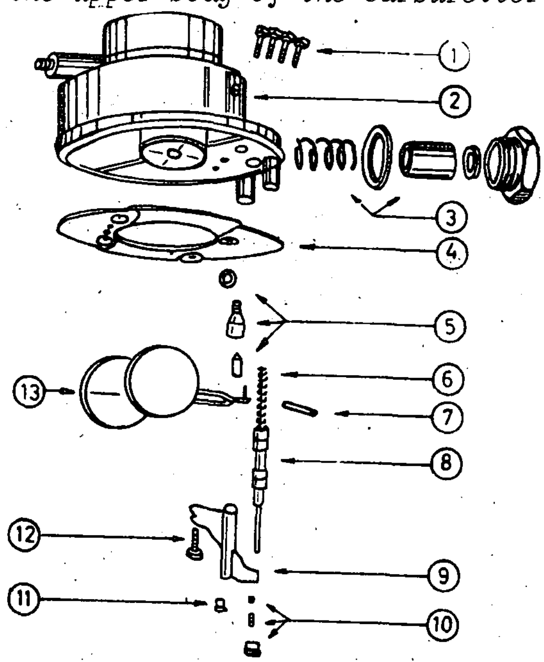

Fig. 1

OBSERVATION:

Use a tray with solvent to place the disassembled parts, neatly arranged.

SAFETY MEASURES:

1. *Avoid spilling the solvent.*
2. *Avoid the presence of fire and elements which cause it.*

a) Loosen the screws (1) and remove the upper cover (2).

OBSERVATION:

Take care not to damage the parts assembled in the cover.

b) Remove the filter and spring (3) of the gas intake line.

c) Remove the hinge pin (7) and the float (13).

d) Remove the valve and the seating (5).

e) Remove the screw (12) which holds the base (9) to the high speed jet system and remove the jet system.

f) Remove the valve and spring (10) of the economizer.

g) Remove the high speed jet (11).

h) Remove the piston (8) and spring (6) of the economizer.

i) Remove the gasket (4) of the cover.

2nd Step - *Disassemble the parts of the central body (fig.2), thus:-*

a) Remove the rod (1) which operates the piston of the acceleration pump, remove the piston and the retracting spring (3).

b) Remove the catch (4) of the outlet valve of the injection system and remove the spring (5) and valve (6).

c) Remove the spring (2) from the acceleration pump.

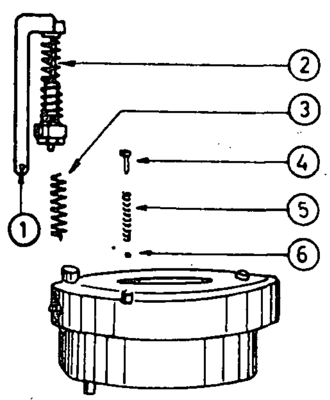

Fig. 2

3rd Step - *Remove the base of the carburettor (fig. 3), thus:-*

a) Remove the screws (4), remove the base and the gasket (11).

b) Remove the screw (2) and the low speed spring (3).

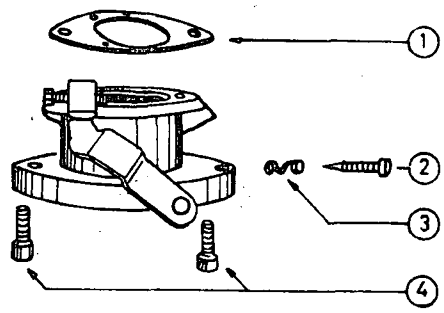

Fig. 3

4th Step - *Clean the parts of the carburettor.*

5th Step - *Blow the intake filter and the different carburettor circuits with compressed air.*

6th Step - *Inspect the parts of the carburettor, thus:-*

a) Check the valve and seating of the economizer.

b) Check the intake valve of the acceleration system.

c) Check the working of the piston of the economizer.

d) Check the low speed control screw.

e) Check the closed position of the throttle valve.

f) Check the flatness of the base of the carburettor.

II TO ASSEMBLE THE CARBURETTOR

1st Step - *Replace the base of the carburettor on the central body and install the gasket, thus:-*

OBSERVATION:
Position the gasket in such a way that the holes coincide with those of the base of the carburettor.

a) Install the base and tighten the screws.
b) Replace the screw and the spring of the low speed system.

2nd Step - *Install the parts of the central body, thus:-*

a) Install the valve and outlet catch of the acceleration system.
b) Install the spring and the piston of the acceleration system and install the rod.

3rd Step - *Install the parts of the upper body of the carburettor, thus:-*

a) Place the gasket and replace the base of the discharge system.

OBSERVATION:
Position the gasket in such a way that its holes coincide with those of the cover.

b) Install the high speed jet.
c) Replace the seating and gas intake valve and install the float.
d) Install the gas intake filter.

4th Step - *Adjust the float (figs. 4, 5), according to specifications.*

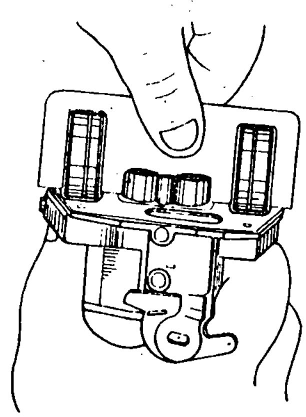

Fig. 4

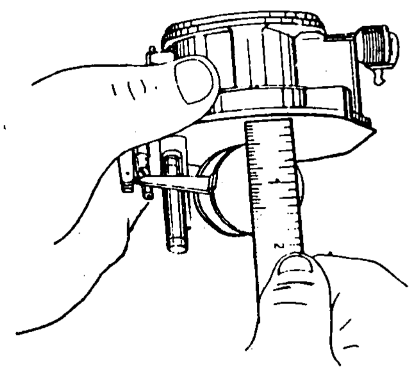

Fig. 5

5th Step - *Install the upper cover of the carburettor and tighten the screws.*

6th Step - *Adjust the vent valve to the correct height (fig. 6).*

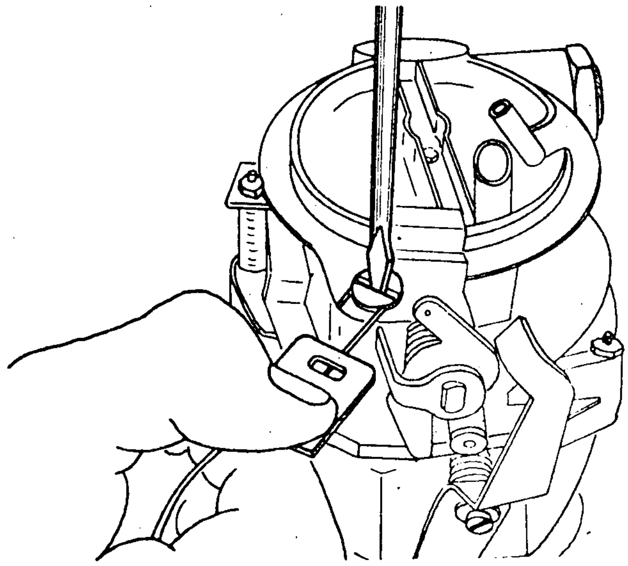

Fig. 6

TECHNICAL VOCABULARY:

CENTRAL BODY - main body

INJECTION SYSTEM - pump system

LOW SPEED CONTROL SCREW - mixture screw

This operation is done by adjusting the external regulating screws of the carburettor, so as to obtain a smooth running engine and a greater mileage from the gasoline.
This is done every time the carburettor is removed for cleaning or for replacing parts.

METHOD OF EXECUTION:

1st Step - *Run the engine until it attains its normal temperature and turn it off.*

2nd Step - *Connect the tachometer to the engine, thus:-*

a) Connect the cables of the instrument: one to earth and the other to the output terminal of the coil or to the input terminal of the distributor (fig. 1).

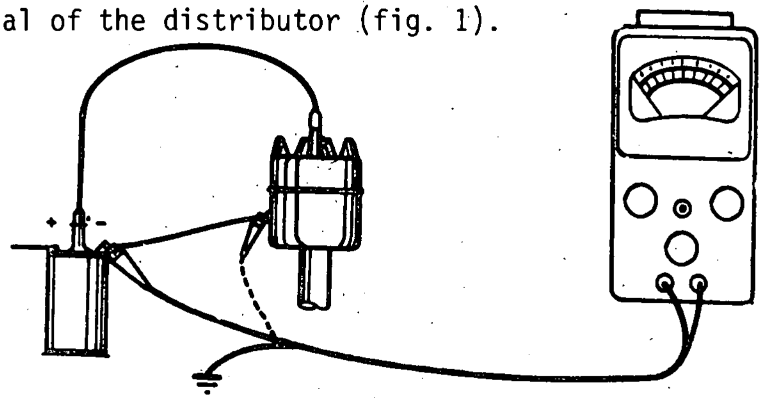

Fig. 1

b) Select a measurement scale suited to the number of cylinders in the engine.

3rd Step - *Connect the gas analyzer (fig. 2), thus:-*

a) Calibrate the instrument (1).

b) Affix the sensing unit (2).

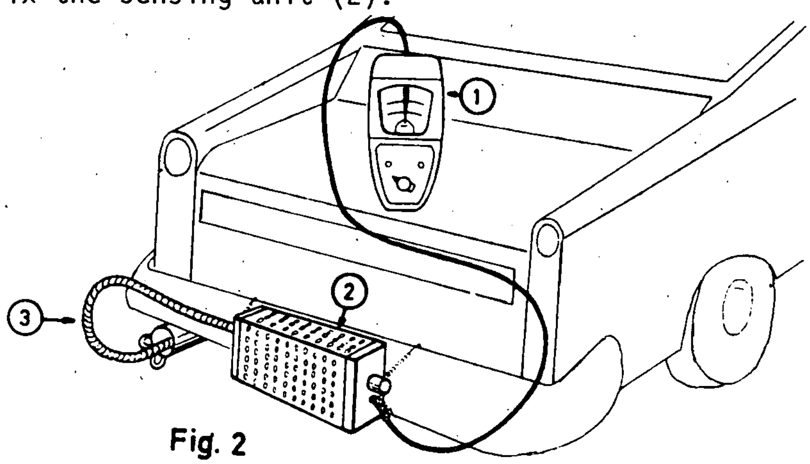

Fig. 2

c) Introduce the line of the unit in the exhaust pipe (3).

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4th step - *Adjust the carburation* at low speed, thus:-

a) Start the engine.

b) Adjust the idle speed screw (Fig. 3), to obtain the minimum number of revolutions specified.

c) Operate the low speed regulating screw, opening it until the engine begins to vibrate and turn it in the opposite direction until obtaining smoothness in the running of the engine.

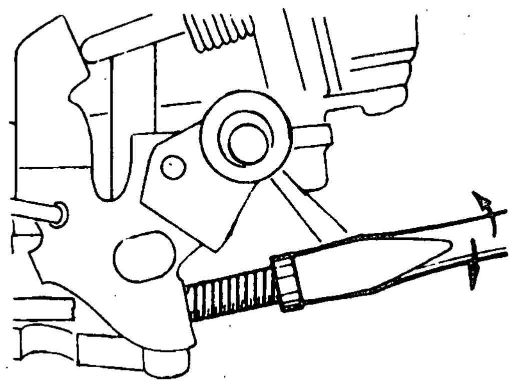


Fig. 3

OBSERVATION

The analyzer should indicate a deviation towards rich mixtures.

5th step - *Adjust the carburation* at high speed, thus:-

a) Regulate the tachometer selector for higher revolutions.

b) Turn the idle speed screw until obtaining the maximum revolutions specified.

OBSERVATION

The analyzer should indicate a rich mixture and then gradually a lean mixture.

c) Turn the idle speed screw until the minimum number of revolutions specified is again obtained.

6th step - *Replace the air filter* on the carburettor.

7th step - *Check the adjustment of the carburation,* with the filter mounted, repeating steps 4 and 5.

8th step - *Stop the engine* and disconnect the instrument.

This is the phase where the intake and exhaust manifolds are removed from the cylinder head. It is done every time that it is necessary to change gaskets or when checking the heat control valve. Besides this, it is done also when changing one of the manifolds or in removing the cylinder head.

METHOD OF EXECUTION:

1st Step - *Remove the intake and exhaust manifolds, thus:-*

a) Remove the carburettor.

b) Disconnect the exhaust pipe.

c) Loosen and remove the securing screws and nuts of the manifolds to the cylinder head.

d) Slowly remove the manifolds from the cylinder head.

e) Remove the sealing rings and the gaskets.

2nd Step - *Separate the intake and exhaust manifolds, thus:-*

a) Hold the manifolds in a bench vice.

OBSERVATION:
Use soft metal jaws.

b) Loosen the screws or nuts that join the exhaust and intake manifolds.

OBSERVATION:
Use a penetrating liquid, if necessary, to remove the rust from the screws.

c) Separate the manifolds.

3rd Step - *Check the manifolds, thus:-*

a) Clean the ducts of the manifolds with a scraper and brush and then blow out with compressed air.

SAFETY MEASURE:
PROTECT YOUR EYES FROM FLYING PARTICLES WHEN USING THE COMPRESSED AIR BLOWER.

b) Check the flatness of the manifolds with a rule and a thickness gauge.

4th Step - *Check the heat control valve of the manifold, thus:-*

a) Remove the thermostatic coil spring and remove the valve shaft.

OBSERVATION:
Use a penetrating liquid, if necessary.

b) Lubricate the heat control valve shaft.

OBSERVATION:
Use the lubricant specified.

c) Install the thermostatic coil spring of the valve and check its working condition.

5th Step - *Assemble the manifolds, thus:-*

a) Install the gasket between the manifolds.

OBSERVATION:
Use adhesive to secure the gasket.

b) Replace the screw, align the surfaces and tighten to the specified torque.

6th Step - *Replace the manifolds on to the cylinder head, thus:-*

a) Install the gaskets after they have been pasted with adhesive.

b) Install the rings in the intake pipes.

c) Install the manifolds and secure them with their screws and nuts.

OBSERVATION:
Cover the port for the carburettor in the intake manifold to prevent foreign particles from entering it.

d) Tighten the securing screws and nuts of the manifolds, in the specified manner, to the specified torque.

7th Step - *Reconnect the exhaust pipe.*

8th Step *Replace the carburettor.*

This is the procedure designed to remove the cylinder head from the engine. It is done when reconditioning the valve mechanisms or as a preliminary step in other repairs to the engine.

METHOD OF EXECUTION:

1st Step - *Drain the water cooling system.*

2nd Step - *Remove the upper hose from the radiator.*

3rd Step - *Remove the carburettor.*

4th Step - *Disconnect the exhaust pipe.*

5th Step - *Remove the cylinder head rocker arms, thus:-*

a) Remove the upper cover of the cylinder head.

b) Loosen the rocker arm adjusters (fig. 1).

c) Remove the securing screws from the rocker arms (fig. 2) - remove the mechanism and the valve lifting rods.

OBSERVATION:
Avoid damaging the heads of the nuts and screws

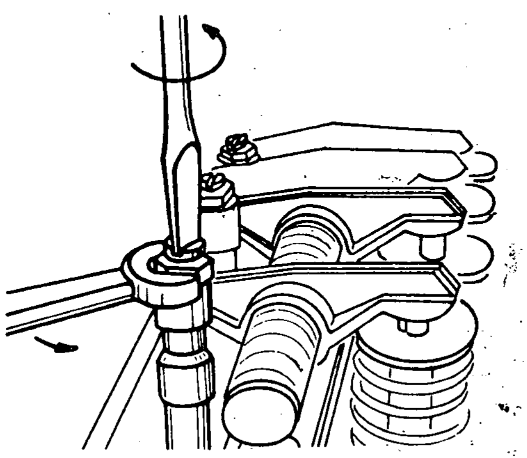


Fig. 1

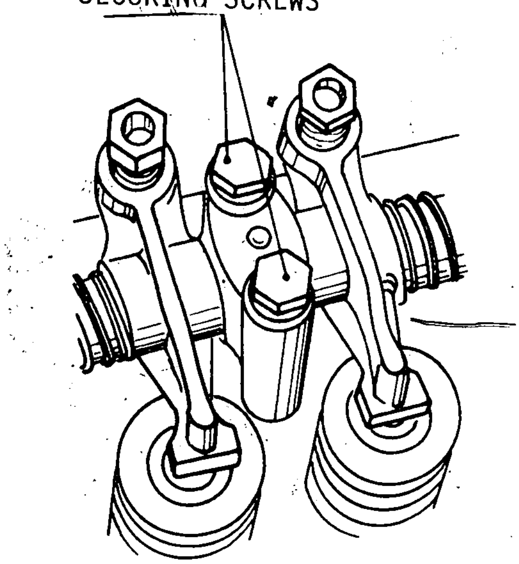


Fig. 2

6th Step - *Remove the spark plugs.*

7th Step - *Remove the cylinder head, thus:-*

a) Disconnect the temperature gauge cable.

b) Loosen the cylinder head bolts in an alternate and progressive manner, from the ends to the centre.

SAFETY MEASURE:

SECURE THE TOOLS IN THEIR BASE, TO PREVENT THEM FROM SLIPPING AND HITTING YOUR HANDS.

c) Remove the bolts and remove the cylinder head.

OBSERVATION:

Seek aid when removing the cylinder head and avoid hitting it.

SAFETY MEASURE:

PROTECT YOUR HANDS FROM THE SHARP BORDERS OR EDGES OF THE CYLINDER HEAD.

d) Remove the cylinder head gasket and cover the cylinders of the engine with a towel.

8th Step - *Clean the surface and the combustion chambers of the cylinder head, using a scraper and a steel brush.*

SAFETY MEASURE:

PROTECT YOUR EYES FROM THE FLYING PARTICLES OF CARBON.

Reinstalling the cylinder head is the final phase in the assembly of the engine, as part of repairing the distribution system or in changing the cylinder head gasket. It should be done, bearing the manufacturer's specifications in mind, so as to prevent deformations to the cylinder head, which can produce loss of compression or water leaks to the engine crankcase.

METHOD OF EXECUTION:

1st Step - *Install the cylinder head on the engine, thus:-*

a) Apply oil, grease or sealing liquid to the gasket of the cylinder head, in accordance with the specifications and install it on the block, making their holes coincide.

b) Replace the cylinder head and proceed to install the securing bolts, while centring the cylinder head and gasket with respect to the block.

OBSERVATION:
Seek aid, if necessary, and avoid damaging the gasket when installing the cylinder head.

c) Tighten, alternately and progressively, the cylinder head bolts , from the centre to the ends, paying attention to the specifications (fig. 1).

d) Connect the temperature gauge cable.

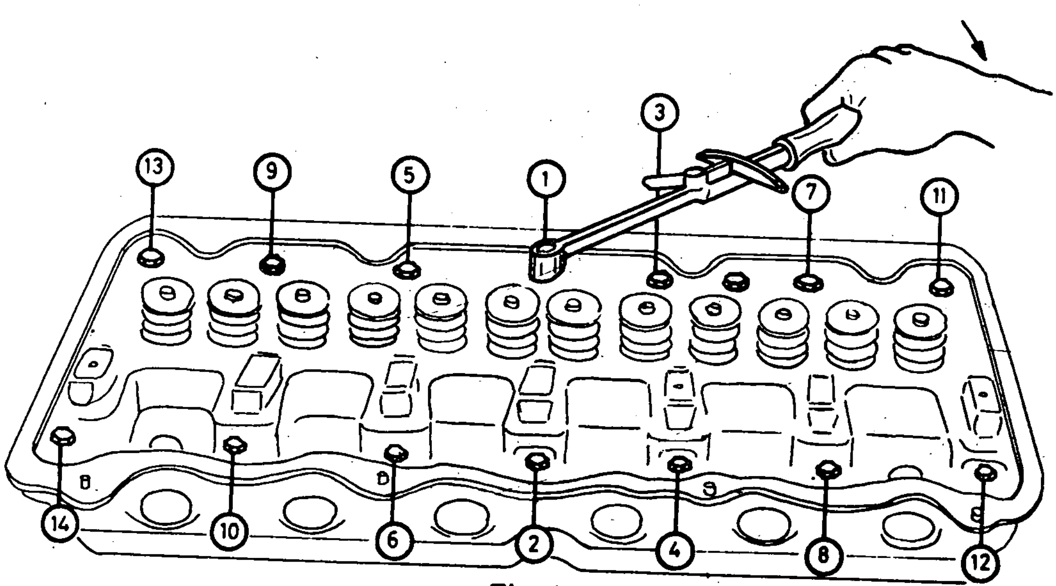


Fig. 1

2nd Step - *Replace the rocker arms on the cylinder head, thus:-*

a) Install the valve lifting rods.

b) Install the rocker arms and adjust the valves, by using a thickness gauge (fig. 2), paying attention to the specifications.

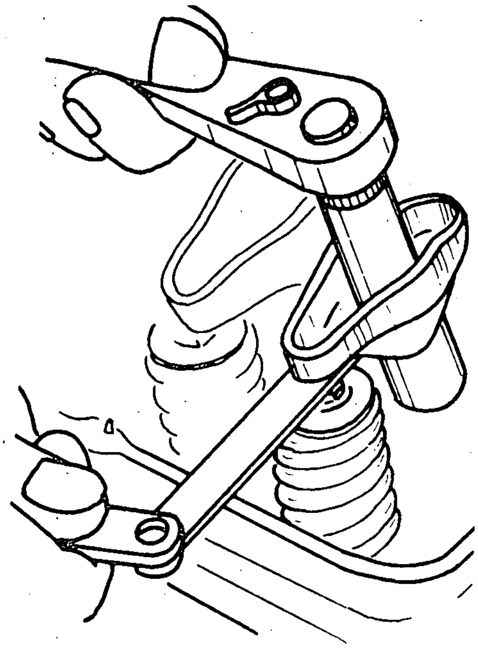


Fig. 2

3rd Step - *Install the side cover of the engine with its respective gasket.*

4th Step - *Connect the exhaust pipe.*

5th Step - *Install the carburettor.*

6th Step - *Install the spark plugs and connect the cables according to the firing order.*

7th Step - *Connect the upper hose of the radiator and refill the water cooling system with water.*

8th Step - *Run the engine so that it may attain its normal working temperature and proceed to check the the valve adjustment.*

SAFETY MEASURE:

WHEN USING THE THICKNESS GAUGE, TAKE CARE NOT TO CUT YOUR HANDS.

9th Step - *Turn off the engine and proceed to change the lubricating oil in the engine.*

TECHNICAL VOCABULARY:

VALVE LIFTING RODS - push rods

The operation of removing and installing the hydraulic valve lifters is done with the aim of cleaning and checking their parts. In this way, the possibility of defective working valves is avoided.

METHOD OF EXECUTION:

1st Step - *Remove the rocker arms and valve lifters.*

2nd Step - *Remove the hydraulic lifters, thus:-*

a) Remove the side covers from the engine, by removing the screws.

b) Remove the hydraulic valve lifters, (fig. 1).

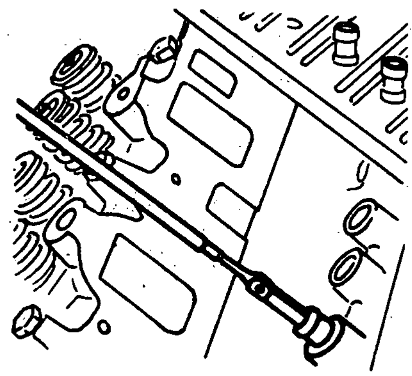


Fig. 1

OBSERVATION:
Place the valve lifters in a pigeon hole tray so as to enable their replacement in the same order.

3rd Step - *Disassemble the hydraulic valve lifters (fig. 2), thus:-*

a) Remove the lock with a bird beak pliers.

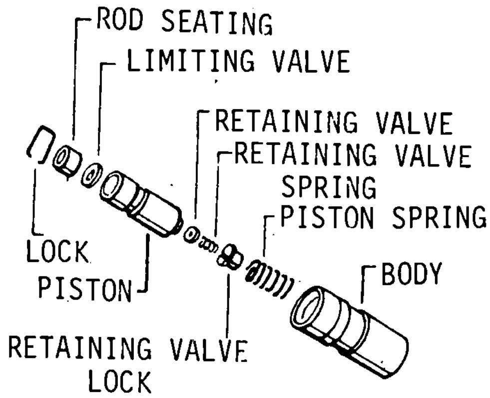


Fig. 2

OBSERVATION:
It may be necessary to compress the piston to loosen the lock.

b) Remove the rod seating, the limiting valve, the piston and its spring.

c) Invert the piston and remove the valve lock by levering it off the valve and remove the retaining valve and the spring.

OBSERVATION:
Avoid interchanging the parts of one piston rod with those of another.

4th Step - *Inspect the parts, thus:-*

a) Clean the parts with a solvent.

b) Visually check to see whether there are scratches, surface cracks or wear on the parts.

OBSERVATION:
Use a lens, if necessary.

5th Step - *Assemble the valve lifters, thus:-*

a) Install the valve in its housing above the piston's trail hole.

OBSERVATION:
Install the parts oiled.

b) Replace the valve lock and its spring, by pushing the lock into its place in the piston.

c) Place the piston spring in the body of the valve lifter.

OBSERVATION:
Make sure that the open part of the piston remains facing upwards.

d) Install the limiting valve, the valve stem seating and compress the piston, placing the lock in the groove of the valve lifter body.

OBSERVATION:
Make sure that the lock remains seated in the groove.

6th Step - *Mount the piston rods and the side covers on the engine.*

7th Step - *Install the valve lifters and the rocker arm unit.*

TECHNICAL VOCABULARY:

BIRD BEAK PLIERS - long nose pliers
PISTON - plunger
PISTON SPRING - plunger spring

The checking of the cylinder head, valves and seatings is done every time that the engine is faulty due to burning or incorrect seating of the valves, which produces loss of compression. It consists of confirming their measurements and tolerances so as to determine their corrections or replacements.

METHOD OF EXECUTION:

1st Step - *Remove the valves from the cylinder head, thus:-*

a) Compress the valve springs, positioning the valve spring compressor between the sustaining plate and the valve head (fig. 1), and tighten the valve spring compressor.

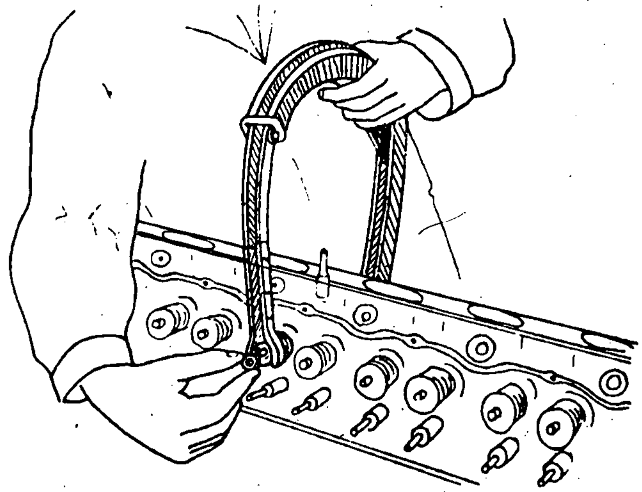


Fig. 1

b) Remove the valve safety locks.

c) Remove the valve spring compressor, slowly letting go its lever to avoid the spring jumping.

d) Remove the springs, locks and valves.

2nd Step - *Clean the disassembled parts, decarbonizing the valves, ducts and the combustion chamber, with a scraper and a steel brush.*

SAFETY MEASURE:

PROTECT YOUR EYES FROM FLYING CARBON PARTICLES.

3rd Step - *Check the cylinder head, thus:-*

a) Check the flatness of the cylinder head, in three directions, with a rule and a thickness gauge (fig. 2).

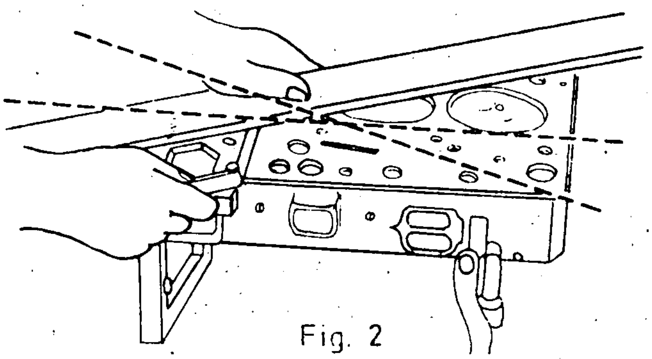


Fig. 2

b) Check the flatness of the manifold seating with a rule and a thickness gauge.

c) Check the cylinder head to see that it is not cracked and the threads for the spark plugs to see if they are in bad shape.

4th Step - *Check the state of the valves, thus:-*

a) Check the thickness of the valve head (fig. 3).

b) Determine the play (clearance) between the stem and the valve guide (fig. 4).

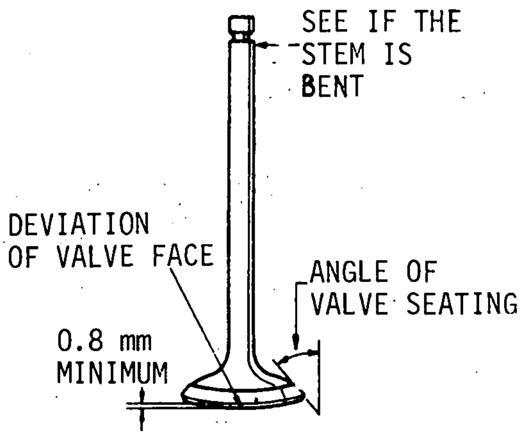


Fig. 3

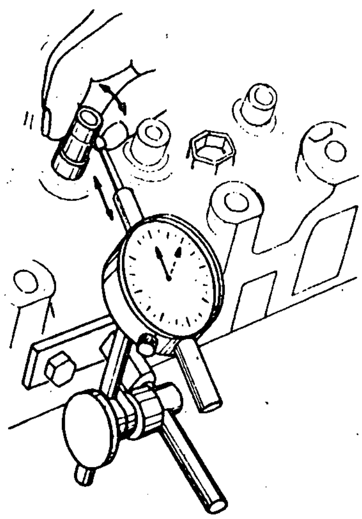


Fig. 4

c) Check the alignment of the valves (fig. 5).

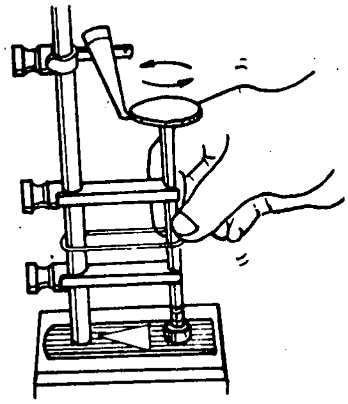


Fig. 5

5th Step - *Check the state of the springs, thus:-*

a) Check the squareness of the springs (fig. 6).

b) Check the free height of the springs (fig. 7).

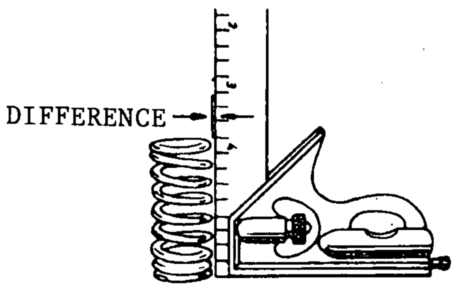


Fig. 6

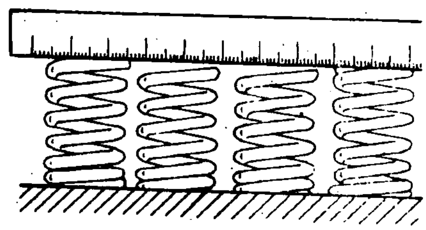


Fig. 7

c) Check the tension in the springs to the level specified (fig. 8).

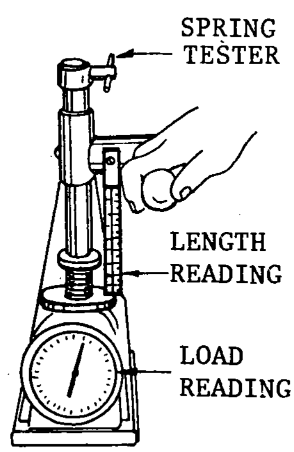


Fig. 8

6th Step - *Check the state of the valve seatings, checking the width (fig. 9) and its possible deviation (fig. 10).*

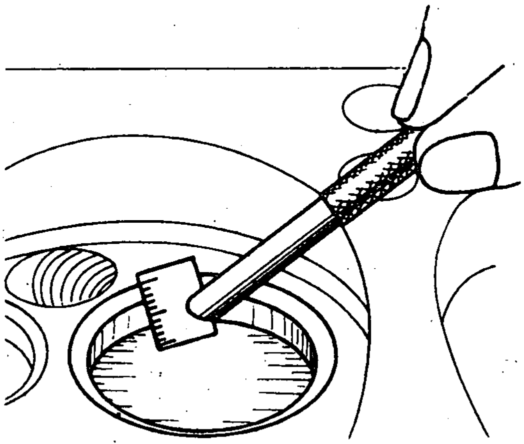


Fig. 9

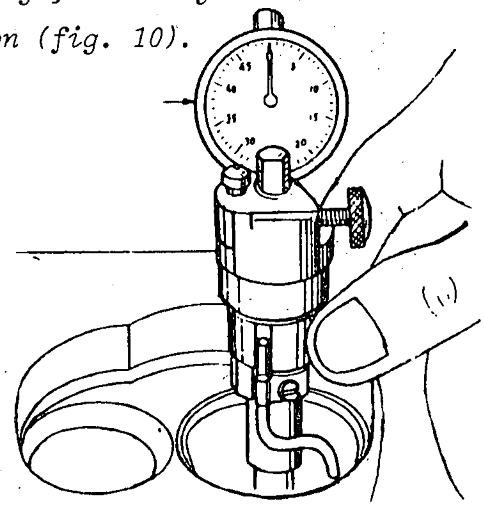


Fig 10

7th Step - *Replace the valves in the cylinder head, thus:-*

a) Install the valves in their respective guides, totally cleaned and lubricated.

b) Install the springs of the valves in their respective housings, with the part of their coils that are closer together, towards the base of the cylinder head.

c) Install the valve plates and the oil seal.

d) Install the locks on the valves by compressing the springs with the valve spring compressor.

OBSERVATION:
Avoid, when applying pressure with the spring compressor, breaking or damaging the seals when installing the valve locks.

e) Check the height of the valves (fig. 11).

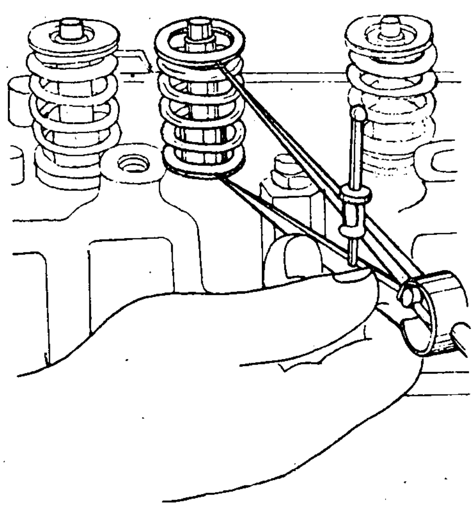


Fig. 11

This is the operation of reconditioning the contact surfaces of the valves and seatings, with the aim of attaining air-tightness in the combustion chamber, thereby obtaining a higher efficiency from the engine.

METHOD OF EXECUTION:

1st Step - *Remove the valves from the cylinder head.*

2nd Step - *Clean the removed parts.*

3rd Step - *Check the cylinder head, the state of the valves, springs and seatings.*

4th Step - *Grind the valves, thus:-*

a) Prepare the grinding machine, giving it the specified angle. Check the level of the cooling liquid and the state of the emery stone.

b) Install the valve in the machine, checking that it is perfectly centred in the chuck, and start grinding, allowing the cooling liquid to flow.

c) Proceed to grind the valve, using the whole width of the emery stone, slowly and continually, and prevent the valve from sticking to the stone.

d) Remove the valve from the machine.

e) Grind the tip of the valve by using the special attachment.

5th Step - *Grind the valve seatings, thus:-*

a) Prepare the grinding equipment for the valve seatings, selecting the type of stones according to the angle (fig. 1), the bushing to be used, and the guide shaft to be inserted in the valve guide.

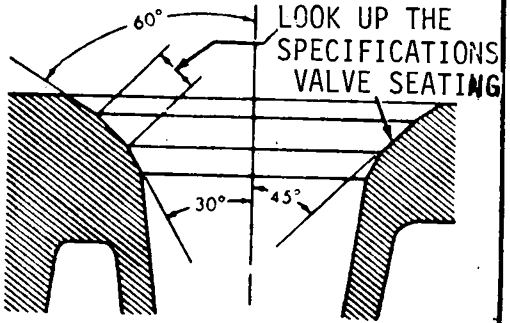


Fig. 1

CINTERFOR
1st. Editi

b) Insert the guide shaft of the stones in the valve guide and secure it to the latter (fig. 2).

c) Grind the seatings, according to specifications (fig. 3).

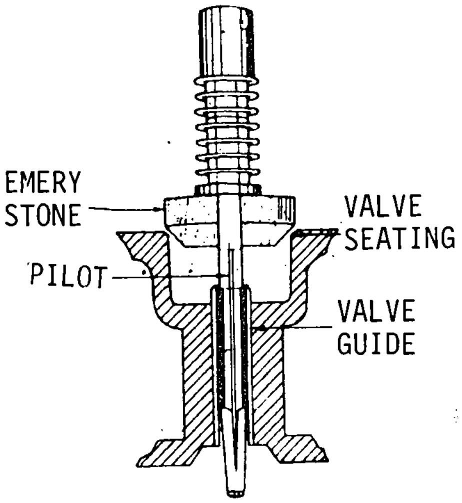


Fig. 2

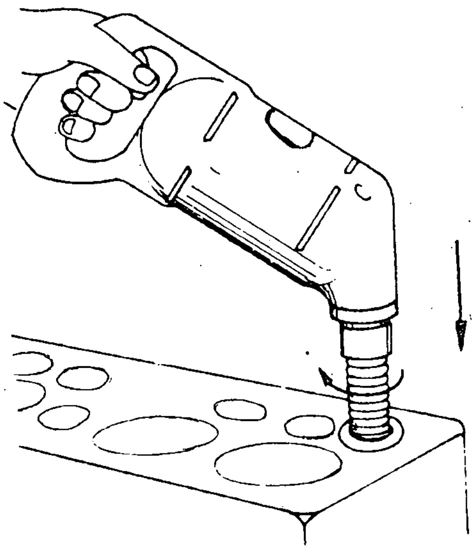


Fig. 3

SAFETY MEASURE:

PROTECT YOUR EYES FROM POSSIBLE FLYING PARTICLES

d) Remove the guide shaft from the emery stone, clean seating and guide.

6th Step - *Seat the valves, thus:-*

a) Apply emery paste on the face of the valve and insert it in its guide. Turn the valve against the seating (fig. 4) without hitting it.

OBSERVATION:
Avoid getting paste on the valve stem so as not to scratch it.

b) Clean the parts with solvent.

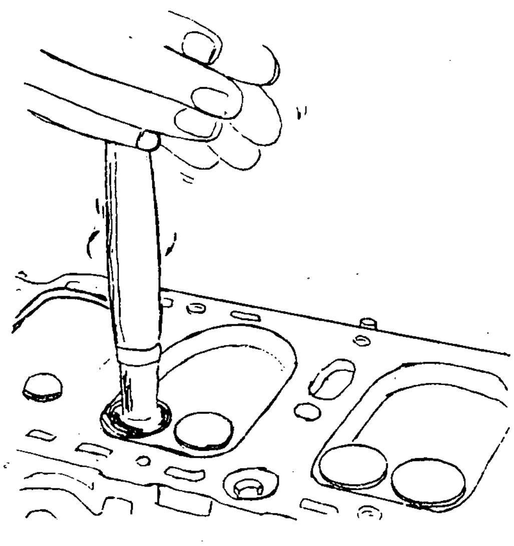


Fig. 4

7th Step - *Check the air-tightness of the valves with its seatings, thus:-*

a) Trace radiating lines, with a carbon pencil, on the face of the valve.

b) Replace the valve, turn it against its seating and check the seating.

8th Step - *Replace the valves in the cylinder head.*

This is the operation which consists of removing the engine from the vehicle so as to make a total or partial adjustment to it, as well as for making other types of inspections or repairs to the vehicle. This operation is done with the aid of lifting equipment which requires maximum precautionary measures.

METHOD OF EXECUTION:

1st step - *Position the vehicle* in the work site.

2nd step - *Remove the bonnet,* removing the securing screws from the bracket.

3rd step - *Drain the* cooling and lubrication systems.

4th step - *Remove the radiator* from the vehicle.

5th step - *Disconnect the accessories from the engine, thus:-*

a) Disconnect the battery cables, generator cables and ignition cables.
b) Remove the temperature gauge transmitting unit and oil pressure gauge cable.
c) Remove the carburettor and the distributor.
d) Disconnect the exhaust pipe.
e) Disconnect the clutch operating mechanism.
f) Remove the bolts which hold the gear-box to the bell housing of the clutch.

OBSERVATION:
Support the gear box with a jack or stand, if necessary.

6th step - *Remove the engine* from the vehicle, thus:-

a) Remove the bolts which hold the engine to the engine mountings.
b) Install the tackle to lift the engine and secure the loop (Fig. 1).

OBSERVATION:
The loop should remain centred.

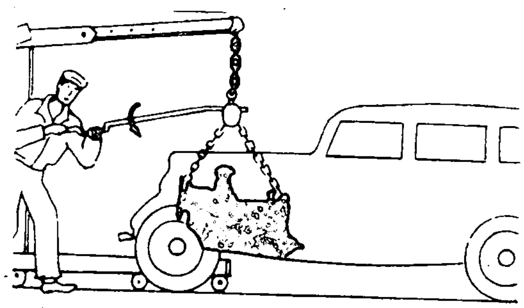


Fig. 1

c) Lift the engine with the lifting equipment until it comes off the front engine mount.

d) Move the engine towards the front until it comes off the gear-box input shaft.

OBSERVATION:

Use a lever to dislodge the engine, if necessary.

e) Remove the engine from the vehicle and place it on a wheeled table.

OBSERVATION:

Avoid damaging other parts of the vehicle when the engine is being removed.

PRECAUTION:

1) PROTECT YOUR EYES FROM FALLING PARTICLES.

2) AVOID GOING UNDER THE SUSPENDED LOAD.

f) Clean the surface of the engine with solvent.

It is the operation of installing the engine in the vehicle after having adjusted it partially or totally, or when it has been removed for making other types of repairs.

METHOD OF EXECUTION:

1st step - *Clean the housing of the engine* with a wire brush and scraper and blow dry with compressed air.

2nd step - *Check the state of the engine mountings.*

3rd step - *Install the tackle* to lift the engine and secure the loop.

4th step - *Replace the engine* in the vehicle, thus:-

a) Install the lifting equipment and support the engine.

b) Lift the engine and position it (fig. 1).

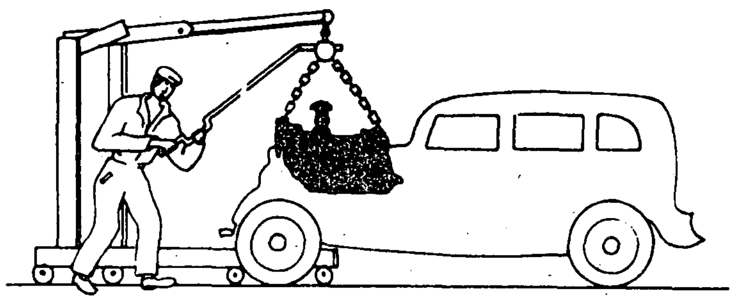


Fig. 1

OBSERVATIONS:

1) Avoid knocking the mounted parts in the vehicle, when installing the engine.

2) Maintain the engine alignment with relation to the gear-box input shaft.

PRECAUTION:

AVOID GOING UNDER THE SUSPENDED LOAD.

c) Push the engine until it couples with the gear-box.

d) Replace the securing bolts of the gear-box.

e) Install the bolts of the engine mountings.

f) Lower the engine until it rests on the mountings, remove the lifting equipment and the tackle.

g) Tighten the bolts of the engine mounting and gear-box, to the specified torque.

5th step - *Reconnect the accessories* of the engine, thus:-

a) Connect the clutch operating mechanisms and adjust them.

b) Connect the exhaust pipe.

c) Replace the carburettor and the distributor.

d) Replace the temperature gauge transmitting unit and the oil pressure gauge cable.

e) Connect the generator, ignition and battery cables.

6th step - *Replace the radiator.*

7th step - *Fill* the lubrication and cooling systems.

8th step - *Replace the bonnet* on the vehicle.

This is the operation which enables the pistons and connecting rods to be removed. This is done when it is necessary to change the rings, bolts, pistons or connecting rod journal bearings.

METHOD OF EXECUTION:

1st step - *Install the engine* on an engine stand (fig. 1).

2nd step - *Remove the cylinder head.*

3rd step - *Remove the crankcase.*

4th step - *Remove the oil pump,* if necessary.

5th step - *Remove the ridges* from the cylinder, thus:-

a) Check the wear to the cylinder, install the ridge-cutting tool and centre it.
b) Adjust the tool to begin the cutting (fig. 2).
c) Cut progressively until the ridges are removed.

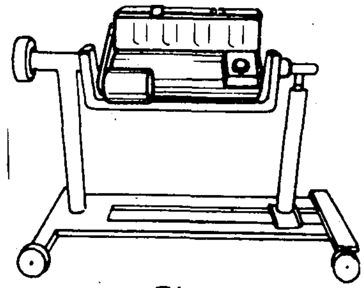


Fig. 1

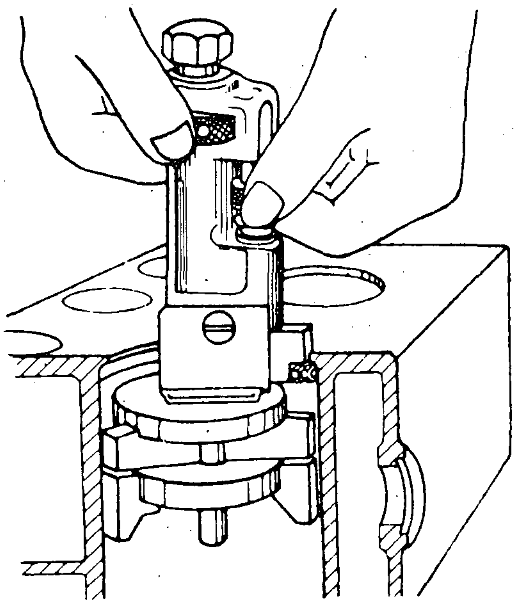


Fig. 2

6th step - *Remove the pistons and connecting rods, thus:-*

a) Turn the crankshaft until the connecting rod is in a position which facilitates the removal.

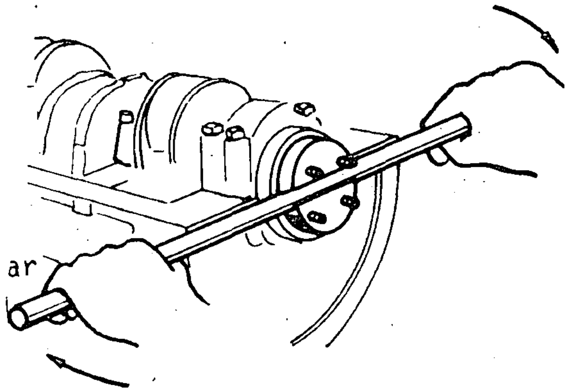


Fig. 3

OBSERVATION:
Use a lever to turn the crankshaft (fig. 3).

PRECAUTION:
AVOID PLACING YOUR HANDS BETWEEN THE CRANKSHAFT AND THE BLOCK SO AS TO AVOID ACCIDENTS.

b) Remove the nuts and the connecting rod cap.

OBSERVATION:
Make sure that the connecting rods and caps are marked so as to replace them in their original positions; if they are not, make reference marks with respect to a point on the block.

c) Push the piston-connecting rod unit (fig. 4) until it comes out of the cylinder.

OBSERVATION:
Avoid scratching the cylinder wall and the crank shaft journal when the unit is being removed.

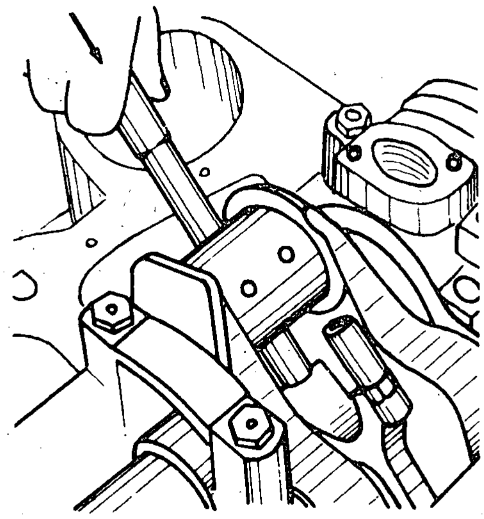


Fig. 4

d) Replace the cap on the connecting rod with its corresponding nuts, keeping to the order arranged when disassembling.

7th step - *Remove the rings from the pistons,* thus:-

a) Place the piston and the connecting rod in a press or bench vice.

b) Remove the rings from the piston by using an extractor (fig. 5).

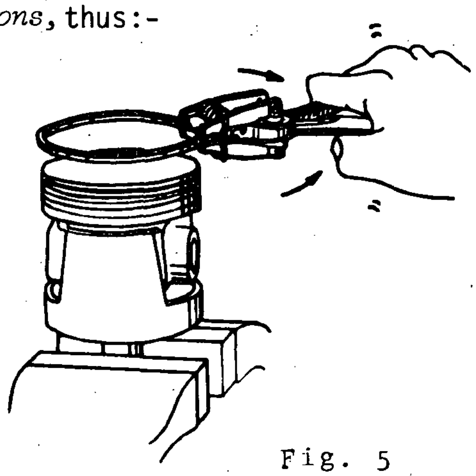


Fig. 5

8th step - *Separate the pistons from the connecting rods, thus:-*

a) Remove the locks from the gudgeon pin with a pointed tip pliers.

b) Remove the gudgeon pin, using an extractor (fig. 6) and separate both bodies.

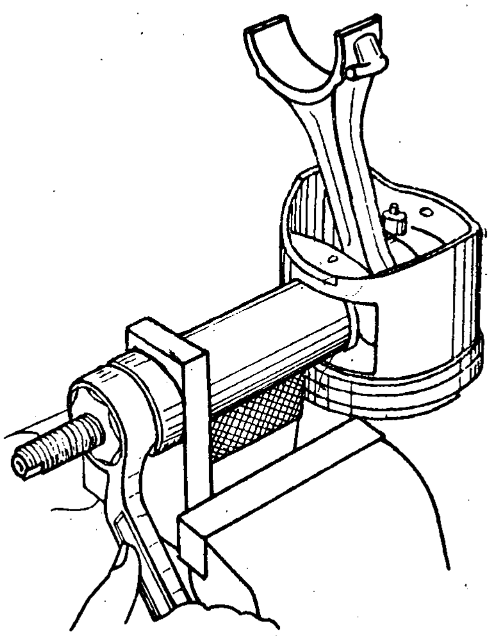


Fig. 6

OBSERVATION:

Confirm the reference marks of the piston and connecting rod so as not to lose the original positioning.

TECHNICAL VOCABULARY:

Crankcase - Oil sump;
Oil pan.

This consists of installing the piston-connecting rod unit in the engine, after having replaced their defective parts. The correct assembling of these parts allows the normal working capacity of the engine, under any working conditions.

METHOD OF EXECUTION:

1st step - *Assemble the pistons and connecting rods, thus:-*

a) Secure the connecting rods in a press or a bench vice.
b) Lubricate the gudgeon pin and the holes of the piston and connecting rod.
c) Install the gudgeon pin by slowly and progressively turning the gudgeon pin fitter (fig. 1) until it remains centred.

OBSERVATION:
Check the reference marks of the piston and connecting rod.

d) Install gudgeon pin locks.

2nd step - *Install the rings in the piston, thus:-*

a) Place the rings in their respective grooves in the piston, with the aid of a fitter.

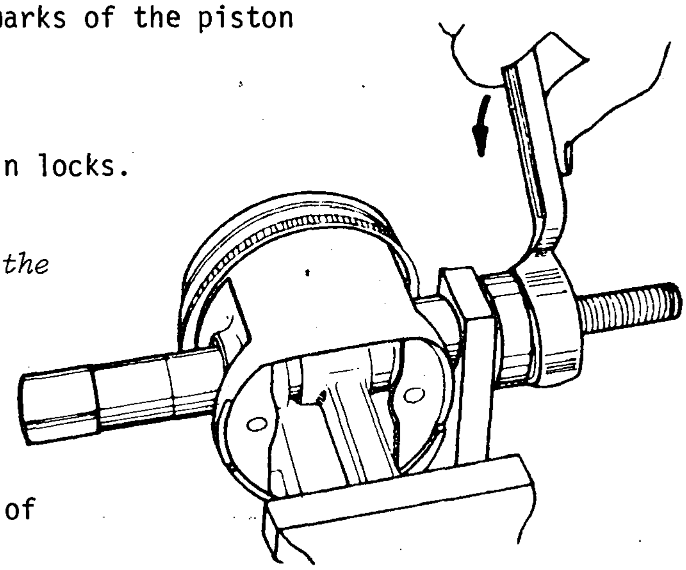


Fig. 1

OBSERVATIONS:
1) Do not open the fitter too much so as to avoid breaking the ring.

2) Make sure that the placing of the rings corresponds to the marks and specifications.

3) Begin by installing the oil ring.

b) Lubricate the grooves of the rings with oil (fig. 2).

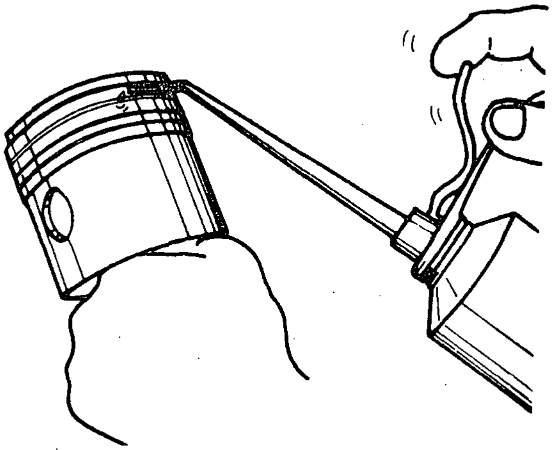


Fig. 2

3rd step - *Replace the connecting rods and pistons* in the cylinders, thus:-

a) Position the gaps of the rings according to the specifications.

b) Install the ring compressor, turning the lever, compressing the rings completely.

c) Clean the connecting rod journal bearings, the crankshaft journal and the cylinders with a dry cloth; lubricate them with oil.

OBSERVATION:
Use a rag that does not let off fuzz when cleaning.

d) Turn the crankshaft until the journal is in a position that facilitates the mounting.

e) Introduce the connecting rod with the piston in the cylinder and tap the piston head with the hammer handle until the connecting rod rests on the crankshaft journal (fig. 3).

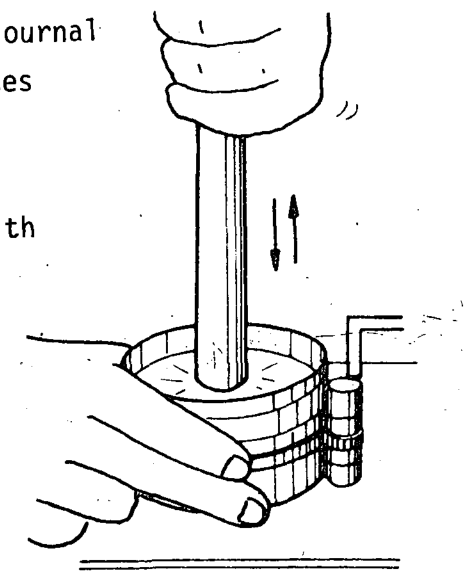


Fig. 3

OBSERVATION:
Check the reference marks on the connecting rods and the block, before replacing the unit.

f) Install the cap of the connecting rod and tighten to the specified torque.

OBSERVATIONS:

1) Ensure that the connecting rod bolt heads are centred in their corresponding housings.
2) Check the position of the cap with respect to the reference marks.

g) Spin the crankshaft to confirm the free movement of the connecting rods.

4th step - *Replace the oil pump.*

5th step - *Replace the crankcase.*

6th step - *Replace the cylinder head.*

7th step - *Remove the engine* from the engine stand.

This operation consists of removing and installing the camshaft in the engine. This is done when replacing the shaft or changing its journal bearings.

METHOD OF EXECUTION:

1st step - *Remove the valve lifters.*

2nd step - *Remove the vibration dampers* from the crankshaft, thus:-

a) Remove the securing bolts of the damper from the crankshaft.

b) Position the extractor and remove the damper (fig. 1).

3rd step - *Remove the timing gear cover* (fig. 2) unscrewing the securing screws.

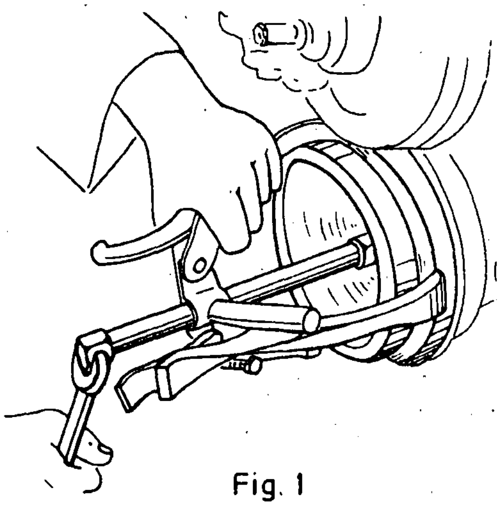


Fig. 1

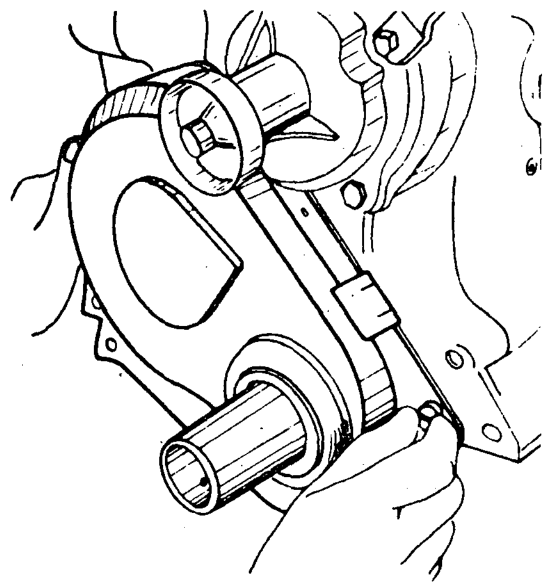


Fig. 2

4th step - *Remove the camshaft* from the engine, thus:-

OBSERVATION:
Check to see whether the timing gear wheels have synchronization marks and whether these coincide.

a) Remove the screws from the thrust plate.

b) Remove the camshaft (fig. 3).

OBSERVATION:
Avoid scratching the journal bearings when removing the shaft.

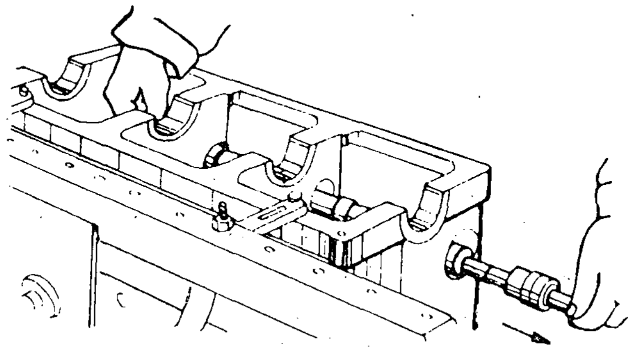


Fig. 3

PRECAUTION:
AVOID HITTING, CUTTING OR GETTING YOUR FINGERS STUCK WHEN REMOVING THE SHAFT.

5th step - *Clean the camshaft* with solvent then dry it with pieces of cloth or compressed air.

OBSERVATION:
Do not use pieces of cloth that let off fuzz.

6th step - *Install the camshaft* of the engine, thus:-

a) Lubricate the camshaft with oil from the engine.
b) Introduce the camshaft , pushing it carefully at the same time as it is being turned, so that it passes through the journal bearings.

OBSERVATION:
Avoid introducing the shaft completely in its supports so as to enable the gears to be synchronized.

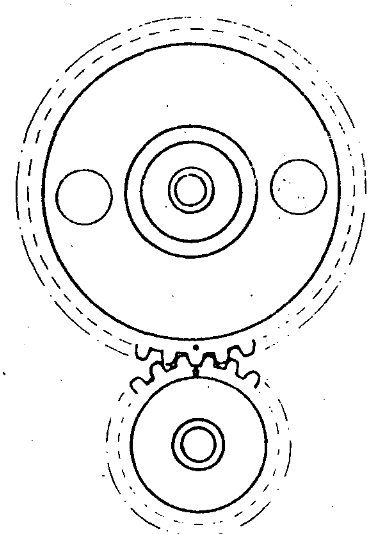


Fig. 4

c) Align the synchronization marks (fig. 4) and push in the camshaft gear until it stops.
d) Replace and tighten the camshaft securing plate screws.

7th step - *Change the oil seal* of the timing gears cover, thus:-

a) Remove the oil seal from the cover with a lever.

b) Clean the oil seal's housing in the cover.

c) Apply adhesive on the housing area and install the oil seal (fig. 5).

8th step - *Remount the timing gear cover, thus:-*

a) Clean the surfaces of the cover and of the engine block, removing the gasket remains.

b) Apply adhesive onto the surface which bears the gasket and place the gasket on the timing gear cover.

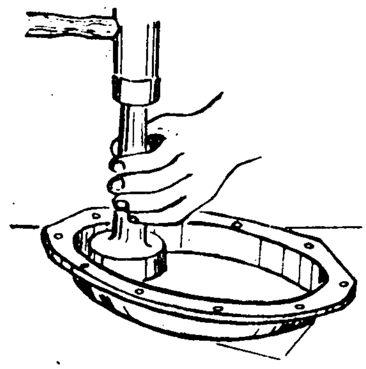


Fig. 5

c) Replace the timing gear cover and install and tighten the screws (fig. 6).

OBSERVATION:
Consult the manufacturer's manual so as to tighten the screws to the correct torque.

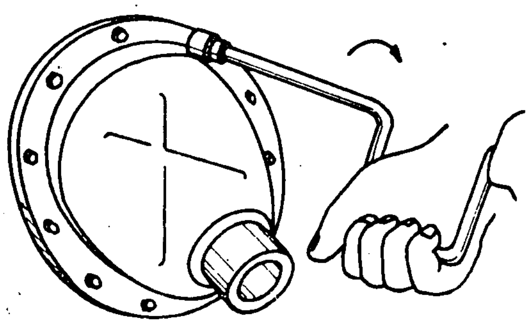


Fig. 6

9th step - *Reassemble the crankshaft* vibration damper, thus:-

a) Clean the vibration damper and align its key-way with the crankshaft key.

b) Install the securing bolt in the vibration damper (fig. 7) and tighten to the specified torque.

OBSERVATION:
Lubricate the friction surface of the seal in the vibration damper.

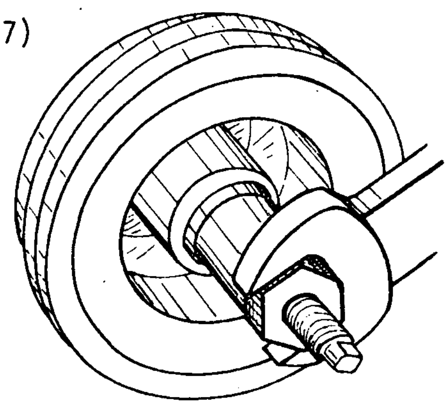


Fig. 7

10th step - *Install the valve lifters.*

This is the phase designed to remove and replace the crankshaft of the engine, as part of its repairing procedure, changing the main journal bearings or in the general repairing of the engine.

METHOD OF EXECUTION:

1st step - *Remove the flywheel.*

2nd step - *Remove the crankshaft, thus:-*

a) Mark the main bearing caps with stroke numbers, with relation to a point on the block.

b) Remove the main bearing caps.

c) Remove the crankshaft and place it on the work bench.

OBSERVATION:
Avoid hitting the crankshaft journals.

PRECAUTION:
WHEN REMOVING THE SHAFT, AVOID DAMAGING YOUR HANDS BETWEEN THE SHAFT AND THE INSIDE EDGES OF THE BLOCK.

3rd step - *Clean the journal bearings,* main bearing caps, block bracket and crankshaft with solvent and a brush.

OBSERVATIONS:
1) Clean the inside parts of the crankshaft with a ramrod (fig. 1).
2) Avoid scratching or hitting the journal bearings.

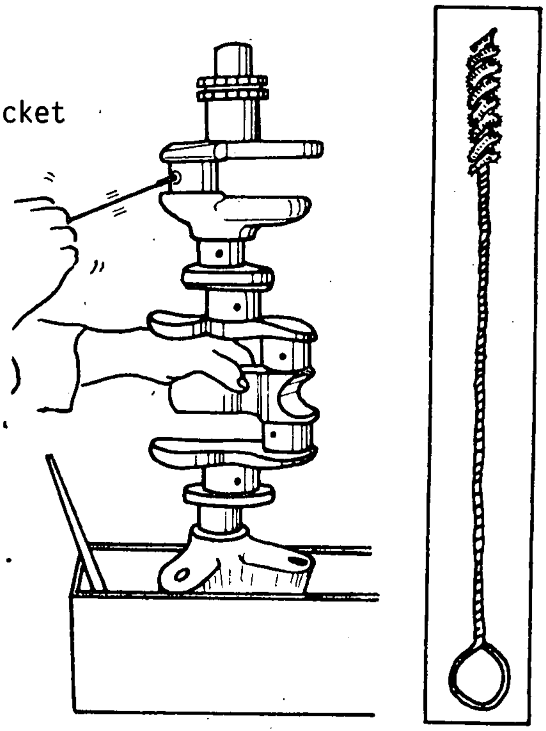


Fig. 1

4th step - *Inspect and check* the crankshaft, thus:-

a) Visually and manually check to see whether the shaft's journals are scratched.

b) Check the state of the spiral groove of the flywheel flange.

c) Determine the wear to the journals, by measuring the taper and ovalness with a micrometer, according to specifications (fig. 2).

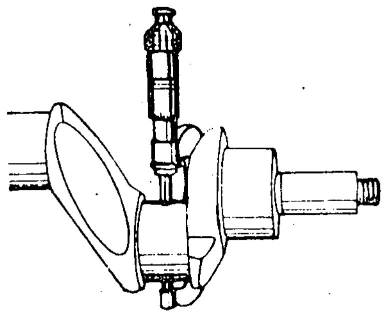


Fig. 2

5th step - *Check tolerance, thus:-*

a) Install the main journal bearings (fig. 3, a, b and c) and control the pressure margin (fig. 3 d).

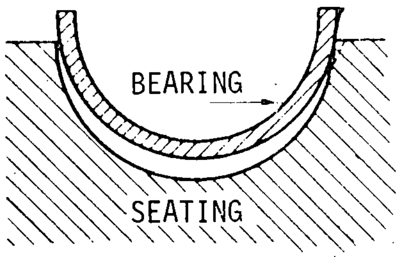


Fig. 3 b

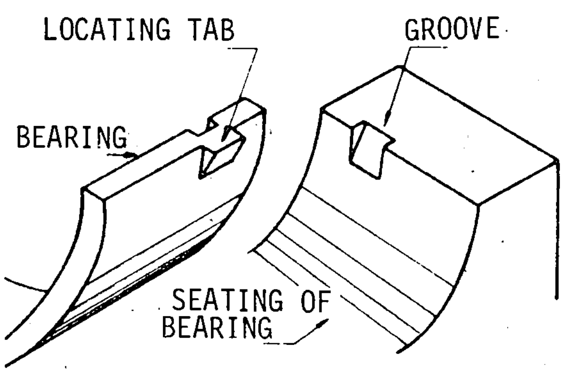


Fig. 3 a

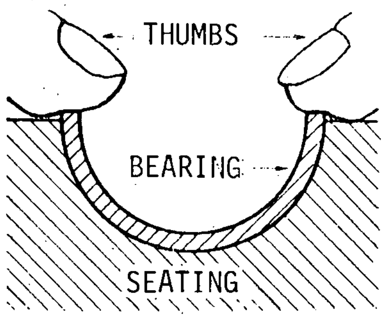


Fig. 3 c

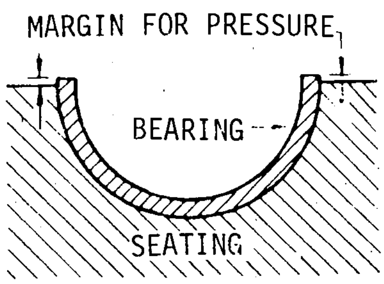


Fig 3d

b) Install the crankshaft and avoid hitting the journal bearings with the journals.

OBSERVATION:
Seek aid if necessary.

PRECAUTION:
AVOID DAMAGING YOUR HANDS BETWEEN THE SHAFT AND THE INSIDE EDGES OF THE BLOCK.

c) Install the main bearing caps, making their reference marks coincide; insert the bolts and tighten to the specified torque (fig. 4).

d) Remove a main bearing cap and place a strip of plastigauge across the journal (fig. 5).

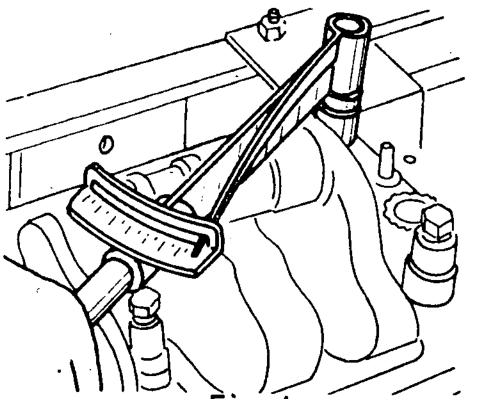


Fig. 4

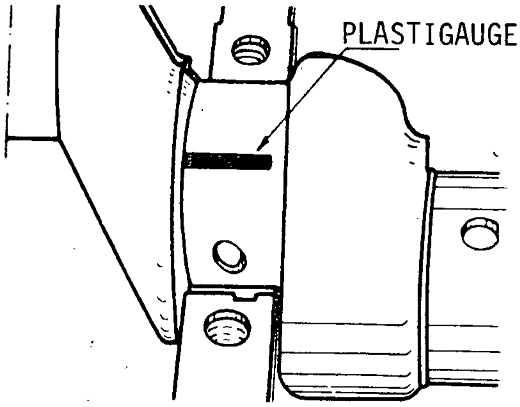


Fig. 5

e) Re-install the cover and bolts, giving them the specified torque.

OBSERVATION:
Do not turn the crankshaft so as not to damage the plastigauge.

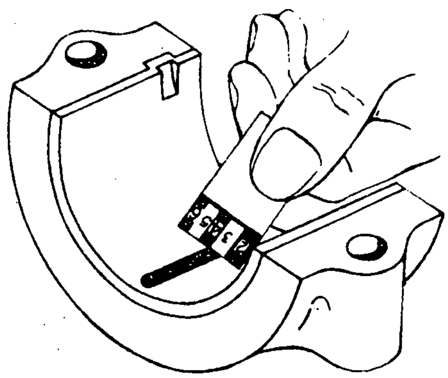


Fig. 6

f) Remove the same cover again and compare the expanded strip with the graduated scale card, according to specification (fig. 6).

g) Replace the main bearing cap and insert the bolts to the specified torque.

OBSERVATION:
Repeat the sub-steps d, e, f and g with all the other main caps.

6th step - *Check the end play of the shaft, thus:-*

a) Install a dial indicator in the block and the tip of the instrument; support it on the flange of the shaft (fig. 7).

b) Push the crankshaft towards one end of the block using a lever and centre the dial of the instrument to position "0".

c) Push the crankshaft against the indicator and read off the instrument, comparing the reading with the specifications provided.

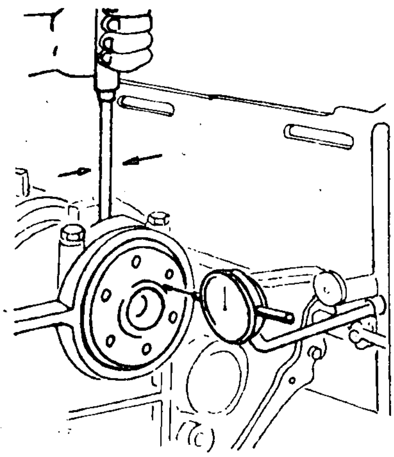


Fig. 7

d) Remove the dial indicator.

e) Remove the crankshaft.

7th step - *Replace the crankshaft, thus:-*

a) Clean the crank-shaft and the journal bearings.

b) Install the oil seal in the main caps of the block.

c) Set the seal with the appropriate tool (fig. 8).

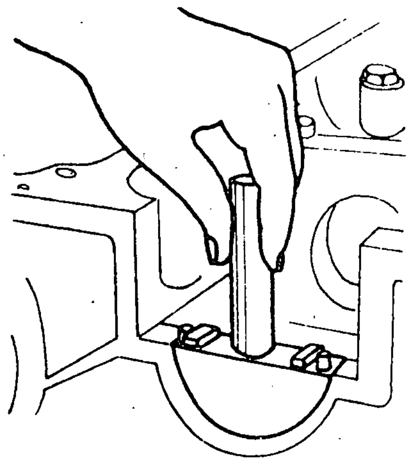


Fig. 8

d) Lubricate the journal bearings and journals.

e) Install the crankshaft, replace the main caps and tighten the bolts to the specified torque.

8th step - *Install the flywheel.*

This checking consists of determining whether the wear to the camshaft is within the minimum tolerances recommended. Consequently, it is advisable to do this operation every time the engine is disassembled, or where an abnormal condition of the camshaft is diagnosed.

METHOD OF EXECUTION:

1st step - *Remove the camshaft.*

2nd step - *Check the camshaft, thus:-*

a) Visually examine the cams, timing gear wheel and the eccentric of the fuel pump to see whether there are pits or deformations.

OBSERVATION:
Use a magnifying glass if necessary.

b) Check the journals of the camshaft with a micrometer according to specifications (fig. 1).

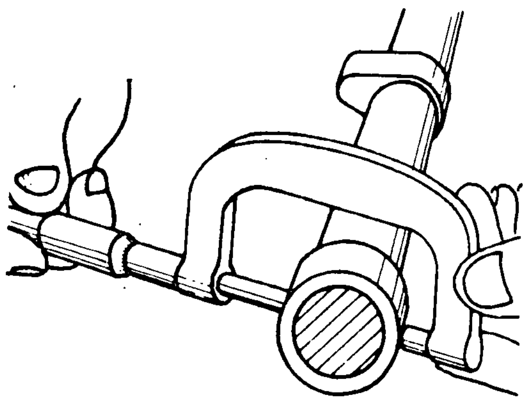


Fig. 1

c) Check the camshaft journal bearings, using an inside gauge.

d) Check the alignment of the camshaft, using a dial gauge (fig. 2) and V blocks on a surface plate.

3rd step - *Lubricate and replace the camshaft.*

4th step - *Check the reading* of the lobe of the cam, thus:-

a) Position the dial gauge (fig. 2) and check the displacement of the valve push rod.

OBSERVATION:
Make sure that the gauge is in the "O" position.

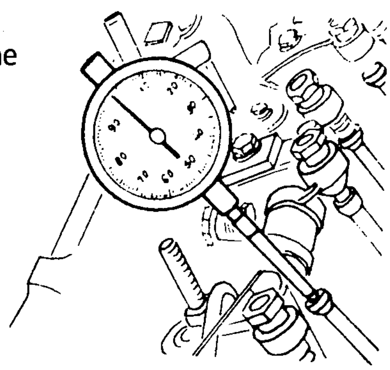


Fig. 2

b) Turn the camshaft until the lobe is at its highest point, record the reading and compare the readings against the specifications.

This operation is done every time that the piston connecting rod unit is removed to check the alignment of the connecting rod, and the wear to the pistons and rings.

METHOD OF EXECUTION:

1st step - *Clean the connecting rod and piston unit, thus:-*

a) Use a scraper to remove the carbon from the piston head.

b) Use the recommended tool for cleaning the piston grooves fig. 1.

c) Use solvent to clean the connecting rods, pistons and dry with compressed air.

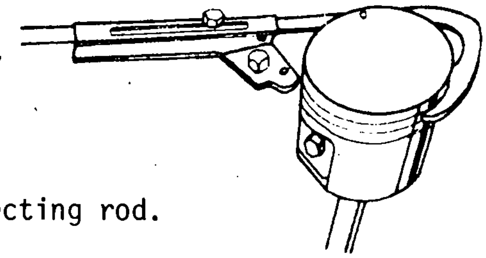


Fig. 1

2nd step - *Remove the piston* from the connecting rod.

3rd step - *Check the diameter* of the bottom of the connecting rod, thus:-

a) Secure the connecting rod in a press.

b) Remove the journal bearings, replace the cap and tighten to the torque specified.

c) Check the diameter of the bottom of the connecting rod with an inside micrometer (fig. 2) and compare it against the manufacturer's specification.

4th step - *Check the alignment* of the connecting rod, thus:-

a) Prepare the alignment tester.

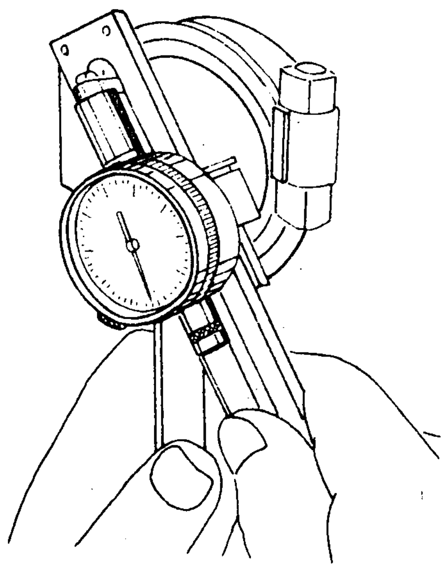


Fig. 2

b) Install the connecting rod with the bolt and check the parallelism of holes in the head and the bottom of the connecting rod (fig. 3).

c) Check the vertical alignment of the connecting rod (fig. 4).

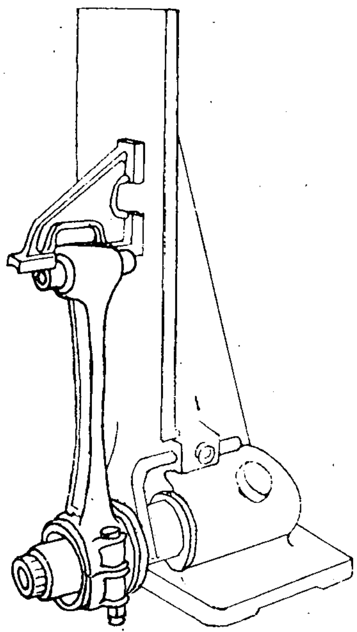


Fig. 3

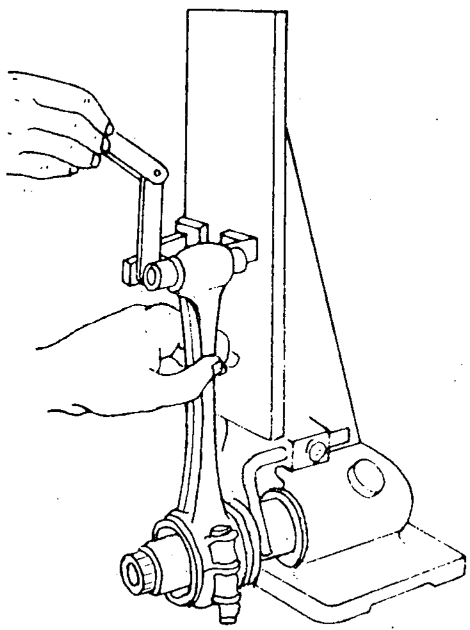


Fig. 4

5th step -*Check the pistons, thus:-*

a) Check the angles of the ring grooves (fig. 5).

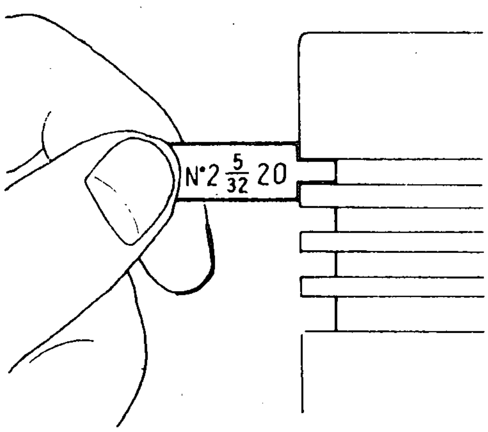


Fig. 5

b) Measure the wear to the skirt of the pistons with a micrometer.

c) Check the wear in the gudgeon pin boss with the corresponding gudgeon pin.

6th step - *Check the rings, thus:-*

a) Check the tolerance of the rings in the grooves of the piston, by using a thickness gauge (fig. 6).

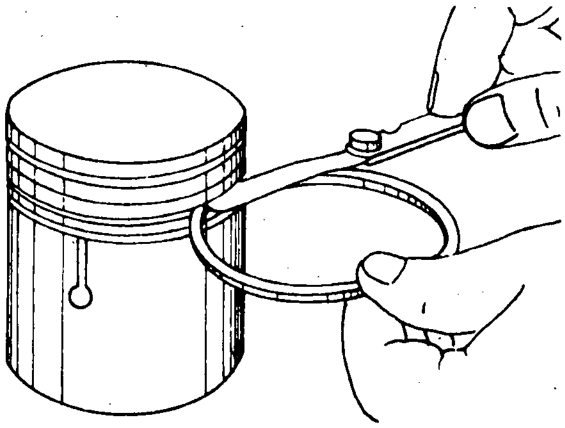


Fig. 6

b) Check the gap of the rings in the cylinder (fig. 7).

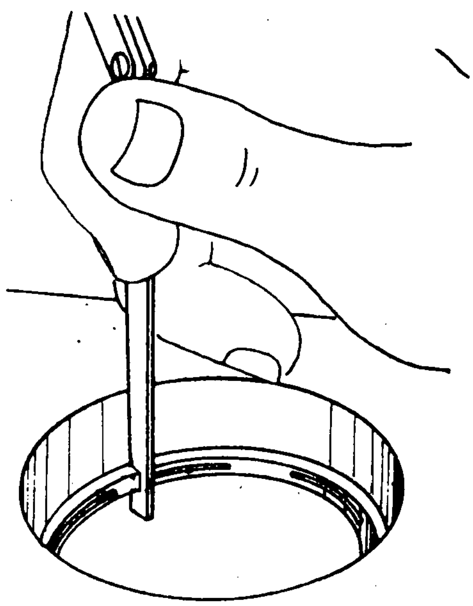


Fig. 7

This is the operation which the mechanic does, once the engine has been disassembled, with the object of determining the wear produced in the different parts of the block.

METHOD OF EXECUTION:

1st step - *Clean and inspect the block, thus:-*

a) Remove the oil duct plugs and the core plugs.

b) Wash the block with solvent and a wire brush.

c) Blow compressed air through the ducts of the block.

OBSERVATION:
If this is not sufficient to eliminate the obstructions, use a metal rod and repeat 'c'.

d) Remove the gasket remains with a scraper (fig. 1).

e) Visually inspect the block to see whether there are cracks or chips.

f) Check the state of the threads and holes in the block.

2nd step - *Check the block, thus:-*

a) Check the flatness on the support surface of the cylinder head.

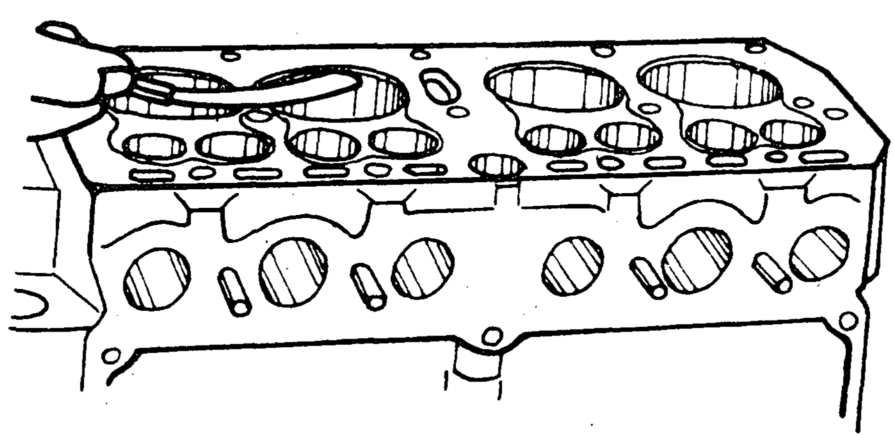


Fig. 1

b) Check the flatness on the support surface of the crank-case.

c) Inspect the cylinder walls to see whether they are scratched or worn.

d) Measure the inside of the cylinder with a micrometer so as to determine if there is ovalness or taper, paying attention to the specifications (fig. 2).

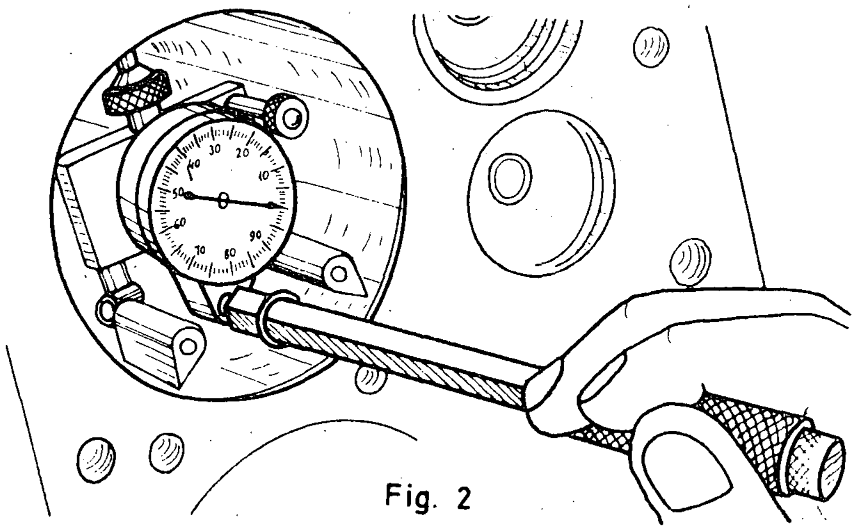


Fig. 2

e) Replace the main bearing caps and tighten to the specified torque.

f) Measure the inside of each one of the main bearings and compare it against the manufacturer's specifications (fig. 3).

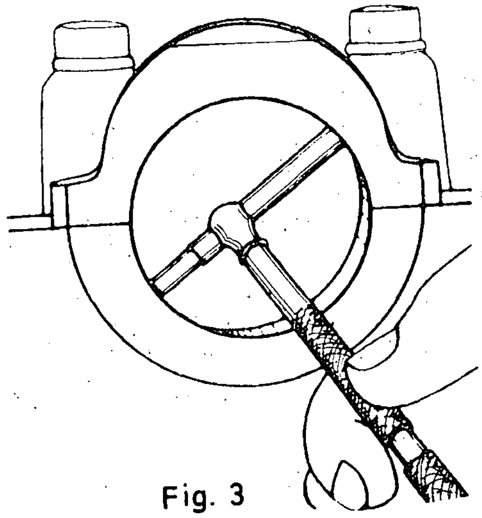


Fig. 3

g) Measure the inside of the camshafts supports and compare them against the manufacturer's specifications.

To avoid difficulties in the starting of the engine, it is necessary to eliminate all dirt particles in the terminals of the battery, to check the electrolyte level and to visually inspect the parts. This enables the life of the battery to be prolonged, ensures higher efficiency, and prevents losses in current.

METHOD OF EXECUTION:

1st Step - *Remove the battery, thus:-*

a) Protect the battery case and the electrolyte caps from blows.

b) Disconnect the cables from the battery, first the ground cable and then the insulated cable.

OBSERVATIONS:

1) If the head of the terminal of the battery is stuck, use a terminal extractor (fig. 1).

2) Avoid sparking by accidentally touching the battery terminals with the spanner.

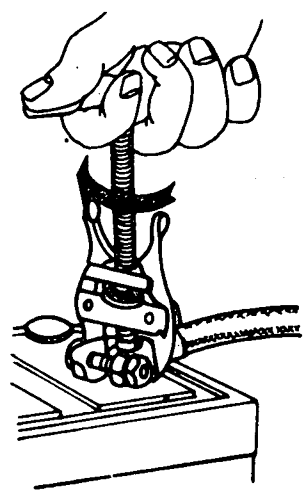


Fig. 1

c) Identify the terminal that is connected to the ground cable.

d) Remove the sustaining frame of the battery and remove it from the vehicle.

OBSERVATION:

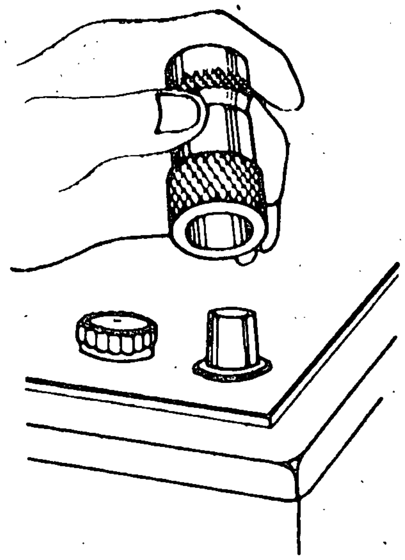
Use a strap to transport the battery and seek aid, if necessary.

SAFETY MEASURE

Avoid spilling the electrolyte because it causes burns.

2nd Step - *Clean the battery, thus:-*

a) Clean the upper part of the battery with a solution of water and sodium bicarbonate and wash it off with water.



b) Dry the battery with a cloth.

c) Remove the caps, make sure that the vent holes are free of any obstruction and replace them.

d) Clean the battery terminals with a wire brush or with the recommended tool (fig. 2).

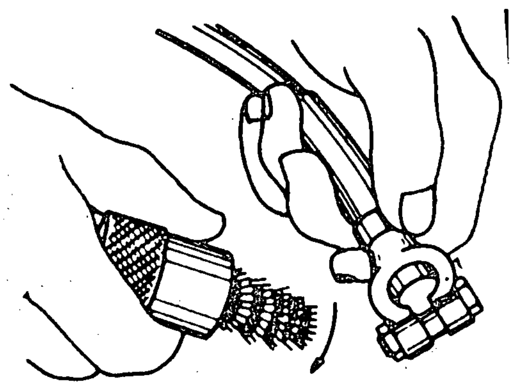
Fig. 2

3rd Step - *Visually inspect the battery, thus:-*

a) Check to see whether the case is cracked, the terminals loose or corroded, the case swollen or the cell covers lifted.

b) Check the level of the electrolyte; if the level is low add distilled water.

4th Step - *Place the battery into the vehicle, thus:-*



a) Clean the battery support using water with sodium bicarbonate. Wash and dry.

b) Wash the terminals with water and sodium bicarbonate, brush them (fig. 3), and, if necessary, file them down.

c) Replace the battery on the bracket and secure it with the frame.

Fig. 3

d) Connect the cables to the battery and cover the terminals with a coat of neutral vaseline, guiding yourself by the identification

OBSERVATIONS:

1) Reconnect the insulated cable first and then the ground cable.

2) Avoid hitting the terminals when connecting them.

A battery discharges because of a faulty supply from the generator or excessive use of electrical components. It then becomes necessary to recharge it. This is supplying electric energy to the battery by means of an external source so as to again attain its normal charged state.

METHOD OF EXECUTION:

1st Step - *Clean and visually inspect the battery.*

OBSERVATION:

If the battery is going to be recharged within the vehicle, disconnect the cables from it.

2nd Step - *Measure the density of the electrolyte of the battery, thus:-*

a) Remove the caps.

b) Insert the sounder of the hydrometer in each cell sucking up the electrolyte until the float is free and record the density reading (fig. 1).

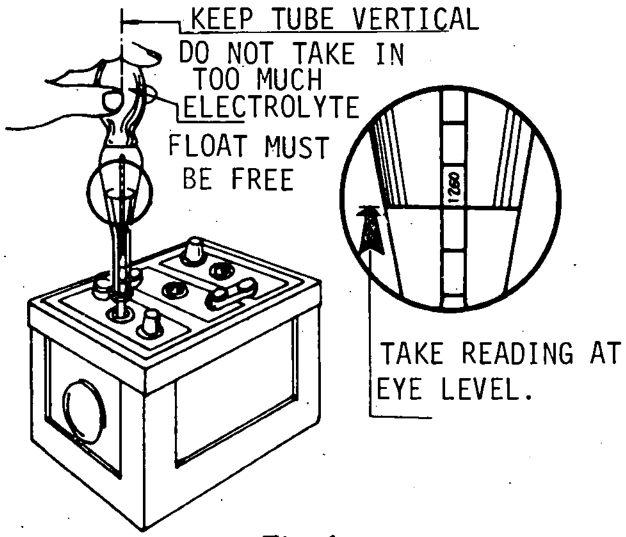


Fig. 1

OBSERVATIONS:

1) In those cells that have a low level, no reading can be taken.

2) Refill the low level cells with distilled water only.

3rd Step - *Charge the battery, thus:-*

a) Determine the voltage, charging time and treatment in accordance with the characteristics of the battery.

b) Connect the battery terminals to the terminals of the same polarity of the charger.

OBSERVATIONS:

1) Make sure that the circuit breaker of the charger is disconnected.

2) Leave the cells open when charging.

SAFETY MEASURE:

WHEN CHARGING THE BATTERY, MAKE SURE THERE ARE NO SPARKS OR FLAMES, AS THEY MAY CAUSE THE BATTERY TO EXPLODE DUE TO THE INFLAMMABLE GASES THAT IT DISCHARGES.

c) Connect the charger.

4th Step - *Remove the battery from the charger, thus:-*

a) Disconnect the charger, on finishing the charging process.

b) Remove the charger terminals from the battery.

c) Replace the caps and clean the cover of the battery.

5th Step - *Check the charged condition of the battery, thus:-*

a) Measure the density.

b) Measure the voltage, under the battery discharge, according to the specifications.

Faulty spark plugs affect the good working condition of the engine. Their cleaning and the adjusting of the gaps of their electrodes, as well as testing their condition, is an operation that the mechanic does frequently.

METHOD OF EXECUTION:

1st Step - *Remove the spark plugs from the engine, thus:-*

a) Disconnect the spark plug cables.

OBSERVATION:
Remove the cables by pulling softly on the hood.

b) Loosen the spark plugs (fig. 1).

OBSERVATION:
Turn the spark plug spanner 3 times.

c) Clean the area surrounding the spark plugs with compressed air.
d) Remove the spark plugs.

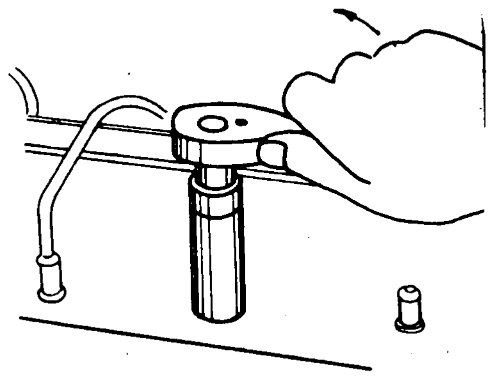


Fig. 1

OBSERVATION:
Do not tilt the spanner; it may break the porcelain part of the spark plug.

2nd Step - *Clean the outside of the spark plug with a brush and solvent (fig. 2), brush the spark plug threads (fig. 3) and dry them with compressed air.*

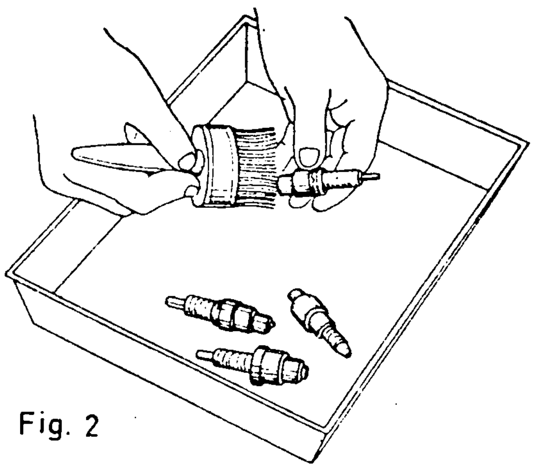


Fig. 2

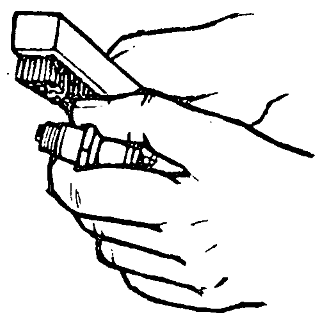


Fig. 3

3rd Step - *Clean and check the spark plugs in the machine.*

OBSERVATION:
Proceed, following the instructions for operating the machine.

4th Step - *Adjust the electrodes, thus:-*

a) File the spark plug electrodes, if necessary (fig. 4).

b) Gap the electrodes (fig. 5) according to specifications.

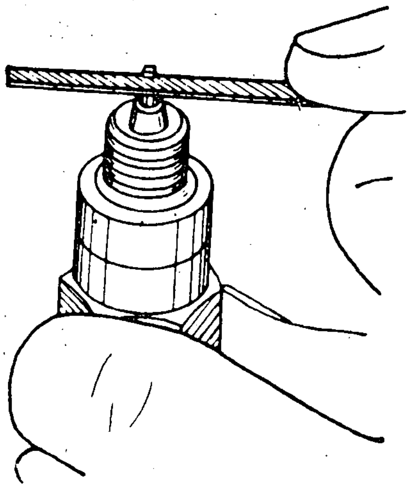


Fig. 4

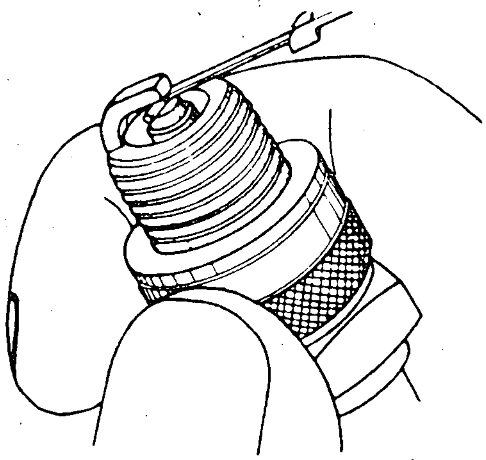


Fig. 5

5th Step - *Place the spark plugs in the engine, thus:-*

a) Replace the spark plugs and screw them in manually.

b) Tighten the spark plugs to the torque specified.

c) Connect the cables to the spark plugs, following the firing order.

CBC **OPERATION:** DISASSEMBLING AND REASSEMBLING THE GENERATOR

This is the operation that consists of removing and replacing parts which make up the generator to inspect, repair or replace them, if necessary. This done, the generator is now in condition to supply the electrical energy necessary to run the engine.

METHOD OF EXECUTION:

1st Step - *Remove the generator from the vehicle, thus:-*

a) Disconnect the electric wires from the generator.

OBSERVATION:
Mark the conductors using a card with the identification of the generator terminals.

b) Loosen the bolts that secure the generator to the vehicle.
c) Bring the generator near to the engine.
d) Remove the generator belt.
e) Remove the generator from the vehicle, by taking out the securing bolts and place it on the work bench.

2nd Step - *Disassemble the generator, thus:-*

a) Remove the dust shield.
b) Remove the brushes and cables from the brush holders (fig. 1).
c) Remove the brush holder cover by removing the securing screws.
d) Remove the pulley unit, front cover and armature from the generator case.

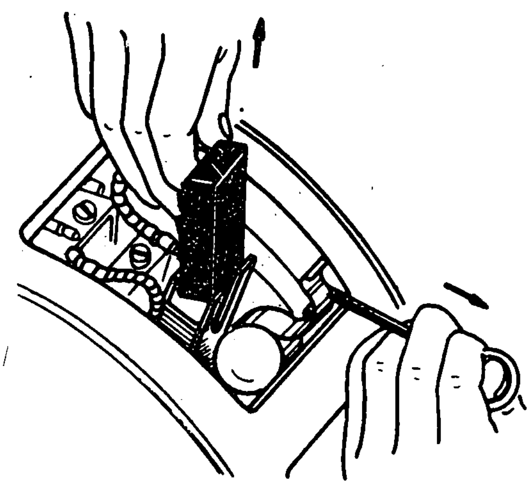


Fig. 1

OBSERVATION:
Use a plastic hammer if necessary.

e) Place the armature in the bench vice and remove the nut from the pulley.

OBSERVATION:
Use soft metal jaws so as not to damage the armature.

f) Remove the pulley with the extractor (fig. 2) and remove the key.

g) Remove the front cover of the armature.

h) Remove the bearing from the front cover, by taking out the plate screws that secure it.

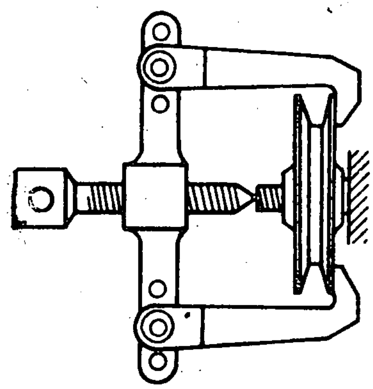


Fig. 2

OBSERVATION:
Some types of generators carry a safety ring.

3rd Step - *Clean the parts of the generator, thus:-*

a) Clean the armature and field coils and the commutator with a brush and compressed air.

b) Wash the covers, bushings, bearings and the rest of the parts with solvent and dry them with compressed air.

4th Step - *Check the parts of the generator, thus:-*

a) Check the wear in the bushing (fig. 3).

b) Check the wear in the bearing.

c) Check the wear in the bearing housing in the front cover.

d) Check the bearing seating on the shaft.

e) Visually check the commutator to see whether it is distorted or has high micas.

f) Visually check the armature and field coils to see if they have broken and burnt insulators or unsoldered connections.

g) Check the tension in the brush springs, according to specifications (fig. 4).

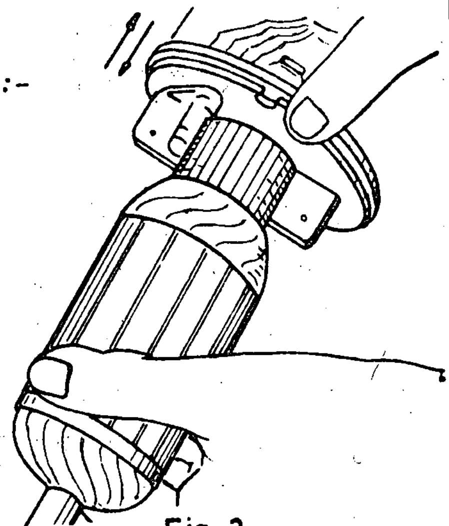


Fig. 3

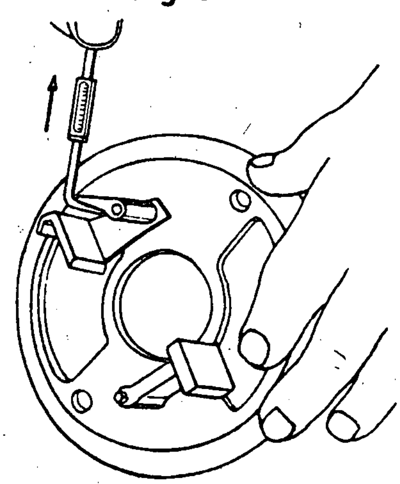


Fig. 4

h) Check the insulation of the brush holders to see whether it is broken or burnt.

i) Visually check the generator belt to see whether it is broken or worn.

5th Step - *Assemble the generator, thus:-*

a) Fit the bearing in the front cover and secure it with the plate, tightening its screws.

OBSERVATION:
Lubricate the bearing with the specified grease if it is the open type.

b) Place the front cover on the armature.
c) Replace the key in the shaft and level it.
d) Place the pulley on the armature.
e) Place the armature in a bench vice and replace the nut of the pulley, inserting the lock washer.
f) Replace the pulley front cover and armature unit into the generator case.
g) Replace the brush holder cover.

OBSERVATION:
Lubricate the bushing with oil.

h) Replace the brushes and connect the brush holder conductors.
i) Manually turn the pulley and make sure that the armature turns freely, without friction, checking that the pulley is centred.
j) Replace the dust shield.

6th Step - *Mount the generator, thus:-*

a) Install the generator, securing it to the bracket on the engine.
b) Replace the belt in the groove of the pulley.

OBSERVATION:
Make sure that the belt is placed on the pulley of the crankshaft and the water pump.

c) Tighten the belt according to specifications (fig. 5).

d) Tighten the screw that secures the generator to the adjustment bracket and those that secure it to the engine.

e) Connect the electrical conductors to the generator, according to previous identification.

f) Start the engine of the vehicle and check the working condition of the generator, observing the charging indicator of the vehicle.

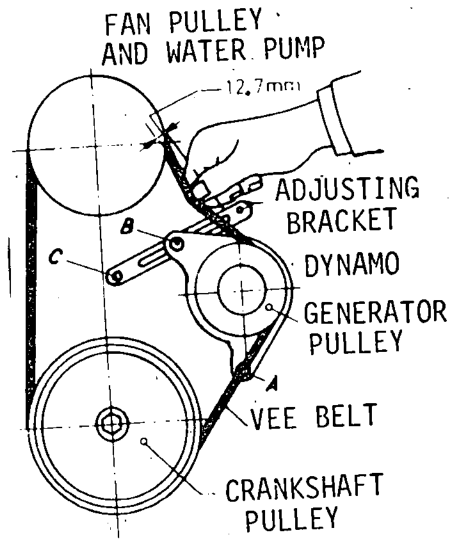


Fig. 5

This is the operation which consists of removing the parts of the starting motor with the purpose of inspecting them, replacing them or for their general maintenance, if it is necessary, to obtain a good working condition in the starting mechanism.

METHOD OF EXECUTION:

I TO DISASSEMBLE THE STARTING MOTOR

1st step - *Remove the starting motor* from the vehicle, thus:-

a) Disconnect the ground cable from the battery.
b) Disconnect the electrical conductors of the starting motor and remove them.

OBSERVATION:
Mark the electrical conductors using a card with the identification of the terminals of the starting motor.

c) Remove the starting motor by removing the bolts that secure it to the engine of the vehicle.

2nd step - *Disassemble the parts* of the starting motor, thus:-

a) Remove the screw that connects the terminal of the motor to the solenoid (fig. 1).
b) Remove the solenoid, by removing the securing screws and the bolt of the shift lever.
c) Remove the dust shield.
d) Remove the securing screws of the field coil conductors to the brushes.
e) Remove the bolts that hold the covers together.
f) Remove the front cover.
g) Remove the rear cover with the operating mechanism.
h) Remove the armature from the case.
i) Remove the shift lever from the rear cover by removing the pivot screw and remove the operating mechanism.

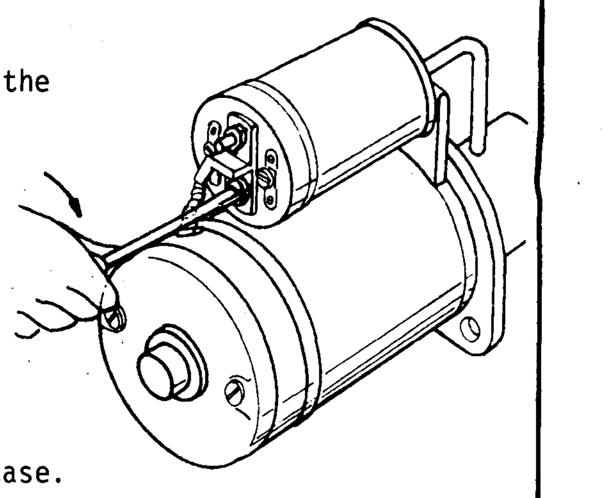


Fig. 1

3rd step - *Clean the parts of the starting motor, thus:-*

a) Clean the armature and field coils, the frame and solenoid with compressed air and a brush.

b) Wash the covers, bushings and the rest of the parts.

c) Clean the overrunning clutch with a dry piece of cloth.

OBSERVATION:
Prevent the solvent from coming into contact with the overrunning clutch.

II TO ASSEMBLE THE STARTING MOTOR

1st step - *Check the parts of the starting motor, thus:-*

a) Check the wear to the bushings in the covers of the overrunning clutch.

b) Check the wear or deformations of the shift lever.

c) Check for surface cracks or damage on the pinion, broken or deformed springs and a worn or deformed ring in the overrunning clutch.

d) Check to see whether the overrunning clutch is locked in one direction and runs freely in the other direction.

e) Visually and manually check the state of the commutator (fig. 2).

f) Visually check the armature and field coils, to see whether there are broken and burnt insulators or unsoldered connections.

g) Check the tension in the brush springs.

h) Check the wear to the brushes and replace them if necessary.

i) Make sure that the brush holder insulators are not broken or burnt.

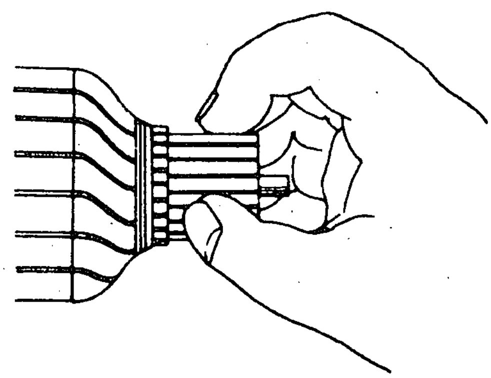


Fig. 2

2nd step - *Replace the parts of the starting motor, thus:-*

a) Install the overrunning clutch into the rear cover.

b) Replace the armature in the case.

c) Replace the rear cover with the overrunning clutch.

d) Install the front cover, lifting the brushes so as not to damage them.

e) Replace the connecting screws of the covers.

f) Connect the armature lead to the brushes.

g) Replace the dust shield.

h) Replace the solenoid and reconnect it.

3rd step - *Check the starting motor with no load, thus:-*

a) Place the starting motor in a bench vice.

b) Connect it directly to a battery.

OBSERVATION:
Use a battery with the voltage that corresponds to the starting motor and make sure that it is completely charged.

c) Use a cable as a bridge to close the solenoid circuit (fig.3).

d) Make sure that the armature spins freely and that the overrunning clutch is disengaged.

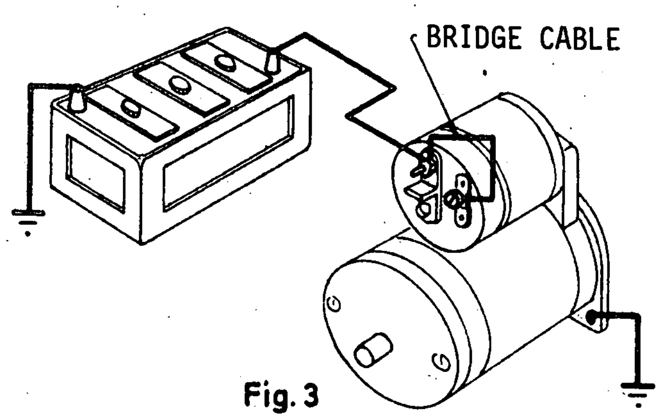


Fig. 3

4th step - *Replace the starting motor, thus:-*

a) Install the starting motor in its housing in the engine of the vehicle and secure it with the bolts to the specified torque.

b) Connect the electrical conductors to the starting motor according to the previous arrangement.

c) Connect the battery ground cable.

d) Check the working of the starter, by operating the starter switch in the vehicle.

CBC

OPERATION:

CHECKING THE IGNITION SYSTEM

This consists of checking the primary and secondary ignition circuits, so as to ensure that each one of the components is in working condition.

METHOD OF EXECUTION:

1st step - *Check the primary circuit* by inspecting all the primary electrical conductors to see if their insulation is worn and the terminals loose or corroded.

2nd step - *Make sure that the current reaches the distributor, thus:-*

a) Remove the high tension cable from the middle of the distributor cap, and ground it so as not to damage the coil.

b) Connect a test light between the distributor terminal and earth, and turn over the engine (fig. 1).

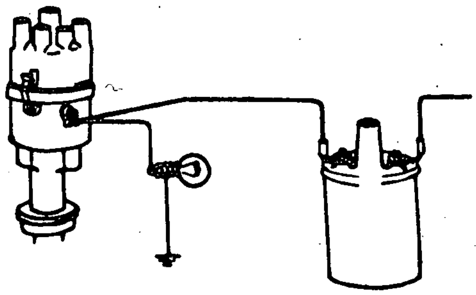


Fig. 1

OBSERVATION:
The test light should come on when the contact points are open and should go off when they close.

3rd step - *Check the secondary circuits, thus:-*

a) Clean the cables that connect the distributor cap to the spark plugs and the one that comes from the central terminal of the coil to the central terminal of the distributor.

OBSERVATION:
Clean the high tension cables with a dry piece of cloth.

b) Make sure that the secondary circuit cable insulation is not worn or that the terminals are not loose or corroded.

4th step - *Check the ignition spark, thus:-*

a) Disconnect all the cables from the spark plugs.

b) Install an adaptor in the terminal of the cable that is going to be tested.

c) Hold the adaptor approximately 4 mm from the engine block.

OBSERVATIONS:

1) Check the spark jump in each one of the spark plug cables, repeating b, c and d.

2) The spark should jump with complete regularity, the prescribed distance (fig. 2).

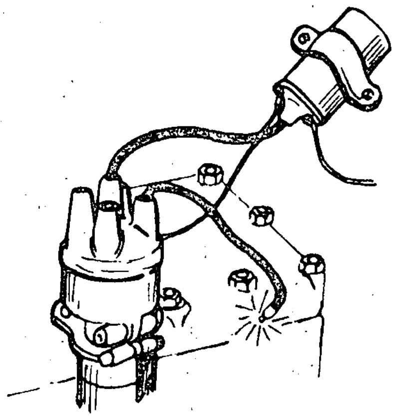


Fig. 2

For an engine to attain maximum efficiency, the ignition system should be timed and kept in perfect working condition, according to the speficications. For this reason, the distributor should be removed from the engine so as to inspect and repair it.

When these operations have been completed, proceed to replace and time it.

METHOD OF EXECUTION:

1st step - *Remove the distributor, thus:-*

a) Remove the spark plug cables from the distributor cap.

b) Disconnect the cable from the coil to the distributor.

c) Unfasten the securing clip from the cap and remove it.

d) Check the direction in which the rotor turns.

e) Disconnect the vacuum line from the distributor.

f) Remove the securing screw of the distributor and remove it.

2nd step - *Replace the distributor, thus:-*

a) Place the piston of cylinder #1 in the top dead centre of the compression stroke.

b) Locate the ignition timing marks on the engine flywheel or on the vibration damper.

c) Make sure that the ignition marks of the vibration damper coincide with those of the block.

d) Insert the distributor in its housing.

OBSERVATION:

Make sure that the distributor is seated on its base and that it couples with the oil pump.

e) Replace the securing screw of the distributor and tighten it so that the distributor can still rotate.

f) Connect the vacuum line to the distributor.

g) Connect the distributor cable to the coil.

h) Move the distributor to the right and to the left until the contact points begin to open.

i) Replace the distributor cap and secure it with its clips.

j) Replace the spark plug cables, beginning with cylinder #1 indicated by the rotor, according to the firing order and in the direction that the distributor shaft rotates.

3rd step - *Time the ignition, thus:-*

a) Position the stroboscopic light and the tachometer.
b) Start the engine and adjust its revolutions, according to the specifications.
c) Rotate the distributor left or right until obtaining the specified advance timing degrees.

OBSERVATIONS:
1) While timing the ignition system, gradually adjust the engine revolutions to the specified figure.
2) Follow the manufacturer's instructions when connecting and using the stroboscopic light and the tachometer.

d) Tighten the securing bolt of the distributor.
e) Make sure that the timing degrees and the revolutions correspond to the specifications.
f) Turn off the engine and disconnect the stroboscopic light and the tachometer.

TECHNICAL VOCABULARY:
stroboscopic light - timing light

The distributor plays an important part in the ignition system. For this reason, its parts should be frequently disassembled so that they may be inspected and have their defective parts replaced. This operation is done also every time that faults are detected in the distributor.

METHOD OF EXECUTION:

I TO DISASSEMBLE THE DISTRIBUTOR

1st step - *Remove the distributor.*

2nd step - *Dismount the contact points plate assembly, thus:-*

a) Place the distributor in a bench vice and remove the rotor.

b) Remove the vacuum advance unit.

c) Disconnect the cables from the condenser and the primary terminal of the contact points.

d) Remove the condenser and the contact points.

e) Remove the securing screws from the contact support plate and remove the plate.

f) Remove the distributor from the bench vice.

3rd step - *Remove the shaft from the distributor, thus:-*

a) Remove the bolt from the pinion of the distributor and remove the pinion (fig. 1).

b) Remove the distributor shaft from the body.

c) Remove the centrifugal advance limiting plate.

d) Remove the retainer springs from the weights.

e) Remove the cam and weights from the distributor shaft.

4th step - *Remove the bushings* from the body of the distributor, thus:-

a) Extract the upper bushing.

b) Remove the lower bushing.

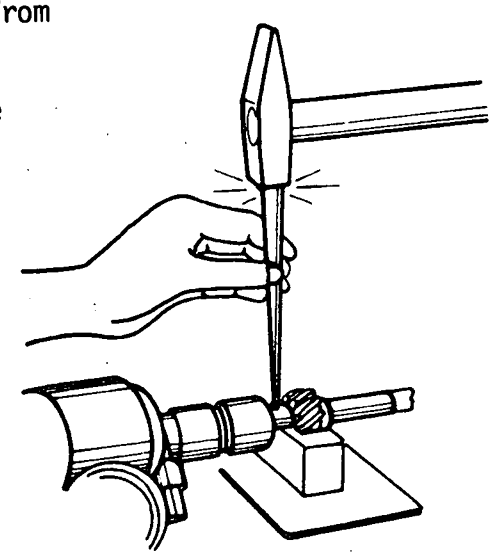


Fig. 1

OBSERVATION:
Use the recommended extractor to suit the type of distributor.

5th step - *Clean the distributor parts, thus:-*

a) Clean the condenser, rotor, contact support plate, vacuum advance unit and the distributor cap, with pieces of cloth and a bristle brush.

OBSERVATION:
Cover the vacuum advance unit duct so as to prevent foreign particles from entering it.

b) Clean the distributor cap contacts with a wire brush (fig. 2).

c) Wash the contact points, centrifugal advance mechanism, pinion and body of the distributor with solvent and a brush. Dry them with compressed air.

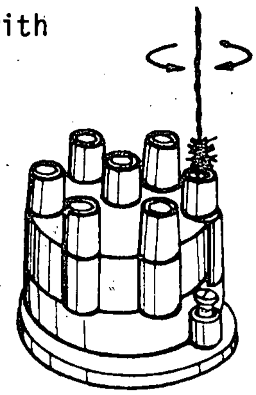


Fig. 2

II TO ASSEMBLE THE DISTRIBUTOR

1st step - *Visually check* the parts of the distributor, thus:-

a) Check the rotor and the distributor cap to see that they are not chipped, or cracked and that the contacts are not worn or corroded.

b) Make sure that the vacuum advance unit is not deformed or cracked.

c) Check the contact points cable to see whether it is torn or badly insulated, and that its terminals are not deformed, loose or broken.

d) Make sure that the contact points are not burnt, twisted or pitted and that the spring is not over-strained, broken or deformed.

e) Inspect the contact support plate, lubrication felt, the parts of the centrifugal advance mechanism and the parts of the cam.

f) Check the distributor housing to see whether it is worn, cracked, or broken and that the threads are not worn.

g) Check the alignment of the distributor shaft with a dial gauge (fig. 3).

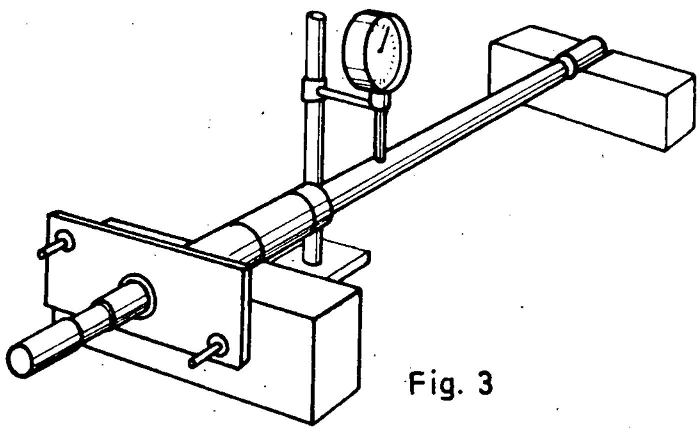


Fig. 3

2nd step - *Install the bushings* in the body of the distributor, thus:-

a) Place the body of the distributor in a bench vice.

b) Install the bushings, using the recommended tool (fig. 4).

c) Ream the bushings, if necessary (fig. 5).

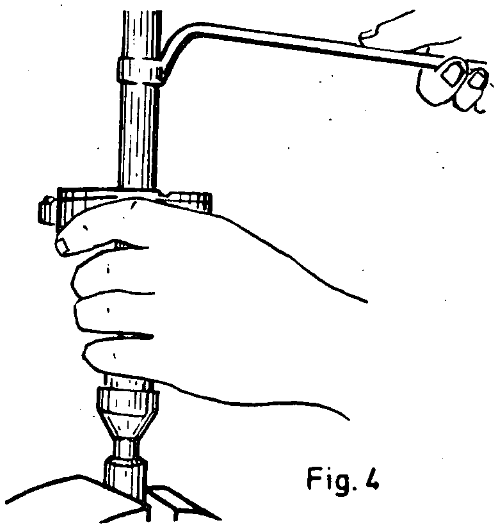


Fig. 4

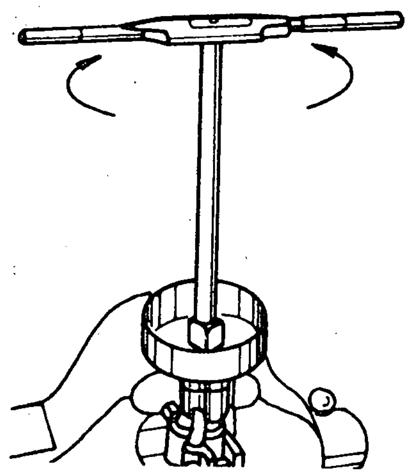


Fig. 5

3rd step - *Mount the distributor shaft, thus:-*

a) Lubricate and introduce the distributor shaft in its housing.

OBSERVATION:
Use the specified lubricant.

b) Install the pinion and its bolt on the distributor shaft.

c) Lubricate and install the cam and the centrifugal advance weights.

OBSERVATION:
Use the recommended lubricant.

d) Install the return springs of the weights and the centrifugal advance limiting plate.

OBSERVATION:
Make sure that the shaft spins freely.

4th step - *Replace the contact support plate, thus:-*
a) Install the contact support plate.
b) Install the vacuum advance unit.
c) Replace the condenser and contact points.
d) Connect the condenser cable and the contact points cable.

5th step - *Adjust the contact points, thus:-*
a) Place the fibre rubbing block of the contact points on a lobe of the cam.

b) Adjust the contact point gap with a thickness gauge, having moved the fixed contact point (fig. 6).

OBSERVATION:
Adjust the contact point gap according to the specifications.

c) Install the rotor and remove the distributor from the bench vice.

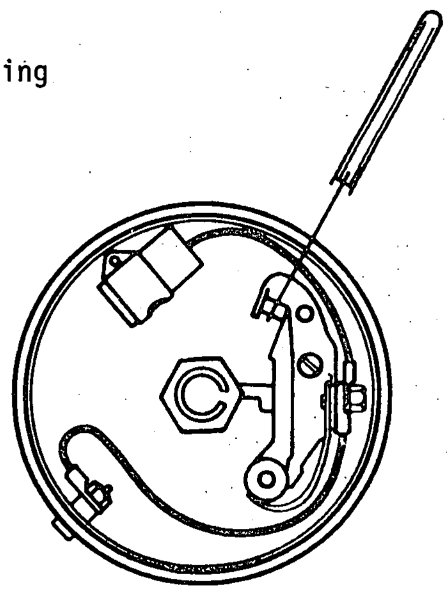


Fig. 6

TECHNICAL VOCABULARY:

contact support plate - contact breaker plate

To enable the detection of faults in the distributor, it is necessary to mount it on the distributor tester with the object of submitting it to various types of tests to make sure that its mechanical and electrical parts are functioning correctly. This procedure is done every time the distributor has been disassembled or repaired.

METHOD OF EXECUTION:

NOTE:
When using the distributor tester equipment, you should follow manufacturer's instructions manual.

1st step - *Install the distributor* in the distributor testing machine (fig. 1) and remove the rotor.

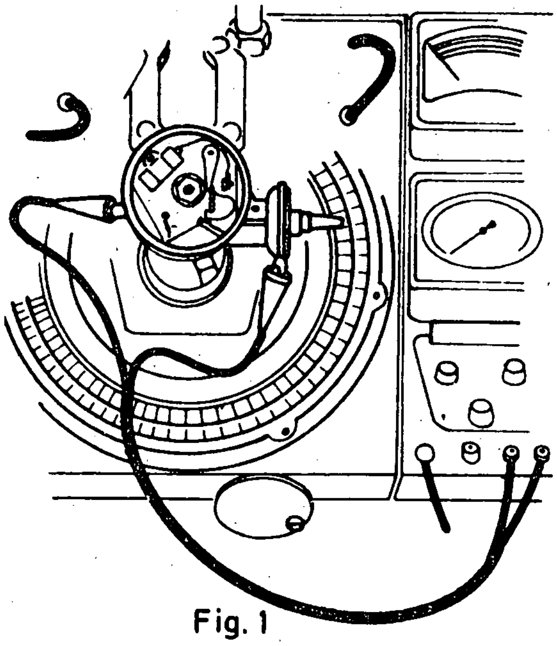


Fig. 1

OBSERVATION:

Make sure that the distributor shaft spins freely.

2nd step - *Start the machine* without spinning the distributor shaft and calibrate the instruments.

OBSERVATION:
All the calibrations that are done in this step should be confirmed against the specifications of the manufacturer of the vehicle.

3rd step - *Test the distributor, thus:-*

a) Check the tension in the spring of the contact points (fig. 2).

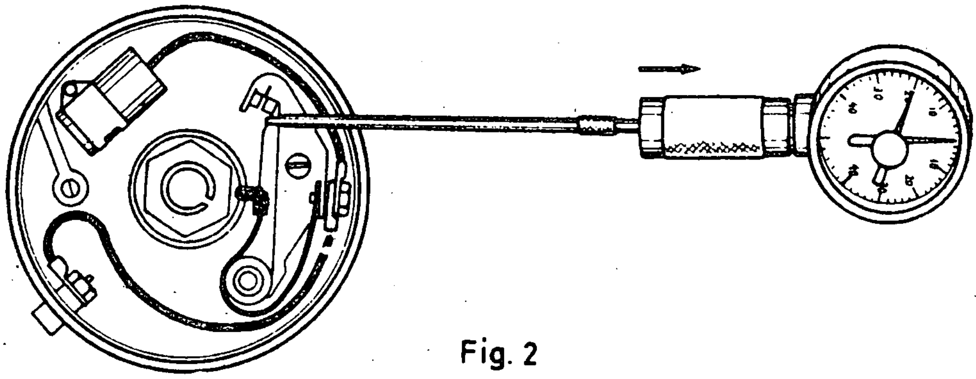


Fig. 2

b) Align the contacts of the breaker points (fig. 3) and measure the primary resistance insulation and current leaks.

c) Measure the cam angle.

d) Check the working of the centrifugal advance mechanism.

e) Check the working of the vacuum advance system.

f) Make sure that the cam angle of the breaker point gap is constant and is in accordance with the amount specified.

g) Check the condenser.

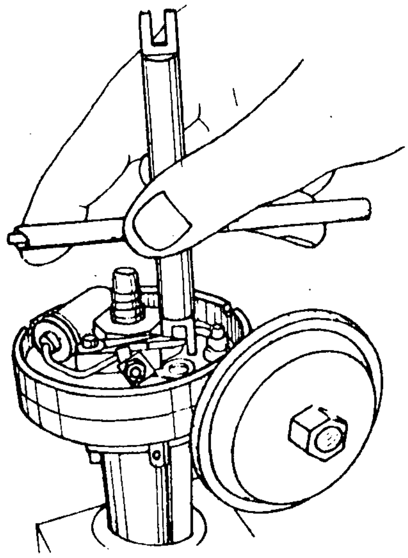


Fig. 3

4th step - *Remove the distributor* from the testing machine and replace the rotor.

TECHNOLOGICAL INFORMATION
SHEETS

They are the basic tools used in applying torsion force to the heads of screws and nuts.

CONSTRUCTION:

The best spanners are made of vanadium-chrome steel so as to attain great resistance and reduced weight. Owing to the high cost of this material, many spanners are made of steel lined with carbon or of molybdenum steel. The size of a spanner is determined by the gap between its jaws, slightly larger than the head of the screw or nut that is to be adjusted so as to enable the spanner to slip easily when positioning it or removing it.

TYPES

Fixed opening or open end Wrench.

These are solid wrenches that are not adjustable, with openings on one or both ends; they are known also as spanish wrenches or open end wrenches.

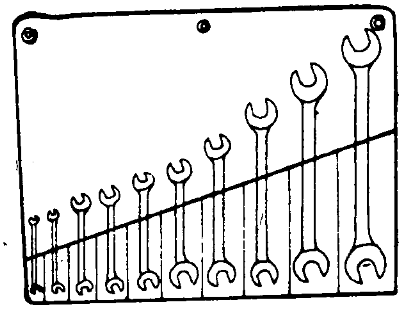


Fig. 1

Generally they come in sets of 6 to 10 wrenches and their sizes vary, usually between 7 mm to 25 mm or ¼" to 1" (fig. 1).

The jaws of these wrenches may be parallel to the handles or may be situated at an angle to the handles that varies from 15^0 - 80^0 (fig. 2). so as to enable operating in restricted spaces.

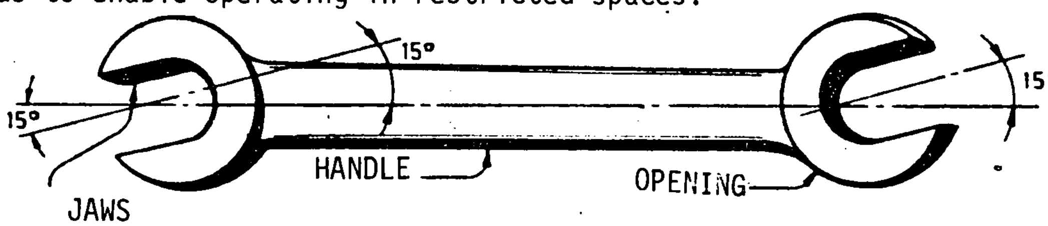


Fig. 2

There are fixed open-end wrenches, called TAPPET WRENCHES, that are very thin and long; they are used in adjusting valve tappets in the engines.

Box Wrenches.

These completely closed wrenches can have 6, 8, 12 or 16 grooves in the head (fig. 3) and are used in narrow or nearly inaccessible places.

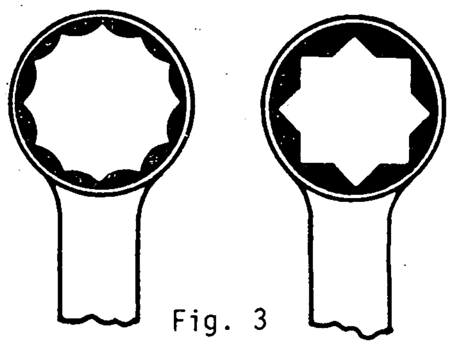


Fig. 3

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1st. Edition

These wrenches can be combined with the open-end type (fig. 4). There are also other box wrenches (fig. 5) that are used essentially on tubing fittings. For the case where there is extra heavy work to be done, there are long handle wrenches with the box head on one end only (fig. 6).
There is a type of box wrench that is solidly made with a short handle that has a steel padding which is tapped with a hammer (fig. 7).

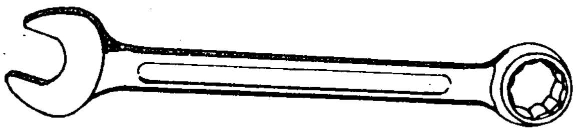
Fig. 4


Fig. 5

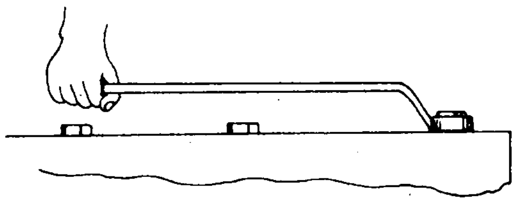
Fig. 6

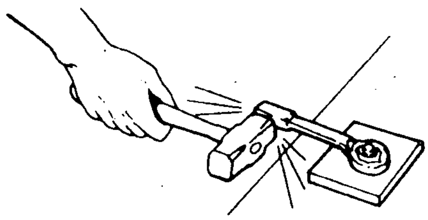
Fig. 7

Socket Wrenches. The opening of the socket generally has 8 or 12 grooves, similar to the box wrench.
Socket wrenches come in sets and have the same commercial characteristics as the open-end and box wrenches; they are designed for light, heavy and extra heavy work.
The opposite end of the jaw opening (fig. 8) has a square hole in which the handle is inserted; these handles are of different shapes so as to adapt to the place and positioning of the nut or screw (fig. 9).

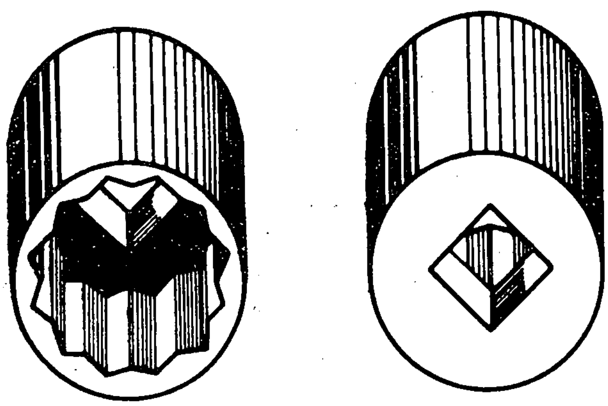

Fig. 8

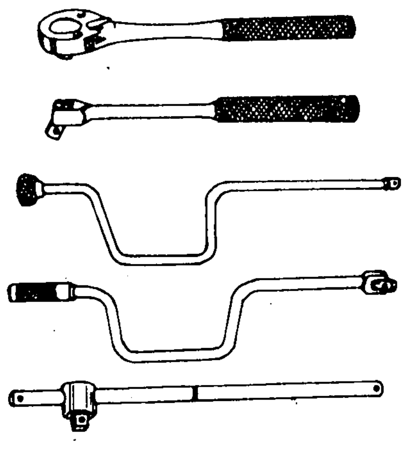
Fig. 9

The universal joint (fig. 10) is placed between the bar and the socket and enables working in different angles, with respect to the screw or nut. There is a type of socket that is extra long (fig. 11) used in removing spark plugs.

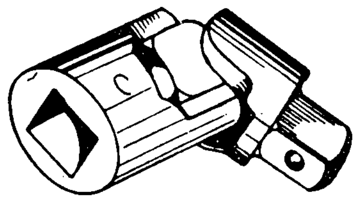

Fig. 10

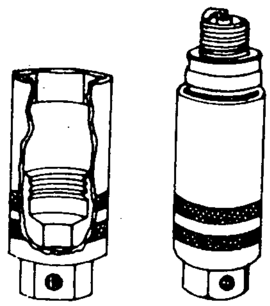

Fig. 11

Adjustable Wrenches. There is a variety of adjustable wrenches; among the most common are : the adjustable end wrench or French wrench (fig. 12); adjustable wrench for pipe work (fig. 13); and the English adjustable wrench (fig. 14).

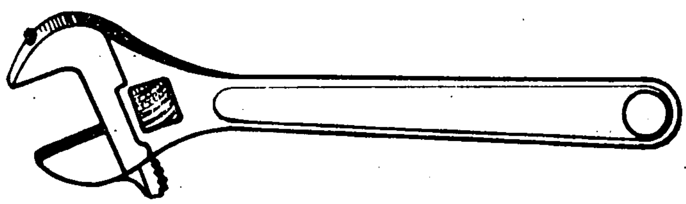

Fig. 12

Fig. 13

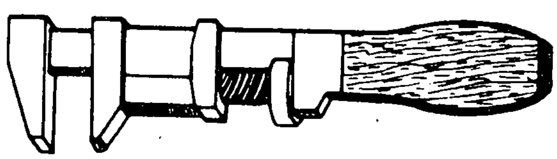

Fig. 14

TECHNICAL VOCABULARY

Spanner - Wrench

Besides the common type of pliers used in mechanics as well as in electricity, there is a great variety used especially in auto-mechanics. Their characteristics, sizes and shapes are variable, and they are designed to suit the job for which they are intended.

TYPES AND USES

Pliers for lock rings. It is used in removing and replacing lock rings with internal or external holes (fig. 1).

Pliers for circlips and Horseshoe Lock Washers (fig. 2). They are used to open horseshoe lock washers used in journal bearings, gears and other parts.

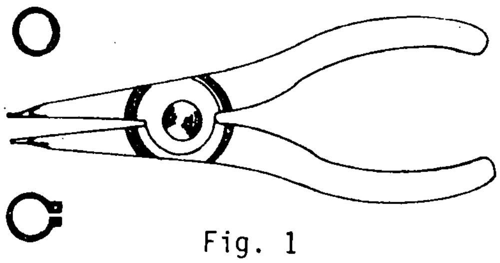

Fig. 1

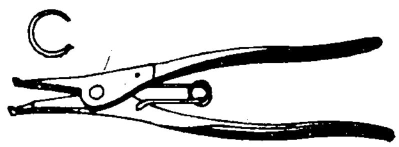

Fig. 2

Link type pliers for circlips (fig. 3). Used to open high tension circlips.

Pliers for grease caps (fig. 4). Its tapered 'V' shaped claws enable it to grip the grease caps and remove them, whether they were screwed on or press-fitted.

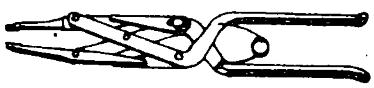

Fig. 3

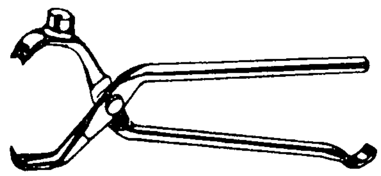

Fig. 4

Pliers for brake springs (fig. 5). Enables the removing and replacing of the return springs of the brake shoes with ease.

Pliers for Brakes (fig. 6). Its special jaws enable the removal of the sustaining cups of the shoe. The socket on one of its handles adapts to the anchoring screw so as to remove the return springs of the brake shoes. The other end of the handle has a tongue that aids the replacing of the return springs, by levering it on.

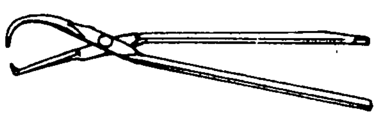

Fig. 5

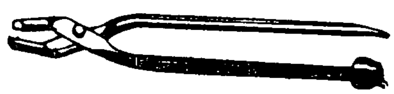

Fig. 6

Pliers for Hoses (fig. 7). Enables the placing and removal of coil spring clamps on cooling or heating system hoses.

Angular jaw pliers for batteries (fig. 8) Its jaws at an angle of 30^0 enable the removal of corroded or damaged battery terminal nuts.

Fig. 7

Fig. 8

Pliers for spark plug terminals (fig. 8). Enables the removal of spark plug terminals even with the engine operating. Its handles, being completely insulated, resist up to 25,000 volts.

Pliers for removing wire insulation (fig. 10). Its 'V' shaped teeth enable the cutting of insulators and their removal.

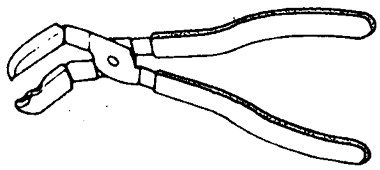

Fig. 9

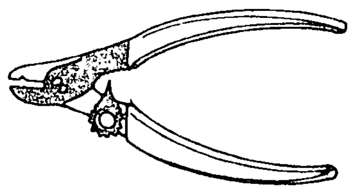

Fig. 10

Pliers for Piston rings (fig. 11). Facilitates the removal and replacement of the piston rings.

Pliers for tyre Chains (fig. 12). It is used to quickly and safely open and close chain links, used on tyres to give them better traction on snow covered or muddy roads.

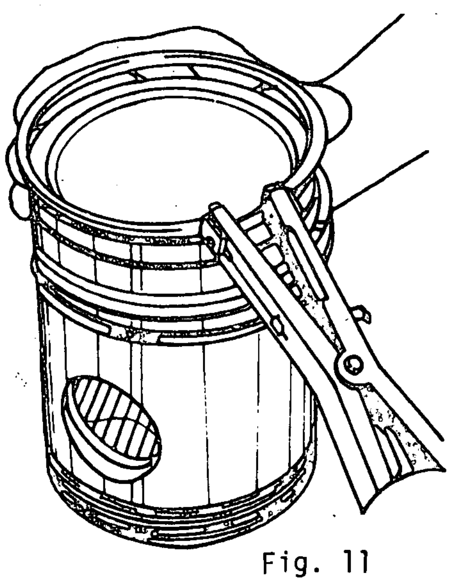

Fig. 11

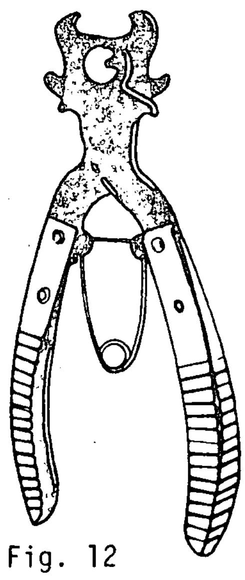

Fig. 12

Moulded linings (fig. 1). They are linings which by moulding, attain the appropriate dimensions and shapes for a given type of shoe, according to the make or model of the vehicle.

Blocks. They are also moulded and differ from the previous ones in their dimensions and shapes (fig. 2). They are used in braking systems for trucks and special vehicles.

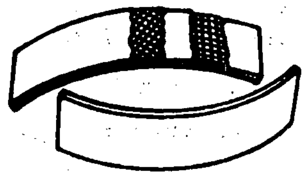

Fig. 1

Pads. They are specially contoured, flat pieces of brake lining (fig. 3) and are used in disc brakes.

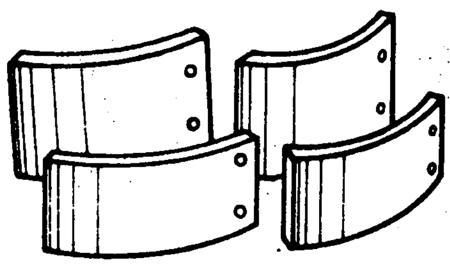

Fig. 2

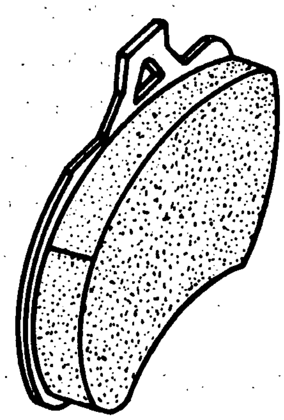

Fig. 3

CONDITIONS OF USE:

When working with brake lining, special care must be taken not to soil them with greases, fuels or brake fluid. If they have been superficially soiled they can be cleaned by sanding them lightly. When the lining has been impregnated with grease, fuel or brake fluid, it alters its braking qualities and should be replaced. Periodically, the brake unit should be blown out with compressed air to remove any dust on the lining.

The state of the brake lining should be checked in accordance with the load to which they are subjected and, bearing in mind the manufacturer's specifications. This consists of noting the thickness of the lining to see whether the wear is considerable enough to warrant their replacement so as to prevent damage to the drum or disc.

Brake lining is that element, which when rubbed against the drum or disc, opposes its rotating movement, making it lose speed or stop the vehicle.

CHARACTERISTICS:

Due to the functions that the lining performs, the following characteristics are emphasized:

- High coefficient of friction between the lining materials and that of the drum or disc.
- The coefficient of friction should hold at the different working temperatures.
- They should be able to regain their normal coefficient of friction when they get wet.
- They should have a high resistance to wear, without scratching the drum or disc.
- They should have a resistance to compression.
- They should not cause noise during the braking.
- Their constituent material should be adaptable to the type of metal used in making the drum or disc.

CONSTITUTION:

They are made of a mixture of substances such as asbestos, rubber (synthetic or natural), resins, drying oils, coke and carbon; they are pressed over a copper, bronze, aluminium or lead thread mesh so as to keep the basic elements more compact. They are treated by means of heat and high pressures so as to bond them, until obtaining the desired shapes, as well as the superficial texture, density and toughness.

TYPES:

Woven lining: They come in rolls or bands of different widths and thicknesses and may be cut to suit the shoe surfaces.
They are used mainly for parking brakes on the drive shaft and mechanically controlled brakes.

Types. The most common type of parking brake, shown in fig. 1, is applied directly to the rear wheels. Other types of brakes used are installed on the transmission, directly on the drive shaft; they are made up of brake lining and a pulley (fig. 3), or of brake shoes and drum (fig. 4).

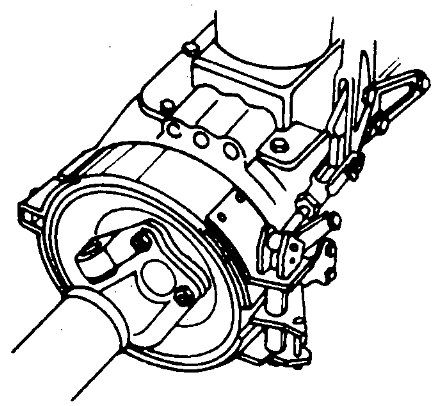

Fig. 3

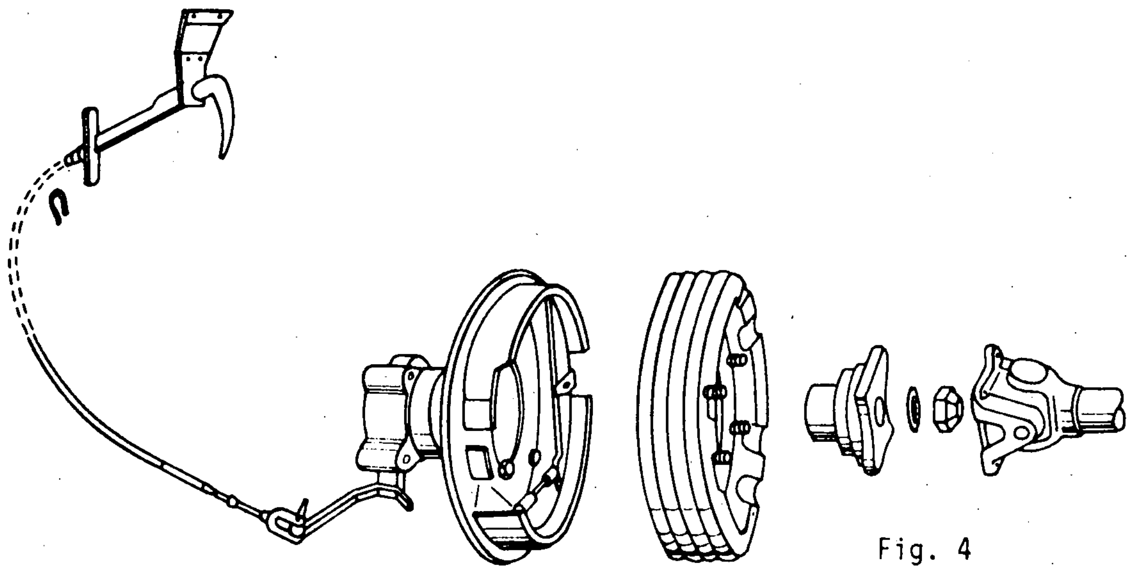

Fig. 4

SUMMARY

PARKING BRAKE	*To the wheels*	They use the shoes of the rear wheels of the main system.	
	To the drive shaft	*With shoes and drum*	
		Pulley and brake lining	

Impeller arm. It has a slot on both ends and is fitted in such a way that one slot catches on to the operating lever and the other on to the primary shoe, with a spring that compensates for the longitudinal play.

FUNCTIONING:

On parking the vehicle, or on applying the brake in an emergency, the driver operates the control lever. This movement moves the intermediate cable and the compensating lever so producing tension in the control cables. The control cable operates the operating lever (fig. 2); this in turn moves the impeller arm pushing the primary shoe on to the drum; the reaction of this shoe moves it into the pivot of application (P) of the operating lever on the secondary shoe, causing it also to be pushed against the drum, thereby causing a progressive braking effect.

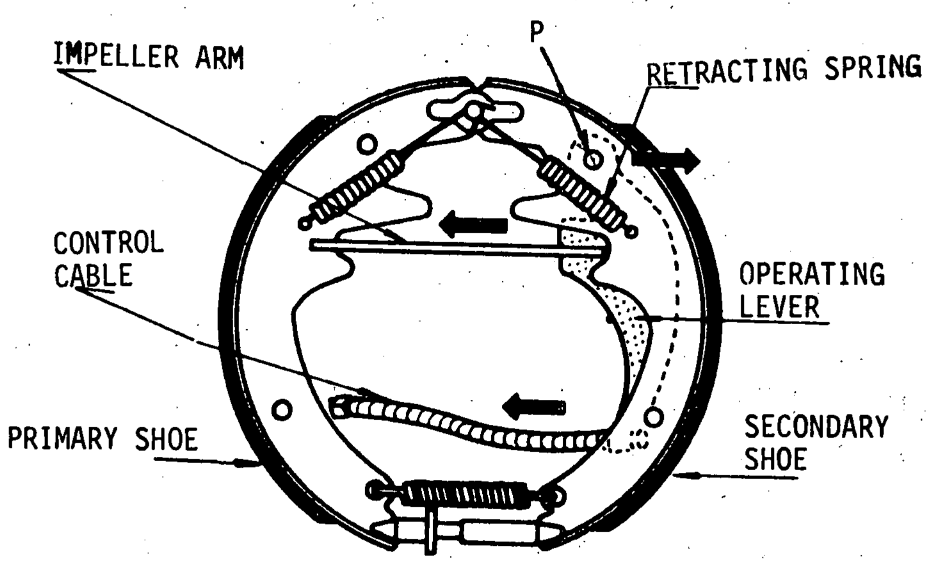

Fig. 2

On releasing the control lever, the cables are loosened and the retracting-springs return the shoes to their rest positions. In order to adjust the parking brake, the adjusting screw is lengthened or shortened, spacing along the compensating lever (fig. 1).

Every vehicle has, for security reasons, two independent braking systems, the main one that stops it when in motion, and the other, the parking brake, used to hold the vehicle in a position of rest on flat or inclined ground, and also used as an emergency brake.

CONSTITUTION:

The parking brake (fig. 1) is composed of the following parts:-

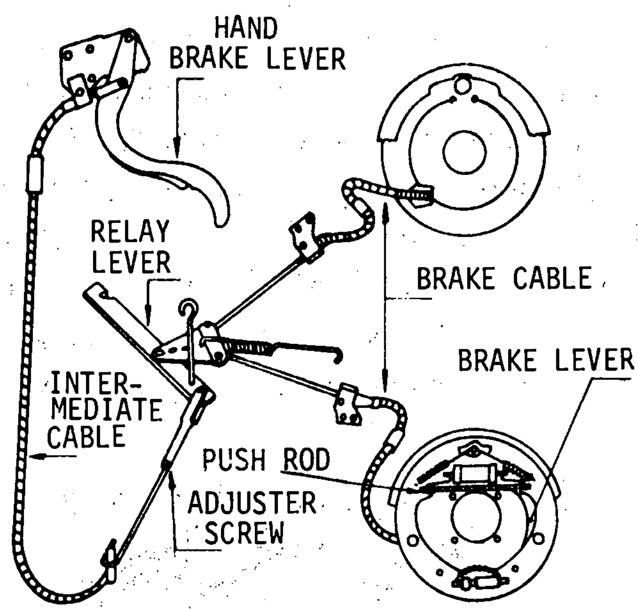

Fig. 1

Control lever. It can be situated on the front panel or on the chassis of the vehicle, and is equipped with a device that secures it in its braking position.

Compensating lever. It is situated below the body and connects the control cables that operate the rear wheel shoes by means of a pin.

Intermediate and control Cables. They are made of flexible steel and are normally sheathed to prevent corrosion. They are fixed to the chassis with clamps.

Operating lever. It is mounted on the secondary shoes of the rear wheels, with a bolt and nut; there is a hook fitted to it on the lower part on which the control cable is connected.

FUNCTIONING:

On pressing the brake pedal, the fluid pressurized by the master cylinder enters the cylinder through a hole situated in its centre between the rubbers, displacing the pistons; these in turn, by means of the rods force the shoes against the drum to stop the wheel (fig. 6).

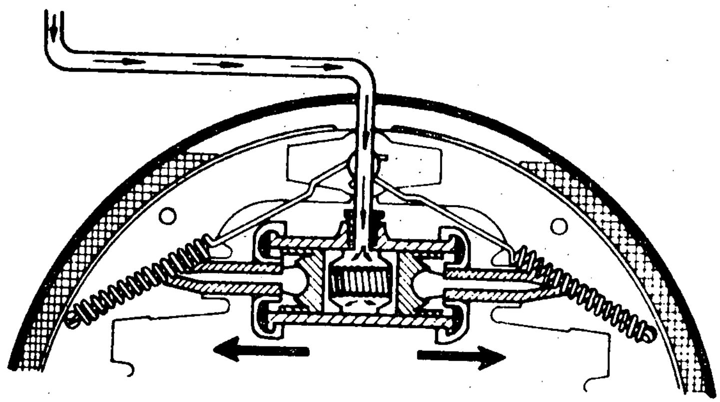

Fig. 6

On releasing the pedal, the hydraulic pressure of the master cylinder decreases, and due to the effect of the shoe-retracting springs, they are removed from the drum surface, moving the pistons in the cylinder to their original positions, thereby forcing the fluid back to the pump.

MAINTENANCE

To upkeep the brake wheel cylinders in good working condition, it is necessary to check them periodically, bearing in mind the manufacturer's specifications and making sure that there are no fluid leaks through the tubings, lines or rubbers.

Pistons: The pistons are those parts of the system that act on the shoes by means of the push rods during the braking operation. They are made of aluminium as this metal does not tend to wear so easily.

Dust covers: There are two dust covers situated at the ends of the cylinder. Their purpose is to prevent foreign particles, that may deteriorate the internal surface of the cylinder, from entering.

Bleeder: In the centre of the cylinder there is a hole into which a bleeder is screwed for the purpose of removing the air in the system.

TYPES:

One-piston cylinders. (Fig. 3) They are used when the control of the shoes is independent; in this case each shoe is operated by a cylinder.

Two-piston cylinder. They are used with the floating type shoes. These shoes are operated by one cylinder (fig. 4).

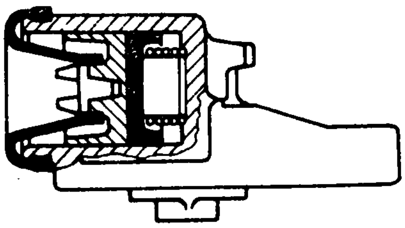

Fig. 3

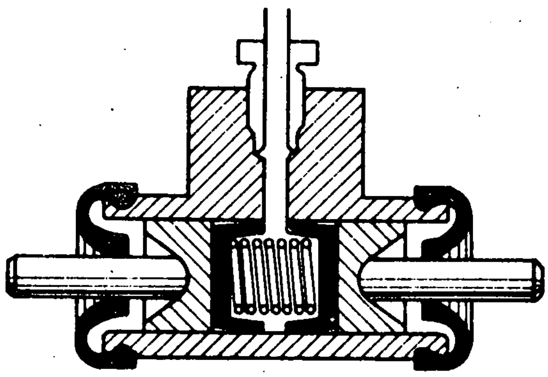

Fig. 4

Spaced out cylinders. Spaced out cylinders have different size diameters to compensate for the more intense load on the front shoe than on the rear shoe (fig. 5).

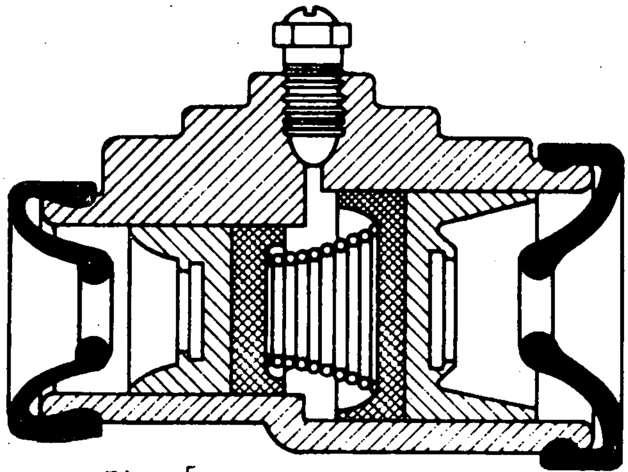

Fig. 5

Brake wheel cylinders are those parts of the braking system that transform the hydraulic pressure produced by the master cylinders into force to push the brake shoes into contact with the drums.

CONSTITUTION:
The following are its component parts (fig. 1).

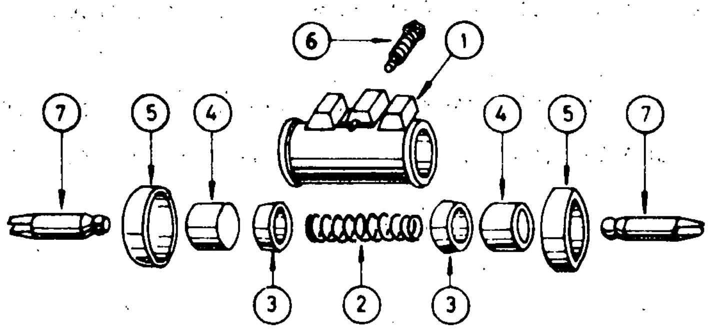

Fig. 1

1. Cylinder body
2. Rubber return spring
3. Cylinder rubbers
4. Pistons
5. Dust cover
6. Bleeder
7. Push rods

The wheel cylinders are mounted on the shoe hold-down plates (fig. 2), and are connected to the hydraulic circuits by means of rubber tubings or lines.

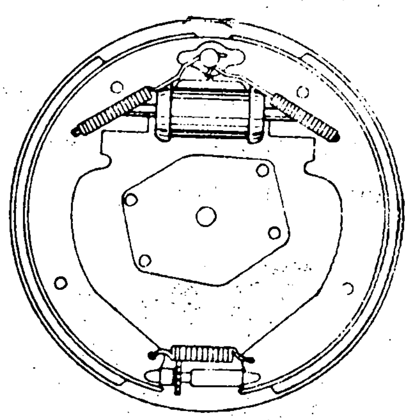
Fig. 2

DESCRIPTION:

Cylinder body: The body of the cylinder, usually made of cast iron, has a highly polished cylindrical cavity in which the pistons are displaced. It also has two holes: one to connect it to the fluid tubing or line, and the other to connect it to the bleeder.

Rubber return spring: The function of the spring is to keep the rubbers supported against the pistons, in the rest position and during displacement.

Cylinder rubbers: They are made of a synthetic material; its cupped shape enables the brake fluid pressure to adjust it air-tight to the cylinder, thereby preventing leaks.

The floating shoe unit includes an automatic adjusting mechanism made up of a cable, an adjusting lever and an adjuster spring (fig. 5).
The cable is hooked to the anchor pin at the top and to the adjusting lever at the bottom and by means of a guide to the secondary shoe.
The adjuster spring is hooked to the primary shoe and to the lever.
The automatic adjuster works only when the brakes are applied with the vehicle reversing.

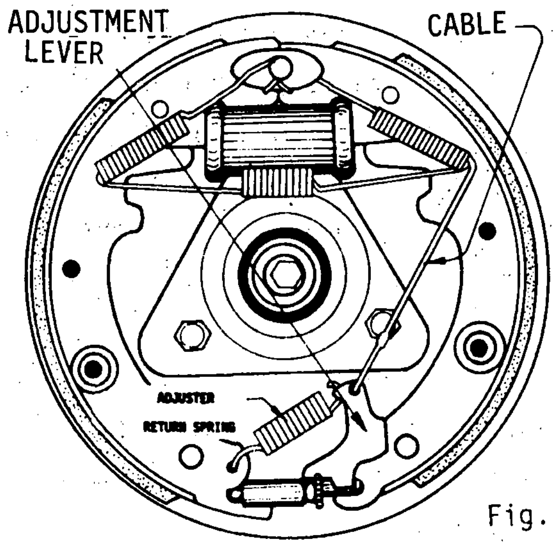

Fig. 5

In this case if the secondary shoe is too removed from the drum, the lever moves sufficiently to hook a tooth of the star of the adjuster. On releasing the brakes, the lever moves the adjuster, correcting the excess clearance between the drum and shoe.

TECHNICAL VOCABULARY:
Primary shoe - Leading shoe
Secondary shoe - Trailing shoe

When the shoe at the front, called the primary shoe, rubs against the drum it tends to drag; this causes the shoe to tend to thrust more against the drum. On the contrary, the rear shoe, known as the secondary shoe, is repelled by the drum, making its action less effective.
For both shoes to work approximately the same, it is necessary to apply more force on the secondary by means of spaced-out cylinders.
The shoes are adjusted by means of the eccentrics situated on the anchor points.

Double Command System. The inconveniences existing in the previous system are tentatively eliminated by making the control of each shoe independent (fig. 3). In this way both shoes are affected by the drum drag.

Floating Shoes. They are connected together by means of a bolt that does the adjusting functions (fig. 4).

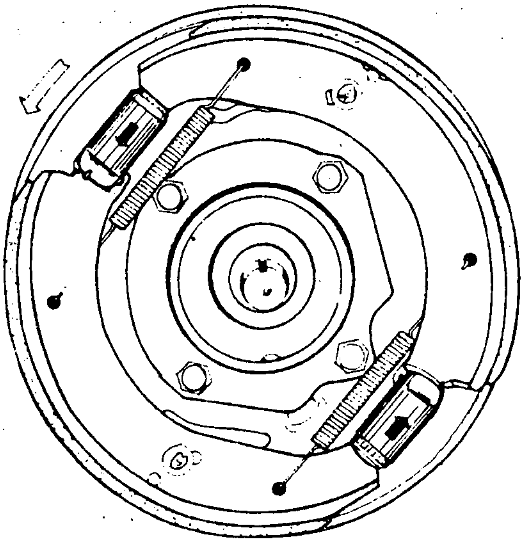

Fig. 3

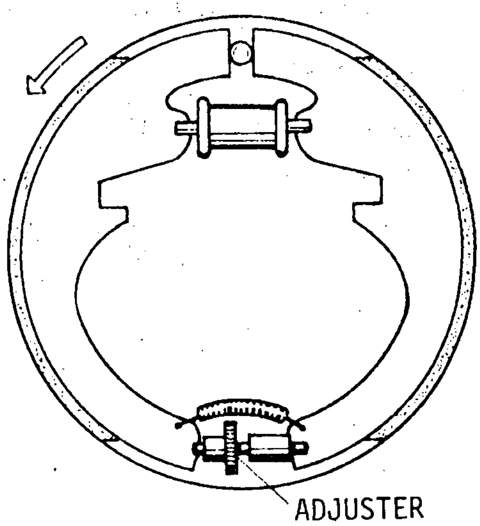

Fig. 4

In this way, on pressing the brakes the primary shoe is dragged and pushes the secondary by means of the adjuster. This enables the secondary shoe to be dragged also, so attaining a more effective and even braking effect of both shoes.
The anchor pin is installed to prevent the shoes from rotating and it also supports them.

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Retracting Springs. They ensure the return of the shoes to their original positions when the brake pedal is released.

Shoe Hold-down Spring. They hold the shoes on to the fixtures on the plate, allowing for the normal braking movement.

Anchor Pin. It acts as a stop for the upper part of the shoes and is hooked to the retracting springs.

Anchor Pin Plate. It acts as a guide and keeps the shoes against the plate.

FUNCTIONING:

On pressing the brake pedal the applied force is transferred to the master cylinder by means of the push rod, which raises the pressure of the fluid in the system, thus transmitting it to the wheel cylinders. The pistons inside the cylinder are displaced, separating the shoes from the anchor pin and overcoming the tension in the retracting springs. The shoe lining rubs on the working surface of the brake drum, stopping its rotation.
On releasing the pedal the pressure of the fluid in the cylinder is reduced. This allows the retracting springs to act, returning the shoes to their rest position.

TYPES:

The different types of drum brake are characterized by the assembly of the shoes on the plate.

Fixed Anchor Shoes. In this case each shoe has a fixed anchor point on which it spins in order to approach the drum (fig. 2). This movement makes the pressure uneven on the surface of the lining, as it supports itself with decreasing force from the high point to the anchor point, resulting in the lining being worn down unevenly.

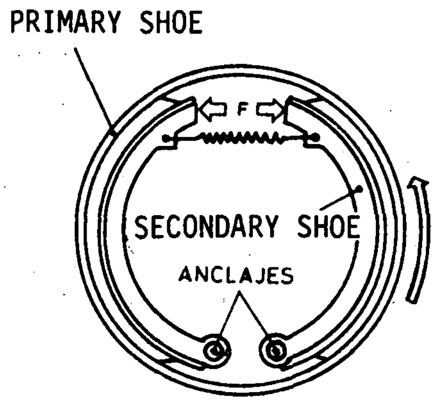

Fig. 2

It is the unit designed to connect the brake shoe lining to the working surface of the drum so as to slow or stop the vehicle.

CONSTITUTION:

The component parts of the type of drum brake used nowadays are (fig. 1):

1. Brake Plate
2. Primary Shoe
3. Secondary Shoe
4. Adjuster
5. Adjuster Spring
6. Retracting Springs
7. Shoe Hold-down Spring
8. Anchor Pin
9. Anchor Pin Plate

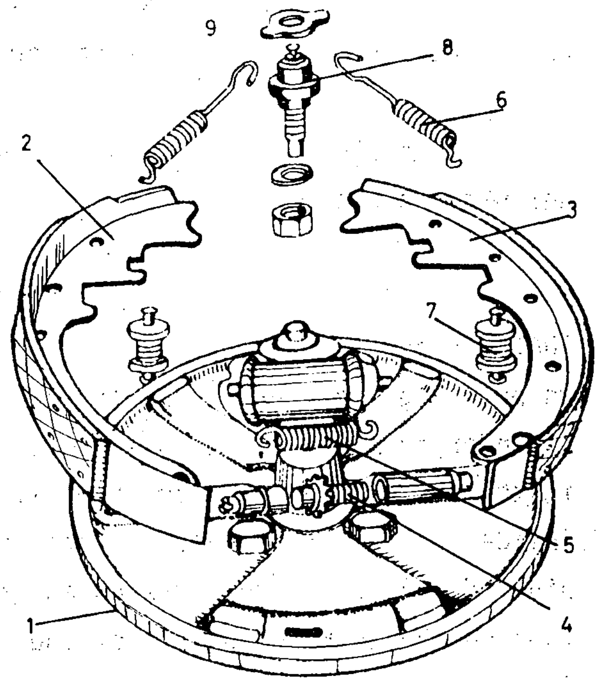

Fig. 1

DESCRIPTION:

Plate. It is made of stamped steel plate, on which the remaining parts of the unit are mounted.

Shoes. They serve as support for the brake lining. They are generally made of steel plate and, in special cases, of cast iron or aluminium alloys.

Adjuster. Its purpose is to adjust the clearance between the shoes and the brake drum.

Adjuster Spring. Its purpose is to keep the shoes and the adjuster together and to prevent the crown of the adjuster rotating by itself, thereby altering the adjustment.

The spring pushes the piston to its rest position faster than the fluid returns to the master cylinder, thus creating a slight vacuum in the piston head. The vacuum causes a small amount of fluid to flow from the compensating port, through the holes in the piston head and the notches on the primary rubber (fig. 6), to the pressure chamber of the pump, so maintaining it full with fluid so that the brakes may be applied again. When the piston is completely loose, the primary rubber uncovers the compensating port allowing the fluid to flow from the pressure chamber to the reservoir, while the retracting springs of the shoes continue to force the fluid to the master cylinder.

The check valve and the return spring of the piston maintain a low hydraulic pressure in the lines and wheel cylinders, when the brake is not applied, so as to prevent air from entering the system.

VALVE

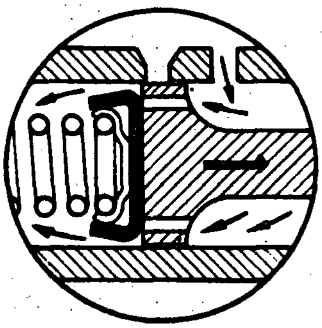

Fig. 6

MAINTENANCE:

In order to upkeep the brake master cylinder in good working condition it is necessary to periodically check:

- Fluid Level.
- Dust Cover.
- Possible leaks in the line connections.
- Air vent on the cover of the Reservoir.
- Operating rod joints.
- Air in the system (bleed if necessary).

TECHNICAL VOCABULARY:

Gasket - Joint

Annular - Ring

The valve is seated on a synthetic rubber washer, which makes up the return mechanism, and is kept in position by the main spring of the master cylinder.

TYPES:

In modern vehicles double cylinders are commonly used, which enable the front wheel braking circuit to be independent of the rear circuit, thereby securing increased safety in the event of leaks or defects in either of them.

These master cylinders are similar to the single master cylinder with the difference that they have a double pressure mechanism with two pistons arranged in series (fig. 4).

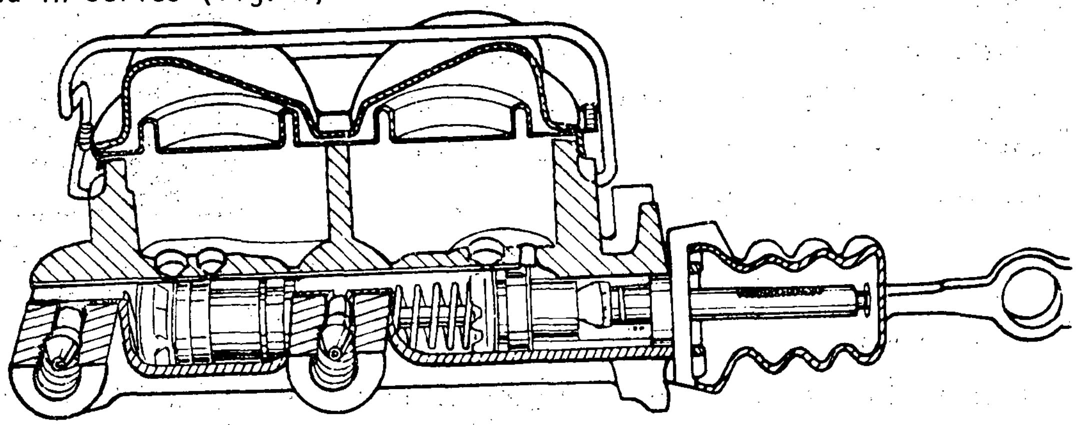

Fig. 4

FUNCTIONING:

On pressing the brake pedal, the operating rod moves the piston inside the cylinder, creating a pressure within the system; a small quantity of fluid passes through the compensating port to the reservoir which enables the braking effect to begin gradually (fig. 5). The primary rubber obstructs the compensating port, sending the fluid from the pressure chamber, through the check valve and lines, to the wheel cylinders.

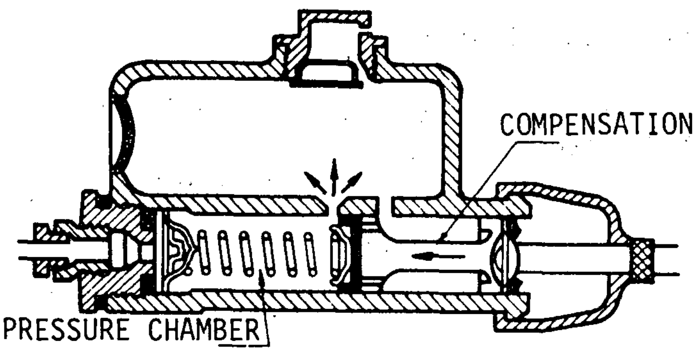

Fig. 5

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The cover of the tank has a little vent, that connects it with the atmospheric pressure; it is fitted with a deflector or trap to prevent fluid from leaking out.
In the cylinder bore, generally iron-based, where the internal parts work, the internal surface should be perfectly cylindrical and smooth to ensure good efficiency.

The Piston. It has a smooth bobbin shape; the central part forms an annular chamber called the compensating port. It is usually made of an aluminium alloy.
The front part which is cylindrically shaped and called the head, has small holes that connect the compensating port with the pressure chamber of the cylinder. At the extreme end it has a circular groove that serves as a housing for the secondary rubber and, besides this, a cavity on which the operating rod is supported.

Rubbers are made of synthetic materials so that they are more able to resist the chemical effects of the brake fluid. The primary rubber is cup-shaped so that there is an air-tight seal when the piston advances. There are notches on its periphery that enable the liquid to pass through when the piston recedes. On its rear surface it is fitted with a metallic reinforcement that prevents the pressure of the liquid from bursting through, where it meets the holes of the piston. The secondary rubber is annular shaped so that it can be installed in the piston groove and prevent the fluid from leaking out of the compensation port.

The Dust Cover is made of synthetic rubber and is situated on top the cylinder and the operating rod so as to prevent dirt or dust from getting inside the master cylinder.

The Check Valve (fig. 3). It is made up of the stamped plate body with small holes that are covered with a synthetic rubber plate riveted to its centre.

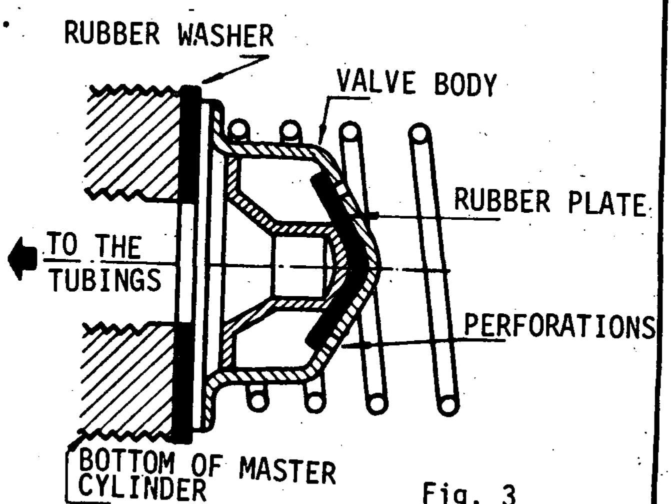

Fig. 3

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BRAKE MASTER CYLINDER

This is the device in the system designed to propel the fluid through the hydraulic system at the necessary pressure and quantity, to operate the braking system, in accordance with the working conditions of the vehicle, as a result of the force applied on the pedal.

CONSTITUTION:

The brake master cylinder is composed of (fig. 1):

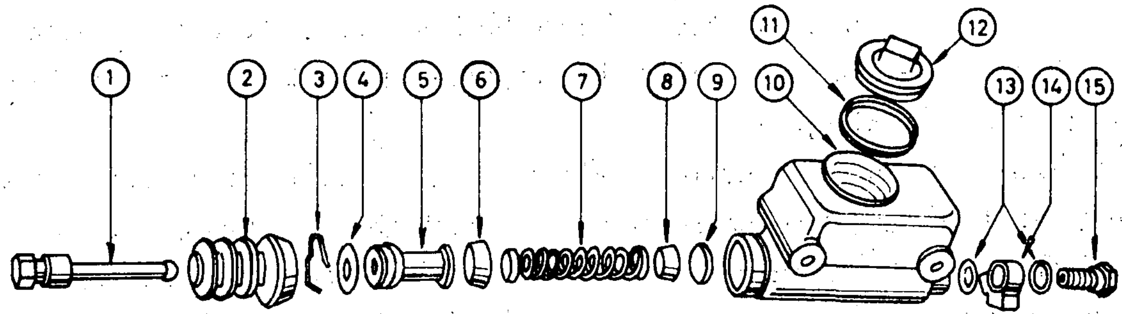

Fig. 1

1. Operating Rod
2. Dust Cover
3. Piston Lock
4. Stop Washer
5. Piston and Secondary Rubber
6. Primary Rubber
7. Piston Return Spring
8. Check Valve
9. Valve seating
10. Master Cylinder Casting
11. Filler Cap Gasket
12. Filler Cap
13. Clearance Nipple Gaskets
14. Outlet nipple
15. Securing Bolt

DESCRIPTION:

The body of the master cylinder is made up of the reservoir of liquid and the cylinder. The purpose of the reservoir is to compensate for the variations in volume of the liquid when functioning. It may be made in one structure with the cylinder or may be a separate unit (fig.2).

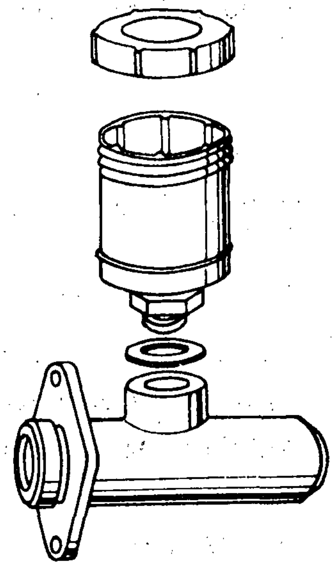

Fig. 2

CONDITIONS FOR USE:

When either the fluid in the system or the one that is to be added is not known, they should not be mixed. In such cases, the system should be emptied and washed out with alcohol before refilling it with a known fluid. Brake fluids get contaminated from constant use; this decreases their basic qualities and for this reason the system should be periodically flushed and the fluid changed.

This is used in hydraulic braking systems and is the most important element of the unit. Its purpose is to instantly transmit pressure from the brake master cylinder to the wheel cylinders.

CLASSIFICATION:

Brake fluids, usually made of a combination of alcohol with vegetable based oils, are classified according to their intended uses: light work fluid, medium, heavy and extra heavy. Nowadays, mainly because of the increased speeds of vehicles, manufacturers recommend using only those fluids suited for heavy and extra heavy work.

CHARACTERISTICS:

Owing to the important part played by the fluid in working the braking system, some rules for use have been laid down to cover the minimum requisites. Among the qualities that characterize a good fluid, the following should be emphasized:

- It should not affect the rubber parts.
- It should not corrode or rust the metals.
- It should have an evaporation point higher than the highest working temperature to which it is subjected. If it evaporates it would become compressible, thereby losing the property of transmitting pressure from the pump.
- It should remain in a fluid state, even at the lowest normal working temperature, otherwise it would create difficulty for its flowing.
- It should lubricate the internal parts of the pump and brake cylinders.
- It should not deposit any residue that may obstruct the free passage through the ducts and openings of the system.
- It should be stable - that is - it should retain its characteristics for a long time.

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Bleeding equipment: The bleeding operation may be done with equipment comprising (fig. 3):

1. Pressure tank
2. Connecting line to the pump
3. Manometer
4. Valve for the air
5. Stop tap

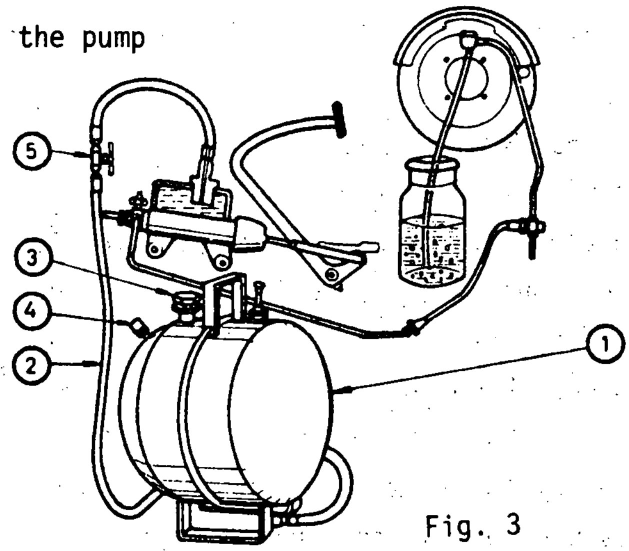

Fig. 3

The tank is filled with brake fluid and then compressed air from outside is injected through the valve. On opening the stop tap the pressurized fluid passes through the line to the brake master cylinder, so that on loosening the bleeder on the wheel cylinders, it would flow out carrying the air along with it. The bleeding operation may be halted when only the fluid flows without air bubbles.

Every time the hydraulic brakes are to be repaired or serviced, air that has entered into the system should be expelled. The ease with which air is compressed absorbs the pressure transmitted by the liquid, thereby creating a loss in the braking efficiency.

GENERALITIES:

Liquids are incompressible at low pressures. Because of this property, they transmit the applied pressure, uniformly, in all directions. The force F applied on the brake master cylinder piston creates a pressure P on the liquid in the system, this pressure is transmitted to the wheel cylinders with no loss of pressure, as is shown here diagrammatically in fig. 1.

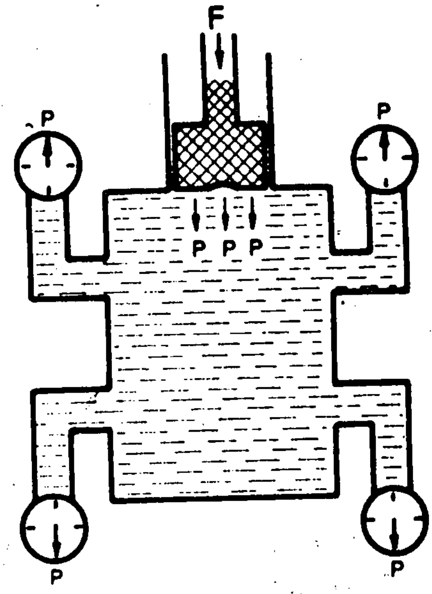

Fig. 1

These fundamental principles, used in operating hydraulic brakes, require that the lines be kept free of air, because it is easily compressed by the pressure of the liquid, thereby absorbing a great deal of the pressure intended for the braking shoes.

Positioning of Bleeding Equipment.

The bleeding of the system restores the efficiency of the brakes, on extracting the air from the lines by means of the bleeding equipment (fig. 2). Owing to the lower weight of the air with respect to the liquid, it tends to be situated in the higher parts of the system. For this reason the bleeding equipment should be situated at a higher level than the wheel cylinder so as to facilitate the extraction of the air.

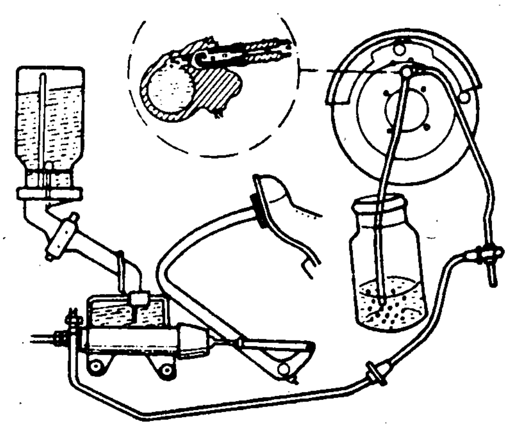

Fig. 2

Parking brake. It is a mechanism that provides an independent method of stopping the vehicle when it is stationary or in the event that the normal braking system fails to function.
The parking brake is operated by a lever or pedal and generally acts on the shoes of the rear wheels (fig. 4).

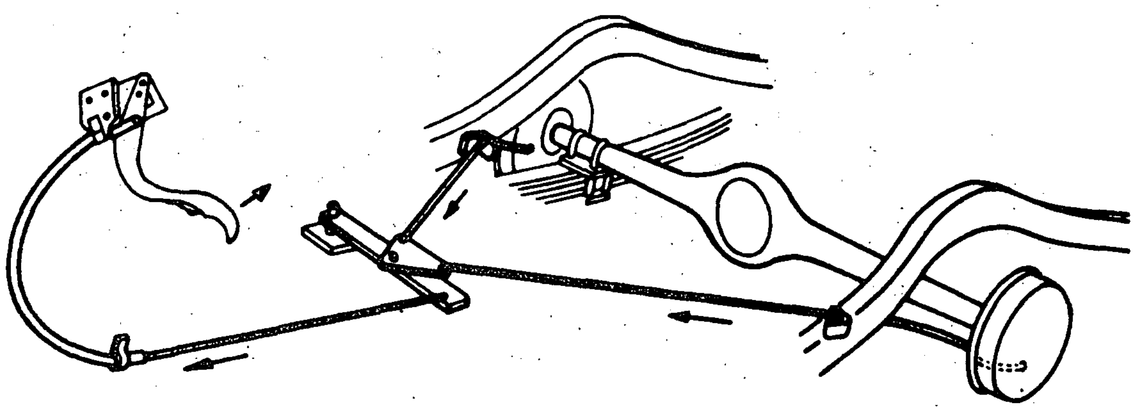

Fig. 4

Pneumatic brakes. The pneumatic braking system is used in trucks and heavy duty buses. In this system, compressed air is used to operate the brake shoe unit on each wheel; it is made up of the following parts (fig. 3):

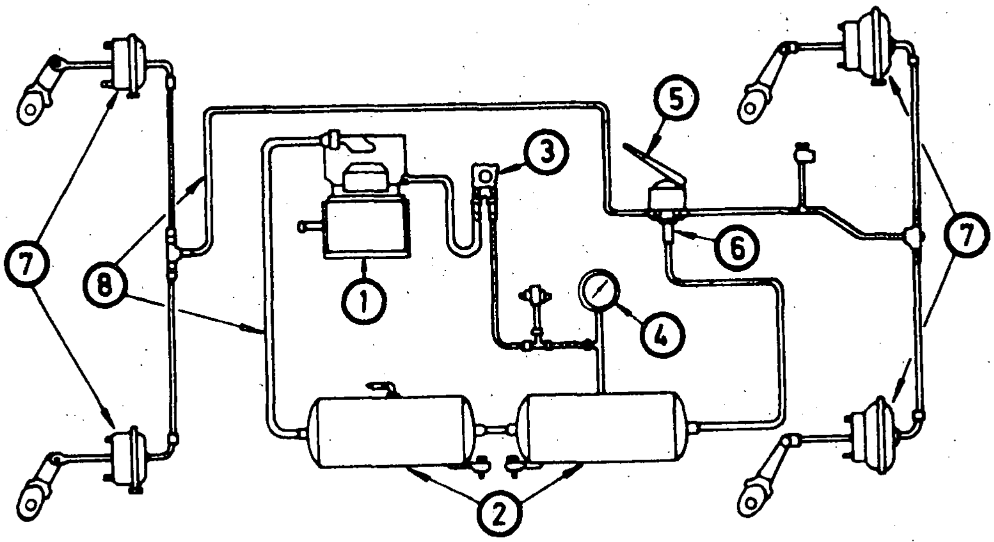

Fig. 3

1. Air Compressor
2. Air Tanks
3. Pressure Regulator
4. Manometer (pressure indicator)
5. Brake Pedals
6. Brake Valve
7. Braking Chambers
8. High Pressure Lines and Hoses

The compressed air is supplied to the storage tank by means of an air compressor operated by the engine of the vehicle. The pressure regulator of the storage tank ensures that the air pressure in the system is not excessive by expelling the excess air.
On pressing the brake pedal, the brake valve allows compressed air to pass from the tank to the braking chambers of the wheels, which by means of the operating levers, push the shoes against the drums.
When the pedal is released, the brake valve stops the flow of compressed air from the tank, and at the same time allows the air trapped in the lines and braking chamber to flow out. This valve is designed in such a way that it allows the gradual and controlled application of the brakes.

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Hydraulic brakes. The component parts of the hydraulic brakes are (fig. 2):

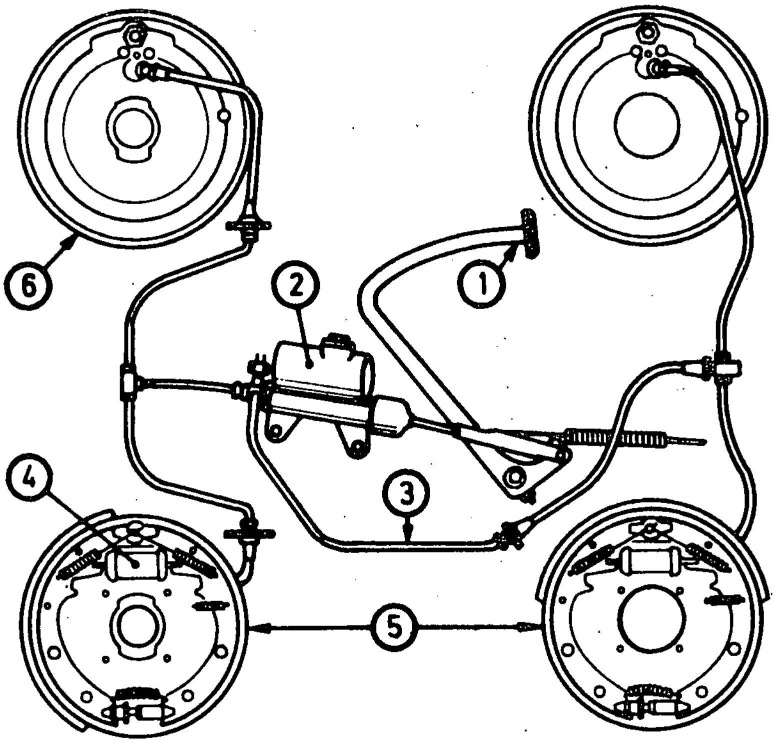

Fig. 2

1. Brake Pedal
2. Brake Master Cylinder
3. Lines and tubings
4. Wheel cylinders
5. Shoe unit
6. Brake drum

In the hydraulic braking system, the shoe displacement that locks the drum is obtained by means of pressure transmitted by a column of liquid.

On pressing the brake pedal it drives the parts, within the brake master cylinder, which send the liquid under pressure through the brake lines to the wheel cylinders; the pistons of each cylinder are displaced outwardly, forcing the shoes and brake lining on to the working surface of the brake drum.

On releasing the pedal the pressure of the liquid drops, the return springs pull back the shoes from the drum, returning them to their original positions and, the liquid in the cylinder back to the brake master cylinder.

With the purpose of re-inforcing the braking power, modern and heavy vehicles are fitted with an aid device in addition to the hydraulic braking system, that operates by a vacuum, known as BRAKE-SERVO.

The braking system in the automobile enables the stopping of the vehicle in a relatively short distance or the reduction of its velocity when in movement. For security reasons, automobiles are equipped generally, with two braking systems:

- Service
- Hand Brake

CLASSIFICATION:

According to how they are operated, they are classified into:

- Mechanical Brakes
- Hydraulic Brakes
- Pneumatic Brakes

CONSTITUTION AND FUNCTIONING:

Mechanical Brakes. They are basically composed of the following parts (fig. 1):

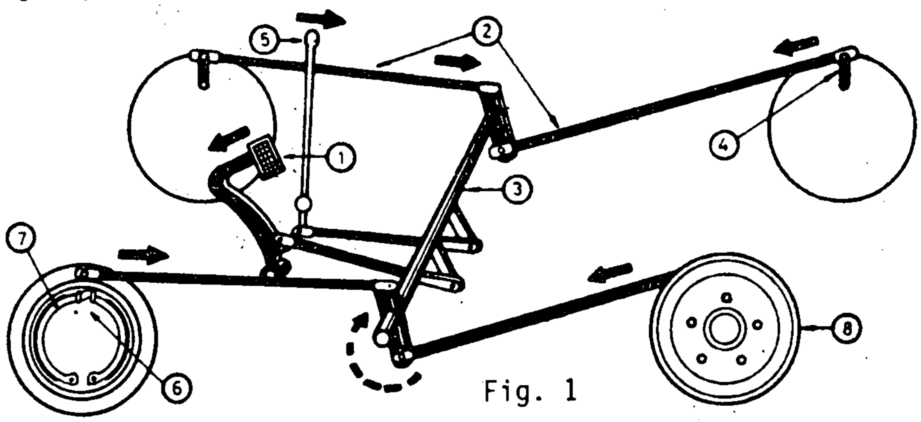

Fig. 1

1. Brake Pedal
2. Rods
3. Cross beam
4. Cam levers
5. Hand brake lever
6. Shoe adjusting cam
7. Shoes
8. Drum

In the mechanical braking system the force applied to the pedal is transmitted to the shoes on the different wheels by means of rods or lines, resulting in the shoes opening and by means of their lining, locking the wheel drums.

Originally the mechanical braking system was the one most used, but as modern cars run at greater speeds, and principally because of the difficulty in maintaining an even braking pressure on the wheels, it became necessary to replace them with hydraulic or pneumatic brakes.

Mono-casing (fig. 6) are those which make up a single structure with the frame.

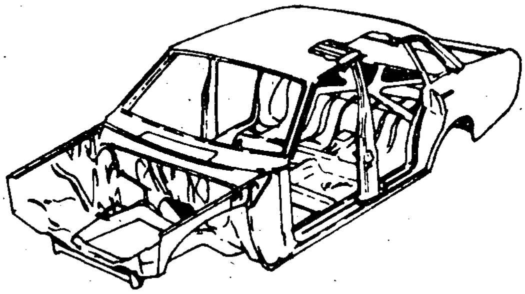

Fig. 6

TYPES

According to their shape, use and characteristics, vehicles may be used for touring (figs. 7, 8, 9 and 10), and for cargo (figs. 11, 12, 13 and 14), among which there are a great variety of makes and models.

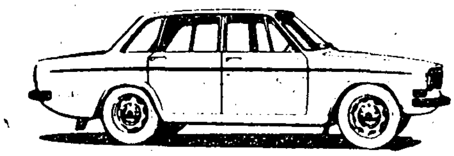

Fig. 7 SEDAN

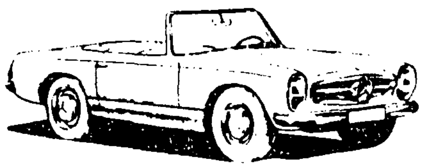

Fig. 8 CONVERTIBLE

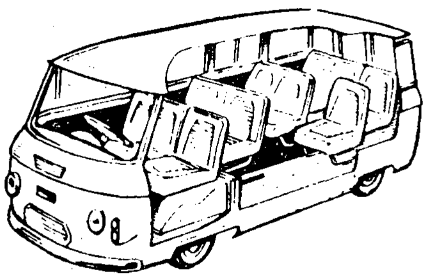

Fig. 9 STATION WAGON

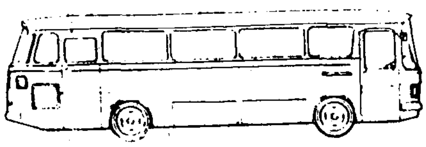

Fig. 10 BUS

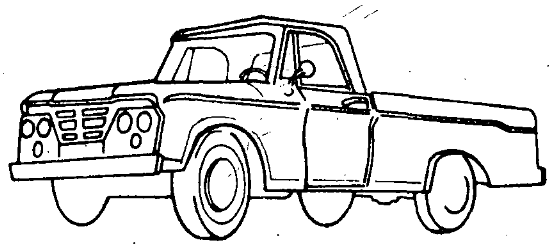

Fig. 11 LIGHT TRUCK

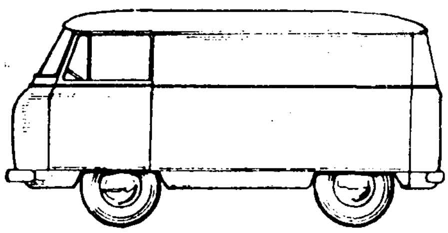

Fig. 12 VAN

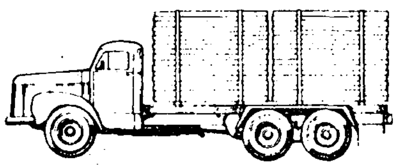

Fig. 13 TRUCK

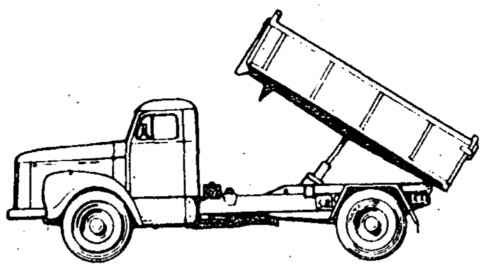

Fig. 14 DUMP TRUCK

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Mounted on the frame are the different parts that make up the systems of the vehicle. These are:

The Engine, a mechanism designed to provide the necessary power to move the vehicle.

The Suspension System, designed to absorb the irregularities of the road, so as to obtain a smooth and safe drive.

The Steering System, has as its object to guide the movement of the vehicle.

The Braking System, designed to slow down or stop the vehicle.

The Electrical System, designed to ensure the starting of the engine, the igniting and the functioning of various accessories.

BODY

Is the structure situated on the chassis designed to transport people or cargo. They may be of three types:

Independent (fig. 4). It is called this way because it is totally separated from the chassis and is fixed to it by means of screws or clamps.

Self-supporting (fig. 5) are those that are fixed to the frame by welding.

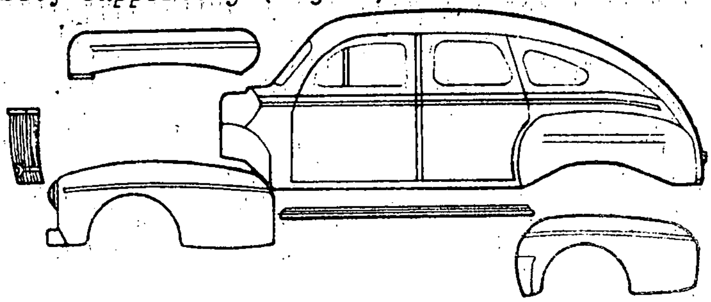

Fig. 4

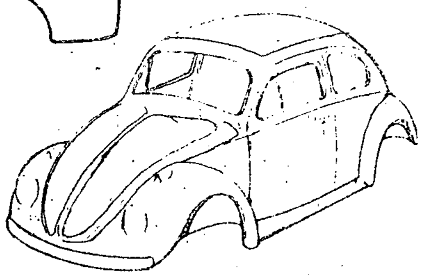

Fig. 5

The Transmission System , a mechanism designed to transmit to the driving wheels the revolutions and power of the engine.

They are vehicles that are self-propelled by means of an internal combustion engine to transport people or cargo.

CONSTRUCTION:
Vehicles are made up principally of:

- Chassis
- Body

CHASSIS

It is made up of the frame and the different systems adapted to the mechanism of the vehicle (fig. 1).

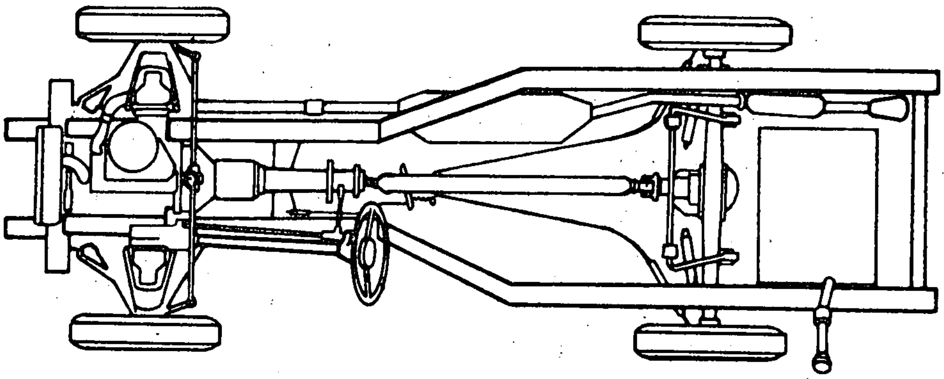

Fig. 1

Frame. Principal part in the structure of the vehicle; it may be of different shapes, the most common among them being the stamped outline (fig. 2) and the platform type (fig. 3).

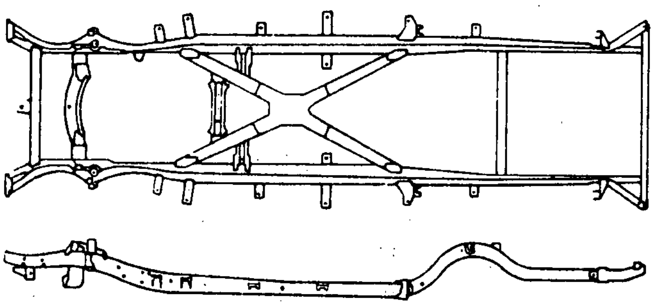

Fig. 2

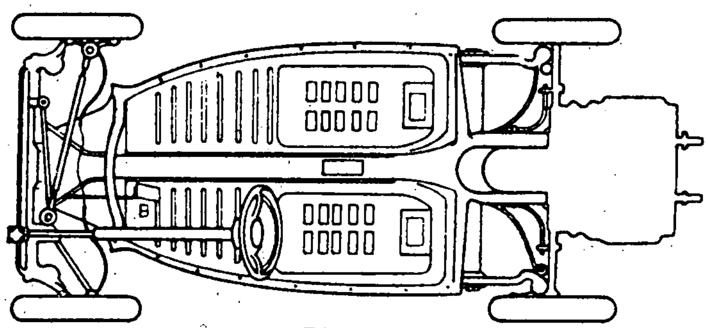

Fig. 3

STORAGE:

Owing to the fact that gauges are measuring instruments, they should be kept in good condition so as to obtain satisfactory results. The main precautions that should be observed are:

- Avoiding rust between the sheets which can alter their thickness, by keeping them lubricated with grease.
- Avoiding damage to them as a result of blows sustained when adjusting a part with the engine running (fig. 4).

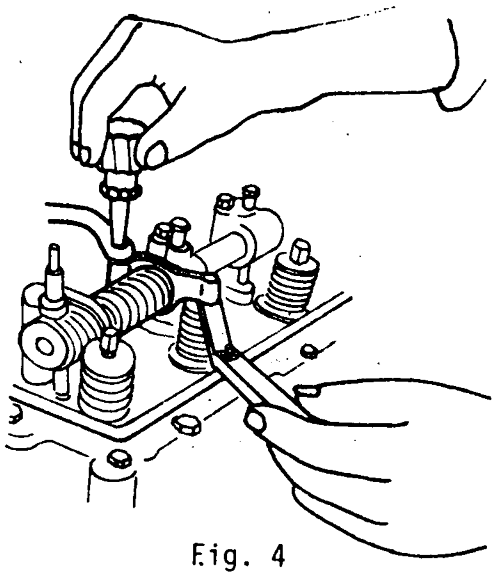

Fig. 4

These are instruments designed to regulate the play or clearance between parts that require accurate separations in order to function properly.

TYPES

The types most used in auto-mechanics are the flat and cylindrical gauges.
Flat Gauges (fig. 1), known also as "feelers" are steel sheets of different sizes that vary in length and width, depending on their application.
Cylindrical Gauges (fig. 2), are steel wires of different diameters that enable the measurement of clearances on curved surfaces (fig. 3).

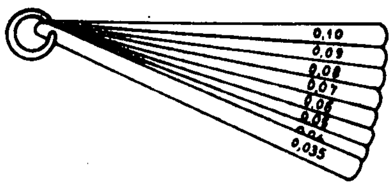

Fig. 1

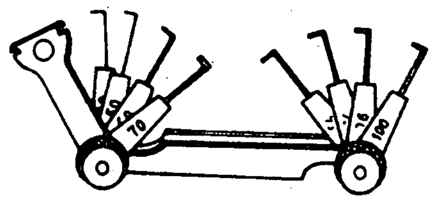

Fig. 2

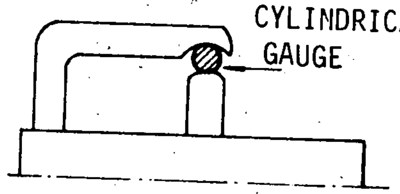

Fig. 3

Both types may be calibrated in the metric system or in inches. The first relays its magnitude in hundreths of a millimetre (1/100 m), the second in thousandths of an inch (1/1000").

CONDITIONS FOR USE

To correctly measure the distance the sheet should pass through rubbing both sides under the influence of its own height. When, because of the location, the measurement cannot be taken in this way, the play is determined by using the sheets immediately smaller and larger.
The first should pass through smoothly and the second should not be able to pass through.
When the distance that is to be measured is greater than the thickest sheet, they are put together until the measurement is attained, by adding their thicknesses.

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- The tension required to operate the steering wheel, so enabling the verification of the pre-load of the bearings of the main-shaft (fig. 5).
- The tension necessary to rotate the pinion, thereby governing the preload of its bearings (fig. 6).

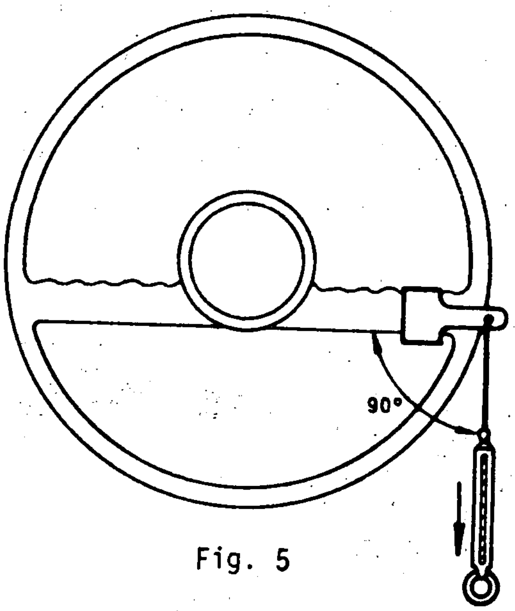

Fig. 5

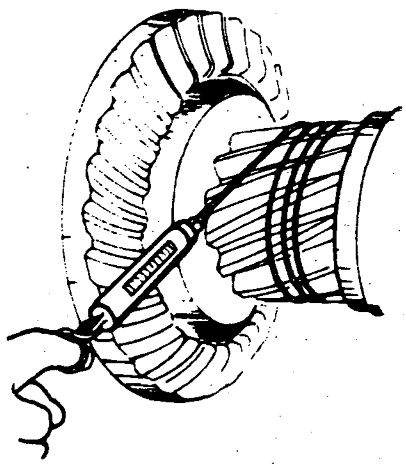

Fig. 6

STORAGE:

Owing to the fact that these instruments are designed to relay precise readings, the tensions to which they are subjected should not extend over the limits prescribed. They should be kept in cases protected by either a grease or vaseline film.

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DYNAMOMETERS (Spring)

A dynamometer is an instrument designed to measure the magnitude of a force, in kilograms or pounds.
It is based on the stress, proportional to the force applied, which a spring undergoes when it is compressed or extended.

TYPES AND APPLICATIONS

Dynamometer for coil springs (fig. 1). It measures the strain that a spring should endure at a given length. It is used in checking the stress of valve springs of the engine and of the clutch pressure plate.

Contact Points Dynamometer (Fig. 2). It measures the stress of the distributor contact spring and of the voltage regulating box.

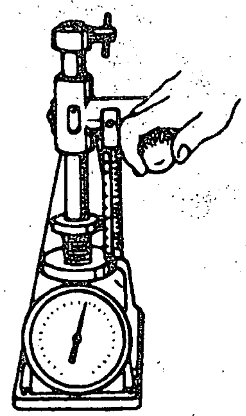


Fig. 1

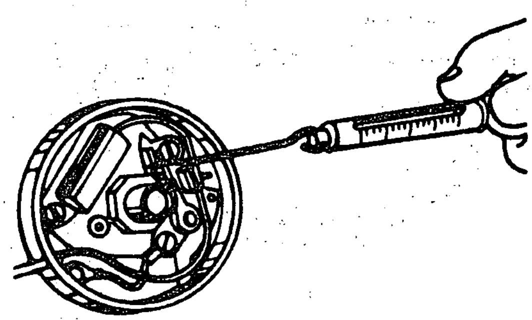


Fig. 2

Generator Brush Dynamometer (fig. 3). It measures the tension in the brush holder spring of the generator and starting motor.

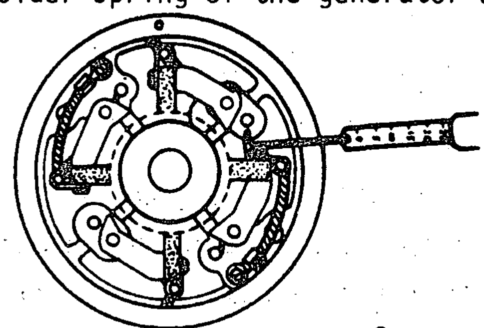


Fig. 3

Balance Type Dynamometer.
It enables the measurement of tensions in different units such as:

- The tension required to displace a calibrated sheet (feeler) between the piston and the cylinder wall (fig. 4).

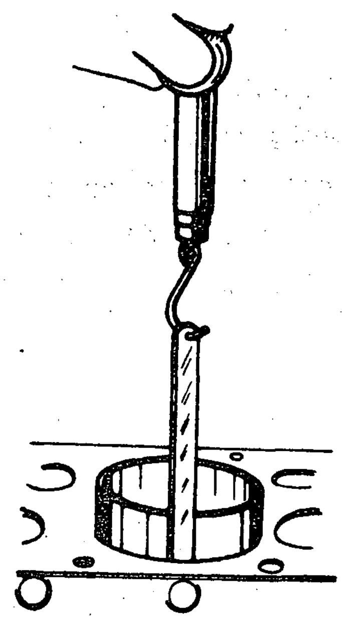


Fig. 4

The tank, made of stamped welded steel plates, has a high margin of safety. Besides, it is equipped with a valve which allows excess air to go out when the pressure reaches its maximum regulated value.

Alternative Two Phased Compressor (fig. 4). These compressors are made up of two cylinders of different diameters that may be prepared in a straight line formation, in a V shaped formation or opposite to each other.

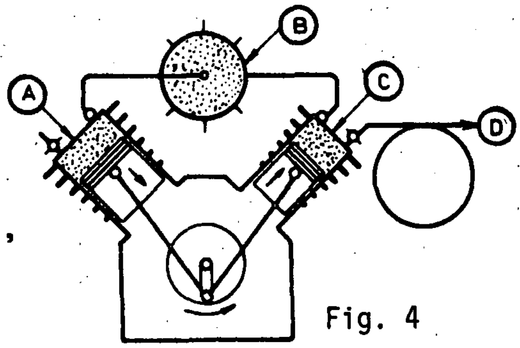


Fig. 4

Air is sucked from the atmosphere by the low cylinder (A), which partially compresses it, sending it to the cooling chamber (B); from here it goes to the high cylinder (C), where it is compressed to the total required pressure, then it goes to the storage tank (D).

The main advantages found in 2-phase compressors are:

- with the cooling device, a lower operating temperature is attained than with the one-phased compressor for the same final pressure.
- Greater volumetric efficiency (over 75%).
- Greater economy for less risk of valve obstruction.
- Uniform and silent functioning.

MAINTENANCE

The maintenance of an air compressor plays an important part in prolonging its durability. This is why it should be serviced regularly, sticking to the manufacturer's specifications.

The general rule for servicing compressors includes the following operations at the periods indicated by the manufacturer:

- Checking the oil level.
- Removing water from the storage tank (bleeding).
- Manually checking the safety valves.
- Cleaning the outside of the cylinder and the cooling fins of the intermediate cooler.
- Cleaning the air intake filter and its purification element.
- Lubricating the operating motor and cleaning it with compressed air to eliminate accumulated dust.
- Changing oil in the compressor.

AIR Compressors are devices widely used in the workshop and their function is to store air under pressure in appropriate tanks **(fig. 1)**.

CLASSIFICATION

Compressors are classified into:

- Alternating compressors (fig. 2).
- Rotary compressors (fig. 3).

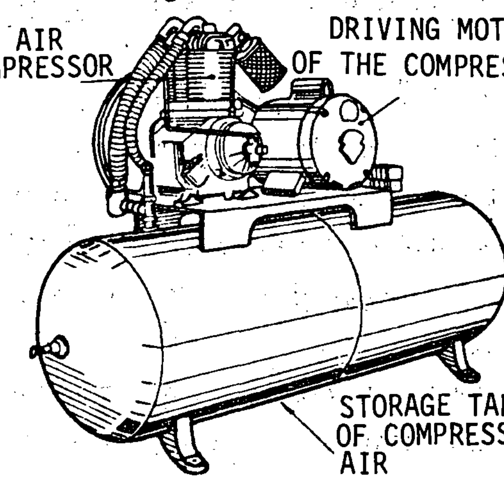


Fig. 1

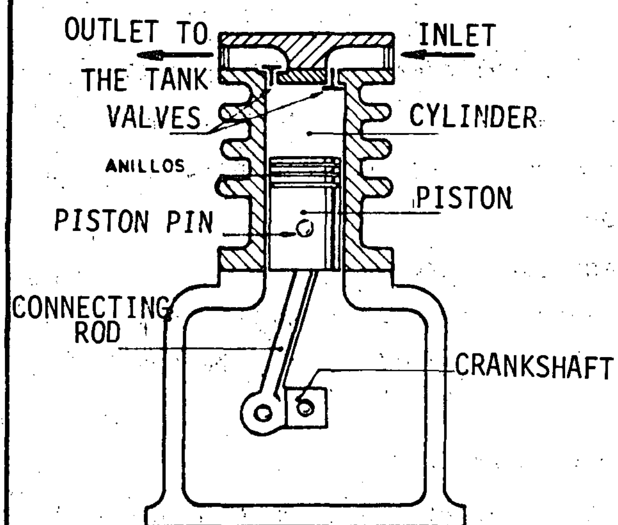
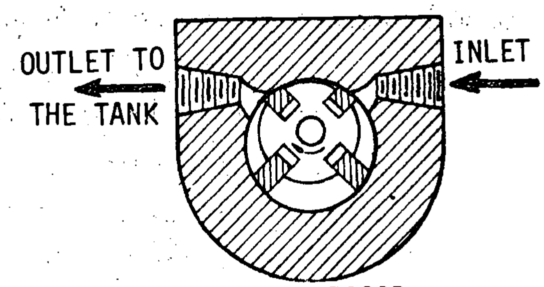


Fig. 2



COMPRESSOR BLADE TYPE
Fig. 3

TYPES:

The most common compressors are the alternating which can be of:

- One phase
- Two phases.

Alternative One Phase Compressor: As with a one-cylinder engine, it is composed of a block, where the crankshaft and its corresponding flywheel are housed. The flywheel serves the purpose of maintaining the uniform rotation of the shaft; it has fans for cooling the cylinder and grooves on its circumference for the belts which transmit the motion from the electric motor.

Fixed to the block is the cylinder, inside which the piston moves creating the suction and compression strokes, with the cap or cylinder head which houses the intake and exhaust valves.

When the piston is depressed, a vacuum is created which causes the intake valve to open, thereby allowing air to enter the cylinder. When the piston is raised the intake valve closes while the exhaust valve opens as a result of the compressed air which is transmitted to the tank.

Cranes are lifting devices that can be operated mechanically or hydraulically and allow lifting a load to the top of their booms. They are usually portable (fig. 7).

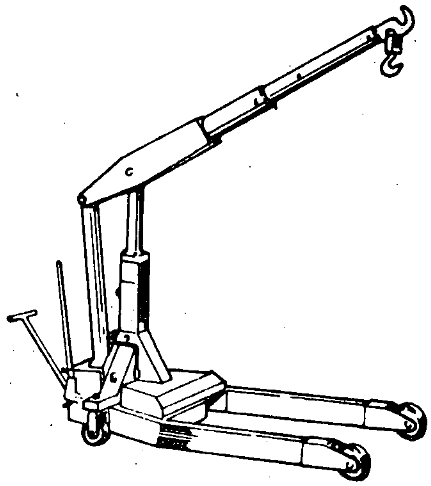


Fig. 7

Jacks are portable lifting devices that enable lifting heavy loads for short distances from the ground. They are made in a great variety of shapes to suit the work for which they are designed.
The three most common types are:

- Screw jacks (fig. 8).
- Ratchet and lever Jacks (fig. 9)
- Hydraulic jacks (figs. 10 and 11).

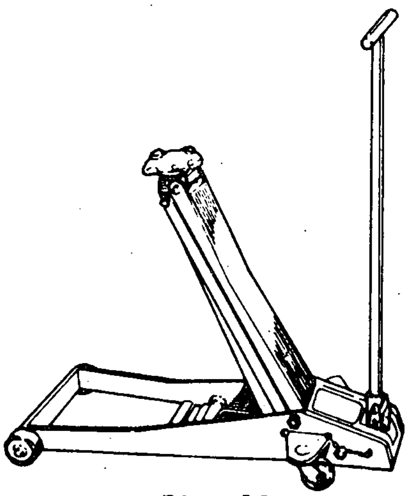


Fig. 10

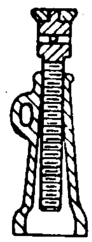


Fig. 8

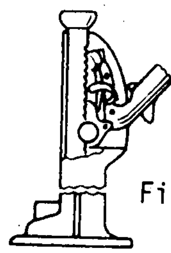


Fig. 9

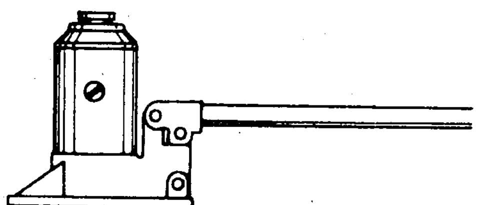


Fig. 11

SAFETY MEASURE

WHEN LIFTING A VEHICLE THAT IS TO BE REPAIRED, THE MECHANIC SHOULD INSTALL METAL STOOLS (fig. 12), *UNDERNEATH THE BODY, BECAUSE PROLONGED STRESS ON THE JACK MAY DAMAGE THE HYDRAULIC MECHANISM CAUSING THE VEHICLE TO DROP VIOLENTLY THEREBY CAUSING ACCIDENTS.*

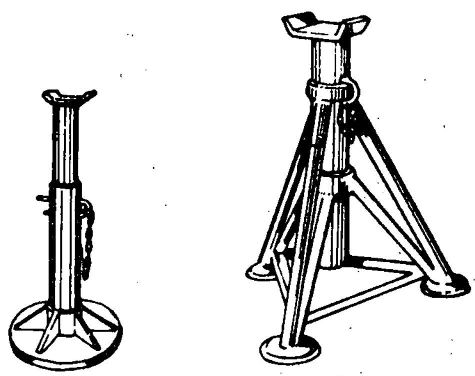


Fig. 12

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Four Column Lifts (fig. 3). These widely used lifts are operated by means of an electric motor and steel cables that are wound around a drum when lifting. They are secured by means of hooks or safety bolts and for lowering the direction of rotation of the motor, is reversed.

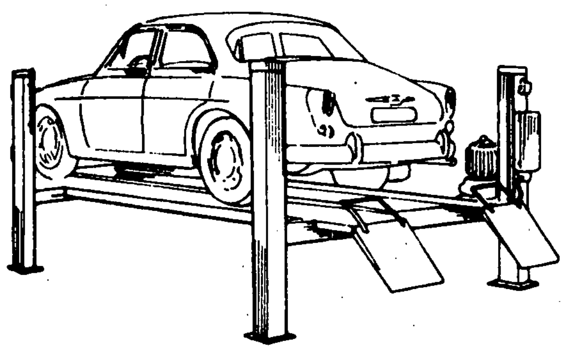

Fig. 3

Ramps (fig. 4). Although this is not a lift in itself, it enables a vehicle to be lifted through a distance to facilitate inspecting and repairing parts on the underside.

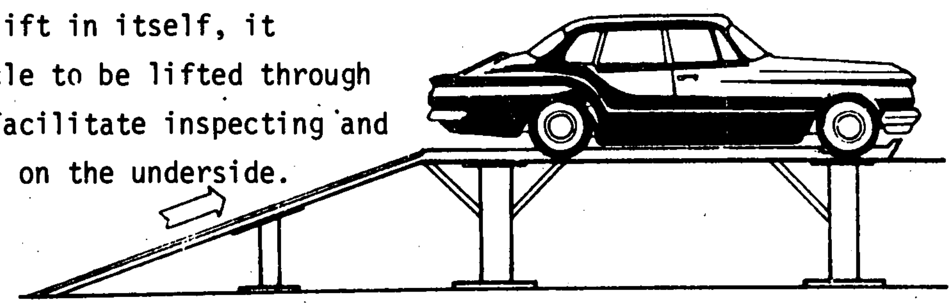

Fig. 4

Tackles, are portable lifting devices that work suspended and are operated manually by means of a chain (fig. 5). They are used to lift parts or units, which because of their weight, cannot be lifted manually. To increase lifting speed, equipment operated electrically, known as capstans, replace the tackles (fig. 6.).

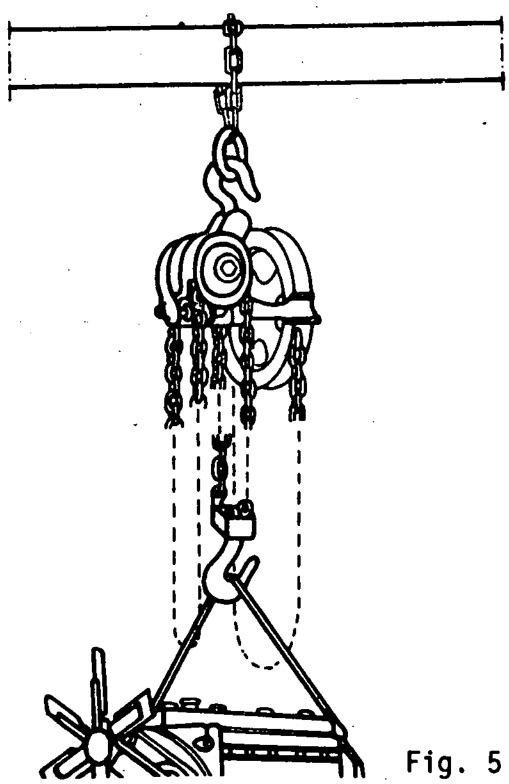

Fig. 5

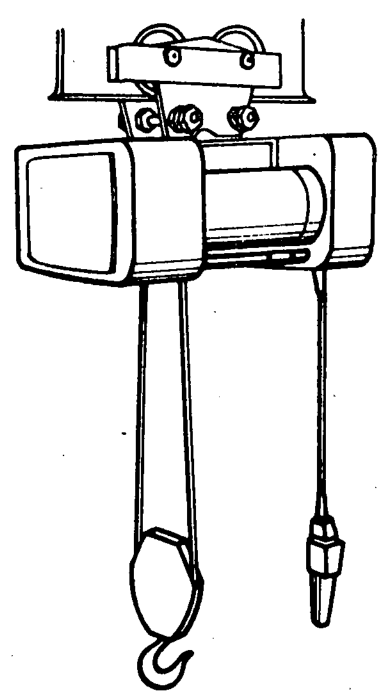

Fig. 6

In many repair and maintenance jobs of a vehicle it is often necessary to lift it.

For this, the mechanic should be helped with a series of lifting equipment whose construction, functioning and operation characteristics differ from one another.

CLASSIFICATION

Among the most commonly used automotive lifting equipment are:-

- Lifts
- Tackles, capstans, cranes
- Jacks

TYPES

Pneumatic-oil lift (fig. 1). These lifts are made up of a cylinder (fig. 2), inside which a column or piston (2), with a finely polished surface is moved.

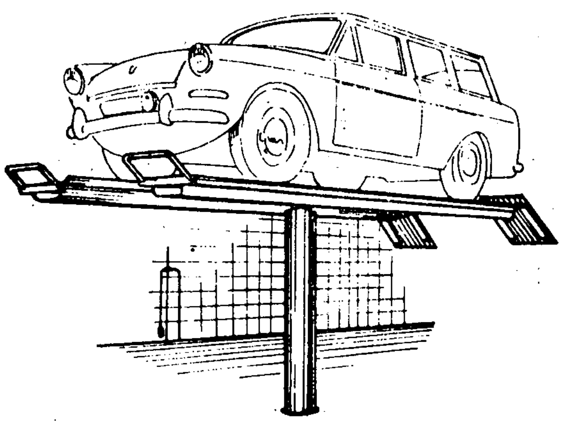

Fig. 1

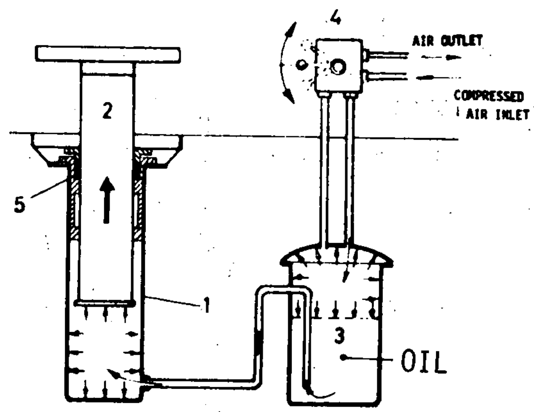

Fig. 2

The cylinder is connected from the lower part, to the oil container (fig. 3), on which the compressed air acts. On opening the air lock (fig. 4), the air enters the connecting container pushing the oil through to the cylinder thereby lifting the column.

The cylinder is fitted with seals and tow presses at the top (fig. 5), to prevent the oil from leaking.

To lower the column, simply open the clearance air lock of the attached container.

For heavy weight or very long vehicles, such as trucks or buses, double column lifts are used.

Automatic Equipment. In the automatic equipment the pressure mechanism is situated at the end of a tube which is introduced directly into the oil container (fig. 2). It is operated by means of a double acting pneumatic pump.

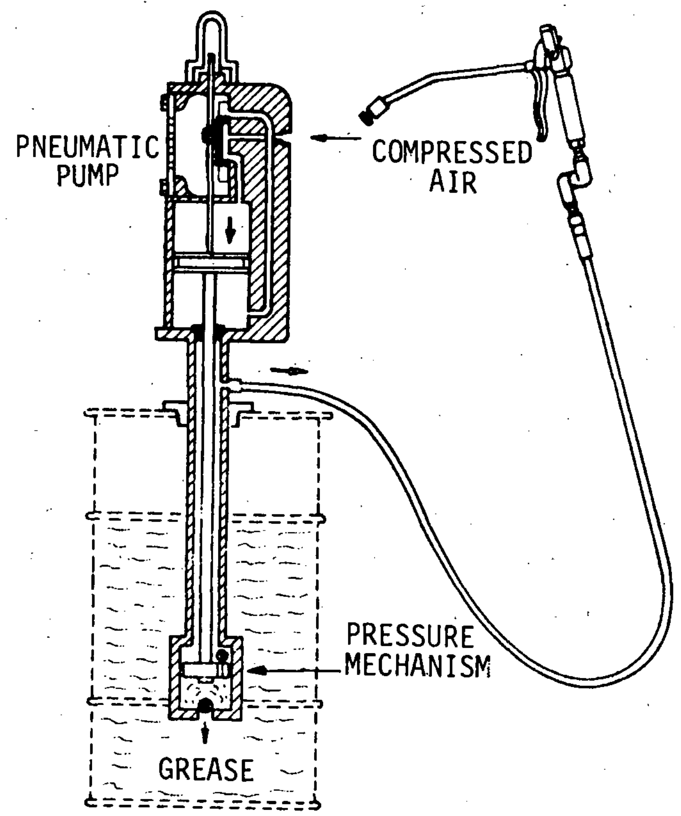

Fig. 2

On triggering the lubricating gun, the lubricant is able to pass through to the ejection stem as the loss of pressure in the mechanism causes the pneumatic pump to operate automatically. This operation starts a continuous flow of the lubricant from the pressure mechanism to the ejection stem of the lubricating gun. The equipment used to put oil in the vehicle operates in a similar way to those above mentioned differing only in the shape of their ejection stems.

Lubricating equipment widely used in mechanic shops and service stations, are devices designed to supply the necessary lubricant to the different systems and mechanisms of a vehicle.

CLASSIFICATION:

This equipment can be classified into two groups:

a) Manual
b) Automatic

DESCRIPTION AND FUNCTIONING

Manual Equipment: Manual lubricating equipment is easily transportable. The oil container forms part of the body of the equipment and is operated directly by the mechanic. It is also called low pressure lubricating equipment. The most common type is shown in fig. 1. The main part of the equipment is the pressure device made up of a little cylinder, a piston and two small ball valves.

On rising, the piston, operated by the lever and aided by the spring and the impelling piston of the container, sucks the lubricant through the valve thereby filling the pressure cylinder. On going down, the piston forces the lubricant, sending it along the tube to the ejection stem.

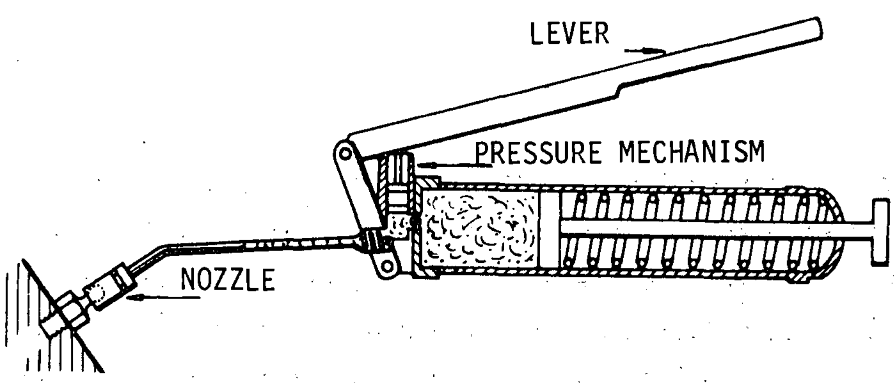

Fig. 1

Needle Bearings. These bearings are used almost exclusively in the counter shaft of the gear-box. They are made up of a cage with small size rollers that can directly rotate in the inside of the triple against the guide bolt (fig. 8).
Some types have an external race (fig. 9) and are used when the part on which they work is not hardened.

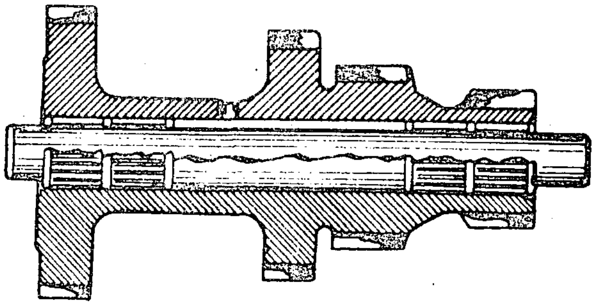

Fig. 8

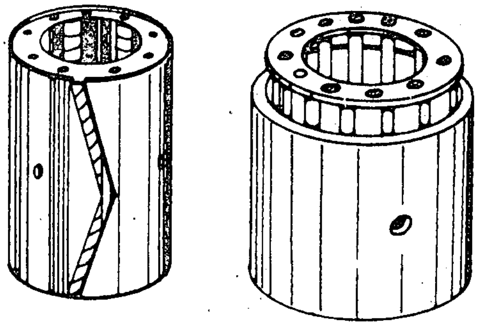

Fig. 9

MAINTENANCE

Bearings can be lubricated with oil or grease and their replacement should be done in accordance with the manufacturer's recommendations.
Normally, bearings lubricated with oil are found in :

- Generators
- Gear boxes
- Steering boxes
- Differentials

and those lubricated with grease in:

- Water pumps
- Wheels
- Clutch
- Universal joints.

Axial or Thrust Bearings (fig. 4). These bearings are used in journal bolts and in the clutch and can work horizontally as well as vertically. They may be made of balls or rollers and may be sealed or may be lubricated.

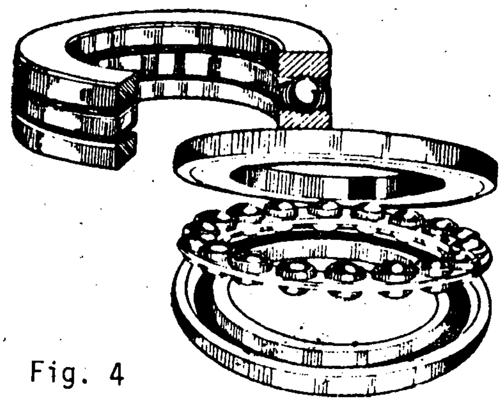

Fig. 4

Radial Bearings (fig. 5). These bearings are widely used in gear boxes and they incorporate a stop ring or lock on the perimeter of the external race. They are lubricated with oil from the same box. They are also used in the intermediate brackets of the universal axle; in this case they contain side caps or seals that prevent the lubricant from leaking.

Combined Bearings, Axial-Radial (fig. 6). These bearings that are widely used in wheels, gear boxes and differentials, have detachable bodies and when installing them, care should be taken to give them the preload specified by the manufacturer.
There are two types: ball and roller bearings. The latter is more often used and it holds the cage to the race or internal cone (fig. 7).

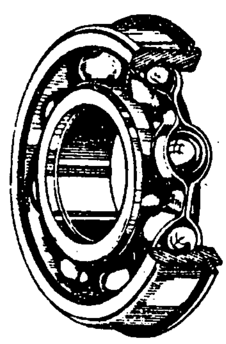

Fig. 5

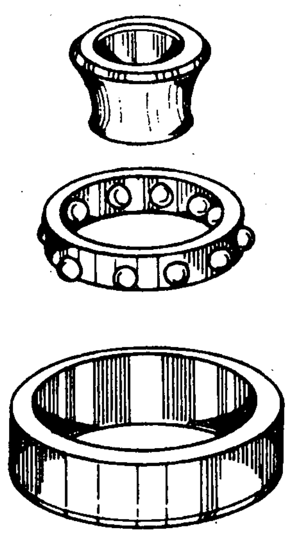

Fig. 6

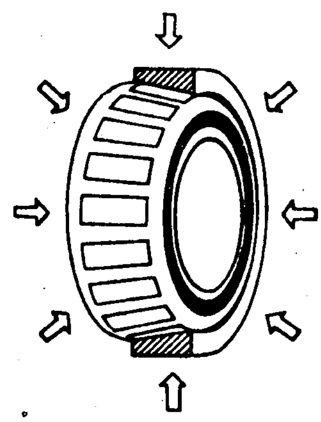

Fig. 7

In an automobile there is a great number of bearings installed in its various systems (fig. 1); although all bearings serve the purpose of reducing friction, they vary in shape and in the arrangement of their parts.

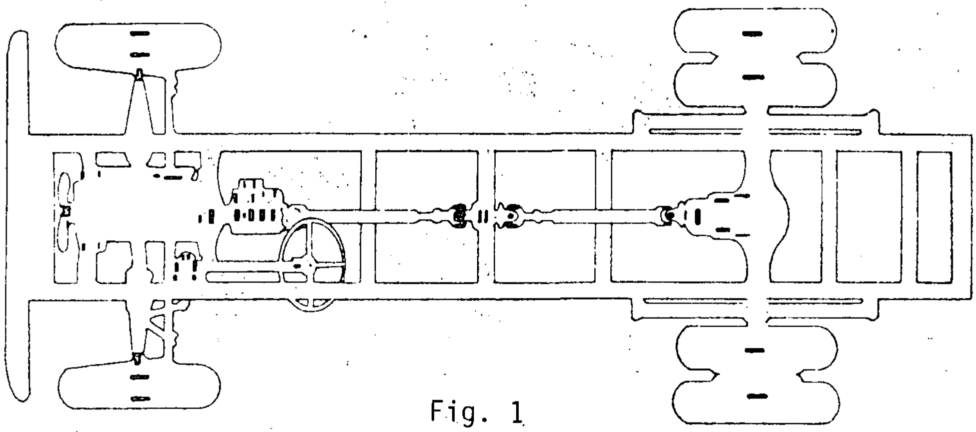

Fig. 1

TYPES AND APPLICATIONS

Water Pump Bearings (fig. 2).

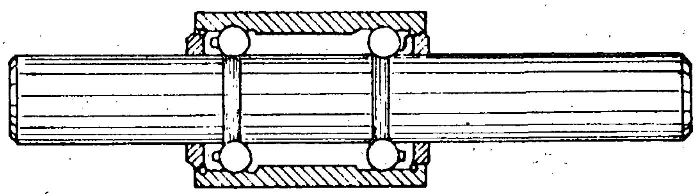

Fig. 2

This type of bearing used in water pumps is especially manufactured to suit them. It is composed of a ball bearing in double file and placed on the ends of the external race.
The internal race has been replaced by a shaft, on the ends of which the impeller of the pump and the flange of the pulley and fan have been placed.
There are grease retainers at the ends of the external race that prevent the leakage of the lubricant put in at the factory. Its endurance is determined by the manufacturer and when replacing it, the unit is replaced as a whole.

Sealed Ball Bearings

(fig. 3). These bearings consist of races, cage balls and side seals; they are used in generators, alternators and in the support of the front end of the main shaft of the gear box. The lubricant is put in at the factory and the side seals prevent it from coming out.

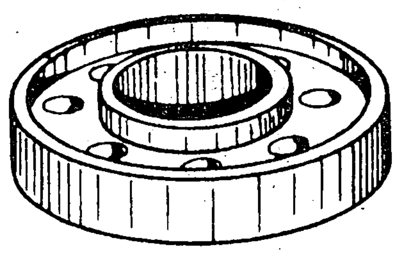

Fig. 3

Their object is to prevent leakage around shafts, of fluids and greases contained by the mechanisms and also to prevent foreign particles from entering them.

CONSTITUTION

Seals are made of different materials, among those most used are: leather, synthetic rubber, felt or plastic. They contain a helical spring inside, which helps to increase the pressure of the lining edge on the shaft to which it is fixed. The outer covering of the seal is generally made of steel (fig. 1).

Materials used in the manufacture of seals are determined by the conditions under which they are to work, such as: temperature, density of the fluid contained in the mechanism, rotating speed and material of the shaft.

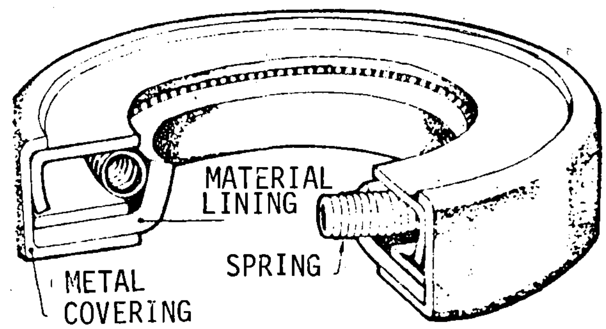

Fig. 1

There is no general rule for determining when seals should be replaced, as their usefulness depends considerably on the conditions of the work which they perform.

TYPES

In an automobile different types of seals are used in the different systems and mechanisms. These may be:

Synthetic Rubber Seal. They are at present the ones most used because of their ability to adapt when replacing them and because they ensure good air-tightness both in the grip on the shaft on which they are placed, as well as in the housing where they are inserted, see figure 1.

Felt and Leather Seal. Leather stops oil or grease from entering and felt keeps out dirt and water (fig. 2).

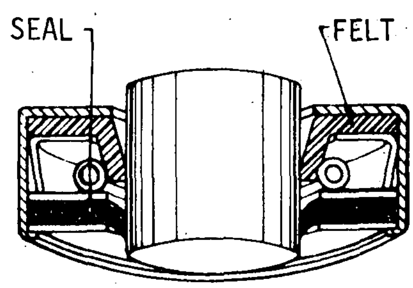

Fig. 2

CONDITIONS OF USE

Every time a mechanism that contains seals is disassembled the seals should be replaced.

On new seals it is advisable to put a bit of oil or grease on the inner sides which come into contact with the shaft so that they would not be damaged by the heat caused by friction, produced when the mechanism is started.

Nipples are generally made from steel or bronze and are designed to provide a strong, air-tight connection with tubings and lines. Nipples surround the tubing at the end of the connection and they ensure a firm connection that resists higher pressures; besides this, the double flare at the ends of the tubing, together with the wedging action of the nipple and the difference in the angles, eliminate any possibility of the tubing slipping (fig. 2).

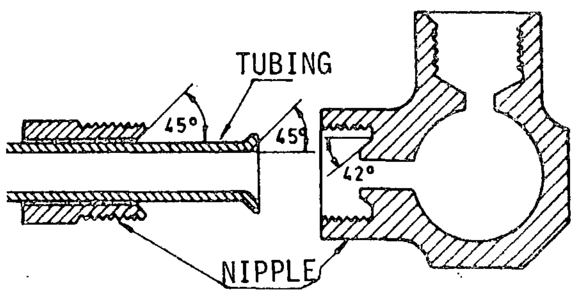

Fig. 2

MAINTENANCE

Tubings should be periodically inspected to detect possible faults, as they may be bent, clogged or have leaks. This results in a drop in pressure and consequently causes malfunctioning of a given system in the vehicle.

Damaged lines should only be replaced by those of the same diameter, length and shape.

If it becomes necessary to change a brake tubing one should take care to clean its inside with alcohol before mounting it in the vehicle.

In the hydraulic braking systems the lines should be periodically inspected to see whether they have been damaged by bumping, rubbing or other causes and should be changed if they have signs of softening, chinks or other damage.

The most common type of leakage is through the nipples and this is caused by their being loose or their threads being in a bad condition.

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Tubings are pipes used to convey fluids in the fuel, lubrication, braking and accompanying systems.

CLASSIFICATION

They are classified into two groups: rigid and flexible.
Rigid tubings are made of copper, steel, aluminium, brass or bronze.
Flexible tubings are made of synthetic materials or rubber.
The ones most used in automobiles are of copper, steel and flex.

CHARACTERISTICS AND APPLICATIONS

Steel tubings are made with a copper and tin coating so as to prevent rusting. They are used principally in the hydraulic braking circuit and in engines with injection systems, because they are subjected to very high pressures.

Copper tubings have the advantage of not rusting as compared to steel lines; also they are more ductile and malleable. They are not recommended for hydraulic circuits where the pressures are very high. They are used frequently in fuel and lubrication systems and in connecting some accessories where the pressures exerted are relatively low.

Flexible tubings are made of several sheets of specially treated synthetic material and at the ends they have steel nipples with a copper and tin covering to prevent rusting (fig. 1).
They are used in the lubrication, braking and fuel systems; they absorb the movements produced between the frame and the wheels and between the engine and the chassis.

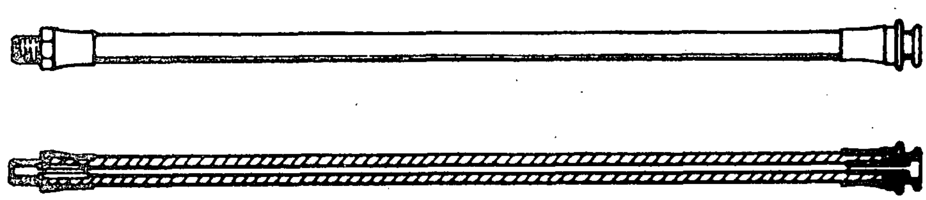

Fig. 1

APPLICATIONS:

MATERIAL	SUITABLE PRINCIPALLY FOR:	USED IN:
Paper	Oil at low pressure.	Water and oil pumps.
Cork	Oil at low pressure.	Housing valve covers.
Asbestos Fabric	All functions and high temperatures.	Intake and exhaust manifolds, cylinder head.
Metal	High pressures and temperatures.	Cylinder Head, Brake Pump, Spark Plugs.
Synthetic Material (Rubber)	Liquids at low temperatures and pressures.	Gas pump and tank.
Plastic	Low temperatures and pressure.	Brake system.
Wood	Oil at low pressure.	Crank Shaft rear seat.
Fibre	Low temperatures.	Carburettor.

SUGGESTIONS FOR USE:

All gaskets should have the same shape as the surfaces which are to be sealed, and should be used in accordance with the manufacturer's specifications.

When a gasket is removed it is not advisable to use it again once its thickness reduces as a result of the effect caused by the pressure to which it has been subjected.

When replacing gaskets it is very important to check the surfaces of the metal parts that are to be sealed and to use the correct adhesive so as to obtain a leak-proof seal.

Their object is to provide an air-tight seal between two metallic parts, so as to prevent gases or liquids from escaping.

MATERIALS

In the mechanisms of a vehicle, there are gaskets that are subjected to different pressures and working conditions, for which reason their constituent material and shapes vary in accordance with their function (fig. 1); they are usually made from the following materials:-

- Paper.
- Cork.
- Compressed asbestos fabric.
- Laminated metal.
- Synthetic material (rubber).
- Plastic.
- Wood.
- Fibre.

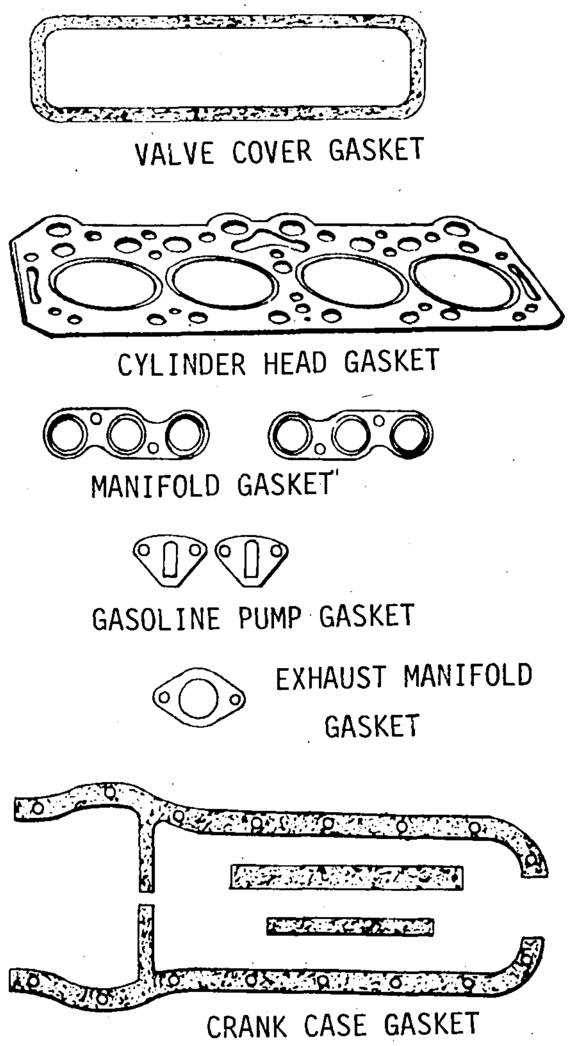

Fig. 1

CLASSIFICATION

Oils are commercially categorized and in general are adapted to suit the engine loads, so for example: there are oils for light loads (ML), medium (MM) and severe (MS). For diesel engines there is instead an oil DG, for normal work or for heavy work (DS).

Oils for gears are adapted to suit their individual pressures and there are oils for high extreme pressures.

GREASES

They are obtained from a mixture of soap with lubricant oils, additives and colourings.

CLASSIFICATION

Greases are classified according to:

- The dripping point, or the temperature at which it begins to melt.
- Consistency - that is the texture of its greasy composition.
- Resistance to pressure,- that is its ability to resist effort without causing a break in the lubricating film.
- Resistance to water - or the ability to remain unaltered when exposed to it.

CHARACTERISTICS

GREASE WITH A BASE OF	TEXTURE	MAXIMUM TEMPERATURE AT WHICH IT CAN BE USED (^{o}C)	REACTION TO WATER	USES
Calcium	Greasy	79	Resistant	For journal bearings in general.
Sodium	Fibrous or smooth	126	Susceptible	For low velocity journal bearings.
Lithium	Greasy to Flexible	149	Resistant	In automotive vehicles, resistant low temperatures.
Aluminium	Greasy	65	Resistant	Special uses, which need great adhesion.

Lubricants are substances designed to prevent wear between two parts whose surfaces are exposed to friction.

OILS

HOW OBTAINED

Lubricant oils are obtained, like gasoline, from the distillation of crude petroleum.

PURPOSE

Oil in a vehicle should fulfil various functions, the most important among them being:-

- To lubricate the mobile parts so that the wear and the loss of power due to friction would be at a minimum.
- To draw out the heat produced by moving parts, so acting as a cooling agent.
- To absorb the impact between journal bearings and other parts of the engine, thereby reducing their noises and extending their utility.
- To obtain a good fit between piston rings and cylinder walls.
- To act as a cleaning agent.

PROPERTIES

Among the most important properties of oils are:

Viscosity is the resistance produced by a liquid in flowing, and is measured by the time taken for a quantity of liquid at a given temperature, to pass through a hole of a specified diameter. This property is represented by an SAE number and there are SAE 20, SAE 30 and SAE 40 oil numbers. These numbers reflect the time taken for the oil to pass through the specified diameter of the viscosimeter.

Some oils that bear the letter 'w' after their number indicate that they should be used in winter or in cold areas.

Owing to the viscosity variations with temperature, oils become better with the addition of chemical substances, called additives, which also prevent the formation of dirt deposits in the engine. The addition of crystalline substances such as graphite and molybdenum bisulphite, reinforce the lubricating film to resist high temperatures as well as high pressures.

PRECAUTIONS

OWING TO THE FACT THAT GASOLINE IS A HIGHLY INFLAMMABLE COMBUSTIBLE, THE MAXIMUM SAFETY MEASURES SHOULD BE TAKEN SO AS TO PREVENT MATERIAL AND PERSONAL ILL EFFECTS.

IT SHOULD BE KEPT IN CLOSED CONTAINERS, IN WELL VENTILATED AREAS, AND AWAY FROM ELEMENTS THAT CAN CAUSE HEAT, FLAME OR SPARKS.

IN THE EVENT OF COMBUSTION, FOAM EXTINGUISHERS SHOULD BE USED OR THOSE OF DRY CHEMICAL POWDER OR CARBON DIOXIDE. IN NO EVENT SHOULD WATER BE USED AS THIS WILL ONLY EXTEND THE FIRE.

GASOLINE COMING INTO CONTACT WITH SKIN PRODUCES DRYNESS AND AN ILLNESS CALLED DERMATITIS.

GASOLINE SWALLOWING PRODUCES POISONING DUE TO THE PRESENCE OF TETRAETHYL LEAD WHICH IS HIGHLY TOXIC.

THE INHALATION OF GASOLINE PRODUCES STUPOR AND UNCONSCIOUSNESS AND ITS COMBUSTION GASES ARE POISONOUS BECAUSE OF THE CARBON MONOXIDE THAT IT CONTAINS.
FOR THIS REASON ONE SHOULD AVOID TURNING ON ENGINES IN CLOSED PLACES OR IN POORLY VENTILATED AREAS.

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In the combustion chamber the mixture of air and fuel is compressed during the compression time or stroke. When the spark from the spark-plug is produced the flame front is displaced quickly (fig. 2), creating an excess pressure that compresses and heats the unignited mixture at one end of the compression chamber (fig. 3), until it ignites automatically. From this ignition point, another flame front advances until it violently collides with the normal flame front (fig. 4), producing a metallic noise that consequently causes:

- Power loss
- Engine overheating
- Internal damage

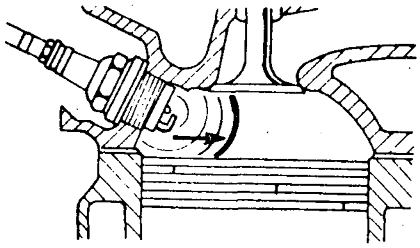

Fig. 2

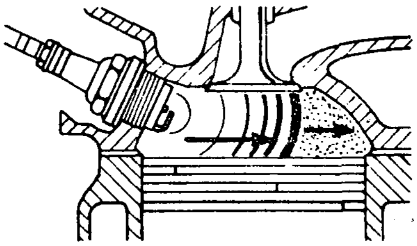

Fig. 3

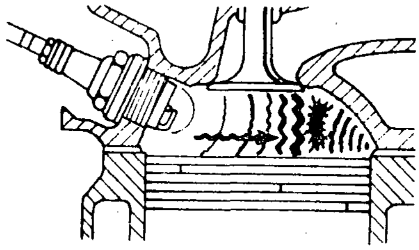

Fig. 4

To prevent the phenomenom of detonation from taking place, manufacturers add antidetonating substances to the gasoline, the most common being tetraethyl lead.

The ability of a fuel to resist detonation is measured by its octane rating. The octane rating of a fuel is determined on testing the gasoline in a test engine in which the index or compression ratio of the cylinder is varied until it begins to detonate.

The octane rating represents the greater or lesser quantity of iso-octane, antidetonating element, with relation to normal heptane, highly detonating, which when mixed, constitute the principal components of gasoline.

TYPES

Gasolines, according to their octane rating may either be: regular or super. Regular gasolines have an octane rating of 80 to 85 octanes, and super about 90 to 100 octanes. To differentiate between them, chemical colours which do not alter their conditions are added to them.

Is one of the combustibles most frequently used in internal combustion engines.

PRODUCTION

Gasoline is obtained through the process of distillation, cracking or hydrogenization of crude petroleum. Although the volume of production is greater by the hydrogenization and cracking systems, the method most used is the distillation process, because of its simplicity. In the distillation process, (fig. 1), the petroleum is heated in a tube-oven, and is sent to a metallic tower that contains various discontinuous levels, where its different components are condensed before flowing out. By this method, besides gasoline, one obtains, combustible gases, petroleum, gas oils and heavy oils with their derivatives.

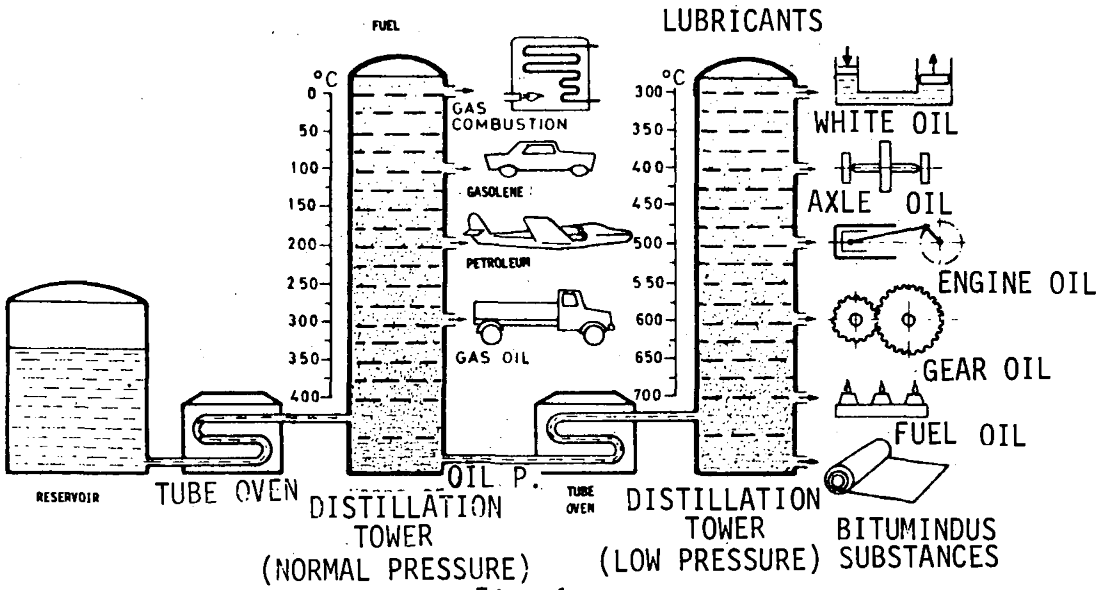

Fig. 1

CONSTITUTION:

Gasoline is composed of a combination of hydrogen and carbon, known as hydrocarbon, that emits a great quantity of thermal energy when it is burnt in oxygen.

CHARACTERISTICS:

The most important characteristics of gasoline are: its volatility, its high speed of combustion, and its resistance to detonation.

Volatility is the tendency of a liquid to pass from this state to the gas state at any temperature. This characteristic is the one that enables an engine to run in cold weather.

CLEANING EQUIPMENT:

Water Pressure Washer. Among the cleaning equipment frequently used, is the water pressure washer preferably used in washing auto bodies.

Vapour Washer (fig. 1). Equipment that works by means of vapour jets; enables the elimination of oil, greases or substances that need temperature changes for them to dissolve.

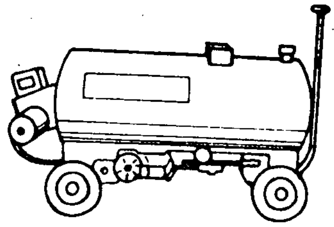

Fig. 2

Perchlorate Washer. Is a tank, that is heated by a vapour coil, and used for voluminous parts. Makes use of a vapourized perchlorate atmosphere to eliminate and dissolve oils, greases and paints.
Owing to the toxic quality of its gases it should be used in ventilated areas.

Throughout his work, the mechanic has to clean various parts and mechanismsof the vehicle, for which reason he makes use of different liquids, tools and equipment.

CLEANING LIQUIDS:

Combustibles. Some of the liquids used in cleaning are commonly used combustibles such as gasoline, kerosene and diesel oil. These elements are inflammable so that they should be used away from any flame or heat.

Alcohol. It is used preferably in cleaning rubber parts and especially in the braking system. It is also inflammable.

Creosote. It is used mixed with water to clean aluninium and antimony parts, such as carburettors and gas pumps. The solution with the parts submerged in it is put to boil until all the grime has been eliminated, especially that produced by the colouring elements of gasoline.

Carbon Tetrachloride. Used in cleaning mechanical parts in general. It should be used in ventilated areas because, although it is not inflammable, it emits highly toxic gases.

Perchlorate. An equally efficient cleaner, it has the same defects. It is used especially in cleaning of painted parts such as the block, cylinder head and other parts.

Rust Removers. Used for cleaning parts covered with rust, they transform iron oxides into sulphates that are easily removable.

CLEANING TOOLS:

They are manual or electrical tools that help eliminate the dirt that the cleaning liquids are not able to remove.
The most common (fig. 1), are scrapers, palette knives, brushes, steel brushes, and wire brushes.
Wire brushes are rotary steel brushes that are used assembled on cords or on the emery machine.

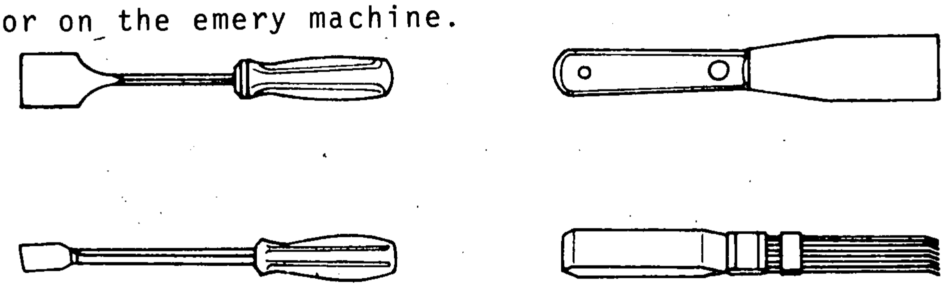

fig. 1

Great Capacity for heavy duty work

0 to 80 m kg
0 to 576 ft. lbs.
0 to 6,912 ins. lbs.

CONDITIONS OF USE:

The use of this wrench is widespread in automobile vehicle works, especially on those parts that require a specified torque and careful replacing such as: engine fly-wheel screws, connecting rod caps, crankshaft bearing caps, differential, cylinder heads and others.

The torque wrench may be used for left or right side threads, but under no condition should it be used to loosen, because if the screw or nut is secured tightly the torque applied might pass its limit and damage the wrench, so altering its precision. To obtain the most exact reading, it is convenient to lubricate the threads of the screw or nut that is to be tightened. When the indicator shows the recommended force the operation of the wrench should be halted.

The torque wrench should be only used to give the final torque. The screw or nut should be previously adjusted with a power wrench.

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TYPES

There are various types of torque wrenches, the ones most used are the indicator and the scale (see fig. 1), and the ratchet (fig. 3); this last one has a regulating device that unfastens when the required adjustment to the given value is achieved, thereby limiting the extent to which it tightens, and refastens automatically when the wrench is loosened.

The automatic regulating device is very safe as it ensures that the wrench does not surpass the specified torque and is adjusted across a graduated drum similar to that of a micrometer.

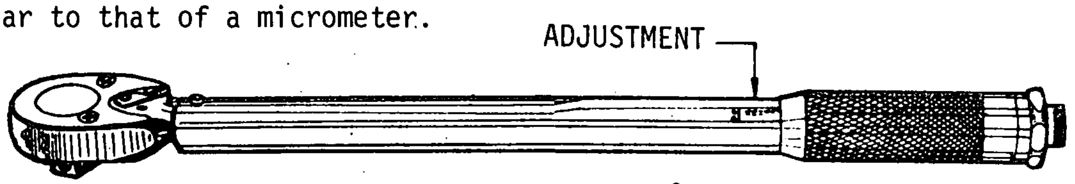
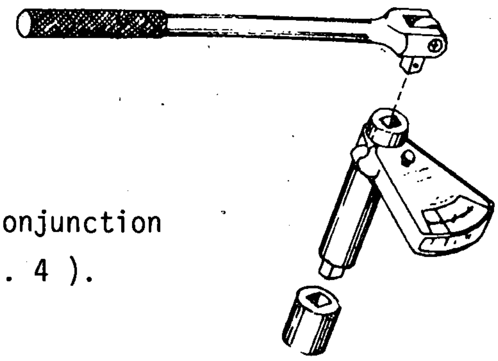


fig. 3



Another type is used in conjunction with socket wrenches (fig. 4).

CHARACTERISTICS

Torque wrenches are characterized by their graduation; they may be of one or two scales, and by the maximum force that can be applied. The scales commonly used are:

For sensitive tightening

0 to 2 m kg

0 to 15 ft. lbs.

0 to 180 ins. lbs.

For normal jobs requiring moderate tightening

0 to 10 m kg

0 to 180 ft. lbs.

0 to 960 ins. lbs.

For variable forceful tightening conditions

0 to 80 m kg

0 to 160 ft. lbs.

0 to 2,000 ins. lbs.

This wrench, frequently used in automobile work-shops, is employed to give screws the torque recommended by the manufacturer, thus avoiding overtightening and deformation of work-pieces.

CONSTITUTION

The torque wrench is made up of: (fig. 1).

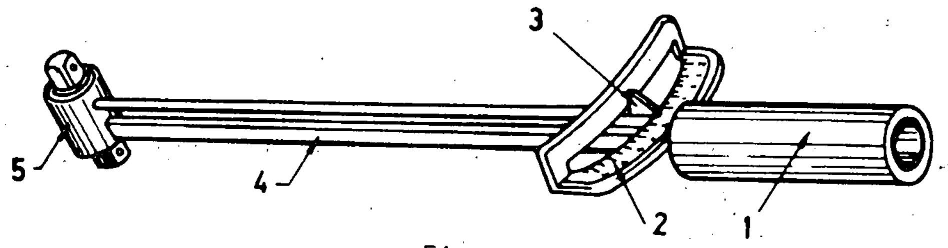


Fig. 1

1. Handle
2. Graduated scale
3. Indicator
4. Arm
5. Coupling union for dies

PRINCIPLE OF FUNCTIONING

The torque wrench, also known as a dynamometric wrench, is based on the principle of levers.

If a force is applied at a distance D (fig. 2), a torque T is spread out on the point of application; this torque value is the product of the distance by the force:

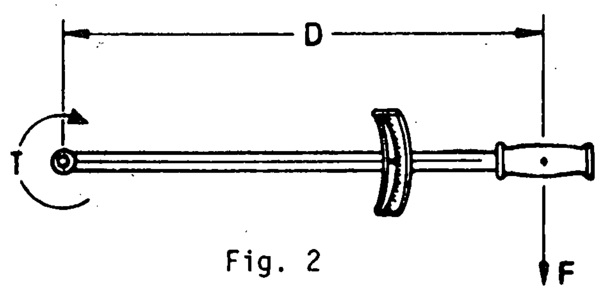


Fig. 2

Torque = distance x force

$T = D \times F$

EXAMPLES

If the distance D is 0.50 m and a force F of 10 kg. is applied, the torque is 5 m kg at the point of application.

If the distance D is measured in inches and the force F in pounds, the reading of the torque will be pound inches.

If the distance D is measured in feet and the force F in pounds, the reading of the torque will be in pound feet.

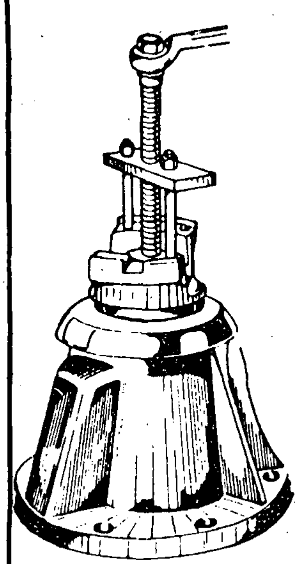


Fig. 10

Differential Flange Puller

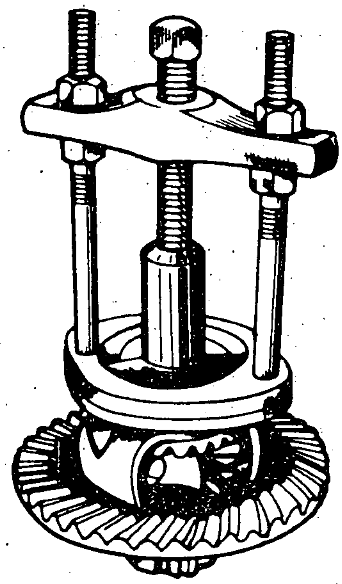


Fig. 11

Differential Cage Carrier bearing puller

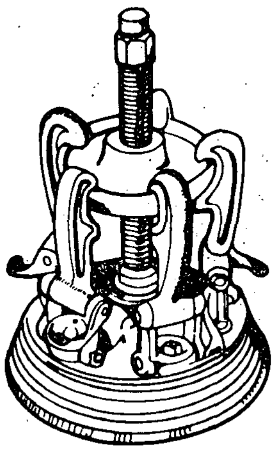


Fig. 12

Brake Drum Puller

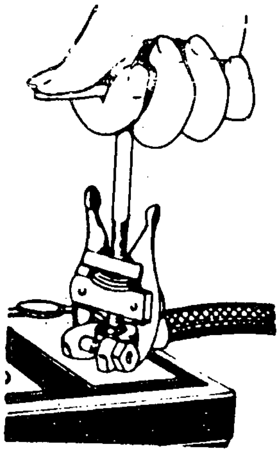


Fig. 3

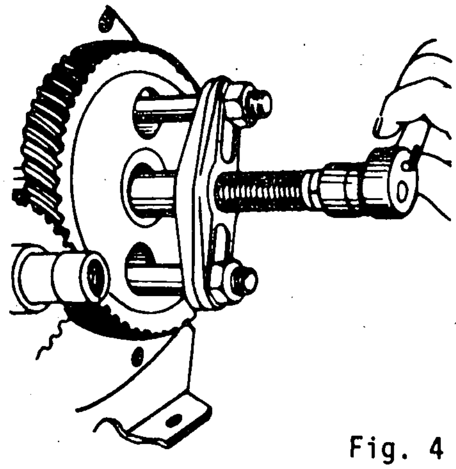


Fig. 4

Battery Terminal
Puller

Timing Gear
Puller

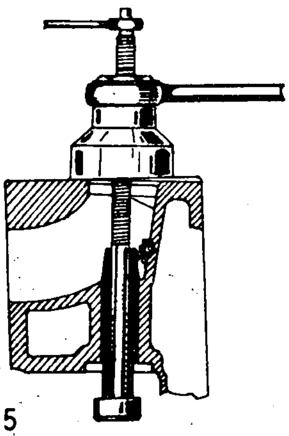


Fig. 5

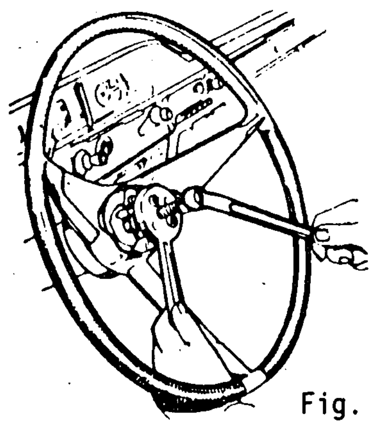


Fig. 6

Valve Guide
Puller

Steering Wheel
Puller

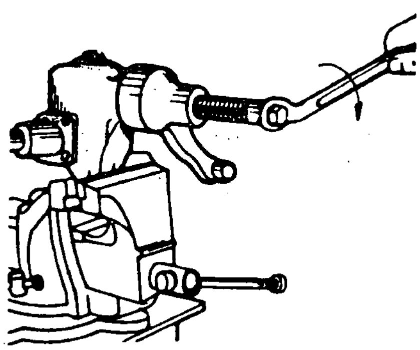


Fig. 7

Steering Pitman
Arm Puller

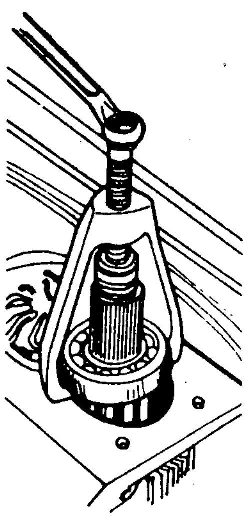


Fig. 8

Gear Box
Shaft Bearing
Puller

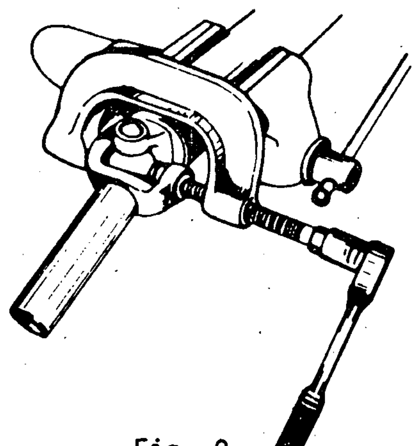


Fig. 9

Universal Joint
Puller

These are tools designed to quickly separate parts of a mechanical unit, assembled under pressure.

CLASSIFICATION
Pullers may be divided into:

- Mechanical
- Hydraulic

Mechanical pullers apply their pressure by means of the displacement of a screw (fig. 1) or by means of slide-hammering (fig. 2).

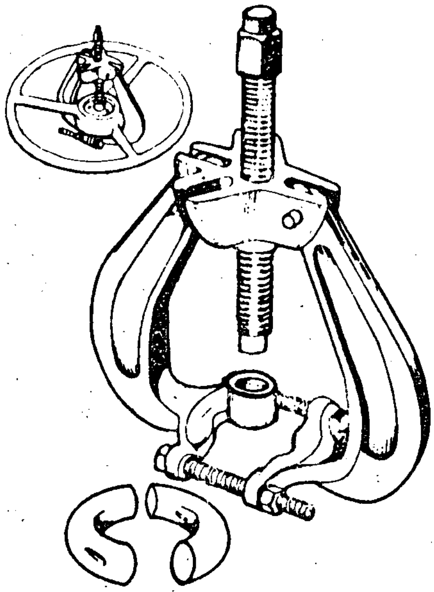


Fig. 1

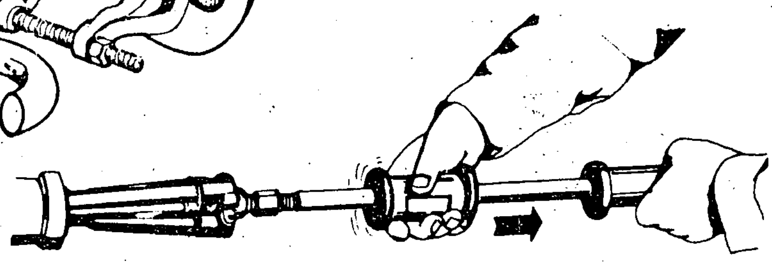


Fig. 2

Hydraulic extractors apply their pressure by means of the displacement of a piston, in a cylinder, which gets its pressure from a hydraulic pump.

CONSTRUCTION
Owing to the strenuous tasks for which they were designed, their make-up is very solid, and they are of special wrought steels.

TYPES AND USES
Every puller is constructed for a specific purpose and some may be used to remove as well as replace parts.
The following figures demonstrate some pullers that are widely used in auto mechanics.

The special cutting, flaring and bending tools are used in giving the tube ends the finishing touches required and the adequate shapes needed to install them in the vehicle with the object of ensuring that the joints are leak proof.

CUTTER

This tool is used to cut copper, bronze, aluminium and steel tubings neatly and quickly. There are many types of cutters.

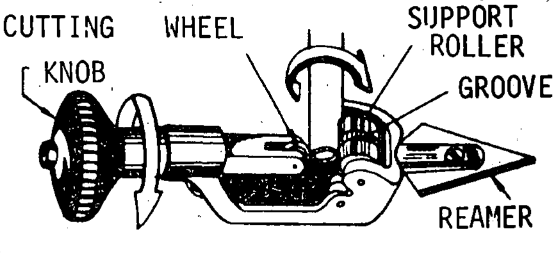


Fig. 1

The one that is most commonly used in shown in fig. 1. It has a special steel cutting wheel, two pressure or support rollers, a reamer and a knob to adjust the position of the cutting wheel every time the cutter completes a rotation. The pressure applied for cutting is correct when the cutting wheel can cut without deforming the tubing, on rotating the tool in a given direction.

FLARING TOOL

This is a tool used to flare the ends of tubing so that the joints do not leak. It consists of a flaring bar or mould (fig. 2), with various holes of different diameters held together by a wing nut. The press has a pressure screw and a polished steel cone designed to flare the tubing end. Double flaring is done with special adapters that reinforce the cone of the tube (fig. 3).

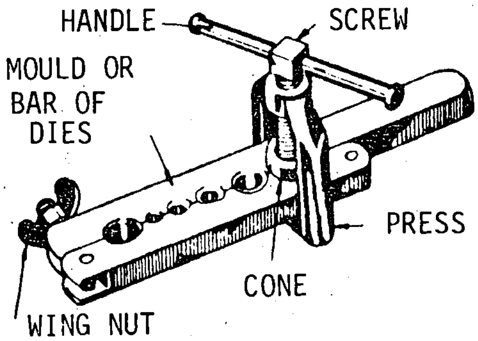


Fig. 2

BENDER

To prevent deforming the tubing when bending it, a special tool is used to give it the shape and angle required. The one most used is called a mandrel (fig. 4). It is equipped with a graduated disc that indicates the initial and final angle of the required bend. It has an open flank that enables positioning the tube at any point along its length.

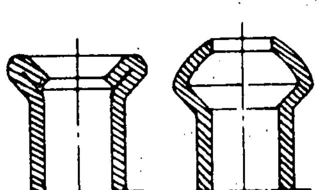


Fig. 3

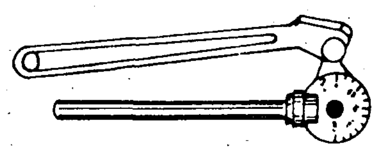


Fig. 4

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Centre Punches. It is used to mark the location of a hole that is to be drilled. The end of this punch is tapered and ends in a point with an angle of 60° (fig. 4).

Hollow punch type. This type of punch is designed to punch soft material such as cork, cardboard, rubber, etc. Its lower end is tapered and hollow with filled edges. (fig. 5).

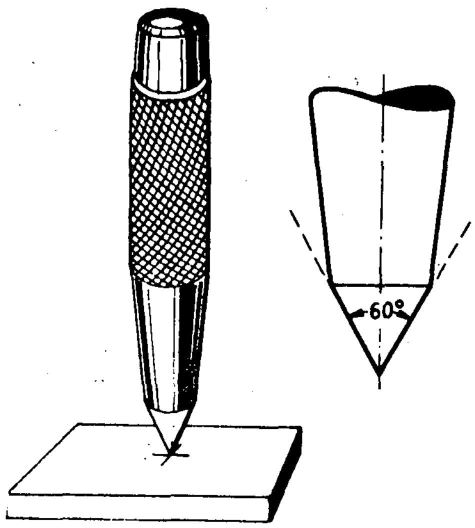

Fig. 4

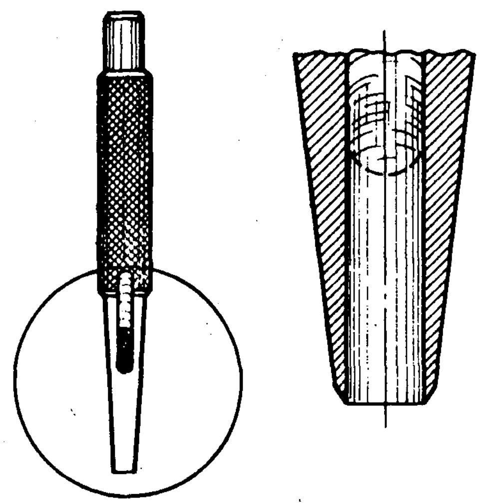

Fig. 5

The cut material rises through the central boring and comes out through a side window.

These punches come in sets of different diameter sizes. The material that is to be punched, should be placed on a soft surface, preferably wood, so as to avoid damaging the point and the cutting edge.

They are manual tools that have great applicability in automotive repair jobs.

CONSTRUCTION:
They are made of carbonized steel in a hexagonal or circular shape. The circular ones are usually lined so as to prevent one's hands from slipping when using them.

TYPES:
There are a great variety of punches, the most common among them being the following:

Drift Punch. This punch has a long slightly conical shaped end. It is used to partly drive out bolts until the cone of the punch reaches the edge of the hole (fig. 1).

Bolt Punch. They are used generally as a follow-up to the starting punch and are different to them, in that their shanks are cylindircal in shape (fig. 2).

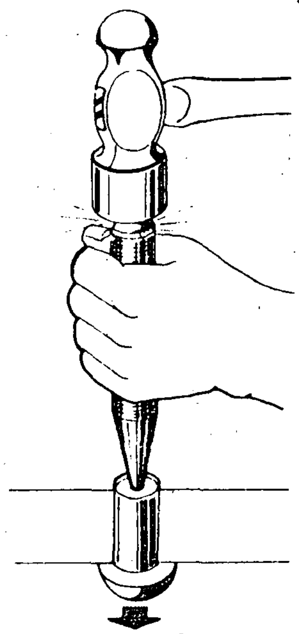

Fig. 1

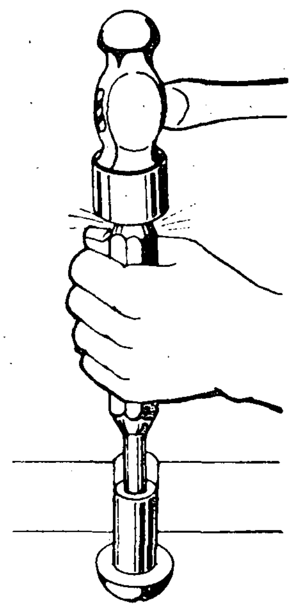

Fig. 2

Lining-up Punch. This punch has a very long conical shank and is used to shift parts, to bring the corresponding holes into perfect alignment (fig. 3).
This punch is especially useful for installing the engine, changing leaf springs, mudguards and other parts.

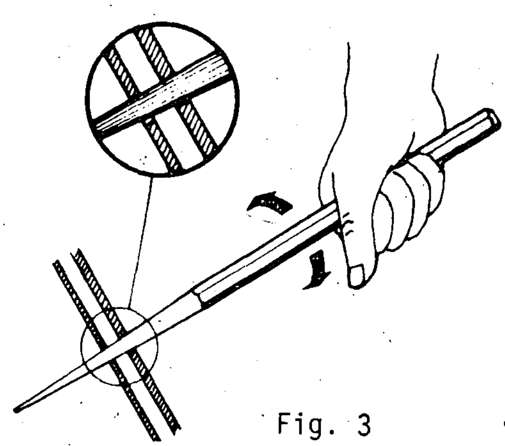

Fig. 3

Total filtration. This system consists of a one-piece sealed filter in which the total oil flow, propelled by the pump, passes first through the filter then through the passages to lubricate the different mechanisms (fig. 3).
The valve enables the oil to pass without being filtered, in the event that the filter is clogged.

Shunt filtration. In this system the filter is mounted on to the side of the engine by means of brackets. Part of the oil propelled by the pump reaches the filter, through a line then passes through the filtering screen and returns to the crankcase (fig. 4); the other part goes through the passages to lubricate the different parts in movement.

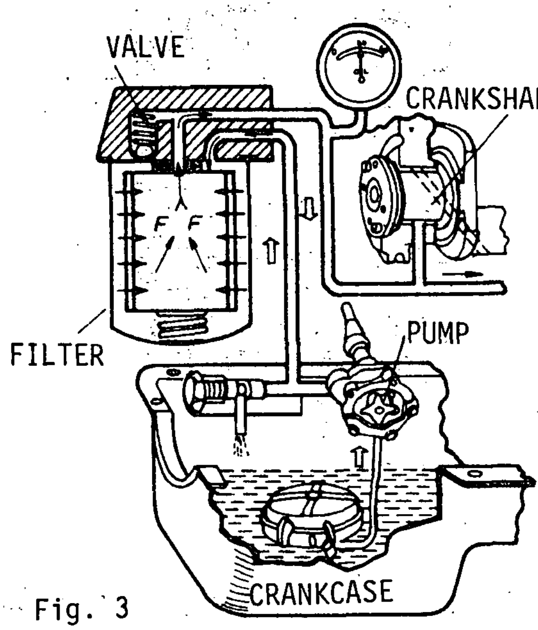

Fig. 3

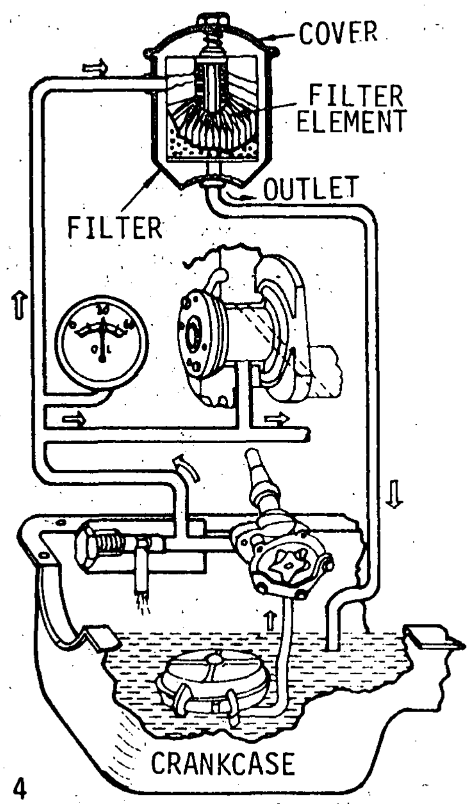

Fig. 4

Centrifugal filtration.
This system differs from the previous ones in that its operation is based on centrifugal force produced, when the filter revolves. This enables separating the metallic or carbon particles in suspension, expelling them towards the perimeter of the tank where they are retained (fig. 5).

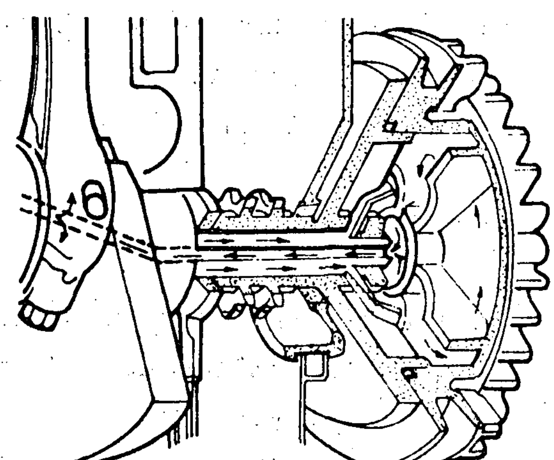

Fig. 5

MAINTENANCE

The maintenance of the filters and the replacement of the filtering screens should be done periodically, according to the manufacturer's specifications.

The oil filter is the part of the lubrication system designed to retain, from the lubricant in circulation, the greater part of the foreign particles in suspension, such as: carbon, products of the decomposition of the lubricant and of metallic particles, that, if not eliminated, would act as abrasive elements.

CONSTITUTION

Oil filters are made up of sealed units with metallic covers directly screwed on to the engine block (fig. 1) or else may be installed by means of brackets and flexible connections to one side of the engine (fig. 2).

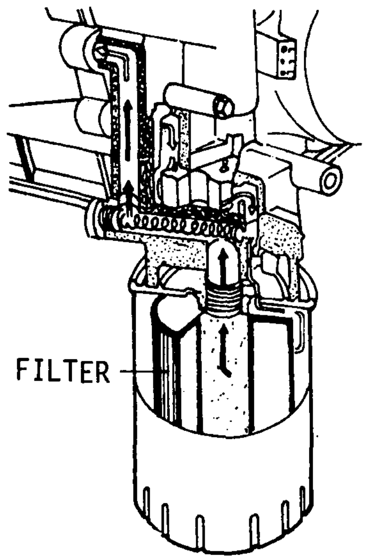

Fig. 1

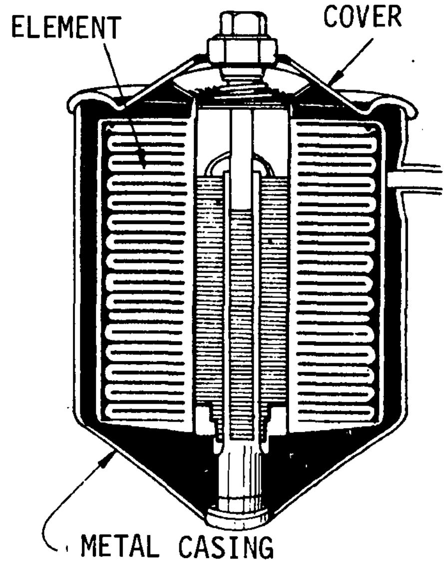

Fig. 2

The inside of the filter contains a bellow shaped filtering screen, so as to offer more surface contact to the oil, resulting in better filtration, and little resistance to the oil flow. Filtering screens are made of synthetic vegetable or textile fibres.

FUNCTIONING

In internal combustion the following filtration systems are used:

- Total filtration (full flow)
- Shunt (by-pass)
- Centrifugal

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Total pressure system. This system is distinguishable as all the moving parts of the engine are lubricated, through passages, by an oil flow under constant pressure, which is carried to the piston pin through a passage in the connecting rod (fig. 4).

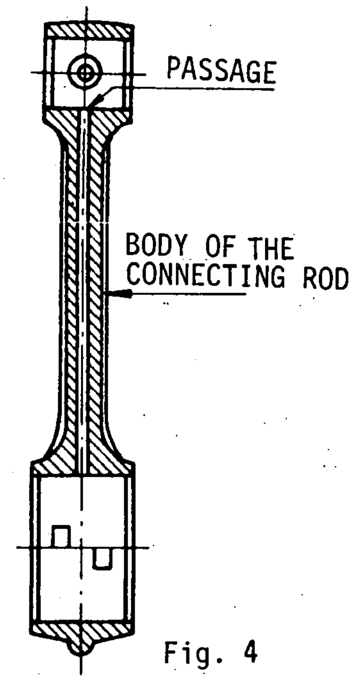

Fig. 4

Dry crankcase system. In this system the oil is stored in a tank outside of the crankcase, from which it falls under gravity to lubricate the moving parts of the engine. On reaching the crankcase it is collected by a pump that returns it to the external tank.

SUMMARY

LUBRICATION SYSTEMS
- *By pressure*
- *By splashing*
- *By total pressure*
- *By dry crankcase*

Lubrication by splashing. The oil from the crankcase is collected by the scoops, incorporated in the bearing caps of the connecting rods, when the crankshaft rotates and throws it on to the cylinder walls and other moving parts (fig. 2). The bearings of the crankshaft, connecting rods and camshaft contain funnel-type passages that receive the oil which goes on to lubricate the inside of the journal bearings.

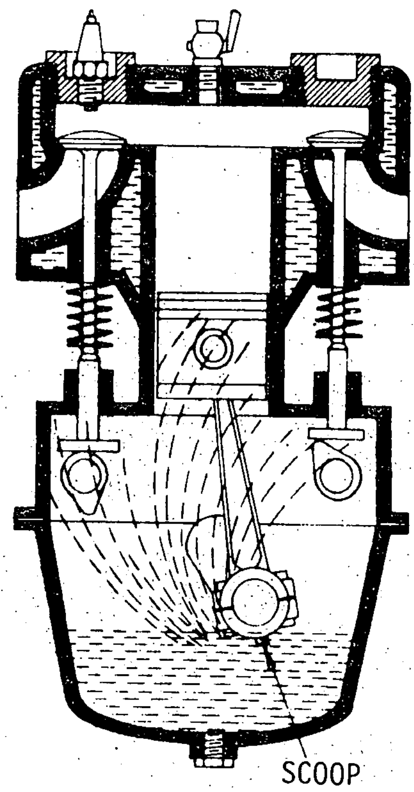

Fig.2

Mixed lubrication system.
This is a combination of the splashing and pressure systems, in which the parts subjected to greater friction, such as the crankshaft bearings, connecting rods and camshaft bearings, are pressure-lubricated and the cylinder walls and tappets lubricated by splashing (fig. 3).

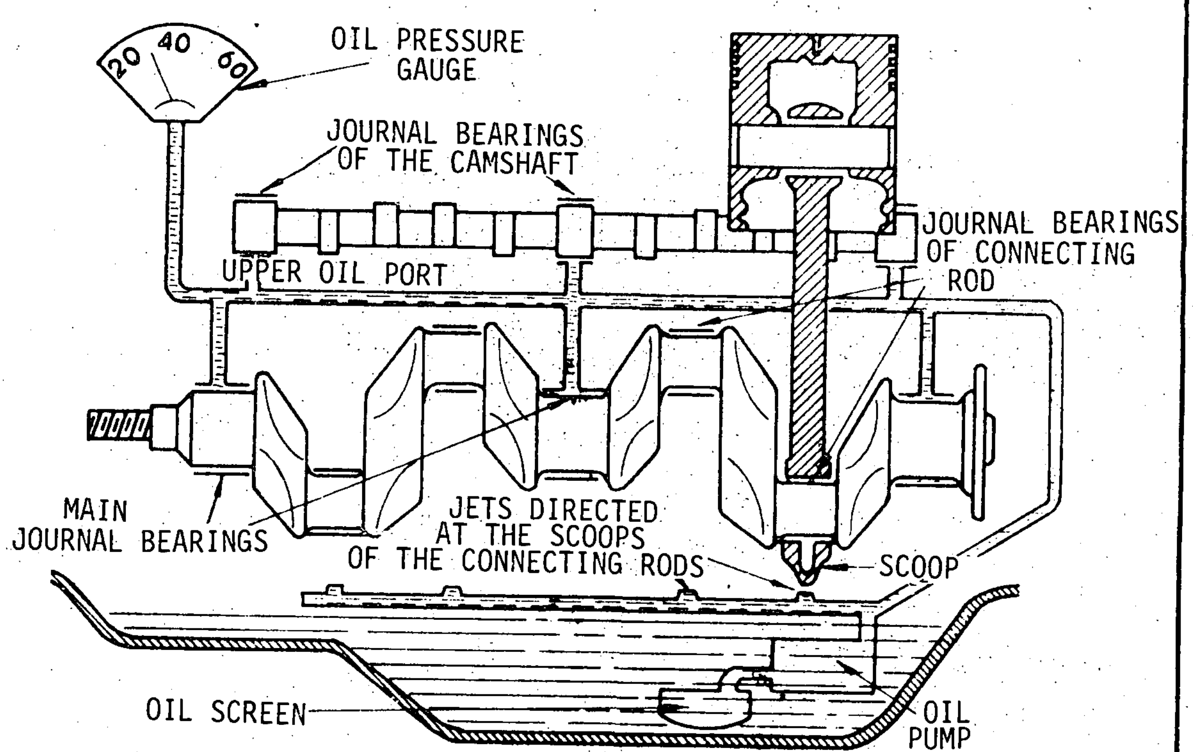

Fig. 3

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They consist of an assembly of parts designed to maintain the oil in circulation between the parts in movement so as to decrease friction, as well as aiding the cooling system to control the temperature of the engine.

TYPES

Lubrication in the engine can be realized in the following ways:

- By pressure.
- By splashing.
- By total pressure
- By dry crankcase.

DESCRIPTION AND FUNCTIONING

Pressure lubrication system. The oil is piped from the crankcase by a pump that conducts it under pressure to the different mobile parts of the engine. It passes through a screen that retains the impurities and particles that can damage some mechanism or friction surface, continuing through the internal pipes of the block to lubricate the crankshaft, connecting rods, piston pins, camshaft , tappets, rocker arms and the valve guides, thus ensuring an oil flow under any operating conditions (fig. 1).

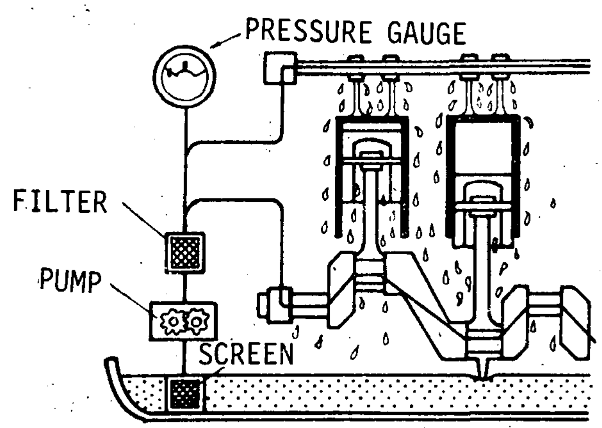

Fig. 1

An oil pressure gauge relays the existing pressure within the system. This is connected by means of a line to the oil circuit. Another method used is a transmitting device installed in the block, connected to the lights indicator in the dashboard of the vehicle.

Pulley. The part designed to transmit the movement, delivered to it by the belt from the crankshaft pulley, to the shaft.

Fan. The part designed to produce an air current through the radiator for cooling the water, especially when the vehicle is at a standstill .

FUNCTIONING

The water pump is operated by means of the belt which connects it to the crankshaft pulley (fig. 2).

On turning on the engine the impeller produces a depression in the intake tube of the pump, sucking in the water from the radiator, to then drive it towards the inside of the block.

On the body of some pumps there is a bypass pipe that enables the water to circulate inside the engine without passing through the radiator, thus enabling it to quickly achieve its normal working temperature (fig. 3). The deviation of the flow of water is obtained by means of the action of a thermostat.

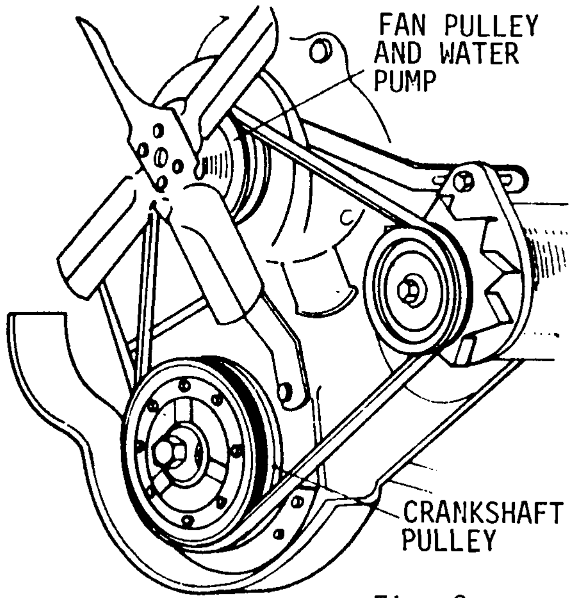

Fig. 2

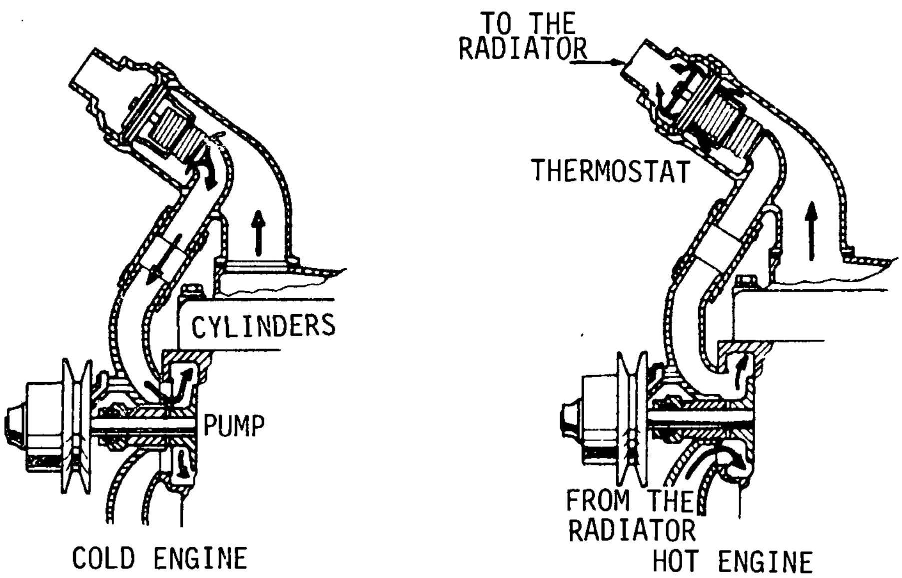

Fig. 3

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It is the mechanical device designed to maintain the water of the cooling system in compelled circulation, through the ports and chambers of the engine, so as to eliminate part of the heat generated during combustion.

CONSTITUTION

The water pump is composed of the following parts (fig. 1)

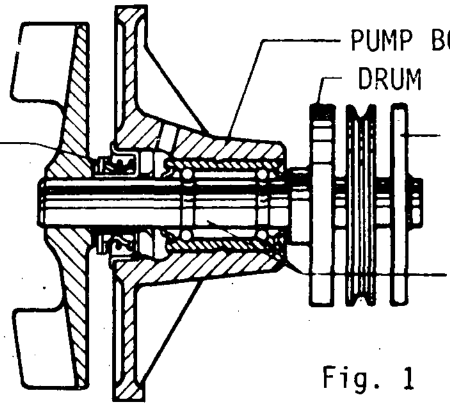


Fig. 1

Pump body. This is the principal part of the pump and is bolted on directly to the engine.
It may be made of cast iron or of an aluminium alloy and contains pipes that connect it to the engine and to the lower tank of the radiator.
Some bodies have a connecting tube to the heating system of the vehicle.

Shaft and bearing. This is the part designed to supply the movement to the drive or impeller. It is manufactured as one unit with the bearing. The pumps which use this system do not need lubrication, as the bearing is sealed and includes its own lubricant from the factory.

Drive or impeller. It is the part designed to propel the water in the system. It consists of paddles which may be straight or curved and is pressure-mounted on one end of the shaft.

Seals. These are designed to prevent water leaks from the pump through the shaft, and are generally made of fibre or graphite. They are pressurized by a spring to keep them sustained between the impeller and the pump body.

Drum or pulley adaptor. It is a circular part pressure-mounted on to the front part of the pump, and allows the pulley and the fan blades to be bolted on.

TYPES

The most common types of thermostats are the bellows type, previously described, and the bimetallic spring type. The latter (fig. 4) consists of two metals, with different coefficients of expansion, which when heated expand, one more than the other, thus operating the valve.

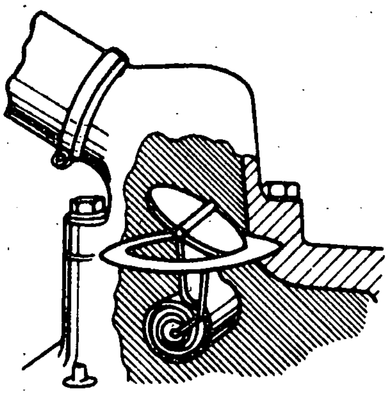


Fig. 4

The thermostat is a valve (fig. 1) operated by the heat of the water of the cooling system. Its purpose is to limit the circulation of the water when the engine is cold, enabling it to quickly attain its normal working temperature.

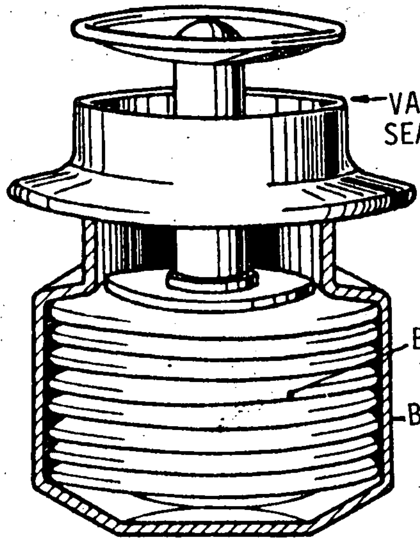
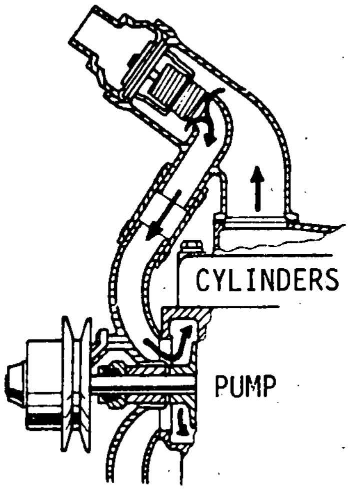


Fig. 1

FUNCTIONING

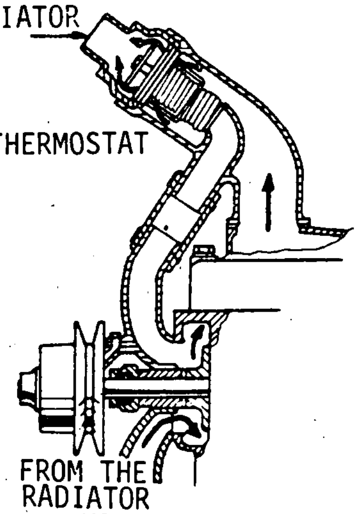
When the engine is cold, the thermostat valve is closed, thus limiting the circulation of the water through the inside of the engine only, without it flowing to the radiator to be cooled (fig. 2).



COLD ENGINE

Fig. 2

When the temperature of the water in the cooling system increases, the thermostat valve begins to open gradually (fig. 3), allowing the water contained in the engine to flow to the radiator to be cooled.
The thermostat contains a liquid which evaporates when the temperature increases, so that the internal pressure may cause the bellows to expand and lift the valve from its seating.



HOT ENGINE

Fig. 3

The pressurized system works under a pressure greater than that of the atmosphere for which reason the boiling point of the water exceeds 100°C.

The cover used in this system consists of the following parts (fig. 3):

1. Pressure valve
2. Spring
3. Vacuum Valve
4. Body

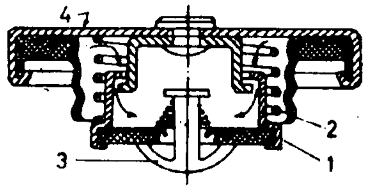


Fig. 3

The water heated with the heat absorbed from the chambers of the engine begins to vaporize and passes on to the upper tank of the radiator; as the cover has a rubber seal, the pressure increases and there is no loss of water.

When the internal pressure surpasses that exerted by the spring, the valve rises (fig. 4), enabling the vapour and accumulated air in the tank to be expelled through the over-flow pipe.

When the engine cools the water condenses and creates a vacuum; the vacuum valve (fig. 5) is separated from its sealing, enabling air to enter until balancing with the external pressure.

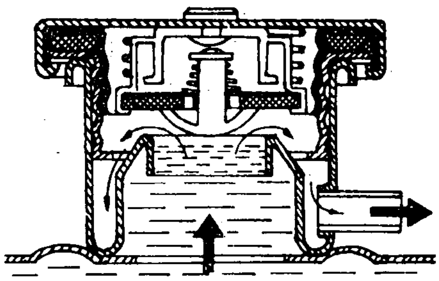

EXCESS PRESSURE

Fig. 4

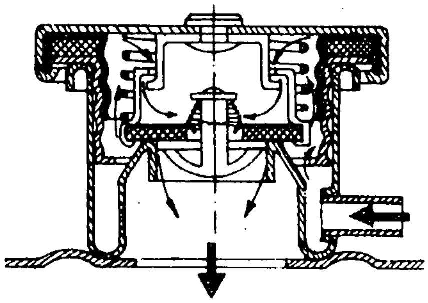


Fig. 5

The lower tank. This one receives the water coming from the core and is connected to the water pump by a hose. On the lower part there is a drain tap or screw plug used to drain the radiator.

FUNCTIONING

The cooling system functions within a closed circuit. The water, which is sucked by the pump from the lower tank of the radiator, is distributed through different ports inside the block and the cylinder head, absorbing the heat generated during the work cycle, returning after to the upper tank of the radiator.

On passing through the core the water transfers its heat to the tubes and fins, for dissipation into the air current produced by the fan as well as by the movement of the vehicle.

TYPES

Radiators are distinguished by the type of core they contain, the most common being the tubular and cellular types.

Tubular radiators. These are very commonly used and their tubes may be circular or of extended divisions; the fins which link and cool them are flat shaped or corrugated.

Cellular radiators. These consist of a great number of narrow passages, formed by pairs of thin metallic strips soldered on to their rims.

CHARACTERISTICS

Both cores can be used in cooling systems that operate under a pressure equal to, or greater than that of the atmosphere; they are said to be pressurized.

The system under atmospheric pressure uses a simple cap which exposes the over-flow pipe, for expelling water, where the pressures are balanced (fig. 2).

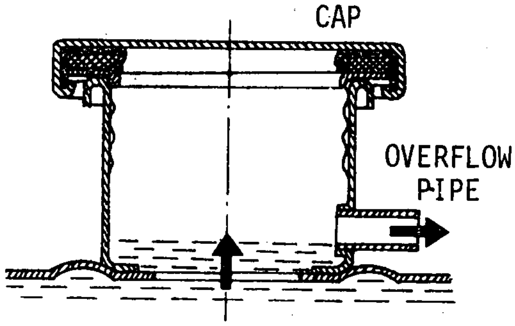


Fig. 2

The radiator is the part of the cooling system designed to cool the water, conveying the heat to the atmosphere, so as to maintain an appropriate temperature in the engine.

POSITIONING

The radiator is generally situated in front of the engine so as to make use of the air current produced when the vehicle is in motion. Sometimes, because of space limitations, radiators are situated at one side of the engine, but without any loss in efficiency. The entry and exit of water from the radiator is effected through flexible hoses which do not receive the vibrations transmitted from the engine.

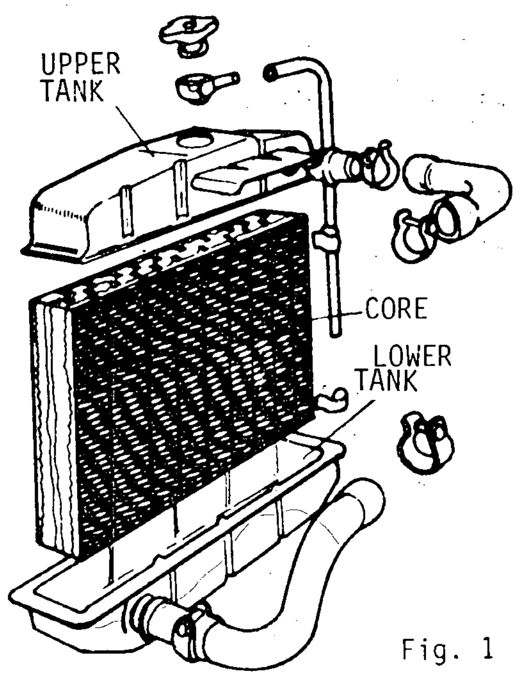


Fig. 1

CONSTITUTION

The radiator consists of 3 principal parts (fig. 1): an upper tank, a core and a lower tank, all joined together by soft soldering (tin).

The upper tank. This is the one which receives the water coming from the engine at a high temperature. Besides the entrance, it has a tube with a rim for installing the cover and the line diverted outside which serves the purpose of expelling the excess water, which tends to overflow due to its volume increase.

This water overflow line extends down one side of the radiator through a suitable distance so that the spilt water does not wet the electrical parts of the ignition.

The core. This is composed of a series of metallic tubes with very fine walls which are connected to both tanks. These tubes are supported and separated by fins that act as heat exchangers. Its fabrication is very varied and the materials most used are copper, brass and aluminium.

If the temperatures, because of regional climatic conditions, are extremely low, the water may freeze; to prevent this, anti-freezers are used. This substance is added to the water and prevents it from freezing while sealing any opening or cracking in the block or cylinder head.

Air cooling system. This system is distinguished by the construction of the block and cylinder head which include cooling fins for better dispersing the heat generated by the combustion of the mixture and the friction of the parts in movement (fig. 2).

A turbine circulates the air around the cooling fins of the engine which makes it possible to maintain the normal working temperature, whether the vehicle is at a stand still or in motion. The quantity of air is controlled by valves situated in the cooling vents which are operated by a thermostat.

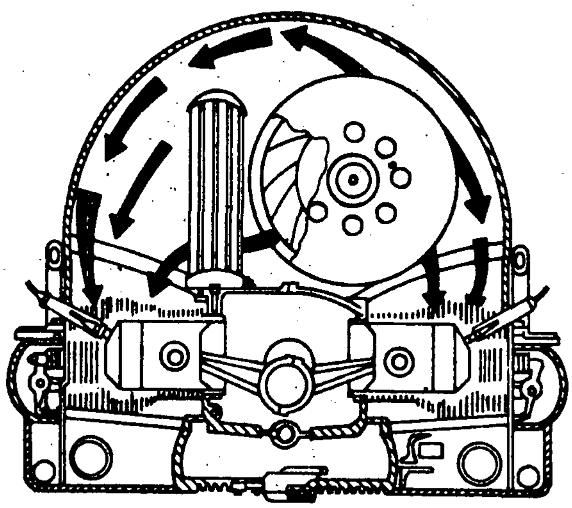


Fig. 2

S U M M A R Y

COOLING SYSTEMS

- *Water*
  - Radiator
  - Water pump
  - Fan
  - Water hoses
  - Thermostat
- *Air*
  - Cooling fins
  - air vents
  - Turbine
  - Thermostat

The system is a unit of parts which enable dissipation of the heat produced in the engine while running, maintaining the temperature normal under any driving conditions.

TYPES

The systems used are:

- Water
- Air

Water cooling system. It consists principally, of the water pump, radiator, fan and water hoses (fig. 1).

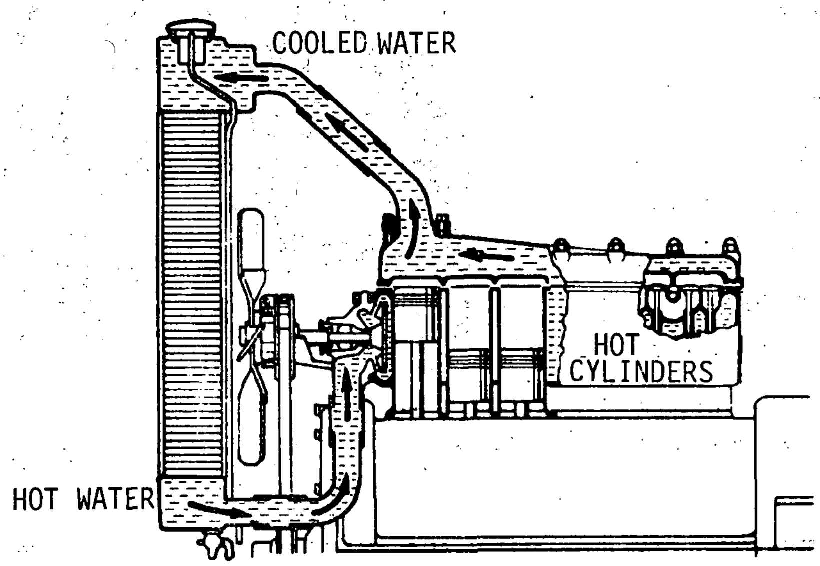


Fig. 1

In this system the cooling liquid circulates around the cylinders and cylinder head of the engine, absorbing the heat generated by the combustion of the mixture and the friction of the parts in movement.

A pump installed within the system enables the circulation of the water continuously through the ports of the block and cylinder head, the hot water then passes on to the radiator, distributed over a large area, which is laid across an air current produced by the rotation of the fan; it is thus cooled adequately by the air which disperses the excess heat.

A thermostat installed between the cylinder head and radiator prevents the water circulating through the system when the engine is cold, running through the engine only.

As the temperature of the cooling water increases, the valve of the thermostat begins to open, enabling it to circulate through the radiator. To indicate the engine temperature, a temperature gauge which forewarns the driver of possible faults, produced by heat excesses, is installed. These temperature gauges may be mechanical or electrical.

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TECHNICAL VOCABULARY:

Expansion - power
- combustion

E) ACCORDING TO THE FUEL IT UTILIZES
- Gasoline or liquified gas.
- Diesel Oil.

F) ACCORDING TO THE COOLING SYSTEM
- Engine cooled by water.
- Engine cooled by air.

SUMMARY

ENGINE SYSTEMS
- Cooling
- Lubrication
- Fuel
- Distribution
- Mobile Assembly
- Electrical

INTERNAL COMBUSTION ENGINE (ALTERNATIVES)

- *Cylinder Positioning*
  - Straight line
  - V-shaped
  - Horizontal
  - Radial
- *Number of Cylinders*
  - Monocylindrical
  - Multicylindrical
- *Work Cycle*
  - Four Stroke
  - Two Stroke
- *Valve Arrangement*
  - In the cylinder head
  - In the block
  - Alternated
- *Fuel*
  - Gasoline or liquified gas
  - Diesel oil
- *Cooling System*
  - By water.
  - By air.

- *V-shaped Engines.* The cylinders are arranged in the block to form a fixed angle, which varies according to the type of engine (fig. 7). In this way the length of the block is shortened.

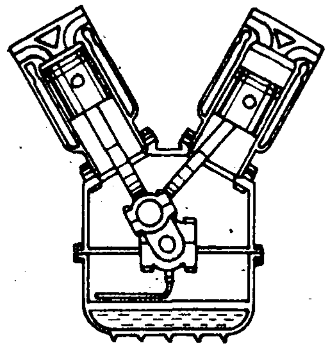


Fig. 7

- *Engines with opposed cylinders.* The cylinders are arranged in the block forming an angle of 180^{0} between them (fig. 8). This enables a better balanced functioning of the engine.

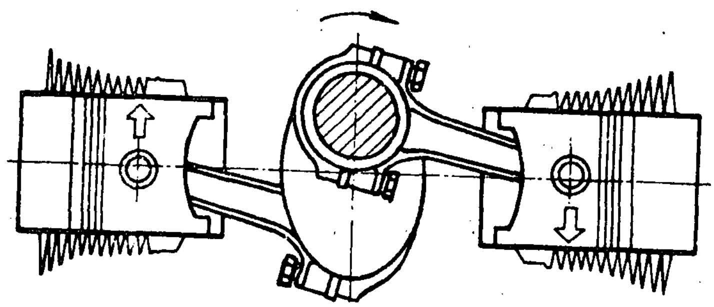


Fig. 8

- *Radial Cylinder Engines.* These are engines in which their cylinders are arranged in a star design. (fig. 9).

B) ACCORDING TO THE NUMBER OF CYLINDERS
- *Monocylindrical.* The engine consists of one cylinder.
- *Multicylindrical.* When the engine contains two or more cylinders.

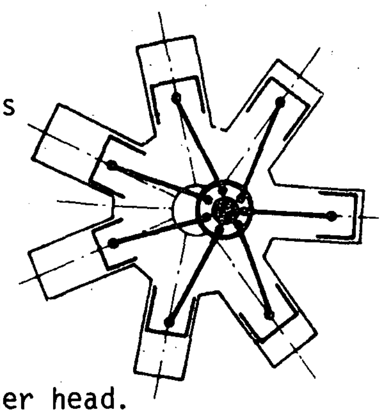


Fig. 9

C) ACCORDING TO THE VALVE ARRANGEMENT
- Engine with all valves in the cylinder head.
- Engine with all valves in the block.
- Engine with valves in the cylinder head and block.

D) ACCORDING TO THE WORK CYCLE
- Four Stroke
- Two Stroke

TWO CYCLE ENGINE

It differs from the four stroke engine in that the work cycle, intake, compression, power and exhaust, are attained in one revolution of the crank-shaft or two strokes of the piston. It functions in the following manner: when the piston begins its downward stroke, boosted by the gases in combustion (fig. 5) it uncovers the exhaust port enabling the expulsion of the gases. Through the intake port a new mixture is introduced into the crankcase, and, being compressed by the piston skirts, it is forced up the transfer port; the crankshaft has completed half of a revolution, having completed the exhaust and intake strokes. The piston begins its upward stroke compressing the mixture until reaching the top dead centre, where it is ignited by the spark plug causing the explosion and in this way it completes the work cycle.

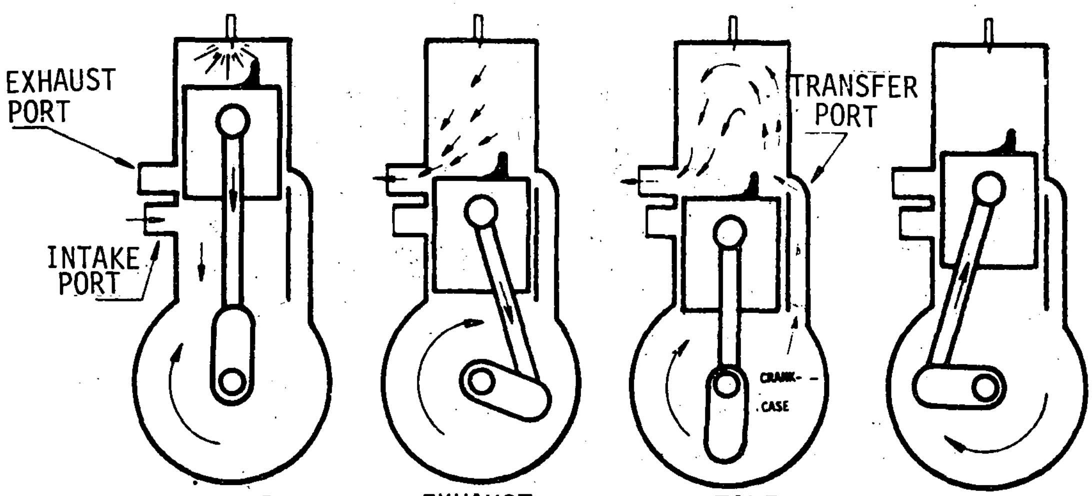


Fig. 5

CLASSIFICATION

Engines are classified according to the following characteristics:

A) ACCORDING TO THE CYLINDER ARRANGEMENT

- Engines in line have their cylinders arranged one behind the other (fig. 6).

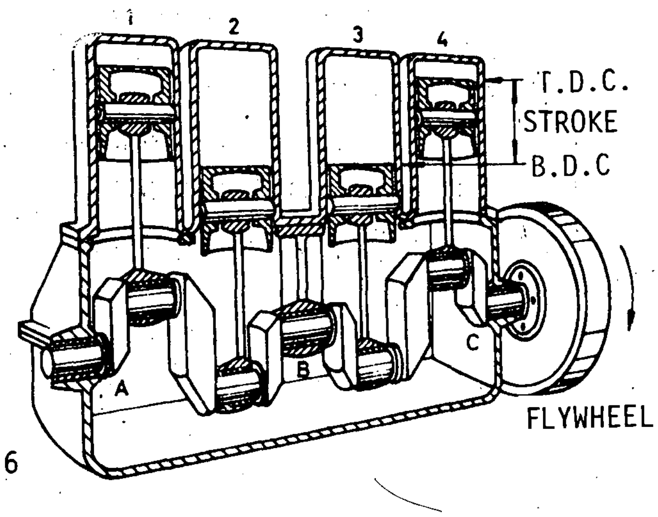


Fig. 6

FUNCTIONING

FOUR STROKE ENGINE

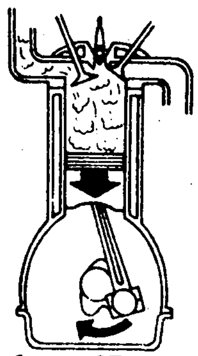
The majority of self propelled vehicles utilize four stroke internal combustion engines; these attain their complete working cycle in four piston strokes or two revolutions of the crankshaft. The strokes are intake, compression, power and exhaust.

Intake. It begins when the piston is at the top dead centre. The inlet valve opens and the piston lowers, drawing in the mixture as a result of the suction it causes (fig. 1); when the piston reaches the bottom dead centre, the intake valve closes. The crankshaft has made half a revolution.

Compression. The piston rises to the top dead centre, while the valves remain closed, thereby compressing the mixture in the combustion chamber (fig. 2). The crankshaft has completed one revolution.

Power. In the previous stroke the mixture was compressed in the combustion chamber. A spark produced by the spark plug ignites the fuel; the gases, on expanding, produce a high pressure that acts against the piston head, forcing it down from the top dead centre to the bottom dead centre (fig. 3). The crankshaft has completed one and a half revolutions.

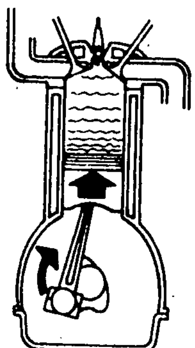
Exhaust. The piston rises from the bottom dead centre (fig. 4) and the exhaust valve opens enabling the spent gases to be pushed out from the cylinder. When the piston reaches the top dead centre the exhuast valve closes.
The crankshaft has then completed two revolutions, on one work cycle.



1 st STROKE

INTAKE

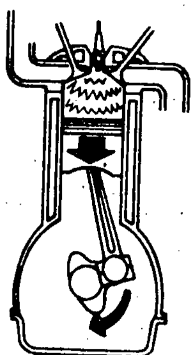
Fig. 1



2 nd STROKE

COMPRESSION

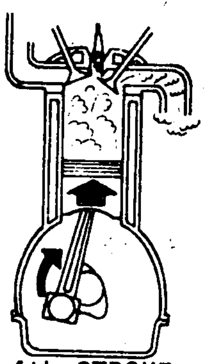
Fig. 2



3 rd STROKE

POWER

Fig. 3



4th STROKE

EXHAUST

Fig. 4

This is the unit of parts and elements that transform the heat energy of the fuels, developed during the combustion process, into mechanical energy. The engine supplies the necessary mechanical energy to propel the vehicle under all driving and working conditions.

DESCRIPTION

The engine consists of the following systems:

- Cooling
- Lubrication
- Fuel
- Distribution
- Mobile Assembly
- Electrical

The Cooling System is designed to maintain the normal working temperature of the engine. The combustion of the mixture inside and the friction of the parts in movement produce high temperatures which this system must control.

The Lubrication System reduces the friction between the parts of the engine in movement, by means of a film of oil between them, so aiding the cooling system in maintaining the engine's normal working temperature.

The Fuel System is designed to supply fuel to the engine, from the tank to the carburettor, which delivers it measured and mixed with air in accordance with the consumption needs of the engine.

The Distribution System. To fulfil the work cycle of the engine it is necessary to open and close the valves; this is achieved by the distribution mechanism, which operates the valves in accordance with a synchronization of movements with the mobile assembly.

The Mobile Assembly is composed of the parts which transform the reciprocating movement of the piston into a rotating movement of the crankshaft.

The Electrical System consists of the starter system that enables starting the engine; the ignition system that provides an electric spark to ignite the air-fuel mixture; and the charging system that should maintain the battery constantly charged to enable feeding the different systems.

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TECHNICAL VOCABULARY:

Pinion gears - planetary gears.

Ring gear - crown wheel.

Differential gears - differential side gears;
- sun wheels.

Velocity - speed.

Drive Pinion and Ring Gear. This type being the most used in vehicles, consists of a conical steel case-hardened pinion which engages the ring gear of the same material.

The arrangement of the drive pinion with respect to the ring gear varies, the two types most used being:

- Spiral
- Hypoid

In the spiral system the centre line of the drive pinion coincides with the centre of the ring gear (fig. 7).

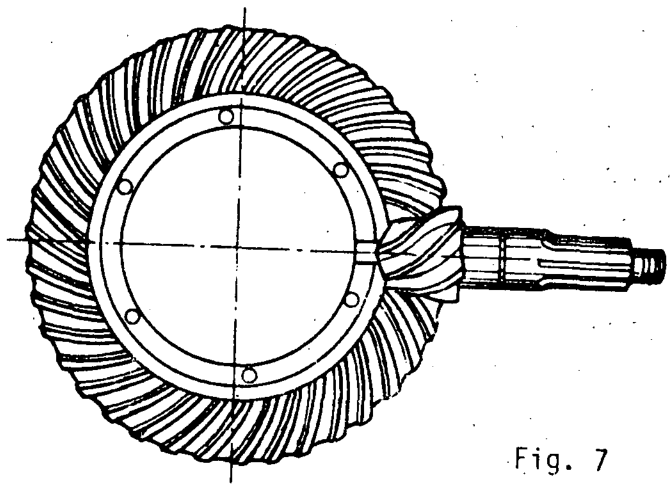

Fig. 7

In the hypoid system the centre line of the pinion is lower than that of the ring gear (fig. 8); this arrangement enables:

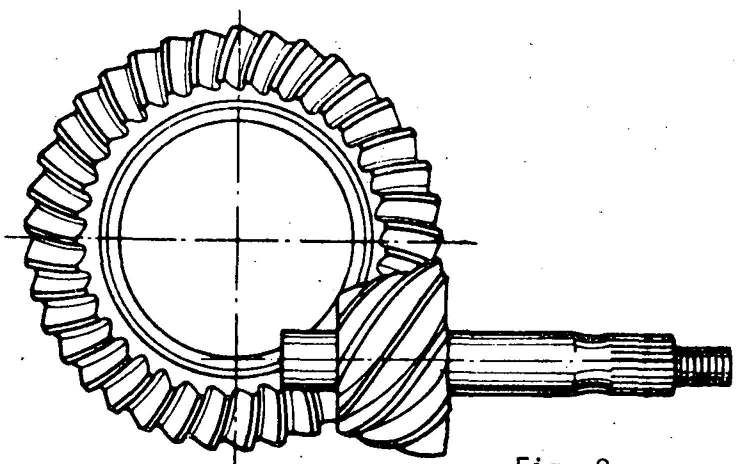

Fig. 8

- Lowering the height of the drive shaft, and as a result, the height of the vehicle from the ground.
- Providing better adjustment because of the increased surface contact.
- Smoother movement and silent functioning.

When the vehicle is driving in a straight line the ring gear, cage and differential gears rotate as a single unit (fig. 4).
The differential pinions move in a circle hauled by their shaft, but without revolving about it, thereby compelling the differential gears to rotate at the same velocity as the cage and the half-axles.
When the vehicle is driving (fig. 5) on a curve, the wheel on the inner arc travels a shorter distance than the one on the outer. As a result the inner wheel should rotate at a lower speed than the outer one.
In this situation, the differential pinions move and rotate on the inner differential gear, thereby increasing the velocity of the differential gear and of the outer wheel.

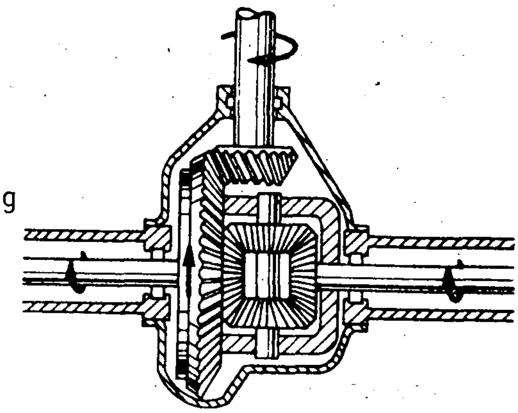

Fig. 4

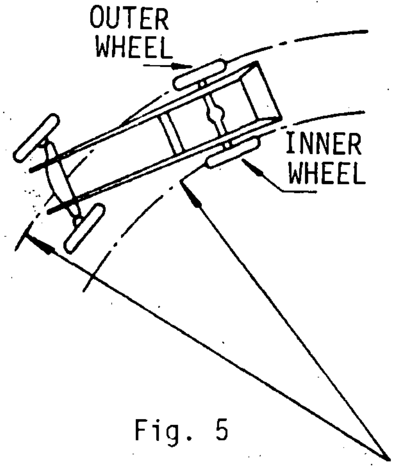

Fig. 5

TYPES

There are two types of differentials:

- Worm screw and ring gear
- Drive pinion and ring gear (conical gearing).

Worm Screw and Ring Gear. This type consists of a Ring Gear, usually made of bronze, which engages a case-hardened and balanced steel worm screw (fig. 6).

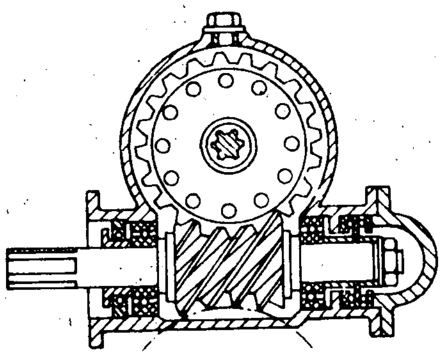

Fig. 6

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Differential Cage. It is mounted in the differential case which houses the ring gear, differential gears and pinion gears; it rotates jointly with the ring gear and enables the movement of the gears and pinions which regulate the differences in velocity of the drive wheels.

Differential Pinions. They are conical shaped gears which directly engage the differential gears; they enable the compensation for the rotation of the drive wheels, during a turn on a curve.

Differential Gears. They are also conically shaped mounted on bearings on the differential cage, they are splined, to enable installing the ends of the half-axles.

FUNCTIONING

The rotating movement transmitted to the drive pinion revolves the ring gear and the differential cage. The pinions (fig. 2) rotate freely about their shaft, and at the same time rotate jointly with it being pulled along by the cage, combining the rotation with a difference in speed of the drive wheels. The differential gears, moved by the differential pinions, rotate about their centres (fig. 3), as they are mounted on bearings in the cage, thereby transmitting this movement to the half-axles of the drive wheels.

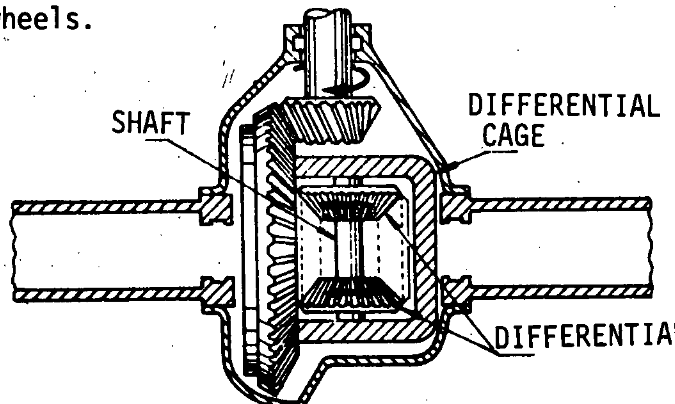


Fig. 2

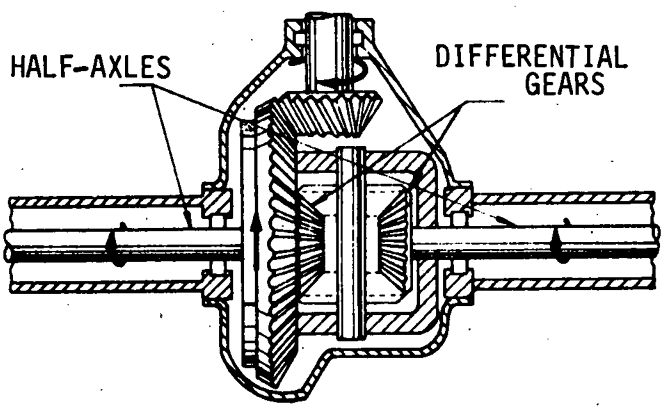
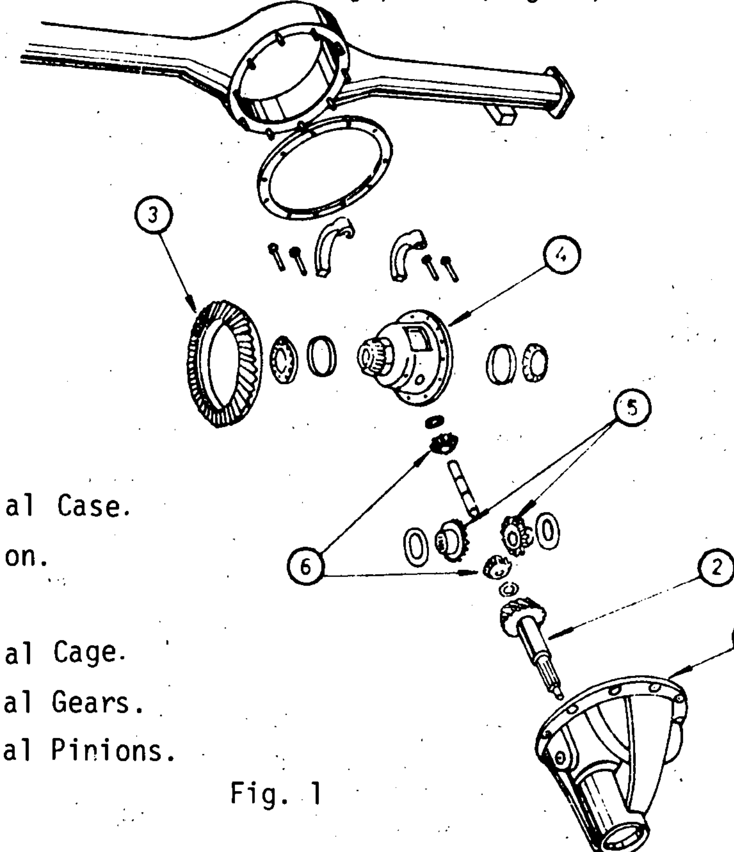


Fig. 3

This is the mechanism, mounted in the differential housing which transmits the movement from the drive shaft to the axles of the wheels, compensating for their different speeds so as to maintain a balanced traction. The speed differences which are compensated for are those produced on turning the vehicle, due to the fact that the wheel on the outer arc of the curve should rotate faster than the inner wheel.

CONSTRUCTION

The differential unit consists of the following parts (fig. 1):



1. Differential Case.
2. Drive Pinion.
3. Ring Gear.
4. Differential Cage.
5. Differential Gears.
6. Differential Pinions.

Fig. 1

DESCRIPTION

Differential Case. It is generally mounted on the rear axle housing and fixed to it with bolts; it houses all the parts of the differential unit.

Drive Pinion. It receives the rotation from the drive shaft and transmits it to the ring gear which changes the direction of rotation. It is conical in shape and is mounted on bearings on the differential carrier.

Ring Gear. It is a gear, conical on one of its side surfaces for engaging the drive pinion; it transmits the rotation to the differential cage.

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Fully Floating Half-Axle Differential Housing. This system, in wide use in heavy vehicles (fig. 3), is distinguishable by the fact that the weight and the load rest on the end of the differential housing. The half-axle transmits the rotation to the wheel hub, which is supported on double bearings mounted on the external part of the differential housing. The displacement of the bulk is eliminated with a nut situated at the end of the differential housing and which also adjusts the pre-load of the bearings. The axle is sustained by means of bolts to the flange and its other end is connected by its splines only.

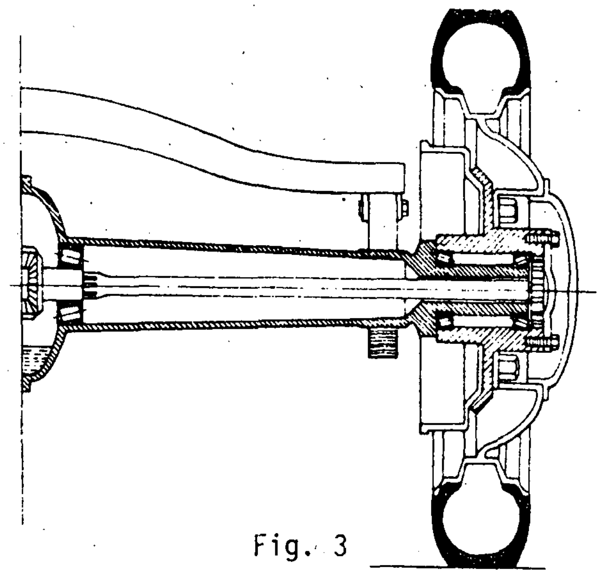


Fig. 3

CONSTRUCTION

The construction of differential housings has been varied throughout the years, with the purpose of obtaining a firm and rigid differential housing of a light material. As a result the "banjo" type has been developed, whose two types (fig. 4) are the most widely used at present. They are normally made of cast steel and sometimes include parts made of steel which is stamped so as to reduce their weight. The half-axles, the parts of the differential unit which separately transmit the movement to the wheels are two bars of the same diameter and sometimes different lengths made usually from chromium nickel steel.

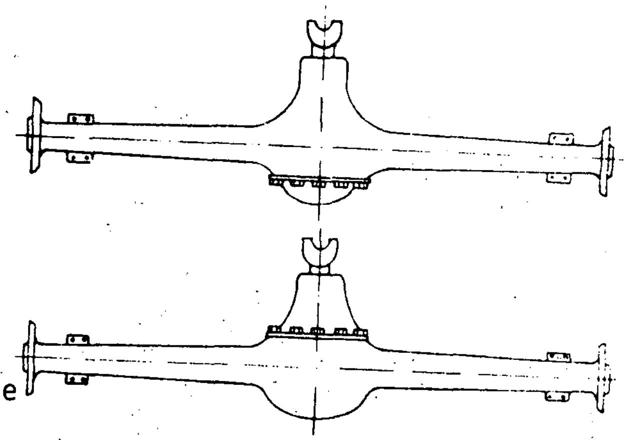


Fig. 4

MAINTENANCE

Periodically, the oil level in the differential unit should be checked and changed according to specifications and leaks at the seals and gaskets should be checked.

The differential housing is the metallic casing in which the differential unit as well as the half-axles are housed and which at the same time constitutes the bracket of the rear suspension system.

TYPES:

The fundamental variations existing in differential housings lie in the assembly of their half-axles in such a way that they may be classified into three types:

- Semi-floating half-axle differential housing.
- Three quarters floating half-axle differential housing.
- Fully floating half-axle differential housing.

DESCRIPTION:

Semi floating half-axle differential housing. It is called floating because the end of the half-axle is mounted on a bearing situated on the inside of the end of the differential housing (fig. 1). The weight of the vehicle rests on the end of the half-axle and it is the type most used in light vehicles.

Three quarters floating half-axle differential housing. In this type of differential housing the half-axle transmits the movement to the hub of the wheel which is supported on the external end of the differential housing on a roller bearing (fig. 2).

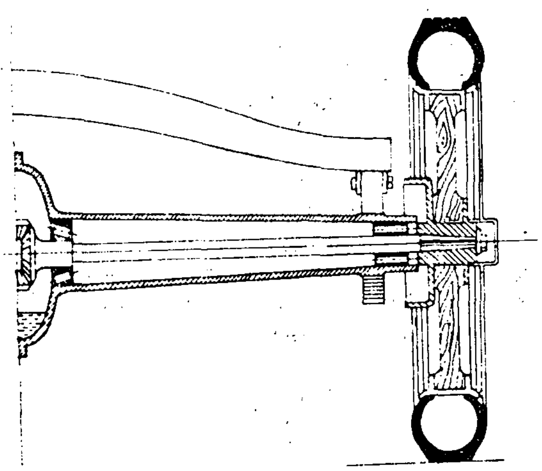


Fig. 1

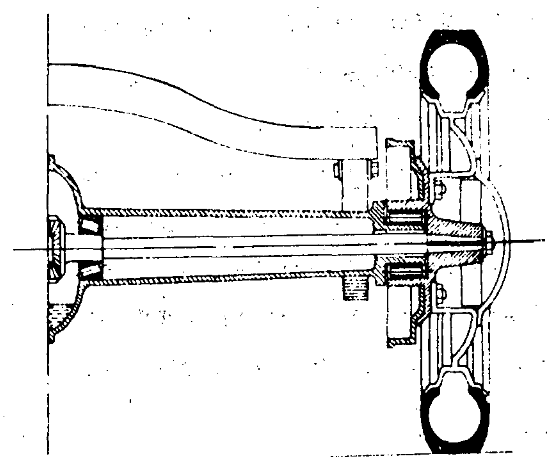


Fig. 2

CONTROL SYSTEMS OF THE CLUTCH MECHANISM

The control system is the mechanism used in operating the clutch; there are two known types:

- Mechanical Control.
- Hydraulic Control.

Mechanical Control. This system consists of a pedal that moves the system of levers which act on the clutch fork (fig. 8).

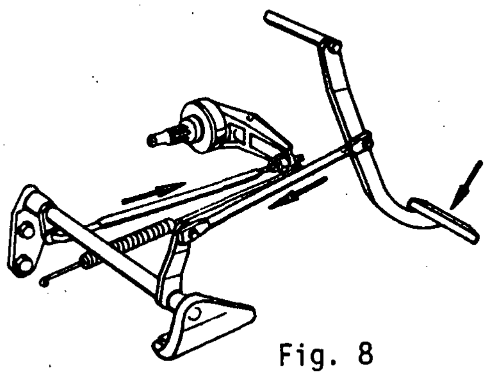


Fig. 8

Hydraulic Control. This system is similar to the hydraulic braking system. It consists of a master cylinder, a line and a slave cylinder, the rod of which acts against the clutch fork (fig. 9).

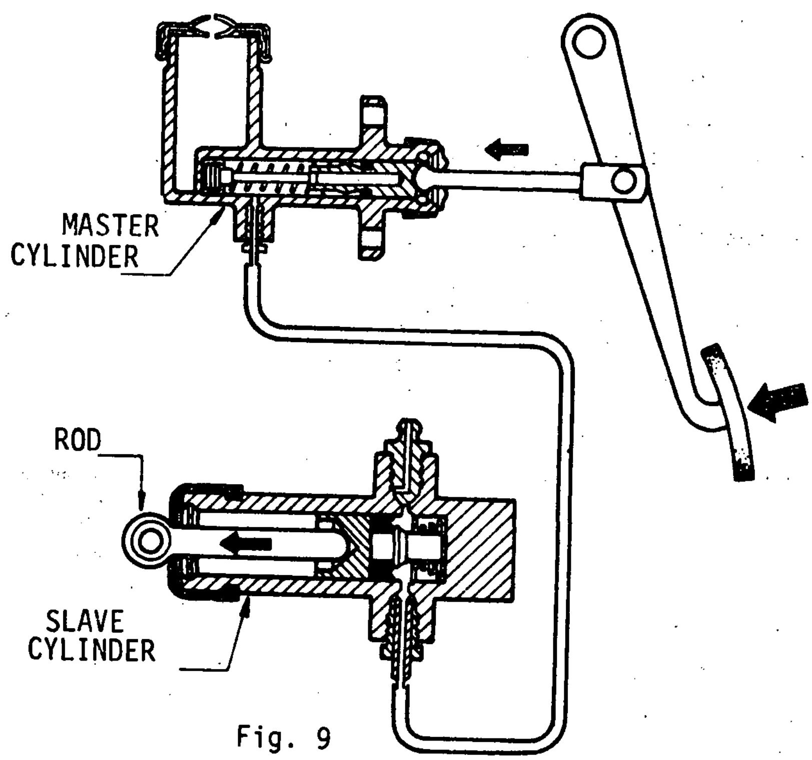


Fig. 9

AUTO MECHANICS

Technological Subject Code

Coil Spring Type. It utilizes the tension of the springs to hold the disc, between the pressure plate and the flywheel, and the release levers when withdrawing the pressure plate (fig. 5).

1. Clutch Cover.
2. Pressure Plate.
3. Pressure Springs.
4. Release Levers.
5. Adjusting Screws.
6. Lever Support.

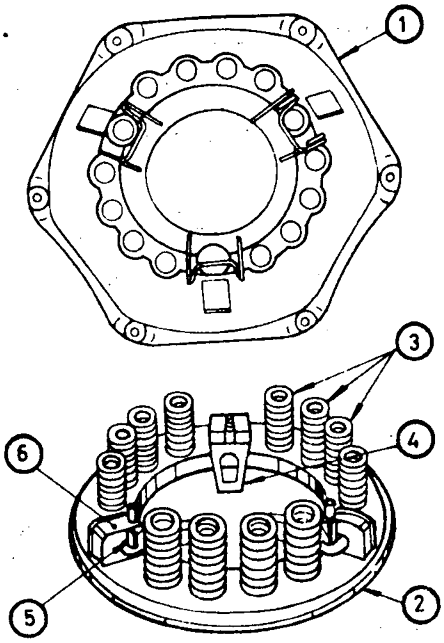


Fig. 5

Diaphragm Spring Type. The principal characteristic of this type of pressure plate is the diaphragm, which replaces the function of the release levers, and supplies the force necessary to push the disc against the flywheel (fig. 6).

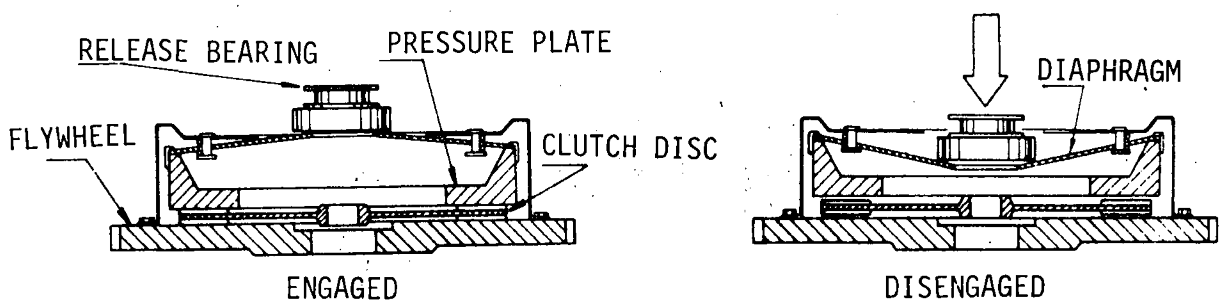


Fig. 6

Semi-centrifugal Type. It differs from the previous ones in that on its release levers there are counterweights (fig. 7). On rotating the pressure plate, the centrifugal force which acts on the counterweights causes the levers to exert a strong pressure on the pressure plate.

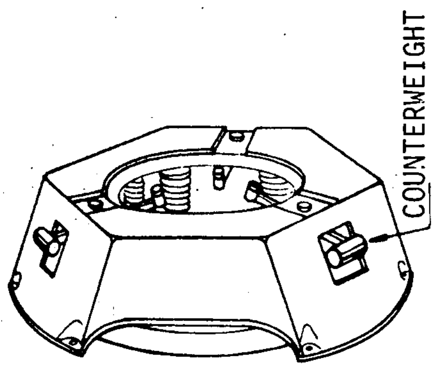


Fig. 7

When the driver releases the pedal, the clutch fork releases the release bearing and the springs cause the pressure plate to press the clutch disc against the face of the flywheel, rotating them jointly (fig. 3).

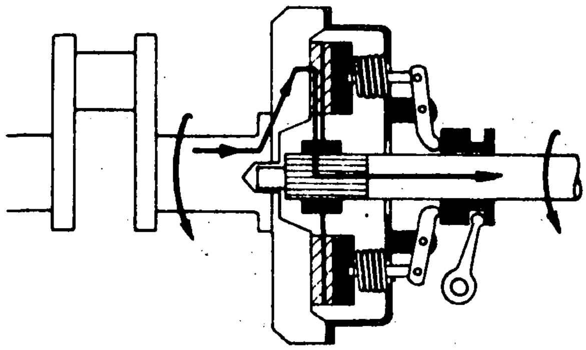


Fig. 3

CLUTCH TYPES

The types of clutches most used are:

- Single Disc Clutch
- Multiple Disc Clutch

Single Disc Clutch. This is the type most used in vehicles and is distinguished by containing only one clutch disc.

Multiple Disc Clutch. This type is used more with heavy vehicles as it is necessary to increase the contact surface between the flywheel and clutch; it consists of two or more clutch discs (fig. 4).

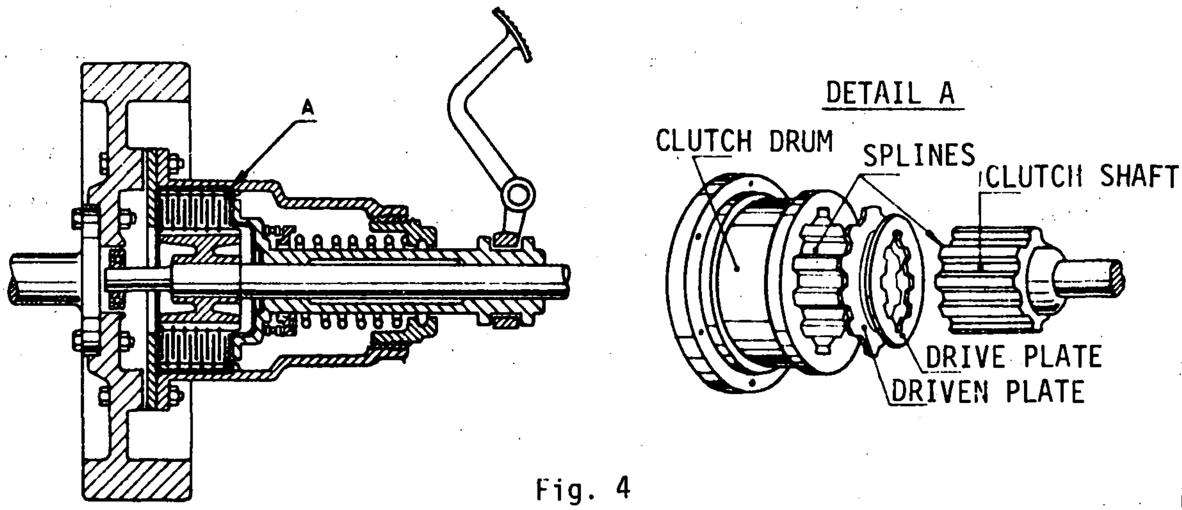


Fig. 4

TYPES OF PRESSURE PLATES:

Types most used are:

- Coil Spring type
- Diaphragm Spring type
- Semi-centrifugal type

The clutch is the mechanism in the transmission system, situated normally between the engine and the gear box, designed to connect and disconnect the rotary movement of the flywheel to the rest of the transmission, at the driver's wish.

CONSTITUTION:

The clutch mechanism is generally composed of the following parts (fig. 1):

1. Clutch Fork
2. Release Bearing
3. Pressure Plate Assembly
4. Clutch Disc.

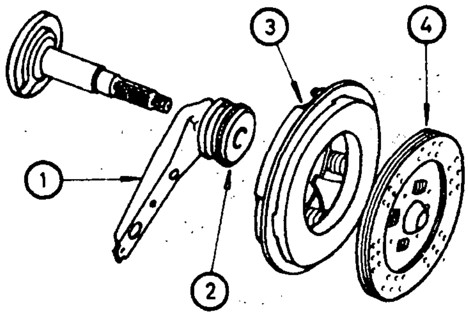


Fig. 1

DESCRIPTION

Clutch fork. This lever is connected at one end of the operating levers and at the other, fork-shaped, to the bearing support so as to produce its displacement.

Release Bearing. On one end of this part is mounted a bearing or graphite ring, and on the other end, is a collar in which the ends of the fork enter; when operated, the fork pushes the bearing support against the levers or diaphragm to disengage the clutch.

Pressure Plate Assembly. The part that serves the purpose of pressing the clutch disc against the surface of the flywheel, by means of the pressure plate, causing them to rotate jointly.

Clutch Disc. It is the part of the mechanism designed to join the flywheel together with the pressure plate, through the friction lining.

FUNCTIONING:

When the driver steps on the clutch pedal, the clutch fork displaces the release bearing towards the release levers, in such a way that the engine can function independent of the transmission (fig. 2).

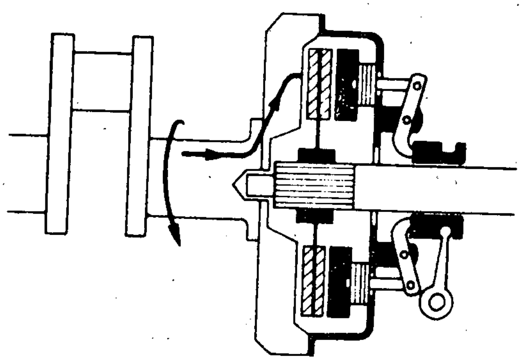


Fig. 2

The gear E is displaced backwards engaging the counter one R, or reverse gear.
The movement is transmitted from the Gear A to gears B and G; these in turn transmit the movement to gear R, making it rotate in the same direction as the gear A.
The gear R transmits, in turn, the movement to the gear E mounted on the projecting shaft, enabling it to rotate in an opposite direction to that of the input shaft.
If 2,000 R.P.M. is supplied to the gear-box and 333 comes out, we say that the ratio is 6:1.
This great gearing down for the reverse gear guarantees reversing safely as the vehicle cannot attain any great speed.

Neutral. In this position there is no transmission towards the output shaft (fig. 6), as there are no gears connected and the movement reaches only to the counter shaft.

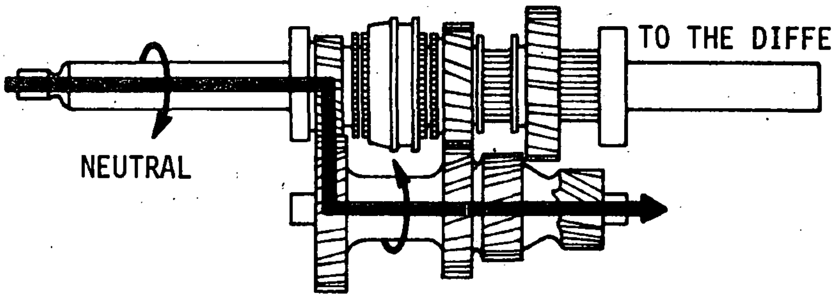


Fig. 6

It is used when the engine is to be kept running, with the vehicle at rest and the clutch engaged.

MAINTENANCE

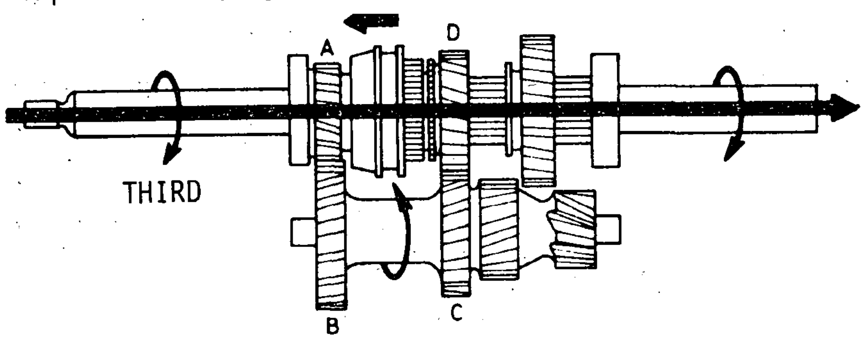
This entire unit of shafts and gear wheels is submerged in lubricating oil with special characteristics. The maintenance of the gear box consists of changing of lubricating oil in accordance with the manufacturer's specifications.

The movement is transmitted from the engine to the axle and the gear wheel A by means of the clutch; the gear A transmits its movement to C and then in turn to D and its axle, its rotation being in the same direction as with the input shaft.

If we see that the engine provides 2,000 R.P.M. to the intake shaft and only 1,000 R.P.M. is produced, we may say that the gear ratio is 2:1.

This combination is used for slightly inclined stretches for which increased traction of the motive wheels is necessary.

Third Gear. The coupling of the synchronizer is shifted forwards until it engages the gear A, connecting the output shaft with the gear of the input shaft (fig. 4).



The movement is transmitted directly from the engine to the transmission, producing a gear ratio of 1:1; the reason for which it is often referred to as "Direct".

It is used when travelling along roads, where the only resistance to be overcome is what is normal in driving.

Reverse Gear. With this gear, a gear wheel situated at the bottom of the gear box is made use of while on constant engagement with the last gear of the counter shaft (fig. 5).

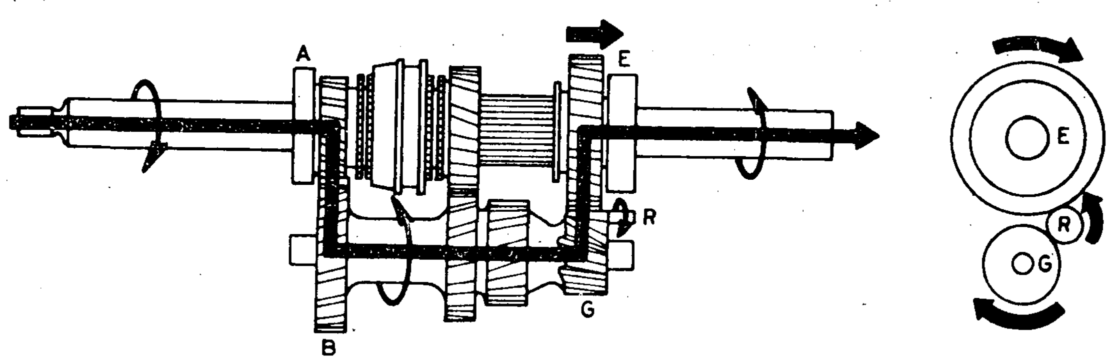


Fig. 5

FUNCTIONING

First Gear. The gear (fig. 2) is shifted forward, along the yoke, engaging gear F.

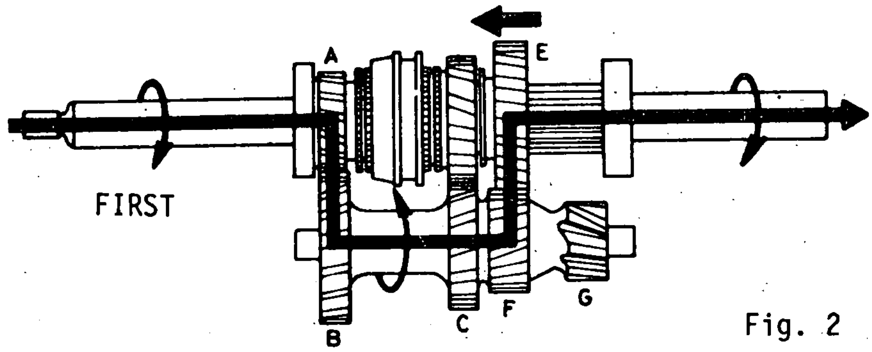


Fig. 2

The movement supplied by the engine is transmitted to gear A and from there, to gear B, as they are in constant contact, but in the opposite direction, and simultaneously to the gear wheels C, F and G as they are jointly bound and made from one unit.
The movement of the gear wheel F is transmitted to the gear E and from there to the output shaft and the rest of the transmission, the direction of rotation changing to coincide with that of the input shaft.
This reduction becomes useful when the vehicle is driving up a very steep road.
If we consider that the engine provides 2,000 R.P.M. to the input shaft of the gear box which reduces it to 500 R.P.M. at the output shaft, we can state that the first gear ratio is 4:1.
This reduction in speed at the output shaft of the gear box accounts for an increase in traction of the drive wheels.

Second Gear. The coupling of the synchronizer S is shifted backwards thereby engaging the gear wheel D, which spins freely on its shaft in constant contact with the gear wheel G. (fig. 3).

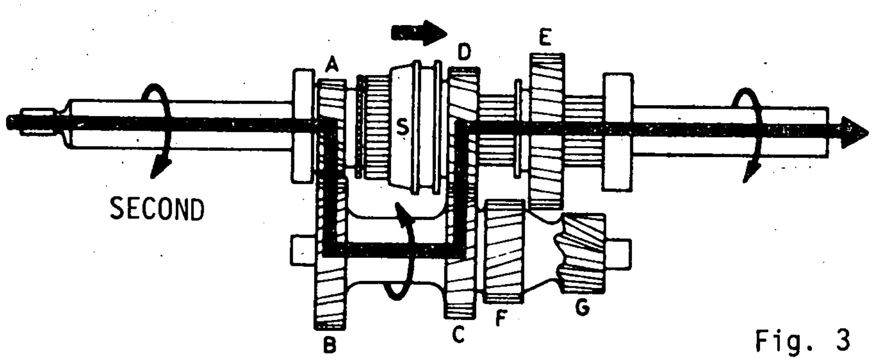


Fig. 3

The gear box is one of the mechanical units of the transmission system which, by means of gears, enables the variation of the transmission speed, contributing to a greater traction of the vehicle.

CLASSIFICATION

Gear boxes may be classified into two main groups:

- Manual gear-boxes
- Automatic gear-boxes

Manual gear-boxes are distinctive because the combination of the different speeds are done directly by the driver. Automatic gear boxes are operated by hydraulic pressures which depend on speed and road conditions. In this case the driver only operates the accelerator of the engine.

MANUAL BOX TYPES

Manual boxes may be:

- Synchronized
- Not synchronized

Notwithstanding the type, they may be of 3, 4, 5, or more speeds.

CONSTITUTION OF THE SYNCHRONIZED BOX

The typical three speed box (fig. 1) is composed of:-

1. Box or case
2. Input or drive shaft
3. Secondary or output shaft
4. Counter or triple shaft
5. First and reverse Idler Gear
6. Second gear
7. Second and third synchronizer
8. Counter and Reverse idler gear
9. Bearings
10. Shifter forks
11. Lever ball and socket joint
12. Gear Lever
13. Rear cover of extension.

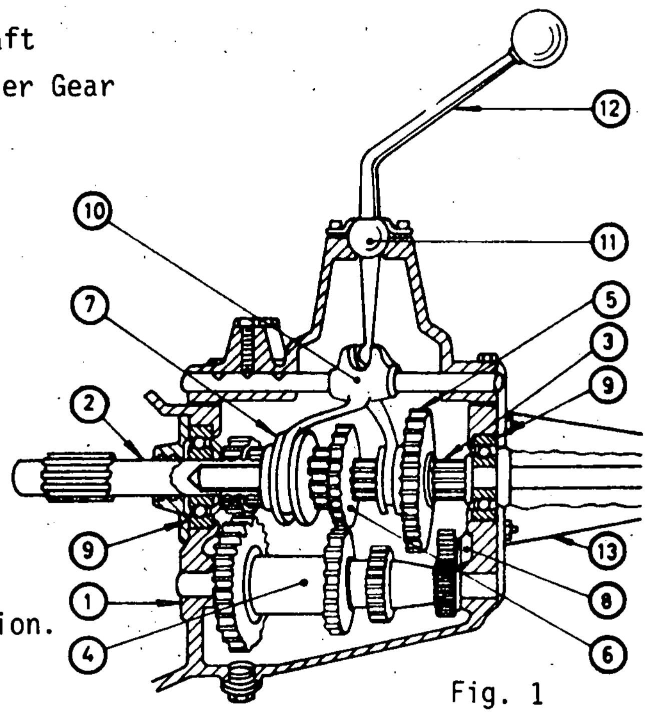


Fig. 1

FUNCTIONING

When the vehicle starts, stops or runs on irregular roads, the differential unit rises and falls constantly. This varies the angle formed by the output shaft of the gear box and the drive shaft; together with this, there would be a variation in the distance between the gear box and the differential. These variations are compensated for by the action of the universal joints and the sliding yoke.

TYPES:

Uncovered Drive Shaft, as shown in fig. 1, is called the Hotchkiss System, and may be comprised of one or more shafts, depending on the type of vehicle.

Solid Shaft with External Covering, is called a torque tube and is connected by means of bolts to the rear differential housing. There is a universal joint on the front end of the shaft which connects it to the coupling of the gear box.

MAINTENANCE:

The drive shaft requires little care, as it is pre-balanced at the factory. Only with some models is it recommended to periodically grease the universal joints.

SUMMARY

DRIVE SHAFT { *Hotchkiss*, *Torque Tube* }

UNIVERSAL JOINTS { *Flexible*, *Ball and Trunnion*, *Cross and Rollers* }

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Flexible Joints, not commonly used, are made up of a rubber disc reinforced with fabrics, similar to those in tyres, to which the universal shaft is bolted on one side and the differential coupling or sliding yoke of the box on the other (fig. 4).

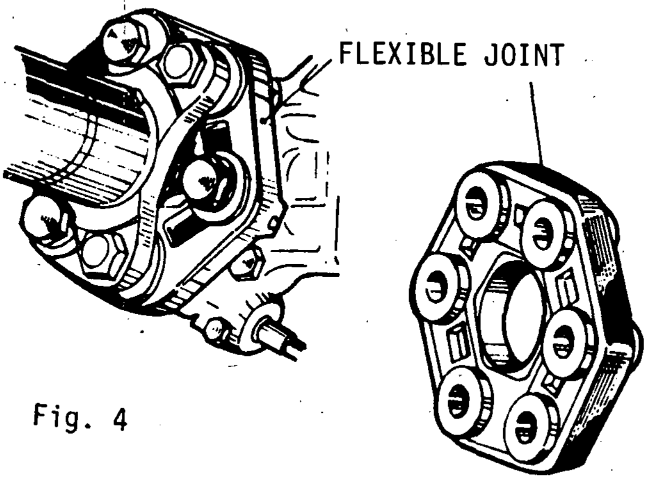


Fig. 4

Ball and Trunnion: With this type, the universal joint and the sliding yoke, combined to form one unit function within the element called the cup (fig. 5).

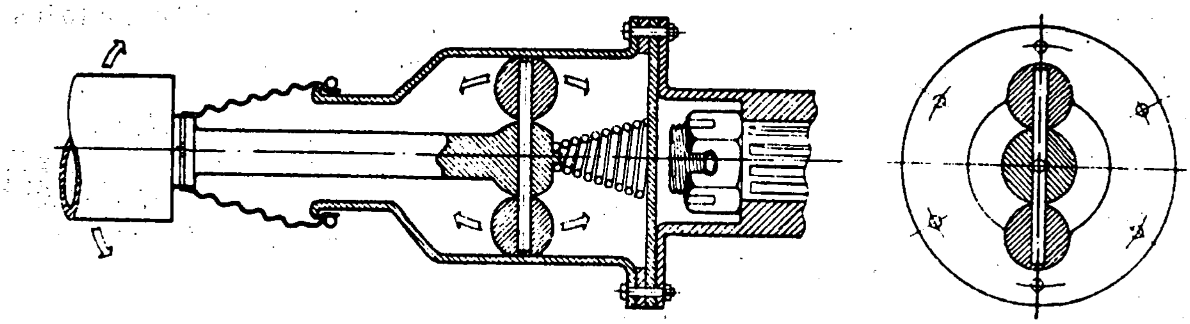
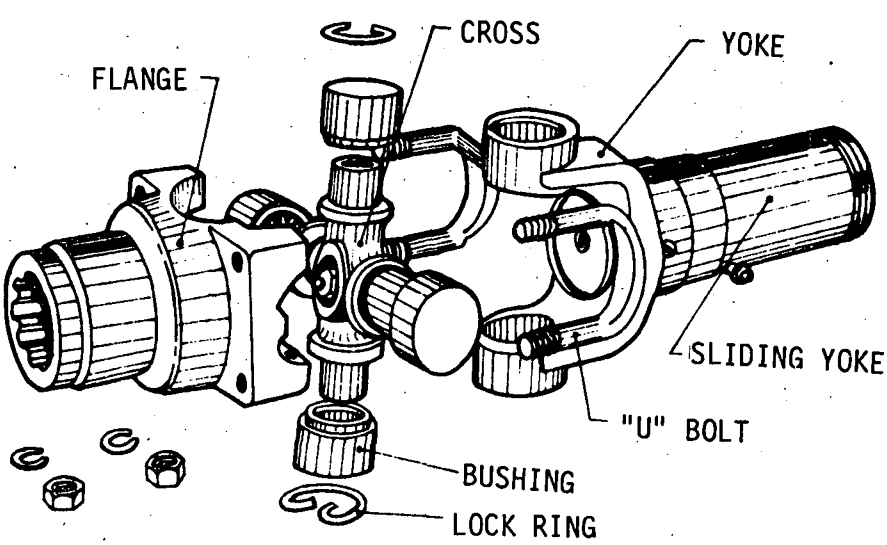


Fig. 5

Cross and Rollers are the most commonly used today. They are mounted on the yokes of the shaft and couplings. The cross is a part with four shafts that form an angle of 90° with each other; each shaft enters a block, in which there is a series of rollers lubricated with grease, for preventing excessive friction (fig. 6).



It is the part of the transmission system designed to transmit the rotating movement from the output shaft of the gear box to the differential, allowing for variations of the angle and transmission length.

CONSTITUTION

The universal shaft is composed of (fig. 1):

- Body or shaft
- Sliding yoke
- universal Joints

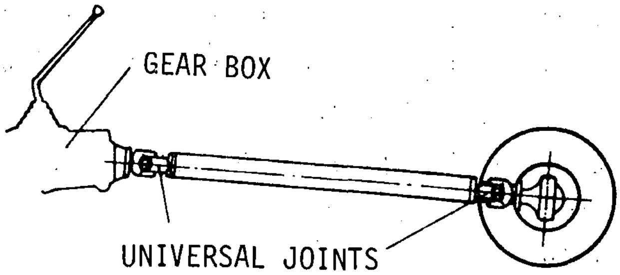


Fig. 1

The Body or Shaft is a steel tube or bar that is properly balanced. The end that is connected to the gear box may have a grooved tip or yoke for installing the universal joint, the other end usually contains a yoke.

Sliding Yokes. When the shaft ends with a grooved tip, it has internal grooves for installing the shaft, enabling its displacement (fig. 2).
When the shaft ends in a yoke and is connected to the yoke by means of a universal joint, it also contains internal grooves for directly connecting it to the output shaft from the gear box (fig. 3).

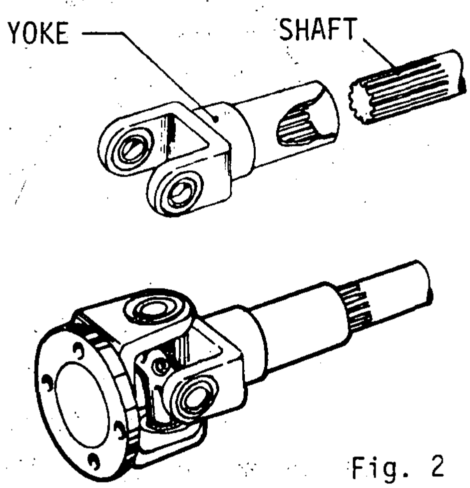


Fig. 2

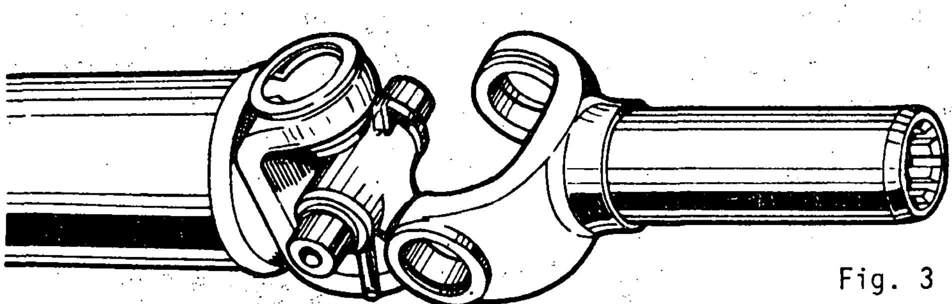


Fig. 3

The Universal Joints enable the shaft to absorb the angle changes produced by the difference in height between the rear differential housing and the gear box, when the vehicle is in movement. The types of joints are:

- Flexible
- Ball and trunnion
- Cross and rollers

FUNCTIONING:

The rotary movement from the engine is transferred to the gear-box, by means of the clutch.

On engaging a set of gears in the gear box and operating the clutch, the movement of the engine from the gear box will be transferred in relation to the velocity which corresponds to the engaged speed.

This movement is transferred through the drive shaft to the differential, which projects it to the half-axles and the respective wheels.

The difference in velocity of each half axle when the vehicle is making a turn, is compensated for by the pinion gears of the differential.

CLASSIFICATION

Transmissions may be classified into:-

- Manual Transmissions
- Automatic Transmissions

Manual transmissions are operated by the driver, who operates the clutch and gear box simultaneously.

Automatic transmissions are operated by hydraulic pressures, in the torque converter, which replaces the clutch, as well as in the gear box.

Types of manual transmissions. Manual transmissions may be :

- Conventional
- Integrated

Conventional types are the most common, having all their parts arranged from the front end of the vehicle to the rear, see figure 1. The integrated types are compact units in which the engine, gear box and differential have been arranged into one assembly, eliminating the drive shaft.

They may be situated at the front part (fig. 6) as well as at the rear part of the vehicle (fig. 7).

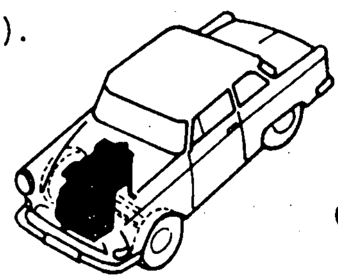


Fig. 6

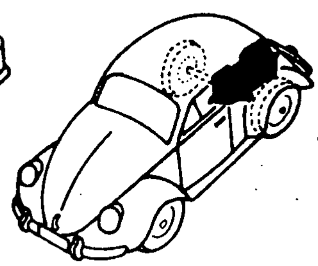


Fig. 7

Gear-box (fig. 3). It is the mechanism in the transmission system that is intended to vary the transmission velocity of the engine, thereby increasing the traction of the wheels.
It also enables reverse propulsion and the functioning of the engine without movement of the vehicle (in neutral).

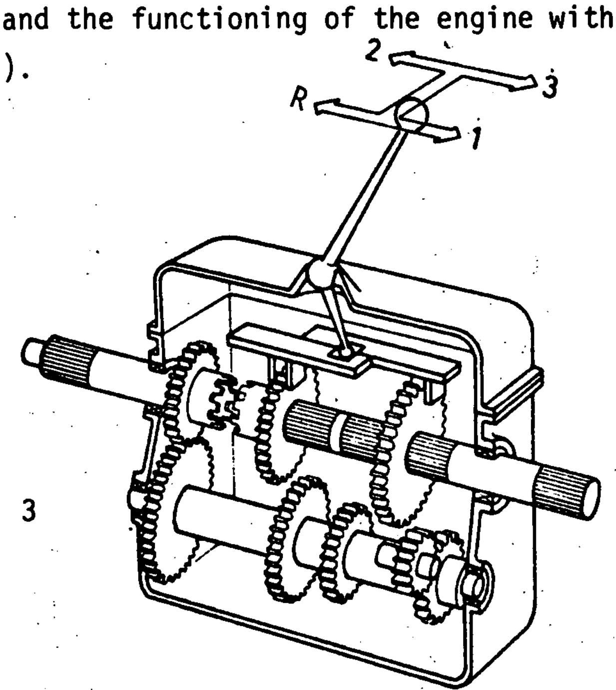


Fig. 3

Drive Shaft or Propeller shaft (fig. 4). It is arranged lengthways below the flooring of the vehicle and it transmits the movement of the output shaft from the gear box to the differential.

Differential: Is the part of the transmission system which is intended to:

- change the direction of the rotary movement transmitted by the universal axle through 90°, by means of a set of gears, to the half axles and wheels (fig. 5).

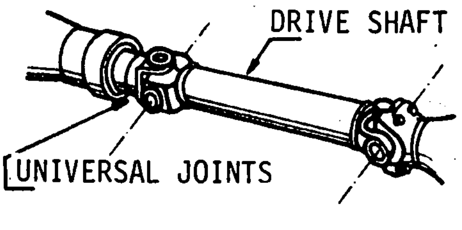
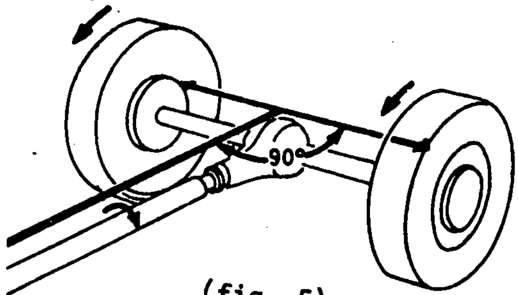


Fig. 4



(fig. 5).

- furnish a constant reduction so as to make use of the efficiency of the engine, which is better at high speeds.
- enable the wheels to rotate at different speeds when the vehicle is making a turn.

The transmission system is made up of an assembly of mechanisms that are designed to transmit the force produced by the engine to the drive wheels of the vehicle.

CONSTITUTION

The transmission system is composed by the following elements (fig. 1).

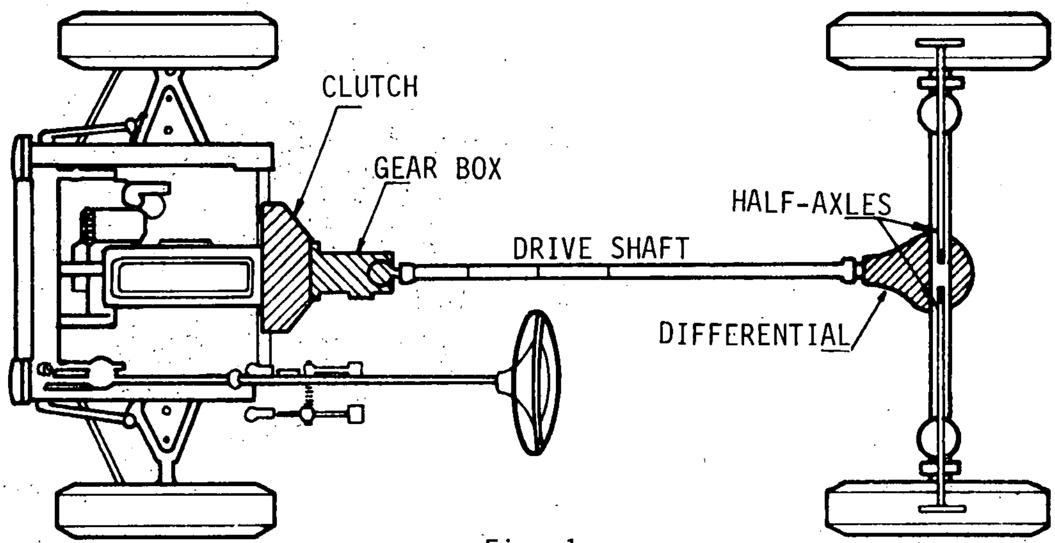


Fig. 1

DESCRIPTION

Clutch (fig. 2). It is the part of the transmission that is situated between the engine and the gear box. Its purpose is to connect and disconnect, at the driver's will, the rotating movement of the flywheel of the engine to the rest of the transmission.

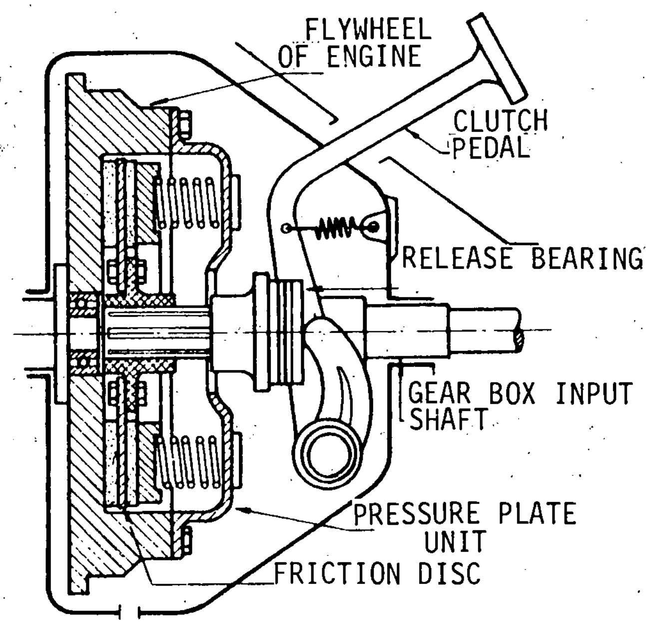


Fig. 2

It compensates for the play in the joints and its adjustment is by modifying the length of the steering rods.

A certain toe-in, generally from 1.5 to 3 mm, absorbs any play or vibration from the steering joints and enablesthe wheels to revolve parallel to the central axle of the vehicle. In front propulsion vehicles, the wheels are toe-out because they tend to close in at the front part.

Toe-out on the curve. Is the extent of toe-out of the wheels on turning (fig. 5). It is controlled by the angle (a) between the steering arms and the horizontal axle of the wheel and its objective is to reduce the excessive friction of the tyres on turning, as both wheels should turn about a common centre (c).

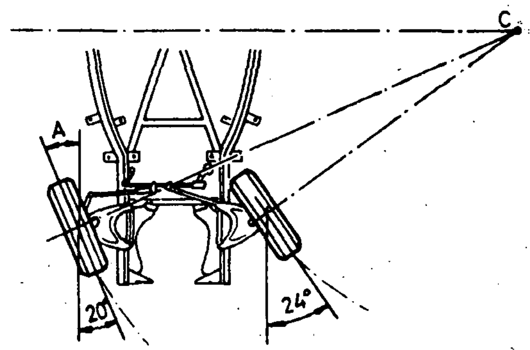


Fig. 5

Aligning equipment. Aligning equipment for checking steering angles are varied and each one should be operated in accordance with the manufacturer's specifications.

When the inclination is backwards in relation with the vertical, the caster is positive, when it is frontwards, it is negative.
The object is to make the wheel tend to move in a straight line and to straighten the steering by itself, after the vehicle has completed a turn.
With this angle, the effect of the weight of the vehicle is situated in front or behind the point of contact of the tyre with the road. When the caster angles are unequal, it causes the vehicle to bear down more heavily towards the side on which the angle is smaller.
An excessive caster angle does not cause tyre wear.

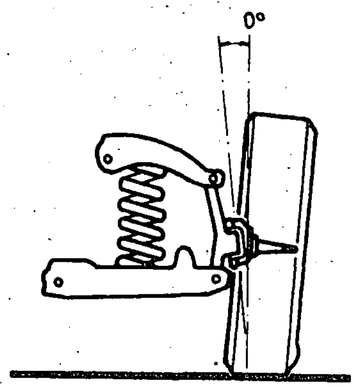


Fig. 3

KING PIN INCLINATION

Is defined as the inclination of the king pin or of the central steering line inwardly, at its top part (fig. 3).
Its purpose is to reduce the necessity of excessive inclination of the wheels or the camber angle.
This angle is not adjustable in all makes of vehicles and if the measurement indicates that it is not the correct one, it is because some of the parts are bent and would have to be replaced.

Toe-in. Is the difference in distance between the front and rear part of the front wheels (fig. 4).

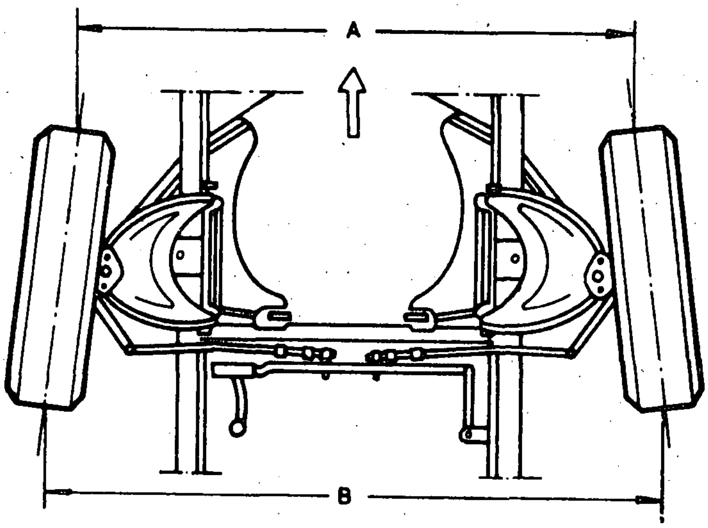


Fig. 4

Steering geometry refers to the angles formed by the front wheels of the vehicle with respect to the vertical or horizontal reference axles. Wheel alignment is a very specialized task that should be done with precision in order to obtain satisfactory results and to enable:

a) Easy driving.
b) Better holding of the wheels on the road.
c) Smoothness in the drive.
d) Greater stability.
e) Greater tyre life.

ANGLES FORMED BY STEERING GEOMETRY

Camber, deviation or vertical inclination angle (fig. 1). This angle is formed by the inclination of the wheel, inwards or outwards at its top, with respect to a vertical line. When the top part inclines outwardly, the angle is positive; when it is inwardly inclined, it is negative. The object is to converge the point of application of the load on the point of contact of the tyre with the road. This facilitates driving, by reloading the weight of the vehicle on the internal bearing of the spindle, and reduces tyre wear.
An inclined wheel tends to steer towards the side of inclination; as a result, if one of the front wheels has a positive inclination greater than that of the other, the vehicle would tend to swerve towards the side on which the inclination angle is greater.

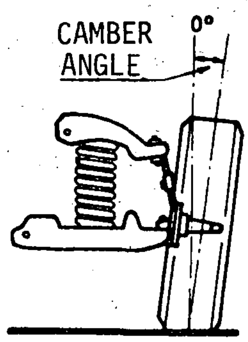


Fig. 1

Caster or advance angle (fig. 2). This angle is formed by the frontward or backward inclination of the spindle steering arm or of the supporting arm of the steering ball joints, at the top, with respect to a vertical reference line.

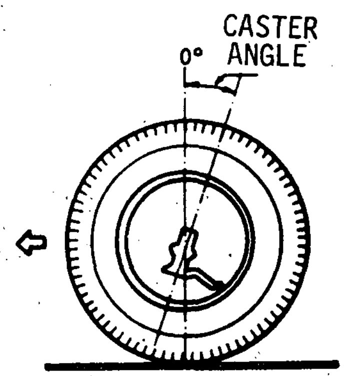


Fig. 2

On driving the worm, the balls roll along its helical duct, displacing the nut; when they reach the end they return through the return tubes of the nut, establishing a closed circuit of circulation (fig. 7).
With some variations to this type the nut moves an interlocking sector mounted on the pitman arm (fig. 8).

Worm and rack type steering box. This type is used only in light vehicles because the friction reduction is limited. It consists of a worm that interlocks with a rack which is connected to the steering arms, through the rods (fig. 9).

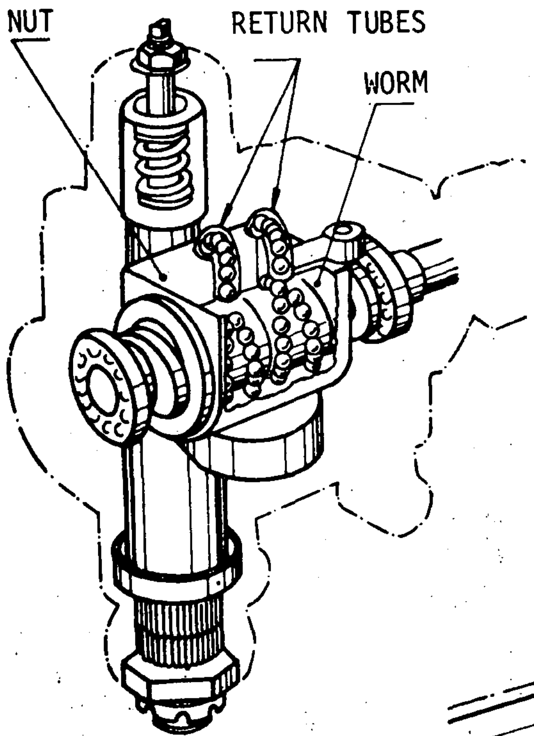


Fig. 7

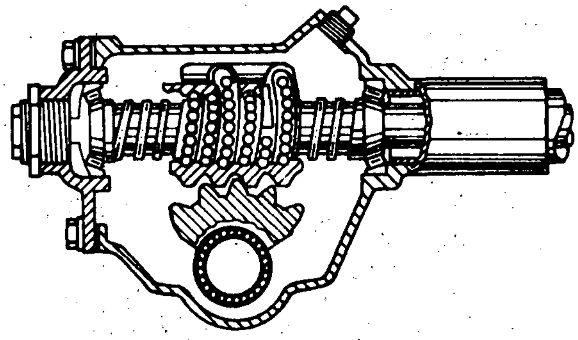


Fig. 8

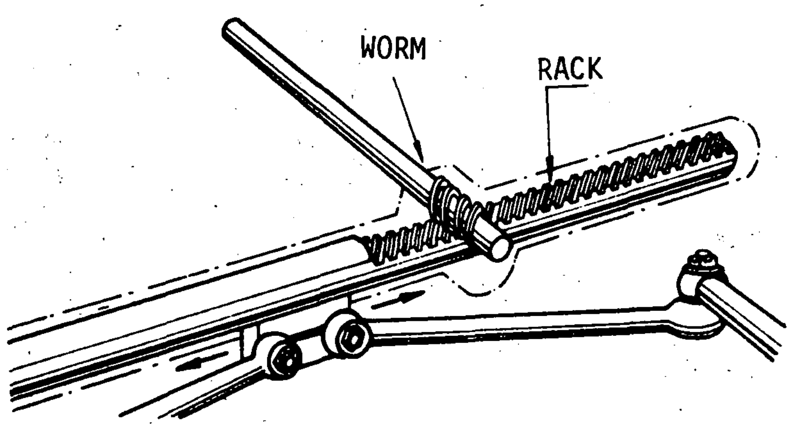


Fig. 9

Because the safety of the passengers of a vehicle depends largely on the steering system, the state of its component parts should be periodically checked so that they may be adjusted or replaced, if necessary.
The torque of the bolts and nuts that secure it should be checked and also the nuts of the ball joints and rod ends should be well fastened by cotter pins that do not reveal any play in their housings.
Their components should be lubricated, as well, according to specifications.

Worm and cross-shaft type steering box. In this type, the sector has a cross-shaft on the end of which there is a bolt that interlocks with the worm. The bolt may be integrated with the cross-shaft or it may be a separate unit mounted on roller bearings so as to reduce friction and facilitate driving (fig. 5). The cross-shaft moves more rapidly as it approaches the ends of the worm due to the greater angle formed. Heavy vehicles employ the use of a double cross-shaft furnished with two bolts mounted on roller bearings (fig. 6).

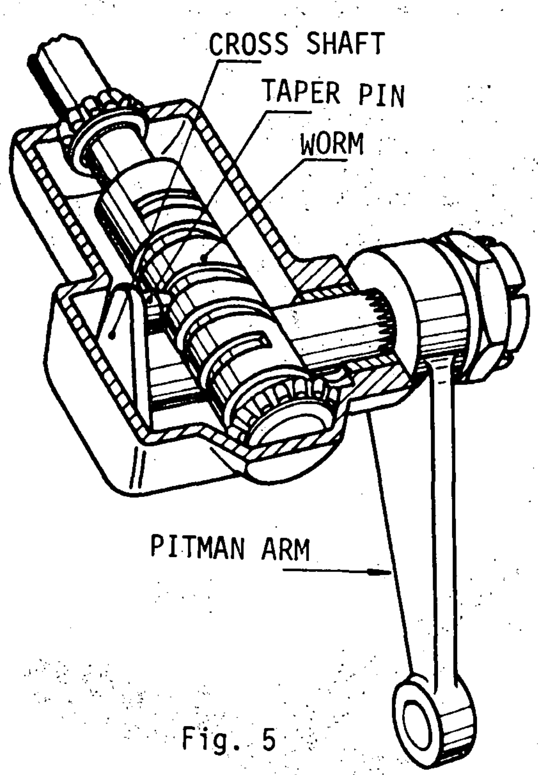


Fig. 5

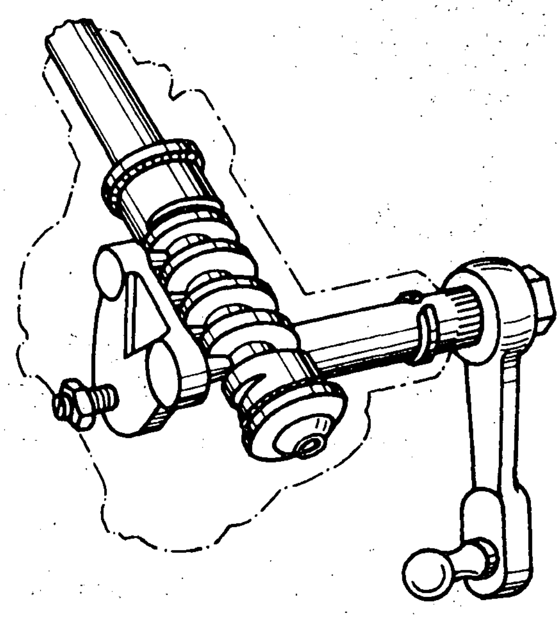


Fig. 6

Worm and circulating ball type steering box. This type of box is one of the most used at present, because friction has been reduced to a minimum.

It consists of a nut that works with the worm; to reduce effort, a row of balls is interposed between them, converting the gliding friction into rolling friction.

TECHNOLOGICAL SUBJECT CODE

TYPES

Mechanical steering units differ basically according to the type of steering box; these may be:

- Worm and sector type.
- Worm and roller type.
- Worm and cross-shaft.
- Worm and circulating ball type.
- Worm and rack type.

Worm and sector type steering box.

In this type of steering box the sector interlocks with the worm directly (fig. 2). The worm is situated on conical roller bearings which absorb the push and load, and the axial play can be adjusted by means of a screw. The sector is also furnished with a screw that regulates the axial displacement, thereby allowing both axles to couple.

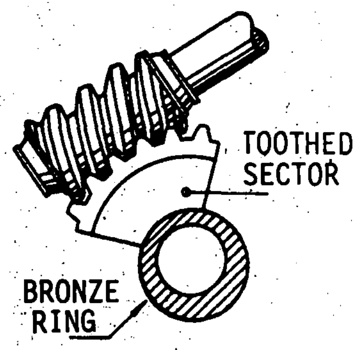


Fig. 2

Worm and roller type steering box. This type of box is distinguished by the fact that it includes a roller in the sector that interlocks with the worm (fig. 3).

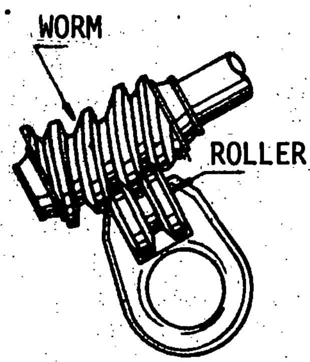


Fig. 3

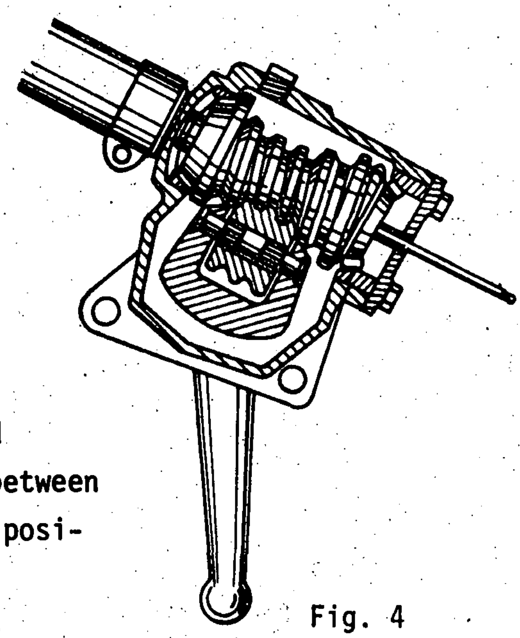


Fig. 4

The worm is peculiar because it has different diameters, smaller at the centre and wider at the ends, so that the engagement between the worm and roller may be the same in all positions during its operations (fig. 4).

On rotating the worm the movement is transmitted to the sector through the bearings; the pitman arm, connected to the sector shaft, is driven transmitting the movement to the wheels, through the rods and arms.

The mechanical steering system is the assembly of parts which guide and operate the front wheels of the vehicle as the driver wishes.

PRINCIPAL COMPONENTS OF THE STEERING (FIG. 1).

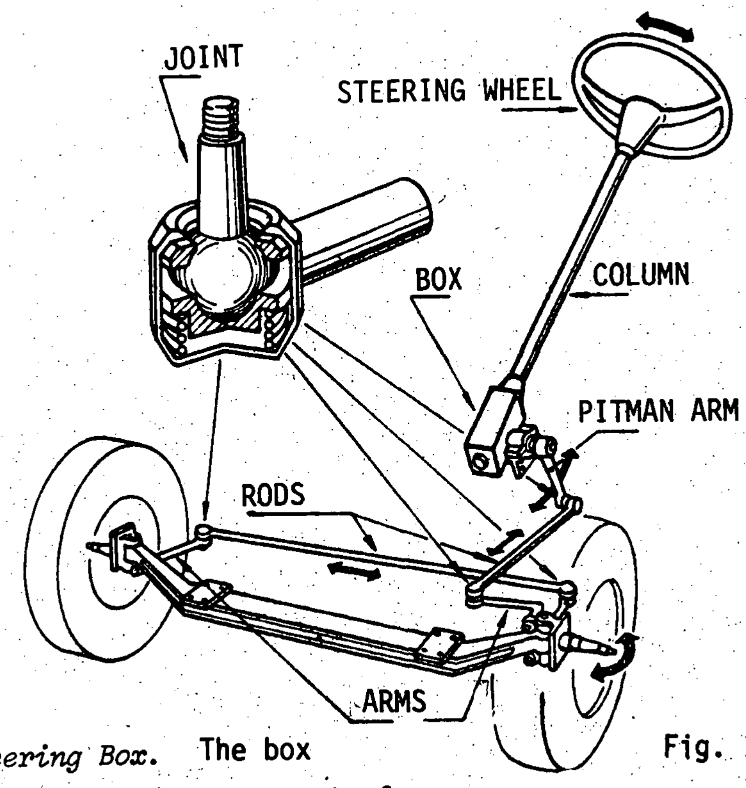


Fig. 1

Steering Box. The box converts the rotating movement of the steering wheel into a rectilinear movement of the arms and rods, allowing the driver to also exert less effort in directing the vehicle.

It is composed of a metallic box which is usually bolted on to the chassis and inside which the worm with its bearings and the sector with its adjusting components are housed, totally submerged in lubricating oil.

Steering Column. It is made up of a hollow tube inside which the worm screw shaft revolves, operated by the steering wheel that is installed at its other end. The steering wheel may be secured by means of keys or splines and the centring of the wormshaft in the column is achieved by means of bearings.

Steering arms, rods and joints. This unit is designed to transmit the sector movement of the box to the wheels. The adjustment of the angles formed by the arms and the rods is achieved by means of the steering joints or ends.

The arrangement of these parts varies and it depends on the type and model of the vehicle and the shape of the suspension.

Static Balance. With different types of equipment to verify and control static balance, the wheel is supported at its centre (fig. 8). The equipment is very sensitive and any tendency of the wheel to incline would indicate the difference in weight and the position in which the little counter weights should be inserted to counteract these differences.

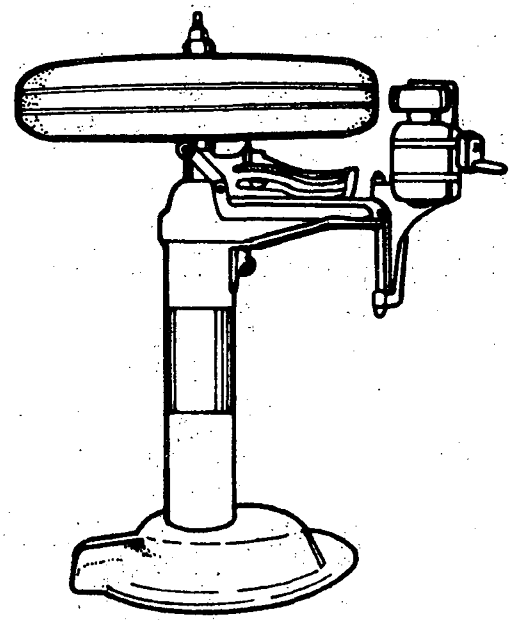


Fig. 8

Nowadays, there is electronic and optical equipment for the control of static and dynamic balance (fig. 9).

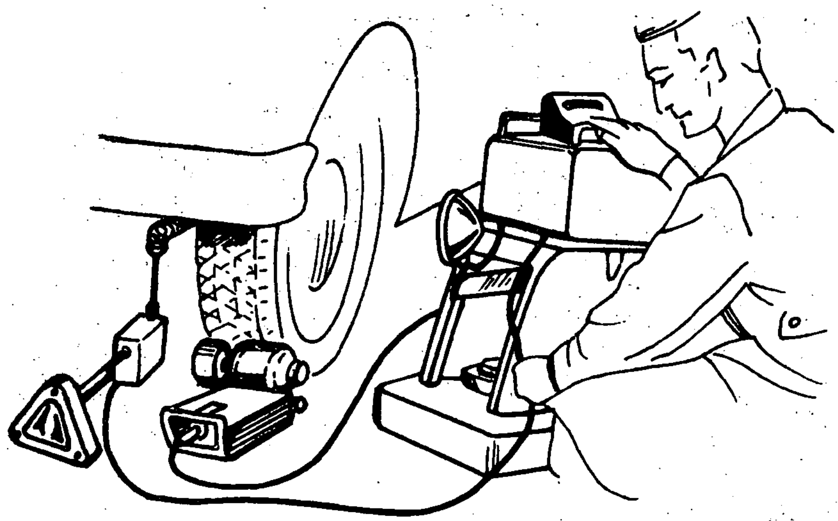


Fig. 9

MAINTENANCE

To get best use from tyres one should:

a) Keep the inflated pressure according to specifications, so as to prevent premature wear or breakage of the fabrics. The pressure should be verified only at atmospheric temperature.

b) Interchange the tyre positions according to the manufacturer's recommendations (fig. 6).

c) Keep the wheels statically and dynamically balanced.

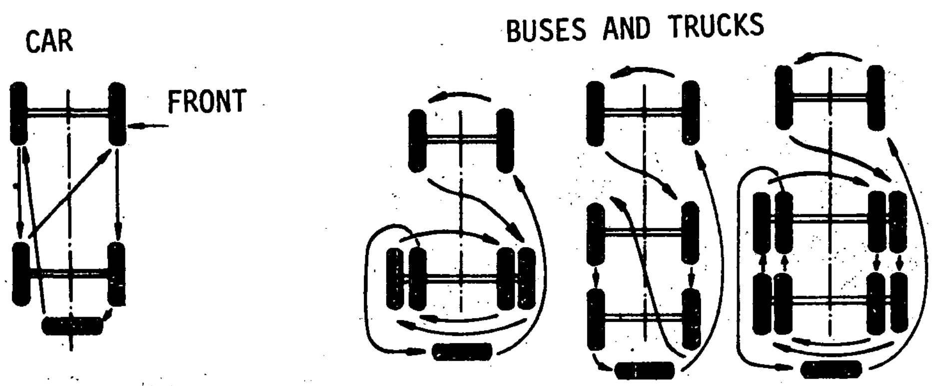


Fig. 6

Any imbalance existing in the front or rear wheels, produces vibrations which in turn lead to premature wear on the tyres. For this reason the wheels should be balanced both statically and dynamically.

Dynamic balance. This can be checked with the wheel still on the vehicle by means of a portable device (fig. 7), which enables a rapid verification.

The vehicle is raised thereby removing the wheels from the ground and the operating pulley of the gyrator is positioned against the tyre; by spinning the wheel at a high speed, if there is any imbalance, it will begin to vibrate, therefore, indicating the need to counter-load it.

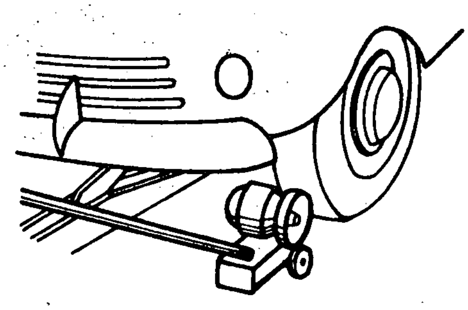


Fig. 7

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Tyres are made of a cotton, nylon or rayon cord binding impregnated with rubber, reference-mark fabrics and a border reinforced with steel wires to keep both sides firm (fig. 4). The binding is covered with rubber side walls, as well as the tread, and the whole system is vulcanized so that it forms one unit. Besides, the tread is specially shaped so as to obtain better traction and adherence of the vehicle to the road. The characteristics and dimensions of the tyre are marked on the side wall, which indicate the tyre division, its internal diameter and the number of fabrics.

Some modern vehicles are equipped with tyres that do not contain tubes (fig. 5), in which case the rim includes an air valve.

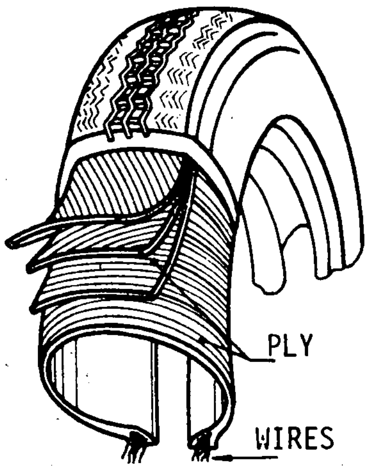

Fig. 4

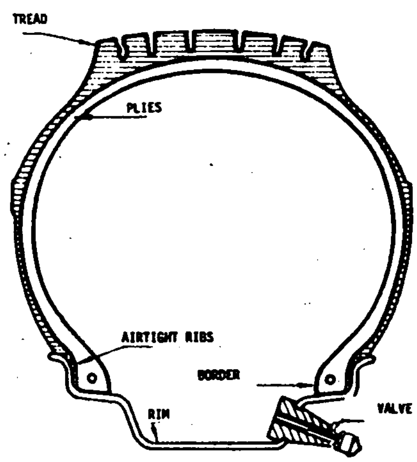

Fig. 5

The tyre border is reinforced in such a way that it presses down firmly on the edge of the rim and in this way the pressure of the air is maintained.

Tubes. It is installed inside the tyre and is inflated with air to a specified pressure, which causes the tyre to resist any change in its shape.

In manufacturing tubes, natural and synthetic rubber are used. Nowadays the material which is most used is Butyl, tubes made with this material being identified by a blue braid. Other tubes made with synthetic material are identified by a red braid and the ones made with natural rubber do not have braids. They are equipped with a valve which enables the air to enter the tube and prevents its flow in the opposite direction.

These are special tubes called self-seal and safety tubes.

The wheels of a vehicle serve the purpose of allowing its movement, obtaining a good drive and partly absorbing the irregularities of the road.

CONSTITUTION

A wheel is composed of the rim, the tyre and the inner tube:

Rims. Rims used in automobiles are of the metallic corrugated type (fig. 1), so that the inner tube and tyre may be installed. There are a great variety of rim shapes for heavy vehicles, the most used being those shown in figs. 2 and 3.

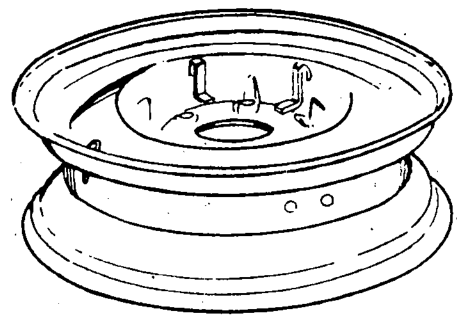

Fig. 1

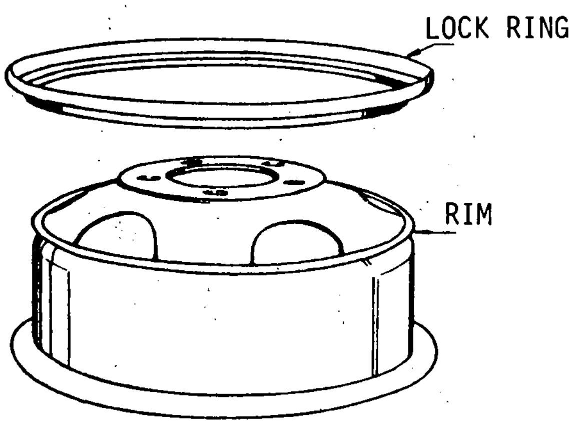

Fig. 2

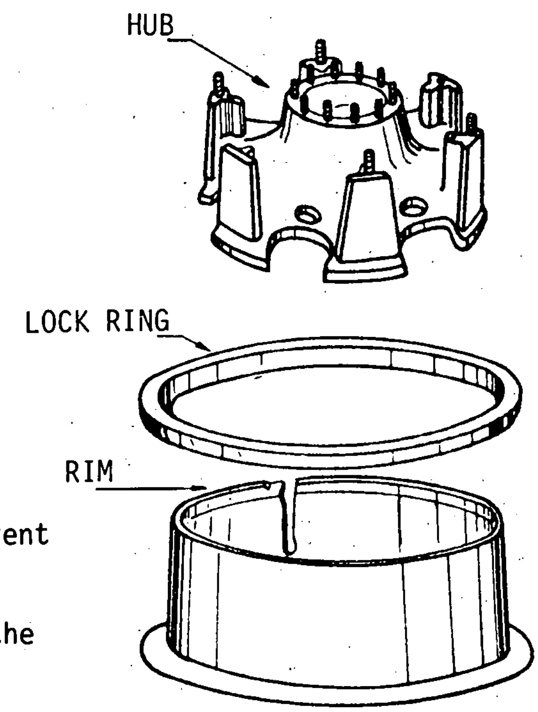

Fig. 3

The lock rings of the rims or hoops, prevent the tyres from slipping out of position when the inner tube is inflated or when the vehicle is in motion. It may be made of stamped or cast steel, for medium or heavy weight vehicles. In automobiles they are made also of alloys of aluminium and magnesium which is a very light, highly resistant material.

Tyres. The tyre, which in most cases, houses an inner tube, is mounted on the rim. In general, there are two types of tyres: those that are equipped with inner tubes and those that do not contain any.

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CLASSIFICATION

Generally, all steering systems are mechanically operated, but due to the auxiliary devices that characterize them they may be classified into:

- Mechanical
- Hydraulic
- Pneumatic

Hydraulic and pneumatic steering systems reduce the effort exerted by the driver by means of a mechanism called the servo-steering. The hydraulic servo (fig. 2) is the most common and is made up of a pump, with a store for the oil, operated by means of a belt connected to the crank shaft pulley; this sends the fluid under pressure to the control valve which sends it to a double stroke hydraulic cylinder, situated between the steering tie rods.
The valve is governed from the steering box in such a way that when a failure in the hydraulic circuit occurs it falls back on the mechanical circuit completely.

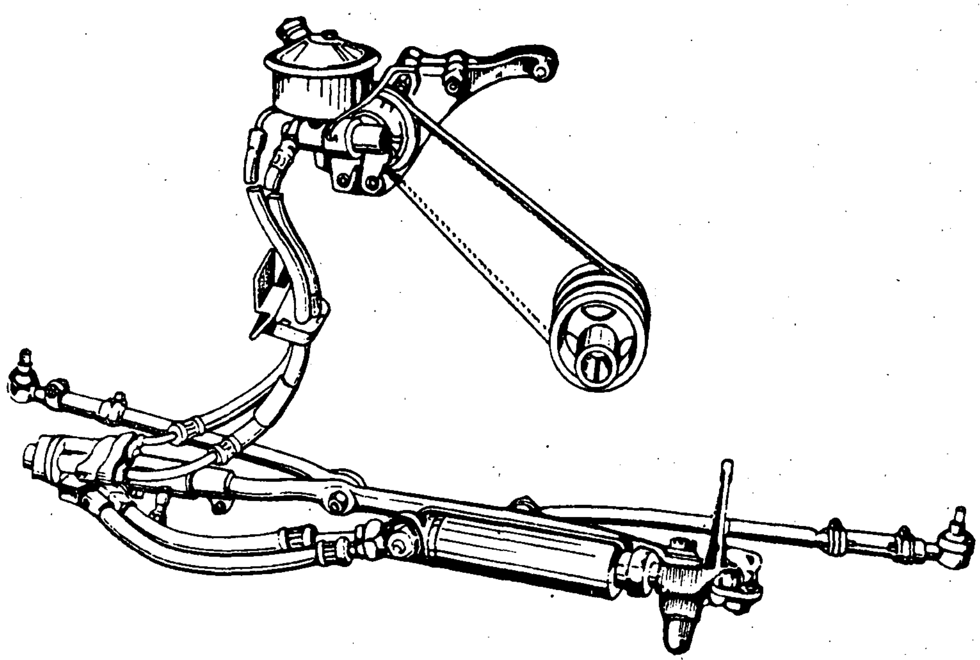

Fig. 2

TECHNICAL VOCABULARY

SPINDLE - Stub axle

The steering system is the mechanism that enables the driver to guide the vehicle in the direction desired.

CONSTITUTION

The principal components of the steering mechanism are (fig. 1):

- The column.
- The steering box.
- The steering rods.

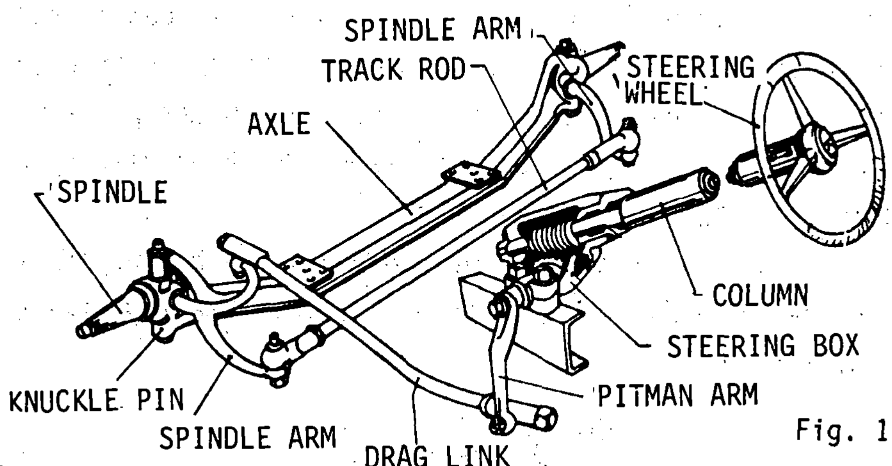

Fig. 1

DESCRIPTION

The column. It contains the steering shaft that connects the steering wheel to the steering box and is supported to the body of the vehicle by means of clamps and bolts.

Steering Box. It is made up of the body which is fixed to the chassis and in it is the worm and sector that work on bearings.

The steering tie rods. These are made of rods with joints on their ends, that transmit the movement of the sector to the steering rod ends.

FUNCTIONING

On turning the steering wheel in any direction, the shaft transmits the movement to the worm screw and the sector in the box, the sector shaft rotates about its centre and by means of the pitman arm, connected at the other end, transfers the movement through the steering tie rods to the spindle arms.

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FUNCTIONING

The wheels receive the impacts caused by the irregularities of the road and they transmit them to the suspension arms by means of the steering knuckle. The coil spring is compressed between the cross-beam and the lower suspension arm, absorbing the movement; at the same time the shock absorber acts preventing the spring from being compressed roughly. The energy absorbed by the spring at the moment of impact tends to return to the wheels, but the shock absorber regulates the spring expansion, enabling the tyre to be in permanent contact with the road.

TYPES

Usually, in compact vehicles the coil spring is situated above the upper suspension arm and the other end is directly supported by the body (fig. 2).

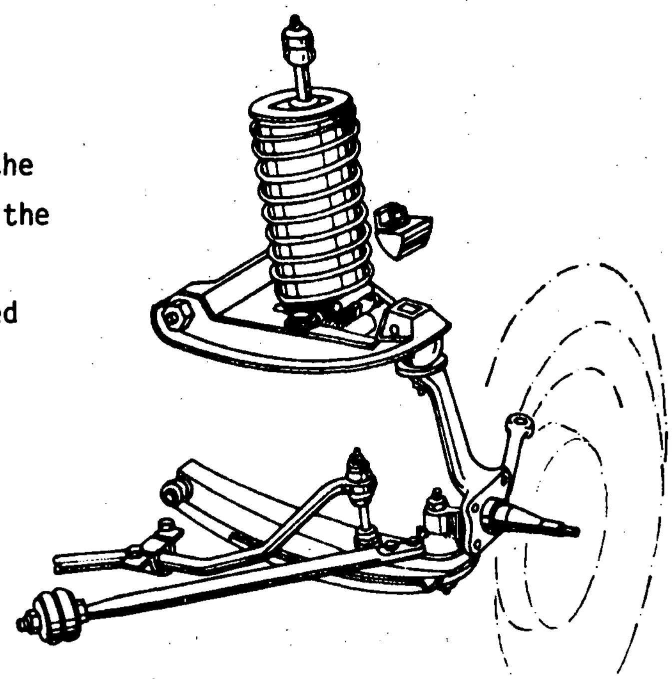

Fig. 2

In another type (fig. 3), the spring is situated on the shock absorber, which is big in size and one end of it is supported by the body and the other by an arm that swings from the cross-beam of the vehicle, acting as a bracket for the steering knuckle.

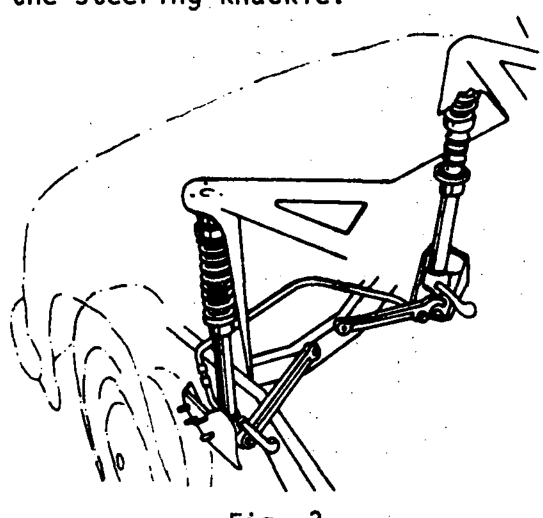

Fig. 3

It is the unit of parts which enables the independent cushioning of the oscillations of the wheels produced by the irregularities encountered on the road, in such a way that they do not affect the rear part of the vehicle to any great extent.

CONSTITUTION

They are generally composed of the following parts (fig. 1):

1. Upper suspension arm.
2. Upper pivot shaft.
3. Upper ball and socket joint.
4. Coil spring.
5. Steering knuckle.
6. Lower suspension arm.
7. Lower pivot shaft.
8. Lower ball and socket joint.
9. Shock absorber.

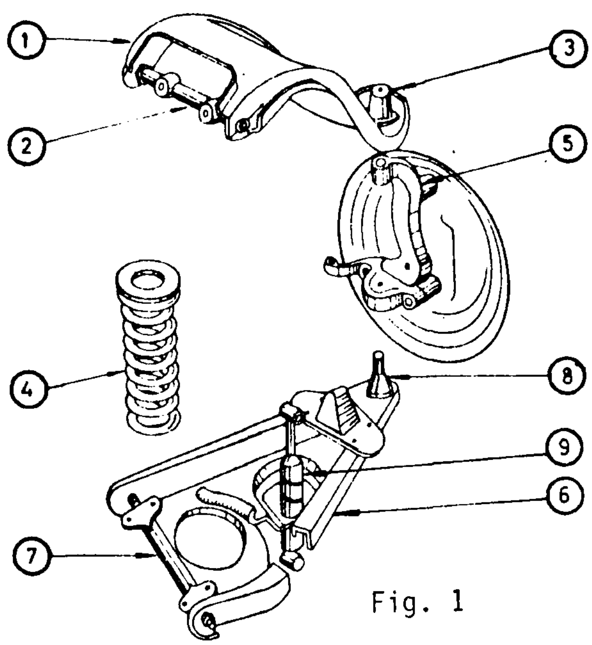

Fig. 1

DESCRIPTION

Suspension arms are of plated steel and are secured to the chassis or the cross-beam by means of the pivot shafts.

Pivot shafts, made of treated steel to make them hard and flexible, have threads on their ends so that the bushing type nuts, on which the suspension arms swing, may be fitted.

Socket joints support the steering knuckle and connect it to the ends of the suspension arms; they enable effecting changes in direction and the irregular movements of the wheels.

Steering knuckle can be directly connected to the suspension arms through the socket joints or be mounted onto a bracket by means of a bolt and nut; it comprises the wheel axle.

The shock absorber is mounted between the lower suspension arm and the chassis of the vehicle so as to absorb the rough movements of the coil spring.

When the suspension rises, the shock absorber is shortened and the piston 'J' compresses the oil in the chamber 'K'. Some of the oil goes through the piston holes to the chamber 'G' and the rest to the annular chamber 'L' through the holes in the cover 'M' (fig. 6).
When the suspension lowers, the process is reversed and the oil is restored to the Chamber 'K'.

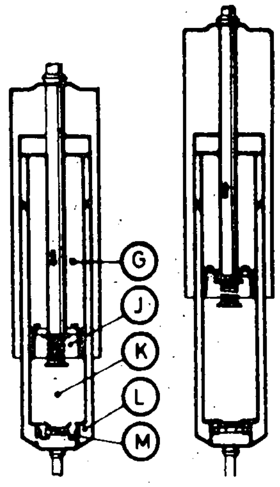

Fig. 6

MAINTENANCE

Periodically the pressure of the securing nuts and screws of the shock absorber should be inspected and checked for possible fluid leaks and worn bushings.
With the rotary or piston type of mechanical and hydraulic shock absorbers, the internal parts can be changed when they function incorrectly. The telescopic shock absorbers are sealed units and only their bushings can be changed; these should be changed when they function abnormally or when they have completed their specified mileage, for which reason they should be changed as a whole, with the object of maintaining the levelling of the vehicle and not contributing to any deficiency in the steering and braking systems.

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Hydraulic shock absorbers. There is a great variety of hydraulic single and double stroke shock absorbers. The best known types are:

- Oscillating paddle board (fig. 3).
- Piston (fig. 4).
- Telescopic (fig. 5).

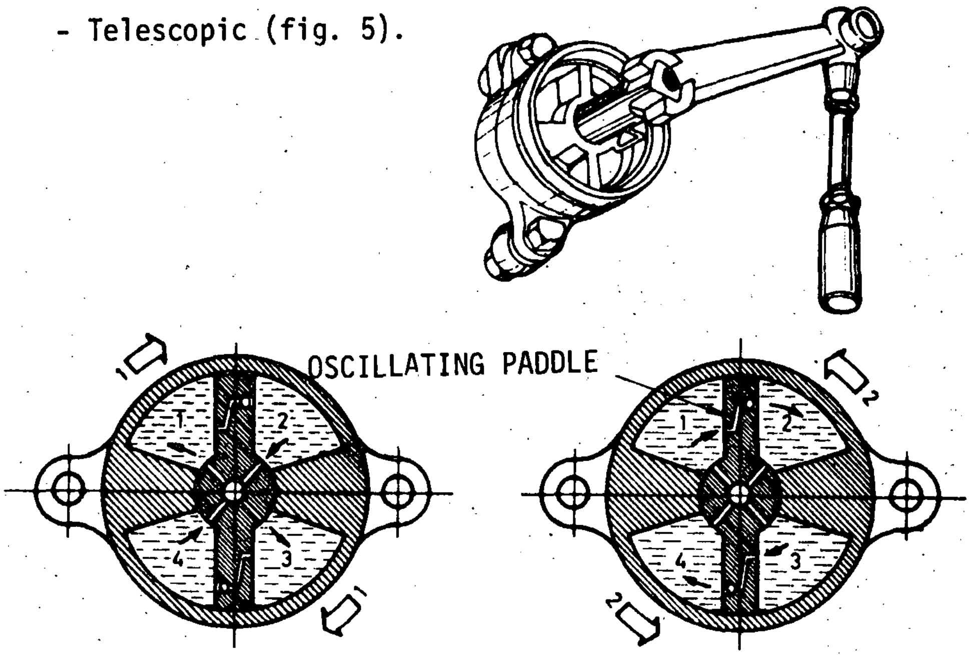

Fig. 3

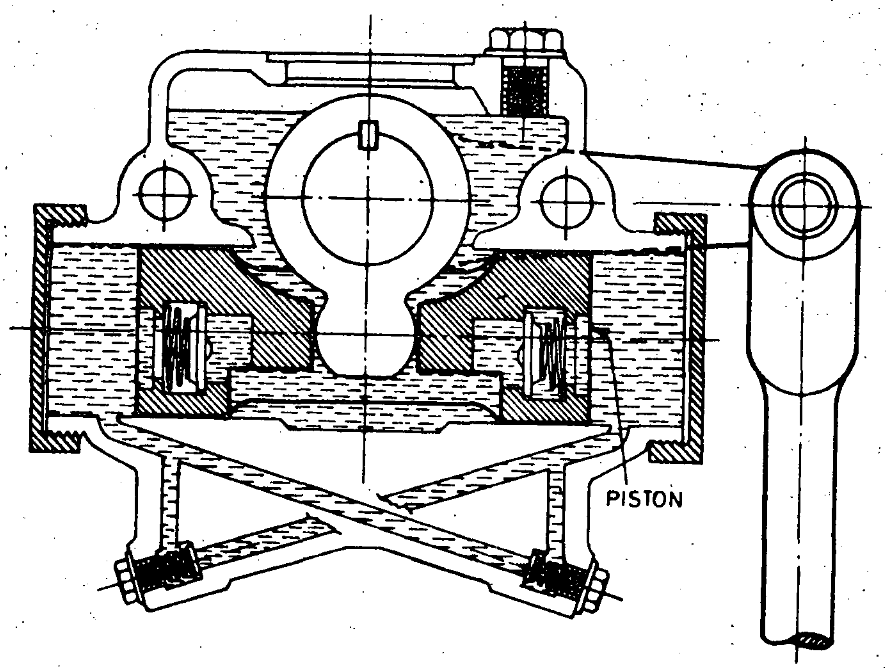

Fig. 4

Fig. 5

The type most used in vehicles is the telescopic type, because of its simple installation and the small space that it occupies. It is fixed at the top to the chassis and at the bottom to the axles.

Shock absorbers are those parts, usually, situated between the chassis and the axles, on each of the wheels, and are designed to reduce the ascending and descending oscillations of the springs, thereby ensuring a smooth and safe drive.

CLASSIFICATION

Shock absorbers are classified into:

- Mechanical
- Hydraulic

the last type being the most used.

DESCRIPTION AND FUNCTIONING

Mechanical shock absorbers.

This type of shock absorber is double stroke, as it absorbs in both of the vertical directions of the suspension, by means of a series of flat or concave steel discs inserted between discs lined with a material with a high resistance to friction (fig. 1). The steel discs are joined to the arms, forming two units; one of these arms is fixed to the chassis and the other to the axle (fig. 2). Both units are connected by means of a screw bolt that is also used to regulate the pressure between the discs; the arms of the shock absorber move in a way similar to a pair of scissors, on adjusting the distance between the chassis and axles; as a result of the friction between discs the rough movement of the suspension springs is lessened.

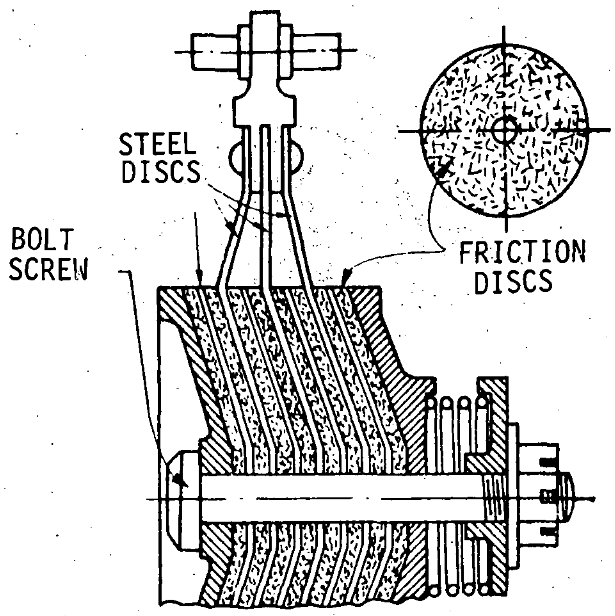

Fig. 1

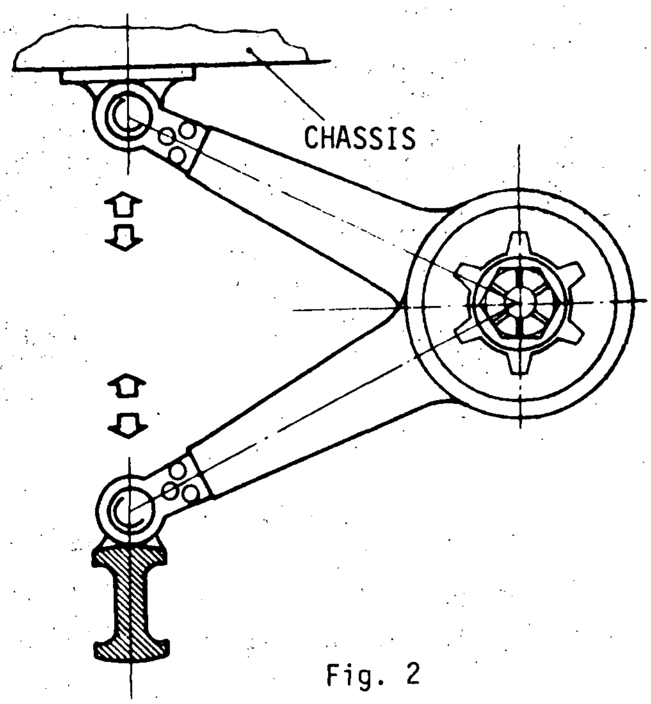

Fig. 2

CHARACTERISTICS

This suspension is typified by the leaf springs that are made up of various leaves of tempered steel of different lengths and curvatures. The principal leaf is called the mainleaf; the second one is usually similarly shaped and is used to reinforce the first; the smaller leaves are arranged on top of each other in a sequence of decreasing lengths and are called third, fourth, fifth leaf, etc. They are secured to their positions by means of clamps and a central bolt.

Some leaf springs carry rubber supplements, waxed fabric or self-lubricating bronze discs that facilitate the rubbing action at the ends of the leaves.

Some types of medium and heavy tonnage vehicles carry auxiliary springs that take effect after a certain load (fig. 2).

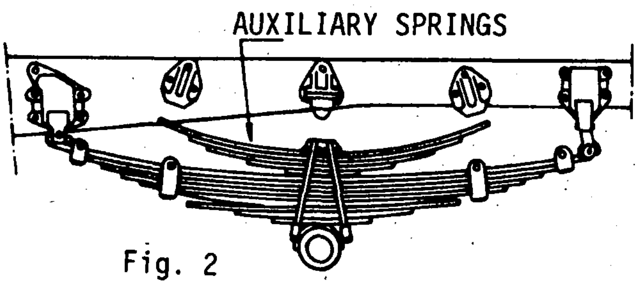

Fig. 2

TYPES

In the rear suspension the semi-elliptical type of leaf springs is the most used, however, there are other types that perform the same function, but differ in their shape and assembly in the vehicle (fig. 3).

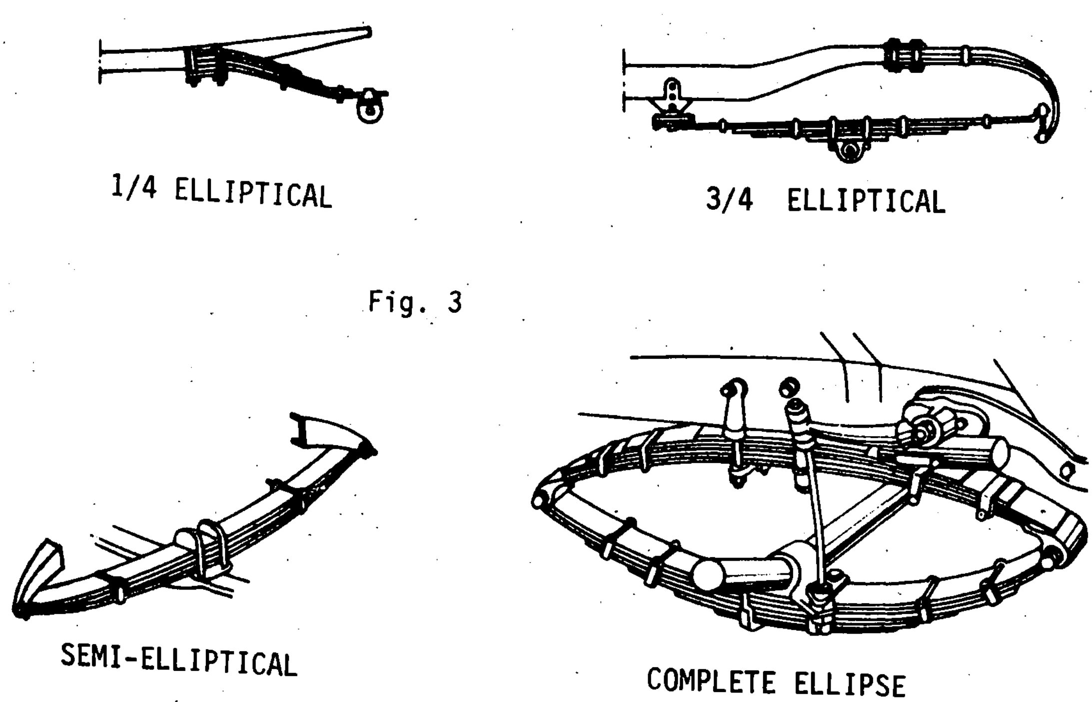

Fig. 3

This type of suspension, installed between the chassis and the differential unit, carries out the following functions:

- It supports the weight of the rear part of the vehicle.
- It absorbs the vertical movement of the wheels.
- It offsets the twisting effects caused by the rotations of the universal axle and of the wheels.

CONSTITUTION

The rear suspension is composed of two leaf springs and two shock absorbers (fig. 1).

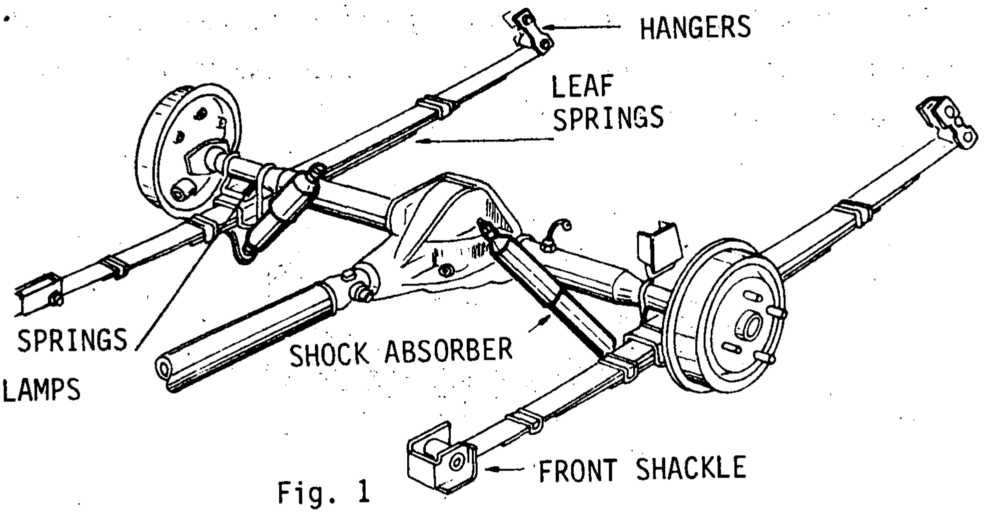

Fig. 1

The leaf springs are installed longitudinally with respect to the chassis of the vehicle, and connected at the ends, the shackles and the clamps allowing them to bend when bounced. They are secured to the rear cross-member by means of clamps. The shock absorbers, generally of the double stroke type, are installed directly between the chassis and the leaf springs.
Rubber stops are placed on the bolsters of the chassis so as to limit the maximum flexing of the leaf springs.

FUNCTIONING

When the vehicle is moving, the wheels receive the bumps, caused by the irregularities of the road transmitting them, through the rear cross-member, to the leaf springs and shock-absorbers, thereby absorbing the rough movements; this enables the chassis and the body to elude the full intensity of the movement.
As a result of this, the resistance to the flexing of the leaf springs compels the wheels to remain in contact with the road.

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Coil spring. This type is the most widely used, and is used especially in the front suspension (figs. 4 and 5).

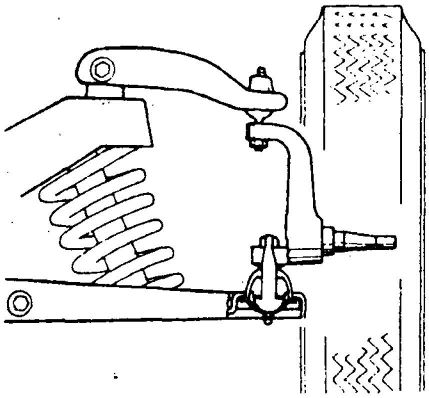

Fig. 4

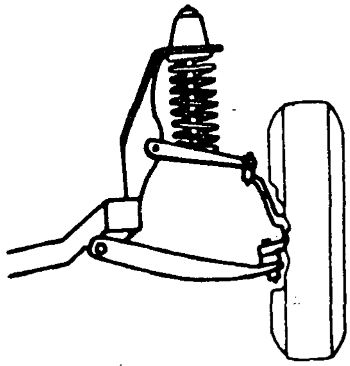

Fig. 5

Torsion bar. In this type a steel bar with a high elasticity is subjected to torsional effort, thereby absorbing the vertical movements of the wheel (fig. 6).

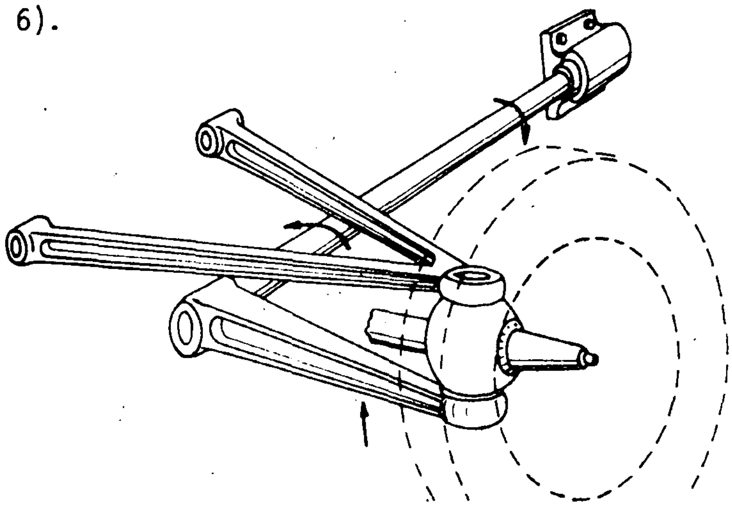

Fig. 6

Hydro-pneumatic. In these systems the cushioning is attained by the compression of a gas in a closed pressure system in a sealed double chamber. The piston is displaced, driven by the wheel's movement, in a cylinder that is connected to the oil reservoir, thus creating a pressure on the gas chamber, by means of the membrane which separates them (fig. 7).

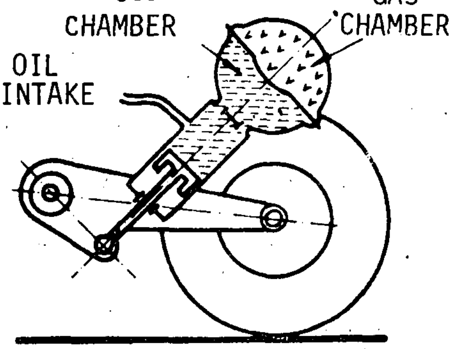

Fig. 7

TECHNOLOGICAL SUBJECT CODE

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RIGID SUSPENSION TYPES

Leaf springs. This type is typical because it generally contains a leaf spring on each end of the axles being secured to the chassis by means of clamps or shackles (fig. 1).

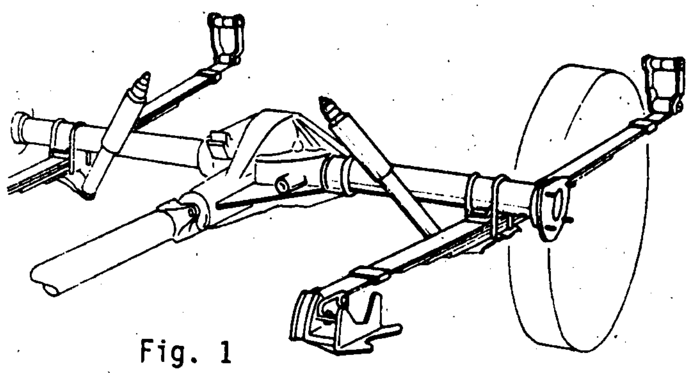

Fig. 1

Coil spring. It is used on the rear cross-members of light vehicles and is situated between the chassis and the axle. It is secured by means of plates with a central bolt at both ends (fig. 2).

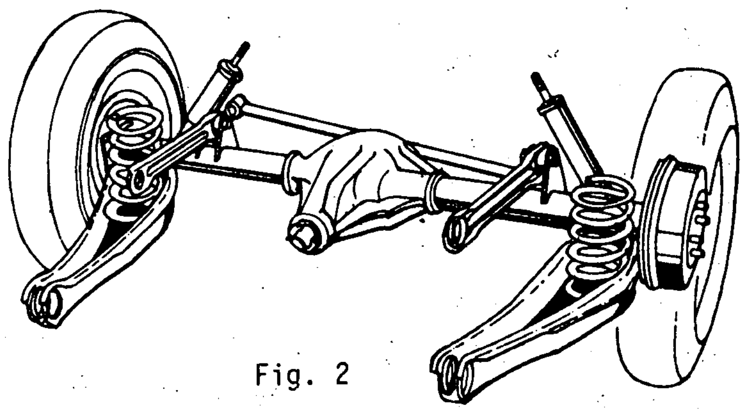

Fig. 2

INDEPENDENT SUSPENSION TYPES

Leaf springs. These are situated obliquely under the chassis and each end is cushioned independently (fig. 3).

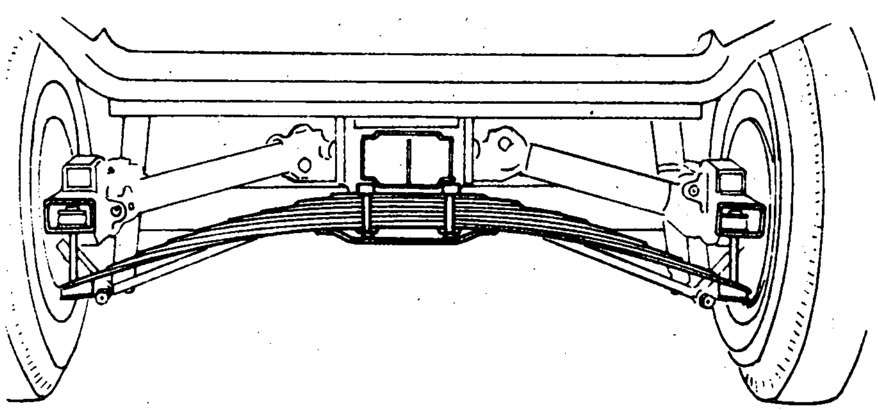

Fig. 3

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The suspension system is a unit of parts, situated between the axles and the chassis of the vehicle, designed to absorb vibrations, caused by irregularities of the road, and to keep the vehicle stable thereby providing greater comfort and safety for passengers or cargo that it transports.

CONSTITUTION

The principal components of the suspension are:

Springs or torsion bars. These are the parts that absorb the vibrations produced by the motion of the vehicle.

Shock absorbers. These are the parts designed to resist the rough movements of spring or torsion bar.

Stabilizing bars. Their purpose is to reduce the inclination of the vehicle when cornering while giving the tyres a good grip on the road.

CLASSIFICATION

Suspension systems are classified into:

- Rigid
- Independent

Rigid suspensions. In this system the axles, front or rear, are rigid and are suspended from the chassis by means of springs. In this type, impacts or vibrations of one wheel are transmitted to the other.

Independent suspensions. In this system the vibrations of one wheel are not transmitted to the others, because it is supported on the chassis by an independent shock absorber and axle.

Vehicles may contain:

- Rigid suspension on the four wheels.
- Independent suspension on the four wheels.
- Independent suspension on the front wheels and a rigid one on the rear wheels.

On releasing the pedal the fluid returns to the master cylinder and ceases to act on the pistons, which return to their positions of rest aided by the reaction of the sealing rings (fig. 2).

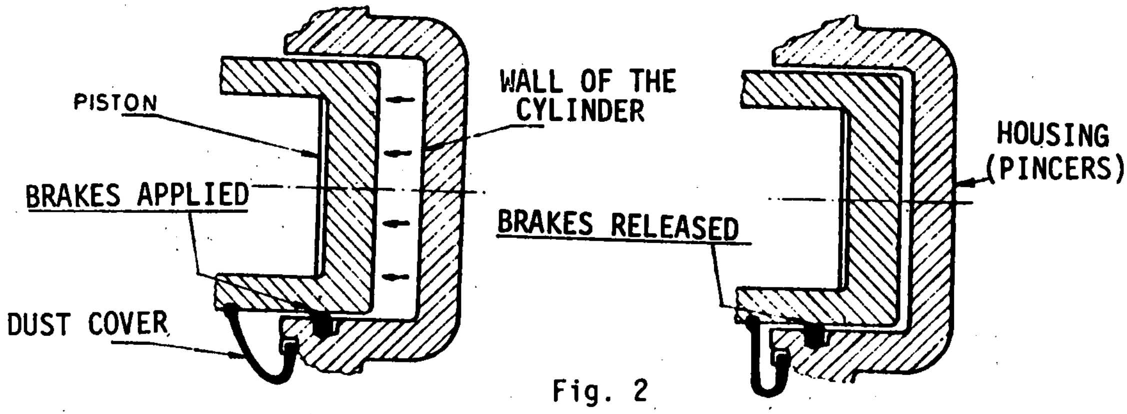

Fig. 2

The piston movement always maintains the brake pads adjusted with respect to the disc, because as the linings become worn, the piston starts moving towards the disc; besides, in order to facilitate the return of the pistons, the brake master cylinder does not have a retention valve.

TYPES:

Disc brakes are characterized by the number of pistons in each calliper; they may contain one, two or four pistons (fig. 3).

ADVANTAGES OF DISC BRAKES:

- They easily disperse the heat generated by friction produced during braking.
- They recuperate their efficiency quickly when they get wet; this is because when rotating, discs centrifuge the water.
- Their discs are less exposed to distortion, which may alter the braking conditions, because they wear laterally and uniformly.

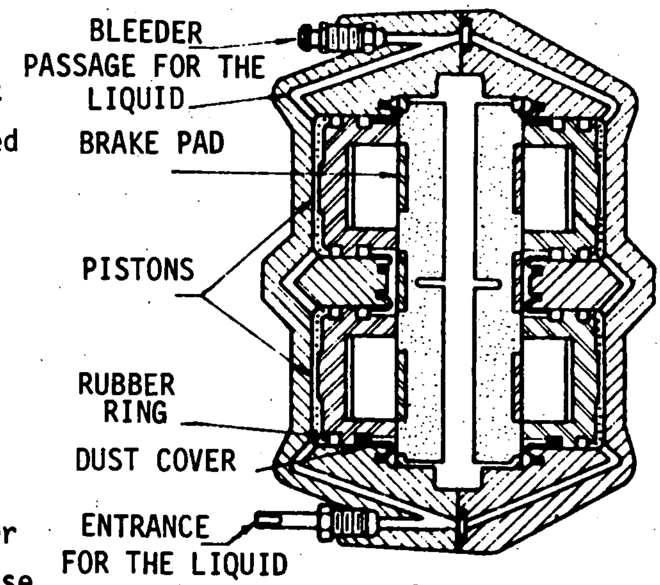

Fig. 3

This is a brake mechanism that is in present use in some vehicles, because of its guaranteed performance under any working conditions.

The parts that make up the disc brake are (fig. 1):

1. Brake disc
2. Callipers
3. Pistons
4. Rubber ring
5. Dust cover
6. Brake pads
7. Anchor bolt
8. Bleeder

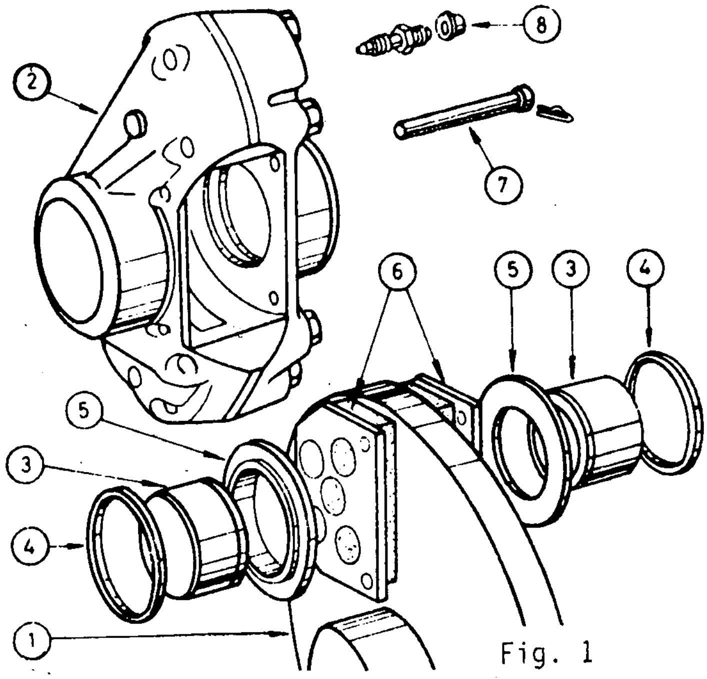

Fig. 1

The disc is the rotating part on which the pads that cause the braking, act upon. They are normally of cast iron.

The calliper is made up of a body, of one or two parts made of cast iron, or of an aluminium alloy, in which is incorporated the brake cylinders and the fluid lines.

The pistons, made usually of aluminium, are displaced in the cylinders and act directly on the pads.

The dust covers prevent dust, which may damage or lock the pistons, from entering the cylinders.

The brake pads are made of steel and the linings are fixed on them.

The rubber rings ensure an air-tight seal between piston and cylinder, preventing fluid leaks.

FUNCTIONING:

The fluid, sent under pressure from the master cylinder to the cylinder, pushes the pistons displacing them in the direction of the brake pads which in turn seize the disc, securing it as with the clamps of a vice, thereby stopping its rotating movement.

The machining of drums is done in special machines, of which there are a great variety, and for which reason it is recommended that the operation instructions of the machine be observed.

With some types of machinery the drum is machined with the wheel mounted (fig. 7); in others, the drum alone is installed and a vibrations damper band is placed on it.

Generally, the machines are equipped with a series of adaptors to machine different types of drums.

In the case of machining discs, the same check should be exercised in accordance with the manufacturer's specifications.

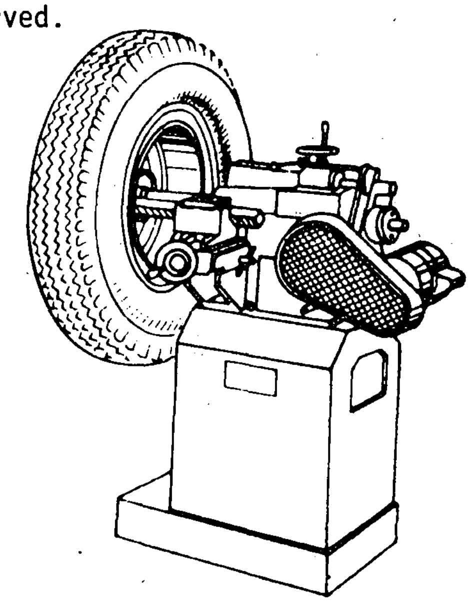

Fig. 7

There are also a variety of machines for machining discs.

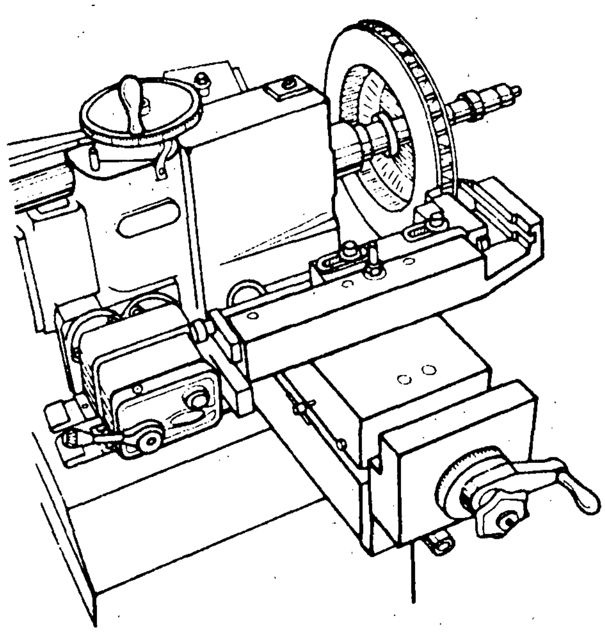

Fig. 8

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Brake discs. A disc is a heavy wheel, with its surfaces flat and parallel to each other, which replaces the brake drum (fig. 4). It is made of steel and some types are fitted with cooling fins (fig. 5), to aid in the dispersion of heat.

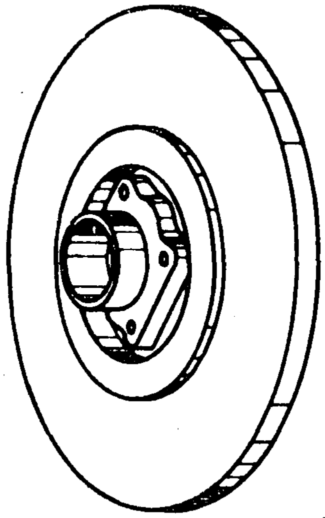

Fig.4

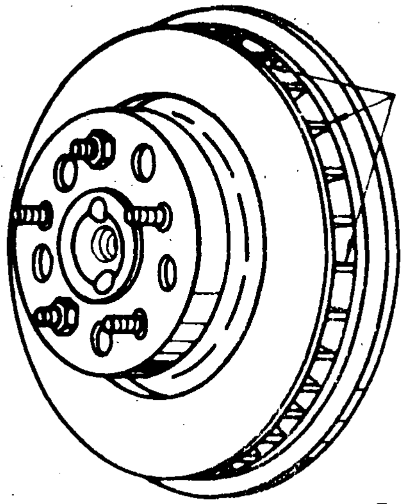

Fig. 5

MACHINING:

Owing to the intense load to which they are subjected, drums and discs should be periodically inspected, so as to detect any possible scratches or distortions on their working surfaces. These faults rapidly wear the lining or the brake pads. Machining is recommended with the object of upkeeping the contact surface completely uniform and perfectly polished. Before proceeding to machine a drum or disc, the quantity of material that is to be eliminated should be determined, so as not to exceed the limits specified by the manufacturer, by using the appropriate measuring instrument (fig 6).

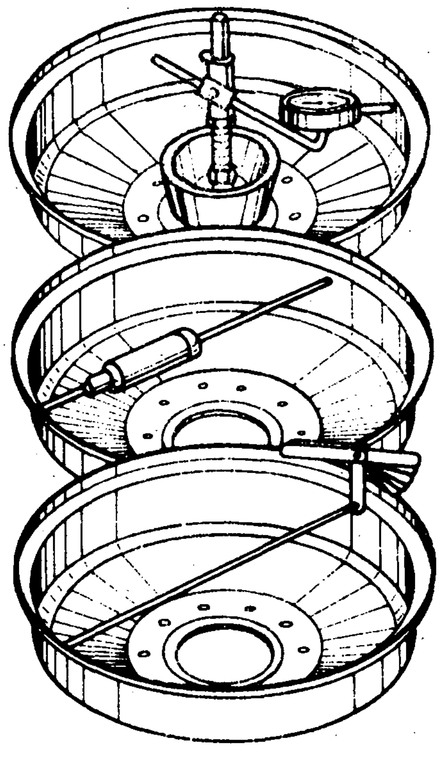

Fig. 6

As a general rule, not more than 25% of the original thickness should be eliminated so as not to weaken it. With the knowledge of the final extent of machining, the brake lining can be machined with accuracy, and as this enables a uniform contact of the lining or tablet with the drum or disc, it ensures a more efficient braking effect.

Drums and discs are the parts of the braking system that endure the most wear and distortion, because of the function that they perform. It is necessary, therefore, to machine them in order to upkeep their contact surfaces in perfect condition, which in turn would ensure a uniform contact with the brake lining.

Brake drum. The drums, on which the wheels are mounted, are designed to receive the braking force by means of the brake shoes. They are bell-shaped and form a unit with the hub (fig. 1), or form separate units (fig. 2).

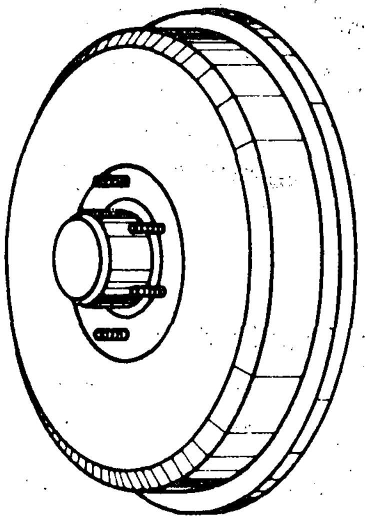

Fig. 1

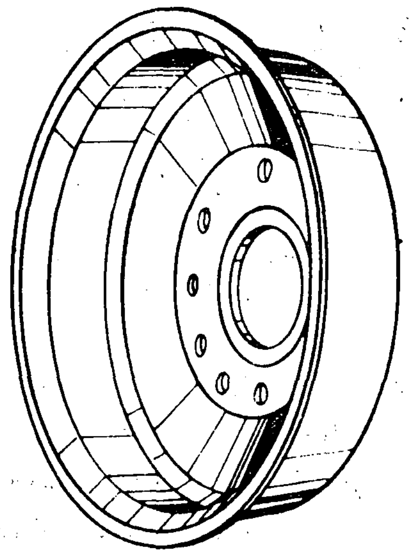

Fig. 2

They are made of cast iron or of an aluminium alloy. Some types are fitted with cooling fins that aid in dispersing the heat produced by friction with the brake lining (fig. 3).

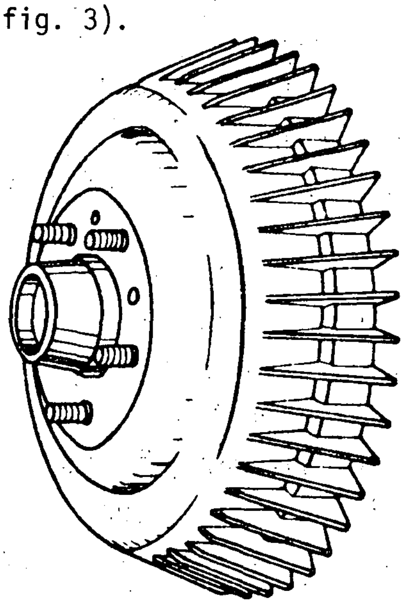

Fig. 3

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Bonding. Bonding is achieved by the effect of heat and pressure on the adhesives placed between the lining and the shoe; they may be:

- Liquid adhesives that are applied on the surfaces to be joined.
- Adhesive tape, made of solid material that is cut to suit and inserted between the two parts.

Bonding is done in specially designed ovens that contain control devices that regulate the time and temperature to which the adhesive should be subjected in accordance with the manufacturer's specifications.

ADVANTAGES OF BONDING:

- The full thickness of the lining is utilized.
- The full surface of the lining is utilized without sacrificing for the rivet holes.
- Minimizes the possibility of scratches on the drum.
- Bonded lining tends less to squeak because of its greater adhesion to the shoe.

Grinding of lining. When the brake lining has been changed or the drums have been machined, it is necessary to grind the lining to suit the diameter of the drum.
The grinding of the brake lining furnishes it with a contact surface in accordance with the radius of the drum and leaves it concentric with the wheel journal bearings.
There are two types of grinding machines for repairing brake lining, a fixed one (fig. 3), and a mobile one that may be mounted on the wheel shafts (fig. 4).

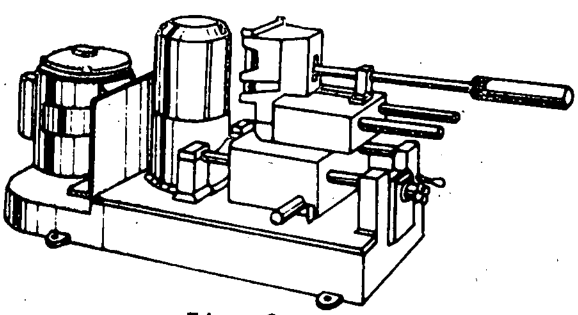

Fig. 3

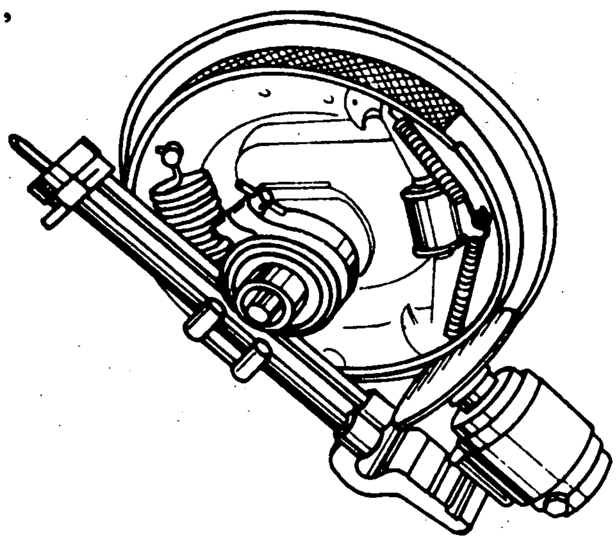

Fig. 4

In the braking process the linings are subjected to high stress due to the friction produced with the drum. For this reason it is necessary to fix them to the shoes all along their surface and to machine them so as to obtain a more effective braking effect.

Attaching brake lining to the shoes is done by either riveting or by bonding.

Riveting. In this case the securing is done with copper, bronze, brass or aluminium rivets. The type of rivet usually used is the flat-head and hollow stem type which ensures a good binding between the lining and shoe (fig. 1).
For securing lining to shoes of trucks and heavy vehicles, the rivets are replaced by screws with nuts usually made of bronze. Manual or automatic machinery (fig. 2) is used for good riveting of the linings. These machines can perform: rivet removal with the aid of special plungers; riveting by means of plunger and mandrels, that can be adjusted to the diameters of the rivets; piercing of the lining with special drills, which also simultaneously do the countersinking, the machining of the lining by means of a motor that rotates a roller with emery paper specially designed for the machine.

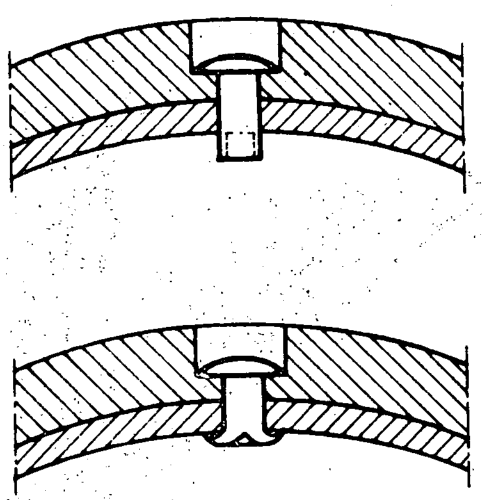

Fig. 1

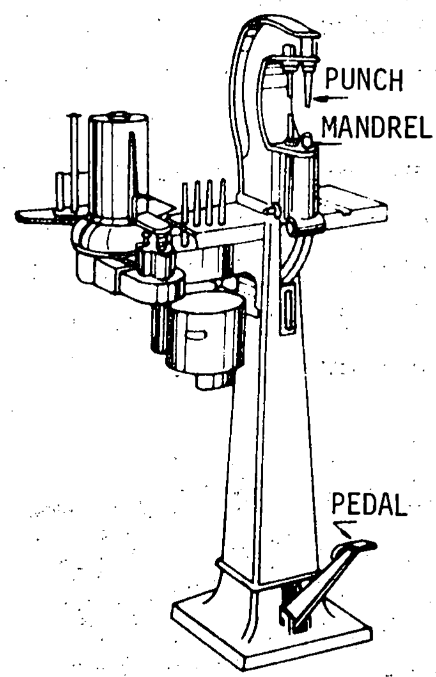

Fig. 2

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It is the internal cavity of the block which houses the crankshaft and in which, besides, the lubrication system of the engine is installed; although the term crankcase has been generalized to refer to the lower cover or tank.

DESCRIPTION

The crankcase is made up of the lower part of the block and the cover; but the term crankcase is popularly used to refer to the oil tank which protects the inside of the block from foreign particles and serves to store the lubricating oil of the engine.
It is joined to the block by means of screws and a cork gasket is placed between them (fig. 1). The crankcase is made of plated steel or of an aluminium alloy; at the bottom there is a drain hole for the oil, sealed by a plug which is generally magnetic for retaining the metallic particles. The housings of the seals which prevent oil leaks are situated in the front and rear collars. Some types of crankcases contain cooling fins for better oil cooling.

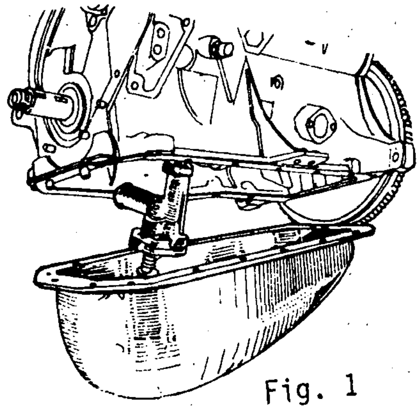

Fig. 1

CRANKCASE VENTILATION

To maintain uniform pressure in the crankcase and eliminate gas, water and oil vapours, derived from the functioning of the engine, it is necessary to ventilate it. For this purpose two types of ventilation are used:

- Direct ventilation
- Closed ventilation (Positive).

Direct Ventilation. In this type, the crankcase ventilation is achieved by the evacuating effect of the whirlwind of air, created principally by the crankshaft, entering through the oil intake pipe to circulate inside the engine dragging along the water, oil and gas vapours, and then expelling them to the atmosphere through the ventilation pipe (fig. 2). This ventilation system is no longer in use due to the contamination it produces in the atmosphere.

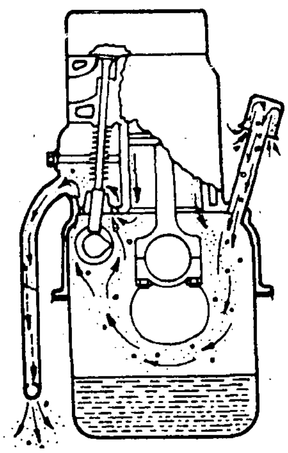

Fig. 2

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Closed Ventilation. In this type, the evacuating effect of the gases goes through a pipe that connects the inside of the crankcase with the air filter or with the filler cap, through which the ventilating air passes: another pipe connects the inside of the rocker arm cover with the air intake to the carburettor or to the intake manifold, through which the crankcase gases are sucked.

When the engine is functioning, it establishes the air circulation (fig. 3) that hauls the vapours towards the cylinders to be burned and subsequently expelled.

A variation to this type contains a vacuum-operated valve in the ventilation pipe near the intake manifold, for controlling the air-flow and preventing the air from becoming excessive while in neutral.

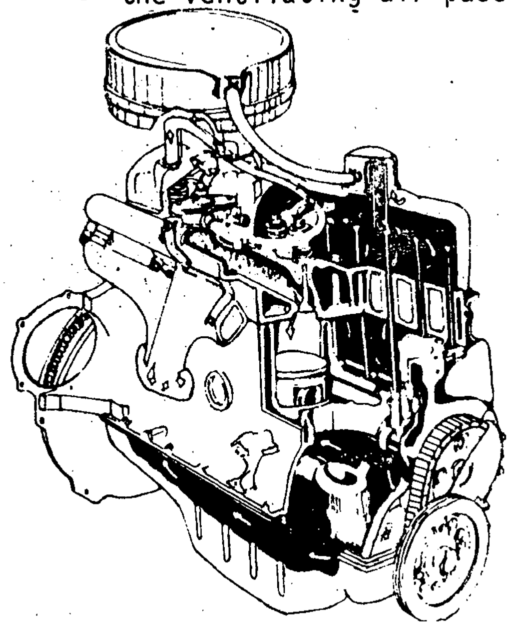

Fig. 3

MAINTENANCE:

It is advisable to periodically clean the component parts of the crankcase ventilation to upkeep it in good condition. If the system contains a valve it would have to be checked every time that the engine oil is changed, bearing in mind the manufacturer's indications.

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This is the mechanism that maintains the oil in constant circulation, in the lubrication system, by means of the engine ducts and the moving parts that require efficient lubrication, because of the conditions to which they are subjected.

CONSTITUTION

The most common pumps are actually made of gearings and are composed of the following parts (fig. 1).

- Body or cast iron casing, with the oil intake and clearance pipes included in the body.
- Gears, one fixed to the driving shaft and is termed the driving wheel, and another called the idler wheel.
- Gear cover plate, covers the box that houses the gear wheels.
- Suction tube unit, with a screen for filtering the oil before going to the pump.
- Pressure regulating valve, device which automatically limits the oil pressure in the lubrication system.

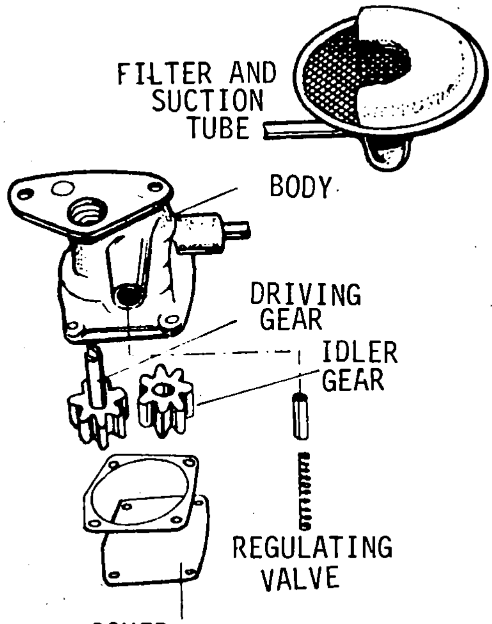

Fig. 1

FUNCTIONING

On starting the engine, the camshaft moves the driving shaft of the pump with the driving wheel (fig. 2). this operates the idler wheel producing a depression that sucks the oil through the screen.

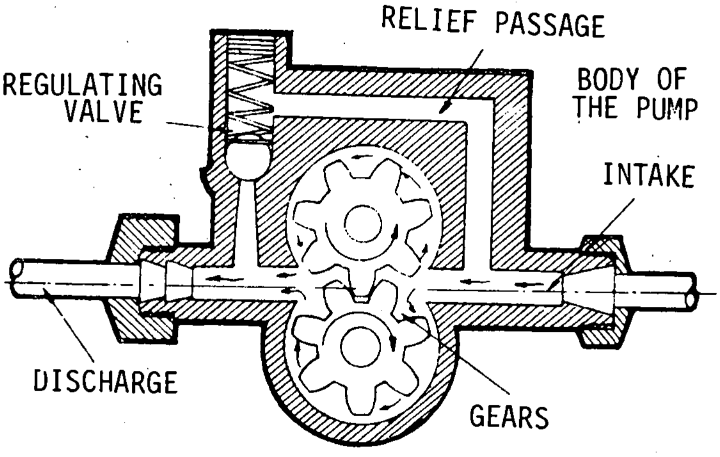

Fig. 2

TECHNOLOGICAL SUBJECT CODE

Then the gear teeth drag it forcing it out under pressure through the outlet pipe, which is directly connected to the pipes in the block, and it goes on to lubricate all the moving parts of the engine.
When the pressure in the systems becomes excessive, the valve overcomes the tension of the spring and the oil passes to the intake pipe of the pump or to the crankcase, automatically regulating the pressure.

TYPES

Other common oil pump types are:

Rotor Type Pump. The rotor pump is also made up of gears (fig. 3); it consists of a float ring with 5 cavities, inside which the rotor, which has 4 teeth, engages and which on turning, drags the ring. The difference in the number of teeth creates a space that is filled when it aligns with the oil intake hole; due to the effect of the rotating parts, the space decreases creating a pressure on the oil before it is expelled.

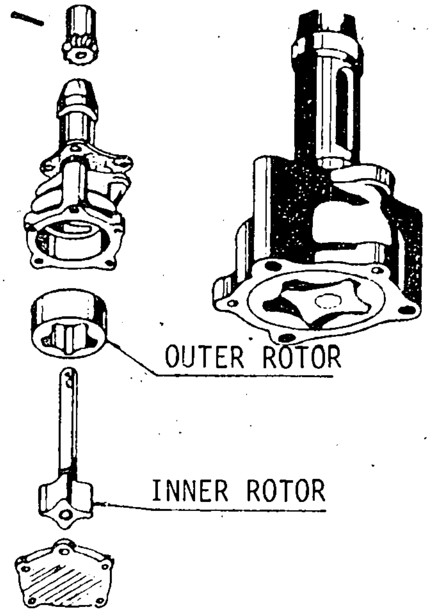

Fig. 3

Vane Type Pump (fig. 4).

It is composed by a cylindrical body (C), in which the eccentric (X) revolves, with 2 skid vanes (P), that tend to open up because of the effect of the central spring and the centrifugal force. When the eccentric rotates, the vane, by the left side, creates a vacuum causing oil to enter through the intake port (E), while on the right side, it pushes the oil under pressure towards the exit.
The wear to the track is compensated for by the effect of the same spring.

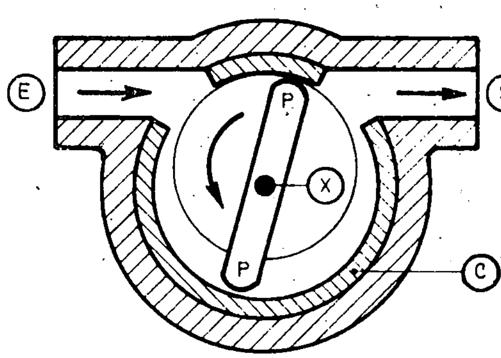

Fig. 4

Piston Pump (fig. 5). The piston movement is achieved by means of an eccentric of the camshaft.
On passing the eccentric, the piston rises sucking in oil through the valve (A), filling the chamber.
When the cam pushes the piston, it lowers pressurizing the oil and sends it through the valve (E) towards the outlet.

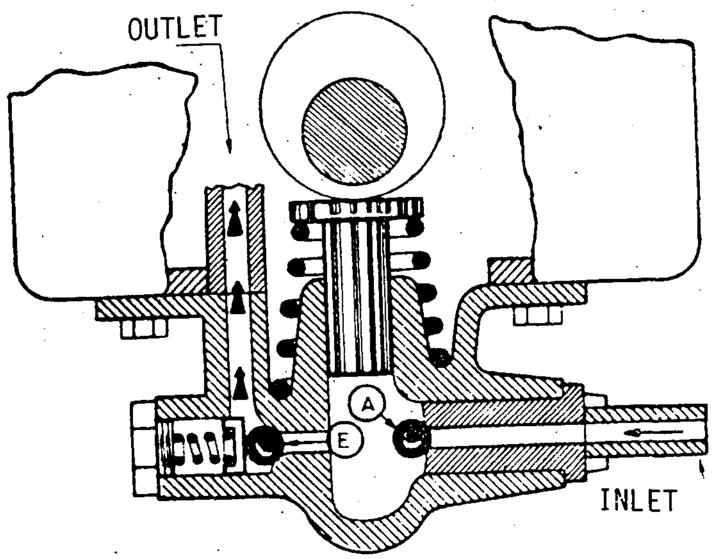

Fig. 5

MAINTENANCE

The gear type oil pumps are very durable, but when they are removed, for some special reason, it is advisable to check the state of their component parts as the excessive wear in some of them may cause the oil pressure to drop.

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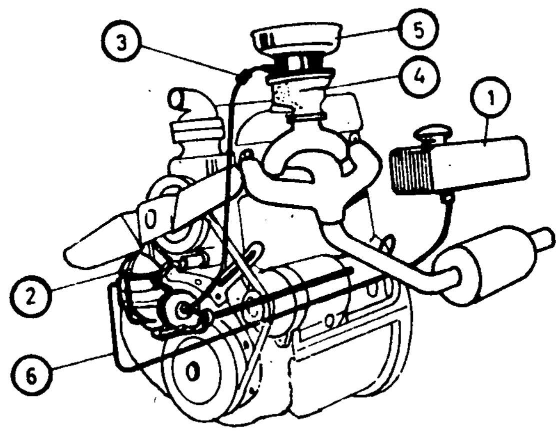
This is the assembly of parts designed to supply fuel to the engine, carrying it from the tank to the carburettor for introducing it, mixed in proportion with air, according to the comsumption needs of the engine.

CONSTITUTION

The fuel system is composed of (fig. 1):

1. Fuel Tank.
2. Gasoline Pump.
3. Gas Filter.
4. Carburettor.
5. Air Filter.
6. Tubings and Lines.



DESCRIPTION

Fuel Tank. It is generally constructed with steel sheets sheathed with a rustproof lining. On the top part it contains the filler tube and cover, which has a vent which allows air to enter at the same rate as it is being emptied. On the lower part is the drain plug for emptying the fuel or for cleaning it. It also contains an electro-mechanical device for measuring the quantity of fuel existing in the tank. Its capacity varies with the type of vehicle.

Gasoline Pump. This is the part of the system that constantly supplies fuel to the carburettor. It is situated between the tank and the carburettor and is operated mechanically or electrically.

Gas Filter. This is the part, inserted in the fuel circuit, which is designed to purify and store the impurities of the fuel. It may be situated before or after the pump or at the entrance to the carburettor.

There are many different types of filters, many of which utilize a fine metallic mesh; others are the sediment type with the filtering screen made of fibre or ceramic, the latter being the most used (fig. 2).
The gasoline which reaches the tank, fills the bowl and passes to the interior of the filtering element, the impurities being deposited on the outer part of the element or at the bottom of the bowl.

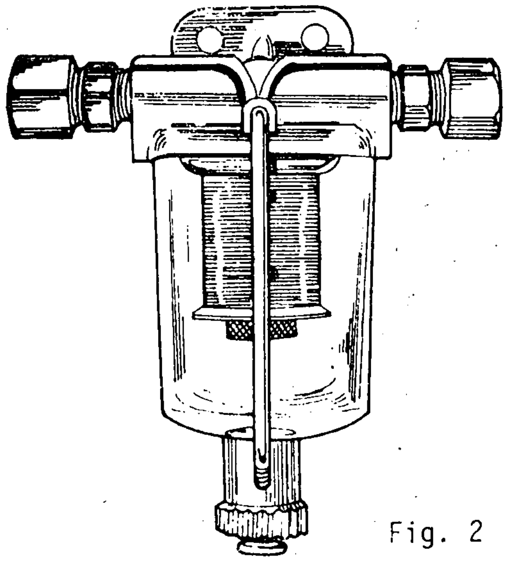


Fig. 2

Carburettor. It is the part of the fuel system, mounted on the intake manifold, which is designed to prepare the gasoline-air mixture in well defined proportions to fuel the engine.

Air Filter. This is mounted on the carburettor or near to it and its purpose is to retain the impurities suspended in the air so as to avoid them getting into the cylinders of the engine.
There are two basic types of air filter; with oil bath (fig. 3), and dry filter (fig. 4); the first may be of metallic shavings or horsehair and the second of micronical paper; this part is replaceable.

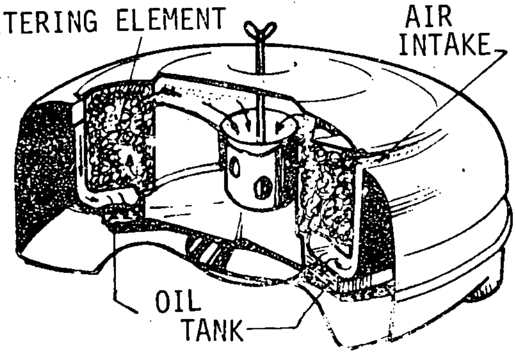


Fig. 3

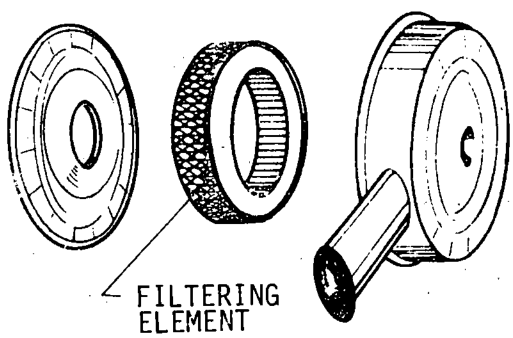


Fig. 4

Tubings and Lines. Their function is to convey the fuel from the tank to the carburettor.
To avoid a rigid connection between tank and pump or the carburettor, which can damage them, flexible lines are used. Tubings are secured to the frame by means of brackets, to avoid vibrations or friction.

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The types most widely used are:

- By gravity
- By pump

By Gravity (fig. 5). In this type, the gasoline tank is situated higher than the carburettor and the gasoline flows by its own weight. The cover of the tank is fitted with a valve with the purpose of maintaining constant atmospheric pressure acting on the inside of the tank; a stop tap is situated between the tank and the carburettor for interrupting the supply.

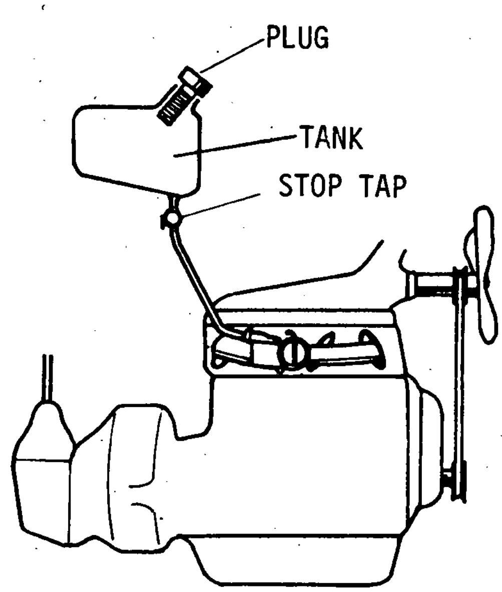

Fig. 5

By Pump. For safety reasons the majority of vehicles have their tanks situated behind and lower than the carburettor. A pump is used to draw the gasoline from the tank. It may be:

- Diaphragm type (mechanical)
- Electric
- Nozzle type.

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FUEL TANK

It is the gasoline stock of the fuel system of the vehicle. It is generally constructed with steel sheets sheathed with rustproof lining and its capacity depends on the type of vehicle.

CONSTRUCTION

The fuel tank is made up by the following parts (fig. 1):

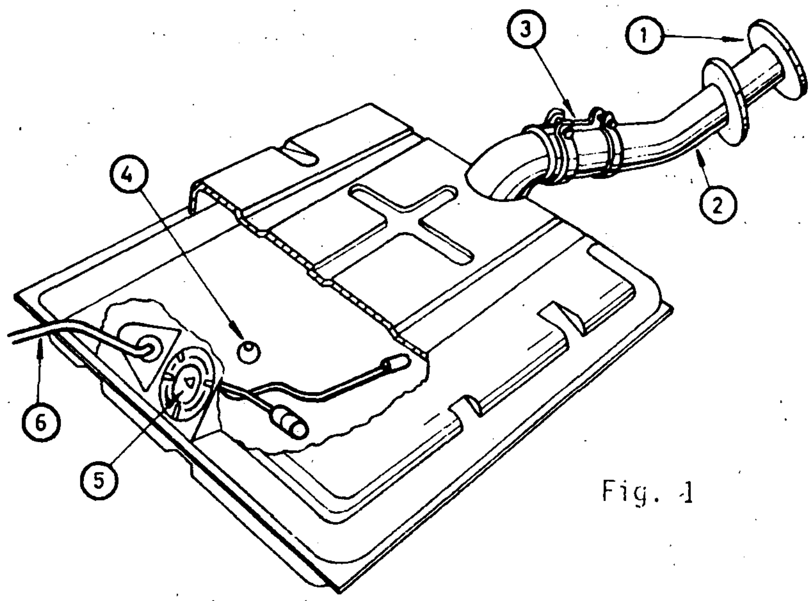


Fig. 1

1. Filler Cap
2. Filler Tube
3. Flexible Hose
4. Drain Plug
5. Fuel Gauge Unit (tank unit)
6. Gas Outlet Tube

Filler Cap. The filler tube has a cap that seals its upper part. This cap prevents foreign particles, which can obstruct the tubings and other parts of the system, from being introduced in the tank. The same cap has a hole that enables air to enter so as to maintain the inside of the tank under atmospheric pressure.

Filler Tube. This is the part through which the fuel is introduced into the tank and is connected to it by means of a flexible hose to avoid the effects of vibration.

Drain Plug. This serves the purpose of emptying the tank when the inside is to be cleaned.

Fuel Gauge Unit. This is the mechanism that monitors the quantity of fuel existing in the tank, by means of an electro-mechanical device and a float.

Outlet Tube. It conveys the fuel, propelled by the gas pump, from inside the tank. Some types contain a filter mesh, for preventing the passage of impurities towards the pump.

MAINTENANCE

The reservoirs should be cleaned after certain given periods so as to eliminate the water which is deposited through condensation.

It is convenient to regularly examine the tanks which are installed under the lower part of the body, because they are often ruptured or dented by stones hurled by the wheels.

To avoid this problem, it is customary to protect it with a wooden or rubber shield placed under it.

This is the device in the fuel system which is designed to constantly supply fuel to the carburettor.

CLASSIFICATION

They may be classified thus:

- Mechanical
- Electrical

Mechanical Pumps. They are generally mounted on the block and are operated by an eccentric of the camshaft.

Electrical Pumps. They are operated by means of an electro-magnet (fig. 1) and are electrically supplied from the contact plate. They have the advantage of being able to be installed in any part of the vehicle.

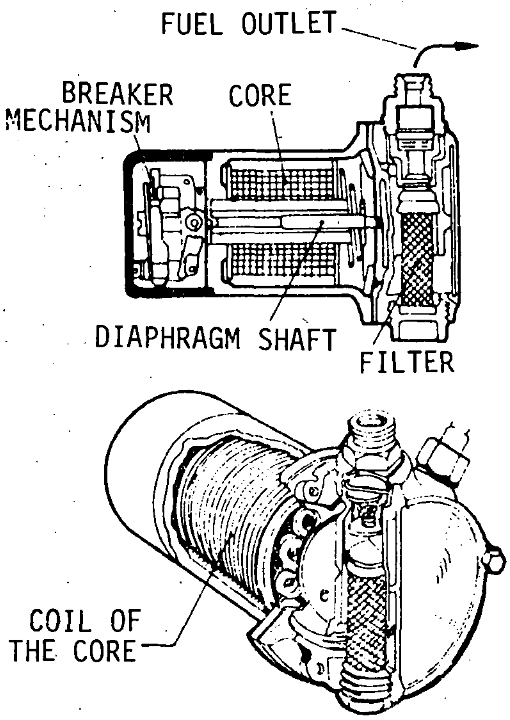


Fig. 1

CONSTITUTION

The pump most used in gasoline engines is the mechanical one (fig. 2) which consists of:

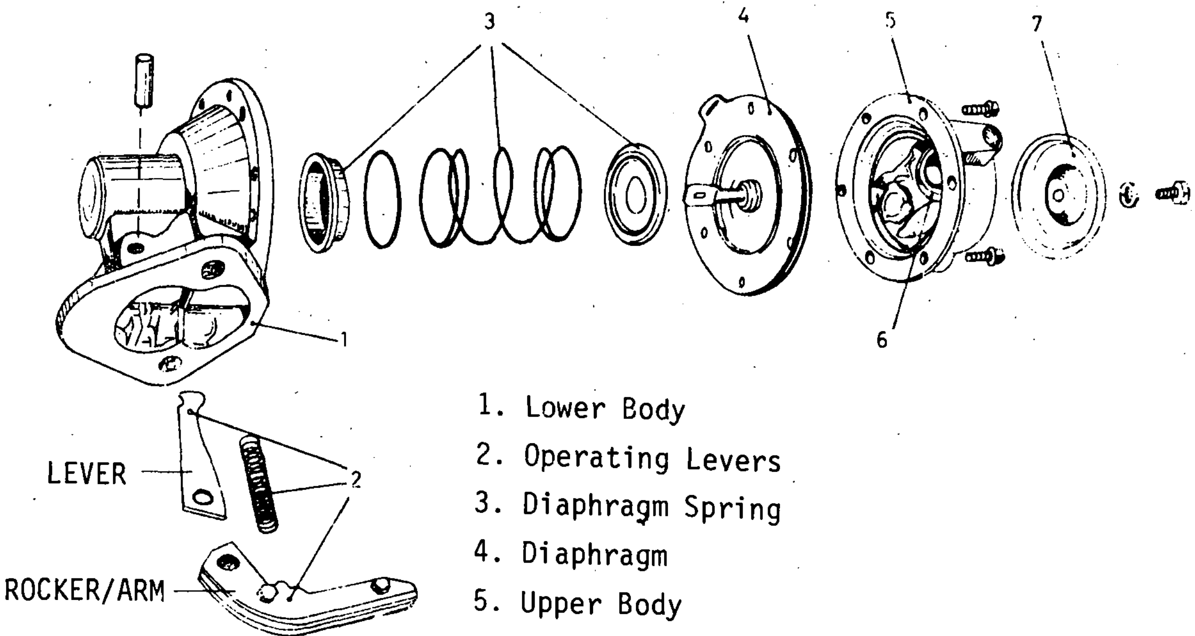


Fig. 2

1. Lower Body
2. Operating Levers
3. Diaphragm Spring
4. Diaphragm
5. Upper Body
6. Valves
7. Upper Body Cover

FUNCTIONING:

The camshaft eccentric pushes the rocker arm (1) and transmits the movement to the diaphragm (2) by means of the operating lever (3). (fig.))

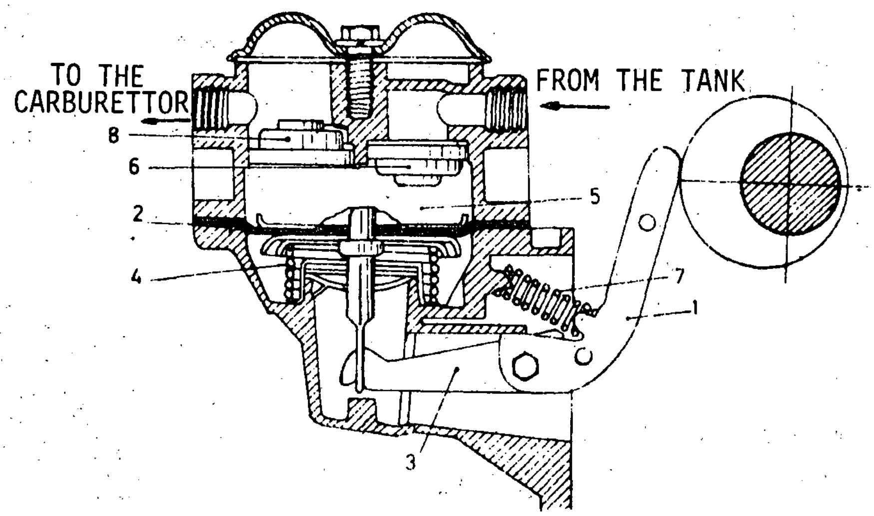


Fig. 3

The downward displacement of the diaphragm, compresses the spring (4) and at the same time creates a vacuum in the chamber (5), causing fuel from the tank to enter it through the inlet valve (6).
As the camshaft rotates, the rocker arm moves up and down with the eccentric as a result of the effect of the spring that holds them together (7). The diaphragm rises pushed by its spring and exerts pressure on the fuel in the chamber forcing it through the outlet valve (8) to the carburettor.
When the carburettor attains its normal level, the inlet valve of the carburettor stops the gasoline flow from the pump. The pressure existing in the carburettor fuel line keeps the outlet valve of the pump closed and prevents the diaphragm from rising, keeping the operating lever in its lower position disconnected from the rocker arm.
When the pressure in the fuel line decreases the diaphragm rises again to operate normally.

This is the part of the fuel system designed to maintain the proportions of the mixture of air and gasoline under different operating conditions of the engine.

DESCRIPTION

The carburettor consists of the following circuits for carrying out its operations:-

- Float system.
- Choke.
- Low speed (idle system).
- High speed.
- Accelerating system.
- Full power circuit.

Float system. This is the circuit designed to maintain a fuel level adequate for the consumption needs of the engine (fig. 1). It consists of a bowl, valve and float. The height of the float level, specified for every carburettor model, controls the closing of the valve.

Choke system. This is the mechanism of the carburettor which enables supplying rich mixtures for starting the engine when cold. It consists of a throttle valve installed in the mouth of the carburettor, which partially obstructs the passage of air (fig. 2). It may be manually or automatically operated.

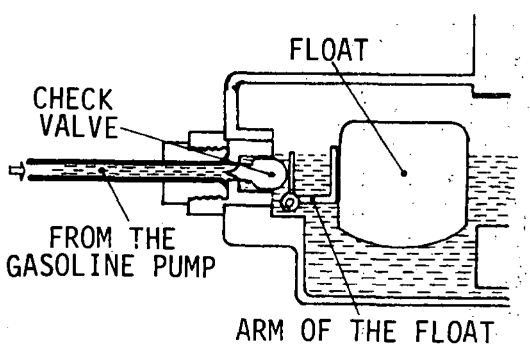


Fig. 1

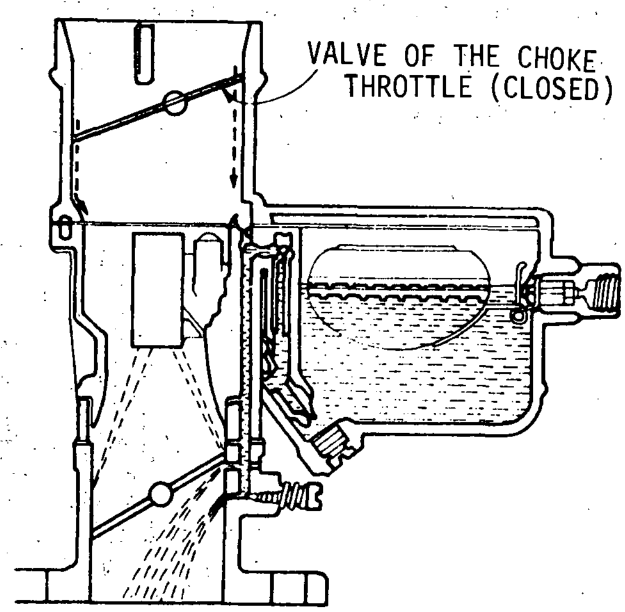


Fig. 2

Low speed or idle system. As its name indicates, this circuit is designed to supply the engine with the suitable quantity of mixture, for it to operate at low revolutions or in vacuum; it consists of calibrated jets which supply fuel to the passages or vents in which the air, from outside, circulates, and where it is mixed and discharged through the discharge ports below the throttle valve (fig. 3).

High speed system. This system is designed to supply greater quantities of mixture for increasing the revolutions of the engine. It consists of calibrated jets, installed in the passages and vents between the bowl and the discharge port of the venturis and the throttle valve (fig. 4).

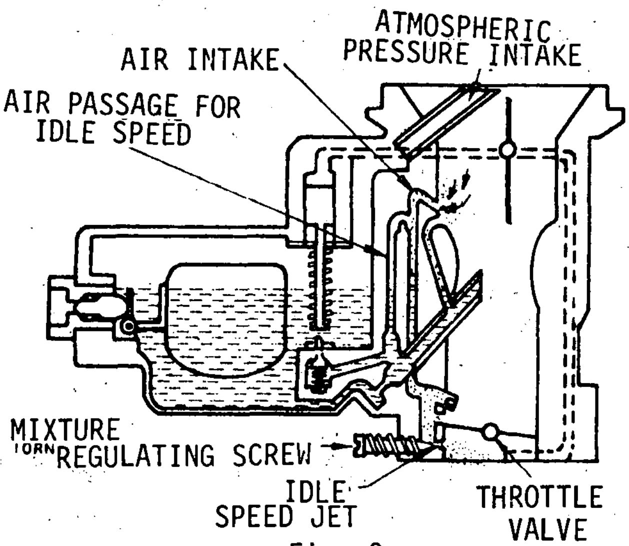


Fig. 3

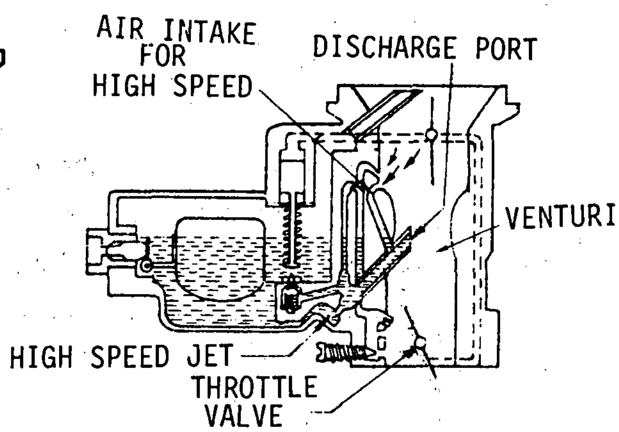


Fig. 4

Accelerating system. This is the system designed to inject an additional quantity of fuel, when the engine is rapidly accelerated, to compensate for the greater quantity of air that is introduced when the throttle valve is opened. It consists of a piston or membrane, valves and the jet nozzle (fig. 5).

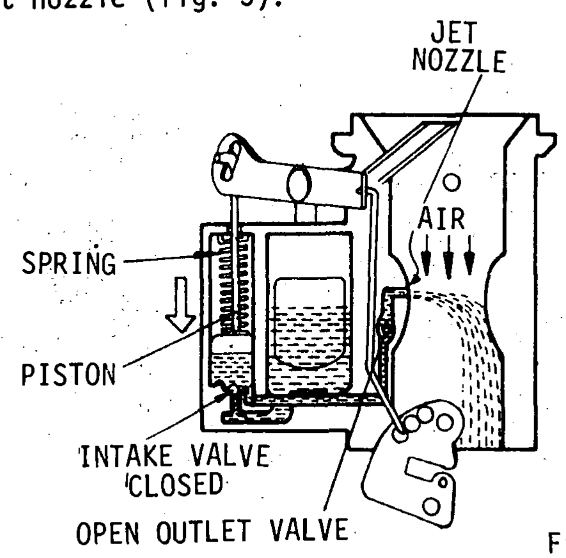


Fig. 5

Full power circuit. This circuit enables compensating for the leannes of the mixtures, due to the smaller vacuum inside the engine, by supplying an additional quantity of fuel to the high speed main jet; it consists of a valve operated by a piston or membrane with a calibrated spring (fig. 6).

FUNCTIONING

The gasoline conveyed by the pump fills the float bowl (fig 7), the depression created inside the engine sucks the air, through the carburettor tube, which on passing through the venturi acquires a greater speed; this produces a depression in the discharge nozzle, causing the gasoline to be sucked in to be mixed with air and continue through the intake manifold to the inside of the cylinders.

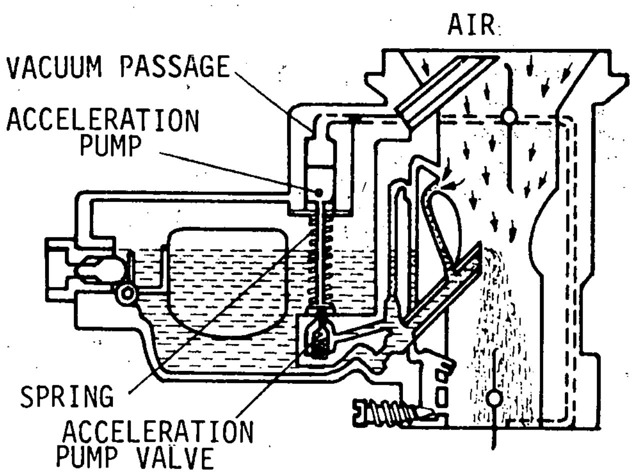


Fig. 6

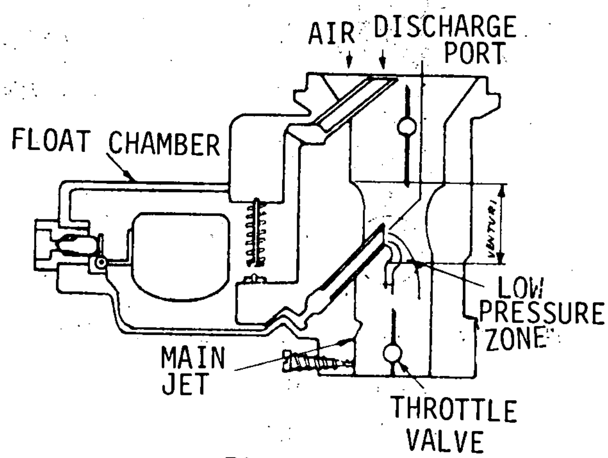


Fig. 7

The throttle valve regulates the amount of air passing through the carburettor tube, the more it is opened the more air and gasoline is introduced in the engine; when the throttle is closed the air continues to enter through internal vents connected with the low speed jets, producing a mixture which is discharged through the ports situated below the throttle valve.

When the engine revolutions increase rapidly due to the throttle opening, it allows a greater quantity of air to enter; partially impoverishing the mixture. By means of the joints connected to the throttle shaft the mechanism of the accelerating system is operated, instantly injecting fuel to compensate for the rapid increase of the revolutions of the engine.

CONDITIONS OF USE

To obtain the maximum use of the fuel, the carburettor should maintain the proportions of air and gasoline constant, considering normal those which are made up in a theoretical proportion of 1 to 15 in the weight of the mixture, that is, for a given weight of gasoline, the weight of the air needed should be 15 times greater. The variation of this relation determines the lean or rich mixtures, the first containing excess air.

CLASSIFICATION

Carburettors are classified according to the position of the barrels with relation to the line of the intake manifold (fig. 8).

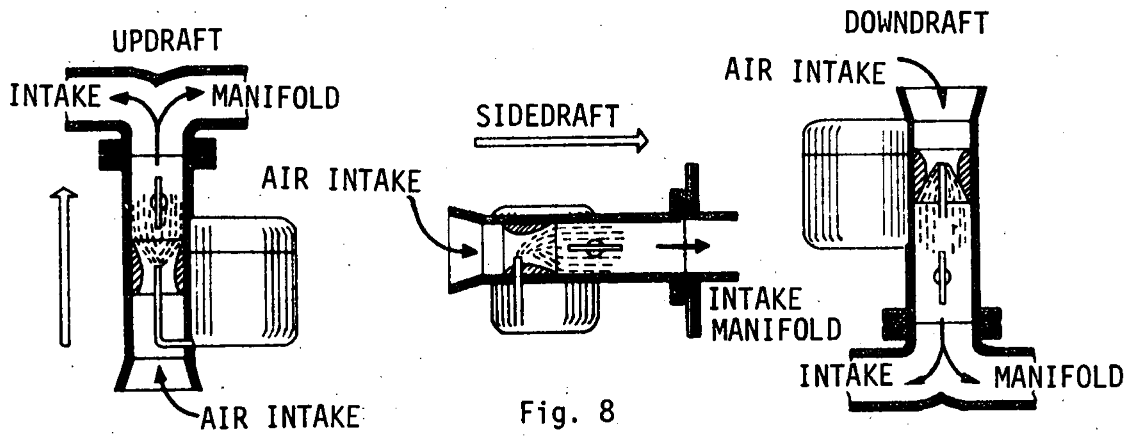


Fig. 8

The different types are distinguished by the number of barrels or venturis:

- Single barrel.
- Dual barrel.
- Four barrel.

S U M M A R Y

CARBURETTOR CIRCUITS	*Float system* *Choke* *Low speed (idle)* *High speed* *Accelerating system*
CARBURETTOR CLASSIFICATION	*Updraft* *Sidedraft* *Downdraft*

This is an electronic instrument which enables checking the percentage of fuel burnt and the relations between air and fuel, during the combustion process, by conducting some of the exhaust gas from the exhaust pipe to the instrument.

DESCRIPTION

The instrument consists of the following parts (fig. 1):

- indicator
- sensing unit
- condenser

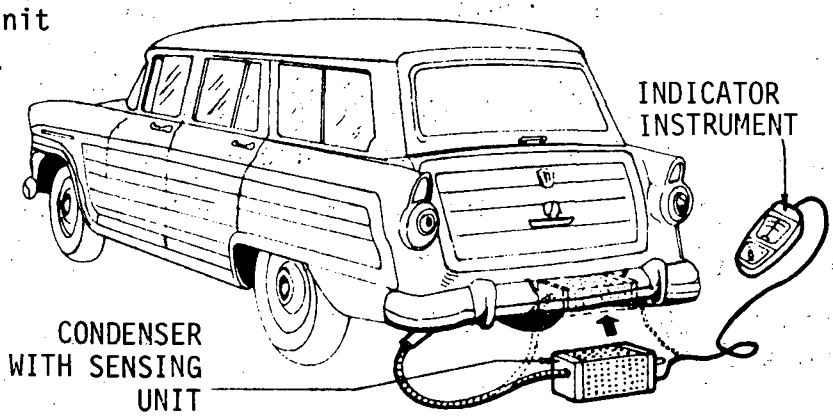


Fig. 1

Indicator. It may be powered by dry cell batteries, included in the instrument, or by the battery of the vehicle; it consists of a sphere or dial with scales that indicate the percentage of combustion efficiency and the proportions of the mixture, analysed by the sensing unit.

Sensing unit. It analyses the combustion-produced exhaust gases collected by the condenser. This unit, depending on the type or model of analyzer, may be incorporated with the indicator or the condenser.

Condenser. This part of the instrument captures the gases, by means of a flexible tube introduced into the exhaust pipe, eliminating as much as possible the water vapour which may damage the sensing unit and convey erroneous readings on the indicator.

FUNCTIONING

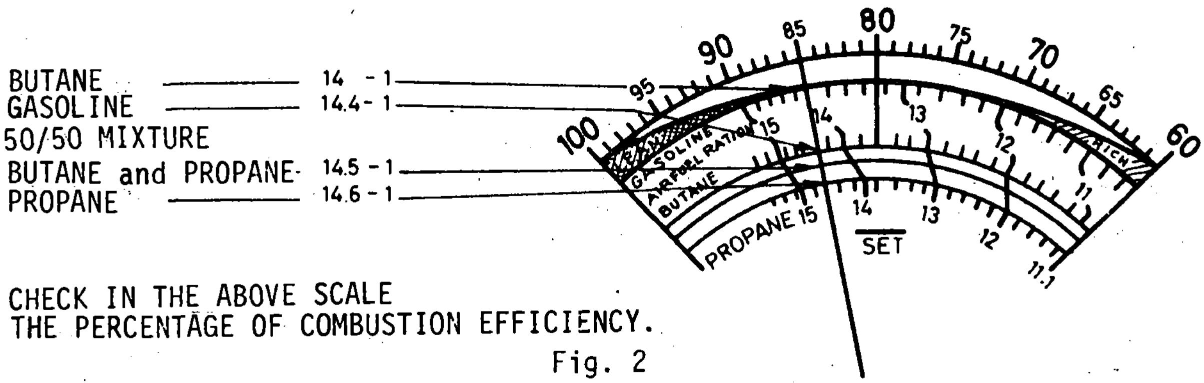
The indicator, connected according to the polarity of battery, should be graduated before operating it. For this reason it has switches which enable:

- Selecting the battery voltage.
- Calibrating the needle on the set line.
- Operating and calibrating the needle according to the specifications of the engine and the water instrument.

Having connected the condenser with the indicator, the engine is operated to the normal specified revolutions, and when it attains its normal temperature the flexible tube from the condenser is introduced into the exhaust pipe.
The ideal reading for low speed (idling), in most engines, should lie between 72% to 76% indicated on the combustion efficiency scale and have an air-gas ratio of 12.5 parts of air to 1 of gasoline or 13.2 to 1.
On increasing the revolutions of the engine a slight drop in efficiency would register. This would progressively increase when the revolutions are stabilized.
From 1,500 to 2,200 R.P.M. it should indicate between 84% to 88% efficiency and a ratio of 14 to 1 or 15 to 1. These values are approximate and vary according to the characteristics of the engine being tested and the type of fuel used (fig. 2).

THE AIR - GAS RATIOS
ARE INDICATED AS FOLLOWS:

% COMBUSTION EFFICIENCY %



CHECK IN THE ABOVE SCALE
THE PERCENTAGE OF COMBUSTION EFFICIENCY.

Fig. 2

If the readings are lower than these values, this indicates a maladjustment in the carburettor or an obstruction in the air filter.
These checks are done every time the carburettor is cleaned or repaired.

CONDITIONS OF USE

Before using the instrument the engine specifications and the operation instructions of the analyzer should be consulted.
Ensure that there are no leaks in the manifolds, muffler, and exhaust pipe which can alter the analysis of the gases. The analyzer should never be used when the engine is burning excess oil or expelling water through the exhaust pipe.

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CARE

After doing the combustion analysis tests the flexible tube should be removed from the condenser and the sensing unit left functioning so as to eliminate the moisture inside it.

Instruments with dry cell batteries should have them removed if they are not in continuous use.

TABLES

The approximate percentages are speficied in the following table:

R. P. M.	COMBUSTION EFFICIENCY	R. P. M.	COMBUSTION EFFICIENCY
800 1,000 1,200	78% to 82%	1,500 1,800 2,000 2,200	84% to 88%

It is advisable to consult the specifications manual of the vehicle for better verification.

TECHNOLOGICAL SUBJECT CODE

The tachometer is an instrument which instantly relays the number of revolutions per minute of the performance of the engine. Normally it is used as a testing instrument in the ignition system, carburation and in the general tuning of the engine.

DESCRIPTION

As different tests in the engine are done under variable working conditions, the tachometer is frequently incorporated with other control instruments so as to facilitate for the mechanic the complete analysis of the engine.
The tachometer most frequently used in auto-mechanic workshops consists of a box in which there is a graduated sphere or dial with scales indicating the revolutions per minute, the angle of contact of the contact points and the ignition resistance (fig. 1). This tester enables checking 6 or 12 volts ignition systems in 1, 2,4 or more cylinder engines; the corresponding circuit is selected turning on the control switch which corresponds to the test being done and for its previous calibration. The instrument is equipped with cables for connecting it to the ignition systems.

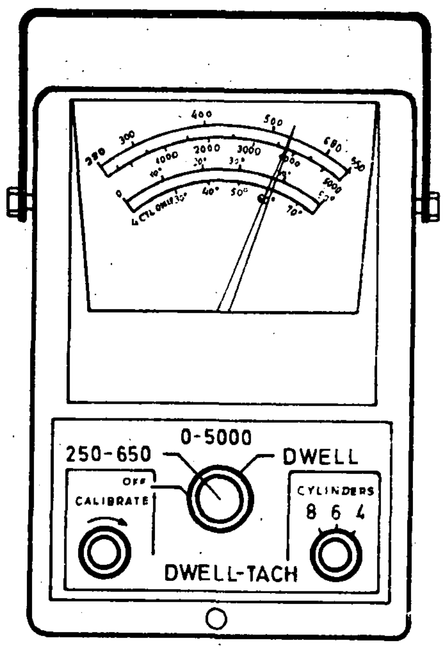

Fig. 1

FUNCTIONING

Before connecting the tachometer it is necessary to check the state of the battery of the instrument and to calibrate it through the reference line marked on the dial. Account should be taken, as well, of the polarity of the battery of the vehicle.

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The tachometer is operated by an electronic control arranged in the equipment and is connected through two cables to their respective terminals, one to the entrance contact point to the distributor or to the exit of the ignition coil and the other cable to earth, (fig. 2). For the contact angle and resistance tests, the same connections of the instrument are used and is achieved by varying the switch position of the equipment according to what is to be tested. The tachometer measures the number of times per minute that the primary circuit is interrupted and this information is translated into R.P.M. on the dial scale.

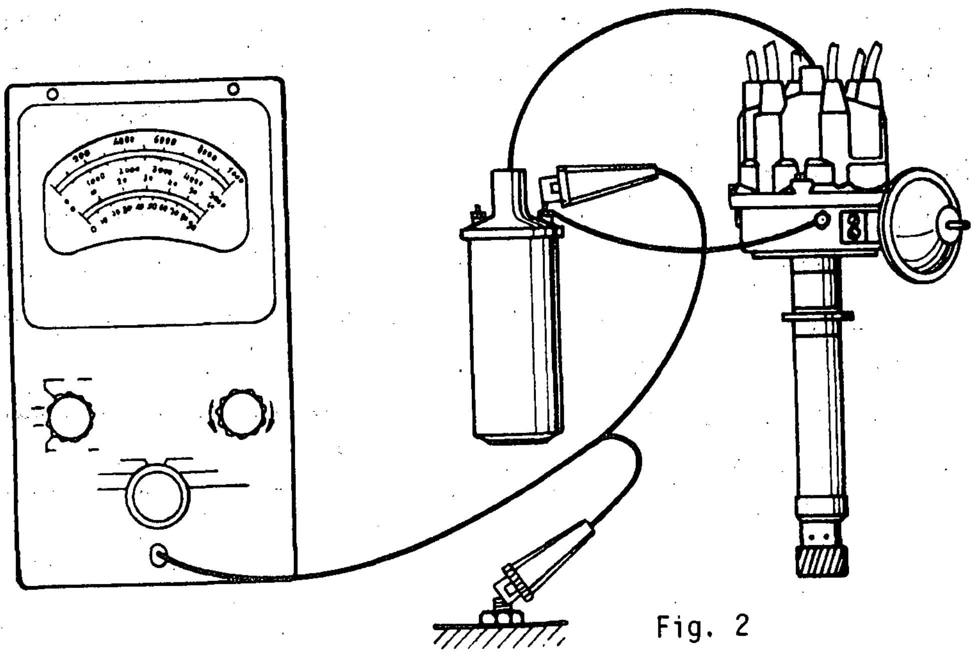

Fig. 2

TYPES

In some vehicles a one scale tachometer is installed (fig. 3), and it is used when it is not advisable to exceed a given circuit system in the engine. Besides, it aids in the driving of the vehicle in changing from one gear to another as well as in observing the power reserve of the engine.

This type of tachometer may be mechanical or electrical and there is a great variety of models among them, the ones most used being the magnetically operated tachometer.

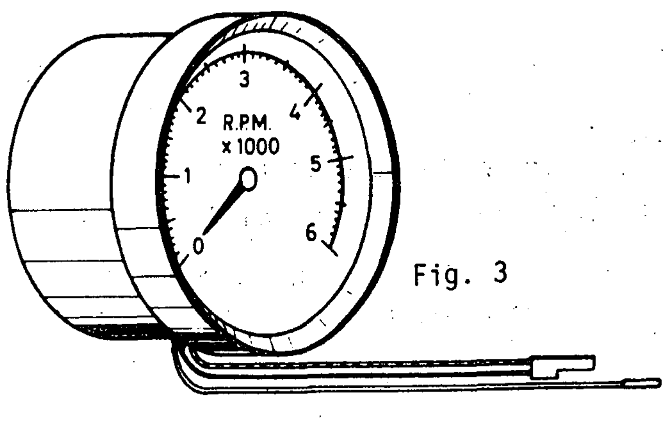

Fig. 3

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The magnetic tachometer (fig. 4). The flexible cable that operates the instrument is secured to the centre of the magnetized bar, which it rotates. This magnet is situated in front of an aluminium disc, which, although not being in contact with it, lies within its magnetic field. When the magnet moves, slight electrical currents are produced on the surface of the disc. Consequently, it tends to rotate following the magnet. A spiral spring opposes this movement, allowing it only to move without completing a revolution.

When the engine is accelerated, the magnet moves faster and the aluminium disc turns through a greater angle; the needle mounted on a shaft connected to the disc follows these movements; thereby indicating the rotating speed of the crankshaft of the engine.

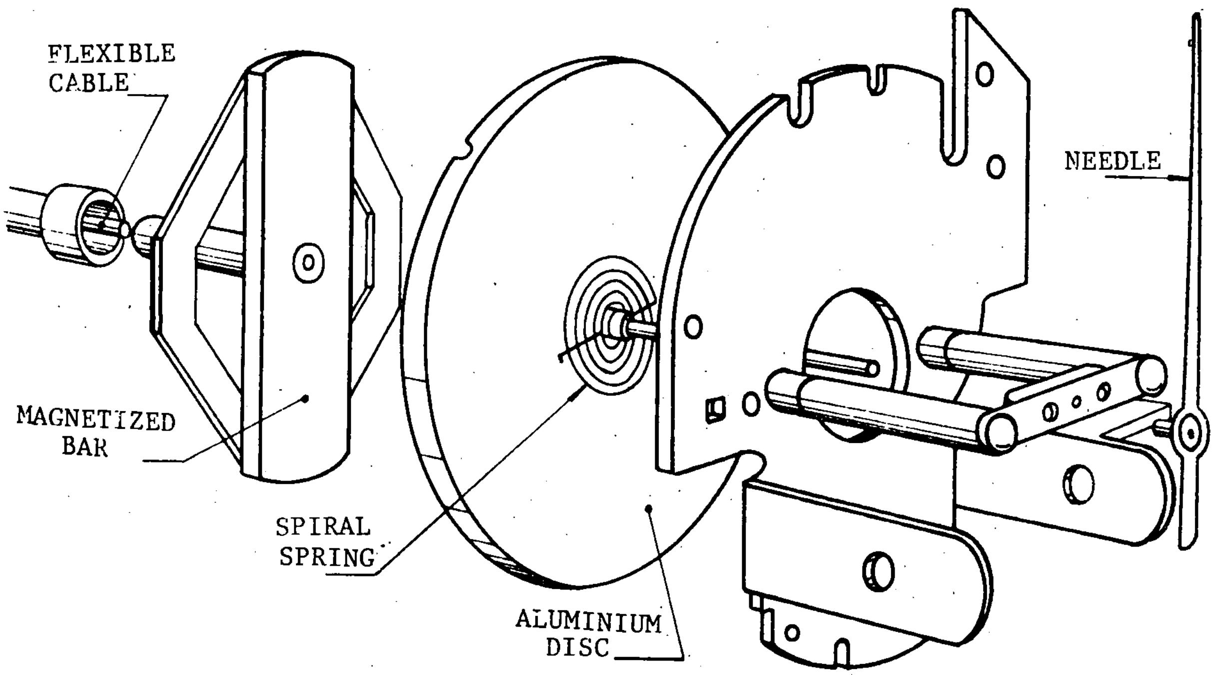

Fig. 4

This is the mechanism which enables the intake and outflow of the gases in internal combustion engines so as to fulfil their work cycles.

CONSTITUITION

It is composed of the following parts (fig. 1):

1. Camshaft.
2. Tappets.
3. Rods.
4. Rocker arms.
5. Valves.
6. Cylinder head.

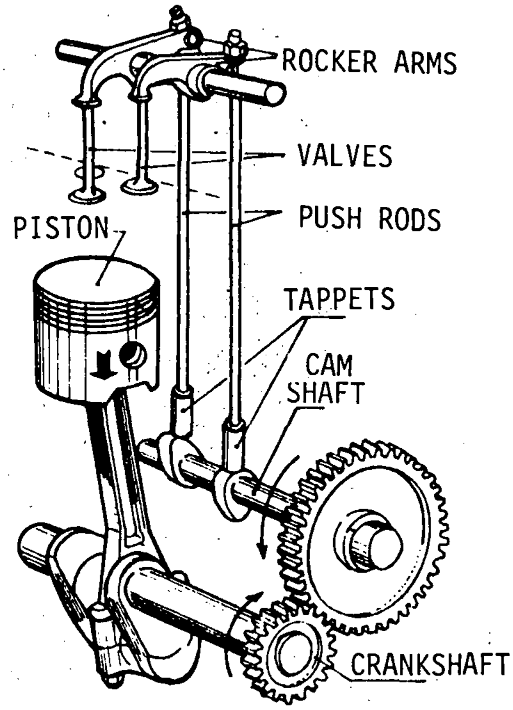

Fig. 1

Depending on the operation of the camshaft, it may be: directly controlled or indirectly controlled. The direct control is carried out by means of gears, with direct intake from the crankshaft in which its rotation movements are in a opposite direction. (See fig. 1). The indirect control is carried out by means of a chain (fig. 2), and its revolutions are in the same direction.

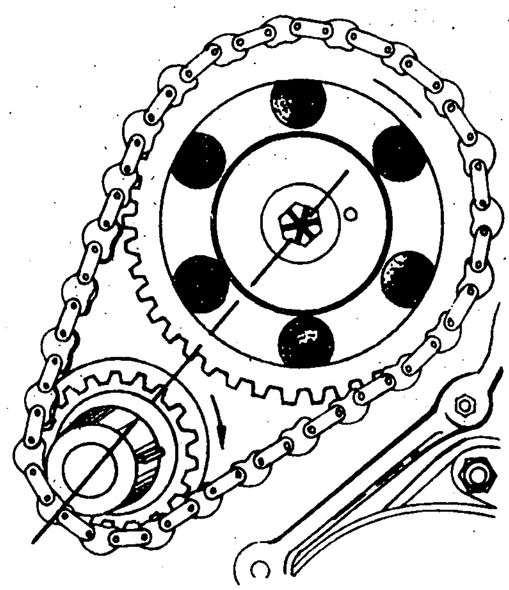

Fig. 2

POSITION

The position of the distribution system may have four alternatives:

- The whole mechanism is situated in the engine block (fig. 3).
- The camshaft, tappets and the exhaust valves are situated in the block and the rocker arms and intake valves on the cylinder head (fig. 4).
- The camshaft and the tappets are situated in the block and the rocker arms and valves on the cylinder head. (See fig. 1).
- All the parts are situated on the cylinder head (fig. 5).

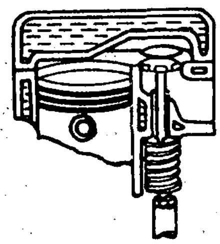

Fig. 3

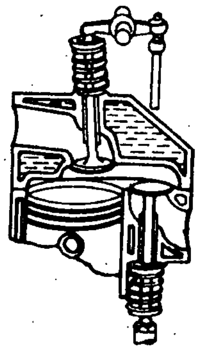

Fig. 4

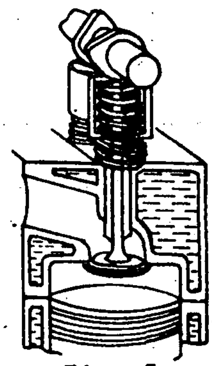

Fig. 5

FUNCTIONING

The crankshaft movement is transmitted to the camshaft by the gears or timing chain.

The cam acts on its corresponding tappet to operate the rod and valve rocker arm, enabling its opening on overcoming the tension of its spring. When the highest part of the cam has passed by the tappet, the valve spring restores it to its closed position against the seating. This motion is transmitted successively to each valve of the different cylinders.

WORK CYCLE

Theoretically, the valves in the engine open and close at the top and bottom dead centres of the piston and this is termed the theoretical working cycle (fig. 6).

In reality, there are variations in the opening and closing of the valves. This is called "practical or real cycle".

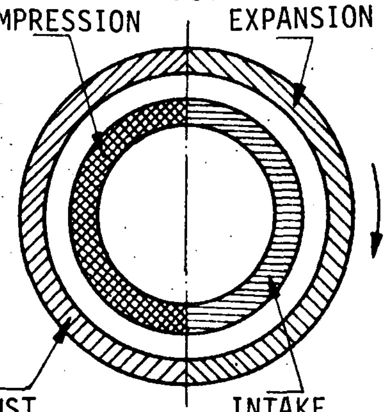

Fig. 6

The principal object of these variations is to increase the performance of the engine, allowing a greater quantity of mixture to enter on the intake stroke and increased burnt gas expulsion on the exhaust stroke. When the explosion in the cylinder occurs, it produces the work stroke of the piston from the top dead centre to the bottom. Before the piston reaches the bottom dead centre, the exhaust valve begins to open (fig. 7), enabling the expulsion of some of the spent gas; this is called advance to the exhaust opening (A.E.O.). The exhaust valve would remain open until the piston has passed the top dead centre, this being called exhaust closing delay (E.C.D.). This

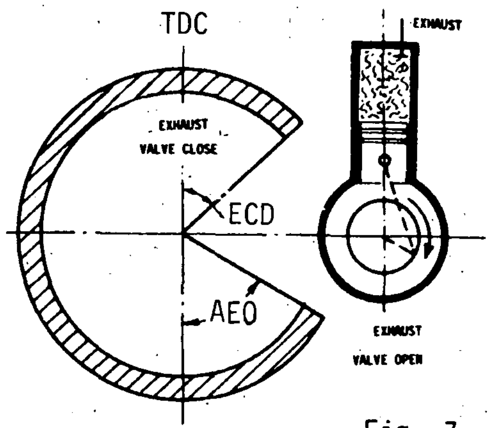

Fig. 7

delay enables advancing the opening of the intake valve (A.O.I.) so as to exploit the depression produced by the quick expulsion of the exhaust gases, with the object of rendering more speed to the mixture entering (fig. 8).
The intake valve will remain open during the whole intake stroke, until the piston has passed the bottom dead centre and begins the compression stroke; this is called intake closing delay (I.C.D.). This enables introducing a greater quantity of mixture into the cylinder, exploiting the entry thrust generated by the intake stroke.
The 4 stroke cycle is represented here graphically by circular diagrams with the opening and closing of the valves (fig. 9).

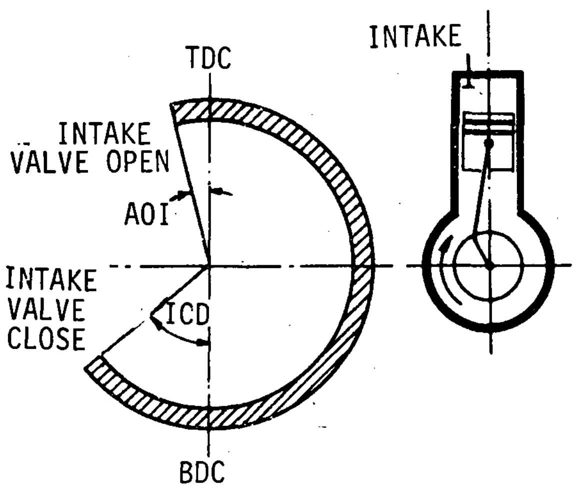

Fig. 8

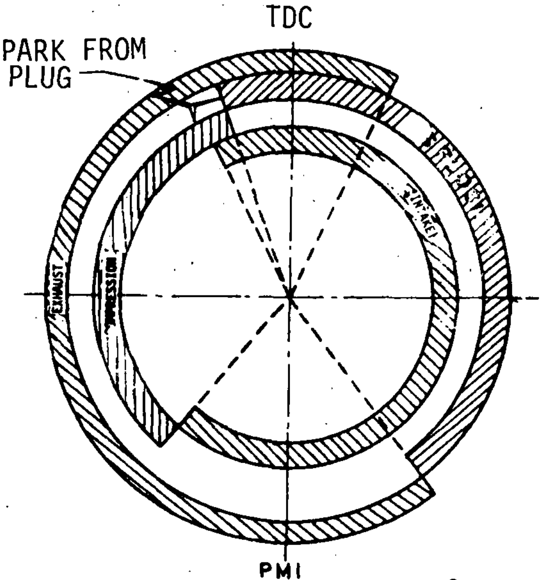

Fig. 9

TECHNOLOGICAL SUBJECT CODE

TYPES

There are three types of distribution systems:

- Open
- Closed
- Crossed (overlap)

Open distribution. In this type, the intake valve is opened when the piston has passed through the T.D.C. and the outlet valve closed before reaching the T.D.C. (fig. 10).

Closed distribution. The intake valve opens at the T.D.C. and the exhaust valve closes at the T.D.C. (fig. 11).

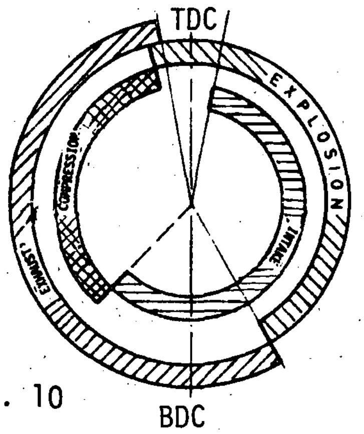

Fig. 10

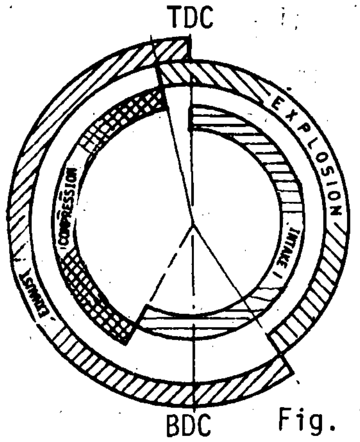

Fig. 11

Crossed distribution. In this type, which is the most used, the intake valve opens before the piston reaches the T.D.C. and the exhaust valve closes when the piston has passed the T.D.C.

Its complete functioning has been explained in the practical or real cycle.

TECHNICAL VOCABULARY:

A.E.O. - valve lead
E.C.D. - valve lag (exhaust valve)
I.C.D. - valve lag (intake valve)
A.O.I. - valve overlap

They are specially shaped tubes mounted on the cylinder head; the intake manifold conveys the mixture of air and gasoline to the inside of the cylinders of the engine and the exhaust manifold evacuates the burnt gases, produced by combustion, to the outside.

CONSTRUCTION

They are made of cast iron or aluminium alloys and their shapes vary according to the engine type.

DESCRIPTION

Intake Manifold (fig. 1). Mounted on it is the carburettor which supplies it with the prepared mixture for distribution to each cylinder. The tubes, because of their shapes, facilitate the course of the mixture and improve the combination of the air with the gasoline.

The intake manifold is secured to the cylinder head by means of bolts or studs with nuts, between which a gasket is installed for preventing the entry of air which would alter the performance of the engine.

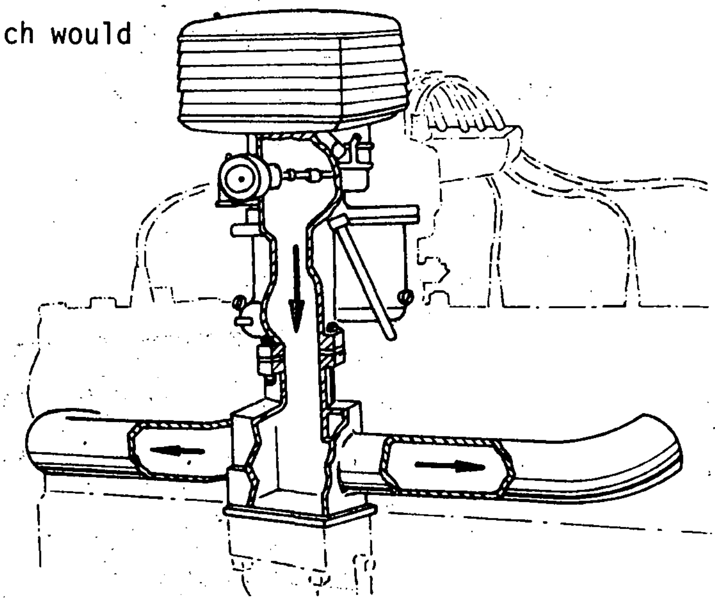

Fig. 1

Exhaust Manifold. It is joined to the intake manifold by means of bolts making up a single body (fig. 2), without intercommunication; this enables use of the heat of the gases for transmitting them to the intake manifold, aiding in the gasification of the mixture.

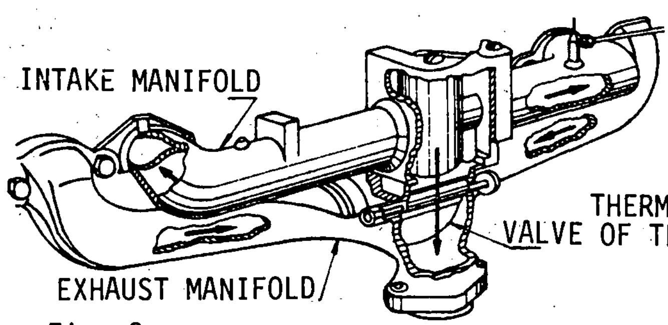

Fig. 2

They generally incorporate a heat valve designed to deviate the gases, when the engine is cold, towards a chamber which encloses the intake manifold (fig. 3), so as to prevent the fuel condensing and affecting the performance of the engine.

The total evacuation of the gases from the engine is achieved through the exhaust pipe connected to the mouth of the manifold. It consists of an exit pipe, muffler and tail pipe (fig. 4).

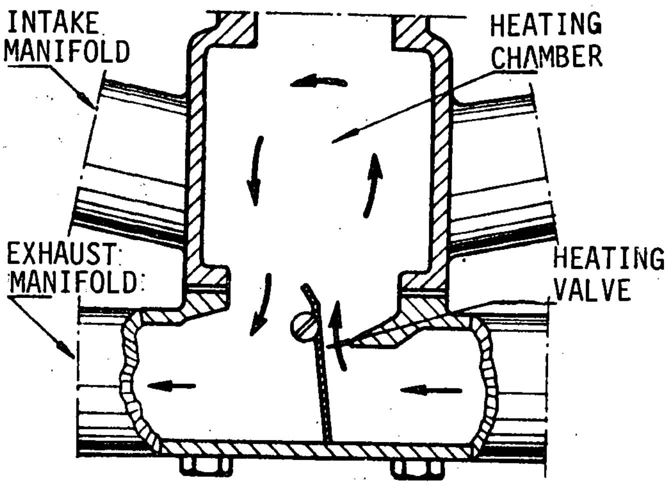

Fig. 3

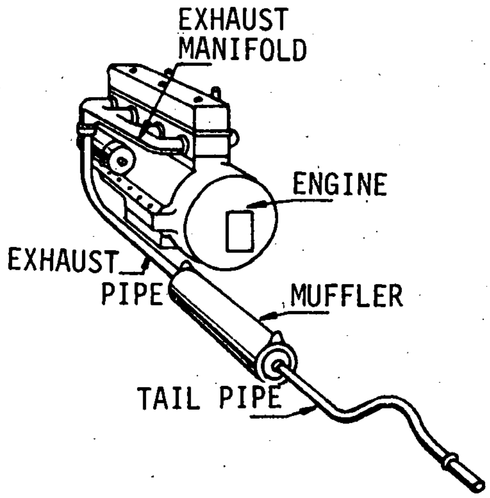

Fig. 4

The muffler, as its name indicates, enables lessening the noises produced by the exhaust gases. (fig. 5).

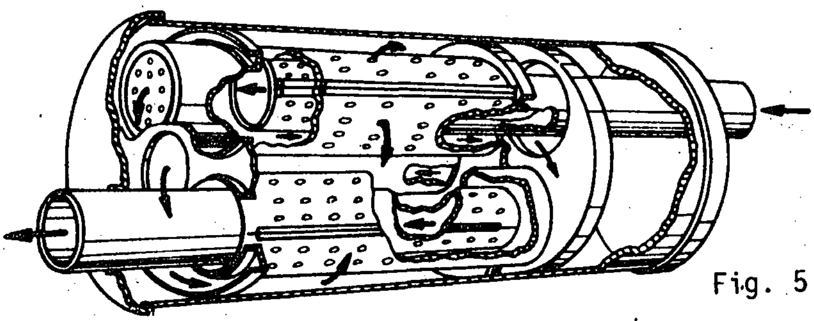

Fig. 5

TYPES

The shapes and installation of manifolds vary according to the engine type. In straight-line engines, the previously described manifolds are commonly used; on the other hand, in V-engines the intake manifolds are installed on the upper part of the block, connecting the cylinder heads from both sides; they are heated by means of internal chambers connected with the circuit covered by the exhaust gases (fig. 6).

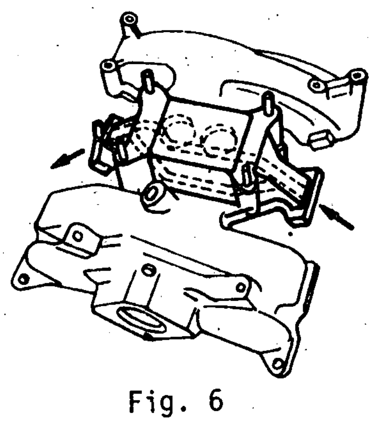

Fig. 6

This is the part of the engine mounted on the upper part of the block which covers the cylinders, making up the compression chamber with the piston head. It is secured to the block by means of bolts or studs with nuts.

CONSTRUCTION

Generally, it is constructed from a single part of cast iron or of aluminium alloys. The first have the characteristics of the metal used in constructing it. It is heavier, it has less heat dissipating capacity, but its coefficient of expansion is also smaller. Those of aluminium alloys (fig. 1) are lighter and have a greater heat dissipating capacity, but have a higher coefficient of expansion which forces strict precautions when carrying out an operation in this type of cylinder head.

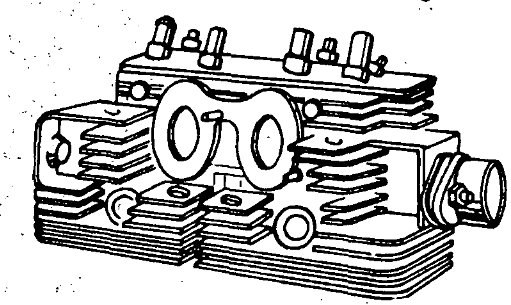

Fig. 1

DESCRIPTION

The cylinder head is machined on its lower surface (fig. 2), to obtain a more air-tight fit with the surface of the block. On this part is situated the compression chambers and inside them the holes with the seatings inserted for the corresponding valves, as well as the water passages which connect the cooling chambers to those of the block; some cylinder heads contain passages for the oil which lubricates the rocker arms.

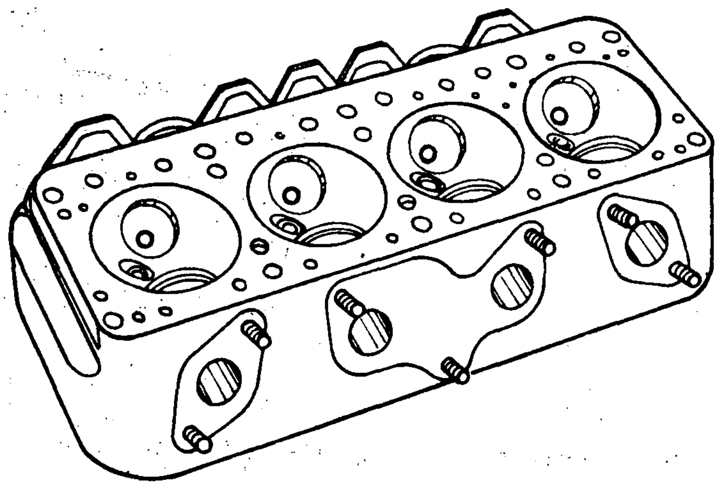

Fig. 2

On the upper part (fig. 3), is the rocker arm mechanism, designed to open the valves, with its edges constructed to accommodate the cover which covers the mechanism.

The intake and exhaust manifolds are mounted at the sides.

A high temperature resistant gasket is placed between the cylinder head and block.

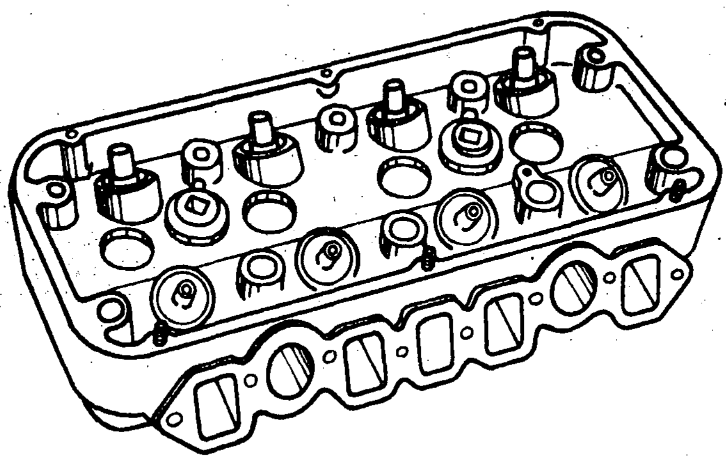

Fig. 3

TYPES

The cylinder head types vary according to the distribution system of the engine, the type most used being the one containing the rocker arm valve mechanism on the upper part of the cylinder head.

In another type, the distribution mechanism is situated entirely on the block and on the cylinder head; only the spark plugs and the securing bolts remain in sight (fig. 4).

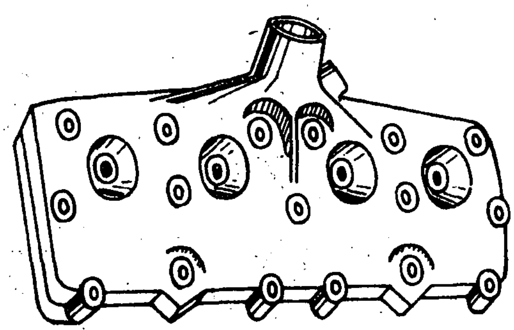

Fig. 4

CHARACTERISTICS

Generally, engines cooled only by air contain cylinder heads made of an aluminium alloy with cooling fins for quickly dissipating high temperatures. (Fig. 1).

These are mechanical or hydraulic devices of the distribution mechanism which receive and transmit the motion of the camshaft for the opening of the valves.

LOCATION

They are interposed between the rocker arm push rod and the cam, in some cases between the valve stem and the cams. They are displaced in cylindrical ports generally drilled in the block on top of the camshaft (fig. 1).

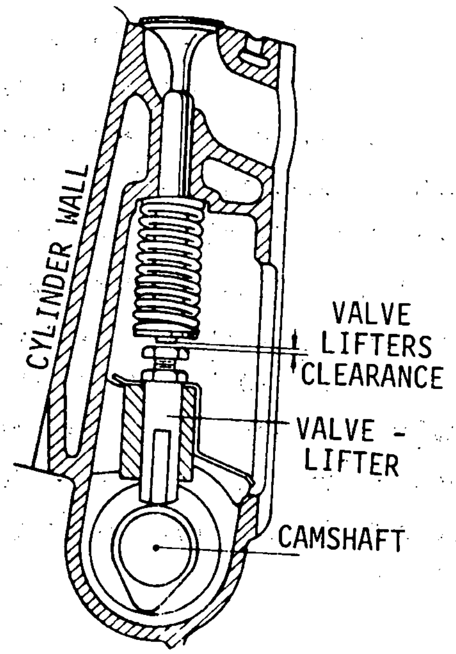

Fig. 1

CONSTRUCTION

They are made of chrome-nickel plated steel. The lower part in direct contact with the cam in an off-centre position for facilitating rotation, is hardened for enduring pressure and friction.

CLASSIFICATION

These devices are classified into:

- Hydraulic
- Mechanical

HYDRAULIC TAPPETS (fig. 2). They consist of a body (1), in which there is a piston (2) which comprises the upper chamber (3). The lower chamber (4) is enclosed between the bottom of the body and the piston; both are connected by a port and a spherical valve (5). This valve enables the flow of oil from the upper chamber to the lower one.

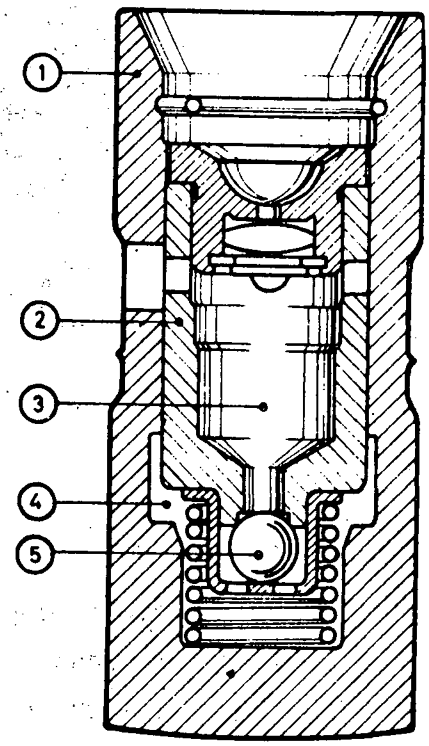

Fig. 2

Functioning of Hydraulic Valve lifters. The valve lifter (fig. 3) is supplied with oil by the pump, through a canal bored all along the length of the engine. When the cylinder valve is closed, the oil from the pump enters under pressure into the upper chamber through the canals bored in the body and piston, and forces the spherical valve to open, overcoming the tension of its spring, and so flowing into the lower chamber. The piston is pushed upwards by the pressure of the oil until it connects with the rocker arm spindle; in this way, any play existing in the valve is compensated for. When the lobe (1) of the cam comes into contact with the tappet (fig. 4), it rises producing an increase in pressure in the lower chamber which closes the valve, so enabling the tappet to function as one single unit. This action is transmitted to the rocker arm push rod unit, opening the valve of the cylinder. When the valve lifter lowers, the valve of the cylinder is closed and the pressure on the piston ceases. The oil excess in the lower chamber returns to the crankcase passing between the piston and the body of the valve lifter.

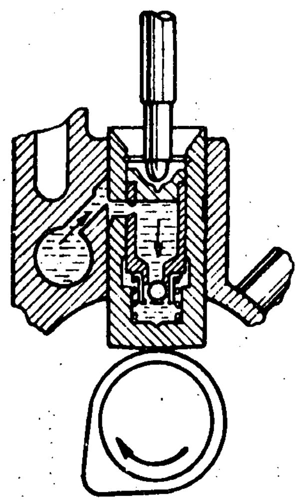

Fig. 3

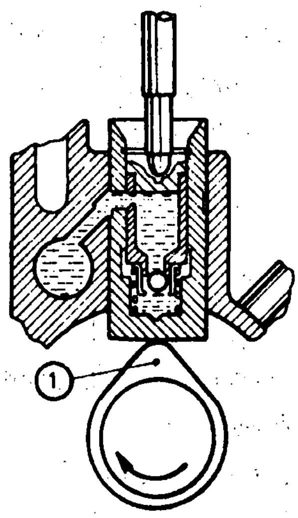

Fig. 4

Hydraulic valve lifter characteristics.

- It functions very silently because it maintains all the parts in permanent contact, which generally require no adjustments.
- The variations resulting from temperature changes or wear are corrected automatically.

MECHANICAL VALVE LIFTERS

Mechanical valve lifters may be classified into:

- valve lifters for lateral valves.
- valve lifters for valves in the cylinder head.

Valve lifters for Lateral Valves. They are the most simple types due to the fact that they function directly between the camshaft and the valve stem (fig. 5). They are equipped with an adjustment device aimed at adjusting the widening play that should exist between the valve stem and the rod.

Valve lifters for Valves in the Cylinder Head. They are similar to those used in lateral valves; however, they differ in that they do not incorporate an adjustment screw and they transmit the camshaft motion to the valves, by means of the push road (fig. 6).

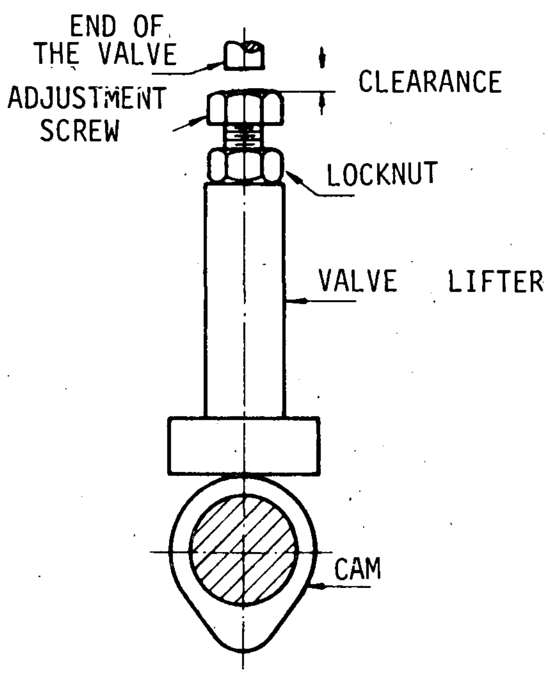

Fig. 5

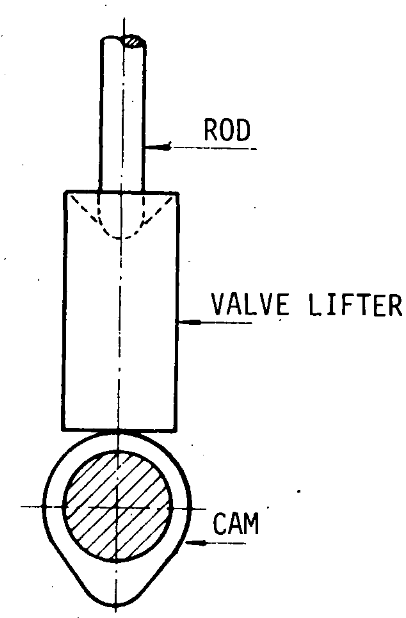

Fig. 6

TECHNOLOGICAL SUBJECT CODE

Valves are the parts of the distribution system that enable the intake or outflow of the gases from the cylinder. They may be operated directly by the camshaft, by means of the valve lifter, or by means of the rocker arms unit.

CONSTITUTION

Valves consist of the following parts (fig. 1):

- Head
- Margin
- Face
- Stem

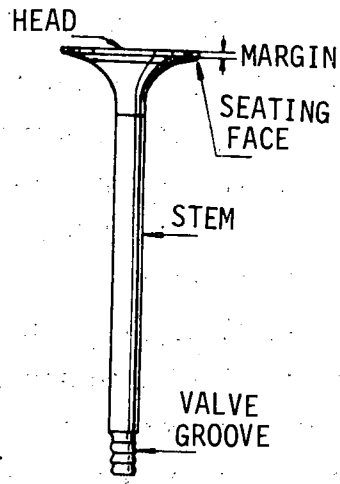

Fig. 1

Head is the upper part of the valve; it may be flat, convex or concave (fig. 2).

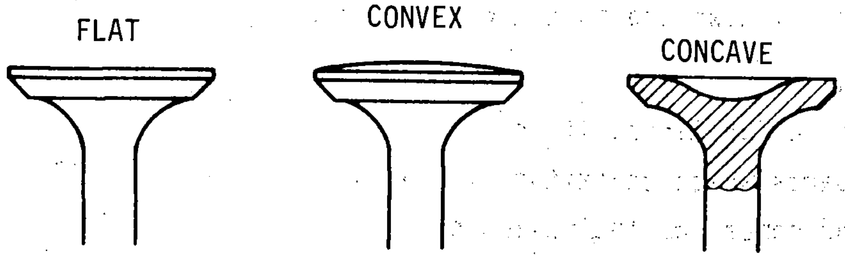

Fig. 2

Margin is the thickness of the valve between the head and its face designed to prevent deformation due to the effect of heat.

Face. This is the part of the valve which is supported by the seat and which seals the flow of gases; it may form an angle of 30° or 45°.

Stem. The lower part of the valve which is displaced in the guide and contains retainer lock grooves at its ends.

CLASSIFICATION

Valves are classified according to the function they perform, into:

- intake valves
- exhaust valves.

Intake Valve. This is the one designed to enable the intake of the fuel mixture into the cylinder. It is made of chrome-nickel plated steel and the head is of a wider diameter than the exhaust so as to facilitate entry.

Exhaust Valve. It enables the expulsion of gases to the outside. Because they function at higher temperatures than intake valves, their heads are of a smaller diameter and more solidly built. The materials are similar to those of the intake valve, with the exception of tungsten which is added to withstand the high temperatures.
In special cases, to maintain them cooler, hollow valves filled with sodium (fig. 3) are used, which on liquefying quickly transfers the heat to the guides and the chambers of the cooling system.

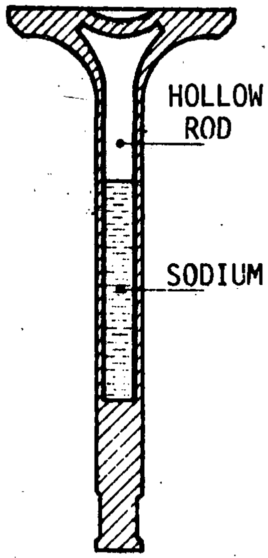

Fig. 3

LOCATION

Valves may be installed in the block of the engine as well as in the cylinder head, and in an alternating arrangement, that is the exhaust valve in the block and the intake one in the cylinder head.

FUNCTIONING

When the valve functions, it is aided by a series of parts which constitute the valve assembly and comprises the following parts (fig. 4):

1. Valve
2. Valve Guide
3. Spring
4. Retainer
5. Lock

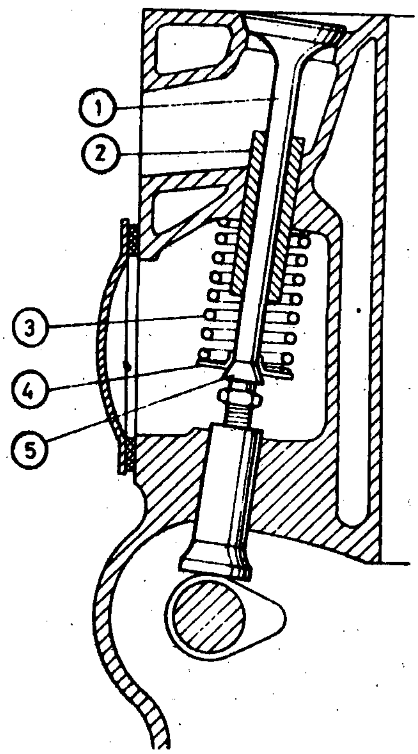

Fig. 4

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The valve rests on a circular ring called the seat, the face of which is parallel to the valve and makes the same angle as it. When the camshaft rotates, one of the eccentrics begins to lift the valve lifter which transmits its movement to the valve stem, overcoming the resistance of the spring, to allow the mixture to enter or the gases to be expelled. When the eccentric passes and the spring returns the valve to its seat, sealing the passage of gases.

CONDITIONS FOR USE

Because valves work at high temperatures, all the parts are subject to expansion, for example, the stem becomes elongated. To compensate for this expansion, some play must exist between the valve stem and the valve lifter or the rocker arm; this opening should be checked at certain given time intervals.

All these adjustments should be made keeping to the manufacturer's specifications.

Refacing enables reconditioning of the contact surfaces between the valve and the seat, since by the effect of high temperatures, corrosive action of gases and the intense work to which it is subjected, deficiencies are produced in the sealing, causing a loss of compression in the engine.

GENERALITIES

Intake valves generally differ from exhaust valves in the width of the head and the close-down angle of the face. An angle of 30^{0} for the intake valve facilitates the flow of the mixture and its head is not as solid because it is more easily cooled; an angle of 45^{0} for the exhaust valve gives it more strength, so avoiding deformations due to the high temperatures they must endure. The heat and the gases produce deficiencies on the valve face; a correct inspection determines the possibility of reconditioning them by means of refacing, which is done with special equipment for the valves as well as the seats.

The quantity of material which is to be eliminated from the face of the valve is determined by the margin thickness, which should not be less than 0.8 mm (1/32"). The angle to which the face should be refaced is specified in the catalogues or may be directly checked with a combination square. Some manufacturers recommend a difference between the valve face angle and the seat angle of $\frac{1}{2}^{0}$ to 1^{0}, known as the interference angle (fig. 1). If, for example, the seat makes an angle of 45^{0} the valve will be refaced to 44^{0}

The valve seats, steel rings independent of the cylinder head, are pressure inserted by means of the process of contraction, through cooling with dry ice and expansion of the cylinder head by applying heat. Seats mounted by this procedure remain perfectly adjusted when the cylinder heads cools.

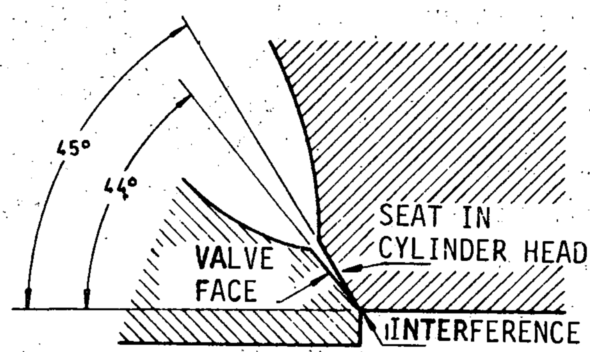
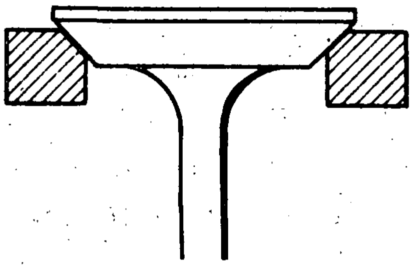
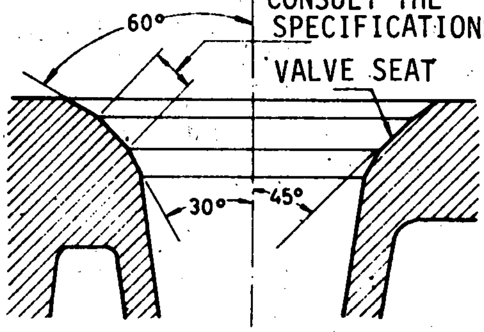


Fig. 1

Seats undergo the same effects as valves, for which reason it is necessary to rectify the contact surface and the width. This is done with abrasive stones or milling cutters which smoothen the surface, maintaining the angle within the specifications. The width of the seat should be between 2.4 and 3mm (3/32" to 1/8"), and should be concentric with the valve face (fig. 2); this is achieved by applying stones or milling cutters with a greater angle for the top part and a smaller angle for the lower part (fig. 3).





REFACING MACHINES

There are machines especially designed to reface valves (fig. 4), which generally consist of:

- Carriage with cone or mandrel
- Emery Stone
- Displacement (handles)
- Angle control.

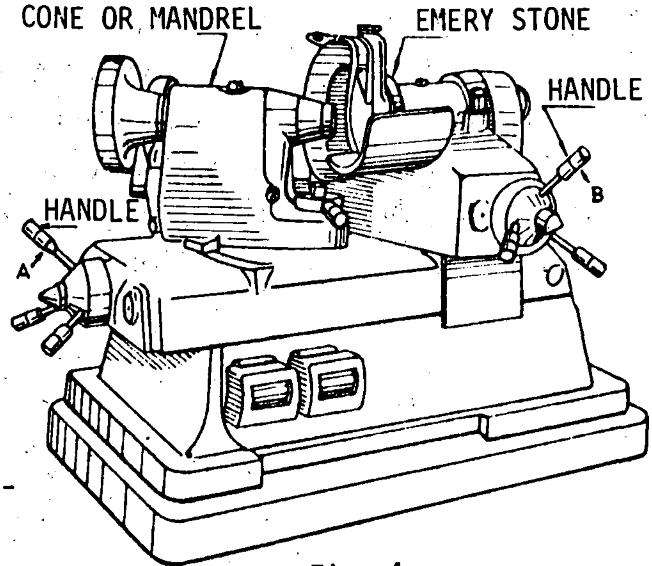


Fig. 4

The carriage, with cone or mandrel sustains the valve and gives it a rotating movement slower than that of the stone to achieve the grinding evenly. The Emery Stone is of a fine grain and its contact surface is conveniently ground. It rotates at high speeds driven by an electric motor. The displacement handle (A) moves the carriage of the cone which sustains the valve, allowing it to move all over the stone. The handle (B) draws the stone near to the valve face until making contact. The scale graduated in degrees enables adjusting the carriage of the cone according to the refaced angle of the valve.

AUTO MECHANICS

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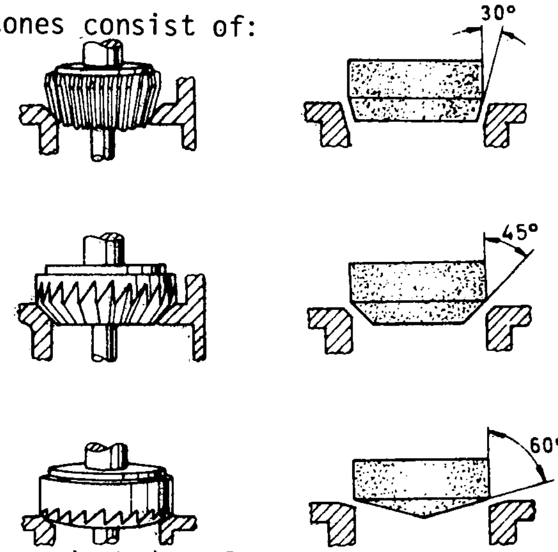
The abrasive stones and the milling cutters for grinding seats are specially shaped and of different diameters and angles (fig. 5).

The equipment for grinding seats with stones consist of:

- Refacing Stone
- Vibro Centric
- Mandrel
- Guides



The refacing machine has a diamond and a graduated scale for grinding the stones to the corresponding angles (fig. 6).

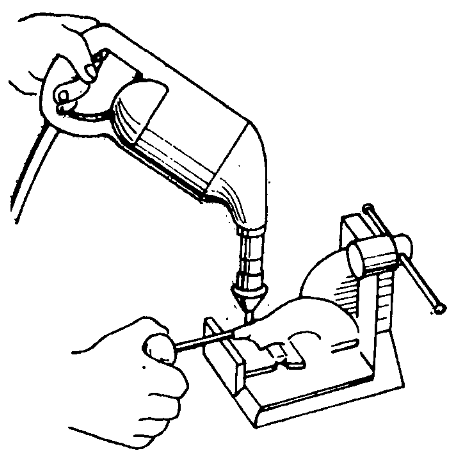


Fig. 6

The vibro centric, similar to the electric cutter, drives the mandrel in which the stone is installed, for refacing or for grinding the seat.

The mandrel moves along the guide or stem positioned in the guide hole of the valve, for grinding the seat concentrically.

The milling cutters are mounted on a bar with guides according to the diameter of the valve body and applied on the surface of the seat, rotating it slowly to attain an even trimming.

TECHNICAL VOCABULARY

Mandrel - chuck.

TECHNOLOGICAL SUBJECT CODE

This is the unit designed to transform the caloric energy of the fuel, given off during combustion, into mechanical energy.

CONSTITUTION

It is composed of the crankshaft, connecting rods and pistons (fig. 1).

Crankshaft. It is the main shaft of the engine designed to transform the alternate rectilinear motion of the piston into continuous circular motion.

Connecting Rods. These are the parts designed to transmit the piston motion to the crankshaft.

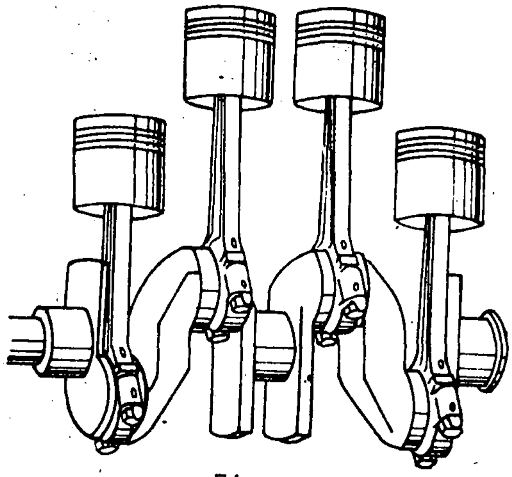


Fig. 1

Pistons. These are the parts that are displaced inside the cylinder and receive the force generated by the expansion of the gases. For an air-tight seal, between cylinder and piston, they carry compression rings which stop the flow of gases towards the inside of the engine and oil rings which remove the oil from the cylinder walls.

CONSTRUCTIVE CHARACTERISTICS

One of the main characteristics of the mobile assembly is the relation between the diameter of the cylinder and the length of the crankshaft stroke or revolution (fig. 2), giving rise to the following three cases:

Long Engine; in this engine the diameter of the cylinder is less than the piston stroke.

Square Engine; the diameter of the cylinder and the piston stroke are equal.

Short Engine; the diameter of the cylinder is greater than the piston stroke.

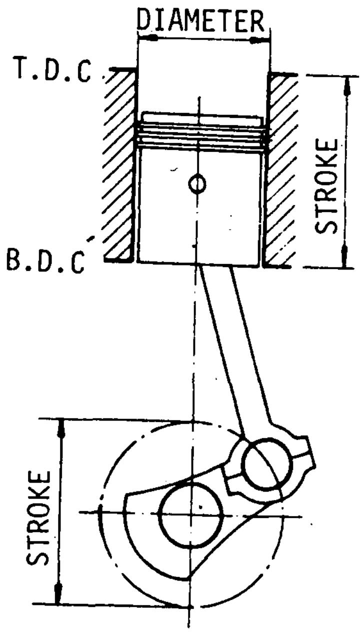


Fig. 2

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Amongst the three types mentioned the one that has the greatest advantage is the short one, as with a same number of revolutions, the distance traversed by the piston in its four strokes, is less than in the other two cases. This enables, as well, decreasing the height of the engine. Another of its constructive characteristics is the displacement of the crankshaft, with respect to the central line of the cylinder (fig. 3), with the purpose of reducing the lateral reaction of the piston during the power stroke. In some cases, the out of centre is established in the piston pin (fig. 4).

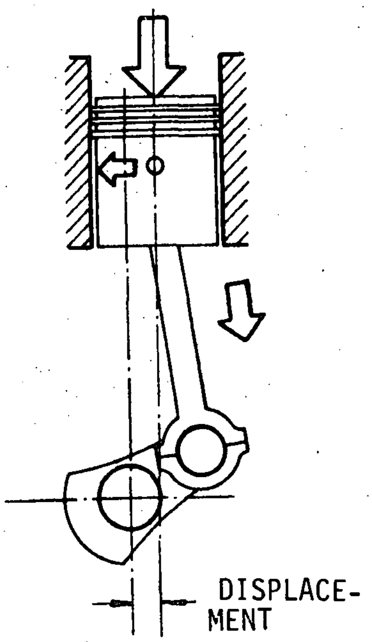

Fig. 3

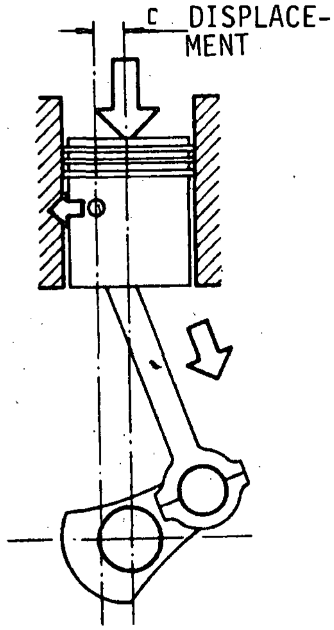

Fig. 4

TECHNICAL VOCABULARY:

Long engine - under square; long stroke
Short engine - over square; short stroke

This is the assembly designed to transmit the force, generated by the expansion of the combustion gases, to the crankshaft.
These parts (fig. 1) enable the conversion of the reciprocating motion of the piston into the continuous circular motion of the crankshaft.

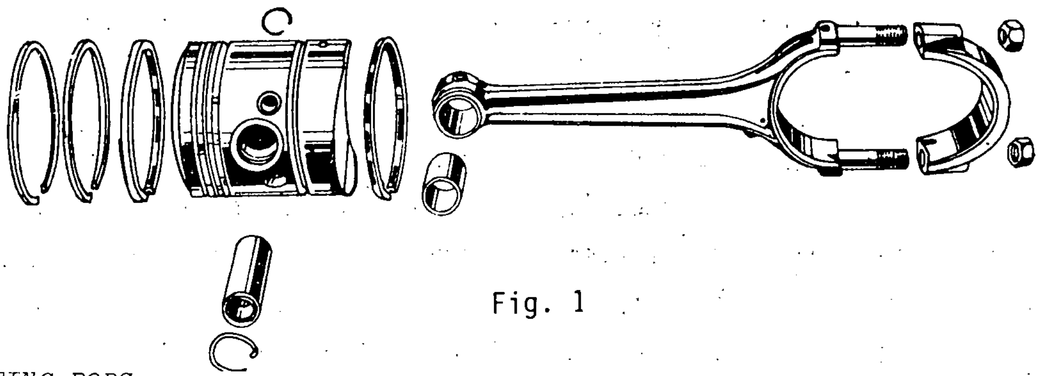

Fig. 1

CONNECTING RODS

They can be divided into three parts:

- Head (small end)
- Body
- Foot (big end)

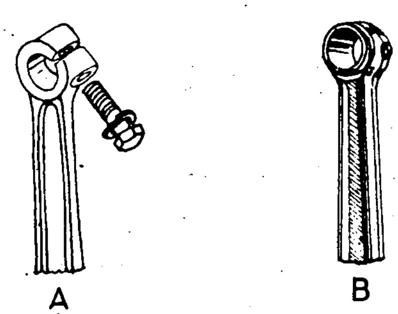

Fig. 2

Head. This is the part of the connecting rod that couples with the piston by means of the pin and may be open (A) or closed (B) (fig. 2).
In the first case, the pin is secured to the connecting rod by tightening the respective screws and both function as a single unit. In the second case, the pin rotates within the connecting rod and both function independent of each other.

Body. It consists of the middle part of the connecting rod and its H-shaped outline section increases its rigidity and reduces its weight. In some connecting rods, a passage is drilled all along its length for conveying oil from the crankshaft journal to the piston pin.

Foot. This is the lower part of the connecting rod that is secured to the crankshaft journal. It is divided into two parts: foot proper and cap. The cap is secured to the foot (fig. 3), by means of special steel bolts (A), bolts with nuts (B) or fetters secured to the foot of the connecting rod (C).

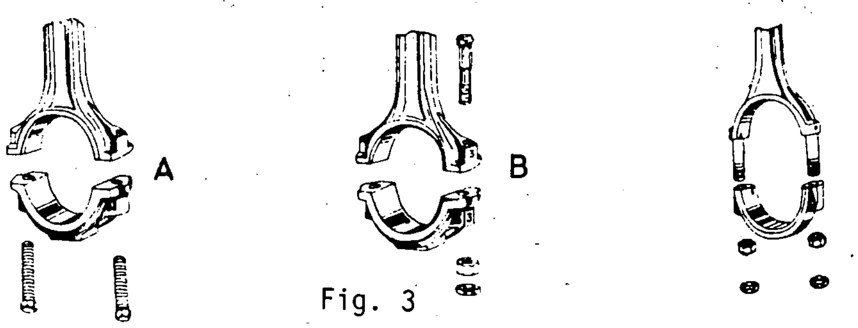

Fig. 3

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The foot and the cap of the connecting rods are usually marked with numbers to indicate the correct installation between them and the cylinder to which they belong. The connecting rods are subjected to great stress that may twist or bend the body, as well as wear down the foot and cap, for which reason it is necessary to inspect them before mounting.

PISTONS

The piston is designed to receive the pressure of the combustion gases and transmit this force to the connecting rod. They are made of an aluminium-silicon alloy, its main characteristics being low specific gravity, high strength, rapid heat dissipation.
Some pistons have a metallic coating of lead or tin, which protects the sliding surface of the cylinder, in the event of a temporary insufficiency of lubricating oil. Its diameter is smaller than that of the cylinder in which it works, so that it may displace itself freely and absorb the expansion it undergoes as a result of the temperature of the combustion gases and the friction.
Because greater temperatures are produced in the piston head and they decrease towards the lower part, the shape of the piston is conical, enabling an even expansion without any clustering occurring. In the piston four parts can be distinguished:

- Head
- Ring Section
- Pin Hole
- Skirt

Head. This is the upper part of the piston which receives the push from the gases and may be (fig. 4).

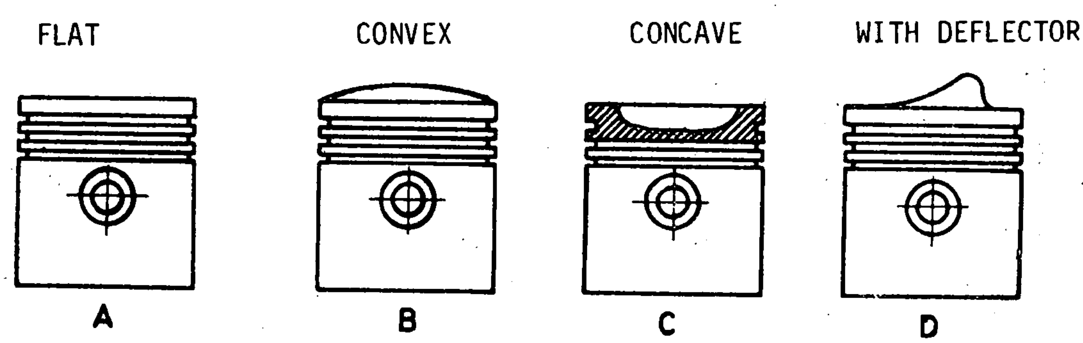


Fig. 4

Ring Section. This section contains the grooves which house the rings. The groove of the oil ring has a slot to allow the oil to flow to the cylinder wall.

Pin Hole. This hole, which goes through the piston, houses the connecting rod securing pin. The pin may be installed in the piston in three different ways:

- fixed in the connecting rod and free in the piston (fig. 5).
- fixed in the piston and free in the connecting rod (fig. 6).
- Loose in the piston and in the connecting rod (fig. 7).

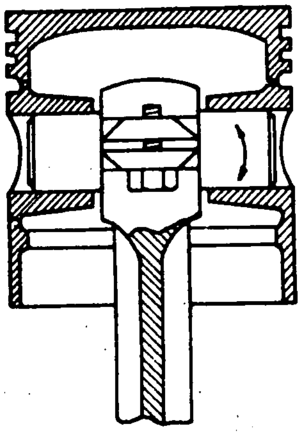


Fig. 5

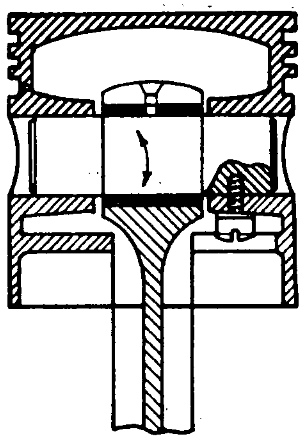


Fig. 6

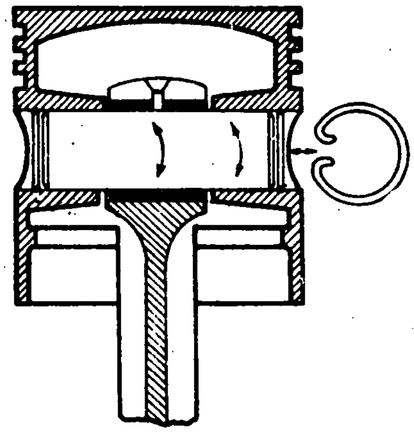


Fig. 7

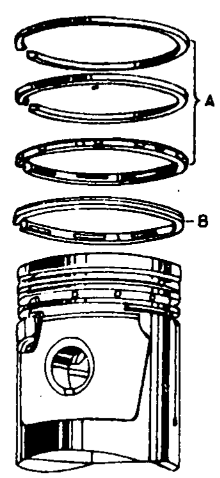
RINGS

They are mounted in the grooves in the ring section of the piston and maintain the combustion chamber air-tight, transferring the heat from the piston to the cylinder while controlling the oil film in the cylinder.

They are made of a fine grain cast iron and their shape corresponds to a definite curve, giving them a natural tension which is sometimes reinforced by means of a laminated spring placed below them.

The are divided, according to their purpose, into compression rings and oil rings (B) (fig. 8).

The most common shape of the compression rings is the square section; but grooved, four-sided and bevel rings are also used. The first compression ring which is the most firmly applied and more subjected to wear is frequently plated with hard chrome.



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The oil rings are situated at the lower part of the ring section, while there are some pistons that incorporate them in the skirts. They generally have one central groove with slots to permit oil drainage towards the cylinder for its lubrication.
They have actually been replaced by a unit of chrome-plated steel sheets with a zig-zag spring between them (fig. 9).

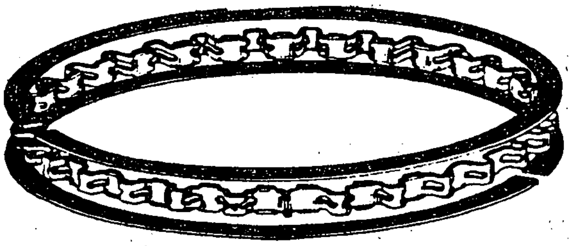

Fig. 9

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In order to repair the engine and especially in repairing those parts related to the reconditioning of the connecting rods and pistons, the following elements should be available:

- Connecting rod aligners
- Extractor and ring fitter
- Piston groove cleaner
- Ring compressor

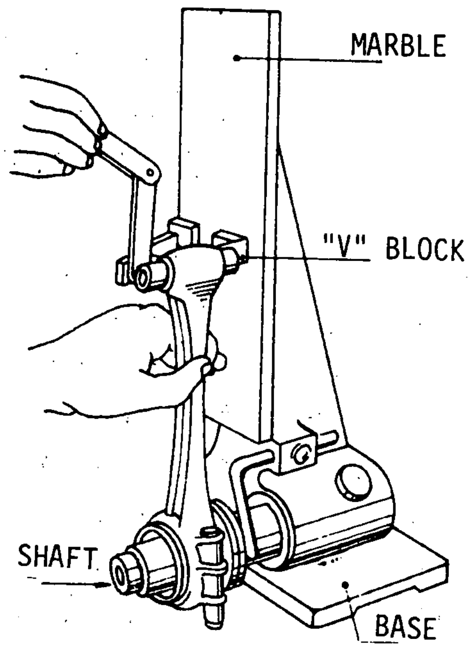

Fig. 1

Connecting Rods Aligner. In order to check the alignment of the connecting rods dismounted from the engine, (it may be done with or without the piston), an aligner is used. This consists of a vertical rule or a marble (fig. 1), which by means of the base is fixed to the work bench, perpendicular to the face of the marble. It has a post on which the connecting rod head is supported; these posts may be interchangeable or have adjustable cones which enable centring the connecting rod with relation to the post of the aligner. The tester or V-Block is placed on the upper part of the marble; it should be supported on the connecting rod gudgeon pin and with a calibrated sheet the possible deviations of the connecting rod can be checked.

This equipment enables controlling the connecting rods in three ways: parallelism between the shaft holes A and B (fig. 2); vertical alignment of the shaft C of the connecting rod; possible twisting of the body of the connecting rod (Warped).

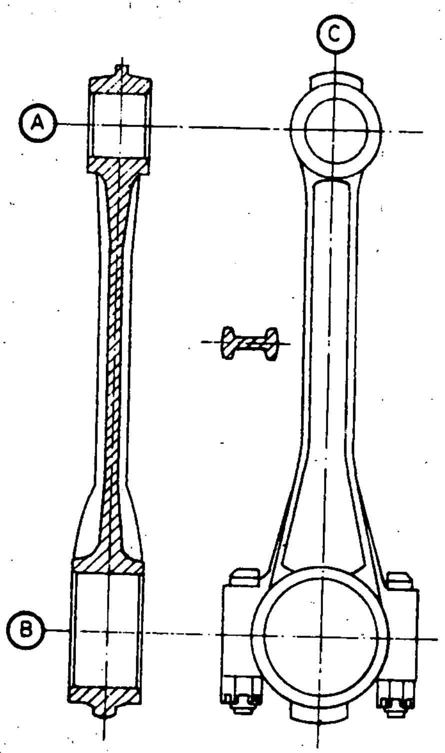

Fig. 2

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Extractor and Piston Ring Fitter (fig. 3). It has two little claws that hold the ring ends. Then, when pressure is applied on the handles of the tool, the ring opens sufficiently to allow removing it or installing it in the groove of the piston.

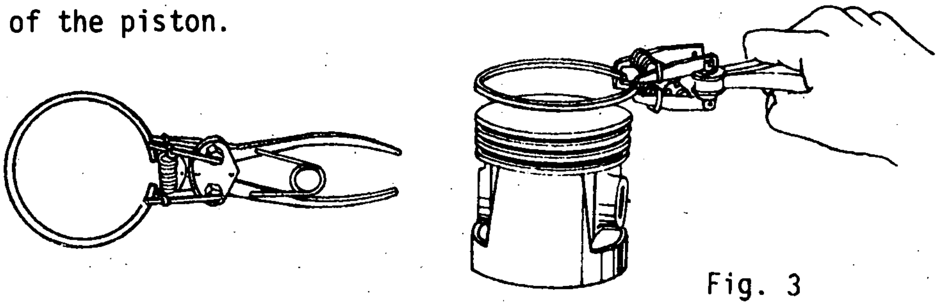

Fig. 3

Piston Groove Cleaner. These are generally used when the pistons are being dealt with and when the rings are being dismounted. The tool consists of scrapers of different sizes for adapting to the grooves; the tool is installed bringing the appropriate scraper into contact with the groove and is secured with the screw (A) (fig. 4). It is then rotated to remove the carbon deposits. This operation is repeated with the remaining grooves, taking care not to remove any metal shavings from the piston which may alter the dimensions of the grooves.

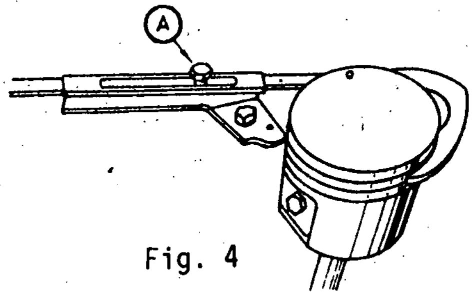

Fig. 4

Ring Compressor. In order to replace the connecting rod-piston assembly with its corresponding rings, it is necessary to compress them in their grooves so as to facilitate fitting them on to a cylinder. For this purpose, a ring compressor (fig. 5) is used; it consists of a curved sheet which is installed on the head of the piston and by means of the lever is tightened until totally compressing the rings in their grooves. The piston is inserted into the cylinder by tapping it gently with the handle of a hammer or a plastic mallet (fig. 6).

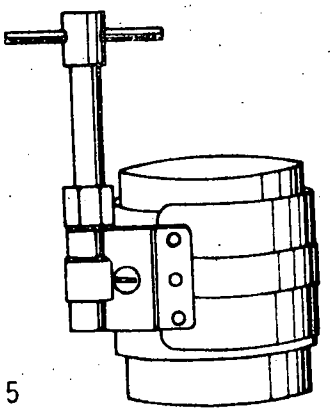

Fig. 5

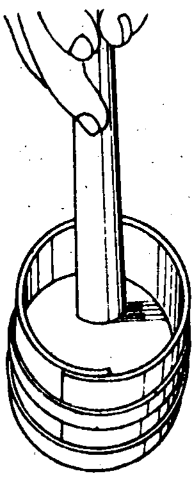

Fig. 6

This is the tool used to remove the ridges on the upper part of the cylinder, where the rings have no effect, when it is necessary to remove the pistons.

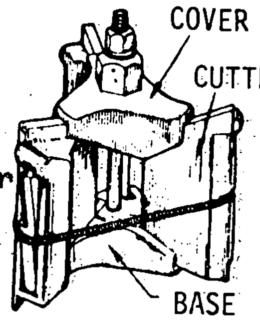

Fig. 1

DESCRIPTION

There are a number of types and models of ridge cutters that vary in their structure as well as in their methods of operations, but all perform the same function with the accuracy which is needed for these cases.
They are composed of the following parts (fig. 1).

Upper Cover. With a hexagonal or square nut for coupling a tool which rotates the unit to produce the cutting. On its lower part it has grooves in which the extendable fins are displaced.

Extendable Fins. They are adjusted to the cylinder by means of the central nut and the screw passing through the control nut of the unit. There are generally three fins and only one of them acts as the cutting tool.

Lower Base. It has grooves, identical to those of the upper cover, which enable displacement of the extendable fins.

FUNCTIONING

Currently this task is done before removing the piston-connecting rod assembly. The ridge cutter is inserted in the cylinder, adjusting it by means of the central nut, until the cutting tool comes into contact with the rough seam ridge, then the entire unit is rotated by means of the nut, so as to eliminate the ridge (fig. 2).

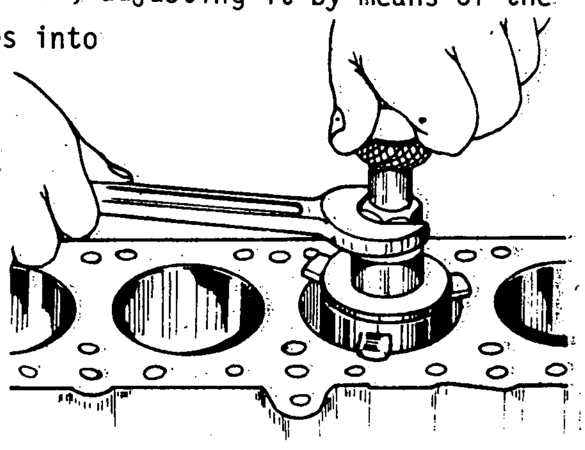
Fig. 2

CONSERVATION

This tool should be kept in its corresponding case, so as to avoid damaging its cutting edge.

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It is one of the principal parts of the distribution system, its purpose being to synchronize the opening and closing of the valves during the work cycle of the engine.

DESCRIPTION

It is constructed of a special machined steel and its cams, eccentrics and journals are heat treated so as to furnish a wear-resistant surface (fig. 1).

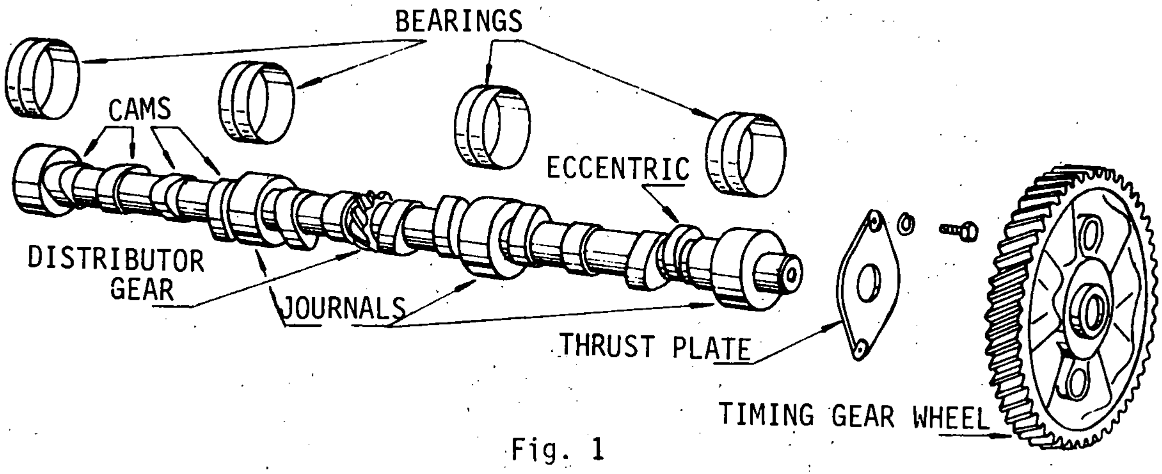

Fig. 1

The number of cams is double the number of cylinders and its special cross-section (fig. 2) determines the gradual elevation of the tappet and the total opening time.

The number of journals is variable, but sufficiently numerous to limit the bending of the shaft.

At a certain point along its length it has an eccentric for operating the gas-pump and a spiral gear, which moves the distributor or the oil pump.

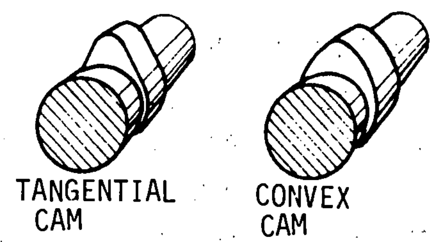

Fig. 2

The front part consists of a housing for securing the timing gear, with double as many teeth as in that of the crankshaft, from which it receives the motion either by direct mesh or by means of a chain.

In the case of direct mesh the direction of rotation is opposite to that of the crankshaft. The gear wheel used is made of fibre or aluminium and has spiral gear teeth which enable a more silent functioning.

The securing in its position and the limiting of the axial play is attained by means of the plate which is inserted between the shaft and its gear wheel.

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POSITIONING

The camshaft is arranged paralled to the crankshaft and may be mounted to one side of the block in straight line engines, or centrally above the crankshaft, in V-shaped engines. It is also commonly mounted on the cylinder head and it may be operated by chain, gears or connecting rods (fig. 3).

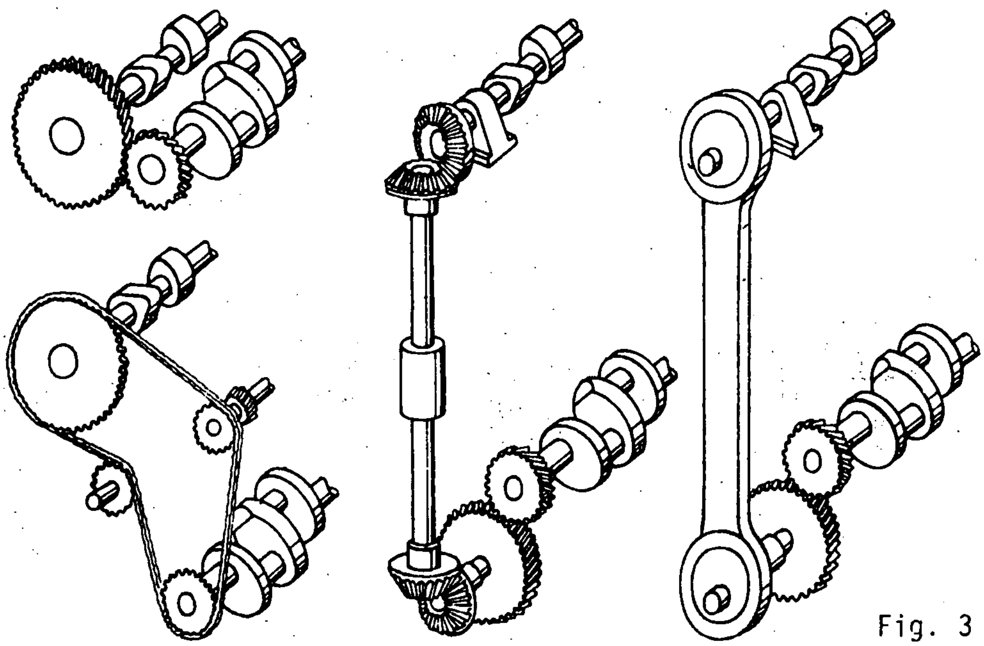

Fig. 3

TIMING

On having assembled the distribution of an engine, the camshaft and crankshaft should remain in the same position as they were when brought from the factory. For this reason gear wheels have reference marks that should be made to coincide when reassembling.

In distribution systems with gear wheels, it is only necessary to coincide the marks directly (fig. 4).

When distribution systems are chain operated, the timings are mostly different and should be done, following the manufacturer's indications. (Fig. 5).

If these reference marks are not found on dismantling the distribution system, the mechanic should make the respective marks.

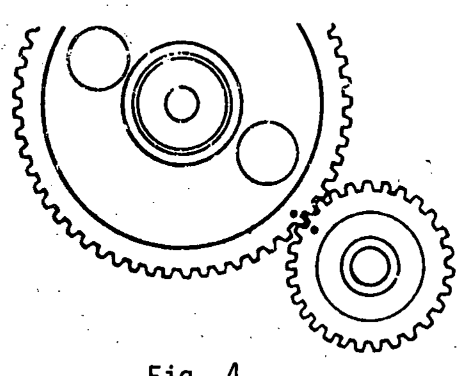

Fig. 4

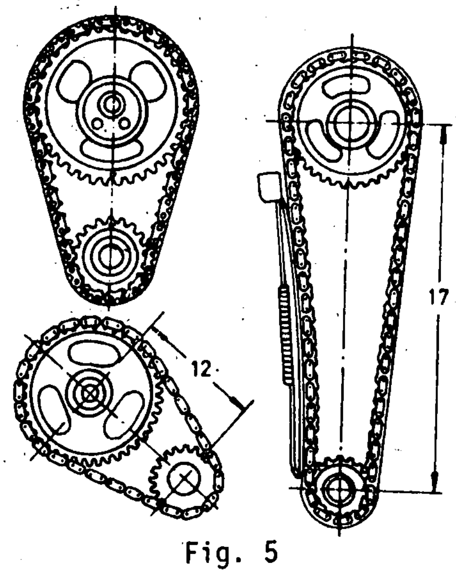

Fig. 5

It is a bent shaft designed to transform the reciprocating motion of the piston into continuous circular motion.

POSITIONING

It is mounted on the engine block and rests on anti-friction bearings inserted between the journals and their caps.

CONSTRUCTION

Generally, crankshafts (fig. 1) are made of wrought iron (chromium-molybdenum), thereby obtaining a structure with a high resistance. In some cases the smeltering process is used, using chrome-silicon plated steel.
In both cases, the surfaces subjected to friction are treated and machined to make them hard and resistant to wear.

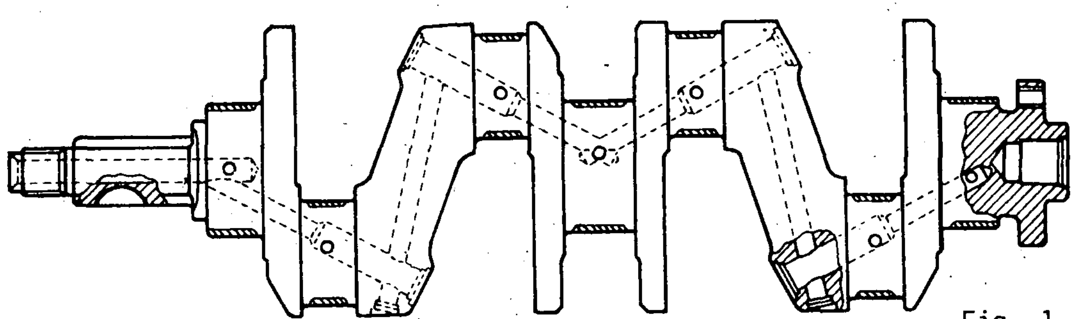

Fig. 1

DESCRIPTION

In the front part, the shaft has a groove with a half round key for installing the distribution gear and in the rear, a flange for holding the fly-wheel of the engine.
There is a hole in the centre of the flange for housing a ball-bearing or a bronze bushing, which serves as a support for the end of the gear box input shaft.
In order to efficiently lubricate the bearings, the crankshafts have passages which connect the main journals to the crankpins, through which the lubricating oil circulates.
The whole unit, including the flywheel, is dynamically and statically balanced so as to eliminate vibrations when it is functioning.

CHARACTERISTICS

The angles formed between crankpins are different for every crankshaft, depending on the number of cylinders. They are calculated by dividing 720^{o} (number of degrees traversed by the crankshaft during a complete cycle or 2 revolutions) by the number of cylinders of the engine.

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For a four cylinder engine the angle would be (fig. 2):

$$720^{\circ} \div 4 = 180^{\circ}$$

For a six cylinder engine the displacement angle would be (fig. 3):

$$720^{\circ} \div 6 = 120^{\circ}$$

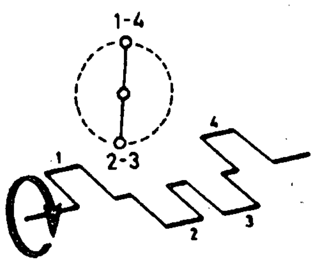

Fig. 2

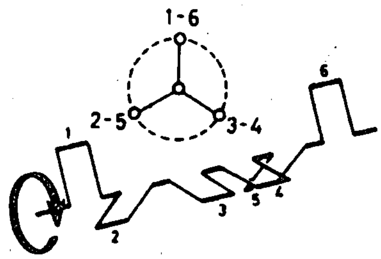

Fig. 3

The four stroke engine requires four strokes from each piston in order to complete its cycle.

Of these four strokes only from the power stroke does the crankshaft receive the power to rotate it, as it must supply energy to obtain the intake, compression and exhaust strokes. For this reason, the crankshaft is furnished with a flywheel which accumulates kinetic energy from the power stroke and renders part of it to the remaining strokes.

The flywheel, fig. 4, of the engine is situated at the rear end of the crankshaft and on its perimeter it has a geared rim or segment, which is controlled by the starter motor gear wheel when the engine is made to function. In order to reduce the effects of the vibrations, produced during acceleration, the crankshafts are furnished with a vibrations mechanical damper, made up of 2 discs (1 and 2) (fig. 5), separated by springs (3) designed to drag the unit as a result of friction.

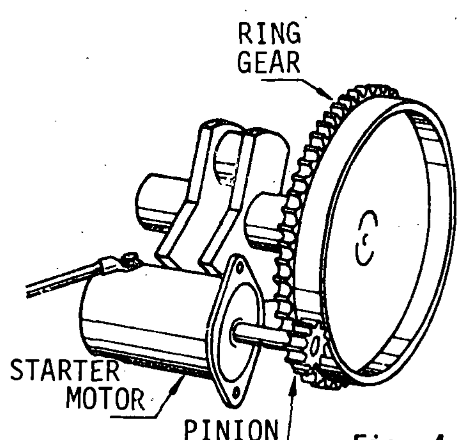

Fig. 4

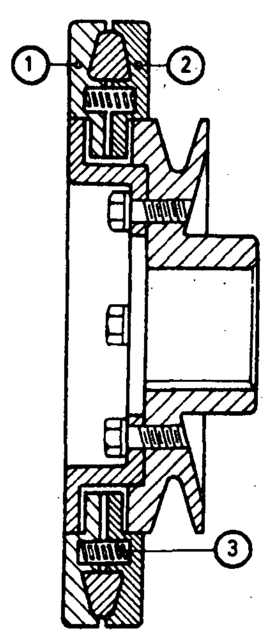

Fig. 5

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It is the main body of the engine in which the parts of the mobile assembly, lubrication system and part of the distribution system are mounted; it serves, as well, as a bracket or support for the parts of other systems, such as, the fuel, cooling and ignition systems.

DESCRIPTION

The block (fig. 1) is cast in one piece from an iron or aluminium alloy. On the upper surface the cylinder head is mounted and on the lower part is the cover of the oil tank.

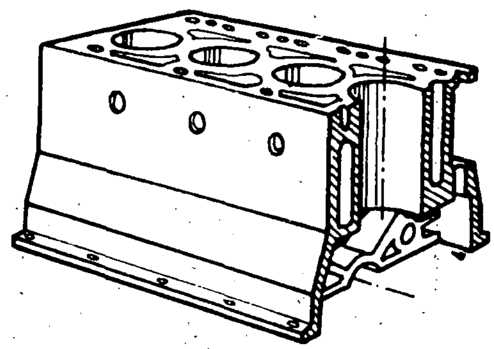

Fig. 1

The front part of the block is covered with the distribution cover and the rear with the clutch casing, the block thereby remaining air-tight by means of gaskets.

The upper and lower surfaces are machined so as to ensure air-tightness, the same being the case with the parts which support the crankshaft and camshaft which require correct alignment for them to function.

In the block there are the cylinders in which the pistons are displaced. There are usually two, four, six and eight cylinders, their positions varying with the type of engine.

Inside the block, we find, also, the oil and water lines; they are accessible from the outside, through the core plugs. Other parts mounted on the block include the water pump, the distributor, fuel pump, the generator or alternator and other accessories.

CHARACTERISTICS

The cylinders may form one body with the block or may be inserted (fig. 2).

These cylinders are called jacket or sleeve cylinders and are made of more friction-resistant materials than the piston rings, they are changed when they have endured maximum wear.

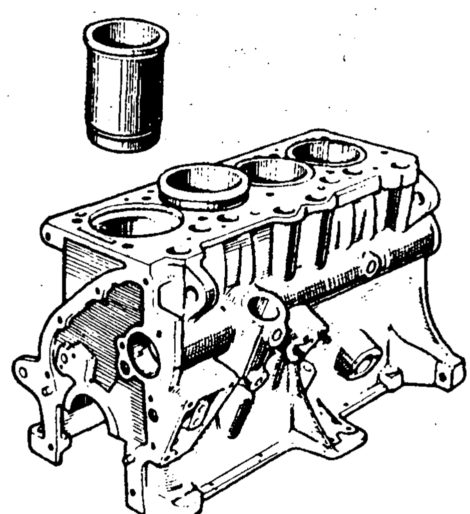

Fig. 2

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The jacket cylinders are referred to as dry and wet depending on how they are cooled.
The dry jacket is the one which is not in direct contact with the cooling system water passages (fig. 3); on the other hand, the wet jacket is cooled by direct contact with the water (fig. 4).

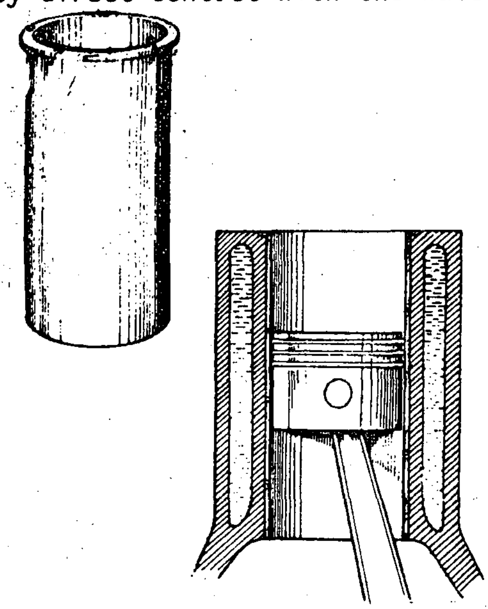

Fig. 3

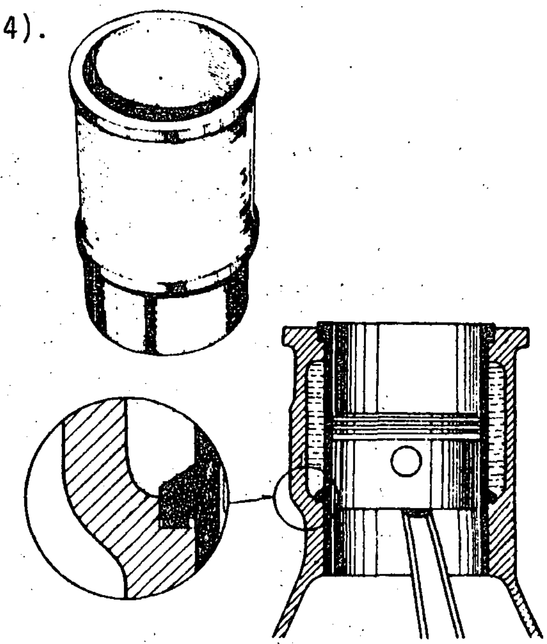

Fig. 4

In the air-cooled engines the cylinders are not generally integral parts of the block; they are superimposed (fig. 5) or else the block is separated into two bodies with superimposed cylinders (fig. 6).

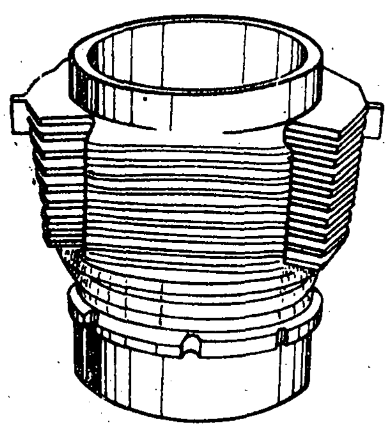

Fig. 5

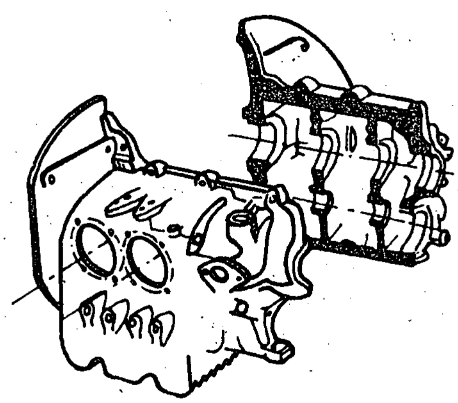

Fig. 6

Normally the blocks made of cast-iron are cooled by water and those of aluminium alloys by air.

This is the unit of circuits designed to fulfil the electrical energy necessities of the whole vehicle; they have been classified into specific systems underlined as follows:-

- Starter system.
- Ignition system.
- Charger system.
- Indicator system.
- Lighting system.
- Special systems (accessories)

DESCRIPTION

Starter system. Enables starting the internal combustion engine, by using an electric motor, as it cannot be put in motion on its own. This system is made up of (fig. 1):

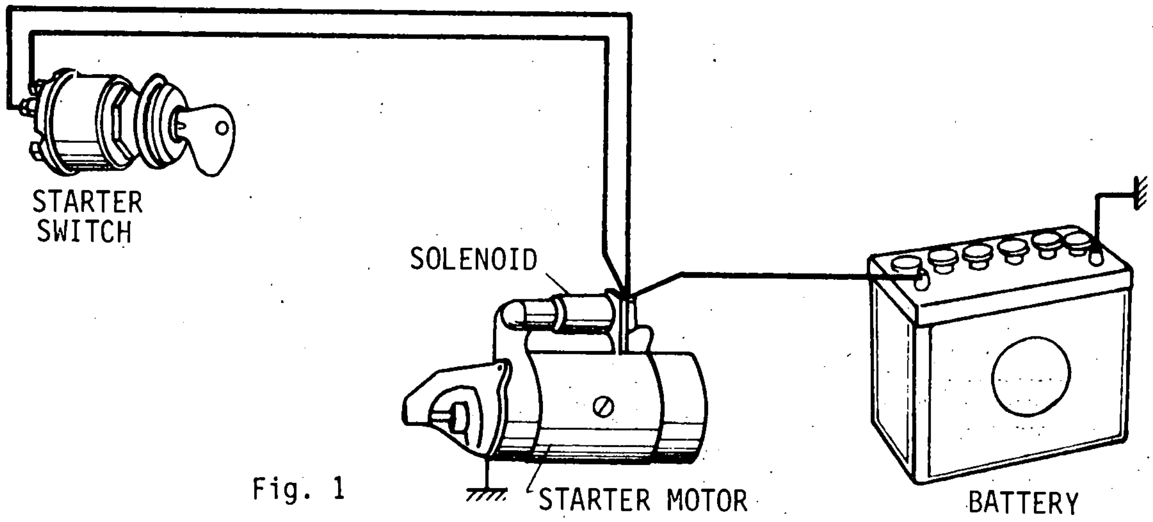

Fig. 1

The battery, which supplies electrical energy to the diverse circuits.
The starter motor, which transforms electrical energy into mechanical energy, thereby rotating the crankshaft of the engine of the vehicle.
The starter solenoid, and electro-magnetic circuit breaker, which connects the battery to the starter motor and in many cases operates its coupling mechanism.
The starter switch, which closes and opens the circuit which operates the solenoid.

Ignition system. This is the one designed to ignite the mixture inside the cylinder, by means of the following parts (fig. 2).

The switch, which closes and opens the ignition circuit.

The coil, which acts as a transformer, raising the voltage of the battery.

The distributor, which closes and opens the primary circuit of the coil and distributes the electrical energy to the spark plugs.

The spark plugs, the electrodes of which produce an electric arc, which ignites the mixture compressed in the engine.

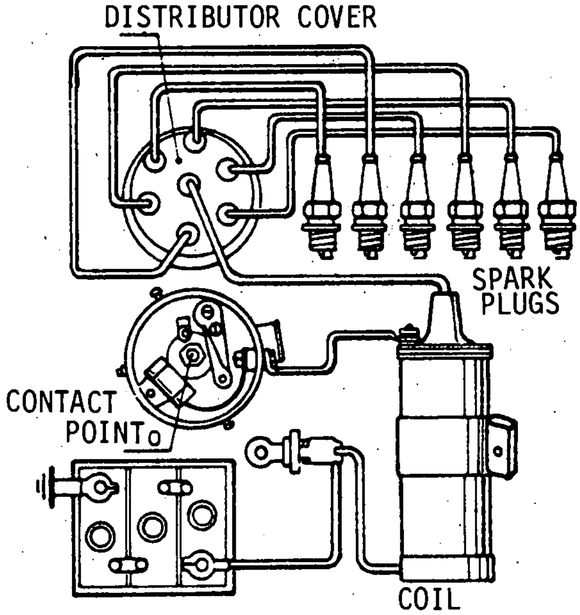

Fig. 2

Charger system. It serves the purpose of maintaining the battery charged for supplying the diverse circuits. It consists of (fig. 3).

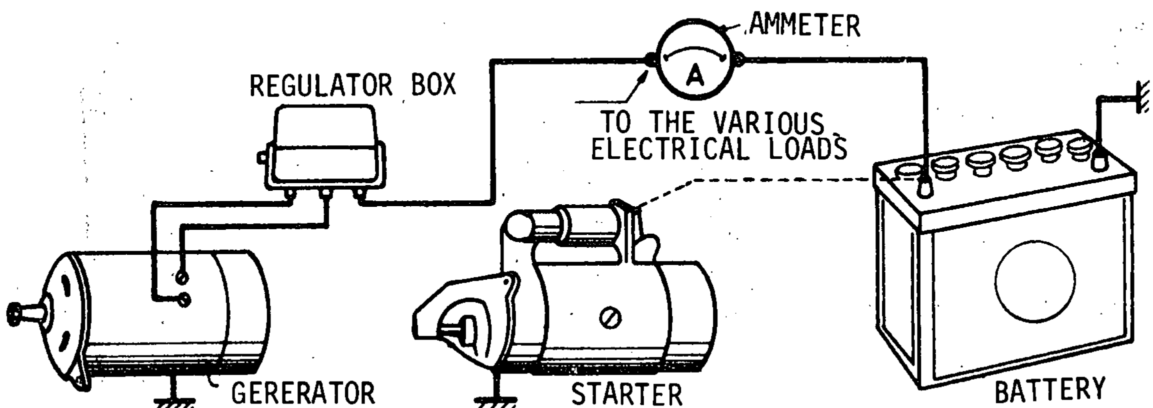

Fig. 3

The battery, which accumulates the energy necessary to supply the electrical circuits of the vehicle.

The generator, which transforms the mechanical energy it receives from the engine of the vehicle into electrical energy.

The regulator box is the part which controls the voltage and limits the current (amperage) which the generator should transfer to the battery; it also prevents the flow of current from the battery to the generator.

The ammeter indicates the quantity of charged or discharged current.

Indicator system. This enables monitoring the working conditions of the engine of the vehicle, by means of indicators for oil pressure, fuel level, battery-charged state, engine temperature and others.
The electrical indicator instruments (fig. 4) are fitted inside with devices, sensitive to the current variations from the transmitter, which monitor on their dials the temperature, pressure or other levels, depending on their function. These monitoring devices enable the driver to conveniently indicate the driving manoeuvres, that is: turning light, brake light, reverse light and include acoustic elements (Horn).

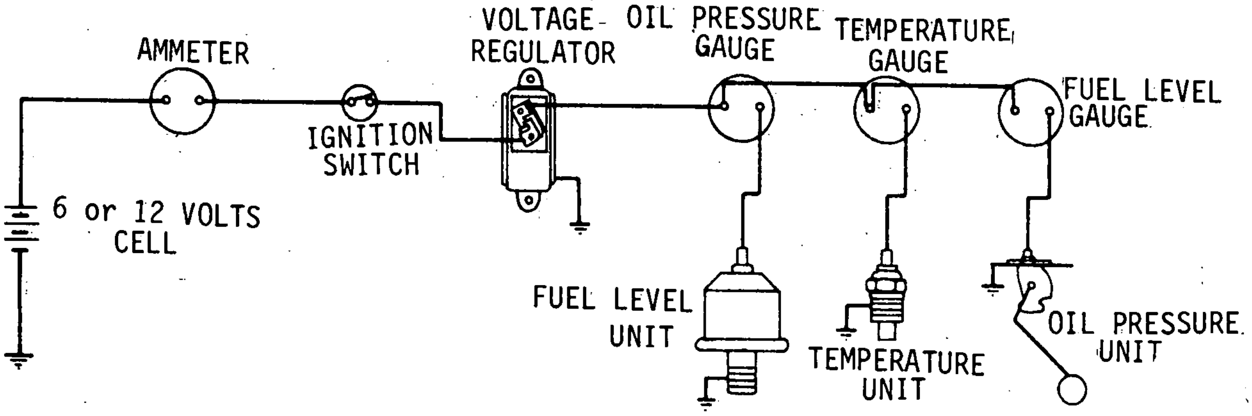

Fig. 4

Lighting system. Vehicles are furnished with lighting circuits of variable intensities and uses, such as: road lights (high and low), park and interior lights.

Special systems. These consist of accessories such as the radio, tape players, heating system and windscreen wipers; they include, as well, mechanisms to raise and lower windows, displace seats and lift bonnets.

This is the assembly of accumulators which transforms chemical energy into electrical energy needed to start the engine and supply the different electrical circuits of the vehicle.

DESCRIPTION

The battery (fig. 1) is made up of cells or accumulators, 3 for those of 6 volts and 6 for those of 12 volts, installed in a case; each cell (fig.2) has positive (+) and negative (-) lead-covered plates, each group being linked by inter-cell connectors; insulator separators are placed between them to prevent them from touching each other. The entire unit is submerged in a chemical solution made up of sulphuric acid and distilled water which is called electrolyte.

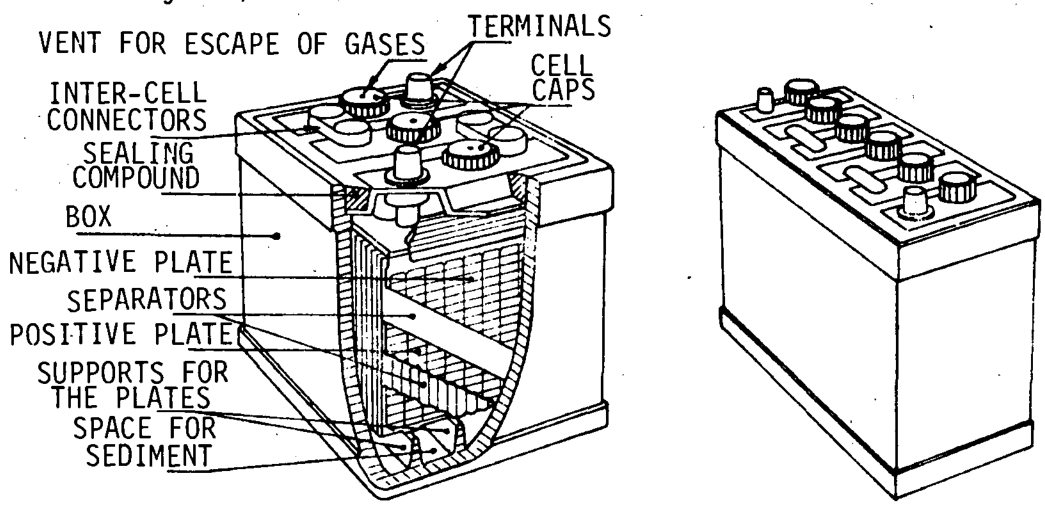

Fig. 1

The cells are connected in series by external cell connectors, producing a voltage output through the battery posts equal to the sum of the voltages of the cells which comprise it.

FUNCTIONING

The transformation process of chemical energy into electricity begins when current is consumed in one of the circuits of the vehicle; the acid of the electrolyte combines chemically with the material of the positive as well as the negative plates.

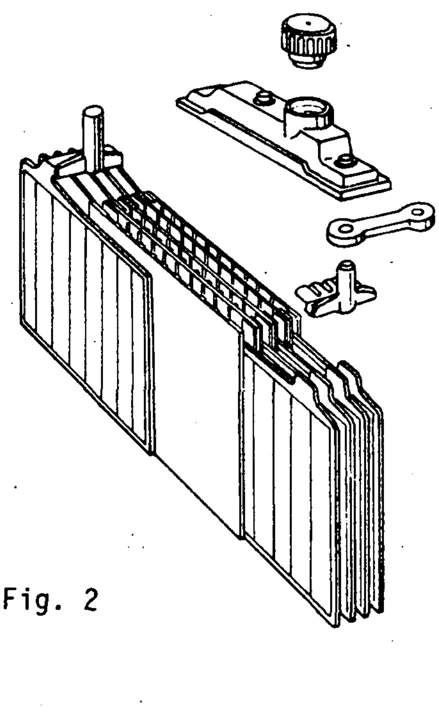

Fig. 2

The intensity of the current supplied by the battery will depend on the quantity of sulphuric acid existing in the electrolyte which has not yet combined with the active materials of the plates. The electrolyte of a completely charged typical battery has about 39% acid and 61% water (by weight). When it is discharged it has about 15% acid and 85% water, this relation being quickly determined by measuring the density of the solution.

MAINTENANCE

The battery should always be kept clean and dry externally in order to prevent current losses. The ventcaps of the cells should be open in order to permit gases, generated during the functioning of the battery to escape. The posts and terminals should be kept clean in order to prevent any resistance to the electric current. They should also be tightened firmly and covered with vaseline so as to prevent formation of sulphate.

SAFETY MEASURE

THE SULPHURIC ACID OF THE ELECTROLYTE IS HIGHLY CORROSIVE. IT DAMAGES CLOTHES AND BURNS SKIN. FOR THIS REASON SPECIAL CARE SHOULD BE TAKEN WHEN OPERATING THE BATTERY.

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The most common and generalized testing and fast-checking instruments for batteries are the densimeter and the high rate discharge tester (startometer).

DENSIMETER

This instrument (fig. 1) enables measuring directly, the density or specific gravity of the electrolyte.

A sufficient quantity of solution is sucked up, from a cell or accumulator, so that the internal element of the instrument may float; this will rise somewhat according to the quantity of acid contained in the electrolyte which has not combined with the plates.

The level of the liquid in the instrument, would indicate on the float scale, the density or specific gravity (fig. 2).

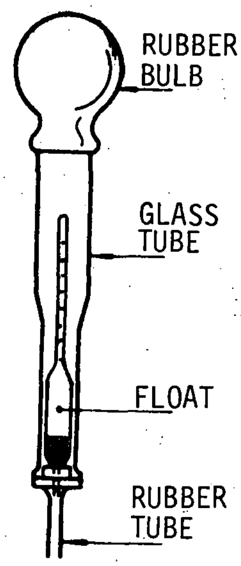

Fig. 1

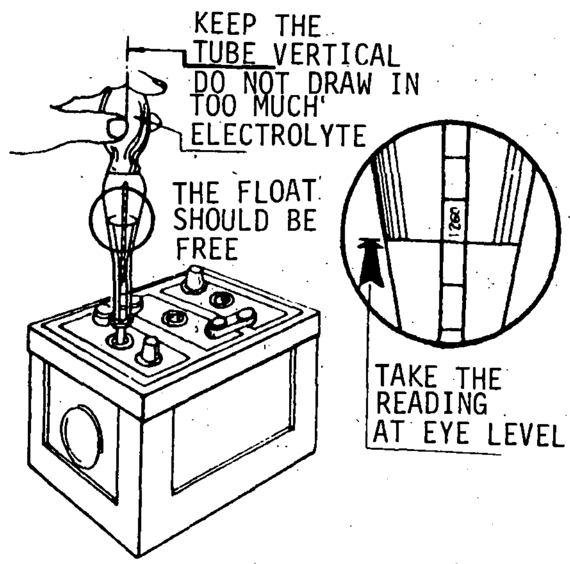

Fig. 2

In this way, also, the charged state of the battery can be approximately determined as there is a relation between density and charge.

The following relations between density and charge may be considered to be approximate.

DENSITY	CHARGED STATE
1.265 - 1.290	Completely charged.
1.235 - 1.260	3/4 charged.
1.205 - 1.230	1/2 charged.
1.170 - 1.200	1/4 charged.
1.140 - 1.165	Barely operative.
1.110 - 1.135	Completely discharged.

These values may vary depending on the temperature of the battery which directly affects the electrolyte, by decreasing its density. For this reason some densimeters incorporate a thermometer for determining exactly the density of the battery.

HIGH RATE DISCHARGE TESTER (Startometer)

This instrument enables measuring the voltage between the terminals or connectors of each cell, by subjecting it to high intensity discharge, producing an effect similar to that of the starter motor when turned on. The voltage, during the testing, should remain within the values set down on the specification tables.

It consists of a brace with two metallic legs with a pointed finish for making good contact with the posts.

A resistance, sufficiently adequate for producing the necessary discharge intensity, is connected in parallel with the voltmeter (fig. 3), fitted with a dial graduated from 0 to 3 volts in both directions. The points of the legs are firmly pressed against the terminals or connectors of each cell of the battery, thus causing an electric current to circulate through the resistance, similar to that consumed by the starter motor.

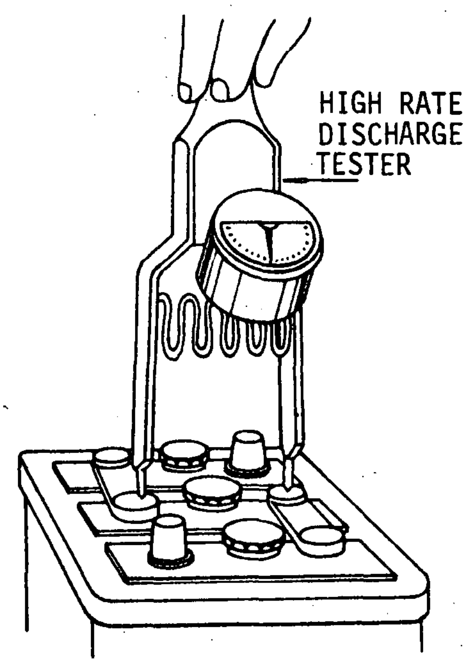

Fig. 3

In these conditions the tension between posts drops in proportion to the charged state of the battery; if the reading is less than 1.6 V in some of the cells, this would indicate that it is in poor condition and should be replaced. If there is a difference of more than 0.2 V between the maximum and minimum reading it should also be replaced. The tests should be done in 10 to 15 seconds, as a longer period would discharge the battery.

TECHNICAL VOCABULARY:

Densimeter - Hydrometer

The charging system of the vehicle does not totally restore the state of the battery, for which reason it becomes necessary to subject it to a charging process from an external power source.

CHARGING PROCESS

There are two basic charging methods:

- Slow charge.
- Fast charge.

Slow charge.. This method is convenient to use when the internal conditions of the cells and plates are not known and when it is absolutely necessary to charge the battery completely.
The recommended system is for 1 ampere for every positive plate of a cell. For example, with a battery of 15 plates per cell, 7 of them would be positive and the charge would be 7 amperes.
Another charging current relation recommended is 1/10 of the capacity of the battery, indicated by the manufacturer in ampere-hours. Example: a battery of 75 ampere-hours (AH) is subjected to a charging current of 7.5 amperes.
A battery is completely charged when the cells are gassing (boiling) freely and there is no increase in density for three successive hourly readings.
Most batteries can be charged completely in 12 to 14 hours.

Fast charge. The fast charge method does not completely restore a battery, but it is enough to meet the energy supply needs of the vehicle in case of an emergency.
The current intensity used in fast chargers is from 75 to 100 amps for 6 volt batteries and half this figure for 12 volt batteries. The time taken for fast charging depends on the state of the battery at the time it is being processed.
If the temperature during the fast charge process rises above 49°C, it is convenient to reduce the intensity of the charging current, since a temperature greater than this amount would damage the battery.

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DESCRIPTION

There are a variety of chargers which provide the intensity and voltage necessary for restoring the battery charge. The majority are transformers which are connected to the lighting system. They are equipped with selectors which enable regulating the intensity and voltage as well as terminals marked for connecting with the corresponding terminals, so as not to reverse the direction of the current.

TYPES

Chargers are distinguished according to their function.

Slow charge charger. They are designed to charge from 1 to 12 batteries connected in series, supplying a charging current of 1 to 6 amperes.

Fast charge charger. They are designed to supply charging currents with intensities of up to 120 amperes. They are used for re-inforcement charging or in an emergency since they complete the task in approximately 1 to 2 hours.

Battery analyzer chargers. These are fast chargers fitted with monitoring instruments for controlling the charged state. They measure the drop in the total tension or for each battery cell, under discharge. It has selectors for using the same instrument, whether voltmeter or ammeter in different scales, for direct measurements, different testing points and a protector bulb for preventing temperatures greater than 50°C during the fast charges.

Fast charge charger for batteries and re-inforcer for the starter. As its name indicates, it can charge high powered batteries and, if necessary, start the engine of the vehicle, providing it with sufficient energy without discharging the battery.

This apparatus enables the mechanic to perform the maintenance operations of the spark plugs (fig. 1), and is designed to clean and test their functioning.

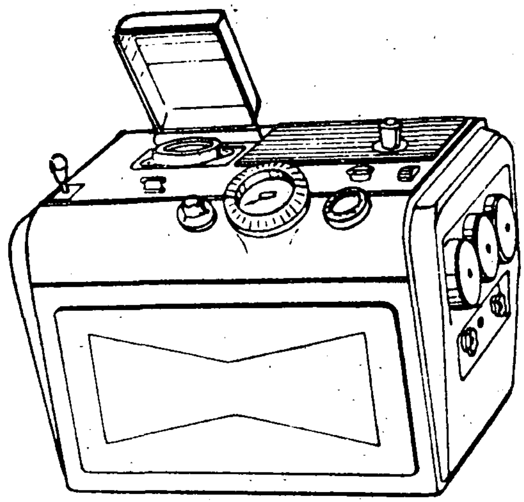

Fig. 1

FUNCTIONING

Spark plug cleaning. This is done normally by sand spraying (fig. 2) which eliminates all foreign particles deposited on the insulation and on the electrodes. It is finished by blowing out the spark plugs with compressed air so as to remove the remnants of sand.

Functioning test. This consists of visually checking the spark jump between electrodes, by means of mirrors in the machine which reflect the chamber and electrodes of the spark plugs (fig. 3).

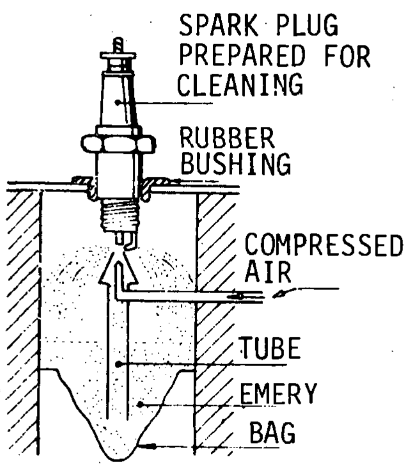

Fig. 2

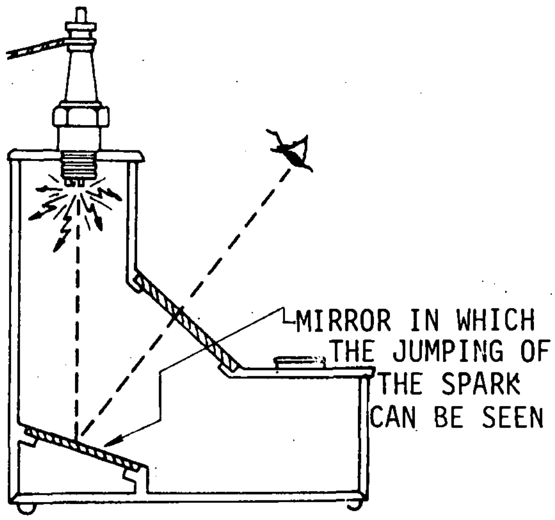

Fig. 3

For the testing to be true the apparatus should simulate the working conditions of the spark plug, the pressure to which it is subjected should be the same as in the engine, for which reason compressed air, controlled by a manometer, is used.

MAINTENANCE

Periodically check the quantity of sand in the machine, using only the type recommended by the manufacturer. Clean off the sand that may have settled on the surface of the machine.

OBSERVATION

Spark plug service. It should be done often if the engine runs under conditions that produce rapid carbon accumulation. Excess carbon and worn electrodes retard the spark jump producing a loss of current which causes ignition failure, fuel and power losses in the engine. Cleaning, testing and adjusting the spark plugs enables re-conditioning them but it is impossible to leave them in the same condition as when they were new.
As a result, if the spark plugs have completed one working cycle, approximately every 16,000 kilometers travelled by the vehicle, the most commendable thing to do would be to replace the entire set.

The generator is the part of the charging system which transforms the mechanical energy into electrical energy with the purpose of restoring the battery charge and supplying the circuits of the electrical system while the engine of the vehicle is functioning.

COMPOSITION (fig. 1):

1. Rear cover or brush end
2. Brushes
3. Case
4. Armature
5. Fan
6. Pulley
7. Front end (front bracket)
8. Pole pieces (pole shoes)
9. Field coils.

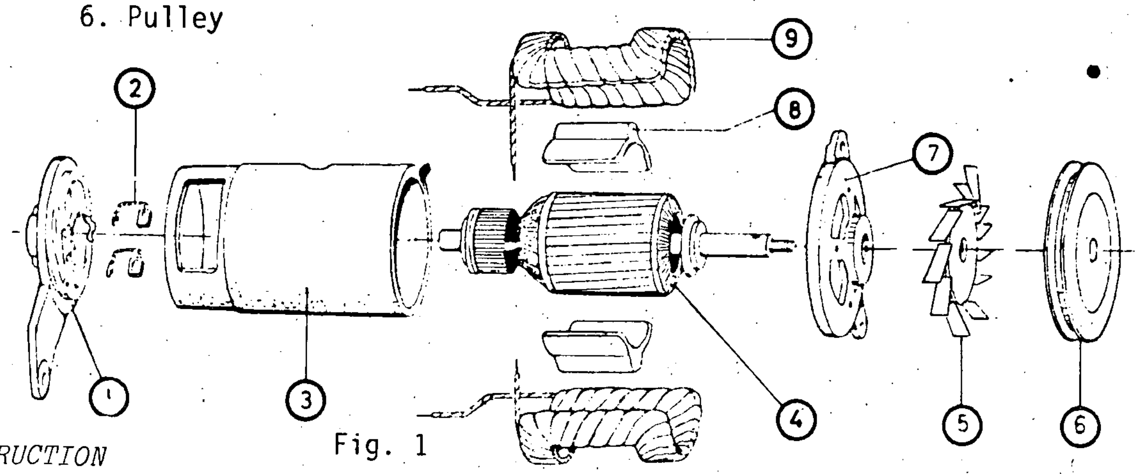

Fig. 1

CONSTRUCTION

Owing to the fact that the generator operates on the basis of the principle of electromagnetic induction the materials used in its construction are magnetisable. The case is made of laminated iron, the pole pieces of cast iron and plated silicon iron is used in the nucleus of the armature. Electrolytic copper-wire covered with insulating varnish or cotton lining is used in the field and armature coils. The brushes are made of carbon so as to prevent premature wear and damage to the commutator (collector).

FUNCTIONING

The generator is mounted on the block of the engine and is operated by the crankshaft pulley, by means of the belt.
On switching on, the engine rotates the armature as the pulley which moves the crankshaft is mounted on its shaft.

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The armature contains several coils which on rotating cut through lines of force from the magnetic field of the ground pole, thereby producing an electric current; this is received by the brush through the collector to run through the external circuit which is closed by the other brush, as shown here diagrammatically in figure 2.

The magnetic effect of the ground poles is reinforced by the field coils on running the electric current through it.

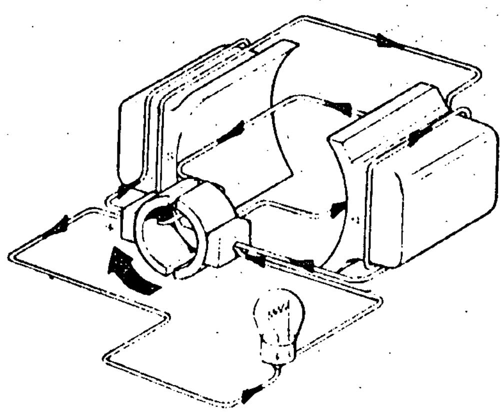


Fig. 2

The battery and electrical system are supplied on the basis of this working principle.

As the revolutions of the engine and generator are not constant the current produced at different R.P.M. would also be variable. In order to avoid damaging the battery, a regulator and ammeter (fig. 3) to regulate and control the charging current are inserted in the circuit.

In the regulator box there is a coil called the circuit breaker designed to allow current to flow from the generator to the battery and to impede its flow in the opposite direction.

The generator also has a fan for cooling it.

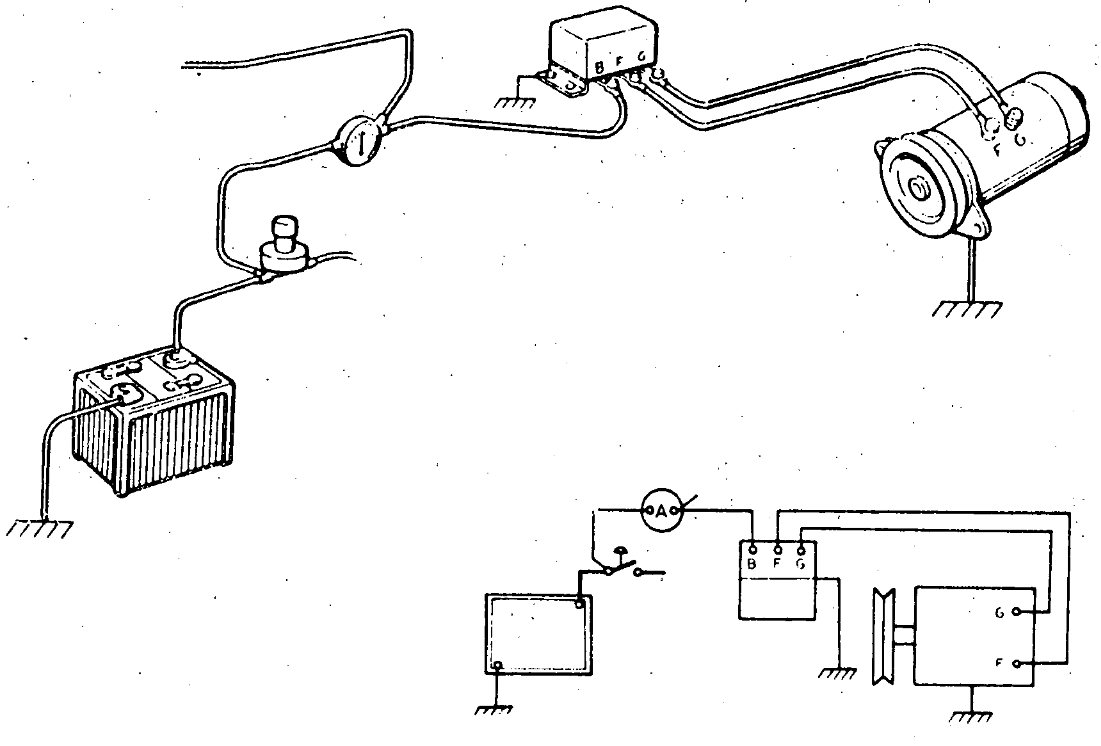


Fig. 3

MAINTENANCE

The generator bearings should be periodically lubricated but not in excess as that may wet the commutator and brushes resulting in a reduction of the current produced.

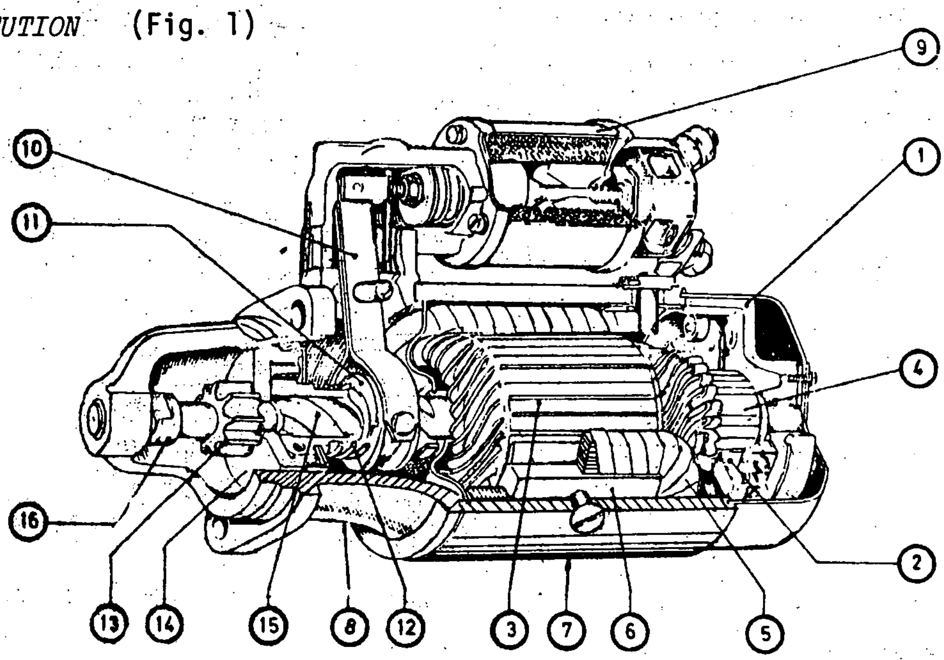
The wear to the brushes should be checked as well as that of the commutator and the spring tensions.

Every time the commutator is being cleaned, it should be done with fine sand-paper; it is not advisable to use emery fabric as its grain, being harder, may incrust between the collector and brushes, thereby producing extensive wear to them. If the collector has a rough or oval surface it should be machined and the mica undercut (electrical insulator) and then polished.

The generator should be always maintained with its connections firm and free of oil, dust or grease.

This is the part of the starter system which transforms the electrical energy into mechanical energy for rotating the crankshaft of the engine, until the first expolsions are produced and it begins to function independently.

CONSTITUTION (Fig. 1)



1. Brush holder cover.
2. Brushes.
3. Armature.
4. Commutator or collector.
5. Field coils.
6. Pole pieces (pole shoes)
7. Housing.
8. Drive housing.
9. Solenoid
10. Shift lever.
11. Collar
12. Spring.
13. Pinion.
14. Overrunning clutch.
15. Shaft with spiral splines.
16. Pinion stop.

CONSTRUCTION

The housing of the starter motor is made of soft iron, the drive housing of cast iron and the brush holder cover usually of aluminium iron or plated steel. The pole pieces are made of cast iron and the brushes of graphite-copper.

The copper conductors are generally of a rectangular cross-section with a capacity for enduring the intensities of the currents necessary for starting the motor.

DESCRIPTION

The starter motor is mounted on one side of the block and bolted on to the clutch casing. It is a small volume, low power, high speed electric motor designed to operate the internal combustion engine by making use of the velocity ratio between the pinion and the flywheel ring gear (fig. 2). For its operation, it receives the current from the battery through the electromagnetic control called the solenoid, which is designed to connect and disconnect the starter motor from the battery and to operate the connection mechanism. The latter is made up of an assembly of parts which enable connecting or disconnecting the pinion with the flywheel ring gear for the running of the engine. The armature shaft, on which the connection mechanism displaces itself, has grooves which may be either straight or spiral and enables the shaft and the overrunning clutch to rotate as one unit. There is, as well, a spring in the mechanism which ensures the meshing between pinion and rim.

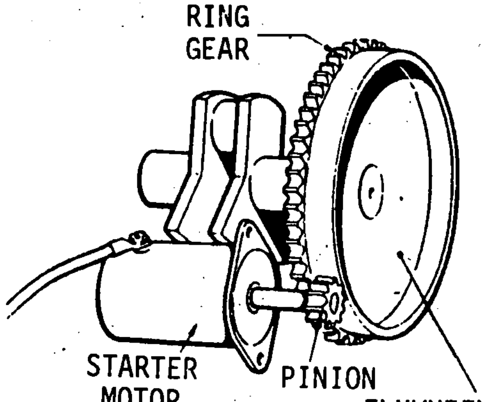


Fig. 2

FUNCTIONING

When the driver turns on the switch (fig. 3) the current from the battery energizes the solenoid which attracts the sliding plunger, thereby closing the starter motor-battery circuit. The current from the battery (fig. 4) runs through the field coils producing the revolution due to the attraction of the fixed poles of the pole pieces over the armature.

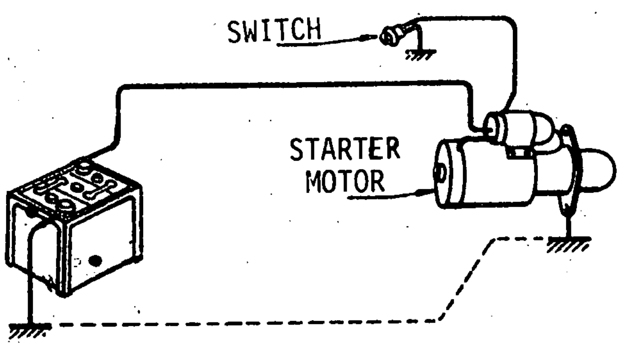


Fig. 3

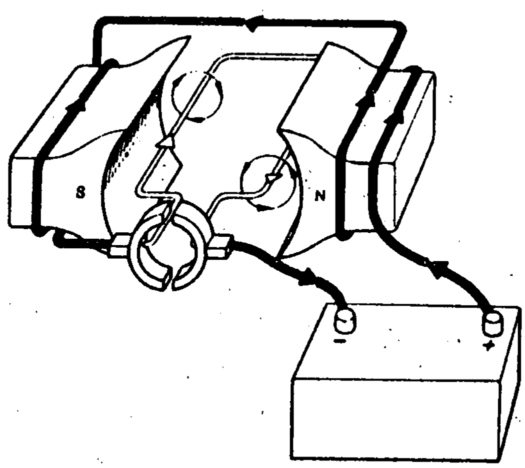


Fig. 4

At the same time the solenoid propels the connecting mechanism by means of the shift lever and meshes it with the flywheel rim gear thereby transmitting the starter motor rotation to the crankshaft of the engine.

When the engine begins to run, the driver releases the switch thereby opening the circuit and the current in the solenoid is discontinued. The plunger, shift lever and collar return to their original positions due to the effect of the spring situated at the end of the plunger and the starter motor ceases to function.

MAINTENANCE

Because of the heavy work it undergoes, the starter motor should be lubricated and inspected after having completed the mileage specified by the manufacturer in order to maintain it in working condition.

- Each time it is dismantled one should inspect the wear to the commutator or collector, make sure that it does not have scores or oval shapes and undercut the mica so that it does not jut out from the commutator bars.
- Besides this, the brushes should be inspected to see whether they are worn and make sure that they rest uniformly with adequate pressure on the commutator or collector.
- The lubrication consists of putting drops of thin oil in the oil cans of the starter motor as well as in the connection mechanism.
- If there are damaged parts they should be replaced conveniently so as to prevent greater damage.

These are the parts of the system designed to raise the voltage of the battery and to produce, in the spark plug electrodes, an electric arc capable of igniting the compressed air-fuel mixture in the cylinders of the engine.

CONSTITUTION

The ignition system (fig. 1) consists of two electrical circuits: primary, low tension and secondary, high tension.

PRIMARY CIRCUIT

- Battery
- Ignition switch
- Primary winding of the coils
- Contact point
- Condenser
- Cables.

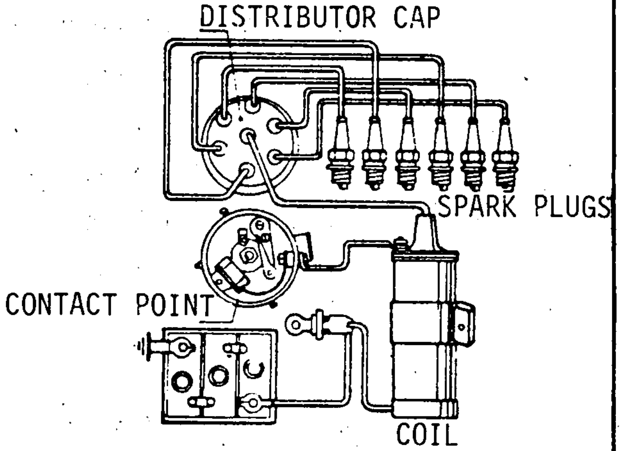


Fig. 1

SECONDARY CIRCUIT

- Secondary winding of the coils
- Distributor cap
- Rotor
- Spark plugs
- Cables

DISTRIBUTOR

It consists of the following parts (fig. 2):

1. Distributor cap
2. Housing
3. Rotor
4. Condenser
5. Contact Points
6. Contact support plate
7. Shaft
8. Cams
9. Centrifugal advance mechanism
10. Vacuum unit

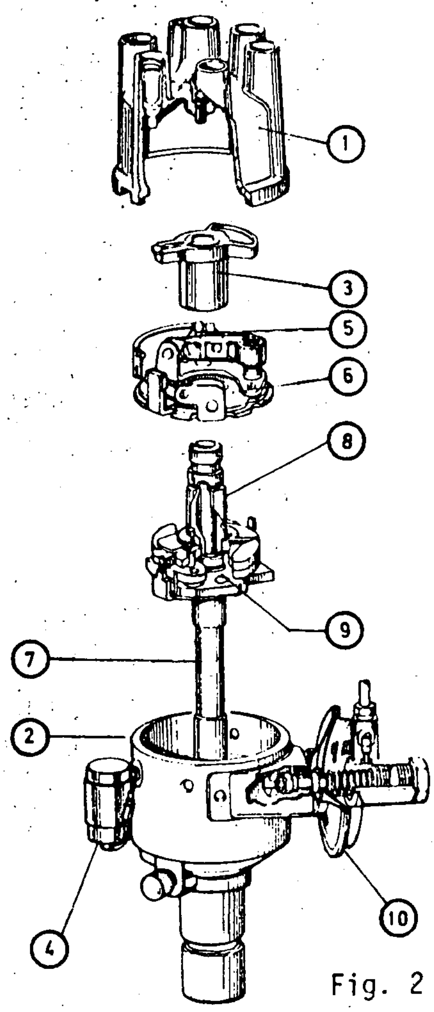


Fig. 2

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The cap is situated on the upper part in one position only and is secured to the housing by means of metallic clamps.
The shaft with the cams which operate the contact points is installed inside it, there being as many cam lobes as there are cylinders in the engine. The rotor, situated at the top of the shaft, is designed to distribute the current to the spark plugs at the instant the contact points open. The distributor shaft receives the movement from the camshaft and the revolution ratio is 1:1.
In order to obtain maximum power at different speeds of the engine, the ignition is advanced by means of advance mechanisms; one utilizes the vacuum of the intake manifold (fig. 3) on the contact support plate and the centrifugal one (fig. 4) utilizes the speed of the engine relayed to the distributor shaft and the displacement of the cams.

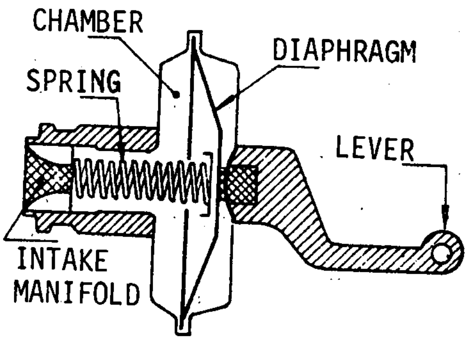

Fig. 3

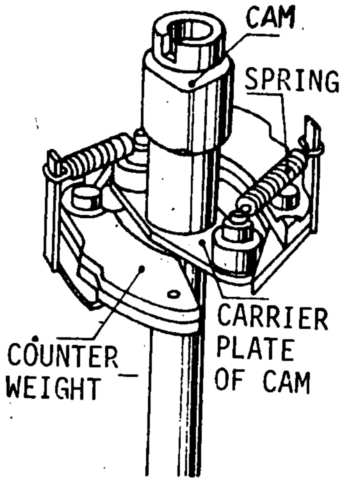

Fig. 4

CONDENSOR

The condensor is made up of two tin sheets separated by an insulator. One of the sheets is connected to the metallic box and the other is connected to the terminal cable of the condenser (fig. 5).
The condenser serves the purpose of absorbing the arc at the contact points when they first open, so as to prevent their premature destruction.

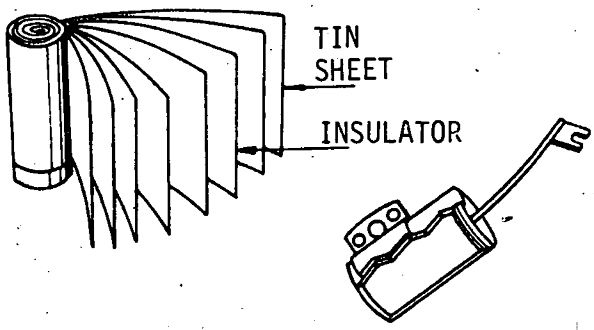

Fig. 5

The coil consists of the following parts (fig. 6):

1. Coil case
2. Primary winding of thick wire
3. Secondary winding of thin wire with thousands of turns
4. Soft iron core for concentrating the magnetic field
5. Porcelain insulator
6. Primary terminal
7. High tension terminal.

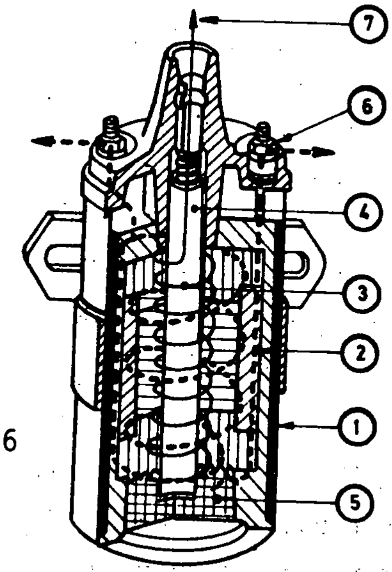

Fig. 6

The primary and secondary windings are insulated by means of layers of paraffin paper.

As the battery does not have the necessary voltage to jump the gap at the electrodes of the spark plugs, a coil is installed in the circuit to act as a transformer or voltage step up.

The coil has two windings superimposed, one of heavy wire occupying a larger section and with few turns called the primary and the other, of fine wire and a greater number of turns called the secondary.

The current from the battery runs through the primary winding and the high tension current induced in the coil runs through the secondary winding.

SPARK PLUGS

The purpose of the spark plug is to ignite, at the desired moment, the fuel mixture compressed in the compression chamber (fig. 7).

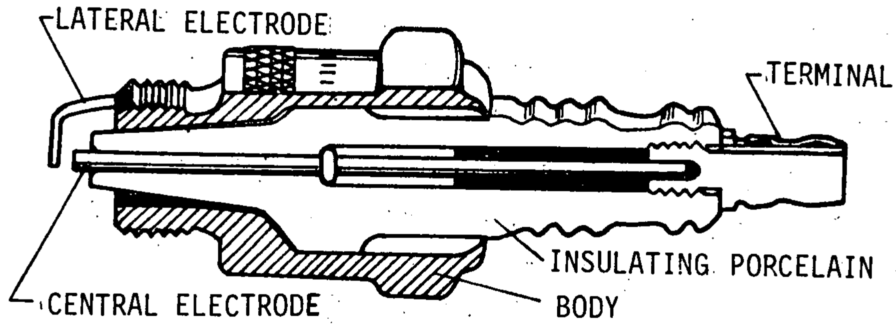

Fig. 7

TECHNICAL VOCABULARY:

Lateral - side; earth; ground

TECHNOLOGICAL SUBJECT CODE

The spark plug is made up of two metallic electrodes insulated from one another. A central electrode, where the high tension current coming from the distributor cap reaches, and a lateral electrode connected to the ground cable of the engine, through the metallic body of the spark plug. The electrodes are separated and due to the higher tension, the current flows from the central electrode to the lateral one producing a spark which begins the combustion of the mixture.

The spark plug body is of a hexagonal shape for fitting the wrench when securing it in the cylinder head; the lower part is threaded and its diameter may be 14, 18 or 22 millimeteres. The manufacturer presents a range of spark plugs distinguishable by their heat rating and are classified as cold spark plug (fig. 8), and hot spark plug (fig. 9); they are used in engines according to their characteristics and working conditions.

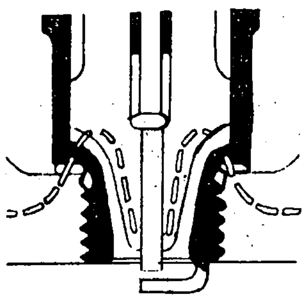

Fig. 8

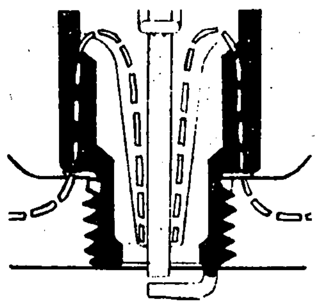

Fig. 9

FUNCTIONING

The distributor is mechanically operated by the camshaft of the engine, when it revolves; the contact points open due to the effect of the cam which opens the contact point at the instant when one of the pistons is on compression: the current is switched off in the primary winding of the coil; the magnetic field produced by this current is abruptly switched off. This produces, in the secondary winding of the coil, through induction, a high tension current which by means of a cable, is carried to the distributor cap. This high tension current does not last for more than the time which the contact points remain open, and as a result the rotor, which at that instant is in front of one of the segments of the distributor cap, allows the current to flow to the spark plug where it produces the arc which ignites the compressed air-fuel mixture. If the engine has several cylinders, the rotor ensures distribution of the current at the precise instant to each one of the spark plugs according to the firing order of the engine.

This is the instrument used to check the ignition timing, in the gasoline engine, and its correct point positioning according to the vehicle's specifications.

CHARACTERISTICS

The main characteristic of the stroboscopic light is its ability to turn on instantaneously at the moment the spark jumps; this can be obtained with a neon gas lamp which works with the high voltage circuit of the ignition system (fig. 1), connected by a cable to spark plug No. 1 and by another to earth or to the battery of the vehicle.

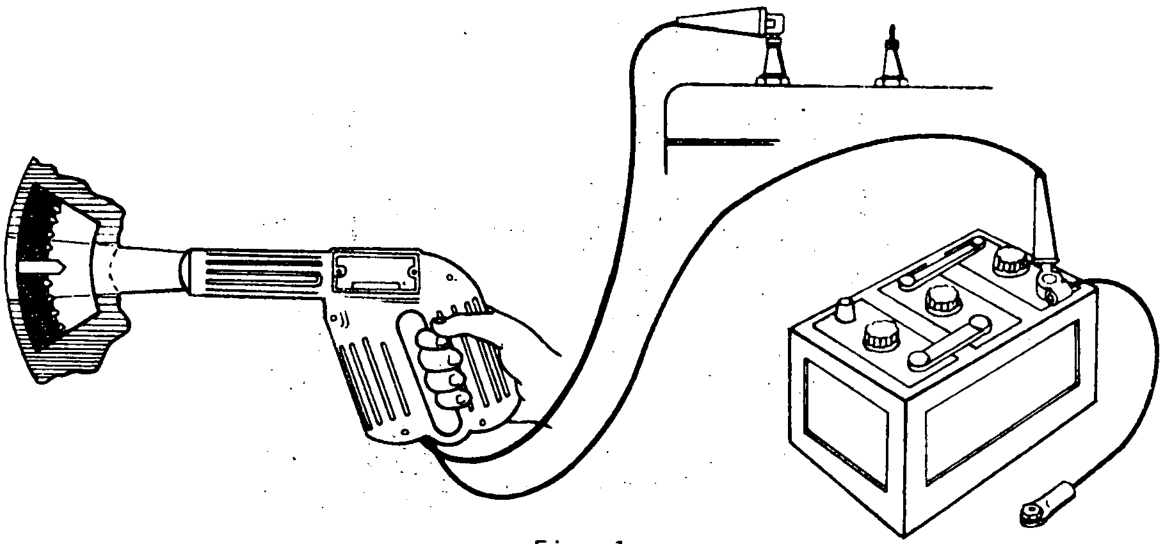

Fig. 1

FUNCTIONING

The following tests can be done with the stroboscopic lamp:

Low speed ignition point positioning. The manufacturer provides the reference marks, one on the flywheel or on the pulley of the engine and another in a fixed point on the block. They are synchronized with cylinder No. 1 so that they can coincide at the end of the compression stroke and indicate the exact point at which the spark jumps.

The light connected with the engine running would produce a flash each time the current reaches spark plug No. 1. Due to the stroboscopic effect, the flash, on illuminating the marks, would make them appear to be stationary. This enables verifying the ignition point and timing in the specified position.

Spark advance control. On the engine being accelerated, the distributor should provide the spark a couple of degrees before the piston reaches the top dead centre in the compression stroke. Due to the stroboscopic effect of the light, the mark would seem to displace itself in an opposite direction to that of the rotation of the pulley of the engine, indicating according to the revolutions, the spark advance degree of the ignition.

Checking consistency. This enables checking the consistency in the spark jumps and is done by connecting the light in series with the high tension cable of the coil (fig. 2). An even flashing of the light would indicate that the ignition system is in good working condition.

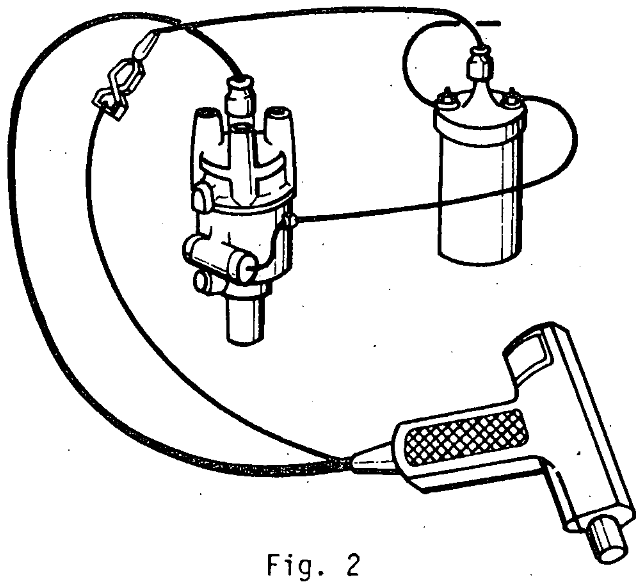

Fig. 2

TYPES

Stroboscopic lights differ from each other in their structure and connections of which there are:

Connection in series. One of the terminals of the lamp is connected to the cable of cylinder No. 1, which has previously been removed from the spark plug; the other terminal is connected to the spark plug.

Connection in parallel. One of the terminals of the lamp is connected to spark plug No. 1, without disconnecting the cable, and the other is grounded.

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The distributor tester or synchroscope is a variable speed machine, in which the distributor is adapted to test its functioning before and after repairs or maintenance service have been done.

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DESCRIPTION

The tester (fig. 1) consists of an electric motor which drives a shaft on which the distributor is mounted, and a rheostat for varying the testing speed. The distributor shaft rotates with a stroboscopic disc furnished with a movable pointer and a neon lamp which turns on when the contact points open. These are seen to be distributed uniformly on the circumference of the disc and correspond to the number of times the sparks jump in one complete revolution of the distributor cam.

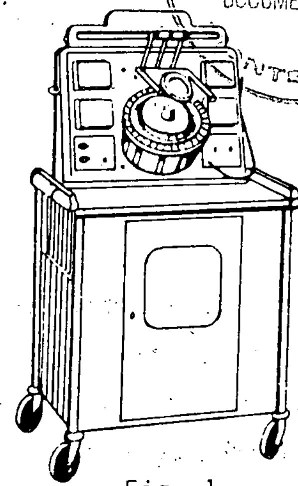

Fig. 1

The illuminated pointers indicate the reference points on a circumference secured to the machine with a scale graduated into 360^{o}; on this, the reading for degree of spark advance or breaker point gap are taken.

It incorporates, as well, the following instruments:-

- A vacuum-meter for checking the suction in the vacuum advance port.
- A tester for the angle through which the cam rotates while the ignition points are closed.
- A tachometer that monitors at all times the revolutions with which it is operating.

FUNCTIONING

Having mounted the distributor and made the connections, the machine is turned on, previously selecting the direction of rotation of the distributor; the instruments included enable controlling firstly the resistance to contact of the breaker points, or the loss of current through lack of insulation. On increasing the velocity, according to the specifications, the cam angle can be checked (fig. 2) as well as the variation in the uniform distribution of the luminous points on the scale; these variations would indicate cam wear or wear to the distributor shaft.

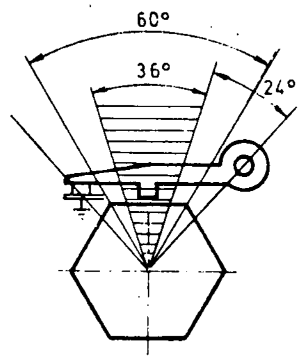

Fig. 2

To check the condition of the centrifugal advance mechanism, the rheostat is rotated, increasing the revolutions progressively. This condition is manifested by the displacement of the pointer with relation to the graduated circumference, for example:

At	350	RPM	0^{o}
At	450	RPM	3^{o}
At	1,600	RPM	11^{o}

To check the vacuum advance mechanism, the vacuum generator in the distributor port creates the specified depression which can be observed on the vacuum meter of the machine; the pointer will be displaced as many degrees as did the advance produced by the port.
Specifications for checking the distributor are supplied in the workshop manual or in the tables included as part of the machine.

CHARACTERISTICS
Testing machines are distinguished generally by the different makes and models which have varied in the last few years adding more instruments which favour the checking and verification of the condition of the distributor.