

Ferrari

365
GT4
BB berlinetta
boxer

BB512
berlinetta boxer

BB512i

WORKSHOP/REPAIR MANUAL

FERRARI-SERVIZIO ASSISTENZA TECNICA-Modena

TABLE OF CONTENTS

PAGE

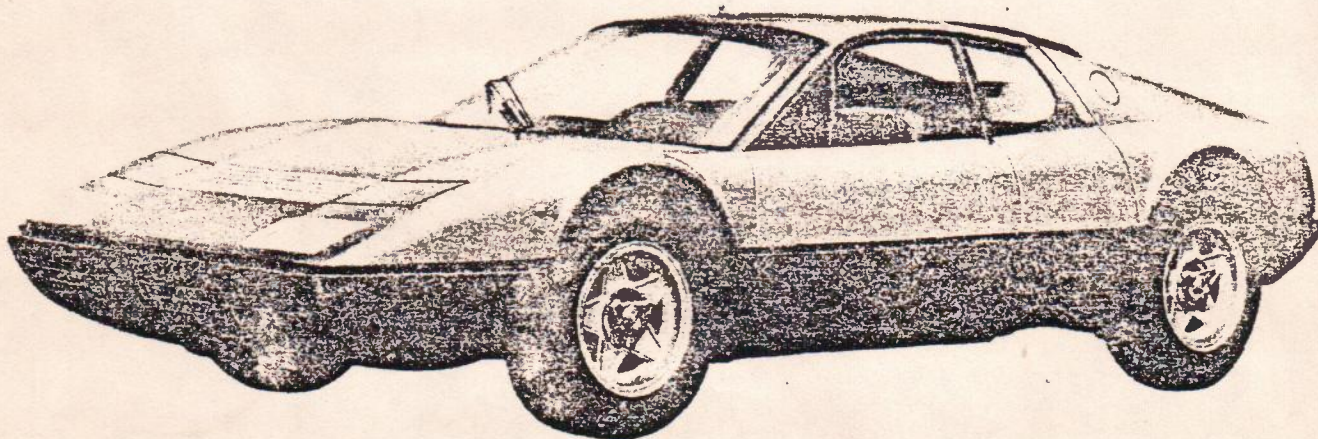
INTRODUCTION	1
GENERAL INFORMATION	5
ENGINE	11
LUBRICATION COOLING FUEL SYSTEM	47
CLUTCH GEAR BOX TRANS-AXLE	69
STEERING	99
FRONT SUSPENSION	105
REAR SUSPENSION SHOCK ABSORBERS	115
BRAKES WHEELS AND TIRES	129
CONTROLS AND INSTRUMENTS HEATING AND VENTILATION AIR CONDITIONING	147
ELECTRICAL SYSTEM	165
REPAIR AND MAINTENANCE TOOLS (ENGINE-CHASSIS) TORQUE SPECIFICATIONS CHASSIS ATTACHMENT POINTS	199
BODY	207

GENERAL INFORMATION

	PAGE
MAIN DATA	5
PERFORMANCE CHARACTERISTICS	6
FILL-UP DATA	8
IDENTIFICATION DATA	9
REPLACEMENT PARTS	9



winifreda.



GENERAL INFORMATION

MAIN DATA

IDENTIFICATION DATA

Chassis type 365.....F102 AB
 512.....F102 BB
 Engine type 365.....F102 A
 512.....F102 B

ENGINE

Placement Central at rear
 Number of cylinders.....12 at 180°
 Cylinder bore 365.....81 mm.
 512.....82 mm.
 Cylinder stroke 365.....71 mm.
 512.....78 mm.
 Total capacity 365.....4391 cc.
 512.....4942 cc.
 Compression ratio 365...8.8 to 1
 512...9.2 to 1
 Maximum horsepower 365.....344
 512.....360
 Corresponding rpm 365.....7200
 512.....6200
 Maximum torque 365.....41.7 Kg.
 512.....46 Kg.
 Corresponding rpm 365.....3900
 512.....4600

CLUTCH

Dry, single plate 365
 Dry, dual plate 512
 Diaphragm pressure plate type
 Mechanical engagement
 Spring assisted

GEAR BOX

All synchromesh, 5-speed, central floor gearshift in open gate.

DIFFERENTIAL

Attached to gear box
 Final drive reduction gear
 "Gleason Hypoid" type
 Reduction ratio
 (to chassis no. 18241)
 365...12/45
 (from chassis no. 18243)
 365...11/43
 512...14/25
 Plate-type differential with limited-slip engagement.

STEERING

Rack and pinion
 Number of turns, lock-.....3/28
 to-lock
 Maximum turning circle.....12.2

FRONT SUSPENSION

Independent, with upper and lower A-arms, coil springs, hydraulic shock absorbers, and transverse anti-roll bar.

REAR SUSPENSION

Independent, with upper and lower A-arms, coil springs, hydraulic shock absorbers, and transverse anti-roll bar.

BRAKES

Wheel Operation:

Self-ventilating, pedal controlled hydraulic operation with 2 independent circuits for the front and rear brakes.
 Vacuum pump-assisted servo.
 Pressure control equalizer valves on rear brakes.

Parking brake:

Hand brake mechanically operating on rear wheels.

WHEELS AND TIRES

Wheels in cast alloy
 Front and rear 365...7 1/2" x 15"
 Front 512...7 1/2" x 15"
 Rear 512.....9.0" x 15"
 Tires
 365 Michelin radial tubeless
 215/70 VR 115 XWK
 512
 Front Michelin radial tubeless
 215/70 VR 15 WX
 Rear Michelin radial tubeless
 225/70 VR 15 WXX
 Spare wheel 365....3 1/4" B x 19"
 512....3 1/5" B x 20"
 Spare tire
 365 Michelin 105R 19 x Tub.
 512 Michelin 105R 20 x Tub.

ELECTRICAL SYSTEM

Voltage.....12

AIR CONDITIONING

Unit Borletti
 Compressor Aspera Frigo HG 700 AP

WEIGHT

Vehicle weight, 365....1235 Kg.
 dry 512....1515 Kg.

PERFORMANCE

Maximum speeds, fully-laden and run-in, level road in good condition:

1st gear.....	89 Km/h
2nd gear.....	125 Km/h
3rd gear.....	165 Km/h
4th gear.....	218 Km/h
5th gear	365.....302 Km/h
	512.....288 Km/h

MAXIMUM CLIMBABLE GRADIENTS

With car fully laden and run-in, on road in good condition:

1st gear.....	60%
2nd gear.....	45%
3rd gear.....	30%
4th gear.....	20%
5th gear.....	15%

BRAKING DISTANCE

Test conditions:
full fuel and oil levels, 2 persons, dry and level road and tires in excellent condition.

ACCELERATION

Standing-start Km/h.....24 sec.
From 0 to 100 Km/h.....5 $\frac{4}{10}$ sec.
From 0 to 200 Km/h.....17 sec.

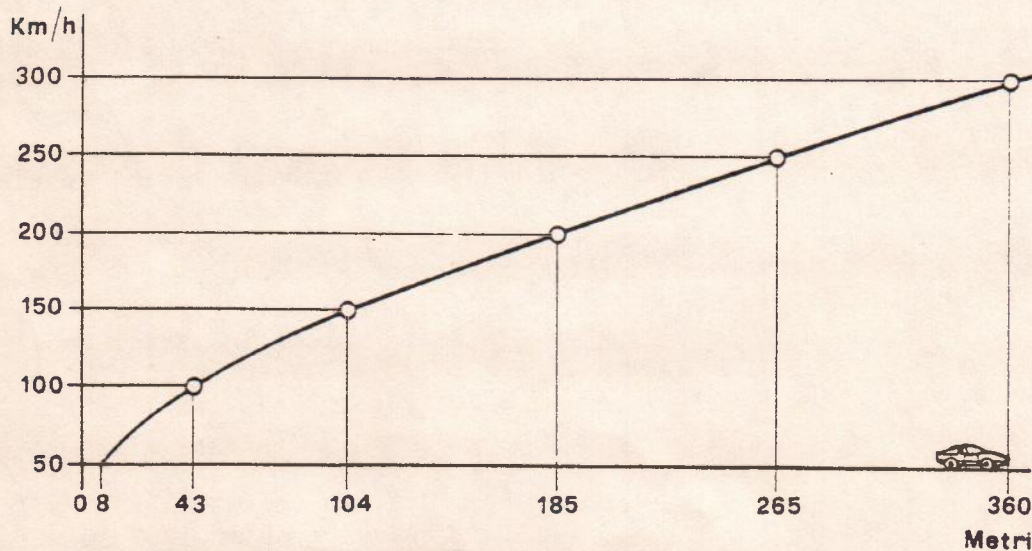


Fig. 2 - Diagram of Braking Distances

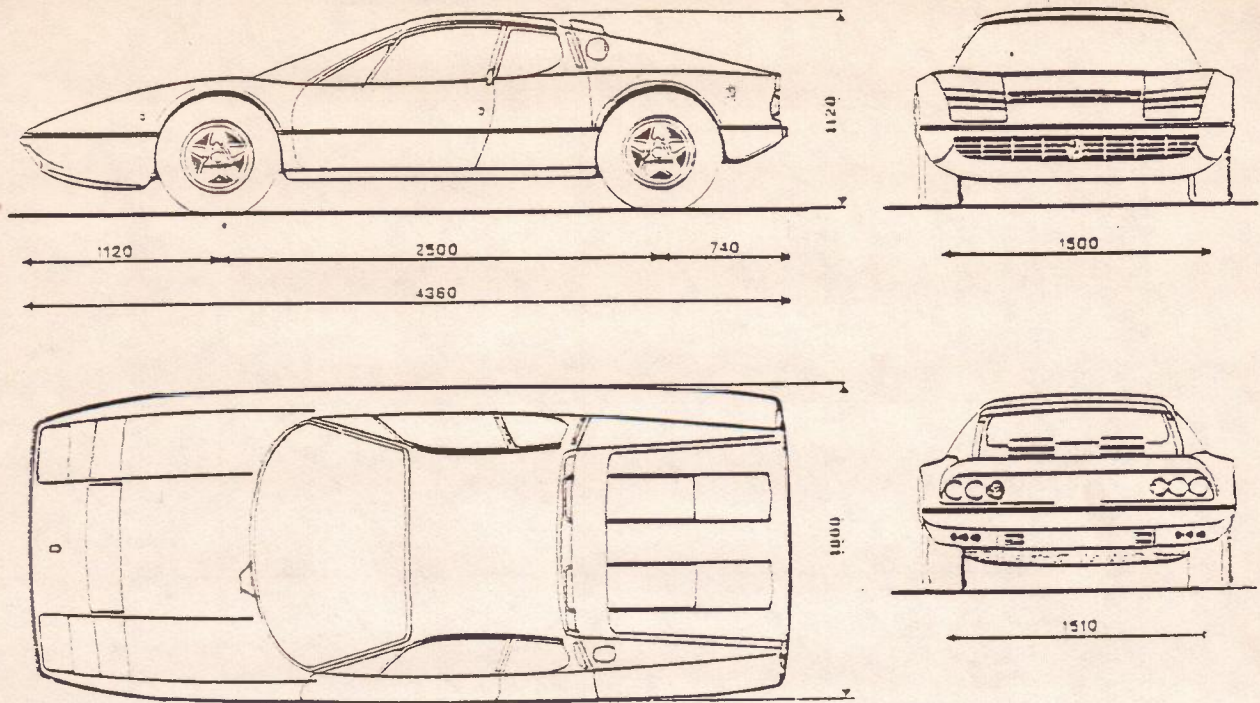


Fig. 3 - Car Main Dimensions in mm. (365)

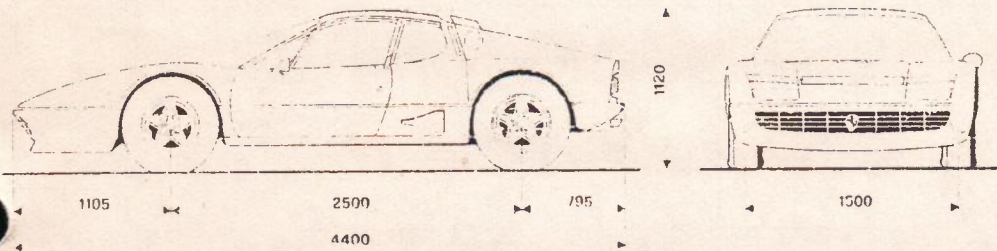


Fig. 3a -

Car Main Dimensions in mm. (512)

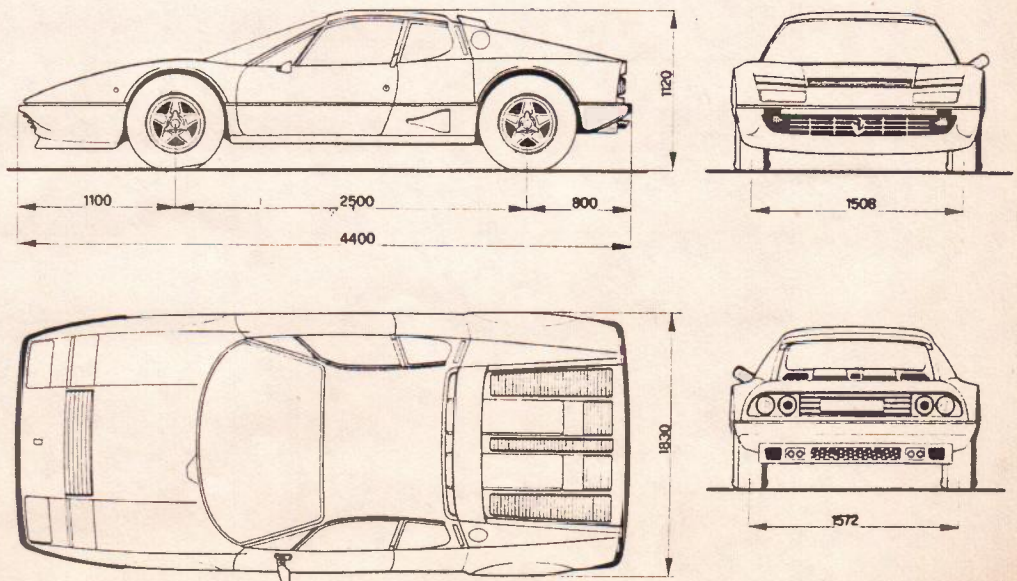
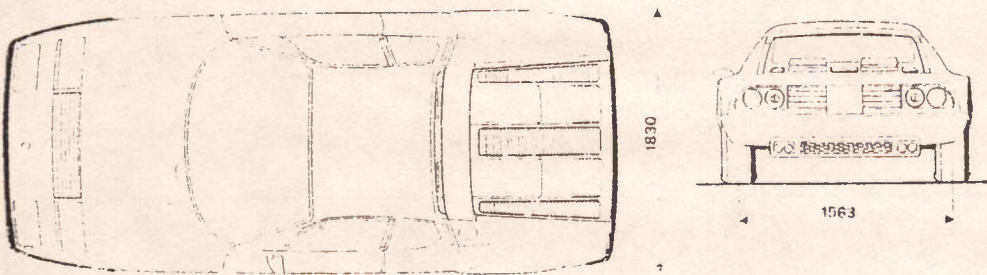
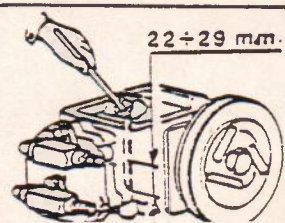
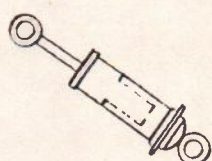
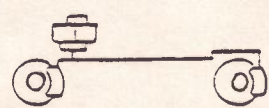
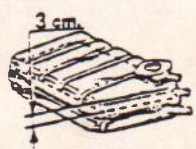
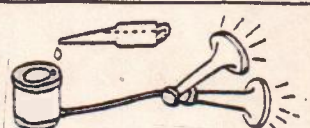


Fig. 3b - Car Main Dimensions in mm. (5121)

LUBRICANTS AND LIQUIDS

ITEM TO BE SERVICED	QUANTITY (liters)	FILL WITH:	UNITS
ENGINE --Oil sump and filter	365 12 512 13	Agip SINT 2000 SAE 10 W 50 - Add 240cc. Moli- kote A additive (365)	 max. 10 min. 7
GEAR BOX-DIFFERENTIAL	365 7.75 512 9.00	Agip Fl ROTRA MP SAE 85 W 90	
AIR CONDITIONING --Compressor --Coolant capacity	0.250 Kg. 1.1 Kg.	Agip TER 54 Freon 12 ANIDRO	 22+29 mm.
SHOCK ABSORBERS --Front (each) --Rear (each)	0.190 0.310	Agip OSO 35 Agip O30 35	
BRAKE CIRCUIT	1.0	365 ATE Type S 512 Agip Super H brake fluid	
STEERING BOX	0.200	Agip Fl ROTRA MP SAE 90	
COOLING SYSTEM	22	Antifreeze mixture	 3 cm.
WINDSHIELD WASHER BOTTLE	2	Water and glass cleaner	
FUEL TANKS	365 120 512 110	Premium fuel 98/100 octane rating	
HORN COMPRESSOR	a few drops	FIAMM oil	

IDENTIFICATION DATA PLATES

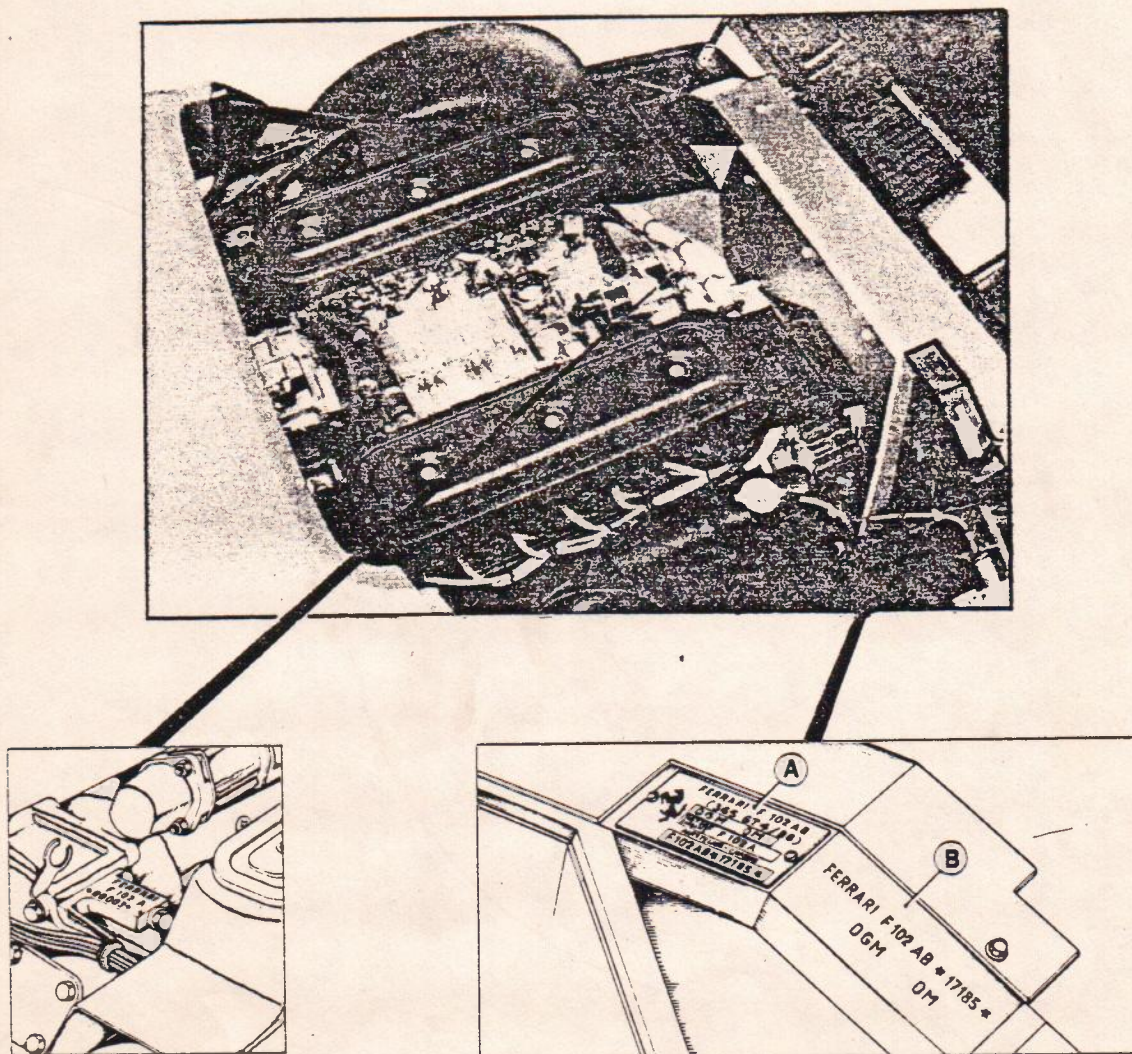
As the locations vary in the 365, 512 and 512i models, check the owner's manual. These plates list homologation, chassis, engine, engine and gearbox lubricants, antifreeze mixture, and type numbers.

REPLACEMENT PARTS

Ordering instructions

When ordering replacement parts, indicate clearly the parts number as well as the number of the design listed in the "Spare Parts Catalog." Also state the engine and chassis numbers of the car being repaired.

Fig. 4 - Location of Vehicle Identification Data



Type (F102A) and engine identification number.

A-Data identification plate: homologation number, engine type, chassis type and number.
B-Chassis identification type (F102AB) and number

ENGINE

	PAGE
MAIN DATA	13
DIAGNOSING FAULTS AND RELATED REPAIRS	15
CYLINDER BLOCK AND CYLINDER SLEEVES	20
PISTON—CONNECTING RODS	22
CRANKSHAFT—MAIN JOURNALS BEARINGS	28
CYLINDER HEADS	31
TIMING DRIVE SYSTEM	35

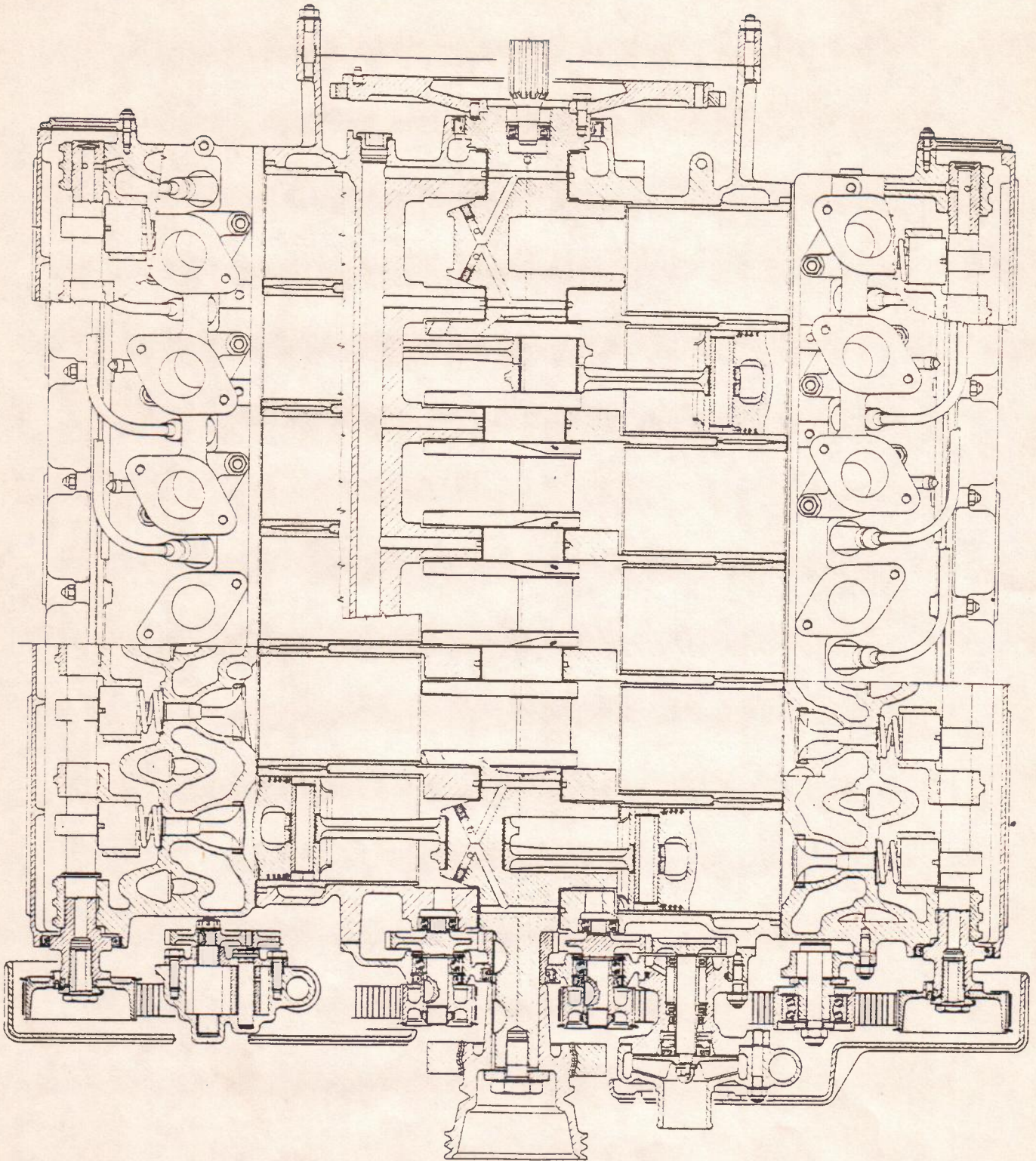


Fig. 1 - Engine Sectional Diagram

ENGINE

MAIN DATA.....	13
DIAGNOSING OPERATIONAL FAULTS AND RELATED REPAIRS.....	15

MAIN DATA

ENGINE		
Type	365	F 102 A
	512	F 102 B
Number of cylinders		12 at 180°
Cylinder bore	365	81 mm.
	512	82 mm.
Cylinder stroke	365	71 mm.
	512	78 mm.
Total capacity	365	4391 cc.
	512	4942 cc.
Compression ratio	365	8.8 to 1
	512	9.2 to 1
Maximum rpm	365	7000
	512	6600
Maximum horsepower (DIN)	365	344
	512	360
Corresponding rpm	365	7200
	512	6200
Maximum torque	365	41.7 Kg.
	512	46 Kg.
Corresponding rpm	365	3900
	512	4600
Taxable horsepower rating (Italy)	365	50
	512	37
CRANKSHAFT		
Number of main journals		7
Main bearings		Thin wall with anti-friction layer
Thrust bearings		2, located at rear support
CONNECTING RODS		
Bearings		Thin wall with anti-friction layer
PISTONS		
Type		Conical skirt section with 4 grooves
1st groove ring		Compression AC to L
2nd and 3rd groove rings		Compression AC (tapered)
4th groove ring		Oil scraper ROF/3P with spring
Wrist pin boss		Centered
Wrist pin		Free-floating type within connecting rod and piston

TIMING SYSTEM

Control
Valves
Camshafts and lobes

Via toothed belts
In cylinder heads
In cylinder heads

FUEL FEED

Electric pumps
Carburetors (365, 512)
Fuel injection (512i)
Air filters

2, CORONA
4, triple-choke Weber 401F3C
2, Bosch K-Jetronic
2

LUBRICATION

Pump
Filters
Pressure regulating valve
Lubrication pressure at 6000 rpm,
oil at 100°
Oil circulation thermostatic control
(365) to chassis no. 17865
Oil cooling

Gear driven
2, replacement type
With adjustment spring

6.5 Kg/cm²

Opening phase at 75° C.
Via radiator (365, to chassis
no. 17865)

COOLING

Type
Fans
Expansion tank

Centrifugal pump, radiator and
thermostat valve
2, electric/automatically
activated
With valve rated at 0.9 Kg/cm²

IGNITION

Type
Firing order

Dinoplex electronic, breakerless
distributor, coil and battery
1-9-5-12-3-8-6-10-2-7-4-11

STARTER

Type
Engagement
On/Off control

Electric
Electromagnetic
Via ignition key

ENGINE MOUNTING

Type

Flexible, on 4 rubber mounts

DIAGNOSING OPERATIONAL FAULTS AND RELATED REPAIRS

THE ENGINE WILL NOT START

Possible Causes	Remedies
1) Battery partially charged.	1) Check and recharge battery as indicated.
2) Battery terminals corroded or damaged.	2) Clean, examine and tighten connections at battery terminals.
3) Faulty starter motor.	3) Examine on test bench.
4) Defective starter commutator switch.	4) Replace.
5) Faulty coil.	5) Examine, replace if necessary.
6) Coil--distributor, distributor--spark plug wires stretched, broken.	6) Examine, readjust connections and replace.
7) Distributor cap cracked.	7) Replace cap.
8) Damp or carbonized distributor cap and cable connections.	8) Dry and clean cap and cable connections.
9) Dirty or out-of-phase reluctor or sensor unit.	9) Check and eventually adjust.
10) Worn or carbonized distributor rotor.	10) Clean, if necessary replace rotor.
11) Central distributor carbon tip loose, or deformed pressure spring.	11) Replace tip and related spring.
12) Dirty or excessively gapped spark plugs.	12) Clean and reset gap.
13) Flooded carburetor due to altered float level or impurity between adjustment screw & seat.	13) Check and adjust if necessary.
14) Non-functioning fuel pumps.	14) Check fuses, connections, filters and fuel level in tanks.
15) Dirt or water in fuel lines or in carburetors	15) Remove and thoroughly clean the carburetors; if fault continues, have the fuel tanks and lines cleaned and flushed.
16) Faulty fuel injection operation (512 BBI)	16) Consult Ferrari 400i fuel injection manual or authorized dealer.

THE ENGINE STOPS

Possible Causes	Remedies
1) Engine idle speed setting too low	1) Increase carburetor butterfly opening slightly and adjust mixture setting
2) Idle speed setting either too lean or too rich	2) Adjust mixture setting
3) Flooded carburetor	3) Turn to instructions under heading "CARBURETOR"
4) Dirt or water in fuel lines or carburetors	4) Remove and thoroughly clean the carburetors; if fault continues, have the fuel tanks and lines, cleaned and flushed.

THE ENGINE STOPS (continued)

5) Starter gear remains engaged with warm engine.	5) Disengage the starter.
6) Corroded or damaged battery terminals.	6) Clean, examine and tighten battery terminal connections.
7) Coil to distributor, distributor to spark plug wires loose.	7) Examine and tighten connections.
8) Dirty, wet, insufficiently or excessively gapped spark plugs.	8) Clean, dry and reset spark plug gap.
9) Dirty, or out-of-phase reluctor sensing unit.	9) Check and eventually replace.
10) Worn distributor rotor surface.	10) Replace rotor.
11) Inexact ignition timing advance.	11) Adjust engine/distributor timing.
12) Defective coil or condensers.	12) Examine and replace if needed.
13) Defective valve operation due to faulty valve seats or defective valve settings.	13) Adjust valve clearances and check each cylinder's compression.
14) Overheated engine, water losses due to leaks and cooling vents.	14) Check radiator water level, water pump and thermostat operation.
15) Faulty fuel injection operation (512 BBI).	15) Consult Ferrari 400i fuel injection manual or authorized dealer.

THE ENGINE LACKS POWER

Possible Causes	Remedies
1) Incorrect ignition timing.	1) Check and carry out timing operations.
2) Accelerator pedal does not travel its full length.	2) Trace cause of blockage and remove.
3) Defective distributor automatic advance.	3) Readjust according to instructions.
4) Incorrect distributor timing.	4) Check timing.
5) Insufficient compression.	5) Check valves seating and cylinders' compression.
6) Dirty, set spark plugs or excessive electrode gap.	6) Clean plugs and reset to exact electrode gap.
7) Worn or improper type spark plugs.	7) Replace spark plugs, use recommended type.
8) Fuel octane rating too low.	8) Use recommended fuel.
9) Worn camshaft lobe(s).	9) Check out lobe(s), replace camshaft if necessary.
10) Fuel mixture too low or too rich.	10) Check out carburetors jet settings.
11) One carburetor not opening completely.	11) Check out controls.
12) Weak valve springs due to deformation.	12) Check as per table on page 36, if necessary, replace springs.
13) Insufficient fuel delivery due to defective fuel pumps or clogged filters.	13) Check out, clean and replace defective units if necessary.
14) Engine components seized; main journals or connecting rods bearings, camshafts, valve in guide.	14) Check, replace defective units.
15) Faulty fuel injection operation (512 BBI).	15) Consult Ferrari 400i fuel injection manual or authorized dealer.

THE ENGINE MISSES AT HIGH REVOLUTIONS

Possible Causes	Remedies
1) Insufficient fuel delivery.	1) Clogged filters in the electric pumps, excessively warm fuel, tanks capacity nearing reserve level.
2) Clogged delivery air intake filter.	2) Clean, blow dry or replace if necessary.
3) Partially clogged fuel lines and carburetor filters.	3) Clean regulator and carburetors filters.
4) Dirty or wet spark plugs or maladjusted gaps or tips.	4) Clean and adjust tips and gaps, replace if worn excessively.
5) Defective or improperly seated spark plug causing pre-ignition.	5) Check condition and type of plug.
6) Ignition timing setting higher than prescribed setting for high RPMs.	6) Check with stroboscope at 7000 RPMs.
7) Valve spring(s) deformed or insufficiently loaded.	7) Check and replace springs.
8) Valve(s) travel impeded in the guide(s) or valve not closing completely.	8) Check, if necessary replace valve and guide.
9) Flooding of one or more carburetors.	9) Check and clean float needle valve and replace if worn.
10) Faulty fuel injection operation (512 BBi).	10) Consult Ferrari 400i fuel injection manual or authorized dealer.

THE ENGINE RUNS IRREGULARLY

Possible Causes	Remedies
1) Dirty or wet spark plugs.	1) Check, clean and reset gap.
2) Inexact ignition timing.	2) Check distributor advance.
3) Maladjusted idle speed mixture.	3) Adjust.
4) Carburetors butterfly valves synchronization.	4) Check.
5) Defective fuel pumps.	5) Check fuel lines connections and filters' cleanliness.
6) Defective fuel pickup pumps.	6) Check travel, blockages in jets and condition or membranes.
7) Irregular cylinders compression.	7) Check with compression gauge.
8) "Seized" or burned engine valves.	8) Check and replace valves.
9) Irregular valve clearances.	9) Adjust.
10) Carburetor flooding due to dirt between needle and seat.	10) Clean carburetor bowls and filters.
11) Altered carburetor float levels.	11) Check levels.
12) Air leaks between air intakes.	12) Check intake rubber seal rings and exhaust flanges tightness.
13) Excessive play in the carburetors control level shafts.	13) Check and replace the faulty units.
14) Non-functioning automatic advance.	14) Check on test bench.
15) Faulty fuel injection operation (512 BBi).	15) Consult Ferrari 400i fuel injection manual or authorized dealer.

NOISY VALVES AND TAPPETS

Possible Causes	Remedies
1) Excessive clearance between camshaft lobe and valve adjustment tab.	1) Adjust by substituting tabs.
2) Worn or deteriorated camshaft lobe or spacer tab.	2) Check and substitute camshaft tabs.
3) Broken valve return spring(s).	3) Replace broken spring(s).
4) Excessive clearance between tappet thimble and guide hole.	4) Check.
5) Valve stem(s) not traveling freely in the guide(s).	5) Check.

NOISY CONNECTING RODS BEARINGS SURFACES

Possible Causes	Remedies
1) Excessive clearance between connecting rods bearing and crankshaft journals.	1) Disassemble engine, check bearing and journals wear, eventually substituting the bearings and resurfacing the crankshaft.
2) Insufficient oil delivery.	2) Check out oil pump and delivery and return tubing.
3) Use of non-prescribed oil.	3) Substitute.
4) Low oil pressure.	4) Check oil pressure regulator valve and filters.
5) Excessive clearance between piston wrist pins and connecting rods bushings.	5) Disassemble engine, check pin and bushing wear, replace worn units.

ENGINE VIBRATES

Possible Causes	Remedies
1) Defective ignition or excessive timing advance.	1) Check out and overhaul the ignition system.
2) Defective carburetion.	2) Check out and adjust.
3) Defective carburetor synchronization.	3) See specific chapter instructions.
4) Excessive clearance between main bearings and crankshaft journals.	4) Check diameter of main journals.
5) Connecting rods and pistons of unequal weight.	5) Check individual groups and equalize weights.
6) Incorrect camshaft lobes and tappet shim tabs clearance.	6) Adjust.
7) Unequal cylinder compression.	7) Test cylinder compression.
8) Worn or hardened elastic engine support mounts.	8) Replace supports.
9) Unbalanced engine flywheel-clutch assembly group.	9) Balance total group as a unit.
10) Non-functioning cylinder(s).	10) Identify cylinder(s) and check spark plugs and cables.

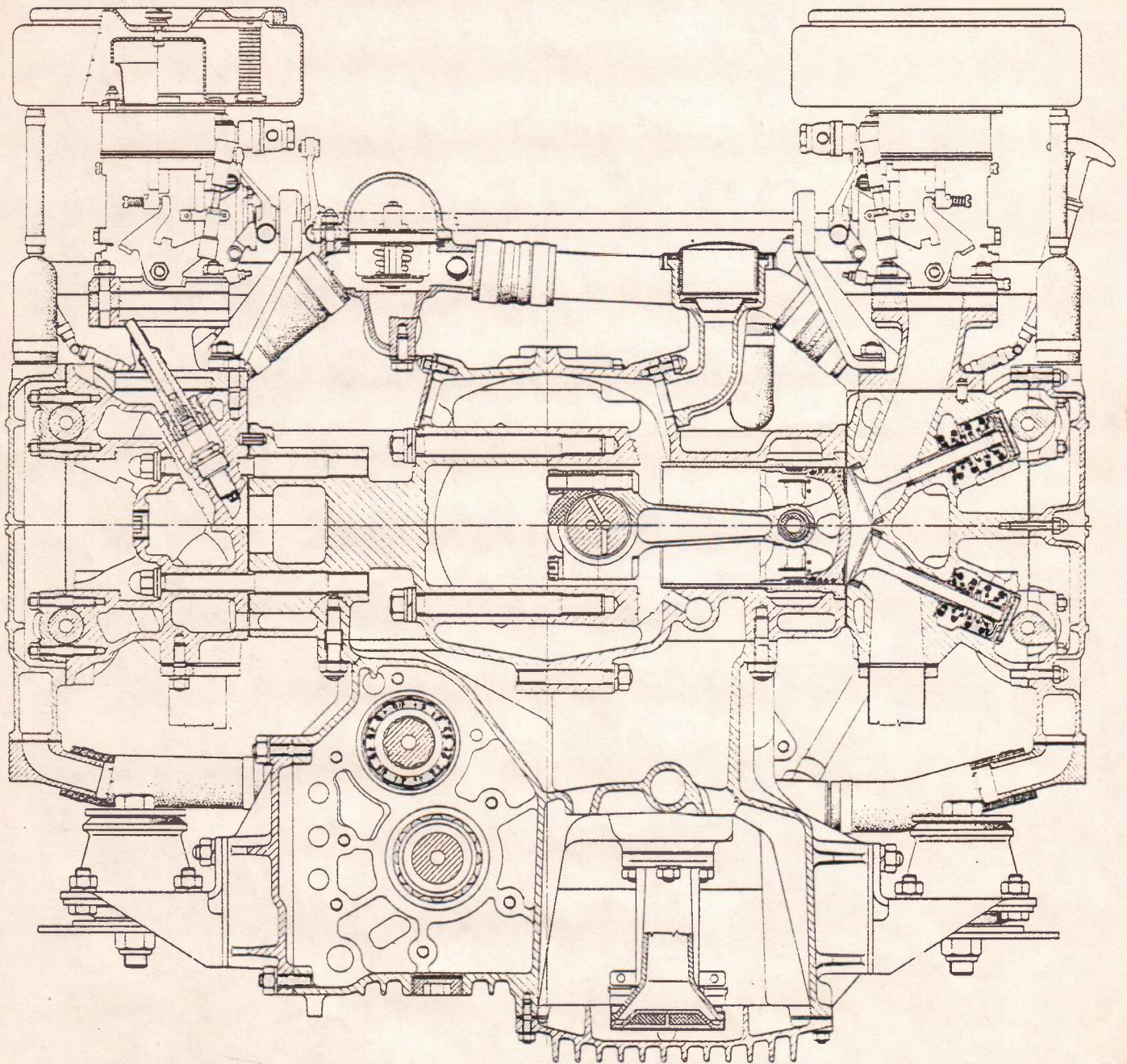
EXCESSIVE OIL PRESSURE

Possible Causes	Remedies
1) Non-specified oil; oil weight too high.	1) Substitute with prescribed oil.
2) Oil pressure regulation valve obstructed or with altered setting.	2) Check and replace faulty units. Readjust to prescribed settings.
3) Clogged oil circuit lines.	3) Clean and flush oil lines, replace filters.

LOW OIL PRESSURE

Possible Causes	Remedies
1) Excessive oil temperature.	1) Do not over-rev engine.
2) Inappropriate oil type for conditions.	2) Substitute with specified oil.
3) Excessive clearance between main and connecting rod journals/bearings.	3) Disassemble, check crankshaft journals, resurface journals and replace bearings.
4) Defective, jammed oil pressure regulating valve.	4) Check out.
5) Clogged oil pump filter.	5) Remove sump cover and clean filter.
6) Faulty oil pressure indicator.	6) Check out and eventually replace.
7) Low sump oil level.	7) Check out and refill to level.
8) Oil pump intake line loose or leaking.	8) Check and tighten stud bolts. Replace tube if necessary.

Fig. 2 - Engine Transverse View



BLOCK AND CYLINDER SLEEVES

PRINCIPAL DATA.....	21
GENERAL INFORMATION.....	21
MAIN BLOCK SURFACES OVERHAUL.....	21
CYLINDER SLEEVES OVERHAUL.....	22

PRINCIPAL DATA

DESCRIPTION	mm.
Cylinder sleeves block installation surfaces diameter	87.000 + 87.035 93.000 + 93.022
Cylinder sleeves centering diameter	86.960 + 86.980 92.966 + 92.988
Cylinder sleeves normal diameter ⁵¹² { 82.08 > MAX ALLOW. 82.10	81.000 + 81.020
--1st oversize diameter	81.150 + 81.170
--2nd oversize diameter	82.300 + 81.320
Maximum tolerable sleeve wear	0.080 + 0.100
Tolerable out-of-roundness and taper	0.010 + 0.015
Cylinder sleeves resurfacing Finish μ	0.6 + 0.8
Cylinder sleeves--heads surfaces extension	0.03 + 0.07
Main bearing journals seating surfaces diameter	66.675 + 66.688

GENERAL INFORMATION

The block is cast in high resistance light aluminum alloy and its cylinder bores are included in the unit. As the cylinders are opposed 180°, the block unit is made up of two groups. At each overhaul, cleaning of the block must be carried out accurately. Remove all plugs and with a pressure hose force kerosene through all lubrication channels.

MAIN BLOCK SURFACES OVERHAUL

Install mandrel 361/AS/4736 (diameter = 66.675, -0.01 to -0.02) on the main bearing surfaces and tighten block halves with the cap bolts (14 x 1.5 = 13.5 Kg, 10 x 1.5 = 6.6 Kg).

Install cylinder heads with used gaskets; tighten bolts to 11 Kg.

If the mandrel rotates without effort, the bearing surfaces are not damaged and the wear is negligible.

If some effort is required, lightly file down the bearing mounting surfaces, starting from the central one outwards.

After having reconditioned the contact surfaces, it is advisable to lightly resurface all contact surfaces with lap grinder AV 240 with a coat of cromax paste or with an oil-based metal polishing compound.

CYLINDER SLEEVES OVERHAUL

The sleeves are of the slip-in type.

Their seating is controlled by the torque on the cylinder heads and retaining ring A.

They are supplied ready for installation within the specified oversizes.

Maximum allowable wear across the diameter is 0.08 ± 0.10 mm. as measured about 10 mm. below the head gasket mating surface.

If wear limits are exceeded it is advisable to replace the cylinder sleeves.

Out-of-roundness and taper must not exceed 0.010 ± 0.015 mm.

Only in extreme cases it is advised to oversize the bore of the sleeves.

If this operation is to be carried out, remove the sleeve from the block and with the proper machining tool grind the inner surfaces to the desired 1st or 2nd oversize specifications.

During this operation closely check that the perpendicularity between the machined surfaces and the resting surface is $\perp 0.02$.

The resurfacing finish must be within $0.6 \pm 0.8 \mu$.

Before re-installation of the sleeves (when removed for any reason) carry out a thorough cleaning and replace the retaining rubber rings.

The cylinder sleeves should not extend beyond the gasket surfaces, without retaining ring A installed, between 0.03 ± 0.07 mm. (.0012 - .0027)

Make sure that the extension for all cylinders is as close as possible to 0.05 mm. (.00196)

For this operation, use tool 542-CS-6788.

Fig. 3 - Seating of Sleeves in the Cylinder Block

A-Retaining ring; B-Tool no. 542-CS-6768

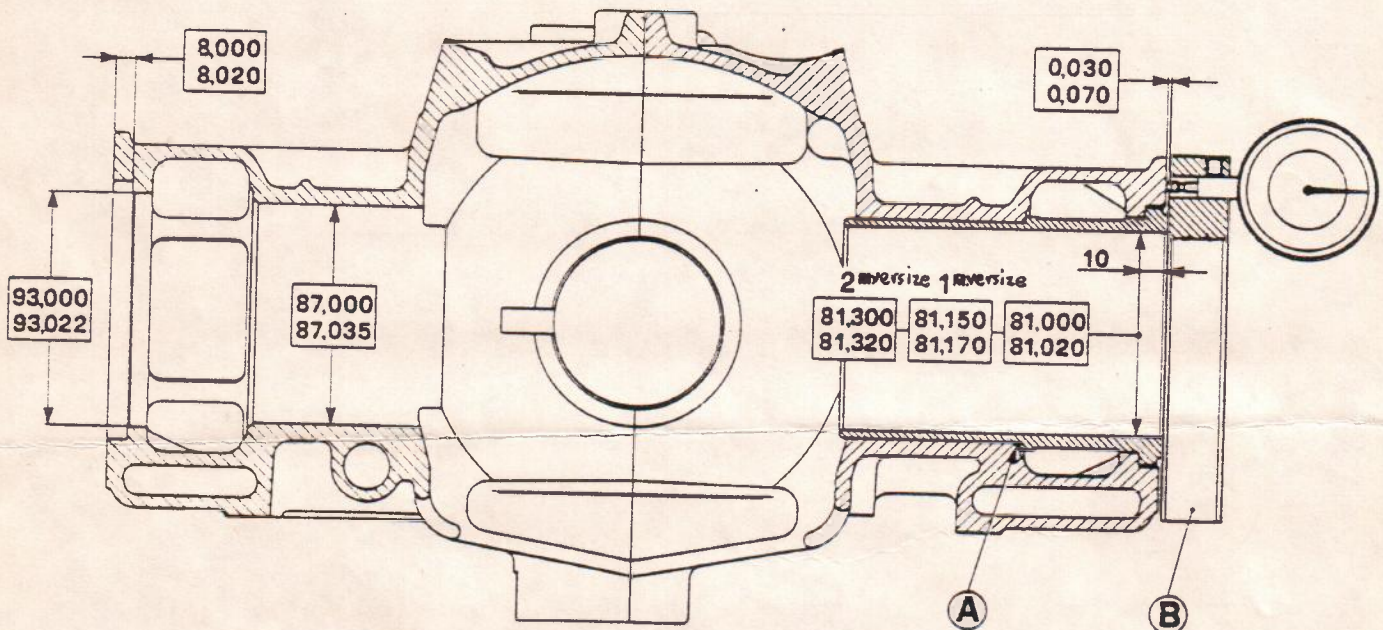


Fig. 3 - Seating of Sleeves in the Cylinder Block

A-Retaining ring; B-Tool no. 542-CS-6768

PRINCIPAL DATA (continued)

DESCRIPTION	mm.
Piston rings clearances (measured with rings installed in sleeves) --1st compression ring AC ato L --2nd compression ring AC tapered --3rd compression ring AC tapered --4th oil scraper ring ROF 3P spiral	$.0118 \left\{ \begin{array}{l} 0.30 \div 0.45 \\ 0.30 \div 0.45 \\ 0.30 \div 0.45 \\ 0.15 \div 0.25 \end{array} \right\} .0177$ $(.0059 - .0098)$
Piston wrist pins boss diameter	$18.500 \div 18.506$
Piston wrist pins normal diameter	$18.494 \div 18.500$
Piston-wrist pin clearances --Assembly clearance --Wear limits	$0.000 \div 0.012$ 0.05
Connecting rod bearing seat diameter	$21.500 \div 21.521$
Connecting rod pin bushings external diameter Connecting rod pin bushings internal diameter Clearance between bushing and connecting rod bushing hole --Wear limit	$21.548 \div 21.535$ $18.515 \div 18.535$ $0.015 \div 0.041$ 0.050
Clearance between bushing and connecting rod bushing hole: interference	$0.014 \div 0.048$
Connecting rods bearing seat diameter	$47.129 \div 47.142$
Connecting rod bearings--normal thickness	$1.714 \div 1.723$
Connecting rod bearings thickness undersizes (replacement)	$-0.254; -0.508; -0.762$
Clearance between connecting rod bearings and crankshaft journals --Assembly clearance --Wear limit	$(.0018 - .0035)$ $0.046 \div 0.089$ 0.12 $(.0047)$
Connecting rods axial play at crankshaft	$0.200 \div 0.339$ $(.0079 - .0133)$

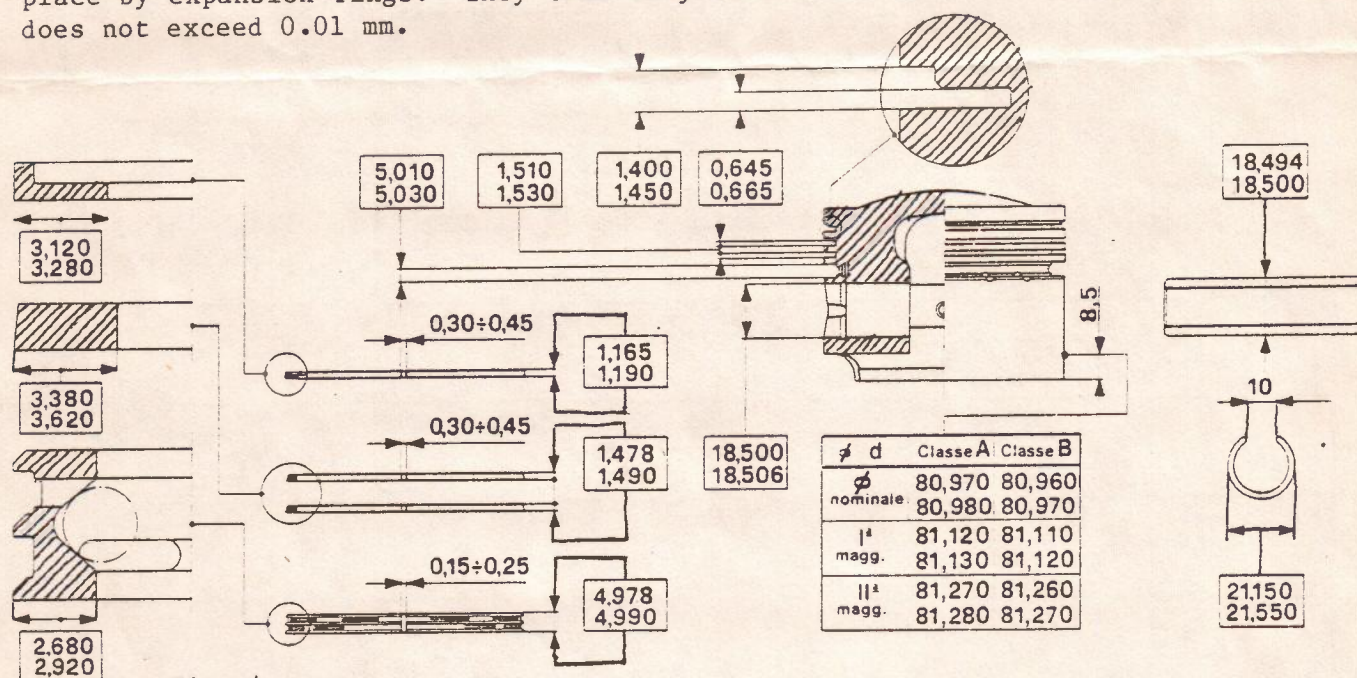
CLEANING

Remove any incrustations from piston domes and ring grooves using a curved scraper. Also remove any impurities from lubrication passages and from the internal surfaces of the pistons and connecting rods. When cleaning is finished make sure that the units are not cracked or damaged, requiring replacement of those units. A Magnaflux check is advised.

PISTON OVERHAUL

The pistons are subdivided into two classes, marked A and B on the top of the piston. The difference between the two diameters does not exceed 0.01 mm. and their weight can vary from 0 to 2 grams.

The wrist pins are mounted on the pistons with a slight pressure and are retained in place by expansion rings. They come only in one size and their diameter difference does not exceed 0.01 mm.



PISTON RINGS CLEARANCES CHECK

Before installing the rings on the pistons, insert rings in the cylinder sleeves and check the existing end clearances; such clearances must meet the specifications.

INSTALLATION OF PISTON RINGS

To facilitate installation of the rings on the pins, use an appropriate mounting tool (commercially available). After installation, orient the ends of the rings so that they are 90° out-of-phase with each other.

OVERHAUL OF CONNECTING RODS

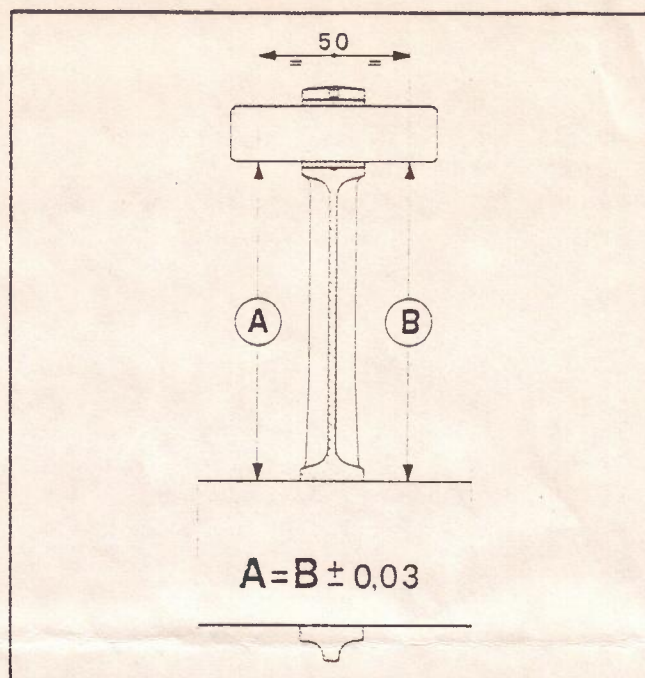
During each engine rebuilding and especially with a replacement of the piston wrist pin bushings it is necessary to check the alignment between the 2 axes. This must be within 0.03 mm. as measured at a distance of 50 mm. from each end.

A Magnaflux check is advisable. The connecting rods are classified according to their weight which is stamped on the stem as indicated in the table. When replacement is required, make sure that the new rods are of the same weight.

Note

With each engine rebuild it is advisable that the nuts of the connecting rod be replaced.

Fig. 5 - Connecting Rods Alignment Check



LETTER	EQUIVALENT IN GR.	LETTER	EQUIVALENT IN GR.	LETTER	EQUIVALENT IN GR.
A	520 ÷ 524	H	548 ÷ 552	Q	576 ÷ 580
B	524 ÷ 528	I	552 ÷ 556	R	580 ÷ 584
C	528 ÷ 532	L	556 ÷ 560	S	584 ÷ 588
D	532 ÷ 536	M	560 ÷ 564	T	588 ÷ 592
E	536 ÷ 540	N	564 ÷ 568	U	592 ÷ 596
F	540 ÷ 544	O	568 ÷ 572	V	596 ÷ 600
G —	544 ÷ 548	P	572 ÷ 576		

Each rod is installed in its corresponding cylinder sleeve with the numbers facing downwards.

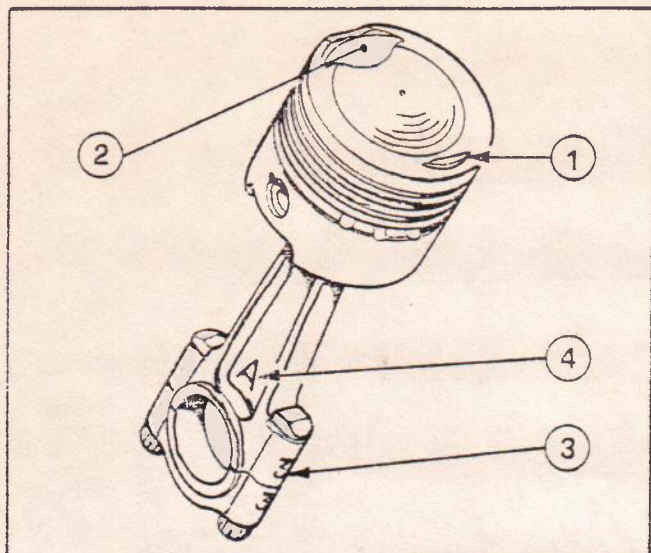


Fig. 6 - Piston/Connecting Rod Unit
 1-External valve identification
 2-Internal valve identification
 3-Cylinder/connecting rod matching numbers stamp
 4-Weight classification identification number (see table above)

CONNECTING ROD BEARINGS

The bearings are of the "thin-wall" variety, and must not be filed or smoothed down in order to avoid damaging their surfaces which are coated with anti-friction material.

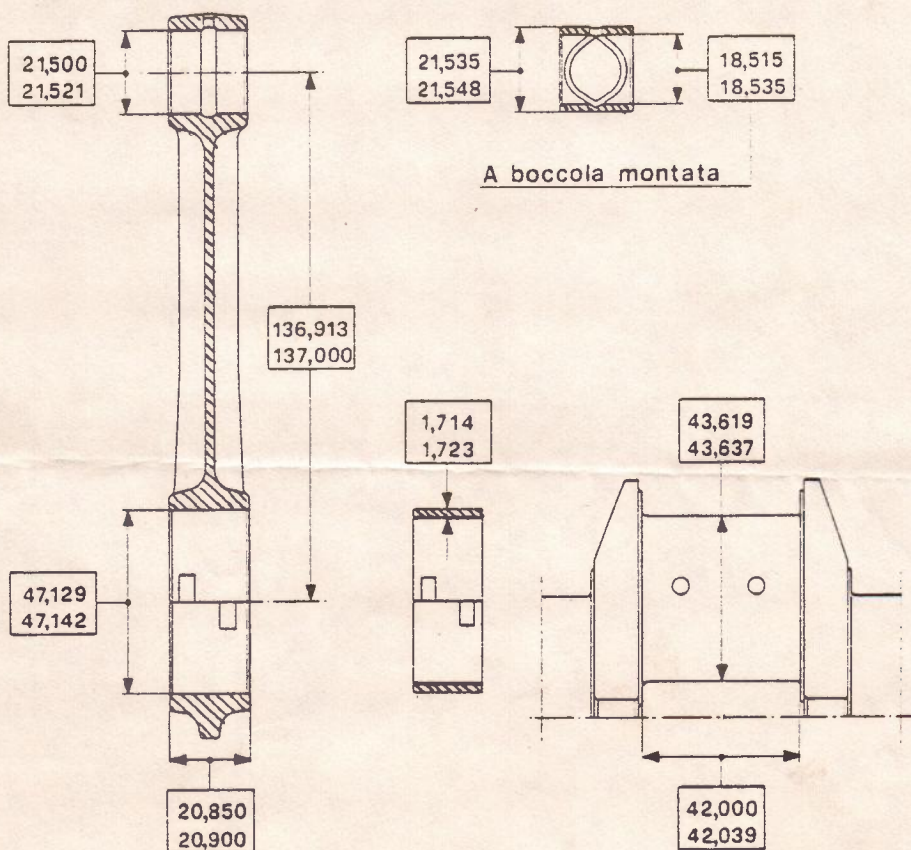


Fig. 7 - Main Data for Connecting Rods, Bearing and Connecting Rod Bushing

CONNECTING JOURNALS DIAMETERS

Normal Diameter	43.619 ± 43.637
1st oversize 0.254	43.365 ± 43.383
2nd oversize 0.508	43.111 ± 43.129
3rd oversize 0.762	42.857 ± 42.875

CONNECTING ROD BEARINGS THICKNESSES

Normal Thickness	1.714 $\div$ 1.723
+0.127	1.841 $\div$ 1.850
+0.254	1.968 $\div$ 1.977
+0.381	2.095 $\div$ 2.104

If any scratches or wear marks are noted, they must be replaced. In order to ensure optimum bearing operation, check their clearances after installing them in their respective engine block seats. Install the bearings in their proper shafts and tighten all bolts to 6.6 Kg. torque; with a dial gauge check the internal diameter of the bearing and the diameter of the respective crankshaft journals. If the resulting clearance is smaller than the wear limit, the same bearings sizes can be used (and if the respective crankshaft journals diameter is unchanged). However, if a higher clearance reading is obtained, replace with undersized bearings and grind the crankshaft journals to the appropriate sizes as indicated in the charts above.

CYLINDER HEADS

PRINCIPAL DATA.....	33
CYLINDER HEAD CHECK.....	34
CLEANING AND OVERHAUL.....	35
VALVE SYSTEM DISASSEMBLY AND OVERHAUL.....	35
VALVE SPRINGS CHECK.....	36

PRINCIPAL DATA

DESCRIPTION	mm.
Cylinder heads height	127 ÷ 127.2
Valve layout (4 mm. separation)	V at 46°
Valve guides cylinder heads seats diameter	13.000 ÷ 13.018
Valve guides external diameter	13.050 ÷ 13.068
Valve guides internal diameter-installed (intake in head (exhaust)	8.000 ÷ 8.015 8.000 ÷ 8.015
Valve guides/seats clearance after installed in head	0.032 ÷ 0.068
Valve stem diameter (intake (exhaust)	7.940 ÷ 7.975 7.960 ÷ 7.975
Valve stem/valve guide installation: --Assembly clearance (intake (exhaust)	0.025 ÷ 0.055 0.025 ÷ 0.055
--Wear limit	0.10
Maximum out-of-center between valve stem and head (intake (exhaust)	0.02 0.02
Tappet seat diameter	37.015 ÷ 37.045
Tappet internal diameter	36.975 ÷ 36.995
Tappet-seat installation --Assembly clearance	0.020 ÷ 0.070
--Wear limit	0.100
Intake valve internal seat diameter	36.900 ÷ 37.100
Exhaust valve internal seat diameter	33.900 ÷ 34.100
Valve seats seating angle (intake (exhaust)	45 + 5' 45 + 5'
Intake valve upper seat diameter	44.220 ÷ 44.240
Intake valve lower seat diameter	44.090 ÷ 44.110
Exhaust valve upper seat diameter	41.220 ÷ 41.240
Exhaust valve lower seat diameter	41.090 ÷ 41.110
Intake valve seat specifications (upper Ø (lower Ø)	44.060 ÷ 44.080 44.000 ÷ 44.020
Exhaust valve seat specifications (upper Ø (lower Ø)	41.060 ÷ 41.080 41.000 ÷ 41.020

DESCRIPTION	mm.	
	Internal Spring	External Spring
Valve Springs		
Full length of spring	40.4	42.1
Full length with valve closed	35.05	38.65
Full length with valve open	26	29.6
Full length with valve under load	24	25.5
Load value with valve closed	12.3 + 0.5 Kg.	16.66 + 0.6 Kg.
Load value with valve open	33.1 + 1.2 Kg.	60.3 + 2.1 Kg.

CYLINDER HEAD CHECK

The two cylinder heads are cast in aluminum alloy, with hemispherically designed combustion chambers, and are equipped with inserted alloy valve seats. The reconditioning of the valve seats must be carried out after checking the diameter of the valve seat recesses and the rings so that their mounting results in an interference of $0.07 \div 0.11$ mm. at the smaller diameter measurement and $0.14 \div 0.18$ mm. at the larger diameter measurement. To insert the valve seats in their recesses, heat the cylinder heads in a furnace at a temperature of $190^{\circ} + 200^{\circ}$ C. and cool the seats in carbon dioxide (dry ice) for 5 to 6 minutes.

All valve seats resurfacing operations must be carried out after their installation on the cylinder heads. The valves are provided with two concentric return springs. It is advisable to replace them whenever the engine is rebuilt and also whenever seating irregularities are noticed or whenever the load value with a closed valve decreases 3 to 5 Kg. When the valve seat wear exceeds $0.6 + 0.7$ mm. they should be replaced. In order to avoid damage to the valve seat placement in the heads, remove the valve seats with the proper reamer.

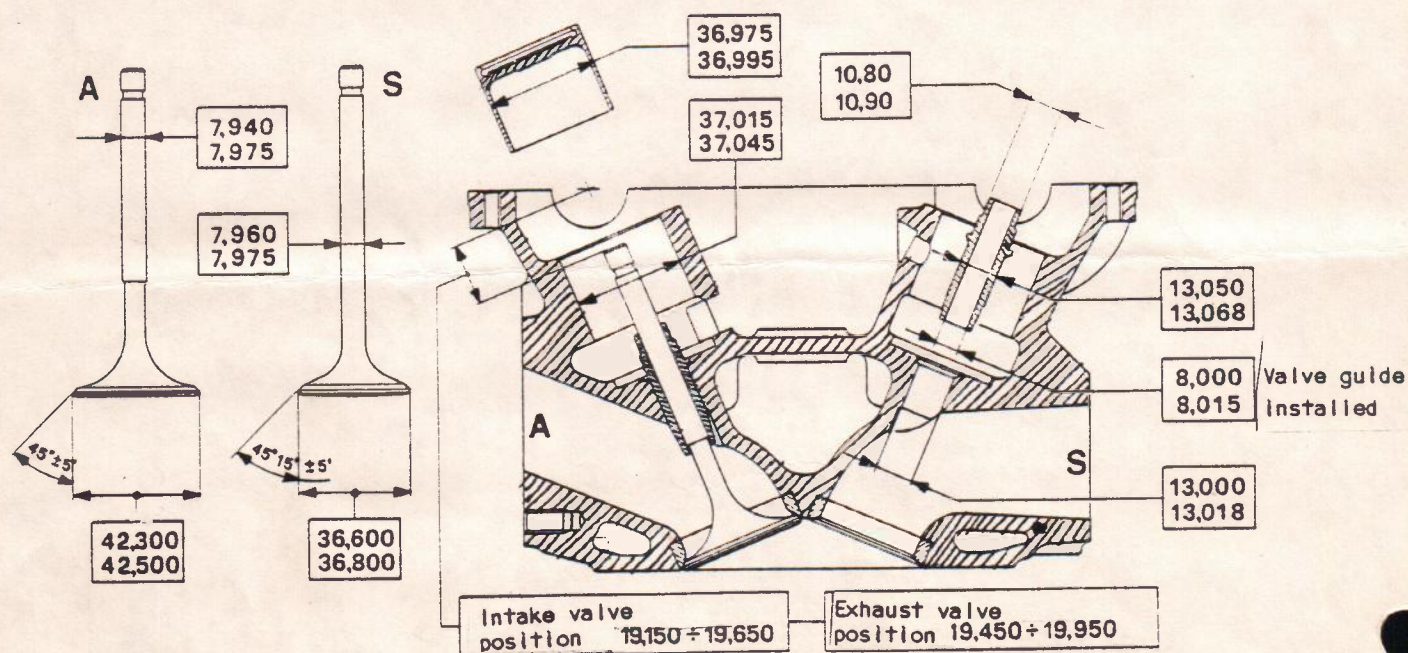


Fig. 9 - Main Data for Valves and Respective Guides

CLEANING AND OVERHAUL

Remove carbon deposits from the combustion chambers and ream the intake and exhaust tubes. Clean with kerosene; if possible, under pressure.

- Check the spark plug holes threads.
- Check that all valve seats are secure in their mounting recesses and are not too loose.
- Check the cylinder heads-to-cylinder block mating surfaces and the cam-shafts support surfaces.
- Check for water leaks in the cylinder heads (Test pressure = $8 + 10$ Kg/cm²)
- Check the hole seats of the valve control thimble tappets.

VALVE SYSTEM DISASSEMBLY AND OVERHAUL

For the disassembly of the valve use tool AV-508.

- Check valve stem wear with a micrometer caliper.
- Check valve seat wear and the top surface of the valve.
- Verify the axial alignment between stem and shaft and the valve clearance in the guide with a guage installed on the head.
- Check for valve guide hole diameter distortion with an inside caliper 902-CS-5969.
- The guide holes should be free of score and wear marks.
- With inside caliper 152-CS-7431, check the diameter and the out-of-roundness of the tappet thimbles seating holes.
- Check the condition of the valve guides oil retaining rings.

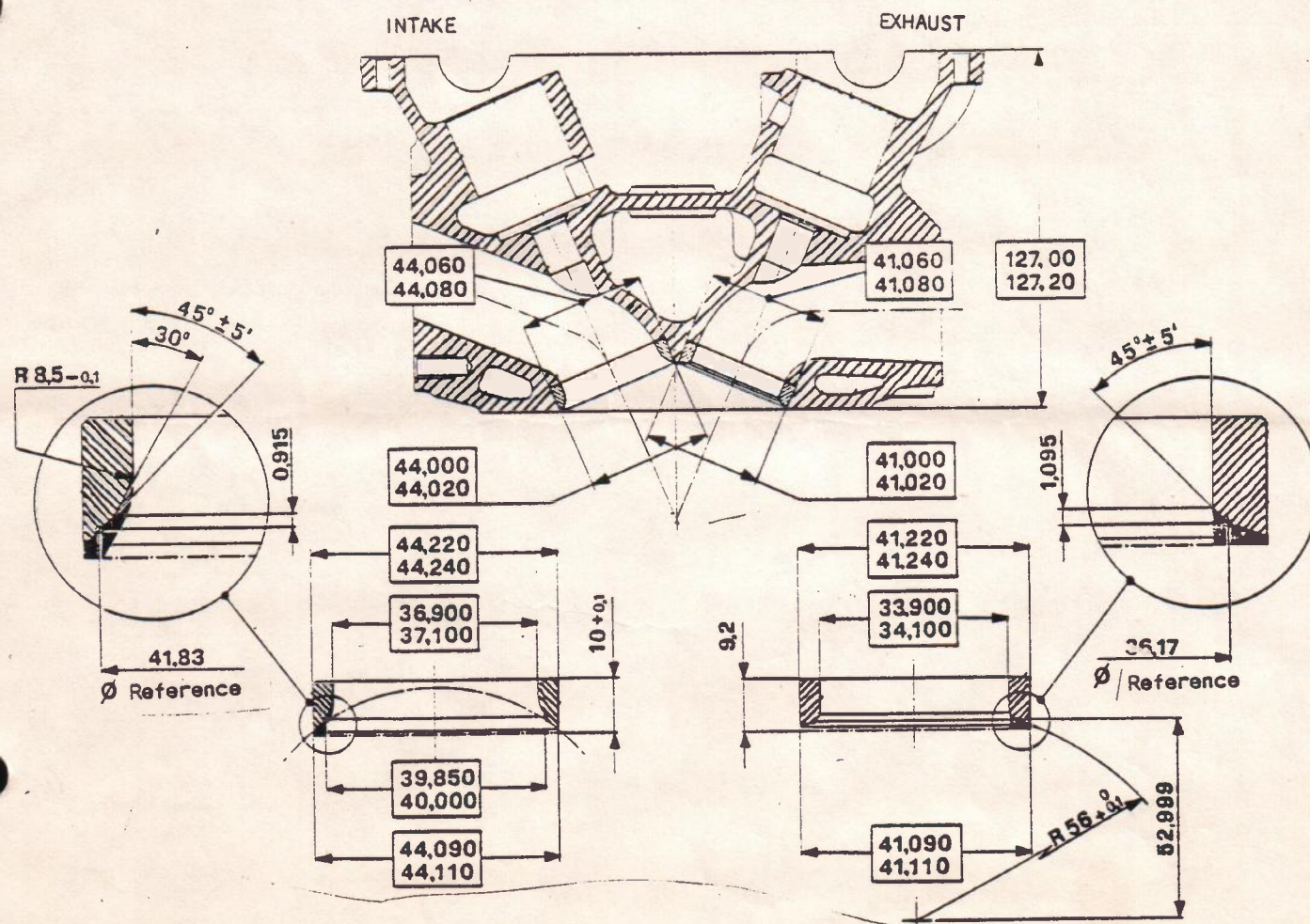


Fig. 10 - Valve Seats Main Data

VALVE SPRINGS CHECK

Check that the springs are not cracked, flawed or have lost their elasticity. Check out spring tension using an elastometer, comparing the meter's readings with the figures given in Fig. 11.

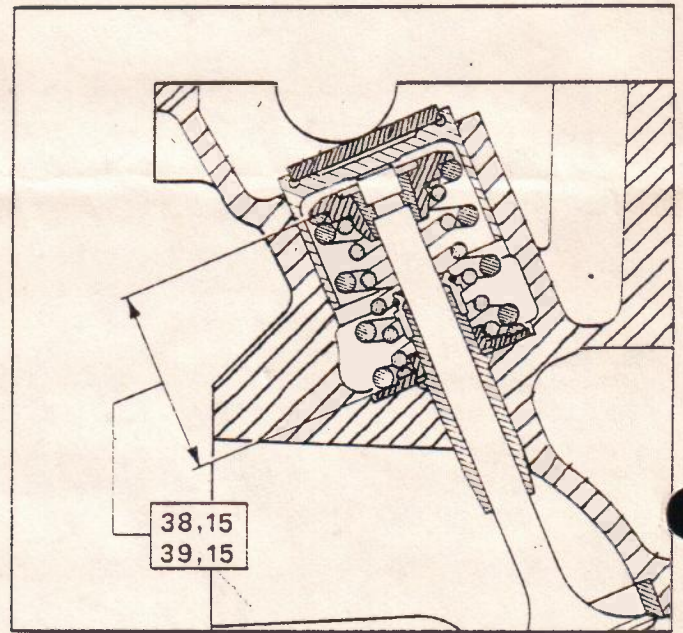
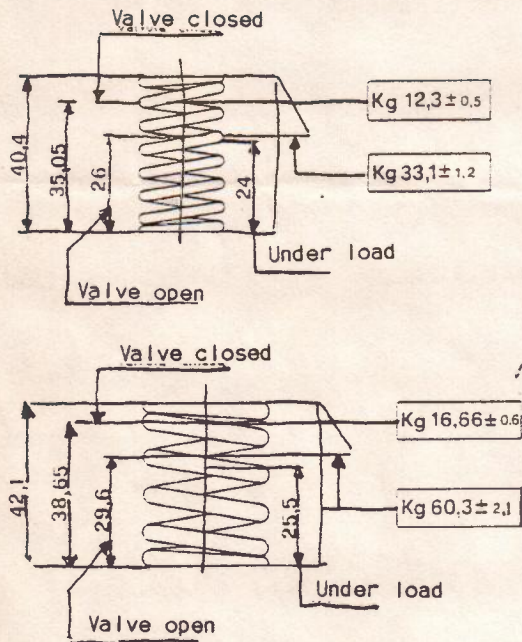


Fig. 11 - Valve Springs Main Data

Note - Prior to valve springs installation, verify that the distance between the lower seating surface the upper retainer unit is 38.65 mm. Whenever the distance exceed 0.5 mm., restore to the desired distance by placing a steel washer of appropriate thickness below the lower retainer unit.

CRANKSHAFT - MAIN JOURNALS BEARINGS

PRINCIPAL DATA.....	29
MAIN AND CONNECTING ROD JOURNALS CHECK.....	30
CRANKSHAFT THROWS END PLAY CHECK.....	30
OIL SEAL GASKETS CHECK.....	30
CRANKSHAFT CLUTCH SHAFT END BEARING CHECK.....	30

PRINCIPAL DATA

DESCRIPTION	mm.
Main journals normal diameter	62.966 + 62.979
Main journals bearings diameter	66.675 + 66.688
Main bearings normal thickness	1.829 + 1.835
Replacement main bearings undersizes	0.254; 0.508; 0.762
Connecting rod journals normal diameter	43.619 + 43.637
Main journals/bearings installation: --Assembly clearance --Wear limit	0.026 + 0.064 0.15
Rear main journal length between throws	40.000 + 40.039
Rear crankshaft supports bearings width (block)	35.180 + 35.230
Rear crankshaft supports bearings thickness	2.310 + 2.360
Replacement thrust bearings oversizes	+0.250
Crankshaft axial play with thrust bearings installed --Assembly clearance --Wear limit	0.100 + 0.240 0.30
Main journals maximum allowable mis-alignment	0.02
Maximum allowable out-of-roundness for main and connecting rod journals after regrinding	0.01
Maximum allowable taper for main and connecting rod journals after regrinding	0.01
Maximum allowable rotation out-of-true of the flywheel attached surface. At a distance of 48 mm. from the axis the maximum allowed tolerance is:	0.025
Main and connecting rod journals surface hardness (Rockwell)	56 Hd
Surface finish of connecting and main crankshaft journals	μ 0.4

MAIN AND CONNECTING ROD JOURNALS CHECK

The wear of the main and connecting rod journals has been reduced to a minimum due to high wear resistance of the contact surfaces, and due to excellent filtration of the lubricating oil.

When resurfacing of the journals is deemed necessary, they should be measured with a micrometer caliper tool and the new diameter must be established in accordance with the reduced size (undersize) scale of the bearings, provided within the clearance limits indicated as follows:

MAIN JOURNALS DIAMETER

Normal ϕ	62.966+62.979
1st undersize 0.254	62.712+62.725
2nd undersize 0.508	62.458+62.471
3rd undersize 0.762	62.204+62.212

MAIN JOURNALS BEARING THICKNESS

Normal Thickness	1.829 $\div$ 1.835
+0.127	1.956 $\div$ 1.962
+0.254	2.083 $\div$ 2.089
+0.381	2.210 $\div$ 2.216

Normally, after the main and connecting rod journals have been ground to the first undersized diameter, they maintain the same original surface hardness; after the second undersize operation it is necessary to re-nitride the crankshaft.

It is advisable in this operation to resurface the main bearings journals to 0.10 mm. oversize and then to renitride them, while the connecting rod journals must be machined down before renitriding them.

CRANKSHAFT THROWS END PLAY CHECK

The crankshaft-to-engine block assembly completed, it is necessary to check the end play between the rear support bearings and the crankshaft throws.

Move the crankshaft axially with a screwdriver and with a gauge measure the clearance between the crankshaft and the thrust bearing.

End play must be within 0.100 $\div$ 0.240 mm. If a higher reading is obtained, replace with thrust bearings of first oversize (0.250 mm.)

Make sure that the lubrication grooves on the sides of the thrust bearings face the crankshaft throws.

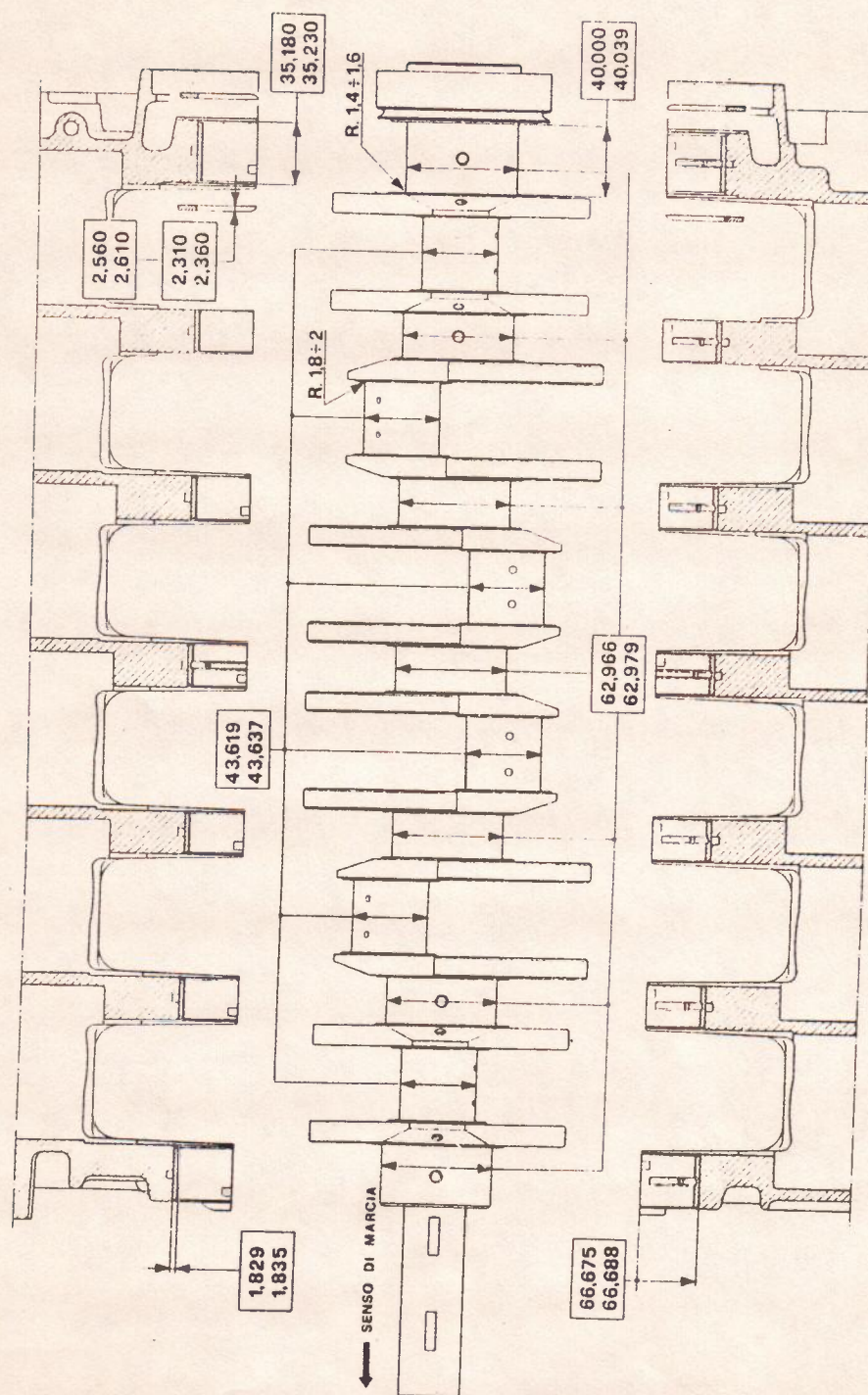
OIL SEAL GASKETS CHECK

With each rebuilding it is advisable to replace the two spring-loaded gaskets located at the ends of the crankshaft, even if they seem to be still in good condition. Also replace all surfaces contact gaskets.

CRANKSHAFT CLUTCH SHAFT END BEARING CHECK

Whenever noisy operation or irregularity is noticed in the rotation of the bearing, it is necessary to replace it. Remove the retaining snap ring and remove the bearing using an appropriate extractor/puller tool.

Fig. 8 - Main Data for Main, Connecting Rods Journals and Support Bearings



ENGINE TIMING

PRINCIPAL DATA.....	37
CAMSHAFTS INSTALLATION.....	37
VALVE CLEARANCES CHECK AND ADJUSTMENT.....	38
TIMING GEAR TOOTHED BELTS.....	39
BELT TENSION ADJUSTMENT.....	40
ENGINE ASSEMBLY AFTER OVERHAUL.....	41
IGNITION TIMING.....	44

PRINCIPAL DATA

DESCRIPTION	mm.
Camshaft journals diameter (with caps installed)	25.020 $\pm$ 25.041
Camshaft seats diameter	24.987 $\pm$ 25.000
Camshafts/seats installation	
--Assembly clearance	0.020 $\pm$ 0.054
--Wear Limits	0.20
Camshaft axial clearance	0.05 $\pm$ 0.129
Adjustment shims selection from 3.5 to 4.60 mm. with intervals of:	0.05
Operating clearance	(Intake 0.20 $\pm$ 0.25 (Exhaust 0.30 $\pm$ 0.35
Timing intervals	0.50
Timing Intake Opening before Top Dead Center	40% PMS
Closing after Bottom Dead Center	48% PMI
Exhaust Opening before Bottom Dead Center	54% PMI
Closing after Top Dead Center	26% PMS
Valve operational lift without clearance	(Intake 9.26 (Exhaust 8.64

CAMSHAFTS INSTALLATION

Each camshaft is marked on the timing case side with an ignition timing notch. With the engine at Top Dead Center 1/6 at the flywheel, the reference notches at the 4 camshafts must be aligned with the notches on the caps.

Note: If one or more camshaft is replaced, it is advisable to surface the support seats with reamer $\varnothing 25$ (821 US 4720).

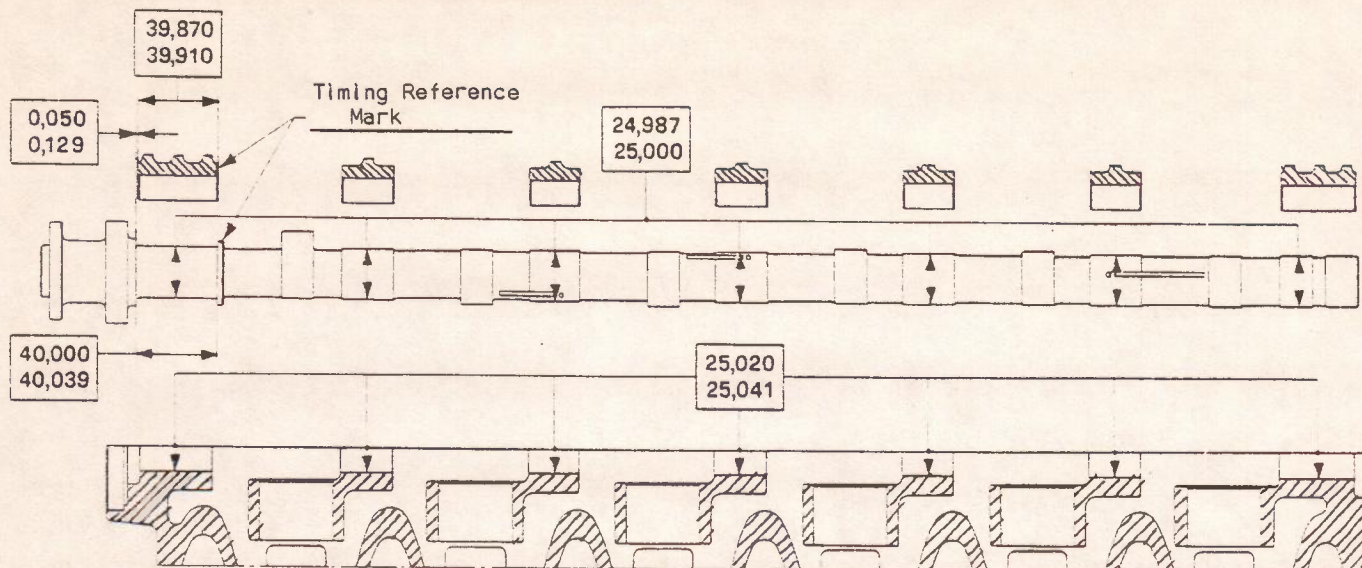


Fig. 12 - Camshafts Main Data

VALVE CLEARANCES CHECK AND ADJUSTMENT

The valves are installed in the cylinder heads in a 46° V layout and are supplied at the outside end with a tappet thimble containing a spacer shim. In order to obtain the exact clearances, shims are available in different thicknesses from 3.25 to 4.60 mm. in intervals of 0.05 mm.

Filing down of the shims is not advised, as their surfaces are specially hardened. Adjust valve and camshaft clearances with a cold engine.

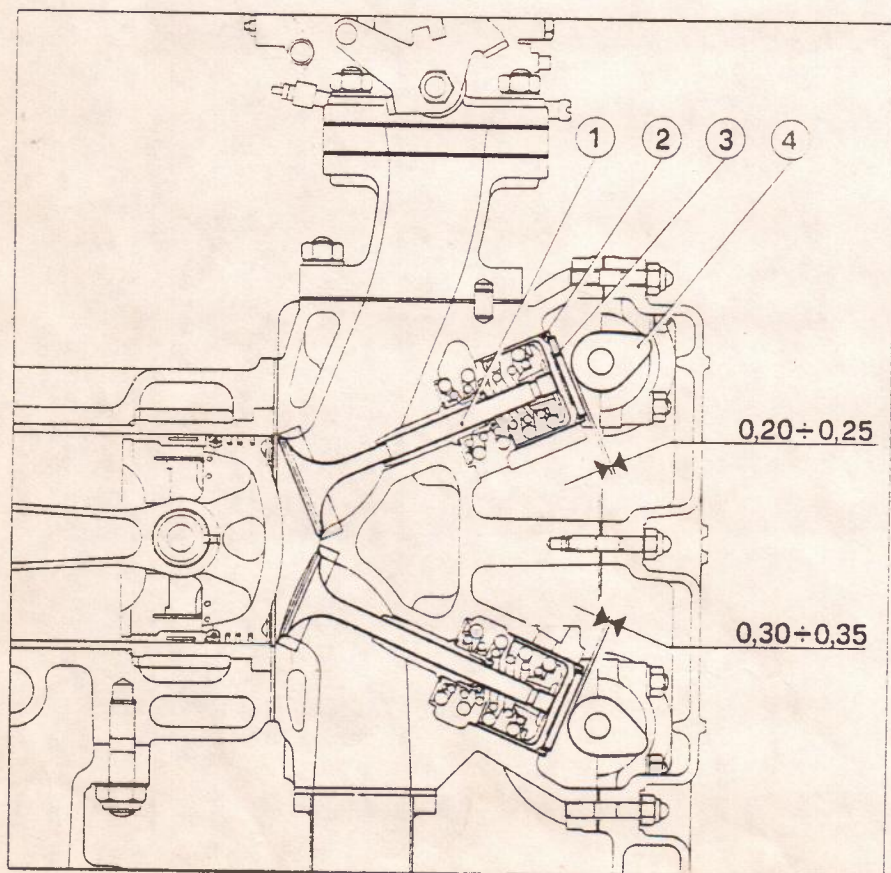


Fig. 13 - Tappet Assembly Check

1-Valve; 2-Valve command assembly; 3-Clearance adjustment shim; 4-Camshaft

TIMING GEAR TOOTHED BELTS

The engine timing is controlled via toothed belts. Their tension adjustment is only required after their replacement.

After initial installation their adjustment must not in any way be altered since this can cause the initial adjustment to be altered quite rapidly. Such alterations or later adjustments, even if limited, can lead to breakage of the belts. Whenever work or repairs to the engine require removal of the belts, they must be replaced.

--Every 15,000 to 20,000 kms., visually check the condition of the belts for wear.

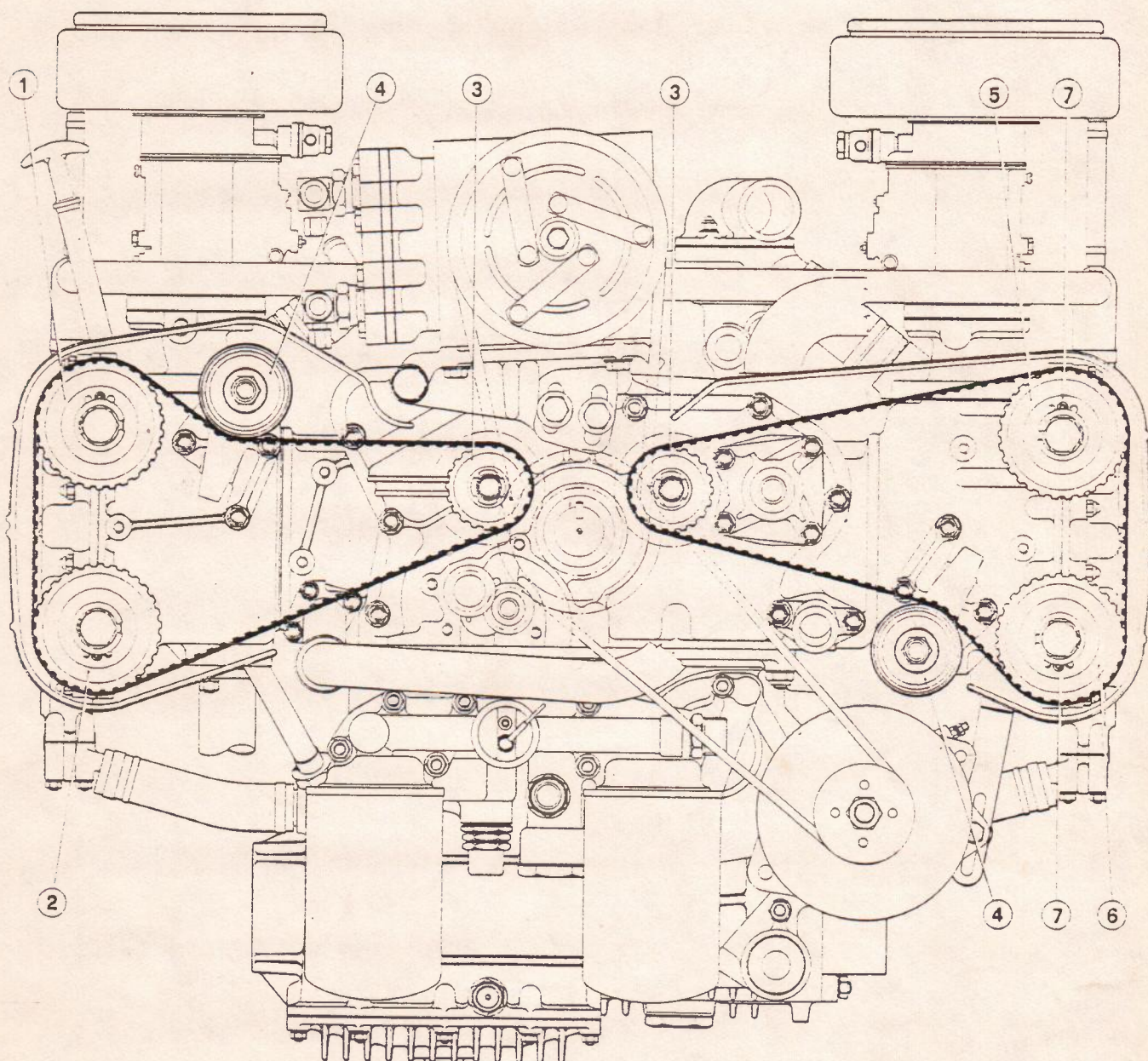


Fig. 14 - Timing Assembly Diagram

1-Intake camshaft drive gear for cylinders 1-2-3-4-5-6; 2-Exhaust camshaft drive gear for cylinders 1-2-3-4-5-6; 3-Centering pin; 4-Chain tensioners; 5-Intake camshaft drive gear for cylinders 7-8-9-10-11-12; 6-Exhaust camshaft drive gear for cylinders 7-8-9-10-11-12; 7-Drag pins.

- At 40,000 kms., closely check the belts. Replace if their condition is doubtful.
- At 60,000 kms., replace the belts.

BELT TENSION ADJUSTMENT

For exact belt tensioning at installation or replacement proceed as follows:

- Turn the engine over to (PMS) Top Dead Center 1/6.
- Loosen tensioner bolts 1 (springs within the tensioner unit will automatically apply the correct tension to the belts).
- Turn the engine over one complete revolution and return to PMS 1/6.
- Tighten down tensioner bolts 1.

Note: Avoid damaging the belts by not folding or squeezing them.

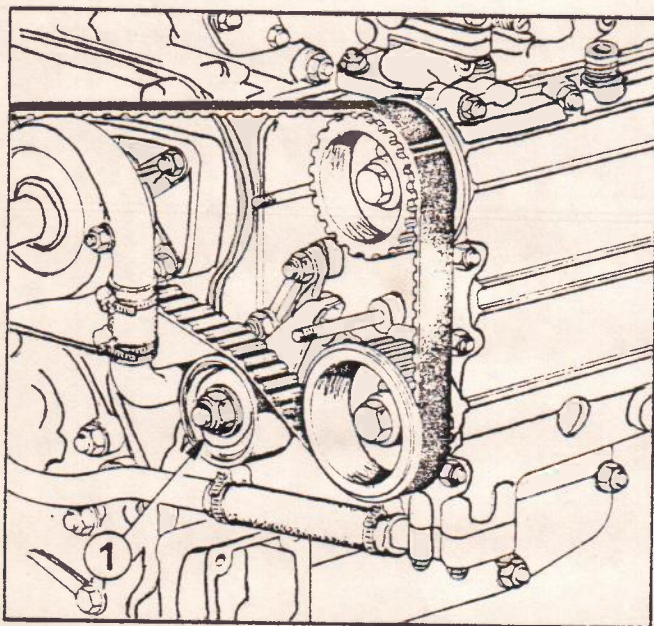


Fig. 15 - Timing Belts
Tensioner
1-Fastening bolt

Note: Pulleys No. dis. 102586 with inside plate guard (engine side) are installed on the right cylinder head exhaust camshaft and on the left cylinder head intake camshaft (Fig. 15).

Pulleys No. dis 102587 with outside plate guard are installed on the right cylinder head intake camshaft and on the left cylinder head exhaust camshaft (Fig. 15).

ENGINE ASSEMBLY AFTER OVERHAUL

NOTE

After each engine overhaul replace all old gaskets and seals with new ones.

--Carry out a careful cleaning of all components especially those equipped with oil passages. Attach the right block half to engine stand AV 778. Install the lower half main journal bearings shells and the split thrust bearings lubricating them with engine oil. Install the crankshaft in the block. Then, after having installed the rest of the main journal bearings shells in the left block half, join the two halves together by tightening the studs to the required torque (table, page 202) using the special extension tool AV 658 where necessary. After fastening the block halves together, the crankshaft should rotate freely and be within specified axial movement clearances. Insert the cylinder sleeves into the block and verify that they extend beyond the cylinder head surfaces according to specifications. Remove them, then install the appropriate retaining rings and re-install the sleeves for final placement. In order to avoid their slippage during engine reassembly, secure them into place with retainer 542-AS-6236. Install the oil seal and flywheel to the rear end of the crankshaft. Attach the timing and oil pump pinion gear to the front end of the crankshaft. Install new bearings for the timing gears in the block.

--Separately rebuild the front case assembly complete with the oil pump, shafts, pulleys, ferrules and timing gears; in addition, the water pumps with pulley and new seals, the crankshaft oil seal and all other related gaskets and block seals. Install this completed assembly onto the block. Fasten the assembly by tightening the two ferrules on the timing drive pulleys to the recommended torques listed on page 202 using tool AV 815. Install timing dial scale AV 810 on the crankshaft.

--Attach the appropriate piston to each connecting rod as illustrated on page 26 (Fig. 6). Install new compression and oil scraper rings making sure that the open ends are about 90° apart from each other. Install the bearings half shells in their proper seats. Even if the older bearings are within the wear limits, it is advisable to replace them at each rebuild in order to shorten the break-in period.

NOTE: All the connecting rods must be of the same weight class. They all should have the same stamped letter indicating their weight class. Their individual weight difference must not exceed 2 grams. Insert the connecting rod-piston units into the sleeves noticing the reference marks.

Lubricate the connecting rod bearings half shells and wrist pins. Tighten each connecting rod bolt to the recommended torque with tool AV 857. (At each engine reassembly it is advisable to replace the connecting rod nuts and bolts.) Make sure that all connecting rods move freely on their wrist pins and that their total end play is within 0.20 : 0.34 mm. Next install the small covers on the upper sides of the block and the oil filler tube.

--Carefully install the two cylinder head gaskets, making sure that all contact surfaces are absolutely clean. Next install the previously rebuilt cylinder heads on the studs. Tighten down the bolts to their specific torques using the sequence in Fig. 16 using tool AV 498.

--Carry out a water seal check using hot water under $8 + 10 \text{ Kg/cm}^2$ pressure.

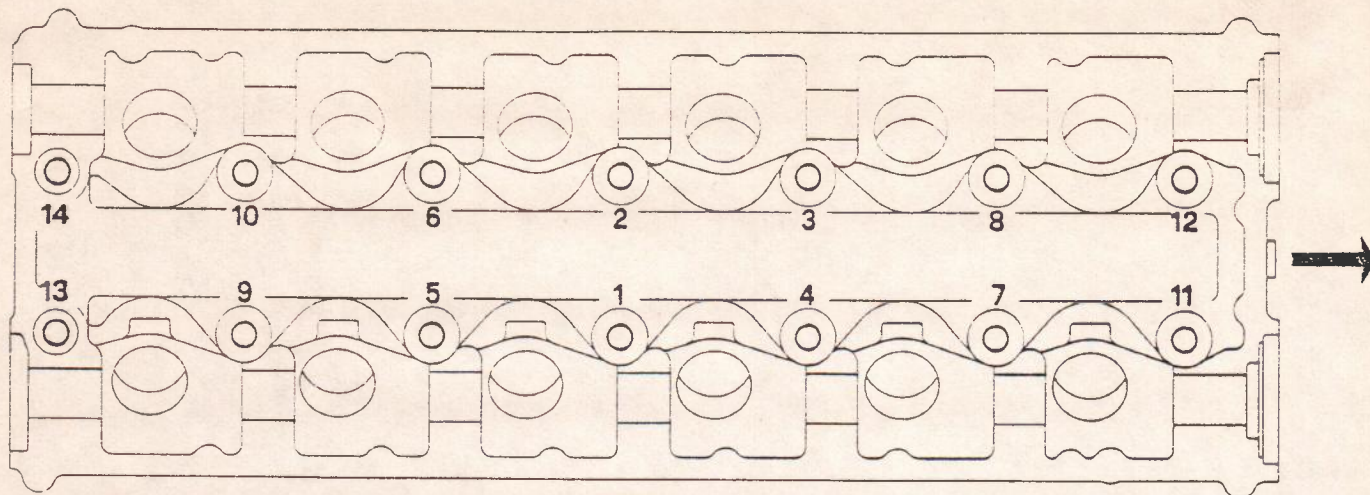


Fig. 16 - Cylinder Heads Tightening Sequence

Check that the cylinder sleeves retaining rings are not leaking.

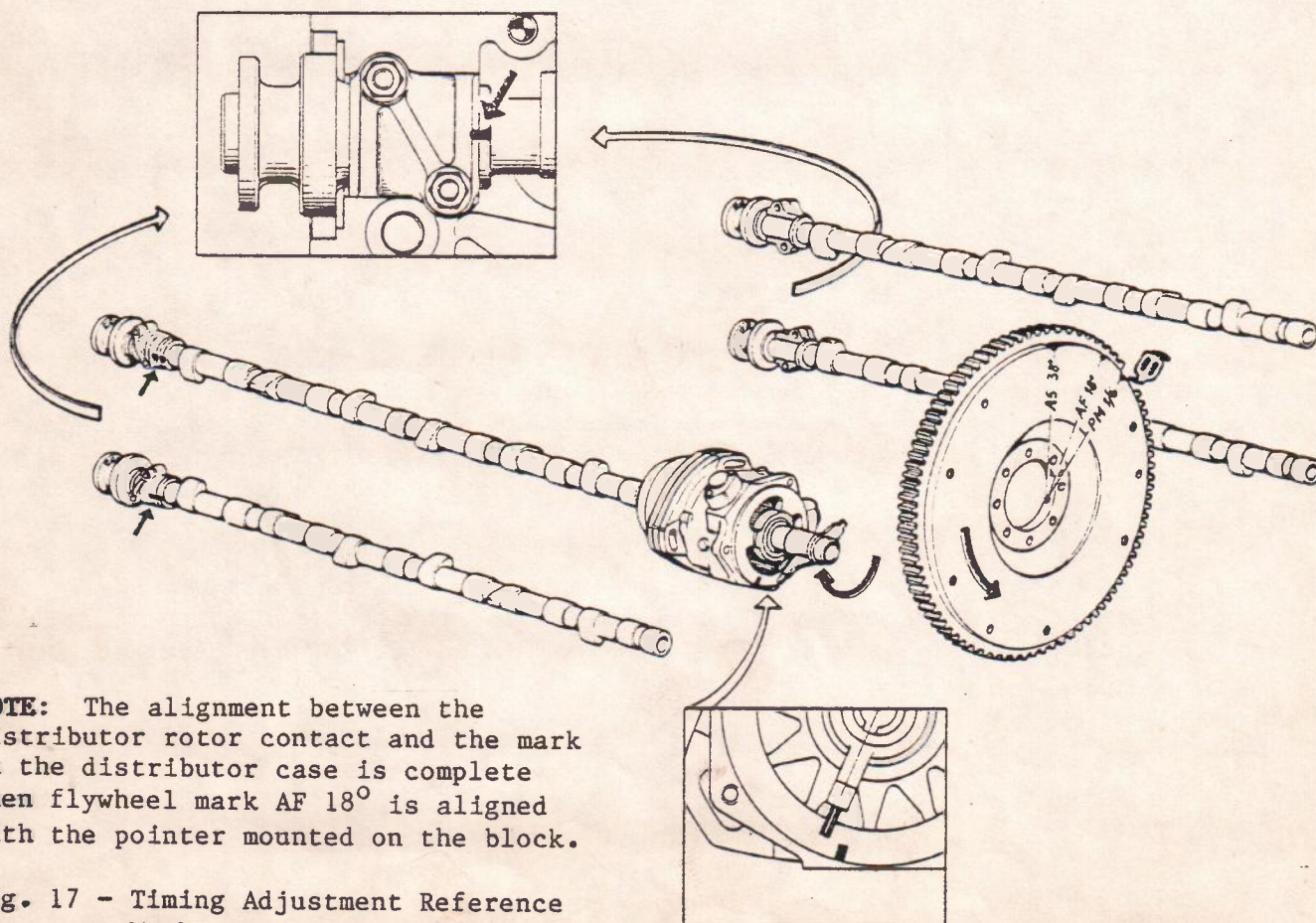
If the pressure remains constant for about 10 minutes the water seal is perfect. Next install the water pump cover.

--Install the air intake collectors with their gaskets.

--Turn the crankshaft over until cylinder No. 1 is at exactly Top Dead Center (PMS) Secure the crankshaft in this position and install the 4 camshafts, making sure that the reference marks stamped on the 4 timing side supports align with the marks stamped on the camshafts.

Install the 4 oil seal rings having previously lubricated them.

--Install on the cylinder heads the two chain tensioners, then install the pulley gears to the camshafts without the drag pins. Install the toothed timing gear belts and adjust them on the gear teeth accordingly, then secure their installation by installing the drag pins.



NOTE: The alignment between the distributor rotor contact and the mark on the distributor case is complete when flywheel mark AF 18° is aligned with the pointer mounted on the block.

Fig. 17 - Timing Adjustment Reference Marks

With the engine at PMS 1/6 loosen the chain tensioner bolts, thus automatically applying the correct belt tension. Slightly turn the crankshaft in its operational rotation one complete turn, while carefully checking the correct positioning of the camshafts. Tighten the chain tensioner bolts. Realign cylinder No. 1 to PMS in the firing phase and using the flywheel markings check that the timing angle adjustments coincide with those in the illustration below.

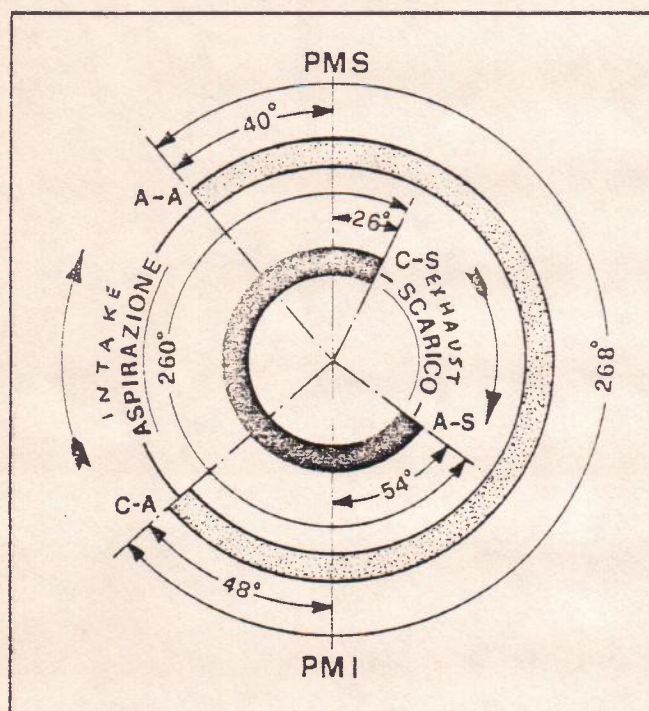


Fig. 18 - Timing Valves Diagram

Tighten pulley bolts to required torque and bend the locking tabs down. Lubricate all engine units with pressure oil pump, making sure that the oil reaches all camshaft lobes and all bearings.

—With a gauge check the clearance at the camshaft lobes and valve adjustment shims and reset if necessary.

NOTE: This last operation may be deleted if the thickness of the adjustment shims (in their final installation) has been predetermined using the special tool 152 CS 7148 which serves to replace the camshafts during engine rebuilding. Zero-set the dial gauge resting it on the flat plate 152 CS 7149. Install the tappets on the valve assemblies with their shims. Mount the gauge in the camshaft supports and check the clearance between the shims and the gauge spindle. This operation will indicate the appropriate shim thickness required.

—Install the carburetors and control shafts. Install the cylinder head valve cover, the timing case covers, the small side covers for the vacuum assist auxiliary pump, the thermostat valve and its related tubings, and the torsional dampener by tightening the fastening bolt with tool 476 to the required torque.

TIMING CLEARANCES		
Intake	0.50 mm.	
Exhaust	0.50 mm.	
Intake	Opening starts before PMS	40%
	Closing starts after PMI	48%
Exhaust	Opening starts before PMI	54%
	Closing starts after PMS	26%

OPERATING CLEARANCES	
Intake	0.20 + 0.25 mm.
Exhaust	0.30 + 0.35 mm.

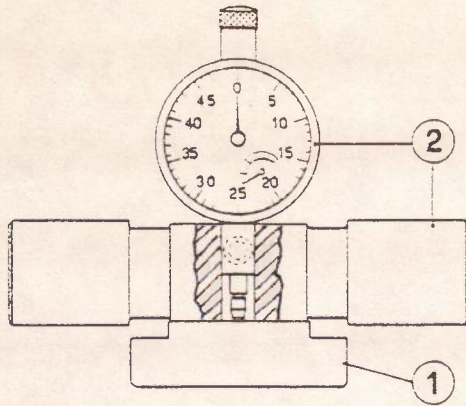


Fig. 19 - Zero-Setting of the Gauge

1-Flat plate 152 CS 7149
2-Gauge 152 CS 7148

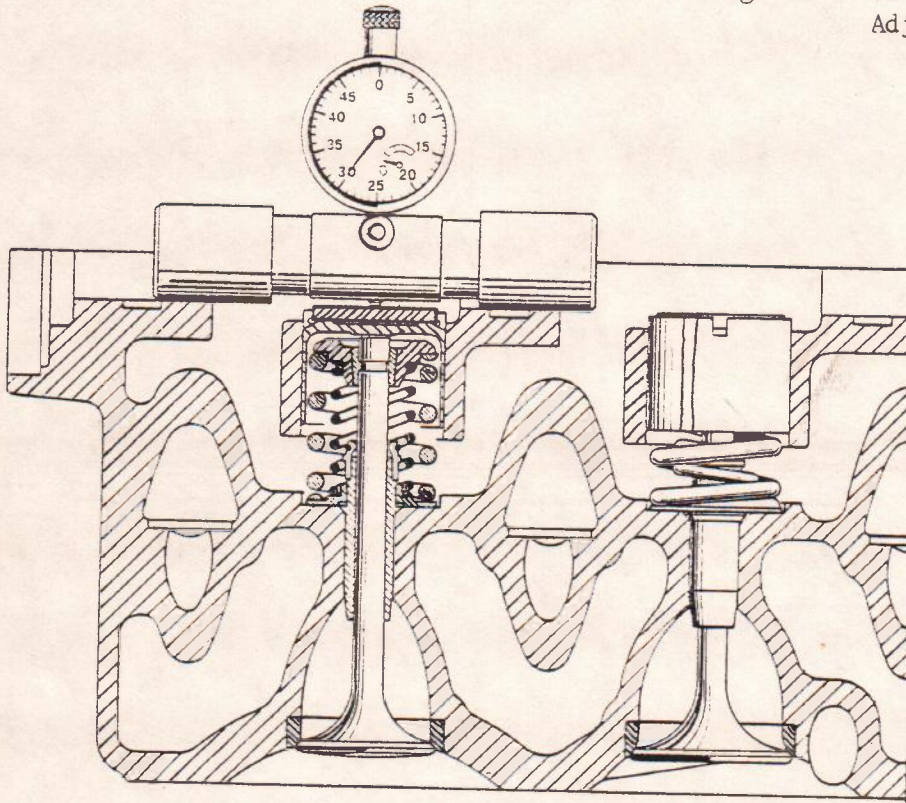


Fig. 20 - Valve Clearance Adjustment

Attach the engine to the gear box together with the oil sump, then install the oil pump intake tube onto it.

NOTE: When bench testing the engine the gear box must be attached, but without the clutch assembly.

IGNITION TIMING

In order to time the ignition timing system observe the following sequence:

—Make sure that the distributor has been adjusted to the specifications listed on page 181.

—Turn the crankshaft in its operational direction until reference mark AF 18° stamped on the flywheel aligns with the fixed reference pointer mounted on the block and cylinder No. 1 is in the firing phase (Note: do not rotate the crankshaft in the opposite direction in order not to loosen the toothed timing belts). Rotate the distributor shaft until the rotor aligns with cylinder No. 1 notch (stamped on the distributor case).

—Tighten down the distributor bolts approximately half-way in the clamp slots.

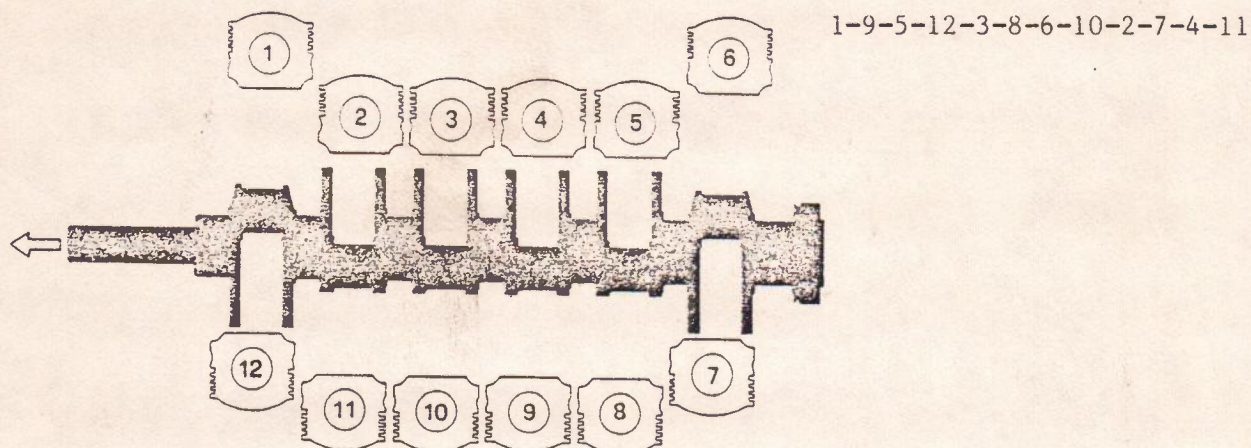
--Connect a strobe timing light to cylinder No. 1 and with the engine running at idle (800 $\rightarrow$ 1000 rpm) make sure that the light is activated when reference mark AF 18° aligns with the fixed pointer.

If alignment does not occur, lightly rotate the distributor with a small hammer until alignment is achieved. At this point fasten down the bolts.

--Increase engine rpm to 5,000.

Now check that the strobe light is activated when reference mark A5- 38° , which corresponds to advance value of 38° at 5,000 rpm, aligns with the fixed pointer.

Fig. 21- Firing Sequence



BENCH TESTING AND RUNNING-IN

After the assembly operations are completed, mount the engine on a test stand to break-in all working surfaces, for timing operations, and to check the power output and the fuel and oil consumption.

Carry out the following operations.

--Fill the sump the required amount of oil.

--Run the engine at 1500 rpm for 5 minutes in order to check for water and oil circulation, and any leakages.

--Check and adjust ignition spark timing at $37^{\circ} \rightarrow 38^{\circ}$ at 5000 rpm.

--Run the engine for an additional 40 minutes at 5,700 rpm with a brake load of 31 Kg. (HP 177). Towards the end of the test time bring up the oil temperature to 100° C and check that pressure is $6.0 \rightarrow 7.0$ Kg/cm².

Stop the engine and after 5 minutes check the sump oil level. Fill with oil up to the required level, recording the amount added. As oil consumption per hour is $0.250 \rightarrow 0.350$ Kg., consumption should be $1.41 \rightarrow 2.00$ grams per hp/hour.

--Carry out a power operation with the accelerator controls fully open, beginning at 2,000 rpm and ending at 7,500 rpm, with increments of 1,000 rpm. At 5,000 and 7,000 rpm, check fuel consumption. Normal consumption is 230 grams per hp/hour at 5,000 rpm and 240 grams per hp/hour at 7,000 rpm.

Without altering the brake load adjustment at 7,000 rpm, gradually release the accelerator controls until the engine is at 5,000 rpm then rechecking fuel consumption. Normal consumption is 230 grams per hp/hour.

--With a carburetor adjustment tool, adjust all carburetors without removing the exhaust tubes.

--Consult the fuel injection manual for final adjustments (512 i).

--Carry out a general overall check for any possible fluid leaks.

LUBRICATION

COOLING

FUEL SYSTEM

	PAGE
LUBRICATION	49
GENERAL SPECIFICATIONS	49
OIL PUMP	50
CRANKCASE EMISSION CONTROL	52
COOLING SYSTEM	53
MAIN DATA	53
RADIATOR	53
WATER PUMP	55
THERMOSTATIC VALVE	55
EXPANSION TANK	56
REFURNISHING THE COOLING CIRCUIT	56
ELECTRIC FANS	56
WINTER OPERATION MAINTENANCE	57
FUEL SYSTEM	59
AIR FILTERS	59
FUEL PUMP	59
CARBURETORS	60
DIAGNOSING FAULTS AND RELATED REMEDIES	61
CARBURETOR OPERATION	63
CARBURETOR ADJUSTMENT DATA	65
CARBURETOR TIMING ADJUSTMENT	66
CARBURETOR MODIFICATIONS (365)	66
FUEL INJECTION SYSTEM (512 BBi)	67
MAINTENANCE AND ADJUSTMENT	67

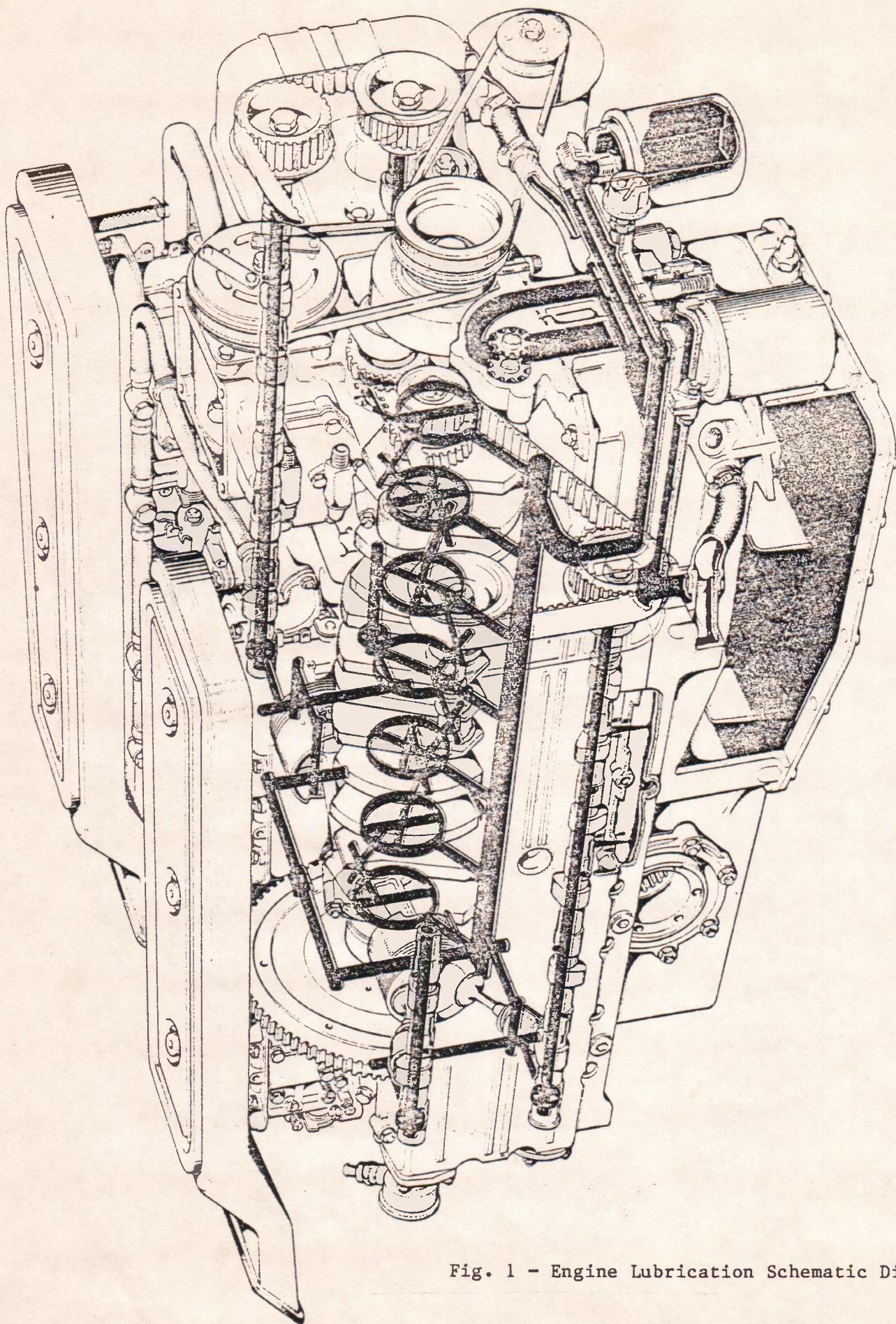


Fig. 1 - Engine Lubrication Schematic Diagram

LUBRICATION

MAIN DATA.....	49
DESCRIPTION.....	50
PRESSURE AND TEMPERATURE.....	50
MAINTENANCE.....	50
USE OF NON-PRESCRIBED OILS—PRECAUTIONS.....	50
OIL PUMP.....	50
CLEANING AND MAINTENANCE.....	50
CRANKCASE EMISSIONS CONTROL.....	52

MAIN DATA

INDIVIDUAL UNITS	mm.
Drive/driven gears outside diameter	35.975 $\pm$ 35.991
Pump body gear housing diameter	36.075 $\pm$ 36.100
Gears external diameter/pump body clearance	0.042 $\pm$ 0.062
Drive/driven gears height	37.959 $\pm$ 37.980
Pump body depth	38.070 $\pm$ 38.100
Installation axial clearance	0.090 $\pm$ 0.141
Engagement clearance	0.2
Driven gear bushing internal diameter (mounted)	12.027 $\pm$ 12.050
Driven gear shaft diameter	12.007 $\pm$ 12.018
Radial clearance between driven gear and shaft	0.009 $\pm$ 0.043
Driven gear bushing seat diameter	15.000 $\pm$ 15.018
Bushing outside diameter	15.021 $\pm$ 15.036
Bushing-gear installation interference	0.003 $\pm$ 0.036
Drive gear shaft diameters	14.976 $\pm$ 14.994
Drive gear bushing internal diameter (mounted)	15.015 $\pm$ 15.027
Installation radial clearance	0.021 $\pm$ 0.051
Wear limits	0.08
Bushing outside diameter	18.018 $\pm$ 18.036
Pump body bushing seat diameter	18.000 $\pm$ 18.018
Installation interference	0.000 $\pm$ 0.036
Drive gear/engine crankshaft engagement clearance	0.040 $\pm$ 0.060

DESCRIPTION

Engine lubrication is of the pressure type with a gear-driven pump. The pump is located at the front cover of the block and is actuated by the engine crankshaft via a system of gears.

In addition, the lubrication system is made up of:

- A screened filter oil pickup mounted on the sump.
- Two full circulation filters installed on a support mounted on the oil sump
- A pressure-regulating valve.
- A heat exchanger installed in the delivery circuit (365 - to chassis no. 17865).
- A thermostatic valve impeding the flow of cold oil to the heat exchanger at temperatures lower than 75° C (365 - to chassis no. 17865).
- An electric oil pressure sending unit.
- An electric oil temperature sending unit.

PRESSURE AND TEMPERATURE

In normal operating conditions, the pressure must be 6 - 7 Kg/cm² with engine rpm at 6000 and oil temperature at 100° C.

NOTE

If with the engine running at the above speed and temperature, the pressure is less than 4.5 Kg/cm², engine revolutions should be diminished at least 1000 rpm and the cause of the low pressure investigated.

In case the temperature indicator surpasses 130° C. it will be necessary to reduce engine operation rpm.

MAINTENANCE

Check the oil level every 500 km. and oil temperature at 60° ÷ 70°, waiting a few minutes after stopping the engine.

Every 5000 km. or 6 months, whichever comes first, change oil and filter.

USE OF NON-PRESCRIBED OILS - PRECAUTIONS

Should for any reason other brands of oil be used, the following procedure is recommended:

- Thoroughly drain the oil after having warmed up the engine.
- Add 7 liters of the desired oil into the sump and warm it by running the engine at 2000 - 3000 rpm for 10-15 minutes.
- Add the maximum amount of oil required of the prescribed weight and replace along with the filters every 5000 km.

OIL PUMP

CLEANING AND MAINTENANCE

- Accurately examine the pump housing and cover; replace these if cracks or excessive wear is noted.
- Check that the intake tube and the pump oil sending tubing is not partially obstructed; force clean with compressed air.
- Examine the gears, the driving, the driven and the control units; if any traces of gear teeth deterioration or excessive shaft wear are noticed, replace the units.

--The operating clearance between the engaged gears is 0.2 mm.; adjust this clearance if necessary. Maximum allowable clearance is $0.30 \div 0.35$ mm. A larger clearance indicates replacement of the gears.

--Check the clearance between the gear edges and the gear housing with a thickness gauge. Assembly clearance is $0.042 \div 0.062$ mm.

Check the clearance between the gear face and the pump cover support surface. Assembly clearance is $0.090 \div 0.141$.

If it exceeds 0.15 mm. it is necessary to replace the gear or the pump body.

--Check the condition of the pump body and the driving gear pump cover bushings, also the bushings inside the driven gear housing.

--Check the condition of the gear shafts. If they show evidence of seizing, replace them.

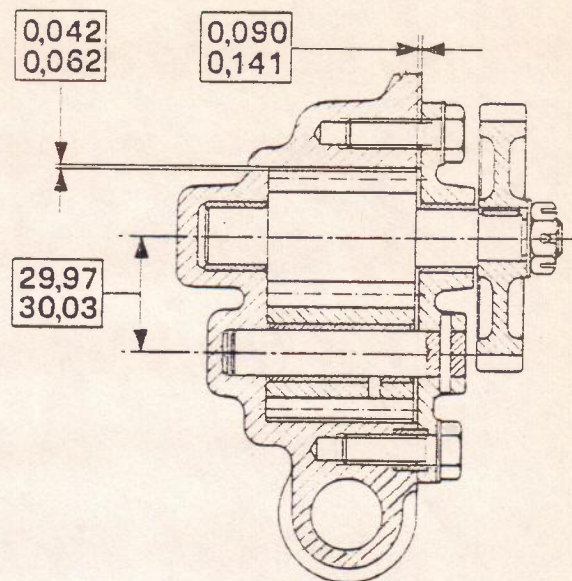


Fig. 2 - Oil Pump Diagram

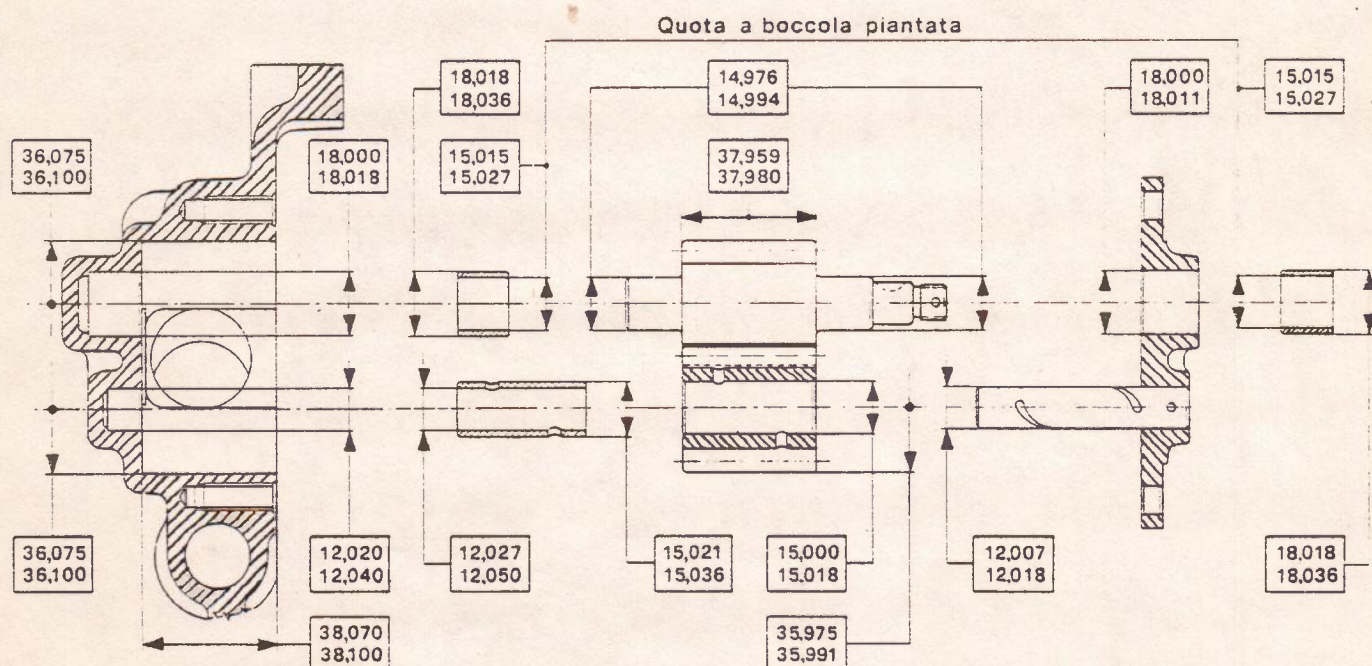


Fig. 3 - Oil Pump Components Assembly Main Data

CRANKCASE EMISSION CONTROL (CEC)

The system illustrated in Fig. 4 is designed to reduce atmospheric pollution. Gas and oil vapors from the engine block are routed through the intake collectors, to the cylinders and combusted there.

Every 20,000 km. have the CEC system cleaned and flushed with the proper solution.

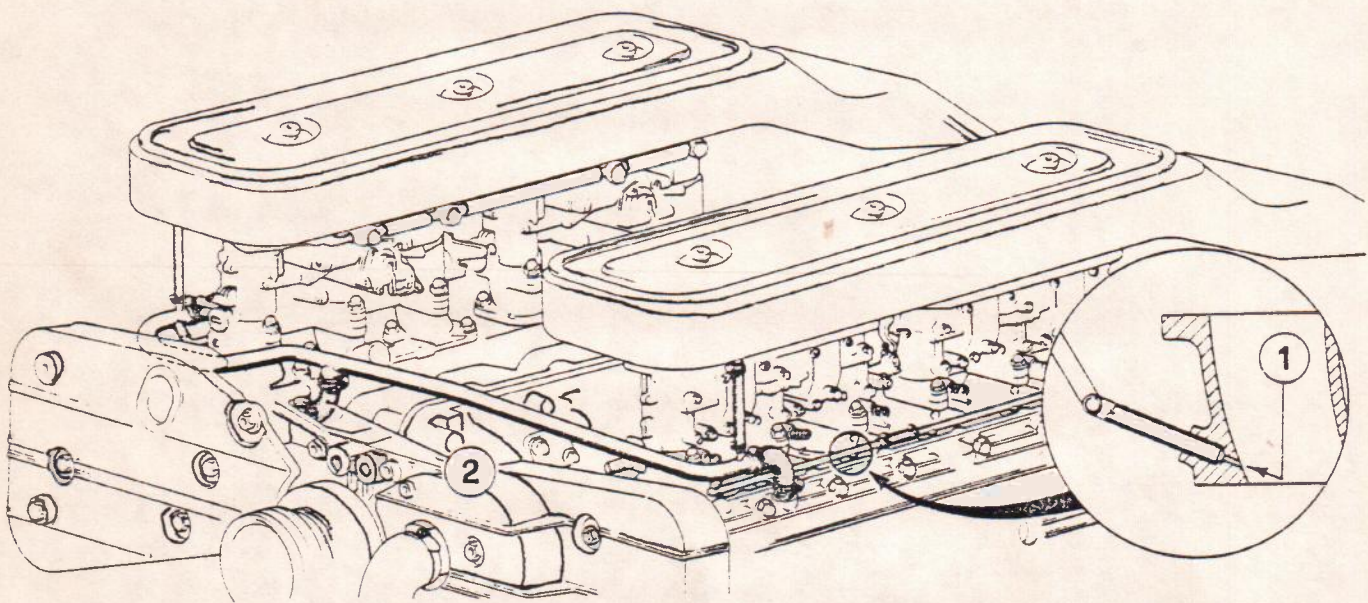


Fig. 4 - Crankcase Emissions Control System

1-Calibrated tubes 1 mm. $\varnothing$; 2-Crankcase exhaust pipe.

MAIN DATA.....	53
DESCRIPTION.....	53
RADIATOR.....	53
WATER PUMP.....	55
CLEANING AND MAINTENANCE.....	55
THERMOSTATIC VALVE.....	55
EXPANSION TANK.....	56
REFURNISHING THE COOLING CIRCUIT.....	56
ELECTRIC FANS.....	56
WINTER OPERATION.....	57
365 - 512 MODIFICATIONS.....	57

MAIN DATA

INDIVIDUAL UNITS	mm.
Maximum pressure	0.9 Kg/cm ²
Maximum temperature	115°C
Radiator fans operational interval	85° ÷ 76° C
Thermostatic valve opening	80° ÷ 85° C
WATER PUMP	
Rotating diameter	84.5 ÷ 84.7
Pump body/vane assembly diameter	0.3 ÷ 0.5
Vane assembly blades/front cover clearance	0.9 ÷ 1.2
Vane assembly/pump body clearance	0.9 ÷ 1
Ball bearings radial clearance (Wear limits)	0.03
Ball bearings axial clearance (Wear limits)	0.05

DESCRIPTION

The cooling of the engine is accomplished by a pressure-circulated water and antifreeze mixture via gear connected to the engine crankshaft.

In addition, the cooling system is made up of the units listed in Fig. 5.

RADIATOR

The radiator, of the horizontal tube type, is fitted at the upper end with an air-bleed valve for use when filling the cooling system or when problems due to defective circulation arise.

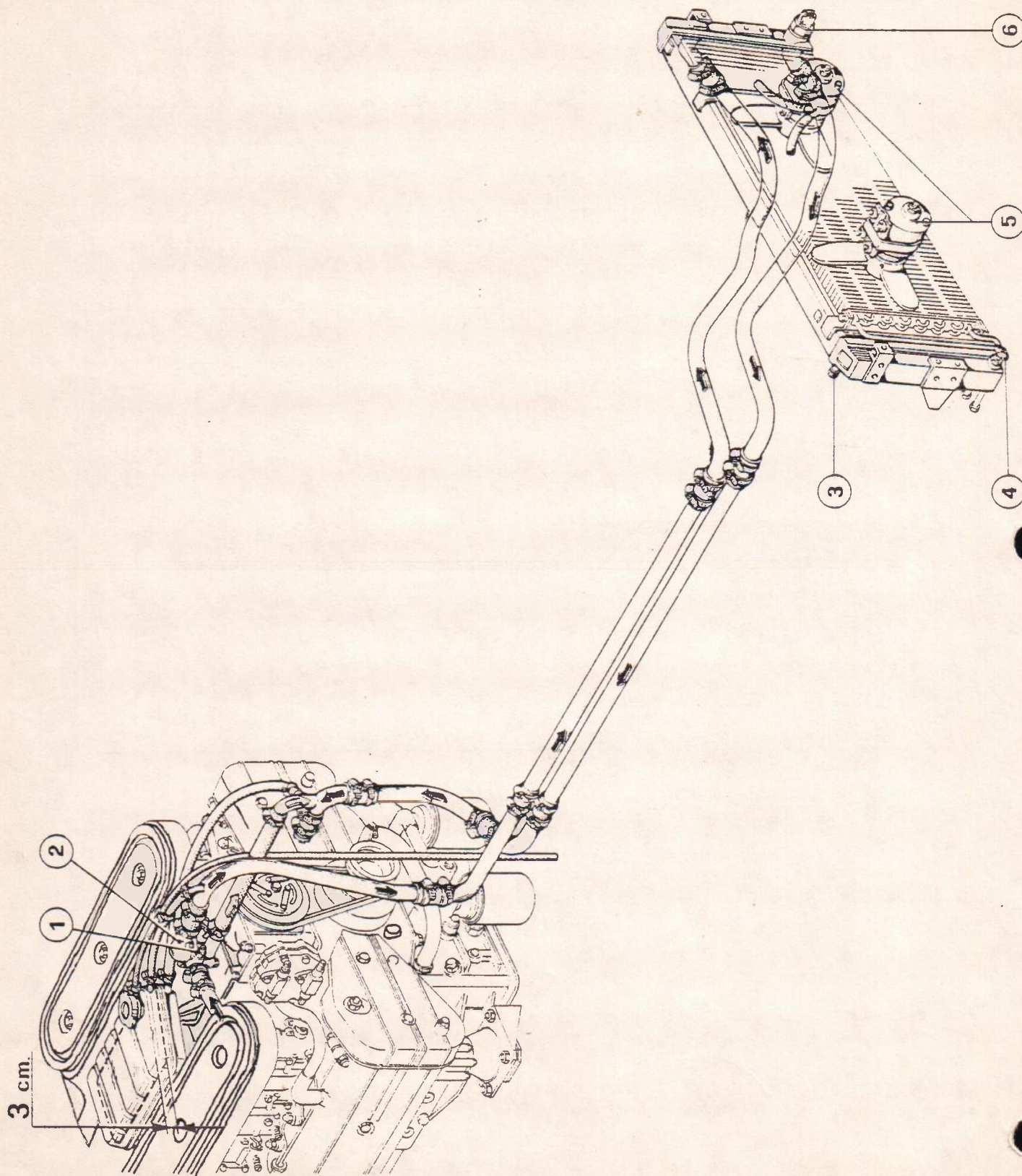
In the lower part of the radiator is fitted a temperature sensitive switch which actuates the electric fans when the temperature reaches 75° ÷ 85° C.

NOTE

It is absolutely necessary never to install any accessories in the lower front part of the vehicle which could in any way impede the flow of cooling air to the radiator.

Fig. 5 - Cooling System Diagram

1-Water temperature measurement point; 2-Thermostatic valve; 3-Air-bleed valve; 4-Water drain tap; 5-Electric fans; 6-Temperature sensitive switch



WATER PUMP

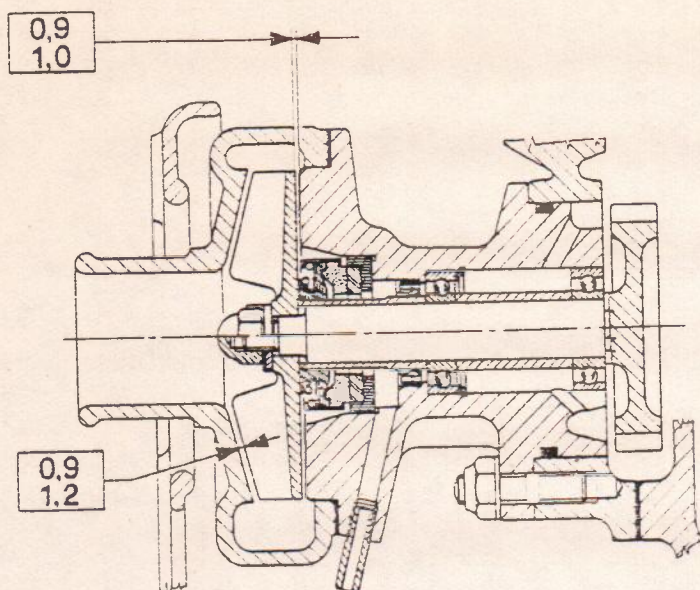


Fig. 6 Water Pump Sectional Diagram

CLEANING AND MAINTENANCE

- Remove calcareous deposits from the pump case and cover and examine for seizure or score marks.
- Check that the vane assembly does not vibrate on the shaft, that the vanes have not been damaged by foreign matter and that it is perpendicularly aligned on the shaft.
- Check bearing rotation and for noise. Check radial and axial clearances.
- It is advisable to replace the water and oil seal gaskets with each engine rebuild and each time that they are removed from their seats.
- Check the condition of the pump cover rubber seal and blow the water passage clear.
- Make sure that the bearings are firmly seated on the shaft and in their seats in the pump case.

THERMOSTATIC VALVE

The thermostatic valve is located at the front of the cylinder heads. It is actuated when the cooling mixture reaches a temperature of $80^{\circ} - 85^{\circ} \text{ C}$.

NOTE

Any delay in reaching engine operating temperature must be attributed to faulty operation or blockage of the thermostatic valve.

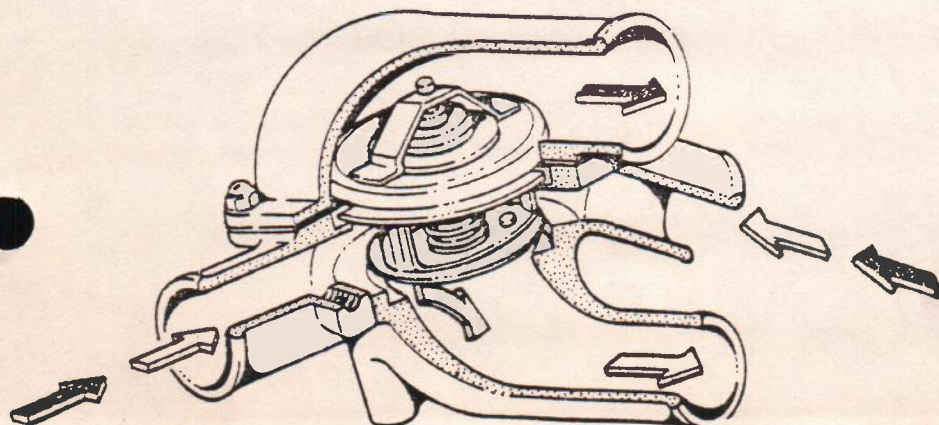


Fig. 7 - Thermostatic Valve

← Cold water circuit with temperature below $80^{\circ} - 85^{\circ} \text{ C}$. (Valve closed)

← Hot water circuit with temperature above $80^{\circ} - 85^{\circ} \text{ C}$. (Valve open)

EXPANSION TANK

The tank takes care of changes in volume and pressure of the mixture which occur during engine heating; it is supplied with a pressure cap located at the top and rated at 0.9 kg/cm² and via which the cooling system should be filled. Regularly check the mixture level in the tank when the engine is cold.

The mixture level in the tank should always be 3 cm. below the filler plug base (see Fig. 5).

REFURNISHING THE COOLING CIRCUIT

This operation is carried out via the expansion tank.

During this operation keep the bleed-valve located at the upper end of the radiator open.

After refilling has been completed it will be necessary to carry out a bleeding of the above-mentioned valve by opening it completely until the coolant flows steadily. In order to avoid losing the coolant it is advisable to connect a tube of the appropriate length from the radiator bleed-valve to the tank pressure cap.

Carry out this operation with a warm engine and with the thermostatic valve in open position.

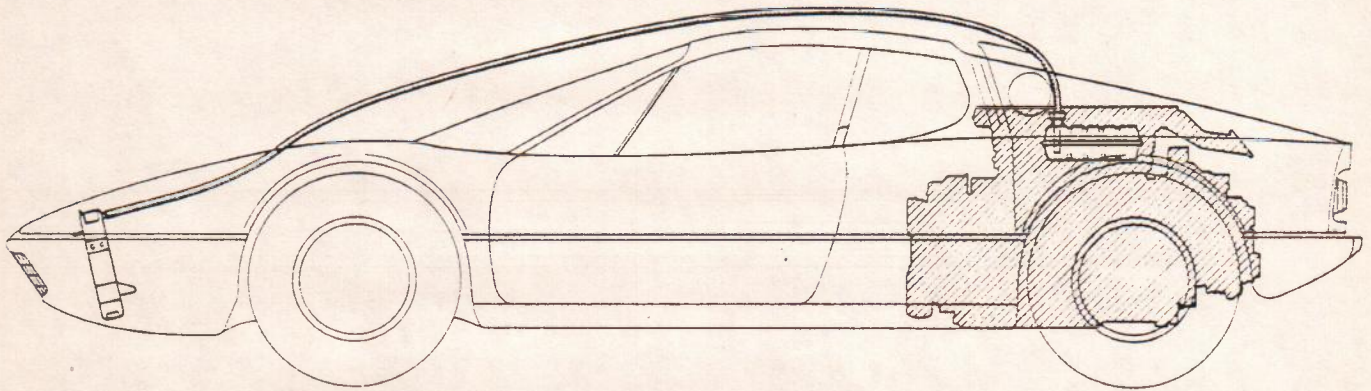


Fig. 8 - Bleeding the Cooling System

ELECTRIC FANS

Two electric fans are located in front of the radiator for cooling the radiator and the air condition system condenser.

When switching on the air conditioner, the right hand electric fan automatically starts until the air conditioner is switched off, unless the water temperature is above 85° C.

With the air conditioner not switched on, both fans will turn on if the water temperature is above 85° C. and will turn off once the temperature is below 76° C.

WINTER OPERATION MAINTENANCE

When outside temperature drops towards 0°C ., it is necessary to check the antifreeze mixture according to the specifications listed below. Failure to do so could result in serious damage to the engine.

TEMPERATURE	ANTIFREEZE MIXTURE IN LITERS
-15°C . ($+5^{\circ}\text{F}$)	7
-30°C . (-22°F)	8.5

WARNING

If during engine operation excessive coolant temperature occurs, proceed as follows: Check the antifreeze mixture level and amount, the thermostatic valve 2 (Fig. 5), the thermo-contact switch 6, the fans 5 and the operation of the water pump.

365 - 512 MODIFICATIONS

THERMOSTATIC VALVE

In view of reducing the vibrations in the cooling water circulation system, it is recommended that two holes of $3.5 \div 4$ mm. in diameter be drilled in the thermostatic valve plates, as shown in Fig. 9.

The orientation of the holes during installation is not critical.

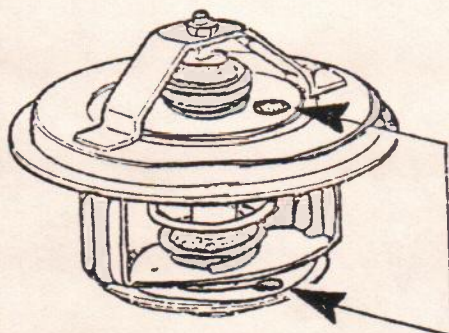


Fig. 9 - Thermostatic Valve Modification

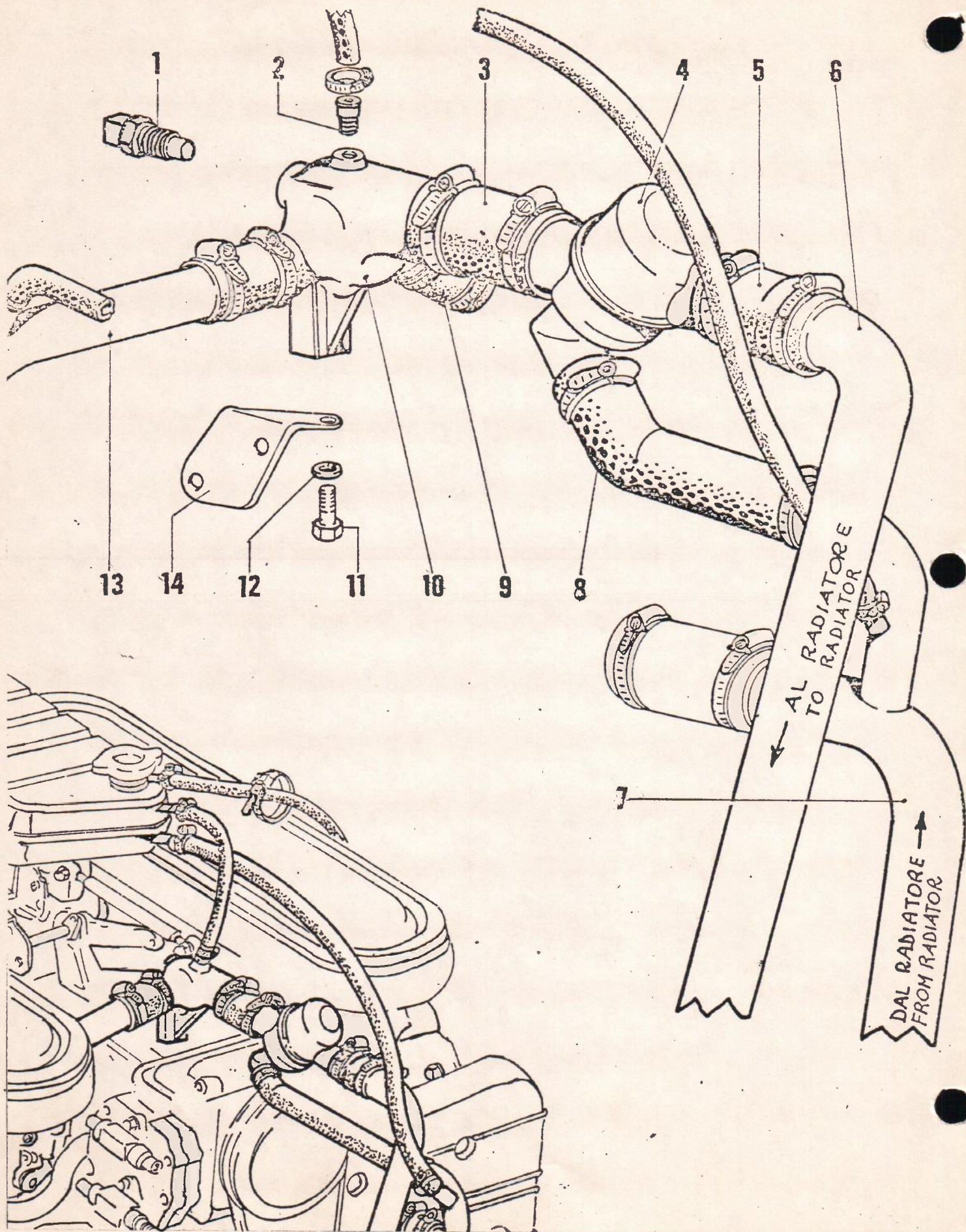
Two holes = $3.5 - 4$ mm. $\varnothing$.

COOLING SYSTEM TUBING - 512

Starting from car chassis no. 22299 the cooling system has been modified according to Fig. 10.

Should you experience problems with water circulation or with vibrations of the pipes on the 512 or the 365 models with earlier chassis numbers, it is advisable to modify the cooling system as shown.

Fig. 10 - Cooling System Modification



FUEL SYSTEM

MAIN DATA.....	.59
FILTERS AND AIR INTAKES.....	.59
REPLACEMENT OF THE AIR FILTERS.....	.59
FUEL PUMPS AND FILTERS.....	.59
WEBER CARBURETORS 40 IF 3C/1-2-3-4.....	.60
DIAGNOSING FAULTS AND RELATED REMEDIES.....	.61
OPERATION.....	.63
CARBURETORS ADJUSTMENT DATA.....	.63
365 MODIFICATIONS.....	.66
FUEL INJECTION SYSTEM.....	.67
MAINTENANCE AND ADJUSTMENT.....	.67

MAIN DATA

UNITS	
FUEL PUMPS	
Voltage	12
Amperage draw	1.5 + 0.2
Delivery	100 liters per hour
Pressure	3 + 0.5 m. H ₂ O

FILTERS AND AIR INTAKES

Each bank of cylinders is equipped with its own air intake, each having its own filter, attached to the carburetor cover.

Always ensure a tight fit of the air intake covers over the filters.

Also check that the aluminum guide located at the bottom of the filter case is not damaged or bent, thus avoiding passage of impurities into the carburetors.

REPLACEMENT OF THE AIR FILTERS

--In order to safeguard engine operation it is necessary that the filters be removed frequently from the case for cleaning or replacement.

Every 10,000 km. wash them with gasoline and blow dry with compressed air from the inside outwards (365, 512).

Every 20,000 km., replace both filters (365, 512).

Every 10,000 km., replace both filters (512i).

FUEL FILTERS AND PUMPS

The carburetors are supplied with fuel via two Corona pumps, pressure-rated at 2.5 + 3.5 meters H₂O.

The delivery circuit is also supplied with two filters, one mounted directly on the fuel tanks pickup tube and the other FISPA type is equipped with a filter element which may be inspected and replaced.

Other smaller filters are installed in the carburetors delivery tubes connections.

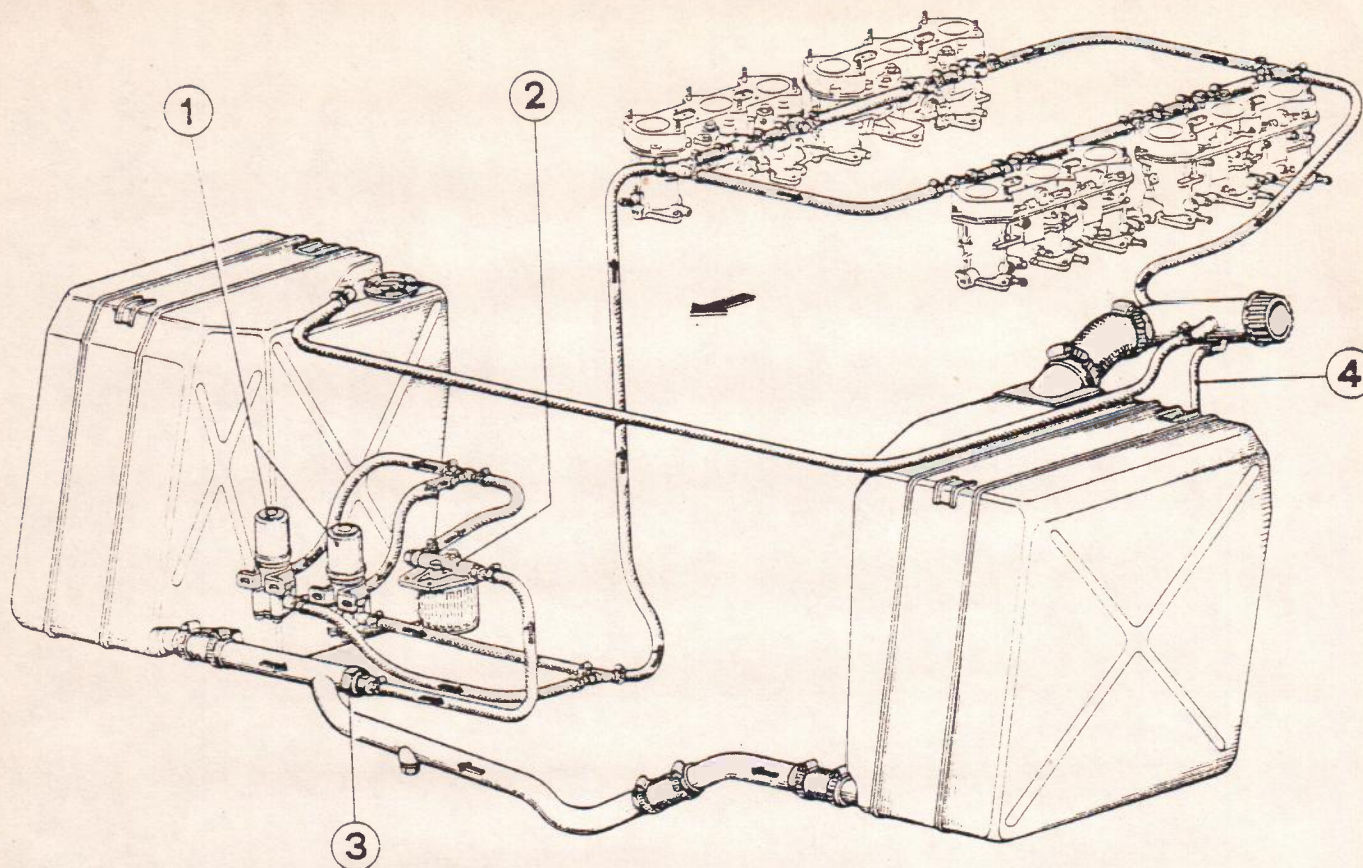


Fig. 11 - Fuel Delivery System Diagram

1-Corona electric pumps; 2-FISPA filter; 3-Filter; 4-Fuel filter neck vent tube

WEBER CARBURETORS 40 IF 3C/1-2-3-4 (365)

40 IF 3C/9-10-11-12 (512)

The engine is supplied with fuel by four, three-barrel carburetors each equipped with a diaphragm-type acceleration pump and two fuel intake passages protected by filters. Each carburetor has its own fuel delivery which feeds one cylinder each.

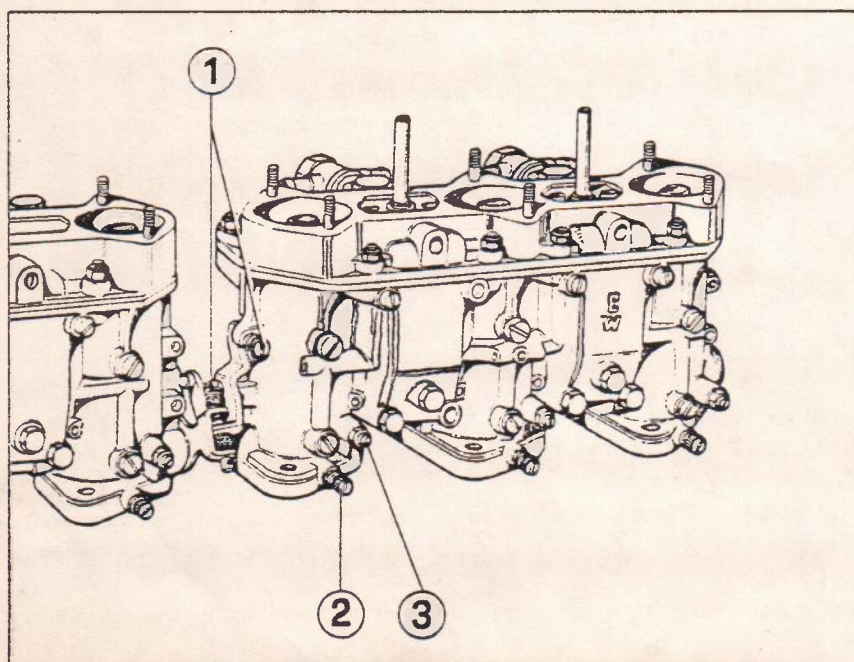


Fig. 12 - Carburetor

- 1-Throttle opening adjusting screw;
- 2-Idle operation mixture adjustment screw
- 3-By-pass tubing vacuum balance adjustment screw

DIAGNOSING FAULTS AND RELATED REMEDIES

ENGINE WILL NOT START (WITH COLD ENGINE)

Possible Causes	Remedies
1) Obstruction in main delivery jets.	1) Dismantle and clean jets.
2) Fuel does not reach carburetor.	2) Check pumps filters operation and whether tanks are empty.

ENGINE WILL NOT START (WITH WARM ENGINE)

Possible Causes	Remedies
1) Faulty idle speed adjustment.	1) Adjust the idle speed unit.
2) Engine overheating causes rapid evaporation of the fuel in the carburetor bowls, with the vapors trapped in the delivery tubes causing a vapor block.	2) Start engine while pressing accelerator pedal fully until the vapor blockage is eliminated.

IRREGULAR IDLE SPEED

Possible Causes	Remedies
1) Air leaks between the carburetors and the intake tubes gaskets.	1) Tighten the carburetor fastening nuts, check that the carburetor mounting flanges are not deformed.
2) Idle jets clogged or loose.	2) Remove jets and blow clean along with related internal tubing.
3) Butterfly throttle valves do not return to idle position due to sticking of the shaft or of existence of free play in the control joints.	3) Check the acceleration control levers alignments. Check that the throttle valve guide shafts rotate freely.

FLOODING AND LOSS OF FUEL

Possible Causes	Remedies
1) Improper seating of needle valve due to wear or dirt.	1) Check for clean surfaces, or replace needle valve.
2) Damaged float (bent or perforated).	2) Replace float.
3) Uneven fuel levels in a carburetor.	3) Proceed to level check as indicated.
4) Seizure or friction which impede smooth movement of float.	4) Check.
5) Abnormal fuel pump pressure.	5) Check.

ENGINE LACKS PICKUP AND TOP SPEED

Possible Causes	Remedies
1) Incorrect fuel level in one or more carburetors.	1) Adjust level according to instructions.
2) Faulty synchronization of carburetor controls	2) Check synchronization with proper instrument.
3) Faulty adjustment of carburetor operation with butterfly throttle valve partially open.	3) Check.
4) Incomplete opening of butterfly throttle valves under full acceleration.	4) Check.
5) Clogged fuel filters (pump filters, tanks, and carburetors).	5) Clean accurately.

EXCESSIVE FUEL CONSUMPTION

Possible Causes	Remedies
1) Imperfect seating of a needle valve.	1) Replace the valve.
2) Deformed or damaged float.	2) Replace the float.
3) Faulty gas level.	3) Adjust level.
4) Altered or loose fast running jets.	4) Check and eventually replace.
5) Incorrect air correction jets.	5) Check and eventually replace.
6) Clogged air intake filter element.	6) Wash with gas and blow dry from the inside. Eventually replace.

BACKFIRING WHEN RELEASING ACCELERATION PEDAL

Possible Causes	Remedies
1) Irregular or faulty adjustment of idle speed circuits, lean mixture.	1) Adjust idle circuits of each carburetor.
2) Unsynchronized carburetor throttle openings.	2) Synchronize all carburetors.
3) Lean carburetion with throttle plates slightly open.	3) Check carburetion at 1500 RPMs.
4) Clogged progression jet(s).	4) Check.
5) Carburetor fuel level low.	5) Bring up to prescribed level.
6) Worn or wrong type of spark plug.	6) Replace with correct type/range of spark plugs.
7) Air leak in exhaust intake tubes.	7) Plug up any air leak.
8) Faulty adjustment of exhaust valves.	8) Check valve adjustment.

CARBURETOR OPERATION

NORMAL RUNNING

The fuel, via needle valves (7), passes into the bowls (6) where the floats (5), hinged on pivot pin (9), control the opening of needles (8) thus keeping fuel level constant. From bowls, fuel flows through main jets (10) and ducts (11), into wells (12); after mixing with the air coming from orifices of emulsifying tubes (4) it reaches, via air corrector jets (3) and nozzles (2), the carburetion area consisting of auxiliary venturis (1) and venturis (13).

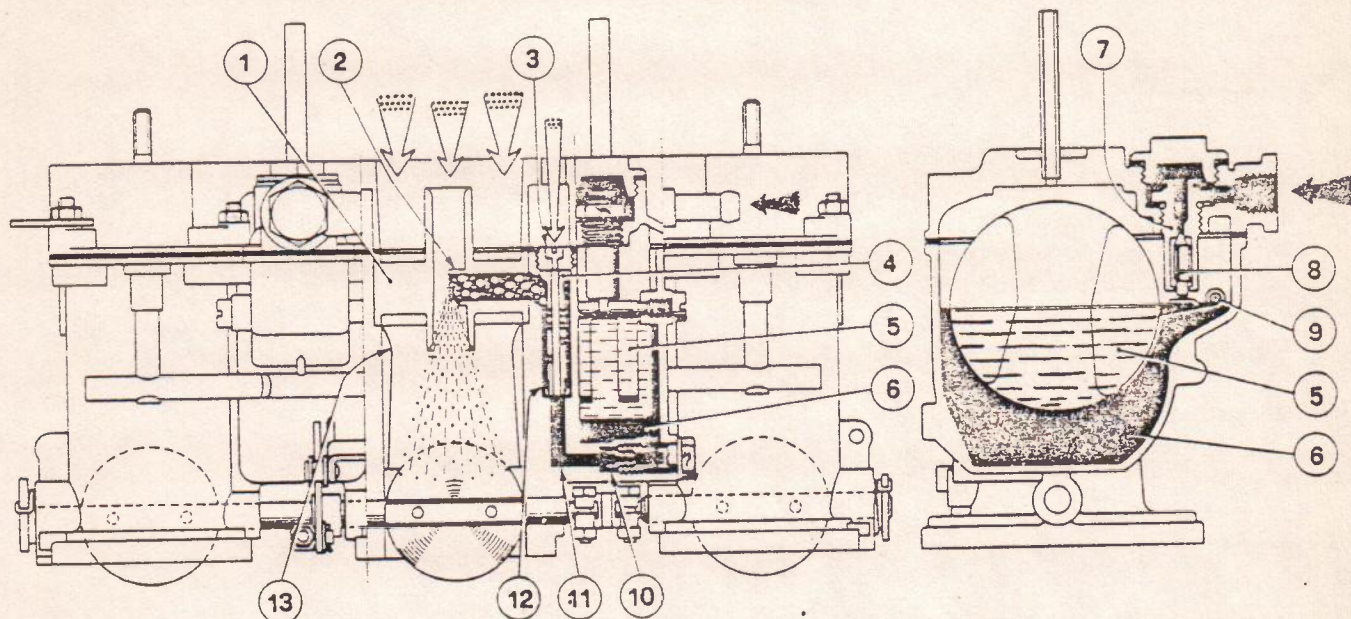


Fig. 13 - Normal Running Operational Diagram

IDLE SPEED AND PROGRESSION

From wells (12), fuel reaches idle jets (23) through ducts (22). After emulsifying with the air coming from calibrated bushings (24), fuel reaches, through ducts (21) and idle feed orifices (19)--the latter adjustable by screws (20)--the carburetor ducts downstream of throttles (18).

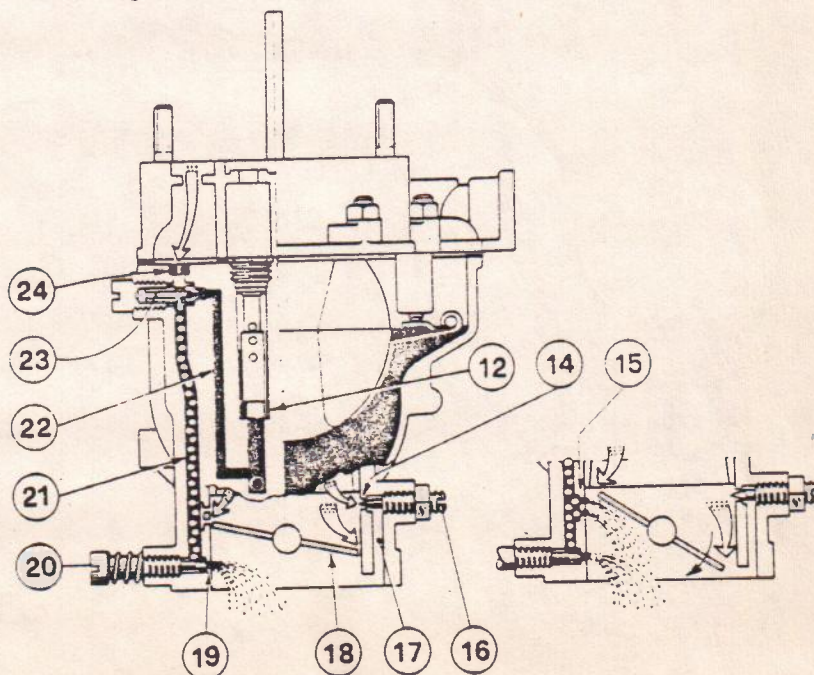


Fig. 14 - Idle Speed and Progression Operational Diagram

The mixture reaches the carburetor ducts also through progression holes (15) near the throttles; this allows a smooth increase in engine angular speed, from idle running on.

In order to obtain uniform air feed by throttles (18) in idling position, in all three carburetor ducts, a quantity of air, variable by adjustment of screws (16), issues downstream of throttles (18) through orifices (14)--on the same level with the tapered adjustment screws (16)--and through ducts (17).

ACCELERATION

Upon closing of throttles, lever (34) sets free the diaphragm (3) which--under the action of spring (29)--draws fuel from the bowls (6) through ball valves (36) and ducts (35).

Upon opening of throttles, by means of lever (34), rod (33), cam (32) and lever (31), the diaphragm (30) injects fuel into carburetor ducts through the delivery valve consisting of diaphragm (28), washer (27), ducts (37), ball valves (26) and pump jets (25).

The intake valve (36), can be supplied with a calibrated side orifice which discharges excess fuel into the bowl.

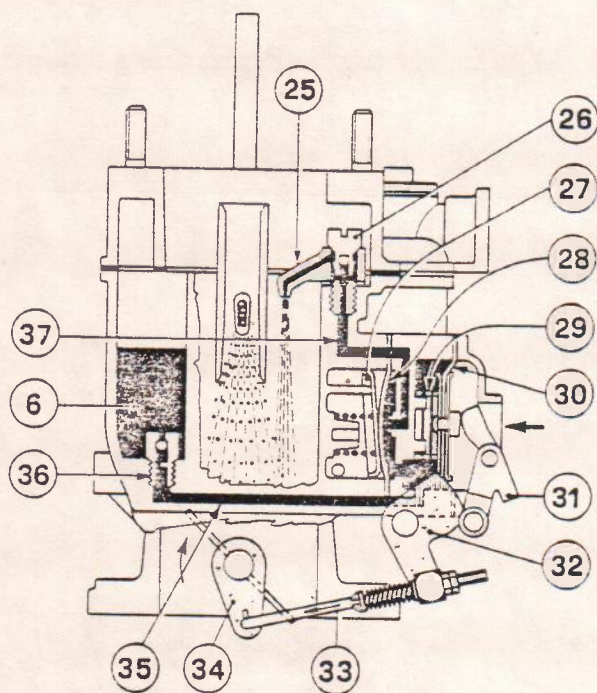


Fig. 15 - Acceleration
Operational Diagram

FLOAT LEVEL ADJUSTMENT OPERATION

In order to carry out this operation it is necessary to proceed as following:

--Remove carburetor cover (C), lift off cover gasket (GZ) carefully so as not to damage it; check that floats (G) travel freely in their seats.

--Place spring (X) between the float and the side of the fuel bowl.

Insert calibration tool (Y) made up of an 18 mm. long spindle (A) held in place by two adjustable nuts, until it rests on the carburetor body surface.

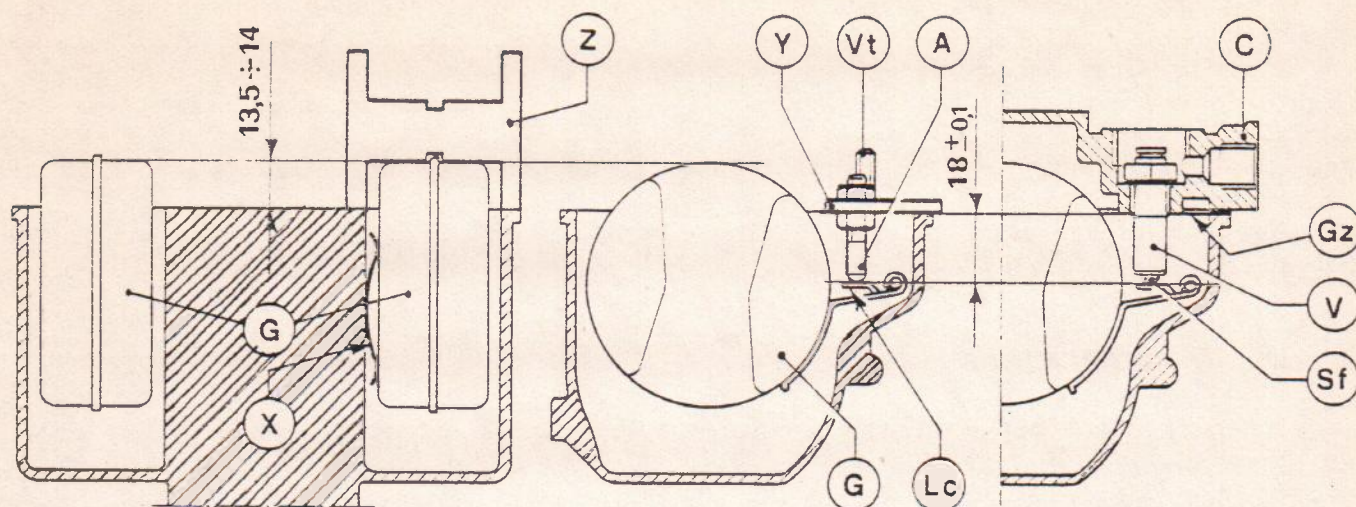


Fig. 16 - Float Level Adjustment Diagram

—Raise the float (G) so that tab (LC) makes gentle contact with the tip of screw (A), making sure that float (G), under pressure of the friction spring, remains in the adjusted position.

—With calibration tool (Z) check that the height of the float is 13.5 ± 14 mm. above the carburetor body top surface; repeat the above operations on the other float.

—Whenever floats (G) are not correctly positioned, modify the position of the tabs (LC) making sure that they remain perpendicular to the axis of spindle (A) and that their contact surfaces are not scored or marked in order to insure the free movement of the spindle contact surfaces (SF) of valves (V).

—Remove the friction spring, install gasket (GZ) and cover (C) making sure that the needle valves (V) are screwed firmly in place; then proceed to the uniform tightening of the cover fastening nuts.

Whenever it is necessary to replace needle valves (V), make sure that the new valves are screwed properly in their seats, installing new sealing washers and repeating the adjustment operations for each float.

CARBURETOR ADJUSTMENT DATA

UNIT	WEBER
	40 IF 3C 1-2-3-4
Venturi	34 mm.
Central diffusor	3.5 mm.
Main jet	1.55 mm.
Air correction jet	1.60 mm.
Emulsion tube	F 26 mm.
Idle jet	0.50 mm.
Idle air correction jet	1.10 mm.
Pump jet	0.40 mm.
Discharge pump	0.40 mm.
Needle valve	1.75 mm.
Pump delivery valve	0.50 mm.
Progression holes	0.80-1.50-1.40 mm.
Float height without gasket	13.5 : 14 mm.
Idle adjustment screw opening	Approx. 4 turns

CARBURETOR TIMING ADJUSTMENT

After having accurately cleaned all jets and carburetor tubes and passages with compressed air, and after having checked the adjustment of the floats levels proceed to final carburetion adjustment as follows:

Tighten down completely the idle speed adjustment screws and then open each one by 4 turns.

Run the engine until warm, connect the 12 mercury vacuum lines to each of the appropriate carburetor intakes.

If the above instrument is not available, use a normal Motometer adjustment gauge along with support base AV961-962.

CARBURETOR MODIFICATIONS (365)

On each carburetor top surface it is necessary to drill 4 breather holes of 1.5 mm. Ø as shown in Fig. 17.

After the modification has been carried out, mark each carburetor with a green painted spot.

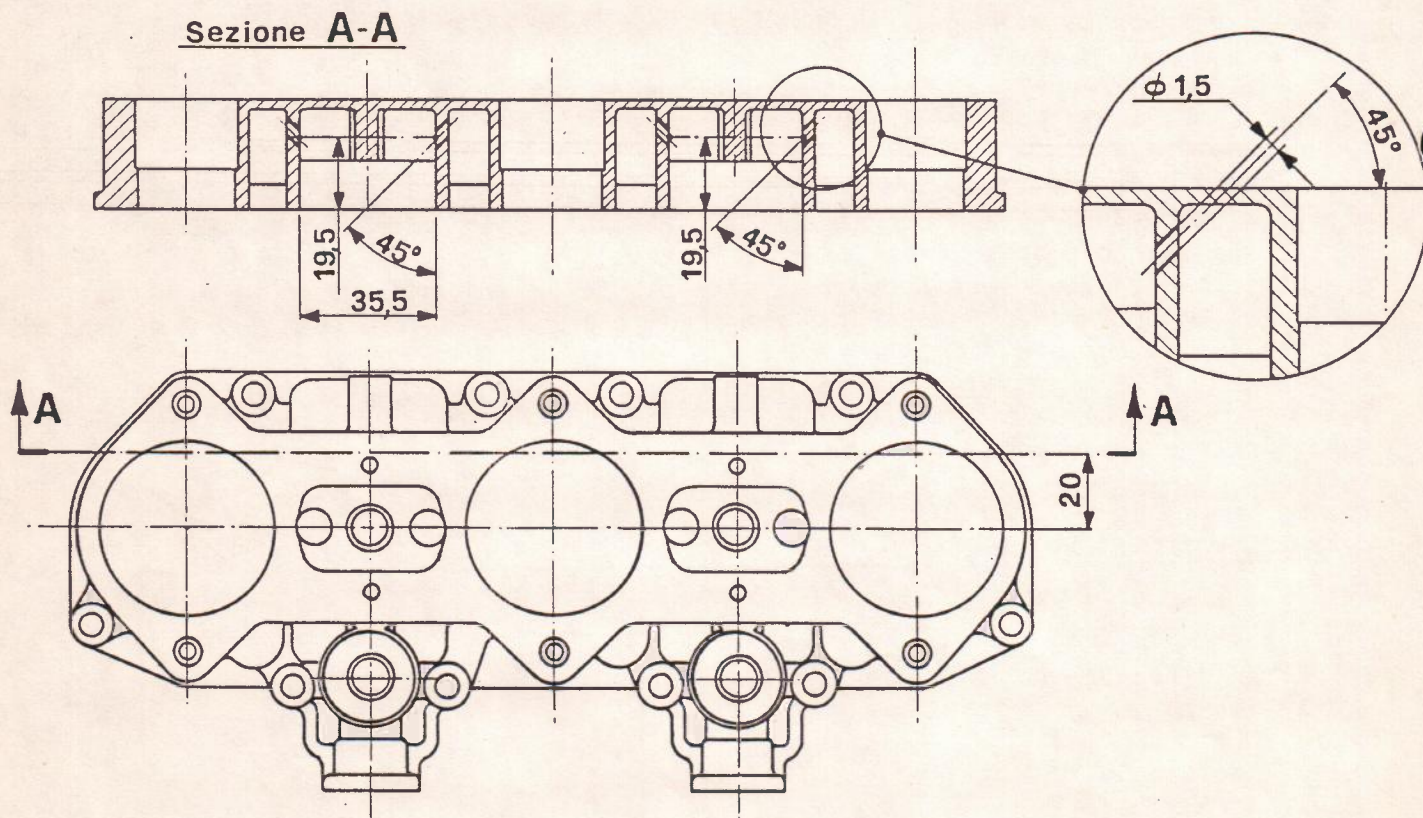


Fig. 17 - Carburetor Modifications Diagram

FUEL INJECTION SYSTEM (512 BBI)

The 512 BBI is equipped with two Bosch K-Jetronic fuel injection systems, one for each bank of cylinders. The system consists of a mixture control unit which, depending upon the intake volume of air metered, allows a quantity of fuel to be delivered to the individual cylinders through the injection valves which produces an optimum air/fuel mixture.

MAINTENANCE AND ADJUSTMENT

In order to carry out these operations, special tools and equipment are required. In addition the maintenance manual Ferrari 400i Iniezione; Principles of Operation, Checking and Diagnosing Procedures © is required. This can be obtained through your Ferrari dealer.

CLUTCH

GEAR BOX

TRANS-AXLE

	PAGE
CLUTCH	71
CHARACTERISTICS AND DATA	71
DIAGNOSING FAULTS AND RELATED REPAIRS	72
REPAIR INSTRUCTIONS	74
GEAR BOX	79
CHARACTERISTICS AND DATA	79
DIAGNOSING FAULTS AND RELATED REPAIRS	80
GENERAL DESCRIPTION	81
SYNCHRONIZER UNITS	81
CHECKS AND OVERHAUL	82
GEAR BOX REASSEMBLY	86
CONTROL LEVER ADJUSTMENT	88
AXLE/DIFFERENTIAL	89
CHARACTERISTICS AND DATA	89
DIAGNOSING FAULTS AND RELATED REPAIRS	91
REPAIR INSTRUCTIONS	92
HALF-SHAFTS/SEMI-AXLES	97

CLUTCH

CHARACTERISTICS AND DATA.....	71
DIAGNOSING MALFUNCTIONS AND RELATED REPAIRS.....	72
DESCRIPTION.....	74
REPAIR INSTRUCTIONS.....	74
CLUTCH DISENGAGEMENT CONTROL ADJUSTMENT.....	74
ENGINE FLYWHEEL.....	76
CLUTCH DRIVER DISC.....	76
PRESSURE PLATE ASSEMBLY UNIT.....	76

CHARATERISTICS AND DATA

Type	Dry, single disc
Clutch plate lining, outside diameter	241.3 mm.
Clutch plate lining, inside diameter	155.4 mm.
Driven disc thickness (not under load)	9.2 + 9.5 mm.
Driven disc thickness (under load)	8.5 mm.
Driven disc wear limits	1 mm.
No. of springs (pressure plate)	1 diaphragm type
Driven plate load	980 Kg.
Pedal disengagement load	23 + 24 Kg.
Pedal free travel distance	15 + 20 mm.
Pressure plate free travel distance	1.5 + 2 mm.
Throwout bearing hub travel distance (no play)	12 mm.
Maximum rearward adjustment for disc wear	8.3 mm.
Flywheel-to-pressure plate distance	52.5 mm.
Theoretical adjustment length of control rod	106 mm.
Control lever pivot allowable misalignment	5 + 6 mm.
Maximum flywheel surface wear	1 mm.
Flywheel surface microfinish	0.8 μ
Engine crankshaft mounting flange/contact surface parallelism	0.08 mm.

PEDAL HELPER SPRINGS—CHARACTERISTICS	INSIDE	OUTSIDE
Unmounted spring length	55 mm.	85.75 mm.
Mounted spring length	39 mm.	43.75 mm.
Mounted spring load	8.5 Kg.	1 Kg.
Center flexibility	2 mm./Kg.	1 mm./Kg.

DIAGNOSIS OF CLUTCH OPERATIONAL MALFUNCTIONS AND RELATED REPAIRS

NOTICEABLE NOISE WHEN PEDAL IS DEPRESSED

Possible Causes	Remedies
1) Throwout bearing excessively worn or lacking lubrication.	1) Replace bearing and bushing.
2) Insufficient free travel play at clutch pedal.	2) Adjust free play travel at clutch.
3) Excessive play between driven disc hub and clutch shaft.	3) Replace driven disc or shaft.
4) Broken, weak, or unhooked pedal return spring.	4) Replace or hook up spring.
5) Insufficient lubrication of the flexible clutch control cable.	5) Lubricate or replace if worn.

CLUTCH PULLS

Possible Causes	Remedies
1) Oily or slippery flywheel, pressure plate, driven plate, facing surfaces.	1) Eliminate the causes of oil leaks, accurately clean flywheel, pressure plate and replace driven disc.
2) Driven disc hub does not travel freely on clutch shaft.	2) Eliminate cause of obstruction. If the fault continues, eliminate the faulty part.
3) Sticking of control mechanism.	3) Identify the cause and eliminate it.
4) Worn pressure plate and flywheel.	4) Check and replace if necessary.
5) Driven disc linings worn (with rivets rubbing against the flywheel or the pressure plate).	5) Replace the driven disc (resurface or replace the flywheel).

CLUTCH SLIPS

Possible Causes	Remedies
1) Insufficient pedal return due to lack of play.	1) Ascertain the cause and readjust the play.
2) Oil or grease on the flywheel and driven disc linings.	2) Thoroughly clean the flywheel disc linings; if the driven disc is impregnated with oil, replace it.
3) Badly worn or scored driven disc linings.	3) Replace the driven disc.
4) Damaged disengagement mechanism.	4) Check and eventually replace.

CLUTCH VIBRATES

Possible Causes	Remedies
1) Faulty or unbalanced mounting of clutch in relation to flywheel.	1) Check and adjust according to reference data.
2) Driven disc unbalanced due to wear or lining damage.	2) Check; if still in good condition, check the linings and the damper spring.
3) Engine crankcase bearing deteriorated or loose.	3) Check and replace if necessary.
4) Excessive play in main and thrust bearings (engine).	4) If play is excessive, replace.

ABNORMAL WEAR OF DRIVEN DISC LININGS

Possible Causes	Remedies
1) Insufficient pedal free travel.	1) Adjust pedal free play.
2) Driver keeping foot on clutch pedal during driving.	2) Place foot on pedal only during operation of clutch. Replace damaged parts.
3) Excessive slipping of the driven disc at starting and during shifting.	3) Avoid slipping of the disc.
4) Faulty control lever alignment.	4) Check and adjust.

CLUTCH DOES NOT DISENGAGE

Possible Causes	Remedies
1) Excessive pedal free play.	1) Adjust pedal free play.
2) Misaligned driven disc.	2) Restore alignment or replace disc.
3) Driven disc hub does not travel freely on the control shaft.	3) Ascertain cause of sticking and eliminate it; if necessary, replace driven disc.
4) Oily or slippery driven disc facings.	4) Replace driven disc.
5) Driven disc linings stuck to flywheel or on the pressure plate due to long storage of car with gear engaged.	5) Engage first gear, push car with clutch pedal at lowest point and release briskly at regular intervals.

CLUTCH DRAGS

Possible Causes	Remedies
1) Throwout bearing support sleeve does not travel freely on its guide due to excessive driven disc linings dust or dirt deposits.	1) Inject oil and kerosene on the clutch shaft. Eventually dismantle the clutch.
2) Pedal stuck in the bushings.	2) Dismantle clutch pedal shaft and eliminate the sticking of the travel.
3) Engine idle speed too high.	3) Adjust the idle speed.
4) Driven disc axially misaligned.	4) Recenter or replace the disc.

CLUTCH PEDAL OPERATION EXCESSIVELY STIFF

Possible Causes	Remedies
1) Throwout bearings sleeve does not travel easily on the shaft due to excessive facing material deposits on the driven disc.	1) Lubricate clutch shaft with oil/kerosene mixture. Eventually rebuild the assembly.
2) Control cable partially seized in its cover.	2) Check, grease, replace if necessary.
3) Excessive control lever pivot point misalignment.	3) Check and reset to exact position.
4) Faulty lever position angle.	4) Check.

DESCRIPTION

The clutch is of the single, dry-disk with a sprung center hub and a mechanical disengagement control equipped with helper springs. Its disengagement is controlled via a throwout ball bearing installed on a sliding sleeve.

REPAIR INSTRUCTIONS**CLUTCH DISENGAGEMENT CONTROL ADJUSTMENT**

For optimal clutch operation it is necessary that the control levers are exactly aligned while at rest, as indicated in Fig. 1. It is particularly necessary to check the mis-alignment at pivot point 3; this must be within 5 ± 6 mm. To simplify this operation, the later versions of this model have been equipped with reference alignment plate 5 and hole 6, mounted on the clutch bell-housing cover.

For adjustment, proceed as follows:

Disconnect adjustment arm 4 from lever 1.

By moving adjustment sleeve 2 forward or backward as necessary, hole 6 of lever 1 must be aligned with the hole in the reference plate (this position assures a mis-alignment tolerance of 5 ± 6 mm.).

Reconnect arm 4 to lever 1 and by loosening and/or tightening the appropriate nut, adjust the clutch clearance (1.5 ± 2 mm.) without altering the position of lever 1.

NOTE: In the rest position lever 1 must be positioned in such a way that the alignment holes in the lever and in the reference plate are exactly opposite each other.

Periodically clean the throwout bearing/clutch shaft sleeve of the dust deposits due to disc facing wear.

Keep the shaft and the upper plate of the helper springs well greased.

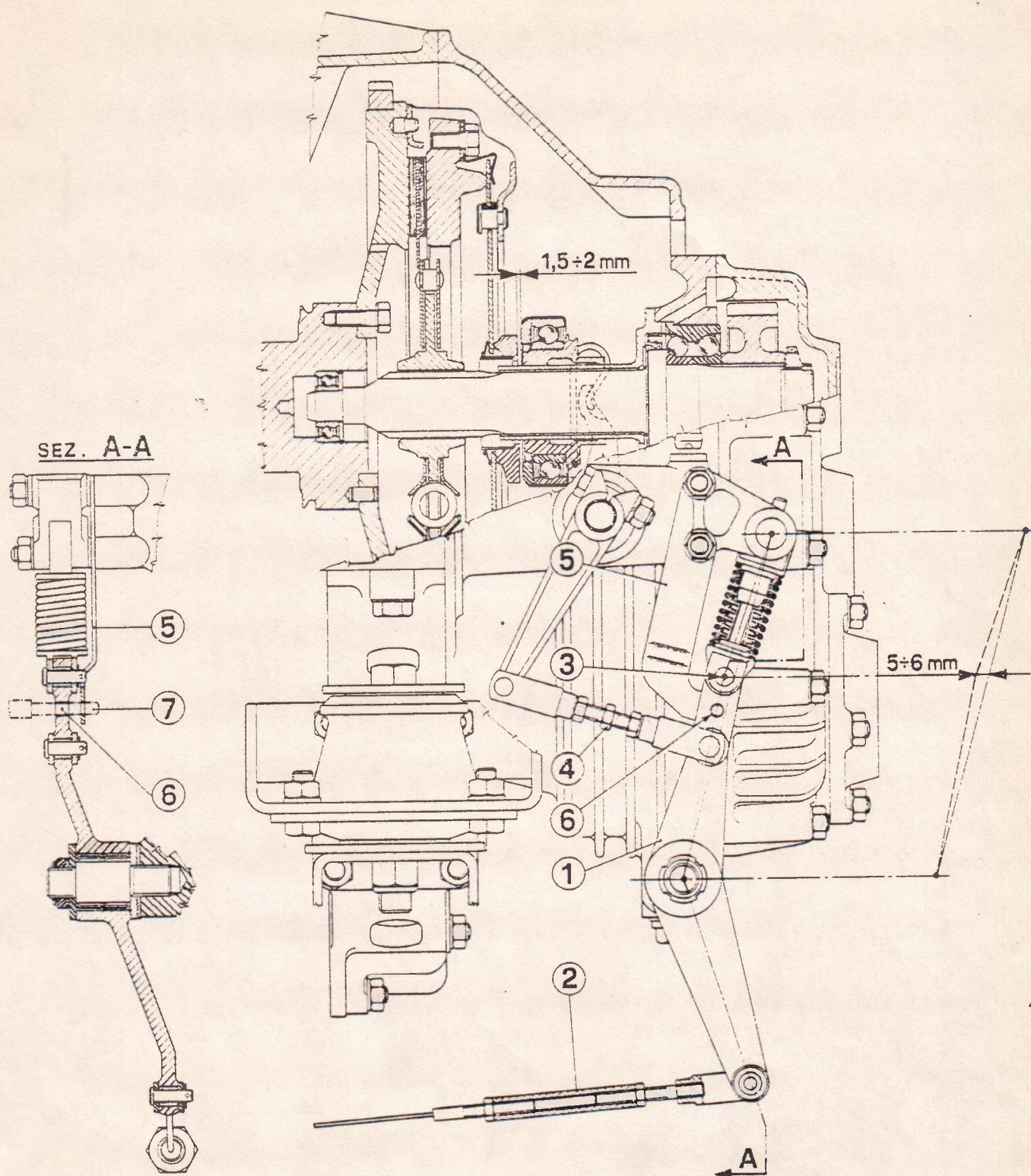
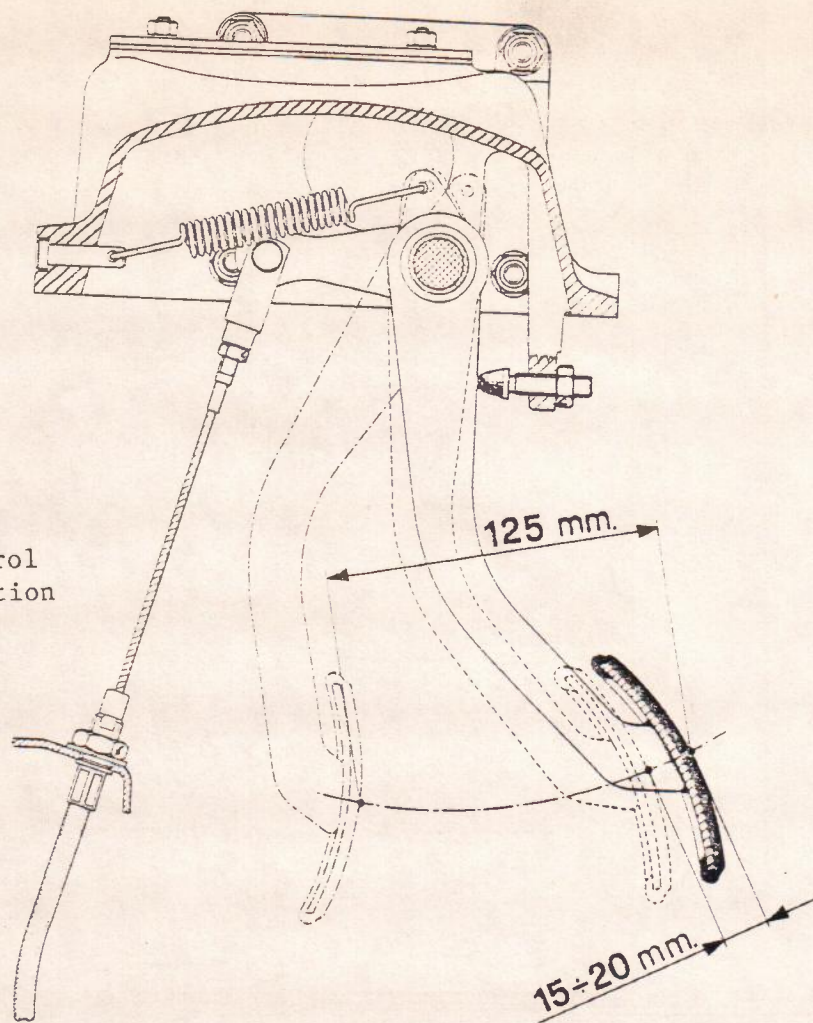


Fig. 1 - Clutch Sectional Diagram

1-Control lever; 2-Adjustment sleeve; 3-Pivot shaft; 4-Adjustment nut; 5-Reference plate; 6-Reference hole; 7-Clutch lever alignment check shaft

Fig. 2 - Clutch Control
Pedal Operation



ENGINE FLYWHEEL

Check the condition of all contact surfaces; if scoring is noticeable, regrinding is required with the least amount of metal to be removed (allowable--1 mm.). The refinished surfaces must be smooth and perfectly parallel to the mounting axis on the crankshaft.

CLUTCH DRIVEN DISC

- Check to see whether the contact surfaces are impregnated with oil or grease. If they are, replace the disc.
- Check the surface wear in relation to the specifications on page 71.
- Check that the disc linings are firmly fastened at the fastening rivets.
- Check that the driven disc hub slides freely and without excessive play on the splined shaft.
- Check that the take-up disc is well seated on the hub.
- With a gauge check the concentricity of the driven disc surfaces, mounting the disc on a mandrel and then on two parallel supports.

PRESSURE PLATE UNIT

Check the driven disc contact surfaces; if heaving scoring is noticed, replace it. Check that the individual plate rivets are free of play. The clutch cover is fastened to the engine flywheel with six bolts and three centering pins. The diaphragm spring and pressure plate are supplied as balanced units as well as the clutch disc. Their replacement does not pose any balancing problem.

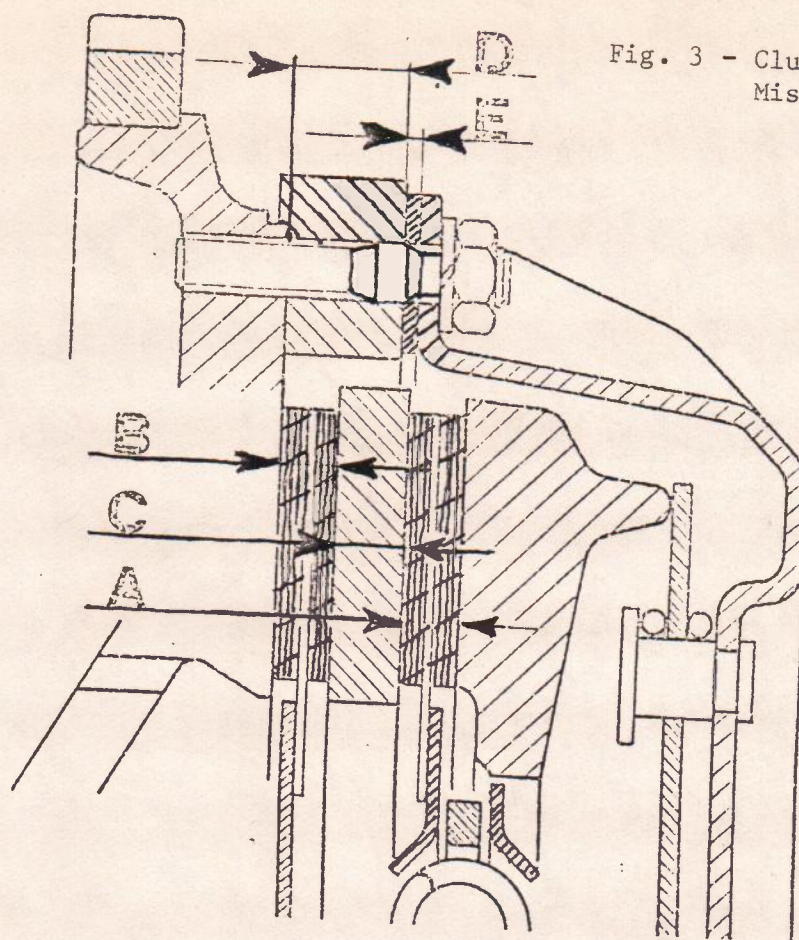


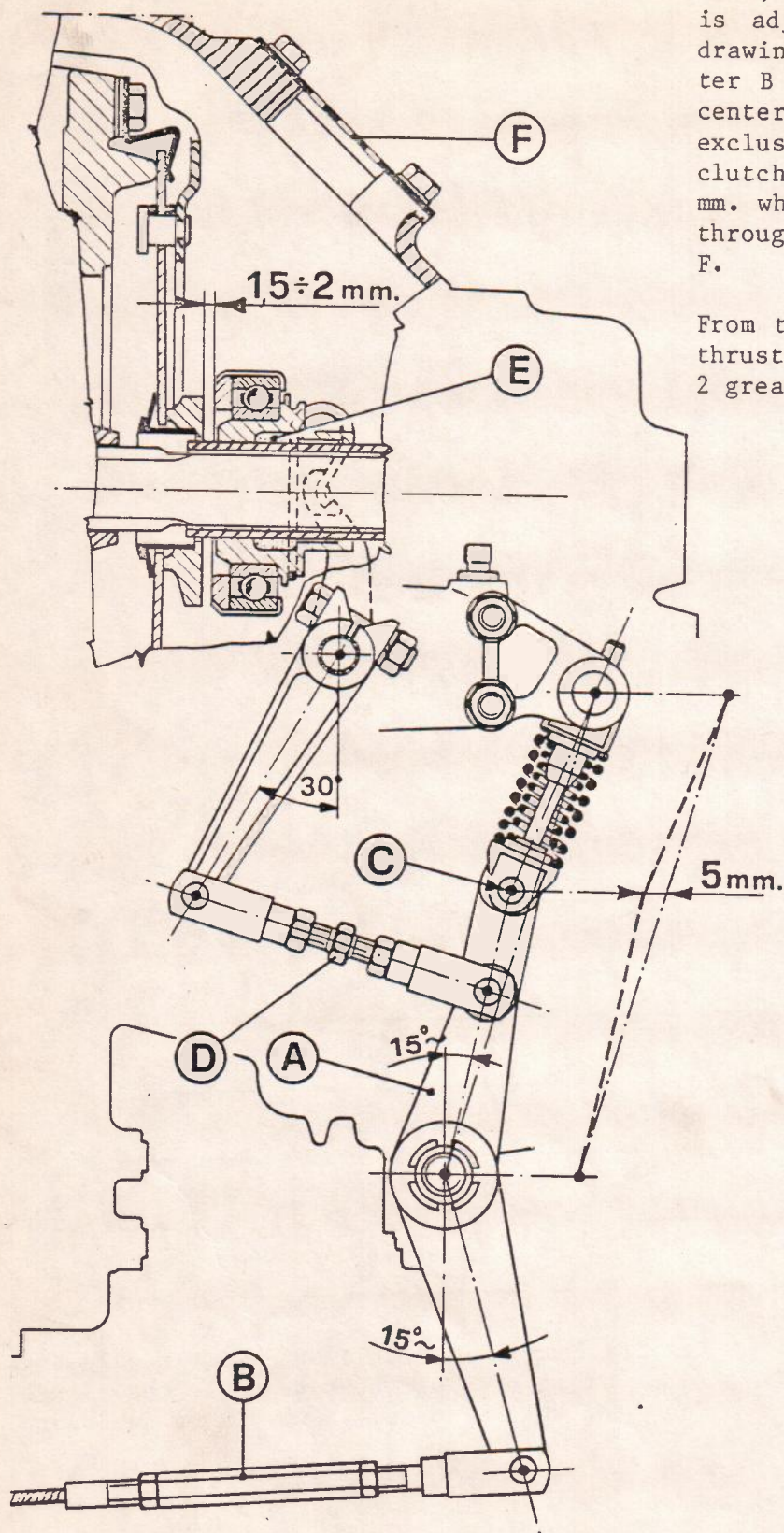
Fig. 3 - Clutch Unit Wear Misalignment

FIG.	PARTS NO.	DESCRIPTION	ORIGINAL THICKNESS	WEAR LIMIT
A	109463	Disc with spring hub	7.5 : 7.6 mm.	1 mm.
B	109462	Disc with rigid hub	7.2 : 7.3 mm.	1 mm.
C	109464	Central pressure plate	8.8 mm.	1 mm.
D	108515	External spacer	14.4 mm.	----
E	109466	Spacer washer	1.5 mm.	----

Every time you disassemble the clutch unit due to faulty operation, it is recommended to check the wear of the clutch component according to the following values. If the total wear is below 1.5 mm., it is possible to reassemble the clutch unit leaving out the spacers "E". If the total wear exceeds 1.5 mm. it is necessary to fit new parts.

Example:

- 1--The addition of the three dimensions A+B+C is included between 21.5 and 22 mm. Reassemble the clutch unit, leaving out the spacers E.
- 2--The addition of the three dimension A+B+C is below 21.5 mm. It is necessary to replace at least the two discs and fit the spacers E.
- 3--The addition of the three dimensions A+B+C is between 22.2 : 23.7 mm. It is possible to reassemble the clutch unit with the spacers E. The bad operating of the clutch is due to different reasons (oil leaks, dust, etc.)



To be sure of the correct clutch operation, it is necessary that the lever A is adjusted as shown in the enclosed drawing. Operate on the proper register B to have the fulcrum C 5 mm. off-center when in rest position. Operate exclusively on register D to adjust the clutch clearance, that must be $1.5 \pm 2 \text{ mm.}$ when checked with a thickness gauge through the proper clutch housing hole F.

From time to time clean and grease the thrust bearing sleeve using Molikote BR 2 grease.

GEAR BOX

CHARACTERISTICS AND DATA.....	79
DIAGNOSING FAULTS AND RELATED REPAIRS.....	80
GENERAL DESCRIPTION.....	81
SYNCHRONIZER GROUPS.....	81
CHECKS AND OVERHAUL.....	82
REBUILDING OF THE GEAR BOX.....	86
GEAR BOX OIL LEVEL MODIFICATION (365).....	87
SHIFT CONTROL ADJUSTMENT.....	88

CHARACTERISTICS AND DATA

Speed/Gears	5 forward, 1 reverse
Forward gears synchronizers	Floating, on needle bearings
Idler gears/bearings radial clearance	0.02 $\pm$ 0.05 mm.
Idler gears/contact surfaces axial clearance	0.27 $\pm$ 0.31 mm.
Wear limits	0.35 mm.
Reverse idler gears axial clearance	0.10 $\pm$ 0.35 mm.
Engagement clearance	0.04 $\pm$ 0.07 mm.
Forks/sleeves clearance	
Axial clearance	
(1,2,3 and reverse gears	0.05 $\pm$ 0.30 mm.
(4th and 5th gears	0.05 $\pm$ 0.25 mm.
Diameter radial clearance	
(1,2,3 and reverse gears	1.25 $\pm$ 1.55 mm.
(4th and 5th gears	1.20 $\pm$ 1.60 mm.
Shift control rods/mounting holes clearance	0.016 $\pm$ 0.061 mm.
Input and output shafts eccentricity (installed)	0.01
Lubrication	Splash type

GEAR BOX RATIOS

RATIOS WITH INDIVIDUAL GEAR ENGAGED			IDLER GEARS RATIOS 28:28		OVER-ALL GEAR RATIOS WITH HYPOID CROWN-WHEEL AND PINION 12:45	
1	37 $\div$ 14	2.642	1	2.642	1	9.907 $\div$ 1
2	34 $\div$ 18	1.888	2	1.888	2	7.080 $\div$ 1
3	30 $\div$ 21	1.428	3	1.428	3	5.355 $\div$ 1
4	27 $\div$ 25	1.080	4	1.080	4	4.050 $\div$ 1
5	23 $\div$ 28	0.821	5	0.821	5	3.079 $\div$ 1
REV.	33 $\div$ 14	2.357	REV.	2.357	REV.	8.838 $\div$ 1

DIAGNOSING MALFUNCTIONS AND RELATED REPAIRS

NOISY GEAR BOX

Possible Causes	Remedies
1) Excessive engagement clearance between engage gears due to wear.	1) Overhaul transmission and replace worn gears.
2) Worn gears, bearings, and synchronizer rings.	2) Overhaul transmission and replace worn units.
3) Out-of-center input and output shafts.	3) Check out shaft alignment and eventually replace.
4) Insufficient oil level in the gear box.	4) Add oil to predetermined mark.

DIFFICULTY AND HARSHNESS IN GEAR ENGAGEMENT

Possible Causes	Remedies
1) Deformation of gear shift lever.	1) Dismantle, eliminate cause of trouble or replace lever.
2) Sticking of the shafts in their gear box supports.	2) Check out.
3) Sliding sleeves travel blocked due to rough surfaces.	3) Check out and replace damaged parts.
4) Use of non-specified lubricating oil.	4) Drain and flush out; replace with prescribed fluid.
5) Defective clutch disengagement releases.	5) Check out.
6) Worn synchronizer rings.	6) Replace.

SPONTANEOUS OR IRREGULAR GEAR DISENGAGEMENT

Possible Causes	Remedies
1) Erratic engagement action.	1) Engage low gear fully before releasing clutch pedal.
2) Detent balls wear and/or deformation of detent springs causing disengagement of control levers.	2) Remove the springs retaining cover and replace worn units.
3) Worn synchronizer rings.	3) Substitute.
4) Worn engagement teeth on sliding sleeves or on worn gears.	4) Check out and replace worn units.

GENERAL DESCRIPTION

The gear box is equipped with five forward and one reverse gear, all synchronized. The synchronization of gear engagement is via floating synchronizer rings. All the gears are in constant contact via helicoidal gear-teeth designed to insure quiet operation. The gear box is placed longitudinally below the engine in relation to the vehicle axis.

The main case, in light alloy, is attached to the engine oil sump, but having its own separate lubrication system. In addition to the gear-changing mechanisms, it also enclosed the crown pinion gears and the differential.

Engine crankshaft rotation is transferred to gear box primary/input shaft via a transmission shaft and three control gears placed at its rear end, the first of which is mated to the clutch shaft.

SYNCHRONIZER GROUPS

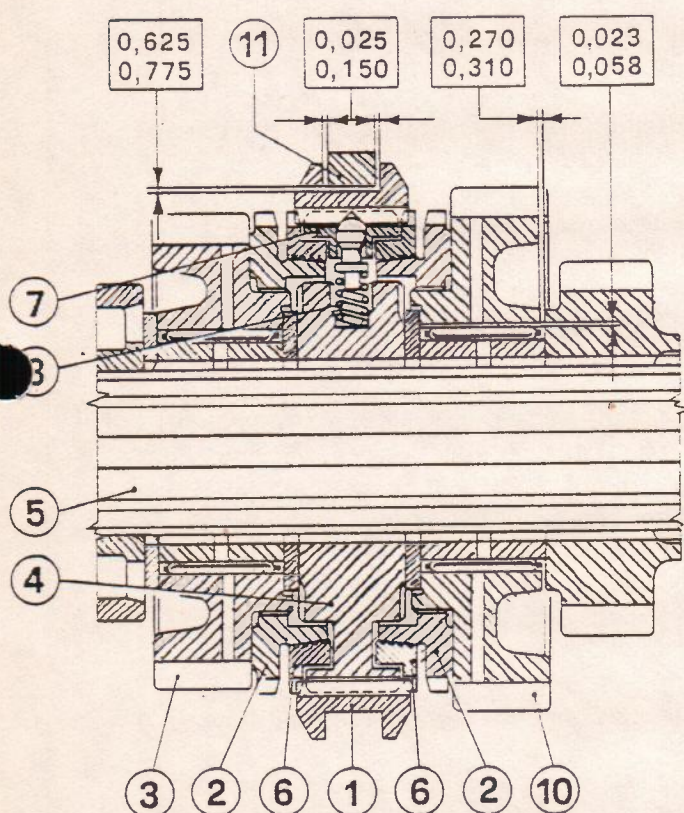


Fig. 3 - 1st, 2nd, and 3rd GEARS
SYNCHRONIZER GROUP

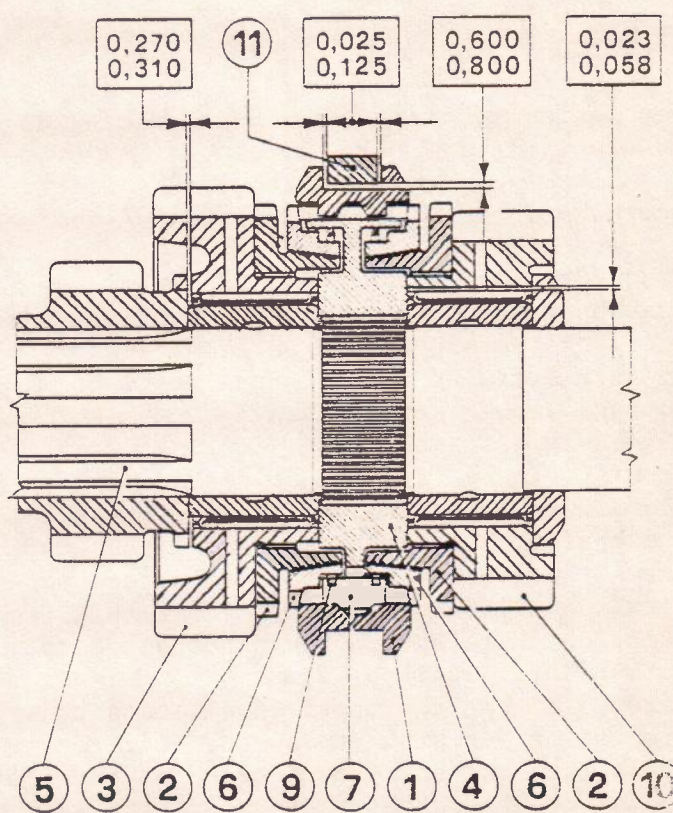


Fig. 4 - 4th and 5th GEARS
SYNCHRONIZER GROUP

1-Sliding sleeves; 2-engagement cluster; 3-Gear; 4-Synchronizer; 5-Shaft;
6-Synchronizer ring; 7-Pressure followers; 8-Pressure spring; 9-Ring insert spring;
10-Gear cluster; 11-Shift fork

Engagement synchronization of the gears is realized via the units illustrated in Figs. 3 and 4. The sliding sleeve 1 is internally slotted for engaging on the cluster 2 of gear 3, thus firmly mating it to the synchronizer group 4 and to shaft 5.

Moving sleeve 1 axially to the right or left, also moves synchronizer ring 6 via the pressure followers 7 which are pressed radially against the sleeve by the pressure springs 8 (Fig. 3) or by the ring insert springs 9 (Fig. 4).

The synchronizer ring completes its operation when its tapered surface makes full contact with the corresponding tapered surface of the engagement cluster. As a result of the small angle of incidence between the two tapered surfaces radial forces are created on gear cluster 10 which rotates while it is being moved. These forces neutralize the differences in angular velocity between gear cluster 10 and synchronizer group 4 and between shaft 5 and the gear cluster as well.

As soon as synchronization between the units occurs, the final shifting of the sleeves takes place, determining the complete synchronization between gear cluster 10 and synchronizer core A.

CHECKS AND OVERHAUL

1) SHAFTS AND GEARS

After having dismantled the units making up the gear box, wash them in kerosene and blow dry with compressed air.

- Check that the case and its covers' mating surfaces are not damaged or scored and the mounting surfaces of the bearings outside cages are free of scores and wear.
- Make sure that roller and ball bearings are in good working condition, if they operate noisily or have roughened surfaces they must be replaced.
- The gear teeth profiles must not exhibit wear, seizure marks or nicks. The contact surfaces should appear polished and exhibit an overall and uniform contact along their length.
- Make sure that the roller bearings races and the idler gears cages on the input (primary) and output (secondary) shafts do not exhibit traces of abnormal wear or are caved in, and check that the radial play does not exceed the maximum allowable value as listed in the table.
- Check the wear on the contact surfaces of the sliding sleeves and the forks. It is extremely important that the two contact surfaces of the forks on the sleeves maintain their perpendicularity in relation to the fork's axis within 0.05 mm.
- Make sure that the operational contact surfaces of the idler gears and the spacers do not exhibit wear or seizure marks.
- Check that the engagement teeth of the sliding sleeves and the idler gears do not exhibit abnormalities or wear which results in difficult engagement.

2) SYNCHRONIZATION UNITS

MAIN DATA

GEARS	WEAR LIMITS X	SYNCHRONIZER CLEARANCE Y	LOAD P ON SLEEVE
1,2,3	0.4 mm.	≥ 0.5 mm.	17 + 25 Kg.
4,5	0.4 mm.	≥ 0.4 mm.	25 + 34 Kg.

The synchronizer rings for 1st, 2nd, and 3rd gears are identical and different than those for 4th and 5th gears; at each dismantling of the gear box, it is advisable to replace them if they have over 30,000 Km. of usage.

An examination of their wear condition is carried out as follows:

--Center the synchronizer ring on its respective friction cone. By rotating both radially against each other, the two tapered surfaces should make a uniform and parallel contact.

Check the clearance between the housing which carries the friction cone and the synchronizer ring with a thickness gauge at several opposite points along their diameter.

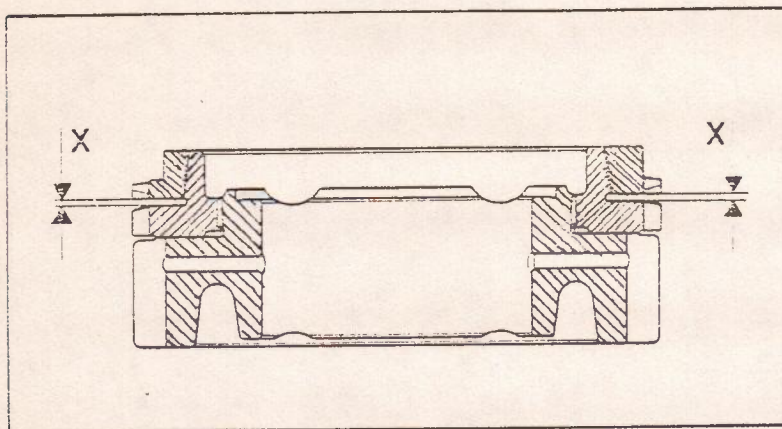


Fig. 5 - Synchronizer Ring
Wear Check

If the clearance indicated is below that allowed in the table, replace the ring with a new one. During this operation carry out a visual check to make sure that the male cone surfaces do not exhibit excessive smoothness due to wear, seized or overheating marks.

--Whenever new units are to be installed it is necessary to check the resulting play at the synchronizer.

Insert the synchronizer ring into its respective friction cone. By rotating both radially against each other, the two tapered surfaces should make a uniform and parallel contact. Place the respective synchronizer group in its assembly position at the working contact surfaces of the gear cluster or the spacer (3rd gear). Select the appropriate thickness tab from a measurement gauge to measure the allowable play at the synchronizer. The tab selected must be easily inserted all along the perimeter of the contact surfaces of the synchronizer ring and the sliding synchronizer group.

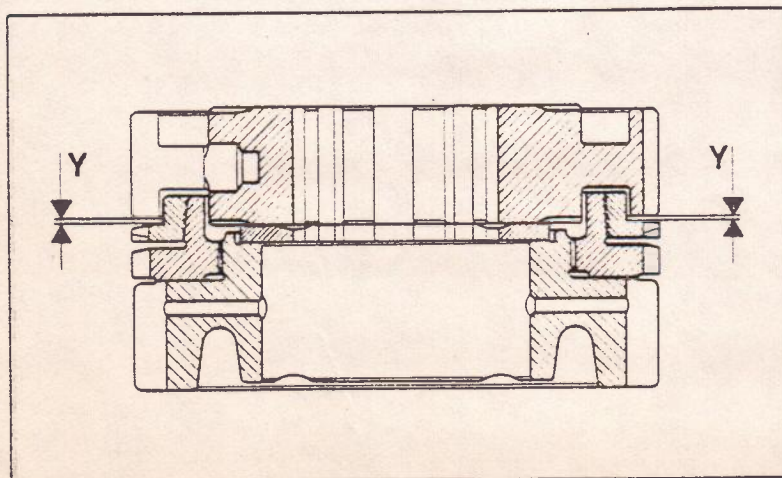


Fig. 6 - Synchronizer
Clearance Check

The upper limit of synchronizer clearance is determined by the wear limits of the synchronizer rings.

It is good practice to mark all units that have been checked in order not to mix them up with the other synchronizer groups.

--Check that the synchronizer group is still within the pre-established axial load values.

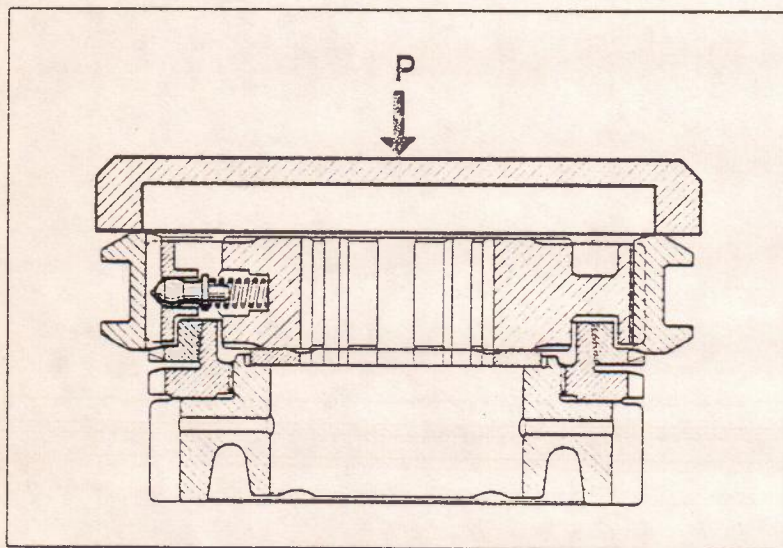


Fig. 7 - Synchronizer Axial Load Check

Install the synchronizer group in a retainer as indicated in the figure. Align the synchronizer ring so that the engagement gear teeth of the sleeve can engage directly onto the respective gear teeth on the sliding cone on the gear cluster. Apply uniform pressure (load) to the sleeve until it loosens, allowing it to mate with the gear cluster. If the prescribed load cannot be achieved then it is probably due to weakened pressure springs. It will be necessary to replace them with new ones.

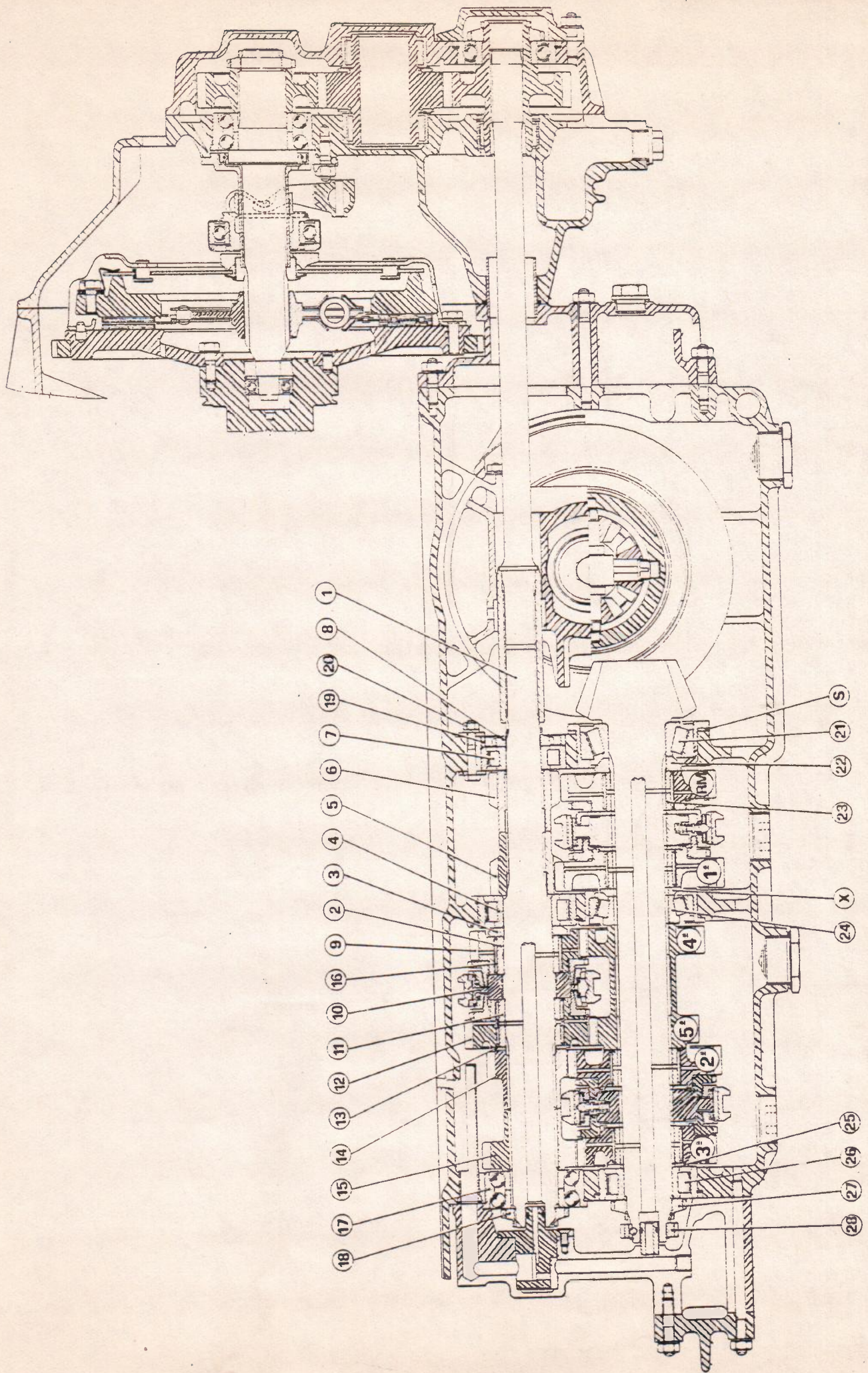


Fig. 8 - Gear Box/Differential Longitudinal Diagram

REBUILDING OF THE GEAR BOX (REFER TO FIG. 8)

After having determined the thickness of spacers S and X as related to the positioning and to the preloading of the pinion as illustrated in the respective chapter on the rear axle, proceed with the reassembly of the gear box.

- Install the differential group complete with ring/crown gear into the case.
- Prepare input (primary) shaft 1 for installation by mounting race 2, spacer 3, roller bearing 4, countershaft gears 5 and 6 of 1st and reverse gears, roller bearing 7 together with race and ring nut 8 on the shaft.

Rotate the case in a vertical position.

Install the 4th gear, cluster 9, synchronizer group 10 of 4th and 5th gears complete with synchronizer rings and sleeve, race 11 complete with needle bearing cage, gear cluster 12, spacer 13, countershaft gears 14-15 of 2nd and 3rd gears.

- Install into the case the input (primary) shaft complete with needle roller bearings cage 16, progressively sliding the units assembled earlier, then install bearing 17 and ring nut 18.
 - Fasten the outside race of bearing 7 with spacer 12 and its respective bolt.
 - Install the reverse idler gear assembly group (Fig. 9).
 - Prepare the output (secondary) shaft, for installation. Place spacer 22 and race 23 next to bearing 21.
 - Install the 1st and reverse gears assembly groups complete with races, spacers, needle bearings cage and synchronizer group.
 - Next install the output (secondary) shaft progressively mounting on it spacer X and bearing 24 and then the 4th and 5th gears countershafts and the 2nd and 3rd gears groups together with the synchronizer group. Lastly, install spacer 25, bearing 26, and ring nut 27.
 - Engage two gears simultaneously and tighten the ring nuts of both shafts to the torques specified in the table using socket tools AV 853 - AV 855 - AV 809.
 - Check that the axial play of the idler gears is within specified limits and that the two shafts rotate freely and without seizing.
 - Next install worm gear 28 with its ball and stop ring.
 - Install the differential group, the side flanges, the retaining rings, and the semi-axes flanges.
 - Next install into the case the control shafts with their respective needle bearings, and the shift forks and fingers.
- Install the springs with retainers and balls in the case, keeping them in place with a tab, or preferably with tool AV 858.
- Center the forks in relation to the sleeves and these in relation to their respective gear engagements until the axial play is equally divided among them.
 - Position the shift fingers so that they are perfectly aligned using tool 706 AS 9561.
 - Install top and side covers.

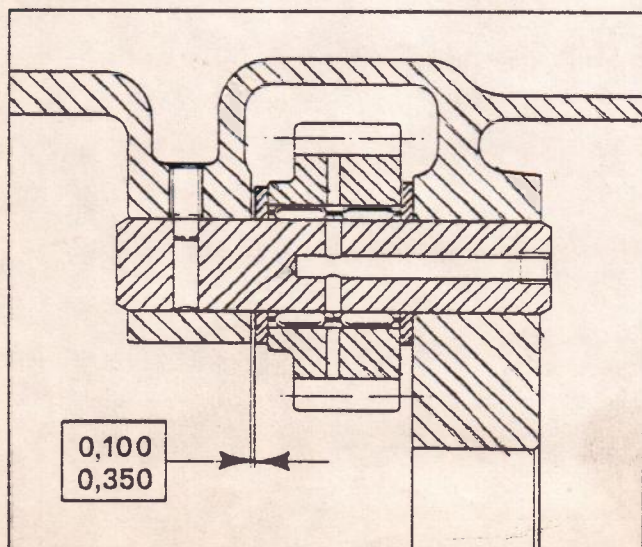


Fig. 9 Reverse Gear Idler Gear Group

GEAR BOX OIL LEVEL MODIFICATION (365)

Waiting for a definite modification to be applied to later gearboxes, we wish to inform you that the level gauge A (No. 107511) and the cap B (No. 107514) shown in the drawing below, will be fitted on cars starting from chassis No. 17747.

While fitting the gauge, pay attention to the orientation; reference mark C must be downwards, then block it well using some drops of LOCTITE and calking. The oil filling (7.750 liters) must be done through cap D.

On cars where this modification has not been carried out, the oil filling must be done through the standard filler hole E.

Afterwards close it and add 2 liters of oil through hole D.

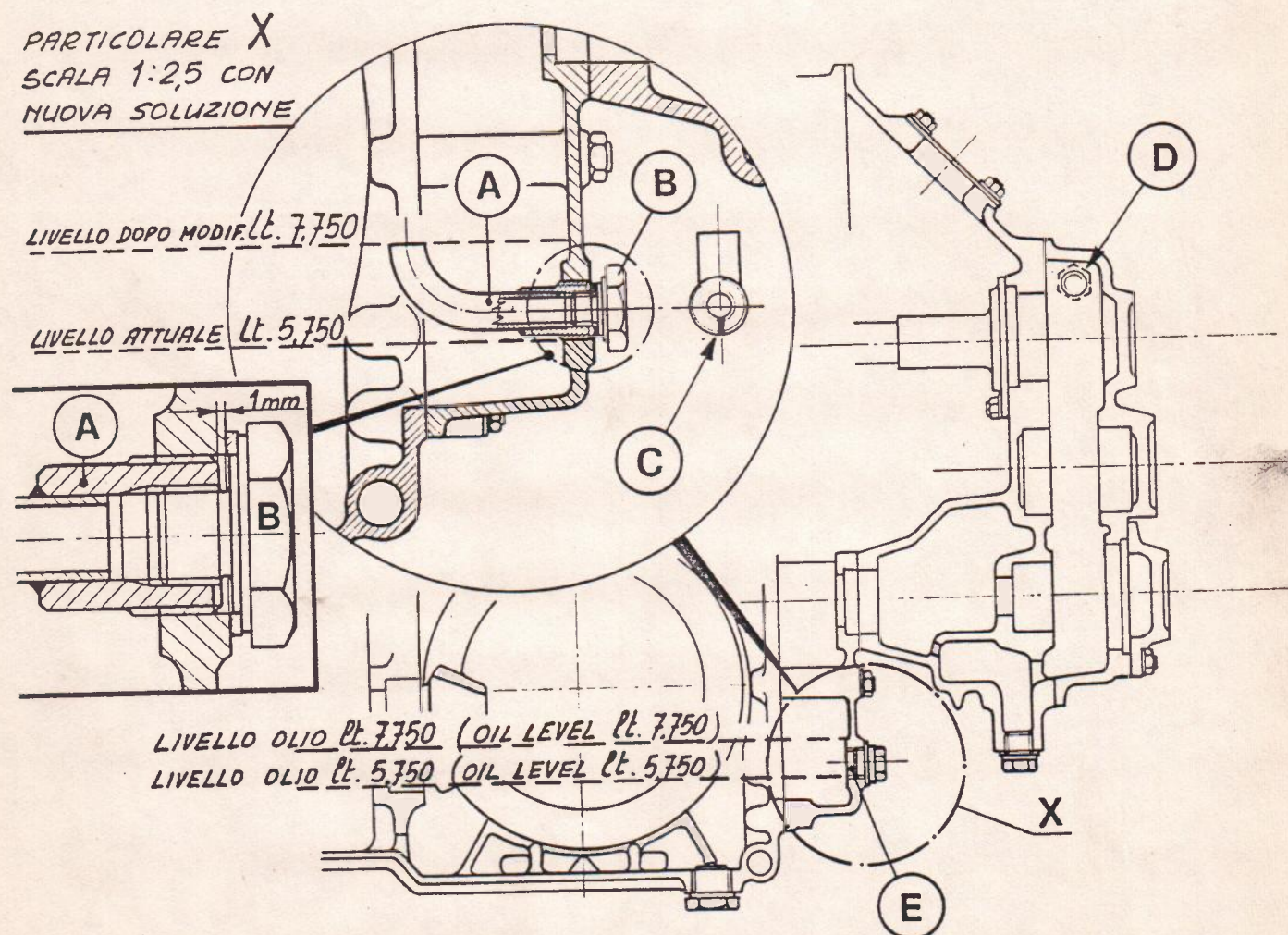


Fig. 10 - Gear Box Oil Level Modification

GEAR BOX SHIFT CONTROL ADJUSTMENT

Dismantling of the shift control lever housing from the chassis is rarely necessary, but at each removal and reinstallation of the gear box, the connecting rod must be disconnected.

To determine the exact position of the shift control lever, carry out the following sequence:

- Engage 2nd gear in the gear box.
 - Move the gear shift control lever to the 2nd gear position slot and insert in the proper hole the bolt for connecting the lever to the gear box.
 - Return the gear shift lever to the neutral position and check that it is equidistant from the two ends of the tabs of each gear slot.
 - If a difference is noted, loosen or tighten as necessary left and right-hand threaded sleeve 1 and nut 2.
 - Once again re-engage 2nd gear, remove the selector plate and check that the side movements of the lever in relation to center position are equal.
 - If a difference is noted, loosen one nut at adjustment sleeve and move the lever as necessary.
- Once again fasten the nut and reinstall the selector plate.
- Check that the position of the control lever is equal in all the gear slots.

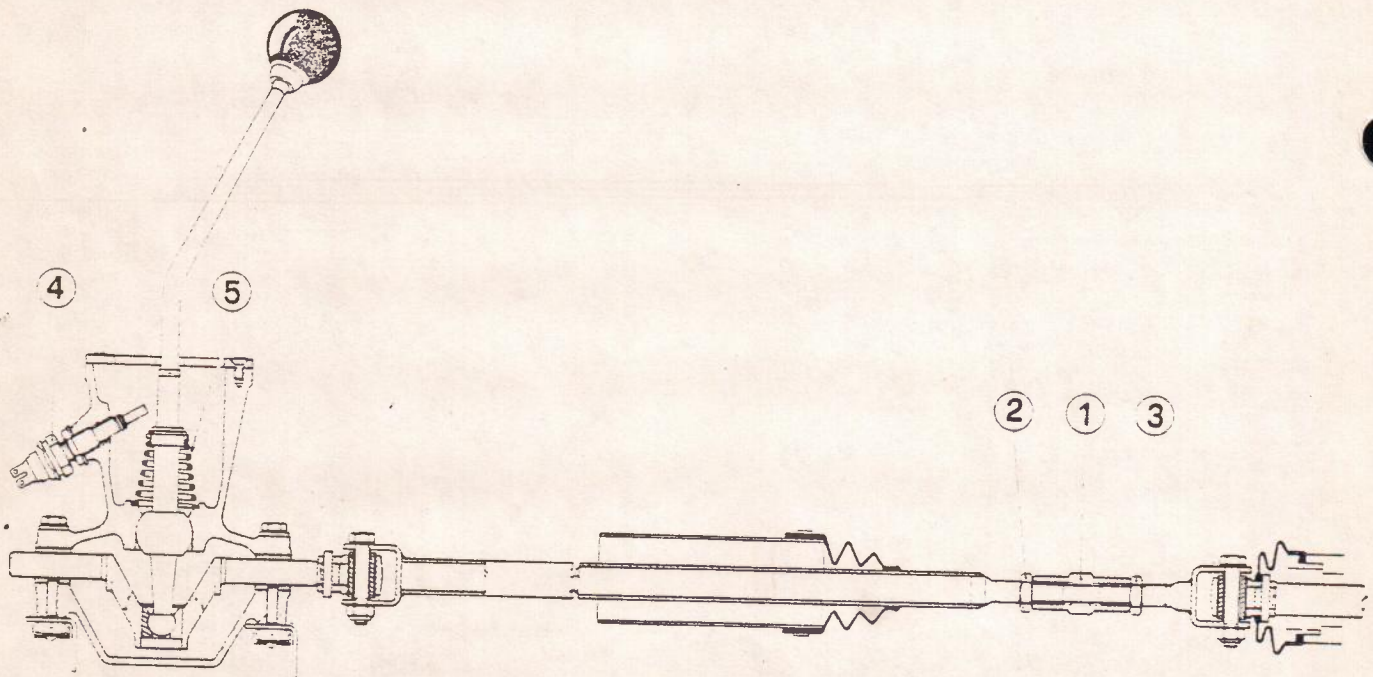


Fig. 11 - Gear Box Shift Control Unit

1-Adjustment sleeve; 2, 3-Tightening nuts; 4-Reverse gear light switch; 5-Neutral clearance return spring

AXLE / DIFFERENTIAL

CHARACTERISTICS AND DATA.....	89
GENERAL DESCRIPTION.....	90
DIAGNOSING MALFUNCTIONS RELATED REMEDIES.....	91
REPAIR INSTRUCTIONS.....	92
CHECKS.....	92
INSTRUCTIONS FOR DETERMINING PRELOAD VALUES OF THE TAPERED ROLLER BEARINGS AND OF THE PINION/RING GEAR ASSEMBLY.....	92
HALF-SHAFTS/SEMI-AXLES.....	97
REMOVAL OF HALF-SHAFTS FROM VEHICLE.....	97
CHECKS.....	97

CHARACTERISTICS AND DATA

Type	Pivoting half-shafts
Differential	Equipped with limited-slip unit
Pinion gear shaft	Hypoidal
Reduction ratio	
To chassis No. 18241	12 / 45
From chassis No. 18243	11 / 43
Differential case bearings	2
Bearing type	Tapered roller
Adjustment via spacer washers	
Pinion bearings preload; measured with 200 0 pulley	1.6 ÷ 1.8 Kg.
Pinion and differential bearings preload measured at pinion with 200 0 pulley	3.9 ÷ 4.0 Kg.
Pinion and ring gear	Constant engagement
Normal clearance on gear teeth sides (pinion/ring gear)	0.12 ÷ 0.17
LIMITED SLIP UNIT	
Type	With friction plates
Number of internally geared plates	4
Number of externally geared plates	4
Number of thrust plates	2
Engagement torque	40%

GENERAL DESCRIPTION

The differential group is made up of a gear assembly unit and a steel case. On the assembly unit is installed the hypoidal ring gear which engages the ring gear, becoming part of the transmission output shaft.

In addition to the hypoidal-toothed planetary and satellite gears, the rear wheels limited-slip unit is installed.

The non-slip steel plates, 5 on each side, have their front contact surfaces hardened with a special molybdenum coating.

This assembly unit is installed in the steel case becoming part of the transmission drive via 2 tapered roller bearings (pre-loaded) and with 2 external half-shaft attachment flanges.

Lubrication is common with the transmission/gear box.

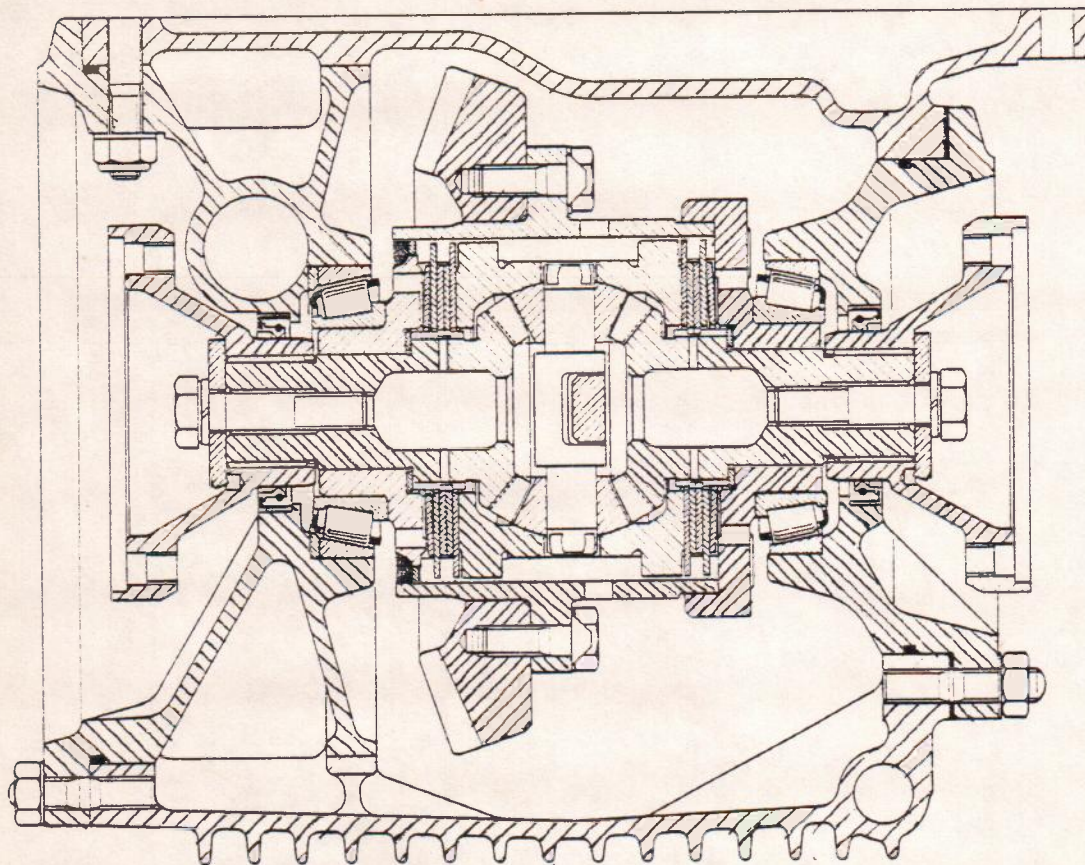


Fig. 12 - Differential

DIAGNOSING MALFUNCTIONS AND RELATED REPAIRS

NOISY DIFFERENTIAL

Possible Causes	Remedies
1) Differential case bearings deteriorated or misaligned.	1) Check pre-loading, replace faulty bearings.
2) Deterioration of ring and pinion gear tooth surfaces.	2) Replace <u>faulty</u> unit.
3) Excessive clearance between contact gear teething.	3) Replace gears.
4) Use of non-prescribed lubricant in case.	4) Substitute the prescribed lubricant.
5) Insufficient quantity of lubricant in case.	5) Check for leaks and fill up to level.
6) Faulty operation of the limited-slip unit (worn plates).	6) Check and replace worn units.

NOISE DURING OPERATION

Possible Causes	Remedies
1) Differential case bearings deteriorated or misaligned.	1) Check pre-loading, replace faulty bearings.
2) Faulty pinion/ring gear teeth contact.	2) Check and re-set contact.
3) Semi-axles cardanic joints with excessive clearance.	3) Replace semi-axles.
4) Insufficient lubrication of the various units.	4) Check for leaks and fill up to level.
5) Excessive ring gear misalignment.	5) Check--eventually replace.

NOISE DURING RELEASE

Possible Causes	Remedies
1) Inexact clearance between pinion and ring gears.	1) Check and reset the clearance.
2) Excessive clearance at pinion gear shaft bearings.	2) Check the bearings pre-load and their clearance.

NOISY WHILE DRIVING ON A CURVE

Possible Causes	Remedies
1) Worn or deteriorated limited-slip plates.	1) Dismantle the limited-slip unit and replace worn plates.
2) Lack of clearance between the various units of the internal case due to faulty assembly or seizure.	2) Substitute all faulty units and check their clearances.
3) Low fluid level.	3) Refill oil to prescribed level.
4) Use of non-prescribed lubricant.	4) Replace with prescribed oil.

REPAIR INSTRUCTIONS

CHECKS

- Verify that the side surfaces of the pinion and ring gear teeth are smooth and free of nicks or scores. Replace if these faults exist.
- Check the operation of the roller bearings and that the internal and external cage rings are still seated properly; if noisy, replace.
- Check the condition of the side oil retaining rings, that of the working surfaces of the limited-slip plates and the wear on the internal and external engagement surfaces. If these surfaces are excessively smooth, replace the plates.
- Check the condition of the limited-slip pressure rings and of the satellite gears shafts.
- Check the condition of the satellite and planetary gear teeth sides and their operational clearances.
- Check the condition of the ring gear mounting bolts and of their internal threads in the case.

VALUES FOR DETERMINING THE PRE-LOAD OF THE TAPERED ROLLER BEARINGS AND OF THE PINION/RING GEAR ASSEMBLY

The correct positioning of the pinion and ring gear in the gear box/differential unit and of the preloading of the tapered roller bearings is carried out in three phases.

- | | |
|-----------------------|--|
| 1 st Phase | Positioning of the pinion in the gear case in relation to the ring gear axis via spacer S. |
| 2 nd Phase | Pre-loading the tapered roller bearings via spacer X. |
| 3 rd Phase | Correct engagement between the pinion and ring gear and pre-loading of the differential tapered roller bearings via spacers Y and Z. |

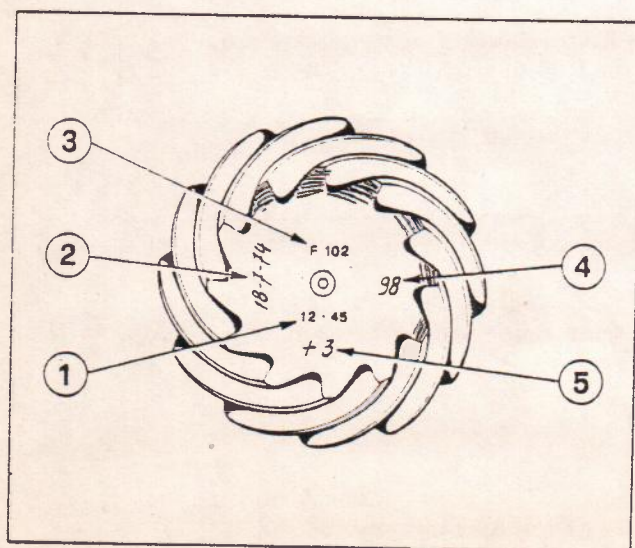
1st Phase POSITIONING OF THE PINION IN THE GEAR CASE IN RELATION TO THE RING GEAR AXIS VIA SPACER C

The thickness of spacer S, to be installed under the carrier for correct positioning, is determined according to the following formula:

$$S = b - (+a) = b - a$$

$$S = b - (-a) = b + a$$

where *b* is a value which takes into consideration the eventual manufacturing differences and is determinable via tool CS 11183.



a is the difference between the bench test value of the pinion/ring gear assembly and the theoretical value 110 mm. *a*, in hundredths of a mm., is stamped on the pinion and is added to be *b* when it is negative (-) and subtracted when it is positive (+).

Fig. 13 - Characteristics of the Pinion Gear Unit
 1-Pinion/ring gear ratio; 2-Production data; 3-Vehicle type; 4-Production unit number; 5-Difference between pinion/ring gear assembly bench test value and theoretical value; it is value *a* expressed in hundredths of a mm.

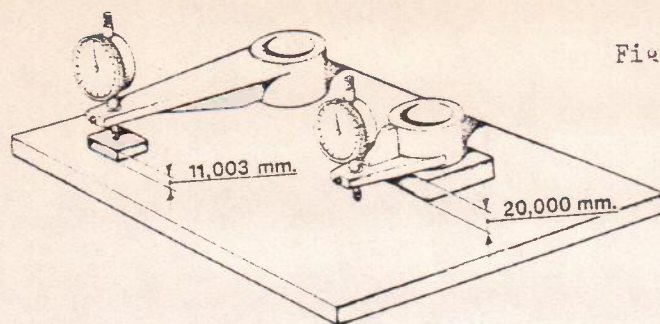


Fig. 14 - Zero-setting of the
Dial Gauges

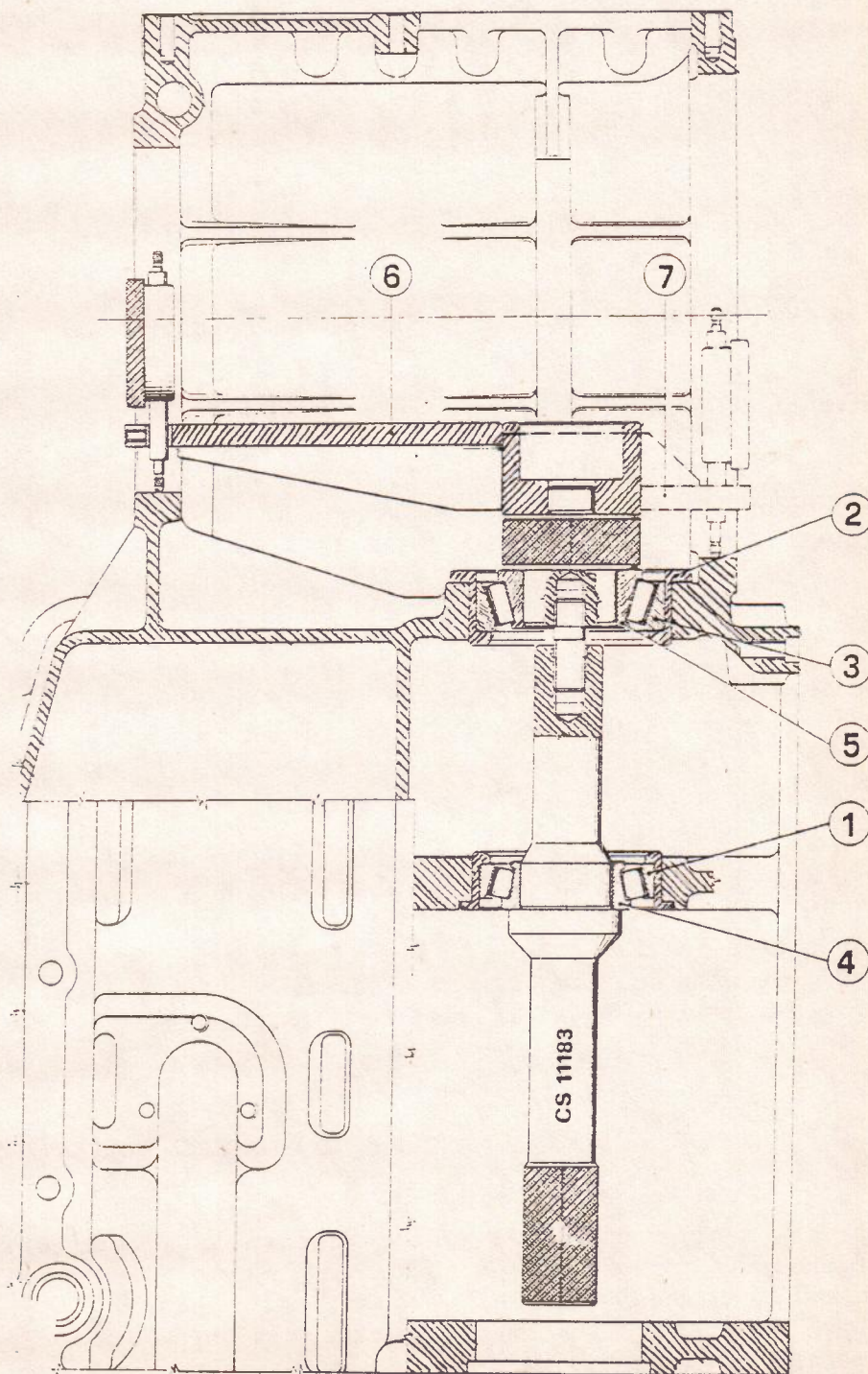


Fig. 15 - Installation Diagram of Tool CS 11183 for Pinion Shaft
Positioning

DETERMINING B (FIG. 15)

With the gear box case mounted on stand AV 794/1/2, install the two outside races for the central bearings of the input and output shafts and the outside cage (1) of the central pinion bearing.

Prepare carrier 2 by installing from the inside race 3 of the bearing on the pinion side. Slide it into the case seat without a spacer.

Install tool CS 11183 complete with bearings in the case. Properly fasten it at bearings 4 and 5. Rotate several times to ensure proper seating of the bearing rings. Zero-set the two dial gauges, installed on supports, using two blocks, one of $20.000 + 0.002$ mm. thickness for the short support, and the other of $11.003 + 0.002$ mm. thickness for the tall support. Install arm 6 on the tool. Carry out an operational reading. Stop the gauges at the point in which the dial needle indicates the minimum value and write it down. Repeat this operation on the other side using arm 7.

The middle figure between the two readings represents value **b**.

Example

Suppose we have a reading of 2.58 on the short arm 7 and 2.60 on the long arm 6. Assume **b** to be: 2.59. Suppose that +3 is stamped on the pinion.

With the formula we can determine: $D = 2.59 - (+0.03) =$
 $= 2.59 - 0.03 = 2.56$

In this example, we would need to install a spacer **S** of 2.56 mm. thickness under carrier 2.

NOTE: The procedure described can be greatly simplified when it is only necessary to replace the pinion without replacing the gear-box case. In this case, no special tools are required. It will be sufficient to vary the thickness of spacer **S** using the difference between the values stamped on the two pinions.

Example:

Old Pinion:	$a = -1$	thus	$110.00 - 0.01 = 109.99$
New pinion:	$a = +5$	thus	$110.00 + 0.05 = 110.05$

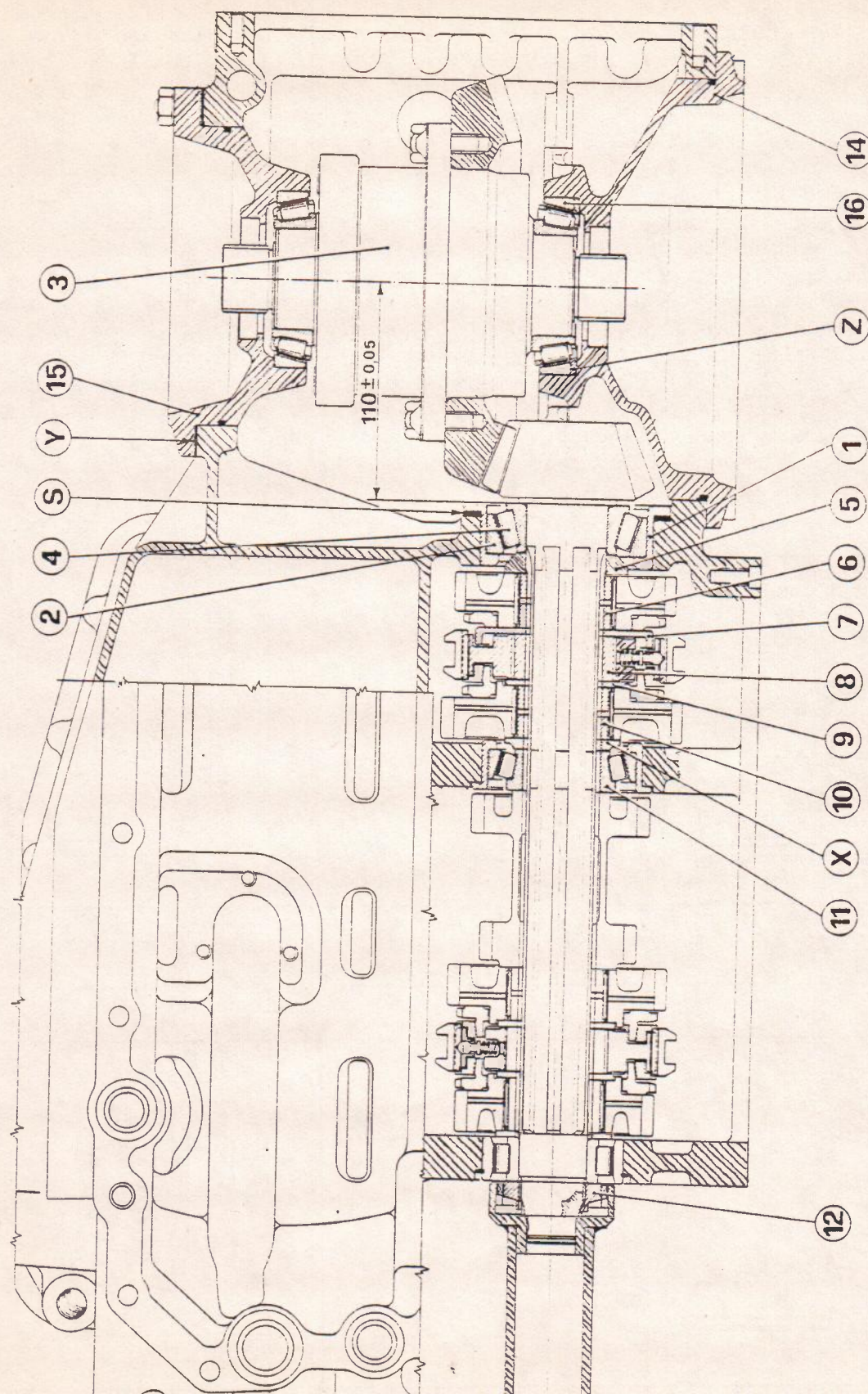
The difference is: $5 - (-1) = 6$

Thus, it will be necessary to move the pinion 0.06 mm. from the ring gear axis of the original assembly, and it will be sufficient to diminish spacer **S** thickness by 0.06 mm.

2nd Phase**PRE-LOADING THE PINION TAPERED ROLLER BEARINGS VIA
SPACER X (FIG. 15)**

Solidly seat carrier 1 into the case and its related spacer **S** of the appropriate thickness. Install differential unit 3 complete with ring gear (it is difficult to install it when the pinion assembly is installed). Install tapered bearing 4, spacer 5, and roller cage 6 on the pinion. Insert into the case spacer 7, drag assembly 8, spacer 9, and race 10 sliding these onto the pinion. Then also install spacer **X** and bearing 4. Then install the other individual units or preferably a rigid tube of the appropriate length which allows the tightening of ring nut 12. Tighten nut to 22 Kg. torque. Using pulley 13 verify that the pre-load is $1.6 + 1.8$ Kg.

Fig. 16 - Tapered Roller Bearings Pre-Load Check



When not using the pulley, remove spacer X to increase or decrease its thickness until the desired value is obtained.

3rd Phase

CORRECT ENGAGEMENT OF THE PINION AND RING GEAR AND PRE-LOADING THE DIFFERENTIAL TAPERED ROLLER BEARINGS VIA SPACERS Y AND Z (FIG. 15)

Coat the gear teeth with red lead paint. Prepare outside flanges 14 and 15 for installation. Install ring Z of 3.00 ± 3.20 mm. thickness and outside race 16 on flange 14. Install flange 14 on the case without fully seating it on its fastening surfaces.

Repeat the operation for flange 15. Proceed to gradually seat flanges 14 and 15 until the clearance between the pinion/ring gear teeth results in 0.12 ± 0.17 mm. and the pre-loading of the bearings is 3.90 ± 4.0 Kg. as measured with pulley 13.

Rotate the pinion a few times while carefully noting the red lead paint impressions on the pinion/ring gear teeth side surfaces. If the impressions are properly aligned, using a dial gauge, check the distance from the surfaces of the case of both flanges. Next install on flange 15 a spacer Y of a thickness equal to the distance measured by the dial gauge.

Decrease spacer Z thickness by an amount equal to the distance of flange 14 from the surface of the case.

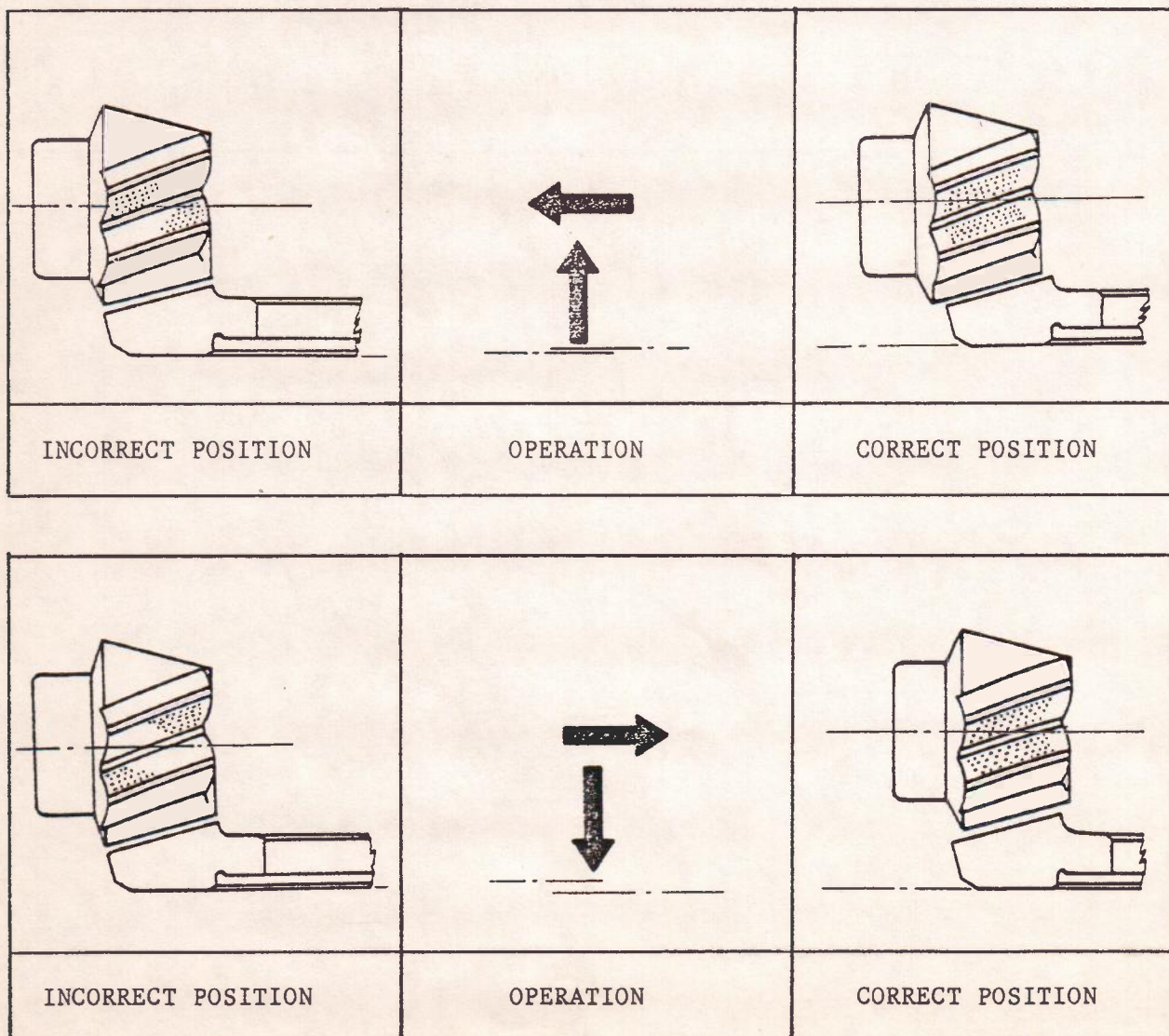


Fig. 17 - Pinion/Ring Gear Alignment

Complete the total assembly with the respective spacers and carry out a final check. In case the contact impressions vary from specifications, proceed to readjust the two units using the examples in Fig. 16.

NOTE: The pre-load values apply to new bearings. For used bearings decrease values 10 + 20 %.

HALF-SHAFTS/SEMI-AXLES

The half-shafts are of a single-unit type (type Lobro); each of which is equipped at each end with a similar cardanic joint assembly made up of large bearing-type balls which can rotate in either direction, and are contained within a sleeved cover containing 140 grams of Mollicote BR 2 lubricant. They do not require periodic lubrication; only when the protective sleeve is broken, it must it be replaced, the spherical joint cleaned and the sleeve housing refilled with the same quantity of the prescribed lubricant.

REMOVAL OF HALF-SHAFTS FROM CHASSIS

Remove the cardanic joints bolts at the differential flanges and on the wheel hub shaft, pushing the units mounted on the ends until each complete unit is removed.

OVERHAUL

When, after prolonged use of the car, vibrations or noises in the rear part of the car are noticed, check the condition of the cardanic joints. If they exhibit play, replace the complete drive shaft units. The new drive shafts do not require a balance check.

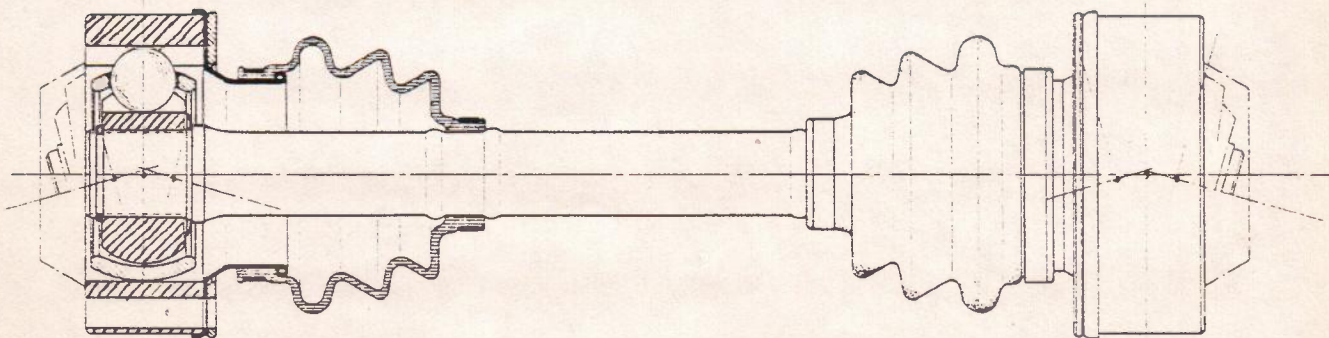


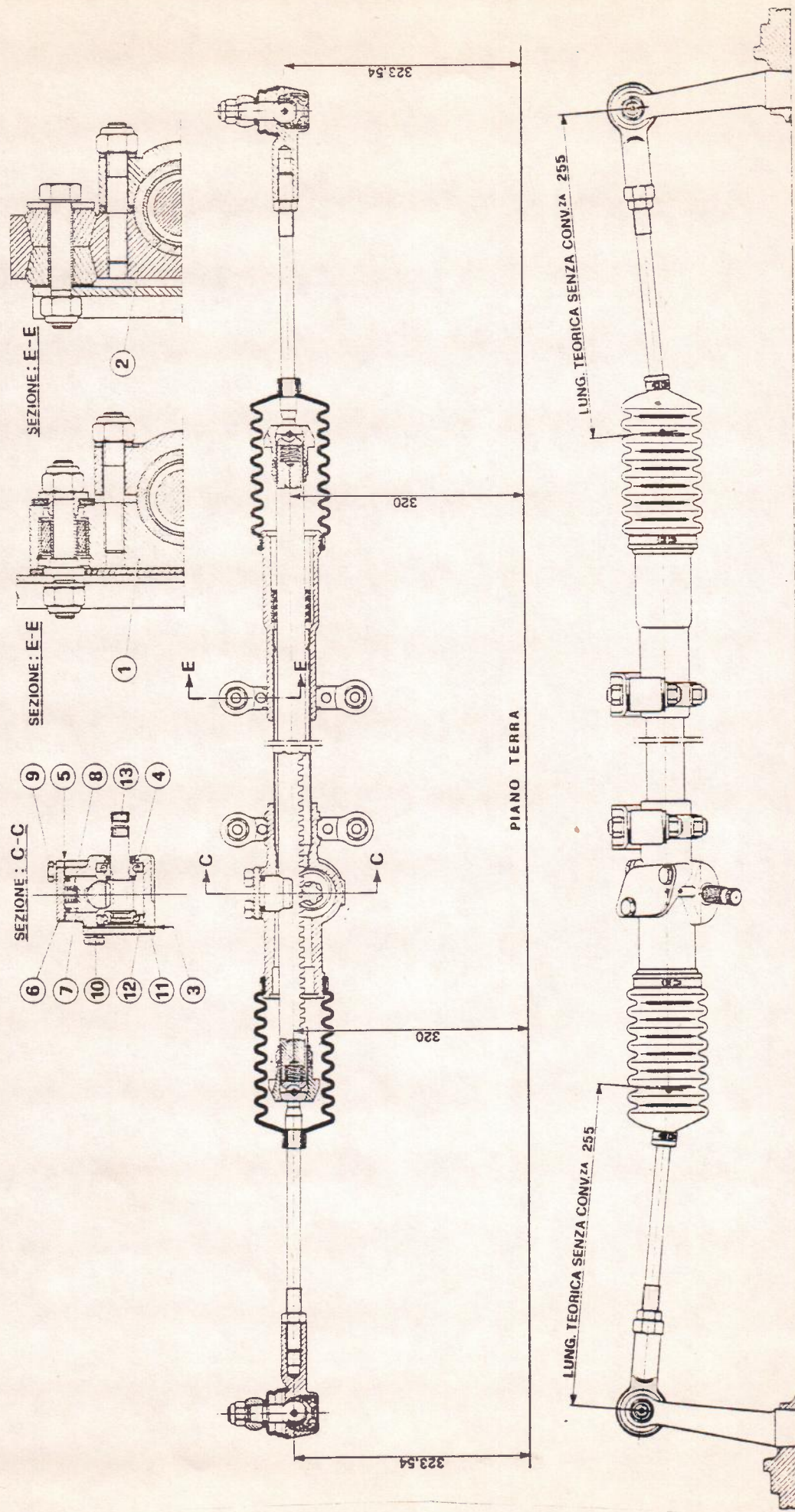
Fig. 18 - Half-Shafts

STEERING

	PAGE
CHARACTERISTICS AND DATA	101
DIAGNOSING FAULTS AND RELATED REPAIRS	102
RACK-AND-PINION ASSEMBLY	104

Fig. 1 - Steering System Assembly

1-Steering case support (first version); 2-Steering case support (second version);
 3-Pinion spacer washer; 4-Steering gear housing; 5-Rack spacer washer; 6-Flange;
 7-Plunger; 8-Spring; 9-Bolt; 10-Bolt; 11-Flange; 12-Spacer; 13-Pinion



STEERING

CHARACTERISTICS AND DATA.....	101
DIAGNOSING FAULTS AND RELATED REPAIRS.....	102
RACK-AND-PINION ASSEMBLY.....	103
DESCRIPTION.....	104
MAINTENANCE.....	104

CHARACTERISTICS AND DATA

Steering, type: CAM GEAR	Pinion rack
Minimum steering circle	12.1 meters
Number of turns of steering wheel, lock-to-lock	3.28
Internal wheel steering angle	$30^{\circ}30' + 30^{\circ}$
External wheel steering angle	$29^{\circ} + 30^{\circ}$
Control pinion bearings	2--support and thrust
Pinion axis inclination	$4^{\circ} 5'$
Pinion rack bearings	1 guide bushing 1 adjustable
Pinion clearance adjustment	Via spacer washer
Steering rack movement wear adjustment	Via spacer plunger and pressure spring
Tracking rods	With ball joints adjust- able at steering rack, with permanently lubri- cated ball joints at shaft lever.
Total rack travel	125.5 mm.
Rack-and-pinion assembly inclination in relation to vertical axis	45°

DIAGNOSING FAULTS AND RELATED REPAIRS

STEERING KNOCK

Possible Causes	Remedies
1) Loose travel adjustment in steering rack.	1) Adjust rack travel.
2) Loose steering rack pinion.	2) Adjust steering rack pinion.
3) Play in ball joints.	3) Replace ball joints on the shaft. Adjust those on the rack.
4) Faulty wheel adjustment.	4) Check and adjust.
5) Unbalanced wheels.	5) Balance wheels.
6) Faulty tire pressure.	6) Refill to required pressure.
7) Irregularly worn or deformed tires.	7) Check; eventually replace.
8) Shock absorber settings too rigid.	8) Check the settings.

FRONT WHEEL FLUTTER

Possible Causes	Remedies
1) Unbalanced wheels (dynamically).	1) Balance the wheels.
2) Faulty tire pressure.	2) Refill to required pressure.
3) Irregular tire wear.	3) Replace the tires.
4) Play in the ball joints or in the steering.	4) Eliminate the play.
5) Faulty front wheel settings.	5) Reestablish exact setting.
6) Faulty shock absorbers.	6) Check out the shock absorbers.
7) Front wheel bearings with excessive play.	7) Reset to exact clearances.
8) Suspension arms play.	8) Check out the suspension.

SWERVING OR SLIDING ON CURVES

Possible Causes	Remedies
1) Faulty tire pressure.	1) Refill to required pressure.
2) Excessively worn tires.	2) Replace the tires.
3) Unbalanced wheels.	3) Balance the wheels.
4) Weakened coil springs.	4) Replace the weakened springs.
5) Malfunctioning shock absorbers.	5) Check their settings.
6) Malfunctioning limited-slip differential unit.	6) Readjust the unit, substituting the plates.
7) Excessive dampening action on the suspension arms.	7) Search for cause of the dampening and eliminate it.
8) Stiffening of suspension arms.	8) Readjust the arm or the arms of the suspension.

THE CAR PULLS TO ONE SIDE

Possible Causes	Remedies
1) Different inflation pressure in the front tires.	1) Bring up to exact pressure.
2) Differing wear on front tires.	2) Check for wear and preferably replace both tires.
3) Faulty setting of front and rear wheels.	3) Check the settings.
4) Front wheel bearings clearances inexact.	4) Reset to prescribed clearances.
5) Deformed coil spring.	5) Check and replace spring.
6) Faulty shock absorbers.	6) Check the shock absorbers.
7) Abnormal contact of the brake pads at one wheel with brake pedal at rest.	7) Check for free travel on the brake pistons in their cylinders.
8) Sticking suspension arm.	8) Check the suspension unit.

STEERING STIFFNESS

Possible Causes	Remedies
1) Low tire pressure.	1) Fill tires to exact pressure.
2) Faulty front wheel settings.	2) Adjust wheel settings.
3) Sticking steering rack within the case.	3) Check steering rack travel.
4) Stiffening of steering controls.	4) Disassemble and check the coupling action between the steering control shaft and steering unit.
5) Stiffening of suspension up-rights ball joints.	5) Replace sticking uprights.
6) Stiffening ball joint shafts of tracking rods.	6) Replace the spherical shafts of the lever on the uprights. Rebuild those on the steering rack.
7) Steering case deformed due to faulty placement.	7) Check placement and steering case.

THE TIRES SQUEAL ON A CURVE

Possible Causes	Remedies
1) Faulty tire pressure.	1) Fill tires to exact pressure.
2) Faulty front and rear wheel settings.	2) Check the setting and correct any differences.
3) Skidding of rear wheels due to tires' limits of adherence.	3) Balance speed of car to radius of curve.

RACK-AND-PINION ASSEMBLY

DESCRIPTION

Steering is of the rack-and-pinion type with a control pinion inclination of $4^{\circ} 5'$ in relation to the axis of the rack, and equipped with symmetrical and independent control tracking rods for each wheel. Their ball joints are permanently lubricated.

MAINTENANCE

Provided there are no leaks from the steering box, it is not necessary to either change or fill up with oil.

- Every 10,000 Km. check the bellows for oil tightness; providing they are in good condition, no further oil level check is necessary.
- If the bellows are found to be leaking, both bellows should be removed and all the oil drained from the steering gear prior to refilling with the correct quantity of oil, without removing the steering gear assembly from the car.

As individual replacement parts are not available for repairs or modifications, it is advisable to replace the complete assembly.

However, adjustment of the clearance between the pinion and the rack is possible by carrying out the following procedure:

Pinion (Refer to Fig. 1)

Reinstall the pinion in its seat without spacer 3. Rest flange 11 on the lower bearing and apply a load of 10 Kg. Measure the distance with a feeler gauge between the steering housing 4 and flange 11 and prepare a spacer having a thickness of 0.05 ± 0.13 mm. greater than the measured distance. Reinstall the flange and the spacer using joint compound, and tighten bolts 10. The pinion should rotate freely without any sign of axial play.

Steering Rack

Install the rack into the rack housing having previously lubricated it; fit plunger 7 without spring 8, install flange 6 on the plunger without spacer 5 and gradually tighten bolts 9 until the pinion can be rotated in each direction 180° with slight effort. Measure the distance between rack housing 4 and flange 6 with a feeler gauge and install a spacer having a thickness of 0.5 ± 0.13 mm. greater than the distance measured. Reinstall spring 8 on dowel 7, spacer 5 using joint compound and tighten down flange 6. Check that pinion 13 can still be rotated in each direction without any stiffness.

FRONT SUSPENSION

	PAGE
DESCRIPTION	107
CHARACTERISTICS AND DATA	107
DIAGNOSING FAULTS AND RELATED REPAIRS	109
SUSPENSION UNITS MAINTENANCE	111
CHECKING AND ADJUSTMENT - TAPERED ROLLER BEARINGS CLEARANCE	111
CHECKING AND ADJUSTMENT - FRONT WHEEL SETTINGS	112

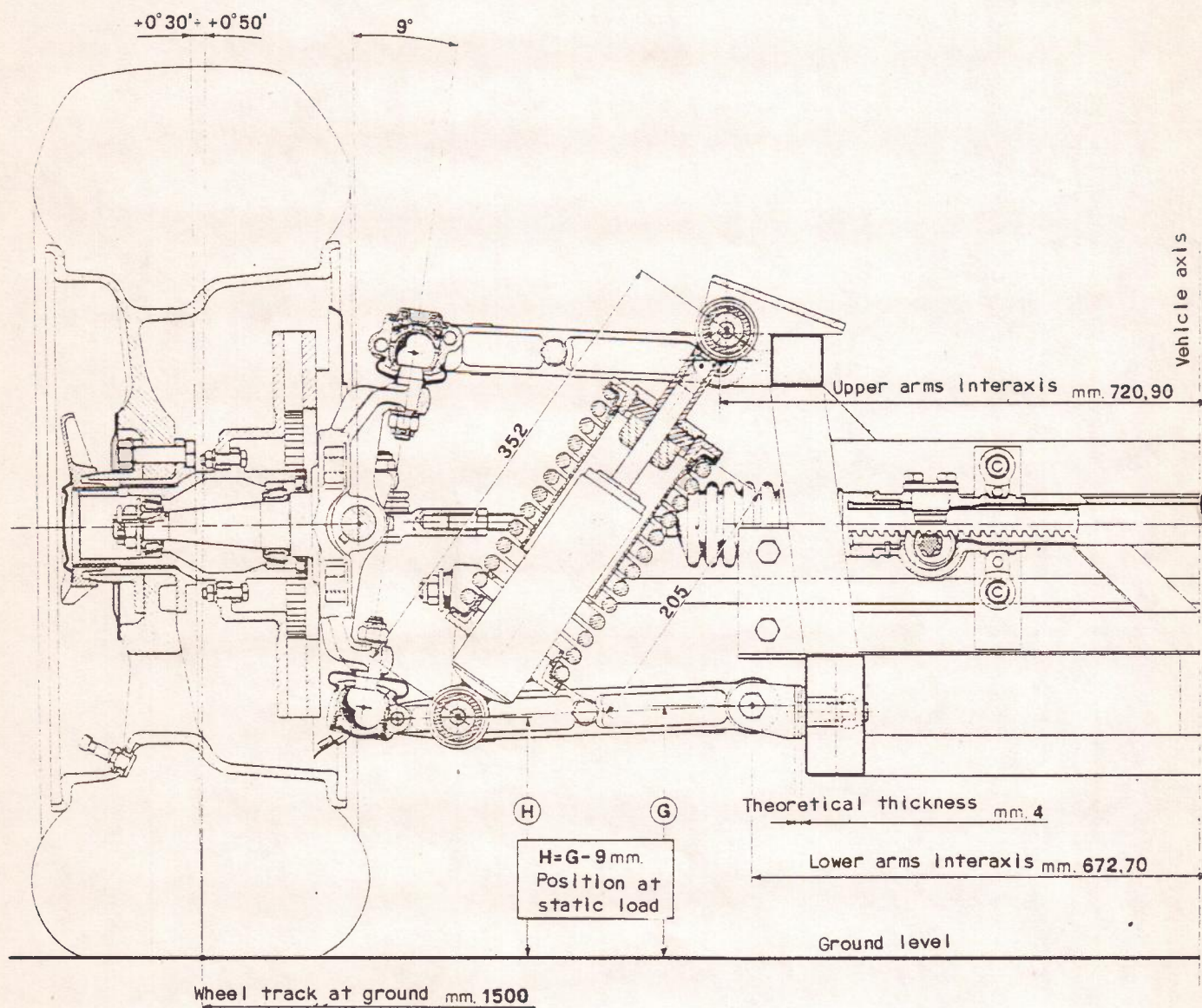


Fig. 1 - Wheel and Suspension Sectional Diagram

FRONT SUSPENSION

DESCRIPTION.....	107
CHARACTERISTICS AND DATA.....	107
DIAGNOSING FAULTS AND RELATED REPAIRS.....	109
SUSPENSION UNITS MAINTENANCE.....	111
SUSPENSION-TO-CHASSIS ATTACHMENT BUSHINGS.....	111
BALL JOINTS - KING-PIN UPRIGHTS.....	111
TAPERED ROLLER BEARINGS CLEARANCE - CHECKING AND ADJUSTMENT.....	111
BEARINGS REPLACEMENT.....	112
CHECKING AND ADJUSTMENT - FRONT WHEEL SETTINGS.....	112
CAMBER ANGLE.....	112
TOE-IN.....	113
CASTER ANGLE.....	114
KING-PIN INCLINATION.....	114

DESCRIPTION

The suspension is by independently sprung wheels using upper and lower transverse wishbones, coil springs, telescopic hydraulic shock absorbers and a transverse stabilizer bar (Fig. 1).

Upper travel is limited by a rubber dampener surrounding the shock absorbers shaft and lower travel is limited by a rubber ring installed within the shock absorber.

CHARACTERISTICS AND DATA

Type	Independently sprung wheels with hydraulic shock absorbers and coil springs.
Stabilizer bar Diameter	Transverse, mounted on rubber grommets. 18 mm.
Upper and lower wishbone arms Chassis attachment King-pin attachment	Via forks welded to chassis Via permanently lubricated flexible ball joints.
Wheel settings data Camber Wheel Toe-in Toe-in adjustment Inclination Caster angle Caster angle adjustment	+0° 40' Via shims 2 mm. Via adjustable length side steering arm 9° 4° Via shims

Wheel bearings	Tapered type
Bearings axial clearance	0.06 $\pm$ 0.10 mm.
Bearings lubrication	Agip Fl 33 FD grease

(*) Vehicle in static load: filled with fuel, 2 passengers and 20 Kgs. of baggage.

Cylindrical coil springs	
	+0
Spring length - no load	360 -7 mm.
Spring length - static load	205 mm.
Spring length - dynamic load	165 mm.
Static load	500 Kg.
Dynamic load	627 Kg.
Flexibility	0.315 mm./Kg.
Wire diameter	12.5 mm.
External diameter	102.5 mm.
Total number of windings	12.5
Direction of coil winding	Right

***NOTE** Equal-load springs must be installed.

DIAGNOSING FAULTS AND RELATED REPAIRS

WHEEL BOUNCE

Possible Causes	Remedies
1) Flattened tire causes rough braking.	1) Replace tire.
2) Unequal tire pressure.	2) Check and refill to correct pressure.
3) Unbalanced wheels.	3) Check and balance.
4) Weakened helicoidal springs.	4) Replace the springs.
5) Malfunctioning shock absorber.	5) Check shock absorber operation on the unit and adjust if necessary.

TIRES EXCESSIVELY WORN

Possible Causes	Remedies
1) Faulty wheel camber.	1) Check.
2) Faulty wheel toe-in.	2) Check.
3) Irregular tire pressure.	3) Check and refill to correct pressure.
4) Excessive acceleration speeds.	4) Acceleration must be progressive.
5) High speeds on rough surface roads.	5) Control speeds.
6) Excessive wheel bearing play.	6) Check clearance and lubricate bearings.
7) Wheel wobbling.	7) Examine to identify what is contributing to the wobbling.
8) Exaggerated use of the brakes.	8) Reduce the use of brakes.
9) Excessive skidding on curves.	9) Eliminate the skidding by reducing curve speed.

NOISY SUSPENSION

Possible Causes	Remedies
1) Noisy or malfunctioning shock absorbers.	1) Check and adjust shock absorbers.
2) Worn arm bushings.	2) Replace bushings.
3) Worn ball joints.	3) Replace ball joints.
4) Worn bearings or with excessive play.	4) Check their operation, replace if necessary and reinstall well lubricated.

THE CAR PULLS TO ONE SIDE

Possible Causes	Remedies
1) Low or irregular tire pressure.	1) Check and inflate to proper pressure.
2) Faulty front wheel setting.	2) Check and adjust setting.
3) Faulty adjustment of the front wheel bearings clearance.	3) Adjust clearances.
4) Faulty shock absorbers.	4) Remove and examine shock absorbers.
5) Weak helicoidal spring.	5) Replace defective spring.
6) Jammed brakes.	6) Check the brakes.
7) Faulty front and rear axles parallelism.	7) Check.

WHEELS WOBBLE

Possible Causes	Remedies
1) Unequal tire pressure.	1) Check and inflatate to proper pressure.
2) Worn wheel bearings or with excessive play.	2) Check and replace if necessary.
3) Faulty shock absorbers.	3) Check shock absorbers.
4) Faulty wheel settings.	4) Check and adjust.
5) Worn arm bushings.	5) Check and replace.
6) Unbalanced wheels.	6) Check.

SUSPENSION UNITS MAINTENANCE

- Check axial and radial play of the attachment shafts of the fork arms.
Replace bushings and shim washers if excessive clearance is noted.
- Check shock absorber condition, adjusting them to their prescribed settings.
- Check the condition of the silentbloc of the upper and lower attachments.
- Check the operation of the control arm rubber bumper (on the shock absorbers) of the suspension arms.
- Check stabilizer bar alignment, the operation of the steering rods' silent-blocs and the rubber support grommets.
- Check condition of wheel hub bearings; replace them if the races and rollers are noisy or worn.
- Check the oil rubber seal on the upright roller bearing; replace it at every rebuilding operation.
- Check the steering knuckle shaft; it should not present worn spots on the bearing seats or on the retaining nut threads.
- Check helical springs in relation to the data characteristics listed making sure that there are not deformations or visible cracks.
- Check the condition of the ball joints; if replacement is necessary, replace both units.

SUSPENSION ARMS-TO-CHASSIS ATTACHMENT BUSHINGS

The suspension arms are connected to the chassis forks via bushings.

If radial or axial play is noted during dismantling of the suspension arms, replace elastic bushing 1 and spacer washer 2.

NOTE. The bushings do not require periodic lubrication.

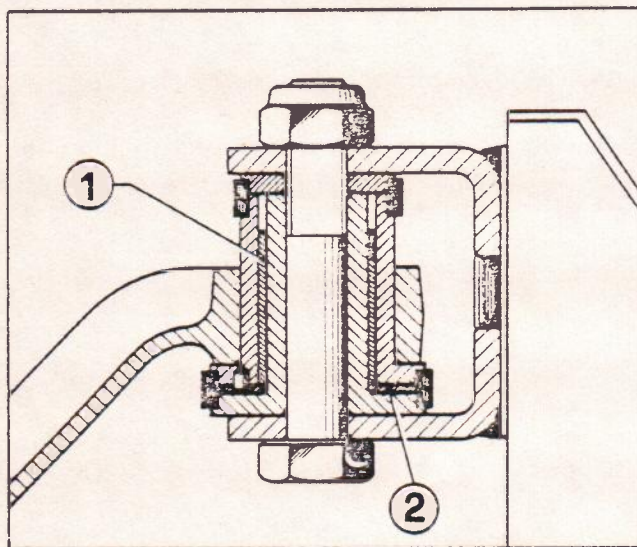


Fig. 2 - Side View of Suspension
Arms-to-Chassis
Attachment Bushings
1-Elastic bushing; 2-Spacer washer

BALL JOINTS - KING-PIN UPRIGHTS

The ball joints are of the permanently lubricated type and do not require any maintenance. Only when excessive play is noted proceed to replace them.

TAPERED ROLLER BEARINGS CLEARANCE - CHECKING AND ADJUSTMENT

Every 10,000 Km., check the axial clearance of the wheel hub at the same spot on the face of the brake disc, using a gauge magnetically mounted to the brake pad caliper. Prescribed clearance: $0.06 \div 0.10$ mm. If these values are exceeded or diminished, remove the cotter pin at the wheel hub shaft nut, loosen or tighten it by $1/12$ of a turn and recheck the clearance.

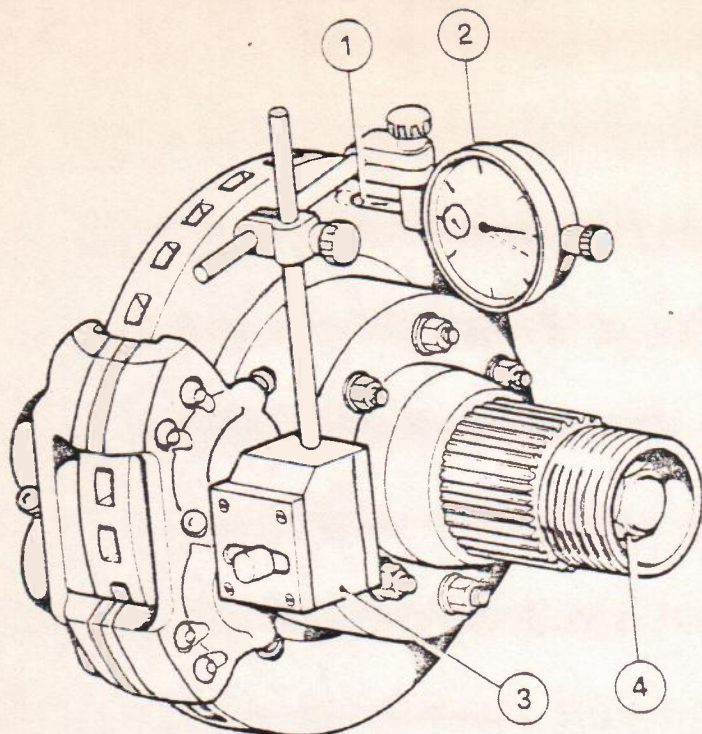


Fig. 3 - Check of Tapered Roller Bearings Axial Clearance
1-Feeler gauge; 2-Gauge; 3-Magnetic mount.

If necessary, slightly lower the retaining nut!
When the adjustment is completed, replace the cotter pin on the retaining nut.

BEARINGS REPLACEMENT

--Tighten with a torque wrench to 2.5 Kg. the upright shaft retaining nut, while rotating the hub a few turns in both directions.
Loosen completely and retighten to 1.5 Kg.; loosen again by about 10° (but not more than 30°) in order to insert the cotter pin.
The resulting axial play must be as close to 0.06 mm. as possible, but not less. Maximum play must not exceed 0.10 mm.
Pack in the space between the wheel hub bearings 120 grs. of grease, and in the space between the bearing and wheel knock-off hub 80 grs. of the same grease, spreading it on the interior surfaces of the hub.

NOTE

The checking of the axial play of the wheel shaft hub bearings must always be carried out by removing the wheel and the disc brake pads.
The internal cages of the roller bearings are mounted on the upright shafts with a slight sliding movement (maximum clearance: 0.028 mm.)

CHECKING AND ADJUSTMENT - FRONT WHEEL SETTINGS

Before starting, it is necessary to conduct a preliminary check of all the individual units of the car that can affect its settings, checking for defects and eliminating them in order not to arrive at faulty settings during the operations.

The inspections to be carried out are:

- Checking of tire pressures.
- Clearance between the steering ball joint arm and pin.
- Clearance of the wheel hub bearings.
- Working operation of the shock absorbers and suspension springs.
- Lower the car to a level surface and under static load.

CAMBER

This setting must be within the minimum value of $+0^{\circ} 30'$ and the maximum value of $0^{\circ} 50'$. When these settings vary, adjust them by varying the number or thickness of

spacer washers 1, located between the mounting forks of the lower suspension arms at the chassis and the chassis itself.

NOTE. The shims are supplied with thicknesses of 1, 1.5, 2, 2.5, 3, 3.5.

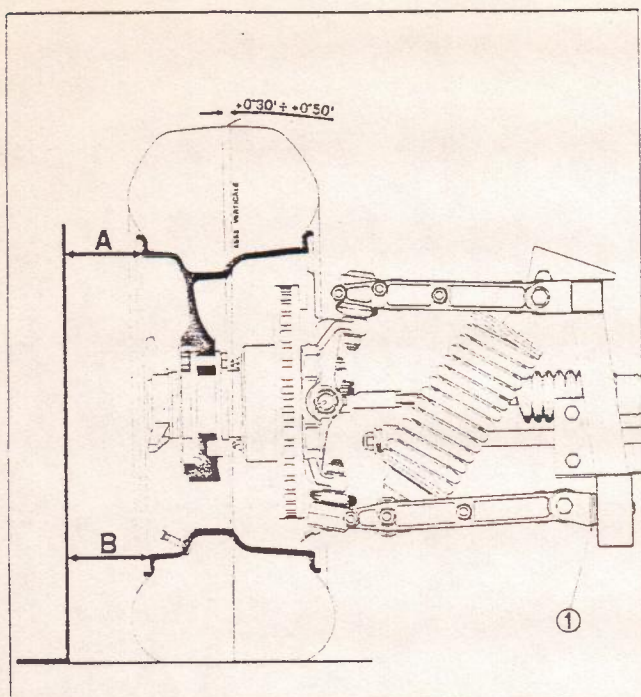


Fig. 4 - Camber

1-Camber adjustment spacer shim.

A = B — 3.4 mm. minimum value

B = B — 6 mm. maximum value

TOE-IN

If during the checking operation the toe-in values are not within 1 ± 3 mm. proceed as follows:

Make sure that the steering housing is in the central position and that the steering wheel is exactly horizontal.

In this position, the two side control rods should be of equal length.

If they are not, proceed to their adjustment.

Loosen the reverse thread nuts 2 of the ball joints 1 on control rods 3 and vary by equal increments their length until arriving at the exact toe-in values. Retighten nuts 2.

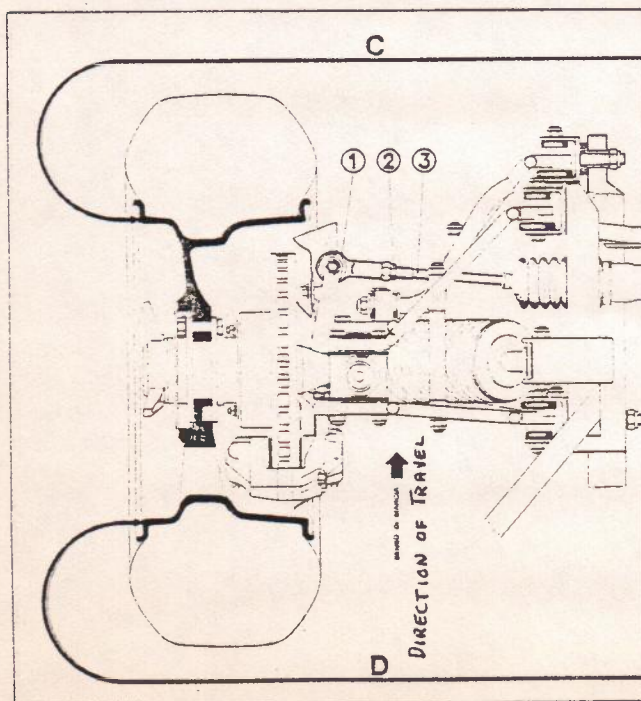


Fig. 5 - Toe-in

1-Ball joints; 2-Lock nut; 3-Control rod

C = D — 1 mm. minimum value

C = D — 3 mm. maximum value

CASTER

For the checking and adjustment of the caster angle, use any of the various appropriate tools commercially available and follow the use instructions.

The caster angle value is 4° .

If the check reveals an altered setting, adjust by moving the existing shims 1 (Fig. 6) from one side to the other of the suspension arms until the angle is achieved.

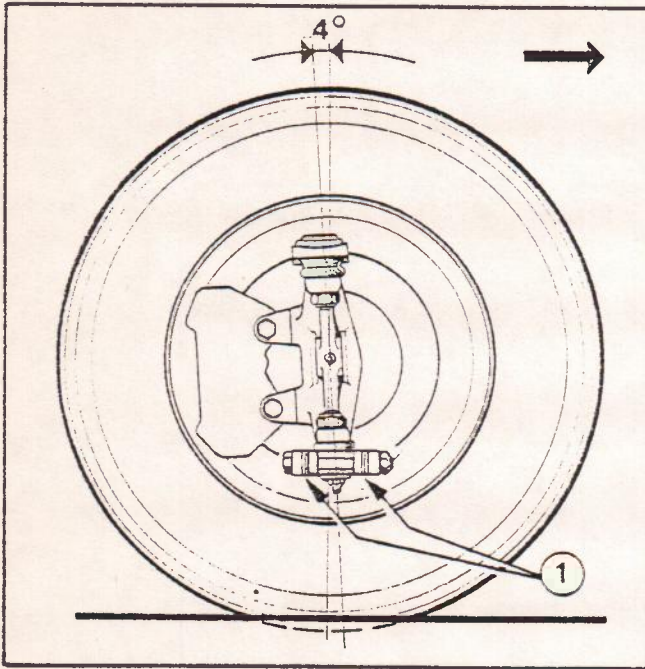


Fig. 6 - Caster Angle

KING-PIN INCLINATION

The angle of inclination of the ball joint is 9° .

It is non-adjustable due to the particular construction characteristics.

This check only serves to make sure that a deformation of the ball joint has not occurred due to a heavy bump.

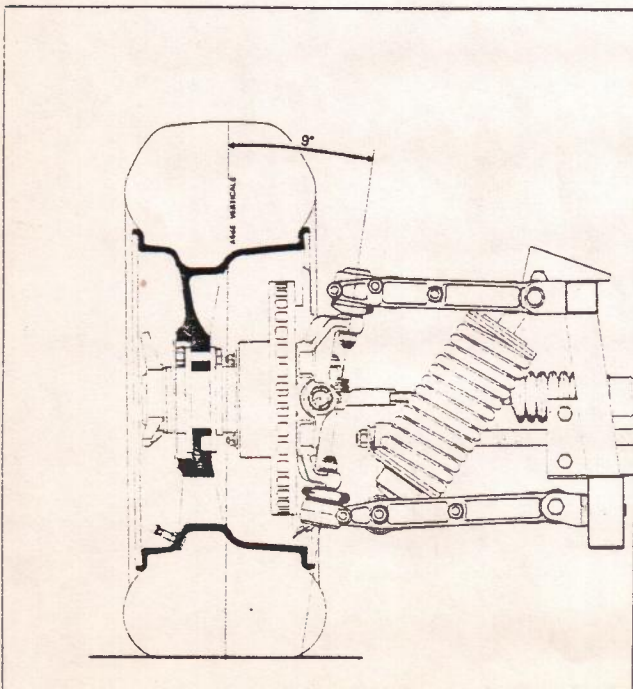


Fig. 7 - King-pin Inclination

REAR SUSPENSION

SHOCK ABSORBERS

	PAGE
REAR SUSPENSION	117
DESCRIPTION	117
CHARACTERISTICS AND DATA	117
DIAGNOSING MALFUNCTIONS AND RELATED REPAIRS	119
SUSPENSION UNITS MAINTENANCE	120
CHECKING AND ADJUSTMENT - WHEEL SETTINGS	120
HYDRAULIC SHOCK ABSORBERS	122
DESCRIPTION	122
CHARACTERISTICS AND DATA	122
DIAGNOSING MALFUNCTIONS AND RELATED REPAIRS	123
OPERATION	123
SHOCK ABSORBERS ADJUSTMENTS	126

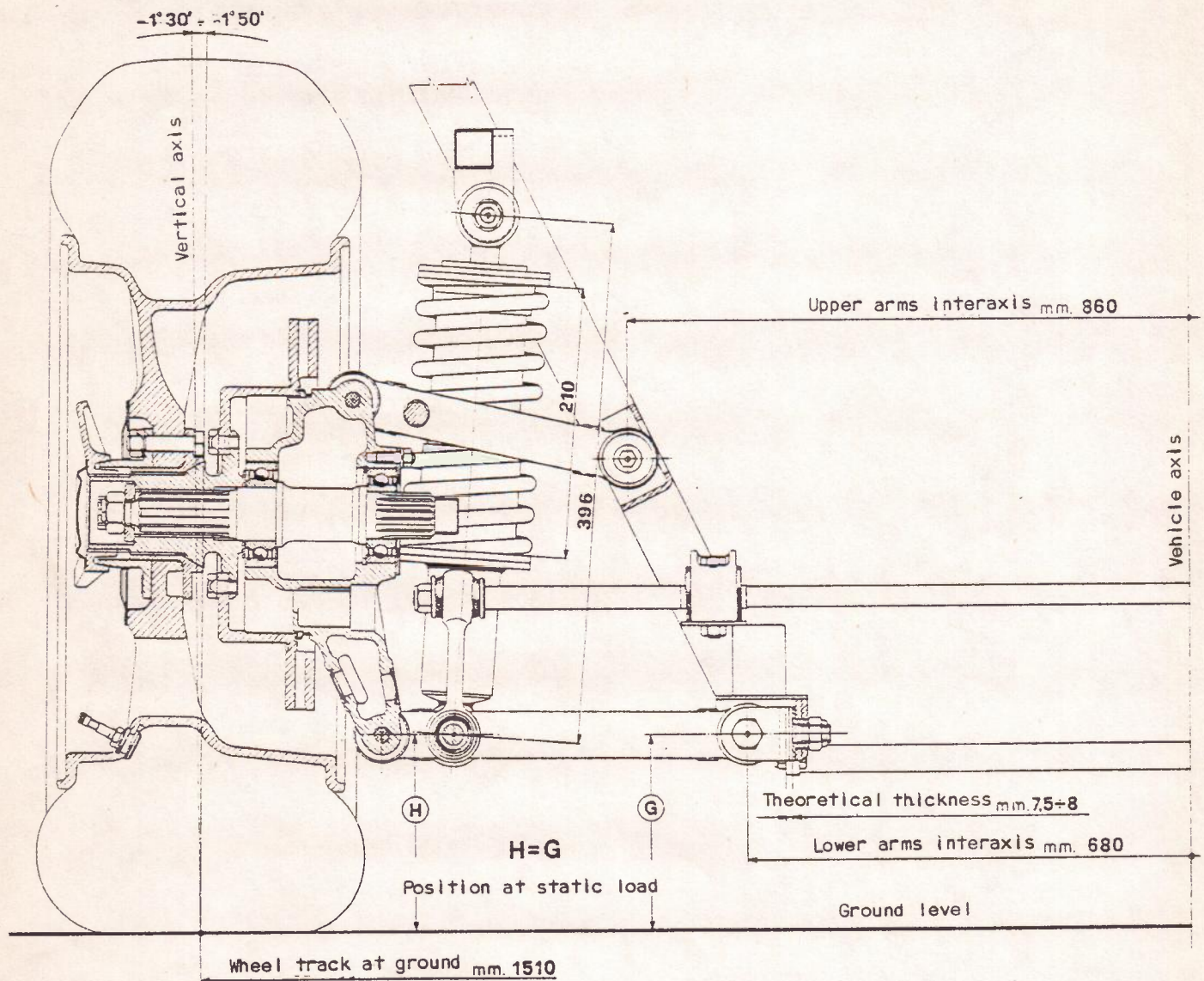


Fig. 1 - Wheel and Suspension Sectional Diagram

REAR SUSPENSION

DESCRIPTION.....	117
CHARACTERISTICS AND DATA.....	117
DIAGNOSING MALFUNCTIONS AND RELATED REPAIRS.....	119
MAINTENANCE AND SUSPENSION UNITS.....	120
SUSPENSION ARMS-TO-CHASSIS ATTACHMENT BUSHINGS.....	120
BALL BEARINGS CLEARANCE AND NOISY OPERATION CHECK.....	120
CHECK AND ADJUSTMENT OF WHEEL SETTINGS.....	120
CAMBER.....	121
TOE-IN.....	121

DESCRIPTION

The rear wheels are independently sprung by means of upper and lower transverse wishbones, coil springs, double acting hydraulic telescopic shock absorbers and a transverse stabilizer bar.

The suspension arms are connected on the outside of the mounting support with bearings supplied with self-lubricating bushings which do not require periodic lubrication and are connected to the chassis via forks and flexible rubberized bushing. The wheel shaft, supported by the control arms housing, rotates on two roller bearings. The transverse stabilizer bar is fastened to the chassis by two elastic supports and its ends are articulated at the lower suspension arms through support housing silentbloc bushings and rubber rings.

CHARACTERISTICS AND DATA

Type	Independently sprung wheels, coil springs and hydraulic shock absorbers
Stabilizer bar	Transverse, mounted on rubber grommets
Diameter	12 mm.
Upper and Lower Suspension Arms	
Chassis Connection	Via forks and elastic bearings (Fland Block)
Suspension Arms Attachment Support Connection	Via elastic bushings (Fland Block)
Wheels	
Camber	-1°40'
Camber	10.1 mm. ÷ 12.30 mm.
Caster adjustment	Via spacer shims
Toe-In*	3 mm. via spacer shims

*Vehicle under static load conditions and 20 Kg. of baggage.

Coil Springs

Spring free length	316 $\pm$ 5 mm.
Length under static load	210 mm.
Length under dynamic load	154 mm.
Static load	280 Kg.
Dynamic load	427 Kg.
Flexibility	0.380 mm./Kg.
Wire diameter	11.5 mm.
Internal diameter	78.5 mm.
Number of coil windings	11
Coil winding direction	Right

NOTE - Installation must be accomplished with springs having matched load characteristics.

DIAGNOSING MALFUNCTIONS AND RELATED REPAIRS

General Noises (Screeching, Thumping, etc.)

Possible Causes	Remedies
1) Unbalanced wheels.	1) Check and rebalance.
2) Wheels out-of-center.	2) Check and adjust.
3) Noisy differential.	3) Consult appropriate section in manual for faults and remedies.
4) Worn shock absorbers, with insufficient stopping action.	4) Reset them or replace them.
5) Weak or broken coil spring.	5) Replace the spring.
6) Deteriorated upper and lower arms bushing or loosened fastening bolts.	6) Check and substitute deteriorated parts.

Irregular or Excessive Wear of Tires

Possible Causes	Remedies
1) Faulty tire inflation pressure.	1) Check and pressure.
2) Unbalanced wheels.	2) Check and rebalance.
3) Wheels out-of-center.	3) Check and adjust.
4) Excessive load in car.	4) Consult data regarding maximum allowable weight.
5) Faulty wheel camber.	5) Check camber values.
6) Check wheel toe-in.	6) Check toe-in values.

The Car Pulls to One Side

Possible Causes	Remedies
1) Faulty tire inflation pressure.	1) Check the pressure.
2) Faulty suspension setting.	2) Check wheel settings and suspension arm operation.
3) Sticking brake on one wheel.	3) Check brake operations on all four wheels.
4) Broken or weak spring.	4) Replace the spring.

Single-Wheel Suspension Failure

Possible Causes	Remedies
1) Faulty tire pressure.	1) Check and refill to proper pressure.
2) Weak or broken coil spring.	2) Replace coil spring.
3) Shock absorber with malfunctioning dampening action.	3) Overhaul the shock absorber and replace worn units.

MAINTENANCE OF SUSPENSION UNITS

- Check the condition of the shock absorbers, readjusting them to their prescribed settings if needed.
- Check the condition of the shock absorbers silentbloc units and that of the rubber washers on the spring support flanges.
- Check the condition of the upper shock absorbers compression travel limit stoppers.
- Check the condition of the coil springs against the listed specifications.
- Check the condition of the flange block elastic bushings at the upper and lower attachment points.
- Check the alignment of the stabilizer bar and the supports' clearances.
- Check the condition of the stabilizer bar mounting bracket rubber inserts.
- Check the condition of the hand brake contact surfaces, the control and adjustment mechanism and of the pads themselves.

SUSPENSION ARMS-TO-CHASSIS ATTACHMENT BUSHINGS

The suspension arms are connected to the chassis forks via FLAN-BLOC type elastic bushings. If during disassembly, excessive wear or deformation is noted, replace the complete bushing assembly.

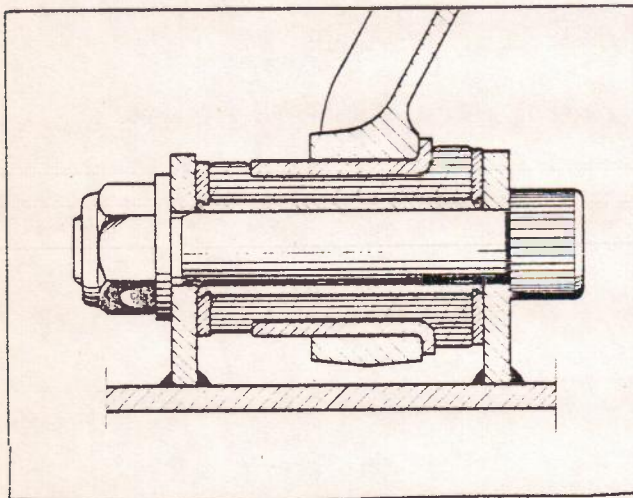


Fig. 2 - Side View of Suspension Arms-To-Chassis Attachment Bushings

CHECKING CLEARANCES AND OPERATIONAL NOISE OF WHEEL BEARINGS

The bearings are of the self-lubricating type and do not require periodic lubrication. As their operational efficiency is not easily checked, it is advisable to replace them at 30,000 + 40,000 km., even if no noise or looseness is noticed.

CHECKING AND ADJUSTMENT OF WHEEL SETTINGS

Before proceeding with the control checks a preliminary inspection of all the units of the car, which can influence the setting of the car, must be carried out in order to discover abnormalities and eliminate them thus eliminating faulty setting readings. The control checks to be carried out are the following:

- Tire pressure.
- Suspension arms play.
- Faulty shock absorbers.
- Deformed or incorrectly load suspension springs.
- Place the car on a flat surface under static load conditions to verify the correct position of the control levers.

CAMBER

Camber settings must be within the minimum value of $-1^{\circ}30'$ and maximum value of $-1^{\circ}50'$. Whenever these values are altered, it will be necessary to readjust the setting by varying the number or the thickness of spacer washers 1, placed between the upper suspension arms-to-chassis attachment forks and the chassis.

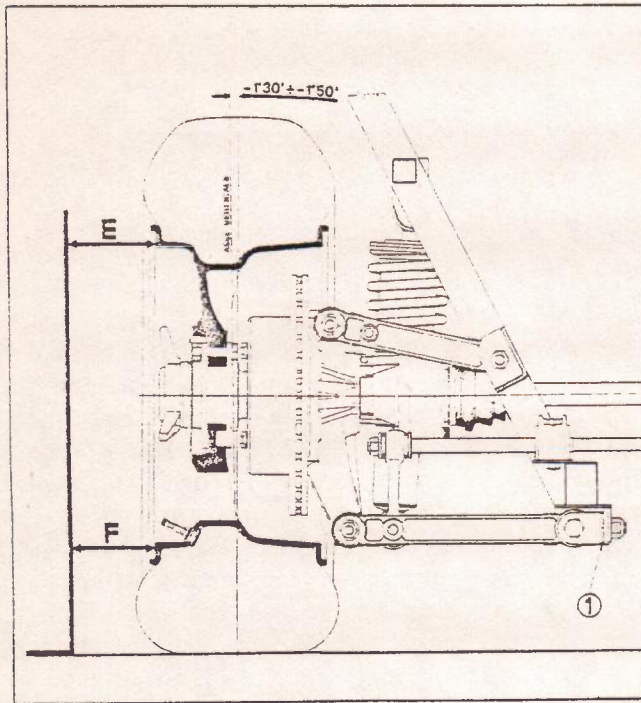


Fig. 3 - Camber
1-Spacer shims.

$$E = F + 10.1\text{mm. minimum value}$$

$$E = F + 12.3\text{mm. maximum value}$$

TOE-IN

If toe-in settings are not within specified limits, vary the number of spacer shims 1 or their thickness at the lower forks.

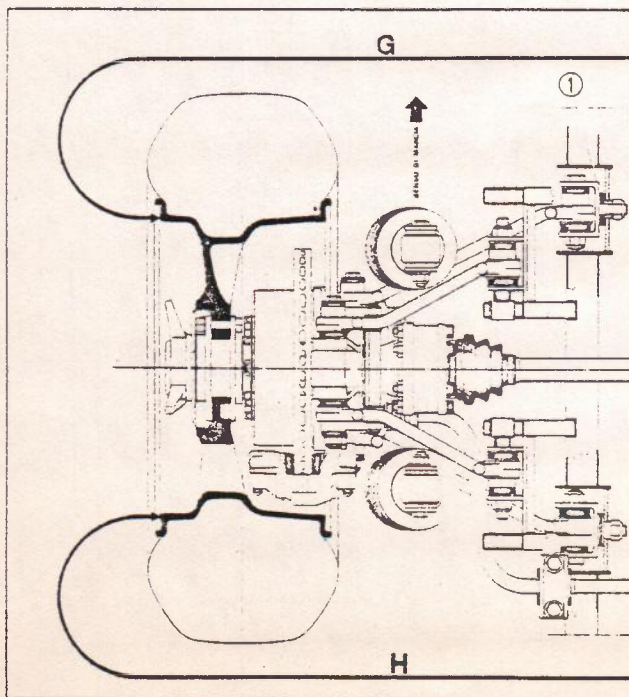


Fig. 4 - Toe-In
1-Spacer shims

$$G = H - 2\text{mm. minimum value}$$

$$G = H - 4\text{mm. maximum value}$$

SHOCK ABSORBERS

DESCRIPTION.....	122
CHARACTERISTICS AND DATA.....	122
DIAGNOSING MALFUNCTIONS AND RELATED REPAIRS.....	123
OPERATION.....	123
COMPRESSION TRAVEL.....	123
EXTENSION TRAVEL.....	125
SHOCK ABSORBER SETTINGS.....	126

DESCRIPTION

The KONI shock absorbers, front and rear, are of the hydraulic and telescopic double effect type. They are made up of a cylindrical unit formed of two tubes of which the internal tube 17 is the pressure cylinder and external tube 18 forms the compensating oil reservoir. On the lower part of tube 18 and on the upper part of shaft 16, are located flanges 22-28 for the support of the suspension springs and on them are mounted two rubber spacers 24-25 for silencing of the springs. Pressure cylinder 17 is sealed from the top by a ferrule screwed on tube 18 opposite seat 4 of the compensating valves 5-26 and which rests at the bottom of the same tube. The ferrule is provided with three rubber ring within which travels shaft 16, which provides at its upper end the attachment for the connection of the shock absorber to the chassis and at the bottom end piston 12 with closing valve 13 and extension valve 11. On shaft 16 is placed the compression travel limiting stop and rubber washer 30. These limit the shock absorber travel during the compression phase. Within cylinder 17 is also located extension travel limiting stopper 29 which limits the travel in the extension phase.

CHARACTERISTICS AND DATA

FRONT	
Type	KONI 82 T - 1833
Static load length	352 mm.
Upper ride clearance	312 ± 2 mm.
Lower ride clearance	397 ± 2 mm.
Stops: Hard rubber - thickness	12 mm.
Sponge vulkollan - thickness	22 mm.
Extension	105 Kg.
Compression	45 Kg.
Oil capacity — each	0.190 liter
Oil type	AGIP OSO 35
REAR	
Type	KONI 82 T - 1834
Static load length	396 mm.
Upper ride clearance	340 mm.
Lower ride clearance	465 ± 2 mm.
Stops: Hard rubber - thickness	10 mm.
Sponge vulkollan - thickness	15 mm.
Extension	90 Kg.
Compression	30 Kg.
Oil capacity - each	0.310 liter
Oil type	AGIP OSO 35

DIAGNOSING MALFUNCTIONS AND RELATED REPAIRS

NOISE

Possible Causes	Remedies
1) Deterioration of the lower and upper attachments.	1) Check the elastic bushing; if damaged or hardened, replace them.
2) Low oil quantity due to leaks.	2) Overhaul the shock absorber and refill with oil according to quantity listed on page 122.
3) Damage or sticking travel limit stopper.	3) Replace the stopper.
4) Sticking or piston shaft 16 in the oil retaining rubber washers.	4) Lubricate the piston.

VARIATIONS IN DAMPENING ACTION

Possible Causes	Remedies
1) Increase in dampening action due to use of non-prescribed oil.	1) Check oil, which in this case is too high of a viscosity and substitute with prescribed oil in the prescribed quantity.
2) Decrease in dampening action due to breakage of a particular unit or the weakening of the expansion spring or a particular valve.	2) Overhaul shock absorber and replace appropriate units.
3) Decrease of dampening action due to lack of oil.	3) Refill with oil to prescribed quantities as specified on page 122.

OPERATION

COMPRESSION TRAVEL

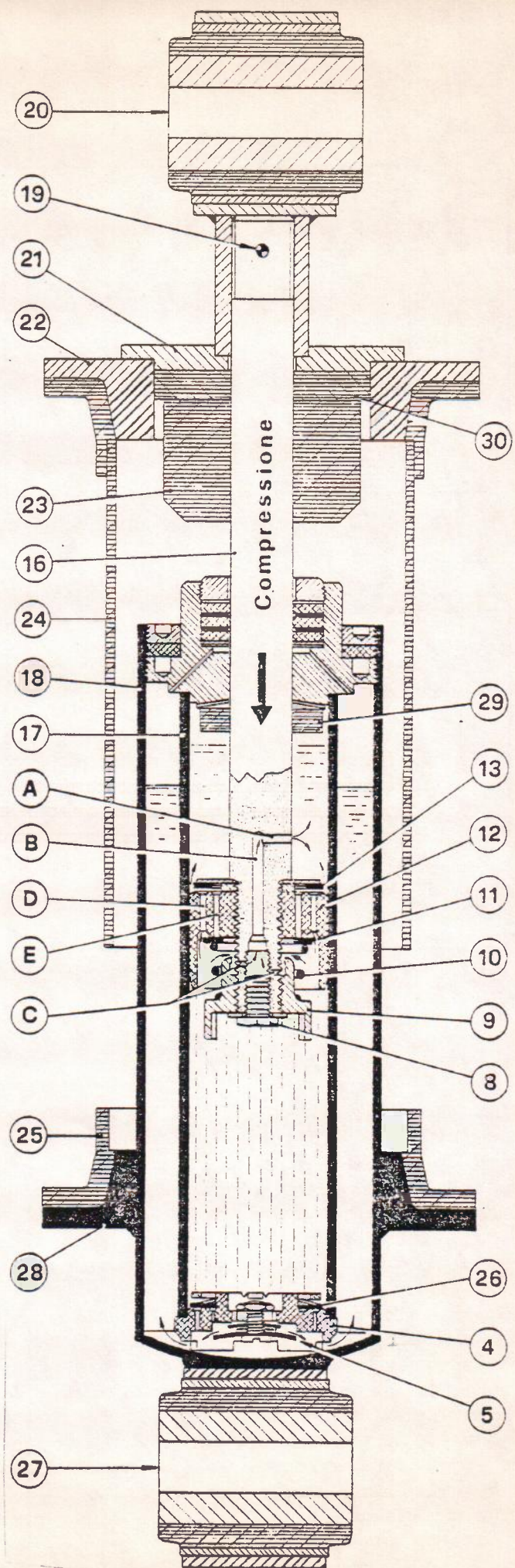
Imagine, for explanatory purposes, a rebounding wheel and the frame in complete rest position. It follows that for each ground contact the wheel will receive an upward impact. This impact is absorbed partially by the suspension flexibility and partially from the shock absorber action during the compression travel, in such a manner that the shock absorber body which is attached to the wheel moves upwards, while the piston attached to the frame remains in the rest position. Due to this displacement, a compression chamber is formed under the piston and a vacuum above the piston.

Under this condition shut-off valve 13 will open and the fluid will flow through holdes D located in the piston and pass into the upper chamber. Other fluid will also move through the register holes C and radial hole A into the upper chamber. Since the upper chamber cannot receive all the fluid which is expelled from the compression chamber, because of the volume occupied by the piston rod, then valve 5, located on the cap, at the lower end of cylinder 17 will bend in an open position by the pressure effect allowing the excess fluid to flow through the filter and plug channels, into the reservoir chamber 18.

The resistance opposed to the fluid passing through valve 5 sets up the absorbing power of the unit.

Fig. 5 - Compression Travel Operation

- A. Radial hole
- B. Axial hole
- C. Calibrated holes
- D. Fluid return holes
- E. Two-way holes
- 4. Valve seat
- 5. Compensating valve
- 8. Stop nut
- 9. Adjustment nut
- 10. Spring
- 11. Extension valve
- 12. Piston
- 13. Valve
- 16. Piston shaft
- 17. Pressure cylinder
- 18. Oil reservoir
- 19. Stop pin
- 20. Upper mounting
- 21. Flange retaining sections
- 22. Spring retaining flange
- 23. Compression travel limiting stopper
- 24. Upper shaft protection spacer
- 25. Lower spring mounting spacer
- 26. Compensating valve
- 27. Lower mounting
- 28. Spring retaining flange
- 29. Extension travel limiting stopper
- 30. Rubber washer



EXTENSION TRAVEL

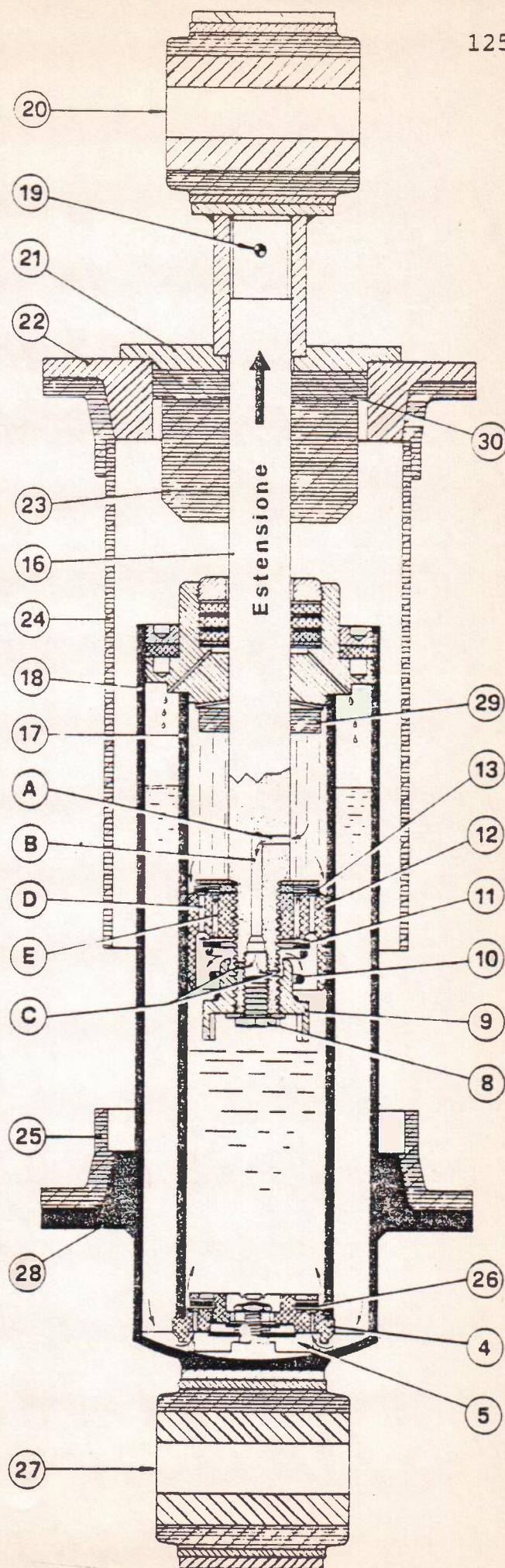
When the wheel, previously in motion, has returned to its normal position, due to the dampening action, at the same time draws the shock absorber body along with it, while piston 12 remains in place, thereby forming a compression chamber. This function causes the shut-off valve 13 to close and part of the fluid to flow into the lower chamber through holes A, B, and C. The excess fluid passes through holes E of piston 12, reaches valve 11 and causes it to open by overcoming the spring pressure 10. At the same time, more fluid enters into the cylinder 18 through valve 26 until it is entirely full, as a result of the vacuum formed in the lower chamber under piston 12. The resistance opposed to the fluid through holes E of piston 12, that created on valve 11 by spring 10 and the resistance of the calibrated holes C, provide the absorbing pressure on the return travel of the unit.

I [diagram of hatched pattern] Oil Under Pressure

II [diagram of horizontal line pattern] Oil At Rest

Fig. 6 - Extension Travel Operation

- A. Radial hole
- B. Axial hole
- C. Calibrated holes
- D. Fluid return holes
- E. Two-way holes
- 4. Valve seat
- 5. Compensating valve
- 8. Stop nut
- 9. Adjustment nut
- 10. Spring
- 11. Extension valve
- 12. Piston
- 13. Valve
- 16. Piston shaft
- 17. Pressure cylinder
- 18. Oil reservoir
- 19. Stop pin
- 20. Upper mounting
- 21. Flange retaining sections
- 22. Spring retaining flange
- 23. Compression travel limiting stopper
- 24. Upper shaft protection spacer
- 25. Lower spring mounting spacer
- 26. Compensating valve
- 27. Lower mounting
- 28. Spring retaining flange
- 29. Extension travel limiting stopper
- 30. Rubber washer



SHOCK ABSORBER ADJUSTMENTS

The shock absorbers are rated according to the data indicated in the diagrams (Fig. 7, 8).

The following instructions refer to shock absorbers adjustments that may be required due to faulty operation or when it is desired to alter the stiffness of the suspension action on the car.

The adjustment operation is carried out as follows:

- Remove the shock absorber from the car.
- Remove the springs and rubber spacers 24 - 25.
- Fasten the shock absorbers in a vise, fastening it at the lower attachment point 27.
- Remove pin 19.
- Holding shaft 16 secure, unscrew upper attachment 20.
- Remove stopper 23.
- Temporarily mount the upper mounting unit 20 and fasten it to a vise;

completely press shock absorber, gradually rotating counter clockwise until the register nut tooth 9 engages in proper seat 4. Maintain rotation without forcing until encountering the resistance created by stop nut 8 against the shoulder surface. Do not force any further to avoid damage to the unit.

At this point, the oil is free to move through valve 11 and both holes C, in effect the shock absorber should operate with extreme flexibility. Maintaining a constant pressure, rotate the shock absorber body two half turns clockwise.

Raise the upper mounting attachment 20 at least 1 cm. without turning it, in order to release engagement tooth 9.

The shock absorber is now reset for normal use, for exact settings it is necessary to use the proper machine tool. The total adjustment range is composed of six half turns to the right; which when fully performed, the shock absorber should attain the maximum rigidity.

Under no circumstances extend or compress the shock absorber while it is in the horizontal position.

Graphs Obtained with GMF Instrument-Travel = 75 mm. - Arm Length 180 mm.

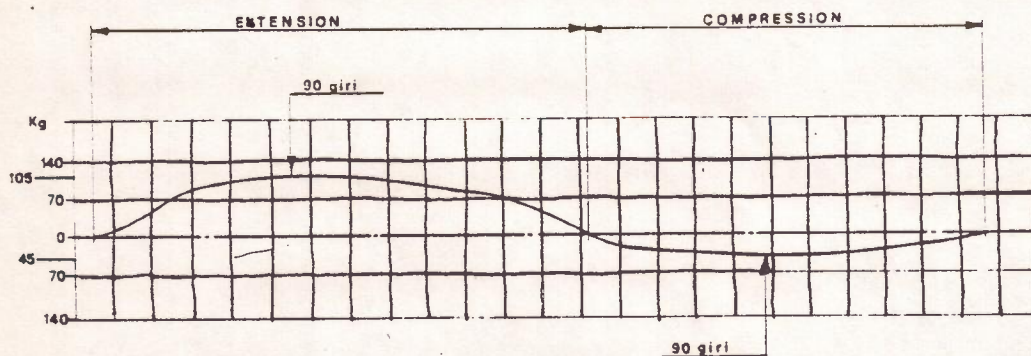
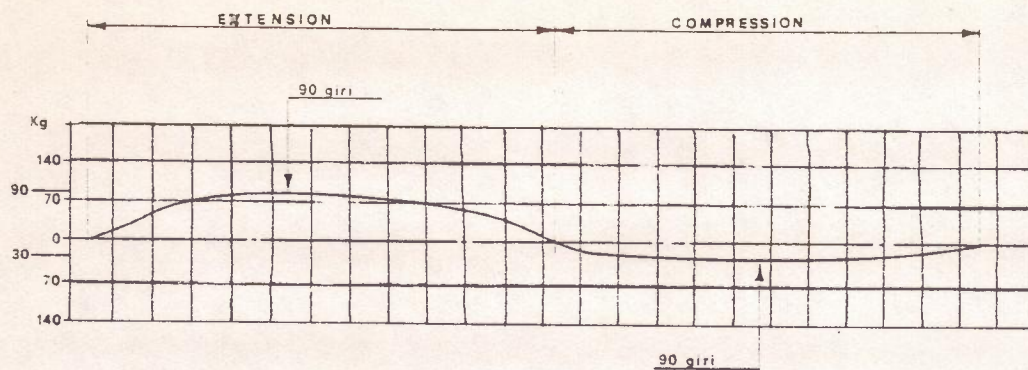


Fig. 7 - Front Shock Absorbers. Setting Diagram: Extension = 105 Kg.
Compression = 45 Kg.

Fig. 8 - Rear Shock Absorbers. Setting Diagram: Extension = 90 Kg.
Compression = 25 Kg.



BRAKES

WHEELS AND TIRES

	PAGE
BRAKES	131
DESCRIPTION	131
CHARACTERISTICS AND DATA	132
DIAGNOSING FAULTS AND RELATED REPAIRS	133
HYDRAULIC BRAKES	136
EMERGENCY BRAKE	138
AIR BLEEDING OPERATION	140
MAINTENANCE INSTRUCTIONS	141
WHEELS AND TIRES	142
CHARACTERISTICS AND DATA	142
DIAGNOSING FAULTS AND RELATED REPAIRS	142
WHEEL BALANCING	144
TIRE MOUNTING AND INFLATION PRESSURE	145

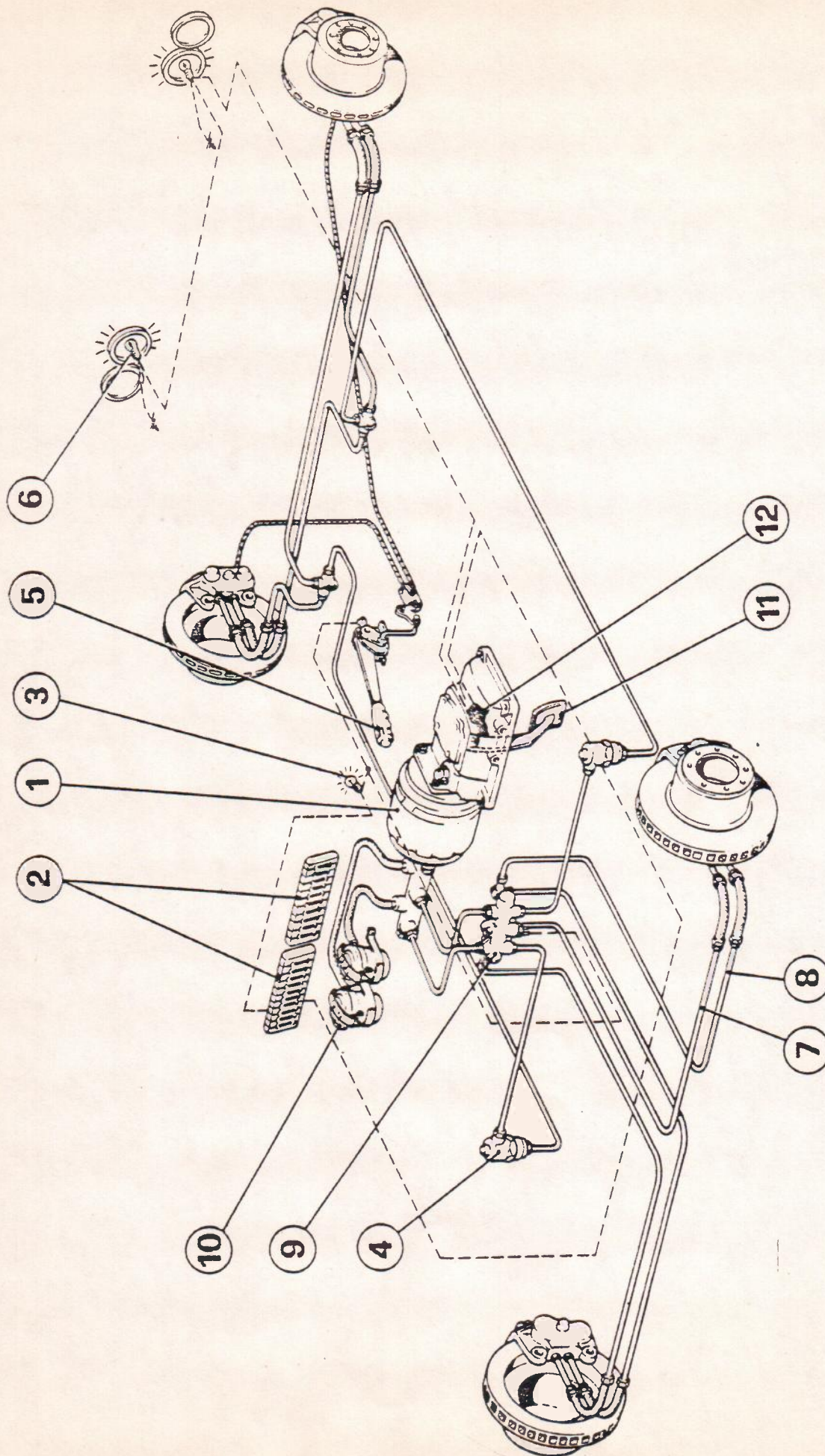


Fig. 1 - Braking System Diagram

1-Vacuum-assisted servo; 2-Fuses; 3-Brake lights and faulty system indicator - hand brake engagement; 4-Pressure regulating valves; 5-Hand brake control lever; 6-Stop light bulbs; 7-Upper circuit; 8-Lower circuit; 9-Pressure variance indicating valve; 10-Brake fluid containers; 11-Brake pedal; 12-Stop lights switch

BRAKES

DESCRIPTION.....	131
CHARACTERISTICS AND DATA.....	132
DIAGNOSING FAULTS AND RELATED REPAIRS.....	133
HYDRAULIC BRAKE SYSTEM.....	136
BRAKE DISCS.....	136
BRAKE CALIPERS.....	136
OPERATION.....	136
VACUUM-ASSISTED BRAKE SYSTEM.....	136
AUXILIARY VACUUM PUMP.....	137
PRESSURE-REGULATING VALVE.....	137
PRESSURE-VARIATION INDICATOR UNIT.....	137
BRAKE FLUID CONTAINERS.....	138
PARKING AND EMERGENCY BRAKE.....	138
PEDAL FREE-TRAVEL ADJUSTMENT.....	138
AIR BLEEDING OF SYSTEM.....	141
BRAKE PADS REPLACEMENT.....	141
MAINTENANCE INSTRUCTIONS.....	141

DESCRIPTION

The braking system assembly is made up of the following components:

- Disc brakes on all four wheels, with hydraulic control.
- Vacuum operated brake servo acting on front and rear wheels. Auxiliary vacuum pump actuated by engine pressure.
- Tandem master cylinders connected to the servo unit.
- Two separate hydraulic circuits.
- Each circuit is individually supplied with its own fluid reservoir.
- Two braking pressure equalizing valves.
- Mechanically operated rear hand brake for parking and emergency use.
- Warning light to signal low brake fluid levels.

The braking hydraulic control system is of the dual-circuit type, with two cylinders and pistons in each caliper and floating type rotating valves.
The cylinders diameter is 25.4 mm. (1 inch).

The system is actuated by a BONALDI Master Vac servo system, equipped with a non-return valve and a three-way connecting sleeve for the vacuum pump.

CHARACTERISTICS AND DATA

FRONT BRAKES

Type	Ventilated disc with pedal control
Brake discs	
- Diameter	288 mm.
- Thickness	Normal 32 mm. Minimum allowable after resurfacing 30 mm.
- Maximum allowable misalignment limits--disc installed on hub (gauge reading)	0.08 mm.
- Disc surface microfinish	radial 50 μ circumferential 32 μ
Brake calipers	Fixed 4-cylinders type
- Cylinders diameter	40 mm.
- Pads braking surface	185.6 cm ²
Disc and pad clearance adjustment	Automatic
Brake fluid	ATE Type 5
- Quantity for entire system (front and rear)	1 liter

REAR BRAKES

Type	Ventilated disc with pedal control
Brake discs	
- Diameter	297 mm.
- Thickness	Normal 22 mm. Minimum allowable after resurfacing 20 mm.
- Maximum allowable misalignment limits - disc installed on hub (gauge reading)	0.08 mm.
- Disc surface microfinish	Radial 50 μ Circumferential 32 μ
Brake calipers	Fixed 4-cylinders type
- Cylinders diameter	34 mm.
- Pads braking surface	126.4 cm ²
Disc and pad clearance adjustment	Automatic
Pressure regulation	Acting on rear wheels on both circuits
Pressure reading	0.7
Brake fluid	ATE Type S
Parking hand brake (only on rear wheels)	Drum type with hand control, with self-centering linings and manually set clearances.

DIAGNOSING MALFUNCTIONS AND RELATED REPAIRS

STUCK BRAKE PEDAL

Possible Causes	Remedies
1) Expanded gasket due to improper or contaminated fluid with kerosene, gas, or mineral oil, etc.	1) Clean vacuum pump unit, replace deteriorated rubber parts and liquid and bleed the system.
2) Cylinder compensating holes plugged due to misadjustment of control units or filled with dirt.	2) Clean and adjust brake pedal free play.
3) Pedal shaft or linkage bound-up in the bushings.	3) Replace the bushings.

SPONGY OR SOFT PEDAL ACTION

Possible Causes	Remedies
1) System containing air due to improper bleeding.	1) Bleed system completely.
2) Flexible tubing expanding under pressure because of poor quality.	2) Replace tubing; bleed the system.
3) Brake discs with deep scores and new pads not perfectly seated.	3) Resurface discs on scored surfaces.
4) Light loss of fluid from a connection or a damaged retaining ring at the control pump or at the cylinders.	4) Check and replace faulty units.
5) Air vents in one or both fluid tanks obstructed.	5) Clean and bleed the system.
6) Empty fluid containers or containing emulsified oil.	6) Add fluid and bleed the system.

PEDAL TRAVEL EXCESSIVE, BUT BRAKING ACTION NOT SPONGY

Possible Causes	Remedies
1) Brake pads too far from the discs due to improper centering or excessive play of the hubs.	1) Check disc centering and eventually resurface or replace them; check wheel hub bearing clearance and eventually replace.
2) Excessively worn pads.	2) Replace.

JAMMED BRAKES AFTER BRAKE PEDAL RETURN

Possible Causes	Remedies
1) Lack of brake pedal free travel.	1) Adjust.
2) Lack of clearance between the vacuum-assist servo ferrule and control pump.	2) Adjust clearances.
3) Control pump compensation hole plugged or covered up.	3) Clean compensating hole; adjust ferrule and bleed the unit.
4) Retaining gaskets swollen or hardened.	4) Clean the unit, substitute all rubber parts and liquid, bleed the system.

JAMMED BRAKES (Continued)

Possible Causes	Remedies
5) Excessively worn flexible tubing or with partially obstructed passages.	5) Replace tubing and bleed the system.
6) Sticking of the caliper pistons with subsequent scoring of the brake pads.	6) Overhaul the caliper, replacing faulty units.
7) Defective brake servo intervention valve.	7) Check, replace valve.

EXCESSIVE BRAKING EFFORT

Possible Causes	Remedies
1) Brake servo unit malfunctioning due to inside mechanical defect or leak in the vacuum tube.	1) Check, replace brake servo.
2) Defective vacuum servo tube pump.	2) Check, replace pump.
3) Use of non-prescribed brake pads.	3) Replace with originally prescribed pads.
4) Brake pads not fully seated or with oily surfaces.	4) "Run-in" the pads, accurately clean them with an emery cloth or replace them.

UNBALANCED BRAKING ACTION

Possible Causes	Remedies
1) Loss of fluid at one caliper.	1) Dry, clean or replace the gaskets, overhauling the caliper and bleeding the system.
2) Seized caliper piston.	2) Replace the complete caliper and bleed the system.
3) Obstructed flexible tubing.	3) Replace tubing or clean it and bleed the system.
4) Use of non-prescribed or unmatched brake pads in both calipers.	4) Replace with proper matched pads.
5) Oil or grease on the surfaces of one or more discs.	5) Wash the disc brakes and check fluid insertion.
6) Inflation pressure and wear unequal in the tires.	6) Check inflation pressure.
7) Wheel camber settings altered.	7) Adjust.
8) Faulty suspension arms settings.	8) Check and readjust.
9) Excessive braking action at front wheels.	9) Check front and rear pads. Eventually replace rear braking limiting valve.

IRREGULAR WEAR OF PADS

Possible Causes	Remedies
1) Defective centering of the caliper in relation to brake disc.	1) Check spacer washers and caliper fastening bolts for looseness.
2) Yielding of the caliper arms under braking pressure.	2) Replace the defective calipers.
3) Obstructed rigid tubing due to clogging or damage.	3) Replace the tube or clean it and bleed the system.

WEAK BRAKING ACTION

Possible Causes	Remedies
1) Leaks at caliper cylinders.	1) Check and eliminate leaks by substituting gaskets.
2) Obstructed rigid tubing due to clogging or damage.	2) Replace the tube or clean it and bleed the system.
3) Excessively worn pads.	3) Replace with new pads even if not worn to the limit.
4) Defective brake servo unit.	4) Check and eventually replace.

SQUEAKING OR WHISTLING NOISES

Possible Causes	Remedies
1) Dust deposits on pad surfaces.	1) Remove pads, rub down the working surfaces with an emery cloth, lightly bevel the pads installation slots, blow clean the calipers with compressed air and clean the brake disc.
2) Weak brake action at the pads due to breakage or malfunctioning of the pressure springs.	2) Check or replace.
3) Pads smeared with oil or grease.	3) Clean in hot water with a metal brush.

TENDENCY OF FRONT BRAKES TO PULL TO THE SIDE UNDER HEAVY BRAKING ACTION

Possible Causes	Remedies
1) Excessive braking action on front wheels.	1) Try brake pads of harder surface adapted for regular braking use.
2) Irregular wear of front tires.	2) Switch the two tires and eventually replace.
3) Use of non-prescribed brake pads.	3) Check and eventually replace.

CONTINUOUS SCRAPING OF THE BRAKE PADS AGAINST THE BRAKE DISCS

Possible Causes	Remedies
1) Seized pump piston.	1) Replace pump.
2) Pump overloaded due to obstruction of compensating holes.	2) Replace retaining rings, clean compensating holes, adjust pedal free-play by bleeding the system.
3) Misalignment of the caliper in relation to the disc due to loosening of plate fastening bolts.	3) Torque bolts to 10 kg.

CONTINUOUS SCRAPING...(Continued)

Possible Causes	Remedies
4) Discs out-of-center.	4) Check centering.
5) Seized brake cylinders.	5) Overhaul caliper and replace cylinders.

HYDRAULIC BRAKE SYSTEM

The car is equipped with a dual circuit braking system. In case of failure of one of the circuits, emergency stops are still possible with the alternate circuit. When this occurs, a dashboard signal light will indicate faulty operation of the system. The system is made up of the following additional units.

BRAKE DISCS

The brake disc are mounted on the front and rear wheel hubs. The discs are surrounded by calipers which are linked at the front with a plate mounted on the suspension upright and at the rear to the suspension lever attachment unit.

BRAKE CALIPERS

The calipers are made up of a two-part housing bolted together. In each half are located two pistons which travel in the cylinders of each half. The function of the cylinders and their related pistons is to transmit with equal effect the brake fluid pressure directly on the braking surfaces. A rubber ring is mounted on the cylinders (placed in a groove within the cylinder) to ensure the hydraulic seal of the piston. A rubber dust cover is mounted on the opposite side of the caliper to avoid the introduction of mud, dirt, or dust in the cylinder which could damage its surfaces. The proper pressure springs aid in avoiding dangerous vibrations of the brake pads during operation.

OPERATION

When pressure is applied to the brake pedal, the hydraulic fluid reacts to the pressure by pushing the three cylinder pistons at each caliper in contact with the two surfaces of the brake discs. By increasing the pressure, braking occurs. This remains uniform throughout the system and the disc faces, thus ensuring effective action and uniform wear of the brake pads. Releasing the pedal decreases the pressure of the fluid in the system, allowing the cylinder pistons to return to their original positions. Piston return travel is controlled by seals. The disc brake pads act upon a relatively small area of the disc surfaces, leaving a large area clear in order to dissipate quickly heat build-up during braking action. For this reason and because of the efficient cooling design of the radial slots on the brake discs, the cooling of the discs is very rapid even during frequent braking at high speeds.

VACUUM-ASSISTED BRAKE SERVO

The vacuum assist brake servo connected to the brake master cylinder is a pneumatic-hydraulic unit which uses the existing vacuum in the intake collector and that produced by the auxiliary pump in order to increase the braking action pressure. The hydraulic master cylinder is of the dual floating valve variety, in that the brakes hydraulic circuit is divided into two completely independent circuits which act simultaneously on both front and rear brakes.

AUXILIARY VACUUM PUMP

The operation of the pump is controlled by the intake valves camshaft of cylinder bank 1-6. The function of the pump is to increase the vacuum pressure in the servo unit and thus to diminish the required braking pressure. It does not require special maintenance and thus should not be altered.

PRESSURE REGULATING VALVES

These are installed on both circuits and regulate the braking pressure on the rear wheels, functioning either under pressure generated in the circuits or when the brake pedal is actuated. They do not require maintenance and their settings must not be altered.

BRAKE SYSTEM FLUID OPERATIONAL PRESSURE VARIATION - WARNING LIGHT SENDING UNIT

Whenever the operational pressure of the braking circuits is different, the sending unit lights up a light mounted on the dashboard.

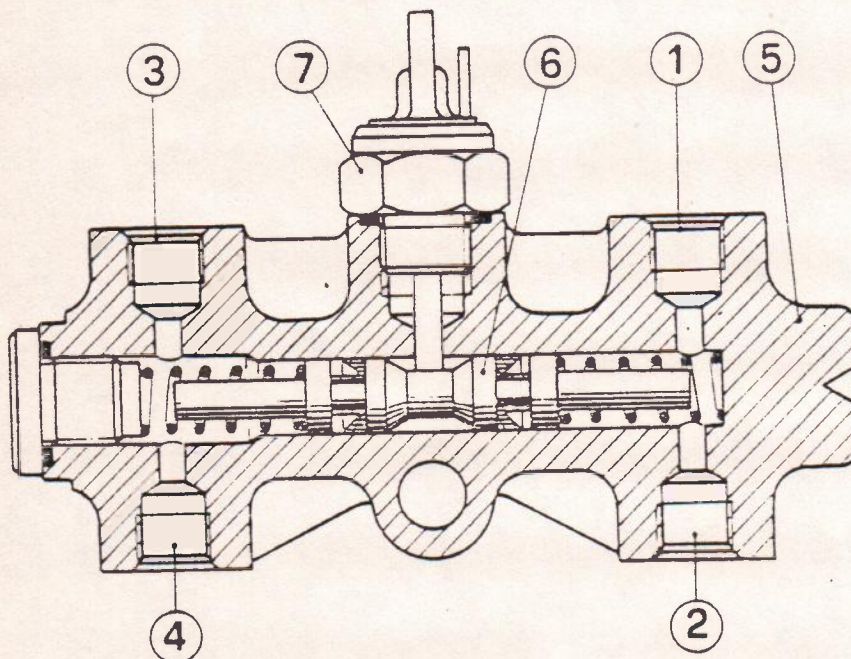


Fig. 2 - Dual-Circuit
Pressure Variation
Sending Unit
1-Inlet - 1st circuit
2-Outlet - 1st circuit
3-Inlet - 2nd circuit
4-Outlet - 2nd circuit
5-Unit body
6-Movable element
7-Sending unit

It is then necessary to locate the cause, which will probably be one of the following:

- Leakage of fluid via one of the connections in either of the circuits.
- Loss of fluid via the pistons retaining gasket.
- Low fluid level in one of the two fluid containers.
- Clogged compensating passage or seized piston at the master cylinder.

The sending unit does not require any maintenance and thus should not be tampered with.

NOTE

The indicator light is connected also to the hand brake and stop lights circuit. Thus, once the light goes on, it will be necessary to make sure that the hand brake is not engaged and that the stop lights are functioning normally before seeking out the cause of the problem in the braking system.

BRAKE FLUID CONTAINERS

Every 5000 Km., carefully check their exterior condition; without removing the cap, check the fluid levels. A tube connects the two containers and equalizes their level; this must always be between the Max. and Min. marks embossed on the containers. Every 10,000 Km., or 6 months, replace the fluid.

EMERGENCY AND PARKING BRAKE

Two small cylinders are located within the rear brake discs. These actuate two sets of self-centering expansion brake shoes 1 and controlled via the hand brake lever 2. The shoes are mounted on the rear suspension support lever and are lined with friction material. Adjustment of the clearance between the lining and the braking surface is carried out via rotation of an externally toothed sleeve 3 on the two threaded shafts mounted on the drums. The clearance between the drum pad and the surface must be 1 mm. and maximum braking action must take place when the hand brake lever has traveled just over half of its total travel distance. This is achieved by varying the length of the cable via adjustment nuts 4.

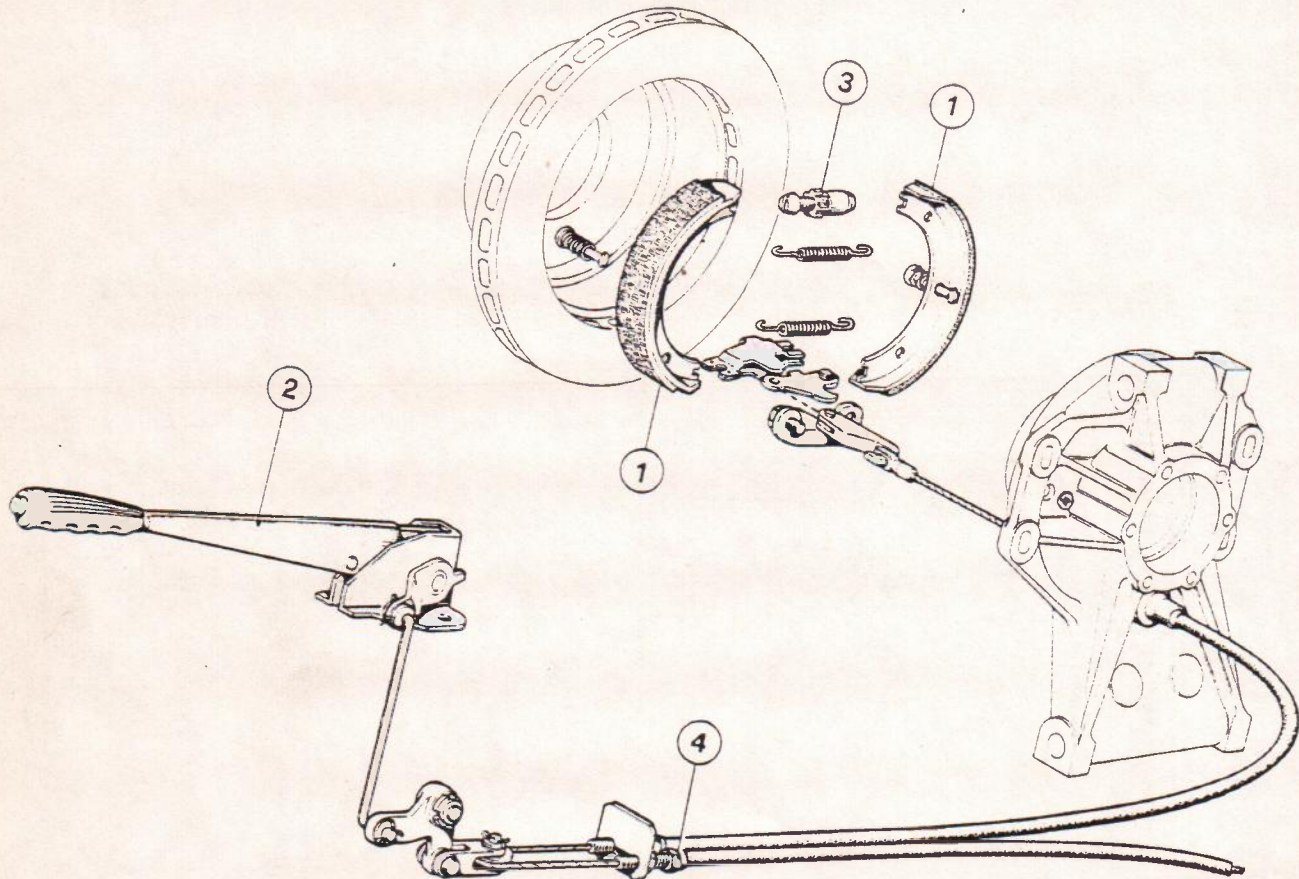


Fig. 3 - Hand Brake System

1-Expansion drums; 2-Hand brake lever; 3-Threaded sleeve; 4-Adjustment nut

BRAKE PEDAL FREE TRAVEL ADJUSTMENT

For efficient operation of the braking system it is essential that the brake pedal has 8-10 mm. of free travel distance before actuating the master cylinder. The setting at which shaft which actuates the pump located in the servo unit has been adjusted by the manufacturer with the appropriate clearance. This clearance must not ever be altered and it is advisable not to detach the pump from the servo unit under any circumstance. When necessary to do so, replace the complete pump servo assembly.

Connecting shaft A linking the brake pedal with the servo unit control rod must be adjusted accurately so that the clearance between the servo unit control rod and the master cylinder control shaft is 0 to 0.3 mm. With this adjustment completed, the brake pedal free travel should be 8 - 10 mm.

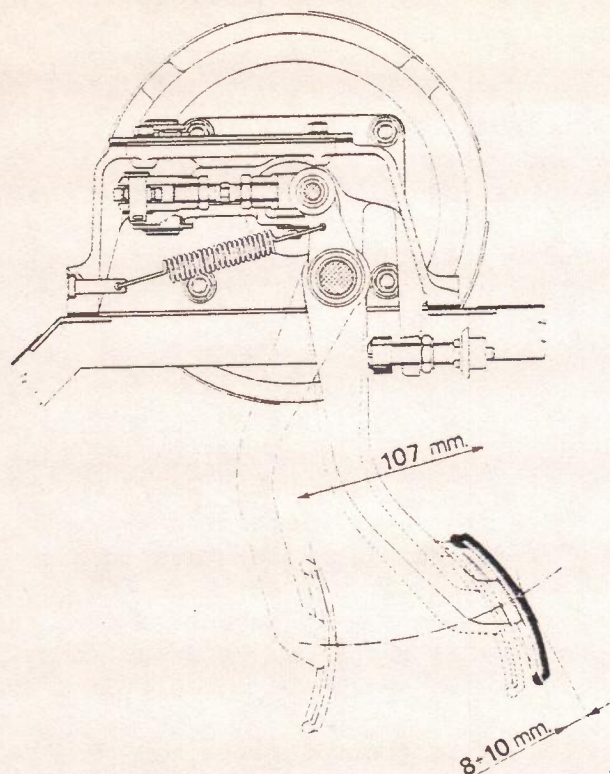


Fig. 4 - Brake Pedal Free Travel

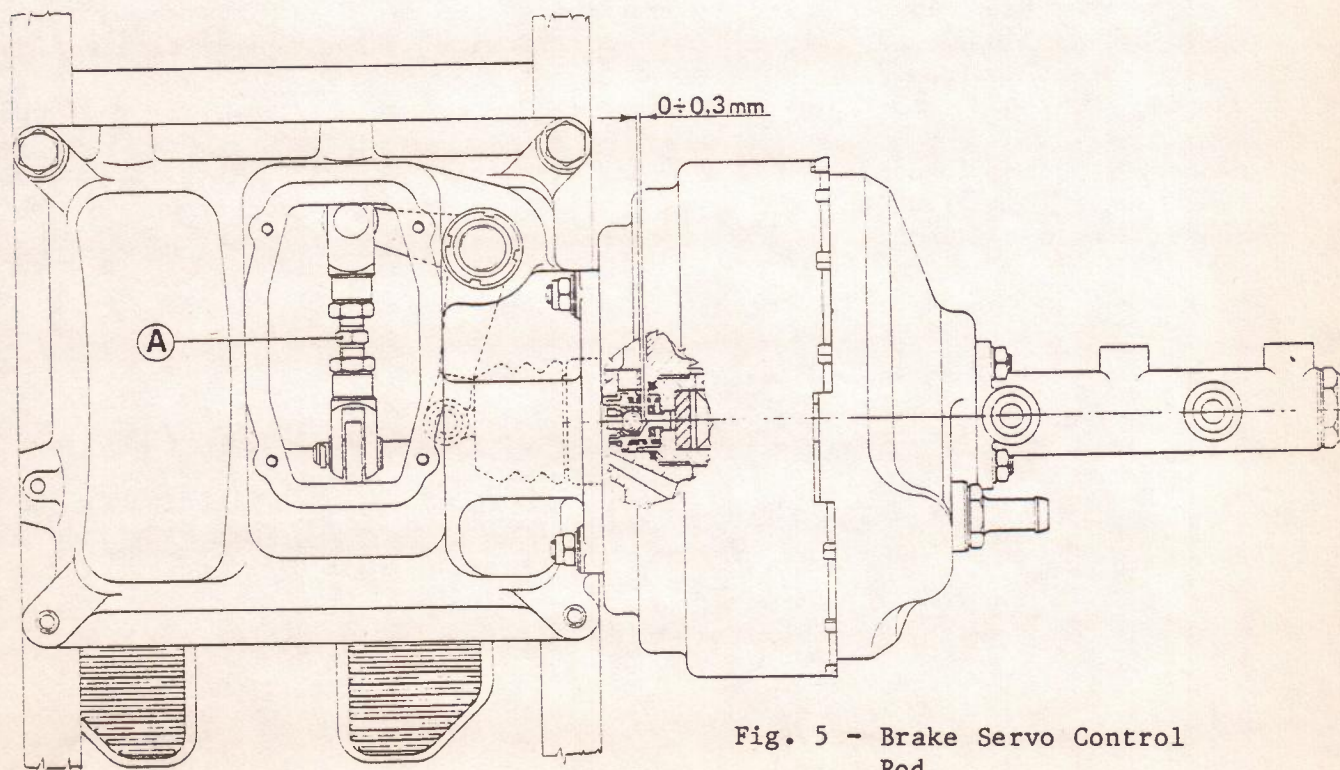


Fig. 5 - Brake Servo Control Rod
A-Adjustment nut

The adjustment of this clearance must be carried out when the pedal is in the stop position as indicated by the stop light indicator lights. Varying this position will necessitate once again the readjustment of the pedal free travel distance by altering the adjustment on the control rod as described above. Total brake pedal travel distance is 107 mm. as measured at the mid-point of the brake pedal pad.

AIR BLEEDING OF SYSTEM

Fill the brake fluid reservoir, bearing in mind that during the bleeding operation the fluid level must never be less than 1/4 of the maximum level. Fill the reservoir with fluid from sealed containers. The fluid which is bled off should not be reused. Use exclusively brake fluid ATE type S.

BEGIN BY BLEEDING THE FRONT BRAKES

When the brake circuits are completely empty, follow the procedure described below:

- Remove all the rubber protective caps from the bleed screws and bleed the front brakes.
- To one of the bleed screws of the lower cylinders of the front caliper fit a bleed tube, the other end of which should be immersed in a clear receptacle containing some fresh brake fluid; loosen the plug 1/2 turn, press the brake pedal several times until liquid is seen to emerge from the tube. Close the bleed screw with the brake pedal pushed all the way down. Repeat the operation on the other bleed screw for the lower circuit, and then proceed to bleed the upper circuit.
- Carry out the same procedures on the other front caliper and then proceed to bleed the rear calipers.

Complete the bleeding of the front and rear brakes following the same procedure and make sure that each time the brake pedal reaches the end of its travel, that the bleed screws are closed prior to returning the pedal to its normal position. Terminate the bleeding operation when no more air bubbles can be detected escaping from the bleeding tube.

- Repeat the above operation on all the bleed screws of the remaining calipers.

When the bleeding is completed, the pedal should be firm without the presence of any sponginess. The braking action should be progressive according to the pedal pressure, once the pedal free travel distance has been overcome.

- Replace the protective rubber caps to all the bleed screws.

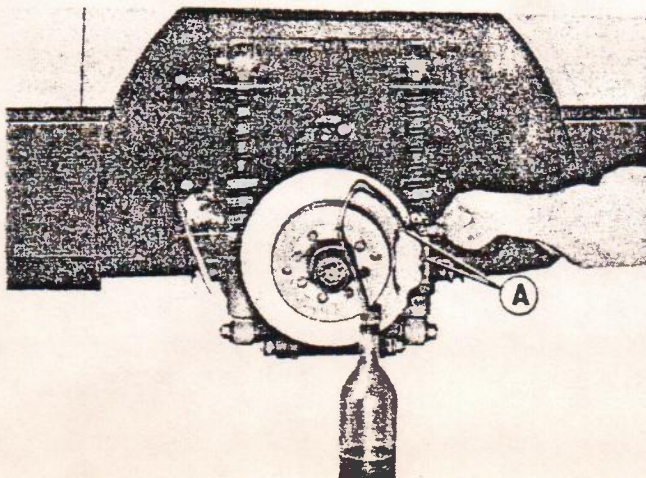


Fig. 6 - Bleeding of the
Brake Cylinders
A-Air bleed screws

BRAKE PAD REPLACEMENT

NOTE - When it becomes necessary to change or examine the pads, the external part of the caliper should first be washed using hot water and a neutral or mild shampoo and then drying the surfaces with compressed air. They should never be washed with gasoline, diesel fuel, paraffin, trico-ethylene, etc. as these may damage the hydraulic cylinder seals. If the replacement brake pads are not of equal thickness, check that the two caliper arms are separated equally from the disc faces throughout their travel. If not, vary the number of surface alignment washers located between the caliper and the support.

It is not safe to use pads in which the thickness of the friction material is less than 3 mm., and their replacement pads should be installed according to the type described above. To remove the pads, slide out towards the center of the car the two pins which hold the pads and the spring-loaded bridge piece in position. Using pliers, pull out the pad by its metal backing plate, and prior to fitting the new pad, push into the cylinder the piston, taking care not to damage the protecting seal. Fit new pads and refit the spring-loaded bridge piece and the retaining pins. Having replaced the pads and before starting the car, pump the brake pedal until it becomes firm and the piston and the pads are in their normal working position. New pads should be bedded-in gradually, avoiding violent or high-speed braking.

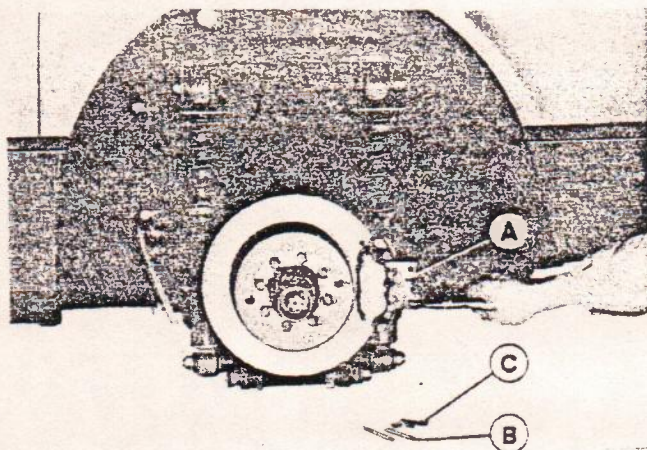


Fig. 7 - Brake Pad
Replacement

A-Pads; B-Pin; C-Spring Plate

MAINTENANCE INSTRUCTIONS

EVERY 5000 Km. check, and if necessary, refill the level of the brake fluid in the reservoir, using only the recommended type of fluid. In the event of the pedal travel becoming excessively long or the braking action becoming irregular, the braking hydraulic circuit should be checked carefully for leaks. Check the condition of the brake pads for wear, and provided they are not near their minimum thickness limit, bleed the brakes. The thickness of the pads can be checked without removing them, by merely removing the wheels.

EVERY 10,000 Km. it is recommended to replace the front and rear pads and also to replace the fluid in the hydraulic circuit. Check the condition of the disc surface, and that the pistons move freely in the calipers, without removing them.

EVERY 30,000 Km. proceed to thoroughly examine the overall braking system (tubes, calipers, etc.)

Should a piston be removed from its cylinder it is essential that its seal be replaced. The resurfacing of the disc surfaces, when it is found to be necessary, should only be carried out in a specialized machine shop and the surface finish must not exceed the values stated in the table. The disc faces must be parallel to each other, and perpendicular to the axis of rotation. When mounted on its own bearings and hub, the run-out must not exceed 0.08 mm. When resurfacing the discs, their thickness should not be reduced more than 2 mm. at the rear and front discs.

The auxiliary vacuum pump does not require periodic maintenance and lubrication. Replace it if defective.

WHEELS AND TIRES

CHARACTERISTICS AND DATA.....	142
DIAGNOSING FAULTS AND RELATED REPAIRS.....	142
WHEEL BALANCING.....	144
TIRE MOUNTING AND INFLATION.....	144
REPAIRS.....	145

CHARACTERISTICS AND DATA

Wheels in cast light alloy	Type	7 1/2" L x 15"			
Radial tires	Type	MICHELIN 2125/70 VR 15 XWX Tubeless			
Spare tire	Type	MICHELIN 105 R 19 X Tubeless			
Air Pressure - Cold Condition		MICHELIN		Front	Rear
Up to 200 Km./h	Kg/cm ²	2.6	3.0		
Over 200 Km./h	Kg/cm ²	2.8	3.3		
Spare tire	Kg/cm ²	5 - maximum speed 150 Km./h			

DIAGNOSING FAULTS AND RELATED REPAIRS

EXCESSIVE WEAR OF TIRES

Possible Causes	Remedies
1) Excessive speed on rough surfaced roads.	1) Adjust speed to road conditions.
2) Sudden speed variations, extreme acceleration from stop or abuse of brakes.	2) Avoid such acceleration or brake abuse.
3) Excessive speed with tires at low pressure.	3) Check tire pressure with cold tires.
4) Over inflated tires.	4) Deflate tire to prescribed pressure.

IRREGULAR WEAR OF TIRES

Possible Causes	Remedies
1) Excessive velocity in curves.	1) Moderate speed.
2) Skidding on curves due to faulty suspension units.	2) Overhaul the suspension.
3) Unbalanced wheels.	3) Balance the wheels.
4) Varying brake pressure on the wheels.	4) Overhaul the braking system.
5) Excessive wheel bearing play.	5) Adjust bearing clearances.
6) Malfunctioning shock absorbers.	6) Replace or overhaul.
7) Differing tire pressure on the same wheel base.	7) Check inflation pressure and bring up to required pressure.

IRREGULAR WEAR OF TIRES

8) Irregular camber of front and rear wheels; wear is noted on only one side of the tread.	8) Check the camber; if it is exact, wear is due to excessive speeds on curves.
9) Insufficient toe-in of front or rear tires; wear is noted on the internal surfaces of the tread.	9) Check and adjust toe-in.
10) Excessive toe-in of the front or rear wheels; excessive wear of the external surface of the tread.	10) Check and adjust.
11) Insufficient tire pressure; wear is noticeable more on the two sides of the tread than at the center.	11) Inflate to proper pressure.
12) Tires over inflated; excessive wear in the center of the tread.	12) Inflate to proper pressure.
13) Misadjustment of the steering assembly with excessive toe-in on one wheel and insufficient toe-in on the other; wear is noted on the external tread of one wheel and on the external tread of the other.	13) Adjust wheel settings and check the steering system units

THE CAR PULLS TO ONE SIDE

Possible Causes	Remedies
1) Unbalanced rear wheels.	1) Balance.
2) Varying tire pressure between the two front tires or between the rear tires.	2) Check and reinflate to proper pressure.
3) Excessive differences in wear between front and rear tires.	3) Substitute excessively worn tires. Place the new ones in the rear.
4) Imperfect alignment between the front and rear axles.	4) Check and align perfectly.
5) Switching of a front wheel with a rear wheel.	5) Remount as required.
6) Camber setting varies between two front and the two rear wheels.	6) Check the camber settings and adjustment.

WARNING

If, when releasing the pressure on the accelerator pedal at high speeds, the car has a tendency to pull on one side or the other, it will be necessary to accurately check the condition of the tires.

On the rear tires, wear should not be overly noticeable, especially at the edges. If the depth of the tread measures less than 2 mm., replace them. If the fault persists, it will be necessary to replace also the front tires, especially if they exhibit similar uneven wear characteristics and measure less than 2 mm. in tread depth.

WHEEL BALANCING

The balancing of the wheels is very important insofar as it will prevent shaking of the front wheels, which result in stress on the steering mechanism and abnormal wear of the tires.

Causes which can influence the wheel balance are:

- Radial misalignment or wheel eccentricity, which can originate from either the tire or the wheel.
- Uneven distribution of the assembly weight in relation to its axis of rotation.

The wheels must be balanced both statically and dynamically with a balancing machine by using the proper weights.

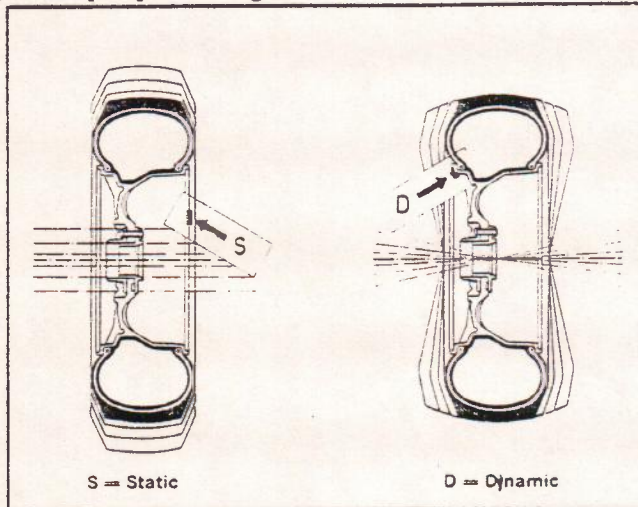


Fig. 8 - Static and Dynamic Balancing

If, when balancing the wheels, it is necessary to add a balancing weight of over 80 grams, rotate the tire on the wheel half-turn.

When the weight exceeds 60 grams, it is advisable to apply two 30 gram weights.

WARNING

It is indispensable, that after the application of the weights, to make sure that when steering the wheels in both directions and checking their full suspension travel, that they do not rub or catch the brakes' flexible tubes and that the tires are perfectly mounted on the wheels.

TIRE MOUNTING AND INFLATION

The cleanliness of the wheel and tire rims contact areas is important to proper mounting installation. Do not use any metallic wire brushes since they will remove the protective layer on the light cast alloy wheels. It is recommended that a coarse cloth be used for cleaning. Lightly grease the tire beads and the wheel rims to ease mounting. The use of a special lubricant as MICHELIN RIC 1291 is recommended.

Prior to mounting of the tubeless tire on the wheel, make sure that the valve is properly mounted on its wheel seat. When replacing the valve, do not rotate it, in order to avoid damaging the retaining ring under it; remove first the retaining nut which secures it to the wheel. Mount the tubeless tire on the wheel using normal mounting equipment used on normal tires.

Inflate to a maximum pressure of 3 to 3.5 Kg/cm² in order to ensure proper seating of the tire beads against the wheel rims. Check that a slight rise in the inflated tire surfaces exists at their outside circumference. This ensures against any potential slippage of the tire bead from the rim due to tire wall flexing when driving on curves.

During inflation of the tire a "popping" noise will indicate that a proper seal of the rim and bead surfaces has occurred.

Whenever difficulty is noted during the initial inflation operation, the inner core of the valve may be removed in order to inflate the tire more rapidly; proceed then as described above.

REPAIRS

Before removing the tire, inflate it to 2 Kg/cm^2 in order to locate the air leak. Place in a tub of soapy water and thoroughly wet the tire. Once the leak has been located, place a pin in the hole, deflate the tire, and remove it from the wheel.

Locate the leak point on the inside of the tire carcass. Using a wire brush, sand down the area around the puncture. Do not blow away the dust in the sanded area and apply a thin coating of sealant and let it dry.

Apply a second coating, let it dry and apply a rubber patch of 35 x 35 mm. size; run a roller over the patch to ensure perfect adhesion and afterwards check for a tight seal.

Maximum cleanliness is the only guarantee for a proper repair. Use only high-quality sealant and patching materials, as for example, the MICHELIN "RERAS" line. Other repair methods should be absolutely avoided; for example, spray anti-leak coatings or rubber plug leak inserts as used on industrial vehicles. For safety reasons, it is not advisable to repair certain types of punctures where laceration of the carcass threads has occurred as this will weaken the blow-out resistance of the tire.

CONTROLS AND INSTRUMENTS

HEATING AND VENTILATION

AIR CONDITIONING

	PAGE
CONTROLS AND INSTRUMENTS	149
DESCRIPTION	149
ANTI-THEFT IGNITION SWITCH	150
DIRECTION/TURN INDICATOR	151
WINDSHIELD WIPER SYSTEM	151
ACOUSTIC HORNS	151
HEATING AND VENTILATION	153
DESCRIPTION	153
DIAGNOSING FAULTS AND RELATED REPAIRS	154
AIR CONDITIONING	155
DESCRIPTION	155
CHARACTERISTICS AND DATA	155
OPERATIONAL TESTING	156
SYSTEM DIAGNOSIS	156
CONTROLS	158
OPERATION	160
PRELIMINARY PREPARATION FOR CHARGING	162
SYSTEM CHARGING	163
COMPRESSOR BELT TENSION ADJUSTMENT	164

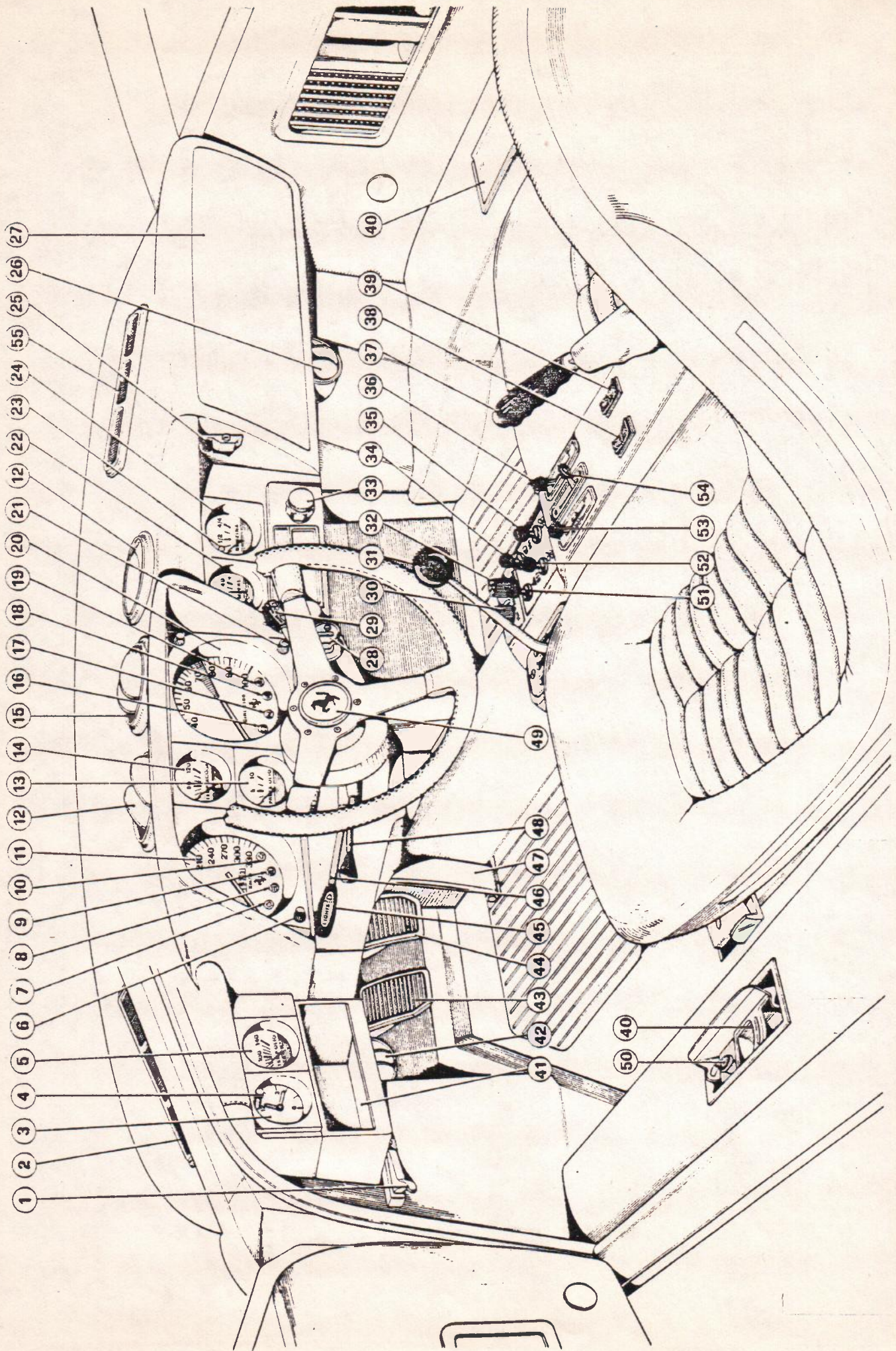


Fig. 1 - Commands and Controls Instrumentation

CONTROLS AND INSTRUMENTS

DESCRIPTION.....	149
ANTI-THEFT IGNITION SWITCH.....	150
SWITCH OPERATIONAL POSITIONS.....	150
DIRECTION/TURN INDICATOR.....	151
WINDSHIELD WIPER SYSTEM.....	151
ACOUSTIC HORNS.....	151

DESCRIPTION

The car's instruments and controls are as follows:

- | | |
|---|---|
| 1-Front lid opening lever. | 26-Adjustable air outlets for warm or fresh air to passenger's feet |
| 2-Left air inlet to windshield. | 27-Glove box compartment (opening the lid, the light switches on automatically. |
| 3-Electric clock; operating independently from the ignition key position. | 28-Ignition, auxiliaries starter and steering lock key. |
| 4-Clock setting control knob; pull and rotate clockwise | 29-Windscreen wiper and washer control lever. |
| 5-Oil temperature gauge. | 30-Temperature control for air conditioning system. |
| 6-Speedometer trip control; turn anticlockwise with car stationary | 31-Gear-box lever. |
| 7-Left side direction warning light (green). | 32-Air volume control for air condition system. |
| 8-Parking light indicator (green). | 33-Radio. |
| 9-Main beam warning light (blue). | 34-Switch for anti-fog lights. |
| 10-Right side direction warning light (green). | 35-2-speed switch controlling right heater electric motor. |
| 11-Journey speedometer trip. | 36-R.H. heater air distribution control |
| 12-Air outlets for warm or fresh air. | 37-Handbrake lever. |
| 13-Oil pressure gauge. | 38-Left hand window control switch. |
| 14-Water temperature gauge. | 39-R.H. window control switch. |
| 15-Adjustable air conditioning outlet. | 40-Ash-tray; for interior cleaning remove the ash-tray by pulling upwards on the internal bars. |
| 16-Warning light for brake system failure-hand brake on (red). | 41-Glove-box compartment. |
| 17-Alternator light. | 42-Adjustable air outlet to driver's feet. |
| 18-Fog lights indicator (yellow). | 43-Clutch pedal. |
| 19-Emergency stop lights indicator. | 44-Brake pedal. |
| 20-Rev counter with indication for maximum permitted R.P.M. | 45-Retractable headlights and lights switch. |
| 21-Instrument cluster light rheostat. | 46-Main beam/dipped beam control lever |
| 22-Ammeter; the index near zero shows that the charging system is efficient and battery charged. The index in other positions shows that the charging system is incorrect or the battery is discharged. | 47-Accelerator pedal. |
| 23-Fuel reserve warning light (red). | 48-Direction indicator lever. |
| 24-Fuel level gauge. | 49-Horn button. |
| 25-Glove box lid lock with key. | 50-Cigarette lighter. |
| | 51-Vehicle HAZARD warning light switch. |

52-2-speed switch controlling left
heater electric motor.
53-Left hand heater air distribu-

tion control.
54-Heater temperature control.
55-Right air inlet to windshield.

ANTI-THEFT IGNITION SWITCH

The switch (Fig. 2) is supplied with a key which can be used in four positions:

- 0: Locked (steering blocked, key removal. The lights can be operated via switch 45 located on the main beam/dipped beam control lever 46 which can be moved in three positions (Fig. 1).
- I: Steering free, key cannot be removed.
- II: Running (ignition on, fuel pump on, auxiliary operations on).
- III: Starting.

NOTE

To assist in unlocking the steering it may be necessary to attempt to rotate the steering wheel in each direction while turning the key.
Do not remove the key while the car is running.

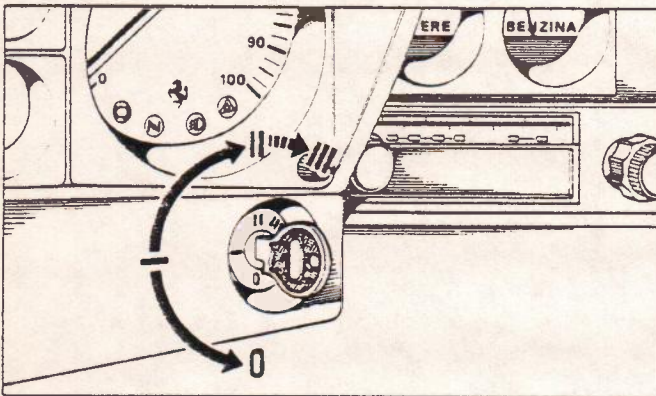


Fig. 2-Anti-theft Ignition Switch

OPERATIONS CONTROLLED BY THE SWITCH

With key in Position II:

Ignition-Starting circuit-Voltage regulator-Generator circuit-Windshield wiper and fluid pump-Directional indicator lights-Stop lights-Radiator cooling fans-Electric fuel pumps-Power window notors-Air conditioning circuit-Heating system fans-Oil pressure gauge-Water temperature gauge-Oil pressure gauge-Fuel level indicator and warning light-Electric tachometer-Brake circuit failure indicator light-Electronic speedometer.

With key in Position III: (operations independent of key)

Parking lights-Low and high-beam lights-Dashboard illumination-Engine compartment and lights-Emergency lights-Horns-Cigarette lighter-Clock-Trunk compartment light-Dome light-Radio-Reverse direction lights.

DIRECTION/TURN INDICATOR

The unit is made up of the following:

- lever for the control of the directional indicator lights, with automatic return to neutral controlled by straightener installed in the steering assembly.
- lever for the control of the outside lights and for the passing (high-beam lights).

The two units make up a single unit mounted on the steering column. When malfunctions occur, replace the complete unit.

WINDSHIELD WIPER SYSTEM

The system is made up of an electric motor-reducer assembly which actuates two wipers. It operates at either low or high speeds which are controlled by control lever 29 (Fig. 1).

The system is equipped with an automatic reset unit which guarantees perfect visibility for the driver.

ACOUSTIC HORNS

The circuit is made up of the following units.

- two sounding horns.
- one compressor.
- a horn switch, located in the center of the steering wheel.
- a protective 25 Amp fuse.

Malfunctions of the horn assembly can be traced to:

- faulty or blocked control switch.
- faulty compressor.
- connecting tubes between the compressor and horn damaged or bent so that the regular flow of air is impeded.
- faulty horns.
- burned valve.

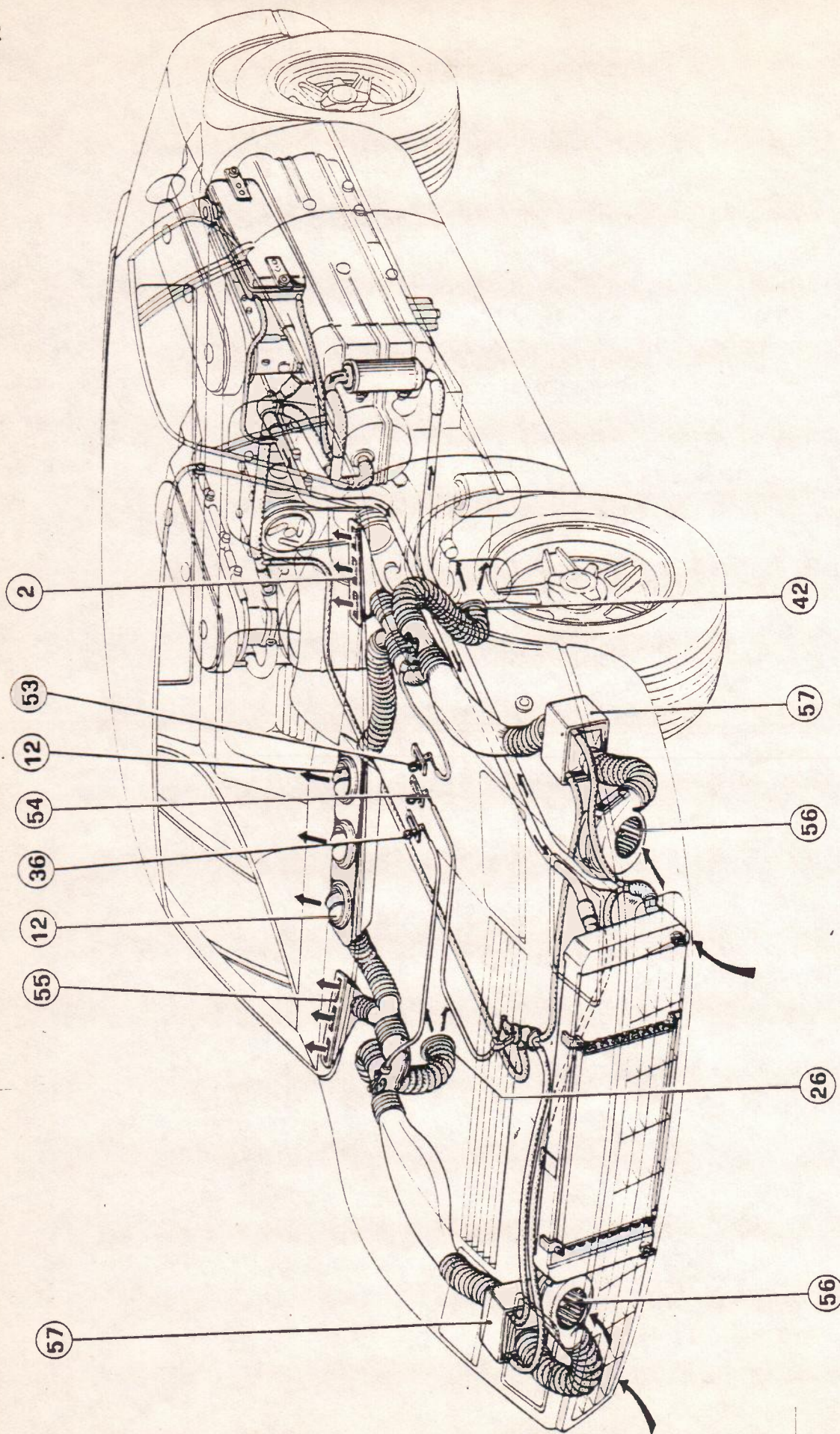


Fig. 3 - Heating and Cooling System Diagram
 2-Left windshield air outlet; 12-Rotating outlets for hot/cold air; 26-Rotating outlet for hot/cold air (passenger side); 36-Rotating outlet for hot/cold air (driver's side); 42-Rotating outlet for hot/cold air (driver's side); 53-Left side heater external air intake control lever; 54-Water heater valve control lever; 55-Front air intake fans; 56-Heater units; 57-Right windshield air outlet

HEATING AND VENTILATION

GENERAL DESCRIPTION.....	153
WINTER HEATING.....	153
SUMMER VENTILATION.....	153
INTERMEDIATE SEASON.....	153
DIAGNOSING FAULTS AND RELATED REPAIRS.....	154

DESCRIPTION

The car is not equipped with moveable vent windows and interior air circulation occurs with the car sealed. This allows for control of outside noise during operation.

Air is ducted into the interior via two air-intakes located on each side of the car's front. From there it travels past the two engine water cooling radiators, is heated and is ducted to the dashboard vents and to the sides reaching the driver and passenger footwells.

WINTER HEATING

- 1) Open completely the hot water valve moving lever 54 to the red dot.
- 2) Move levers 36-53 to the intermediate position; this directs hot air to the directional vents 2 - 12 - 26 - 42 - 55.
- 3) If hot air is desired only to the windshield, move levers 36-53 down completely.
- 4) When the car's speed is reduced, in order to increase the flow of hot air engage the electric fans 55-57 by moving levers 34 and 51 down.

If the car is to be stored or little used during the winter season and if the engine cooling system is not equipped with anti-freeze mixture, it will be necessary to either drain the water from the radiators and the engine, making sure that all residues are drained by raising the rear of the car about 25 cm.

SUMMER VENTILATION

- 1) Turn off the hot water valve by moving lever 54 upwards (blue dot).
- 2) Repeat the winter operations described in instructions 2-3 above.
- 3) If necessary, when the car's speed is reduced, engage the electric fans 56-57 by moving the switches 35-52 downwards.

INTERMEDIATE SEASON

To de-mist the interior of the windshield, follow instruction 1 and 3 under **WINTER HEATING** (above).

DIAGNOSING FAULTS AND RELATED REPAIRS

INSUFFICIENT HEATING

Possible Causes	Remedies
1) Hot water does not reach the radiators in sufficient quantity: a) Valve not fully open. b) Faulty valve. c) Water passages partially clogged.	a) Check the valve and the control mechanism. b) Replace. c) Check and clear.
2) Faulty thermostat valve.	2) Replace.
3) Defective or non-operating control valves.	3) Check valves and controls.
4) Defective front cold air fans or burned fuses.	4) Replace fuses-eventually replacing the faulty fan(s).

AIR CONDITIONING

GENERAL DESCRIPTION.....	155
CHARACTERISTICS AND DATA.....	155
SYSTEM OPERATIONAL CHECK.....	156
OPERATION OF CONTROLS.....	158
MAINTENANCE.....	159
OPERATION.....	160
IMPORTANT INSTRUCTIONS.....	160
PRELIMINARY OPERATIONS FOR CHARGING SYSTEM.....	162
COMPRESSOR SERVICE VALVES.....	162
SYSTEM DISCHARGE VIA VACUUM PUMP.....	162
SYSTEM CHARGE VIA CHARGING UNIT.....	162
COMPLETE CHARGE OF SYSTEM.....	163
LEAK DETECTION.....	163
COMPRESSOR BELTS TENSION ADJUSTMENT.....	164

GENERAL DESCRIPTION

The system is made up of a compressor driven from the engine via belts through an electromagnetic clutch; this is activated by the battery current via a switch located on the tunnel. The cooling liquid used (FREON 12) is circulated from the compressor through a condenser, a purifier-dessicator, an expansion valve, an evaporator, then returning to the compressor. Temperature variation and the volume of air sent through the car are controlled by the thermostat and rheostat switches located on the central tunnel. The cooled air enters the car via directional outlets. Warm and humid air is drawn in by the evaporator via intakes located under the dashboard on the passenger side; once in the evaporator it is cooled and the humidity removed and condensed and discharged via a tube located in the lower part of the housing containing the evaporator. The cooled and dehumidified air enters the passengers' compartment via the three vents located on the dashboard. For optimum operation of the system it is indispensable that no humidity exist in the system and that allowing of warm outside air to enter the car's interior be kept at a minimum because of the interior's lower pressure. Inspect the condition of the door seals frequently.

CHARACTERISTICS AND DATA

System type	Borletti
Compressor	Aspera - Frigo HG 700 AP
Operating pressure	See table page 156
Fluid used	FREON 12 ANHYDROUS
System capacity	1.10 Kg.
Fluid replacement (to make up losses)	Annually
Compressor oil	
Type	AGIP TER 54 or SUNISCO G4
Compressor level	22 - 29 mm.
Check (fluid losses)	Annually

SYSTEM OPERATIONAL CHECK

The system must run for about 15 minutes in order to stabilize its operation. Verify that the system is completely charged using test gauges and the filter sight glass. Maximum pressure is 15 - 18 Kg./cm² depending on ambient temperature. The filter sight glass should be free of bubbles. The parts of the system requiring low pressure should be a 1-2 Kg./cm² according to the ambient temperature. Below are listed the high pressure readings along with the corresponding ambient temperatures.

Ambient Temperature	High Pressure
27° C	10 - 12 Kg./cm ²
32° C	12 - 14 Kg./cm ²
35° C	13 - 14.5 Kg./cm ²
38° C	15 - 16.5 Kg./cm ²
40° C	16.5 - 18 Kg./cm ²

HIGH AND LOW PRESSURES/TEMPERATURE CHECKS

The components under high pressure should be uniformly hot to the touch. A difference in temperature indicates a partial clogging of the liquid or gas lines at that point. The components under low pressure should be uniformly cold to the touch, but should not exhibit an excessive perspiration at the intake pipe or at the compressor service valves. Any excessive perspiration or freezing of the low pressure service valve usually indicates that the expansion valve is allowing an excessive volume of refrigerant fluid into the evaporator.

SYSTEM DIAGNOSIS

First Example

Observations.

Insufficient cooling due to insufficient quantity of refrigerant, fluid leak.

- 1-Excessively low pressure at the low pressure gauge.
- 2-Excessively low pressure at the high pressure gauge.
- 3-Lack of bubble formation at the filter sight glass indicating lack of fluid but only of gas.

Conclusions:

Insufficient quantity of refrigerant in the system. Seek out the leak and recharge the system.

Second Example

Insufficient cooling due to insufficient quantity of refrigerant caused by a slight fault or small leaks.

- 1-Too low pressure read at the low pressure gauge.
- 2-Too low pressure read at the high pressure gauge.
- 3-Bubbles or mist noticed at the filter sight glass.

Conclusions:

Insufficient quantity of refrigerant in the system due to slight leaks.

(NOTE: Normally the system will lose 200-500 grams of freon annually.)
Search out the leak and recharge the system.

Third Example

Insufficient cooling due to air and humidity in the system.

- 1-Constant pressure indicated at the low pressure gauge (the pressure should drop until the compressor is disengaged, the gauge should exhibit a slow oscillation).
- 2-Slightly higher pressure indicated at the high pressure gauge.
- 3-The sight glass is free of bubbles and only shows an occasional bubble.
- 4-The intake tubing is hot to the touch.

Conclusions:

Air present in the system. Air and humidity present in the Freon liquid.
Search out the leak, discharge the system, replace the purifier-dessicator.
Recharge the system.

Fourth Example

Insufficient cooling due to internal compressor leaks or leaks at the seals.

- 1-Too high pressure indicated at the low pressure gauge.
- 2-Too low pressure indicated at the high pressure gauge.
- 3-The system is totally charged (absence of bubbles at the sight glass).

Conclusions:

Check and adjust the compressor.

Fifth Example

Hot air escapes from the evaporator - defective condenser operation.

- 1-Excessively high pressure indicated at the low pressure gauge.
- 2-Excessively high pressure indicated at the high pressure gauge.
- 3-Some bubbles are occasionally noticed at the sight glass.

Conclusions:

Irregular or defective condenser operation; too high a pressure reading in the high pressure area is the cause of insufficient cooling. Check the fans and condenser, the system may be overcharged with refrigerant fluid; the condenser may be clogged with oil.

Sixth Example

The system functions in the morning and evening, but does not cool during the warm period of the day.

- 1-Pressure of 1-2 Kg./cm² is indicated at the low pressure gauge; at times the pressure drops to 0.
- 2-Pressure of about 15 Kg./cm² is indicated at the high pressure gauge; when the low pressure reaches zero, the pressure indicated at the high pressure gauge drops at the same time.
- 3-The initial air is cold, becomes warm when the low pressure gauge moves to zero.

Conclusions:

Dessicator filter saturated with humidity, it removes humidity during high temperatures, the humidity collects at expansion valve opening, freezes and blocks the flow of refrigerant fluid.

Discharge the system, replace the dessicator filter, recharge the system.

Seventh Example

Air coming from the evaporator is not cold due to air/humidity which have contaminated the refrigerant fluid.

- 1-Too high pressure indicated at the low pressure gauge.
- 2-Too high pressure indicated at the high pressure gauge.
- 3-Occasional bubbles indicated at the sight glass.

Conclusions:

Air/humidity in the system which have diluted or contaminated the refrigerant. Discharge the system, replace the dessicator filter, complete the discharge and recharge the system.

Eighth Example

Insufficient cooling due to defective expansion valve operation.

- 1-Too high pressure indicated at the low pressure gauge.
- 2-Too high pressure indicated at the high pressure gauge.
- 3-Air coming from the evaporator too hot.
- 4-High humidity condensation at the intake tube and at the evaporator.

Conclusions:

The expansion valve allows an excessive amount of refrigerant fluid through the evaporator.

Check and eventually replace the valve. Make sure that the thermo-contact of the valve bulb-to-evaporator tube is not disconnected or corroded.

Ninth Example

Insufficient cooling due to defective expansion valve operation.

- 1-Too low pressure indicated at the low pressure gauge.
- 2-Too low pressure indicated at the high pressure gauge.
- 3-Air coming from the evaporator is barely cooled.
- 4-High humidity condensation or freezing at the expansion valve intake connection.

Conclusions:

Freon refrigerant flow clogged at the expansion valve. High condensation or freezing at the intake connection, clogged valve filter, upper end of valve hot, closed valve nozzle or the bulb has lost its thermostatic fluid. Check and eventually replace the valve.

Tenth Example

Clogged condition in the high pressure area; partial cooling of the evaporator.

- 1-Too low pressure indicated at the low pressure gauge.
- 2-Too low pressure indicated at the high pressure gauge.

This situation, as in the preceding one, indicates a limited flow of the refrigerant fluid along with a pressure reading at the gauge lower than normal. The condenser and the purifier become Freon liquid containers holding the charge. The noticeable quantity from the fan freezes the refrigerant fluid stationary in the condenser and the pressure indicated at the high pressure gauge drops. If, instead, the system is overcharged with Freon the pressure indicated at the high pressure gauge could be considered normal or perhaps excessively high. In this case, check that the blockage has occurred in the system before entering the evaporator filter.

Conclusions:

Blockage of the purifier or in another part of the circuit - blocked purifier or partial blockage due to rubber particles detached from the tubing.

OPERATIONS OF CONTROLS AND STARTING THE COMPRESSOR

After starting the engine, rotate switch 30 clockwise to the first position in order to start the compressor 58 and the right radiator cooling fan 63.

By turning switch 32 clockwise to the first position it activates the following: the compressor's electromagnetic clutch, fan motor 63 and evaporator 59.

To increase or decrease the amount of air, use switch 32.

To increase or decrease cold temperatures, use switch 30.

Do not run switch 30 to its maximum setting for long periods in order to avoid evaporator icing.

NOTE

For normal operation of the system close down levers 36 and 53. In the electrical control circuit are installed a high and low pressure pumps which stop the operation of the compressor when the pressure reaches too high or too low readings (as in the case of a discharged system).

In order to ventilate the interior of the car with the engine not running, leave the two evaporator fans running (controlled via switch 32).

MAINTENANCE

Normally the system will require the following periodic operations:

- Complete replacement of the FREON liquid annually; more often to detect any leaks.

- Annual check of the compressor's oil level.

- Check of the compressor drive belts tension.

For these operations and for any malfunctions repairs we suggest that you contact a representative of the BORLETTI, VOXON, or FERRARI works, or any specialized repair shop.

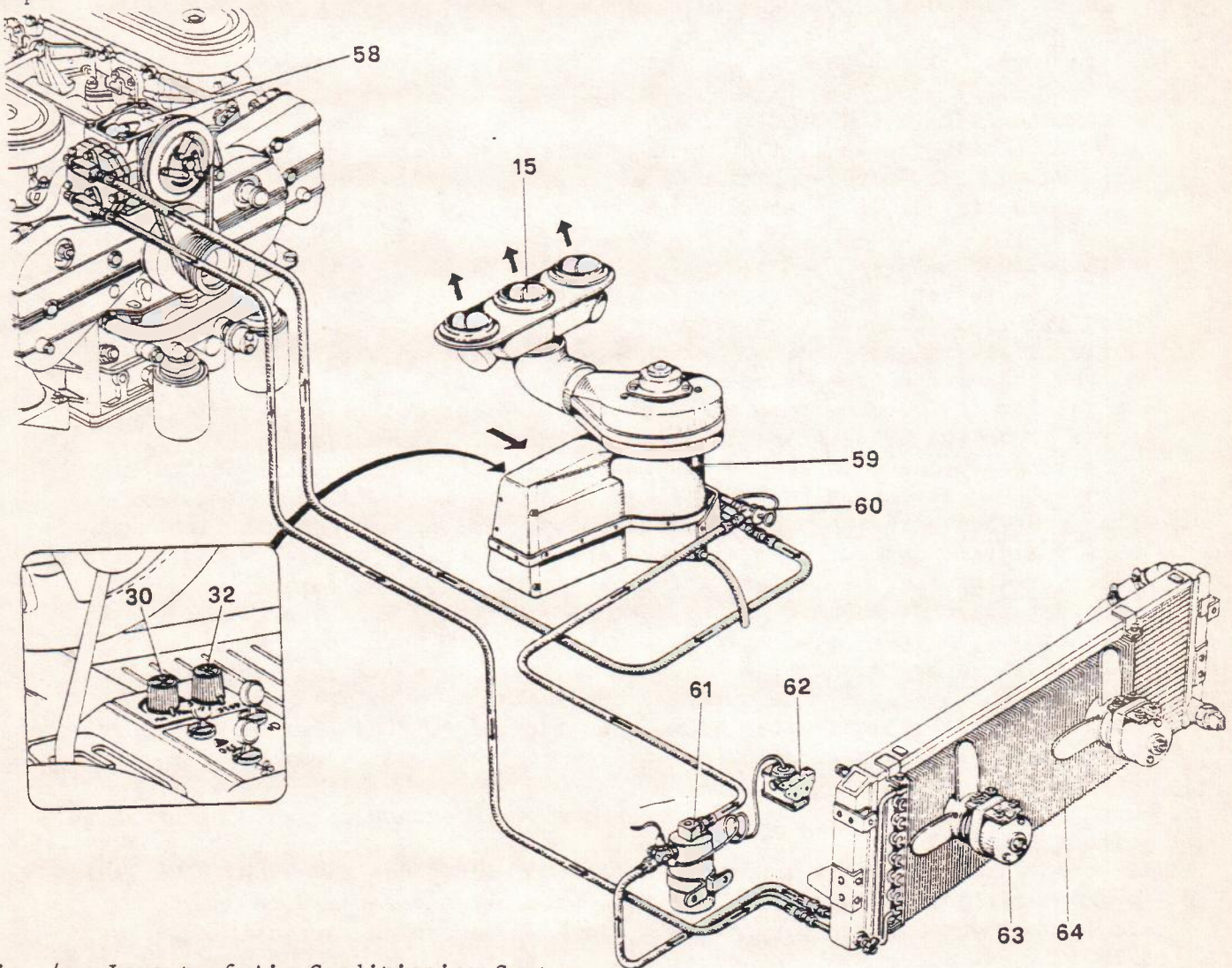


Fig. 4 - Layout of Air Conditioning System

15-Directional outlets for cooled air; 30-Cooled air temperature regulator; 32-Cooled air volume regulator; 58-Compressor; 59-Evaporator; 60-Freon liquid expansion valve; 61-Purifier; 62-Pressure pump; 63-Right-hand fan; 64-Condenser

OPERATION

IMPORTANT INSTRUCTIONS

ASPERA FRIGO HG 700 AP Compressor

- Before installing the compressor on the engine, it is necessary to mount it on two wooden supports, with the drive shaft pointing down, without touching any surfaces so that no pressure is placed on the shaft. Leave the compressor in this position for 30 minutes. This operation is necessary so that the oil can lubricate perfectly the shaft gasket before operating the compressor.
- The compressor is shipped from the manufacturer adequately lubricated and filled with the quantity of oil required for operation.
- If any unspecified oil is added, it will contaminate the entire system and will void the compressor and its related units' warranty, and the warranty on its related parts.

USE AGIP TER 54 OIL OR SUNISO G4 EXCLUSIVELY

- The compressor oil level is to be checked before installation while on the mounts; remove one of the two side plugs, insert a metal indicator tab and measure the quantity of the fluid.
Check the tightness of the two plugs. The oil level in a new compressor is 38 to 40 mm. After initial use, the level must be kept at 22 to 29 mm.

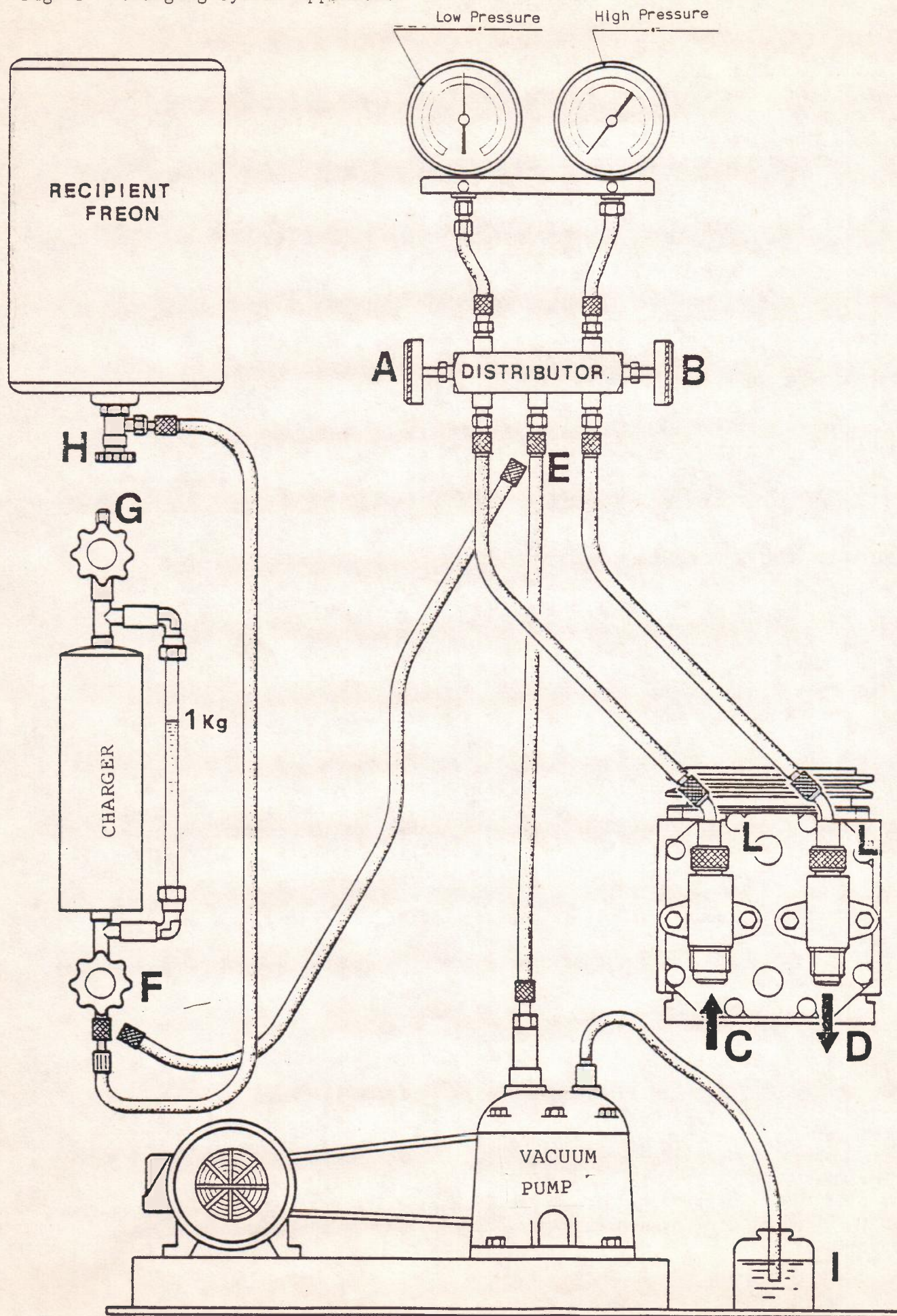
ELECTROMAGNETIC (ELECTROLOC) CLUTCH

- The clutch must be installed on the compressor before installation of the unit on the car. The operation must be carried out with maximum care and the appropriate bolt on the shaft must be tightly secured.

INSTALLATION

- Do not use water for any purpose during the installation of the unit, or when its tubing is not tightly connected.
During discharging, loading, or adjustment operations, water can be poured on the condensator to reduce excess condensation.
- Do not for any reason, remove the plastic caps at joints of the flexible tubes or of the connections until ready for their installation.
This simple precaution eliminates the possibility that humidity or impurities will enter the system and cause operational and maintenance damage.
- Also use care with the purifier-dessicator units by not removing the caps until ready to connect them with the other components of the system. If the purifier-dessicator units are left open for a period of time, they can become saturated with humidity and that can radically influence their proper operation. If the installation is only partially completed, or it must be left that way overnight or for several hours, close off every flexible tube opening and especially the purifier connections.
- Do not use any sealant materials on the surfaces of the flexible tubes connections. We recommend using a small quantity of compressor oil for this purpose.
- During the tube connecting operations use two wrenches to avoid deformation of the tubings.
- If the system is totally empty of the FREON liquid due to major leaks in the system, replace the purifier, as it is probably saturated with humidity.
- It is not necessary to completely drain a system which partially filled with FREON fluid. If possible, locate and repair the leak without any dismantling, and add additional fluid to the prescribed level.
- Do not subject the compressor belt to excessive tension during the mounting and dismounting operations.

Fig. 5 - Charging System Apparatus



PRELIMINARY OPERATIONS FOR CHARGING OF THE SYSTEM

NECESSARY TOOLS

- Motor/vacuum pump unit.
- Charging unit for measuring and loading of the FREON fluid, with visible level marked with corresponding increments to 1 Kg. of FREON, and two connecting taps and tubing.
- Distributor unit, with service lines gauges panel and controls for high and low pressure.

The gauges panel unit is made up of:

- Discharge gauge with 0 to -700 mm. of mercury graduations and a 0 to 10 Kg./cm² graduations for low pressure,
- A gauge graduated from 0 to 35 Kg/cm² for high pressure.
- Propane gas lead indicator.
- Compressor service valves connection - AV 965

COMPRESSOR SERVICE VALVES

The compressor valves are of the stem type with automatic shut-off. For discharging of the system (via pump) and its recharging, it is necessary to use a special connector (tool AV 965), equipped with a tang which keeps the valves open during these operations. The intake valve is the one with the larger diameter and its is connected with the evaporator return tube, while the smaller delivery valve is connected to the condenser.

BLEEDING OF SYSTEM VIA VACUUM PUMP

- Make sure that the engine and the air conditioning systems are cold.
- Connect the compressor high pressure valve to the gauge panel and the gauges to the vacuum pump.
- Open the gauge panel high pressure tap and make sure that the low pressure tap is completely closed.
- Run the pump for at least 30 minutes to remove air from all tubings; check the vacuum indicated on the gauge. The system should reach a vacuum reading of 710 - 750 mm. Hg in less than 5 minutes.
- Immerse the end of the cold air outlet tube in a container filled with compressor oil. No escaping air bubbles should be noticed. Formation of air bubbles indicates leaks in the system. To eliminate them, check all tubings and connections and eventually proceed to a check of the complete system after a partial recharge. Eliminate all leaks and repeat the above steps.
- Shut off the high pressure tap at the gauge panel.
- Turn off the vacuum pump.
- Check that the pressure at the gauges does not rise above 25 mm. Hg. every 4 or 5 minutes.
- If the pressure remains constant, there are no leaks and we can proceed to charging the system.

SYSTEM CHARGE VIA CHARGING UNIT

A) FILLING THE CHARGER

- About 1 Kg. of FREON 12 fluid is needed to fill the system.
- Connect the charger connection with the fluid tank; open the tank tap. Alternatively open and close the connection at the charger so as to release any air in the connecting tube.
- Allow the fluid to fill into the charger until filled. If the charger will not fill to the prescribed mark, some excessive internal pressure is present. Bleed off the pressure by very brief openings and closings of the upper charger tap.

B) CHARGING THE SYSTEM

- Connect the charger to the gauge panel making sure to bleed any existing air in the connecting tube by opening and closing the gauge panel connector several times while maintaining the charger tap slightly open.
- Close the panel connector and open the high pressure connection tap. Continue operation until the charger is empty.

SYSTEM CHARGING

- For a more rapid charge of the system, electrically warm the FREON liquid container until its internal pressure indicate 7 - 8 Atm. For maximum security connect a pressure gauge or a safety valve at the FREON container or at the gauge panel so that the pressure does not exceed set limits, thus avoiding an explosion of the container due to excessive pressure.

NOTE - Every 7° C. of temperature increases pressure about 1 Atm.

TESTING FOR LEAKS

Whenever the system does not maintain its charge it will be necessary to locate any FREON fluid leaks.

Use a propane gas indicator equipped with a 1 meter long rubber tube.

- The engine is turned off and all fans or ventilators in the surrounding area must be turned off. The car must not be located where there is any moving air, otherwise any leaking FREON gas will be blown away and not be seen.
- Move the indicator tube end over all connections and linkages, compressor valves, and the rear part of the clutch unit to check the drive shaft gas-ket sealing of the compressor.
- If there are any FREON leaks the burning blue propane gas flame will turn green in color when contacting the leak.

ATTENTION: keep the torch away from the face and do not breathe in the gas; keep away from the carburetors, gasoline containers or tanks, or painted surfaces of the car. Locate the leaks, carry out the necessary repairs and proceed to the flushing out of the system.

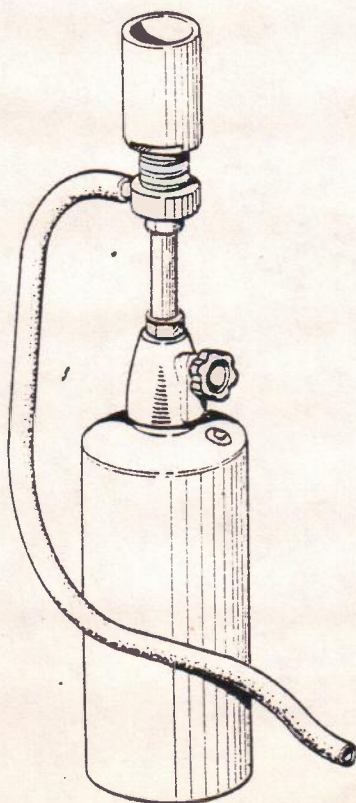


Fig. 6 - Propane Torch
Leak Tester

COMPRESSOR BELTS TENSION ADJUSTMENT

TENSION TESTED WITH COLD ENGINE

MANUAL TENSION CONTROL

Distance at arrow A on one side of the belt must be 3 mm. with a pressure of 2 Kg. with a new belt and 1 Kg. with a belt already in operation.

CONTROL VIA TENSION TESTER

With a new belt the tension load must be 22.5 Kg. as indicated on scale 11M on a tension tester type "GATES 150."

With an already operational belt the load must be 19 Kg.

To increase belt tension, loosen bolts B which fasten the compressor support to front engine block cover.

Move the support in an anti-clockwise direction and retighten the bolts.

NOTE

During these operations and at other times it is recommended that the condition of the belts be examined.

Do not exceed the belts' tension in order to avoid abnormal loads on the compressor bearings.

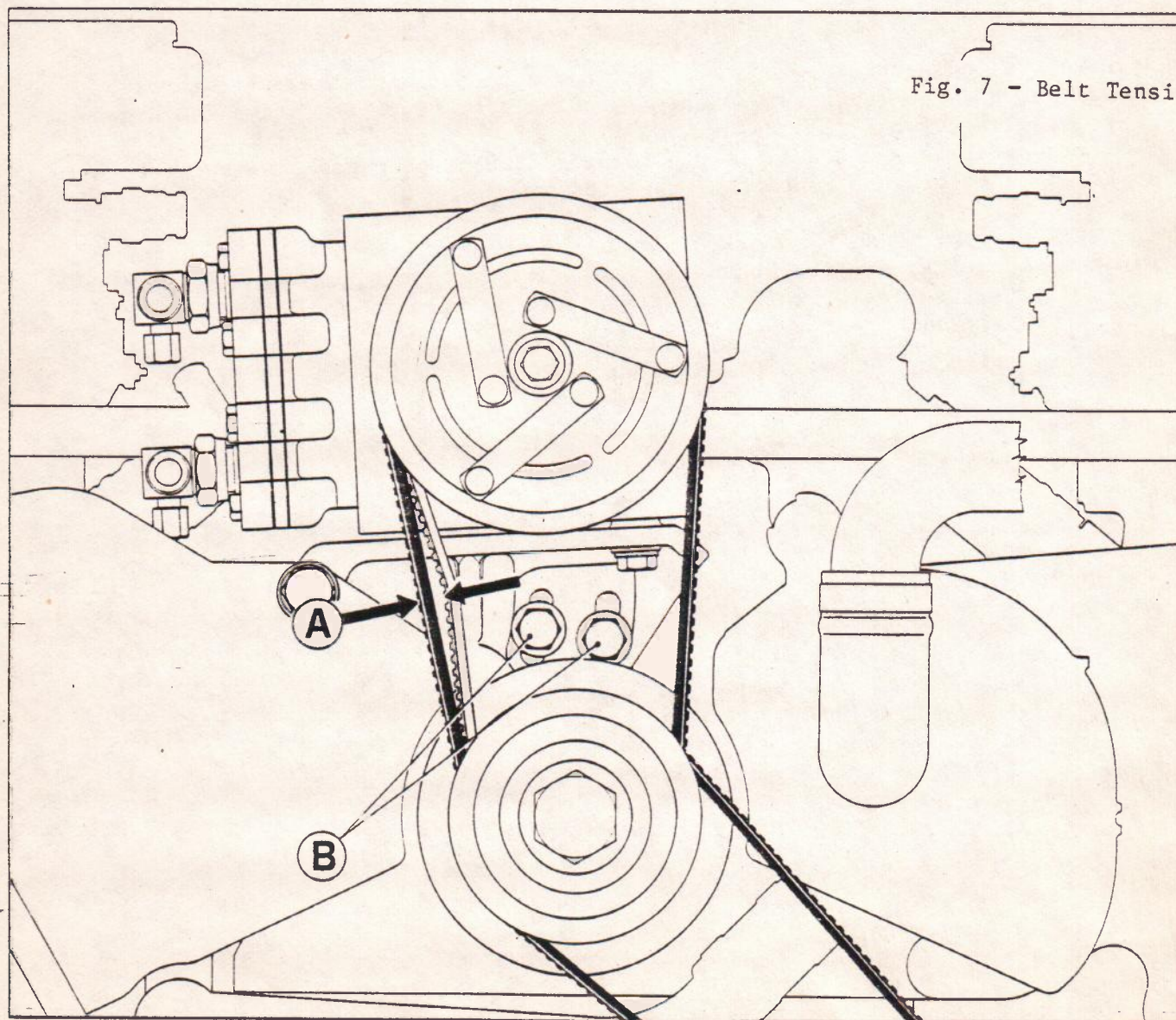


Fig. 7 - Belt Tension

ELECTRICAL SYSTEM

	PAGE
BATTERY AND ALTERNATOR	166
CHARACTERISTICS	166
CHECKS AND MAINTENANCE	166
MARELLI CHARGING SYSTEM	168
REPAIR INSTRUCTIONS	170
BOSCH CHARGING SYSTEM	174
BELT TENSION ADJUSTMENT	175
STARTER MOTOR	177
CHARACTERISTICS	177
FAULTS AND REPAIRS	178
GENERAL DESCRIPTION	179
MAINTENANCE	179
OVERHAUL	180
IGNITION SYSTEM	181
CHARACTERISTICS	181
FAULTS AND REPAIRS	182
DISTRIBUTOR	183
DINOPLEX ELECTRONIC SYSTEM	186
IGNITION COIL	187
SPARK PLUGS	187
LIGHTING SYSTEM	189
CHARACTERISTICS	189
HEADLIGHTS	190
VALVES AND RELAYS	193
ELECTRICAL SYSTEM DIAGRAM	195

BATTERY AND ALTERNATOR

CHARACTERISTICS.....	166
CHECKS AND MAINTENANCE.....	166
ELECTROLYTE LEVEL.....	166
CHARGING LEVEL CHECK.....	167
POSSIBLE ABNORMAL DISCHARGE CAUSES.....	167
CHARGING SYSTEM.....	168
ALTERNATOR BELT TENSION ADJUSTMENT.....	175

CHARACTERISTICS AND DATA

DESCRIPTION	TO CHASSIS NO. 18259	FROM CHASSIS NO. 18265
Alternator	MARELLI GCA 113A-55A	BOSCH 0.120.489.541
Nominal voltage	12 V	12 V
Test voltage	14.2 V	14 V
Initial load velocity (alternator rpms)	1000	1000
Maximum current at 6000 rpm	60 A	55 A
Field coil winding resistance at 20° between collector rings	4.1 + 0.1 ohms	4 + 0.4 ohms
Maximum continuous velocity	12,000 rpms	12,000 rpms
Battery		
Nominal charge	74 Ah	
Nominal voltage	12 V	

The functioning of the car's electrical system depends a great deal on the battery's condition; thus it is good practice to check it regularly and carefully. The battery must be firmly mounted in the car, so that it does not move or can be damaged by bumps.

CHECKS AND MAINTENANCE

The battery must always be kept clean and dry, especially at the upper part. Check that there are not cracks in the top cover of the battery, since they can cause loss of the electrolyte level.

Avoid any leaks, since the electrolyte is highly corrosive with any materials that it comes into contact. The filler caps of each cell must be pressed in tightly, broken ones should be replaced immediately. The terminals must be kept tight and coated lightly with vaseline to avoid oxidation.

ELECTROLYTE LEVEL

In maintenance of the battery, only water is needed to replace that which has evaporated.

Carry out this check every 3,000 Km.; in warm weather, every 1,500 Km. The electrolyte level must be above the upper edges of the separators, but no more than 5 mm.

STATE OF CHARGE CHECK

This check is carried out using a battery densitometer. The battery is charged when electrolyte density in each cell is between 1270 and 1280 grams/ liter. When the density reading is 1150 grams/liter, the battery is discharged; recharge it to the proper level. Charging is carried out as follows:

- Remove the battery from the car.
- Clean thoroughly, especially the upper part.
- Remove filler caps and check the electrolyte level as explained above.
- Attach a battery charger.
- Using a current of 5 amperes intensity continue until:
 - a) The electrolyte density reaches the 1270/1280 grams/liter (30 : 31 Be) limit in each cell of the battery.
 - b) The density value remains constant for three consecutive readings in a one hour period.
 - c) The voltage value of each cell remains constant for three consecutive readings during a one hour period.
 - d) Active oiling of the fluid occurs in each cell area.

Whenever the car is not to be driven for long periods of time, the battery must be checked every two months and recharged every time that the density readings are below 1200 grams/liter in order to avoid full discharge and consequent sulfating of the battery plates. The condition makes the battery unusable.

If at the end of the charging operation, the electrolyte level in one of the cells is lower than the others, there is probably some fault in the battery. Either the case has begun to or is cracked, or a short circuiting of the cell plates has occurred. Having repaired the case or repaired the faulty battery units, proceed to refill with new electrolytic solution. This solution is prepared by pouring a quantity of chemically pure sulfuric acid (for the accumulators) in distilled water until the prescribed density level is reached.

WARNING

IT IS DANGEROUS TO POUR WATER INTO THE ACID, OR TO HAVE AN OPEN FLAME IN THE VICINITY OF THE ACID, OR STARTING SPARKS NEAR THE BATTERY, ESPECIALLY DURING THE CHARGING OPERATION.

CAUSES OF ABNORMAL DISCHARGE

Causes of a full discharge of the battery can be traced to the following:

- Insufficient charge (the alternator does not charge sufficiently).
- Excessive discharge (usually due to too many frequent successive starts, or prolonged use of the lights with the engine turned off).
- Defective insulation in the electrical system.

MARELLI ALTERNATOR CHARGING SYSTEM

The system is made up of an alternator and a transistorized regulator. The stator functions as an inducer, the rotor as an inductor. The stator, a 12 pole Lundell type, mounts the energizing coil in which flows the direct current, supplied through two sets of brushes (one connected to terminal F [Fig. 1] and the other on terminal -), and a two-ring commutator which generates the magnetic field necessary to induce the alternating voltage in the stator. The stator is made up from a laminated body, provided with 36 slots in which is installed a three-phase, 12 pole, delta-connected winding. From the vertices extend three wires connecting the delta winding with the rectifier group, enclosed on the opposite cover to that of the drive end. There are 6 silicon rectifier diodes, formed in sets of two each, in three separate holders. Each diode holder mounts in the center of a terminal on which is connected the alternating current lead. The three diode holders exposed to the voltage are properly insulated from the cover to which they are fastened. On each holder, as previously explained, are attached two diodes. One diode allows the current to flow only from the case to the stem (the stem is marked in red and the case is marked in black); the other diode allows the current to flow only from the stem to the case (the stem is marked in black and the case is marked in red). The first diode is the positive one, the second diode is the negative one.

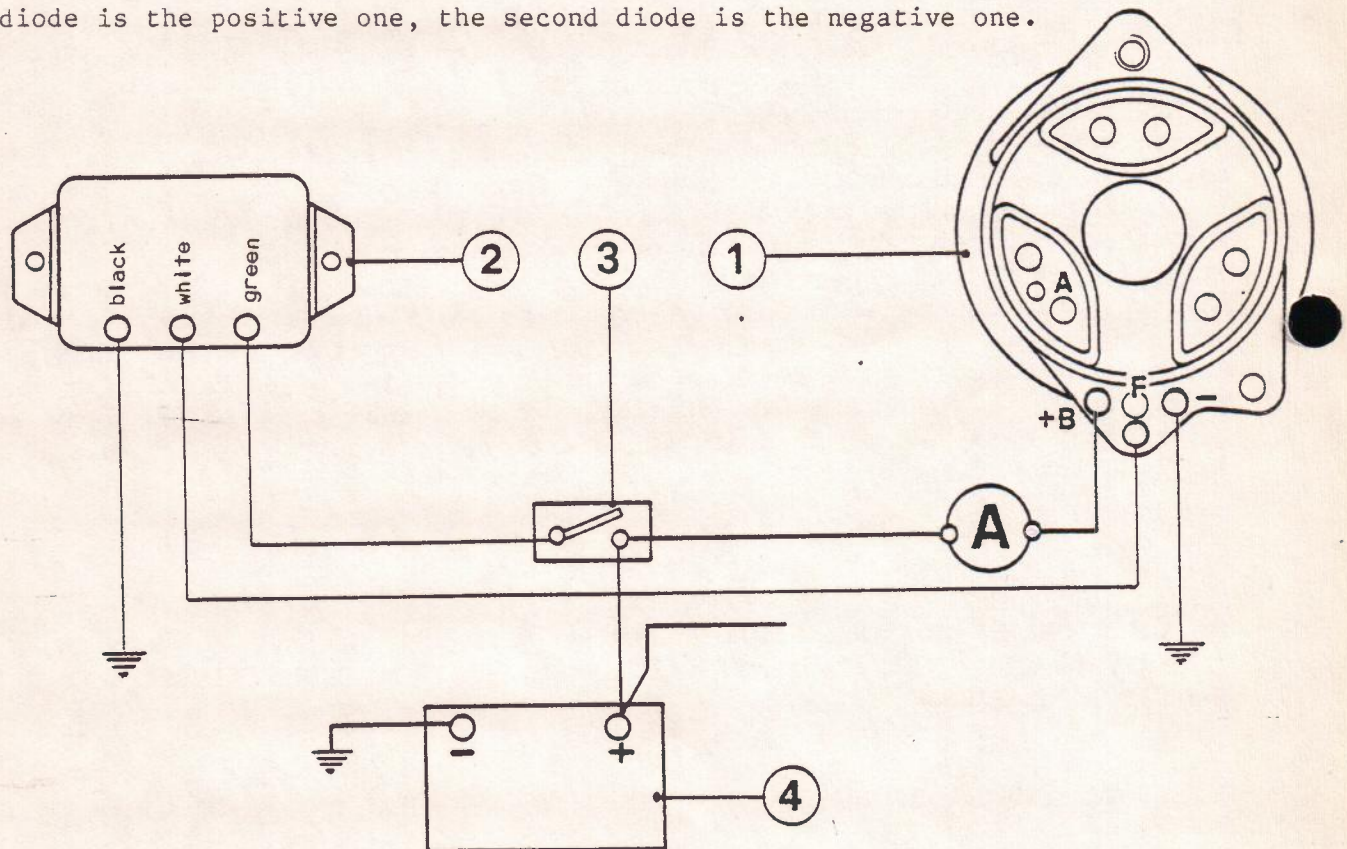


Fig. 1 - Charging System Electrical Diagram

1-Alternator; 2-Voltage regulator; 3-Ignition key; 4-Amperage meter

From the three red-marked stems (one for each diode), extends a union lead which is connected to the positive (+B) terminal of the alternator; while from the three black marked stems (one for each diode carrier) extends a union lead which is connected to the negative terminal. This setting performs a double half-wave type, three phase bridge; the current will flow externally only from the positive terminal to the negative terminal, and not in the opposite direction. As a result, it will not be necessary to provide an automatic cut-out, as opposed to that which takes place in a generator. Moreover, in a self-limiting current control alternator, an automatic cut-out is unnecessary.

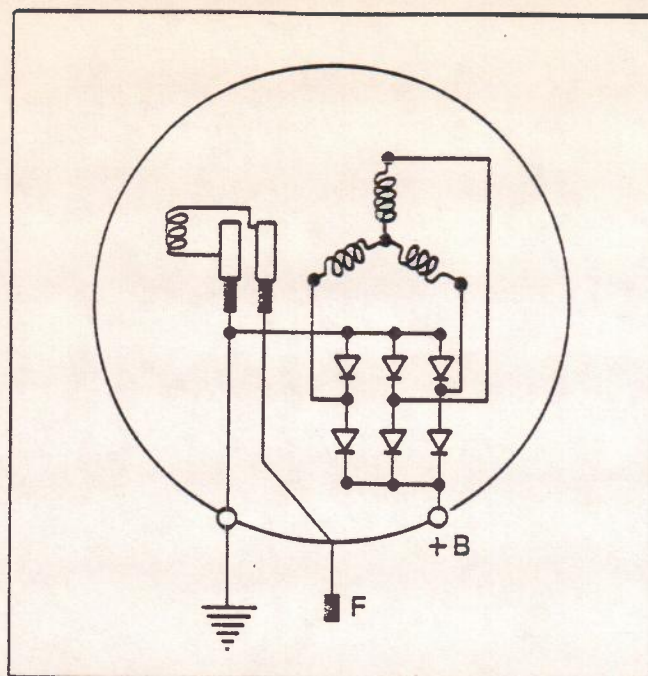


Fig. 2 - Alternator
Electrical
Diagram

VOLTAGE REGULATOR

The alternator field flux, as may be notice from the wiring diagram (Fig. 3), is conducted through the voltage regulator which, by acting on the field current, maintains a constant voltage, independent of the engine revolutions and load. The regulator is of the transistorized, totally static type. It is provided with three terminals; a black terminal which is connected to the ground, the white terminal which is connected to terminal F of the alternator, a green terminal, which connected through the ignition switch to the postive line of the circuit. The functioning of the voltage regulator is essentially as follows:

When the car's ignition switch is turned on, battery voltage is applied to the terminal points of the voltage divider R1-R2-R3 (R1 has variable resistance). A part of this voltage is confronted with that of reference diode Z1 (Zener voltage). While the line voltage of the potential divided is lower than that on the diode, there will not be any current passing through the resistor R4, the voltage between the base and the emitter of the transistor T1 will be zero, and the transistor T1 will remain cut-off.

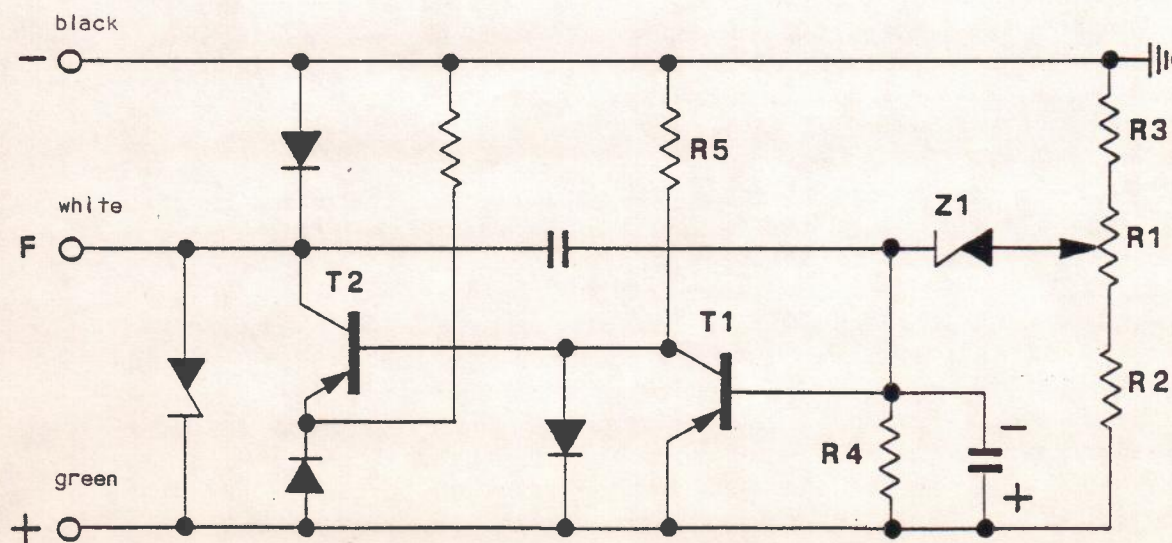


Fig. 3 - Voltage Regulator Electrical Wiring Diagram

Between the emitter and the base of the transistor T2 there will be applied a voltage (positive on the emitter and negative at the base); therefore transistor T2 will be conducting and maximum voltage will be applied to the field. When the alternator starts to energize, it will raise the line voltage; consequently the voltage obtained at the potential divider will exceed that of the Zener voltage, causing diode Z1 to conduct; on the terminal points of resistance, R4 will appear a potential which will affect the conduction of transistor T1. Operationally, the circuit voltage will be all localized at the terminal points of resistance R5. Transistor T2 will be cut-off with the result of opening the field circuit. The alternator voltage will drop to a value such that the reference diode cannot conduct any longer, and T1 returns to being a cut-off, while T2 again becomes a conductor. It is this closed and open alternation of the circuit which produces the voltage control of the regulator and this is further improved by the addition of other components with auxiliary functions. The variable resistance R1 of the potential divider allows the setting of the regulator to the desired voltage (14.2). In case of improper operation or eventual damage it is advisable to replace the complete regulator unit.

REPAIR INSTRUCTIONS

FAULTS TO WHICH THE UNIT MAY BE SUBJECTED

- Grounded stator winding
- Broken (interrupted) stator winding
- Short-circuited stator winding
- Diodes short-circuited or grounded
- Energizing circuit short-circuited
- Energizing circuit grounded
- Voltage regulator setting maladjusted
- Non-functioning voltage regulator

ON-CAR CHECKING OPERATIONS

Insert the key in the ignition switch and turn it to the second position so as to turn on the lighting and ignition indicator lights; the ampere gauge should indicate a discharging condition. By starting the engine and accelerating to 3000 rpm, the gauge should show a charging condition even with the lights turned on. If this does not happen, there may be a fault in the charging system. After making sure of the fitness of the charging system, it will be necessary to check out the alternator. Also check the voltage regulator operation by checking at the battery terminals with a meter, with the engine running and turned off. If the voltage at the posts increases when the engine is running, the alternator is charging; if the voltage, when the engine speed is increased, does not exceed 14.2 to 14.5 volts, then the regulator is also in good operating condition. If the voltage exceeds 15 volts, then the regulator is not functioning normally.

ALTERNATOR BENCH TESTING

FIELD CIRCUIT - In order to ascertain the condition of the charging circuit, measure with the engine turned off, the resistance between terminal F and the - terminal (ground). If the resistance measurement is zero, there is a short-circuit in the energizing coil or at the brushes connection. Only if the resistance measurement is zero, energize the alternator with a 12 volt battery, with the positive terminal on connection F and the negative terminal connected to the - cable (ground), checking both voltage and current. If with a voltage of 12 volts, the current is about 2.4 Ampere, the field is free of irregularities; if the current is slightly higher than this value, there is a partial short-circuit; if the reading is much lower, there is a faulty contact of the brushes on the connector or a faulty solder joint in the connections. If the resistance measurement is beyond the range of the meter readings, there is a break in the energizing circuit or a faulty soldered contact in the connections.

OUTPUT CONTROL CHECKS

When this check is carried out, it also allows the complete checking out of the functioning of the alternator. Mount the alternator, complete with its fan, to the test bench where its speed can be varied with continuity. The characteristic output curve, with constant voltage at 14 volts, is the one illustrated in the diagram and with the readings taken during warm operating conditions. The diagram to use is the following:

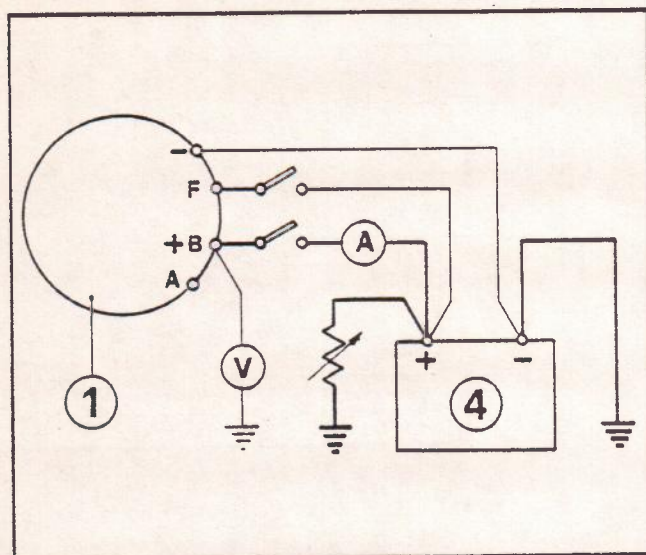


Fig. 4 - Alternator Bench
Test Diagram
1-Alternator; 4-Battery

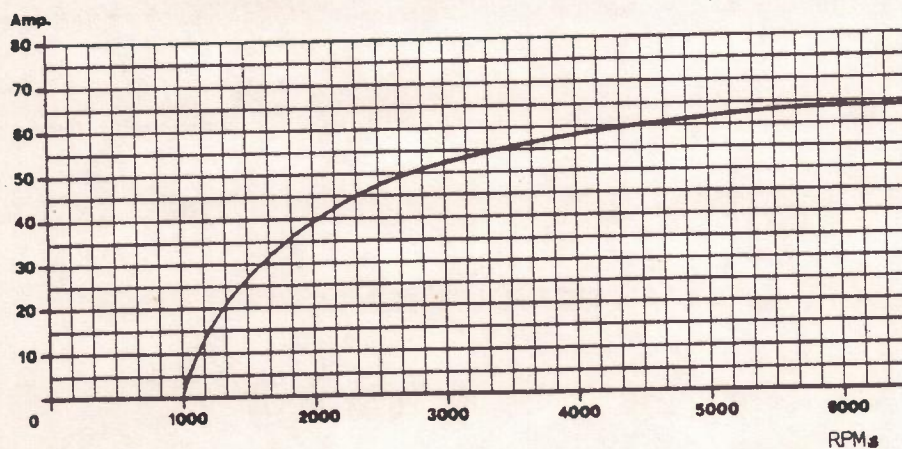


Fig. 5 - Current Output
Diagram

CHECKING OF THE DIODES

The operation of the diodes can begin to fluctuate or can be short-circuited. The second fault is more common than the first. With the engine stopped, and without removing the side cover of the diode unit, we can test for a short-circuit as follows:

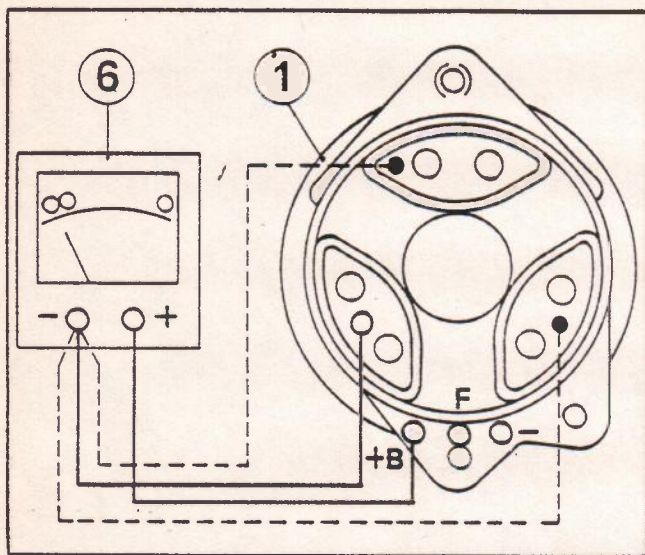


Fig. 6 - Diode Control Checks Wiring Diagram

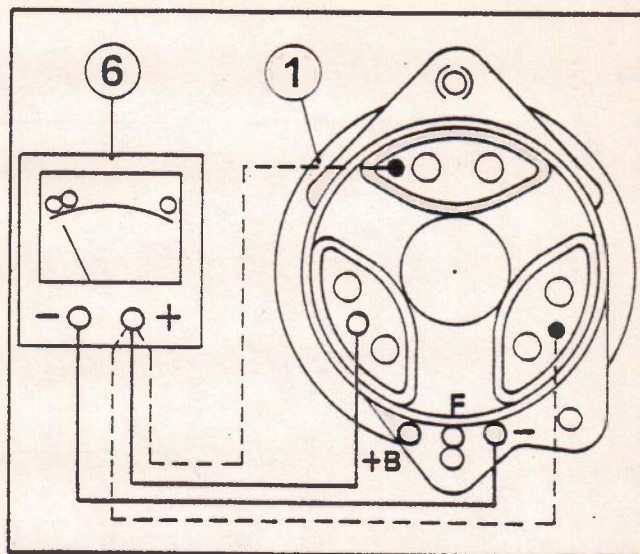


Fig. 7 - Diode Control Checks Wiring Diagram

With the positive cable of the tested placed on the +B connection of the alternator, alternatively measure the resistance between the terminal and the three diode holders. If the resistance reading is for all practical purposes beyond the reading range of the meter, none of the positive diodes is short-circuited (Fig. 6). Analogously, with the + cable of the tester alternatively placed on each of the diode holders, measure the resistance between them and the - terminal (ground) of the alternator. If the resistance reading is beyond the meter range, none of the negative diode holders is short-circuited (Fig. 7). With the diode holder cover removed it is easy to identify the short-circuited diodes since they will display practically no resistance in both directions (from the stem to the case, and from the case to the stem).

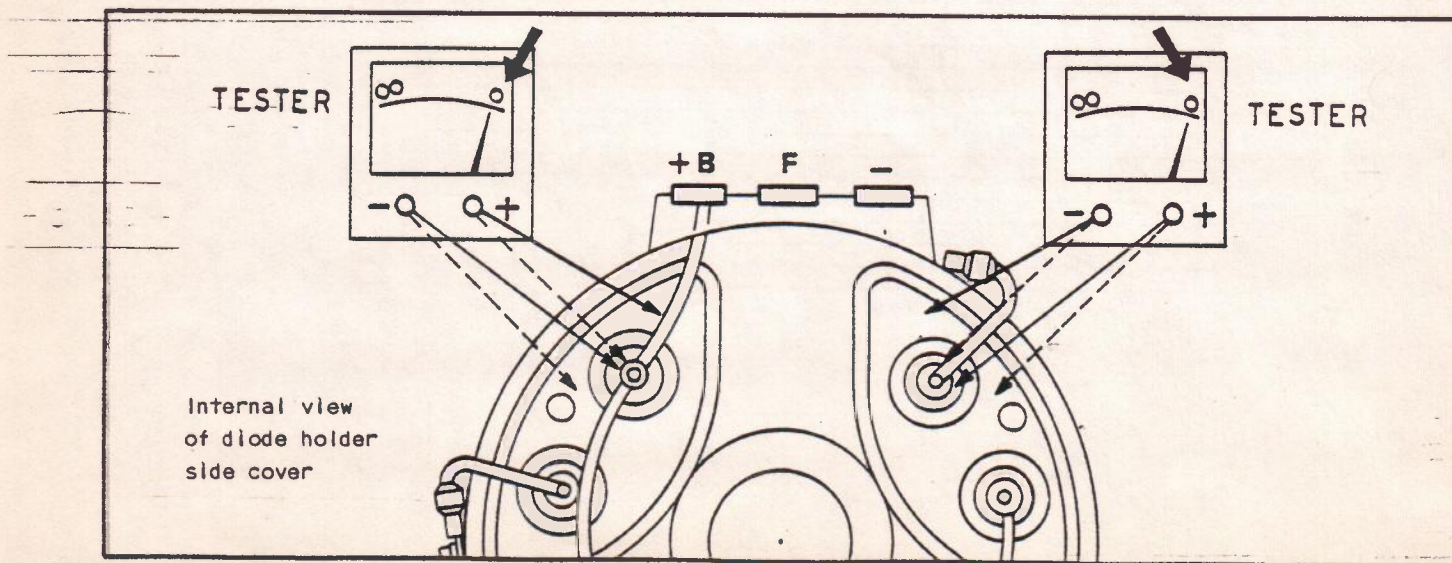


Fig. 8 - Wiring Diagram for the Identification of Short-Circuited Diodes

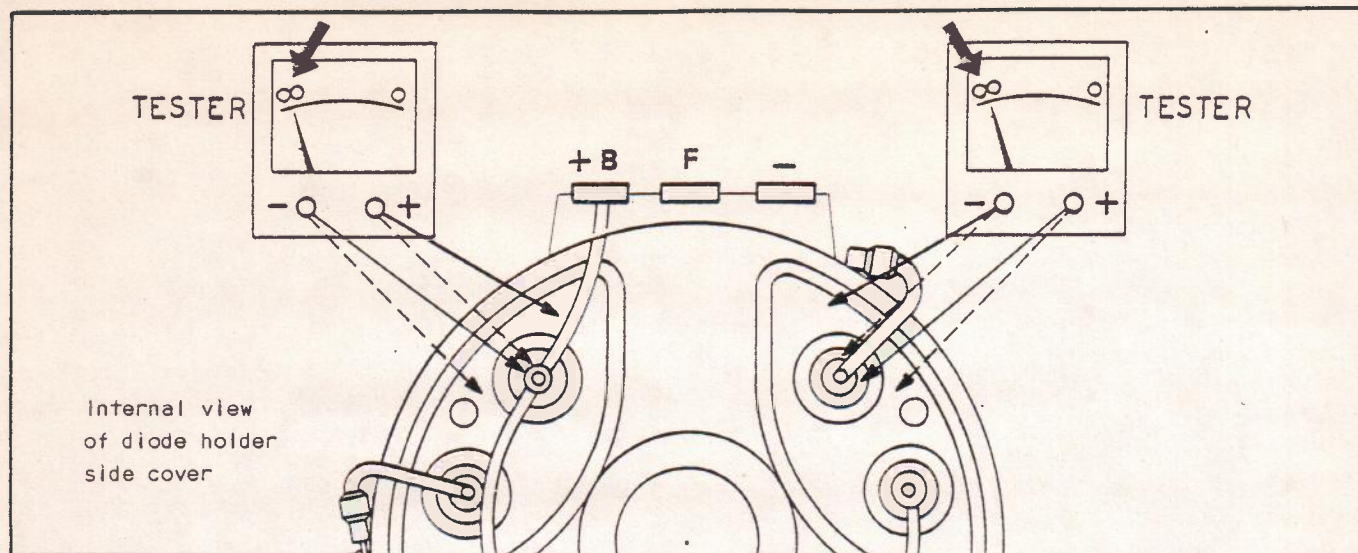


Fig. 9 - Wiring Connections Diagram for the Identification of Eventual Interruptions in the Diodes

Operational malfunctions of the diodes can only be ascertained by removing the diode unit cover. A malfunctioning diode displays a resistance reading out of the range of the meter in both directions (from the stem to the case, and from the case to the stem).

FAULTY OR SHORT-CIRCUITED DIODES MUST BE REPLACED

For replacement, use diodes of a same make; pay particular attention to their correct installation and to the soldering at the base of the diode. Diode replacement is best carried out by a specialized shop equipped for such work.

CHECK OF THE INDUCTION WINDING

To identify any possible short circuit in the winding, without removing the alternator from the car, check for continuity between the three diode holders. If continuity is lacking between each of the holders and the other two, one of its three phases is faulty either at its connection to the diode holders or in the winding.

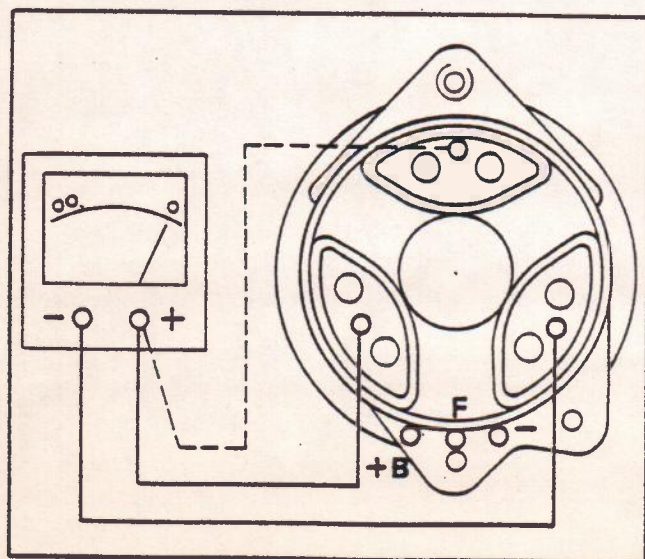


Fig. 10 - Wiring Diagram for Checking Induction Winding Continuity

IMPORTANT NOTICE - Eventual checks aimed at isolating insulation faults, conducted with either a voltage higher than the maximum value or equal to 110 volts or with a "megger" (megaohmmeter), should not be conducted with the alternator mounted in place, nor with the diode holders mounted on the alternator dismantled from the car since the rectifier diodes will be irretrievably damaged.

BOSCH ALTERNATOR CHARGING SYSTEM

The system is made up of an alternator, a transistorized voltage regulator incorporated in the alternator, a charge indicator light, and an ampere gauge to indicate battery charge. The following diagrams and notes, regarding both installation and functional characteristics, refer to the following components:

Alternator: BOSCH 0.120.489.542 (55A)

Transistorized voltage regulator: BOSCH 0.192.052.004

Insufficient charge indicator light

Ampere gauge

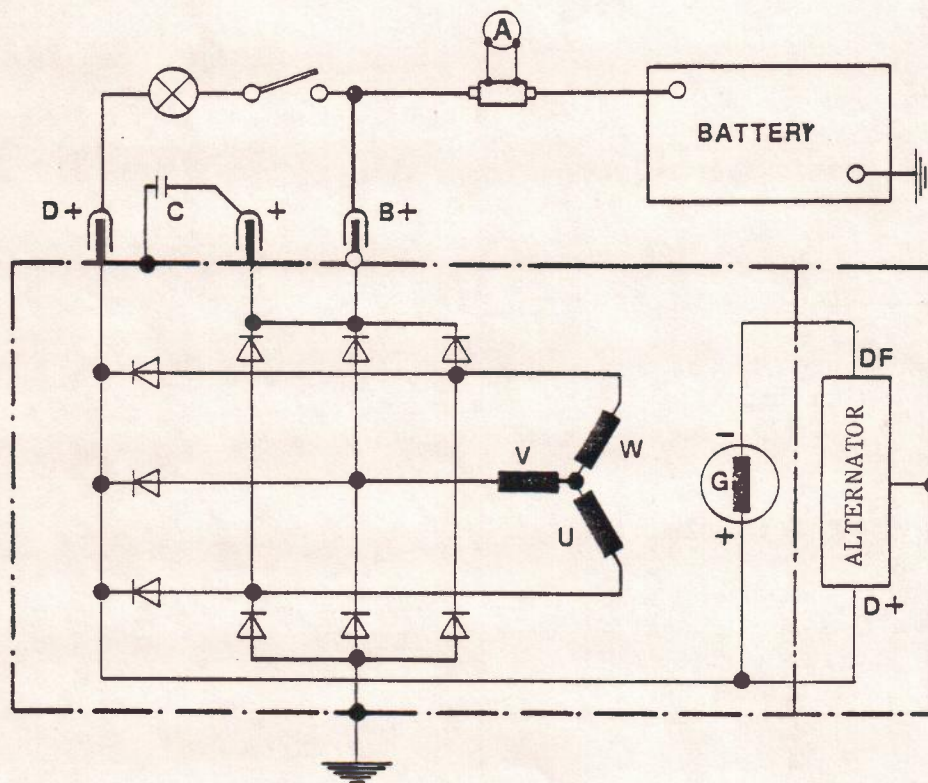


Fig. 11 - Alternator and Charging System Electrical Diagram

The stator functions as an inducer, the rotor as an inductor. An energizing coil is installed on the rotor; the electric current supplied through two sets of brushes and a commutator which generates the magnetic field necessary to induce the alternating voltage in the stator.

The stator is made up of a laminated body, which is equipped with a three-phase, delta-connected winding. The three ends of the winding connect to the rectifier unit.

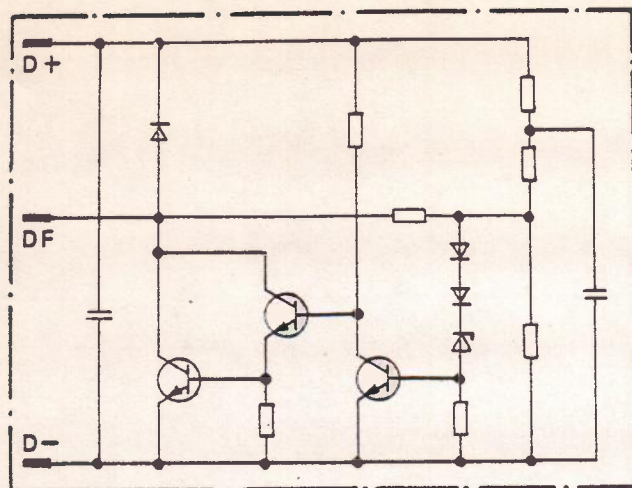


Fig. 12 - Voltage Regulator
Electrical Diagram

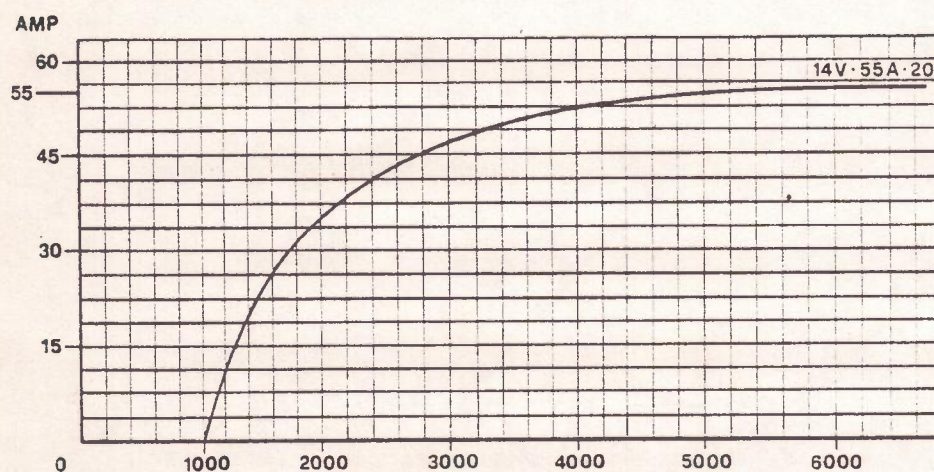


Fig. 13 - Current Output
Diagram

ALTERNATOR BELT TENSION ADJUSTMENT

TENSION TO BE ADJUSTED WITH COLD ENGINE

MANUAL TENSION CHECK

Arrow A measured with a straight edge must be 4.5 mm. under a 1.5 Kg. load; with a new or operational belt it is 0.3 Kg.

CHECK VIA TENSION TESTER

With a new belt the tension load must be 22 Kg. as indicated on scale 7 M of a tension tester "type GATES 150."

With an already operational belt, the load must be 19 Kg.

To increase belt tension, loosen bolt B at the adjustment rod, moving the alternator to the outside and retighten the bolt.

NOTE

Every 5,000 Km.: Check belt tension.

Every 20,000 Km.: Replace.

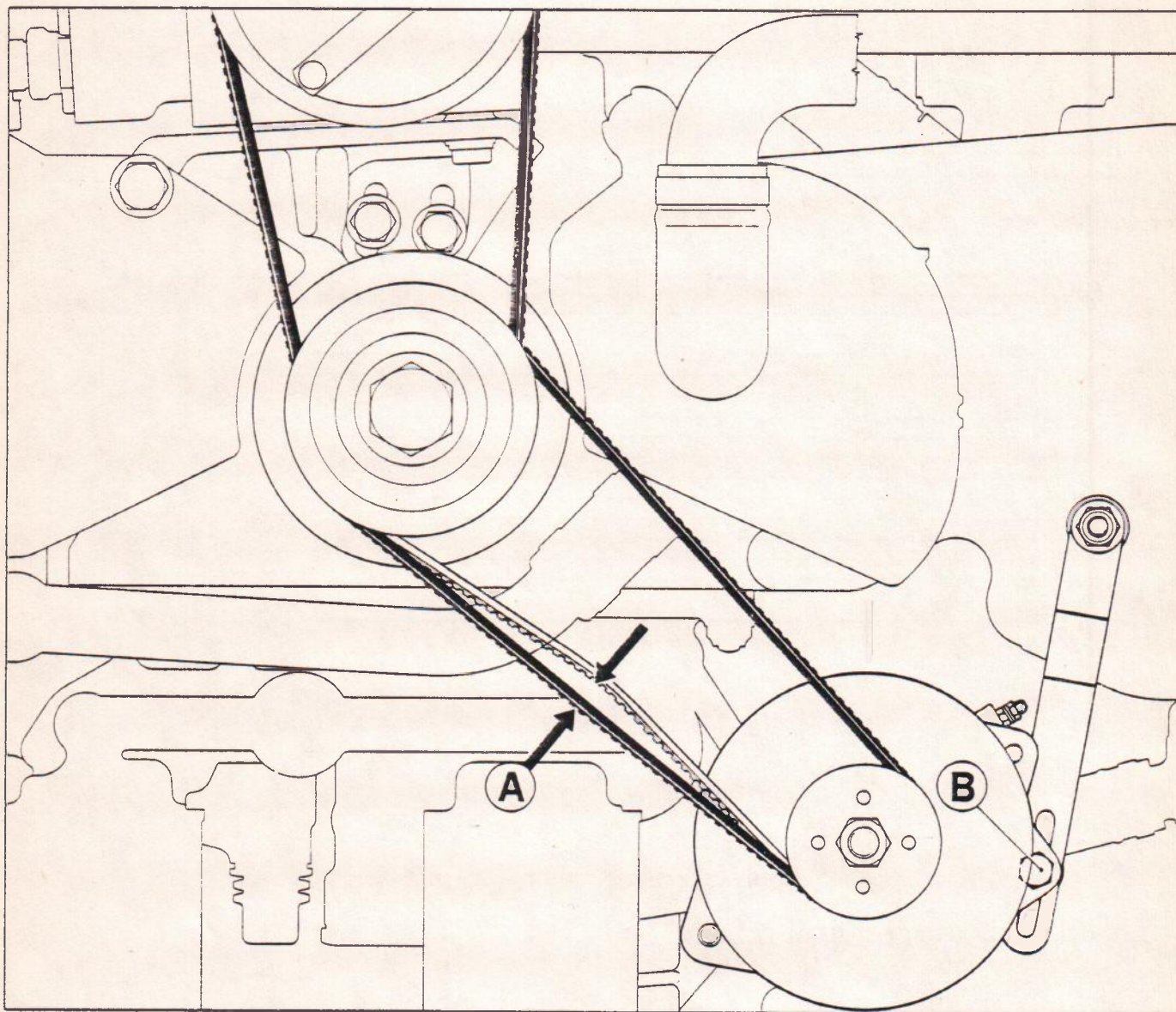


Fig. 14 - Belt Tension Adjustment

STARTER MOTOR

CHARACTERISTICS AND DATA.....	177
DIAGNOSING MALFUNCTIONS AND RELATED REPAIRS.....	178
GENERAL DESCRIPTION.....	179
MAINTENANCE.....	179
OVERHAUL.....	179

CHARACTERISTICS AND DATA

Type	E 100-1.5/12 Var. 1 F
Voltage	12 V
Nominal power	1.5 KW
Direction of pinion rotation	Clockwise
Poles	4
Field winding	Mixed
Engagement	Free Wheeling
Control	Electromagnetic
Test bench data	
--Operational test (at 20° C):	
Current	300 A
Speed	1300 rpm
Voltage	9.3 V
--Starting test (at 20° C):	
Current	540 ± 20 A
Voltage	6.6 ± 0.1 V
--No-load test (at 20° C):	
Current	30 ± 5 A
Voltage	11.7 ± 0.1 V
Speed	4800 ± 200 rpm
Mechanical checks	
--Spring pressure at brushes (fresh condition)	0 ± 0.1 Kg.
--Driven shaft axial play	0.07 ÷ 0.7 mm.
--Commutator blades insulating groove's depth	1 mm.
--Operational efficiency: static torque required for slow rotation of pinion shaft	≤ 2.8

Characteristics and Data (continued)

Lubrication --Internal engagement grooves and shaft bushings --Sleeve and disc	AGIP SINT 2000 SAE 10W50 AGIP F 1 GR MU/EP 2
Electromagnet --Current absorbed --Field winding resistance at 20° C	

DIAGNOSING MALFUNCTIONS AND RELATED REPAIRS

THE MOTOR DOES NOT TURN

Possible Causes	Remedies
1) Battery terminals and related connections oxidized. 2) Loosened battery or switch connection. 3) Battery completely discharged. 4) Lack of commutator contact due to excessively worn brushes. 5) Electromagnetic switch contacts oxidized, or defective switch winding. 6) Grounded induction or inductor. 7) Grounded solenoid winding.	1) Remove the connections, clean connections and terminals accurately, smear with vaseline and reconnect. 2) Check and tighten. 3) Check and recharge battery. 4) Replace brushes. 5) Check and clean contacts: oxidation can be determined by poles in short circuit. 6) Deterioration of the insulation, deteriorated commutator plates. 7) Replace solenoid.

THE MOTOR TURNS SLOWLY

Possible Causes	Remedies
1) Worn brushes. 2) Short-circuited inductor or induction winding poles. 3) Oxidized or loosened battery terminals and related connections. 4) Loosened battery or switch connection. 5) Battery in low charging state, or with one or two faulty poles. 6) Grounded armature winding.	1) Replace the brushes. 2) Locate short-circuited poles with a high frequency unit. If located, make needed repairs. 3) Remove the connections, clean connections and terminals accurately, smear with vaseline and reconnect. 4) Check and replace. 5) Check. 6) Replace armature.

EXCESSIVE STARTER MOTOR NOISE DURING STARING PHASE

Possible Causes	Remedies
1) Excessively worn self-lubricating bushings.	1) Replace the bushings.
2) Engagement pinion slow in disengaging from flywheel.	2) Defective operation of the engagement control due to wear or sticking of the lever, weakening of the spring wear of the sleeve on the hub or on the electromagnet core in its seat. Remove motor and replace faulty units.

GENERAL DESCRIPTION

In the electrical starter motor the engagement of the pinion is obtained through the thrust and spiral drive type engagement unit; the control of the movement is achieved electrically via an electromagnetic switch. The starter motor is designed so as to be energized with a continuous 12 volt battery current, which also energizes the car's other electrical circuits and develops a potential of 1.5 CV.

MAINTENANCE

Before starting any maintenance operations on the starter motor, disconnect the battery positive (+) cable. Periodically clean the pinion and ring gear teeth and lightly grease them using a small brush.

Check the condition of the commutator and the brushes. If the commutator is dirty, clean it with a rag moistened with gasoline and blow off with compressed air the carbon and brass dust between the plates of the commutator.

Raise the brush springs (without twisting them) and slide the brushes in their guides; if they do not slide freely, clean the brushes with a rag moistened with gasoline. Clean the guides in the same manner.

The starter motor is mounted on self-lubricating, porous bronze bushings which do not require any lubrication.

OVERHAUL

In case the starter motor should be disassembled for an overhauling operation, clean all components properly before reassembly.

If the commutator shows any burned spots or deep scores, it will be necessary to turn it on a lathe.

The reduction value on the diameter should not exceed $0.5 \div 0.6$ mm.

After the turning operation, undercut the mica segments between the commutator plates to a depth of approximately 1 mm., then clean thoroughly.

If the brushes are worn past $2/3$ of their length, they should be replaced with the original type and size. Even if only one of the brushes is worn, replace both.

After replacing them, run the starter without load in order to seat the brushes properly to the commutator surface. When assembling, make sure that all components are electrically insulated (armature, commutator, field coils, brush holders, etc.). Check by connecting a 220 volt circuit in series with a 5 W lamp. While performing the test, the lamp should not light. The inside pole shoe diameter, mounted, is $67.80 \div 67.97$ mm. Check for the correct value by using a caliper gauge.

Tighten to the end of the shoe mounting screws. Remove the worn bronze bushings by turning the diameter down a thin layer, or by cutting longitudinally in two opposite points.

The new bushings are remounted by press fit with the proper tool, employing a ground and hardened guide shaft.

Before mounting, there should be a clearance of 0.1 mm. on the diameter between the shaft and the bushing.

The center punch should be mounted on the proper press and motor support should be set on the press plane surface with the hold exactly aligned in relation to the center punch.

Assemble the bushings on the shaft and mount it via press fit in the support.

The final load should be from 300 to 800 Kg.

The replacement self-lubricating bushings are supplied ready for installation and do not require lubrication or any surface finishing operation to prevent clogging of the lubrication holes.

When on a mounted bushing, the inside diameter does not correspond to the specified value, regrind or ream the hole to the proper size.

Do not use gasoline for cleaning operations. Clean with compressed air or use a dry cloth.

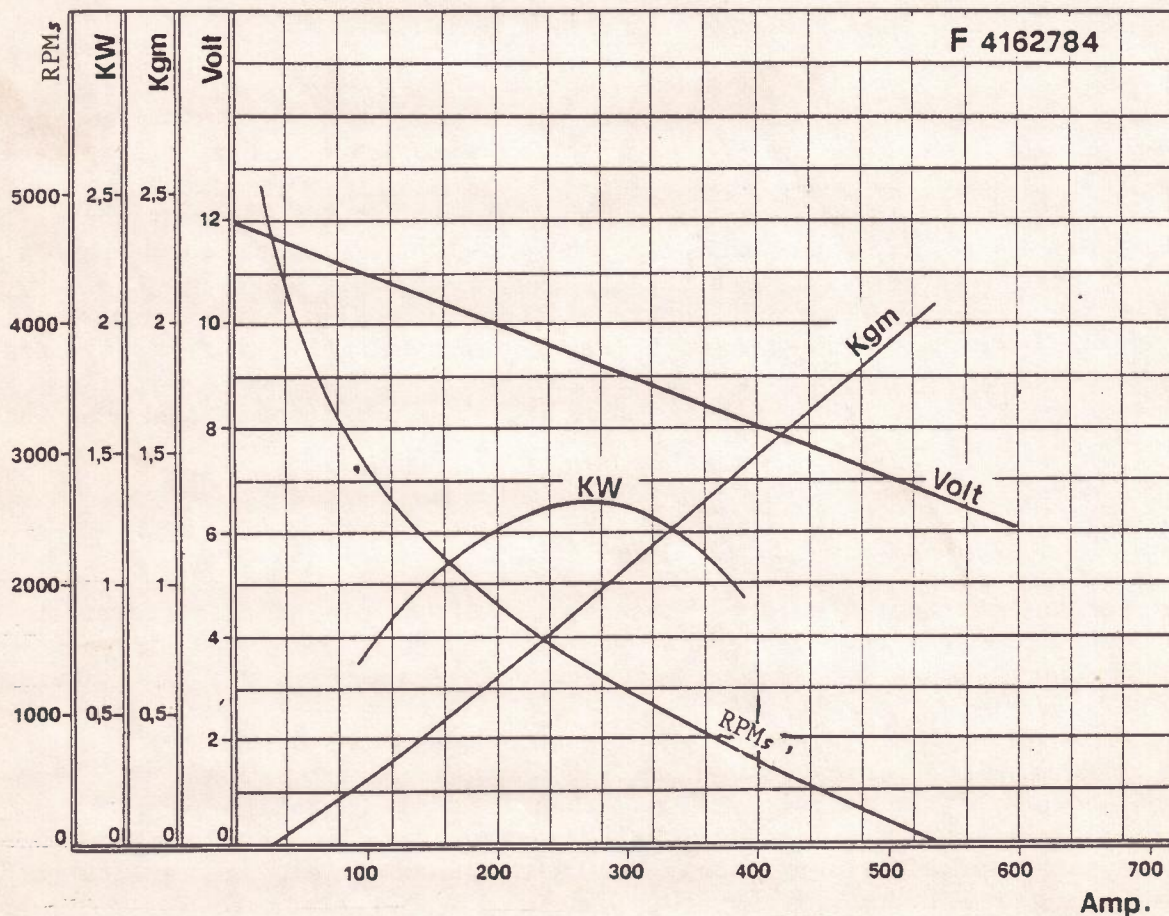


Fig. 15 - Starter Motor Operational Curves

IGNITION SYSTEM

CHARACTERISTICS AND DATA.....	181
DIAGNOSING MALFUNCTIONS AND RELATED REPAIRS.....	182
IGNITION DISTRIBUTOR.....	183
DESCRIPTION.....	183
IMPULSE PICKUP.....	183
ADVANCE CURVE CHECK.....	184
DISTRIBUTOR MAINTENANCE.....	185
REPAIRS.....	185
ELECTRONIC SYSTEM.....	186
IGNITION COIL.....	187
LEAK TEST.....	187
INSULATION TEST.....	187
SPARK PLUGS.....	187
DESCRIPTION.....	187
CHECKS AND REPAIRS.....	188

CHARACTERISTICS AND DATA

IGNITION DISTRIBUTOR		
Type		MARELLI S158A
Initial advance at engine		$16^{\circ} \div 18^{\circ}$ at R 1
Automatic advance at 3300 rpm at distributor		$13^{\circ} \pm 1^{\circ}$
Advance at 5000 engine rpm		$36^{\circ} + 38^{\circ}$
Gap between timer wheel (reluctor) and pick-up		$0.12 \div 0.24$ mm.
ELECTRONIC SYSTEM		
Type		MARELLI AEC 104 BK
Nominal voltage		12 V
Input polarity		Negative ground
Maximum operating frequency		800 Hz
Amperage draw at 25° C	(Test voltage (Draw	12 V 10 A
IGNITION COIL		
Type		MARELLI BAE 202-B
Primary winding resistance at 20° C + 50° C		$0.98 \pm 4\%$ ohms
Secondary winding resistance at 20° C + 50° C		$6000 \pm 10\%$ ohms
SPARK PLUGS		
Type		CHAMPION N7Y
Electrode gap		0.6 mm.
Thread length and pitch		14 x 1.25 mm.
Installation torque		2 Kg.

DIAGNOSING MALFUNCTIONS AND RELATED REPAIRS

LACK OF IGNITION

Possible Causes	Remedies
1) Discharged battery.	1) Recharge battery.
2) Current circuit grounded or interrupted.	2) Check and repair.

DEFECTIVE IGNITION

Possible Causes	Remedies
1) Excessive clearance between timer wheel (reluctor) and pickup.	1) Check the shaft bearings.
2) Distributor cover scored or with burned or humid contacts.	2) Replace the cover if scored; clean the contacts.
3) Rotor brush burned or scored.	3) Replace the rotor brush.
4) Spring-loaded carbon contact broken or with defective spring.	4) Replace contact and spring. Clean the contacts at the brush.
5) Discharging or defective high voltage connections.	5) Check terminals and cables.
6) Faulty Dinoplex system operation.	6) Check and eventually substitute.

IGNITION ADVANCED BEYOND NORMAL SETTING

Possible Causes	Remedies
1) Weakening of centrifugal regulator.	1) Replace springs with original.

IGNITION RETARDED BEYOND NORMAL SETTING

Possible Causes	Remedies
1) Excessive clearances in the distributor's control units.	1) Check clearances, replace worn units if wear is excessive, then reset timing.
2) Automatic advance not functioning.	2) Remove the distributor and check the advance.

MALFUNCTIONING IGNITION COIL

Possible Causes	Remedies
1) Loose or dirty connections.	1) Clean the connections and tighten.
For any other malfunctions, replace the coil.	

IGNITION DISTRIBUTOR

DESCRIPTION

The ignition distributor illustrated in Fig. 16 is made up of two electrical impulse pickup units 1 and an aluminum alloy case complete with an upper ball bearing support, with a shaft assembly equipped with reluctor wheel 3, an automatic centrifugal advance 4, a lower ball bearing support 5, a twin-tip rotor 6, and a distributor cap 7.

The case is designed so that one flange mounts on the engine. To verify the ignition contact operation check the condition of the pickup assembly. The control shaft is one assembly along with the case containing the advance unit weights.

The centrifugal action of the weights is controlled by compression springs.

The weights, due to the effect of the centrifugal force, increase the rpm's resulting in a change in the degree of dwell of the pickup wheel (reluctor) 3 thus advancing the action of the pickup unit 1.

Each position of the movement of the weights correspond to a different position of the pickup wheel (reluctor), thus determining the amount of advance required at different operating rpm's.

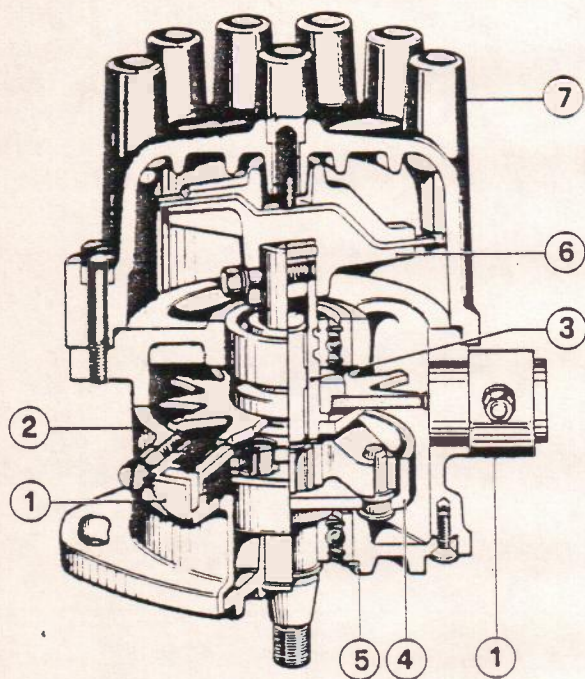


Fig. 16 - Distributor

1-Pickup assembly; 2-Case with upper support; 3-Pickup wheel (reluctor); 4-Automatic centrifugal advance; 5-Lower support with ball bearing; 6-Rotor; 7-Cap

PICKUP ASSEMBLY

Two pickup assemblies are incorporated in the distributor (R1=primary magnetic pickup, R2=secondary pickup unit which is non-functioning in this system).

Operationally they are made up of two parts: A - rotor; B - stator.

A - The slotted reluctor mounted on the distributor shaft functions as a breaker cam and is made up of non-magnetic steel wheel with 12 teeth with angle of 30° between each tooth.

B - The stator is rigidly connected to the body of the distributor. It is located opposite the reluctor wheel and separated by an air gap of 0.12 ± 0.24 mm. It is made up of a non-magnetic steel housing containing a magnet and a coil.

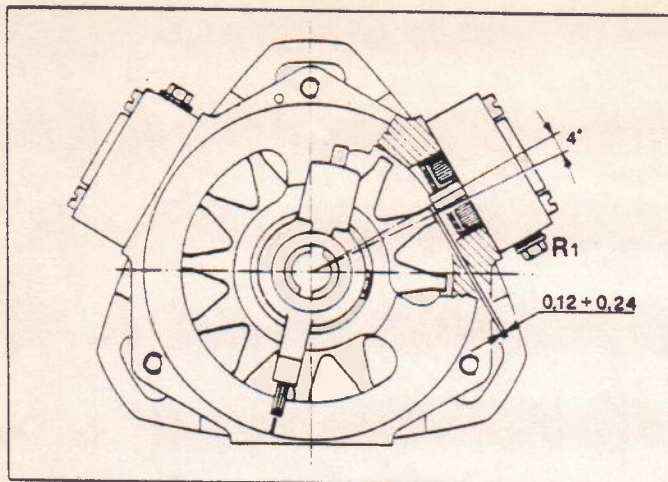


Fig. 17 - Pickup Assembly/Pickup Wheel (Reluctor) Gap Check

During the rotation of the distributor, every time that a reluctor tooth tip comes into alignment with the tip of the stator pickup unit, variations in their magnetic flux are generated which link with the coil winding. As a result, there are generated, at the coil connections, induced electrical impulses which are proportional to the speed and frequency of the distributor rpm's. These impulses are amplified and made available for use by the electronic capacitor discharge ignition unit. The high tension voltage, conducted through the rotor and the tips of the reluctor pickup, is delivered via the appropriate high tension cables to the spark plugs.

ADVANCE CURVE CHECK

With the gear box in neutral, gradually accelerate the engine to 5,000 rpm. With a stroboscopic timing light connected to cylinder 1, check through the slit on the flywheel housing that the advance is 38° as indicated on the flywheel (A5/ 38°). If not, remove the distributor from the engine and mount it on a distributor check bench. The advance curve must be between the prescribed tolerance limits as indicated on Fig. 18. If it does not, carry out a general overhaul of the distributor.

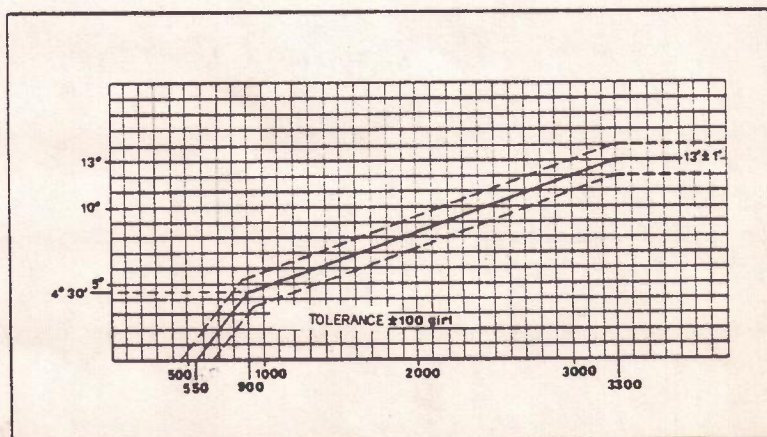
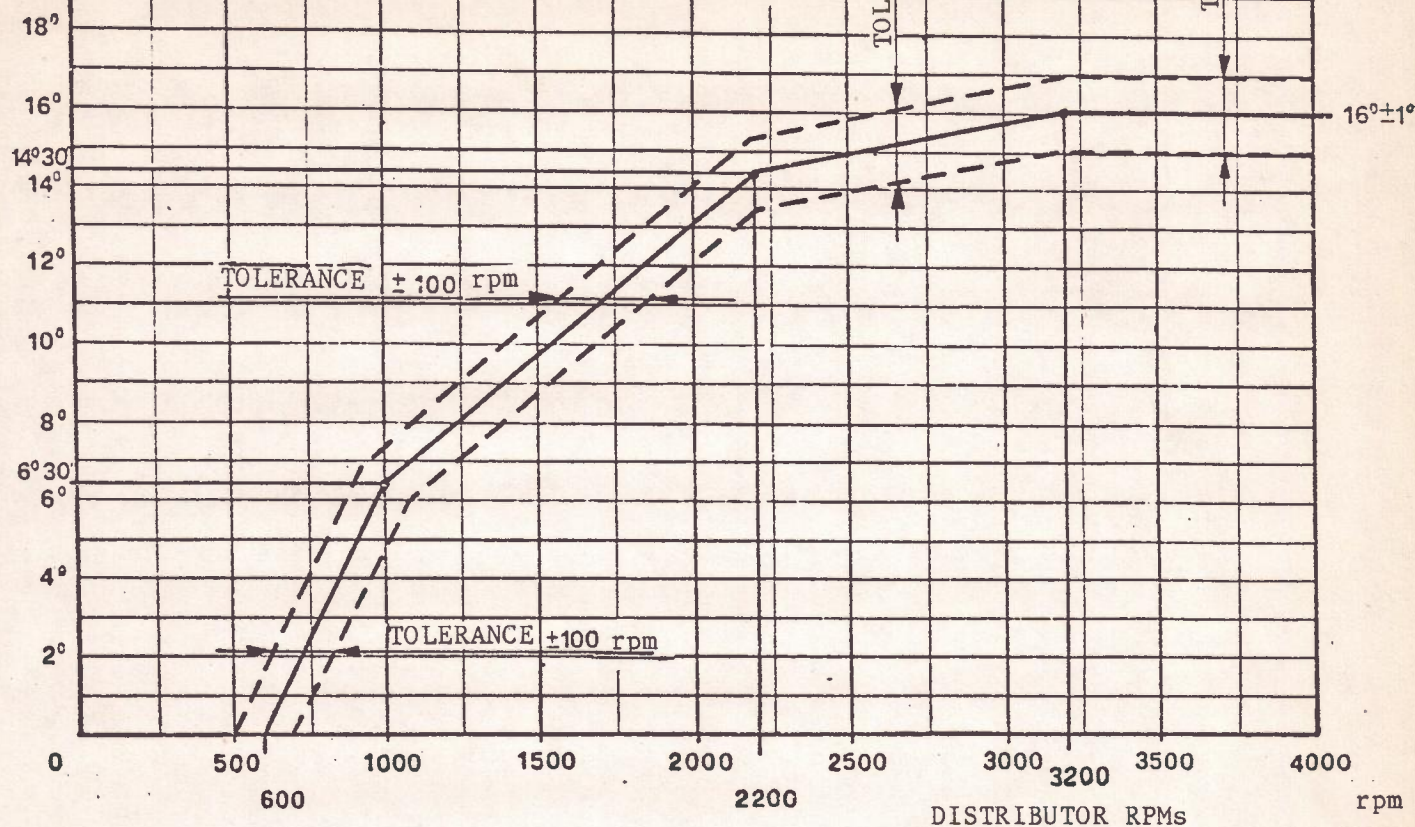


Fig. 18 - Automatic Distributor Advance Curve (365).

DISTRIBUTOR ADVANCE DEGREES



DISTRIBUTOR MAINTENANCE

Generally, normal maintenance requires only lubrication and cleaning of the insulated parts. Lubrication of the rest of the distributor is not necessary, since it is equipped with sealed bearings packed with the proper type and amount of grease for normal operation of the car. Check the distributor high tension units (cap and rotor). Remove the distributor cap and pull out the rotor, checking that they are clean and free of dirt and carbon dust; if cleaning is required, a clean white rag moistened only with gasoline should be used.

If the rotor tips and the faces of the tips of the (reluctor) pickup wheel are burned or encrusted with deposits, it is necessary to clean them using a fine file emery cloth. Make sure that the rotor is properly seated in the shaft and that no abnormal play is noted.

The distributor cap central carbon core must move freely in its seat and must be properly anchored within the spring. In the rest position, the carbon core must be inserted at least one-third of its length in the seat.

REPAIRS

In checking for distributor malfunctions and before proceeding to repair any individual unit, make sure that the malfunctions are not due to external causes (spark plug, carburetor, fuel injection unit, electrical connections, ignition key circuit, etc.) and that the distributor is in proper timing with the engine.

Repairs are undertaken as follows:

Check that all electrical connections are secure, and that current is being delivered to the ignition system. Accurately clean the inside and outside of the distributor cap, the rotor tips, making sure that there are no traces of carbonization.

Turn the engine over with the starter motor and remove the spark plug cables one at a time to check current delivery (it should spark when the cable tip is held against the cylinder block). This will identify whether the malfunction is located at each plug or lead wire. Replace all plugs when done.

If current is not reaching the spark plugs, the defect may be in the electronic ignition system, the coil, or the distributor.

If current is not reaching the spark plugs, temporarily replace the ignition coil with another sound one and repeat the test. If current still is not being delivered, the defect must be located in the ignition distributor or in the electronic system. However, if current is reaching the spark plugs, then the malfunction is in the original coil which then must be replaced.

DINOPLEX ELECTRONIC SYSTEM

IMPORTANT RULES

High voltage. It is dangerous to handle the high voltage cables while the engine is running.

Carry out check and repairs of the system only with the ignition key removed.

WARNING

--Do not disconnect the battery while the alternator is functioning, otherwise the Dinoplex system will be immediately damaged.

--Make sure that there are no irregular contacts or looseness between the battery terminals and their relative connections.

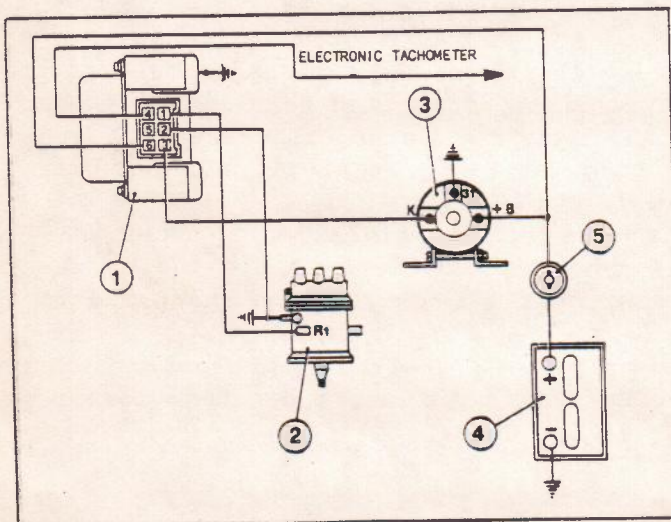


Fig. 20 - Electronic Ignition
Wiring Diagram

1-Dinoplex electronic unit; 2-Distributor; 3-Ignition coil; 4-Battery; 5-Ignition key

- Do not install any additional suppression condensers to the coil when installing a radio, as this will adversely affect the performance of the electronic ignition system.

Adequate suppression capability is already incorporated in the system.

IGNITION COIL

COIL OPERATIONAL CHECK (AT $25^{\circ} \pm 5^{\circ}$ C)

Connect the coil to the Dinoplex electronic ignition system and the magnetic impulse pickup unit as indicated in Fig. 20. With the distributor mounted on a distributor tester, rotate the distributor at the speeds indicated below and applying voltage to the coil as listed below, the following amperage draw values and relative spark lengths should be observed. Measurement of the coil's amperage draw is carried out with spark meter set at the third setting, and the contact gap set at 10 ± 0.5 mm.

VOLTAGE INPUT	DISTRIBUTOR SPARK - RPM	AMPERAGE DRAW	CRITICAL SPARK LENGTH	
			COLD - mm.	HOT - mm.
$6 + 0.2$	50	1.5	11	11
$12 + 0.2$	500	3.75	16	17
$12 + 0.2$	4000	9.5	18	18
$14 + 0.2$	6000	13.5	20	20

The hot check must be carried out at least after 1 hour of normal voltage input with the distributor rotating at 1500 rpm. Each test must last 10 seconds, during which the spark must be regular. The critical length of the spark is defined as the minimal distributor or spark meter gap at which the absence of sparks is begun to be noticed.

LEAK TEST

At $20^{\circ} \pm 5^{\circ}$ C. temperature, verify that the coil resists an effective voltage load of 1000 volts (50 Hz) applied for 3 seconds between the primary terminal and the outside metal case, without any electrical discharges occurring.

INSULATION TEST

At warm ($80^{\circ} \pm 5^{\circ}$ C.) temperature, verify that the insulating resistance at the ground, as measured between the battery terminals and the ground, remains above 50M ohms at 500V cc.

SPARK PLUGS

DESCRIPTION

The spark plugs must endure severe operating conditions. They should possess, for this reason, special thermal, electrical, and mechanical characteristics, and should be perfectly gas-sealed.

- Their thermal conductivity assures a rapid dispersion of heat, allowing a regular, smooth, and continuous engine operation.
- Good insulation and perfect dielectric strength, even at high temperatures, will prevent any loss of current flow or leaks.
- Effective resistance to sudden temperature changes, even if those differences are relatively high.
- Good mechanical resistance which will guarantee against any damage during the operation and handling.
- Perfect gas sealing, which will aid in preventing overheating or provoke self-ignition.

In every engine, the spark plugs should operate within two different thermal limits, which are respectively labeled as: self-cleaning temperature and self-ignition temperature.

The thermal characteristics of the spark plugs are, therefore, the determining factors for their proper selection in the different types of engines. The spark plugs are selected conventionally according to their heat range, which corresponds to a definite number established in relation to the number of seconds required by the spark plug to provoke self-ignition on a standard engine. Consequently, a **cold** spark plug is usually designated as one with a high heat range, while a **hot** spark plug is one designated with a low heat range. In a high RPM speed engine, with a high compression ratio or supercharged, it is necessary to use **cold** or high heat range spark plugs.

However, not all spark plug manufacturers apply the same conventional number to indicate the identical heat range. Therefore, it is necessary to consult the conversion charts before installing in the engine spark plugs different from those advised by the car maker. When the spark plugs begin to provoke self-ignition, refer to the same type as mounted on the engine, but replace them with those of the next higher grade of heat range. If, instead, the spark plugs being used display carbon or oil-soot deposits, replace them with spark plugs of the next lower grade of heat range. It is not advisable to use spark plugs with a heat range different from that specified. A somewhat empirical method, used quite often in practice by experts, to determine the proper type of spark plugs, consists in checking the insulator color of the center electrode as follows:

--Whitish insulator	install colder spark plugs
--Blackish or sooty insulator	install hotter spark plugs
--Brownish insulator	correct spark plugs installed

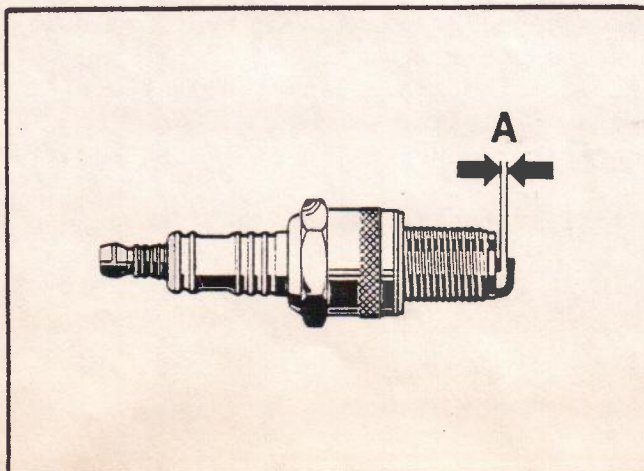
CHECK

Every 5,000 Km., or whenever the engine indicates ignition irregularities, it is necessary to remove all spark plugs and to check the electrode gap, to check for encrustations of the ceramic space and for sooty deposits produced by excess fuel at certain engine RPMs or by oil seeping into the combustion chamber. It is advised to replace plugs excessively encrusted or sooted. Remove encrustations with a small steel file, wash the plugs in gasoline and blow dry accurately; reset the gap at 0.6 mm. using the proper tool and great care.

Check on the proper test bench with the plugs under air pressure of 7 to 8 Kg/cm², with the ends of the spark gap set at 8 mm.; the sparks should jump regularly between the two electrodes. If frequent discharges are noted between the ends of the spark gap gauge instrument, or between the spark plug insulation and the ground, it is advisable to replace it.

EVERY 10,000 Km., replace all plugs.

WARNING - Lightly lubricate all plug threads before mounting them on the engine. If the spark plug spacer washer is new, tighten all plugs first to a 1.5 Kg. torque and then to 2 Kg. torque.



A = 0.6 mm.

Fig. 21 - Spark Plug

LIGHTING SYSTEM

CHARACTERISTICS AND DATA.....	189
HEADLIGHTS.....	190
CONTROLS.....	190
HEADLIGHTS.....	190
REMOVAL.....	190
HEADLIGHTS EMERGENCY RAISING/LOWERING UNIT.....	191
HEADLIGHT ALIGNMENT.....	191
FUSES AND RELAYS.....	193
ELECTRICAL SYSTEM DIAGRAM.....	196

CHARACTERISTICS AND DATA

BULBS (USE)	TYPE	WATTAGE (12V)
Headlights main beams Headlights dipped beams Fog lights	HALOGEN (iodine vapor)	55
Rear parking and stop lights Front parking and directional lights	Spherical, double filament	5/21
Rear directional lights Reverse lights	Spherical	21
License plate lights	Spherical	5
Luggage compartment light Engine compartment light Interior light (roof) Glove box light Ash tray light	Cylindrical	5
Side directional lights Open-door marker lights	Tubular	4
Instrument panel lights Fuel reserve warning light Brake system failure warning light Headlights main beam indicator light Direction indicator flasher lights Emergency lights indicator Fog lights indicator	Tubular	3

CONTROLS

HEADLIGHTS LIFTING	
Normal: electric control	With headlights lifting motors and switch located at lights control lever.
Emergency: manual control	With hand knobs at the headlights lifting motors.
Headlights control	With lever located under steering wheel.
Driving compartment illumination	Three-way position switch at the lamp housing.
1st position: on-off illumination with opening and closing of doors	Switch pushed forward.
2nd position: illumination off	Switch in neutral position.
3rd position: illumination independent of door opening-closing	Switch pushed backward.
Engine compartment illumination	Hood opening with parking lights on.

HEADLIGHTS

REMOVAL

Remove the headlights as follows:

- Raise the headlights to maximum height using the outside lights control lever.
- Remove the lifting motors fuses or disconnect the battery positive cable.
- Remove trim panel A fastening screws (Fig. 21).
- Loosen screw C, pull out the headlight and remove bulb F (Fig. 23).
- Remove headlight and lift out the reflector and glass assembly.
- Replace the bulb, taking care not to touch the quartz bulb with bare fingers; if this occurs, wipe it clean with alcohol.

NOTE - The bulbs must not be replaced with non-specified types or wattage, thus avoiding malfunctions of the system.

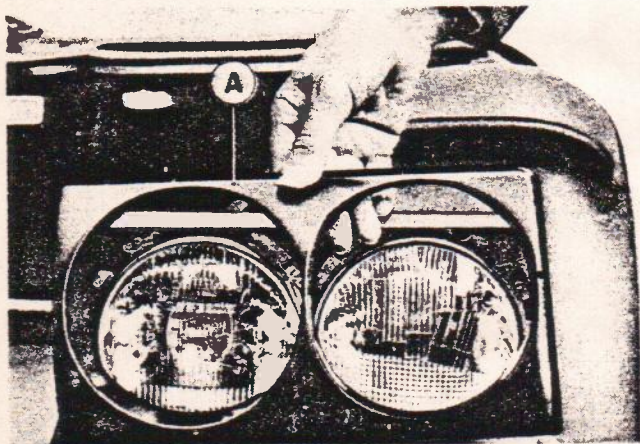


Fig. 22 - Headlights Trim Panel Removal
A-Trim panel fastening screws

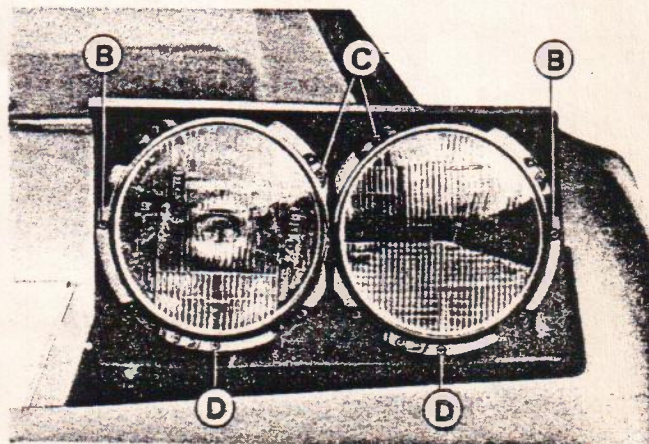


Fig. 23 - Fastening & Alignment Screws
B-Horizontal alignment adjustment screws; C-Reflector assembly fastening screws; D-Vertical alignment adjustment screws

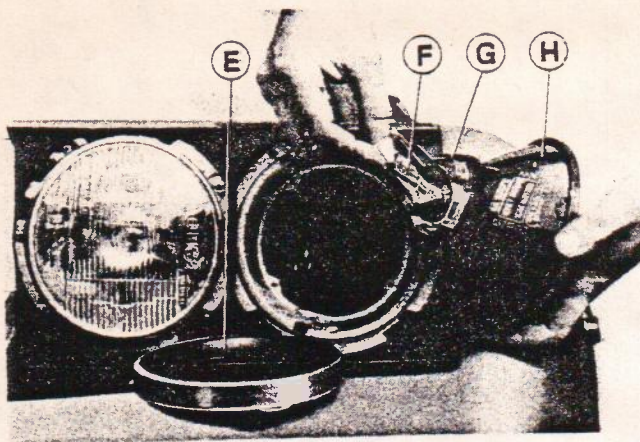


Fig. 24 - Headlight Bulb Replacement
E-Headlight retaining ring; F-Bulb;
G-Bulb retaining spring; H-Head-
light reflector and glass

HEADLIGHTS EMERGENCY RAISING/LOWERING UNIT

In case of a malfunctioning of the electric lifting unit, carry out the following steps:

- Remove the lifting motors fuses from the fuse box or disconnect the battery positive cable in order to avoid any short circuit.
- Rotate knobs A in an anti-clockwise direction, two or three complete turns each alternatively.
- Continue this until lifting is completed.

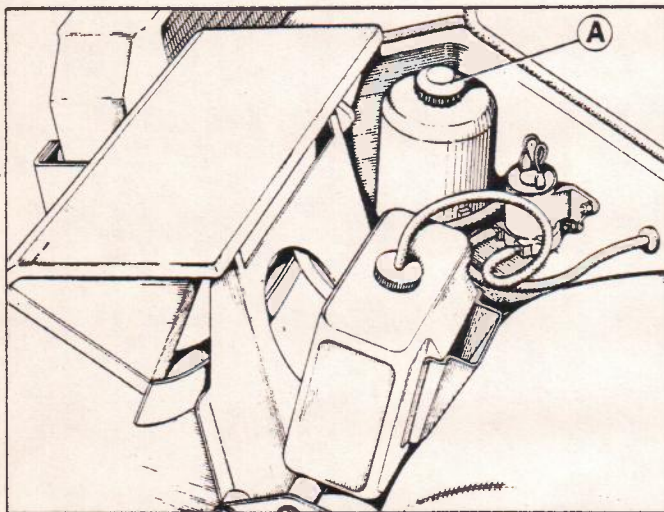


Fig. 25 - Headlights Lifting Motor
A-Headlights emergency lifting
control knob

HEADLIGHTS ALIGNMENT

This operation must be carried out with the car unladen, for both main and dip beam headlights. Check that tire pressures are within prescribed limits.

Place the car on a level surface, 10 meters from a blank opaque white vertical screen surface situated in a shaded location and check that the vehicle axis is perpendicular to the screen surface. Shake the car sideways in order to settle the suspension system.

Trace two sets of vertical lines a-a and a'-a' on the flat surface (Fig. 26): respectively at distance where $A' = 1280$ mm. and $A = 970$ mm. which correspond to the inter axis of the inside and outside headlights; these lines must be equidistant from the perpendicular to the longitudinal axis of the car.

Next, trace two sets of horizontal lines b-b and b'-b' at B which equals C - 14 cm., B' which equals C - 6 cm. for new cars or for cars with rebuilt suspensions, as well as for those which have been settled in, and C is equal to the distance from the ground surface to the center of the headlights measured at the time of alignment.

NOTE

A new vehicle can be said to be in a settled condition when it has completed the running-in period and operations described in the first free service/maintenance coupon.

In order to carry out the alignment, turn on the dip beams (outside headlights); adjust them by turning screws B for horizontal alignment, so that:

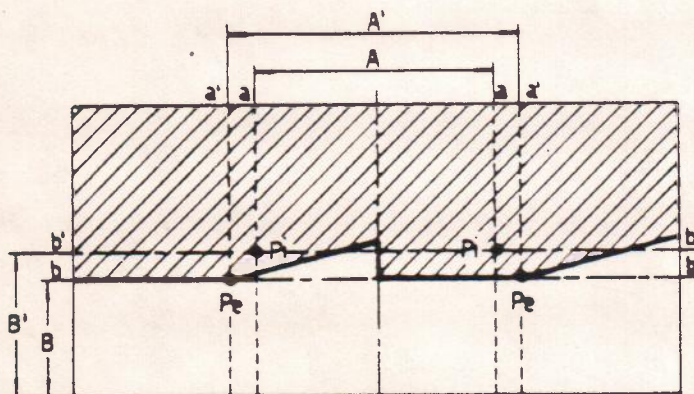
--The horizontal demarcation line between the dark and bright areas lie on line b-b;

--The demarcation lines pointed upwards (about 15°) separate at intersection points P_e (or just outside of them), between the vertical lines a'-a' on the horizontal line b-b.

For the alignment of the inside main beam units, turn on the lights and: turn screws 4 for vertical alignment, turns screws 5 for horizontal alignment so that the central area of maximum brightness (luminous center) occurs at intersection P_i , between horizontal lines b'-b' and the two lines a-a.

An increase of 26 cm. distance between A and A' can be tolerated, this corresponding to a total headlight divergence of 3° .

Fig. 26 - Headlights Alignment



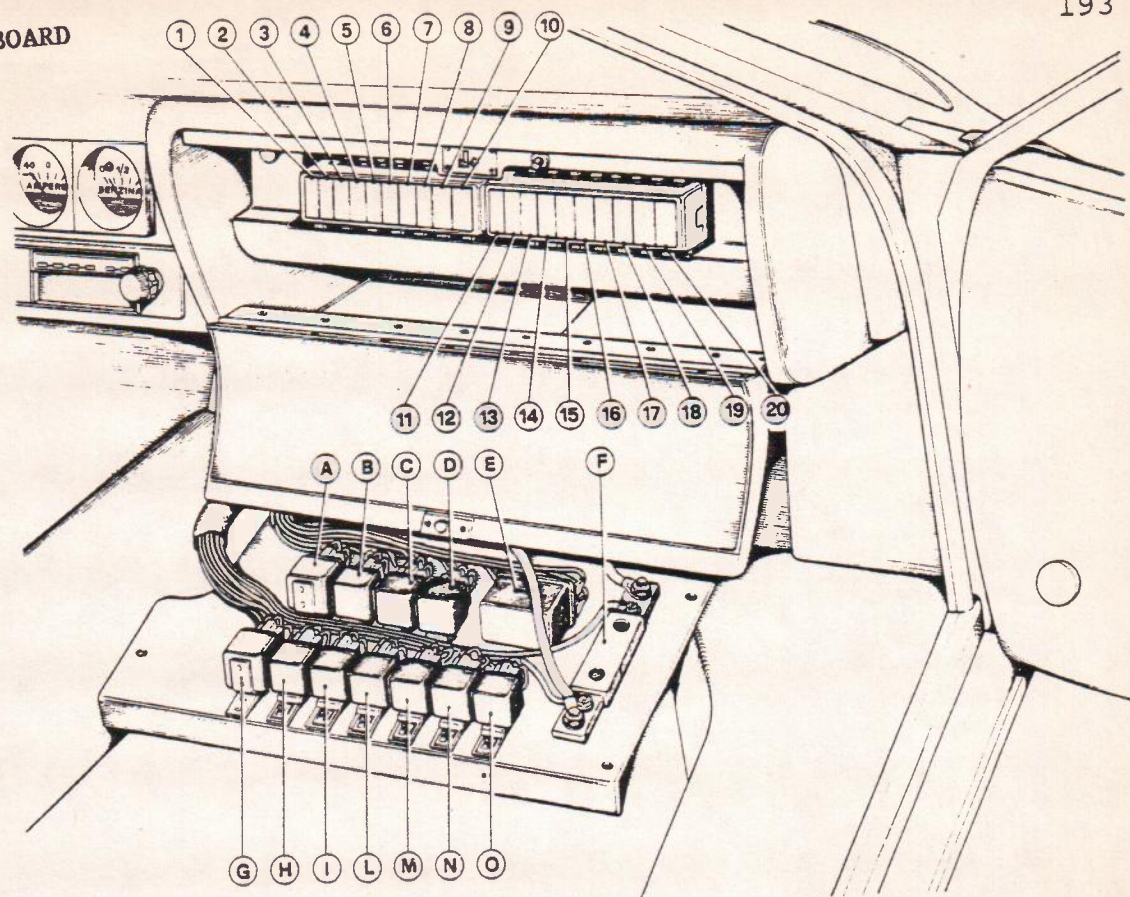


Fig. 27 - Fuses and Relays

LEFT BOX

- 1-A 8-Regulator
- 2-A15-Windshieldwiper-Directional lights
- 3-A 8-Fan relays-Instrument
- 4-A 8-Electric pumps
- 5-A 8-Stop lights-Water thermometer
- 6-A25-Left/right fans - Air conditioner
- 7-A15-Right headlights motor
- 8-A15-Left headlights motor
- 9-A25-Right window motor
- 10-A25-Left window motor

RELAYS

- A - Headlights main beam (STRIBEL SR 9833 2X10A)
- B - Headlights raising control (BOSCH 03.322.04.125 20/30A)
- C - Right headlights raising motor (BOSCH 03.322.04.125 20/30A)
- D - Left headlights raising motor (BOSCH 03.322.04.125 20/30A)
- E - Emergency lights flasher (SIPEA LEC-A 72013 7.5A 90W)
- F - Ammeter shunt (BORLETTI 50A)
- G - Parking lights (STRIBEL SR 9833 2X10A)

RIGHT BOX

- 11-A 8-Right main beam
- 12-A 8-Left main beam
- 13-A 8-Right dip beam
- 14-A 8-Left dip beam
- 15-A 8-Parking lights-Engine compartment light-Ashtray
- 16-A15-Parking lights-Instrument panel light-Fog lights
- 17-A25-Horns-Cigarette lighter-Clock-Interior-Flashers
- 18-A15-Emergency flasher-Interior-Radio
- 19-A25-Right radiator fan
- 20-A25-Left radiator fan

- H - Lights flasher (BOSCH 03.322.04.125 20/30A)
- I - Door windows motors (BOSCH 03.320.14.125 30A)
- L - Air conditioner radiator fan (BOSCH 03.320.14.125 30A)
- M - Right radiator fan (BOSCH 03.320.14.125 30A)
- N - Left radiator fan (BOSCH 03.320.14.125 30A)
- O - Horns (BOSCH 03.320.14.125 30A)

WIRING DIAGRAM

- 1-Fog lamp
- 2-Headlight main beam
- 3-Headlamp dipped beam
- 4-Front parking and direction indicator lights
- 5-Direction indicator side flashers
- 6-Alternator
- 7-Voltage regulator
- 8-Ignition distributor
- 9-Ignition coil
- 10-Starter motor
- 11-Horn relay
- 12-Sending unit for water temperature gauge
- 13-Sending unit for oil temperature gauge
- 14-Sending unit for oil pressure gauge
- 15-Engine compartment light
- 16-Engine compartment light switch
- 17-Battery
- 18-Reverse light switch
- 19-Stop light switch
- 20-Fuse boxes
- 21-Flasher for direction indicators
- 22-Windscreen wiper
- 23-Left electric heater fan motor
- 24-Left electric heater fan switch
- 25-Right electric heater fan switch
- 26-Right electric heater fan motor
- 27-Left cooling fan motor of radiator
- 28-Right cooling fan motor of radiator
- 29-Relay switch for radiator left cooling fan motor (12V-20A)
- 30-Relay switch for radiator right cooling fan motor (12V-20A)
- 31-Electronic ignition unit
- 32-Rheostat and switch for instrument light (4.5 ohms)
- 33-Direction indicator lever switch
- 34-Main/dipped beam changeover and flash switch
- 35-Windscreen wiper and washer pump three-position switch lever
- 36-Parking light switch
- 37-Ignition switch
- 38-Vehicle hazard warning lights switch
- 39-Fog lights switch
- 40-Electronic speedometer
- 41-Oil pressure gauge
- 42-Oil temperature gauge
- 43-Water temperature gauge
- 44-Electronic revolution counter
- 45-Fuel level gauge
- 46-Clock
- 47-Ammeter
- 48-Fog lights engagement indicator
- 49-Fuel reserve warning light
- 50-Warning light for brake system failure and handbrake on
- 51-Left direction indicator light
- 52-Right direction indicator light
- 53-Parking lights indicator
- 54-Generator charge indicator
- 55-Headlamp main beam warning light
- 56-Glove box light
- 57-Glove box light switch
- 58-Open-door marker light
- 59-
- 60-Ashtray with cigarette lighter and courtesy lamp
- 61-
- 62-Handbrake warning light switch
- 63-Emergency lights flasher indicator
- 64-
- 65-Acoustic horns switch
- 66-
- 67-Vehicle hazard warning light
- 68-Windshield washer pump
- 69-Door jam switch for interior lights and open doors marker lights
- 70-Interior light with incorporated switch
- 71-Fuel level sender unit
- 72-Luggage compartment light
- 73-Luggage lamp switch
- 74-Spark plugs
- 75-Relay switch for left headlamps lifting motor
- 76-Relay switch for right headlamps lifting motor
- 77-Thermostatic control switch for radiator fans motor
- 78-Radio suppressor capacitor incorporated inside the alternator $C = C \mu F$
- 79-Radio suppressor capacitor $C = 1 \mu F$
- 80-Radio
- 81-
- 82-Radio receiver protection fuse
- 83-
- 84-Loudspeaker inside the doors
- 85-
- 86-Electric fuel pumps
- 87-Relay for headlamps (12V-20A)
- 88-Main beam/dipped beam relay (12V-20A)
- 89-Horn compressor motor
- 90-

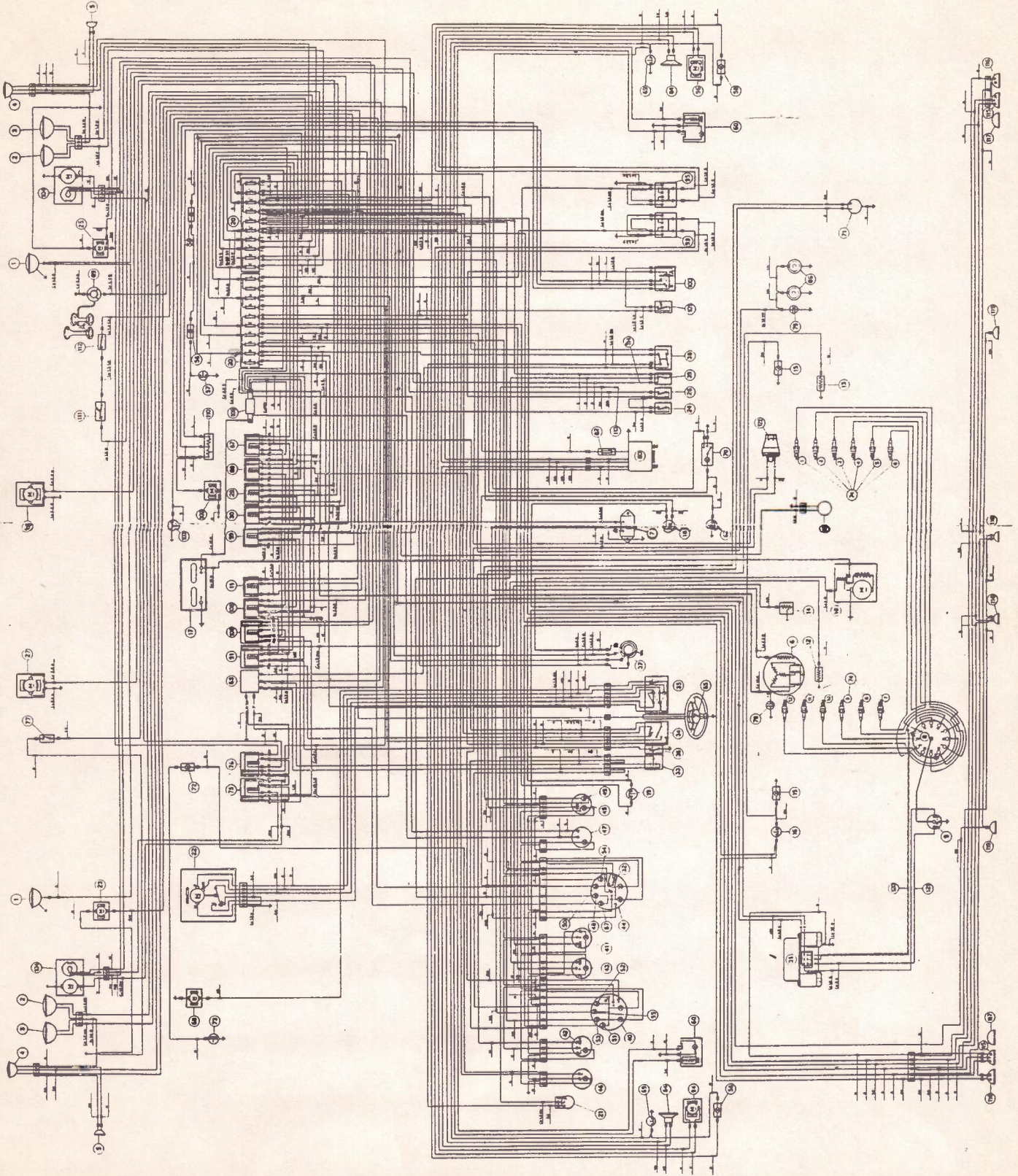


Fig. 28 - Electrical wiring diagram

- 91-Relay for day or night head-lamp flash
- 92-
- 93-Left window control switch
- 94-Left window operating motor
- 95-Right window control switch
- 96-Right window operating motor
- 97-
- 98-Air conditioner compressor
- 99-Relay switch for right radiator fan motor (when air conditioner is engaged)
- 100-Rotary knob to control air conditioner fan speed
- 101-Air conditioner temperature control knob
- 102-Evaporator unit fan motor
- 103-Control switch for oil pressure in the brake circuits
- 104-Headlight lifting motor
- 105-Relay switch headlamp lifting motors (12V-20A)
- 106-Shunt for ammeter
- 107-
- 108-Relay for window motors (12V-20A)
- 109-
- 110-Resistor for air conditioner fan speed control
- 111-Maximum pressure switch for air conditioner
- 112-Minimum pressure switch for air conditioner
- 113-Cable connecting relay 91
- 114-Cables connecting fog lights
- 115-Stop and rear parking lights
- 116-Rear direction indicator
- 117-Rear fog light
- 118-Number plate lamps
- 119-Reverse lights
- 120-Plug adaptor
- 121-Special insulated wire for 1200 effective Volt tension
- 122-Impulse generator for electronic speedometer

COLORS OF CABLES

- | | |
|-------------------------------|-------------------------------|
| A - Light Blue | BN - White striped black |
| B - White | GN - Yellow striped black |
| C - Orange | HN - Grey striped black |
| G - Yellow | VN - Green striped black |
| H - Grey | AR - Light blue striped red |
| L - Blue | HR - Grey striped red |
| M - Brown | AB - Light blue striped white |
| N - Black | RN - Red striped black |
| R - Red | MN - Brown striped black |
| S - Pink | GR - Yellow striped red |
| V - Green | GV - Yellow striped green |
| Z - Violet | CN - Orange striped black |
| AN - Light blue/black stripes | |

REPAIR AND
MAINTENANCE
TOOLS
(ENGINE - CHASSIS)

REPAIR AND MAINTENANCE TOOLS

PAGE

200

INSTALLATION TORQUE
SPECIFICATIONS

202

CHASSIS ATTACHMENT POINTS

205

TORQUE
SPECIFICATIONS

CHASSIS
ATTACHMENT
POINTS

REPAIR AND MAINTENANCE TOOLS

PART NUMBER	DESCRIPTION
ENGINE	
AV 778-778/1	Engine mount
361 AS 4736	Mandrel for checking crankshaft bearings installation
AV 240	Bearings mounting surfaces lap grinder
AV 658	Torque wrench extension for engine blocks assembly
542 CS 6768	Cylinder sleeves/block installation extension gauge
542 AS 6236	Cylinder sleeves installation retainer
207 CS 5730	81 mm 0 cylinder sleeves calibrated gauge
312 AS 5513	Valve guides installation punch
312 AS 5514	Valve guides extractor punch
902 CS 5969	Valve guides micrometer gauge
821 US 4720	Camshafts seats reamer
AV 508	Valve springs installation/compressing tool
152 CS 7148/9	Tappet shims thickness measurement gauge
706 AS 9560 706 AS 9560/A	Valve shim discs removal tool with camshafts in place
AV 498	Cylinder head studs socket tool
AV 857	Connecting rods nuts socket tool
AV 819	Camshafts/distributors engagement coupling punch
AV 823	Timing assembly ring GACO MIM 4460 punch
AV 824	Timing assembly ring GACO SN 25497 punch
AV 816	Timing cover bearings punch
AV 815	Timing pulleys ring nut socket tool
AV 865/2	Connecting rods bushings punch
AV 826 AV 827 AV 831 AV 910	Water pressure testing tools
AV 811	Oil seal punch (flywheel end)
AV 810	Engine timing degree scale (goniometer)
AV 476	Torsional damper socket
AV 929	Camshafts retaining flange (distributor end)
AV 961-962	Motometer universal base/support
152-CS-7431	Tappet seats bore gauge

PART NUMBER	DESCRIPTION
CLUTCH	
AV 388	Clutch assembly centering shaft socket
AV 854	Clutch shaft ring nut socket
195 AS 6271	Clutch control shaft ring nut socket
GEAR BOX - DIFFERENTIAL	
AV 794/1 AV 794/2	Gear box-differential mount
AV 7180	Gear box pinion shaft bearing punch
AV 7184	Gear box pinion shaft bearing outside ring punch
AV 5764	Differential bearing punch
AS 8729	Differential bearing outside ring punch
AV 809	Output (secondary) shaft ring nut socket
AV 853	Input (primary) shaft ring nut socket
AV 855	Input (primary shaft nut socket
AV 856	Input shaft 1st gear ring nut socket (to chassis # 17535)
CS 11183	Pinion shaft alignment/positioning tool
AS 5067	Tapered bearing pre-load measurement pulley
AV 858	Gear box springs compression tool
706 AS 9561	Shift forks alignment/positioning tool
365 AS 5839	MIM 4560 ring differential installation punch
CHASSIS - VARIOUS	
AV 485	Steering wheel housing ring nut socket
706 AS 9016	Steering wheel extractor
506 AS 7783	Wheel hubs flange ring nut socket
506 AS 7394	Suspension and steering uprights ball joints extractor
125/84054/55	Wheel hubs extractor
AS 7396	Ball joints levers punch
AV 695	Air conditioning system connector

202
INSTALLATION TORQUE SPECIFICATIONS

INDIVIDUAL UNITS	THREAD	TORQUE SPECIFICATIONS IN KG.
ENGINE		
Cylinder heads stud nuts	11 x 1	11
Engine half-blocks fastening stud nuts	14 x 1.5	13.5
Engine half-blocks fastening stud nuts	10 x 1.25	6.6
Connecting rods caps fastening bolts nuts	10 x 1	6.6
Camshafts caps studs nuts	6 x 1	0.9
Flywheel-to-crankshaft bolts	8 x 1	3.1
Spark plugs	14 x 1.25	2
Camshafts pulley gears fastening bolts	18 x 1.5	11
Torsional damper-to-crankshaft mounting bolts	18 x 1.5	20
Timing gears shaft fastening ring nut	17 x 1	13
Starter motor fastening bolts	8 x 1.25	2.7
Timing gears sleeve-to-camshafts fastening bolts	12 x 1.25	11
Timing belts self-adjusting fastening bolts	12 x 1.25	6.6
ACCELERATOR		
Accelerator pedal-to-control lever fastening nut	8 x 1.25	3
CLUTCH		
Clutch shaft ring nut	30 x 1.5	20
Clutch control shaft/lever pin fastening ring nut	15 x 1	11
Clutch control lever fastening bolts	8 x 1	2.1
Flange/clutch servo assembly-to-bell housing fastening stud	8 x 1.25	2.1
Covers and intermediate housing fastening stud	8 x 1.25	2.1
Clutch pressure plate fastening bolts	8 x 1.25	3.5

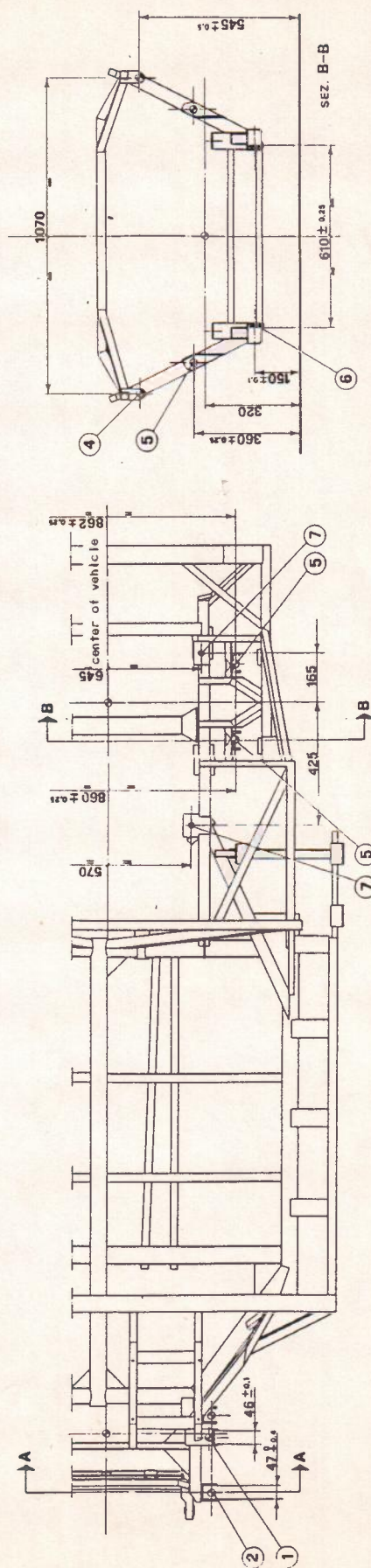
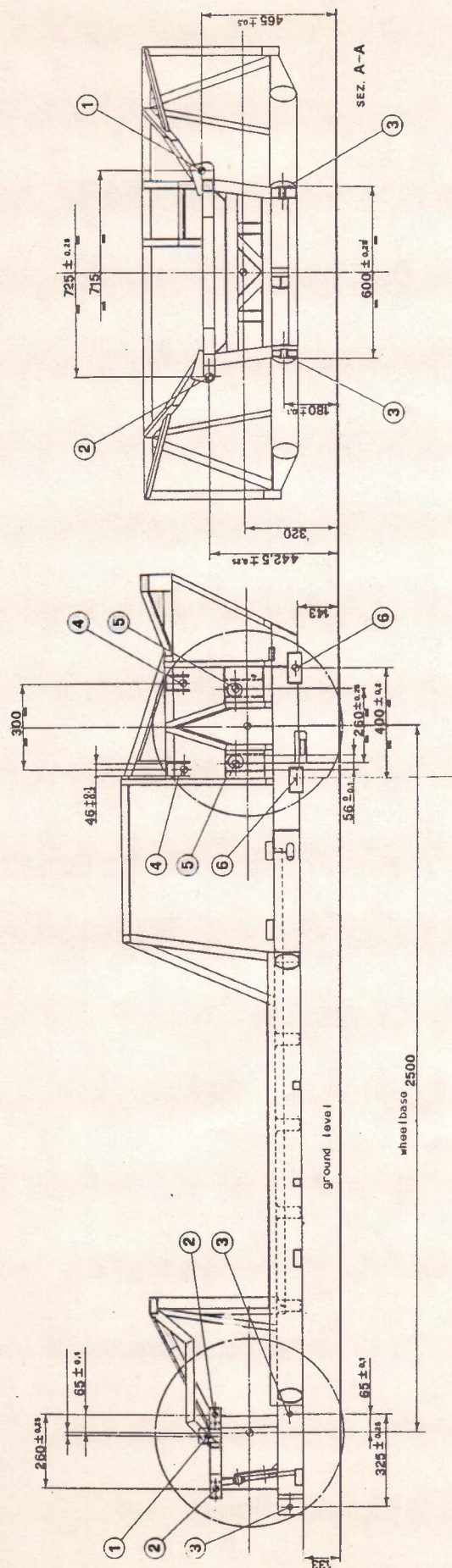
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INDIVIDUAL UNITS	THREAD	TORQUE SPECIFICATIONS IN KG.
GEAR BOX AND DIFFERENTIAL		
Input (primary) shaft driven gear ring nut	34 x 1.5	22
Gear box-to-engine block fastening stud	10 x 1.25	5
Gear box-to-support fastening stud	10 x 1.25	5.5
Gear box mount-to-support mounting bolts	10 x 1.25	5.5
Side covers fastening bolt	10 x 1.25	5.5
Input (primary) shaft front ring nut	30 x 1.5	20
Input (primary) shaft rear ring nut	25 x 1	18
Output (secondary) shaft ring nut	34 x 1.5	22
Gear box control forks and followers fastening bolts	8 x 1.25	3.2
Ring gear-to-differential fastening bolts	10 x 1.25	7
Differential semi-axle attachment flange fastening bolt	12 x 1.25	12
Semi-axle-to-differential fastening bolts	10 x 1.25	6
Engine/gear box-to-chassis support mounting bolt	16 x 1.5	8
FRONT SUSPENSION		
Flange-to-wheels fastening bolts	12 x 1.25	7.5
Stabilizer bar-to-shackle fastening nut	12 x 1.25	5
Front suspension fork-to-chassis fastening bolt	14 x 1.5	8
Suspension arms-to-chassis mounting forks fastening bolts	12 x 1.25	5.6
Shock absorbers-to-chassis mounting bolts	12 x 1.25	7
Suspension upright-to-ball joints fastening nut	12 x 1.5	6.4
Ball joints-to-levers fastening bolts	10 x 1.25	7
Shock absorber-to-lower arms fastening bolts	12 x 1.5	7
Suspension arms to ball joints fastening nut	20 x 1.5	16
Brake caliper-to-suspension upright fastening bolts	1/2"-20 UNF2	10
Brake disc-to-suspension upright fastening	8 x 1.25	2.1
Suspension arms spacers fastening bolt	12 x 1.25	8
Steering levers ball joints-to-suspension upright fastening nut	7/16"-20UNF	4

INDIVIDUAL UNITS	THREAD	TORQUE SPECIFICATIONS IN KG.
REAR SUSPENSION		
Semi-axle-to-wheel fastening bolts	10 x 1.25	8
Semi-axle flange-to-wheel shaft fastening ring nut	27 x 1.25	22
Wheel hub-to-shaft fastening nut	18 x 1.5	18
Flanges-to-wheels fastening bolts	12 x 1.25	7.5
Suspension arms-to-chassis mounting forks fastening bolts	12 x 1.25	5.6
Shock absorbers-to-chassis mounting bolts	12 x 1.25	7
Shackle-to-stabilizer bar fastening nut	10 x 1.25	5
Suspension levers-to-hub carrier fastening bolt	12 x 1.25	7
Forks fastening bolt	14 x 1.5	8
Hub bearing retaining flange fastening stud	8 x 1.25	2.1
Brake caliper-to-rear hub fastening bolts	12 x 1.25	10
Brake disc-to-rear hub fastening bolts	10 x 1.25	5
Suspension arms spacers fastening bolt	12 x 1.25	8
Shock absorber-to-suspension mounting nut	14 x 1.25	7
Stabilizer bar-support-to-chassis fastening bolts	10 x 1.25	5
BRAKES		
Pedal assembly control lever shaft ring nut	16 x 1.5	10
Brake servo fastening bolt	8 x 1.25	2.1
STEERING AND CONTROL		
Steering wheel hub fastening ring nut	22 x 1.5	8
Ball joints-to-steering assembly fastening bolt	10 x 1.25	5
Steering box-to-chassis fastening column	8 x 1.25	4
Steering box support fastening nut	8 x 1.25	2
Steering assembly bearings fastening ring nut	22 x 1.5	14

CHASSIS ATTACHMENT POINTS

1-Front shock absorbers upper mount; 2-Front suspension upper arms mount; 3-Front suspension lower arms mount; 4-Rear shock absorbers upper mount; 5-Rear suspension upper arms mount; 6-Rear suspension lower arms mount; 7-Engine supports mounts



BODY

	PAGE
GENERAL DESCRIPTION	208
DOOR	209
WINDOWS	210
HOODS	212
FRONT AND REAR BUMPERS	212
DASHBOARD (INSTRUMENT PANEL)	212
SEATS	212
CHASSIS	213
BODY MAINTENANCE	213

BODY

GENERAL DESCRIPTION.....	208
DOORS.....	
REMOVAL.....	209
REINSTALLATION.....	209
ALIGNMENT.....	209
WINDOWS.....	
DOOR WINDOWS REMOVAL AND REINSTALLATION.....	210
FIXED DOOR WINDOWS REMOVAL AND REINSTALLATION.....	210
WINDSHIELD REMOVAL AND REINSTALLATION.....	210
REAR WINDOW REMOVAL AND REINSTALLATION.....	211
REAR FIXED SIDE WINDOWS REMOVAL AND REINSTALLATION.....	211
HOODS.....	
TRUNK AND ENGINE HOODS.....	212
FRONT AND REAR BUMPERS.....	212
INSTRUMENT PANEL.....	
REMOVAL AND REINSTALLATION.....	212
SEATS.....	
REMOVAL AND REINSTALLATION.....	212
CHASSIS.....	213
BODY MAINTENANCE.....	
SPOTS REMOVAL FROM SEAT COVERS.....	213
LEATHERETTE CLEANING.....	213
LEATHER CLEANING.....	213
CHROMED PARTS.....	213
PATINING - TOUCHING UP SPOTS.....	214
PASTEL TINTS.....	214
METALLIC TINTS.....	215
WASHING THE CAR'S EXTERIOR.....	217

GENERAL DESCRIPTION

Ferrari 365 GT4/BB - F 102 AB - with tubular chassis, two doors, two directional lights

- Opening hood - with front hinging, latch control from the interior of the car via lever located under instrument panel at steering wheel side.
- Front window - with curved layered safety glass blue-tinted, with radio antenna incorporated, with two-piece aluminum corner supports painted black, fastened with silicone sealant 854804 IVI INVES.

- Doors** - hinged at front, two blue-tinted safety windows, front window vent permanently mounted, windows controlled via electric motor. Locked externally via key.
- External door handles** - lever-style, painted black.
- Rear window** - flat, brass rectangle painted black fastened with silicon sealant 854804 IVI INVES.
- Front trunk** - accessible via front hood.
- Rear license plate holder** - located at trunk lid grille center.
- Bumpers, foot and rear** - in black resin incorporated into the chassis frame. The front bumper includes the radiator grille, the rear bumper the reverse lights (two on each side).
- Fuel tank filler cover lid** - located at left rear side as part of the engine hood.
- Seats** - sliding bucket type, with adjustable back and head rests.
- Instrument panel/dashboard leather** - padded resin molding. Instruments located centrally above steering wheel, three movable interior ventilation air vents located at center; two side fixed vents.
- Glove compartment** - located at passenger side, with lockable lid and courtesy mirror on inside.
- Sun visors** - roller-shade type, suction cup fastening.
- Map pockets** - in door liners.
- Wilton carpeting front and rear.
Trunk lined in swanskin flannel.
Leather-lined interior

DOORS

REMOVAL

Door removal is carried out via the following steps:

- Remove the stop ring with door completely open.
- Remove, by tapping, the hinge pin.
- Remove the door from its supports.

REINSTALLATION

Reverse the above operations.

ADJUSTMENT

The following steps must be carried out in order to properly adjust the doors after reinstallation, especially if the original alignment has been altered. Loosen the locking plate fastening screws and move it by tapping it until obtaining a proper alignment with the door. The door must open and close perfectly; the lock should also be in proper order; the interior door lock button should move down easily, with a slight pressure. An additional adjustment can be made on the door window raising and lowering cable through an adjustment cam located at the lower part of cable.

WINDOWS

REMOVAL AND REINSTALLATION OF THE SLIDING WINDOWS

The removal of the sliding windows is carried out as follows:

- Remove the inside door opening handle and the door lock knob.
- Remove the panel after having unscrew the fastener screws.
- Unscrew the rear sliding window support screws and shift it towards the rear of the car.
- Remove from the window glass the moving support by unscrewing the appropriate screws.
- Carefully slide out the glass pulling it upwards and pivoting it towards the front of the car.

For reinstallation, reverse the above procedure.

REMOVAL AND REINSTALLATION OF THE FIXED VENT WINDOWS

For removal of these, after having removed the inside door panel, use a drill and an appropriate bit to remove the support brace. Push the glass downward from the top and lightly towards the front.

Reinstallation is carried out by placing the glass in its proper seat, pushing it upwards. Place the support brace and fasten it into place to the door frame.

REMOVAL AND REINSTALLATION OF WINDSHIELD

The removal of the windshield is carried out as follows:

- Open the front hood, raise the windshield wiper.
- Remove the inner front mounting frames and protect the instrument panel.
- Remove the upper and lower trim strips.
- With a razor knife slice the sealant all around the perimeter of the glass (Take care not to damage the radio antenna leads at bottom center.).
- From the inside of the car, manually push from the top of the glass. This will loosen the windshield from its base and aid in its removal.

For reinstallation, carry out the following steps:

- Remove all traces of sealant from the glass using heptane fluid.
- Complete the cleaning operation using silicone sealant PRIMER 854803 (supplied in the silicone sealant kit 854804 IVI INVES) being careful not to touch painted surfaces.
- Apply protective tape and paper edging all around the outside upper and side windshield car mounting surfaces and to the inside and outside perimeter of the windshield, leaving a border of approximately 1 cm. wide.
- Apply a bead of silicone sealant 854804 IVI INVES to the inside border of the windshield.
- Place the windshield in position, making sure it is centered and attach the radio connection clip.
- Tape protective paper over the outside trim strips; install them in their place.
- Remove excess sealant and spread any remaining quantity so as to obtain a smooth and homogenous line.
- Remove the protective paper and allow to dry for 24 hours.

REMOVAL AND REINSTALLATION OF THE REAR WINDOW

The removal of the rear window is carried out as follows:

- Remove the seats and headrests, the side, lower, and upper frame supports.
- From the inside of the car, using a razor, cut the sealant all around the glass edge (if the rear window is equipped with electrical defroster wires be careful not to cut the electrical contacts placed in the upper area - passenger side).
- From outside of the car manually press at the upper part of the glass; this will release the glass from its seat.

For reinstallation, proceed as follows:

- Carefully remove all traces of old sealant.
- Complete the cleaning operation using silicone sealant PRIMER 854803 (supplied with silicone sealant kit 854804 IVI INVES) being careful not to touch painted surfaces.
- Cover with paper and masking tape the glass surface facing the outside (rear) of the car.
- Install the glass in place, being careful to center it using trim tabs.
- From the outside of the car, cut the masking tape, using a razor knife, following the inside perimeter of the glass seat.
- Remove the glass from its seat, the masking tape along the perimeter of the glass and clean with PRIMER 854803.
- Apply a bead of silicone sealant 8540804 IVI INVES at the window seat from the inside of the car.
- Reinstall the glass in its seat making sure that it is properly centered using trim tabs.
- From the outside, remove excess sealant with a spreader and smooth it out so as to obtain a smooth and homogenous line.
- Allow to dry for 24 hours, remove paper from the glass and proceed to reinstall the glass frame supports, seats, and headrests.

REMOVAL AND REINSTALLATION OF THE REAR SIDE WINDOWS

The removal of the rear side windows is carried out as follows:

- Remove the door lock latch centering block.
- Remove the rivets which hold the window frame in place, using a drill and the appropriately sized bit.
- Slide out the upper inside seal and remove the rivet which fastens the upper part of the frame.
- With a razor slice the sealant on the inside and outside and slide out the glass along with the frame pulling both towards the front of the car.

For reinstallation, proceed as follows:

- Carefully remove all traces of the old sealant using heptane.
- Complete the cleaning operation using silicone sealant PRIMER 854803 (supplied with silicone sealant kit 854804 IVI INVES) being careful not to touch painted surfaces.
- Clean both the window seat and the upper inside seal and apply a coat of silicone sealant.
- Install the glass complete with the seal and support frame in its seat. Align properly before fastening it with rivets.
- Slide in the upper inside seal and reinstall the door lock latch centering block.

HOODS

FRONT AND ENGINE COMPARTMENT HOODS

The trunk and engine hoods are hinged, respectively, at the front and at the rear via internal hinges and their closing is via two engagement latches at each hood. The engine hood is also equipped with a security lock. Support for the hoods is provided by two shock absorbers. In order to remove or replace the hoods, remove the upper shock absorbers retaining bolts, then remove the bolts fastening the hinges to the hood.

During installation the hood must be seated perfectly and must open and close easily and without force. To open the engine compartment hood, actuate the lever situated inside the car near the driver's door sill.

FRONT AND REAR BUMPERS

For removal of both bumpers (sub-frame), proceed as follows:

--Remove the fastening bolts at the frame, disconnect the reverse lights electrical cables connection and the front stoneguard.

--Pull out each one, respectively, from the front and back of the car.

For installation of the bumpers, it is necessary, before fastening them, to carefully align each in their position.

INSTRUMENT PANEL

REMOVAL AND INSTALLATION

For removal of the panel, proceed as follows:

--Remove the steering wheel, the steering housing, and the directional indicator assembly.

--Remove the steering wheel assembly frame supports and the windshield mounting framing.

--Remove the instruments, disconnecting the plugs.

--Remove the internal frame supports of the dashboard unit and unscrew the glove compartment screws, and remove by pulling towards the inside of the car.

--Remove the dashboard retaining screws and remove it by pulling it towards the inside of the car.

--Lastly, remove the front instrument panel support.

For installation, follow the steps outlined above in reverse.

SEATS

REMOVAL AND INSTALLATION

For removal of the seats proceed as follows:

--Slide the seat back and remove the two front seat guides fastening bolts.

--Slide the seat forward and remove the two rear seat guides fastening bolts.

--Remove the seat.

CHASSIS

Always contact your Ferrari dealer for service assistance when chassis work is required.

BODY MAINTENANCE

SPOTS REMOVAL FROM SEAT COVERS

In order to insure a long life and an excellent condition of the cloth covers, it is necessary that a careful periodic cleaning be carried out.

Dust particles, which can imbed themselves in the seat covers, must be removed periodically (every two weeks), or more often if the car is used more frequently. The cleaning should be done with a brush and/or a vacuum cleaner.

The cleaning of the cover material can also be carried out by washing with water and a neutral soap using a rag or a brush and washing in the direction of the fabric's nap and not against it.

Rinse out the soap with a fresh, clean rag, rubbing it on the cloth; when it dries, brush the nap of the cloth in order to give it its original appearance. For the elimination of spots, it is necessary that they be removed as soon as possible after their occurrence. If left to dry too long they will oxidize and their removal will be more difficult and make it impossible to restore the original appearance.

Certain types of spots require special spot removers for their removal from the coverings.

LEATHERETTE CLEANING

Never use oil, varnishes or ammonia solutions for its cleaning. In the use of cleaners, make sure that the proper type is used, and that it is one that will not cause loss or alteration of elasticity, or loss of shine, and avoid cleaners that will cause damage to the material.

To keep the material clean, it is advisable to simply wash it with a wet rag and a laundry soap.

Rinse out afterwards with a clean, wet rag and remove all traces of soap.

Lastly, rub the material with a clean, dry rag to bring back the original shine.

LEATHER CLEANING

--For removal of dust and particles use a sweeper, an air bulb syringe or a dry clean cloth.

--For removal of any possible spots, use water and a neutral soap with a soft sponge; rinse and dry rapidly with a chamois cloth.

CHROMED PARTS

For keeping the chromed parts in good condition, wash them periodically with a rag moistened in oil; dry them and rub them with a rag moistened in oil fluid. Lastly, rub the chromed parts with a clean woolen rag until every trace of oil is gone.

PAINTING - TOUCHING UP SPOTS

Paints used by the Ferrari firm for painting the 365 GT4 BB is of the heat-setting acrylic type (ACRILUR) for the color tints and thermoplastic acrylic type (EUROLAC) for the metallic tints.

PASTEL TINTS

A - PROCEDURE FOR MINOR TOUCH-UPS NOT REQUIRING A PRIMER COAT

- 1--Carefully sand down the surface to be painted with a 600 grade sandpaper.
- 2--Apply 4 or 5 light coats of ACRILUR paint starting from the center. Wait a few minutes before applying each coat.
Before application, the paint must be diluted to 20% with thinner 6 C 310 and catalyzed 3% (of the diluted paint) with catalyst 19 T 14, with an application viscosity 17" Ford 4 at 20° C.
- 3--Allow to dry under infra-red lamps for 30 minutes at 80° ÷ 90° C since the catalyst is not activated at lower temperatures.
- 4--Very accurately buff the repainted surface with 1200 grade sandpaper.
- 5--Apply a fine grit buffing compound and complete the job with a final application of polish.

B - PROCEDURE FOR TOUCH-UPS WHICH REQUIRE A PRIMER COAT

- 1--Sand down the surface to be redone and clean carefully with white rags moistened with ethyl alcohol.
- 2--Apply the primer (epoxy type 28-G-29) catalyzed at 100% with catalyst 27E29.
- 3--Allow to dry under infra-red lamps for 30 minutes at 80° ÷ 90° C.
- 4--Sand down the filled area with a 280 grade sandpaper.
- 5--Spray the filled area with 4-5 coats of epoxy primer 28Y44 catalyzed at 20% with catalyst 27T40, diluting with thinner 6C25.
Application viscosity: 25" - 30" FORD 4 at 20° C.
- 6--Allow the epoxy primer to dry under infra-red lamps for 30 minutes at 80° ÷ 90° C.
- 7--Sand smooth the primed surface with a 400-500 grade sandpaper.
- 8--Clean the surface with white rags moistened with ethyl alcohol.
- 9--Spray 4 or 5 light coats of heat-setting ACRILUR enamel working from the center of the primed area.
Allow a few minutes between each coat.
Before use, the enamel must be diluted 20% with thinner 6C310 and activated at 3% of the diluted mixture with catalyst 19T4.
Application viscosity: 17" FORD 4.
- 10--Allow to dry under infra-red lamps for 30 minutes at 80° ÷ 90° C. as the catalyst does not activate at lower temperatures.
- 11--Accurately sand down the retouched area with a 1200 grade sandpaper.
- 12--Apply a fine grit buffing compound and complete the job with a final application of polish.

C - PROCEDURE FOR TOUCH-UPS OF LARGE TINTED SURFACES

The procedure to be carried out is the one illustrated in the technical bulletins regarding car painting with thermoplastic EUROLAC products, in which such applications are carried out with ease and minor problems and with products which require minimum drying time and a not overly precise technique.

We would like to stress that while thermoplastic enamels can only be touched up exclusively with thermoplastic acrylics, the heat-setting products can be touched up with other touch-up paints without any limitations.

- 1--Sand down the surface to be redone and clean the area carefully with white rags moistened with ethyl alcohol.
- 2--Apply the filler coat. This must be of the two-part epoxy type. Allow to dry according to the manufacturer's instructions.
- 3--Sand the filled surface with 220 grade sandpaper until a uniform surface finish is achieved.
- 4--Apply the primer coat. This must be of the two-part epoxy type. Allow to dry according to the manufacturer's instructions.
- 5--Uniformly sand down the surface with wet 320 grade sandpaper. Accurately clean the sanded area first with distilled water and then with ephane.
- 6--Spray 2 or 3 light coats of acrylic enamel of the desired color, allowing a few minutes of air drying between each coat.
Before application the enamel must be diluted, 1:1 ratio in weight, with GLIDDEN-SALCHI 6C132 acrylic thinner. If this thinner is not available, it is possible to use DuPont thinner 360 2S (recommended by American DuPont for its thermoplastic acrylics).
- 7--Allow to air dry at ambient temperature for about 60 minutes or 10 minutes after spraying, heat the painted area with infra-red lamps for 40-45 minutes at $70^{\circ} \div 80^{\circ}$ C.
- 8--Accurately sand the retouched area with 1000 grade sandpaper.
- 9--Apply a fine grit buffing compound and complete the job with a final application of polish.

If the appropriate paints and other materials are not available heat-setting (hardening) paints and catalysts can be used for touching-up large tinted surfaces.

METALLIC TINTS

D - PROCEDURE FOR SMALL TOUCH-UPS WHICH DO NOT REQUIRE FILLER COAT

- 1--Carefully sand down the area to be touched-up with 600 grad sandpaper.
- 2--Spray 4 to 5 light coats of EUROLAC acrylic enamel. Allow a few minutes to air dry between coats. The enamel, prior to application, must be diluted in proportion of 1:1.3 in weight with GLIDDEN-SALCHI acrylic thinner 6C132. If this is not available, it is possible to use DuPont thinner 3602S (recommended by American DuPont for its thermoplastic acrylics). It is very important that metallic enamel is accurately mixed: prior to dilution, prior to pouring into the spray paint container, and prior to each application. This is necessary in order to avoid having the suspended metallic particles being deposited to the bottom of the containers and thus altering the color/shade of the paint.
- 3--Allow to air-dry at ambient temperature for about 60 minutes, or 10 minutes after spraying, heat the painted area with infra-red lamps for 40-45 minutes at $70^{\circ} \div 80^{\circ}$ C.
- 4--Sand down the sprayed surface with wet 600 grade sandpaper. Wash accurately first with distilled water and then with ephane.
- 5--Spray 4 or 5 light coats with enamel diluted in 1:1.3 to 1:1.4 proportion in accordance to the procedure outlined in step D 2 above.
Apply 2 or 3 final coats of 20-T-7 clear EUROLAC acrylic enamel diluted in 1:1.2 proportion with 6-C-132 thinner. If this is not available, it is possible to use DuPont thinner 3602S (recommended by American DuPont for its thermoplastic acrylics).

- 6--Repeat the drying operation described above in step D3.
- 7--Sand down the retouched area with 1000 grade sandpaper.
- 8--Apply a fine grit buffing compound and complete the job with a final application of polish.

E - PROCEDURE FOR TOUCH-UPS WHICH REQUIRE A LIGHT FILLER COAT

- 1--Carefully sand down the area to be retouched until obtaining a bare metal surface. Clean the sanded area with clean rags moistened with ephane or aviation gasoline.
- 2--Apply the two-part epoxy filler coat and allow it to dry according to the manufacturer's instructions.
- 3--Sand the filled area with wet 220 grade sandpaper. Accurately clean the sanded area first with distilled water and then with ephane.
- 4--Spray 4 to 5 light coats of EUROLAC acrylic enamel. Allow to air dry for a few minutes between each coat.
The enamel, prior to application, must be diluted in proportion of 1:1.3 in weight with GLIDDEN-SALCHI acrylic thinner 6C132. If this is not available, it is possible to use DuPont thinner 3602S (recommended by American DuPont for its thermoplastic acrylics).
It is very important that metallic enamel is accurately mixed: prior to dilution, prior to pouring into the spray paint container, and prior to each application. This is necessary to avoid having the suspended metallic particles being deposited to the bottom of the containers and thus altering the color/shade of the paint.
- 5--Allow to air-dry at ambient temperature for about 60 minutes, or 10 minutes after spraying, heat the painted area with infra-red lamps for 40-45 minutes at $70^{\circ} \div 80^{\circ}$ C.
- 6--Sand the sprayed area with wet 600 grade sandpaper. Accurately clean the sanded area first with distilled water and then with ephane.
- 7--Spray 4 or 5 light coats with enamel diluted 1:1.3 to 1:1.4 proportion in weight according to the procedure outlined in section E4 above.
Apply 2 or 3 final coats of 20-T-7 clear EUROLAC acrylic enamel diluted in 1:1.2 proportion with 6-C-132 thinner. If this is not available, it is possible to use DuPont thinner 3602S (recommended by American DuPont for its thermoplastic acrylic enamels).
- 8--Repeat the drying operation described above in step E5.
- 9--Sand the retouched area with 1000 grade sandpaper.
- 10--Apply a fine grit buffing compound and complete the job with a final application of polish.

F - PROCEDURE FOR TOUCH-UPS OF LARGE METALLIC TINTED AREAS

- 1--Carefully sand down the area to be retouched until obtaining a bare metal surface. Clean the sanded area with clean rags moistened with ephane or aviation gasoline.
- 2--Apply the two-part epoxy filler coat and allow it to dry according to the manufacturer's instructions.
- 3--Sand the filled area with 220 grade sandpaper until the surface is smooth and uniform. The sanding operation must cover the total surface treated until all the original paint is removed.
- 4--Apply the two-part epoxy primer and allow it to dry according to the manufacturer's instructions.
- 5--Uniformly sand the primed area with wet 320 grade sandpaper. Clean the sanded surface accurately first with distilled water and then with ephane.

- 6--Spray 4 or 5 light coats of EUROLAC acrylic enamel. Allow to air dry for a few minutes between each coat.
The enamel, prior to application, must be diluted in proportion of 1:1.3 in weight with GLIDDEN-SALCHI acrylic thinner 6C132. If this is not available, it is possible to use DuPont thinner 3602S (recommended by American DuPont for its thermoplastic acrylic enamels).
It is very important that metallic enamel is accurately mixed: prior to dilution, prior to pouring into the spray paint container, and prior to each application. This is necessary to avoid having the suspended metallic particles being deposited to the bottom of the container and thus altering the color/shade of the paint.
- 7--Allow to air-dry at ambient temperature for about 60 minutes, or 10 minutes after spraying, heat the painted area with infra-red lamps for 40-45 minutes at $70^{\circ} \div 80^{\circ}$ C.
- 8--Sand the sprayed area with wet 600 grade sandpaper. Accurately clean the sanded area first with distilled water and then with epthane.
- 9--Spray 4 or 5 light coats with enamel diluted in proportion 1:1.3 to 1:1.4 in weight following the procedure outlined above in section E4.
Apply 2 or 3 final coats of clear EUROLAC 20-T-7 acrylic enamel diluted in 1:1.2 proportion with 6-C-132 thinner. If this is not available, it is possible to use DuPont thinner 3602S (recommended by American DuPont for its thermoplastic acrylic enamels).
- 10--Repeat the drying operation outlined above in step D7.
- 11--Sand the retouched area with 1000 grade sandpaper.
- 12--Apply a fine grit buffing compound and complete the job with a final application of polish.

WASHING THE CAR'S EXTERIOR

The car must be washed periodically as needed according to its use and according to the types of roads it has been driven on.

When washing, avoid a high nozzle pressure.

When washing, do not rub the sponge heavily into the surface in order to avoid potential scratching of the paint by dirt particles.

After washing and rinsing, accurately dry the whole car with a chamois skin, so as not to leave traces of water which will cause spots.

If after washing and drying the finish is not shiny, apply a good commercial polish.

If during its application, the applicator daubber becomes discolored with the car's paint, it will not affect the shine or the paint itself.

Oil, grease or tar spots on the car's paint can be removed with a small amount of gasoline and quickly rubbed with a dry rag.