Ferrari

246 GT - GT/S

REPAIR AND WORKSHOP MANUAL

FERRARI-SERVIZIO ASSISTENZA TECNICA-MODENA

CONTENTS

INTRODUCTION

The following is a copyrighted translation of the official S.E.F.A.C.-Ferrari Dino 246 GT — Instruzioni Tecniche repair manual. Please note the two-part arrangement. The first 61 pages are addenda to the original repair manual and contain technical data and instructions for later manufactured Dinos. Thus, if your car is of a later number (from No. 01118 on) you will have to consult both the original manual (190 pages) and the appropriate cross-referenced Addenda section pages.

Technical specifications have been kept metric, as per the original manual, insofar as the metric system is currently replacing the present U.S. system and that Ferrari mechanical parts are metric in measurement, and therefore require the appropriate metric tools. A Conversion Table is included in page iv for any measurement questions.

One valuable supplement to this manual is the Spare Parts Catalogue for the Dino, available either from Ferrari dealers or through F.A.F. Motorcars, Inc., in Atlanta, Georgia. The Catalogue will go a long way in showing in clear detail the parts you have just extracted from the car and will further aid in de-mistifying these marvelous machines, which have intrigued this translator since first seeing the 125 S, driven by Franco Cortese in competition at the Circuito di Caracalla in 1947, as a ten year old, and since having rebuilt a 250 GT engine.

One final technical note, some mechanical terms may change here and there in the manual. Pains have been taken to avoid this, but some may still be located. Please forward a note if some misinformation results so that I can inform all purchasers of this manual of such changes.

Finally, I would like to dedicate this effort to Enzo Ferrari and the memory of Dino Ferrari, all "Ferraristi," and to Mary, my ever-helpful wife and Caterina and Vittorio, our children.

August 18, 1976

Angelo Wallace

CONVERSION TABLE

METRIC STANDARD	INTO U.S. STANDARD	MULTIPLY METRIC BY	USE
Atmosphere (ATM)	Lbs. per. sq. in. (PSI)	14.70	Tire Pressure
Centigrade (C^{o})	Fahrenheit (F^{o})	$(C \times \frac{9}{5}) + 32$	Temperature
Cubic Centimeters (cc.)	Cubic Inches (C.I.)	.06102	Displacement
Kilometers (Km.)	Miles (Mi.)	.6214	Distance
Kilograms (Kg.)	Pounds (Lbs.)	2.205	Weight
Kilometers per Hour (KPH)	Miles per Hour (MPH)	.6214	Speed
Kilogram Meters (KgM.)	Pound Feet (Lb. Ft.)	7.233	Torque
Liter (L.)	Quarts (Qts.)	1.057	Liquid Measure
Meter Pressure (Olio)	Lbs. per sq. in. (PSI)	1.42	Oil Pressure
Millimeters (mm.)	Inches (In.)	.03937	Dimensions
Kilograms/sq. cm.(Kg/cm^2)	Lbs. per sq. in. (PSI)	14.22	Oil Pressure

Ferrari

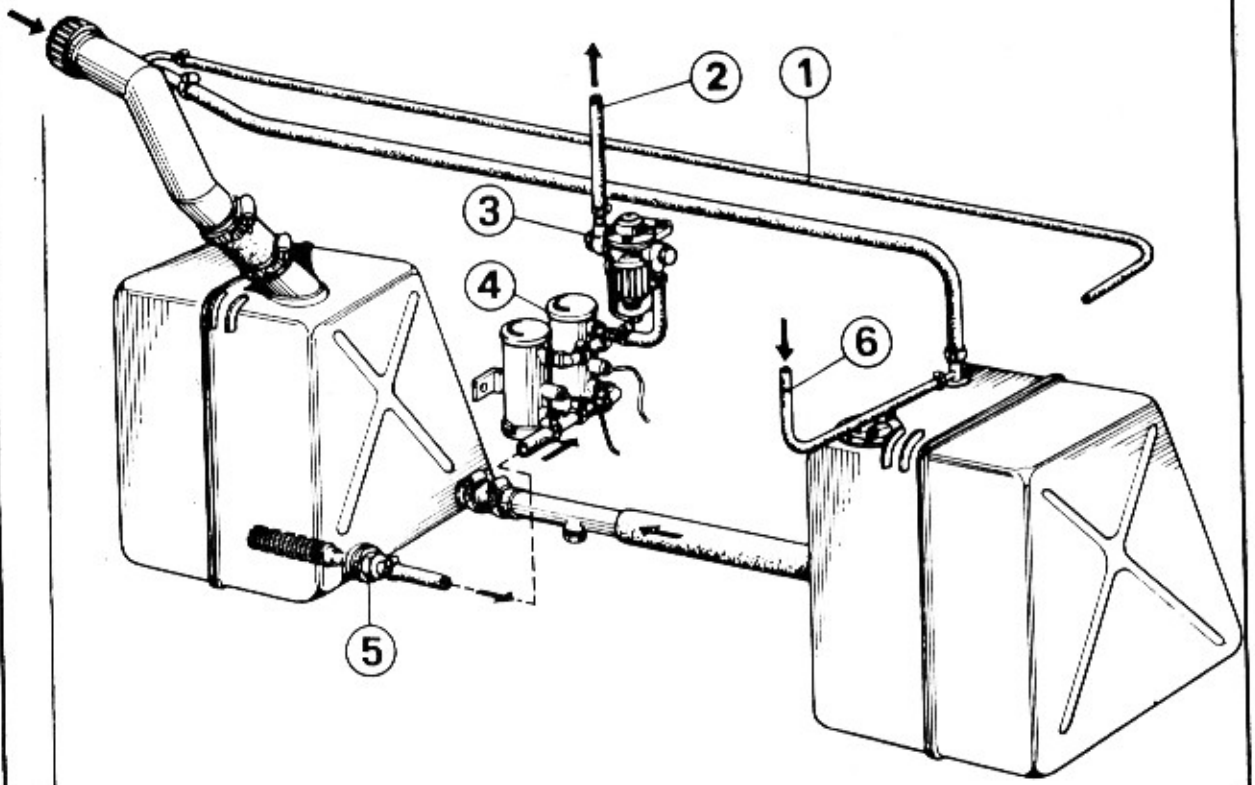
VETTURA

Dino 246 GT

REPAIR AND WORKSHOP MANUAL

TABLE OF CONTENTS

VARIATIONS FROM VEHICLE NUMBER 01118 to VEHICLE NUMBER 02130

Refer to page	DESCRIPTION
	ENGINE
5	ELECTRICAL SYSTEM Distributor . . . . . .Marelli S 125 B x 15 High tension coil . . . . . .Marelli BAE 200 A Emergency ignition coil. . . . .Marelli BZR 201 A Dinoplex electronic unit. . . . .Marelli AEC 103 A
7	FUELS AND LUBRICANTS Front and rear hydraulic brake circuits. . .ATE type H fluid
59	FUEL SYSTEM  Fuel system diagram 1. Vent tubes for tanks, 2. Filters to carburetors tube, 3. Regulating filter, 4. Bendix pumps, 5. Filter, 6. Fuel return tube.
60	CARBURETORS Carburetors. . . . . Weber 40 DCNF/13

Refer to page

68

Crankcase gases and oil fumes ventilation diagram

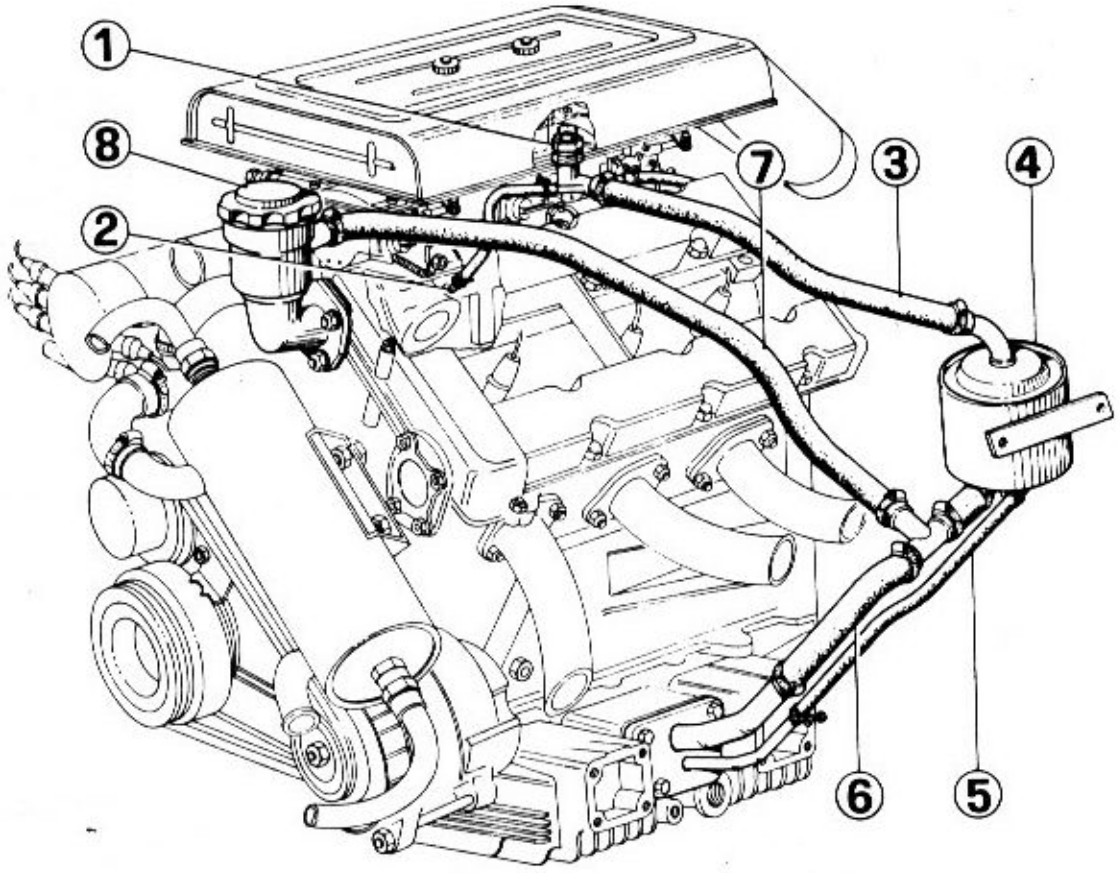


Fig. 49. Crankcase ventilation system

1. Crankcase pressure limiting valve, 2. Calibrated intakes to the induction manifolds, 3. Crankcase exhaust to pressure limiting valve tube, 4. B low-by and ventilation assembly, 5. Breather to sump oil drain tube, 6. Lower ventilation tube, 7. Three-way oil filler tube, 8. Oil filler cap.

76

GEAR BOX

DATA AND CHARACTERISTICS

Axial free-play between mounted gears and surfaces. .	.0.25÷0.30 mm.
Maximum wear limits.	.0.35 mm.
Lubrication of gear box assemblies	.splash type

Refer to page

78

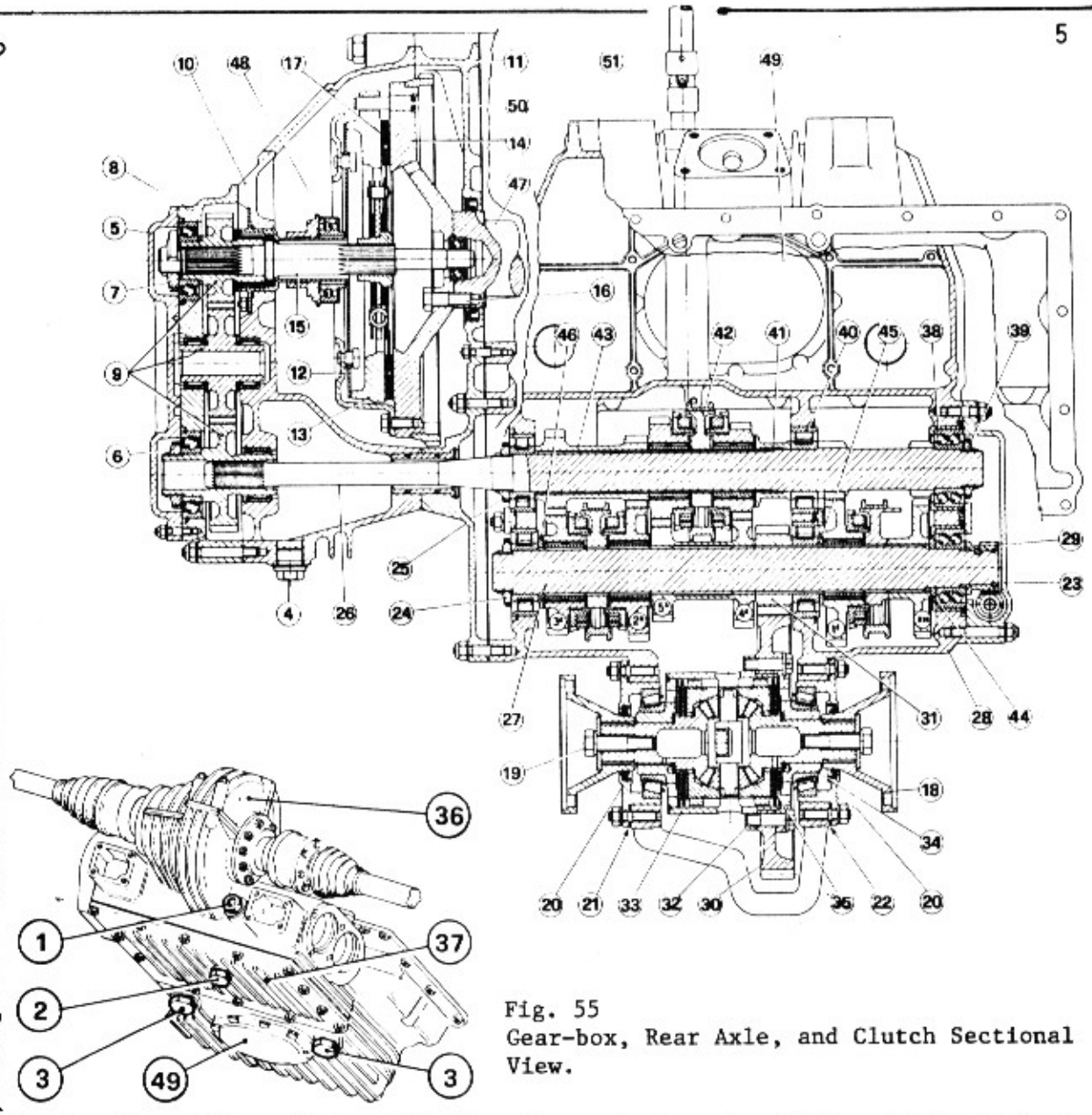


Fig. 55
Gear-box, Rear Axle, and Clutch Sectional View.

1. Gear box-differential oil filler plug , 2. Gear box-differential oil drain plug, 3. Engine oil drain plugs, 4. Clutch housing oil drain plug, 5. Clutch return housing cover, 6. Ferrule, 7. Ferrule, 8. Clutch-drive gearing support case, 9. Drive gearing, 10. Clutch bell-housing, 11. Intermediate housing, 12. Clutch cover, 13. Pressure plate, 14. Engine flywheel, 15. Clutch shaft, 16. Flywheel to crankshaft fastening bolts, 17. Clutch driven disc, 18. Semi-axle flange, 19. Flange fastening bolts, 20. Bearing support side covers, 21. B earing preload washer, 22. Ring gear positioning washer, 23. Gear box rear cover, 24. Ferrule, 25. Ferrule, 26. Drive shaft, 27. Output shaft, 28. Gear box case, 29. RPM counter unit, 30. Differential ring gear, 31. Ring gear pinion, 32. Ring gear to differential fastening bolts, 33. Plate-ty pe differential, 34. Differential cove r, 35. Plates, 36. Top cover, 37. Gear box case lower cover, 38. B all bearing, 39. Ferrule, 40. Roller bearing, 41. Spacer, 42. Guide body, 43. 2nd and 3rd gears mounted gearing, 44 . Spacer, 45. Spacer, 46. Spacer, 47. Crankshaft, 48. Clutch ball release bbearing, 49. Engine oil cover, 50. Clutch alignment pin, 51. Gear box control shaft .

STEERING

92	Collapsible steering housing	See Table 30, Group 70. Parts Book for cars No. 01118 on.

REFER to page

FRONT SUSPENSION

103

WHEEL MOUNTING VIA UPRIGHTS

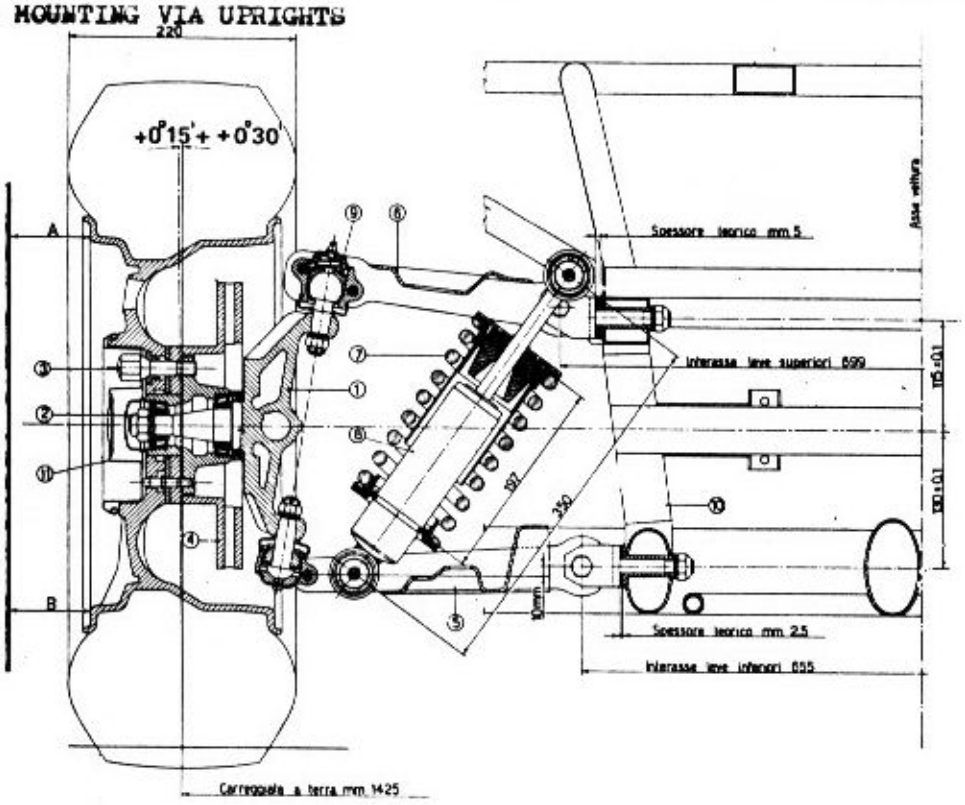


Fig. 63. FRONT SUSPENSION--TRANSVERSE SECTION

REAR SUSPENSION

113

WHEEL MOUNTING VIA UPRIGHTS

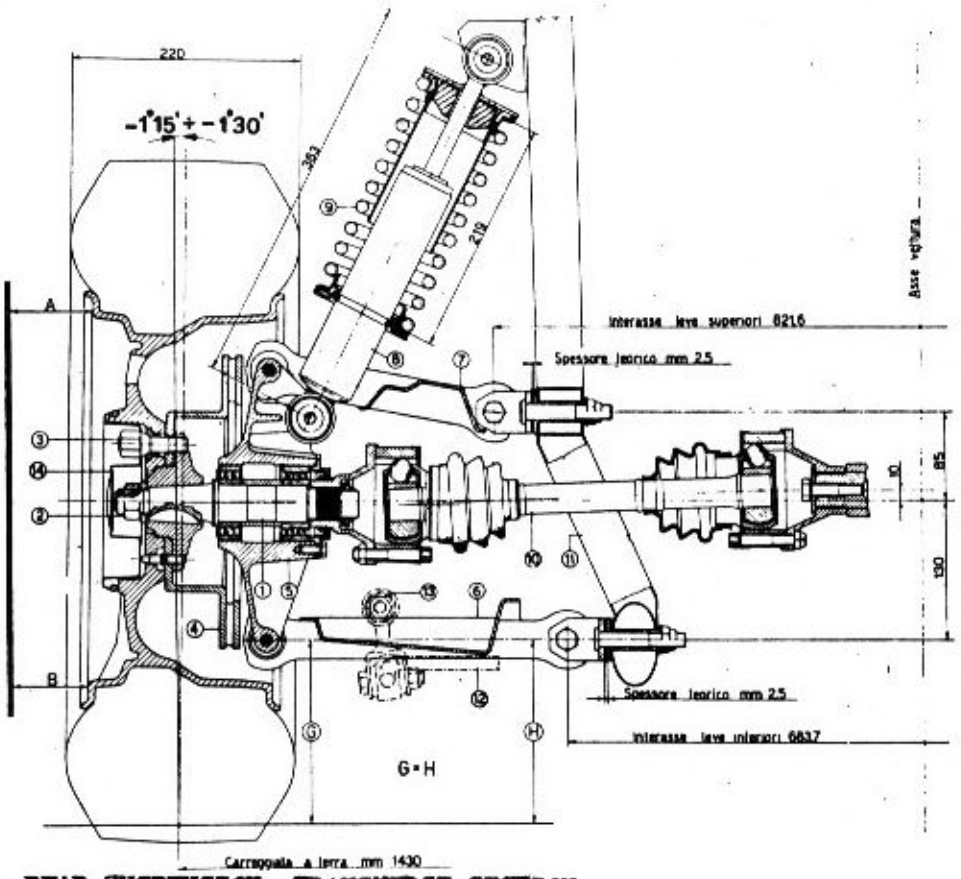


Fig.70. REAR SUSPENSION--TRANSVERSE SECTION

REFER to page .

SHOCK ABSORBERS (HYDRAULIC)

116

Data and characteristics

Front	
Type	.Koni 82x1579 Sp2
Rear	
Type	.Koni 82x1603 Sp2

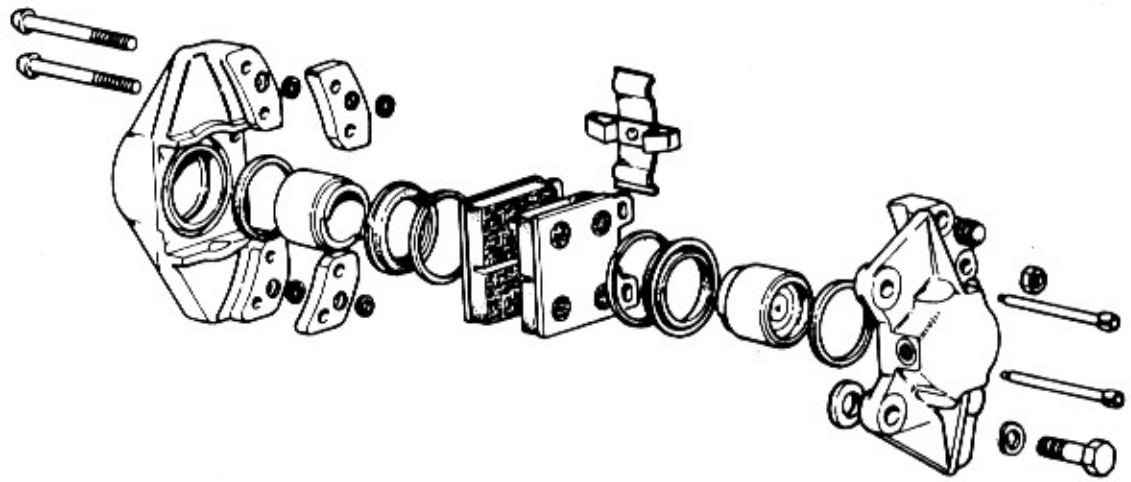
BRAKES

124

Data and characteristics

Front brakes (ATE)

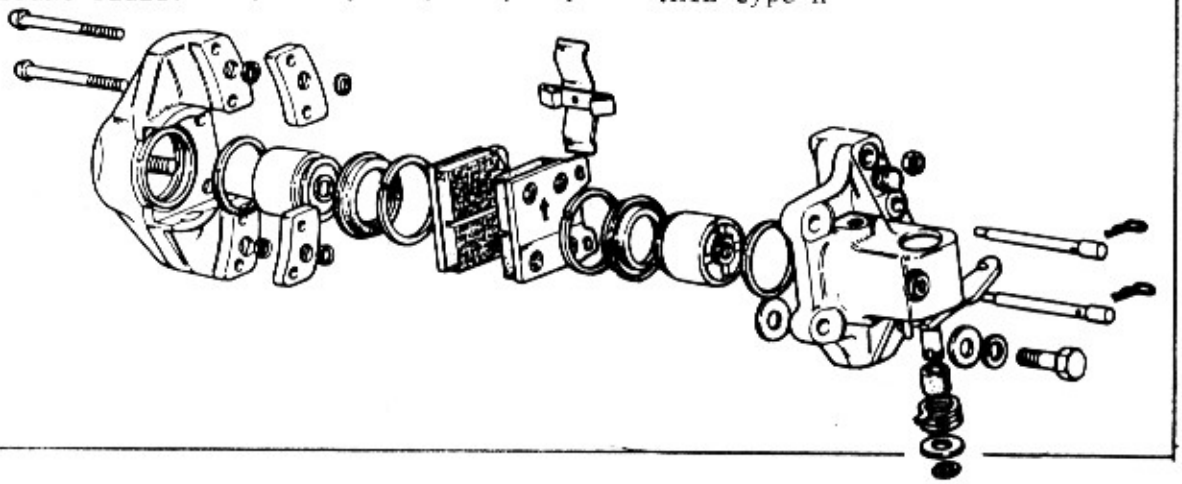
Disc diameter	.271 mm.
Disc thickness	.22 mm.
Cylinders diameter	.48 mm.
Number of cylinders for each caliper.	.2
Brake pads.	.TEXSTAR 1431 FF type
Brake fluid.	.ATE type H



124

Rear brakes (ATE)

Disc diameter	.277 mm.
Disc diameter	.20 mm.
Cylinders diameter	.38 mm.
Number of cylinders for each caliper.	.2
Brake pads.	.TEXSTAR V 1431 FF type
Brake fluid.	.ATE type H



REFER to page 133

Emergency and parking brake
Incorporated in the rear brake calipers, mechanically controlled by hydraulic cylinders.

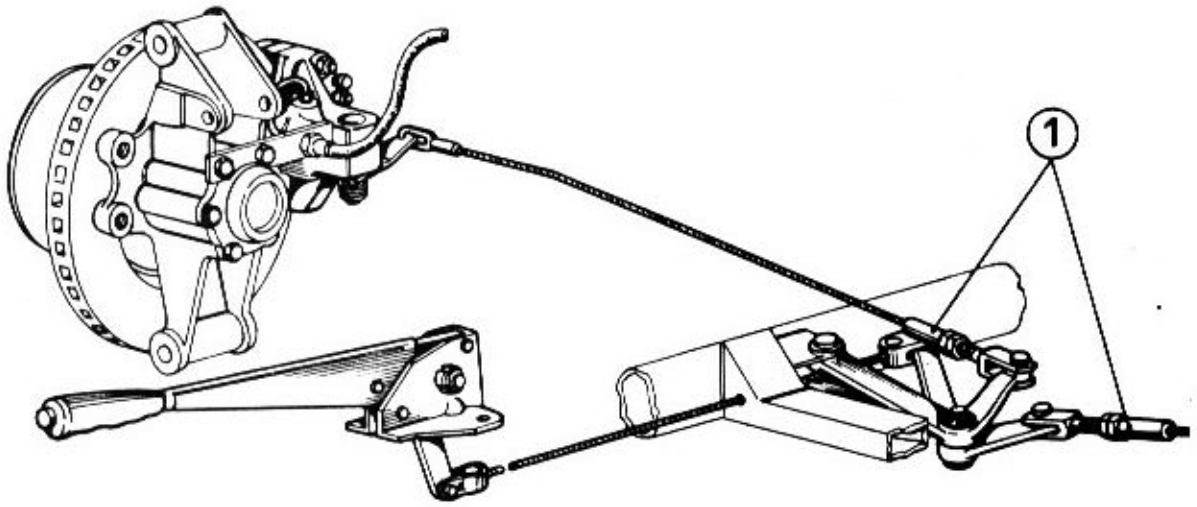


Fig. 84 Hand brake diagram.
1. Cable adjustments turnbuckles.

Adjustment
Pad wear is automatically compensated for.
Stretched or loose cables can be adjusted by tightening of turnbuckles 1.

165

DINOPLEX ELECTRONIC GROUP (Marelli AEC 103 A)

General data
The engine normally operates via the electronic ignition system.
Only in the event of irregular running of the Dinoplex unit, the electronic ignition system can be by-passed.
To do this, move the snap-in plug 1 into the seat 2, and the terminal 3 from the normal coil 4 to the emergency coil 5. The terminals must only be moved to the "Emergency" position with the ignition switched off.
Under these conditions, ignition is via battery, distributor and ignition coil.
Under these conditions the RPM counter is not operating.

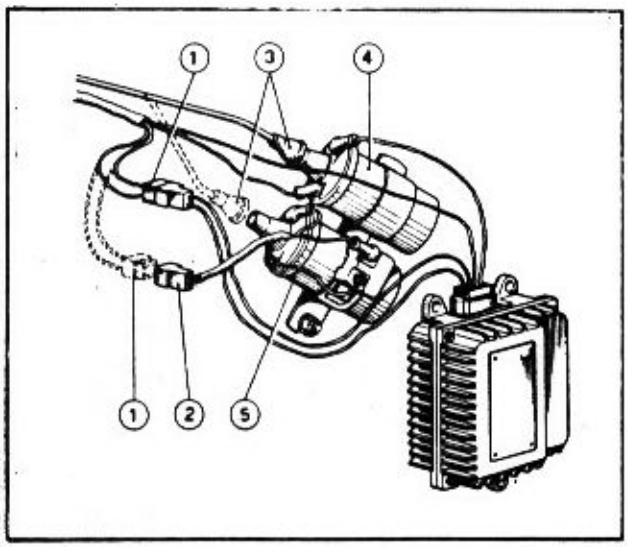


Fig. 104 Normal and emergency ignition system diagram.

1-2 Plug to connect "Emergency" ignition
3 Cable from coil to distributor
4 Normal coil
5 Emergency coil

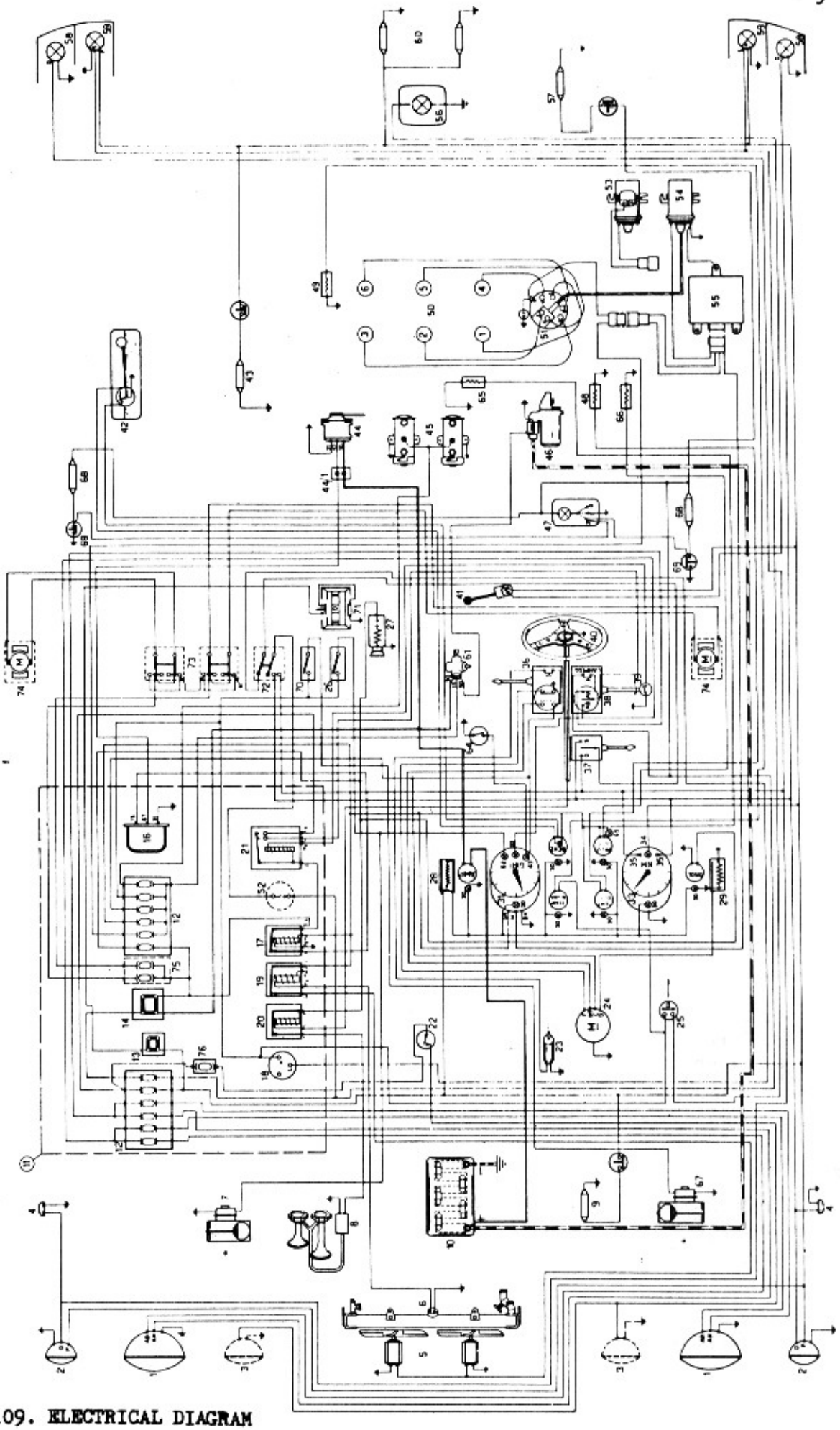


Fig. 109. ELECTRICAL DIAGRAM

Refer to page 173

ELECTRICAL DIAGRAM DESCRIPTION

1. Headlamps - Main beam and dip beam (iodine vapor bulbs)
2. Front side and directional lights
3. Fog lights (on request)
4. Direction indicator lights
5. Cooling fans moters
6. Temperature sensitive switch for radiator fans
7. Heating/ventilation fan motor
8. Horn compressor motor
9. Front trunk light
10. Battery
11. Electrical panel
12. Fuse box (6 fuses)
13. Terminal board for switched current
14. Permanently live terminal board
15. Fuse box (6 fuses)
16. Alternator regulator
17. Charging circuit relay - Lucas 33231
18. Directional flasher unit
19. Radiator cooling fan relay (Lucas 33213)
20. Horn relay
21. Main beam, dip beam and side lights relay - Lucas 33213
22. Fog light switch - on request
23. Wiper washer switch
24. Wiper washer motor
25. Stop light switch
26. Heating/ventilating fan switch
27. Cigarette lighter
28. Instrument light rheostat
29. Rheostat for varying wiper speed
30. Instrument lights
31. Electronic rev counter
32. Main beam warning light
33. Speedometer
34. Side light warning light
35. Direction indicator warning lights
36. Wiper and screen washer lever.
37. Direction indicator lever
38. Main beam, dip beam and headlamp flash lever
39. Relay switch for side, dip and main beam lights
40. Horn button
41. Reverse light switch
42. Fuel level gauge transmitter
43. Engine compartment light
44. Alternator
44/1. Alternator terminal board
45. Electric fuel pumps
46. Starter
47. Interior light
48. Oil temperature transmitter
49. Water temperature transmitter
50. Spark plugs
51. Distributor
52. Emergency light switch (only in vehicles requiring this)
53. Emergency coil
54. Electronic ignition unit coil
55. Dinoplex electronic ignition unit
56. Reverse lights
57. Luggage compartment light
58. Rear direction indicator lights
59. Rear position and stop lights
60. License plate lights
61. Ignition switch and steering lock
62. Heating/ventilating fan warning light
63. Choke warning light
64. Choke warning light switch
65. Low oil pressure warning and transmitter
66. Oil pressure guage
67. Interior ventilation fan
68. Interior courtesy light
69. " " " switch
70. Interior ventilation control switch
71. Cigarette lighter light (12 V-5W bulb)
72. Emergency lights control deflection switch (only in vehicles requiring it)
73. Power windows control motor commutator (on request)
74. Power windows motor (on request)
75. Power windows circuit fuses (on request)
76. Fog lights 15 Amp. fuse.

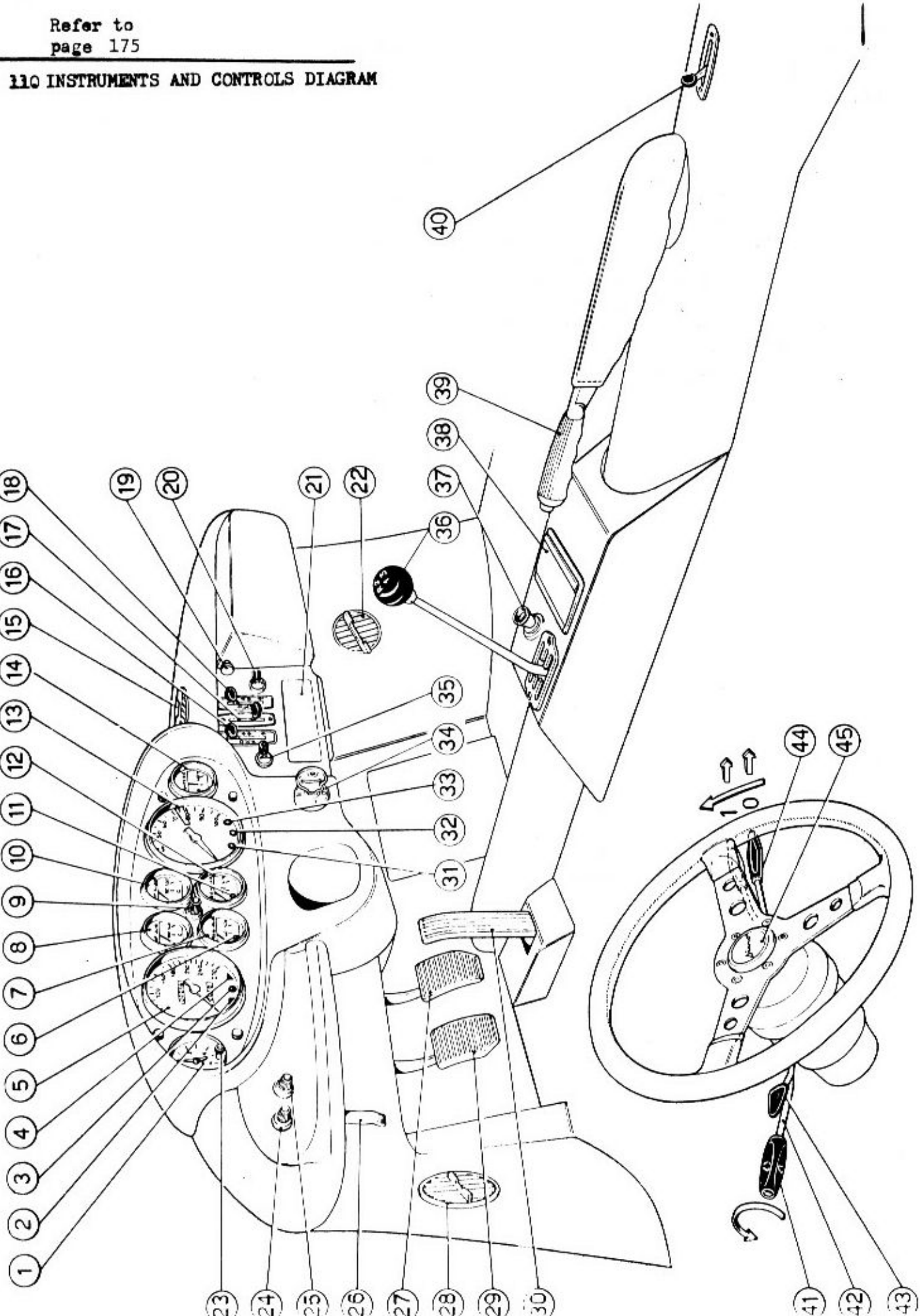
REFER to page

INSTRUMENTS AND CONTROLS

REFER to page	Description
173	1. Electric clock
	2. Left turn indicator (green light)
	3. Headlights indicator (green light)
	4. Right turn indicator (green light)
	5. Speedometer
	6. Low oil pressure indicator (red light)
	7. Electric oil pressure gauge
	8. Oil temperature gauge
	9. Odometer zero control
	10. Water temperature gauge
	11. Fuel reserve indicator (red light)
	12. Fuel level indicator
	13. Tachometer
	14. Ampere gauge
•	15. Defroster with adjustable vanes
•	16. Cold air control lever
•	17. Heater temperature control
•	18. Warm air control lever
	19. Glove compartment knob
•	20. Right ventilation control
	21. Radio location cover panel
	22. Side air inlet
	23. Clock setting knob
	24. Instrument lights rheostat
	25. Windshield wipers speed control rheostat
	26. Front hood opening lever
	27. Brake pedal
	28. Side air inlet
	29. Clutch pedal
	30. Accelerator pedal
•	31. Right air ventilator indicator light (orange light)
	32. Main beam warning light (blue light)
	33. Choke control indicator (red light)
	34. Ignition switch
•	35. Left air ventilator switch
	36. Gear shift lever
	37. Cigarette lighter
	38. Ashtray
	39. Emergency brake handle
	40. Choke control
	41. Light switch
	42. Side, dip, head, and headlamp flash control lever
	43. Direction indicator lever
	44. Windshield washer and spray control lever
	45. Horn signal

Refer to
page 175

Fig. 110 INSTRUMENTS AND CONTROLS DIAGRAM



REFER to page

176/79

IGNITION AND STEERING LOCK

Key position

0-Locked.
Steering locked and key removable. The lights can be switched on actuating switch 41 on the light switch lever 42 in the three positions. (Fig.110, p.12)

II-Running position.
Ignition, electric fuel pump and normal running services available.

III-Start

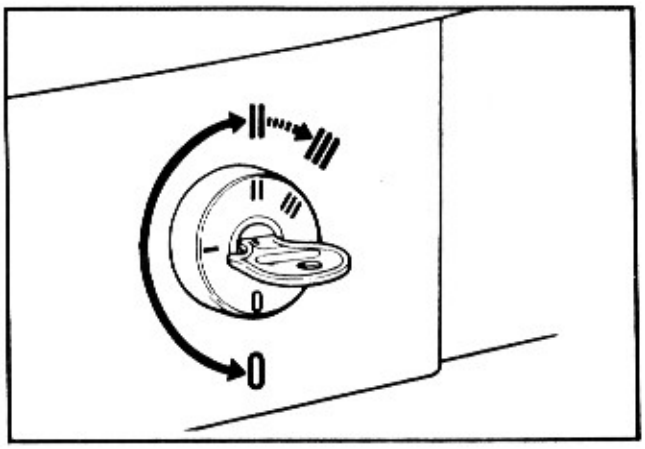
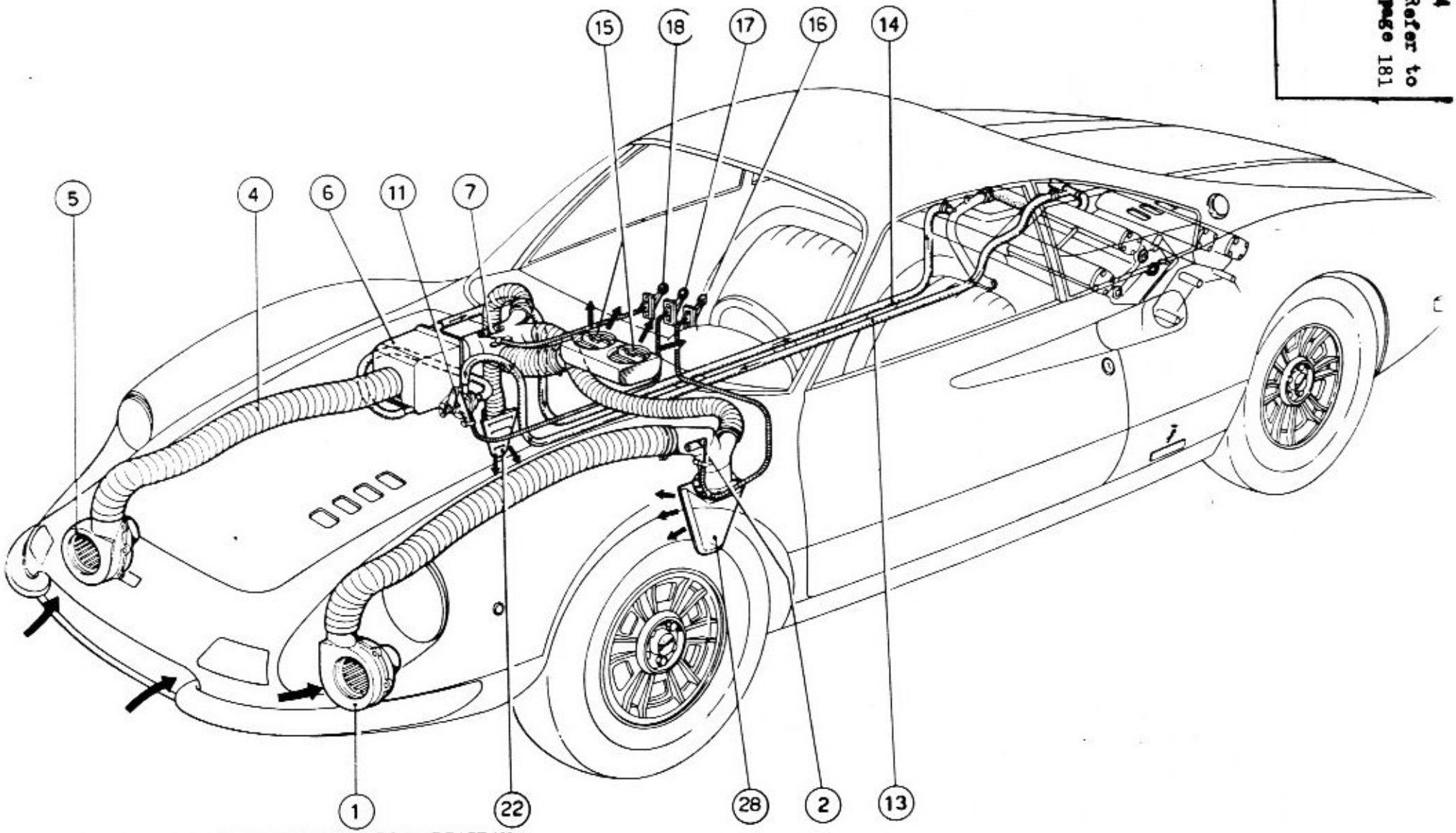


Fig. 111 Ignition and steering lock.

14
Refer to
Page 181

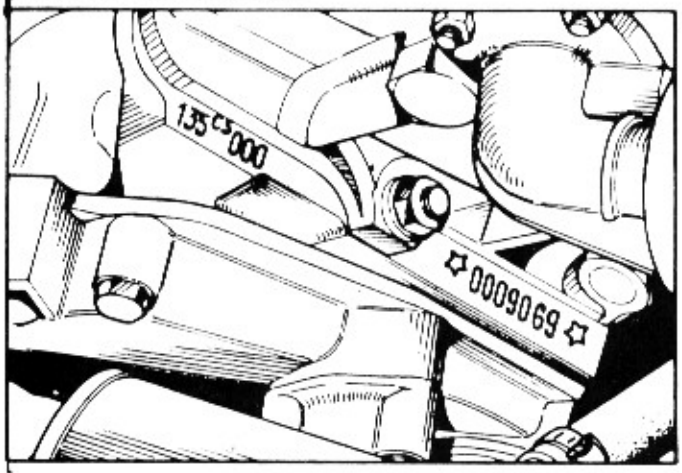


HEATING AND VENTILATION SYSTEM DIAGRAM

1. left ventilating fan, 2. Fresh air intake control valve, 4. Right-hand intake tube, 5. Right ventilating fan, 6. Heater, 7. Three-way air control valve, 11. Hot water tap, 13. Hot water from engine to tap, 14. Cooled water to engine return, 15. Defroster vents, 16. Control lever, 17. Hot water tap control lever, 18. Valve control lever, 22. Side vent, 28. Side vent.

VARIATIONS FROM VEHICLES No. 02132 ON

REFER to page	DESCRIPTION	
5	ENGINE	
	Electrical equipment	Marelli S 125 Bx 15
	Distributor	Marelli BAE 200 A
	Ignition coil	Marelli BZR 201 A
	Emergency coil	Marelli AEC 103 A
	Dinoplex electronic unit	
7	Fluids	
	Front and rear hydraulic brake circuit	ATE type H fluid
8	Identification data	



C- Engine identification number.

48 Lubrication

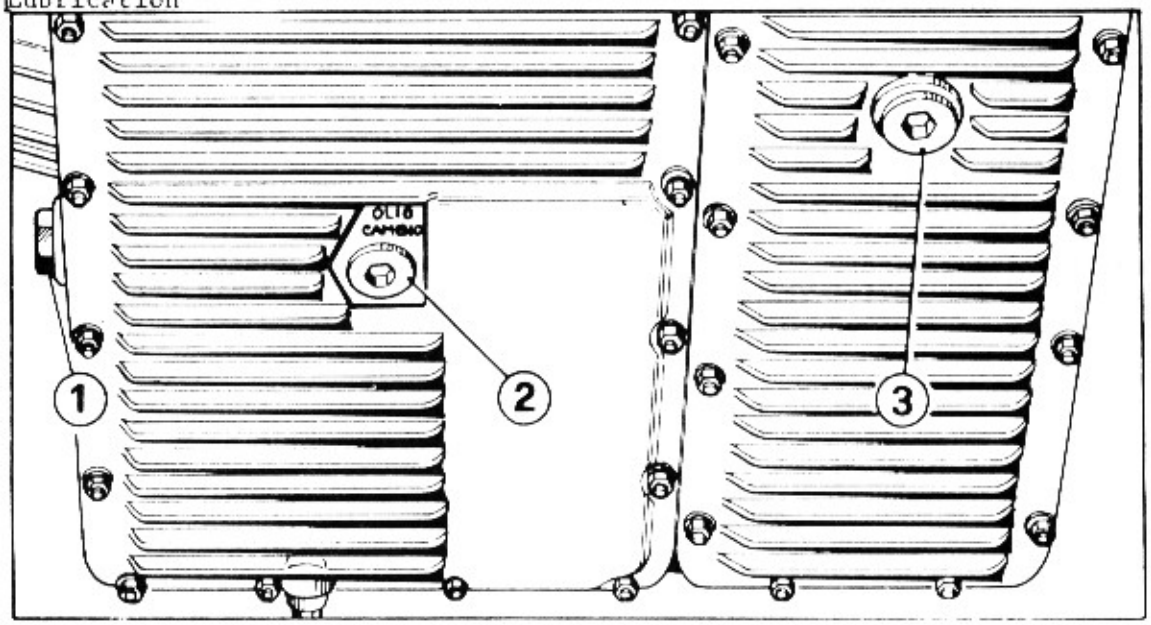


Fig. 31 Engine and transmission drain plugs diagram
1. Transmission fluid fill and level check plug. 2. Transmission fluid drain plug. 3. Engine oil drain plug.

53

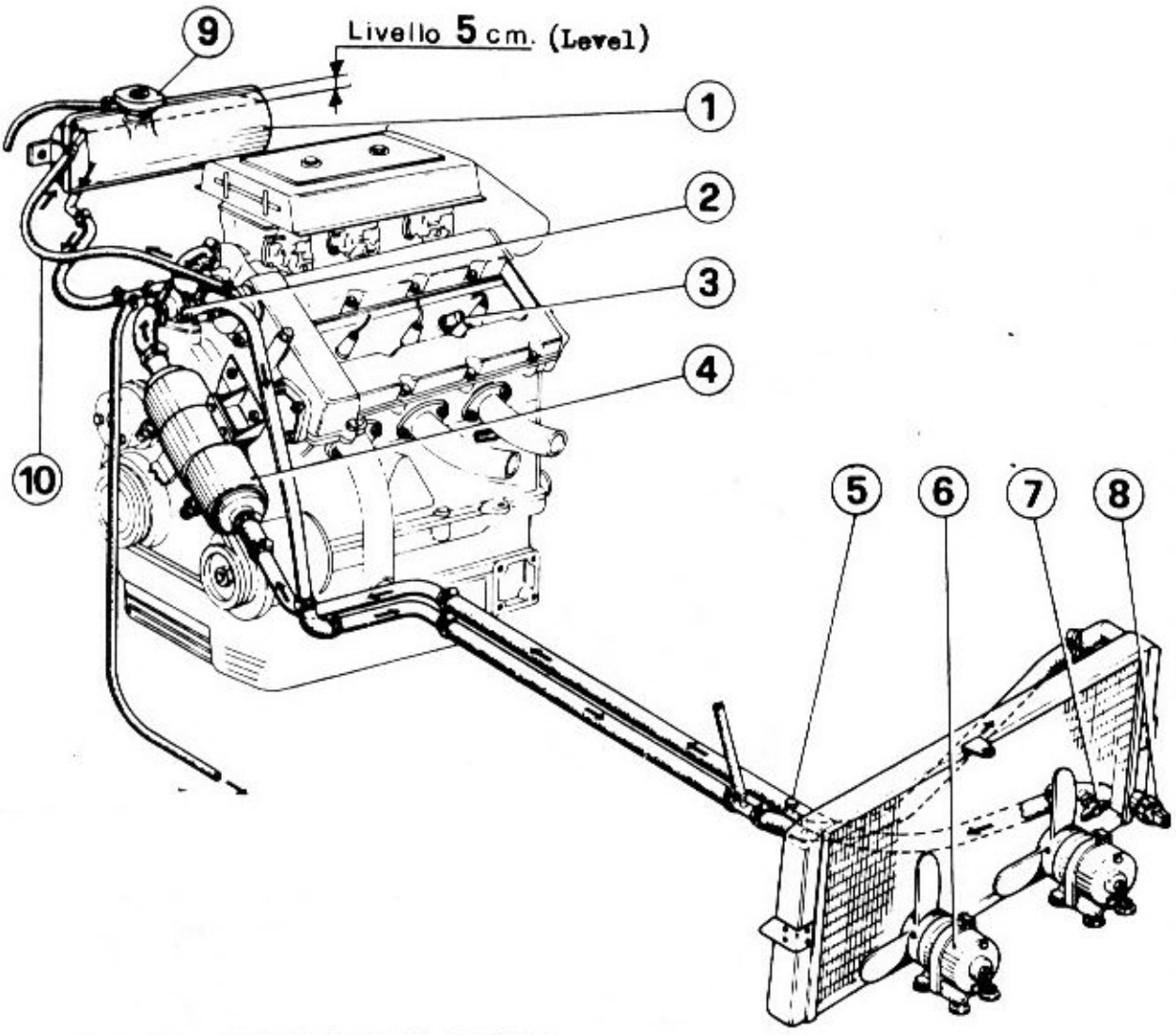


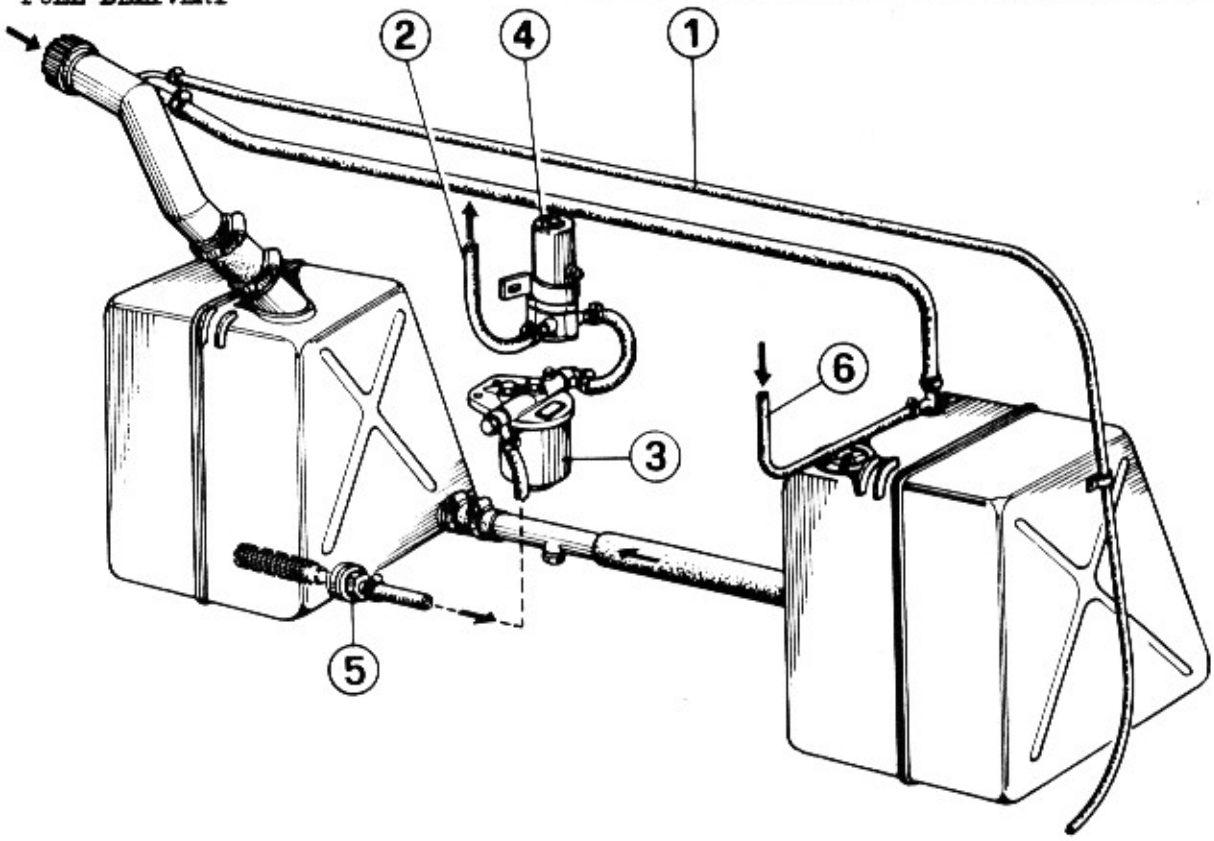
Fig. 35. ENGINE COOLING DIAGRAM

1. Supplemental expansion tank, 2. Thermostatic valve, 3. Thermocouple, 4. Heat exchanger, 5. Air relief valve, 6. Electric fans, 7. Water drain tap, 8. Thermo-contact, 9. Tank cap, 10. Overflow tube.

Refer to page

58

FUEL DELIVERY



FUEL DELIVERY DIAGRAM

Tanks vent tube, 2. Pump to carburetors tube, 3. FISPA filter, 4. CORONA pump, 5. Filter, 6. Fuel return tube.

FUEL PUMP

GENERAL DESCRIPTIONS

The engine is supplied by a CORONA electric fuel pump.
The pump is self-regulating and supplies the engine under 0.3 Kg/cm^2 of pressure.
Pump operation begins when the ignition key is in position II.
The pump's electrical circuit is protected by an 8 ampere fuse.

60

CARBURETORS

Carburator. . . . . .Weber 40 DCNF/13

Refer to page

68

CRANKCASE GASES AND OIL FUMES VENTILATION SYSTEM

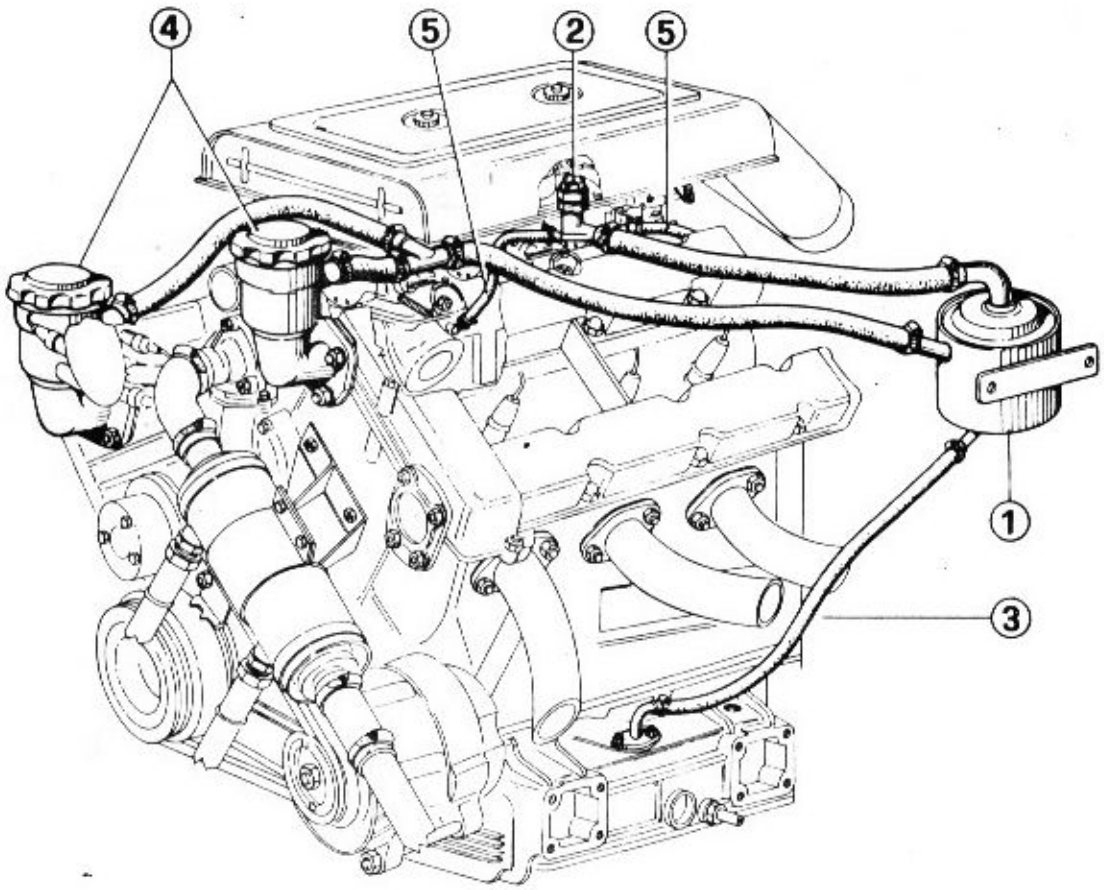


Fig. 49. ENGINE CRANKCASE FUMES RECYCLING DIAGRAM.

1. Oil fumes condensator, 2. Engine block pressure limiting valve, 3. Oil drain tube from condensator to sump, 4. Oil supply filler caps, 5. Intake manifolds uniform tubes.

GEAR BOX

76

CHARACTERISTICS AND DATA

Synchronizers for first to fifth gears. . . .	.Spring ring type
Radial clearance beteen mounted bearings and surfaces.	.0.019 ÷ 0.054 mm.
Maximun wear limits.	.0.10 mm.
Axial clearance of mounted gears.	.0.25 ÷ 0.30 mm.
Maximum wear limits.	.0.35 mm.
Clearance between gears control fork and interior of sliding sleeve.	.0.10÷0.20 mm.
Maximum wear limit.	.0.30 mm.
Lubrication of gear-box gearing.	.splash type

ENGINE/GEAR BOX DRIVE

Engine/ gear box ratio.	. 30/33 (0.909)
Central gearing thrust washers.	. Roller type

Refer to page

GEAR-BOX RATIOS

78

	GEAR-BOX RATIOS		RATIOS WITH 30/33 REDUCTION DRIVE	ENGINE rpm RATIO: Wheel rotation with 17/65 final drive gears
1°	42 : 13	3,2307	3,5548	13,581 : 1
2°	38 : 17	2,2035	2,4238	9,2755: 1
3°	34 : 21	1,6190	1,7699	6,766 : 1
4°	30 : 25	1,200	1,3200	5,047 : 1
5°	26 : 29	0,8955	0,9850	3,766 : 1
RM	45 : 15	3,000	3,300	12,617 : 1

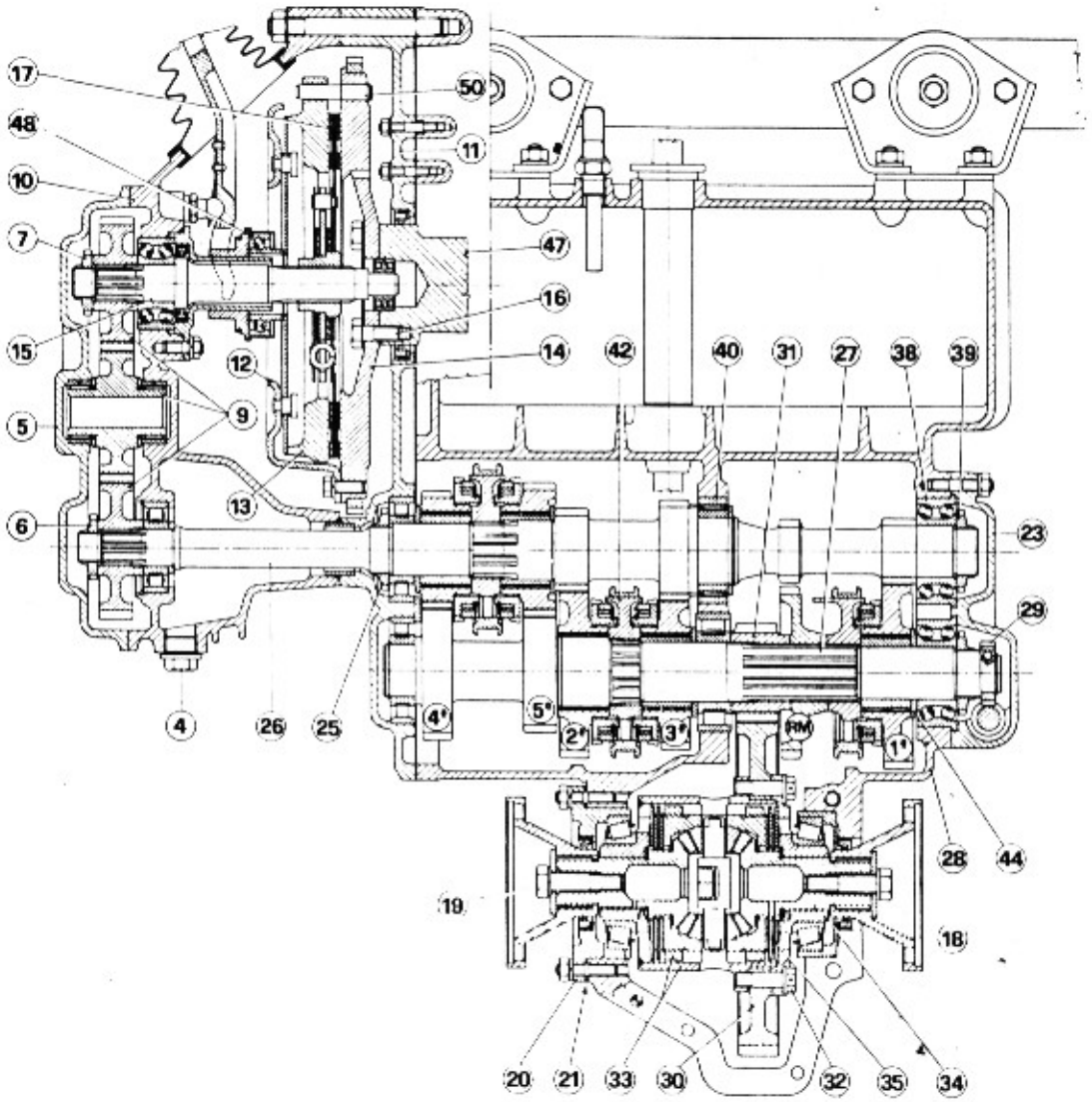


Fig. 55. GEAR-BOX, DIFFERENTIAL AND CLUTCH SECTIONAL DIAGRAM
17. Clutch disc, 14 . Flywh eel, 48. Ball release bearing, 47. Engine crankshaft, 9. Mating pinion, 26. Gear-box input shaft, 27. Gear-box output shaft, 18. Semiaxle flange, 21. B earing preload washer, 33. Differential assembly, 35. Limited-slip differential plates, 31. Differential pinion, 28. Gear-box and differential assembly case.

REFER to page

81

Synchronizer rings for gear engagement

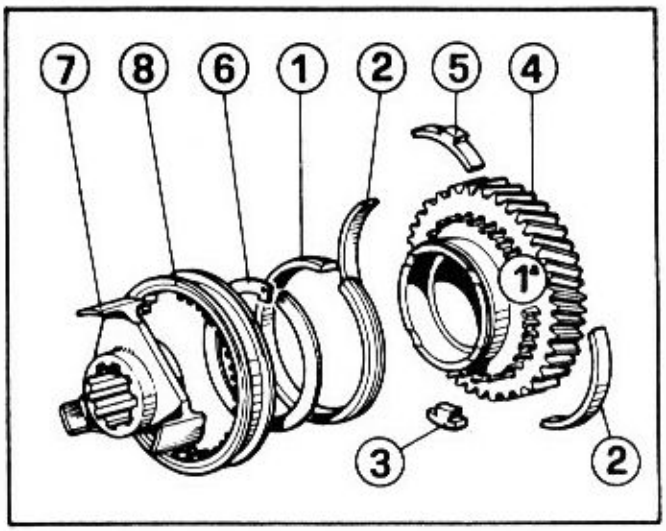


Fig. 56 First gear and synchronizer units.

1.Synchronizer ring 2.Synchronizer drag springs. 3.Stop dowel 4.1st gear 5.Thrust dowel 6.Retaining snap ring 7.Sliding sleeve hub 8.Sliding sleeve.

Operational description

Gear engagement synchronization is completed by the illustrated units in fig. 56. The sliding sleeve 8 is internally toothed, designed to engage on the synchronizing ring gear of mounted gear 4 on the output shaft.
The gearing is now solidly engaged on the sliding hub.
The spring synchronizing ring 1 gradually equalizes the rotation rate during the movement of the sliding sleeve.
Actuated by the sleeve, synchronizing ring 1 is dragged until one of its ends is engaged in acceleration, as well under decelaration, thus pushing against thrust dowel 5 and producing a rotational effect which allows rapid synchronization.
Two drag pins (2), one functioning during acceleration and the other during decelaration, are attached in order to increase the friction of the synchronizing ring against the sliding sleeve.
The spring is compressed between thrust dowel 5 and the stop dowel 3 and deformed aginst the synchronizer ring.
Thus, the synchronizing action , due to the pressure of the ring, is progressively increased by the radial pressure of the spring.
The synchronizing action ends when the sliding sleeve and the drag gear rotation velocity is equal, the spring extend and the synchronizer ring closes.
Under these conditions the final travel of the sleeve will occur with minimum effort, until it is coupled with the engagement teething fo the gear.
When engagement is completed, the synchronizer ring releases within the sliding sleeve to aid in the securing of the engaged gear.

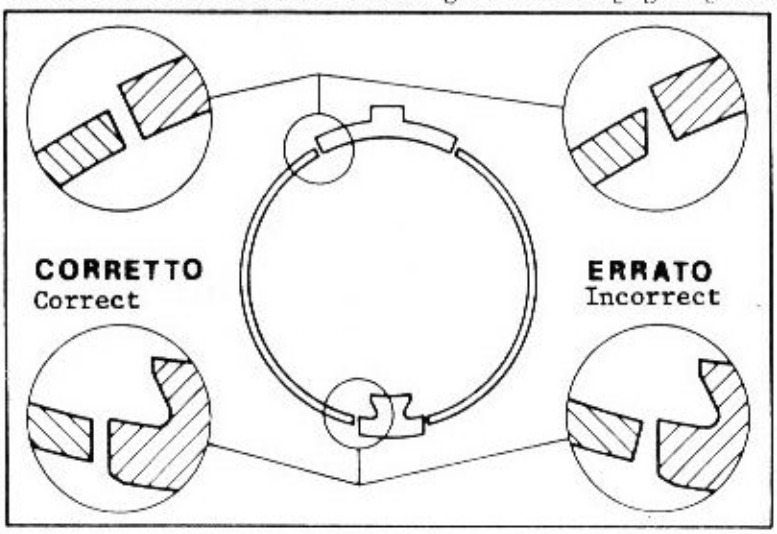


Fig. 56 bis. Stop ring assembly diagram.

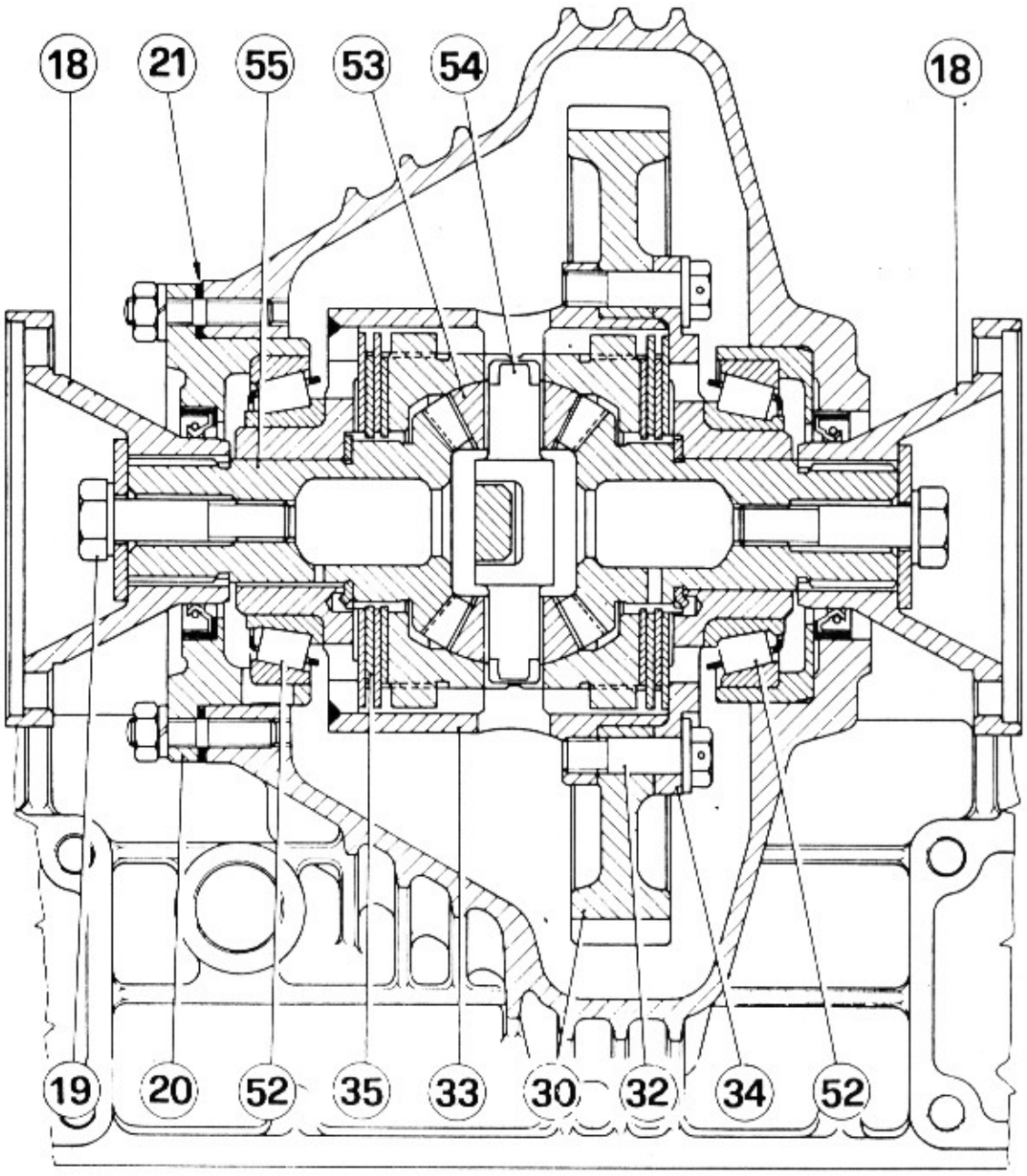
Refer to page

REAR AXLE

85-6

CHARACTERISTICS AND DATA

Cylindrical coupling reduction ratio. 17/65
Crown pinion alignment. . . . . Spacer shim eliminates this operation



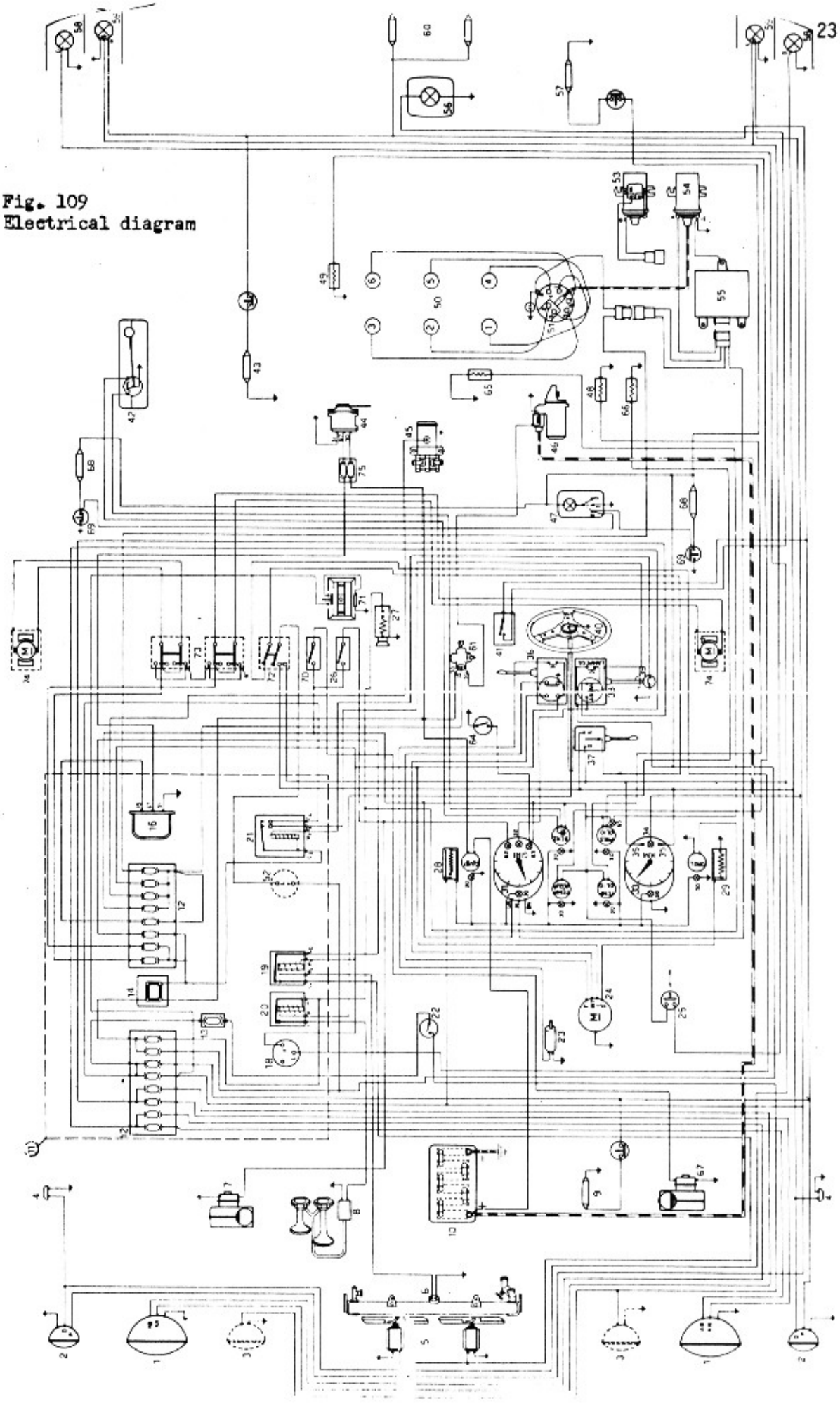
87

Fig. 58. LIMITED-SLIP DIFFERENTIAL: PLATE TYPE

18. Semiaxles attachment flanges, 20. Bearing support side cover, 30. Ring gear, 19. Flange attachment bolts, 21. Preload bearing shim, 32. Ring gear attachment bolts, 33. Differential case, 34. Differential case cover, 35. Internal and external plates, 52. Tapered roller bearings, 53. Satellite gears, 54. Satellite gears shafts, 55. Planetary gears.

Refer to page	
92	STEERING **Telescopic steering wheel mounting unit.** . . . . See Table 29, Group 74 in Parts Diagram book from car number 02768
100	FRONT SUSPENSION As from car number 01118 (see p. 6)
109	REAR SUSPENSION As from car number 01118 (see p. 6)
125	BRAKES As from car number 01118 (see p. 7-8)
116	SHOCK ABSORB ERS As from vehicle number 01118 (see p. 7)
165	DINOPLEX ELECTRONIC IGNITION UNIT (Marelli AEC 103 A) As from car number 01118 (see p. 8)
174-5	DASHB OARD CONTROLS AND SIGNALS As from car number 01118 (see p. 11-12)
176	IGNITION SWITCH WITH ANTI-THEFT DEVICE As from car number 01118 (see p. 13)

Fig. 109
Electrical diagram



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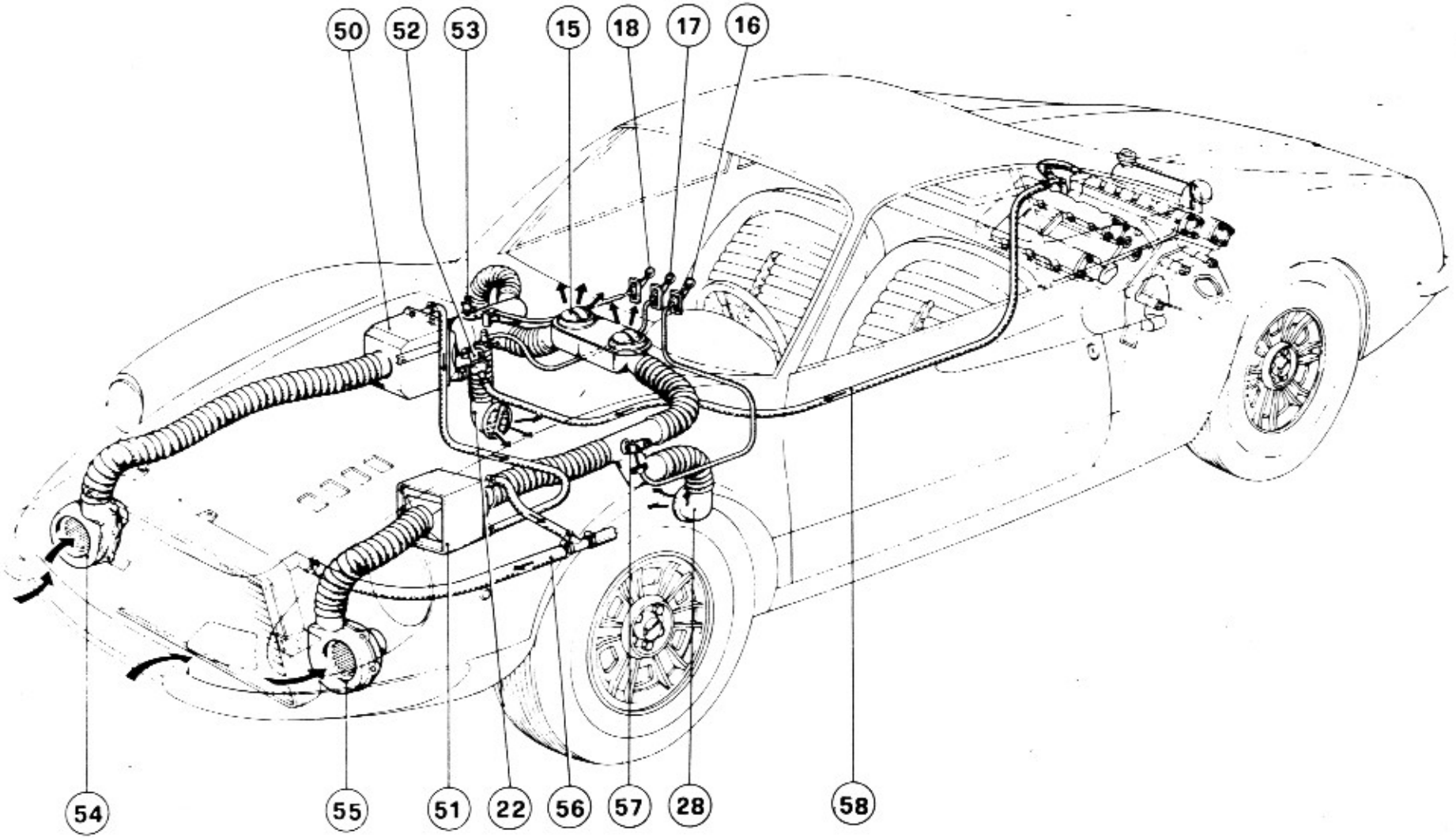
173

ELECTRICAL DIAGRAM DESCRIPTION

1. Headlamps - Main beam and dip beam (iodine vapor bulbs)
2. Front side and directional lights
3. Fog lights (on request)
4. Direction indicator lights
5. Cooling fans motors
6. Temperature sensitive switch for radiator fans
7. Heating/ventilation fan motor
8. Horn compressor motor
9. Front trunk light
10. Battery
11. Electrical panel
12. Circuit fuses (8 valve box)
13. 8amp. fog lights fuse
14. Permanently live terminal board
15.
16. Alternator regulator
17.
18. Directional flasher unit
19. Radiator cooling fan relay (Lucas 33213)
20. Horn relay
21. Main beam, dip beam and side lights relay - Lucas 33213
22. Fog light switch - on request
23. Wiper washer switch
24. Wiper washer motor
25. Stop light switch
26. Heating/ventilating fan switch
27. Cigarette lighter
28. Instrument light rheostat
29. Rheostat for varying wiper speed
30. Instrument lights
31. Electronic rev counter
32. Main beam warning light
33. Speedometer
34. Side light warning light
35. Direction indicator warning lights
36. Wiper and screen washer lever
37. Direction indicator lever
38. Main beam, dip beam and headlamp flash lever
39. Relay switch for side, dip and main beam lights
40. Horn button
41. Reverse light switch
42. Fuel level gauge transmitter
43. Engine compartment light
44. Alternator
45. Fuel pumps
46. Starter
47. Interior light
48. Oil temperature transmitter
49. Water temperature transmitter
50. Spark plugs
51. Distributor
52. Emergency lights switch
53. Emergency coil
54. Electronic ignition unit coil
55. Dinoplex electronic ignition unit
56. Reverse lights
57. Luggage compartment light
58. Rear direction indicator lights
59. Rear position and stop lights
60. License plate lights
61. Ignition switch and steering lock
62. Heating/ventilating fan warning light
63. Choke warning light
64. Choke warning light switch
65. Low oil pressure warning and transmitter
66. Oil pressure gauge
67. Interior ventilation fan
68. Interior courtesy light
69. " " " switch
70. Interior ventilation control switch
71. Cigarette lighter light switch
72. Emergency lights control deflection
73. Power windows control motor commutator
74. Power windows motor
75. Alternator protection fuse box (60 and 8 amp.)

Refer to page 181



VENTILATION AND HEATING DIAGRAM

15. Defroster with directional vanes, 16. Cold air control lever, 17. Heater controls, 18. Warm air control lever, 22/28. Side air diffusers, 50/51. Heaters, 52. Hot water control tap, 53. Three positions air control butterfly valve, 54/55. Right and left electric ventilators, 56. Engine to radiator connecting hose, 57. Three positions air control butterfly valve, 58. Engine to heater control water connecting hose.

AIR CONDITIONING

GENERAL DESCRIPTIONS

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 dashboard switch.
The cooling liquid used (Freon 12) is circulated from the compressor through a condensator, a purifier-dessicator, an expansion valve, then returning to the compressor. Temperature variation and the volume of air sent through the car are controlled by thermostat and rheostat switches located on the air-conditioning control panel.
The cooled air enters the car via directional outlets.
For best operation of the system it is indispensable, above all, that no humidity exist in the system.

CHARACTERISTICS AND DATA

System	Type	BORLETTI
Compressor	"	ASPERA
Operating pressure	Kg/cm²	15÷18
Fluid used		FREON 12
System capacity	liters	1.1
Fluid replacement (to make up losses)		Annually
Compressor oil		SUNISO GRADE 43044
Compressor level — Maximum height	mm.	40
Compressor level — Minimum height	mm.	27
Check (fluid losses)		Annually

FAULTS DIAGNOSIS AND RELATED REPAIRS

THE COMPRESSOR DOES NOT FUNCTION

Possible causes	Repairs
1. Electrical current not reaching the electromagnetic clutch	1. Dirty or deteriorated ring carbon contacts.
2. Stretched or deteriorated drive belts.	2. Check tension or replace belts.
3. Faulty control switch or broken cable	3. Check and eventually replace.
4. Faulty pressure gauge switch with burned or non-functionaing contacts.	4. Check and eventually replace.

THE COMPRESSOR FUNCTIONS BUT AIR IS NOT COOLED

Possible causes	Repairs
1. Empty or low FREON level in the system.	1. Partially refill the system and search for leaks (p. 33) (engine must be turned off).
2. Purifier-dessicator clogged or humid.	2. Replace.
3. Expansion valve faulty or with clogged filter.	3. Replace.
4. Thermostat control at panel faulty or irregularly adjusted.	4. Check and eventually replace.
5. Pressure gauge tube cracked or slow in functioning.	5. Check and eventually replace.
6. Loss of FREON at a particular connection.	6. Check with tester (engine off).
7. Non-functioning evaporator fans.	7. Examine rheostat for cause.

THE COOLING TEMPERATURE DOES NOT REACH THE PRESCRIBED MINUM LEVEL

Possible causes	Repairs
1. Compressor does not reach maximum pressure due to wear or other causes.	1. Check pressure, connecting compressor to high pressure manometer.
2. Low FREON level in the system.	2. Search and eliminate leaks; refill (p. 33-34).
3.Maladjusted expansion valve or clogged filter.	3. Replace.
4. Poor condensator cooling due to partial obstruction of the air intake.	4. Check.
5. Evaporator fans velocity slowed by defective rheostat.	5. Check that the fans' three speeds function effectively.
6. Right ventilator does not function when the compressor operates.	6. Lack of electrical current due to burned fuse or faulty motor; check and eventually replace the motor.
7. Humidity in the system.	7. Check the purifier-dessicator view glass; if fogged, replace the purifier.

OPERATION OF CONTROLS AND STARTING THE COMPRESSOR

- After starting engine, rotate the rheostat switch 48 clockwise to the first position in order to engage the magnetic clutch and to start the compressor. The right hand ventilator is also now in operation.
-- Also rotate the commutator knob clockwise. At the first position the evaporator fans will turn on. At the second and third positions their speed will increase and also increase the speed and volume of the circulated air.
- To increase the amount of cool air turn knob 48 clockwise.

NOTE

When the system's pressure reaches about 18 atm., the pressure gauge cuts off the current and the compressor stops, when it will turn on again when the pressure reaches about 14 atm.
In order to ventilate the interior of the car with the system off, allow the two ventilators to operate, these are controlled by knob 48.

MAINTENANCE

Normally the system will require the following periodic operations:
- Complete replacement of the FREON liquid annually.
- Annual check of the compressor's oil level.
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.

FUNCTIONING (Part I)

- Before installing the compressor on the engine, it is necessary to mount on two wooden supports, with the drive shaft pointing down, without touching any surfaces so that no pressure is places 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 voiding the compressor and related units' guarantee.

USE SUNISO GRADE 43044 OIL EXCLUSIVELY

- The compressor oil level is to be checked before installation while on the mounts; remove one of the side plugs: insert a metal indicator tab and measure the quantity of fluid. Check that both plugs are tightened properly. The oil level in a new compressor is 40 mm. After initial use, the level must be kept at $27 \div 30$ mm.

ELECTROMAGNETIC CLUTCH

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

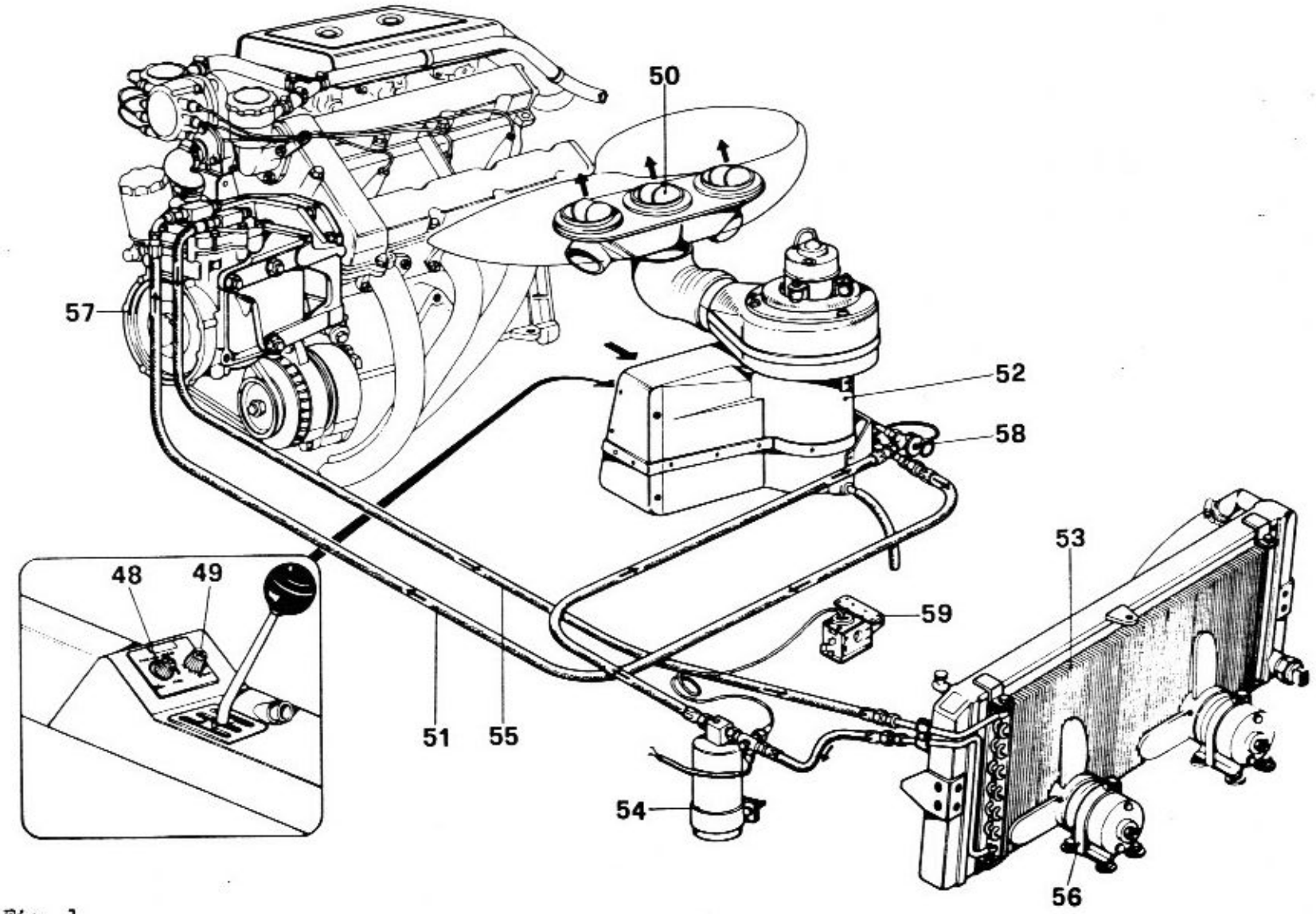


Fig. 1.
AIR CONDITIONING DIAGRAM.

48. Air temperature regulator, 49. Air volume regulator, 50. Air diffusion vents, 51. Compressor to evaporator Freon gas tube, 52. Evaporator, 53. Condensator, 54. Purifier, 55. Compressor to condensator Freon gas tube, 56. Right ventilator, 57. Compressor, 58. Freon gas expansion valve, 59. Pressure valve.

INSTALLATION

- Do not use water for any purpose while installing the system, or when its tubing is not tightly connected.
During discharging, loading or timing aoperations, water can be poured over the condensator to reduce excess condensation.
- Do not, for any reason, remove the plastic caps at he 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 do operational and maintenance damage.
- Also use care with the purifier-dessicator by not removing the caps until ready to connect them with other components.
If the unit is left open for a period of time, it can become saturated with humidity and can radically influence its proper operation. If the installation is partially completed, or must be left that way overnight or for several hours, close every flexible tube and especially the purifier connections.
- Do not use any sealant material on the seats of the flexible tubes connections. We recommend using a small quantity of compressor oil for this purpose.
- If the system is totally empty of FREON due to major leaks, replace the purifier, as it is probably satured with humidity.
- It is not necessary to completely drain a partially FREON filled system. If possible locate and repair the leak without any dismantling, and add additional FREON (check to see that the glass indicator window "clears" as noted in Part III on p. 34).
- Do not subject the compressor belts to excessive tension or stretching during assembly and removal operations. Normal belt tension is measured at 6÷ 8 mm. distance downward.

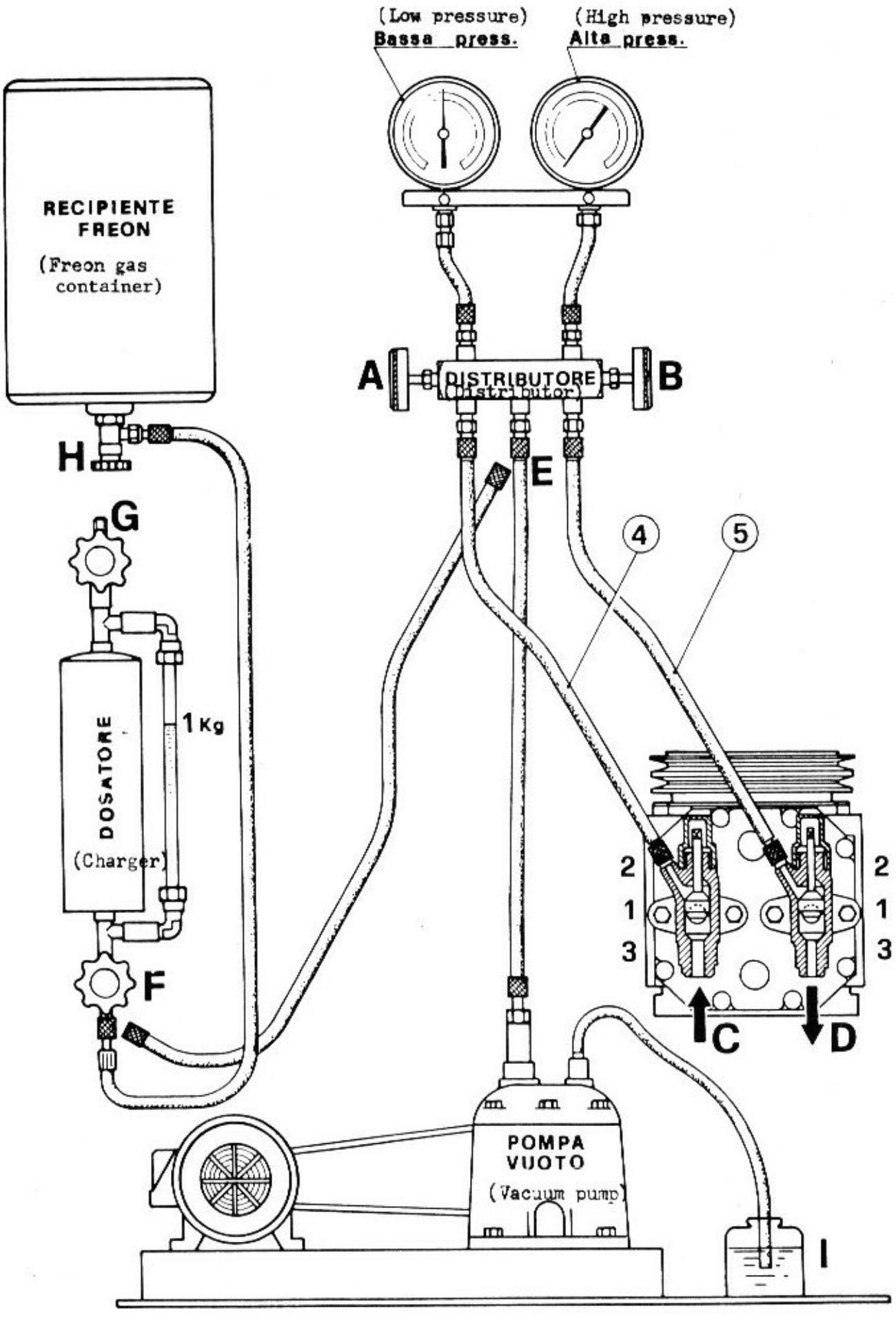
PRELIMINARY OPERATIONS FOR SYSTEM CHARGING (Part II)

Necessary tools:

- Motor unit-discharge pump.
- Charging unit for measuring and loading of FREON, with visible level marked with corresponding increments to 1 Kg. of FREON;
- Distributor unit, with service lines gauges panel and controls for high and low pressure.
The gauges unit is made up of:
- Discharge gauge with 0 to -700 mm. of mercury graduations and a 0 to 10 Kg/cm^2 graduarions for low pressure.
- A gauge graduated from 0 to 35 Kg/cm^2 for high pressure.
- Propane gas leak indicator (fig. 3).

COMPRESSOR SERVICE VALVES

The intake and delivery service valves C and D situated on the compressor are of the double seat type which close whenever they are fully screwed in or completely unscrewed.
When valves C and D are fully screwed in, position 3 (fig. 2) the intake and delivery tubes to the system are fully closed, while tubes 4 and 5 remain open (service lines) between the compressor and the valves A and B of the high and low pressure gauges for control, charge or discharge operations. When the valves C and D are screwed out, they are in their normal functioning position, while service lines 4 and 5 are closed. If valves C and D are not closed, in either opposite seat, both delivery lines remain open.
The intake valve is the larger one (5/8 ") and is connected with evaporator 52 return tube 51 (fig 1), while the smaller delivery valve (1/2 ") is connected with the condensator 53 upper connection and its return line, to the upper connection of purifier 54.


(Low pressure)
Bassa press.
(High pressure)
Alta press.
RECIPIENTE FREON
(Freon gas container)
A
DISTRIBUTORE
(Distributor)
B
H
E
G
4
5
DOSATORE
(Charger)
1 Kg
F
2
1
3
2
1
3
C
D
POMPA VUOTO
(Vacuum pump)
I

BLEEDING AIR FROM THE SYSTEM

Bleeding of the system should be preferably done with a vacuum pump. If one is not available, the system can be emptied using a compressor; however maximum vacuum cannot be obtained, thus lowering the system's efficiency. Thus, the engine must operate for a time in order to actuate the compressor.

CONNECTIONS

- Remove the protective caps from the compressor intake and delivery valve stems and those of service lines 4 and 5.
- Connect the low pressure gauge flexible tube to service line 4 on the intake valve. Also connect the high pressure gauge flexible line to the delivery valve.

DISCHARGING WITH A VACUUM PUMP

- Connect compressor, gauges and pump as in fig. 2.
- Position the valves as follows:
  - Valve A= open position
  - Valve B= open position
  - Valve C= position 2
  - Valve D= Position 1
- Allow the pump to run for 5 minutes and then immerse the end of the air exit tube in a container 1 filled with compressor oil. No air bubbles should be noted. Any air bubbles will indicate leaks in the system. To eliminate leaks, check all tubing and connections of the complete system while charging with FREON.

DISCHARGING THE COMPRESSOR

Position the valves as follows:
- Valve A= Closed position
- Valve B= Open position
- Valve C= Position 2, less 1/2 turn
- Valve D= Position 3.

Turn completely to the right the air temperature regulator knob 48 and the air volume control knob 49, with engine speed at 1200÷1500 rpm. Operation time is for 15 minutes, and the vacuum value is at 28" of mercury (at 700 mm. of mercury).
- Check that the vacuum meets specifications and that after 10 minutes of discharging there are no air bubbles. For this check, immerge the end of the air escape tube in container 1 (fig. 2).

END OF DISCHARGE OPERATION

- Before stopping the compressor, position the valves as follows:
  - Valve A= Closed position
  - Valve B= Closed position
  - Valve C= Position 2, minus 1/2 turn
  - Valve D= Position 2, minus 1/2 turn.
- Turn off compressor for 10 minutes; if the pressure remains constant, there are no leaks.

PARTIAL CHARGE FOR SYSTEM LEAK TESTING

Link connection F of the charger to connection E of distributor (see fig. 2) after having placed the valves in the following positions:
- Valve A= Closed position
- Valve B= Closed position
- Valve C= Position 2
- Valve D= Position 1.

Set engine speed at 1200-1500 rpm. Charging time is 15 to 20 minutes. Control knobs 48 and 49 turned fully to the right (fig. 1)
- Open charger tap F and loosen connection E to allow a small quantity of FREON to escape in order to bleed air from the tubing, then close again.
- Open valve B and charge the system with 0.250 Kg. of FREON 12.

TESTING FOR LEAKS

Use propane pressure indicator (fig. 3), attached with a one meter long rubber tube. The engine is turned off and all fans or ventilators in the surrounding vicinity 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 noticed.
- Move the indicator tube end over all connections and linkages, compressor valves, the rear part of the clutch unit to check the drive shaft gasket seal.of the compressor.
If there are any FREON leaks the blue propane gas flame will turn green in color.

ATTENTION:

Keep the torch away from the face and do not breathe in the gas; keep away from the carburetors, gas containers, or painted parts. Locate the leaks, correct them and then proceed to bleed the system.

FULL CHARGING OF THE SYSTEM (Part III)

FILLING THE CHARGER

- About 1 Kg. of FREON is needid to fill the system. For this operation use the proper charger.
- Solidly fasten on a high permanent stand the FREON container.
- Fasten the charger in a lower position in order to fill the charger. The charger should be set up as to be movable for use next to the car.
- Connect the charger tubing with the FREON container, turn taps H and F and let the fluid flow into the charger until filled. If it will not fill to the prescribed mark, some internal gas pressure is creating a counter pressure blocking the flow of FREON.
- Eliminate this counter-pressure by quickly and slightly opening and closing several times tap G.
- After filling the charger turn the taps H and F off and disconnect the FREON container tubing.
The charger is now ready for charging the system.
- Follow all the operations described in Part II by charging the system with all the FREON in the charger.
- Normally, when 0.900 Kg. of FREON have been charged into the system, the view window of the purifier will have cleared.
The last 100 grams are filled in as reserve. The charge is complete when the high pressure gauge registers 200-250 lbs/sq.inch (15÷18 Kg/cm^2) and when air bubbles are no longer noted in the purifier examination window.

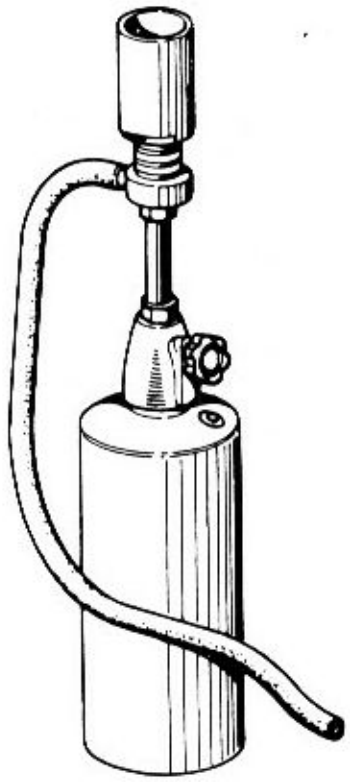


Fig. 3 Propane gas pump leak tester.

- On warm days, a fan placed 30 to 90 cm. in front of the car and blowing on the condensator will aid in charging more rapidly, if a vacuum pump is not used.

DISCONNECTING THE GAUGES AFTER COMPLETING THE SYSTEM'S CHARGE

Position the valves as follows:
- Valve A= Closed position
- Valve B= Closed position
- Valve C= Position 2
- Valve D= Position 2
- Tap F= Closed

Disconnect connection E. Disconnect service lines 4 and 5 from valves C and D. Replace valve controls C and D safety covers. The system is now ready for operation.

VARIOUS OPERATIONS (Part IV)

TOTAL DISCHARGE OF FREON FROM THE SYSTEM (compressor turned off);

- Connect the gauges without connecting the FREON container and position the valves as follows:
- Valve A= Closed position
- Valve B= Closed position
- Valve C= Position 1
- Valve D= Position 1.
- Slowly open valve a, the gas will escape from E with traces of oil; recheck after the pressure has been discharged. If the high pressure does not decrease, carefully open valve B, making sure that there is not a sudden rush of oil.

CHECKING COMPRESSOR OIL LEVEL WITH SYSTEM CHARGED

- For this operation, the compressor and the engine must be turned off. Position the compressor valves and gauges as follows:
- Valve A= Closed position
- Valve B= Closed position
- Valve C= Position 3 (closed)
- Valve D= Position 3 (closed)

After the above operations, connect valve A with valve C and valve B with valve D. Leave the FREON container tube disconnected from the gauges. Then position the valves as follows:
- Valve A= Closed position, minus 1/2 turn
- Valve B= Closed position, minus 1/2 turn
- Valve C= Position 3
- Valve D= Position 3

in order to eliminate the FREON internal pressure. Open one of the compressor taps and with a tab measure its fluid level (See Part I). If low, fill to prescribed level.
- Normally, the oil level must be checked after replacement of a defective seal or because of a leak. Any oil shortage can be noted in the purifier examination window.

DISCHARGING GAS FROM THE COMPRESSOR

Position the valves as follows:
- Valve A= Closed position
- Valve B= Open position
- Valve C= Position 3
- Valve D= Position 3.

Allow the compressor to run for 10 to 15 minutes. Check its vacuum level by inserting the end of a tube connected to the gauge in E in a container filled with compressor oil.
There should be no air bubbles noted. If so, there is a leak in the system. Check according to instructions for leak testing (Part 2).

DISCONNECTING THE COMPRESSOR WITHOUT DISCHARGING THE SYSTEM

Place valves C and D in position 3, unscrew the fastening bolts of the two valve groups on the compressor and remove it last from its support.

FUEL EVAPORATIVE EMISSION CONTROL SYSTEM

GENERAL DESCRIPTIONS

ENGINE

CARBURETORS TECHNICAL DATA

Carburetor type Weber	40 DCNF 19
Choke diameter	32 mm.
Main jet	1.25 mm.
Air correction jet	2.20 mm.
Idle jet	0.55 mm.
Idle air jet	1.20 mm.
Central diffuser	4.50 mm.
Pump jet	0.50 mm.
Pump cams	11 total

Pump delivery valve	1.00 mm.
Emulsion tube	F/24
Float chamber valve	1.75 mm.
Level (vertical float)	52-0.25 mm.
Starter jet	F 6/60
Progression holes	
No. 1	0.80 mm.
No. 2	0.90 mm.
No. 3	1.30 mm.

Engine air supply: specially provided for with a sealed air intake.

CTHER ADJUSTMENTS

Idle speed: Through a cam regulated by the temperature of the engine timing lubrication.

Operation:
- With oil temperature at 20°C., the tappets must be aligned with the 20 stamped on the cam. Cold engine speed: 1600 ± 200.

- With engine warm: oil temperature at 80° C., the cam is barely in contact with the tappets. Engine speed= 1000 rpm's ± 50.

Microswitch tappets in retarded position:

With the cam tappets under minimum acceleration and near the 20 mark, the microswitch should have not as yet begun to open the circuit leading to the distributor. See page 39 for adjustment instructions.

ENGINE ELECTRICAL SYSTEM

Distributor with dual points	One Marelli 50.10.256.3 or S.125C
Points advance	9° ÷ 7° (Before Top Dead Center)
Distributor set-up	
Points retard	2° ÷ 4° (After Top Dead Center) (of engine)
Automatic centrifugal advance	30° ± 1° of engine
Total advance	39° ± 2° beyond 5.500 n/1'
Distributor microswitch	One UNIMAX 2HB 58-1
Coils	One Marelli BAE 200A and BZR 201A (Emergency)
High tension transistorized unit	Marelli AEC 103A
Air pump clutch control unit	Siemens-Eletta type VAF-0447/A
Generator	Marelli GCA 119A
Fuel pump	Corona, model 8240

AIR INJECTION SYSTEM

SAGINAW air pump	G.M. No. 340.CS.23.7806.206
Air pump belt	Gates Polyflex 7M 200
Control valves	Two G.M. 5354987
Diverter valve	G.M. 7029196
Air pump clutch	Baruffaldi EKM 1

FUEL VAPORS CONTROL SYSTEM

Sealed fuel filler cap	FIAT 124A 100.104030.418.1665
Controlled capacity tanks	Two Ferrari
Fuel vapors separator	Ferrari
Three-way valve	Borg Warner cux 2219 or FIAT 100 GBC/1140/104806/4226204
Active carbon filter	SAVARA 5126/50

EXHAUST SYSTEM

Exhaust system	ANSA muffler and special tubing
Exhaust collector headers	With exhaust gases pre-relief tubes.

ENGINE

General description

On the cars equipped with an exhaust gases emission control system, several modifications have been introduced; specifically:
-Idle speed operation, controlled by the engine oil temperature.
-Microswitch, actuating on the the dual points distributors.
-Special carburetors adjustment.
-Exhaust collector headers tubes equipped with gas analysis connections.
All these units ensure gas exhaust emissions of low levels, as long as these units are kept in correct adjustment and maintenance.

Mechanical checks and adjustments

Spark plug maintenance

Champion UN 19V spark plugs are used which have a central recessed electrode and an additional surrounding circular electrode.
The electrode gap is set by the manufacturer (1.27± 0.4 mm.) and is not adjustable.
When the central electrode is worn or the porcelain is cracked or dark grey in appearance, replace the plug.
Every 5,000 km., check plugs accurately and replace if necessary.
During checking operations, run engine at idle speed in order to check for electrical discharges at the spark plug connections.
With the high tension Dinoplex unit the sparks produce an audible sound and a luminous spark.
If necessary, replace faulty cable connections.
Every 10,000 Km., replace plugs.

Carburetors maintenance

Periodic maintenance is suggested by the factory and its authorized dealers.
The cars have a specially designed adjustment for exhaust gases emission controls and this must not be altered under any circumstances. The carburetors are supplied with special screws for the adjustment of the mixture, and must only be adjusted during the peridic maintenance.
The mixture adjustment screws have a friction ring and a spring which control

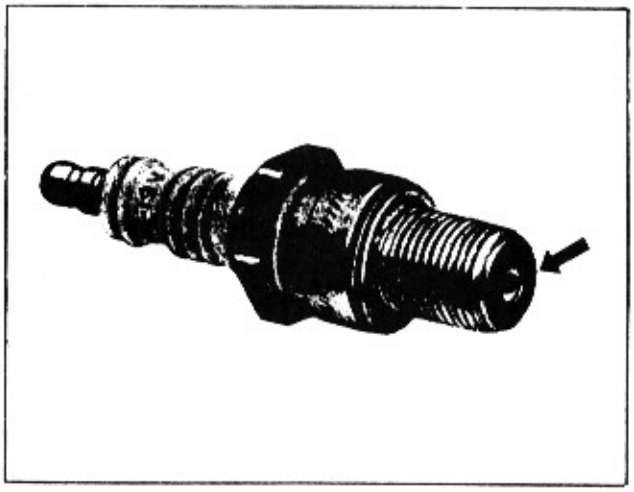


Fig. 1 Champion spark plug UN 19V

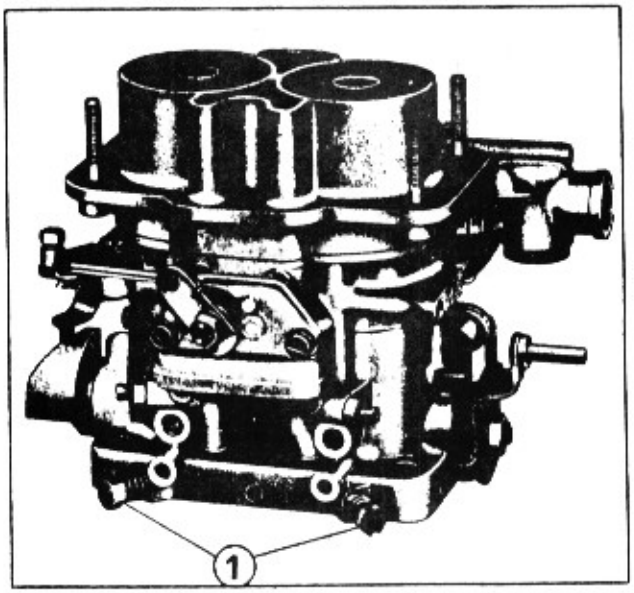


Fig. 2 Carburetor Weber 40 DCNF 19
1. Mixture adjustment screws.

this free movement and assure a slight mixture enrichment in a progressive loosening of the screws.

Mixture control operations
These operations must be carried out every 15,000 Km.
Do not, under any circumstances, alter the adjustment of the mixture control screws after these operations are completed.
If the air and gas filters maintenance operations have been scrupolously followed, the carburetors should not need any additional maintenance in the periods between maintenance schedules.

Procedure: a CO gas analyzer, warmed to the manufacturer's specifications, is used.

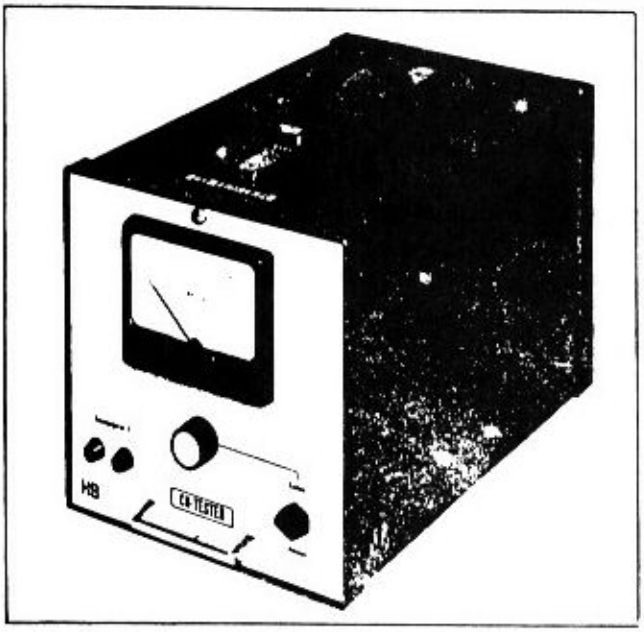


Fig. 3 CO analyzer, Hartmann type.

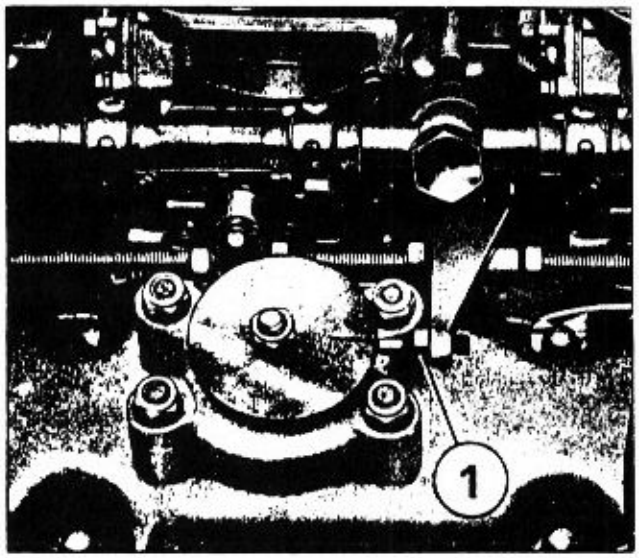


Fig. 4 Idle speed unit.

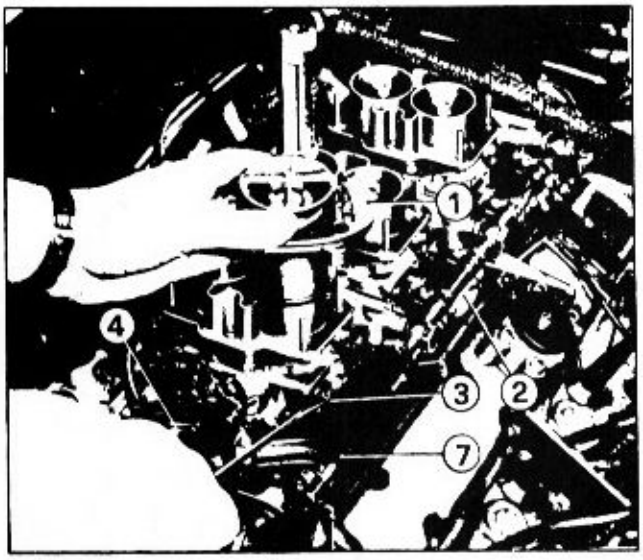


Fig. 5 Synchronizer unit for carburetors. 1. Motometer unit, 2. Butterfly valves control shaft, 3. Valves adjustment screws, 4. Idle speed adjustment screw, 7. Valves control unit.

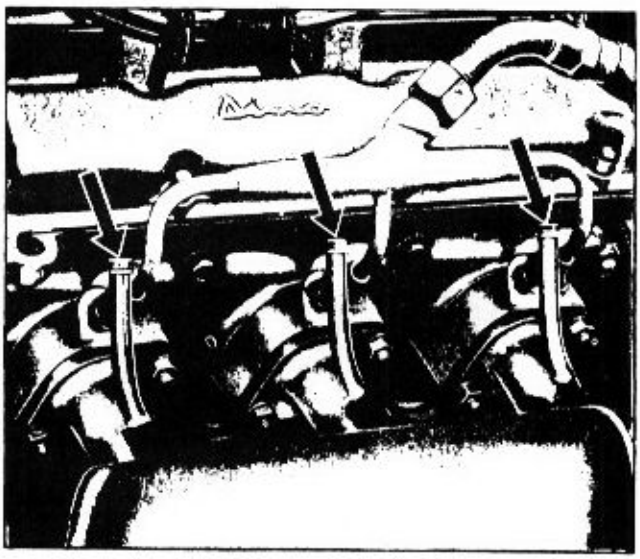
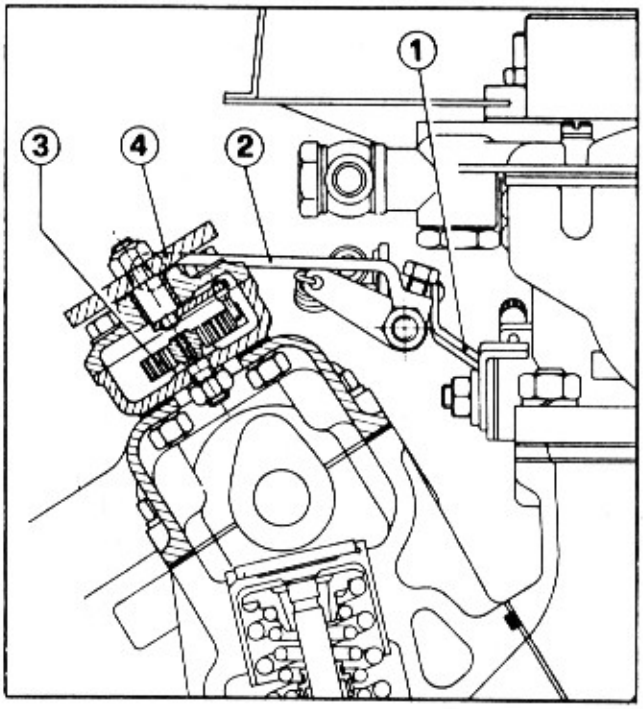


Fig. 6 CO gas check connections.

Run engine at idle speed, checking that all cylinders are functioning properly and that there are no electrical discharges across the spark plug caps.
When oil and water temperatures are around 90°C., remove the air intake and check whether the idle speed cam is functioning freely.
With the engine speed at 1000 rpm's, equalize the butterfly valves openings using a carburetor synchronizer tool.
When the valves openings have been equalized, check whether the engine idle speed rpm's remain at the 1000 rpm's minimum with the idle speed cam in an inoperative position.
If the speed decreases, increase it by adjusting butterfly valves adjustment screws 3.
Prepare the CO analyzer by connecting the analyzer dip-stick to the tube at the top of the exhaust collector connected to the body of the first carburetor (each carburetor body feeds a cylinder). A connection is attached to each collector for the insertion of the analyzer dip-stick.
With the analyzer dip-stick connected, engine speed at least at 1000 rpm's, with air pump functioning, engine oil and water temperature at 90°C., the CO analyzer gauge count should be between 1.1%±0.2%.
If the mixture is too rich, lightly close the mixture adjustment screws for each carburetor (ensuring each time that the analyzer indicator does not move) and adjust to reach the prescribed CO values.
Repeat the operation for all six carburetors, disconnect the analyzer dip-stick and reconnect the air intake.
Accelerate the engine to render inoperative the idle speed control cam and check for the last time the engine idle speed and the CO % count, which must not vary for each cylinder.
The idle speed unit contains a bimetallic spring which moves a circular diameter cam.

With oil temperature below 60°C., the high part of the cam surface is in contact with a small tappet connected through an arm with a butterfly valve control lever. Therefore, the butterfly valves are slightly open; if the engine is started, with ambient temperature of 20°C., a few seconds after starting it will automatically reach a minimum of 1200 rpm's.



Idle speed unit diagram.
1. Butterly valves control lever,
2. Tappets, 3. Bimetallic spring,
4. Cam.

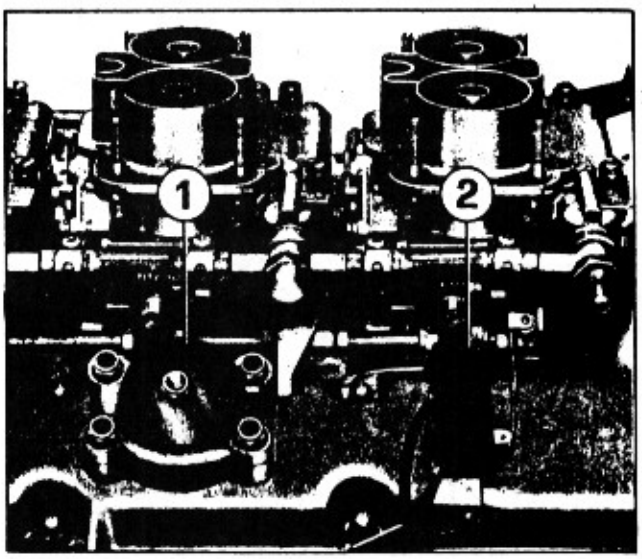


Fig. 8
1. Idle speed control cam.
2. Distributor microswitch.

As the oil temperature increases and the engine warms up, the cam rotates and, after a maximum of 1600 rpm's, it becomes inoperative allowing the engine to stabilize at an idle speed of 1000 rpm's (minimum) amd with oil temperature at 80°C.

Adjustment of the idle speed cam.

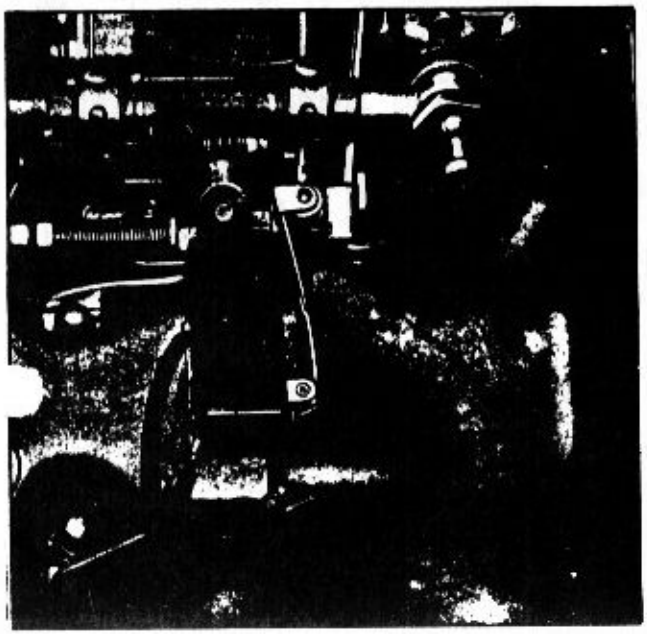
Adjustment with cold engine:

-With engine oil temperature at 20°C., check that the idle acceleration tappet aligns to the number 20 stamped on the top of the cam.
Remove the cam and rotate the internal bimetallic strip.
-Start the engine , accelerate for 30 seconds at 2500 rpm's and then let it run at idle speed and check that it remains at 1100-1200 rpm's for one minute.
Allow the engine to warm up by accelerating it several times.
After about 10 minutes, the maximum idle speed with the engine hot (oil temperature at about 80°C.), the cam will be completely rotated and the idle speed will be 1000 rpm's with the cam disconnected.

Adjustment with warm engine:

-With engine oil temperature at 80°C., the tappet must just touch the cam and the engine speed should be 1000 rpm's.
-If the above conditions cannot be obtained, it will be necessary to work on the adjustment nut 1 (fig. 4), moving the tappet towards the cam to obtain a higher engine speed and away from it to obtain a lower one.
During the maintenance operation, in the disconnecting of the unit, check that there are no deposits, accurately cleaning and lubricating if necessary.
In reattaching the unit, ensure that with an engine oil temperature of 20°C., the number 20 marked on the cam is aligned with the tappet.
Proceed then to test the cold starting procedure as described earlier.

Attention: If, with a cold engine, the engine speed is noticeably above 1600 rpm's, check the microswitch adjustment to see if it has already opened the circuit, actuating the advance tappet of the distributor, thus causing the engine timing to be advanced and run at a faster speed.
It is necessary that, with the idle acceleration engaged, the engine be retarded and, by moving the accelerator lever (with the tappet of the idle speed aligned at the 20 mark), the microswitch opens the circuit (a distinct click will be heard).



Distributor microswitch.

The microswitch is mounted on the rear tappet cover. The movement of the cut-out switch is controlled by a small arm which carries a small wheel in contact with a small support (adjustable through two nuts) fixed on the carburetors butterfly valves control lever.
In the distributor there are located two sets of contacts:
R1: normal advance points
R2: retard points
R2 retards by 11 the engine advance in relation to R1 (see p. 43).

Fig. 9 Microswitch adjustment.

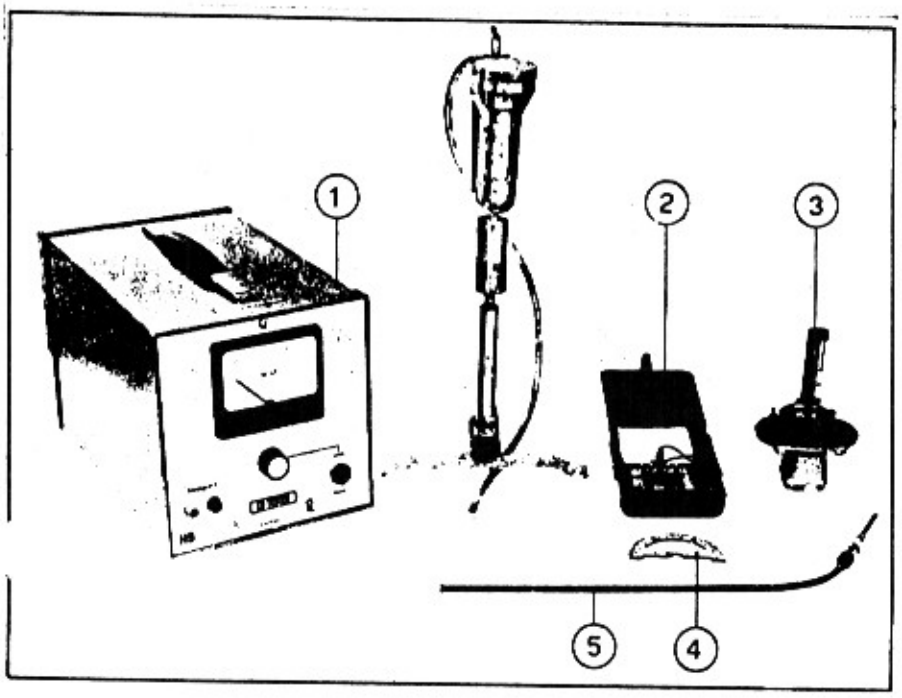


Fig 10 Special tools.

1. CO analyzer with exchanger
2. Ohmmeter
3. Carburetors synchronizer
4. Goniometer scale
5. Exhaust header tubes connection cable.

R2 functions until a certain engine speed is reached and the microswitch opens the circuit allowing R1 to function.

Adjustment of the microswitch

Regular operation: during engine operation at idle speed, the engine should be retarded, with the microswitch operating the R2 points; as soon as the accelerator lever is moved from the position with the tappet at the 20 mark of the idle speed (maximum height), the microswitch must open the circuit and allow points R1 to function.
Check: with engine off, but hot, with idle speed cam rotated so that its tappet is aligned to the 20 mark (with carburetors butterfly valves slightly open), move the microswitch tab towards the body of the microswitch itself. You should not hear any click sound, which indicates the opening and the closing of the microswitch.
Such a click will be heard instead, when the accelerator lever will be moved slightly from the above-mentioned position, as when accelerating.
To adjust, it will be necessary to to eventaully work on the nuts mounted on the carburetors lever in reference to the arm on which rests the microswitch lever.
If, when cold, the engine idle speed exceeds 1600 rpm's, check the microswitch adjustment: the engine timing could be advanced.
If the engine, while being progressively accelerated during driving, runs unevenly, the microswitch is keeping the engine retarded too long, therefore it is necessary to adjust the lever travel as mentioned above.
The microswitch needs no maintenance, with only a periodic check every 15000 kms. of its cables and contacts to ensure that no current interruptions exist and that the cables are well insulated.
If a cable must be disconnected, or if one of the cut-out switch ground cables is missing or disconnected, the engine will idle at 1400 rpm's rather than at 1000 rpm's. To check whether the microswitch is functioning properly, directly ground the cable coming from the distributor. A decrease in engine speed will be noted since the distributor retard points will be activated.

ATTENTION: the car should not be run with the microswitch continously engaged as the retarded timing of 11° on the engine advance advance setting can cause faulty running at high rpm's.

ENGINE ELECTRICAL SYSTEM

Dual contact ponts series distributor.

General description

The distributor is of the dual contact points series type. the first series, principal contact point R1, the second series, contact points R2. The R2 points retard the distributor 5° 30' (distributor rotation) in relation to points R1. In order to adjust the R2 points, use the adjustment screws and the holes in the distributor housing.
The ignition spark is generated by points R1 or R2 according to the position of the microswitch.
The distributor needs no particular maintenance if the normal periodic checks and maintenance suggested in the Use and Maintenance booklet are carried out.

Engine ignition timing

Remove the right rear wheel and stone guard, so that the engine crankshaft damper and the cover next to it are visible.
With the engine idling at 1000 rpm's, check with a stroboscopic light that the mark on the damper is aligned with the -4 mark on the tab.
Rotate the distributor to align the two marks.

Distributor Marelli S 125 C (50.10.256.3)

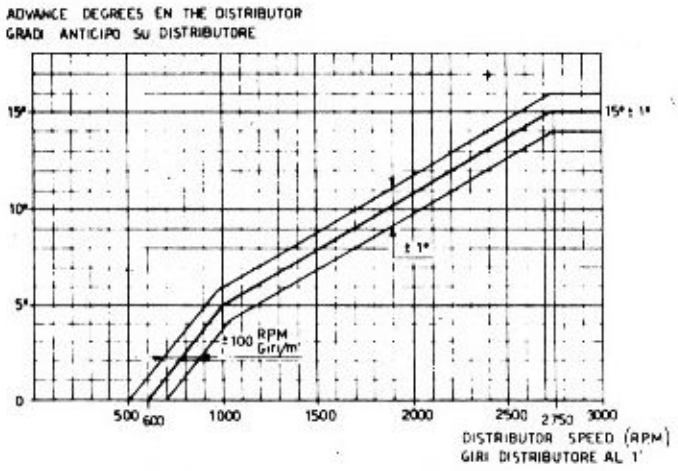


Fig. 11 Automatic advance variation

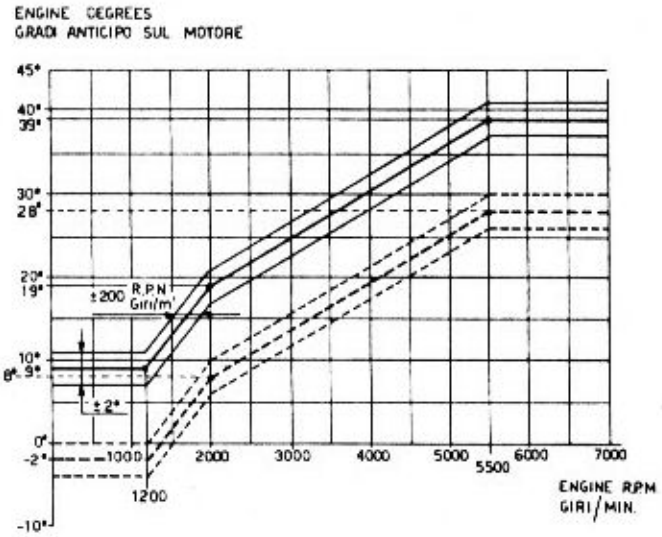


Fig. 12 Ignition advance diagram
——— Ignition advance full power carried out with normal points.
- - - Ignition advance during the cycle carried out with retarded points.

Characteristics

Normal speed operation: R1
○∢Opening angle: 28°± 2°.
Closing angle: 32°± 2°.
Low speed operation (R1 connected to R2) with angles varying by 5° 30'(distributor angle) (degreed of retard of R2 over R1).
●∢Opening angle: 22° 30'± 2 .
Closing angle: 37° 30'± 2 .
I= Microswitch actuated by carburetors control lever.
R1= Principal contacts. Dwell= 53.5% (R1)
R2= Secondary contacts. Dwell= 62.5% (R2)

Timing of contact points R1 in relation to R2

Substitute the distributor rotor with the special one marked with an index mark. Attach a protactor scale (goniometer) on the distributor housing (see fig. 13) and connect the ohmmeter between R1 and the distributor housing. Rotate the distributor shaft until the meter indicates that R1 is opening the circuit and check the amount of degrees on the scale.
Then connect the ohmmeter between R2 and the distributor housing and further rotate the distributor shaft until R2 opens the circuit.

The difference in degrees read on the scale should be 5° 30'.
If different readings are obtained, adjust the relative position of R1-R2 by loosening the bolts on the distributor housing and proceed to repeat the operation. This check must be carried out without removing the distributor from the engine, taking care to disconnect the contacts of the electrical system and substituting the normal rotor with the special one.
The rotation of the distributor shaft can be obtained by moving the car with a gear engaged.

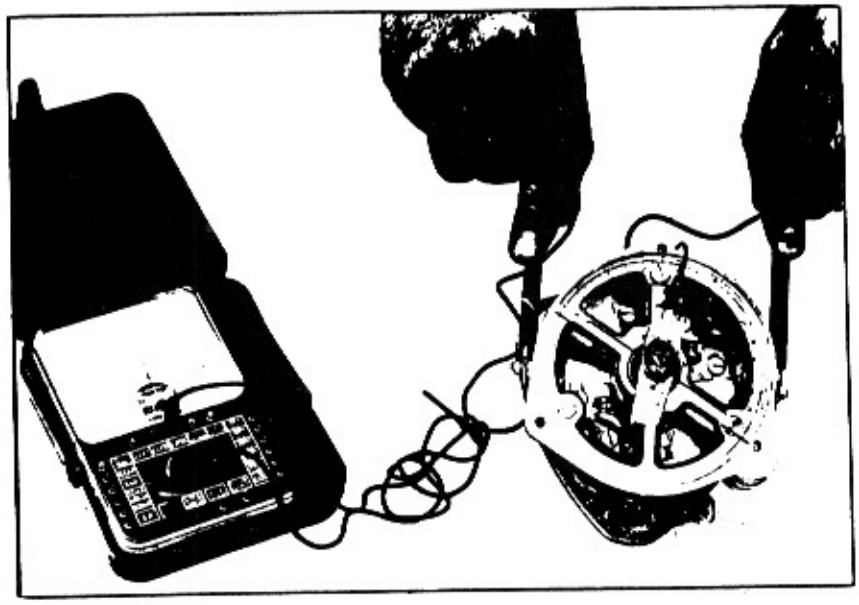


Fig. 13

Timing of the distributor.

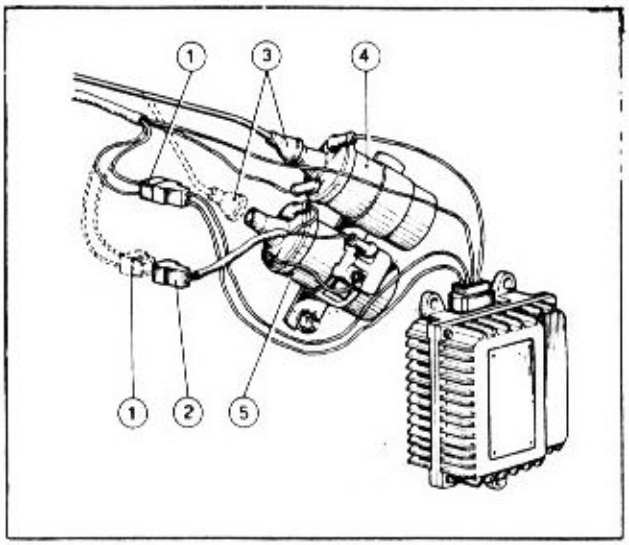


Fig. 14 Normal and emergency ignition diagram.

1-2 Emergency ignition connections
3 Cable from coil to distributor
4 Normal coil
5 Emergency coil.

Dinoplex electronic unit

The engine normally operates via the electronic ignition system.
Only in the event of irregular running of the Dinoplex unit, the electronic ignition system can be by-passed.
For this purpose, move the snap-in plug 1 into the seat 2, and the terminal 3 from the normal coil 4 to the emergency coil 5.
The terminals must only be moved to the "Emergency" position with the ignition switched off.
Under these conditions, ignition is via battery, distributor and ignition coil. When the emergency ignition is switched on the rpm counter is not working.

WARNING

High voltage ignition. It is dangerous to touch the high voltage cable terminals while the engine is running. All work on the equipment should be carried out with the ignition key removed.

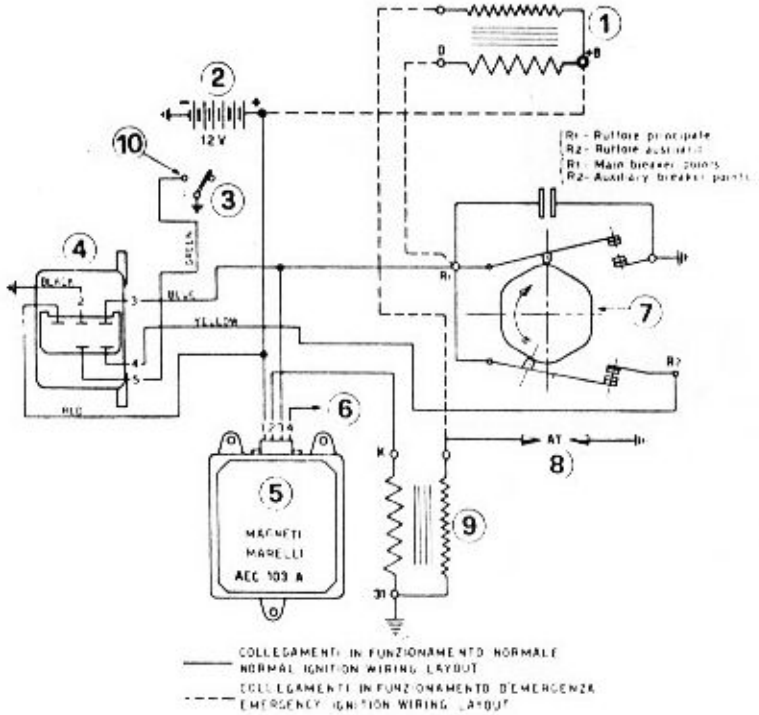


Fig. 15 Dinoplex wiring diagram.

1. Emergency coil, 2. Battery, 3. Microswitch, 4. Misfire prevention micro switch unit N.SS. MIB-64814011, 5. Electronic ignition, 6. Electronic tachometer, 7. Marelli distributer, 8. Spark plugs, 9. Electronic ignition coil Marelli BAE 200 A, 10. Micro switch contact-normally closed.

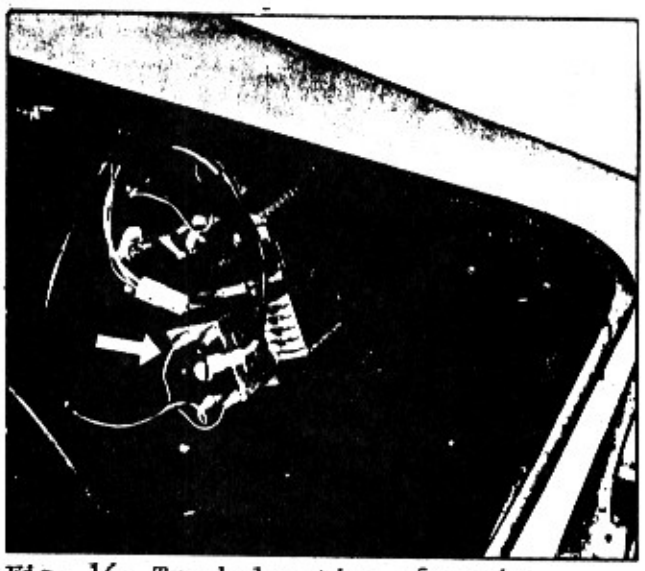


Fig. 16. Trunk location of car's air pump electronic control unit.

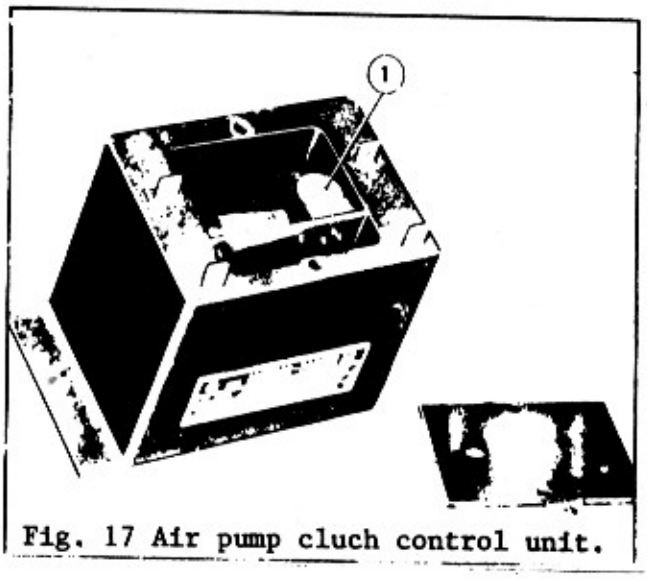


Fig. 17 Air pump cluch control unit.

1. Speed adjustment screw.

The unit is located in the baggage trunk. It controls the electromagnetic clutch of the air pump to which it is connected, disengaging the pump from the engine when the rpm's reach approximately 4200.
The unit does not require any maintenance. If necessary, work can be carried out on the electromagnetic clutch disengagement control via screw 1. By rotating screw 1 clockwise, the clutch disengages at higher rpm's.
Do not turn the screw down too much so as to bring disengagement of the clutch below 4200 rpm's, in order to stay within the operating limits and to avoid possible damage to the unit.

ATTENTION

Avoid having the clutch disengaging above 4500 rpm's, since above these limits the pump could be damaged.

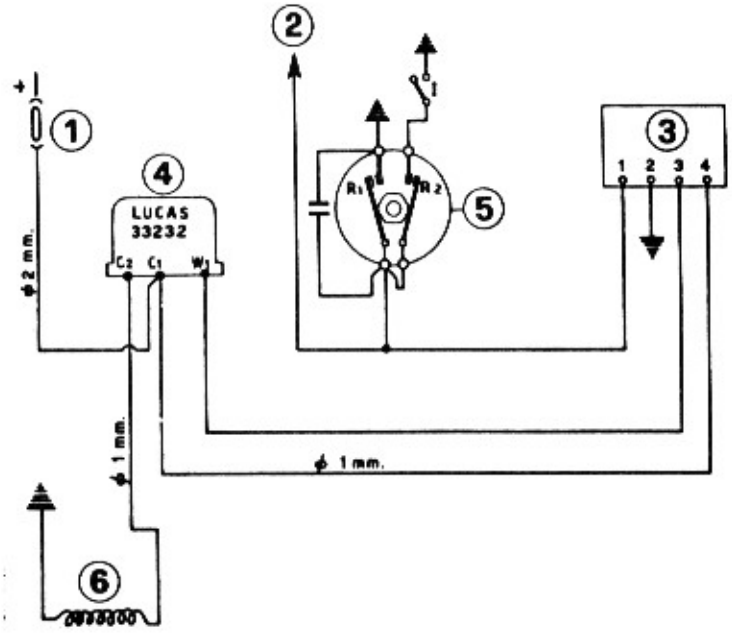


Fig. 18 Air pump clutch wiring diagram.

1. Air pump fuse, 2. Dinoplex, 3. Control unit, 4. Relay, 5. Marelli distributor, 6. Air pump clutch solenoid.

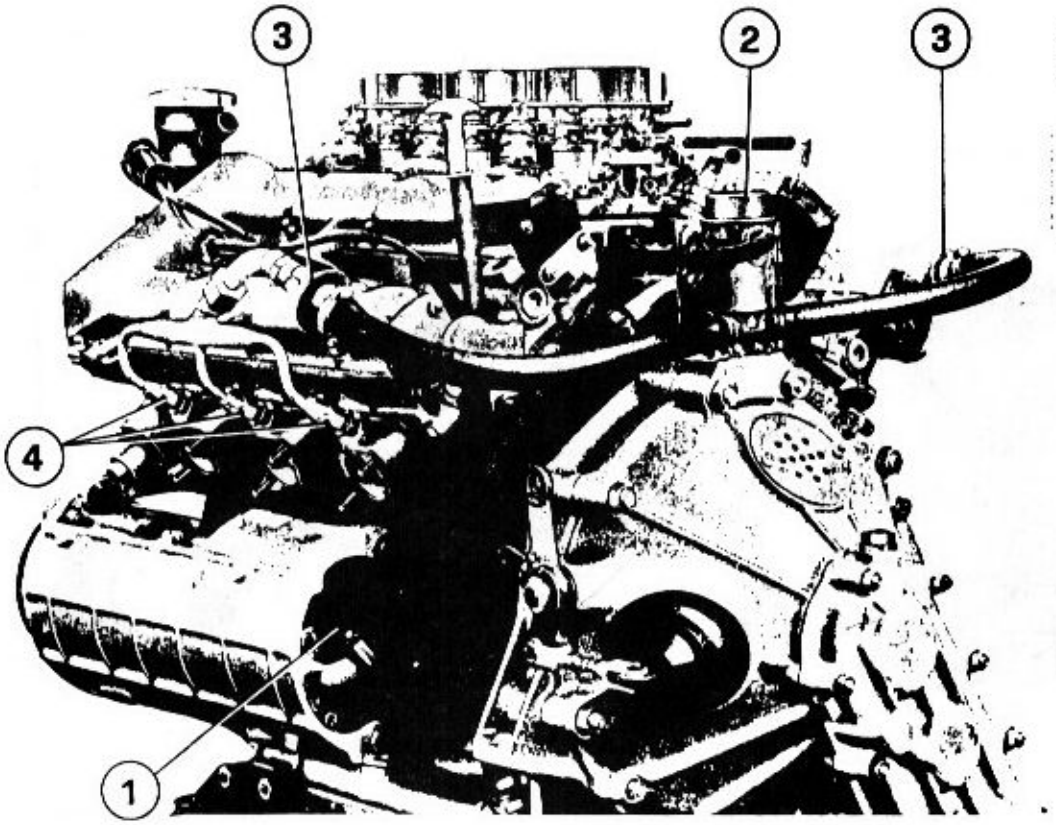


Fig. 19
General layout.

1. Air pump.
2. Diverter valve.
3. Non-return valve.
4. Injectors.

AIR INJECTION SYSTEM

The system consists of an air pump (complete with supports and attachments), an electromagnetic clutch, injectors (one for each cylinder), an air exhaust valve, two control valves, air collectors, and tubing for the connecting of the various components.

General maintenance

Every 5000 Km. check the condition and tension of the alternator belt as explained on p. 49 (COOLING chapter).
The belt transmits motion to the alternator which then transmits it to the air pump .
Every 10,000 Km. check for leaks between the connections and the valves.

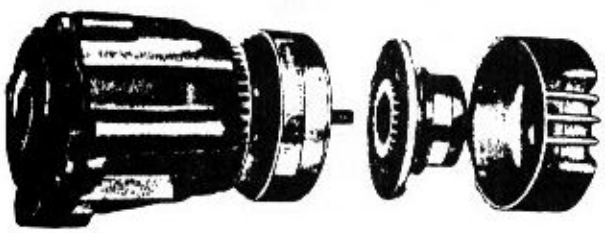


Fig. 20 Electromagnetic clutch.

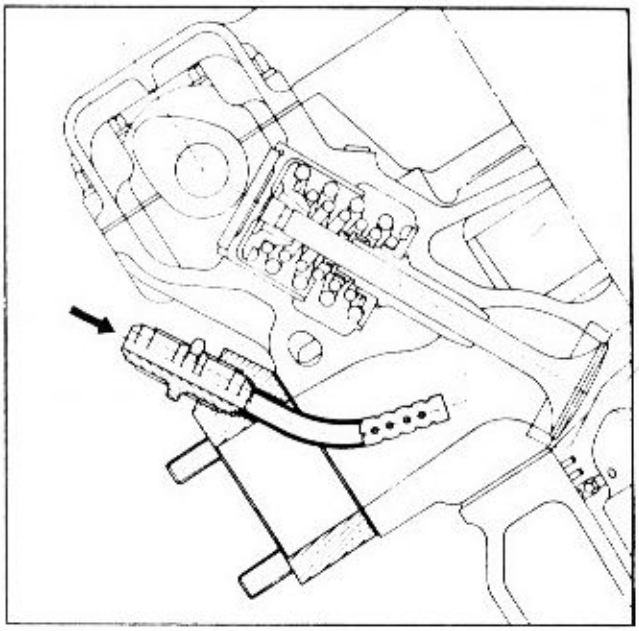


Fig. 21 Injectors.

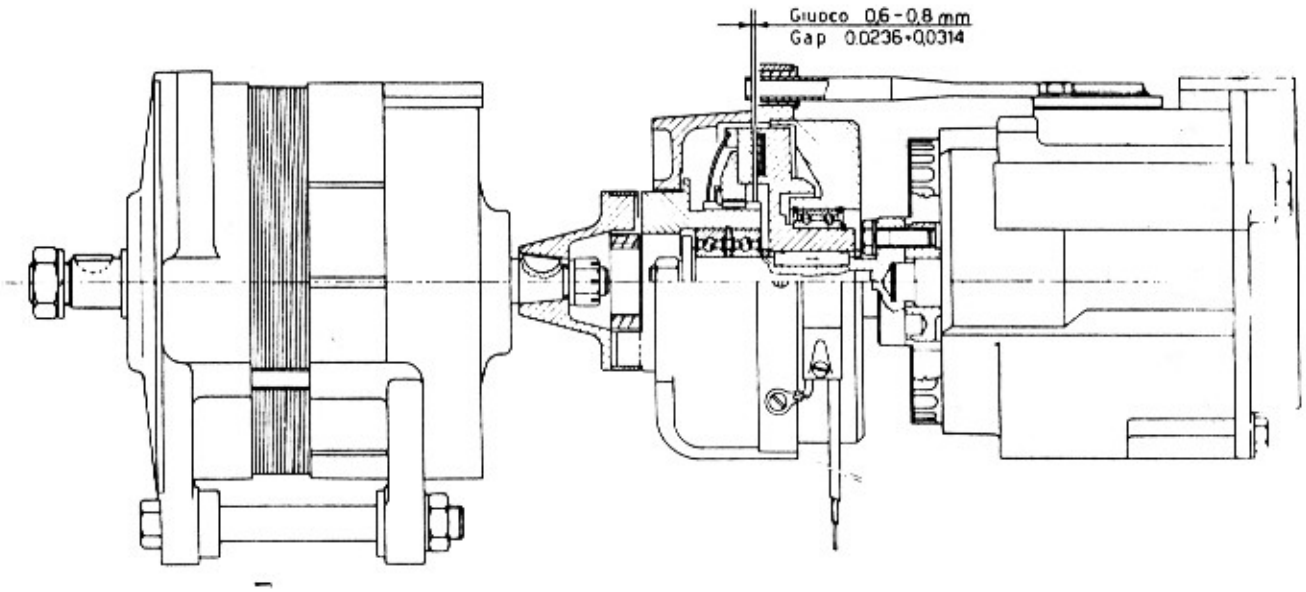


Fig. 22 Clutch diagram.

If exhaust explosions are noted, check the depression tube connected to the exhaust valve eliminating any occlusion.
The control valve actd to impede the flow of exhaust gas from returning to the pump.
Every 15,000 Km. check the clutch disengagement action.

Accelerating to 4200 rpm's, check that during the period of acceleration the clutch remains engaged, this indicates that the air pump is functioning (to check this, it is sufficient to remove one of the rubber tubes which deliver air to the injectors from the diverter valve and check to see whether pressurized air is coming out of the tube).
Over 4200 rpm's the clutch must be disengaged, that is, the air pump should not be delivering air.
Clutch clearance: between $0.6 \div 0.8$ mm. If greater, remove the magnetic part of the clutch using the proper tool; remove the clutch shaft spacer and replace it with a thinner one, thus reducing the clearance.

Air pump

The air pump (fig.23) compresses fresh air across the injectors and the related tubing in the exhaust system. This air injection ignites the uncombustible particles of the exhaust, reducing the HC and CO levels.

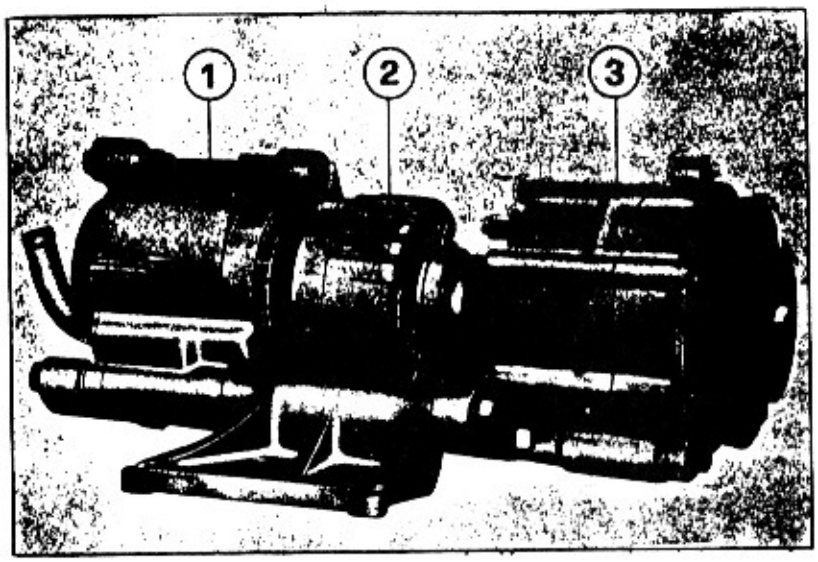


Fig. 23 Air pump unit with clutch and generator.

1. Air pump.
2. Electromagnetic clutch.
3. Generator.

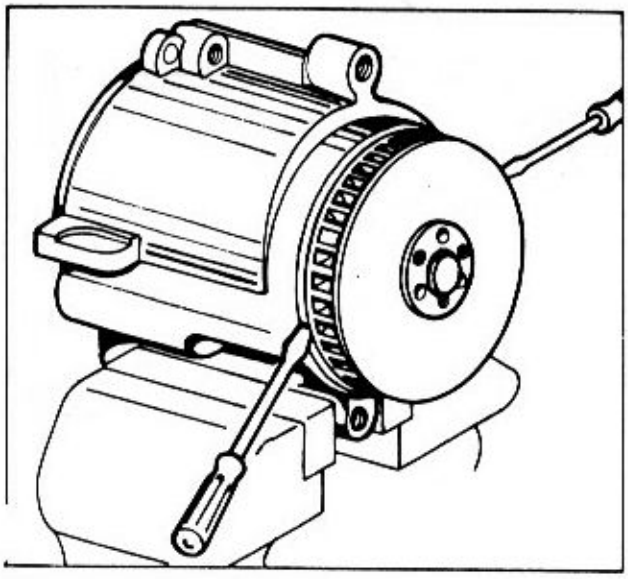


Fig. 24 Removal of fan unit.

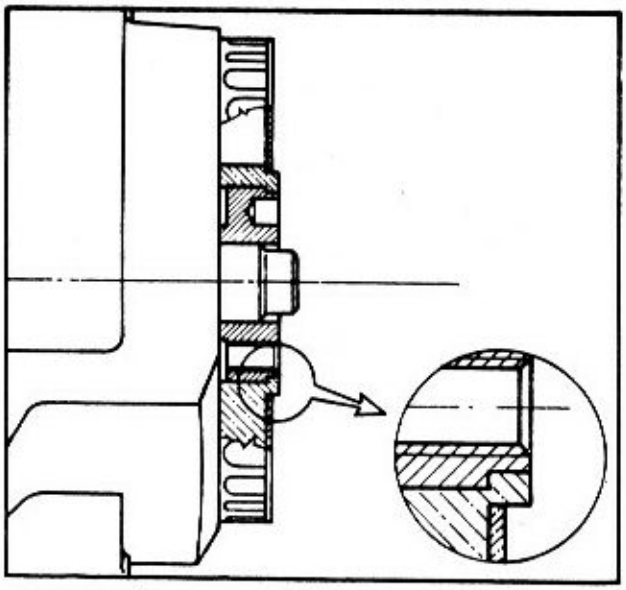


Fig. 24/1 Fan unit assembly diagram.

Air Filter.

The design of the channeling of air towards the pump fan (fig. 24) also allows for the filtering of incoming air. The direction of the fan's rotation centrifugal force forces impurities to collect on the walls of the fan. In order to clean it, it is necessary to remove the fan unit from the pump. This operation can be carried out after removing the pump clutch unit and generator from the engine.

Warning:

In reassembling the fan unit after cleaning, follow these directions:
1) The fan's internal positioning must be well seated in the existing centering point located at the centering pin (fig. 24/1).
2) Be sure that no impurities enter the pump through the fan slots.

Diverter valve (Fig. 25)

The exhaust valve, when actuated by a rapid decrease in pressure in the collector, impedes the travel of air to the injectors, preventing any explosions in the exhaust system during the period when a richer misture is required. The exhaust valve also houses a safety valve which allows the air from the pump to be bypassed if the clutch does not disengage at high rpm's.

GASOLINE VAPORS EMISSION CONTROL SYSTEM

Description

In order to control gasoline vapors evaporating from the gas tanks, they have been channeled through a system of tubes to an active carbon filter in the engine compartment, where they are absorbed.
During the engine operations, a flow of warm air regenerates the carbon component so that it extracts the gasoline vapors and channels them into the intake collectors.
The general layout is indicated in fig. 26.

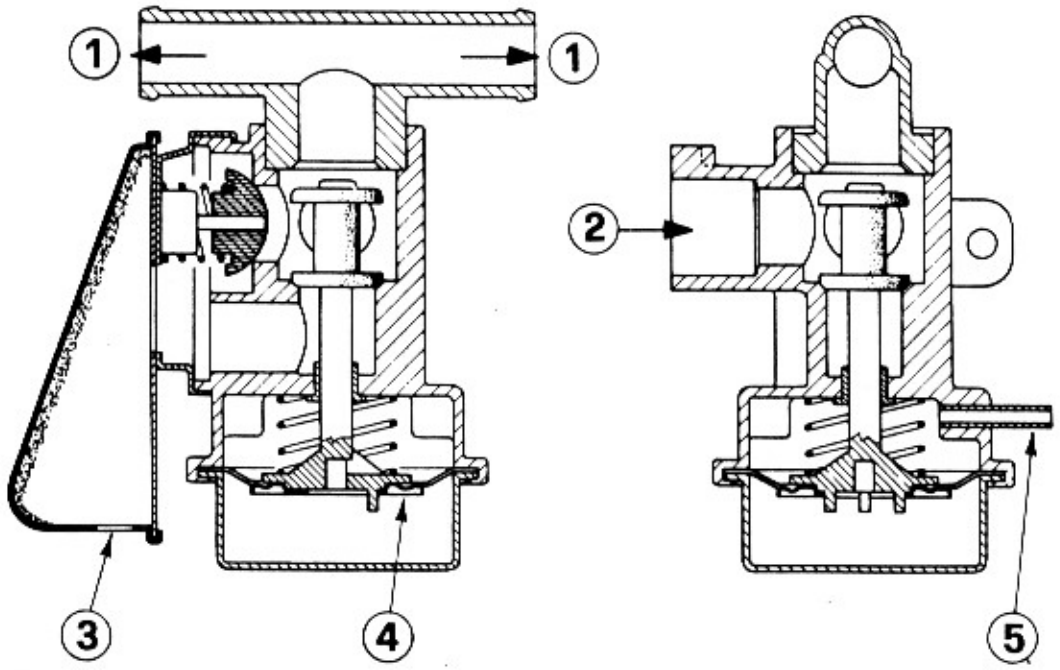


Fig. 25 Diverter valve in open position.
1. Exit tubes, 2. Intake, 3. Air exhuast, 4. Membrane, 5. Low pressure tube.

The system is essentially made up of the following components:

- A perfect seal gas tank cap.
- Limited capacity gas tanks (62 liters).
- Outlet tubing with vapor separator.
- Three-way valve which provides:
  that the tanks are always under light pressure; allowing of incoming air to continuously equalize the pressure and prevent low pressure conditions; the elimination of extremely high pressures through a safety valve.
- An air intake with an air tight seal valve.

ADDENDA to: AIR INJECTION SYSTEM--General maintenance (page 48-9)

Every 30,000 Km. disconnect the overflow collectors, loosening the injectors connecting bolts, remove the injectors and proceed to accurately clean them, eventually replacing the injectors if necessary.

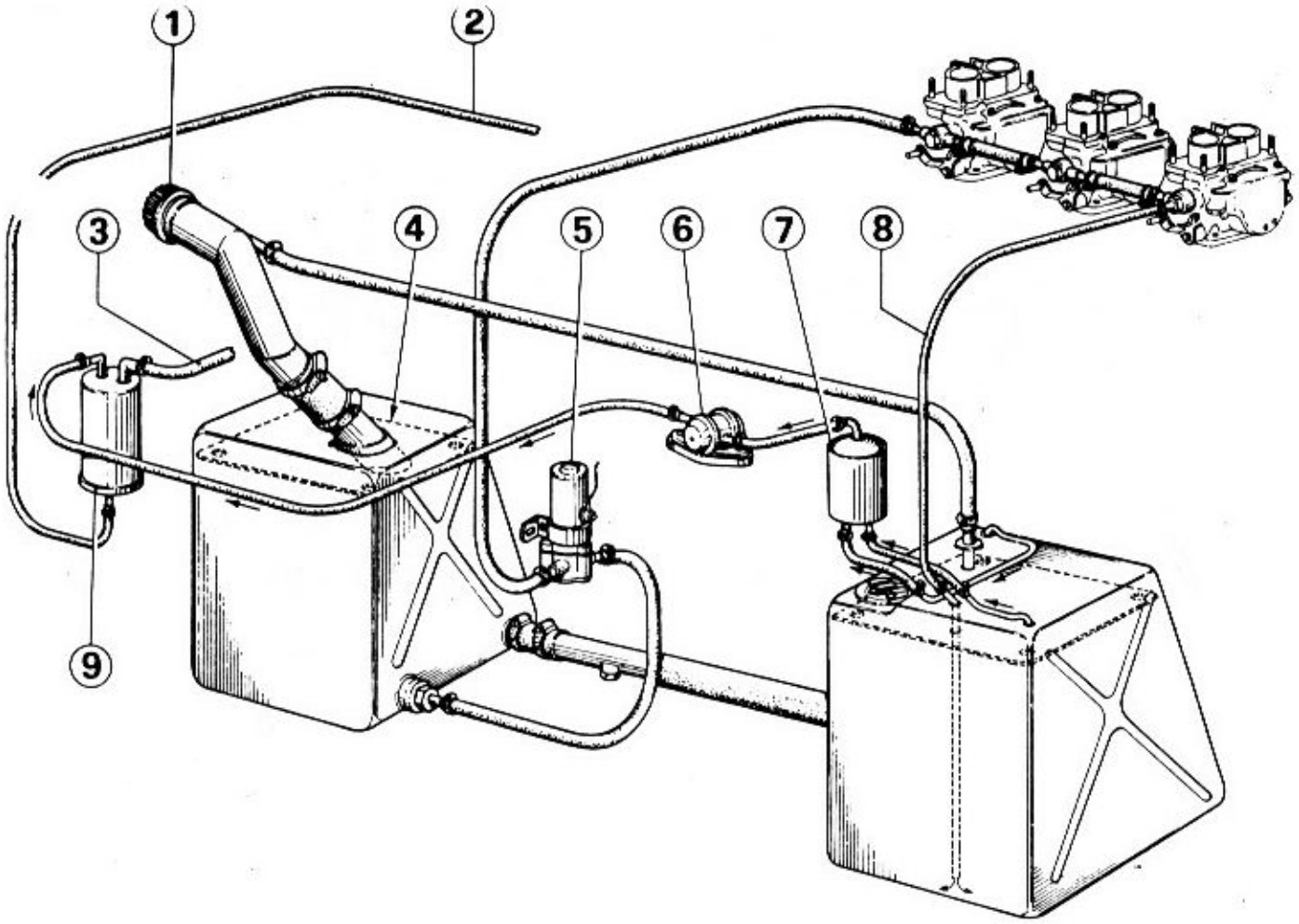


Fig. 26. Fuel vapors emission control unit diagram.

1. Gas filler cap, 2. Carburetor butterfly valve fuel return line, 3. Exhaust hot air intake tube, 4. Maximum fuel level, 5. Fuel feed pump, 6. Three-way control vave, 7. Liquid vapor separator, 8. Fuel return tube, 9. Activated carbon filter.

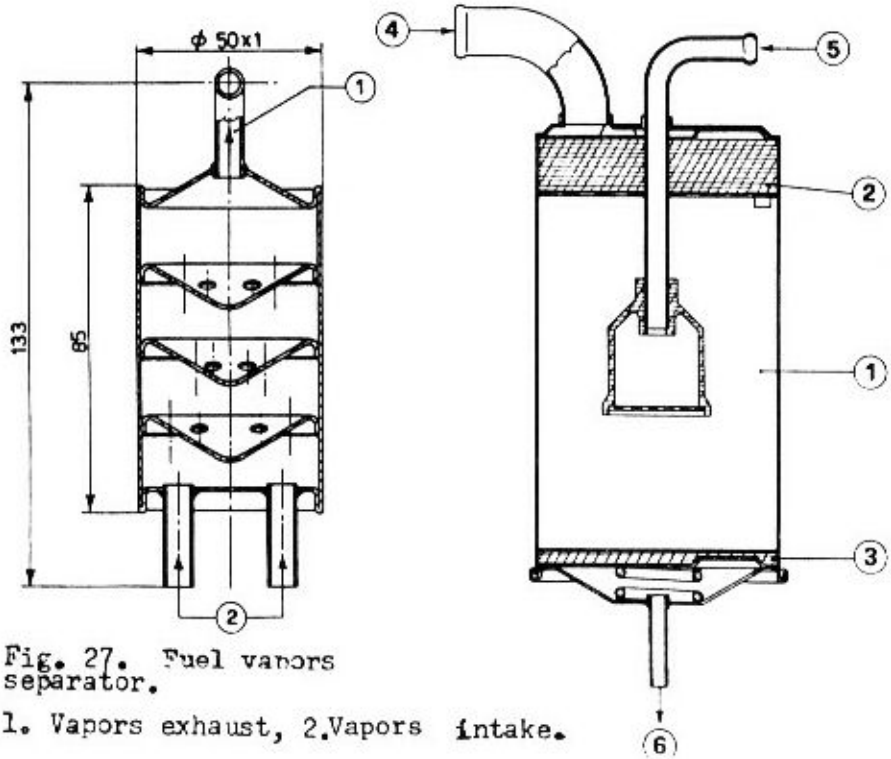


Fig. 27. Fuel vapors separator.

1. Vapors exhaust, 2. Vapors intake.

Fig. 28. Activated carbon filter.

1. Activated carbon,
2. Regenerating air filter,
3. Synthetic filter, 4. Hot regenerating air intake,
5. Fuel vapors intake,
6. To fuel feed intake tube.

AIR INTAKE

The air intake unit between the filter cartridge container and the air intakes contains a valve controlled by engine oil pressure.
With the engine running, oil pressure keeps the valve open permitting air to enter the carburetors, and when the engine is turned off, the valve closes due to the falling off of the oil pressure, thus not allowing gas vapors to escape.
At the moment of starting the engine, the lower pressure caused by the starter action opens a small valve within the larger valve so as to provide sufficient air for the starting of the engine.

Attention:

If during the running of the engine, the oil pressure should suddendly fall, this may be due to an oil leak in the air intake valve.
The engine will then suffer a noticeable decrease of efficiency in that the valve will close not permitting a flow of air into the engine.
Quickly stop the car, close off the engine to air intake oil delivery tube, check the oil level for a lower reading, and take your car in to the Ferrari dealer and have the fault remedied.

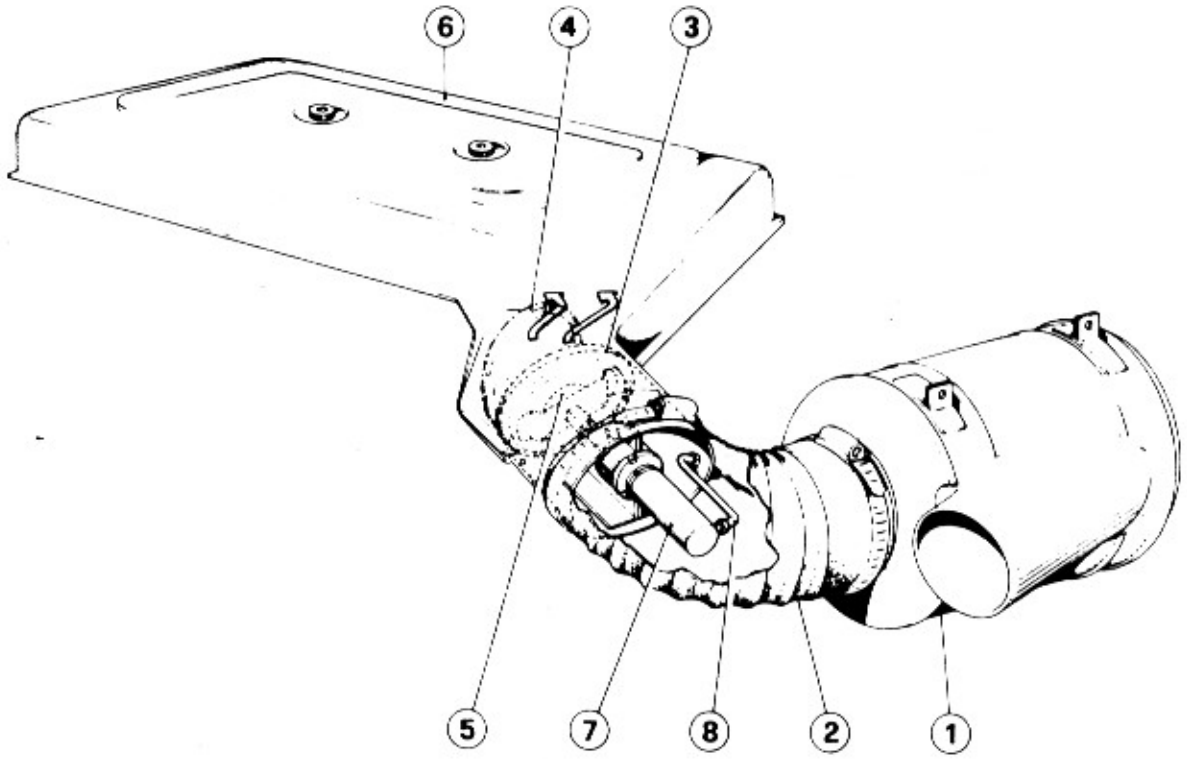
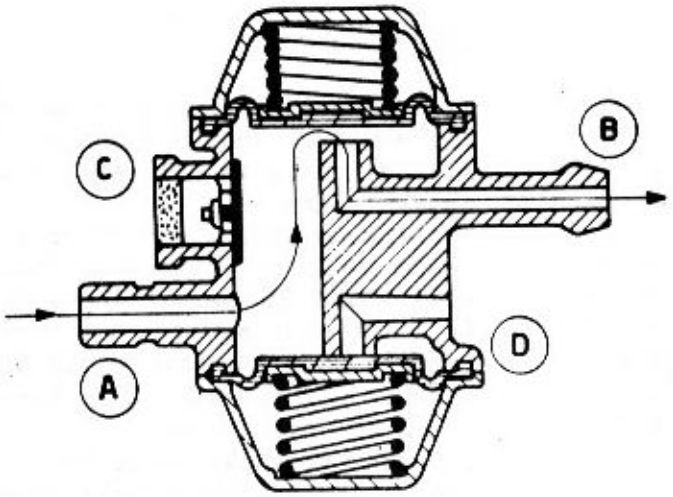


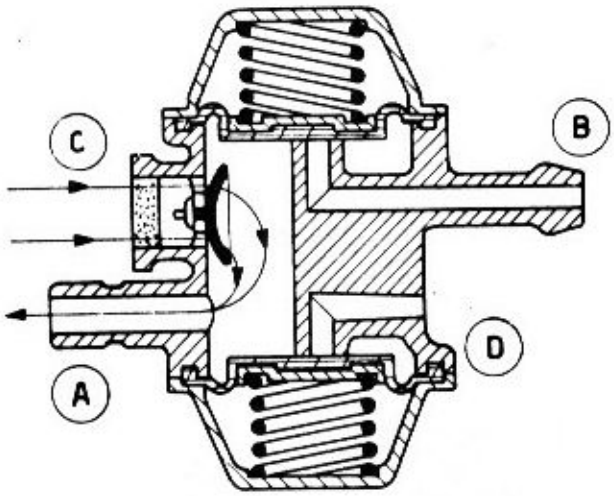
Fig. 29. Air intake.

1. Air filter container, 2. Guide tube, 3. External valve in closed position, 4. Internal valve in open position, 5. Internal valve, 6. Carburetors air box, 7. Valve control piston, 8. Oil delivery tube.



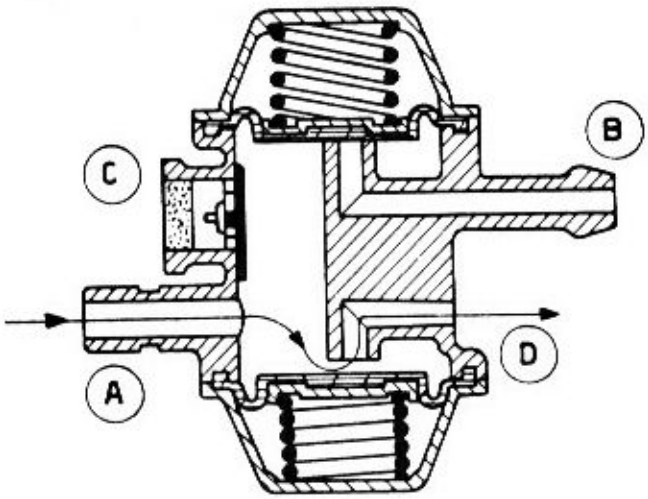
Position 1

From tank to activated carbon filter.



Position 2

Ambient air to tank.



Position 3

Fuel gases from tank to outside (excessive tank pressure).

Fig. 30. Three-way valve.

A-From tank; B-To activated carbon filter, C-Air intake for tank, D- Security (pressure relief valve).

EXHAUST SYSTEM

The exhaust system has been designed to meet exhaust emissions control limits.

The exhaust connections must be perfectly secured.

Make sure that the exhaust flow is properly controlled in order to avoid damage due to excessive heat.

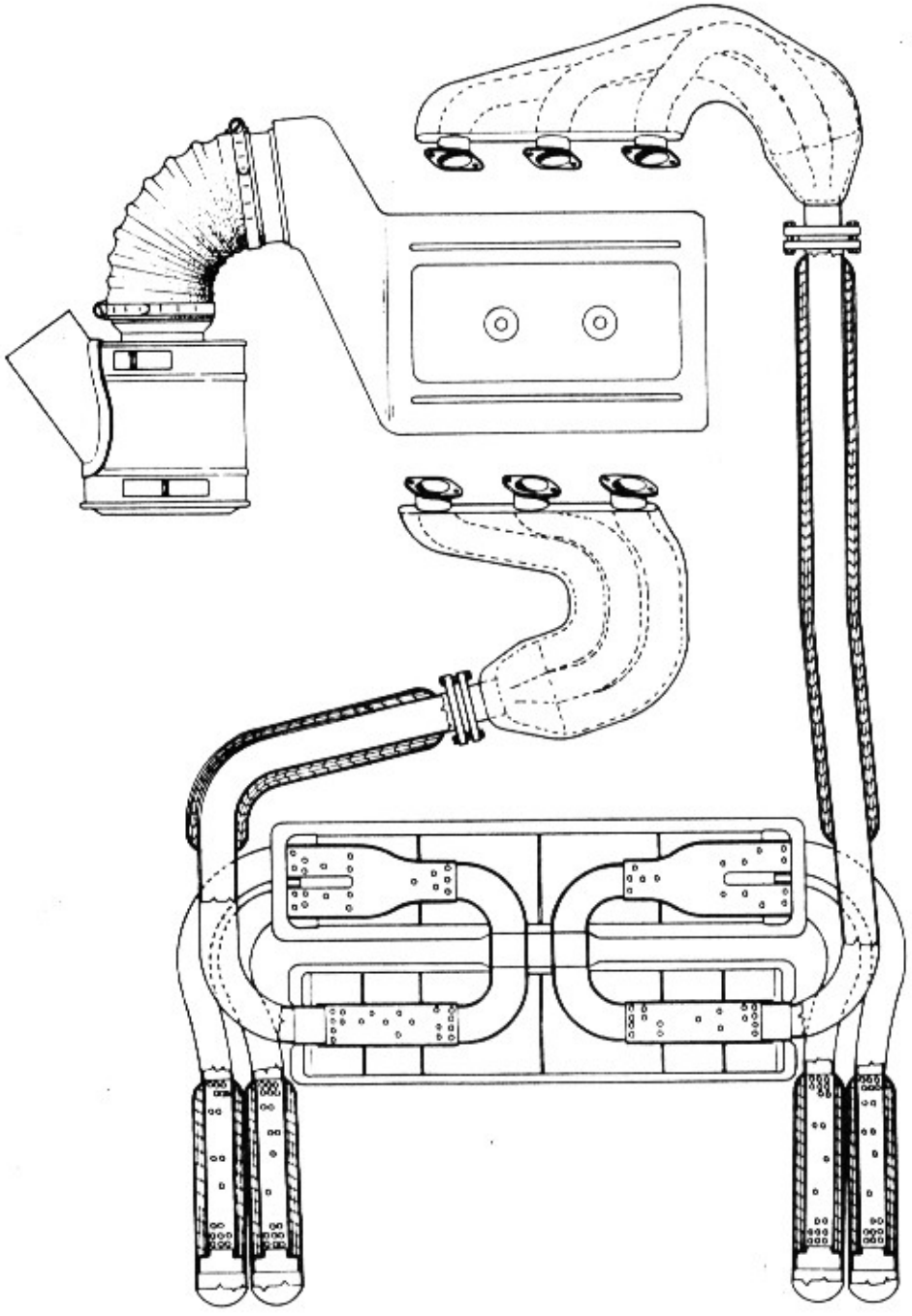


Fig. 31. EXHAUST SYSTEM DIAGRAM

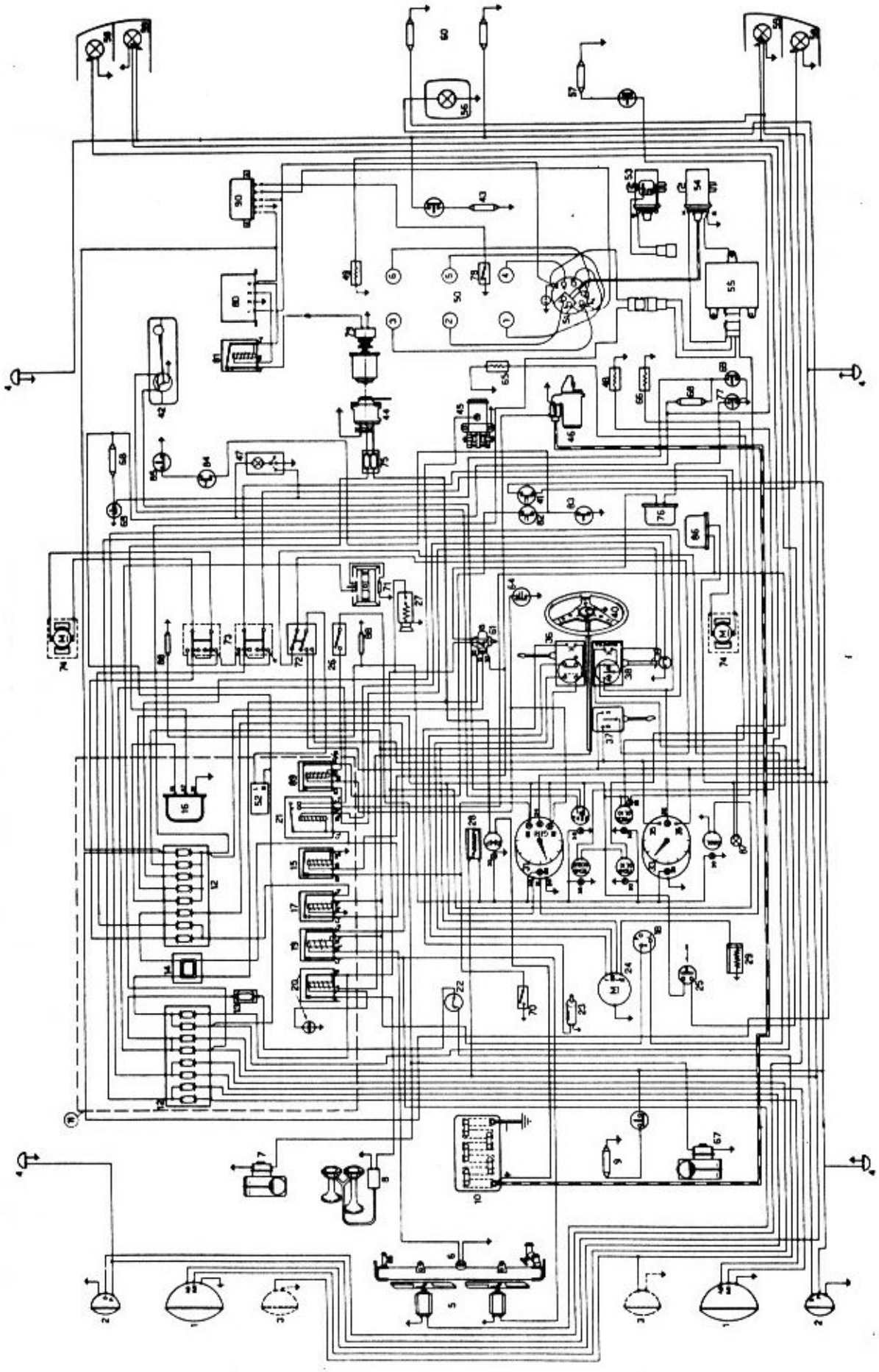


Fig. 32. Electrical wiring diagram.

ELECTRICAL DIAGRAM DESCRIPTION

1. Sealed beam lights-main and dip beams
2. Front side and directional lights
3. Fog lights (on request)
4. Direction indicator lights
5. Cooling fans moters
6. Temperature sensitive switch for radiator fans
7. Heating/ventilation fan motor
8. Horn compressor motor
9. Front trunk light
10. Battery
11. Electrical panel
12. Circuit fuses (8 valve box)
13. 8amp. fog lights fuse
14. Permanently live terminal board
15. B rake efficiency light relay (SIPEA T 5210)
16. Alternator regulator
17. Power windows control circuit relay (Lucas 33213)
18. Directional flasher unit
19. Radiator cooling fan relay (Lucas 33213)
20. Horn relay
21. Main beam, dip beam and side lights relay - Lucas 33213
22. Fog light switch - on request
23. Wiper washer switch
24. Wiper washer motor
25. Stop light switch
26. Heating/ventilating fan switch
27. Cigarette lighter
28. Instrument light rheostat
29. Rheostat for varying wiper speed
30. Instrument lights
31. Electronic rev counter
32. Main beam warning light
33. Speedometer
34. Side light warning light
35. Direction indicator warning lights
36. Wiper and screen washer lever
37. Direction indicator lever
38. Main beam, dip beam and headlamp flash lever
39. Relay switch for side, dip and main beam lights
40. Horn button
41. Reverse light switch
42. Fuel level gauge transmitter
43. Engine compartment light
44. Alternator
45. Fuel pumps (electrical)
46. Starter
47. Interior light
48. Oil temperature transmitter
49. Water temperature transmitter
50. Spark plugs
51. Distributor
52. Emergency lights switch
53. Emergency coil
54. Electronic ignition unit coil
55. Dinoplex electronic ignition unit
56. Reverse lights
57. Luggage compartment light
58. Rear direction indicator lights
59. Rear position and stop lights
60. License plate lights
61. Ignition switch/steering lock indicator control switch
62. Brake failure indicator light
63. Hand brake engagement light
64. " " " " switch
65. Low oil pressure warning and transmitter
66. Oil pressure gauge
67. Interior ventilation fan
68. Interior courtesy light
69. " " " switch
70. B rake fluid pressure control unit
71. Cigarette lighter light switch
72. Emergency lights control deflection
73. Power windows control motor commutator
74. Power windows motor
75. Alternator protection fuse box (60 and 8 amp.)
76. Ignition key indicator
77. " " " switch
78. Distributor points opening retard microswitch
79. Air pump electromagnetic clutch control
80. Electromagnetic clutch electronic block
81. Relay for 80 (LUCAS 33232)
82. Gear-box engaged swithh (car not in Motion)
83. Driver's seat belt switch (on when belt not in use)
84. Passenger's seat switch (off when seat is occupied)
85. Passenger's seat belt switch (on when belt not in use)
86. Seat belts not in use--sound indicator
87. Seat belts not in use--indicator light
88. Dashboard instrument lights
89. Seat belts control circuit relay (SIPEA T 5220)
90. Electronic anti-oscillating unit (microswitch 78).

REPAIR AND MAINTENANCE TOOLS

Design Number	Description ENGINE
AV - 617	Rotating engine mount.
AV - 508	Valve springs removal and assembly tool.
A. - 60337	Wooden bench for cylinder heads valve work.
361-AS-4426	Piston/rings to cylinder sleeves insertion tool (piston Ø 92.5 mm.).
312-AS-5514	Valve guides extraction tool.
312-AS-5513	Valve guides mounting tool.
L722-AS-5897	Engine timing protractor/goniometer with graduated disc 312-AS-7006.
706-AS-9560 706-AS-9560 A	Valve adjustment shim discs removal tool, with camshafts in place.
AV. 223	Connecting rods bolts socket (used with torque wrench).
152-CS-7148	Tool gauge for measuring adjustment shim discs thickness.
152-AS-7149	Zero-setting gauge tool to measure adjustment shim discs thickness.
AV. 468	15 mm. socket for cylinder heads nuts (use with torque wrench).
361-AS-4736	Mandrel for checking camshafts mounting.
AV. 240	Main support bearings lap grinder.
A. 90355	Engine valve guides bores planer (8 mm.).
706-AS-9562	Ring for oil retainer assembly on rear side of crankshaft.
A. 60077	Connecting rod retaining tool during wrist pin bushing reaming.
A 60213	Connecting rod bushing removal and reassembly punch.
A. 90307	Expanding reamer (20mm. Ø) for connecting rod bushing hole.
A. 60346	Piston wrist pin removal and reassembly punch.
632-AS-7084	Piston wrist pin retaining ring assembly tool (piston Ø 92.5 mm.).
622-AS-5422	Camshafts drag pins extraction tool.
622-AS-5960	Camshafts drag pins assembly tool.
AV. 466	Camshafts timing tool.
A. 96213	Combustion chamber depth-to cylinder heads plane gauge.
USAG.ART.278L	Spark plug socket tool.
152-CS-7431	Valve guides seats checking tool with stopper (37.015 mm.ϕ).
AV 476	Socket for fastening HØLSET damper (use with torque wrench).
A. 96134	Ring gauge (92.5 mm. ϕ)for zero-setting measurement of cylinder sleeves.
A.40206/801	Percussion extractor to be used with tool A.40207/813.
A.40207/813	Crankshaft-clutch guide bearing extraction tool-also for removal of rear support of timing shaft drive.
A. 94058	Mandrel for countersinking of valve seats in cylinder heads.
A. 94041	Engine valve guide holes stem brace (8 mm. Ø).
062-AS-8878	Carburetors butterfly valves synchronization tool (at 1500-2000 rpm).
AS -9798	Top Dead Center (P.M.S.) checking tool.

A. 96306	Graduated reference disc for controlling timing in mounted engine.
A. 60544	Cross-beam tool for lifting engine.
A. 61001/12	Rotating engine mounts fastening frame members.
35.021863	Cylinder heads valve seats resurfacing countersink (45°).
35.021158	27° countersink for reduction of upper part of intake valve seat size.
35021863	55° countersink for reduction of lower part of valve seats.
35.022042	27° countersink for reduction of lower part of exhaust valve seat size.
	CLUTCH
706-AS-6663	Roller cages insertion tool.
706-AS-6665	Oil seal ring insertion tool.
706-AS-6666	Bearing insertion tool.
706-AS-6667	Bearing insertion tool.
706-AS-6668	Roller bearing races mounting tool.
506-AS-7783	Clutch shaft tool
706-AS-7238	Clutch shaft extractor.
	GEAR BOX
706-AS-6681	Input shaft fastening unit for assembly of individual components.
706-AS-6684	Bearing mounting tool.
706-AS-6683	Bearing cage mounting tool.
706-AS-6685	Bearing tool.
175-AS-5568	Fastening tool for self-locking ferrule of input shaft rear bearing.
706-AS-7458	Gear drive ferrule fastening tool.
706-AS-6705	Input shaft ferrule tool.
706-AS-6679	Bearing mounting tube.
706-AS-6680	Bearing mounting tube.
706-AS-6678	Bearing mounting tube.
706-AS-9561	Lever forks to gear shift control alignment tool.
706-AS-6527	Output shaft ferrule tube.
AV.477	Oil drain plug tool (socket size 12 mm.) from car chassis No. 02132. (To chassis number 02130, tool AV 477)
	DIFFERENTIAL
175-AS-5067	Preload measurement pulley.
706-AS-6704	Pulley extension.
165-AS-5763	Spacer for mounting of differential for preload measurement.
365-CS-5341/A	Tool for determining thickness of preload washer.
365-CS-5341/b	Sample cone.
365-AS-5839	Side covers oil rings mounting tool.
365-AS-5764	Tool for mounting bearings to differential case hubs.
	STEERING
706-AS-7237	Steering wheel housing hub extractor.
706-AS-7396	Nut for removal of steering column from suspension upright.
506-AS-7394	Extractor for removal of suspension upright ball joints shafts.
AV.485	Tool for tightening hub to steering wheel self-locking ferrule.
706-AS-9016	Steering wheel hub extractor (from chassis No. 01118).

	SUSPENSIONS
125-84054/55 125-84054	Front and rear wheel mounting hub extractor. Extractor bolts.
706-AS-9565/A 706-AS-9009/P	Shafts for positioning of car static weight without mounted shock absorbers.
506-AS-7394	Uprights ball joints shafts extractor.
706-AS-9566	Shock absorber spring removal and assembly tool.
A.74140	Tool for securing of nuts: on front uprights and rear wheel support shafts.
	FOR CARS WITH CHASSIS NO. 01118 ON
706-AS-9002	Rear wheel support shaft extractor.
706-AS-9006	Extractor for removal of rear wheel hub from shaft.

Ferrari

VETTURA

Dino

246 GT

MAINTENANCE AND REPAIR INSTRUCTIONS

SECTION 1

GENERAL DATA

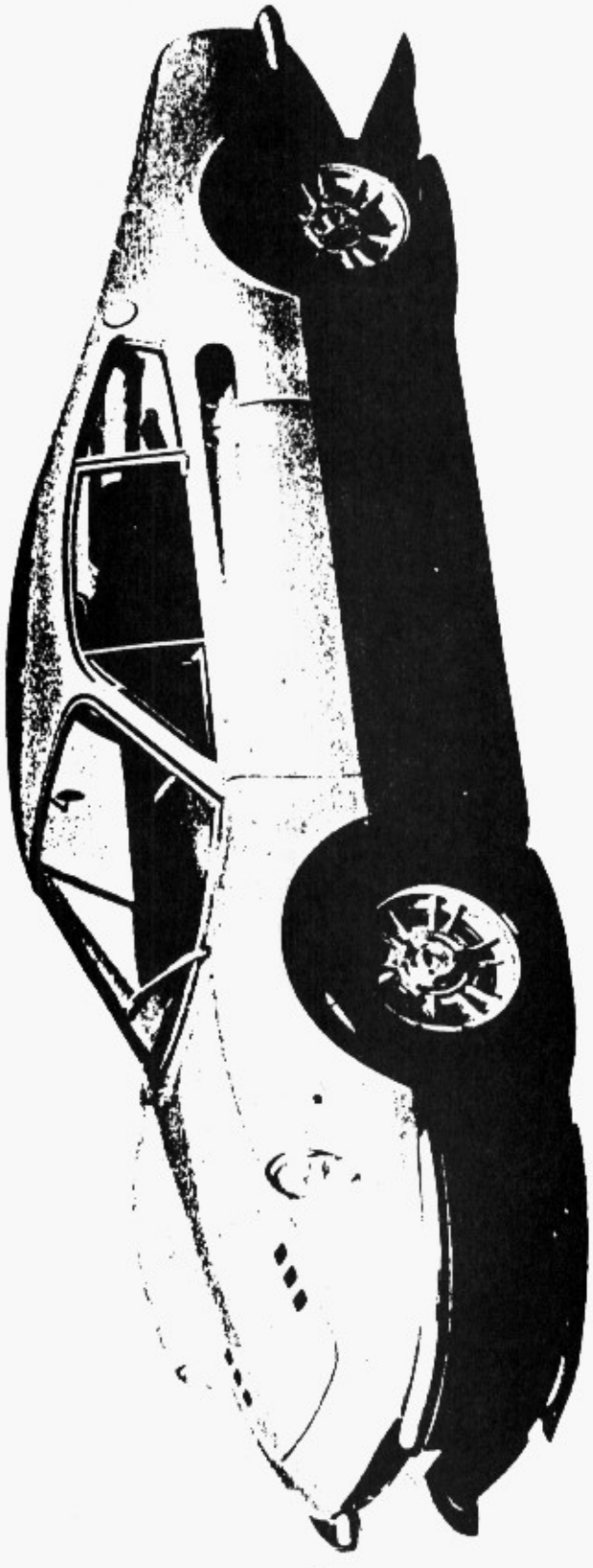


Fig. 1 - VETTURA DINO 246 GT

GENERAL DATA

PRINCIPAL DATA

IDENTIFICATION DATA

Chasis type	246 GT
Engine type	135 CS

ENGINE

Layout	rear in transverse position
Number of cylinders	6 V 65°
Bore	92.5 mm.
Stroke	60 mm.
Piston Displacement	2418 cm^3
Compression ratio	9:1
Maximum b.h.p.	195
Equivalent r.p.m.	7600
Maximum r.p.m.	7800
Maximum torque	23 kg.
Equivalent r.p.m.	5500
Taxable horsepower(Italy)	26.7

CLUTCH

Single plate, dry

GEAR BOX

5 forward and 1 reverse gear
Synchronizers on all forward gears
Operation by central floor lever mounted in tunnel.

REAR AXLE

Oscillating semi-axles
Cylindrical reduction coupling with helicoidal gear

Reduction ratio	16/58

STEERING

Rack and pinion
Steering shaft with center section mounted with two cardanic joints.

Minimum steering diameter	11.40 m.

equal to 3.1/4 steering wheel turns

FRONT SUSPENSION

Independently sprung wheels.
Upper and lower transverse wishbone suspension arms, coil springs, telescopic hydraulic dampers and a transverse anti-roll bar.

REAR SUSPENSION

Independently sprung wheels.
Upper and lower transverse wishbone suspension arms, coli springs, telescopic hydraulic dampers and a transverse anti-roll bar.

BRAKES

Disc type on all four wheels with independent front and rear circuits.
Bonaldi Master Vac vacuum brake servo.
Braking regulator located on rear circuit. Mechanical hand brake unit positioned on rear brakes.

WHEELS AND TIRES

Light alloy wheels	14 x 6½
Radial type MICHELIN tires	205/70 VR 14 X (tubeless)

ELECTRICAL SYSTEM

Current	12 volt
Battery	Ah 60
Alternator	F 4207930
Starter motor	Marelli MT 42E
Dual contacts distributor	S 125 AX 15°
Coil	Marelli BZR 205 A-12V-8F
DINOPLEX electronic unit (capacitive discharge type)	Marelli AEC-101-DA

WEIGHTS

Car in driving condition (filled with fuels, oils, water, spare wheel, tools and accessories)	1080 Kg.
-rear axle maximum allowable weight	800 Kg.
-front axle maximum allowable weight	800 Kg.
Number of seats	2

PERFORMANCE

Maximum speeds on open road, with two passengers, good road conditions and engine fully run-in:

in first gear. . .	Km/h 66.5
in second gear. . .	" 96.5
in third gear. . .	" 134
in fourth gear. . .	" 181
in fifth gear. . .	" 235
in reverse gear.. .	" 75

Maximum steepness of slope that can be climbed, with road in good condition and engine fully run-in:

in first gear. . . .	.45%
in second gear. . . .	.35%
in third gear. . . .	.25%
in fourth gear. . . .	.18%
in fifth gear. . . .	. 9%

ACCELERATION

0 - 100 km/h	7 seconds
0 -200 km/h	27 2/10 seconds

Standing mile=final speed 26 8/10: seconds at 190km/h

Flying mile=corresponding velocity: 325 km/h

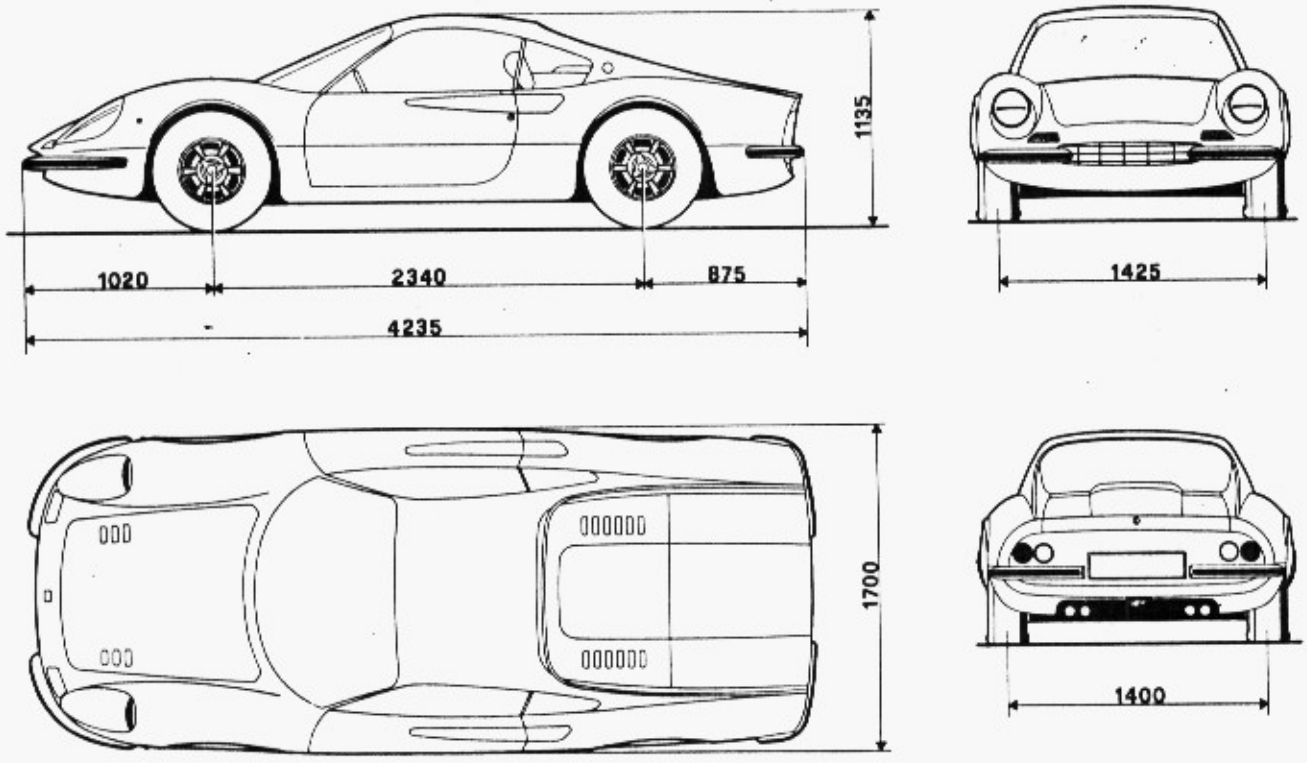


Fig. 2. Principal vehicle dimensions. (in mm.)

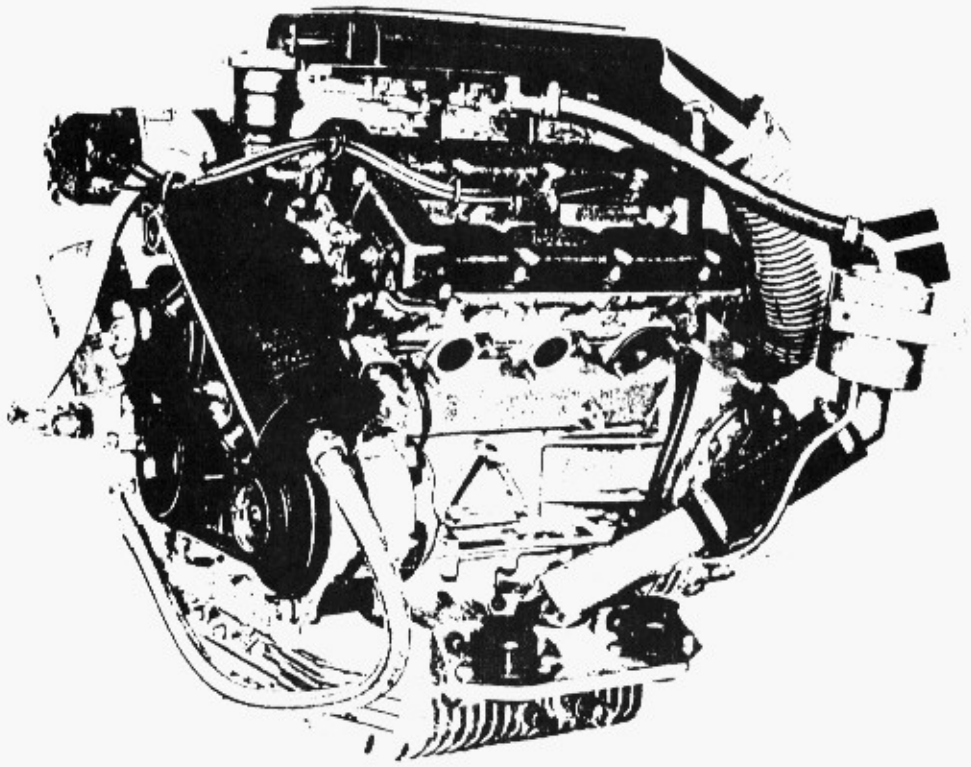


Fig. 3. Side view of assembled engine and components.

CAPACITIES

Items to be filled	Quantity lt.	Quantity Kg.	Fuel and oil types
Fuel tanks	70		Super premium 98/100 octane
with a reserve of	12 - 14		
Radiator, engine and cooling system	17		Antifreeze mixture (2)
Engine and filter (1)	7		SHELL oil (4)
Gear box and differential	4		SHELL SPIRAX HD 90 or EP 80 oil
Front braking circuit	0.300	0.270	SHELL DONAX-SAE 70/R3
Rear braking circuit	0.280	0.252	" " "
Steering gear	0.200	0.180	SHELL SPIRAX EP 90 oil
Front hydraulic shock absorbers (each unit)	0.190	0.171	SHELL DONAX A1
Rear hydraulic shock absorbers (each unit)	0.260	0.234	" " "
Windshield washer bottle	1	1	Water and cleaner mixture

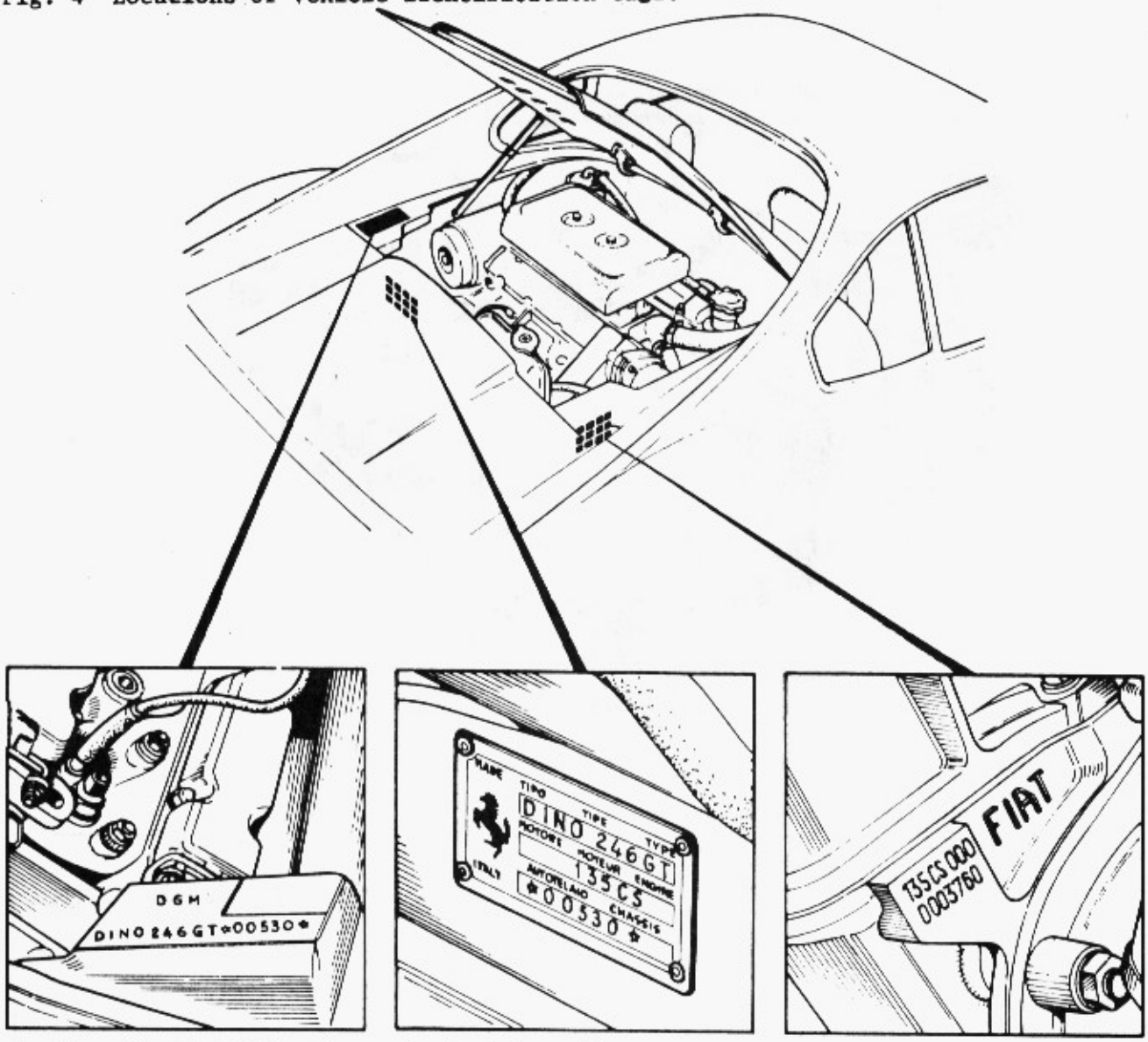
1) The total capacity of the engine, filter and tubing is 8 liters. The quantity indicated above is that which must be replaced when the oil and filter is changed, as indicated on page 43.

2) For external temperatures below 0 C. add SHELL ANTIFREEZE in the following quantities: -10° C.=lt. 3.5; -15° C.=lt. 4.7; -20° C.=lt.5.7; -30° C.=lt.6.4.

3) For effective windshield cleaning one container of glass cleaner is recommended in summer and two in winter.

4) For temperatures to -15 °C. use oil SHELL SUPER MOTOR OIL 100
For temperatures below -15 °C. use SHELL X 100-10W30.

Fig. 4 Locations of vehicle identification tags.



A. Chassis identification number

B. Position of general data plate.

C. Engine number.

SPARE PARTS

Spare parts orders must be supplied with the following information:
- vehicle model (commercial name designation)
- chassis type and number
- engine type and number
- spare part number, (taken from spare parts catalog).

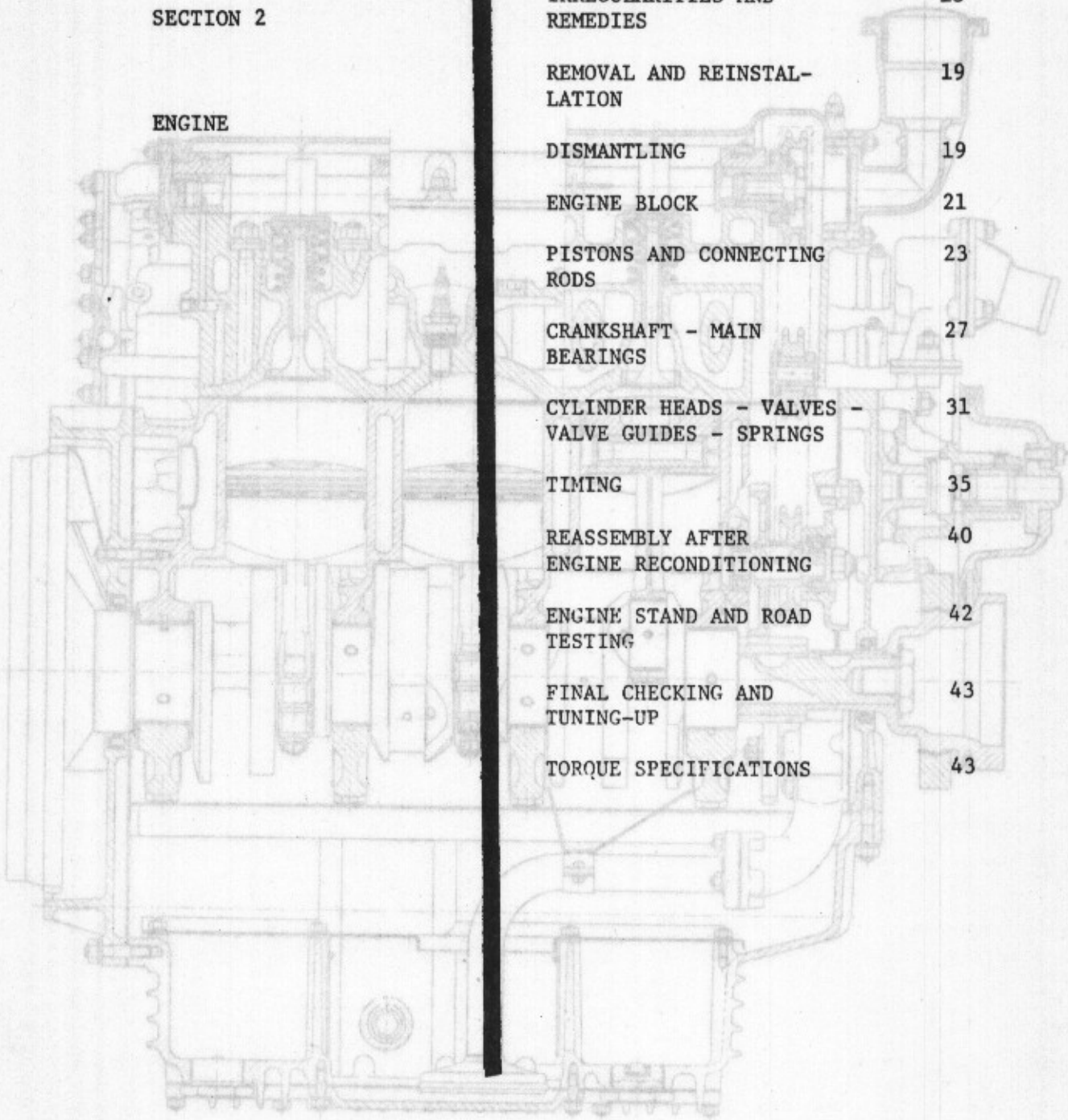
VEHICLE KEYS

Each vehicle is supplied with two sets of keys (of two keys each) for:
- Ignition switch, starter motor and various signals.
- Door and trunk locks.

Each key is stamped with an identification number.

SECTION 2

ENGINE



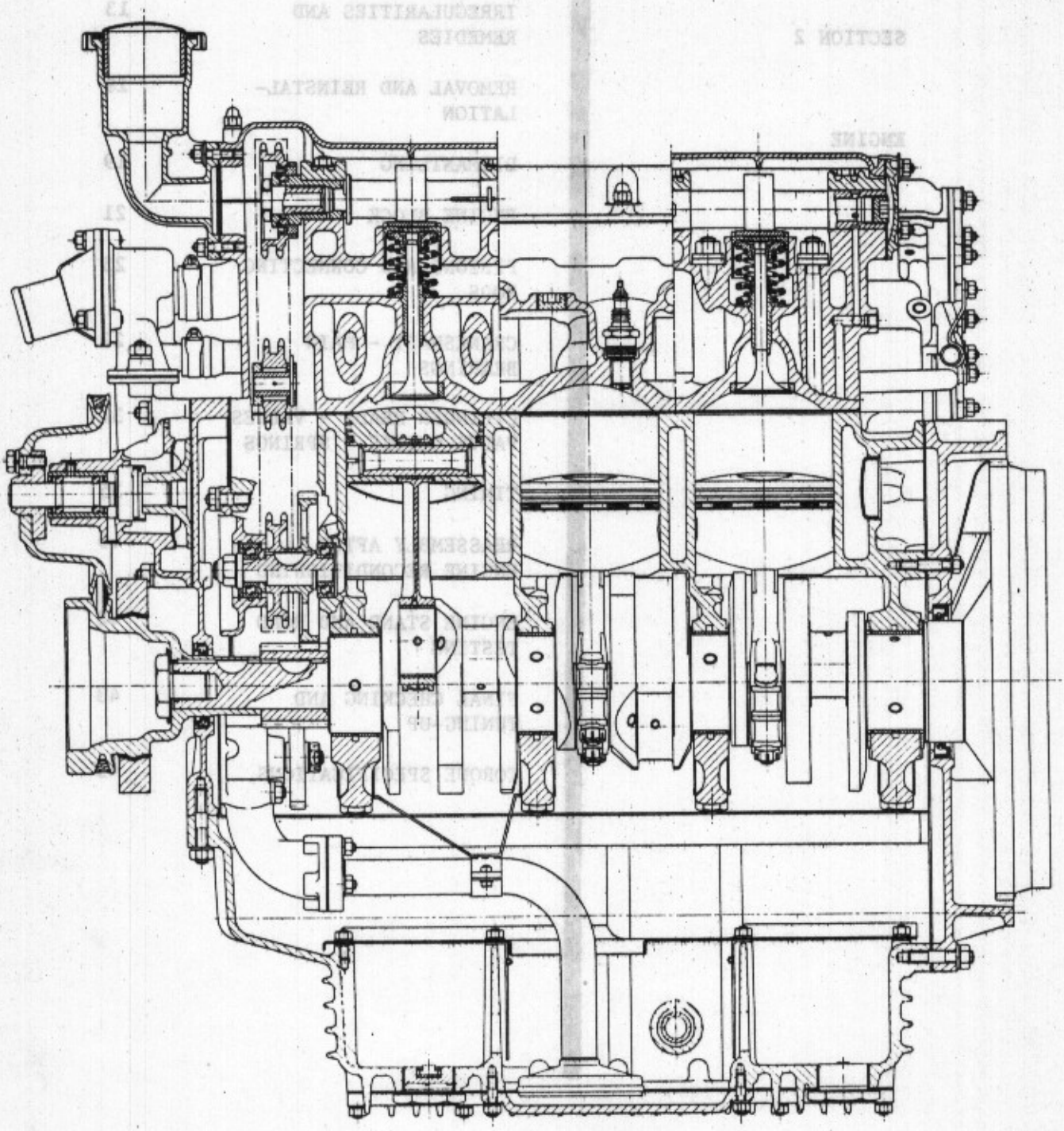


Fig. 5. ENGINE (CYLINDERS SIDE VIEW)

ENGINE

PRINCIPAL DATA

ENGINE		
Type.	.	135 CS
Number of cylinders, V of 65°. .	.	6
Cylinder diameter	.mm.	92.5
Piston travel.	.mm.	60
Total capacity.	.cm³	2418
Compression ratio	. -	9:1
Maximum horsepower (S.A.E. net) .	.CV	195
Corresponding rpm's	. -	7600
Maximum rpm's.	. -	7800
Maximum torque.	.Kg.	23
Corresponding rpm's. . . .	. -	5500
Rated fiscal horsepower (Italy). .	.CV	26.7
CRANKSHAFT		
Number of main bearing supports		4
Main bearings		Thin wall type with anti-friction layer
Support rings		2 on the rear support
Crankshaft rotation		Clockwise
CONNECTING RODS		
Bearings		Thin wall type with antifriction layer
PISTONS		
Type		Conical piston skirt section
Ring for first groove		Retaining
Ring for second groove		Oil scraper
Ring for third groove		Slotted oil scraper type with internal spring
Pin boss		
Pin		Free-floating type within the connecting rod base and the piston
TIMING		
Control		Chain
Valves		Integral within cylinder heads
Camshafts and lobes		Mounted atop cylinder heads

FUEL SUPPLY SYSTEM	
Fuel pumps	2 electric (Bendix)
Fuel pumps control	Via ignition key
Carburetors	3 dual-throat Weber type 40 DCNF / 7
Air filter	Single cartridge type
Crankcase ventilation system	With limiting valve in air intake.
LUBRICATION	
Pump	Gear type
Filter	Cartridge type
Pressure limiting valve	Adjustable type
Oil pressure	6 ÷ 6.5 Kg/cm^2.
Oil cooling	via heat exchanger
IGNITION	
Type	Electronic: with battery, distributor, Dinoplex unit, coil (high tension type). Emergency ignition functioning between distributor and normal coil.
Firing order	1 - 4 - 2 - 5 - 3 - 6
Initial timing advance	6° On the engine
Centrifugal automatic advance (on engine)	30°
Distributor points gap	0.32 - 0.38 mm.
Spark plugs	Champion N 60 y
Electrode gap	0.4 ÷ 0.5 mm.
Diameter and thread	14 x 1.25 mm.
STARTING	
Type	With electric motor
Engagement	Electromagnetic
Control	Via key
ENGINE MOUNTING	
Type	Four elastic supports

DIAGNOSING ENGINE MALFUNCTIONS AND RELATED REMEDIES

THE ENGINE WILL NOT START

Possible causes:	Remedies:
1)Battery partially charged	1)Check and recharge battery as indicated on p. 145.
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 to distributor, distributor to spark plugs wires stretched, broken	6)Examine, readjust connections and replace faulty cables
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, oxidized or excessively gapped distributor points	9)Clean and readjust gap
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)Short-circuited condensator or insufficiently insulated	12)Check condensator on test bench, replace if defective
13)Burned distributor fuse	13)Replace and locate cause
14)Dirty or excessively gapped spark plugs	14)Clean and reset gap
15)Flooded carburetor due to altered float level or impurity between adjustment screw and seat	15)Check and adjust if necessary
16)Non-functioning fuel pumps	16)Check fuses, connections, filters and fuel level in tanks
17)Dirt or water in fuel lines or in carburetors	17)Remove and thoroughly clean the carburetors; if fault continues, have the fuel tanks and lines cleaned and flushed
18)Defective Dinoplex unit	18)Switch over to emergency ignition system and have unit replaced as soon as possible (tachometer will not function in this mode)

THE ENGINE STOPS

Possible causes:	Remedies:
1)Engine idle speed setting too low	1)Increase carburetor butterfly valve opening slightly and adjust mixture setting (p. 64)
2)Idle speed setting either too lean or too rich	2)Ajust mixture setting (p. 64)
3)Flooded carburetor	3)Turn to instructions under heading "CARBURETOR"
4)Dirt or water in fuel lines or in carburetors fuel	4)Remove and thoroughly clean the carburetors; if fault continues, have the fuel tanks and lines cleaned and flushed
5)Corroded or damaged battery terminals	5)Clean, examine and tighten battery terminals connections
6)Coil to distributor, distributor to spark plugs wires loose	6)Examine and tighten connections
7)Dirty, wet, insufficiently or excessively gapped spark plugs	7)Clean, dry and reset spark plug gap
8)Dirty, oxidized or worn distributor contacts	8)Clean and readjust gap
9)Worn distributor rotor surface	9)Replace rotor
10)Inexact ignition timing advance	10)Adjust engine/distributor timing
11)Defective coil or condensers	11)Examine and replace if necessary
12)Defective valve operation due to faulty valve seats or defective valve settings	12)Adjust valve clearances and check each cylinder's compression
13)Overheated engine	13)Check radiator water level, water pump and thermostat operation, water losses due to leaks and cooling vents
14)Defective Dinoplex unit	14)Switch over to emergency ignition and have unit replaced as soon as possible.

THE ENGINE LACKS POWER

Possible causes:	Remedies:
1)Incorrect ignition timing	1)Check and carry out timing operations (p. 42)
2)Accelerator pedal does not travel its full lenght	2)Trace cause of blockage and remove
3)Defective distributor automatic advance	3)Readjust according to instructions given in the appropriate chapter
4)Insufficient clearance at the distributor points opening	4)Adjust the points opening gap
5)Incorrect distributor timing	5)Check timing (p. 41)
6)Insufficient compression	6)Check valves seating and cylinders compression
7)Dirty, wet spark plugs or excessive electrode gap	7)Clean plugs and reset to exact electrode gap (p. 167)

8)Worn or improper type spark plugs	8)Replace spark plugs, use recommended type
9)Fuel octane rating too low	9)Use recommended fuel
10)Worn camshaft lobe(s)	10)Check out lobe(s), replace camshaft if necessary
11)Fuel mixture too low or too rich	11)Check out carburetors jet settings (p. 60)
12)One carburetor not opening com-letely	12)Check out controls
13)Weak valve springs due to defor-mation	13)Check as per table on page 34 , if neces-sary, replace springs
14)Insufficient fuel delivery due to defective fuel pumps or clogged filters	14)Check out, clean and replace defective units if necessary
15)Excessively loose timing chain tension	15)Check out chain tensioner, if necessary, replace chain
16)"Seizing" of engine internal units, as: connecting rod or main bearings - pistons - camshafts, sticking of a valve in its guide, etc.	16)Check out, replace defective unit(s)
17)Defective Dinoplex unit	17)Replace unit.

THE ENGINE MISSES AT HIGH SPEEDS

Possible causes:	Remedies:
1)Insufficent fuel delivery	1)Clogged filters in the electric pumps, excessively warm fuel, fuel tanks capacity nearing reserve level
2)Clogged delivery air filter	2)Clean, blow dry or replace if necessary
3)Partially clogged fuel lines and carburetors filters	3)Clean regualtor 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 rpm's	6)Check with stroboscope at 6000 rpm's
7)Distributor cut-out switch springs weak or deformed	7)Check and replace if necessary
8)Valve spring(s) deformed or in-sufficiently loaded	8)Check and replace springs
9)Valve(s) travel impeded in the guide(s) or valve not closing completely	9)Check, if necessary replace valve and guide
10)Flooding of one or more car-buretor	10)Check and clean float needle valve and replace if worn
11)Water in fuel	11)Thoroughly clean the fuel system
12)Defective Dinoplex unit	12)Replace.

ENGINE RUNS IRREGULARLY

Possible causes:	Remedies:
1)Dirty or wet spark plugs, or excessive gap	1)Check, clean and reset gap
2)Inexact ignition timing	2)Check distibutor 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 of membranes
7)Irregular cylinders compression	7)Check with compression gauge
8)"Seized" or burnt engine valves	8)Check and replace valves
9)Irregular valve clearances	9)Adjust (p. 38)
10)Carburetor flooding due to dirt between needle and seat	10)Clean carburetor bowls and filters
11)Altered carburetor float levels	11)Check levels (p. 64)
12)Air leaks between air intakes and cylinder heads and between exhaust tubes and heads	12)Check intake rubber seal rings and exhaust flanges tightness
13)Excessive play in the carburetors control lever shafts	13)Check and replace the faulty units
14)Non-functioning automatic advance	14)Check on test bench
15)Distributor cut-out switch tarnished or with inexact clearance	15)Check, clean and adjust
16)Defective Dinoplex unit	16)Replace.

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 and tabs
3)Broken valve return spring(s)	3)Replace broken spring(s)
4)Excessie clearance between tappet thimble and guide hole	4)Check (p. 36)
5)Valve stem(s) not traveling freely in the guide(s)	5)Check (p. 32)
6)Worn or loose timing chain	6)Check chain tensioner efficiency; check chain wear.

NOISY CONNECTING RODS BEARING 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 bushing	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 (p.40-2).
2)Defective carburetion	2)Check out and adjust
3)Defective carburetor synchronization	3)See specific chapter instructions (p.64)
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 seized 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 obtructed 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 (p.47)
2)Inappropriate oil type for conditions	2)Substitute with specified oil (p.49)
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.

LOW OIL PRESSURE (cont'd)

Possible causes	Remedies
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. Incorrect pick-up pump positioning.	8. Verify positioning.
9. Air leak in the air intake system.	9. Check out and eventually replace.

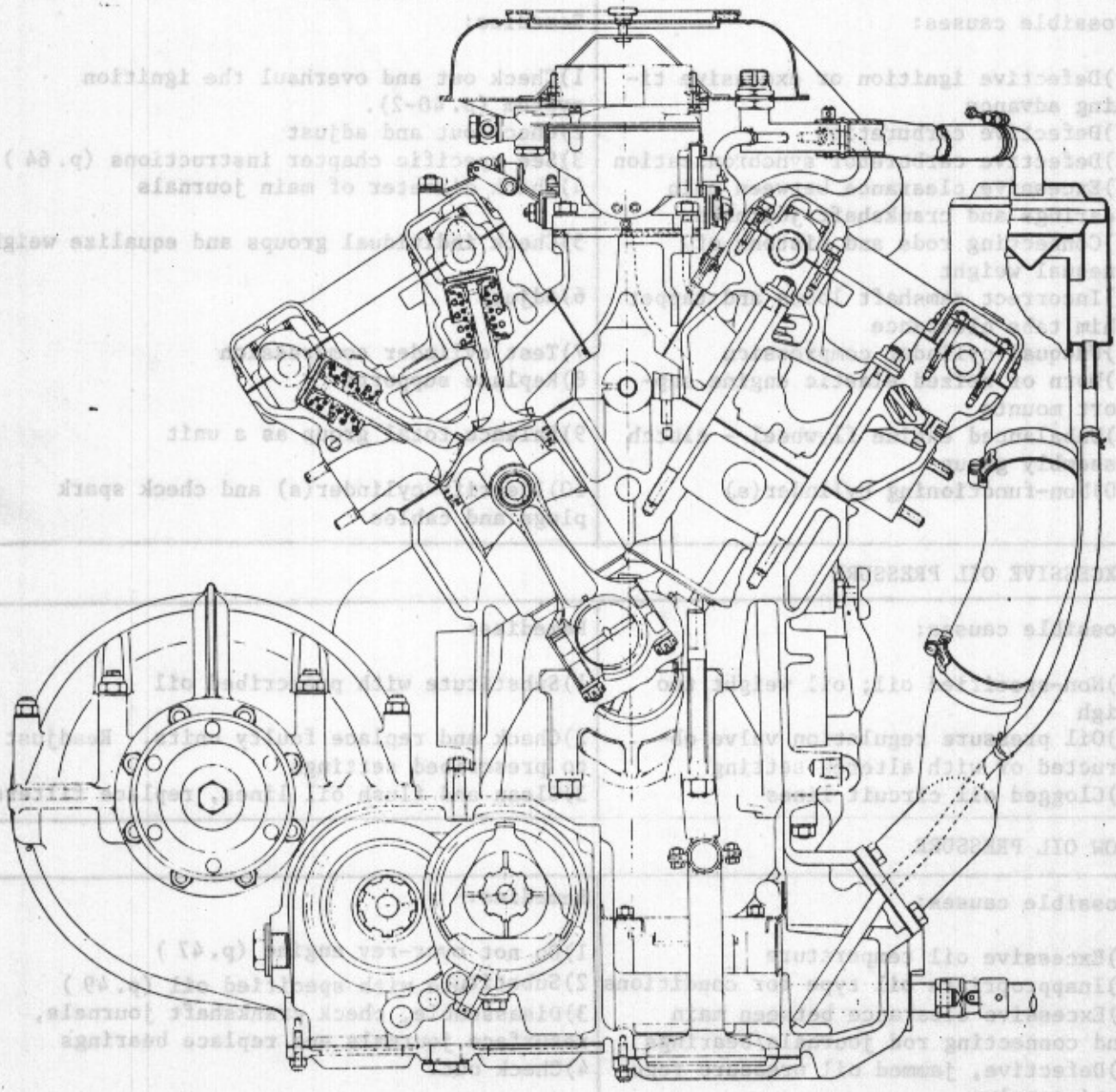


Fig. 6. Transverse engine view.

REMOVAL AND INSTALLATION OF ENGINE FROM CAR

Operations to be completed:

1-Place supports at rear of the vehicle.
2-Remove engine and trunk lids.
3-Disconnect battery ground cable.
4-Remove engine-trunk partition panel.
5-Remove rear wheels.
6-Remove right fender stone guards.
7-Open engine - radiator water taps.
8-Remove cylinder heads to radiator water tubing together with the two sleeves.
9-Remove the auxiliary fuel tank cap and the air filter unit, removing the blow-by tubes from the carburetor box.
10-Remove the two rubber sleeves and the top part of the blower.
11-Disconnect the auxiliary water tank and its transverse chassis support.
12-Disconnect the muffler mounting flanges after having first disconnected the expansion unit.
13-Disconnect the heat exchanger water tubes.
14-Remove the oil filter/support unit.
15-Remove the heat exchanger and the oil filler/drain tubes.
16-Remove the cylinder heads - heat exchanger water tube.
17-Disconnect the oil filler tube from the engine.
18-Remove the distributor cap, disconnecting the high and low tension cables.
19-Disconnect the water, oil and starter motor cables at the engine connections.
20-Disconnect the engine ground cable and the reverse gear electrical cable.
21-Disconnect vacuum brake booster intake tube.
22-Remove the gear shift control connection.
23-Disconnect the engine/chassis accelerator pedal support.
24-Disconnect the carburetor main and return gas lines.
25-Disconnect the clutch controls from the shaft by sliding the cover from the support located at the gear-box.
26-Disconnect the semi-axles and differential flanges.
27-Remove the four engine to chassis fastening bolts.
28-Support the engine with tool A.60544 or with two metal cables hoists.
29-Raise engine slightly and disconnect the two rear engine support mounts.
30-Raise engine with the clutch side lowered and remove it diagonally to the longitudinal axis of the car.

For reinstallation, repeat the above operations in reverse order.

NOTE
For many units, as the heat exchanger, the rear exhaust header, and the rear engine supports mounts, we suggest that they be removed from the engine in order to facilitate removal and reinstallation.

Disassembly of the engine

-After having removed the entire engine unit from the car, and having disconnected the clutch bell housing, the clutch, the flywheel and the intermediate housing as described on p. 74, proceed to disconnect the engine from the gear box.
-Connect the two side mounting arms of rotating engine stand AV 617 to the engine block.
-Remove the intake manifold nuts at the crankcase and disconnect them completely at the carburetors as a unit.

-Disconnect ignition distributor from the engine.
-Remove spark plugs; also disconnect the small camshaft covers at the end of the cylinder heads.
-Remove the two camshaft covers.
-Loosen the four bolts that fasten the timing gears to the camshafts.
-Turn the engine crankshaft clockwise until the front torsional vibration damper notch is aligned to the distributor case notch. At the same time, make sure that the alignment marks on the four camshafts are aligned with the marks on the caps of the front camshaft supports. If not aligned, turn engine over one additional revolution.
-WARNING
Do not turn engine over until the camshafts have been removed from the cylinder heads.
-Remove the four timing gears bolts loosened earlier,with,tool 622-AS-5422 extract the centering and drag pins.
Remove the gears from the box.
-Remove all the camshaft support caps from the cylinder heads.
-Loosen the water return pipe from the engine heads, together with the thermostat and water intake tube at the water pump.
-With tool AV-498 loosen all cylinder heads fastening bolts and remove heads from the engine block.
-Disconnect the torsional damper.
-Disconnect the timing case from the block, together with the oil and water pump.
-Remove the engine intermediate housing together with the crankshaft oil seal, also remove the oil pressure sending unit.
-Turn the engine block over, removing the connecting rod caps and slide the connecting rod-piston unit through the lower part of the cylinder sleeves.
-Remove the main bearing support caps and remove the crankshaft.
-Remove the two timing reduction gears supports together with the timing chain control pinions.
-To remove the shoulder supports ball bearings (if necessary), loosen the nuts on the small shafts and push these out from the bearings. Remove the two external elastic rings and slide out the bearings.
An expansion extractor or tools A 40206/801 C. and 40207/813 can be used to remove those bearings press-fitted in the engine block.
-Remove the valve control tappets keeping them together with their respective clearance adjustment shims; with tool AV.508 remove the valve springs and the oil retaining rings and the intake and exhaust valves.

ENGINE BLOCK

Characteristics

The cylinders are of a special alloy, cast together with the engine block. The cylinder sleeves are bored out of the same block casting. The engine block also contains four support seats for the main bearings. On the rear supports are mounted thrust bearings for the crankshaft.
The engine oil pan also serves as the gear box case cover.

General cleaning

Immerse the block for 20 minutes in a tub containing a water and soda solution of 80° ÷ 85° C. With a pressure hose spray the block with the solution to eliminate any deposits in the lubrication channels of the block.
Dry out with compressed air the block, particularly the lubrication channels.

Cylinder sleeves control

Examine the sleeve surfaces and carry out the dimensional measurements as indicated in figure 7.
Maximum tolerated wear is 0.05 ÷ 0.08 mm. over the nominal diameter measurement.
If wear or deformation is within the 0.05 mm. limit, fine hone the cylinder sleeve surfaces with an emery cloth mounted on a grinder before insertion of the pistons.

Warning
If wear and out-of-roundness is found and the sleeve must be resurfaced, follow these directions:
If the amount of material is small (less than 0.15 mm.), it is sufficient to only hone the sleeves; if it exceeds the 0.15 mm. limit, reboring is necessary.

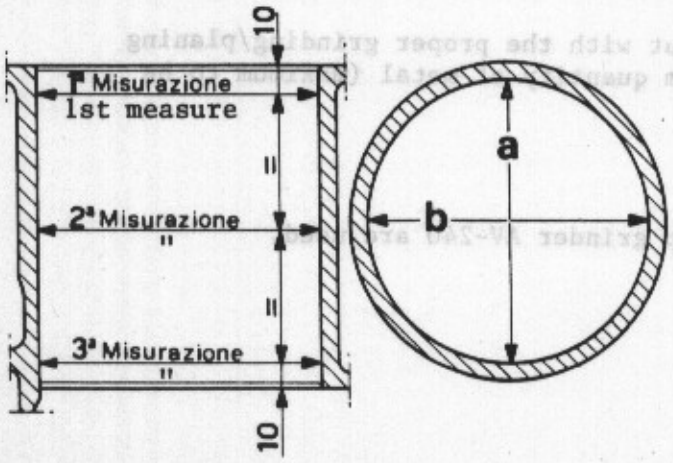


Fig. 7 Measurement diagram for cylinder sleeves.

Cylinder sleeves diameter.

NOMINAL	Nominal ϕ	92,500 ÷ 92,530
Class A	"	92,500 ÷ 92,515
" C	"	92,515 ÷ 92,530
1° Maggiorazione	Oversize ϕ	92,700 ÷ 92,730
Class A	"	92,700 ÷ 92,715
" C	"	92,715 ÷ 92,730
2° Maggiorazione	Oversize ϕ	92,900 ÷ 92,930
Class A	"	92,900 ÷ 92,915
" C	"	92,915 ÷ 92,930
3° Maggiorazione	Oversize ϕ	93,100 ÷ 93.130
Class A	"	93,100 ÷ 93,115
" C	"	93,115 ÷ 93,130

Remember that maximum reboring must not exceed 0.6 mm.
The resurfacing of the sleeves must be performed to match the diameter of the replacement pistons (0.2 ÷ 0.4 ÷ 0.6 mm.) and the corresponding clearance between the parts.
Warning: when choosing pistons make sure that they are matched with and to the corresponding cylinder sleeve size.

Cylinder sleeves boring

Measure the sleeves in order to establish the exact diameter to which they must be bored.
After having mounted the block to the proper inclined surface and secured to the support surface of the reamer, insert the mandrel of the reamer, with a centering device, into the sleeve.
Execute an exact centering of the mandrel in relation to the sleeve and secure the support surface of the reamer.
Remove the cap of the centering device and regulate the projection of the tool to the desired diameter.
Having set the projection, begin boring leaving 0.04 ÷ 0.05 mm. of surface to be finely ground out in the next operation.

Resurfacing (grinding) of cylinder sleeves

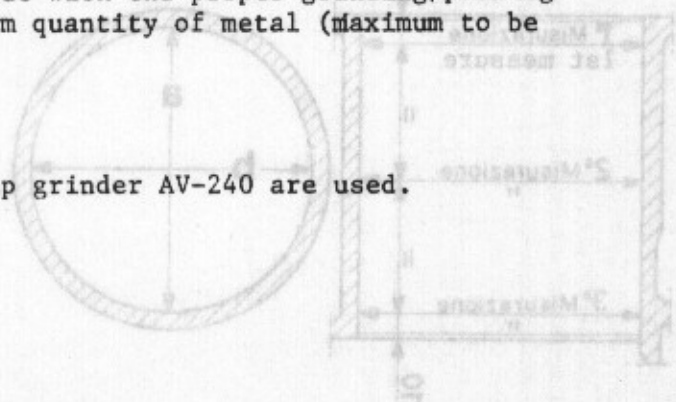
Mount and secure the block to the surface of the grinder.
Using a series of medium grade grinding blocks, then a series of fine grade, proceed to grind.
In order to obtain the desired surface roughness (35 ÷ 38 microinches) go over the sleeve with a grinding cloth attached to the grinder.
Repeat the above operations on all the cylinders.

Checking, resurfacing of engine block/cylinder heads surfaces

After extended use of the engine or after use in conditions of extreme engine overheating, it is advisable to check out these surfaces. Using a flat ruler coated with lamp black or similar substance, spread the material over the surfaces.
In order to resurface the areas, it is necessary to remove all cylinder head studs.
The resurfacing operation must be carried out with the proper grinding/planing machine in such a way as to remove a minimum quantity of metal (maximum to be removed= 0.2 ÷ 0.3 mm.)

Check of main bearing supports alignment

For this operation, tool 361-AS-4736 and lap grinder AV-240 are used.



PISTONS - CONNECTING RODS

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.

Piston/cylinder sleeve and piston wrist pin clearance control

Piston/cylinder sleeve clearance control is achieved by matching the bore size to the correct piston size. These sizes must be accurately matched.
NOTE: if the car has been run for 50÷60,000 km. at engine rebuild, it is advisable to replace the pistons.
Repalcement pistons are supplied in oversizes of 0.2 - 0.4 - 0.6 mm.

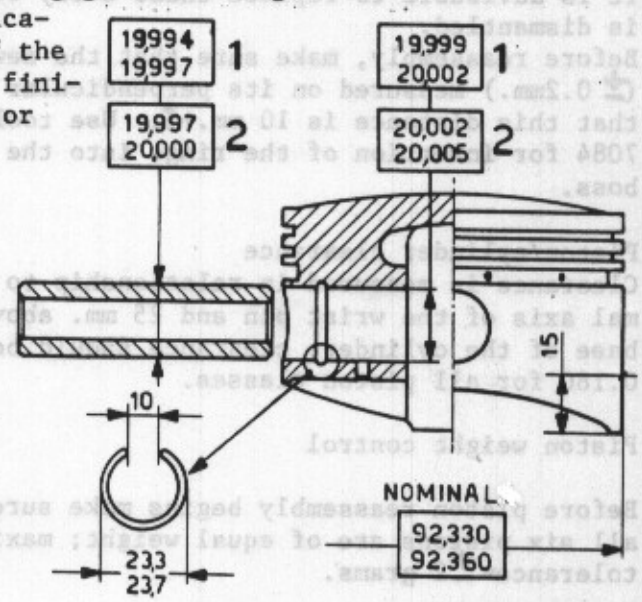


Fig. 9 Principal piston and wrist pin data.

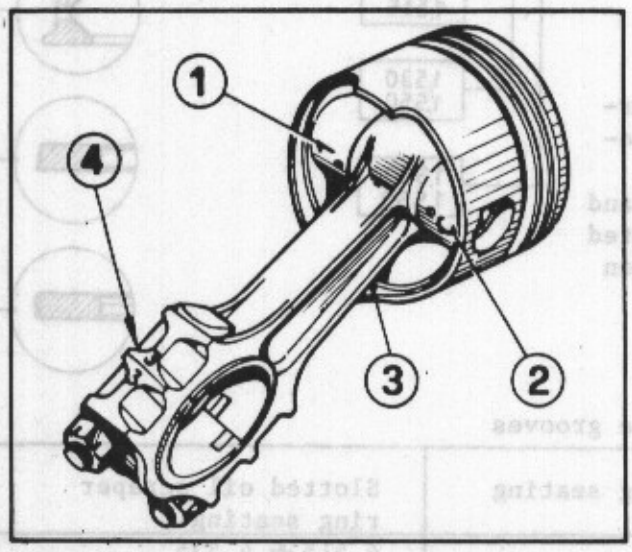


Fig. 8 Piston/connecting rod unit
1. Number indicating wrist pin/piston boss assembly matching sizes, 2. Letter indicating piston class size, 3. Number indicating piston oversize, 4. Stamped number indicating proper cylinder/connecting rod match.

Piston data

NOMINAL		ϕ 92,330 ÷ 92,360
Class A		" 92,330 ÷ 92,345
" C		" 92,345 ÷ 92,360
1° Maggiorazione	first oversize	ϕ 92,530 ÷ 92,560
Class A		" 92,530 ÷ 92,545
" C		" 92,545 ÷ 92,560
2° Maggiorazione	second oversize	ϕ 92,730 ÷ 92,760
Class A		" 92.730 ÷ 92,745
" C		" 92.745 ÷ 92,760
3° Maggiorazione	third oversize	ϕ 92,930 ÷ 92,960
Class A		" 92,930 ÷ 92,945
" C		" 92,945 ÷ 92,960

Pistons are matched in three categories, each with a nominal base diameter and with two additional categories of wrist pin diameter.
The letter and the number indicating the piston class and the wrist pin/piston boss size are stamped on the base of the connecting rod and on the internal rim of the piston (fig. 8).
Wrist pin/piston boss clearance is 0.002 ÷ 0.008 mm.
One method of checking out the wrist pin/piston fit is to insert the preselected wrist pin, highly lubricated with clean engine oil into the piston boss. If the fit is correct, the wrist pin will fit in by hand pressure.

Piston/wrist pin retaining ring

It is advisable to replace these every time that the piston/wrist pin assembly is dismantled.
Before reassembly, make sure that the new rings' external diameter is 23.5 mm (± 0.2mm.) measured on its perpendicular axis in relation to its cut edges and that this distance is 10 mm.+1. Use tool 632-AS-7084 for insertion of the rings into the piston boss.

Piston/cylinder clearance
Clearance is measured in relationship to the normal axis of the wrist pin and 25 mm. above the base of the cylinder; clearance should be 0.160 ÷ 0.180 for all piston classes.

Piston weight control

Before piston reassembly begins make sure that all six pistons are of equal weight; maximum tolerance = ± 2 grams.

Piston rings

Rings - grooves clearance
The clearance is checked by assembling the correct ring to the piston groove and using a proper thickness gauge.
NOTE: it is necessary for proper functioning and long engine life to adhere closely to the listed assembly clearances. (Axial clearance of piston rings and their relative grooves)

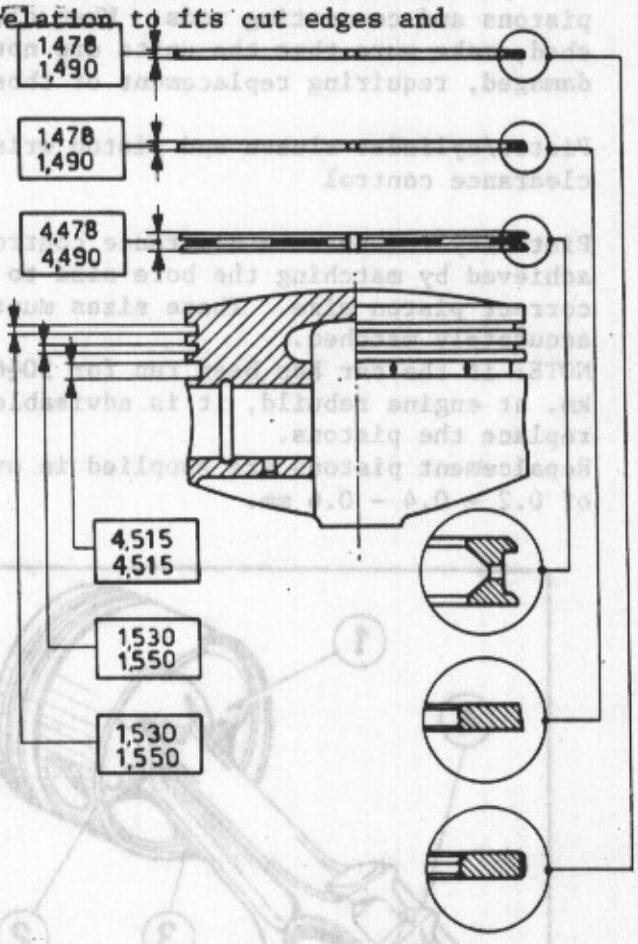


Fig. 10 Rings - piston grooves data.

Clearances for piston rings and their relative grooves

Compression ring seating	Oil scraper ring seating	Slotted oil scraper ring seating
1.530 ÷ 1.550	1.530 ÷ 1.550	4.515 ÷ 4.535
Compression ring	Oil scraper ring	Slotted oil scraper ring
1.478 ÷ 1.490	1.478 ÷ 1.490	4.478 ÷ 4.490
Clearances		
0.040 ÷ 0.072	0.040 ÷ 0.072	0.025 ÷ 0.057

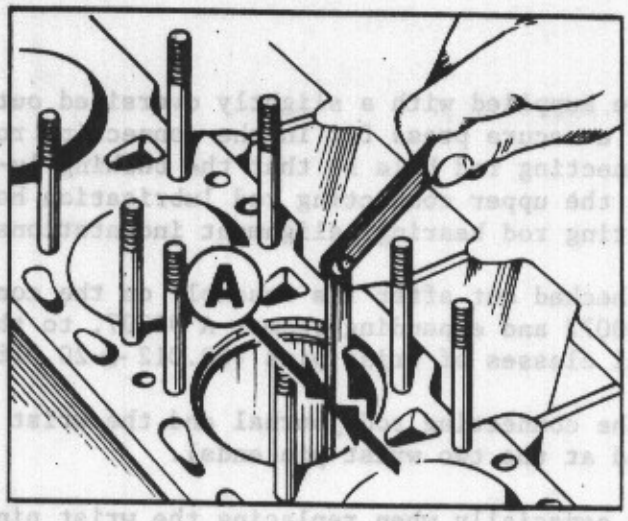


Fig. 11 Checking piston ring clearance

Piston ring clearance data

Ring type	A =Clearance=mm.
1 Compression ring	0.30 ÷ 0.45
2 Oil scraper ring	0.30 ÷ 0.45
3 Oil scraper ring	0.25 ÷ 0.40

Checking clearance of piston rings ends

The clearance must be checked prior to mounting them on the pistons and it must be measured after insertion of the rings the cylinder (fig. 11) and they must conform to the table measurements above.
In case of insufficent clearance, grind the ring ends with an appropriate grinding tool. After mounting them on the pistons, arrange the ring end gaps 120° from each other.

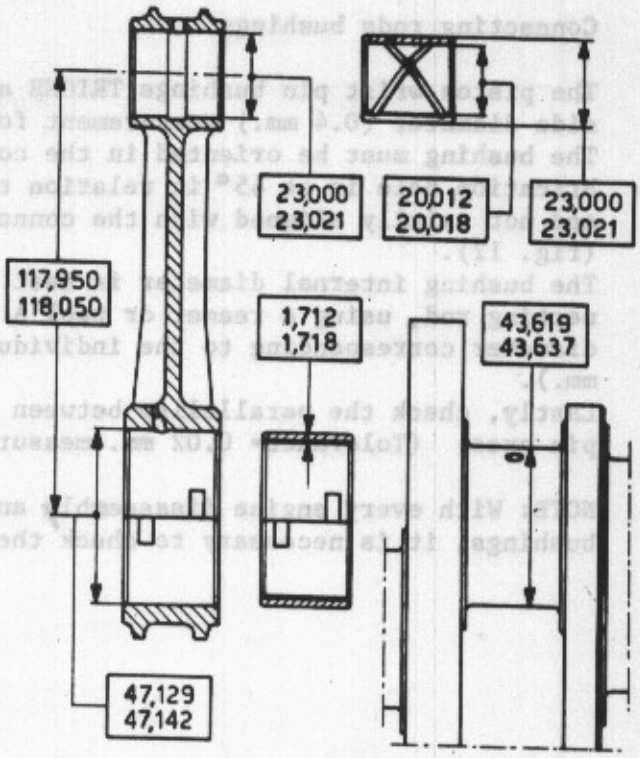


Fig. 12 Connecting rods and connecting rods bearings data.

Connecting rods bearings thickness data

NORMAL	By undersize diameter in mm.				
	0,127	0,254	0,508	0,762	1,016
1,712	–	1,839	1,966		
1,718	–	1,845	1,972		

NOTE: During any dismantling or rebuilding of an engine, the rings must be replaced.
NOTE: the clearance A (fig.11) must be held constant for all cylinder sleeves over sizes. Rings are available in oversizes of 0.2 ÷ 0.4 - 0.6.

Connecting rods bearings

The "thin-wall" type bearings must not be filed or smoothed, and their surfaces must be protected at all times prior to assembly. If deep scratches or wear are noticed, they must be replaced. After ascertaining the condition of the bearings, check out the bearings/crankshaft journals clearances, using the appropriate micrometer and thickness gauges.
If the obtained clearance is within assembly limits of 0.056 ÷ 0.099, or under the 0.12 mm. journal wear limits, replacement of same size bearings is allowable, without having the crankshaft journals machined.
If the clearance limits have been exceeded, substitute with undersized diameter bearings and resurface the crankshaft journals as indicated on p. 11 and according to the specified limits.

Connecting rods bushings

The piston wrist pin bushings TRIONE are supplied with a slightly oversized outside diameter (0.4 mm.) measurement for a secure press fit in the connecting rod. The bushing must be oriented in the connecting rod hole so that the bushing lubrication hole is at 45° in relation to the upper connecting rod lubrication hole and not axially aligned with the connecting rod bearings alignment indentations (fig. 12).
The bushing internal diameter is best checked out after its assembly on the connecting rod, using a reamer or tool A 60077 and expanding reamer A 90307, to the diameter corresponding to the individual classes of wrist pins (20.012 ÷ 20.018 mm.).
Lastly, check the parallelism between the connecting rod journal and the wrist pin axes, (Tolerance= 0.02 mm. measured at the two wrist pin ends).

NOTE: With every engine disassembly and especially when replacing the wrist pin bushings, it is necessary to check the parallelism between the two axes.

CRANKSHAFT - BEARINGS

Checking and resurfacing of main and connecting rod journals

The crankshaft must not be scored. "Magnaflux" it to examine, and replace if cracks are discovered. Light seizure marks on the journals may be polished out by using the finest grade "carborundum" stone.

Diameter of connecting rod journals

NORMAL	Undersized by mm.				
	0,127	0,254	0,508	0,762	1,016
43,619 43,637	—	43,365 43,383	43,111 43,129		

Diameter of main journals

NORMAL	Undersized by mm.				
	0,127	0,254	0,508	0,762	1,016
62,948 62,966	—	62,694 62,712	62,440 62,458		

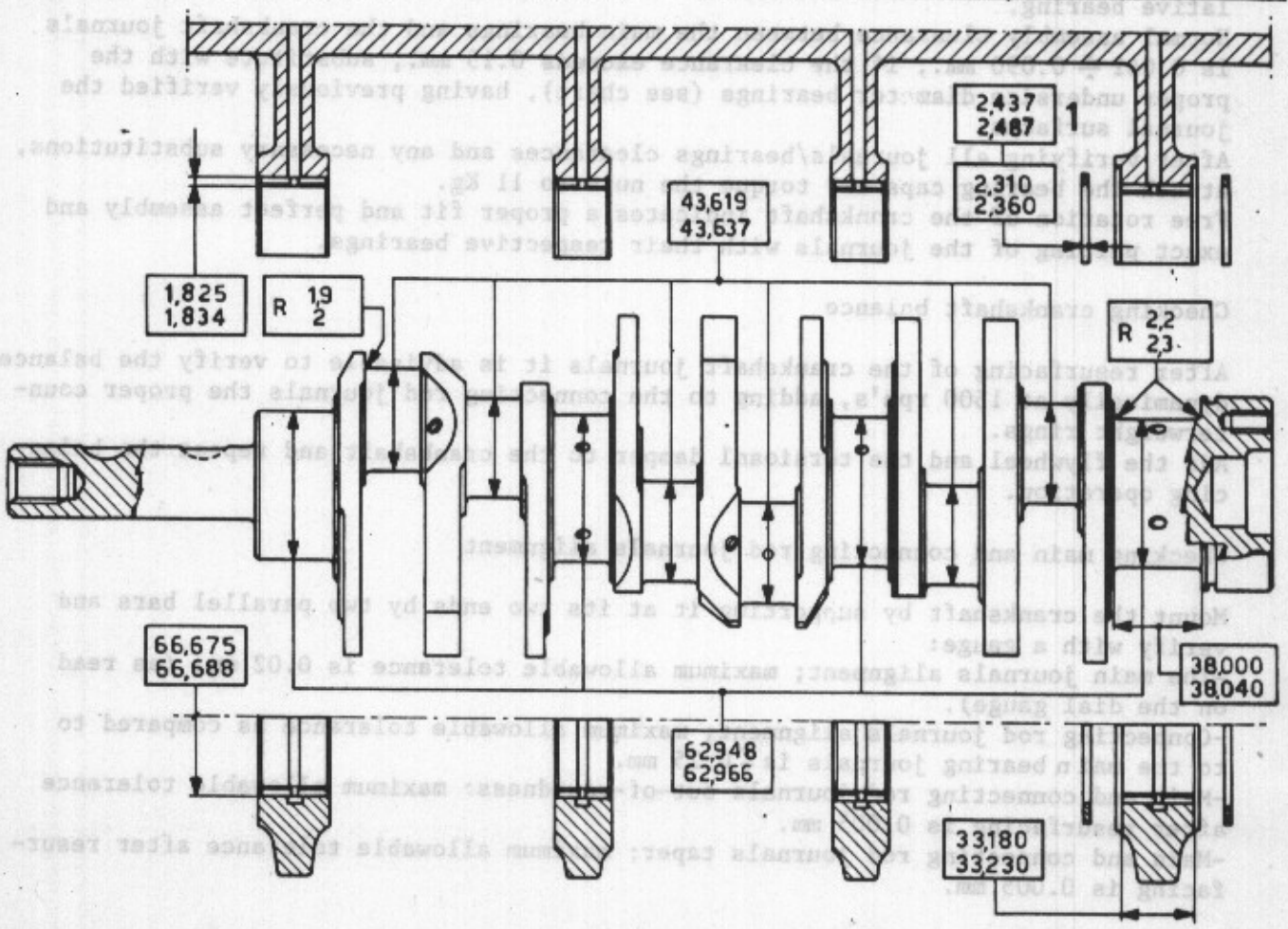


Fig. 13 Principal data for main, connecting rod journals and support (thrust) rings.

Main bearings thickness data

NORMALE	Oversize by mm.				
	0,127	0,254	0,508	0,762	1,016
1,825	—	1,952	2,079		
1,834	—	1,961	2,088		

When scoring of the journals is deep; or when the out-of-roundness exceeds 0.05 mm. measured with a micrometer, the journals must be resurfaced. This operation must be carried out in view of the assembly clearances and the bearing oversize needed. Resurfacing of the main and connecting rod journals must be done so as to arrive at the corresponding diameter values listed in the tables, and according to the radius of the journals as shown in fig. 13.

Main bearings

Replace these if scores, seizure, or excessive wear marks are noted. Bearings cannot be restored to original specifications or modified.
If, after examination, the bearings can be judged as reusable, verify the existing bearing/individual crankshaft journal clearance by the following method:
-Assemble the main bearings to their journals and their caps.
-Torque tighten all cap nuts to 11 Kg.
-With a properly adjusted (zero adjustment setting) gauge, verify the bearings diameter.
-With a micrometer verify the crankshaft journals diameter.
-Compare the difference between the surface values of each journal and its relative bearing.
Normal assembly clearance between the main bearings and the crankshaft journals is 0.041 ÷ 0.090 mm.; if the clearance exceeds 0.15 mm., substitute with the proper undersize diameter bearings (see chart), having previously verified the journal surfaces.
After verifying all journals/bearings clearances and any necessary substitutions, attach the bearing caps and torque the nuts to 11 Kg.
Free rotation of the crankshaft indicates a proper fit and perfect assembly and exact pairing of the journals with their respective bearings.

Checking crankshaft balance

After resurfacing of the crankshaft journals it is advisable to verify the balance dynamically at 1500 rpm's, adding to the connecting rod journals the proper counterweight rings.
Add the flywheel and the torsioanl damper to the crankshaft and repeat the balancing operation.

Checking main and connecting rod journals alignment

Mount the crankshaft by supporting it at its two ends by two parallel bars and verify with a gauge:
-The main journals alignment; maximum allowable tolerance is 0.02 mm. (as read on the dial gauge).
-Connecting rod journals alignment; maximum allowable tolerance as compared to to the main bearing journals is ± 0.25 mm.
-Main and connecting rod journals out-of-roundness: maximum allowable tolerance after resurfacing is 0.005 mm.
-Main and connecting rod journals taper; maximum allowable tolerance after resurfacing is 0.005 mm.

-Crankshaft axis/flywheel support surfaces perpendicularity: a gauge indicator fastened approximately 35 mm. from the crankshaft axis must not indicate any variations over 0.025 mm. when the crankshaft is rotated.

Checking crankshaft supports clearance

Verify the crankshaff supports (thrust bearings) clearance between the rear supports half-rings and the crankshaft surfaces.
Attach a gauge with a magnetic base to the engine block and insert a screwdriver at each end between the crankshaft and the block.
Move the crankshaft sideways and verify that the movement is within the values of 0.050÷ 0.240 mm. on the dial gauge face.
If the movement exceeds 0.35 mm. (maximum allowable tolerance), replace the thrust bearings half-rings with o.127 mm. oversized ones, available as replacements and having a thickness of 2.437 ÷ 2.487 mm.
In the assembly of the half-rings, remember that the grooved side of the rings must face towards the crankshaft support.

Engine flywheel with ring gear

Verify the condition of the ring gear; replace entire unit if gear teeth are damaged.
The flywheel starter motor shaft and clutch contact surfaces must be only lightly worn and should not show scratch marks.
To verify that these contact surfaces are absolutely aligned on the rotation axis, place the flywheel on the engine crankshaft, place both on two parallel supports and with a dial gauge verify that the surfaces of the clutch disc and cover do not rotate more than 0.1 mm. out-of-center.

Cleaning oil lubrication passages

For an accurate cleaning operation of these passages it is necessary that all fill and drain plugs be removed.
Accurately wash the internal passages with gasoline and blow dry with compressed air.
Lastly, press in the new unthreaded stoppers and secure into place with a punch.

Checking crankshaft friction bearing

An internally lubricated, sealed roller bearing is located at the rear end of the crankshaft.
Whenever noise or wear is noticed in the rotation of the bearing, it is necessary to replace it by removing it with an extractor A 40206/80I and tool A 40207/813, making it necessary to remove the engine flywheel since it holds the bearing in place.

CYLINDER HEADS

Removal and remounting

While it is relatively easy to loosen , remove and remount the rear cylinder head with the engine still mounted to the car, the loosening of the front one presents difficulty, thus it is necessary to remove the complete engine unit from the car. For this operation refer to the steps listed on page 19. To reattach the cylinder heads to the engine block follow the operations described for the loosening and removal in reverse, and observe the following steps:
-Always replace the old cylinder head gaskets with new, keeping them clean and free of grease.
Also, always replace valve cover gaskets.
-Tighten the cylinder heads to block stud nuts in the order illustrated in fig. 14 in two steps:
1st step, torque down to 4 Kg.
2nd step, torque down to 8 Kg.

Disassebly and reassembly

Place cylinder head on support 1 (A.60337). Adjust tool 2 (AV508DINO) as shown in fig. 15 and compress the valve springs and loosen the retaining valve cone halves. Remove the springs with their respective caps, making sure that after examining them they are replaced back with their respective seats. Slide out

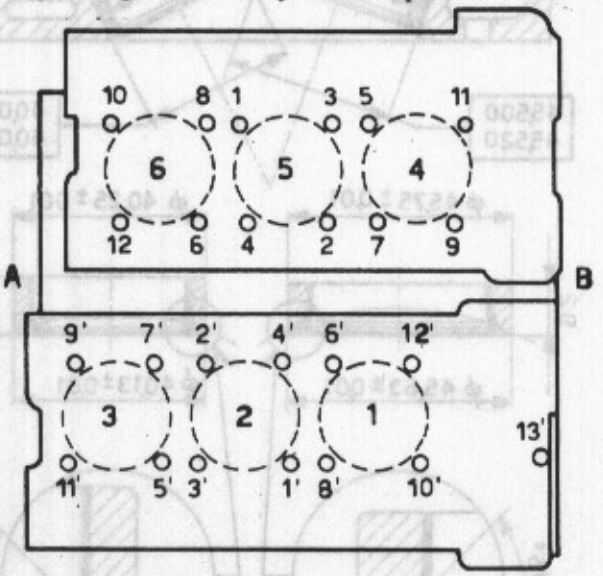


Fig. 14 Head bolts tightening sequence.

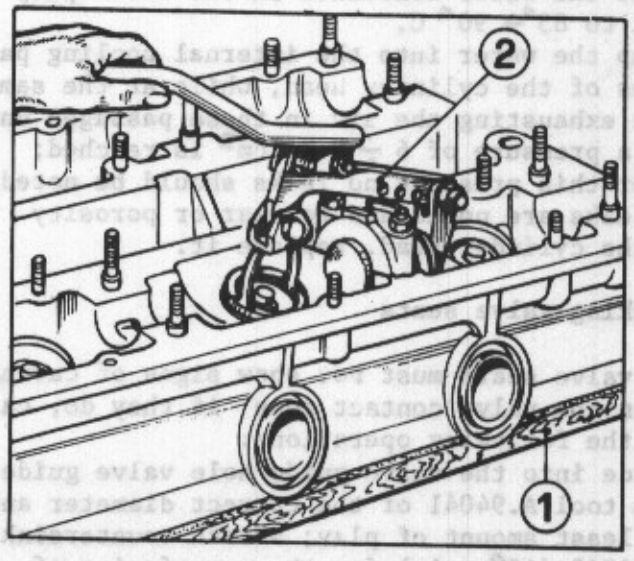


Fig. 15 Cylinder heads valve removal with tool AV508(DINO).
1.Resting surface, 2.Valve removing tool.

valves from the bottom of the cylinder head.
Reassembly of the head is accomplished by retracing the disassembly operations in reverse.

Cleaning

Remove carbon deposits from all combustion chambers. Do the same for the exhaust tubes, check and clean intake tubes and camshaft lubrication passages.
We advise cleaning the combustion chambers by immersing the head in a liquid cleaning solution as "MAGNUS 755" for 10 to 15 hours after having completely dismantled the cylinder heads.
Rinse out with compressed water, blow dry with compressed air and reassemble all units after lubricating them.

Checking and resurfacing of support surfaces

Slide the cylinder heads on a flat machined surface that has been freshly coated with machine dye.
The dye marks must be uniformly distributed on the flat surface of the head.
If they are not, surface imperfections exist, and the head must be resurfaced.
No more than 0.1 ÷ 0.2 mm. of metal must be removed during the resurfacing operation.
Check out the combustion chambers depth with gauge A.96213, for excessive wear and check that depth differences do not exist.
When the resurfacing of the heads exceeds the stated limits, replace the heads.
Check for signs of of seizing or excessive wear (see fig. 22) of the camshaft seats.

Checking hydraulic operations

In order to carry out the inspection of the hydraulic operations of the cooling passages of the cylinder heads, complete the following steps:
-Assemble on the cylinder heads the particular units required for the cooling operations.
-Heat the water contained in the water pump bowl to 85° ÷ 90° C.
-Pump the water into the internal cooling passages of the cylinder head, while at the same time exhausting the air in these passages until a pressure of 6 ÷ 8 Kg/cm² is reached; under this pressure no leaks should be noted.
If leaks are noted due to wear or porosity of the cylinder head, replace it.

Checking valve seats

The valve seats must not show signs of caving-in in the valve contact zone; if they do, carry out the following operations:
-Slide into the valve guide hole valve guide stem tool A.94041 of the correct diameter and the least amount of play; attach countersink 35021768 (45° angle) for the resurfacing of

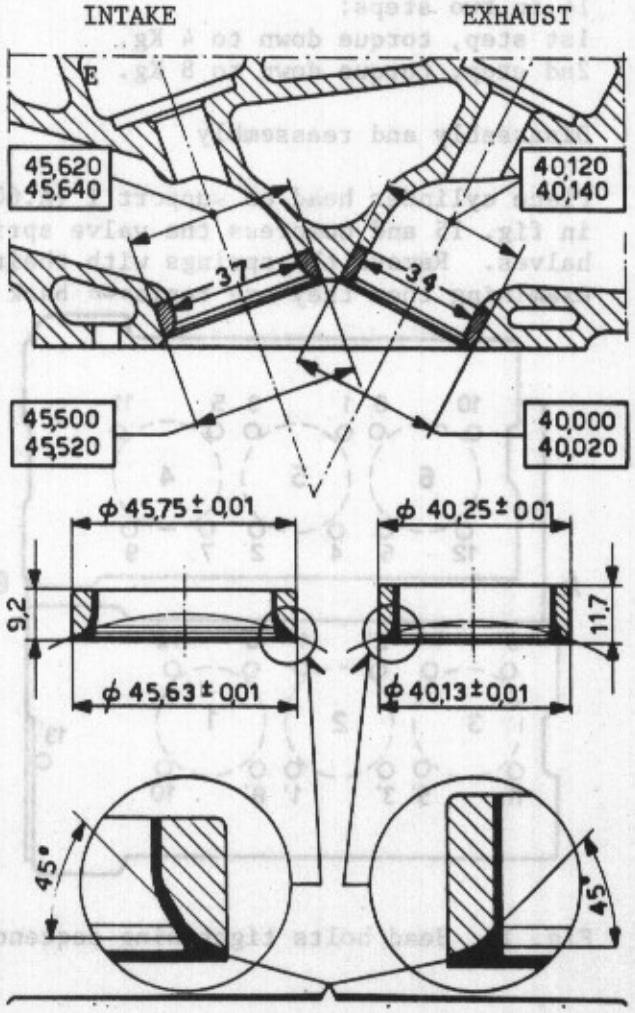


Fig. 16 Valve and valve seats principal data.

Amount of material to be removed with valve seat tool mounted.

the seat. To reduce the size of the intake valve seat by 1.2 mm. use countersink A.94104 (27°), for the exhaust valve seat use countersink A.94103 (55° angle).
If the valve seats are caved-in more than 0.6 ÷ 0.8 mm., it is necessary to replace the valve seat ring as follows:
Ream out the internal diameter of each ring to reduce it by 0.3 ÷ 0.4 mm. to facilitate its extraction without damaging the cylinder head recesses.
-With a gauge measure the the two diameters of each valve seat recess.
-With a micrometer measure the two external diameters of each ring.
-Fit in each recess the proper ring which should be larger by 0.13 ÷ 0.01 mm.for both intake and exhaust.
-Heat the cylinder heads in a furnace (180° ÷ 200°C).
-Cool the valve seat rings for 5 to 6 minutes in carbon dioxide (dry ice) and assemble into the proper recesses using the proper mounting tools.
Befor thoroughly cooling the cylinder heads make sure that the rings are properly seated in their recesses.
Resurface the new valve seats using countersinks 35021768, A.94104, A.94103 after having remeoved any excess metal from the mounted valve seats (fig. 16).

Checking and resurfacing valves

Using buffing or rotating brushes remove carbon deposits from the valves.
Make sure that the valve stems are not deformed , worn or exhibit any cracks.
The stem diameter of a new valve is 7.940 ÷ 7.975 mm.
Verify that the valve stem/valve guide clearance is 0.025 ÷ 0.069 mm. for both intake and exhaust valves(fig.17).
Verify that the centering tolerance between the stem and the valve seat is 0.02 mm.
Verify that the valve seat is not excessively worn or damaged; if necessary, resurface the seat using the appropriate honing tool.

Valves/valve guides assembly data

Valve guide internal ⌀	Valve stem ⌀	Assembly clearance
8.000	7.940	0.025
8.015	7.975	0.075

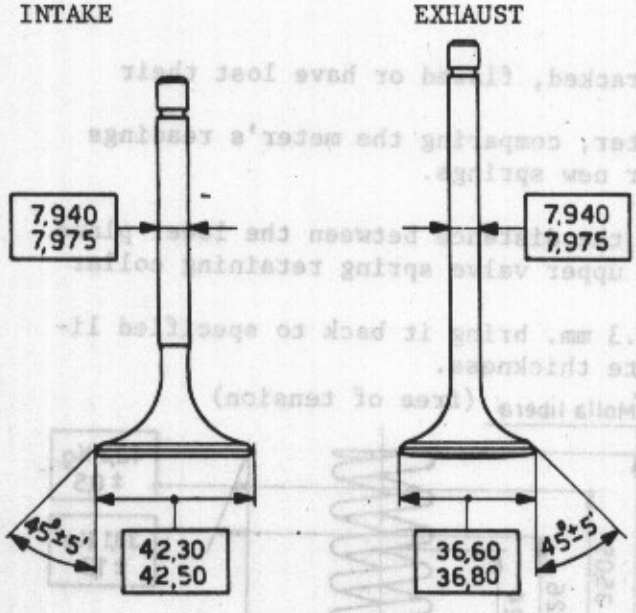


Fig. 17 Intake and exhaust valves principal data.

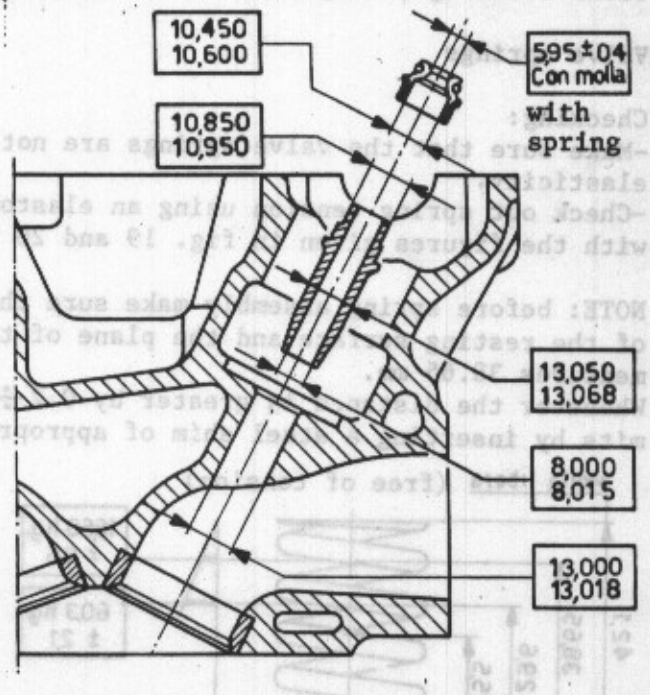


Fig. 18 Valve guides data.

Verify during the honing operation that the thickness of the valve at the valve head is not less than 1 mm. for the intake valve and not less than 1.5 mm. for the exhaust valve. It is advisable to replace the valves during engine repair, especially if the engine has been run for 50 ÷ 60,000 km.
It is also advisable at every rebuild of the valves, to replace the oil retaining rings at the stems, adjusting the new rings on the guides after assembling the valves.

Testing valve action

After valve assembly, carry out the following operations:
-Mount spark plugs.
-Fill the combustion chambers with gasoline or kerosene.
-Blow compressed air (at least 4 ÷ 5 Kg/cm^2) into the intake and exhaust tubes, plugging the air compressor nozzle with a rubber seal in order to achieve a tight fit and prevent air leaks.
-Air bubbles should not be noticed around the valves.

Valve guides

The valve guides are fitted in their seats with an interference of 0.032 ÷ 0.068 mm. Verify that the valve guides are not loose in their seats.
Verify the guide/stem clearance (fig. 18).
The assembly clearance is 0.025 ÷ 0.075 mm. and wear limits are 0.15 mm.
Replace valve guides whwnever the stem/guide clearance is excessive and cannot be corrected with new valves. To remove and reassemble the valve guides, use extractors 312-AS-5514, 312-AS-5513.

NOTE: replacement valve guides are furnished with their internal diameter surfaces already finished. In case of resurfacing, remove scratches or deformations occuring during assembly using polishing tool A.90355.

Valve springs

Checking:
-Make sure that the valve 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. 19 and 20 for new springs.

NOTE: before spring assembly make sure that the distance between the lower plane of the resting surface and the plane of the upper valve spring retaining collar measures 38.65 mm.
Whenever the distance is greater by 0.2 ÷ 0.3 mm. bring it back to specified limits by inserting a steel shim of appropriate thickness.

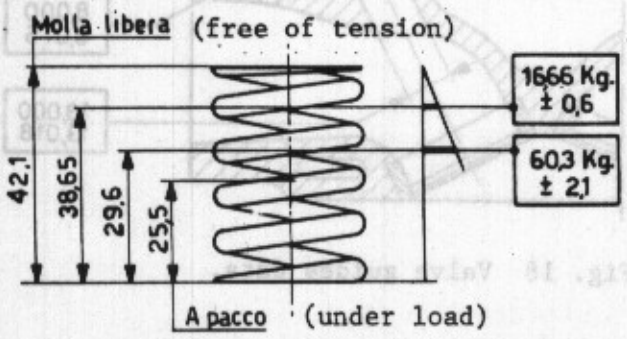


Fig. 19 External valve spring check data.

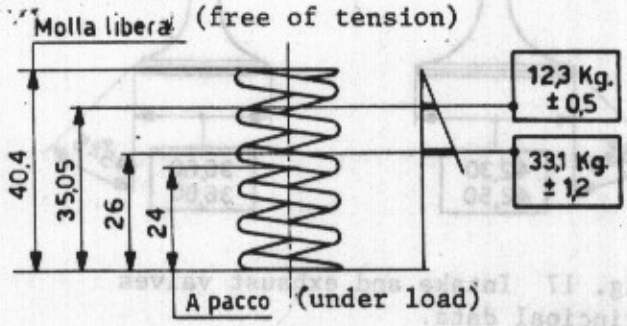


Fig. 20 Internal valve spring check data.

VALVE GEARING (TIMING)

Description

The valves are mounted in the cylinder heads, and are operated by four overhead camshafts.
The camshafts, each pair, are driven by a two row chain from intermediate gears driven by the crankshaft.

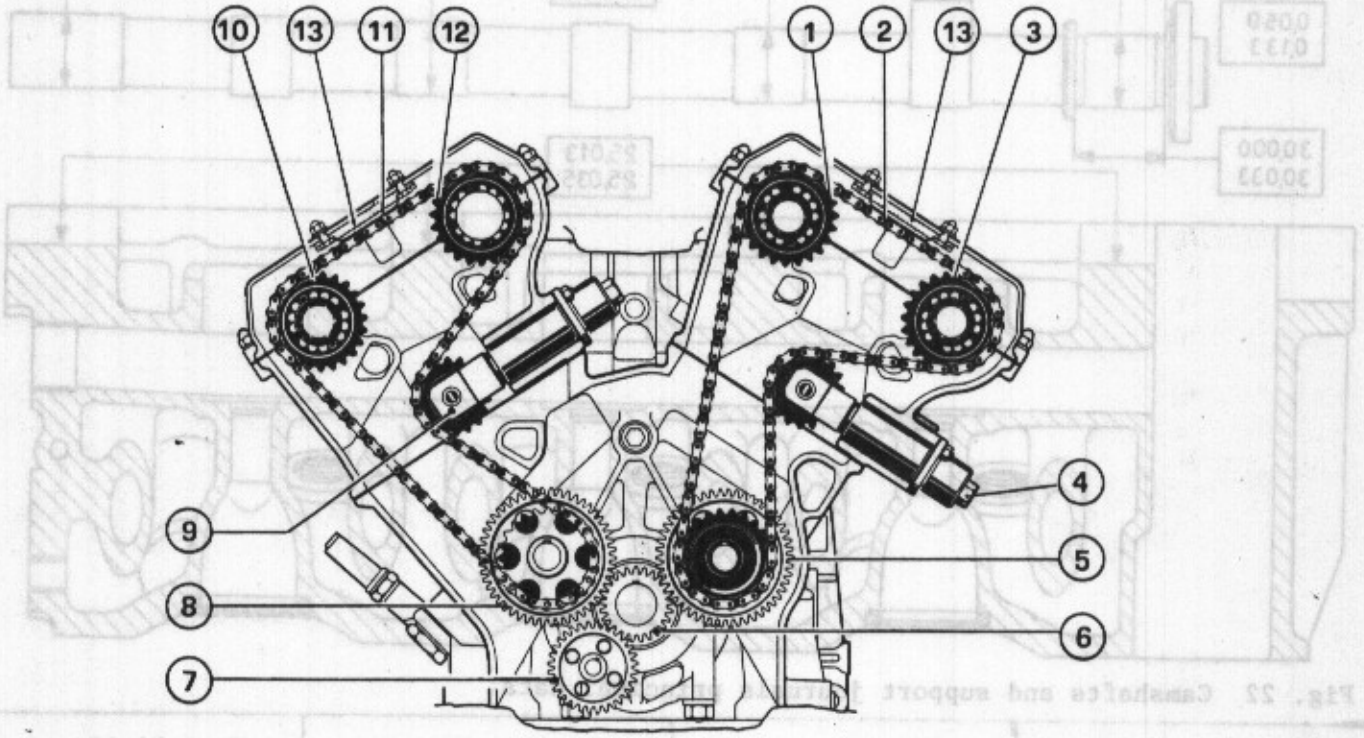


Fig. 21 Diagram of camshaft drive gearing
1.Intake camshaft for cylinders 4-5-6; 2.Chain driving sprockets 1 and 3; 3.Exhaust camshaft sprocket for cylinders 4-5-6; 4.Timing chain tensioner 2; 5.Relay gear and sprocket for driving timing chain 2; 6.Straight cut gear on crankshaft 2 for driving gears 5, 7 and 8 and the water pump and alternator drive pulleys; 7.Oil pump drive gear; 8.Double relay gear for driving chain 11; 9.Chain tensioner for chain 11; 10.Exhaust camshaft sprockets for cylinders 1-2-3; 11.Chain driving sprockets 10-12; 12.Intake camshaft sprocket for cylinders 1-2-3 and timing drive; 13.Timing chain guides.

Camshafts

The camshafts support journals must be smooth and their surfaces in perfect condition. If seizure and wear marks are noted and these cannot be removed with the finest grade rubbing stone, it is suggested that the camshaft be replaced.
-Camshaft lobes require precise examination. Their surfaces must be smooth and free of wear, scratches or alterations of lobe profiles.
-Verify the total height of the lobes. Intake=36.70 mm., exhaust=36 mm.
-To verify the support journals alignment, place the camshaft on a test surface, supported at both ends by parallel bars; with a dial gauge verify the two intermediate support journals. Eccentricity must not exceed 0.02 mm. If it exceeds 0.10 mm., straighten the camshaft with the appropriate tool press.

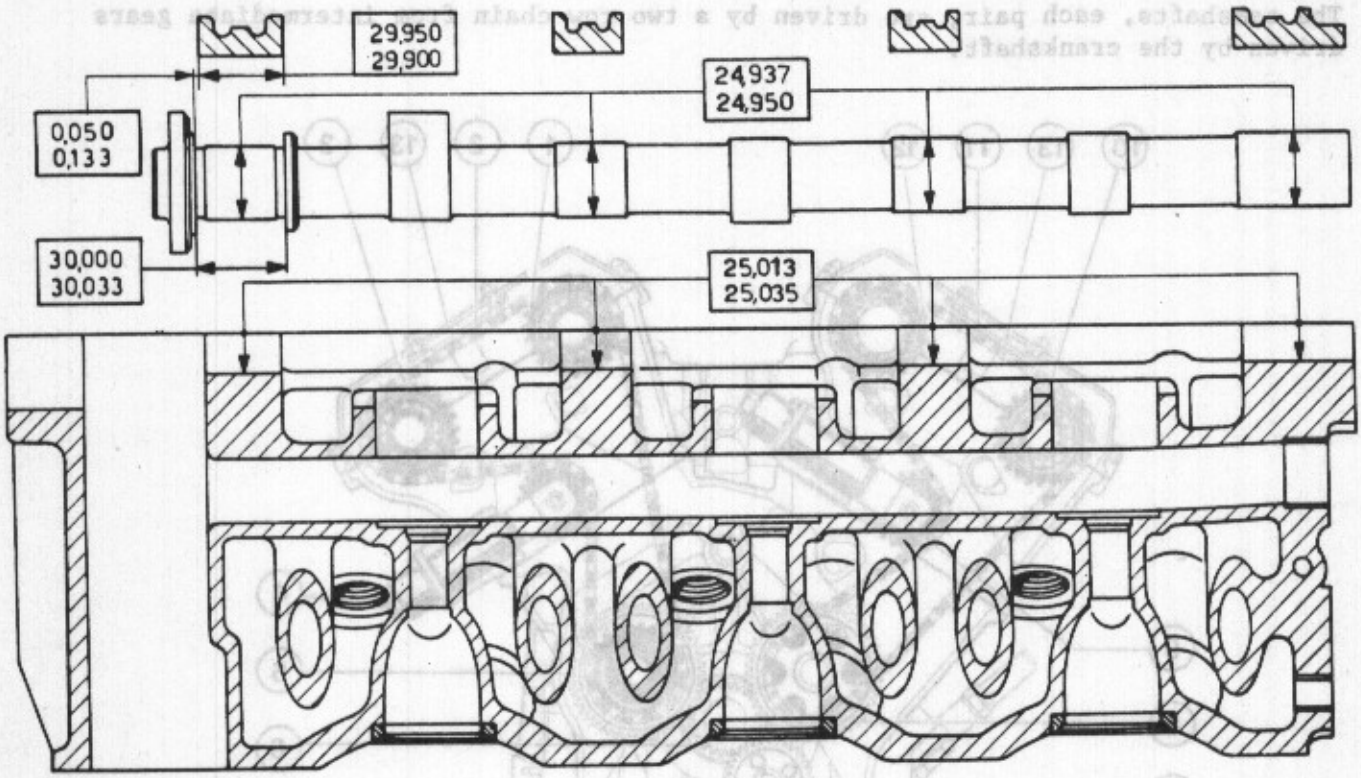


Fig. 22 Camshafts and support journals principal data

Camshaft journals diameter in mm.	Support hole diameter in mm.	Assembly clearance in mm.	Wear limits in mm.
24.937 ÷ 24.950	25.013 ÷ 25.035	0.063 ÷ 0.098	0.15
Camshafts axial clearance	---	0.05 ÷ 0.14	0.2

Valve tappets assemblies

The surfaces of the adjustment shims in contact with the camshaft lobes must be smooth and free of wear, nicks or seizure marks. The outside surface between the tappets and the guide holes must not be excessively worn, out-of-round,or show scratches.
The assembly clearance between the tappets and the guide holes is 0.02 ÷ 0.07 mm.; if these limits are exceeded, substitute the tappet with one that reesta-

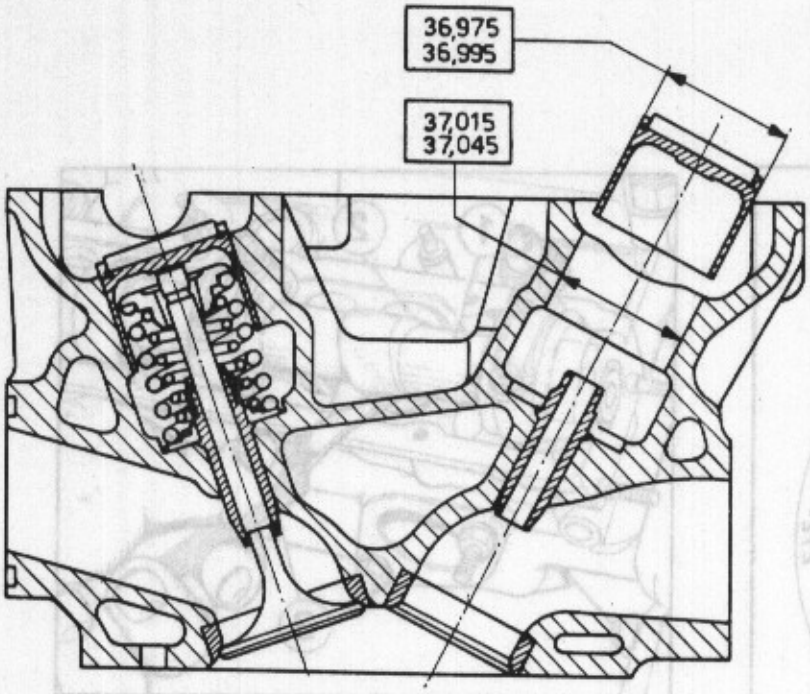


Fig. 23 Assembly data for tappets and their relative cylinder head seating.

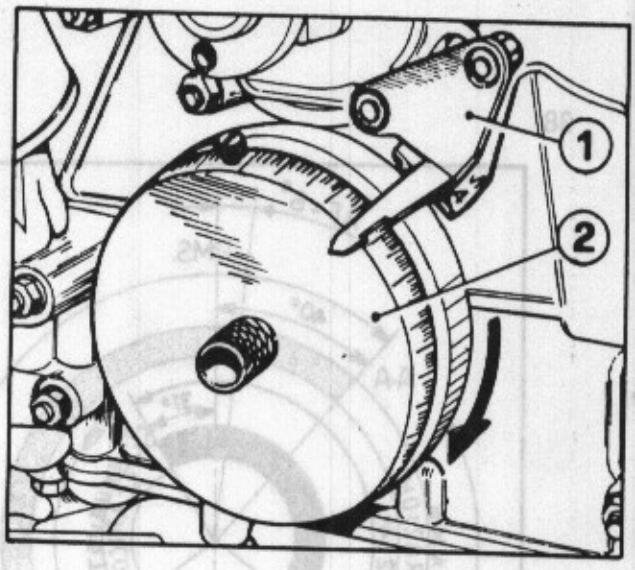


Fig. 25 Positioning of goniometer (protractor scale) for timing check.

blishes the lower tolerance limit.
In order to obtain the exact clearance between tappets and camshaft journals, the tappet shims are provided in thirty different thicknesses (from 3.25 to 4.70 mm.,with an increase of 0.05 mm. between sizes).
The surfaces of the tappet shims must not be tampered with under any circumstances (fig. 23).

Camshafts timing

The timing is to be accomplished in the following manner:
Position the pulley, positioned on the crankshaft, with the reference marks aligned with the notch mark 3 - 4 stamped on a tag attached to the engine block.
Without changing the above reference marks, verify that the notch marks on the camshafts and their front support caps are aligned.
The alignment of the individual marks ensures correct camshaft timing. This alignment can only be completed if cylinder number 3 is positioned in its firing phase, and with the camshaft journals opposed to each other and pointing upwards.
Tappets/camshaft lobes clearance, after timing is set:
intake and exhaust 0.50 mm.

Intake	Opens just before P.M.S. mark	40°
	Closes just after P.M.I. mark	52°
Exhaust	Opens just before P.M.I. mark	53°
	Closes just after P.M.S. mark	31°

AF= Fixed spark advance mark $6° \pm 1°$

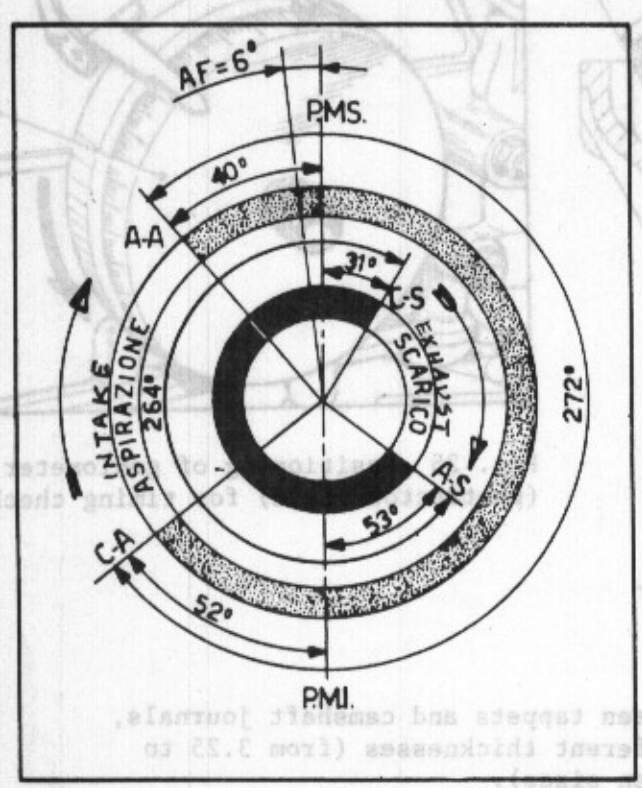


Fig 24 Camshaft operation and timing diagram, 0.5 mm. theoretical degree gap.

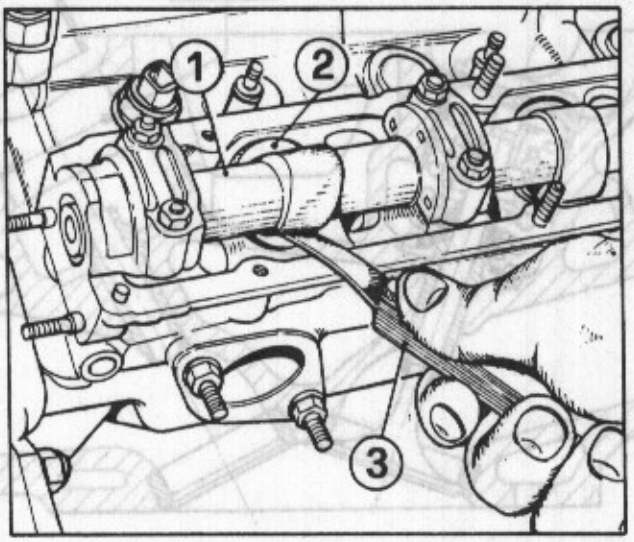


Fig. 26 Checking tappets clearance
1. Camshaft, 2. Tappet assembly,
3. Thickness gauge.

Checking and adjusting valve tappets clearance

In order to check the clearance between the camshafts and the corresponding tappets, carry out the following operations:
-Disconnect the spark plug cables.
-Loosen the retaining nuts of the camshafts front and rear covers.
-Disconnect the accelerator control lever from the timing cover.
Remove the camshaft covers.
-Rotate the crankshaft until the number 4 cylinder valves are in balance (fig. 27), i.e. the exhaust is just about to close and the intake valve is just about to open.
-Check the clearance between the tappet and the lobes at cylinder 3 since this cylinder is at top dead center at the end of the compression stroke and therefore, both valves are fully closed.
Having checked the valve clearance of cylinder 3, check the clearance of the other cylinders, remembering that when the valves of cylinder 5 are in balance, check the clearance of cylinder 1, and when the valves of cylinder 6 are in balance check the clearance of cylinder 2 and vice-versa.

Tappets and camshafts lobes clearance, with cold engine:

Intake	0.15 ÷ 0.20 mm.
Exhaust	0.25 ÷ 0.30 mm.

The clearance between the camshaft lobes and tappets is measured by the variation of the thickness of the steel shims located between the top of the thimble type tappets and the camshaft lobes.

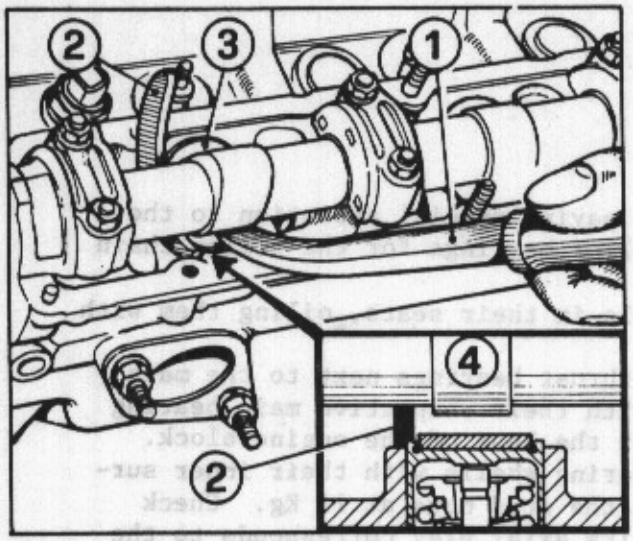


Fig. 27 Shim removal
1. Tool 706-AS-9560, 2. Spacer 706-AS-9560/A, 3. Tappet, 4. Camshaft.

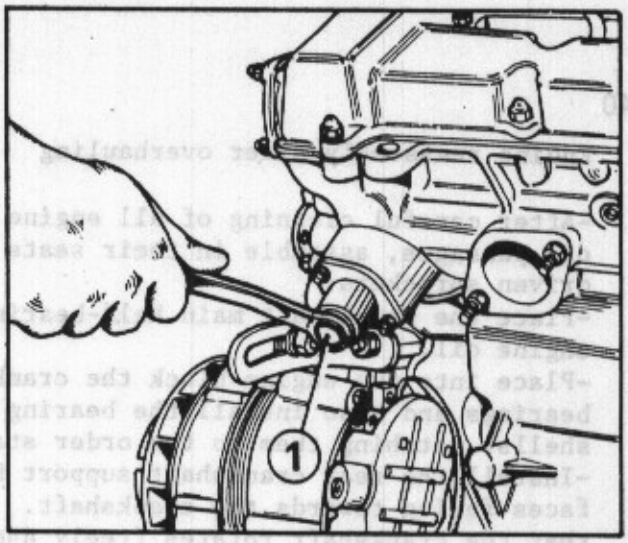
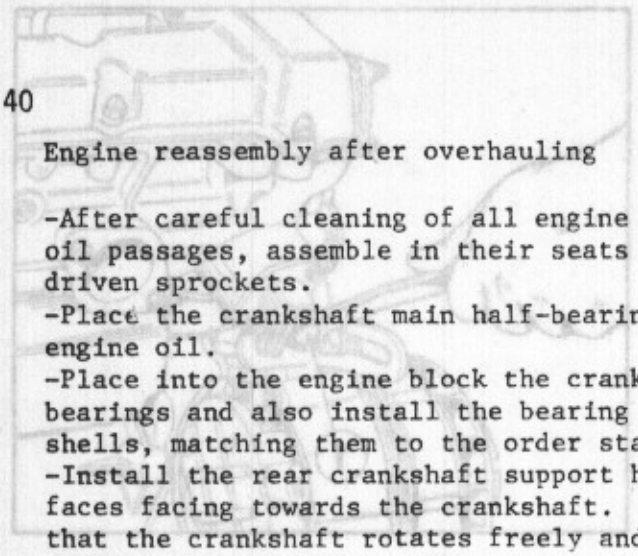


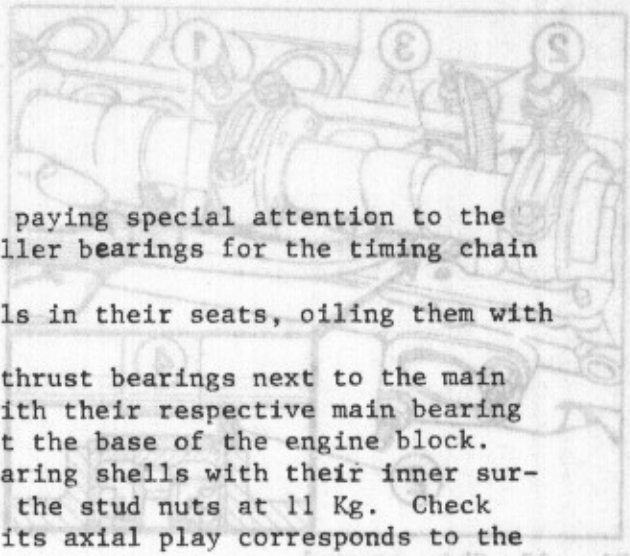
Fig. 28 Adjustment of timing chain tension
1. Nut with sleeve.

To remove the shims, use tool 706-AS-9560, push down on the valve stem caps. Then insert the spacer 2 (fig. 27) to keep the tappet assembly down. After removing tool 1, use compressed air to remove the shim from between the tappet assembly and the cap.

Adjustment of timing chain tension

Whenever it is found necessary to check the timing chain tension owing to excessive noise, proceed as follows:
Loosen by 2 or 3 turns the nut on sleeve 1 (fig. 28) which is screwed onto the timing chain tensioner fixed to the crankcase; this permits the movement of the internal push-rod, which carries the spring. This, with appropriate loading, pushes the chain tensioner against the chain thereby applying the correct tension. Rotate the engine one or two revolutionsand then retighten the lock nut. Repeat the operation on the other row of cylinders. Should the noise still persist remove the camshaft covers and carry out a general check-up.
If the chain has stretched, or for other reasons the marks on the camshafts are found to vary in relation to those on the caps by more than 1 mm., the following procedure should be carried out:
Rotate the engine to top dead center 3 - 4.
Remove the bolt which holds the sprocket to the camshaft which is out of position and remove the two dowel pins placed 180 apart. Rotate the camshaft by the small amount necessary, in order to bring the marks once again into alignment and replace the dowel pins in the two holes in the sprocket, which correspond to those of the camshaft. Tighten once again the nut and the washer which holds the dowel pins in position. Moving by one hole corresponds to a change of 3° in the timing.





Engine reassembly after overhauling

-After careful cleaning of all engine units, paying special attention to the oil passages, assemble in their seats the roller bearings for the timing chain driven sprockets.
-Place the crankshaft main half-bearing shells in their seats, oiling them with engine oil.
-Place into the engine block the crankshaft thrust bearings next to the main bearings and also install the bearing caps with their respective main bearing shells, matching them to the order stamped at the base of the engine block.
-Install the rear crankshaft support half-bearing shells with their inner surfaces facing towards the crankshaft. Torque the stud nuts at 11 Kg. Check that the crankshaft rotates freely and that its axial play corresponds to the prescribed values on p. 28 .
-Assemble pistons with their individual connecting rods according to the diagram in fig. 8 so that the exhaust valve indentation on the piston top points to the outside part of the engine block and the numbers stamped on the connecting rod and its bearing cap. The number stamped on the piston boss represents its class and must correspond to the class of the cylinder into which it is inserted. The number stamped on the connecting rod must also correspond to that of the cylinder which is stamped on the cylinder heads. Torque all head bolts to 7.5 Kg.
-Mount new cylinder heads gaskets (it is advisable to replace these with every removal of the cylinder heads).
-Continue to assemble all the cylinder heads units after checking or substitution (valve guides, valves, valve oil retaining rings, and the two chain tensioners mounted mounted on the bottom). Mount both cylinder heads to the block and torque to 8 Kg. the stud nuts according to the torque schedule in fig. 14.
-To check for cylinder heads water leaks, use the appropriate testing pump; fill the cooling chambers of the block and cylinder heads with hot water if possible, them build up water pressure to 7 ÷ 8 Kg./cm and hold under pressure for 10 ÷ 15 minutes.
Turn each piston to top dead center and blow compressed air into the spark plug holes and into the oil tubes. If no water or oil leaks are noticed, the assembly is correct and normal.
-Place the engine in vertical position and wind the timing chains around the gears mounted on the front small sump. Mount and secure this unit in its proper seating in the block stretching the chains towards the cylinder heads.
-Mount the timing and oil pump driving gears on the crankshaft.
-Fasten the front timing cover with the oil pump group; then fasten the torsional vibration damper torquing the bolt with wrench 706-AS-9563 to 20 Kg. elinating the safety washer.
-Place the engine block in an horizontal position, and fasten tool A 60186 on the engine flywheel flange. Turn piston number 3 to exact top dead center position using tool A 96306/½.
-Check that in this position, the notch stamped on the crown of the torsional vibration damper is aligned with the index mark of P.M. (dead center) 3 - 4 stamped on the stationary tab on the side of the timing case.
-Mount in their seats the intake and exhaust camshafts of cylinder 3 with the camshaft alignment marks in exact alignment to the index marks stamped on the front support caps. Mount all caps to the other support and torque them to 3.3 Kg. (fig. 29).
-Repeat the same operation for the other bank of cylinders without turning the crankshaft.

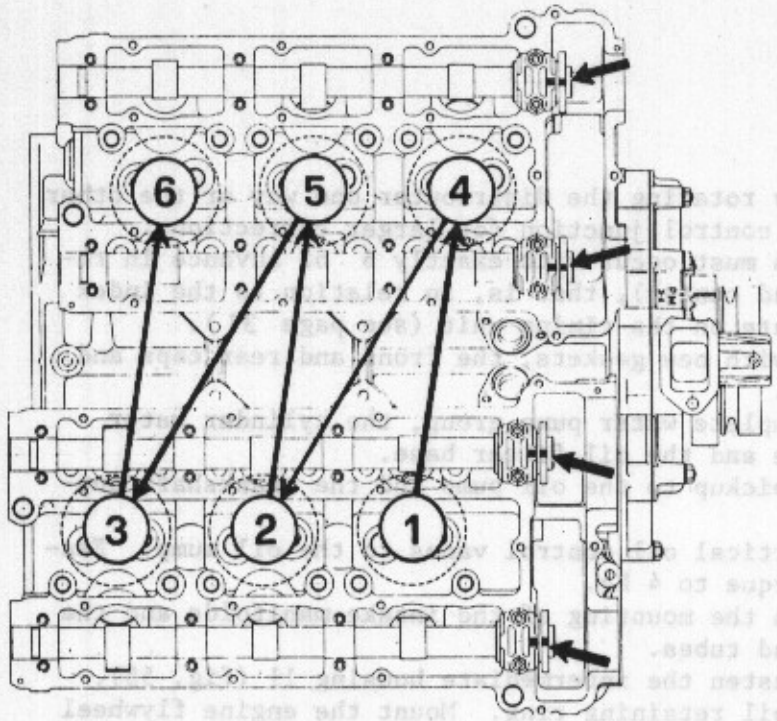
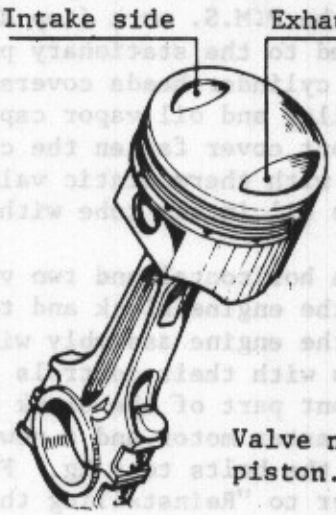


Fig. 29 Ignition diagram
Firing order: 1-4-2-5-3-6.
Camshafts alignment marks in relation to Dead Center marks 3/4 with cylinder 3 in firing phase.



Valve notches in piston.

-Wind the timing chains on the gears of the chain tensioners and on each of the four camshafts timing gears.
Arrange the gears on the camshaft hubs and temporarily tighten the mounting nuts so that the gears can rotate freely on the camshafts.
Loosen the two timing cahin tensioners before tightening them to the exact tension.
Rotate the crankshaft a few times in both directions 10 ÷ 15 ° and turn again to the P.M. mark (dead center) 3 - 4 (see engine timing diagram on p. 35).
-Recheck that the camshaft reference marks are in the exact position in reference to the supports; if not, adjust with tool wrench AV.466.
Mount the two drive pins in the drive gears, making sure that the holes on the gears and on the camshafts are perfectly aligned. Tighten the gear assembly bolts on the camshafts, first inserting the pin retaining washer and the safety plate.
-Check with a feeler gauge the gap between the tappet and the lobe of each valve and replace the shim plate so that the gap is:
intake: 0.15 ÷ 0.20 mm.
exhaust: 0.25 ÷ 0.30 mm.
-Lubricate all engine units with a pressure pump, checking that this oil reaches all camshaft lobes and bearings.
-Again turn piston 3 to top dead center in the firing phase.
-Check that the distributor points contacts gap is 0.32 ÷ 0.38 mm.
-Turn the distributor rotor arm with the red notch in alignment to the mark on the distributor case; turn the small control shaft in the direction of the arrow, rotating the arm 240 (fig. 102), that is , in relation to cylinder 3 firing phase marked on the distributor cap, until the the switch 4 contacts begin to open up.
Fasten the distributor in its seat with the studs positioned in the middle of the mounting holes.
-Chekc the exact opening point of the contact points using a thin feeler gauge or with a stroboscopic light; rotate the crankshaft backwards for a few turns and with a few light taps rotate in the other direction until the feeler gauge blade can be removed from the contacts with the slightest pressure, or until the stroboscopic light goes out.

_Slight corrections can be made by rotating the distributor one way or the other on its support; or on its support control junction for larger corrections.
-The start of the contact openings must occur with exactly 6 of advance in relation to the P.M.S. mark (top dead center), that is, in relation to the index mark stamped to the stationary plate on the timing unit (see page 37).
-Mount the cylinder heads covers with new gaskets, the front and rear caps and the oil filler and oil vapor caps.
-On the front cover fasten the complete water pump group, the cylinder water intake cap with thermostatic valve and the oil filter base.
-Fasten the oil intake tube with pickup to the oil pump and the crankshaft support.
-Fasten the horizontal and two vertical oil control vanes to the oil sump. Fasten it to the engine block and torque to 4 Kg.
-Complete the engine assembly with the mounting of the intake manifolds and the carburetors with their controls and tubes.
-On the front part of the block fasten the intermediate housing 11 (fig. 55), with the starter motor and a new oil retaining ring. Mount the engine flywheel tightening the bolts to 4 Kg. For mounting of the clutch and clutch control group, refer to "Reinstalling the Clutch" on page 75 .

Running in and bench testing of rebuilt engine

Once the assembly is finished, mount the engine on a test stand, for the running-in of all reworked surfaces, for timing purposes and to check power output and oil and gas consumption.
The following operations must be carried out:
-Fill the engine with oil to the proper level.
-Run engine for 5 minutes at 1500 rpm's to check water, oil circulation and for leaks.
-Run the engine for 40 minutes at 2300 rpm's, with a brake load of 11.4 Kg.(cv 26).
-Repeat the test for 40 minutes at 4000 rpm's, with a brake load of 13.5 Kg. (cv 54).
-Check and adjust the ignition timing at 38° at 5000 rpm's.
-Carry out another check for 40 minutes at 5700 rpm's with a brake load of 18 Kg. (cv 102); toward the end of the test the oil temperature should be 110 C. and its pressure at 60 Kg/cm^2. Stop the engine, check the engine oil level and after 5 minutes of engine rest, check the oil level again.
-Restart and run engine to 5700 rpm's, with a brake load of 18 Kg. (cv 97), for one hour without interruption, keeping the oil temperature at 110° C.
With engine stopped, after 5 minutes refill the oil capacity to exact level, measuring the quantity puored in. One hour's consumption should be between 0.150 ÷ 0.250 Kg., equal to 1 ÷ 1.30 grams per CV/hour.
-Check the power output curve, with the accelerator fully open, starting from 2000 rpm's to 7500 rpm's with pauses between each 1000 rpm's increases. At 5 and 7000 rpm's check the fuel consumption.
The normal figures are 220 grams per CV/hour at 5000 rpm's and 240 grams per CV/hour at 7800 rpm's.
Without altering the brake load adjustment at 7000 rpm's, gradually close down the accelerator to 5000 rpm's and recheck fuel consumption. The median value is 230 grams per CV/hour.
-With a tuning instrument adjust all carburetors without removing the exhaust manifolds.
_Make a final check of the engine for external leaks.

NOTE: If the engine is reinstalled in the car without a bench test (running-in of the engine), it is advisable to recheck the tightness of the cylinder head bolts after mounting the engine in the chassis, slowly loosening them, then re-torquing them to 8 ÷ 8.2 Kg.

Engine Assembly Operations Check.

If the overhauled engine has not been bench-tested, this must be done after it has been mounted back in the car, in order to verify correct reassembly and operation. After ensuring that the carburetor bowls are filled, start the engine, and while running, carry out the following operations:
- make sure that all water sleeves and delivery tubes are not leaking fluids. This must be done for both the engine cooling circuit and the car's internal heating system. Tighten all respective connections and clips.
- there must not be any oil leakages:
a) from the cylinder head gaskets. If leaks are noticed, make sure that the cylinder head bolts are properly tightened. If leaks continue, it is necessary to remove the cylinder head covers and verify that the cylinder head gaskets are properly mounted; remount them if necessary, or replace them if damaged.
b) tighten all oil pan bolts to assure against leaks.

NOTE: If the engine has been bench tested, operations a and b will not be necessary as all operations checks should have been performed then.
Verify that the carburetors throttle connections fully open and close the carburetor butterfly valves, adjust the connections if necessary. Make sure that the cold-start choke system can be fully engaged and disengaged.
Accurately verify that the idle speed circuit functions as described in the section "Carburetors" (page 64).
Check and tighten, if needed, the alternator and the water pump belt according to the proper tension.
Verify the operations of the engine's electrical system and contacts by checking their respective dashboard instruments lights.

TORQUE SPECIFICATIONS

Individual Units	Thread	Torque specifications in Kg.
Cylinder heads	10 x 1.25	8
Main bearings caps	12 x 1.25	11
Connecting rods bearings caps	10 x 1	7.5
Camshafts caps	6 x 1	3.3
Flywheel	10 x 1.25	8.5
Spark plugs	14 x 1.25	3.8
Engine to chassis mounts	12 x 1.25	7
Camshafts toothed gears	18 x 1.5	11
Torsional damper	18 x 1.5	20 (min. 17 - max. 21)

NOTE: If the engine is reinstalled in the car without a bench test (running-in of the engine), it is advisable to recheck the tightness of the cylinder head bolts after mounting the engine in the chassis, slowly loosening them, then re-torquing them to 8 ÷ 8.2 Kg.

Engine Assembly Operations Check.

If the overhauled engine has not been bench-tested, this must be done after it has been mounted back in the car, in order to verify correct reassembly and operation. After ensuring that the carburetor bowls are filled, start the engine, and while running, carry out the following operations:
- make sure that all water sleeves and delivery tubes are not leaking fluids.
This must be done for both the engine cooling circuit and the car's interna1 heating system. Tighten all respective connections and clips.
- there must not be any oil leakages:
a) from the cylinder head gaskets. If leaks are noticed, make sure that the cylinder head bolts are properly tightened. If leaks continue, it is necessary to remove the cylinder head covers and verify that the cylinder head gaskets are properly mounted; remount them if necessary, or replace them if damaged.
b) tighten all oil pan bolts to assure against leaks.

NOTE: If the engine has been bench tested, operations a and b will not be necessary as all operations checks should have been performed then.
Verify that the carburetors throttle connections fully open and close the carburetor butterfly valves, adjust the connections if necessary. Make sure that the cold-start choke system can be fully engaged and disengaged.
Accurately verify that the idle speed circuit functions as described in the section "Carburetors" (page 64).
Check and tighten, if needed, the alternator and the water pump belt according to the proper tension.
Verify the operations of the engine's electrical system and contacts by checking their respective dashboard instruments lights.

TORQUE SPECIFICATIONS

Individual Units	Thread	Torque specifications in Kg.
Cylinder heads	10 x 1.25	8
Main bearings caps	12 x 1.25	11
Connecting rods bearings caps	10 x 1	7.5
Camshafts caps	6 x 1	3.5
Flywheel	10 x 1.25	8.5
Spark plugs	14 x 1.25	3.8
Engine to chassis mounts	12 x 1.25	7
Camshafts toothed gears	18 x 1.5	11
Torsional damper	18 x 1.5	20 (min. 17 - max. 21)

SECTION 3

LUBRICATION

COOLING

FUEL FEED

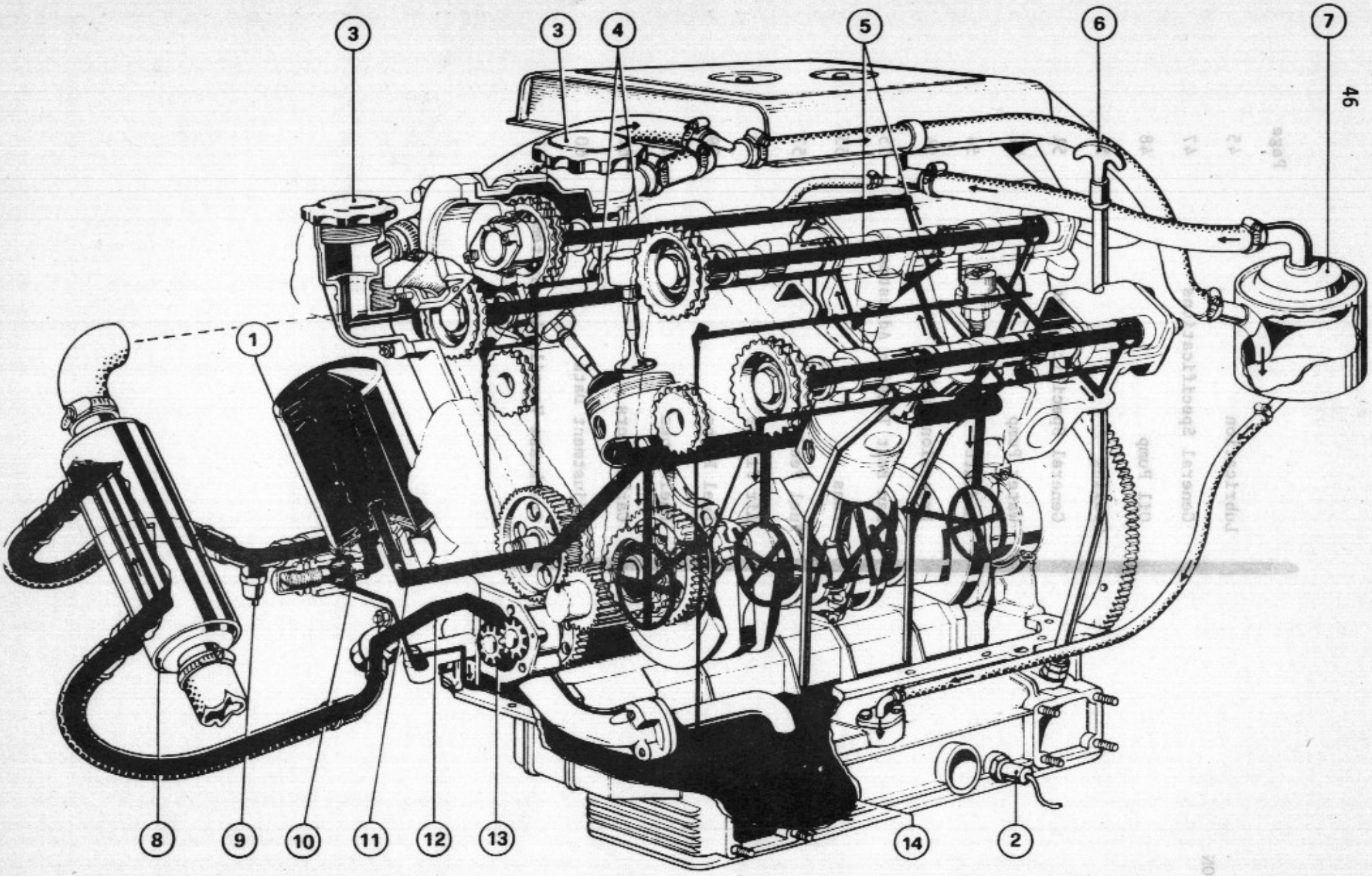


Fig. 30. Engine Lubrication Diagram

LUBRICATION

General Descriptions

Description

Engine lubrication is of the pressure type with a gear-driven pump fastened to the engine timing assembly and controlled by gears driven by the crank shaft.
The lubrication system is made up of:
--A screened intake tube pick-up, attached to the oil sump and to the pump.
--A leak proof filter mounted on the timing assembly.
--An oil pressure regulator valve as part of the filter support.
--A heat exchanged installed in the oil cooling sending circuit.
--A low oil pressure electrical cut-out warning switch.
--An oil pressure electrical transmitting unit.
--An oil temperature thermocouple.

Oil Pressure

The normal oil lubrication pressure must not drop below 5.5 Kg/cm^2 or go over 7 Kg/cm^2, with the engine running under load at 7800 rpm's and oil temperature at $110 \div 120\,^{\circ}C$.
If under the above temperature and rpm conditions the pressure drops below 4.5 Kg/cm^2, it is necessary to drop the maximum allowable operating rpm's by 1000 and analyze and search for the cause of the falling pressure.

Oil Circuit

Oil circulation within the engine occurs as follows:
The pump sucks the oil from the sump and sends it through a tube to the heat exchanger mounted on the delivery circuit.
Here the oil is heated if its temperature is lower than the engine cooling water which circulates around the heat exchanger, and cools the oil if its temperature is higher.
From the exchanger it goes through the filter, and along the engine lubricating the various units.
NOTE: The maximum quantity of oil must be 7 liters, including the oil in the filter, and its level must be checked every 500 Km with the proper oil gauge dipstick.

The oil level must never go below the above minimum and maximum levels indicated on the dipstick when changing or adding oil.

Every 10,000 Km, when the engine is hot, drain the oil by removing the three (3) drain bolts below the sump (fig. 31).
Also replace the oil filter and check for leaks after the operation.
With a new or rebuilt engine the oil change must occur at lower intervals and precisely:
after 1000 Km and after 3000 Km.
At 3000 Km also replace the filter.

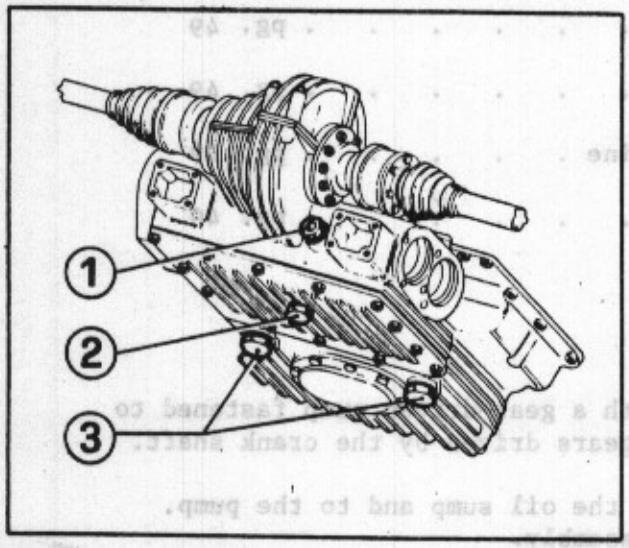


Fig. 31. Position of drain and filler plugs. (engine and gearbox-differential)

1. Gearbox and differential oil filler plug. 2. Gearbox-differential oil drain plug. 3. Engine oil drain plugs.

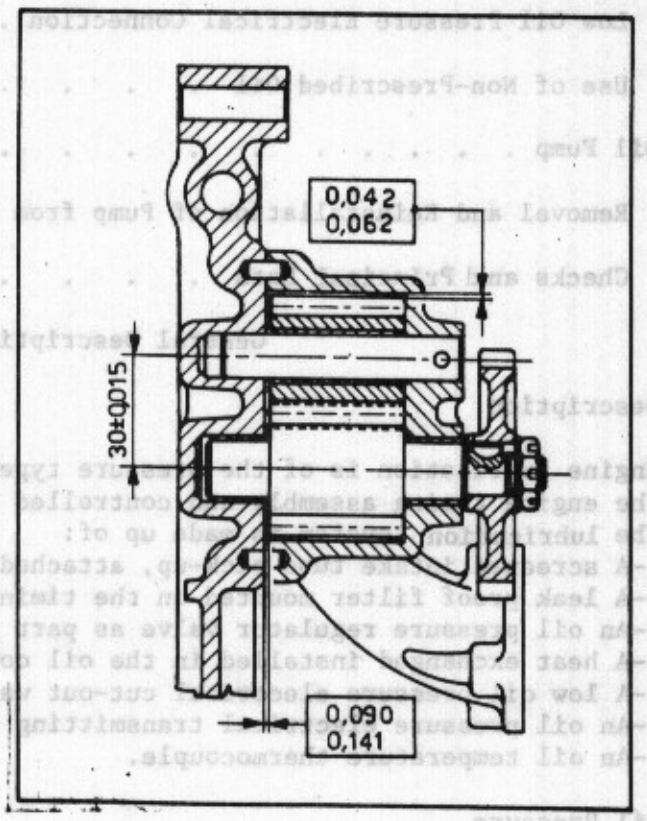


Fig. 32. Oil pump sectional view.

Oil Pressure Indicator and Low Pressure Warning Light.

The indicator is mounted in the upper part of the engine block. It is connected to a dashboard instrument through an electrical cable. A red indicator light is contained within the dashboard instrument.
The low pressure warning light turns on when the ignition is turned on and turns off when the engine starts, and the oil pressure is sufficiently high to ensure normal lubrication at low operating speed.
The warning light comes on when the oil pressure is below $0.5 \div 0.8$ Kg/cm^2.

Use of Non-Prescribed Oil.

If it is required to use a different type oil then that recommended, it is necessary to adopt the following procedure:
--Completely drain the engine oil, with engine hot, by removing the drain plugs or the inspection cover of the intake filter.
--Add into the sump 4 liters of the prescribed type oil and warm it by running the engine for about 10 minutes at 2000 ÷ 2500 rpm's.
Drain this oil and substitute the filter.
--Fill to the maximum level with new oil and change oil and filter every 1000 Km.

Oil Pump

Removal and Remounting of Pump from Engine

To work on the oil pump it will be necessary to remove the entire engine, transmission and clutch group from the car.
For this operation, refer to page 19.
Fasten the whole group to rotating engine stand AV617 and execute the following operation:
--Drain the oil from the engine and the clutch housing.
--Disconnect the clutch housing with the clutch control mechanism unit, the clutch, the engine flywheel and the intermediate housing as described on page 74.
--From the front part of the engine timing unit remove the water pump, the torsional vibration damper, and the alternator control pulley.
--Unscrew all bolts that fasten the engine to the sump and with a proper lift, or steel cables, lift the unit from the rest of the group and maintain in a horizontal position in order not to force the centering pins.
--Unscrew all screws and bolts which fasten the cover the timing unit and to the oil pump intake tubing and disconnect it completely from the pump.
--Also disconnect from the cover the entire pump group and with an extractor remove the control gear from the oil pump pinion shaft.

Disassembly

--Remove the pump cover and remove the two gears from the pump housing.

Examination and Principle Data

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. Carry out all the checks listed in the table on page 50 and replace all units whose wear limits exceed those listed on the table.
For reassembly of the group to the timing unit and on the engine, reverse the operations described for the removal as above.

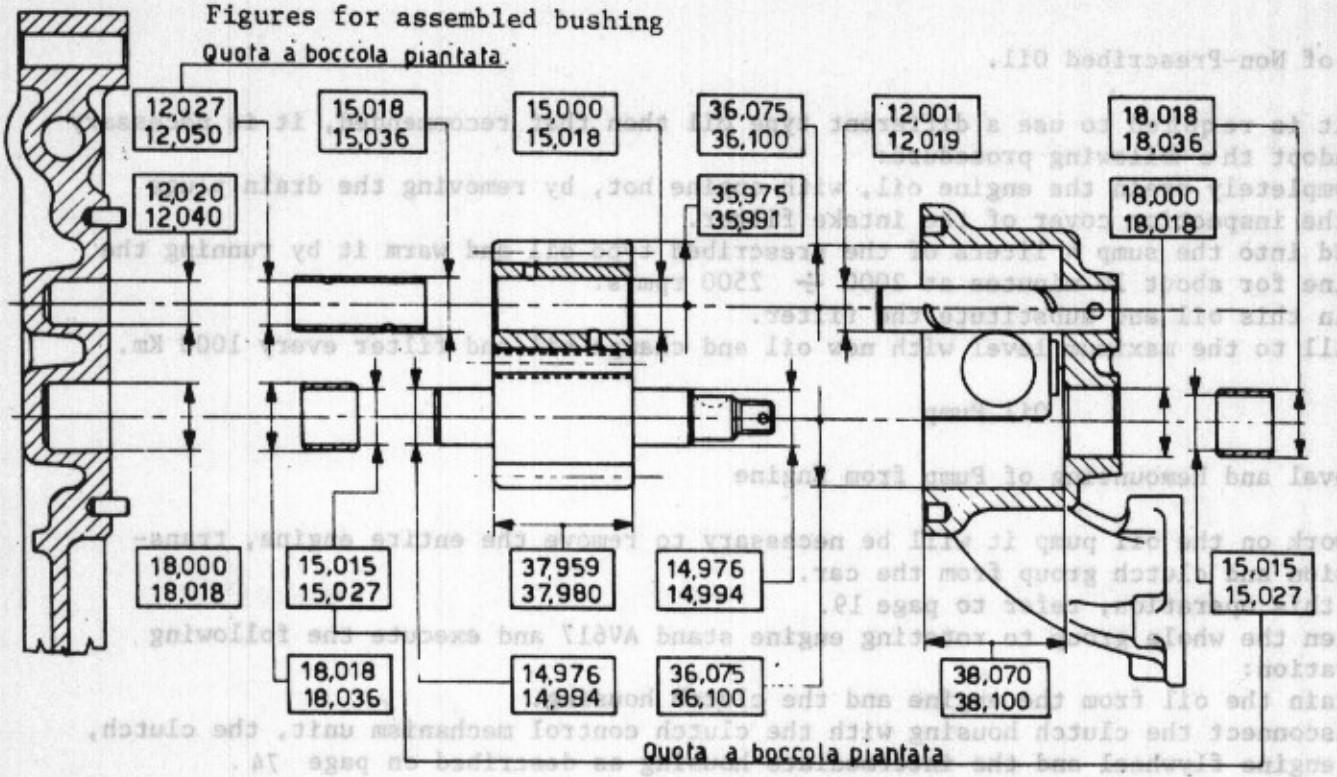
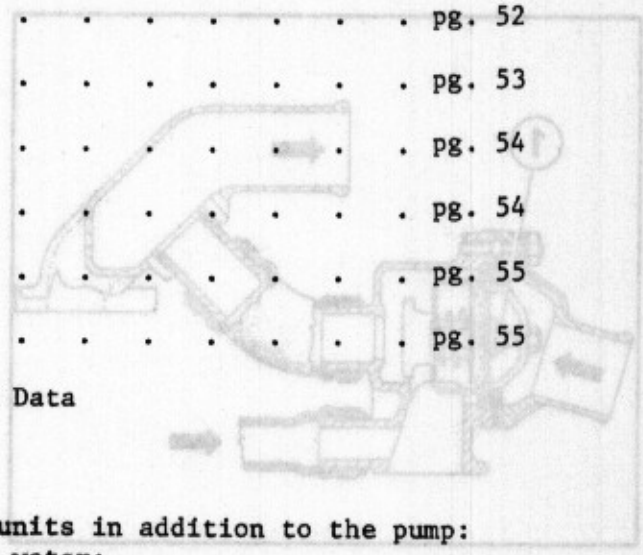


Fig. 33. Principal data for clearance checks of oil pump and oil pump drive units.

Assembly Clearance and Interference Data

Pump Units	Assembly Clearances (mm)	Wear Limits (mm)
Between the main drive shaft bushing and the relative pump body seat.	0.000 ÷ 0.036 interference	
Between the gear height and the pump body depth.	0.090 ÷ 0.141	
Between the main drive shaft and the pump body bushings holes.	0.021 ÷ 0.051	0.08
Between the driven gear hole and the external diameter of the bushing.	0.000 ÷ 0.036 interference	
Between the central shaft and the driven gear.	0.008 ÷ 0.049	
Between the driven gears external diameter and the pump body.	0.042 ÷ 0.062	
Between the driving and driven gear teeth sides.	0.2	

ENGINE COOLING



General Data

Description

The cooling system contains the following units in addition to the pump:
--a horizontal radiator for cooling of the water;
--a thermostat placed in the pump water intake;
--a heat exchanger for engine oil cooling;
--a supplementary expansion tank connected to the radiator and the water pump;
--two electric fans (3 bladed) for radiator cooling, mounted on the chassis. Their engagement and disengagement are regulated by a thermostatic switch mounted on the lower part of the radiator;
--a water drain tap located on the radiator to pump hose;
--an air bleed valve located on the top part of the radiator.

Cooling Circuit

Circulation occurs under pressure (Kg/cm q 0.9). Maximum allowable temperature is 110÷115° C.
Engine cooling occurs through an antifreeze/water mix giving protection to -10° C. (For other ambient temperature settings see page 7 schedule).
The cooling circuit is as follows:
The pump retrieves water from the lower part of the radiator and sends to the cylinders and the heads, passing it first through the heat exchangers.
The thermostatic valve, situated in the water intake tube, controls the flow of water through the radiator until it reaches the proper working temperature necessary to provide engine protection.
The sensing element of the valve is connected through a cylinder head cooling water exhaust tube; the water circulation is also interrupted by this valve, forcing the water returning from the cylinders to the radiator.
The valve begins operating at 82 ÷ 84° C.

The pump intake tube is also connected with the expansion tank, which serves to provide additional water to the cooling circuit.
To refill the system carry out the following operations:
--Loosen the air bleed valve to spill water into the expansion tank.
--When water bleeds out of the valve close the valve and refill the system.
--Start the engine and heat the water to normal operating temperatures;
Reopen the bleed valve and close again if water escapes;
with great caution remove the expansion tank cap after a few minutes if the water is very hot.
--Refill until the tank level is about 5 cm. below the pour spout.

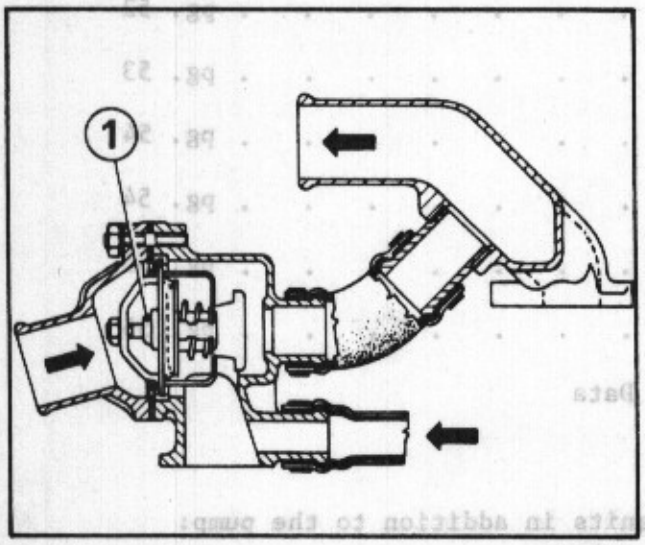


Fig. 34. Thermostat valve support side view.

1. Thermostat valve.

Faults and Checks

If excessive heating of the water is noted during engine operation, proceed to check the thermostatic valve operation and water temperature; if it is normal (82 °C ÷ 84 °C.), overheating is probably due to the following:
--Defective operation of the thermostatic switch.
--Air in the system.
--Irregular or partial functioning of the radiator electric fans.
--Irregular functioning of the water pump.
--Defective tank cap.
--Loss of water through the system-low water level in supplementary tank.
--Leak into the engine due to faulty cylinder head gaskets.
--Inefficient cooling of radiator due to encrustations or sediment.
Internal engine leaks can be traced by running the engine at low rpm's and checking whether air bubbles are formed in the expansion tank which has been completely refilled.
Leaks can also be noted if oil is noticed in the radiator water.

Water Pump

Removal and Reinstallation

The water pump group can be removed from the engine, without removing the engine, as follows:
--Drain all the water from the system opening the lower drain cap.
--Lift the car from the rear and remove the right wheel from the hub.
--Disconnect the oil tube between the heat exchanger and the filter.
--Remove the oil filter.
--Disconnect from the hub of the pump shaft the control pulley and the belt.
--Remove the water intake tube from the pump and the connecting tube to the expansion tank.
--Remove the pump group from the timing unit.
For reinstallation of the pump repeat the above operations in reverse.

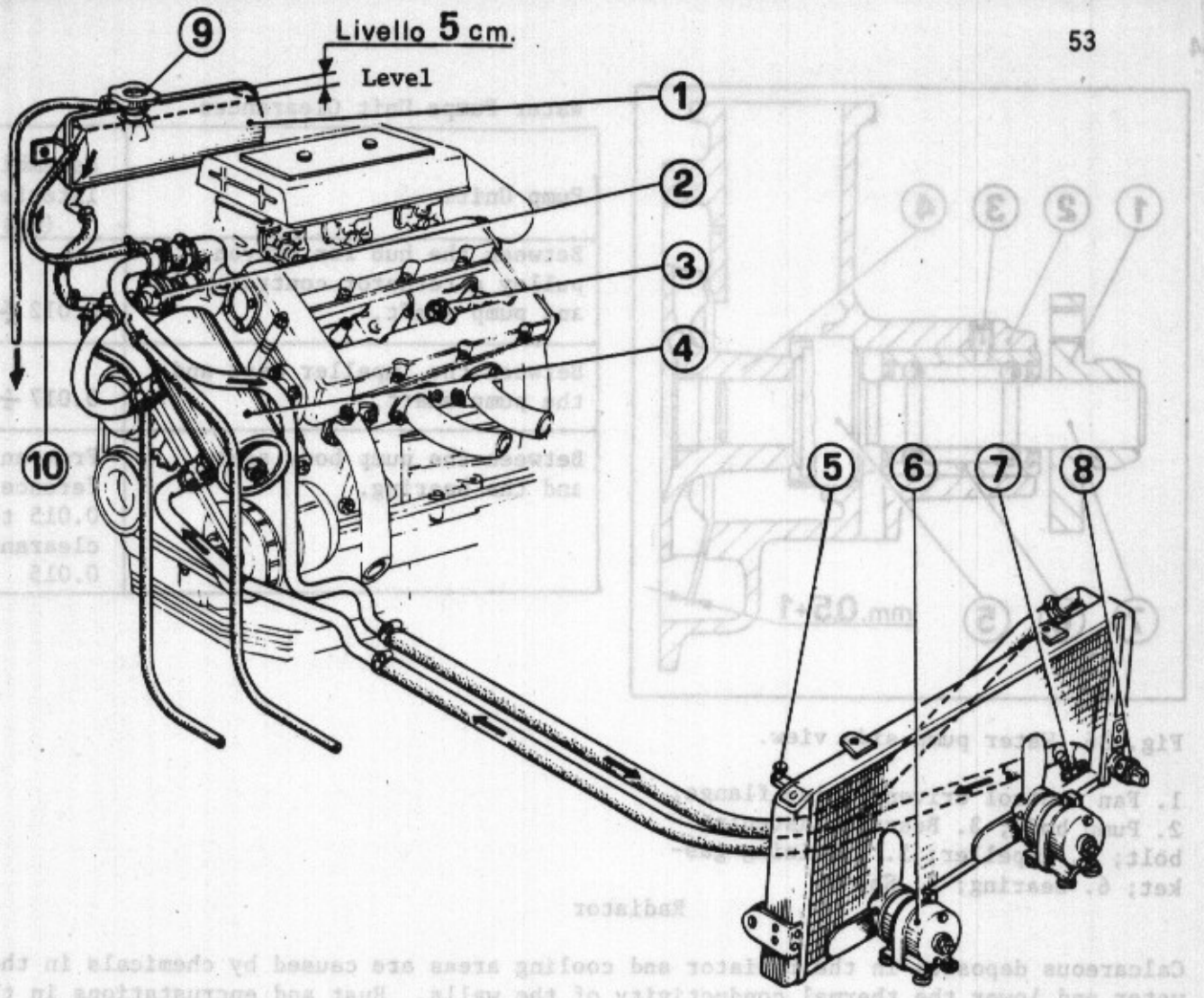
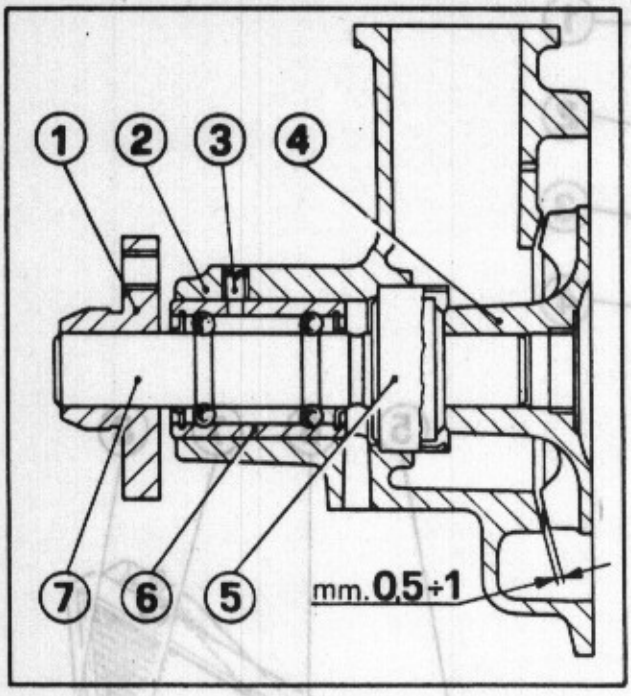


Fig. 35 Engine Cooling Diagram.
1-Supplementary expansion tank; 2-Thermostatic valve; 3-Thermostat; 4-Heat Exchanger; 5-Air bleed tap; 6-Electric fans; 7-Water drain tap; 8-Thermo-Contact switch; 9-Tank cap; 10-Bleed tube.

Overhauling and Checks

Bearing 6 (fig. 36) of the pump is part of a unit with shaft 7 of impeller 4.
The internal housing of the bearing is pressure sealed with lubricant when manufactured, and needs no lubrication during operation. The bearing is fastened to the pump housing through retaining bolt 3. If the bearing needs replacement, the bearing/shaft unit must be replaced, remembering that impeller 4 and the pump control pulley hub 1 are mounted on the shaft with a small press and must withstand rotation forces of 2.5 Kgs. When assembling the pump unit ensure that the gap between the impeller blades and the pump housing is 0.5 ÷ 1 mm.



Water Pumps Unit Clearances

Pump Units	Assembly Interference (mm)
Between the hub for driven pulley alternator control and pump shaft.	0.012 ÷ 0.060
Between the impeller seat and the pump shaft.	0.017 ÷ 0.060
Between the pump body seat and the bearing.	From an interference of 0.015 to a clearance of 0.015

Fig. 36. Water pump side view.

1. Fan control driven pulley flange; 2. Pump body; 3. Bearing fastening bolt; 4. Impeller; 5. Retaining gasket; 6. Bearing; 7. Shaft.

Radiator

Calcareous deposits in the radiator and cooling areas are caused by chemicals in the water and lower the thermal conductivity of the walls. Rust and encrustations in the system can be noticed by a reddish coloring or additional density of the cooling water, and can indicate cooling system obstructions. Also any retardation in the warming up of the water can be traced to a leak or clogging-up of the thermostatic valve.
NOTE: The internal cleaning and disencrustation of the radiator and cooling tubes must be conducted according to the instructions prescribed by the manufacturer of the internal cleaning liquid used.
This operation should be carried out yearly before the winter season and the adding of the antifreeze solution.
Check the water level and addition of water must be done with a cold engine.
Do not add any outside additional unit to the car that can impede the air flow to the radiator.

Expansion Tank

This is located in the rear part of the car, behind the engine, and is connected by two tubes to the radiator and the water pump.
A cap with a bleed valve and an excessive tube, rated at 0.9 Kg/cm^2, is situated at the top. It receives hot water and steam from the radiator, condenses the steam and recycles the water when the radiator is cooled. With cold engine and regular operation, the expansion tank water level is stabilized at about 5 cm. from the top thread of the tank.

Alternator and Water Pump Control Belt Tension Adjustment

The alternator and water pump are driven, through pulleys, by a belt driven by a pulley mounted on the front end of the engine crankshaft.
The exact tension of the belt is of maximum importance to good engine operation; incase of loose tension the belt has a tendency to slip on the pulley with the following grave consequences:
--tendency of the engine towards overheating due to insufficient water pump rotation;
--insufficient charging of the alternator, due to insufficient rotation;
If belt tension is excessive, it will cause undue pressure on the water pump drive shaft increasing wear on its bearing, as well as on the alternator bearings.
To adjust belt tension, proceed as follows:
--Loosen nuts 1-2 (fig. 37) of the alternator fastening bolts at the mounting posts.
--Move the alternator towards the outside until exact belt tension is obtained;
--tighten the nuts in order to fasten the alternator in position;
--finally check that the belt can be compressed to 10 ÷ 15 mm. under 10 Kg. pressure.

Electric Fans

Two engine water cooling fans are mounted in front of the radiator. Their engagement is controlled by an electric thermocontact switch located in the lower part of the radiator and switches on when the water temperature reaches 84° C.
Their disengagement occurs automatically when the water temperature reaches 75° C.
The fans electric circuit is protected by a 30 A fuse.

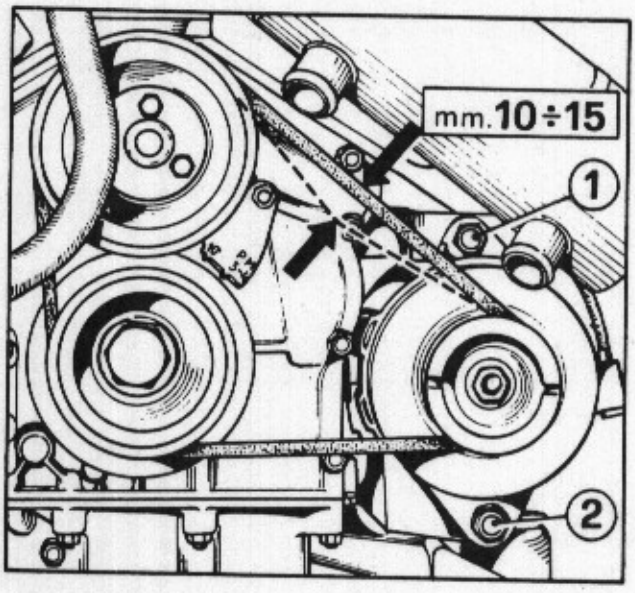


Fig. 37. Belt tension adjustment.

Alternator and Water Pump
Control Belt Tension
Adjustment

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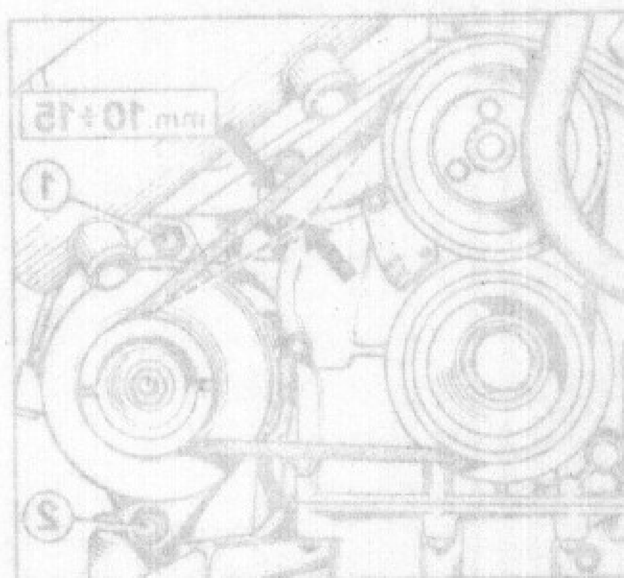
Fig. 37. Belt tension adjustment.



FUEL FEED

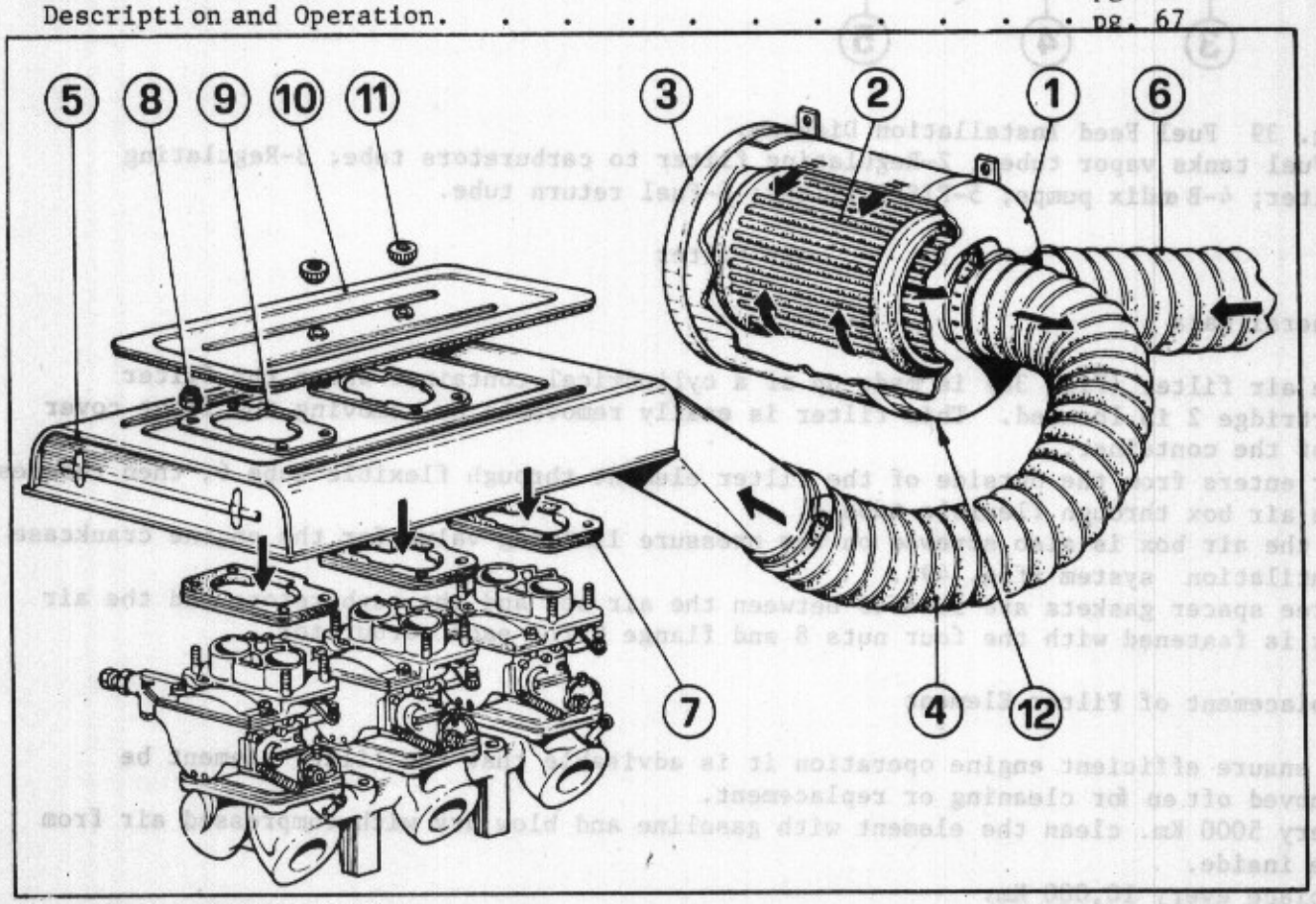


Fig. 38 Air Filter Unit.
1-Filter container; 2-Filter; 3-Container cover; 4-Container to air box air tube; 5-Air box; 6-External air tube to filter container; 7-Carburetor gasket; 8-Carburetor/air box retaining nuts; 9-Reinforcement flange; 10-Air box cover; 11-Cover retaining nuts ; 12-Water drain hole.

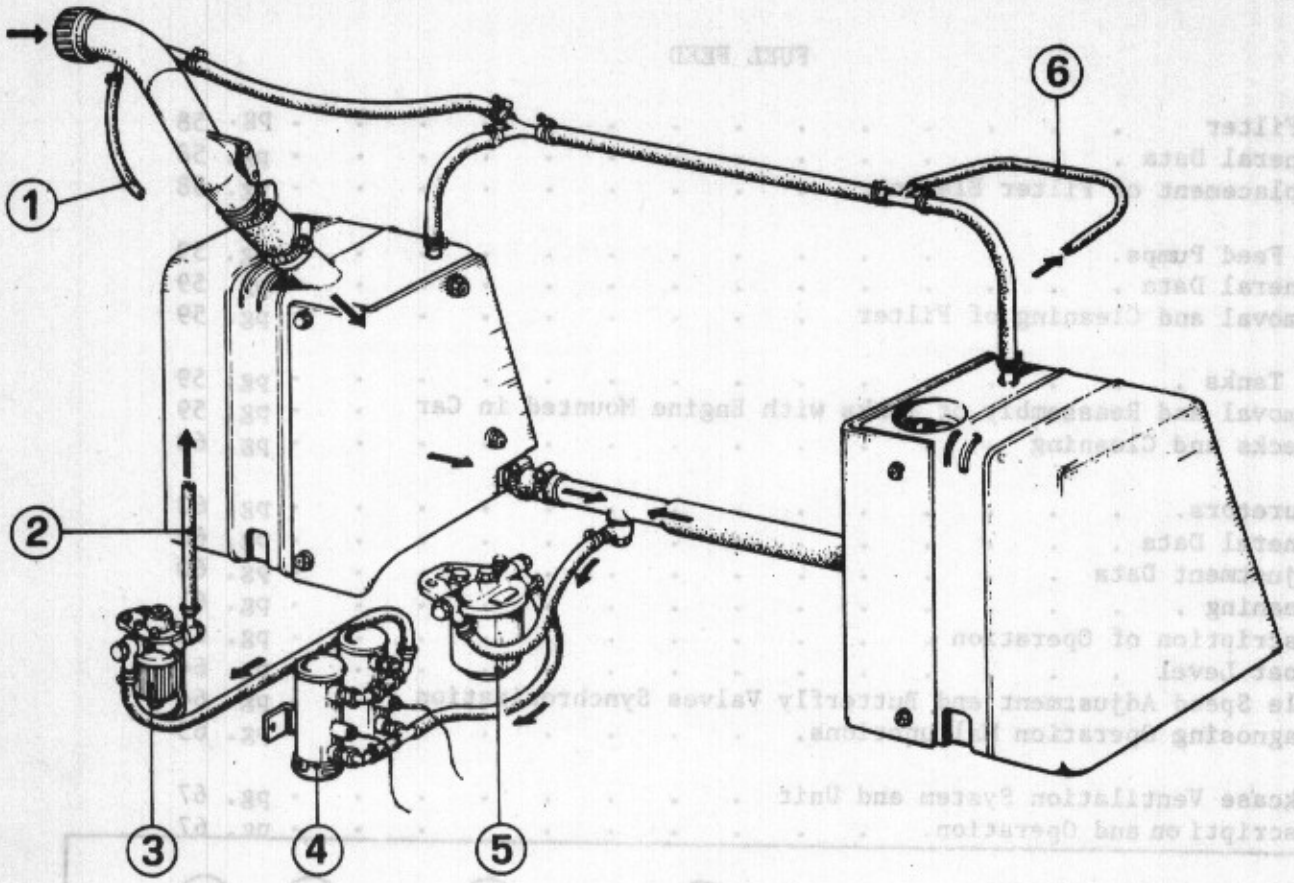


Fig. 39 Fuel Feed Installation Diagram.
1-Fuel tanks vapor tubes; 2-Regulating filter to carburetors tube; 3-Regulating filter; 4-Bendix pumps; 5-FISPA filter; 6-Fuel return tube.

Air Filter

General Data

The air filter (Fig. 38) is made up of a cylindrical container where the filter cartridge 2 is located. This filter is easily removable by removing the front cover 3 of the container.
Air enters from the outside of the filter element through flexible tube 6, then reaches the air box through flexible tube 4.
On the air box is also screwed on the pressure limiting valve for the engine crankcase ventilation system (fig. 49).
Three spacer gaskets are located between the air box and the carburetors and the air box is fastened with the four nuts 8 and flange 9 for each carburetor.

Replacement of Filter Element

To ensure efficient engine operation it is advisable that the filter element be removed often for cleaning or replacement.
Every 5000 Km. clean the element with gasoline and blow dry with compressed air from the inside.
Replace every 10,000 Km.

Fuel Feed Pumps

General Data

The engine is fed by two electrical BENDIX 476087 12V fuel pumps which are both connected in the rear of the car next to the base of the left gas tank. They deliver fuel from the principle filter which connects the two tanks and deliver the fuel across the regulating filter to the three carburetors.
The pumps are self-regulating and feed fuel to the engine under $0.25 \div 0.3$ Kg/cm^2 of pressure.
Their engagement is simultaneous and the fuel feed electrical system is protected by an 8 Amp fuse.

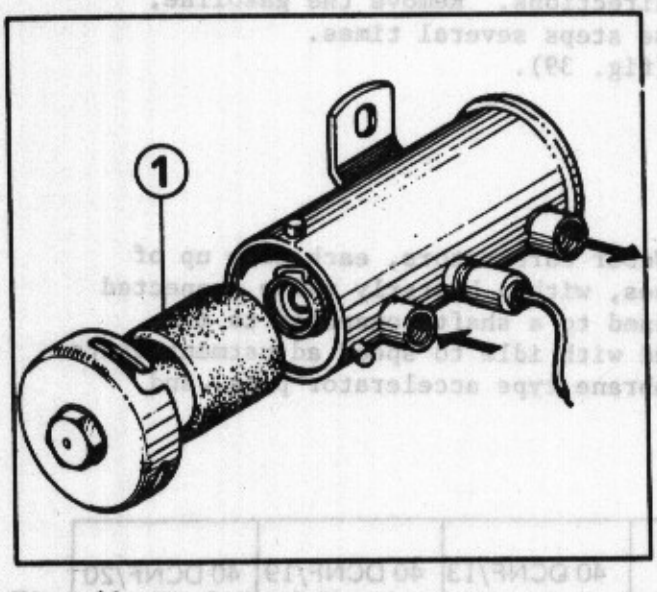


Fig. 40 Fuel Feed Pump
1-Filter

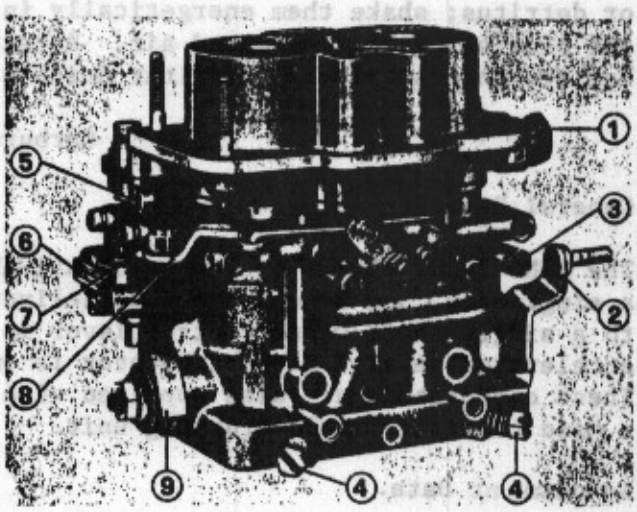


Fig. 41 Weber Carburetor
1-Fuel inlet; 2-Throttle butterfly control lever; 3-Idle speed adjustment screws; 4-Idle speed mixture adjustment screws; 5-Idle speed jets; 6-Accelerator pump lever; 7-Lever pivot; 8-Choke control lever; 9-Accelerator pump cam.

Removal and Cleaning of Filter

Every 20,000 Km. it is necessary to remove the lower cover from each pump, remove the filter, clean it in gasoline, and blow dry with compressed air. This operation can be carried out without emptying the tanks, by temporarily closing the rubber tubing that delivers the fuel to the pumps with a clamp.

Fuel Tanks

Removal and Reassembly of Tanks with Engine Mounted in Car

For removal of the tanks, carry out the following operations:
--Unscrew the gas tank filler cap;
--remove all fuel by removing the drain plug from the connecting tube between the two tanks;
--raise the rear of the car, remove the rear wheels;
--disconnect the pump delivery tube and remove the filter from the tank;
--remove the lower connecting tube of the two tanks;
--remove from the left tank the filler tube connecting sleeve;
--remove the gas level indicator electrical cable connection;
--remove the two crankcase ventilation tubes and the carburetor fuel return tube;
--detach the shock absorbers from the suspension arms and the mud guards' shields;

--remove the lower suspension arms from the wheel supports and push them down as far as possible;
--loosen the tanks fastening straps by unscrewing the lower retaining nuts;
--slide out the two tanks.

NOTE: For reinstallation, reverse the above steps.

Checks and Cleaning

Closely check the tanks, especially along the connection ends, making sure that there are no leaks; if leaks are noticed, repair them by welding, or replace them.
To clean internally, inject gasoline under pressure in order to flush out deposits or detritus; shake them energetically in all directions. Remove the gasoline, and blow out with compressed air. Repeat these steps several times.
Replace the cartridges on filter units 3 - 5 (fig. 39).

Carburetors

General Data

The DINO 246GT engine is fed by 3 dual-choke Weber carburetors, each made up of a single bowl and 2 separate fuel delivery lines, with a butterly valve connected to a single shaft whose control lever is fastened to a shaft connected to the accelerator pedal. Each carburetor is supplied with idle to speed adjustment units. These carburetors are also supplied with a membrane type accelerator pump, and a hand controlled cold-starting unit.

Adjustment Data.

WEBER 40 DCN/ F	40 DCNF/7	40 DCNF/13	40 DCNF/19	40 DCNF/20
Choke	mm. 32	mm. 32	mm. 32	mm. 32
Central diffusor	" 4,5	" 4,5	" 4,5	" 4,5
Main jet	" 1,25	" 1,25	" 1,25	" 1,25
Air correction jet	" 2,20	" 2,20	" 2,20	" 2,20
Idle (slow running) jet	" 0,50	" 0,50	" 0,55	" 0,50
Slow running air correction jet	" 1,20	" 1,20	" 1,20	" 1,20
Pump	Camma N.27	Camma N.11	Camma N.11	Camma N.11
Pump jet	mm. 0,50	mm. 0,50	mm. 0,50	mm. 0,50
Pump delivery valve	" 1,00	" 1,00	" 1,00	" 1,00
Spring loading	" 1,75	" 1,75	" 1,75	" 1,75
Emulsion tube	F/24	F/24	F/24	F/24
Level (vertical float)	mm52±0,25	mm.52±0,25	mm.52±0,25	mm.52±0,25
Starter jet	F7/80	F6/60	F6/60	F6/60
Progression holes	1mm 0,80 2 " 0,90 1 " 1,30	1mm 0,80 2 " 0,90 1 " 1,30	1mm 0,80 2 " 0,90 1 " 1,30	1mm 0,80 2 " 0,90 1 " 1,30

Cleaning.

Every 10,000 Km., or when the engine indicates irregular operation due to to fuel feed defects, it is advisable to remove the carburetors from the engine, disassemble them with the exception of the butterfly valves and their shafts and soak them for 10 ÷ 15 hours in a "Magnus 755" bath. Then wash with water under pressure and blow dry with compressed air all units, paying special attention to the idle speed circuits holes.
Mount the carburetors back on the engine, lubricating the butterfly valves shafts and the various threaded parts.

Description of Operation

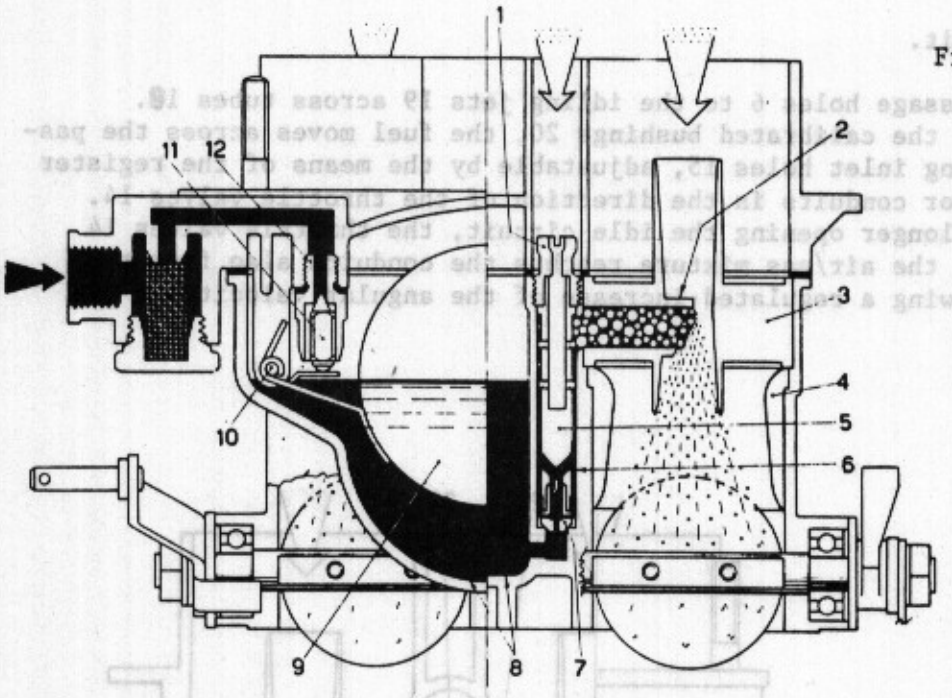


Fig. 42 Normal circuit

Normal Circuit.

The fuel reaches the needle valve 12 passing through the bowls 8, in which the float 9, free to oscillate on fulcrum lever 10 regulates the needle opening 11, maintaining a constant fuel level. From bowl 8, into the main jets 7, the fuel reaches the passage holes 6 where it is mixed with air bleeding through the emulsion tubes 5 entering from the air passage valve 1, then through the spray nozzles 2 reaching the combustion chamber composed of chokes 3 and venturi 4.

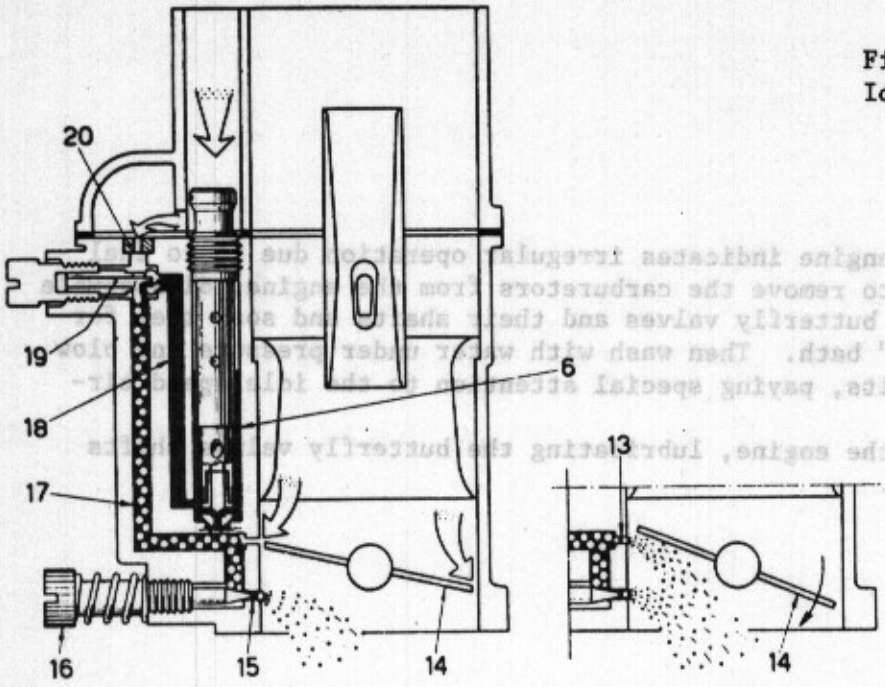


Fig. 43
Idle and Progression Circuit.

Idle and Progression Circuit.

The fuel flows from the passage holes 6 to the idling jets 19 across tubes 18. Mixed with air provided by the calibrated bushings 20, the fuel moves across the passage holes 17 and the idling inlet holes 15, adjustable by the means of the register screws 16, to the carburetor conduits in the direction of the throttle valves 14. When the carburetor is no longer opening the idle circuit, the throttle valves 14 are progres si vely opened, the air/gas mixture reaches the conduits also from the progression holes 13, allowing a regulated increase of the angular velocity of the engine.

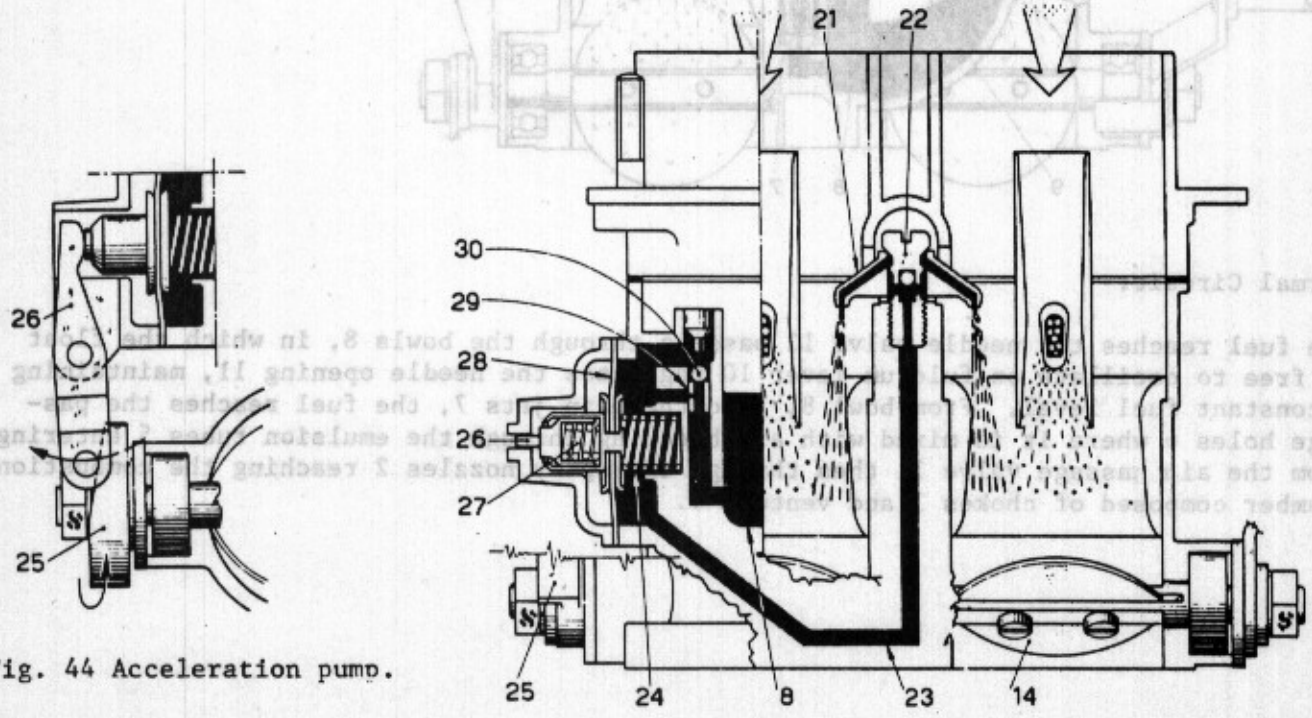


Fig. 44 Acceleration pump.

Acceleration Pump.

When closing the throttle valves 14, lever 26 frees the pump membrane 28, which is actuatuated by spring 24 to draw fuel from bowl 8 across the spherical valve 30. When operating the throttle valves, through the action of shaft 25 and lever 26, membrane 28 injects fuel into the carburetor conduits through passage 23, the sending valve 22 and the spray nozzles of the pump jet 21.
Spring 27 absorbs the rapid openings of throttle valves and prolongs the distribution of the fuel.
Excessive fuel distributed by the accelerator pump is discharged back into bowl 8 together with fuel vapors of the pump chamber through the metered opening 29.

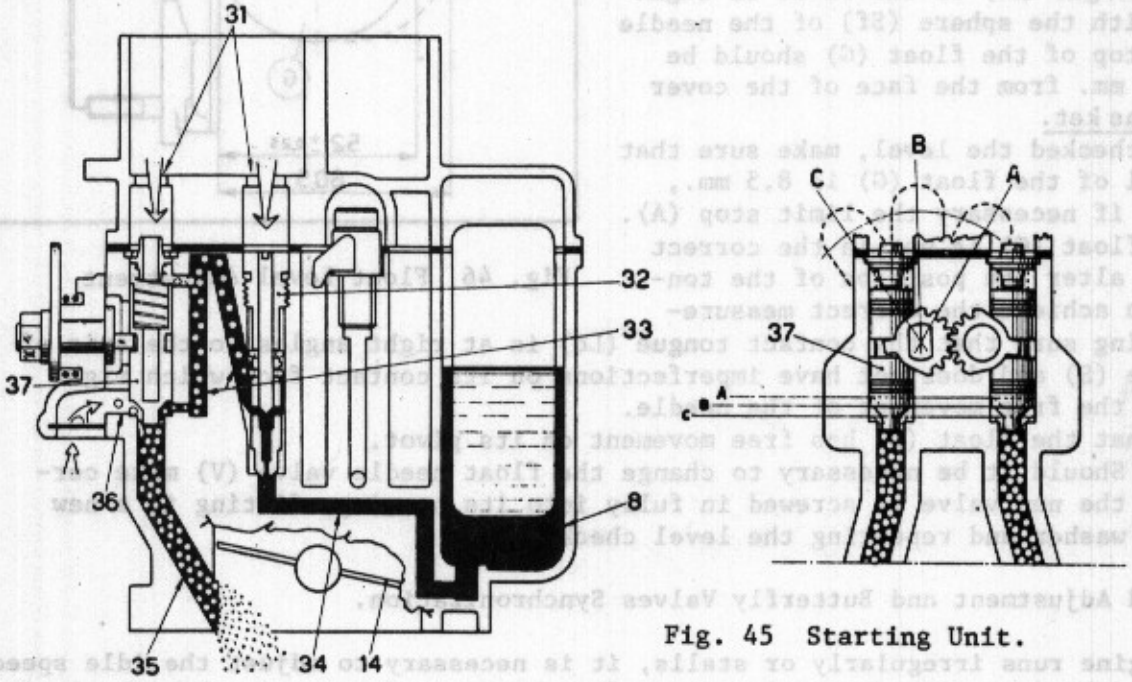


Fig. 45 Starting Unit.

Starting Unit.

The fuel flowing from bowl 8 passes to the starting unit through tubes 34 and starting jets 32. Mixed with air from holes 31 it reaches the valve opening 37 through tubes 33, where completely emulsified with the air entering from holes 36, it is sent on tho the carburetor conduits to the direction of the throttle valves 14 through passage holes 35.
Cold engine start. Unit engaged--lever in position A.
Warm engine Start. Unit partially engaged--lever in position B
Effective operation of the unit during driving. During engine warm-up, even while driving, progressively disengage the unit.
Normal driving conditions of the car. Unit is not engaged--lever in position C, as soon as engine has reachednormal operating temperature.

Float Level (Adjustment).

Prior to adjusting the float chamber level, it is necessary to carry out the following controls:
--Make sure that the float chamber valve (V) is screwed fully into its housing.
--Hold the carburetor cover (C) vertical so that the weight of the float (G) moves the sphere (Sf) which is mounted on the valve (S).
--With the carburetor cover (C) vertical and the tongue (Lc) of the float in light contact with the sphere (Sf) of the needle (S), the top of the float (G) should be 52 ± 0.25 mm. from the face of the cover without gasket.
--Having checked the level, make sure that the travel of the float (G) is 8.5 mm., adjusting if necessary the limit stop (A).
--If the float (G) is not in the correct position, alter the position of the tongue (L) to achieve the correct measurement, making sure that the contact tongue (Lc) is at right angles to the axis of the needle (S) and does not have imperfections on its contact face which might influence the free movement of the needle.
--Check that the float (G) has free movement on its pivot.
Warning. Should it be necessary to change the float needle valve (V) make certain that the new valve is screwed in fully into its housing, fitting in a new retaining washer and repeating the level check.

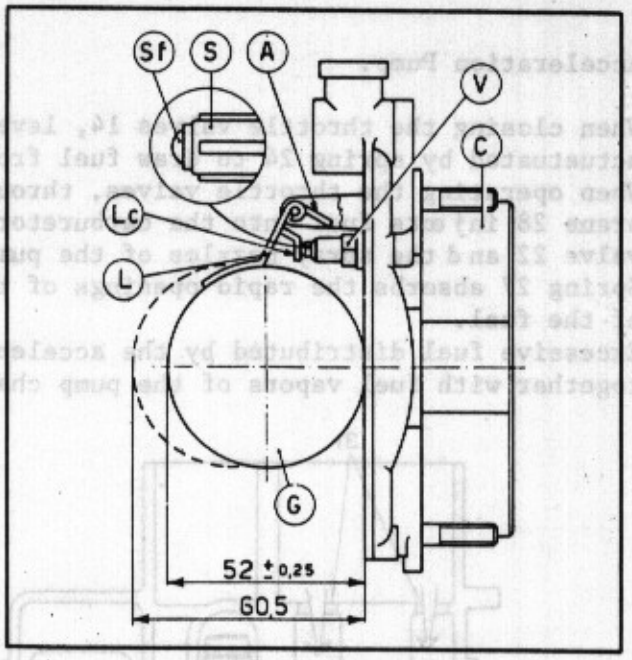


Fig. 46 Float Level Adjustment

Idle Speed Adjustment and Butterfly Valves Synchronization.

If the engine runs irregularly or stalls, it is necessary to adjust the idle speed; this should be done with the engine warm after having made certain that the ignition equipment and spark plugs are in good condition.
Proceed as follows:
--Remove the air filter and detach the control lever 7 (fig. 48) of the throttle butterfly relay lever.
--Close completely all the screws 4 (fig. 47) and unscrew each by two turns.
--Unscrew by one turn the slow running adjustment screw 3 of carburetors 1 and 2. Carburetor 1 is regarded as the nearest to the water thermostat.
--With the engine running, open the slow running adjustment screw 3 of carburetor No. 3 until the engine is running at 900 ÷ 950 rpm's. The use of an independent electric revolution counter attached to the ignition system and grounded to the engine is recommended.
--With the motor-meter synchronizing gauge appliedto the intake of the control side of carburetor No. 3, adjust the air aperture until the little float is halfway up the sight tube.
--Apply the synchronizer to the intakes of the control side of the remaining carburetors, and check that the float oscillates in the same position. Any variation should not be either above the upper line or below the lower line.
--If the float is not withinthese limits, loosen the nuts 6 (fig. 48) which will move the butterfly control lever until the float is in the correct position.
Should the engine speed change, it is necessary to return to the original setting by manipulating screw 3 of carburetor 3. Tighten the nuts controlling the position of the butterfly control lever making sure that this does not produce a tightening of the control.

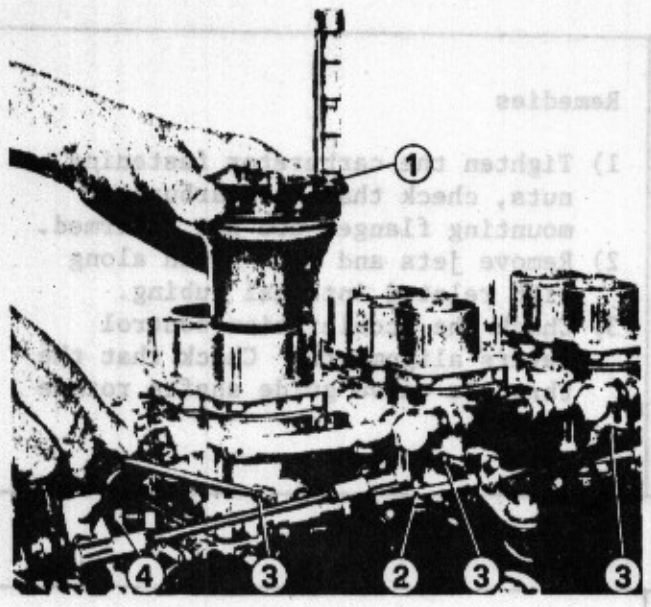


Fig. 47 Synchronization of throttle butterfly valves.
1.Synchronizing gauge (Moto-meter); 2.Butterfly control rod; 3.Idle speed adjustment screws; 4.Idle speed mixture adjustment screws.

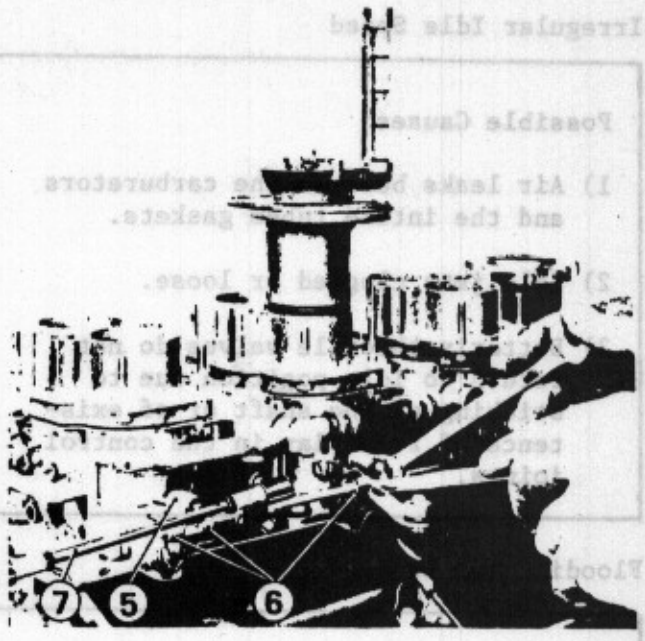


Fig. 48 Adjustment of butterfly valves at carburetors 1 and 2.
5.Butterfly valve control rod attachment block; 6.Lock nuts; 7.Butterfly valves relay lever.

Diagnosing Carburetor Operations Malfunctions and Relative Remedies

Engine Will Not Start (With cold engine)

Possible Causes	Remedies
1) Starter Control does not open completely.	1) Check the starter circuit unit.
2) Obstructed starter jet.	2) Dismantle and clean jet.
3) Fuel does not arrive to carburetor.	3) Check pumps operation, check filters 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.
3) Starting unit does not close down completely.	3) Eliminate the cause of the irregular closure of the starting unit.

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) Butterly 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) Imperfect seating of a needle valve due to wear or dirt.	1) Check for dirt between the needle and the valve seat, otherwise replace valve.
2) Faulty float. (Deformed or damaged)	2) Replace float.
3) Uneven fuel level in carburetors.	3) Adjust level, according to instructions on page 64 .
4) Seizing or wear which impede the regular movement of the float.	4) Check.
5) Abnormal fuel feed pumps pressure.	5) Check pressure: must be 0.25 ÷ 0.30 Kg/cm^2.

Engine Lacks Pickup and Speed

Possible Causes	Remedies
1) Incorrect fuel level in one or more carburetors.	1) Adjust level according to instructions on page 64.
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) Starting unit remains partially engaged.	1) Verify.
2) Imperfect seating of a needle valve.	2) Replace the valve.
3) Deformed or damaged float.	3) Replace the float.
4) Faulty gas level.	4) Adjust level, as per instructions on page 64.
5) Altered or loose fast running jets.	5) Check and eventually replace.
6) Incorrect air correction jets.	6) Check and eventually replace.
7) Clogged air intake filter element.	7) Wash with gas and blow dry from the inside. Eventually replace.

Ignition Knocks When Releasing Acceleration Pedal and Engine In High RPM's Operation

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 carburation when throttle plates slightly open.	3) Check carburation at 1500 ÷ 2000 rpm's.
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.
9) Irregular ignition timing.	9) Check timing of distributors.

Crankcase Ventilation System and Unit

Description

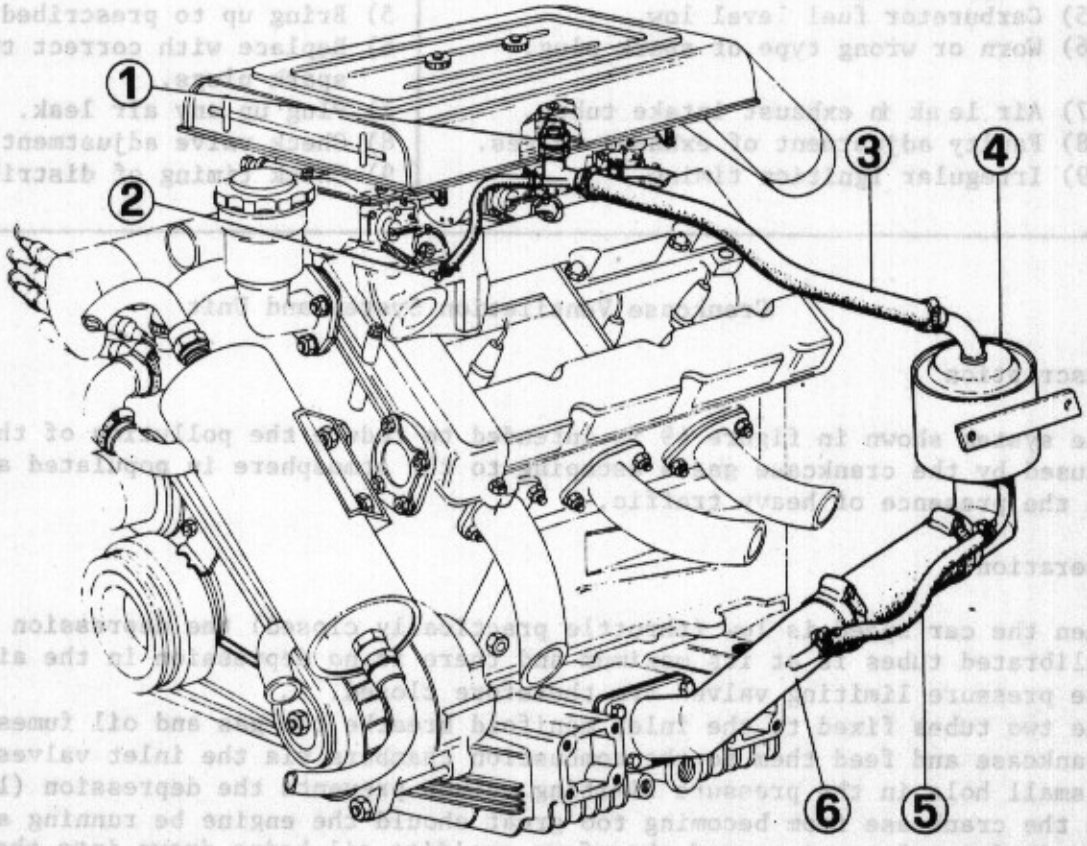
The system shown in figure 49 is intended to reduce the pollution of the atmosphere caused by the crankcase gases escaping to the atmosphere in populated areas and in the presence of heavy traffic.

Operation

When the car speed is low (throttle practically closed) the depression in the calibrated tubes is at its maximum and there is no depression in the air intake; The pressure limiting valves are therefore closed.
The two tubes fixed to the inlet manifold breathe the gas and oil fumes from the crankcase and feed them to the combustion chambers via the inlet valves.
A small hole in the pressure limiting valves prevents the depression (low pressure) in the crankcase from becoming too great should the engine be running at low speeds for a long time, and therefore avoiding oil being drawn into the inlet manifolds.

When the car speed increases, the pressure in the calibrated tubes decreases, the crankcase pressure increases with the pressure in the air intake. This causes the limiting valve to open, allowing the crankcase gases to be sucked in via the carburetors to the combustion chambers.

Fig. 49 Crankcase Ventilation System Diagram



1-Engine Block pressure limiting valve; 2-Calibrated intakes to the induction manifold; 3-Connecting tube from crankcase to pressure limiting valve; 4-Ventilation and blow-by assembly; 5-Oil drain tube from breather to sump; 6-Lower ventilation tube.

SECTION 4

CLUTCH

GEAR-BOX

REAR AXLE

CLUTCH

Characteristics and Data

Type	Dry, single disc
Driven plate	Elastic with damper springs
Clutch plate lining external diameter	228.6 (9") mm.
Clutch plate lining internal diameter	155 mm.
Driven plate thickness (not under load)	8.2 mm.
Driven plate thickness (under 500 Kg. load)	7.6 $\pm$ 0.2 (*) mm.
Wear limits of linings	1mm.
Out-of-roundness limits of disc side surfaces	0.15 mm. (maxmimum limit)
Engagement and disengagement mechanism	Diaphragm spring
Pedal free-play in relation to the distance between the disengagement sleeve and the friction ring	20 $\div$ 25 mm.
Length of travel of the clutch disengagement control flange, corresponding to a disengagement travel of the pressure plate of 1.4 mm.	8 mm.
Disengagement control	Mechanical

*With driven disc under 500 Kg load, the two disc faces must be parallel within a tolerance of 0.15 mm. and must rotate freely when pressure disc is 1.3 mm. away from the face.

Description

The clutch is of the dry, single plate type with a diaphragm spring. The pressure needed on the pedal to disengage the clutch is noticeably decreased by helper spring 6 (fig. 51) which acts as a servo control (or assistance spring) on the pedal itself when disengaging.

Diagnosing Clutch Operation Malfunctions and Related Remedies

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 pedal.
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.
6) Pressure plate faces damaged.	6) Replace entire unit.

Clutch Pulls

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

The 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 on the driven disc linings.	2) Thoroughly clean the flywheel and 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.
5) Defective diaphragm spring.	5) Check and eventually replace.

The Clutch Vibrates

Possible Causes	Remedies
1) Faulty or unbalanced mounting of clutch.	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 springs.
3) Engine crankcase bearing deteriorated or loose.	3) Check and replace if necessary.
4) Excessive play in main and thrust bearing (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.

The 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) Seized engine crankshaft bearing.	4) Replace the bearing.
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 the car with clutch pedal at lowest point and release it at regular intervals.

The 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 or travels incompletely.	2) Dismantle the 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.

Repair Instructions

Pedal Free Play Adjustment

The pedal travel free play is 25 mm. corresponding to the 2 mm. clearance (fig. 51) existing between the sliding sleeve and the thrust bearing face of the clutch engagement control flange. Before adjustment, check that the pedal cable travels freely in its cover and that all other clutch mechanisms are not sticking during operation.

The adjustment is carried out by loosening the lock nut 2 (fig. 50) on the adjustment rod 1 and unthreading the forked shaft 3. Rethread 3 until pedal travel free play is 20 ÷ 25 mm. Retighten lock nut 2. If pedal travel free play decreases to less than ½ the distance before its maintenance period (every 10,000 Km.), it will be necessary to readjust it to the prescribed values in order to avoid high wear on the discs and the possibility of slippage at high rpm's.

In order to completely disengage the driven disc, the pedal must travel 130 mm. excluding the 25 mm. of travel needed to recover free travel.

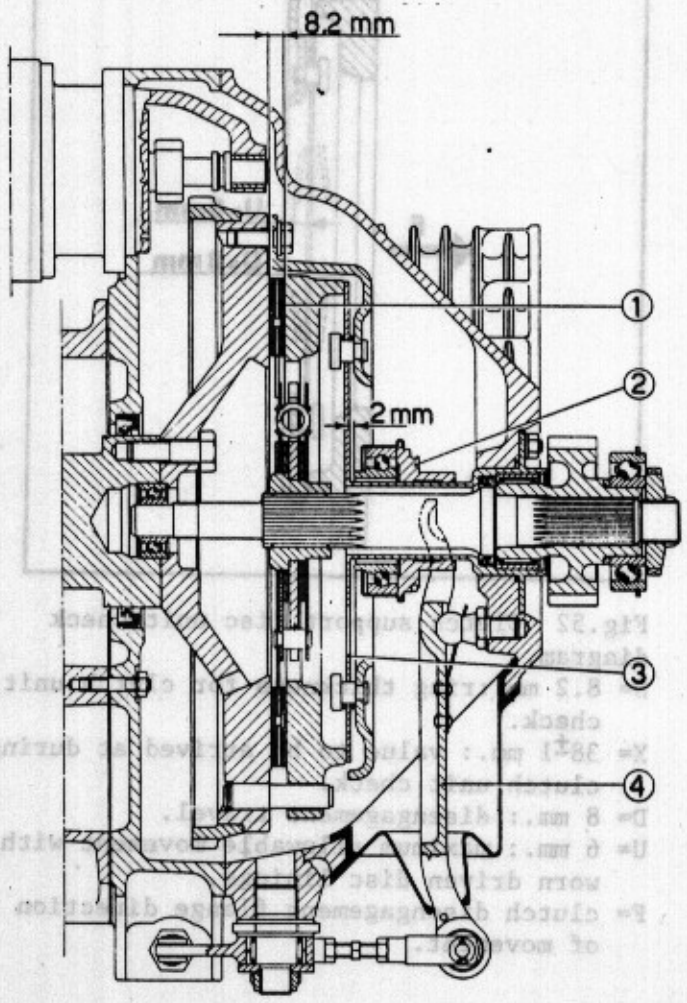


Fig. 51 Clutch
1.Clutch disc; 2.Sliding sleeve;
3.Diaphragm spring; 4.Disengagement lever.

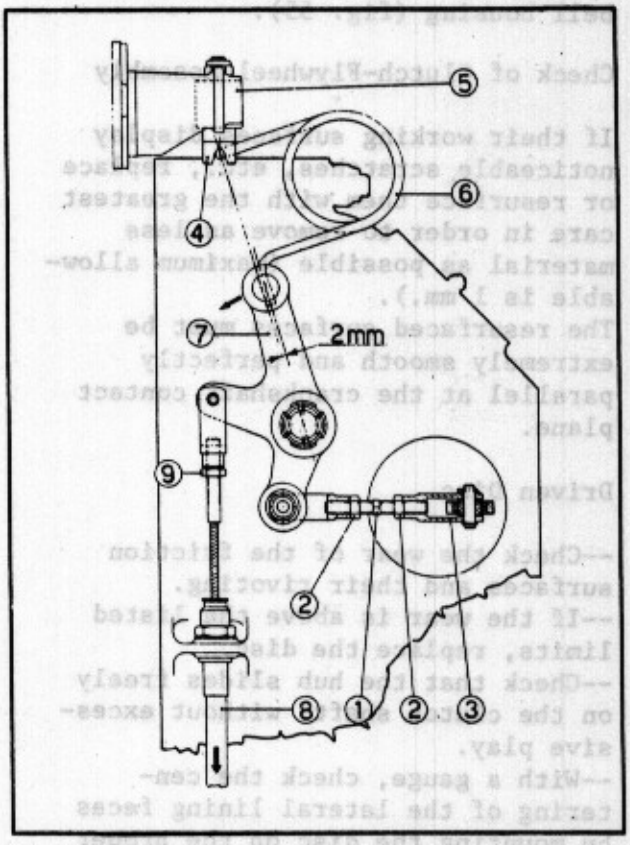


Fig. 50 Clutch Control Diagram
1.Adjustable control rod; 2.Locknut;
3.Adjusting fork; 4.Helper spring pivot; 5.Helper spring bracket;
6.Helper spring; 7.Relay lever;
8.Flexible control; 9.Lock nut on flexible cable.

Removal of Clutch

In order to work on the clutch, with the engine in the car, execute the following operations:
--Lift the rear of the car, rest it on supports, remove left rear wheel.
--Remove the rear stone guard by removing the retaining bolts from the chassis.
--Drain the oil from the clutch housing through plug 4 (fig. 55).
--Disconnect disengagement lever 4 (fig. 51) from the control pedal.
--Disconnect flexible cable 8 from relay lever 7 (fig. 50) and disconnect assistance spring 6 at the top.
--Unscrew all clutch housing coupling bolts from the intermediate housing.
--Disconnect the clutch housing together with the complete acuating gears.
--Mark reference points on the clutch cover and clutch 12 so that they may be replaced in the same position in order to avoid altering the balance (fig. 55).
--Unscrew the clutch cover bolts and remove pressure plate 13 (joined to the clutch cover) and the driven disc 17 (fig. 55).
For the removal of the actuating gears, roller and ball bearings, and spacer washer, remove cover 5, unscrew ferrules 6-7 and remove the gear housing 8 from the clutch bell housing (fig. 55).

Check of Clutch-Flywheel Assembly

If their working surfaces display noticeable scratches, etc., replace or resurface them with the greatest care in order to remove as less material as possible (maximum allowable is 1 mm.).
The resurfaced surfaces must be extremely smooth and perfectly parallel at the crankshaft contact plane.

Driven Disc

--Check the wear of the friction surfaces and their rivoting.
--If the wear is above the listed limits, replace the disc.
--Check that the hub slides freely on the clutch shaft, without excessive play.
--With a gauge, check the centering of the lateral lining faces by mounting the disc on the proper mandrel.
To check the parallelism of the two disc faces, mount the clutch on the flywheel and measure the distance between the flywheel and the pressure plate at different points along its circumference.
If the difference is over 0.15 mm. replace the disc and check the spring assembly of the hub.

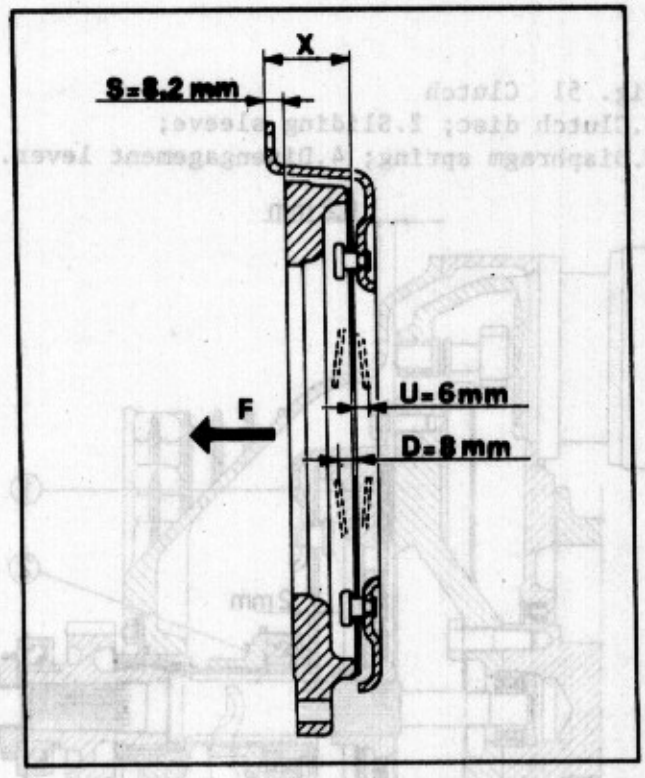


Fig.52 Clutch support disc unit check diagram.
S= 8.2 mm.:ring thickness for clutch unit check.
X= 38±1 mm.: value to be arrived at during clutch unit check.
D= 8 mm.: disengagement travel.
U= 6 mm.: maximum allowable movement with worn driven disc linings.
F= clutch disengagement flange direction of movement.

Pressure Plate

If the working surfaces exhibit noticeable scratches, it is advisable to replace the complete unit, along with its cover. Substituting the complete unit allows to have a total dynamically balanced assembly to be reinstalled.

--Check the working operation of sliding sleeve 2 (fig. 51) and the disengagement ball bearing.
--Before reinstalling the clutch unit into the car, place the clutch cover on a flat surface (to duplicate the engine flywheel surface). Place a ring 8.2 mm. thick (fig. 52), which duplicates the driven disc; then with a 500 Kg. pressure on the clutch disengagement flange in direction F, submit the unit to four gear disengagements. In the above operation, check that:
--In one gear disengagement D (fig. 52), its travel of 8 mm. corresponds to a disconnecting distance of the pressure plate of 1.4 mm.
--If different measurements than the above are noticed, it is necessary to replace the pressure plate and the clutch cover unit.
--The friction ring surfaces of the clutch disengagement control flange must be free of damage.

Replacement of Clutch

The diaphragm spring and the pressure plate ring unit is supplied already balanced as well as the friction disc. Thus their replacement will not present any balancing problems.
If the flywheel needs resurfacing (maximum allowable amount of metal to be removed = 1 mm.), ensure that the reworked surface remains perfectly parallel to the crankshaft support surface.

Reinstallation of Clutch

Before reinstalling the clutch, check the working operation of the clutch shaft 15 ball bearing and its position on the engine crankshaft (fig. 55).
--Lubricate the sliding hub which carries the disengagement bearing and mount it in its fixed guide in the clutch bell housing.
--Mount the pressure plate 13 guide pegs on the flywheel if it has been resurfaced, and tighten the bolts to the crankshaft (4 Kg. torque).
--Mount the clutch to the flywheel, with the driven disc centered with shaft 15 temporarily removed from gearing 9 of the control unit. Check that the reference marks between the pressure plate and flywheel correspond and torque the retaining bolts to 4 Kg.
--Fasten bell housing 10 to intermediate housing 11, removing cover 5 if necessary to rotate shaft 15 to facilitate the engagement of the grooved hub of the driven disc.
--Reattach the starter motor and all previously removed disengagement control units.
--For the reattachment of the control group, when it has been removed, follow these operations:
--check that the adjustment shims of the central pinion shim adjustment are in good condition;
--slide the shims on the two hubs, with the oil grooves facing the sides of the pinion, well lubricated and place the three gears in their proper places;
--evenly spread Hilomar paste to the contact surfaces of cover 8 to the bell housing and tighten the bolts to 4 Kg. check that the axial movement of the central pinion is $0.15 \div 0.25$ mm.
--torque ferrule 7 at 13 Kg. and ferrule 6 at 20 Kg.
--mount cover 5, mating the surfaces covered with Hilomar paste and torque the retaining bolts to 2.5 Kg.

GEAR BOX

Characteristics and Data

Gears	5 forward - 1 reverse
Gear Types: 1-2-3-4-5 speeds : reverse gear	Permanently engaged helicoidal gearing. Direct gearing.
Spring ring synchronizers	1-2-3-4-5 speeds.
Radial clearance between needle roller bearing races and mounted gears.	0.02 ÷ 0.05 mm. Maximum limits = 0.10 mm.
Axial clearance between mounted gears and surfaces.	0.07 ÷ 0.10 mm.
Gear contact clearance.	0.03 ÷ 0.04 mm.
Roller and ball bearings radial free clearance.	Maximum limits = 0.05 mm.
Ball bearings axial free clearance.	Maximum limit = 0.50 mm.
Shafts alignment.	Maximum allowable tolerance = 0.025 mm.
Lubrication oil pump Lubrication oil: type : quantity	Gear type. Shell SPIRAX HD90 or EP80 4 liters

Gear Box Ratios

Gear Box Ratios		
1°	40 : 13	3.075
2°	36 : 17	2.117
3°	32 : 21	1.524
4°	27 : 24	1.125
5°	24 : 28	0,857
R.M.	40 : 15	2,667

Gear Reduction Ratios: 27 x 33	
1°	3.76
2°	2.59
3°	1.862
4°	1.375
5°	1.048
R.M.	3.257

Overall Gear Ratios Using 16 x 58 Final Drive Gears	
1°	13.55 : 1
2°	9.38 : 1
3°	6.76 : 1
4°	4.99 : 1
5°	3.80 : 1
R.M.	11.82 : 1

Diagnosing Malfunctions and Related Remedies

Noisy Gear Box

Possible Causes	Remedies
1) Excessive engagement clearance between engaged gears.	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 unspecified lubricating oil.	4) Drain and flush out; replace with oil Shell SPIRAX HD90 or EP80.
5) Defective clutch disengagement release.	5) Check out.

Spontaneous Gear Disengagement

Possible Causes	Remedies
1) Erratic engagement action.	1) Engage low gear fully before releasing clutch pedal.
2) Worn engagement teeth on sliding sleeves or on worn gears.	2) Check out and replace worn units.
3) Worn synchronizer rings.	3) Substitute.

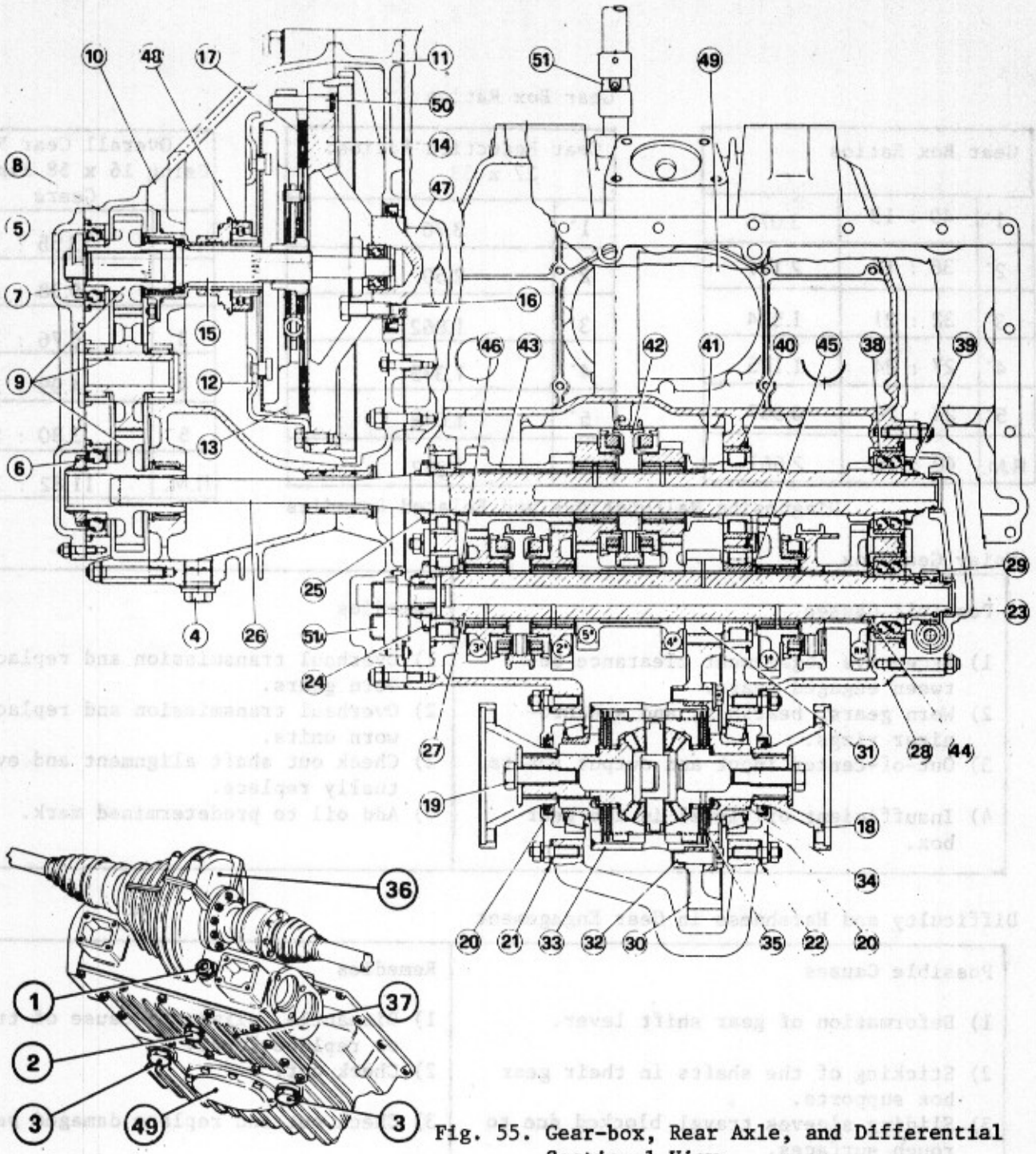


Fig. 55. Gear-box, Rear Axle, and Differential Sectional View.

1. Gear box-differential oil filler plug , 2. Gear box-differential oil drain plug, 3. Engine oil drain plugs, 4. Clutch housing oil drain plug, 5. Clutch return housing cover, 6. Ferrule, 7. Ferrule, 8. Clutch-drive gearing support case, 9. Drive gearing, 10. Clutch bell-housing, 11. Intermediate housing, 12. Clutch cover, 13. Pressure plate, 14. Engine flywheel, 15. Clutch shaft, 16. Flywheel to crankshaft fastening bolts, 17. Clutch driven disc, 18. Semi-axle flange, 19. Flange fastening bolts, 20. Bearing support side covers, 21. B earing preload washer, 22. Ring gear positioning washer, 23. Gear box rear cover, 24. Ferrule, 25. Ferrule, 26. Drive shaft, 27. Output shaft, 28. Gear box case, 29. RPM counter unit, 30. Differential ring gear, 31. Ring gear pinion, 32. Ring gear to differential fastening bolts, 33. Plate-ty pe differential, 34. Differential cove r, 35. Plates, 36. Top cover, 37. Gear box case lower cover, 38. B all bearing, 39. Ferrule, 40. Roller bearing, 41. Spacer, 42. Guide body, 43. 2nd and 3rd gears mounted gearing, 44 . Spacer, 45. Spacer, 46. Spacer, 47. Crankshaft, 48. Clutch ball release bbearing, 49. Engine oil cover, 50. Clutch alignment pin, 51. Gear box control shaft . **51A. Gear-box oil pump gearing.**

General Information

The gear box has five forward, all synchronized gears, and one reverse gear. The forward speed gears are always in contact via helical gear-teeth design to insure maximum qui et running.
The engagement of the reverse gear occurs through the displacement of a sliding straight-cut gear.
The bear box is placed in a transverse rear position in relation to the longitudinal axis of the car. It is made up of the following units:
--Main box, cast in "silumin," which houses all gear box components.
--Engine oil sump, which is an integral part of the bear box and is laterally located to the longitudinal parallel axis of the gear box itself.
The engine is fastened to the oil sump and the oil for its lubrication is completely separated from that of the gear box.
--The housing for the rear axle and differential, also integral to the gear box, is situated parallel to and behind the longitudinal axis of the gear box.
--Clutch bell housing and clutch control gear units are located to the extreme left of the gear box.
--Right side cover for rpm counter and for forced oil delivery, for lubrication of the gear box are fastened to the opposite side.
--Lower cover for the closing of the gear box assembly and reassembly opening.
--Switch for reverse gear light with rear gear engaged and exterior lights turned on.

Instructions for Repairs

Removal of the Unit from the Car

To carry out this operation follow the instructions listed on page 19. The gear box/rear axle group must be removed together with the engine.

Disassembly of the Gear Box

For this disassembly and the removal of the differential carry out the following operations:
--Place complete engine and clutch unit on rotating stand AV617 and drain the gear box oil from tap 2 (fig. 55), drain engine from taps 3 or remove cover 49, drain control gears oil through tap 4.
--Proceed to the removal of the clutch and control units carrying out the operations described on page 74, under "Clutch."
--Disconnect the torsional damper from the engine crankshaft. Remove bolts 16, and cover 11 with the oil pump, by unscrewing the bolts that hold it to the gear box.
--Disconnect the engine from the gearbox housing.
--Check the clearance between the teeth of the differential cylindrical coupling. Normal clearance is 0.03÷0.04 mm. When it exceeds 0.12 mm. due to gear teeth wear, it is advisable to replace it.
--Remove flanges 18 from the planetary gears unscrewing bolts 19.
--Also remove from the differential housing the two side covers 20 keeping them together with their respective spacer washers; washer 21 for the conical roller bearings pre-load, and washer 22 for the ring gear positioning.
--Remove cover 36 from the differential housing; check the alignment between the differential pinion 31 and the ring gear 30 and remove the differential group as a unit.
--Turn over the housing and remove side cover 23 and lower cover 37.

--Remove three-part gear box control lever, removing the pivot connection from the housing.
--Loosen the bolts that fasten the smaller and larger gear forks to their respective levers and remove first the first and reverse gear forks then the second and the third gear, making sure that the stop ball bearing, and the first gear small fork do not fall into the housing.
--To remove the fourth and fifth gear lever first remove the bolt that fastens the lever's guide bushing.
--Check all surfaces for axial clearance of all disengaged gears.
--Engage fourth or fifth gear and reverse and unscrew ferrule 25 on the input shaft 26 and ferrule 24 on the output shaft 27. Ferrule 24 has a left hand thread.
--Remove the sliding reverse gear pinion and its shaft.
--Lightly push out the output shaft toward the ball bearing thus removing the two rpm counter unit stop half-rings and slide the shaft out of the clutch side.
--From the side opposite the clutch unit, remove the input shaft.
--Remove all other transmission units from the gear box.

Synchronize r Rings

Gear engagement synchronization is presented in fig. 56 with the particular operating units. Sliding sleeve 8 is internally geared destined to engage on the top of synchronizer 5 of the gearing, connecting it to the dragging body 6, then to the shaft. The synchronizer spring ring 2, during the movement of the sliding sleeve, gradually adjusts the engine rotation rate. Actuated by sleeve 8, the synchronizer ring is dragged until one of its ends, during either acceleration or decelleration, engages against the guide ring 3 thus producing a rotating effect which produces rapid synchronization.
At the end of this action, the synchronizer ring is eccentrical and the area of major thickness faces the surfaces opposite the two points of the ring.
The synchronizing action ends when there is no longer any difference in velocity between the sliding sleeve and the dragging gear.
In these conditions, the final movement of the sleeve will occur with a slight force until its seating within the engagement gearing of the gear unit.
With engagement completed, the synchronizer ring is released internally within the sliding sleeve allowing the securing of the engaged gear.

Checking and Rebuilding

--Wash all parts with kerosene and blow dry with compressed air.
--Check that the case and covers are not cracked, and that the seats of the roller bearing external cages are free of lines and wear.
--Ascertain that the roller and ball bearings are operating freely without load. If noise or difficulty in rolling is notice, due to wear, replace them.
--Check that gear teeth surfaces are free of seizure or wear marks, or niches. The surfaces must be smooth and the gear contact area be uniform and extending to the total length of the gear tooth.
--Make sure that the travel surfaces of the bearings and the mounted gear cages on the input and output shafts do not show abnormal wear, and that the side movement does not exceed the listed limits.
--Check the wear of the sides of the sleeve grooves and the gear control forks.
--Make sure that the contact surfaces of the mounted gears and the spacers do not show wear or seizure marks and that their side clearances do not exceed the maximum limits listed on page 76. To check side play, especially when replacing a particular gear, it is advisable to assemble all related units on the correct shaft, while outside of the housing.
Then tighten ferrules 25 and 39 of the input shaft to 13 Kg. torque, and the output shaft to 20 Kg. torque (fig. 55).

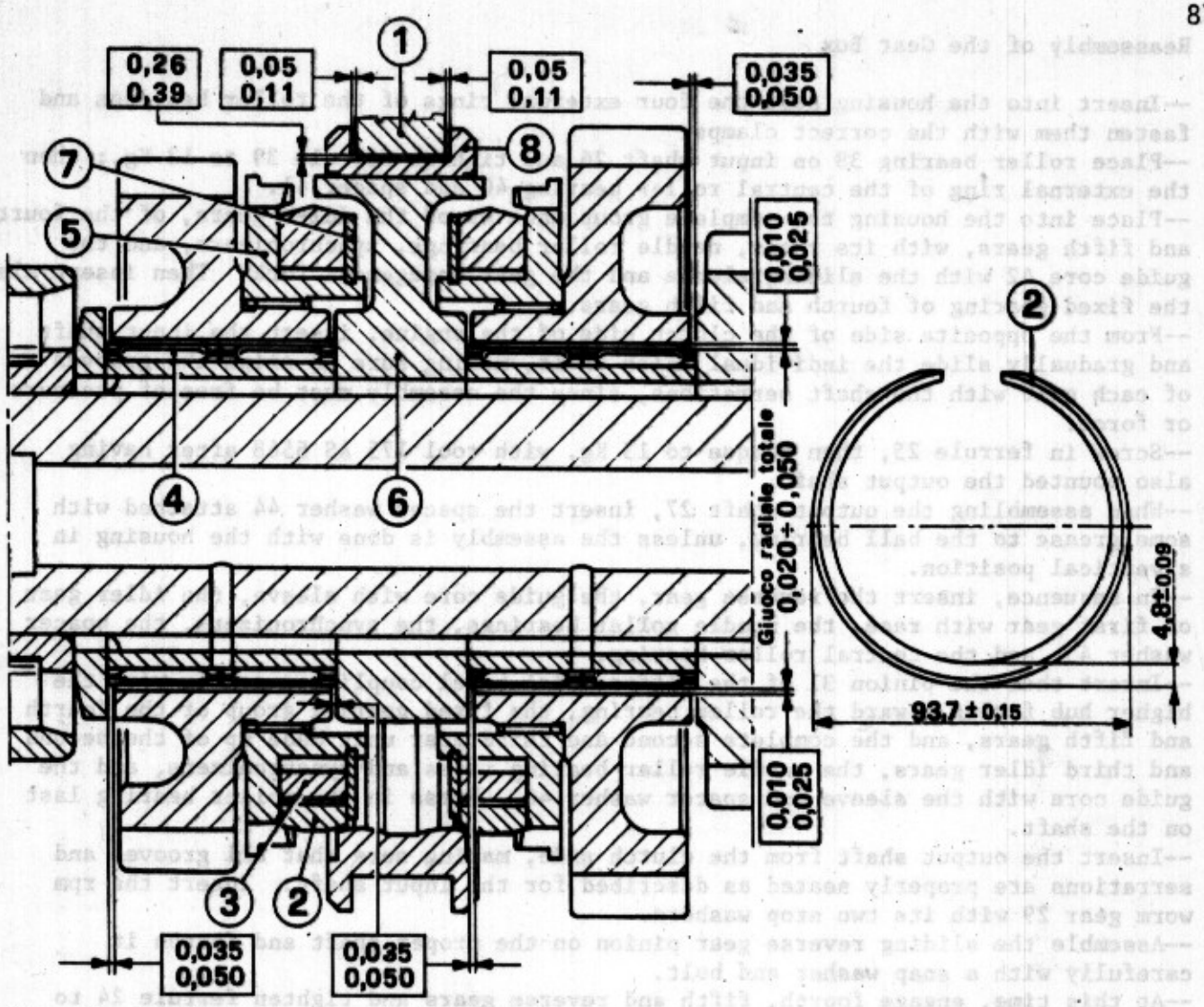


Fig. 56 Synchronizer Group Assembly Clearances
1-Fork; 2-Spring ring; 3-Guide ring; 4-Roller cage for mounted idler gears; 5-Dragging body; 6-Guide core; 7-Elastic stop ring; 8-Sliding sleeve.

--Examine the external conical surfaces of synchronizer ring 2; new rings exhibit surfaces with noticeable irregularities which allow a premeasured appropriate wear desired for proper seating and long life. They should not exhibit excessive wear, scores, or overheated areas. The synchronizer rings have equal characteristics.
--Check that the engagement teeth of the sliding sleeve and idler gear do not exhibit unevenness or wear which interferes with the engagement.
--Check that there are no excessive clearances or roughness between the grooves and the keys of the groove units and that their sliding action on the shafts are not obstructed.
--Make sure that all lubrication holes in the shafts are clear and that the oil intake rubber rings at the shaft ends are in good condition.
--Check that all the oil pump units and gear surfaces are in operating condition, and check the wear on the gear bushings and shafts.
--Check guide rings 3 for any abnormalities.
--Check and preferably replace the crankshaft oil seal ring.

Reassembly of the Gear Box

--Insert into the housing seat the four external rings of the roller bearings and fasten them with the correct clamps.
--Place roller bearing 38 on input shaft 26 and tighten ferrule 39 to 13 Kg.; then the external ring of the central roller bearing 40 and spacer 41.
--Place into the housing the complete group made up of the idler gears, of the fourth and fifth gears, with its races, needle roller bearings, synchronizers, and the guide core 42 with the sliding sleeve and the gear engagement fork. Then insert also the fixed gearing of fourth and fifth gears.
--From the opposite side of the clutch side of the engine, insert the input shaft and gradually slide the individual units on it, making sure to align the grooves of each unit with the shaft serrations, since the assembly must be free of pressure or force.
--Screw in ferrule 25, then torque to 13 Kg. with tool 175 AS 5568 after having also mounted the output shaft.
--When assembling the output shaft 27, insert the spacer washer 44 attached with some grease to the ball bearing, unless the assembly is done with the housing in a vertical position.
--In sequence, insert the reverse gear, the guide core with sleeve, the idler gear of first gear with race, the needle roller bearings, the synchronizers, the spacer washer 45, and the central roller bearing.
--Insert then the pinion 31 of the differential bevel coupling assembly with the higher hub facing toward the roller bearing, the fixed gearing group of the fourth and fifth gears, and the complete second and third gear unit made up of the second and third idler gears, the needle roller bearing races and synchronizers, and the guide core with the sleeve and spacer washer 46. Press in the roller bearing last on the shaft.
--Insert the output shaft from the clutch side, making sure that all grooves and serrations are properly seated as described for the input shaft. Insert the rpm worm gear 29 with its two stop washers.
--Assemble the sliding reverse gear pinion on the proper shaft and fasten it carefully with a snap washer and bolt.
--At this time, engage fourth, fifth and reverse gears and tighten ferrule 24 to 20 Kg. and ferrule 25 to 13 Kg.
--Again recheck that all idler gears axial clearance is within 0.07 ÷ 0.10 mm. and that the as sembly rotates freely.
--Replace, if necessary, the rubber oil retaining rings on the roller bearings keepers and on the oil tube of the shafts; fasten cover 23, already having its contact surfaces spread with a sealing paste. Tighten the nuts to 4 Kg.
--Insert the fourth and fifth gear shaft, than pushing into the housing the shaft's guide bushing; fasten it with the proper bolt and sealing paste. Also insert in its seat the shaft's securing pin.
--Place in their proper seats the three balls with their related springs, keeping them in place with the proper tool.
--For alignment of the forks use tool 706 AS 9561 keeping the fourth and fifth gear shaft (which has an integral fork) oriented in such a way that the tool at the bottom of the groove remains vertical and free in the other two forks.
--Tighten the clamp bolts of the above forks and those of the first, reverse, third and fourth gears, making sure that the gear engagements occur normally and that in idle gear, the forks do not display side pressure in the sleeve grooves. Then tighten bolts and safety fasten them with a 1 mm. thick hardened steel wire.
NOTE: The three shafts only have a niche for the positioning of the idler gears; under running conditions the synchronizer ring functions within the sliding sleeve groove.

--Seat properly the three coupled gear engagement levers, with the flat washer over and under and the pivot shaft inserted in its seat.
--Remount the complete differential unit with its side covers 20 and spacer washer 21 22 in their respective positions. Spread sealing paste on washers and housings and torque nuts to 4 Kg.
--Fasten the two semi-axles attachment flanges 18 to the planetary gears, coating first the washers with a sealing paste and torqueing bolts 19 to 8 Kg.
--Reattach the housing cover of the differential group coating the contact surfaces with sealing paste and tighten the stud nuts Ø 8 to 4 Kg. and those of diameter (Ø) mark 10 to 7 Kg.
--Fasten the lower cover of the gear box housing 37 (fig. 31) with its proper gasket.
--Attach the intermediate housing 11 with its proper gasket to the engine block and gear box housing, first making sure that before the bolts are tightened and that the engagement gearing of the oil pump is properly seated.
--Fasten the starter motor to the intermediate housing 11.
--Fasten the flywheel 14 to the crankshaft 47, torqueing bolts 16 to 4 Kg.
--Follow with the reattachment of the clutch group and control mechanism as described on page 75 under the heading "Clutch," and pour in four liters Shell SPIRAX HD90 or EP80 oil.
Every 5000 Km. check the oil level and add oil if necessary to required level.
Every 10,000 Km. drain all oil after having warmed up the gear box after use.

Gear Box Controls

The gear box controls are operated via a shaft which is connected to the operating lever which is placed on a fixed chasis support.
The lever is one piece and is pivoted at the support with a ball joint. At the end of the lever is placed a shift knob with gear shift positions marked on it. The engagement of reverse gear is possible only by pushing or pressing before placing it into gear.

Adjustment of Control Lever

Rarely will there be any need to dismount from the chasis the gear change control shaft support, but at every mounting of the gear box, it is indispensible to remove the connecting shaft (fig. 57).
To determine the exact position of the control shaft, execute the following operations:
--Engage third gear.
--Check that the two shaft cardanic joints do not exhibit any free play.
--Place the gear selector lever in third gear position in the gear selector plate and insert in the proper hole the pin for the connecting of the gear box shaft. Attach a washer and cotter pin to the pin.
--Move the selector lever to neutral and check to see if it is equi-distant from the two ends of each gear.
--If a difference is noted, make adjustments on sleeve 1 which is threaded both right and left by loosening lock nuts 2.
--Again, reengage third gear, remove the two screws which fasten the selector plate and check that the lateral movement of the gear selector lever in both directions from a central position is equal.
--If a difference is noted, loosen only one lock nut of the adjustment sleeve and move the lever as necessary. Retighten the lock nut and fasten the selector plate.
--Check that the selector lever position is regular in all gear slots.

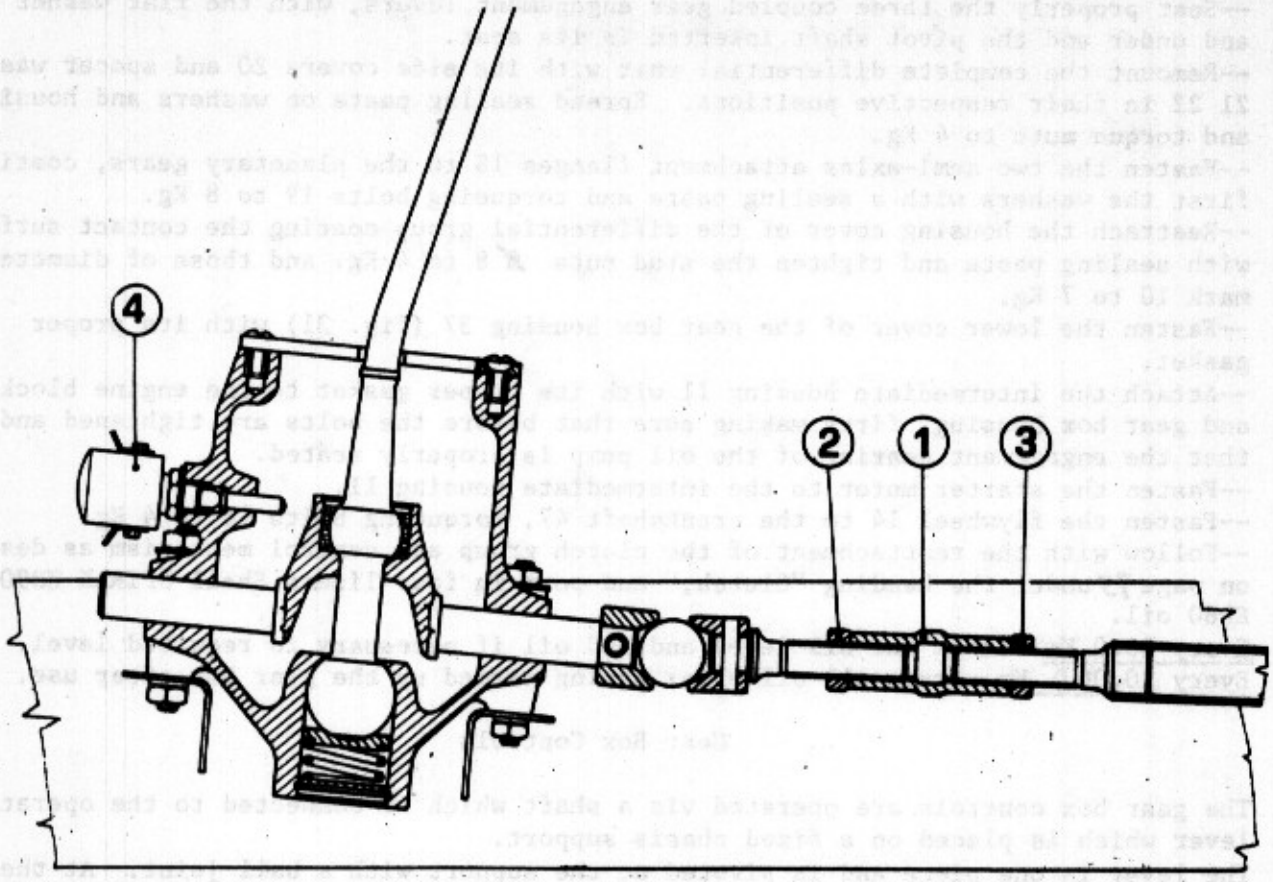


Fig. 57 Gear box gear shift lever control unit.
1.Adjustment sleeve;2-3.Lock nuts; 4.Reverse gear position light switch.

REAR AXLE

General Description

--The unit is made up of a steel case and cover which enclose within their flanges the cylindrical ring gear with helical gear teething which engages the drive pinion coupled to the gear-box output shaft. The transmission ratio is 16/58.
--In the rear axle case, besides the planetary and the conical toothed satellite gears, is located a rear wheels limited-slip differential control unit, needed for stability in curves.
--The limited-slip differential control unit contains four steel plates on each side, with front surfaces treated with molybdenum to produce an effective contact surface.
--The unit is supported within the case, as part of the transmission, by two pre-loaded conical roller bearings, and by two external semi-axle fastening flanges.
--The unit is lubricated along with the transmission by the same oil.

Characteristics and Data

Type	Oscillating shafts
Differential	With limited slip unit
Reduction Coupling	Helicoidal teething
Reduction ratio	16/58
Different ial case bearings	2
Bearing type	Conical roller bearings
Adjustment	Through spacer washers
Bearings pre-load: measured with pulley of 200 Ø	2.88 ÷ 4.030 Kg.
Pinion and ring gear	Coupled

Characteristics ... continued

Clearance between contact teeth surfaces	0.03 ÷ 0.04 mm.
Clearances wear limits	0.12 mm.
Semi-axle types	Oscillating
Rear wheel base	1400 mm.
Lubricating oil	Shell SPIRAX HD90 or EP80 4 liters (complete change)

Diagnosing Differential Malfunctions and Relative Remedies

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 faulty unit.
3) Excessive clearance between contact gear teething.	3) Replace gears.
4) Use of non-prescribed lubricant.	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) Semi-axles cardanic joints with excessive clearance.	2) Replace semi-axles.
3) Insufficient lubrication of the various units.	3) Check for leaks and fill up to level.

Noise During Release

Possible Causes	Remedies
1) Excessive clearance between the gear teeth of the cylindrical coupling.	1) Substitute the coupling gears.
2) Excessive play in the semi-axles cardanic joints.	2) Replace the semi-axles.
3) Differential bearings deteriorated or irregular.	3) Check pre-loading or substitute the bearings.

Noise 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) Use of non-prescribed lubricant.	3) Replace.

Instructions for Repairs

Disassembly of the Differential

--Mount the ring gear vertically, removing bolts 32 which fasten it between the case 33 and its cover 34, remove all the differential and limited-slip units; the planetary and satellite gears and their shafts, the thrust rings, and lastly the internal and external plates 35.
--To slide out the internal rings of the bearings from the case halves hubs, use a universal extractor adapted for the task.

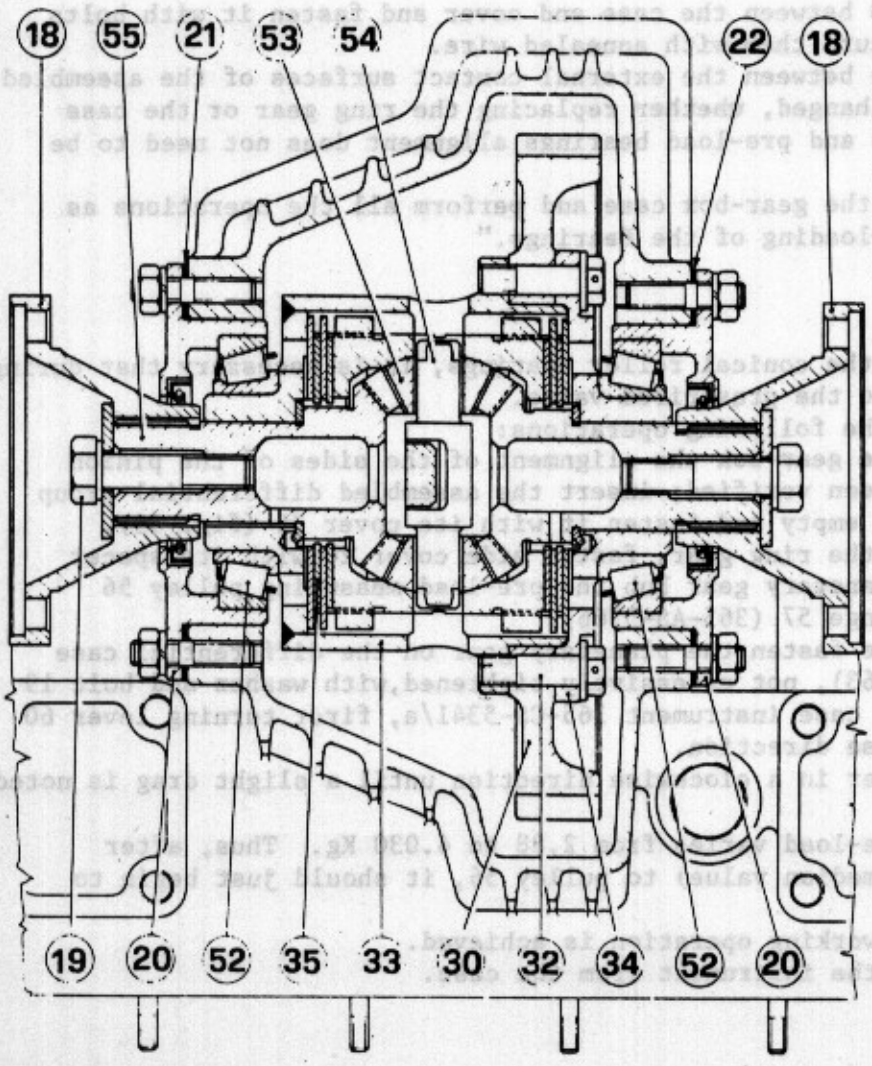


Fig. 58 Limited-slip differential: plate type.
18Semi-axles attachment flanges;
19.Flange fastening bolts;
20.Bearing support side cover;
21.Preload bearing shim;
22.Ring gear positioning shim;
30.Ring gear;
32.Ring gear fastening bolts;
33.Differential case;
34.Case cover;
35.Internal and external plates;
52.Tapered bearings;
53.Satellite gears;
54.Satellite gears shafts;
55.Planetary gears.

Checks

--Check that the contact surfaces of the pinion drive and the ring gear teething are smooth and free from niches and irregularities. When these are present, replace both units.
--Check the condition of the roller bearings and see whether the internal and external rings are still secure in their seating.
--Check the condition of the side covers 20 oil retaining rings, the condition of the limited-slip differential plates contact surfaces, and the wear on their internal and external engagement surfaces. If these surfaces are exceedingly smooth, replace them.
--Check the condition of the limited-slip pressure rings and of the satellite gear shafts.
--Check the condition of the planetary and satellite gears teeth and their seating clearances.
--Check the condition of the ring gear fastening bolts and of the case bolt holes threads.

Reassembly

--Place differential case 33 in a vertical position and insert into it the centering rings, the internal and external plates 35, the pressure rings, the planetaries, and lastly, the satellites with their shaft.
--Carefully mount ring gear 30 between the case and cover and fasten it with bolts 32 torqued to 8.5 Kg., and secure them with annealed wire.
--Check that the end clearance between the external contact surfaces of the assembled differential group remains unchanged, whether replacing the ring gear or the case itself, so that the ring gears and pre-load bearings alignment does not need to be readjusted.
--Install the whole unit into the gear-box case and perform all the operations as described in the section "Pre-loading of the Bearings."

Pre-Loading of the Bearings

For the proper functioning of the conical roller bearings, it is necessary that during assembly they are pre-loaded to the prescribed value.
To obtain the value, perform the following operations:
--During the disassembly of the gear-box the alignment of the sides of the pinion and ring gear 30 should have been verified; insert the assembled differential group in its seat with the gear box empty and fasten it with its cover 36 (fig. 55).
--On the case, on the side of the ring gear, fasten side cover 20 with its spacer washer 22 and insert on the planetary gear hub the pre-load measuring pulley 56 (175-AS-5067), fastened to flange 57 (365-AS-5766).
--On the other side of the case fasten the planetary gear on the differential case with spacer ring 58 (365-AS-5763), not excessively tightened,with washer and bolt 19.
--Then attach to the rear axle case instrument 365-CS-5341/a, first turning lever 60 two turns in a counter clockwise direction.
--After mounting, turn the lever in a clockwise direction until a slight drag is noted when the ring gear is rotated.
The value of the prescribed pre-load varies from 2.88 to 4.030 Kg. Thus, after applying a weight of 3.5 Kg. (median value) to pulley 56, it should just begin to turn slowly.
--Operate lever 60 until this working operation is achieved.
--Tighten screw 61 and remove the instrument from the case.

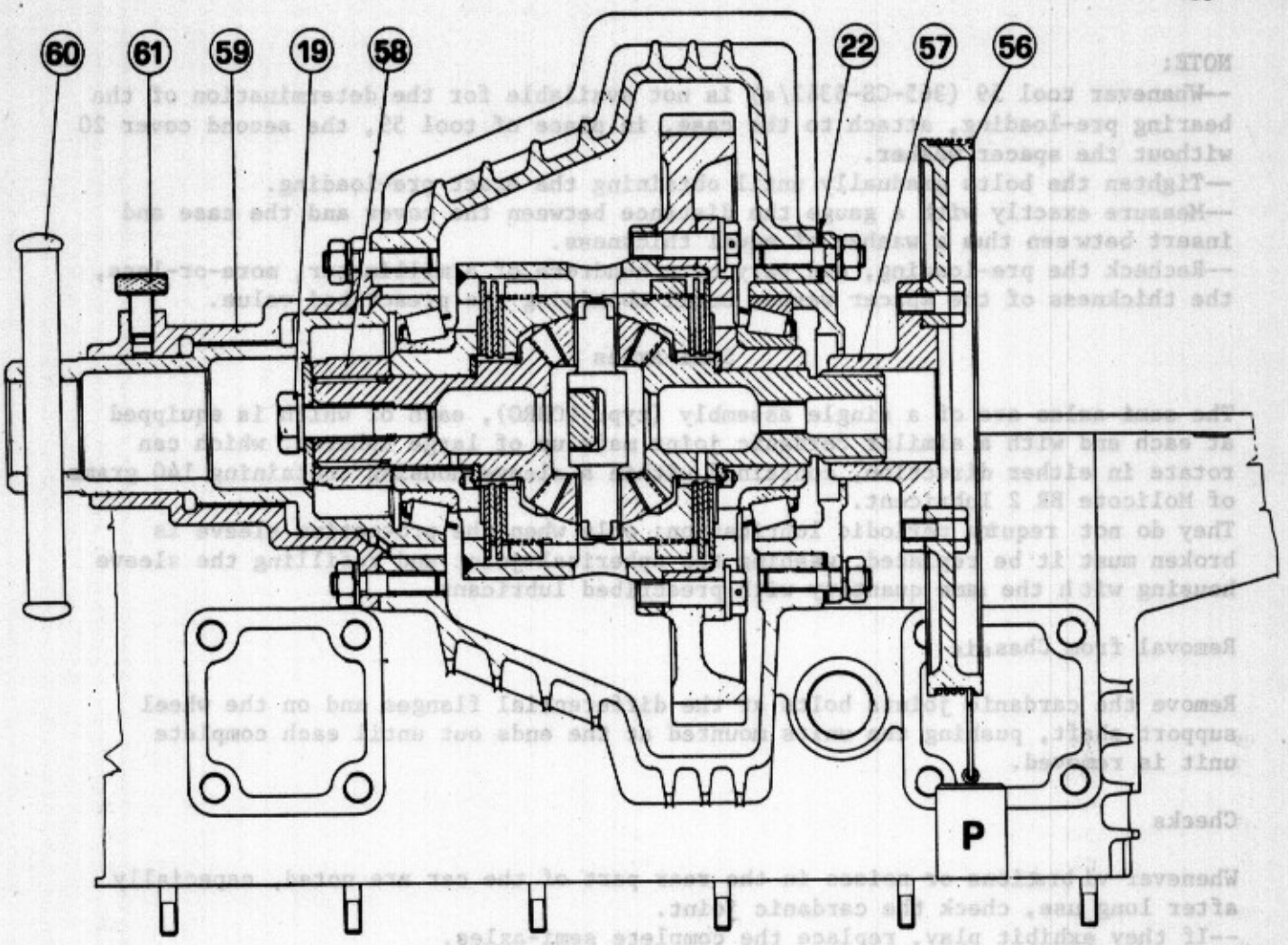


Fig.59 Preloading of the bearings.
19.Flange fastening bolt; 22.Ring gear positioning shim; 56.Pulley (175-AS-5067); 57.Pulley mounting flange (365-AS-5766); 58.Spacer ring (365-AS-5763); 59.Tool 365-CS-5341/A; 60.Arm; 61.Fastening nut.

--Insert into the instrument, with test cone tool 365-CS-5341/b, the side cover 20 with the external ring of the roller bearing pressed in its seat (fig. 60), making sure that a good contact between the contact arm of the gauge and the cover is established; by rotating the knurled knob of the gauge, turn the decimal and milimetric scales indicators to the 0 setting.
--Remove cover 20 and on the test cone attach tool 59 removed from the case; the scale indicators will complete one rotation which will correspond to the thickness of spacer washer 21 (fig. 61).
--Fasten the cover 20 to the case with spacer washer 21 and recheck the pre-load. If the pre-load does not correspond, vary by a hundreth of a millimeter, more-or-less, the thickness of the spacer washer until obtaining the prescribed value.
--Remove the differential group from the case and proceed to reinstall the transmission.

NOTE:
--Whenever tool 59 (365-CS-5341/a) is not available for the determination of the bearing pre-loading, attach to the case, in place of tool 59, the second cover 20 without the spacer washer.
--Tighten the bolts gradually until obtaining the exact pre-loading.
--Measure exactly with a gauge the distance between the cover and the case and insert between them a washer of equal thickness.
--Recheck the pre-loading, and vary by a hundreth of a millimeter, more-or-less, the thickness of the spacer washer until obtaining the prescribed value.

Semi-Axles

The semi-axles are of a single assembly (type LOBRO), each of which is equipped at each end with a similar cardanic joint made up of large spheres, which can rotate in either direction, contained within a sleeve housing containing 140 grams of Molicote BR 2 lubricant.
They do not require periodic lubrication; only when the protective sleeve is broken must it be replaced, washing the spherical joint and refilling the sleeve housing with the same quantity with prescribed lubricant.

Removal from Chassis

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

Checks

Whenever vibrations or noises in the rear part of the car are noted, especially after long use, check the cardanic joint.
--If they exhibit play, replace the complete semi-axles.
--The new semi-axles do not require preventative balancing.

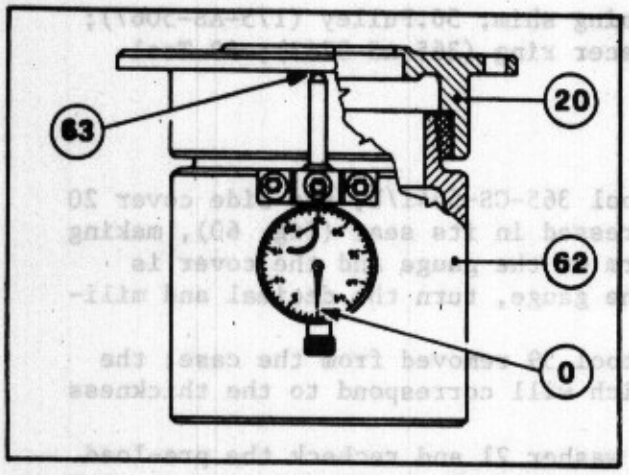


Fig. 60 Zero-setting of gauge.
20.Bearing carrier cover; 62.Tool 365-CS-5341/b; 63.Contact arm.

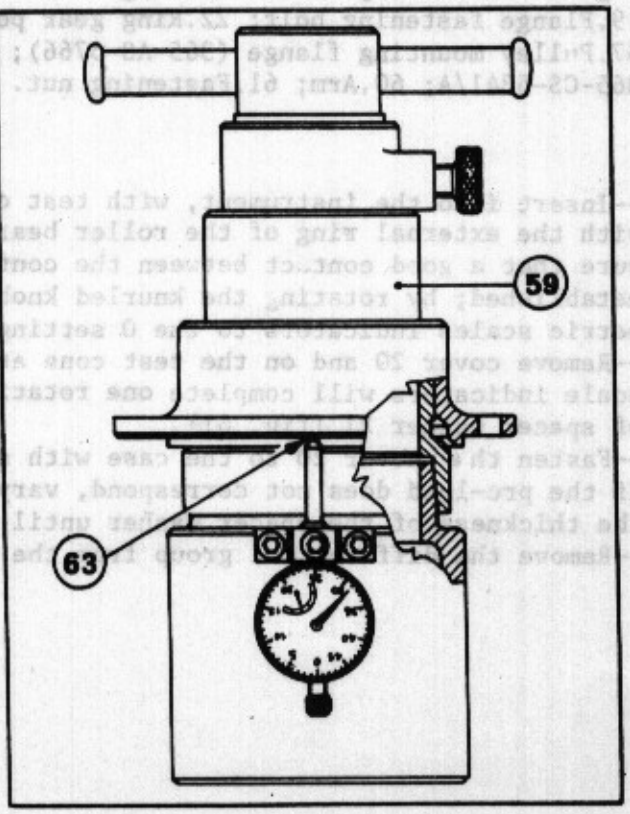


Fig. 61 Determining Thickness 21 using tool 365-CS-5341 a/b.

SECTION 5

STEERING

STEERING

Characteristics and Data

Steering type: CAM-GEAR	Steering rack
Minimum Steering diameter	11.40 meters
Number of steering wheel turns, lock-to-lock	3.28
Control pinion bearings	2-support and thrust
Pinion axis inclination	4° 5'
Steering rack bearings	1 guide bushing; 1 adjustable plunger
Pinion clearance adjustment	Via spacer washer
Steering rack movement wear adjustment	With plunger, spacer washer and pressure spring
Tracking rods	With ball joints adjustable at steering rack, with permanently lubricated ball joints at shaft lever.
Front wheel Toe-in (car under static load condition)	2 ÷ 3 mm.
Steering box lubricant	Shell SPIRAX EP90; 0.200 Kg.

Diagnosing Operation Malfunctions and Related Remedies

Steering Knock

Possible Causes	Remedies
1) Loose travel adjustment in steering rack.	1) Adjust rack travel (pg.96)
2) Loose steering rack pinion.	2) Adjust steering rack pinion (pg.96)
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 Shimmy

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 (pg. 107).
6) Faulty shock absorbers.	6) Check out the shock absorbers (pg. 118/21)
7) Front wheel bearings with excessive play.	7) Reset to exact clearances.
8) Suspension arms play.	8) Check out the suspension.

Swerving or Sliding in Curves

Possible Causes	Remedies
1) Faulty tire pressure.	1) Refill to required pressure.
2) Exessively 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 (pg. 130).
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 (pg. 96-7).
4) Stiffening of steering controls.	4) Disassemble and check the coupling action between the steering control shaft and steering unit.
5) Stiffening of suspension uprights 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.

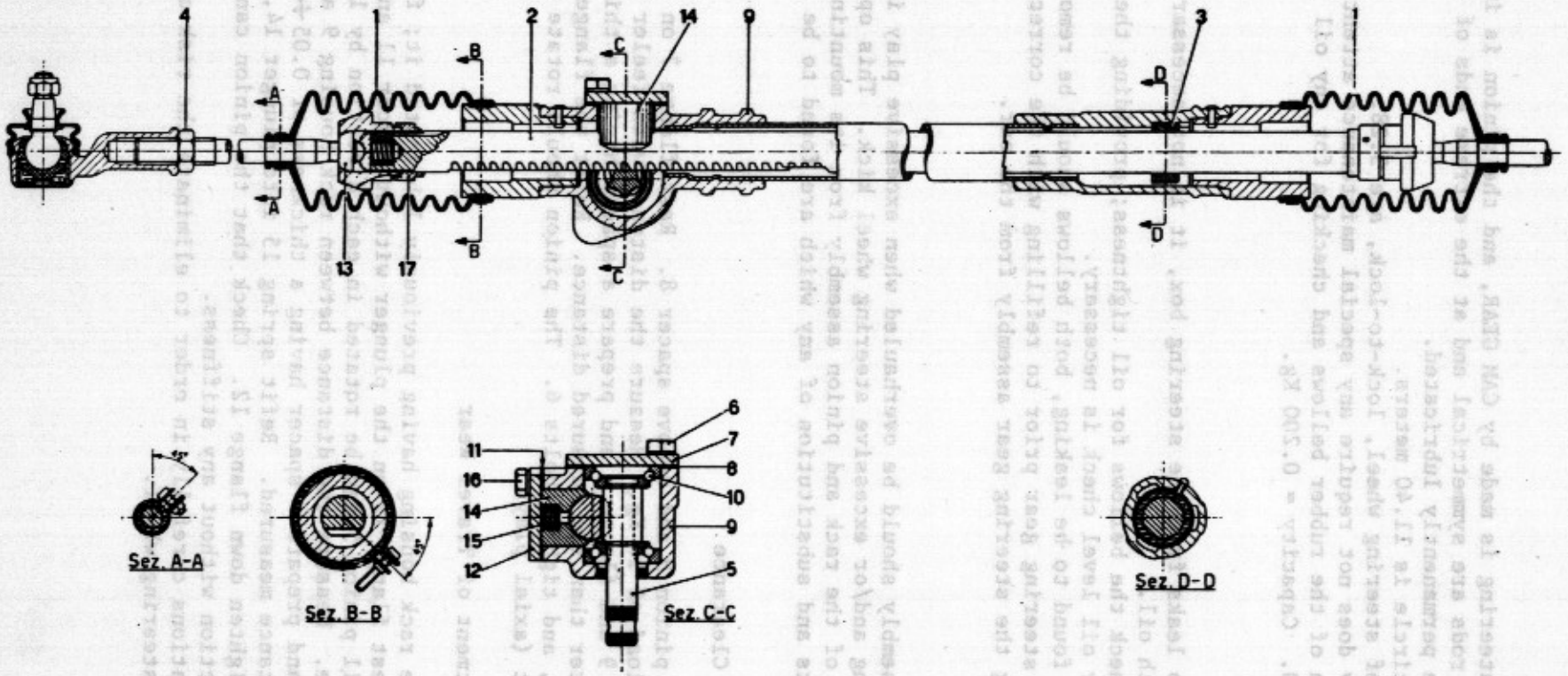


Fig. 62. STEERING.

1. B ellows, 2. Rack, 3. Rack bushes, 4. Lock nut, 5. Pinion, 6. Bolt, 7. Flange, 8. Pinion spacers, 9. Steering gear housing, 10. B all joint, 11. Rack spacer, 12. Flange, 13. Ball joint, 14. Plunger, 15. Spring, 16. Bolt, 17. Lock nut for ball joint.

Steering

Description

The rack and pinion steering is made by CAM GEAR, and the pinion is inclined by 4° 5'. The tracking rods are symmetrical and at the extreme ends of the rack. Their ball joints are permanently lubricated.
The minimum turning circle is 11.40 meters.
The number of turns of steering wheel, lock-to-lock, are 3.28.
The steering assembly does not require any special maintenance attention apart from a periodic inspection of the rubber bellows and checking for any oil leaks.
Use Shell SP IRAX HP90. Capacity = 0.200 Kg.

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.

Overhauling

The steering gear assembly should be overhauled when excessive play is found, inaccuracy of steering and/or excessive steering wheel kick. This operation requires the removal of the rack and pinion assembly from its mounting.
Checking of components and substitution of any which are found to be faulty is necessary.

Pinion-Adjustment of Clearance

Refit in its housing pinion 5 and remove spacer 8. Rest flange 7 on the lower bearing and apply a load of 10 Kg. Measure the distance with feeler gauges between the steering housing 9 and flange 7 and prepare a spacer having a thickness of 0.05÷ 0.13 mm. greater than the measured distance. Refit the flange and the spacer using joint compound, and tighten bolts 6. The pinion should rotate freely without any sign of end float (axial play).

Steering Rack- Adjustment of Travel Wear

Fit the rack into the rack housing having previously lubricated it; fit plunger 14 without spring 15, rest flange 12 on the plunger without spacer 11 and gradually tighten bolts 16 until pinion 5 can be rotated in each direction by 180° with a light pressure. Measure the distance between rack housing 9 and flange 12 with a feeler gauge and prepare a spacer having a thickness of 0.05÷ 0.13 mm. greater than the distance measured. Refit spring 15 into plunger 14, spacer 11 using joint compound and tighten down flange 12. Check that the pinion can still be rotated in each direction without any stiffness.
Carry out these operations carefully in order to eliminate the risk of stiffness, and/or kicks at the steering wheel.

Rack Bushings

If during the inspection it is found that the rack has play because rack bushings 13 in the housing are worn, it is necessary to contact the suppliers CAM GEAR ITALIANA o f Gardone Val Trombia.

Tracking Rods

The ball joints which hold the tracking rods onto each end of the rack, are in satisfactory condition when it is possible to move them through their full angle of travel. When using a load of 1.5 ÷ 2.5 Kg. at the opposite ends (0.40 ÷ 0.60 Kg.), in the event of the ball joints being removed, it is recommended that the lock nut 17 be replaced, and should be tightened to a torque of 4.5 ÷ 5 Kg.

SECTION 6

FRONT SUSPENSION

FRONT SUSPENSION

Description

The suspension is by independently strung wheels using upper and lower transverse wishbones, coil springs, telescopic hydraulic shock absorbers and a transverse stabilizer bar (fig. 63).
The wishbones are joined to the front suspension uprights, using two ball joints, their housings being attached to the wishbone. The inner ends are fixed to the chasis via rubber bushings.
The bushings do not require periodic lubrication.
Every 5,000 Km. grease the front suspension upright joints.

Characteristics and Data

Type	Independently strung wheels with hydraulic shock absorbers and coil springs.
Stabilizer bar Diameter	Transverse, mounted on rubber mounts. 16 mm.
Upper and Lower oscillating arms Chasis connection Upright connection	 Via forks and elastic bushings Via ball joints

Suspension Uprights	
King-Pin inclination	9° 30'
Caster*	4°
Caster adjustment	Permanent adjustment (to chasis #01116) Via shims (from chasis #01118)
Wheels	
Camber inclination	Min. +0° 15' ÷ Max. +0° 30'
Inclination measured at wheel base	Min. 1.55 ÷ Max. 3.10 mm.
Inclination adjustment	With shims
Toe-In (*)	2 ÷ 3 mm.
Toe-In adjustment	Via adjustment of steering lateral arms length
Wheel bearings	Shell ALVANIA EP2 Grease
Suspension Settings with Loaded Car	2 people + 20 Kg. of baggage
Ground clearance	125 mm.
(*) Car in Static Laden Condition	Full of fuel, 2 people and no baggage

Suspension Springs	
Spring free height	319 mm.
Static load	407 Kg.
Spring height under 407 Kg. load	197 mm.
Minimum admissable weight in reference to spring length of 197 mm.	390 Kg.
Wire diameter	12.5 mm.
Internal spring diameter	77.5 mm.
Flexibility	mm./Kg. 0.3
Spring widing direction	Right

Note: The springs are identified and separated according to their load and are marked with different colors at the coil. During reassembly make sure that the springs are matched according to their color markings.

Diagnosing Operating Malfunctions and Relative Remedies

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 abosrber operation on the unit and adjust if necessary.

Tires Excessively Worn

Possible Causes	Remedies
1) Faulty wheel inclination.	1) Check.
2) Faulty wheel toe-in.	2) Check.
3) Irregular tire pressure.	3) Check and refill to correct pressure.

Tires Excessively Worn (cont.)

Possible Causes	Remedies
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 with Shell ALVANIA EP2 Grease
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 the functioning of the bearings, replace if necessary and reassemble and lubricate with Shell ALVANIA EP2 grease.

The Car Tends to Pull 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 clearances.	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 inflate 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.

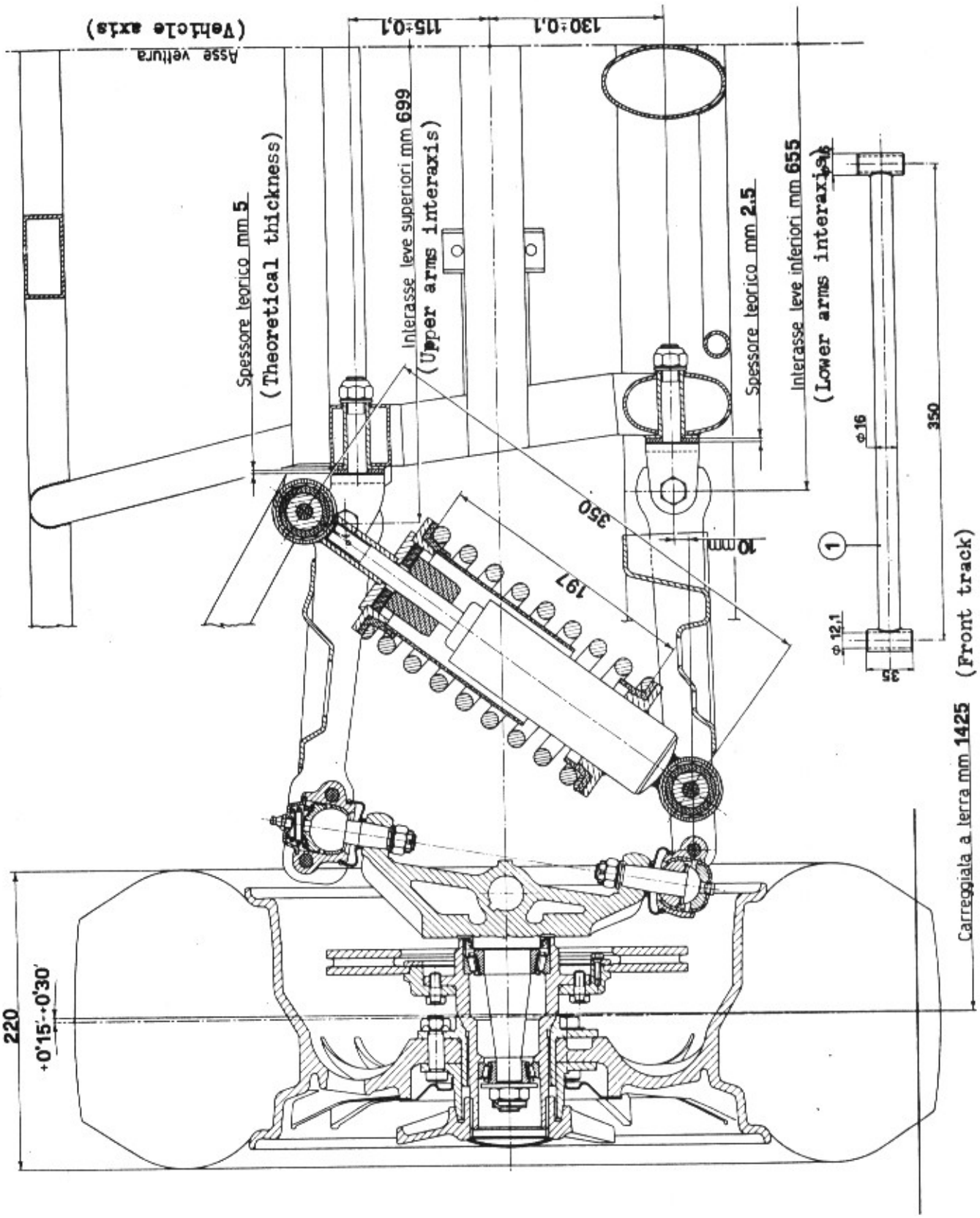


Fig. 63. Front suspension side view.

1. Wheel setting tool.

Removal of Suspension from Car

Carry out the following operations:
--Loosen the wheel retaining hubs, raise the front end of the car and remove wheels.
--Unscrew the bolts that fasten the stabilizer bar connecting rods to the lower arms.
--Unscrew the bolts that fasten the bar to the chassis and remove it as a unit at the connecting rods.
--Remove the bolts that fasten the shock absorbers to the lower arms and the chassis. (If it is not necessary to carry out a check of the springs and the shock absorbers it is not necessary to remove the shock absorbers from the chassis.)
--With a syringe remove the brake fluid from the supply container and detach the clamps of the suspension uprights flanges without changing the number or position of the spacer washers.
--Unscrew the blocking bolt of the wheel hub on the uprights and with extractor tool 125-84054/55 remove the hubs together with the brake disc.
--Unscrew the bolts that fasten the suspension arms to the forks fastened at the chassis. (If it is necessary to remove the forks from the chassis do not alter the suspension settings during reassembly.)
--With tool 706-AS-9566 remove the top ring from the shock absorber and remove the coil springs.
Removal of the independently sprung arms from the uprights.
--Loosen the two fastening bolts from the ball joints holding the suspension arms to the upright.
--Remove the tapered shafts from their seats with extractor tool 506-AS-7394.
--Spread out the arms and remove the upright.
NOTE:
The uprights cannot be dismantled; if it is necessary to replace them, replace the entire unit.

Checking of the Suspension Units

--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' silentblocs and the rubber support grommets.
--Check condition of wheel hub bearings and replace worn races, balls, or cages. Roughness or noise during rotation should not be tolerated.
--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 bearing seats or on the retaining nut threads.
--Check that the wishbone arms are not deformed.
--Check helical springs in relation to the data characteristics listed on page 100-01 making sure that there are no deformations or visible cracks.
--Check the condition of the upright rubber seals.
--Check that the two springs are equal in coloration at the first coil.

Attachment Bushings of Oscillating Arms to Chassis

If radial or axial play has been noted during the above mentioned checking operations, carry out the following operations:
--Remove the internal elastic bushing 1 (fig. 64) of each bearing and press in a new one without rough handling or adding oil or grease.
--Replace shim washer 2 making sure that the chromed side mates with the chromed surface of the internal steel bushing 3.
--Insert the arms in the chassis mounting forks and tighten bolt 4 nuts to 7 Kg.; making sure that there is no play or seizing during the travel of the arms; if faulty conditions exist also replace internal bushing 5, and if needed to lightly diminish height, since the shim washers are both of equal thickness.
--Again, remove the arms from the forks.
NOTE:
If the upper or lower arms are to be replaced after having assembled bushing 3, electrically weld it at two points in order to avoid side movements. Whenever welding, be careful to avoid deformation of bushing 1.

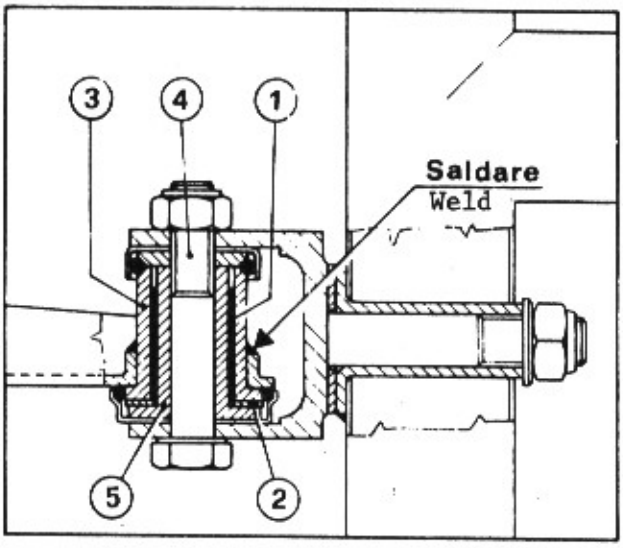


Fig. 64 Side View of Oscillating Arms to Chassis Attachment Bushings
1-Elastic bushing; 2-Spacer washer; 3-External bushing; 4-Bolt; 5-Internal bushing.

Ball Joints for Upright Units

Fasten the ball joints housing to the wishbone arms by tigtening the bolts to 5 Kg.
Connect the lower arm to the upright mounting, introducing the tapered shaft of the ball joint in its seat, without tightening the bolt too much. Check that the arm moves freely and without play. If it does, replace the complete ball joint unit.
Repeat the operation for the upper arm; then torque the retaining bolts of both units to 7 Kg.

Remounting Suspension to Car

Remount on the chassis mounting forks the two wishbone arms connected at the upright, first applying the rubber dust rings, lightly lubricated, to the bearings.
Tighten the retaining bolts to 7 Kg., move the suspension unit upwards and allow it to move downwards. If properly assembled, it will drop gradually of its own weight.
Now, install the springs on the shock absorbers using tool 706-AS-9566 and fasten this group to the suspension arms and the chassis leaving the retaining bolts temporarily lightly tightened.

Reattach the wheel hub with the disc brake and brake pads clamps and tighten the bolt of the upright shaft as indicated in the preceding section. Mount the stabilizer bar and with the car at normal level and under static load conditions, tighten the shock absorber bolts, the stabilizer bar bolts, and those bolts connecting the arms to the forks according to the torque values listed on page 140.

Checking and Adjustment of Wheel Conical Roller Bearings Clearance

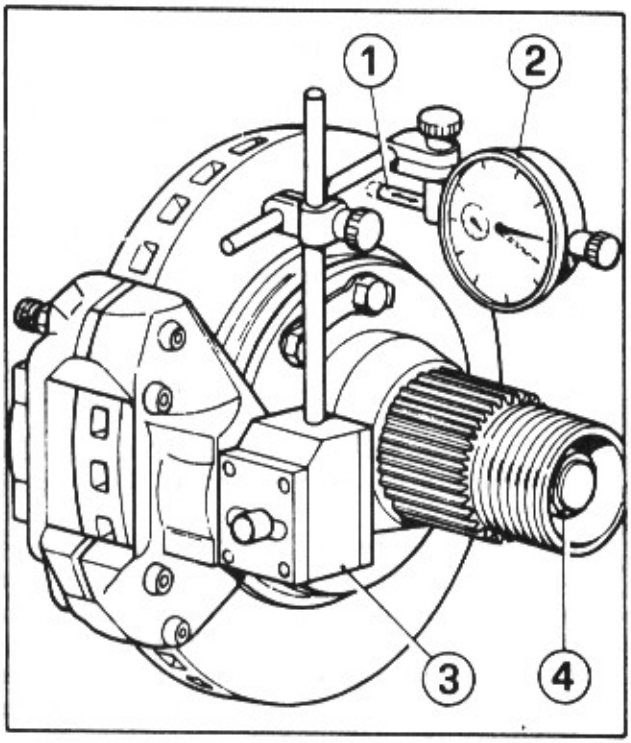


Fig. 65 Check of Tapered Roller Bearings Axial Clearance
1-Gauge feeler; 2-Gauge; 3-Magnetic mount; 4-Stop nut

In order to ascertain whether there is any bearing axial play, carry out the following operations:
--Apply a magnetic support 3 to the brake pad housing.
--Mount the contact arm so that it touches the disc brake surface and return the gauge indicator needle to zero.
--Remove the disc brake pads and check the movement of the dial indicator needle after rotating the brake assembly several times in both directions.
--The prescribed movement of the needle is: minimum = 0.06 mm. maximum = 0.10mm.
If it reads over or under these figures, remove the cotter pin on the upright shaft retaining nut, and loosen or tighten by ½ turn and recheck.
If necessary, slightly lower the retaining nut or replace it. When adjustment operation is completed, replace the cotter pin on the retaining nut.
Every 10,000 Km., check the bearing play and repeat, if necessary, the above operations. Make sure that there are no losses from the wheel hub lubricant retaining ring.

Replacement of Bearings

When replacement is necessary, carry out the following operations:
--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 ten degrees (but no more than thirty degrees) 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.
Insert in the wheel shaft space between the two bearings 120 grams of Shell ALVANIA EP2 grease, spread 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.

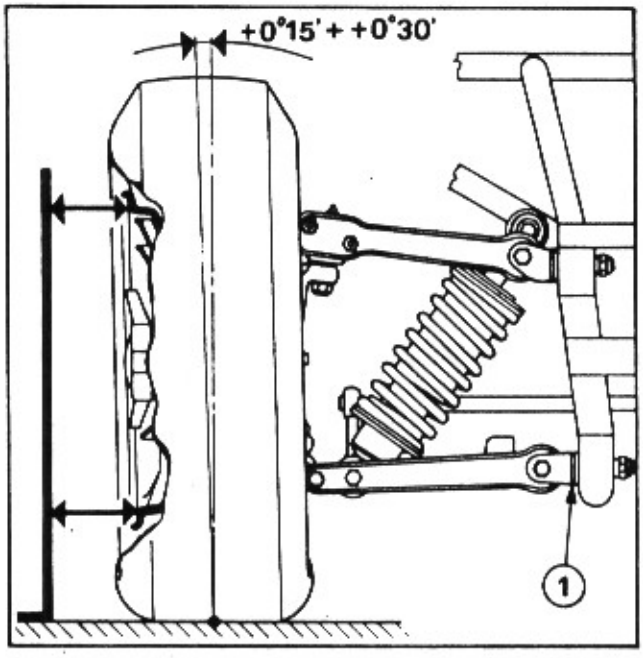


Fig. 66. Wheel Camber Inclination
1-Inclination adjustment spacer washer.

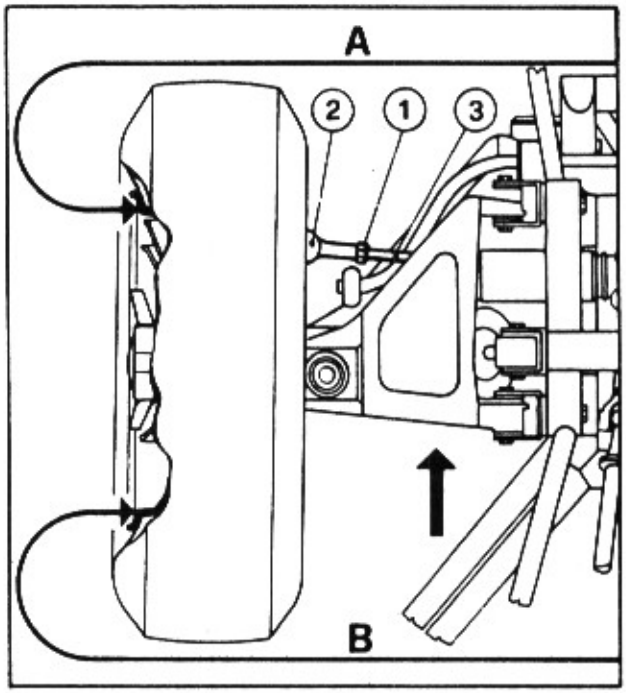


Fig. 67 Toe-In
1-Lock nut; 2-Ball joint; 3-Tracking rod

Checking and Adjustment of Wheel Settings

Before staring, 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.
--Front roller bearings play.
--Clearance between the pinion and the steering gear rack.
--Play between the steering ball joint arm and pin.
--Working operation of the hydraulic shock absorbers.
--Play between the uprights mountings and the ball joints shafts.
Car is now in level position and under static load conditions.

Camber Setting

This setting must be within the minimum value of +0° 15' and the maximum value of + 0° 30'.
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.

Toe-In Setting

The toe-in setting values are measured between the external limits of the wheel diameter.
A=B mm. (minimum); A=B - 2 -3 mm. (maximum) (fig. 67)
If the above values are not present, loosen retaining bolt 1 of ball joint 2 of the tracking rods 3; varying by equal amounts their length until reaching the exact toe-in. Retighten retaining nuts 1.

Caster Setting

The caster setting is not adjustable, due to construction details of the car. Its value is 4°. If the setting does not result in 4° ± 20', check for play in the ball joints, in the arm mountings on the chassis, or for deformations of the chassis or the wishbone arms, or damages suffered by the chassis.

King-Pin Inclination Setting

This setting is not adjustable due to the particular construction characteristics of the upright itself.
Its value is 9° 30'.

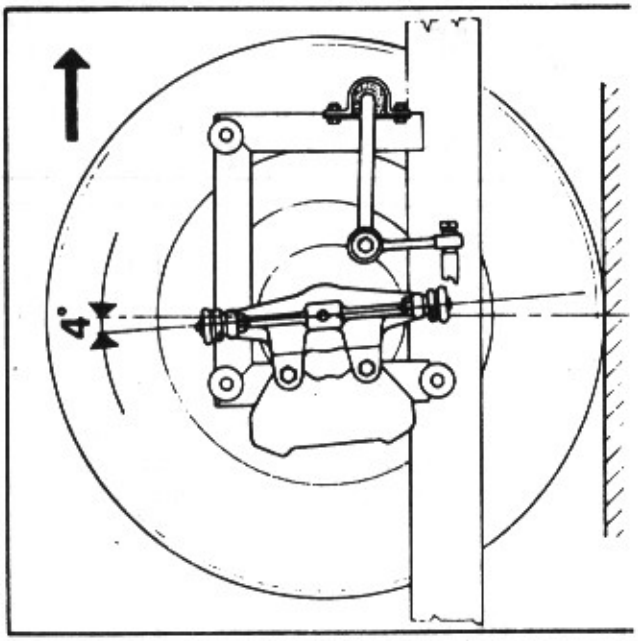


Fig. 68 Incidence (caster) angle.

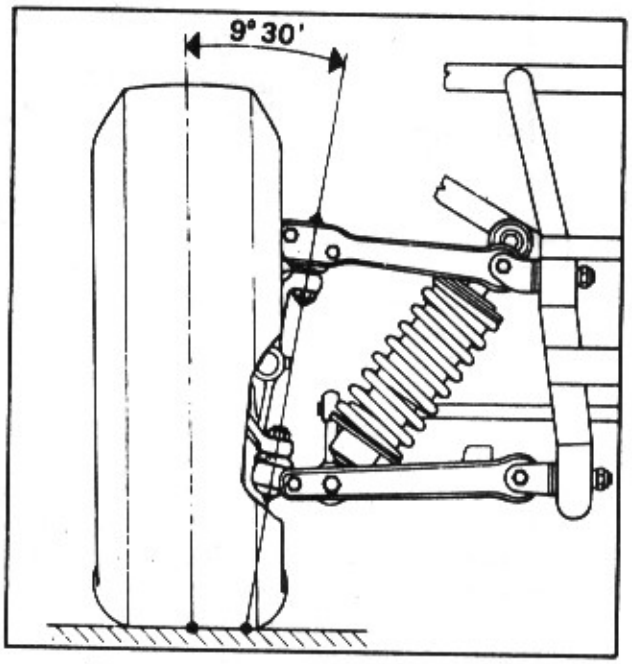


Fig. 69 Upright King-Pin Inclination

SECTION 7

REAR SUSPENSION

SHOCK ABSORBERS

REAR SUSPENSION

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 bushings.

--The wheel shaft, supported by the control arms housing, rotates on two roller bearings, the outside one being of sealed lubrication, while the inside one must be lubricated at the time of assembly with 150 grams of Shell ALVANIA EP2 in the space between the two 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.

--The shock absorbers co-axially support the coil springs and are fastened to the chassis and to the suspension control arms retaining supports with a silentbloc bushing. They control the bumps of the suspension with rubber bump stops situated within them.

Characteristics and Data

Type	Independently sprung wheels, coil springs and hydraulic shock absorbers
Stabilizer Bar Diameter	Transverse, mounted on rubber grommets 13 mm.
Upper and Lower Suspension Arms Chassis connection Suspension arms attachment support connection	 Via forks and elastic bearings (Fland Block) Via self-lubricating elastic bushings.

Wheels	
Inclination angle (*)	Min-1° 15' ÷ Max. -1° 30'
Inclination measured at wheel base	Min. 7.7 mm. ÷ Max. 9.3 mm.
Inclination adjustment	Via shims
Toe-In (*)	0 ÷ 3 mm.
Toe-In adjustment	Via shims
Rear Suspension Springs	
Spring free length	350 mm.
Static load	437 Kg.
Spring length under 437 Kg. load	219 mm.
Minimum admissable weight in reference to spring length of 219 mm.	420 Kg.
Wire diameter	12.5 mm.
Internal spring diameter	77.5 mm.
Flexibility	0.3 mm./Kg.
Spring winding direction	Right
*Vehicle in static laden condition	Full of fuel, 2 people and no baggage.

Diagnosing Malfunctions and Related Remedies

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 bushings 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 the pressure (page136).
2) Unbalanced wheels.	2) Check and rebalance.
3) Wheels out-of-center.	3) Check and adjust.
4) Excessive load in car.	4) Consult on page regarding maximum allowable weight.
5) Faulty wheel inclination angle.	5) Check the inclination.
6) Faulty wheel toe-in.	6) Check toe-in.

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 arms operation.
3) Sti cking brake on one wheel.	3) Check brake operations on all four wheels.
4) Broken or weak spring.	4) Replace the spring

Suspension Fails to Function On One Wheel

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.

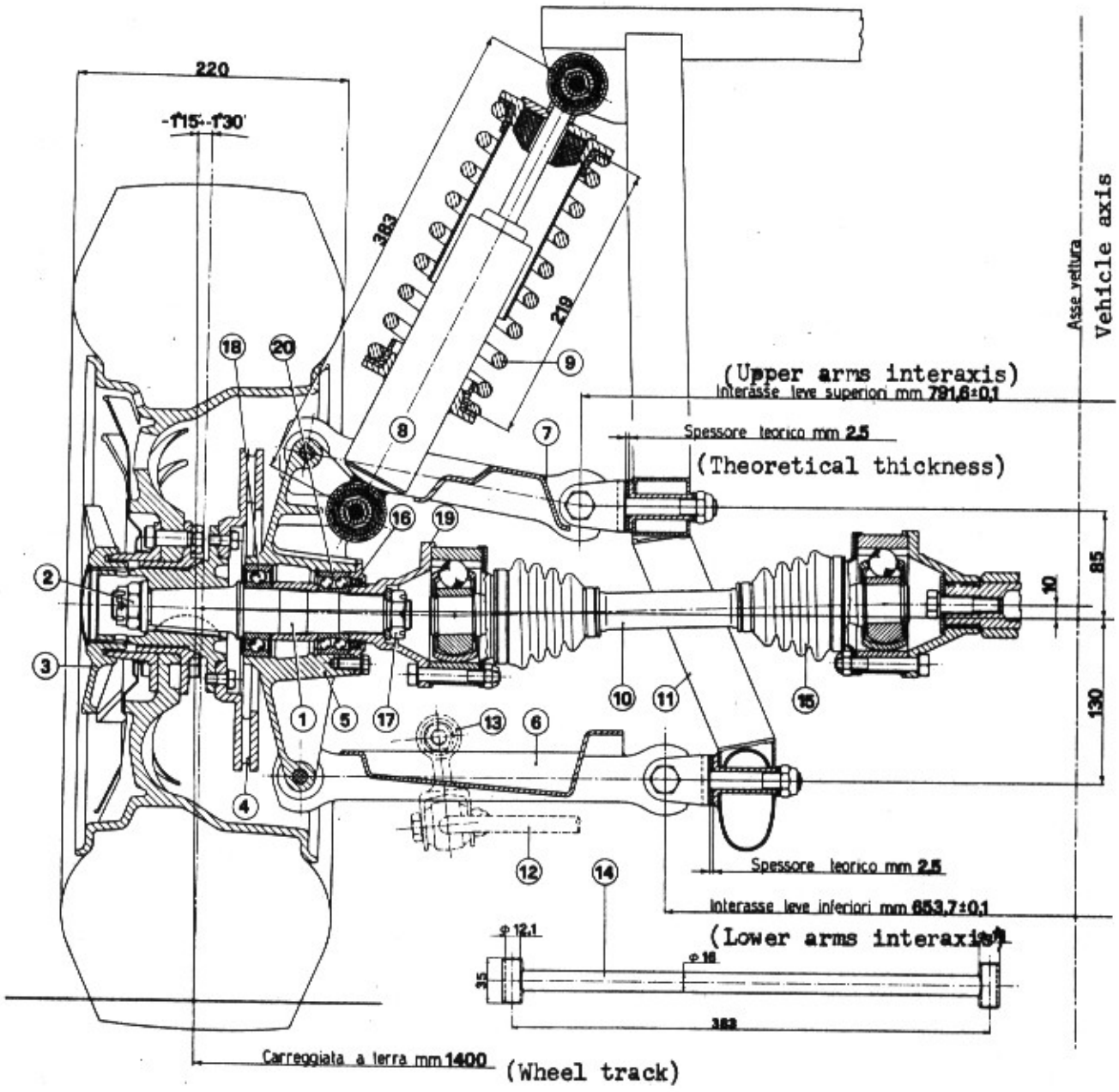


Fig. 70. REAR SUSPENSION TRANSVERSE SECTION.

1. Rear wheel flange, 2. Crown nut, 3. Wing nut, 4. Brake disc, 5. Upright, 6. Lower wishbone arm, 7. Upper wishbone arm, 8. Shock absorber, 10. Drive shaft (semi-axle), 11. Support, 12. Torsion bar, 13. Spacer washer, 14. Wheel setting tool, 15. Protective cover, 16. Retaining ring flange, 17. Crown nut, 18. Outside bearing, 19. Drive shaft fastening flange, 20. Inside bearing.

Removal of Suspension from Car

Carry out the following operations:
--Loosen wheel retaining hubs 3 (fig. 70) and the wheel support shaft nut 2 with a 27 mm. socket tool, then raise the car and remove the wheels.
--Unscrew the nuts that unite the connecting units 13 of the stabilizer bar to the lower arms 6.
--Uns crew the bolts that fasten the bar to the chassis and remove the complete unit along with the chassis attachment units.
--Remove the bolts that fasten the shock absorber to the upper suspension arms and to the chassis 11; (if it is not necessary to check or adjust the shock absorber springs, do not remove them from the chassis).
--Remove the brake fluid from the main supply tank with a syringe; disconnect the fluid tubing from the brake calipers and support housing and the emergency brake connections at the control arms support housing, without varying the position and quantity of the spacer washers for the centering of the brake disc.
--Remove nut 2 which fastens the wheel support hub on the wheel shaft, and with extractor tool 125-84054/55 screw to the hub, remove it together with the brake disc.
--Disconnect the cardanic joints of the semi-axle from flange 19 at the wheel shaft 1.
--Remove the bolts that fasten the upper and lower suspension arm to the support and remove these together at the wheel support shaft.
--With a 32 mm. socket tool remove the internal nut 17 with a puller or press push the wheel shaft together with roller bearing 18 towards the outside.
--Remove the stop flange 16 bolts and with an extractor remove roller bearing 20.
--Disconnect the upper and lower suspension arms from the chassis without disassembling the forks; if necessary, be sure not to vary the number or position of the spacer washer placed between the forks and the chassis.
--With tool 706-AS-9566 remove the upper ring from the shock absorber and remove the coil sp rings.

Checking Suspension Units

Check for axial and radial play of the suspension arms connecting unit bearings, (if play is noticed, replace the bushings and the alignment washers--see page 104.
Also check the condition of the elastic bushing (flandblock) of the suspension arms--to-the-chassis retaining forks.
Check the condition of the shock absorbers, readjusting them to their prescribed settings if needed.
Check the condition of the silentblocs of the upper and lower attachments and the condition of the bump stops at the top of the suspension arms (mounted on the shock absorbers).
--Check the stabilizer bar alignment, the condition of the pull rods silentblocs and that of the rubber support grommets.
--Check the condition of the wheel shaft bearings and replace them if noise or play is noticed (carry this out with the bearings cleaned out with gasoline or kerosene and blown dry with compressed air).
--Replace the oil retaining ring on flange 16 (fig. 70).
--Carefully check the coil springs referring to the characteristics listed on page 111making sure that they are not defective, yield excessively, and that they are free of cracks.
--Check the coloring across the first coil of the springs for matching.
--Check the wheel shaft and roller bearing seats alignment. If possible, also carry out a magnaflux check of the shaft for internal cracks.

Mounting and Adjustment of Arms

If axial and radial play of the bearings has been noted at the check before the removal of the suspension arms from the lever support housing, proceed in the following manner:
--Remove internal flexible bushing 1 (fig. 71) of each bearing and press in a new one without damaging the surfaces or greasing or oiling them.
--Replace spacer washer 2 and remount the bearings in their seats in the arms, temporarily not mounting the rubber dust covers. Connect the levers to the support housing and tighten bolts to 7 Kg. Observe that there is no play or obstruction during the complete travel of the arms; if there is, also replace the steel bushing 3 and if unavoidable lightly lower the height, since the spacer washers are of the same thickness. Again, remove the arms from the support housing to install the lightly lubricated rubber dust covers.

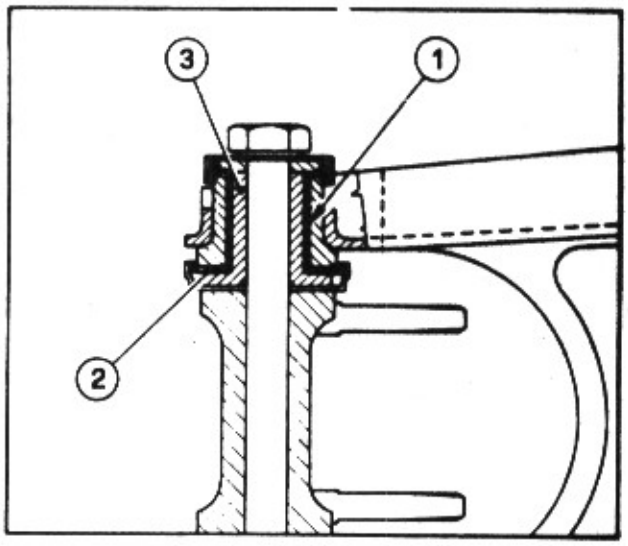


Fig. 71 Side View of Suspension Arms-to-Chassis Attachment Bushings
1-Elastic bushing; 2-Spacer washer; 3-Internal bushing.

--Check that the rubber elastic bearings (flandblock) for the attaching of the suspension arms to the chassis are in perfect condition; if not, replace them.
--Remount the complete rear assembly repeating the dismantling operations in reverse.
--During assembly lubricate roller bearing 20 (fig. 70) with Shell ALVANIA EP2 grease and add a reserve supply of it of about 150 grams between the two bearings 18 and 20. Tighten the outside nut 2 to 22 Kg. and the internal bearings 17 to 20 Kg.
--Once mounting is completed place the car in a level position and under static load conditions; tightened with torque indicated on the list on page all the retaining bolts of the shock absorber at the chassis and at the suspension arms of the stabilizer bar and the suspension arms at the lever attachment housing and at the chassis mounting forks.

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.

Wheel Camber

Camber settings must be within the minimum value of -1° 15' and maximum value of -1° 30'.
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. 72).

Toe-In

Toe-in settings must be within the minimum value of 0 mm. and the maximum value of 3 mm., measured between the outside diameter of the wheel rims.

C = D (Minimum) C = D - 3mm. (Maximum)

If the above values are not present, adjust the spacer washers 1 between the forks and the chassis of each suspension unit, but only on the front attachment points of the lower and upper arms.

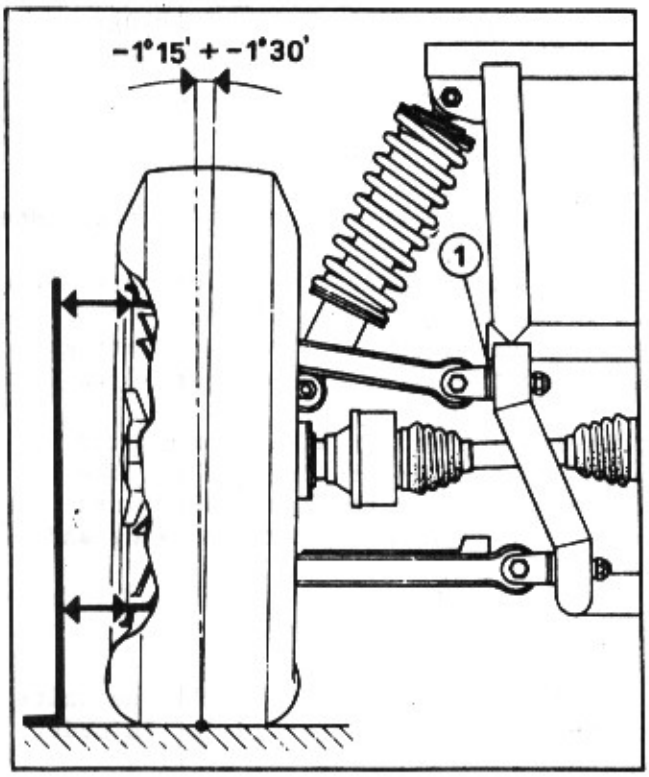


Fig. 72 Camber
1-Camber adjustment spacer washer

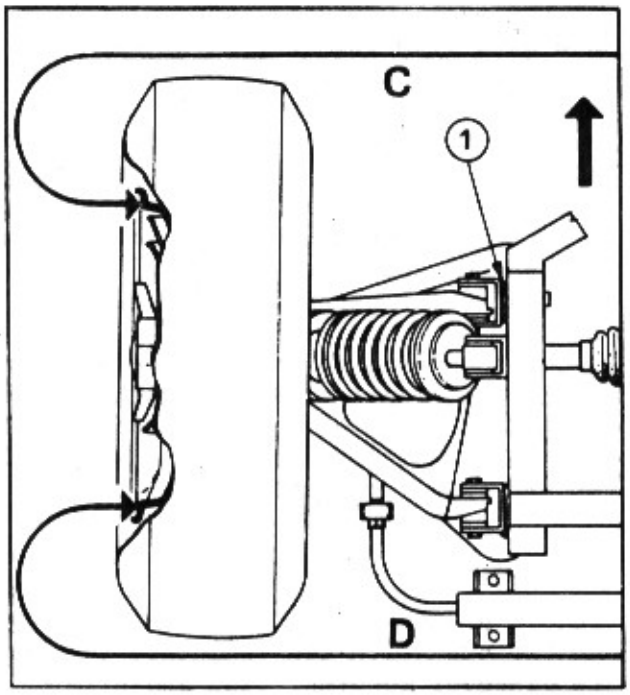


Fig. 73 Toe-In
1-Toe-in adjustment spacer washer

SHOCK ABSORBERS

Characteristics and Data

Front	
Type	KONI 82P-1579 SP 1
Internal cylinder diameter	32 mm.
Compression travel	48 mm.
Extension travel	47 mm.
Extension-Setting	105 Kg.
Compression-Setting	45 Kg.
Oil Capacity	0.190 liters
Oil Type	Shell DONAX A1
Rear	
Type	KNOI 82 N-1603 SP 1
Internal cylinder diameter	32 mm.
Compression travel	80 mm.
Extension travel	67 mm.
Extension-Setting	90 Kg.
Compression-Setting	25 Kg.
Oil Capacity	0.260 liters
Oil Type	Shell DONAX A1

Diagnosing Operation Malfunctions and Related Remedies

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 119/22.
3) Damage or sticking travel limit stopper.	3) Replace the stopper.
4) Sticking of 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 of 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 117.

Descriptions

The KONI shock absorber, 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 rings 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.

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 holes 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.

Extension Travel

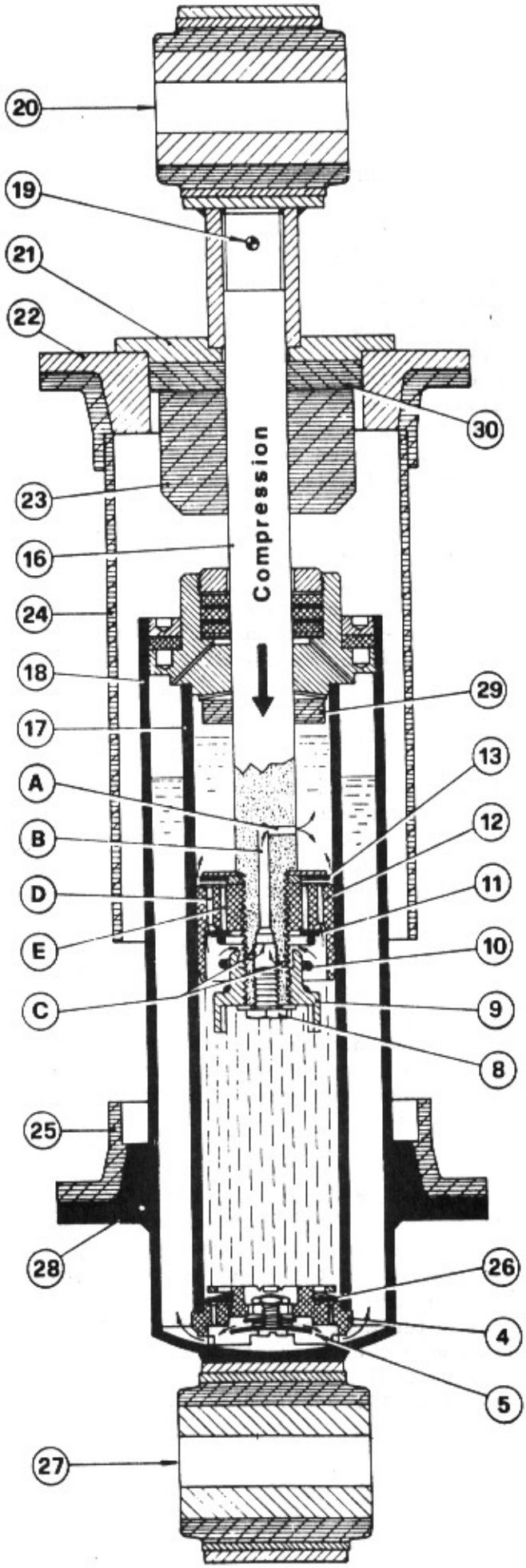
When the wheel, previously in motion, has returned to its normal position, due to the dampening action, at the same time draws the shock absorber body along with it, while piston 12 remains in place, thereby forming a compression chamber. This function causes the shut-off valve 13 to close and part of 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.

Shock Absorber Settings

The shock absorbers are rated according to the data indicated in the diagrams (fig. 76). The following instructions refer to shock absorber adjustment in case of inefficient conditions due to a long period of usage or inadequate operation, or even when it is desired to provide either a more rigid or more flexible suspension.
The adjustment operation is carried out according to the following steps:
--Remove the shock absorber from the car.
--With tool 706-AS-9566 press flange 22 until it is not possible to remove the two plates 21. Gradually release the pressure until the spring is free.

Fig. 74. 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.



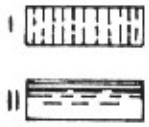
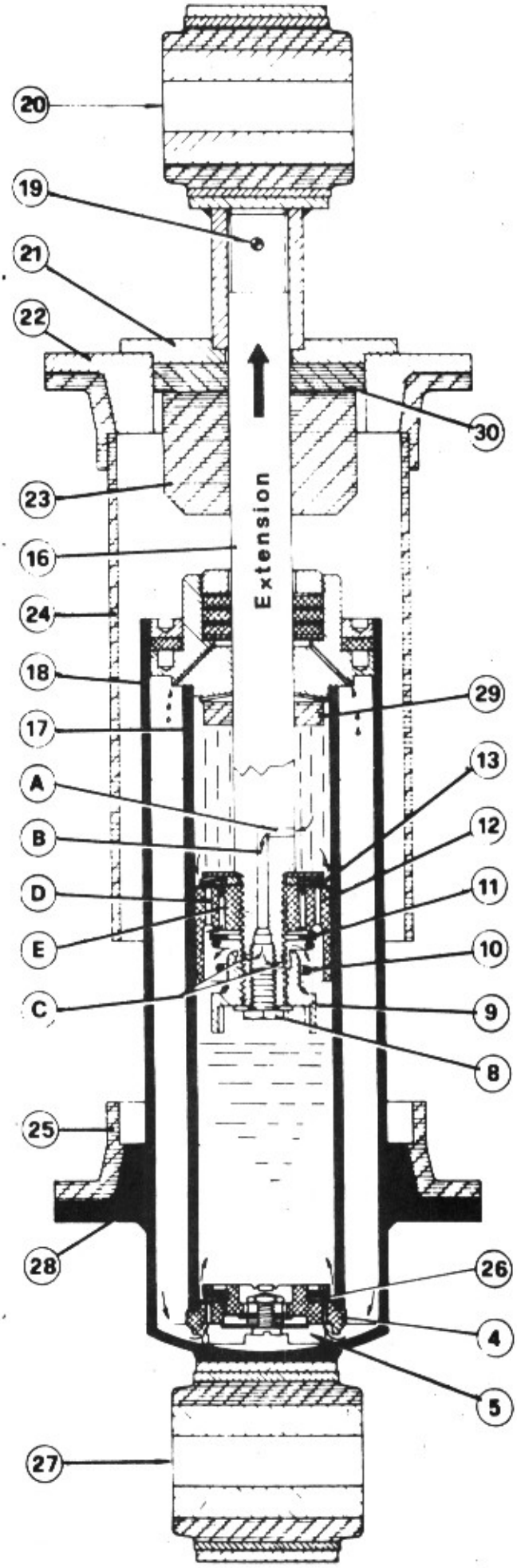


Fig. 75. EXTENSION TRAVEL OPERATION.

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.



--Remove spring and rubber washer 24 and 25.
--Fasten the shock absorber in a vise, fastening it at the lower attachment point 27.
--Remove lock 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.

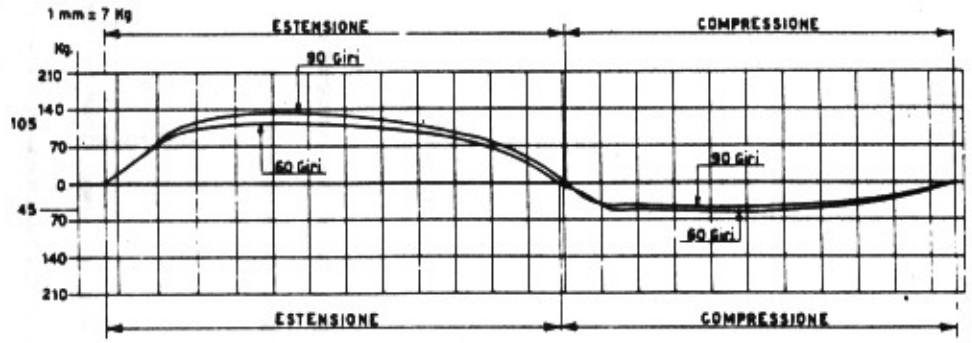


Fig. 76 Front Shock Absorbers. Setting Diagram: Extension = 105 Kg.
Compression = 45 Kg.

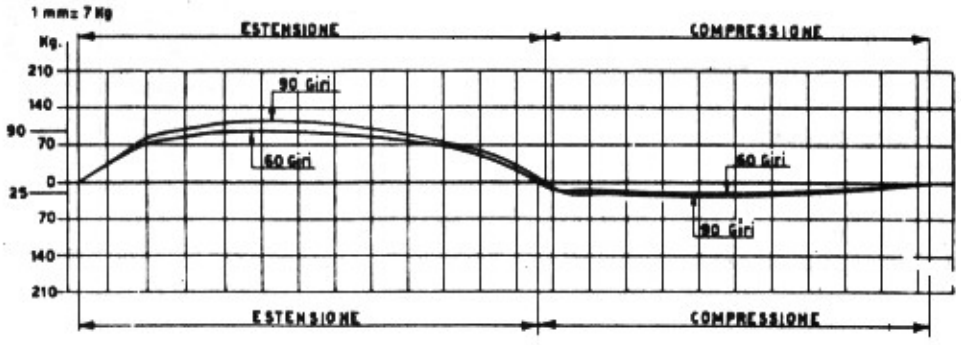


Fig. 77 Rear Shock Absorbers. Setting Diagram: Compression = 25 Kg.; Extension = 90 Kg.

SECTION 8

BRAKES

WHEELS

TIRES

TORQUE SPECIFICATIONS(CHASSIS)

BRAKES

Description

Hydraulic Brakes

The hydraulically operated brakes consist of a ventilated disc brake on each wheel with pads operated by a tandem master cylinder fixed to a vacuum servo.
The hydraulic circuits are independent from the front and rear wheels, and each is supplied by its own gravity feed reservoir.
The rear hydraulic brake circuit is fitted with a pressure limiting valve which regulates the braking on the rear wheels in relation to the force applied to the brake pedal.

Parking and Emergency Brake

These brakes are operated by a hand brake lever placed between the seats which is mechanically connected via pulleys and metal cables to the pads on the rear brake discs.

Characteristics and Data

Hydraulic Circuit	Dual
Front Brakes	
Type	Disc with wear pads
Disc diameter	270 mm.
Caliper pistons diameter: external	38.195 mm.
internal	54 mm.
Brake pads minimum thickness	3 mm.
Brake discs thickness	25 mm.
Rear Brakes	
Type	Disc with wear pads
Discs diameter	254 mm.
Caliper pistons diameter: external	30.251 mm.
internal	42.874 mm.
Brake pads minimum thickness	3 mm.
Brake discs thickness: nominal	18.4 ÷ 18.6 mm.
minimum allowable after resurfacing	17.4 ÷ 17.6 mm.
minimum allowable after wear	17 mm.
Pneu-hydraulic vacuum servo--type	MASTER VAC-BONALDI
Pump Cylinder Diameter	7/8" (22.225 mm.)
Clearance between pump piston and ferrule	0.3 mm.
Brake pressure limiting valve	At rear brake circuit
Oil type for hydraulic brakes control unit	Castrol Girling Brake Fluid Amber
Quantity: Front	0.30 liter
Rear	0.28 liter
Detergent liquid for washing disc brakes	Fiat LDC
Emergency and Parking Hand Brake	Mechanical on rear disc brakes

Diagnosing Malfunctions and Related Remedies

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; bleeding the system.
3) Brake discs with deep scores and the 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 (page 134) 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 (page 131).
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.
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) Use of non-prescribed brake pads.	2) Replace with originally prescribed brake pads
3) Brake pads not fully seated or with oily surfaces.	3) "Run-in" the pads, accurately clean them with an emory 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 the 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 inclination 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 the rear braking limiting valve.

Irregular Wear of the Pads

Possible Causes	Remedies
1) Defective centering of the caliper in relation to the 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) Apply brakes at speed several times.
2) Weak brake action at the pads due to breakage or malfunctioning of 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 over loaded 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.
4) Discs out-of-center.	4) Check centering.
5) Seized brake cylinders.	5) Overhaul caliper and replace cylinders.

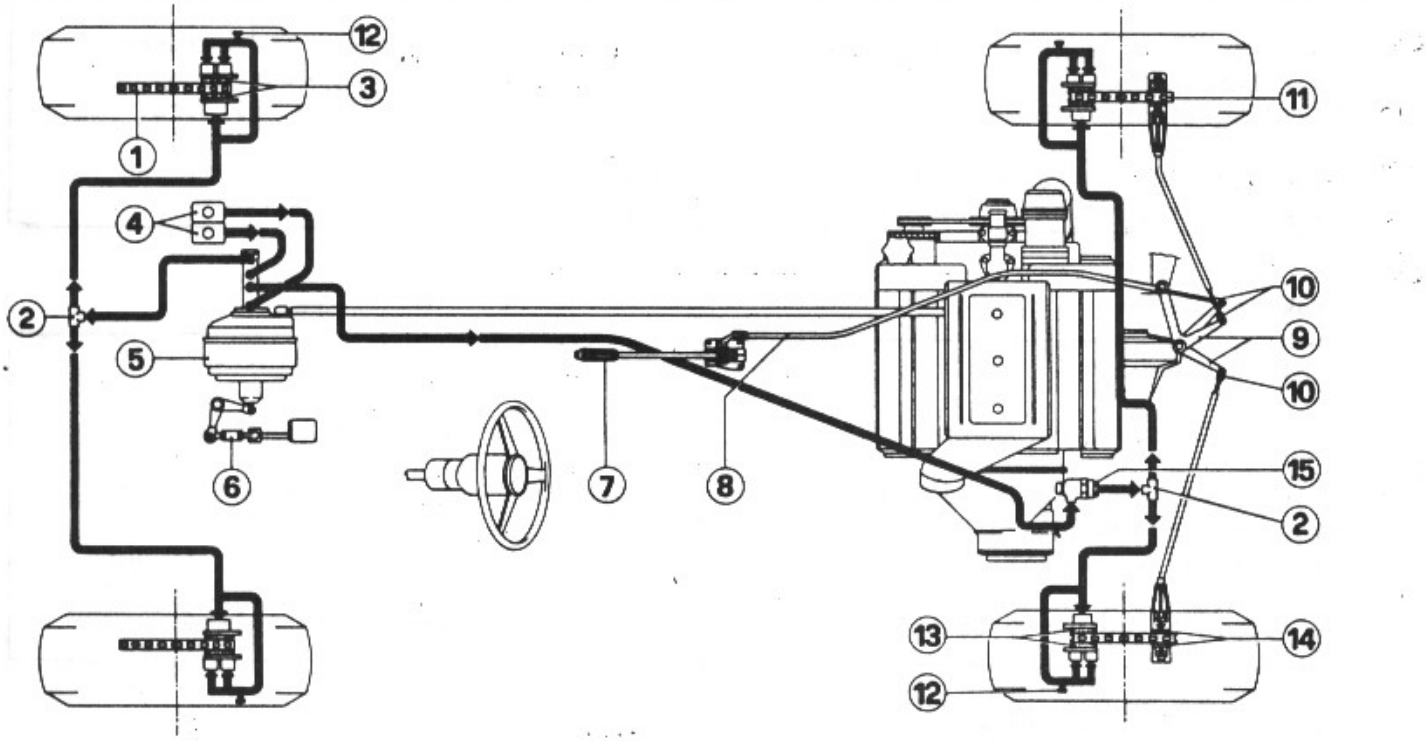


Fig. 78 Braking System Diagram
1-Front discs; 2-3-way connection; 3-Front calipers; 4-Hydraulic reservoirs; 5-Brake servo and master cylinder; 6-Pedal stop; 7-Hand brake lever; 8-Hand brake cable; 9-Hand brake lever assembly; 10-Cable adjustments; 11-Rear discs; 12-Bleed screws; 13-Rear brake caliper; 14-Hand brake caliper; 15-Pressure limiting valve.

Vacuum Assist Brake Servo

The vacuum assist brake servo BONALDI MASTER VAC (fig. 79), connected to the brake master cylinder is a pneumatic-hydraulic unit which uses the existing vacuum in the air chamber to lower the braking effort applied to the brake pedal.
An essential condition in the safe operation of the unit is that the engine should never be shut off while the car is in motion.

Hydraulic Brake Master Cylinder

The hydraulic brake master cylinder is of the dual floating valve variety, in that the brakes hydraulic circuit is divided into two circuits for the independent braking action of front and rear brakes.
The diameter of the cylinder housing is 7/8" (22.225 mm.).

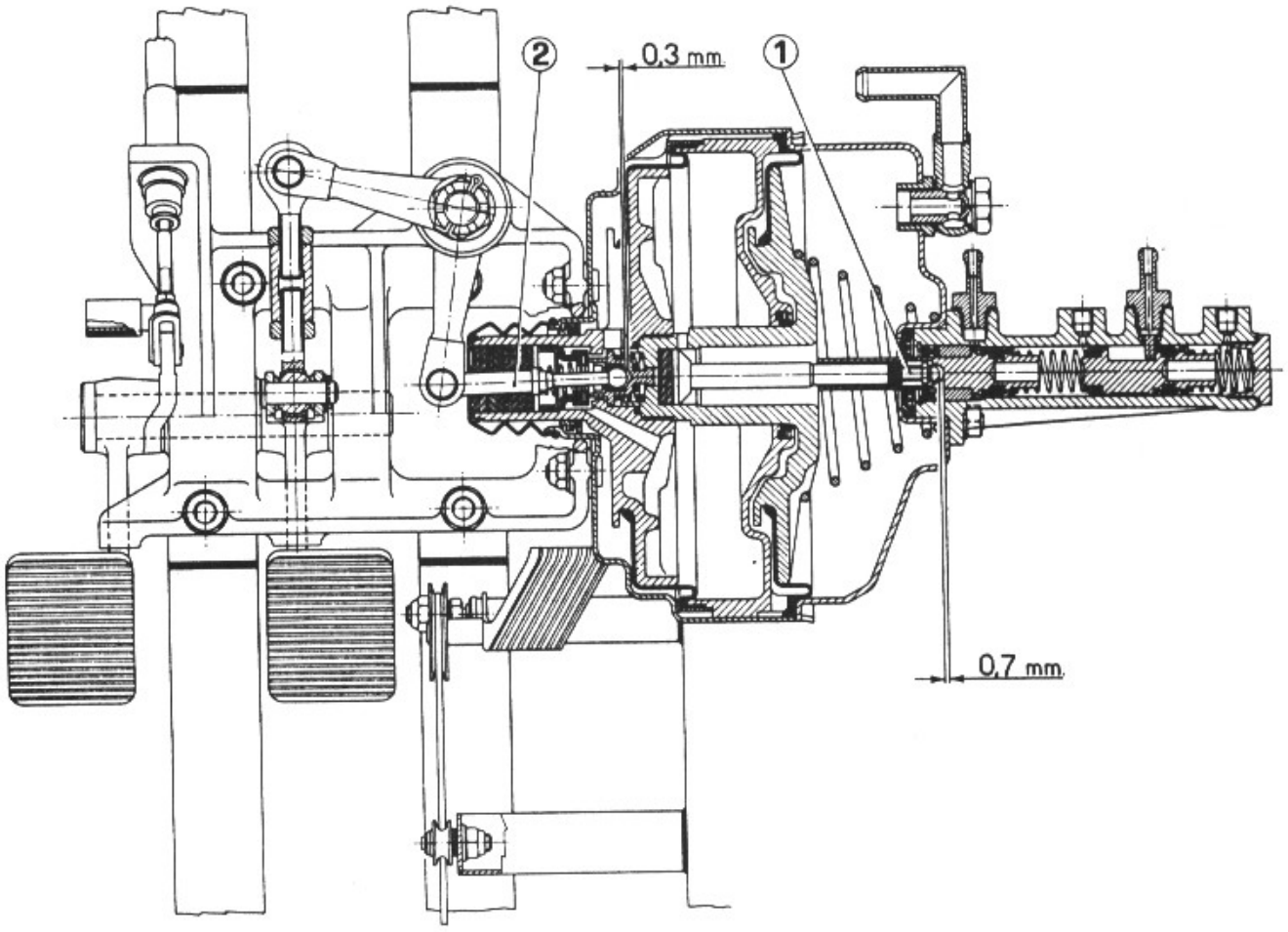


Fig. 79 Side View of Brake Servo and Dual Circuit Hydraulic Cylinder
1-Brake servo/pump clearances adjustment nut; 2-Brake servo actuating rod

Wheel Brakes

Brake Discs

The brake discs are supplied with cooling slots; the front one having larger slots for additional cooling. The discs are permanently 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 brake calipers are made up of a two part housing held together by bolts and each caliper contains three cylinders; one in the internal half of the housing, and two on the external 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 dirt, dust or mud in the cylinder, which could damage its surfaces. The proper pressure springs aid in avoiding dangerous vibrations of the brake pads during braking action.

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.
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.

Hydraulic Brake

Rear Brakes Pressure Limiting Valve

The limiting valve consists of cylindrical body 1 inside which slides piston 2 having two diameters guided and lubricated by hole 3.
Spring 4 holds the piston against threaded plug 5 and the sealing washer 6 at the opposite side.
When the oil from the master cylinder arrives in chamber 7 via hole 8, it pushes on the face of the sealing washer 9 and on its external diameter against plug 5, then to the rear brakes via the oil passage visible in fig. 80.
In this condition, the oil pressure in the front and rear calipers and that in chamber 7, are all equal until the pressure reaches 40 ÷ 50 Kg/cm^2.

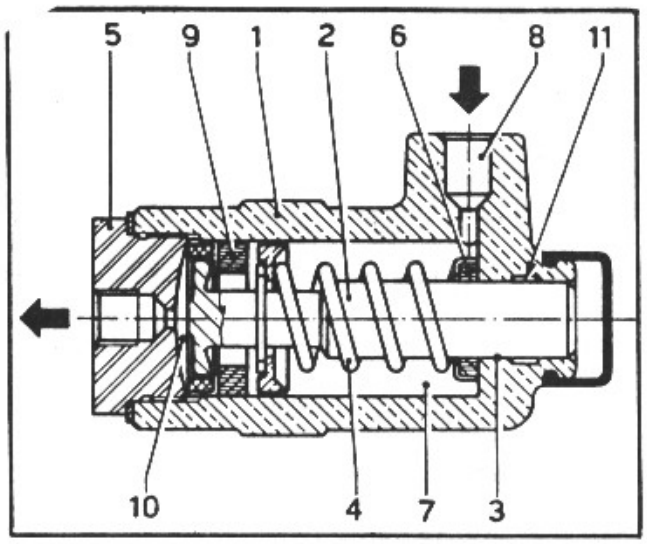


Fig. 80 Oil Pressure Limiting Valve
1-Valve body; 2-Dual diameter piston; 3-Guide and lubrication in the piston; 4-Thrust spring; 5-Threaded cap; 6-Piston retaining ring; 7-Rear brakes fluid chamb er; 8-Oil travel from pump; 9-Piston seal ring; 10-Oversized piston end; 11-Cavity for Shell RETINAX A grease.

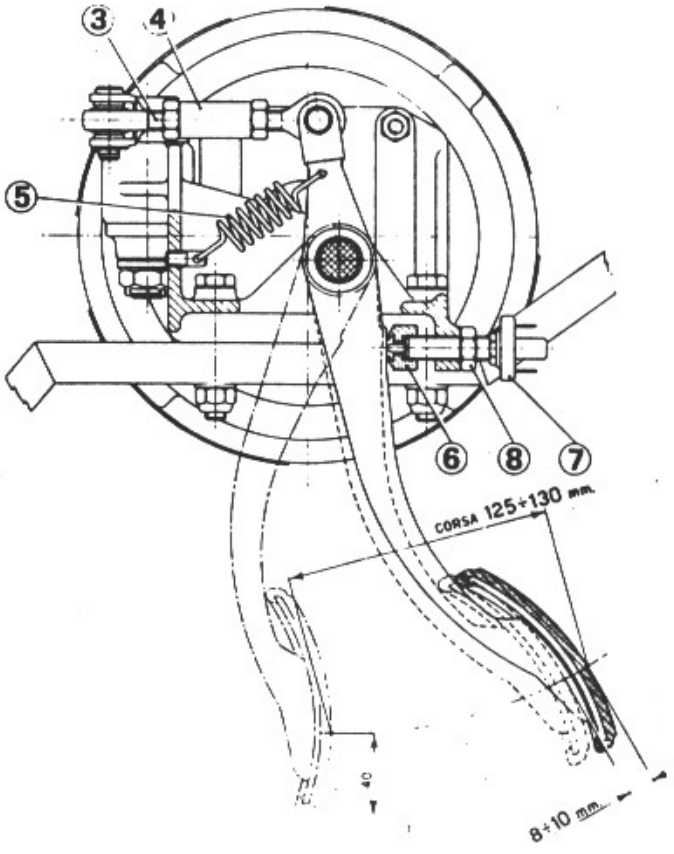


Fig. 81 Brake Pedal Free Play and Prestop
3-Lever; 4-Pedal/brake servo clearance adjustment sleeve; 5-Pedal return spring; 6-Brake pedal stop nut; 7-Prestop 8-Prestop position lock nut.

Over this value, the increased pressure created on the front face 10 of piston 2 moves the piston, thereby further compressing spring 4 and also moving with it sealing washer 9; in this way the connection between the rear calipers and the chamber is interrupted. As a result of the increased pressure on the piston and its movement, the oil pressure to the rear cylinders in respect to that in chamber 7 is reduced at the ratio of 1:0.603 approximately for all the remaining pedal travel.

Adjustment of Brake Pedal Free Play

For correct functioning of the brakes, it is important that the brake pedal prior to operating the master cylinder, has a free travel of 8 ÷ 10 mm.
For this reason push rod 1 which pushes on the master cylinder and which is located inside the brake servo is adjusted during manufacture to have a clearance of 0.7 mm. This clearance must never be varied. In the event of the car having indications of the brakes being applied without the pedal being pressed, or in the event of its being necessary to change the master cylinder, it is necessary to remove the master cylinder from the brake servo in order to check accurately using the appropriate instruments, so that the clearance between the push rod and the master cylinder is in within prescribed limits.

The connecting rod 3 to which is fitted the adjustment sleeve 4 should be adjusted accurately in such a way at push rod 2 (fig. 79) connecting the lever to the brake servo, there is a clearance between 0 mm. and 0.3 mm. before the play on push rod 1 is taken up .
The maximum travel of the brake pedal is 125 ÷ 130 mm., measured at the midway position of the pedal pad.

Replacing Brake Pads

The pads can be inspected from the outside of the caliper by removing the wheel; if examination shows damage, or when their thickness is less than 3 mm. they must be replaced.
For their replacement: remove the anti-rattle clips 1, the retaining clips 2, slide out pins 3, and remove plates 4 which carry the pads.
Push the pistons into the caliper housing, being careful not to damage the piston protecting rubbers.
Fit the plate with the new pad and refit the dust protection plates, the pins, the split pins, and the lock pins. After replacing the pads, before using the car, it is necessary to pump the brake pedal in order to bring up the pads to their normal working position.
Types of pads:
Front--FIAT 114 BS 100-1-65012
Rear--FIAT 114 BS 100-1-65212

Brake Bleeding

Fill the reservoirs, bearing in mind that during bleeding, the fluid level should never go below ¼ full.
Start by bleeding the front brakes. Fit to the bleed screw of the wheels a plastic or rubber hose keeping the other end below the surface of some brake fluid in a transparent container; slacken the bleed screw and press the pedal down through its full travel until oil is seen to enter the transparent container. Close the bleed screw and repeat the same operation on the other wheel.

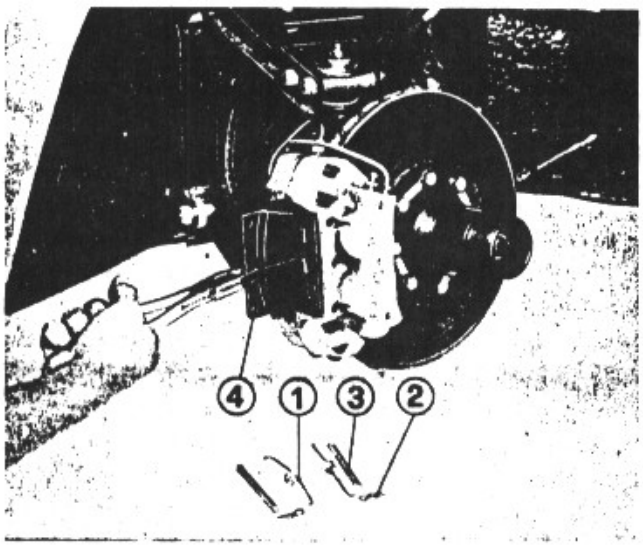


Fig. 82 Pad Replacement
1-Anti-rattle pins; 2-Retaining clip; 3-Pin; 4-Pad

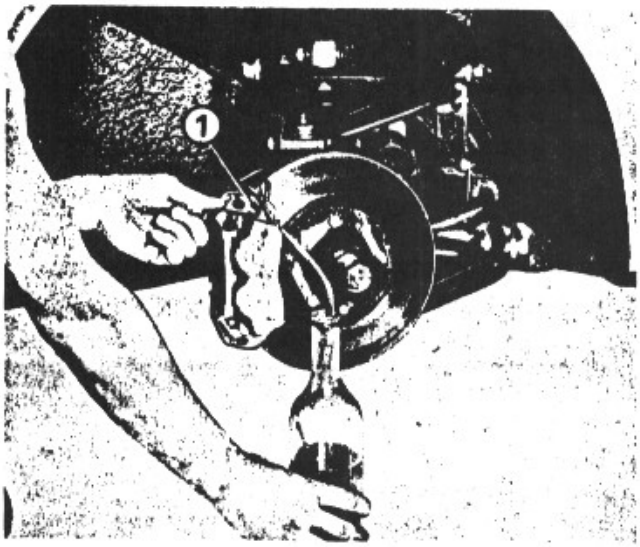


Fig. 83 Bleeding Air from Hydraulic Brake Unit Tubing
1-Bleed screw

NOTE: While the brake pedal is pushed fully down close the bleed screw and then allow the pedal to return. Press the brake pedal again, reopen the bleed screw, repeat the bleeding operation in the bleed tube.
Close the bleed screw while the pedal is fully depressed and repeat the same operation on the other wheel.

Rear Brake

The bleeding of the rear brakes is carried out in a similar manner.

Warning:
The fluid which has come out of the bleed tube should not be used again without previously filtering it and being allowed to stand to deaerate.

Adjustment of Emergency and Parking Brake

The clearance between the brake pad and the disc surfaces is self-adjusting; however if the clearance exceeds 0.25 mm., readjust as follows:
--Place the car in static load conditions.
--Check that brake pad wear is not excessive.
--Place emergency brake control lever at rest.
--Tighten the brake pad against the discs via adjustment nut 1.
--Regulate control cable 2 and clamp 3.
--Loosen the adjustment nut so as to bring about a clearance of 0.1÷0.15 mm between each pad and disc.
--After having worked the hand brake lever a few times, check that the pad/disc clearance remains the same, that the mechanism is centered in relation to the disc, and that it does not rub against the pads.
--Move the hand brake lever about 1/3 of its travel and adjust cables 4 and 5 with clamps 6 and 7 until they are not stretched and the car is not braked.
--Lightly grease the brake control fittings making sure that the grease does not come in contact with the brake discs and pads.
--Finally tighten adjustment nut 1 against the stop.

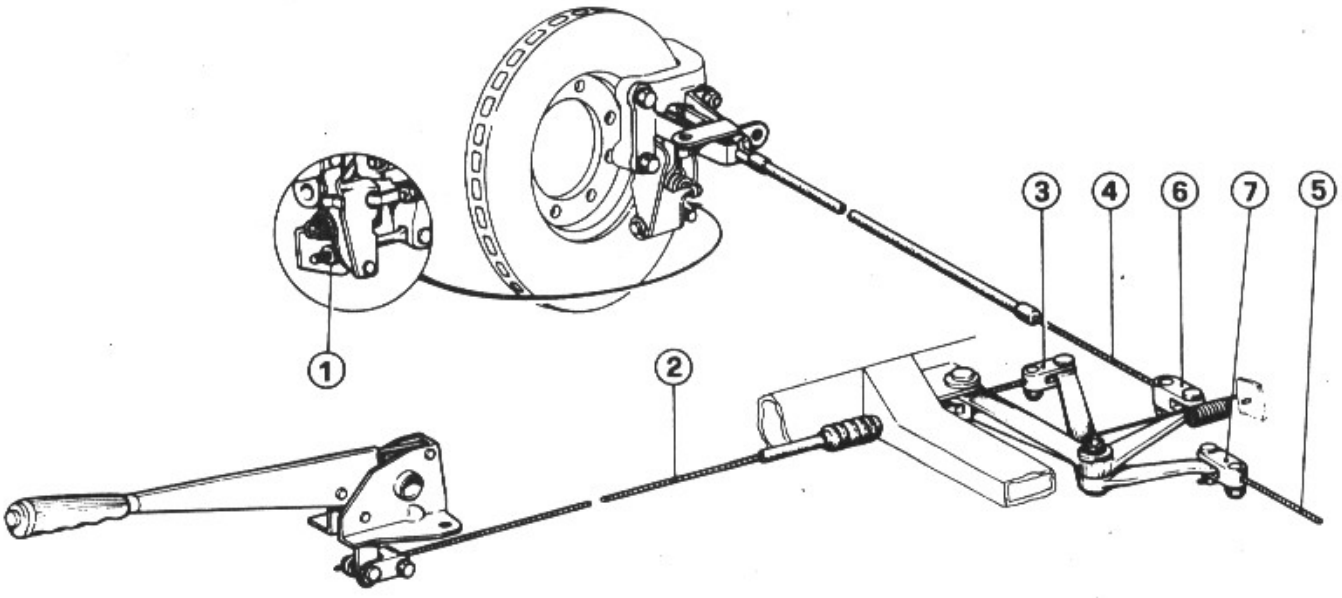


Fig. 84 Hand Brake Diagram
1-Adjustment nut; 2-Control cables; 3-Pivot control unit; 4-5-Side cables; 6-7-Cable connections.

Overhauling Instructions

Checking and Assembly

During the overhauling operation of the brake system, and before reassembly of the individual units follow these instructions:
--Check that the brake caliper cylinders and their pistons do not exhibit seizure or abrasion marks; replace these units if damaged.
NOTE: Any time the pistons are disassembled for overhauling, it is necessary to always replace the retaining gaskets at the seats of the caliper half-housings, an essential step for exact operation of the system.
--Check the squareness of the front and rear discs in relation to their rotation axis (fig. 85). The maximum out-of-centeredness indicated at the dial gauge must not exceed 0.08 mm.; if it does, accurately check and control the mounting of the disc on the wheel hub. If out-of-centeredness persists, replace the disc.
--Check the contact surfaces of the disc; if excessive wear or unevenness is noted, replace them.
Any eventual resurfacing of the disc surfaces, when wear is not excessive, must be carried out by a specialty shop, and beyond the surface finish grade (32 micro-inches), such surfaces must be perfectly smooth and parallel.
--Check that the caliper arms are equidistant and parallel to the discs' contact surfaces, if necessary adjustment is needed check spacer washers 1 (fig. 86) of 0.2 mm. thickness and tighten the retaining bolts of the front calipers to the uprights and those of the rear calipers to the suspension levers attachment support to 10 Kg.

Principal Maintenance Data

Every 5,000 Km. check and if necessary refill the brake fluid level in the reservoirs using only the recommended type of fluid. When the pedal travel is found to be excessively long or the braking action is irregular, it is necessary to check the brake system thoroughly for functioning and fluid leaks.
Every 10,000 Km. it is recommended that the brake pads be changed and to replace the fluid in both hydraulic circuits.
Before removing the pads wash with FIAT LDC liquid detergent the surrounding surfaces and blow dry with compressed air. For this operation do not use gasoline or other similar substances, in order not to deteriorate the dust covers.
Substitute the pads and check that the wheels rotate freely, properly seat in the brakes, prior to heavy use of the brakes.

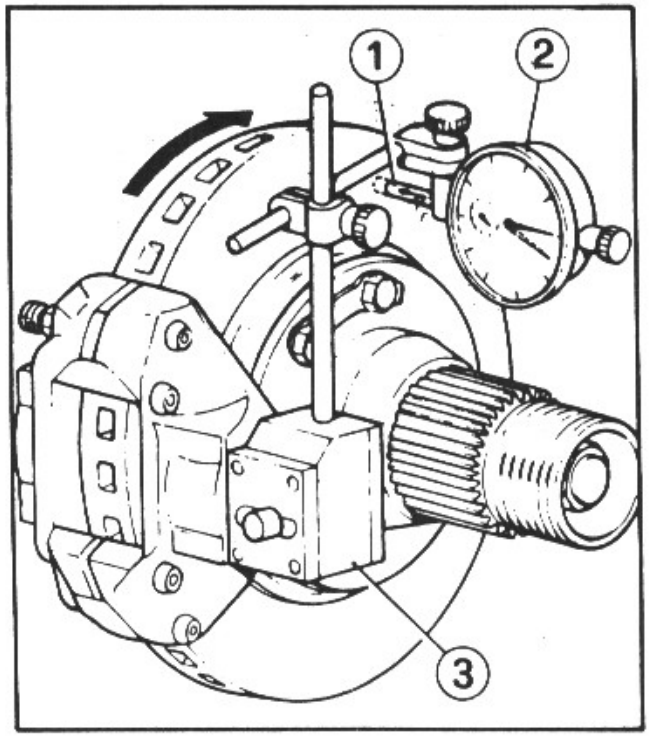


Fig. 85 Check of Brake Discs' Squareness
1-Feeler gauge; 2-Dial gauge; 3-Magnetic support

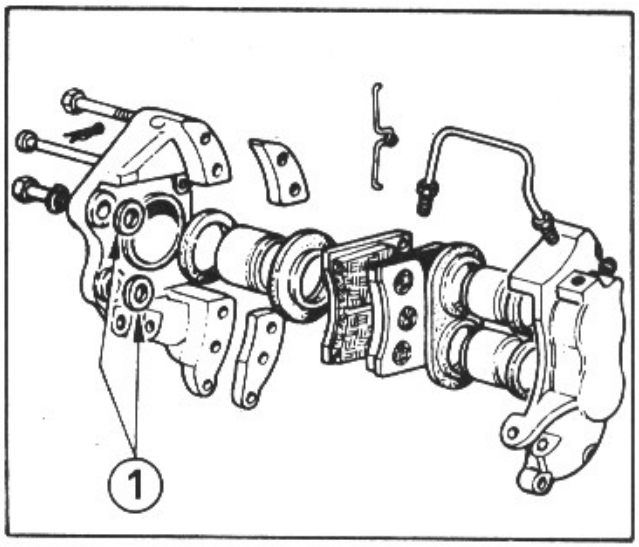


Fig. 86 Rear Caliper
1-Washer for positioning of caliper on disc brake

WHEELS AND TIRES

Characteristics and Data

Wheels	Cast in light alloy
Diameter	14 x 6½"
Tires	
Type	Michelin X 185 VR 14 (Tubeless)
Tire Pressure	
Front	1.9 Kg/cm^2
Rear	2.2 Kg/cm^2

Diagnosing Malfunctions and Related Remedies

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 (page 107).
3) Unbalanced wheels.	3) Balance the wheels (page 138).
4) Varying brake pressure on the wheels.	4) Overhaul the braking system.
5) Excessive wheel bearing play.	5) Adjust bearing clearances (page 106).
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(cont.)

Possible Causes	Remedies
8) Irregular inclination angle of front and rear wheels: wear is noted on only one side of the tread.	8) Check the angle of inclination; 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 in one wheel and insufficient toe-in in the other: wear is noted on the internal tread of one wheel and on the external tread of the other.	13) Adjust wheel settings and check steering unit.

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.

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 avoid bumps on 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.
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.

Removal and Repair of the "Tubeless" Tires

--Inflate tire to 2 Kg/cm^2 to check for air leaks, using a tub filled with water and rubbing soapy water on the tire surfaces.
After locating the leak mark it with a wax marker.
--Deflate the tire by removing valve stem.
--Place the tire on a wheel mount with the valve facing upwards and break the beads from the wheel by pressing on its sides, without using hammers, pry bars, etc.
--Smear grease on the wheel hubs and begin to raise the rim of the tire at the left hand side and at the same time on the opposite side to push the bead in the channel of the wheel rim.
With a second lever proceed to remove the tire in the normal manner, taking care to avoid damage to the wheel rims.

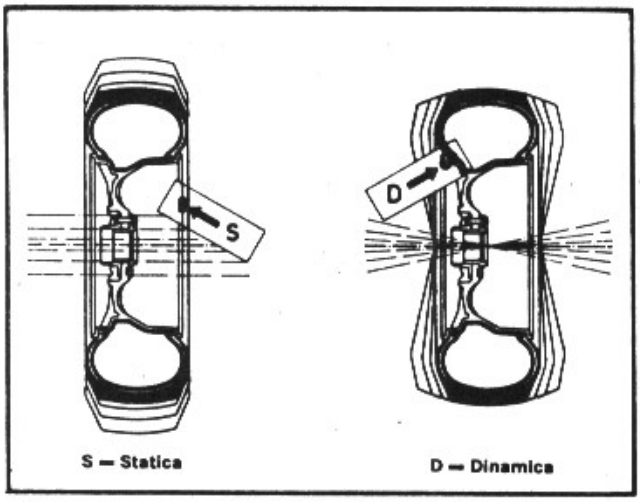


Fig. 87 Static and Dynamic Balancing.

--Mark on the inside of the tire the position of the leak, temporarily inserting a pin in the hole and placing the wheel upright, and with a metal brush roughen the area of the hole and remove all dust.
--Spread a coat of adhesive and allow to dry, then add a second light coat.
--Apply a tire patch, making sure that it is perfectly flat and adhering to the surface.
WARNING:
--Maximum cleanliness is required for correct repairs.
--Do not use non-prescribed pastes or patches.
--It is not advised to use spray-type leak repair solutions.
--It is prohibited to use rubber inserts or plugs to repair tire punctures (American type).
--It is not advisable to repair punctures greater than nail holes or when the hole diameter is greater than 4 mm.

Remounting of Tires

--Scrupolously clean the tire rims. With a wire brush or fine sandpaper eliminate encrustations or other deposits. Never use any kind of grinding stone.
--It is advisable to apply a light coat of fast-drying paint (aluminum). After drying smear some grease on the rims to ease mounting.
--If the tire is not new, clean the tire beads carefully with a rag.
--With a clean brush apply grease to the tire beads.
--Place the wheel on a mounting stand, with the valve facing upwards.
--Carefully mount the tire.
--First inflate tire to 3 Kg/cm^2; deflate it, then after inserting the valve stem, inflate to proper pressure.
--Check for perfect mounting.

TORQUE SPECIFICATIONS

Summary Table for Chassis Bolts Mountings

Individual Unit(s)	Thread	Torque (Kgm.)
Clutch		
Clutch shaft ferrule fastening	17 x 1	12
Clutch housing fastening	8 x 1	4
Gear-Box and Differential		
Input shaft ferrule fastening	30 x 1.5	19
Gear box front and rear covers fastening	12 x 1.25	7
Differential case cover fastening	8 x 1	4
	10 x 1.25	7
Gear control lever ferrule at gear box	20 x 1	13
	34 x 1.5	20
Differential bearings retaining flange fastening	8 x 1	4
Semi-axles to hub differential flanges fastening	10 x 1.25	7
Ring gear to differential fastening:		
With normal bolts	10 x 1	8.5
With TENSILOCK bolts	10 x 1	10.4
Output shaft ferrule fastening	32 x 1.5	20
Front Suspension		
Shock absorbers fastening	10 x 1	5
Ball joints to suspension uprights fastening	12 x 1.5	6.4
Torsion bar fastening	10 x 1	5
Torsion bar shims fastening	12 x 1.25	7
Suspension levers to forks fastening	12 x 1.25	7
Suspension attachment forks to chassis fastening	14 x 1.5	10
Steering lever to suspension upright fastening	20 x 1.5	16
Brake calipers to uprights fastening	12 x 1.25	10
Lever guide to upright fastening	3/8"	4.5
Disc brakes to wheel hubs fastening	8 x 1	4
Rear Suspension		
Disc brakes to hubs fastening	8 x 1	4
Wheel shaft internal flange fastening	24 x 1.5	22
Wheel hub fastening	22 x 1.5	20
Brake calipers to support fastening	12 x 1.25	10
Shock absorbers fastening	10 x 1	5
Suspension levers to forks fastening	12 x 1.25	7
Lever forks to chassis fastening	14 x 1.5	10
Suspension lever to hub carrier fastening	12 x 1.5	7
Semi-axles to flange fastening	10 x 1.25	7

Individual Unit(s)	Thread	Torque (Kgm.)
Steering		
Ball joints to steering box arms fastening	12.7 (½")	7
Steering lever to upright fastening	20 x 1.5	16
Cardanic joint to steering column fastening	10 x 1.25	5
Steering box support to chassis fastening	8 x 1.25	3
Steering wheel shaft hub tightening ferrule fastening	22 N C	12

SECTION 9

ELECTRICAL SYSTEM

BATTERY

Characteristics

Type	Marelli 6 AT 11
Nominal tension	12 volts
Normal capacity (20 hour discharge rate)	60 Ah

The battery is located in the front compartment under the spare wheel and is protected by a cover held in place by wing nuts.

Checks and Maintenance

The battery must be kept clean and dry, especially at the top. Avoid spilling of liquid, since electrolyte is corrosive to materials that it contacts. Terminals and cable covers must be individually covered with a light grease (vaseline).

Electrolyte Level

To bring up the level, use distilled water, without adding acid, since only water evaporates from the battery.
The electrolyte must come up and cover the separaters, and reach to the lower ring of the fill caps.
A higher electrolyte level causes the fluid to spill out, allowing electrolytic gases to cause corrosion of the battery cable covers and the terminals and the battery support.
The electrolyte level must be checked every 2500 Km., or every 15 days if the car is not being driven. In summertime, check more frequently.

Checking the State of Charge

To do this, one must measure the density of the electrolyte with a battery densitometer, referring to the following table.

Density	Battery Charged At:
1.28	100%
1.25	75%
1.22	50%
1.19	25%
1.16	Almost discharged
1.11	Discharged

The density level is read at the top level of the densitometer, holding it vertically and seeing that the gauge floats freely in the electrolyte.
To exactly determine the battery's state of charge, it is not necessary to measure density in the following cases:
--When the electrolyte level is low.
--When the electrolyte is too hot or too cold; its temperature must range between 15° and 25° C.

--After adding water, it must have a chance to mix within the acid (several hours if the battery is discharged).
--Soon after having carried out starting and electrical units tests, make sure that the eleetrolyte mixture is uniformly diffused.
--When electrolyte is bubbling, make sure that no bubbles remain in the densitometer when measuring density.
Whenever it is found that:
--density differences higher than 0.2 between one battery element and another exist;
--or excessively high density exists: 1.30;
--or a low density exists: 1.22;
and if at the same time, excessive heating of the battery is noticed during its use (10° over ambient temperatures), check the manufacturer's suggestions.
Recharge the battery monthly if car is stored.
Recharging is best done with a low intensity of current (maximum of 3A) until fluid in all battery cells is boiling actively.

Causes of Abnormal Discharge

Battery discharge during use (excluding long storage times) indicates abnormal functioning conditions. The causes may be:
--Malfunction of the charging unit (alternator-regulator units). Check instructions for these units, locate malfunction and overhaul alternator and regulator units if necessary, according to the instructions in this manual.
--Loss of current due to isolated defects in the electrical system. Especially in faulty moun ting of new electrical equipment (special warning lights, fog lights, etc.), since tampering with the electrical system can easily produce these defects. Using an ohm meter a check can be conducted by connecting the terminals at the positive cable disconnected from the battery and the ground.
For conditions that can affect the electrical insullation (wet vehicle, etc.), resistance readings should not drop below 10,000Ω.
Another check that can be conducted by the use of the milliamp meter is to connect the battery positive cable and the positive terminal post of the battery to the meter, the current reading must not exceed 1 m A.
--Corroded or dirty terminals can either break or short-circuit the system.
NOTE: Loos ening and tightening of the positive cables from and to the battery terminal must be done after disconnecting the negative cable (grounded to the chassis) from the battery.

External Recharging

Recharging by external means can be conducted only after long storage periods or after having checked out the electrical system as mentioned earlier.
Recharge according to these steps:
--Remove battery from car, and clean;
--check electrolyte level;
--attach battery to charging unit and check state of charge;
--before mounting in car, clean the battery.

CHARGING SYSTEM

Characteristics and Data

Alternator	
Type	FIAT A12M-124/12/47
Nominal Voltage	12 V
Alternator power	840 W
Initial velocity with 12V charge (20° C)	1020 ± 50 rpm's
Current output at battery charge of 13V at 5,000 rpm's and at thermal condition A	≥47 A
Maximum current	~58 A
Maximum velocity continuous	13.000 rpm's
Maximum velocity temporary for 15'	15.000 rpm's
Resistance winding inductor at 20° C between the two collector rings	4.5 ± 0.1
Resistance winding inductor at 20° C between pole 67 and ground at 500 rpm's	$4.6 \begin{smallmatrix} +0.2 \\ -0.1 \end{smallmatrix}$
Rotation, control side	Clockwise
transmission ratio $\frac{\text{motor}}{\text{alternator}}$	1:1.636
Rectifier (diode mode1)	
Type	4 AF 2
Nominal voltage	12 V
Permanent direct current	20 A
Maximum peak reverse voltage	150 V
Maximum direct current	25 A

Characteristics and Data (cont.)

Voltage Regulator Check and Adjustment	
Type	RC 1/12 B
Alternator velocity---checking and adjustment	5,000 rpm's
Battery capacity	40 ÷ 50 Ah
Input tension for thermal stabilization (for 15' ÷ 18')	12.5 ÷ 13 V
Current for checking second phase	2 ÷ 12 A
Tension for adjustment of second phase	14.2 ± 0.3 V
Current for checking of first phase	25 ÷ 35 A
First phase adjustment tension, lower reading, in relation to second phase tension	0.4 ÷ 0.7 V
Plug/ground resistance at 25° ± 10° C.	28.2 ± 2 Ω
Resistance between plug 15 and plug 67 with open contacts	5.5 ± 0.25 Ω
Air space between core and contact anchor	1.9 ± 0.07 mm.
Second phase contacts gap	0.4 ± 0.05 mm.

Diagnosing of Malfunctions and Related Remedies

Possible Causes	Remedies
1) Grounded stator winding.	1) Replace stator.
2) Broken stator winding.	2) Replace stator.
3) Short-circuited stator winding.	3) Replace.
4) Short-circuited or broken diodes.	4) Replace the diodes (page 151).
5) Short-circuited energizing circuit.	5) Bench test, eventually replace.
6) Broken energizing circuit.	6) Check diodes, brushes, and rings.
7) Maladjusted regulator.	7) Readjust.
8) Non-functioning regulator.	8) Replace regulator (page 149).
9) Short-circuited circuit breaker.	9) See instructions on page 150.
10) Broken circuit at circuit breaker.	10) Check brushes and rings.

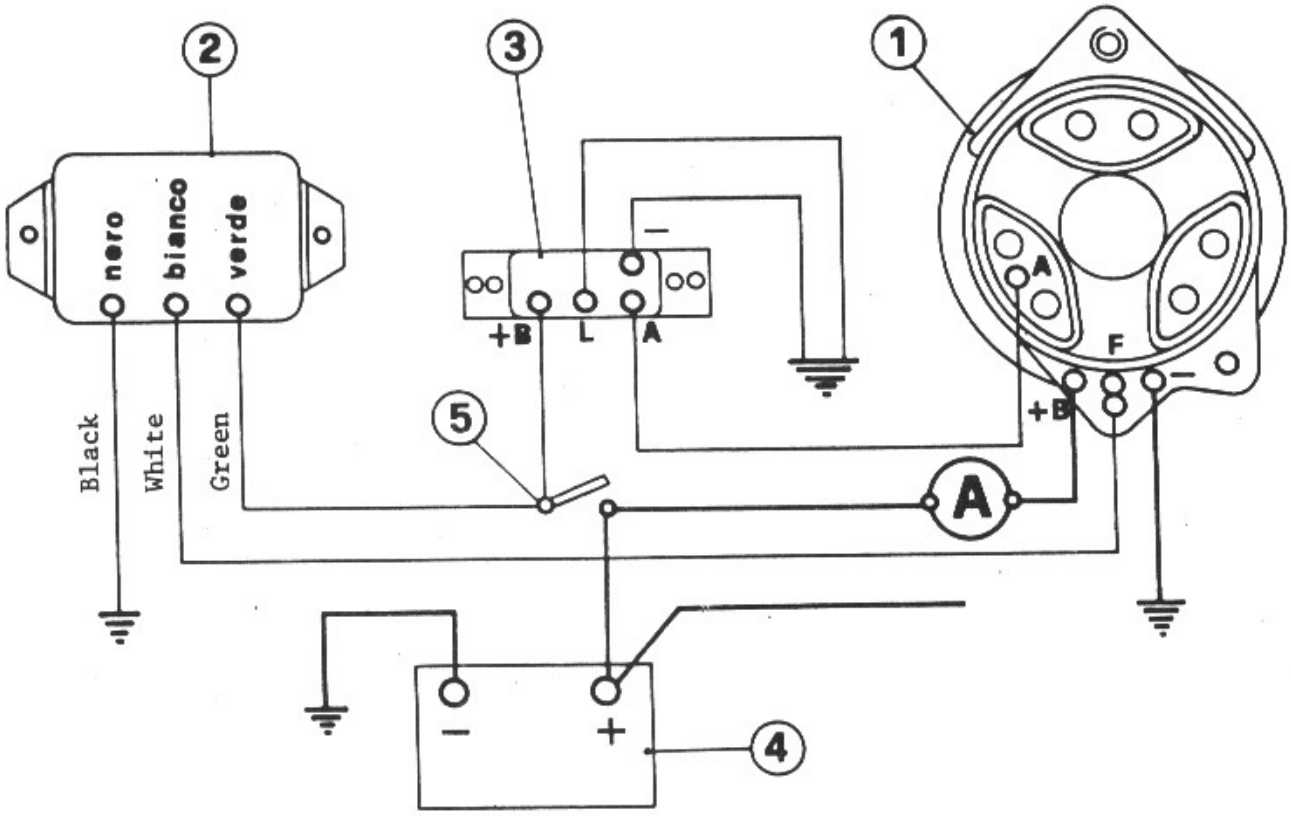


Fig. 88 Charging System Connections Diagram
1-Alternator; 2-Voltage regulator; 3-Relay; 4-Battery; 5-Ignition key(switch)

Alternator

General Information

The alternator is a three-phase type, with an incorporated rectifier unit, essentially composed:
1 stator; 1 rotor; 6 rectifier diodes; 2 covers.
The stator, a 12 pole type, mounts the energizing coil in which flows the direct current, supplied through two sets of brushes (one connected on terminal F, and the other on terminal 3--fig. 88), and a two-ring commutator which generates the magnetic field necessary to induce the alternating voltage in the stator.
The stator is formed from a laminated body, provided with 36 slots in which is installed a 3-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 six silicon diodes, formed in sets of two each, in three separate holders. Each diode holder mounts in the center a terminal in which is connected the alternating curring lead. The three diode holders exposed to the voltage, are properly insullated from the cover in which they are fastened.
On each holder, as previously explained, are attached two diodes. One diode allows the current to flow only from case to stem (stem marked in red and the case marked in black), the other only from stem to case (stem marked in red). We shall call the first diodes the positive ones, the second ones negative (fig. 89).

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

Voltage Regulator

The alternator field flux, as may be noticed from the wiring diagram (fig. 90), is conducted through the voltage regulator which, by acting on the field current, maintains a constant potential independently from the number of revolutions and load.
The regulator is a transistor type and completely static. It is provided with three terminals; a black terminal which is connected to the ground, the white one to terminal F of the alternator, and the green one is connected through the ignition switch to the positive line of the circuit.
The operations is essentially the following:
By switching on the ignition, the battery voltage is applied to the terminal points of the voltage divider R1-R2-R3 (R1 is a variable resistance). A part of this voltage is confronted with that of reference diode Z 1.
While the line voltage of the potential divider is lower than that on the diode, there will not be any current passing through the resistor R 4, the voltage between base and emmitter of the transistor T 1 will be zero, the transistor T 1 will remain cut-off.
Between emmitter and base of the transistor T 2 there will be applied a voltage (positive on the emmitter and negative on the base), therefore transistor 2 will be conducting and maximum tension 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, causing the diode Z 1 to conduct: on the terminal points of resistance R 4 will appear a potential which will affect the conduction of transistor T 1.
The circuit voltage will practically localize all at the terminal points of resistance R 5. Transistor 2 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 more, and T 1 returns to be cut-off, while T 2 again becomes a conductor.
It is this open and closed alternation of the circuit which produces the voltage control of the regulator and is further improved by the addition of other components with auxiliary functions.

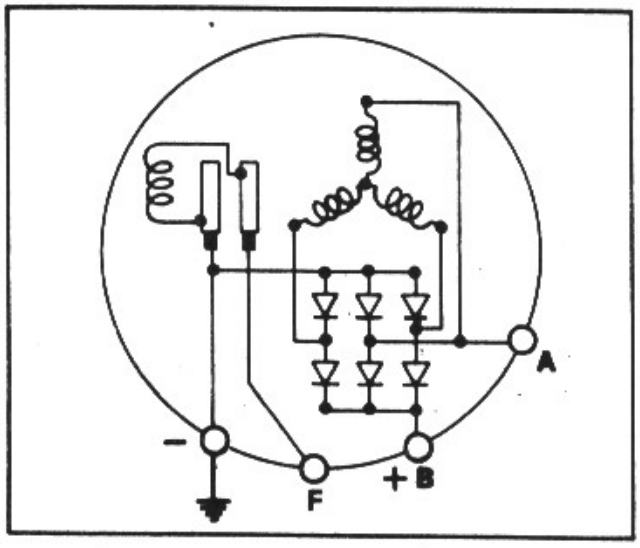


Fig. 89 Alternator Electrical Diagram.

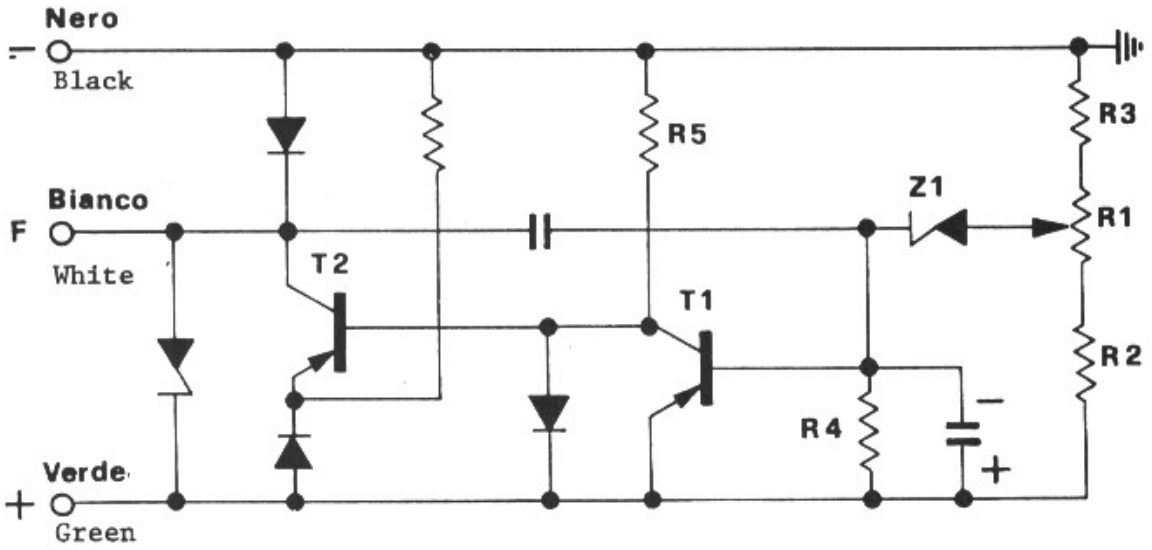


Fig. 90 Voltage Regulator Electrical Diagram

The variable resistance R 1 of the potential divider allows the setting of the regulator to the desired voltage (14.2 V).
In case of improper functioning or eventual damage, it is advisable to replace the comple te regulator unit.

Repair Instructions

On-Car Checks

Insert the key in the ignition switch and turn in position 2, the ampere gauge will indicate a discharge condition. By starting the engine and accelerating to 3,000 rpm's, the gauge must show a charging condition even with the lights turned on.
If this does not happen, it could be caused by 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.
Check the voltage regulator by checking at the battery terminals with a meter, with engine both running and shut-off. If the tension at the posts increases when running, the alternator is charging; if the tension, when the engine is accelerated, does not exceed 14.2 ÷ 14.5 volts, then the regulator is also in working condition; however, if the tension exceeds 15 volts, then the regulator is not functioning normally.

Alternator Bench Test

Field Circuit--In order to ascertain the condition of the charging circuit, measure th e resistance between terminal F and the ground terminal (fig. 92).
If the resistance is zero, there is a short circuit in the ignition coil or in the brushes connection.
Only if the resistance is zero, energize the alternator with a 12 V battery, with the positive terminal on connection F and the negative one to the ground cable, checking both voltage and current.
If with a voltage of 12 V the current is about 2.4 A 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 contact in the connections.

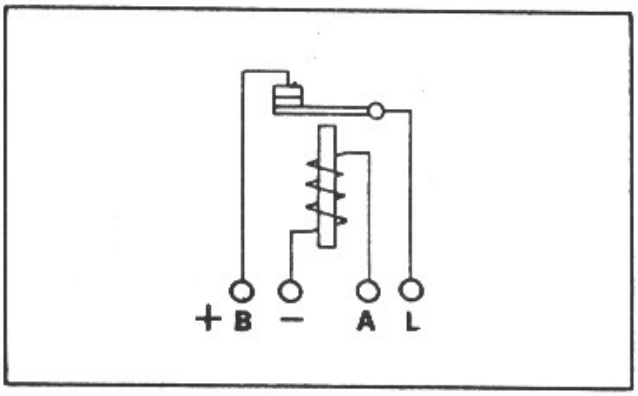


Fig. 91 Circuit Breaker Wiring Diagram

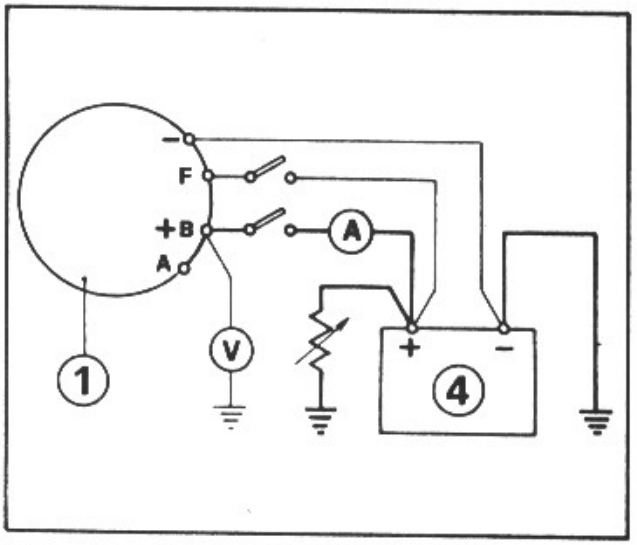


Fig. 92 Alternator Bench Test Diagram
1-Alternator; 4-Battery

If the resistance measures over the meter reading there is a break in the ignition circuit or a faulty contact in the connections.

Output Control Checks

When possible, conducting this control check allows to completely investigate the functioning of the alternator.
Mount the alternator, complete with its fan, to the test bench where its velocity can be varied with continuity.
The characteristic output curve, with constant tension at 14 V, is the one illustrated in fig. 93 diagram and with alternator in a warm condition.

Overhaul of Diodes

The diodes can begin to fluctuate or be short-circuited.
The second fault is more common. With engine stopped, without removing the side cover of the diode unit, we can test for a short circuit as follows:
With the positive wire of the tester placed on the + B terminal of the alternator, alternately measure the resistance between the terminal and 3 diode holders.
If the resistance reading is for all practical purposes beyond the reading range of the meter, none of the positive circuits is short-circuited (see fig. 94)
Analogously, with the + of the tester alternately placed on each of the diode holders, measure the resistance between them and the - terminal (ground) of the alternator. If the resistance reading is out of the meter range, none of the negative diode holders is short-circuited (see fig. 95).

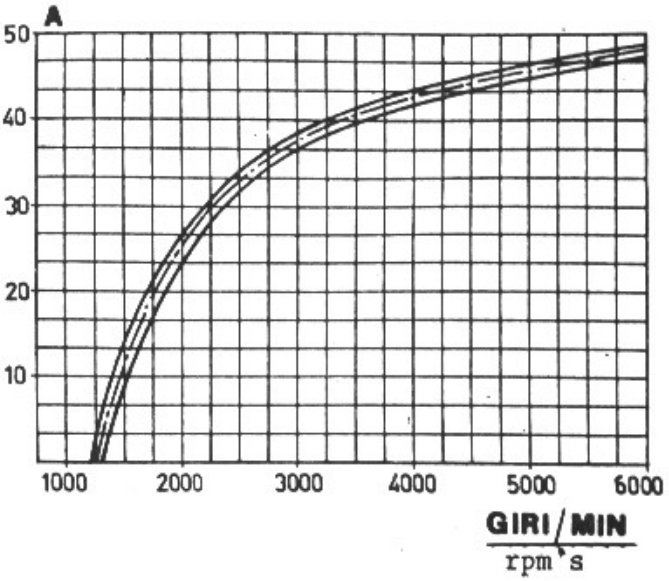


Fig. 93 Current Output Diagram

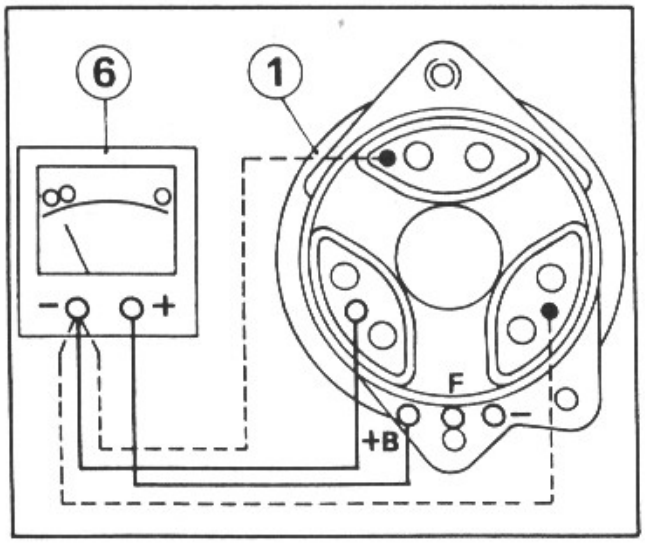


Fig. 94 Diode Control Checks Connections Diagram

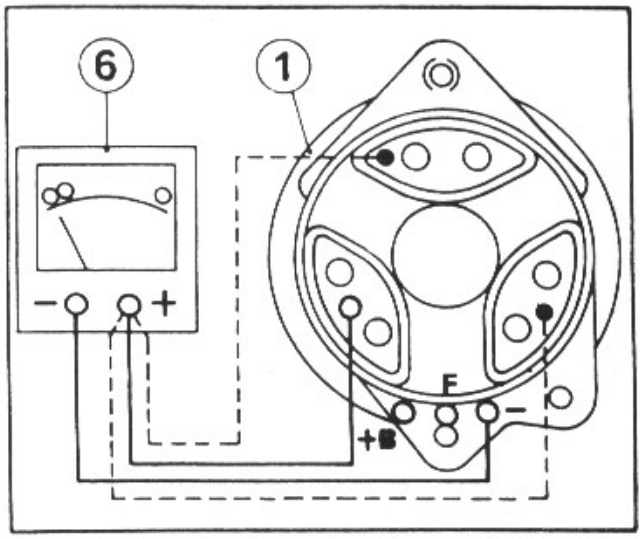


Fig. 95 Diode Control Checks Connections Diagram

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).
Ascertaining of eventual operation interruptions in the diodes can only be done by removing the diode unit cover.
A diode with an interrupted operation 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 the 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 shop equipped for such work.

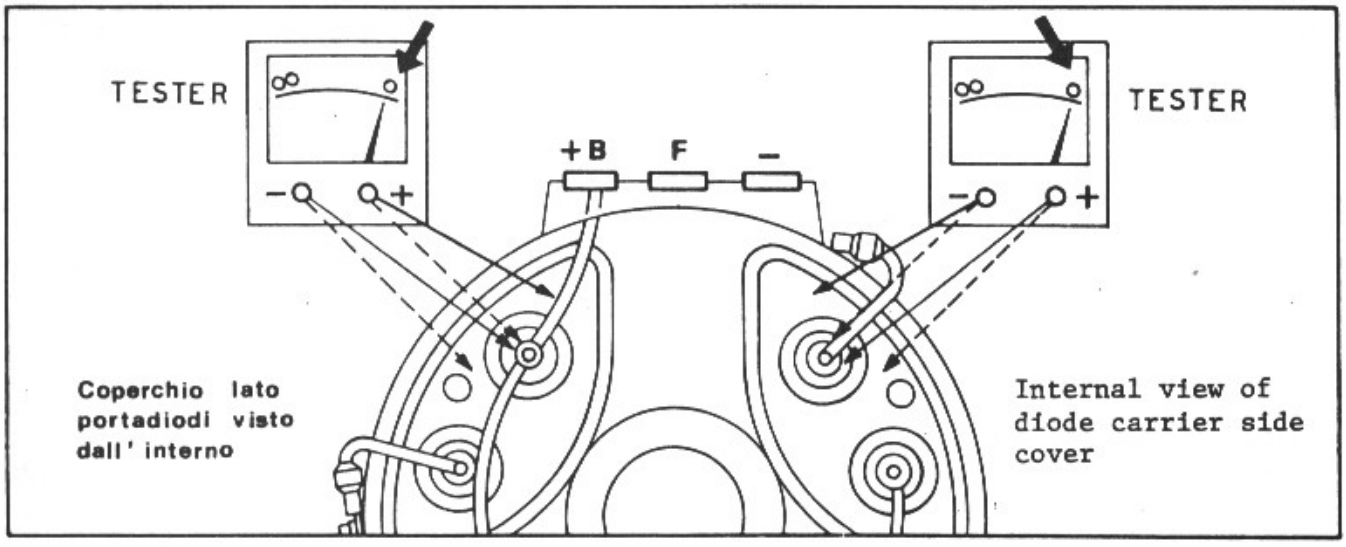


Fig. 96 Identification of Eventual Short Circuits in Diodes Connection Diagram

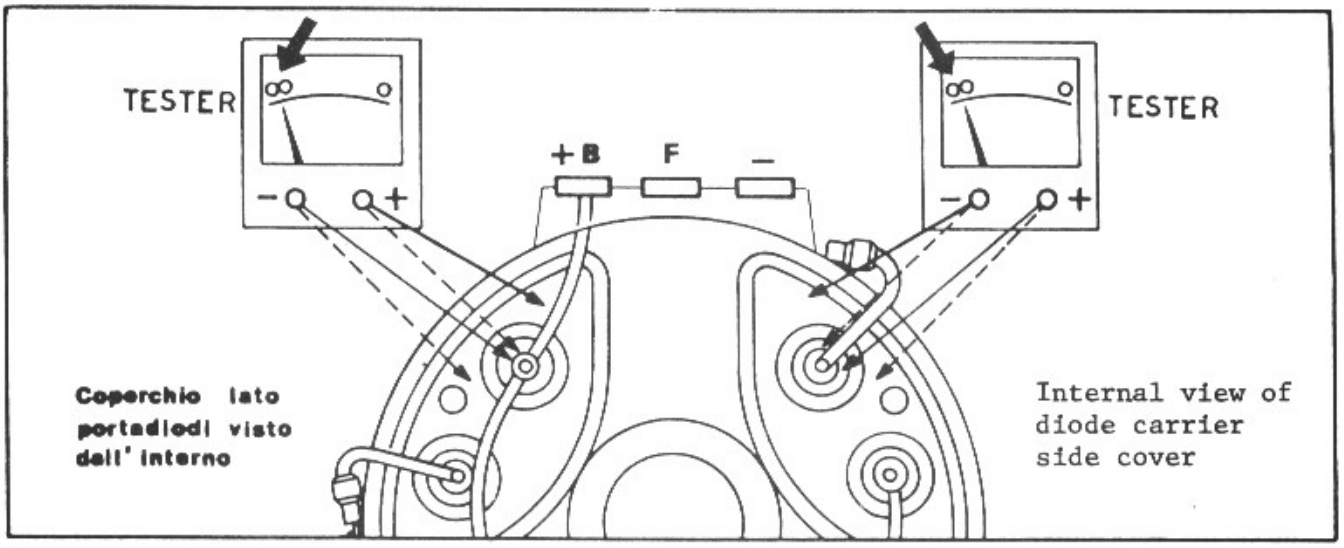


Fig. 97 Identification of Eventual Interruptions in Diodes Connection Diagram

Check of Induction Winding

To make sure that a faulty operation exists, without removing the alternator from the car, check for continuity between the 3 diode holders.
If continuity is lacking, between each of the holders and the other two, one of its 3 phases is faulty either in its connection to the diode holders or in the winding.
WARNING: Eventual checks aiming at isolating faults, conducted either with a voltage higher than the maximum value or equal to 110 V or with a "megger" should not be used with the alternator mounted, nor on the diode holders with the alternator dismounted; the rectifier diodes will be irremediably damaged.

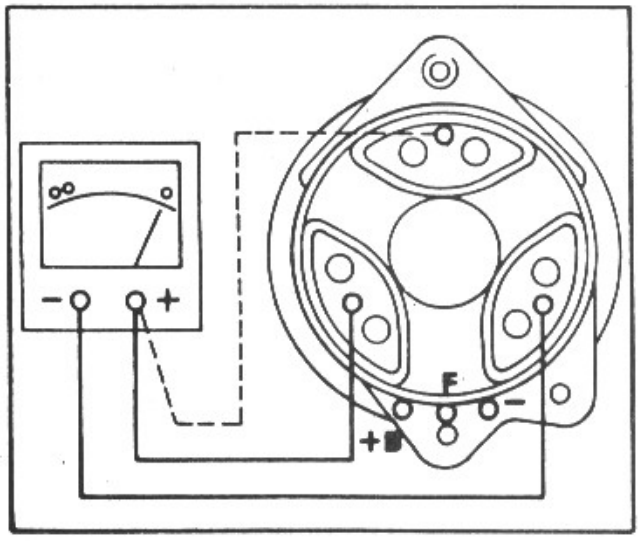


Fig. 98 Connection Diagram for Checking Induction Winding Continuity

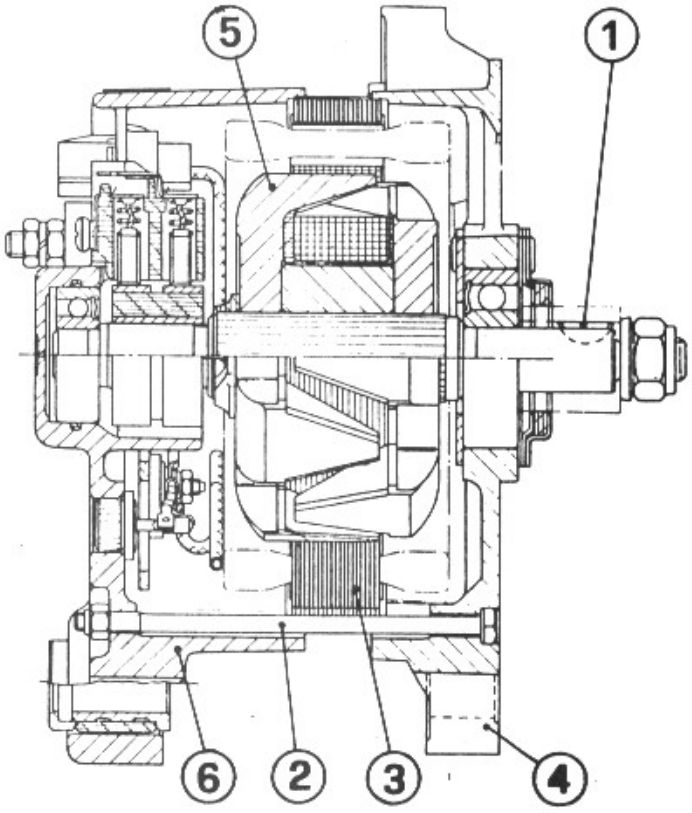


Fig. 99 Alternator Side View

Dismantling of Alternator

—Remove slot pin 1 from shaft (fig. 99).
—Unbolt and remove bolts 2 which fasten the covers to stator 3.
After completing the above steps the alternator can be dismantled in the following sub-groups:
Side control cover 4 with rotor 5.
Diode side cover 6.
Stator with induction winding 3.

Reassembly of the Alternator

Reverse the above dismantling operations.
Pay careful attention to the brushes.
Before inserting the rotor in the side diode holders cover use the proper instrument for inserting it in the two forks placed on the cover.

STARTER MOTOR

Characteristics and Data

Type	Marelli MT 42 E
Voltage	12 V
Nominal horse power	1 C.V.
Direction of pinion rotation	clockwise
Poles	4
Engagement	free-wheeling
Control	electromagnetic
Checking of Mechanical Characteristics	
--Operating condition (free of load): static torque required for turning pinion in slow rotation	$\leq 0.4 \div 0.6$ Kgcm.
--Spring pressure on brushes (in good condition)	0.85 ± 0.05 Kg.
--Depth of insulation space between the plates	1 mm.
--Internal diameter of bushing of commutator side support	14 + 0.027 mm.
--Internal diameter of control side support bushing	12.515 + 0.015
--Internal diameter of case with mounted poles	65.7 + 0.35 mm.

Characteristics and Data (cont.)

Electromagnetic Switch IE 13 P.	
--Absorption at 12 V	27 ÷ 33 A
--Cold resistance at 20° C.	0.395 ± 0.02 Ω
--Core travel	9.5 mm.
--Spring load: with contacts open	0.6 ÷ 3.3 Kg.
--Spring load: with contacts closed	6 ÷ 8 Kg.

Diagnosing Operating Malfunctions and Related Remedies

The Motor Does Not Turn

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

The Motor Turns Slowly

Possible Causes	Remedies
1) Worn brushes (defective contact).	1) Replace the brushes.
2) Short-circuited inductor or induction winding poles.	2) Locate short-circuited poles with a high frequency unit. If located, make needed repairs.
3) Oxidized or loosened battery terminals and related connections.	3) Remove the connections, clean connections and terminals accurately, smear with vaeline and reconnect.
4) Battery in low charging state.	4) Check.

Excessive Starter Motor Noise During Rotation

Possible Causes	Remedies
1) Excessively worn self-lubricating bushings.	1) Replace the bushings.
2) Engagement pinion slow in disengaging from fly wheel.	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 of the electromagnet core in its seat. Remove motor and replace faulty units.
3) Worn fly wheel teeth.	3) Replace the fly wheel.

Test Bench Instructions

Operation Checks

Operation checks (at ambient temperature of 20° C.).
The starter motor is acuated by the battery, in a steady state delivery of voltage during the check.
The rheostat is adjusted in such a way that at the prescribed absorption (take-up) it corresponds exactly to the motor terminals' take-up of the voltage indicated earlier.
If this condition cannot be checked, the readings cannot have any test value, except for torque (and only of approximate value).
Check the schematic on fig. 100.
On a test bench, provided with a geared flywheel with a ratio of 1:10 between the pinion and the flywheel and equipped with a dynometric brake, acuate the starter motor lever, engaging it on the flywheel and with the solenoid switch closed, engage starter for 10 starts of 4 seconds duration each, with 30 second intervals.
Braking the starter at 250 A. of current, the reading should be 0.8 Kg. of torque at 1100 - 1500 rpm's, with 9.5 V. of voltage.

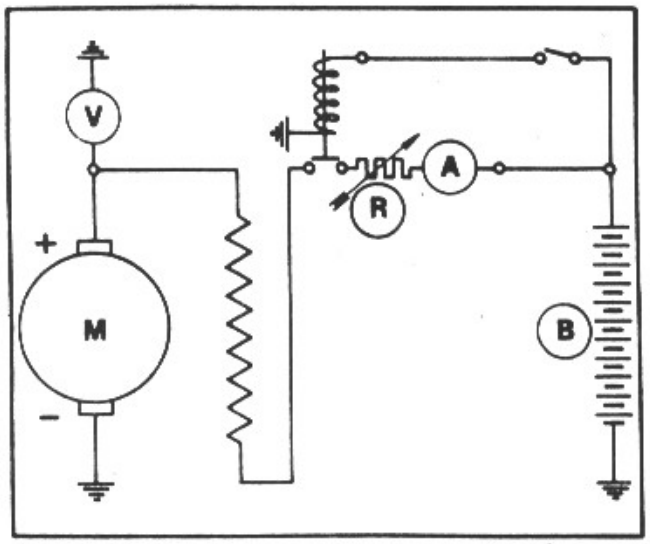


Fig. 100 Starter Motor Bench Test Electrical Connections Diagram.
M--Starter Motor; V--Volt meter, 15 V at gauge; A--1000 A. amperometer; B--Battery, 12 V. - 60 Ah.; R--Rheostat, 800 A. capacity.

Test with an unengaged starter.
Energizing the starter with a current of 11.5 V., the absorbed current reading should be: $\leqslant$ 50 Amp and 9,000 to 12,000 rpm's.

Test under short-circuit conditions.
Energizing the starter with a current of 7 V., it must absorb a current of $\leqslant$500Amp and develop a torque of $\geqslant$ 1.9 Kgm.
The minimal voltage readings of the pinion gear action should be: $\leqslant$7V.; warm, $\leqslant$8.5V.
The armature brake-moment is 2.5 ÷ 6 Kgcm.

Repair Instructions

Overhauling

--Disconnect the battery cable and the starter-to-solenoid terminal at the electromagnetic screws by loosening bolts 8 and 9.
--Loosen the two bolts with their spring and flat washers, the electromagnetic switch supports on the sides of the pinion gear case, then slide out the electromagnetic unit.
--Remove the brushes protective band on the commutator side support.
--Disconnect the end from the positive brush holder.
--Gently lift the brushes and place the ends of the springs against the sides of the brush holders in order to avoid nicking the brushes.

--Unbolt the two limited-slip bolts of the two supports' retaining arms, then slide out the brush holder support paying attention to the seating washers (a fiber and a steel one) mounted on the shaft.
--Slide out the unit from the pinion side support.
--Slide out the cotter pin of the starting control shaft, and then slide out the shaft itself.
--The armature unit is eased out together with the engagement unit and with the fork lever, which remains unengaged, and with the seating washers.

If the engagement drive unit must be disassembled, it will be sufficient to remove the electric stop ring, and slide out the component parts in sequence.

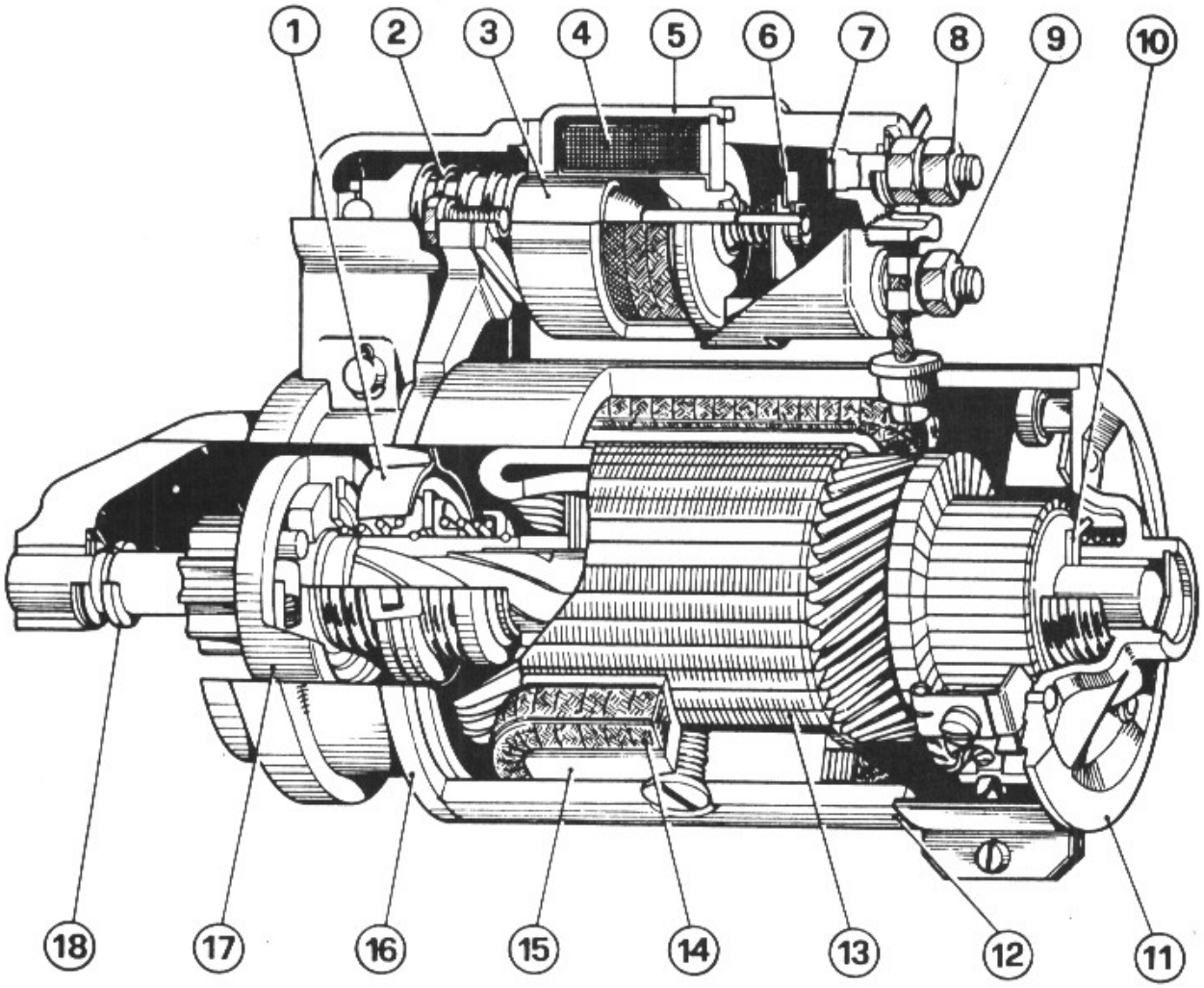


Fig. 101. Starter motor Marelli MT 42 E.

1. Actuating link, 2. Solenoid disengagement spring, 3. Solenoid disengagement, 4. Solenoid coil, 6. Solenoid contact, 7. Fixed contact, 8. Battery cable connection, 9. Solenoid to starter motor terminal, 10. Disc type braking unit, 11. Support, 12. Case, 13. Armature, 14. Field winding, 15. Polarity expansion unit, 16. Rear side support, 17. Drive (engagement) gearing, 18. Stop ring.

Commutator Resurfacing

In case the commutator shows any burned spots or deep scores, it is necessary to turn it on a lathe. The reducing value of the diameter should not exceed 0.5 ÷ 0.6 mm.
After the turning operation, undercut the mica segments to a depth of approximately 1 mm., then clean thoroughly.

Replacement of Self-Lubricating Bushings

Remove the bushings, enlarging their diameter on a lathe until noticeably reducing their thickness, or cut them longitudinally at two opposite points.
Before assembly, a clearance of 0.1 mm. should exist between the shaft and the bushing.
The replacement self-lubricating bushings are provided ready for assembly, and do not require lubrication and should not be tampered with.

Replacement of Brushes

If the brushes have worn down past two-thirds of their length, they must be replaced with the exact type. Even if only one brush is worn, it is good practice to replace both.
After replacing, run the starter without load in order to allow the brushes to seat themselves properly on the commutator surfaces.

IGNITION SYSTEM

Characteristics and Data

Distributor Unit	
Type	Marelli S 125 AX 15o
Initial Static Advance (on the engine)	6°
Centrifugal Automatic Advance (on the engine)	30° ± 2°
Contact Points Clearance	35 ± 0.05 mm.
Number of Rotor Brushes	2
Rotors' Contacts Pressure	1000 ÷ 1200 grams
Condensator Capacity at 50 ÷ 100 Hz	0.20 ÷ 0.25 μF
Condensator Insullation Resistance at 100 • C. and at 100 V c.c.	>1 MΩ/μF
DINOPLEX C Unit	
Type	Marelli AEC 101 DA
Changeover Switch	Enclosed
Coil	
Type	Marelli BZR 205 A
	12V - 8 F
Primary Current Resistance in ohms at 20° C.	1.3 ÷ 1.5
Secondary Current Resistance in ohms at 20• C.	5500 ÷ 7000
Resistor resistance	0.7 ÷ 0.9Ω
Ground Resistance (Insullation) at 500 Vcc.	>50 MΩ

Characteristics and Data (cont.)

Spark Plugs	
Type	CHAMPION N6OY
Electrode gap	0.4 ÷ 0.5 mm.
Thread diameter and pitch	M 14 X 1.25
Torque	3.8 Kgm.

Diagnosing of Malfunctions and Related Remedies

Lack of Ignition

Possible Causes	Remedies
1) Burned fuse.	1) Replace the fuse.
2) Discharged battery.	2) Recharge battery.
3) Curren' circuit grounded or interrupted.	3) Check and repair.

Defective Ignition

Possible Causes	Remedies
1) Alternating short-circuiting of the condensator.	1) Insufficient voltage in secondary circuit. Weak spark. Strong spark between contacts. Replace the condensator.
2) Contacts too close or dirty.	2) Adjust clearances and clean points.
3) Distributor cover scored or with burned or humid contacts.	3) Replace the cover if scored: clean the contacts.
4) Rotor brush burned or scored.	4) Replace the rotor brush.
5) Spring-loaded carbon contact broken or with defective spring.	5) Replace contact and spring. Clean the contacts at the brush.
6) Contacts sticking on the shafts.	6) Lubricate shafts with vaseline.
7) Contact return springs deformed or weak.	7) Replace the points' support unit and check that the contacts are not sticking on the shafts.
8) Points' clearance excessive.	8) Weak spark especially at high speeds. Adjust contacts to 0.35 ± 0.03 mm.
9) Discharging or defective high voltage connections.	9) Check terminals and cables.

Ignition Advanced Beyond Normal Setting

Possible Causes	Remedies
1) Weakening of centrifugal regulator.	1) Replace springs with original.
2) Excessive points' wear.	2) Replace entire points group.

Ignition Retarded Beyond Normal Settings

Possible Causes	Remedies
1) Excessive clearances in the distributors' 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.
3) Worn contact supports.	3) If wear is excessive, replace the contacts of the two units, otherwise adjust points' clearance.

Malfunctioning DINOPLEX Unit

Possible Causes	Remedies
1) Loose or dirty connections.	1) Check and clean.
2) Erratic action of the commutation lever with engine in operation.	2) Replace DINOPLEX Unit.
3) Battery terminals connections loose or disconnecting with engine in operation.	3) Check terminal connections. If tight, replace DINOPLEX Unit.
--For any other malfunction, replace the DINOPLEX Unit.	

Malfunctioning Ignition Coil

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

Distributor Unit

Description

The ignition distributor S 125AX15° was developed for the needs of high rpm's engines; it is composed of two contact sets with a single 3-lobe camshaft.
The two breakers are connected in parallel and are phased 180° from each other so that when one breaker closes the circuit while the other is opening the circuit.
The distributor rotates at half the engine speed, and supplies it with three sparks for each rotation.
The automatic advance originates from a stamped aluminum-bronze ground, functioning inside a hardened steel case in acting through rollers placed on the proper serrations on the camshaft. The engine fastening is of the flange type.
A notch in the rotor and a corresponding one on the distributor case indicate the exact position for timing the distributor with cylinder 1 of the engine and also corresponds to the No. 1 marked on the cap position of the ignition cable from that cylinder.
After the first 1,000 Km. of operation of the car, check the contact clearance, it should measure 0.35 ± 0.03 mm.
Every 3,000 Km. remove the distributor cover and remove the rotor; clean it with a lint-free cloth dampened with gasoline and blow dry.
Check the contact clearance; if necessary reset by loosening screws 2 and its eccentric levers.
Place one or two drops of engine oil on the cam lubrication felt washer.

Distributor Test Bench Tests

Mount the distributor on a test bench equipped with a variable-speed motor.
Hook-up an ignition coil and a battery, and hook-up the six spark plugs cable connections of the distributor cap with the terminals of the other spark gap gauge.

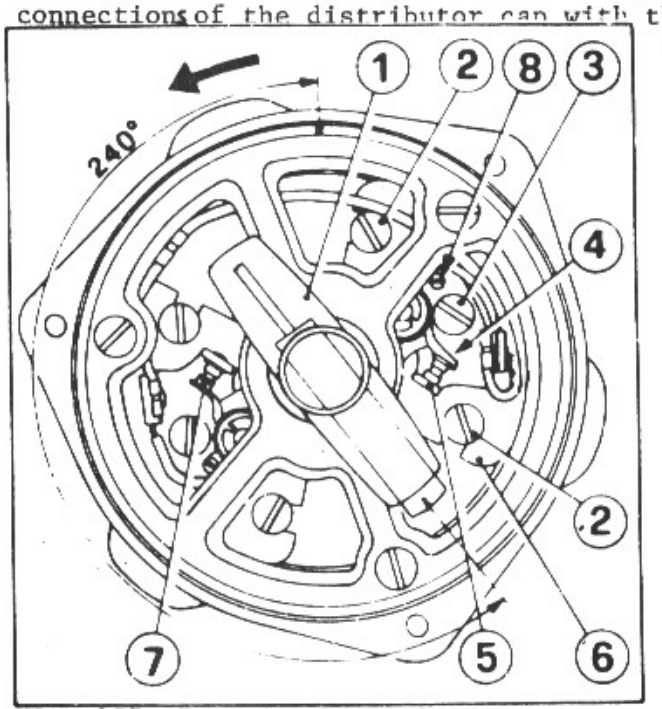


Fig. 102 Ignition Distributor
1-Rotor brush; 2-Contact breaker assembly fixing screw; 3-Screw holding fixed contact; 4-Moving contact; 5-Fixed contact; 6-Contact breaker assembly base; 7-Second contact breaker 8-Eccentric pin.

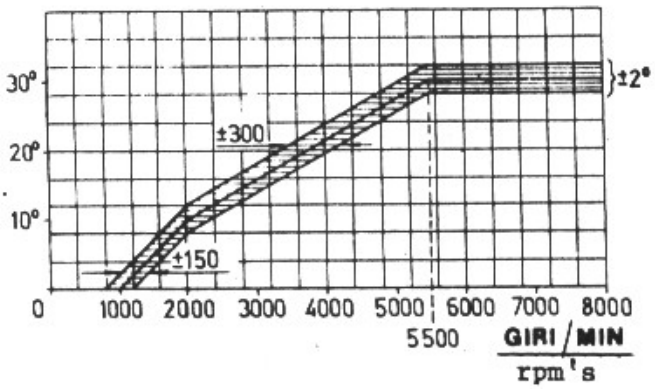


Fig. 103 Automatic Advance Curve Diagram

with the connections at the points comparable to the distance between the distributor and the spark plugs. Actuate the distributor in its prescribed rotation for a few minutes to a speed of about 2,000 rpm's and with the ends of the spark gap at a distance of about 5 mm.
Increase the distance to 10mm. and check to see if internal discharges are occurring within the distributor. These discharges are detected both by their noise and by diminished intensity or by the lack of some sparks at the
of the test bench.

Automatic Advance Curve Check

Mount the distributor on a test bench equipped with electrical testing apparatus and connect terminal D of a coil with the low voltage terminal of the distributor; then connect the high voltage terminal of the coil to the graduated disc of the test bench instrument. Actuate the distributor to 300 ÷ 400 rpm's and check the graduated disc value degrees in relation to the degree values produced by one of the three sparks.
Increase the speed of the distributor; if the increase in rpm's of the motor is not great compared to the earlier velocity, the degree reading will be the same in relation to the same spark.
Continuing to increase the speed of the rotation and checking the readings at each increase of 200 ÷ 300 rpm's it is possible to check the number of advanced stages of the beginning of the spark (in reference to the distributor), in relation to the functioning values of the rotation speed of the distributor.
Remembering that the distributor has a rotation of half of that of the engine, it is necessary to double the indicated values (whether the number of rpm's as well as the advance degrees) in order to trace the automatic advance path in relation to the motor and checking it against the diagram in fig. 103.
The distributor's automatic advance reaches a value of 30° at 5500 rpm's at the engine.
Maximum ignition advance is 36° ± 1 including the 6° of fixed initial advance established with the engine running at 5500 rpm's.

Synchronizing Points Timing

Whenever the points unit must be replaced, mount the distributor on a test bench, as described in the preceding section.
Check that the initial opening of the contacts for cylinder 1 takes place exactly when the notch on the rotor arm is aligned with the timing mark on the distributor case.
Acuate the distributor to about 400 rpm's/1 and align the zero of the graduated disc in relation to the spark of cylinder 1 which occurs between the disc and the rotating point.
Check that the six sparks occur in relation to the disc gradations of 0°, 60° , 120° , 180° , 240° , 300° , with a tolerance of ± 1° .
If a higher reading is observed, check the three sparks controlled by a contact breaker in relation to the other two, loosen screws 2 (fig. 102) of the contact breaker support arm set at 0° alignment, and move the arm in the needed direction until obtaining the desired tolerance between the points.
Securely tighten screws 2 when synchronization is complete.

Electronic Capacitive Discharge Unit (DINOPLEX)

Description

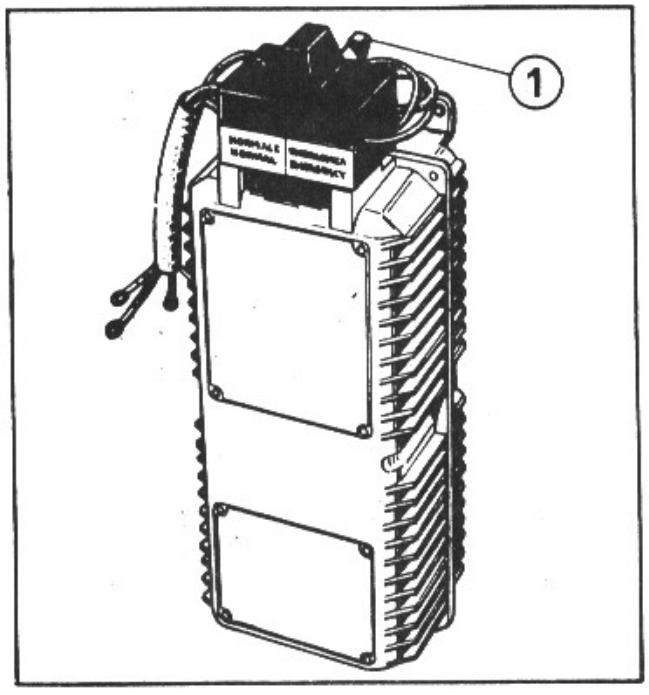
The engine normally operates via the electronic ignition system, with the changeover switch in the "Normal" position.
In the event of irregular functioning of the DINOPLEX Unit, the electronic ignition system can be bypassed by moving the changeover switch to the "Emergency" position.
The switch must only be moved to the "Emergency" position with the ignition switched off.
Under these conditions, ignition is via battery, distributor and ignition coil.

Important Instructions

WARNING: High voltage ignition. It is dangerous to uncover the terminals which are protected by the red rubber sleeves. All work on the equipment should only be carried out with the ignition key removed.
It is dangerous to touch the cable terminals while the engine is running.
When the ground is wet, there is risk of an electric shock when touching either the coil or spark plug leads. In the event of the green covered cable being changed, it should be filled with Silastic RTV 732 grease (Marelli product).

WARNING:
1) Do not disconnect the battery while the alternator is functioning, otherwise the DINOPLEX C Unit will be immediately damaged.
2) Make sure that there are no irregular contacts or looseness between the battery terminals and their related connections.
3) Do not apply any additional suppression condensers to the coil when installing a radio, as this will adversely affect the performance of the ignition system. Adequate suppression is already incorporated.

Fig. 104 DINOPLEX C Electronic Unit
1-Ignition chageover switch lever (normal and emergency).



166

COIL BZR 205A-12V.8F

Bench Test Instructions

To check the condition of the ignition coil, the following steps are necessary:

Ohm Resistances

The ohm resistance of the primary winding must not go below 1.3 ohm at 20° C.
The resistance of the secondary winding must be: 5500 ÷ 7000 Ω.

Ground Insulation

The coil must resist an alternating voltage of 500V, at 50 Hz, which applied for 3 minutes between one end of the primary winding and the metallic case, without noticing any discharges.
The insullation resistance in relation to the ground must be above or equal to 50 MΩ at 500Vc.c.: this measurement can be carried out with a megaohmeter.

Measurement of Spark Length

Actuating the coil with the distributor, without using the distribution of the high voltage, and delivering all the sparks on a spark gap gauge with an ionized end for the measurement of the maximum length of the spark. When warm, and after two hours of operation of the coil at 50 sparks per second, the length of the spark must be at least 12 mm. at 12 V.

SPARK PLUGS

Description

The spark plugs must endure severe operating conditions. They require, therefore, special attention in order to attain the smooth running of the engine and a long period of efficiency.
They should withstand the rapid variations of temperature and pressure that take place in the cylinders. At the same time, they should resist the corrosive and combustion gas action, especially when employing fuels with a high percentage of corrective anti-detoant additives.
They should possess, for these reasons, special characteristics (thermal, electrical, mechanical) and should be perfectly gas-sealed:
--Good thermal conductivity assures a rapid dispersion of heat, allowing a regular, smooth and continuous engine operation.
--Good insullation and perfect dielectric strength, even at high temperatures, will prevent any loss of current flow or leaks.
--An effective resistance to sudden temperature changes, even if these differences are relatively high.
--Mechanical resistance which guarantee any damage during the operation and mounting.
--A perfect gas seal, which will prevent overheating or provoke self-ignition.
In every engine, the spark plugs should operate within two different thermal limits which respectively are: self-cleaning temperature and self-ignition temperature.
The thermal characteristics, therefore are the determining factors for the 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 one designed with a high heat range, while a hot spark plug is one designed with a low speed range.
--In high speed engines with a high compression ratio or of the super-charge type, it is necessary to use cold or high heat range spark plugs.
For engines with intermediate characteristics, use intermediate heat range spark plugs.
However, not all manufacturers apply the same number to indicate the identical heat range.
In such cases, it is necessary to consult the conversion charts before mounting in the engine spark plugs different from those advised by the car manufacturer.
When the spark plugs provoke self-ignition, refer to the same type as mounted in the engine, but replace with those immediately of a superior grade of heat range. If, instead, the used spark plugs show carbon or oil soote formation, replace them with spark plugs providing an immediate 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, but which is very much used in practice by experts, to determine the proper type of spark plugs, consists in checking the insulator color of center electrode:
--Whitish insulator = mount colder spark plugs.
--Blackish or sooty insulator = mount hotter spark plugs.
--Brownish insulator = correct spark plugs.

Checks and Repairs

Every 5,000 Km., or whenever the engine indicates ignition irregularities, it is necessary to remove all spark plugs and to cheek the electrode gap, to check for encrustations of the ceramic space and for sooty deposits produced by excess fuel at certain engine rpm's 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 0.5 mm. using the proper tool and great care.

Electrical Test

Check on a proper test bench with the plugs under air pressure of 7 ÷ 8 Kg/cm^2, with the ends of the spark gap gauge 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 insullation 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 2.5 Kg. torque, then to 3.8 Kg. torque.

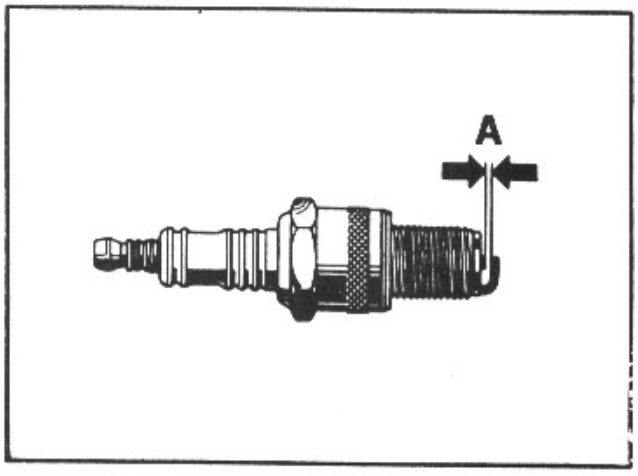


Fig. 105 Electrode Gap Check
A = 0.4 ÷ 0.5 mm.

168

LIGHTING SYSTEM

Characteristics and Data

Headlights	2
Twin filament iodine bulbs	
--Main beams	W55
--Dip beams	W55
Front side and direction lights	2
Twin filament bulb:	
--Side lights	W5
--Flashing directional lights	W21
Directional Side lights	2
Bulb	W3
Rear and Stop lights	2
Twin filament bulb:	
--Rear light	W5
--Stop light	W20
Rear Lights	2
Bulb	W20
License Plate lights	2
Bulb	W5
Reverse lights	2
Bulb	W25
Outside lights control and headlights control	Via lever positioned at steering wheel.
Internal car lights	
--Bulb	W5
--Control switch:	
Pressure type	Built in car roof
Automatic, when doors are opened	On door mounts

Characteristics and Data (cont.)

Engine compartment lights --Bulb, with on-off hood cover switch		W5
Trunk compartment lights --Bulb, with on-off trunk opening automatic switch		W5
Glove compartment lighting --Bulb, with incorporated push button switch		W3
Dashboard lighting --8 bulbs, 1 for each instrument		W3
Signals operation		
Direction indicators Low engine oil pressure indicator Fuel reserve indicator Interior heating fan engagement indicator Starter engagement indicator Lights operation indicator Headlights at full beam operation indicator	7 bulbs	W3

Headlights

Focusing of Headlights

The headlights are of the asymmetrical main beam and dip beam type. Their alignment is obtained with an empty car in the following steps:
--Check tire pressures. Front: 1.9 Kg/cm^2, Rear: 2.2 Kg/cm^2
--Place the car on a level surface, 5 meters from a flat white vertical surface in the shade and make sure that the car is evenly perpendicular to the plane of the vertical surface.
--Shake the shock absorbers from side to side in order to uniformly settle the suspension units.

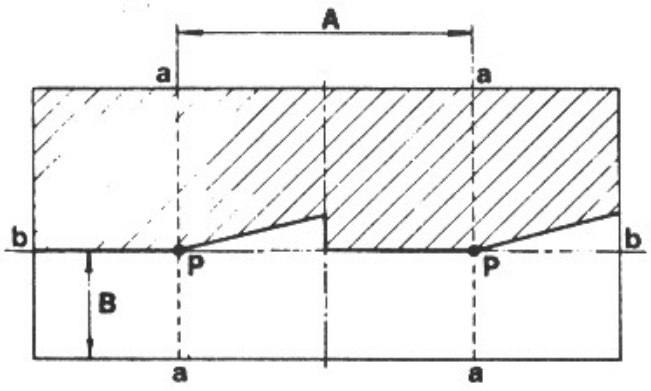


Fig. 106 Diagram for the Alignment of Headlights
A = 1255 mm., distance from the centers of the headlights; B= C-10 cm. with car in prepared condition; C=height from ground of the center of the headlights measured at alignment

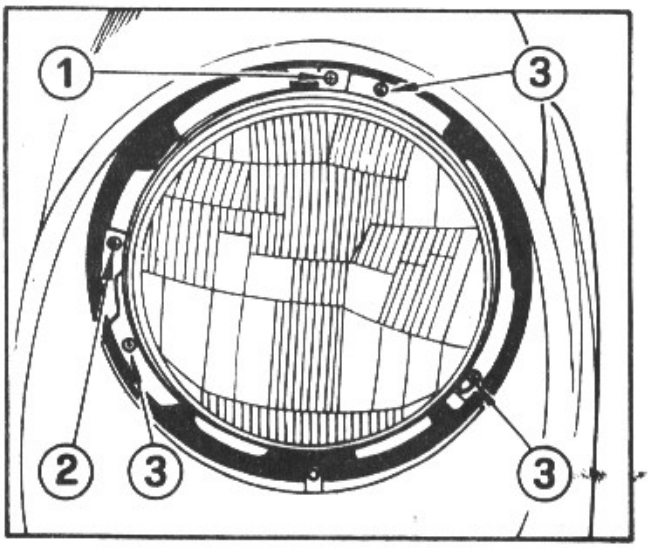


Fig. 107 Headlight Adjustment Screws
1-Vertical alignment screws; 2-Horizontal alignment screws; 3-Lighting unit fastening screws

On the vertical surfaces (fig. 106), trace two vertical lines at distance A = 1255 mm. corresponding to the interaxis of the lights; these lines must be equidistant perpendicularly, and vertical at the car's longitudinal axis.
Now trace an horizontal line b-b at height line B from the ground. To align, turn the main and dip beams of the lights on and orient them by adjusting screws 2 (fig. 107) for vertical alignment and screws 3 for horizontal alignment so that:
--the demarcation line between the dark and lit area is on line b-b (fig. 106).
--the demarcation lines inclined upwards (about 15°) begin at intersection points P or just outside of them.
WARNING: The iodine vapor bulbs should absolutely never be touched with bare hands. Handle the bulbs only by their base. They should not be replaced with different types or different wattage, in order to avoid difficulties in the electrical system.

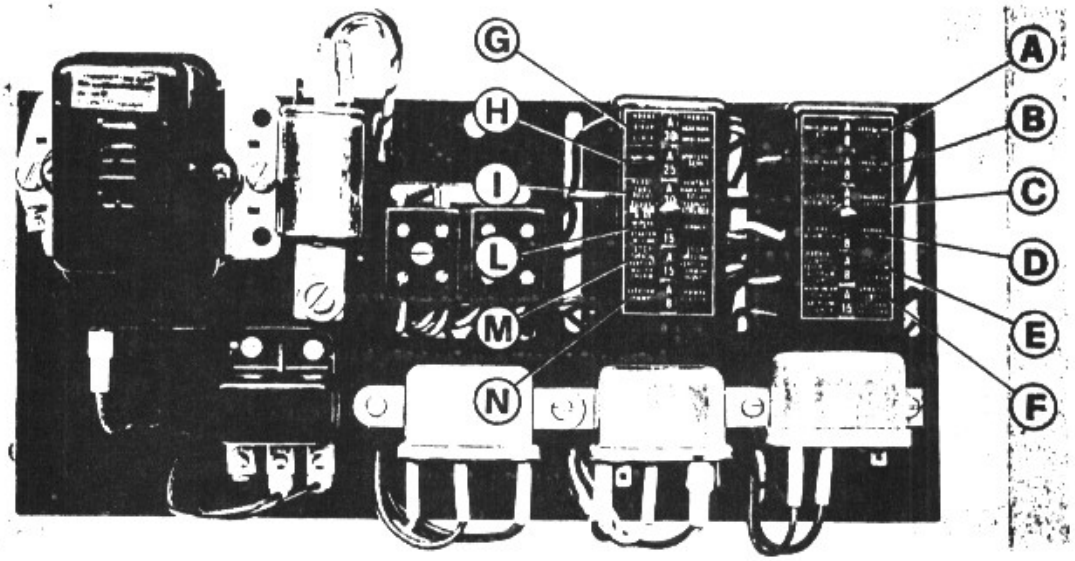


Fig. 108 Fuse Panel

Right Fuse Box

Fuses		Protected Circuits
A	8 Amperes	Right hand main beam
B	8 Amperes	Left hand main beam
C	8 Amperes	Right hand dip beam
D	8 Amperes	Left hand dip beam
E	8 Amperes	Side lights Reverse lights Instruments lights
F	15 Amperes	Headlight flashers Engine/luggage compartments

Left Fuse Box

Fuses		Protected Circuits
G	30 Amperes	Horn Cigarette lighter Clock
H	25 Amperes	Distributors
I	30 Amperes	Radiator fans Alternator regulator relay Instruments
L	15 Amperes	Wind-shield wipers Starter light
M	15 Amperes	Stop lights Direction indicator lights Heater fan motor Water thermometer
N	8 Amperes	Electric fuel pumps

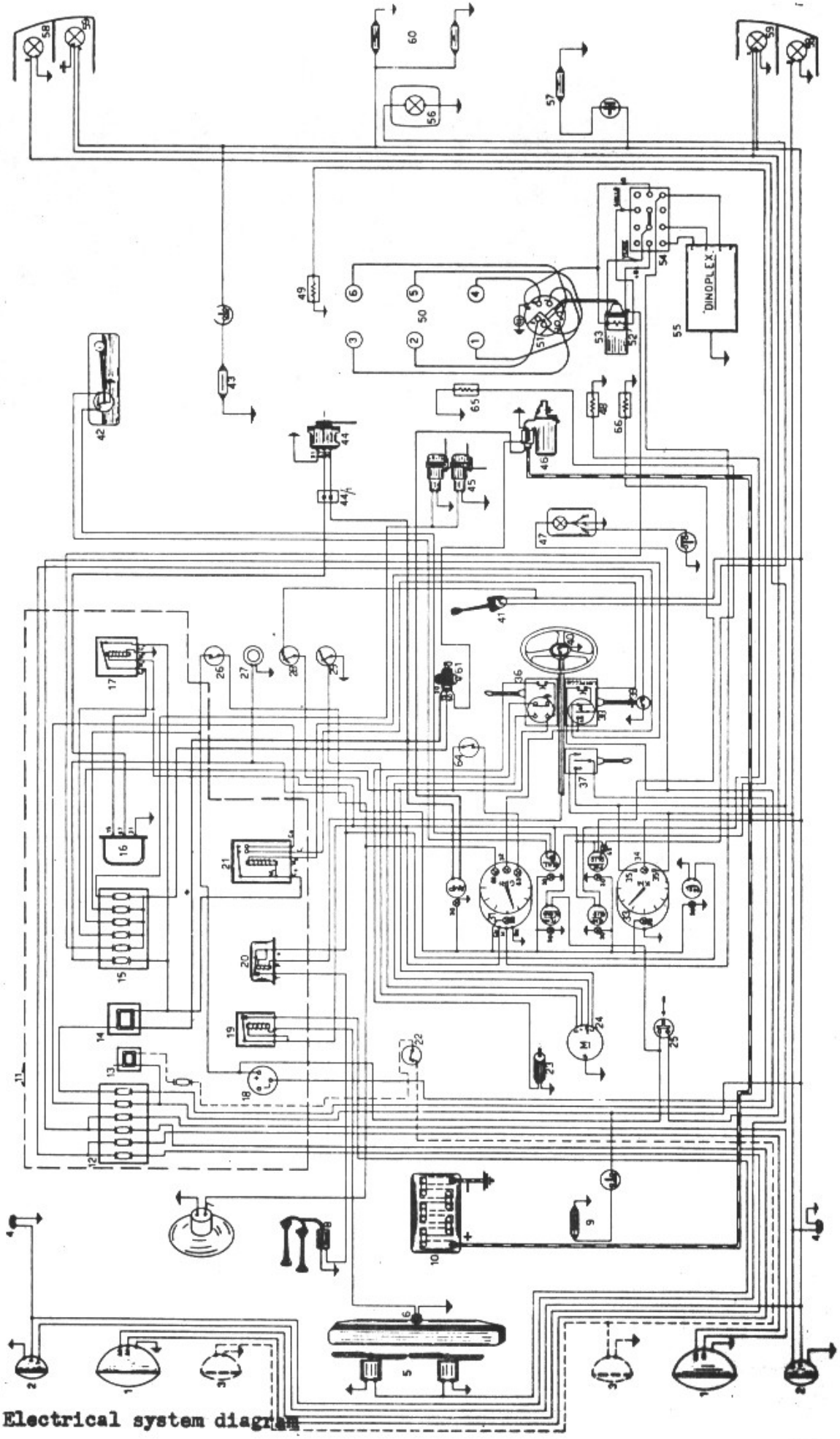


Fig. 109. Electrical system diagram

173

ELECTRICAL DIAGRAM DESCRIPTION

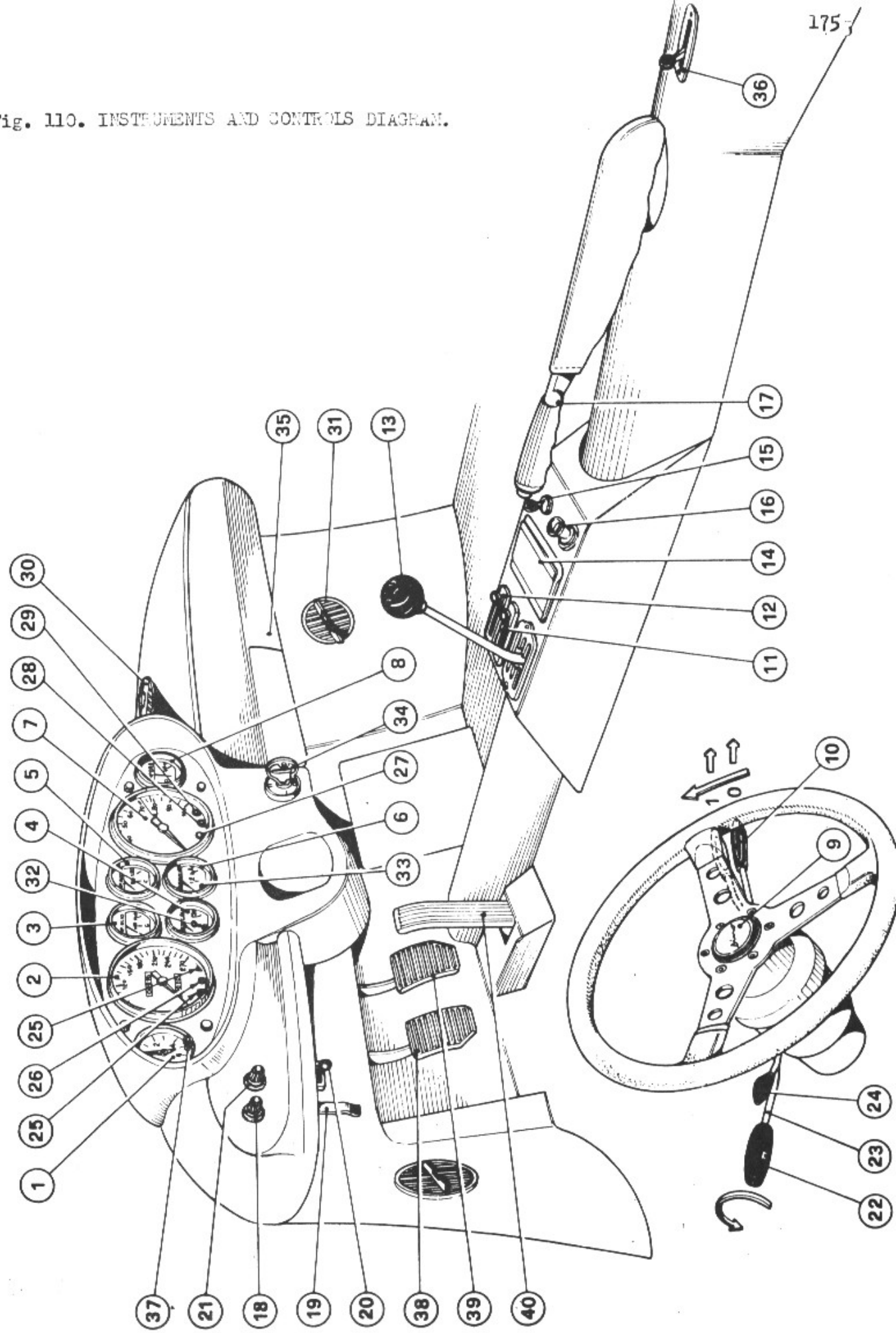
1. Headlamps - Main beam and dip beam (iodine vapor bulbs)
2. Front side and directional lights
3. Fog lights (on request)
4. Direction indicator lights
5. Cooling fans moters
6. Temperature sensitive switch for radiator fans
7. Heating/ventilation fan motor
8. Horn compressor motor
9. Front trunk light
10. Battery
11. Electrical panel
12. Fuse box (6 fuses)
13. Terminal boards for switched current
14. Permanently live terminal board
15. Fuse box (6 fuses)
16. Alternator regulator
17. Charging circuit relay-Lucas 33252
18. Directional flasher unit
19. Radiator cooling fan relay (Lucas 33213)
20. Horn relay
21. Main beam, dip beam and side lights relay - Lucas 33213
22. Fog light switch - on request
23. Wiper washer switch
24. Wiper washer motor
25. Stop light switch
26. Heating/ventilating fan switch
27. Cigarette lighter
28. Instrument light rheostat
29. Rheostat for varying wiper speed
30. Instrument lights
31. Electronic rev counter
32. Main beam warning light
33. Speedometer
34. Side light warning light
35. Direction indicator warning lights
36. Wiper and screen washer lever
37. Direction indicator lever
38. Main beam, dip beam and headlamp flash lever
39. Relay switch for side, dip and main beam lights
40. Horn button
41. Reverse light switch
42. Fuel level gauge transmitter
43. Engine compartment light
44. Alternator
45. Fuel pumps
46. Starter
47. Interior light
48. Oil temperature transmitter
49. Water temperature transmitter
50. Spark plugs
51. Distributor
52. Resistor
53. Coil
54. Four-pole by-pass switch (Dinoplex ignition unit to emergency ignition)-incorporated in the unit
55. Dinoplex electronic ignition unit
56. Reverse lights
57. Luggage compartment light
58. Rear direction indicator lights
59. Rear position and stop lights
60. License plate lights
61. Ignition switch and steering lock
62. Heating/ventilating fan warning light
63. Choke warning light
64. Choke warning light switch
65. Low oil pressure warning and transmitter
66. Oil pressure gauge

CONTROL INSTRUMENTS--STARTER AND SIGNALS

Description of Control Instruments

1--Electri c clock
2--Speedometer
3--Oil thermometer
4--Electric oil pressure gauge
5--Water thermometer
6--Fuel level indicator
7--Revolution counter
8--Ammeter
9--Horn button
10-Windshield wiper and washer control
11-Heater temperature control (hot water)
12-Heater air control
13-Gear lever
14-Ash tray
15-Heater fan switch
16-Cigarette lighter
17-Handbrake lever
18-Instrument lighting rheostat and wiper
19-Front compartment opening control
20-Fresh air intake control
21-Odometer zero control
22-Light switch
23-Side-dip-head-and headlights flasher control lever
24-Direction indicator lever
25-Direction indicator warning light (green light)
26-Side lights, warning light (green)
27-Heater fan warning light (orange)
28-Main beam warning light (blue)
29-Choke control warning light (red)
30-Rotating defroster grills
31-Side air inlet
32-Low oil pressure warning light (red)
33-Reserve fuel supply light(red)
34-Starter control
35-Glove compartment
36-Choke control
37-Clock setting knob
38-Clutch pedal
39-Brake pedal
40-Accelerator pedal

Fig. 110. INSTRUMENTS AND CONTROLS DIAGRAM.



Indicator Gauges

In case of faulty or non-operation of one or more indicators, first make sure that all connections are sound, check the condition of all contacts, and their particular fuses.
In order to proceed with replacement of the instruments and/or of the indicator lights, remove the instrument dashboard cover by unscrewing the four knurled screws at the corners of the cover. Turn on the instrument lights so as to ascertain the faulty bulbs or units and remove them after removing their mounting supports.
Remove the dust cover from the tachometer housing to make any work or repairs on that unit easier.

Ignition and Steering Lock

The ignition switch (fig. 111) is supplied with the proper key which fits four positions:
1) Locked (Halt)--Steering locked and key removable. (The lights can be switched on actuating switch 22 on the light switch lever 23 placing the lever in position 3).
2) Garage--Steering unlocked, key removable.
3) Start (Fahrt)--Ignition-electric fuel pumps and normal running services available.
4) Start.
WARNING: In order to facilitate the unlocking of the steering it is sometimes necessary while attempting to rotate the key, to try and rotate the steering wheel back and forth.
Do not remove the key if the car is not stationary as this may lock the steering.

Electrical Circuits Independent of Ignition Switch

--Lights (side, dip beam, main beam, reverse, instrument lights, auxiliary lights).
--Front, internal, and rear compartment lights.
--Horn.
--Cigarette lighter.
--Clock.

Electrical Circuits Under Control of Ignition Switch

--Starter motor.
--Radiator fan.
--Charging circuit.
--Windshield wipers.
--Choke warning light.
--Stop lights.
--Direction indicator lights.
--Heater and ventilation fan.
--Electric fuel pumps.
--Instruments: water thermometer, revolution counter, oil thermometer, oil pressure gauge, fuel level indicator, etc.)

Steering Wheel Control Lever Stalk

The unit is made up of the following:
--Turn signal indicator, with automatic return controlled by the straightening of the steering wheel after a turn.
--Main beam-dip beam control lever with enclosed rotating switch for outside lights.
--Windshield wiper and washer switch.
The three instruments form a single group, fastened below the steering wheel.
In case of malfunction, replace the complete unit.

Removal and Remounting

The following operations should be carried out:
--Remove the steering wheel.
--Unscrew the locking retaining nut that fastens the steering wheel hub to the steering column.
--With tool 706-AS-7237 remove the hub, making sure not to lose the related alignment key.
--Unscrew the two control unit retaining screws.
--Remove the assembly as a total unit.
To reinstall, reverse the above operations.

Window Washing Unit

It is made up of an electric motor which acuates two reduction units which control the two synchronized wiper arms.
The unit is equipped with an automatic wipers neutral position return unit. The wipers return to a rest position at the bottom of the windshield.
This action of the unit is controlled through acuating the right lever at the control lever's stalk.

Instructions for Identifying Malfunctions

Malfunctions or non-functioning of the window washing unit are due to the following causes:
--Malfunction or breakage of the control stalk lever.
--Faulty assembly of the unit.
--Faults in the electric motor or in the reduction units.
In the first example, replace the control stalk unit as indicated in the preceding section.
In the second example, check that there are no blockages or deformations in the lever support or in the articulation mechanisms. If necessary, check to see if reassembly is required.
In the third example, check the electric motor on a test bench and replace if malfunctioning.

Removal and Reassembly

The window washer unit is removed through the front trunk cover.

Removal of the Motor

--Remove the guide wheel and the protective bulkhead of the unit.
--Disconnect the electric cables from the motor.
--Unscrew the right reduction unit control cover from the motor.
--Loosen the arm that fastens the motor on its support and remove it together with the right reduction unit coupling assembly.

Reduction Unit Groups

--Unscrew the nuts of the wiper arms bearing spacers and the retaining nuts of the arms.
--Remove the wiper arms.
--Unscrew the reduction unit supports-to-chassis fastening bolts and remove both groups completely.
--Make sure that the reduction units and the cover are well lubricated.
For reassembly, reverse the operations making sure that the motor and reduction units are totally free in their movements.

Horn

The horn circuit is made up of the following units:
--2 horns of different sound: a high and a low tone respectively.
--A horn switch button, placed in the center of the steering wheel.
--A circuit protection 8 amp fuse which also protects the electric cigarette lighter and clock circuits.

Instructions for Locating Malfunctions

The horn system malfunctioning can be traced to:
--Non-functioning horn button.
--Malfunctioning or obstructed compressor.
Check that the connections, the cables and the horn button are functioning and do not show traces of oxidation.
Whenever the fault can be traced to the horn button, replace it.
Any malfunctions in the compressor indicate need for replacement of the unit.

Removal and Remounting

For removal of the group carry out the following operations:
--Remove the proper fuse from the fuse box.
--Remove the battery protection plate bolted to the lower apron of the car.
--Disconnect the current cable from the compressor and the air pressure tube at the horns.
--Loosen the two compressor arm retaining nuts and remove the compressor.
--Remove the horns' retaining nuts and remove the horns.
To reinstall, reverse the above operations.
NOTE: The horns' sounding note cannot be varied.
Every 2500 Km. lubricate the compressor with a few drops of FIAMM oil or with vaseline oil.

Window Cleaning

Operation

--Via a pump.
--Controlled through a lever positioned at the steering wheel (fig. 110).

Liquid to be Used

Summer--1 liter of water with 30 cm^3 of FIAT DP 1 or a quantity of glass cleaner.
Winter--1 liter of FIAT DP 1 or 1 liter of water with an appropriate quantity of glass cleaner.

Fuel Level Indicator

The malfunctioning of this unit is generally attributable to the sending unit contained in the right hand gas tank.
For eventual replacement of the unit, carry out the following steps:
--Raise the car at the rear.
--Remove the right rear wheel, the stone guard and the brake cooling air tube.
--Remove the electrical cables and remove the unit's retaining bolts.
--With great care, remove the unit choosing the best position for removal so as not to alter the setting of the instrument by changing the float's position.
--For reassembly, reverse the above operations.

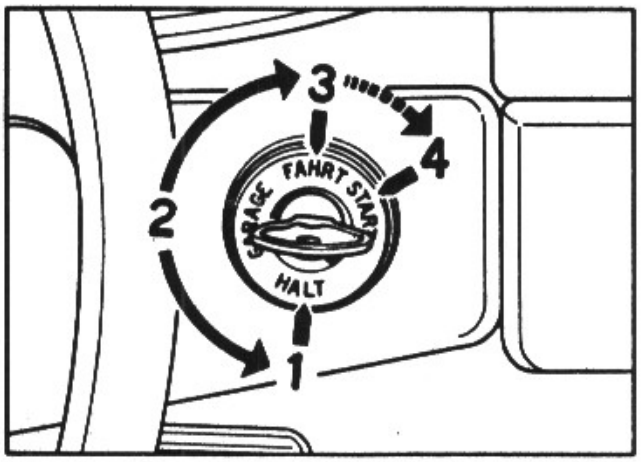


Fig. 111 Ignition and Steering Lock Switch

VENTILATION AND HEATING SYSTEM

Description

The ventilating and heating system components are:
--two front air intakes; located on the side of the radiator.
--one fan located at the right hand air intake.
--one radiator located near the right hand air intake.
--a tap control which opens or closes the entrance of the flow of hot water from the engine to the radiator.
--two directional air vents located on the dashboard for the demisting of the windshield.
--two side air vents.

Diagnosing Malfunctions and Related Remedies

Insufficient Heating (The Hot Water does Not Arrive in Sufficient Quantities to the Radiator)

Possible Causes	Remedies
1) Control tap not fully open.	1) Check the opening action.
2) Control tap with deteriorated shut-off seal.	2) Replace the tap.
3) Control tap-to-engine water tubing partially clogged.	3) Disconnect tubing and blow clear with compressed air.
4) Faulty or maladjusted thermostatic valve.	4) Check and eventually replace the valve.
5) Air tubing valves not closing completely.	5) Check the valves. Adjust closing action.
6) Non-functioning fan.	6) Check fuse and electrical circuit.
7) Irregularly functioning fan.	7) Overhaul fan or replace it.

Operation

Air flow into the car is controlled by two sets of levers: lever 3, located under the left side of the dashboard, controls air intake at tube 1 (fig. 112), lever 8, located at the tunnel, controls incoming air at tube 4 across heater box 6. Lever 12, next to lever 8, controls the opening and closing of tap 11 for the intake of hot water from the engine to the radiator. Switch 15 (located at the tunnel) actuates the fan at the right hand air intake tube.

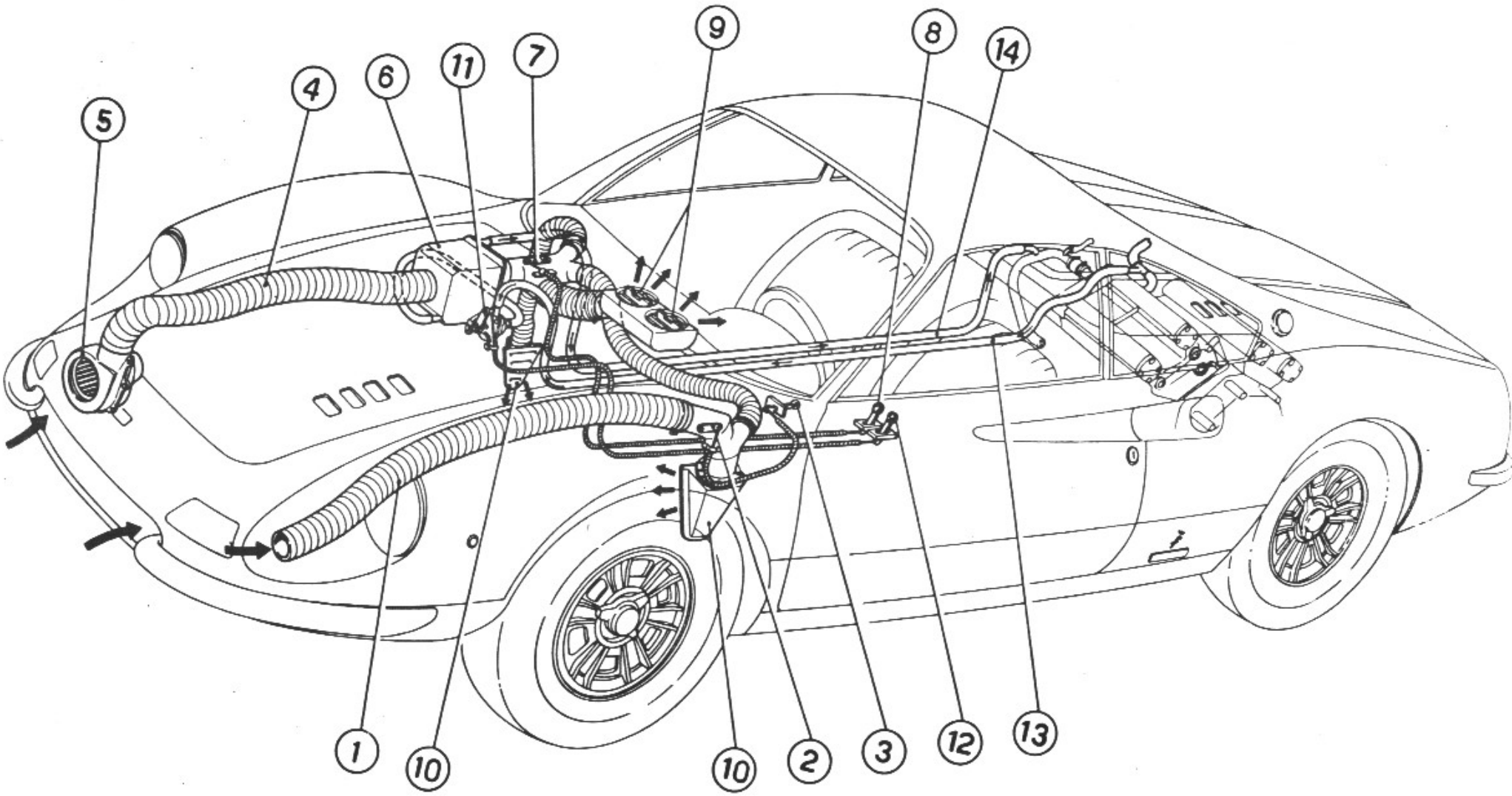


Fig. 112. Heating and ventilation system diagram.

1. Left fresh air intake tube, 2. Fresh air intake control valve, 3. Control lever, 4. Right air intake tube, 5. Ventilating fan, 6. Heater unit, 7. Three-way air control valve, 8. Air control valve lever, 9. Defroster air outlet, 10. Side air intakes, 11. Hot water tap, 12. H ot water tap actuating lever, 13. Engine to tap hot water tube, 14. Return water pipe to engine.

Instructions for Use

Summer Ventilation

Outside air intake. Rotate the triangular vent side windows as required. Partially lower the side windows actuating the appropriate levers.
Front air intake.
--Close the hot water valve moving lever 12 to the blue spot.
--Move lever 8 to the intermediate position (E). In this position the air is directed to the defroster and to the side air intakes.
--With lever 3 push to the left, cold air is directed via the side air intake.
--To direct cold air only to the windshield, move lever 8 to its lowest position and close valve 2.
--At low car speeds, switch on the heater and ventilation fan.
NOTE: With lever 8 in position (O), air flow, hot or cold to the defroster and side air intakes is excluded.

Intermediate Season

For the demisting of the windshield follow the first and fourth instructions for winter heating.
In order to obtain fresh air in the car, open valve 3.

Winter Heating

--Open completely the hot water valve, moving lever 12 towards the red spot.
--Close valve 2 pulling it to the end of its travel lever 3.
--Move lever 8 to the half way position (E). In this position hot air will enter via the defroster 9 and the two side air intakes 10.
--Moving the lever 8 to the lower end of its travel all the air is directed to the defroster. The temperature of the air is varied by opening or closing valve 2 with control 3.
--When the car speed is reduced, in order to increase the air flow, switch on the heater and ventilation fan using switch 15 (fig. 110).
--Should the heating be inadequate, first check the correct functioning of the thermostat which regulates the engine air temperature.

SECTION 10

CHASSIS

CHASSIS

General Description

Dino 246 GT .607L, with tubular chassis, two doors, two directional lights.
Opening hood, with front hinging, control from the interior of the car via a lever located under the instrument dashboard, near the steering wheel.
Outside lighting with curved-layer safety glass; black rubber moldings with chromed brass frame held by black L.A.M.A.C. sealer.
Front doors hinged at the front, with security lights: adjustable at the front, equipped with a blocking lever actuated by a push button which insures its locking in the closed position: the door can be opened at the rear via a lever handle.
Locking of doors via key.
External door handles--lever type, chromed.
Rear lighting--round shaped; round black rubber gasket and chromed brass ring.

Rear luggage trunk with locking lid and push button opening control.
Rear license plate holder located at rear center of the car, under the trunk lid.
Bumpers--front and rear, with black rubber inserts in steel shells.
Field tank lid, located on the rear left side, provided with a locking mechanism actuated by a control lever located in the car, at the rear left side of the driver's seat.
Seats, sliding bucket type.
Instrument dashboard--padded resin molding, with velveteen "sky" covering. Instruments located at center of steering wheel with central controls, with two movable interior ventilation air vents. On the passenger side there is a glove compartment.
Sun visors, padded and movable in two directions; vanity mirror on the passenger side, map pocket on the driver's side.
Carpeting--in car's front and rear floors, front and rear trunks.
Internal upholstery--in leatherette (with cloth central seat panels, or leather upholstering upon request).

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 Door Windows

The removal and reinstallation of the door windows is completed in the following steps:
--Remove the window cranking handle and the interior door opening shields.
--Remove the door panel after removal of the retaining screws.
--Remove the internal door molding by unscrewing the proper screws.
--Loosen the vent window retaining screws and turn it facing the front of the car.
--Remove the support unit from the window glass which actuates it by unscrewing the proper screws.
--Slide the glass carefully out.
To reinstall, reverse the above operations.

For the removal and reinstallation of the vent windows the steps outlined above must be followed as well as these additional steps:
--Lower the side windows all the way down, remove the vent window frame by lightly pushing from the top down and forward; thus allowing the frame to slide out of its guide and permitting its removal.
For reinstallation, the above steps must be reversed.

Removal and Reinstallation of the Windshield

The removal and reinstallation of the windshield is carried out in the following manner:
--Remove the windshield wipers from their mounts.
--Remove the side covering of the windshield.
--Remove the windshield trim ring from the molding.
--From the inside of the car, apply hand pressure to the top part of the windshield to loosen the glass from its gasket seating.
For reinstallation of the windshield follow these instructions:
--Clean the black L.A.M.A.C. putty from the windshield surfaces with a cleaning fluid.
--Mount the gasket and trim ring on the windshield.
--Insert a cord in the groove of the gasket.
--Insert the glass in its proper base, working from the inside of the car.
--Pull the end of the cord to aid in the seating of the glass in its retaining flange. A screwdriver will aid in facilitating the installation. Before installation is completed, apply black L.A.M.A.C. sealant in the internal groove of the gasket. After installation clean the glass with the proper cleaning fluid.

Removal and Reinstallation of the Rear Window (Lunette)

Follow the same removal operations as for the windshield except that no black L.A.M.A.C. sealant is applied.

Removal and Reinstallation of Rear Side Windows

The removal and reinstallation of the rear side windows is carried out as follows:
--Remove the top flanked mounting molding by unscrewing the retaining screws.
--Remove the internal rear side support by unscrewing the two retaining screws.
--Slide out the internal gasket and unscrew the fixed glass frame support screws.
By pressing on the rear inside part of the glass, slide it from its seat.
For reinstallation of the glass, carry out the following steps:
--Clean off the old silicon sealant with the proper solvent and apply fresh sealant according to manufacturer's specifications.
--Mount the rubber gasket on the edge of the glass.
--Mount the glass in its base and fasten its frame to the body.
--Install the inside air sealed gasket on the body window outline.
--Install the rear internal support and its supporting screws.
--Install the rear top flanked mounting molding and its retaining screws.
--Clean off the excess silicon sealant 854804 with the proper solvent.

Hoods

Trunk and Engine Hoods

The trunk and engine hoods are hinged at their front via two internal hinges and their closing is controlled by a lock with a stop latch.
The positioning support of the lids is provided by a retaining lever.
If replacement of the hood is required, remove the retaining lever blocking screw (only the top one on the trunk lid); remove the blocking screws of the hinges. In its mounting seat the lid must align itself perfectly in its proper seating and it must open and close easily without forcing.
The adjustment of the lid in relation to the trunk is obtained by adjusting the lid hinges and the stop latch.
To open the engine compartment hood, actuate the lever situated inside the car to the left rear of the driver's seat.

Front and Rear Bumpers

General Description

The front and rear bumpers are made up of a sheet metal body, with a surfaced rubber molding housing a steel core.

Removal and Reinstallation

The removal is accomplished by removing the proper screws situated on the bumper support arms.
The rubber strip molding can be removed from its seat by removing, at the front bumpers, the rubber strip fastener screws and raising the rubber retaining clip.
For the rear bumpers, if removal of the rubber strip is necessary, it will be required to loosen the license plate light support and to remove the screw located at the opposite end.
When reinstalling the bumpers, make sure that they are positioned properly before tightening them down.

Instrument Dashboard

Removal and Reinstallation.

For the removal of the dashboard the following steps are necessary:
--Loosen the side fastening screws.
--Remove the steering wheel from the guide mount.
--Loosen the control levers unit located under the steering wheel mounting cone.
--Unscrew the steering wheel guide mount cover fastening screws and remove it.
--Loosen the instrument dashboard face by unscrewing the four knurled retaining screws.
--Loosen the mileage counter cable and slide out the dashboard face control pins.
--Open the front trunk lid; the rear trunk-wheel bulkhead must be removed to gain access to the car's interior heating control cables.
--Proceed to remove the dashboard face.
For reinstallation, carry out the above operations in reverse order.

Seats

General Description

The seats are of the fixed frame bucket type, mounted on two sliding rails.
The seat adjustment control for the driver's seat is located on the right side, for the passenger's seat it is located on the left side of the seat.
The padded head rests are mounted on the interior-engine compartment bulkhead.

Removal and Reinstallation

For the removal of the seats carry out the following operations:
--Slide seats all the way back and remove the two front guide fastening bolts.
--Slide seats all the way forward and remove the two rear guide fastening bolts.
--Remove the seats.
To remove the head rests, first remove the bulkhead behind the seat backs by tapping out the four rivet fasteners: then remove the two head rests mounting springs and slide out the rest from its seating.
To reinstall, reverse the above operation.

Chassis

Always contact your FERRARI dealer for service assistance when chassis work is being considered.

Maintenance of the Chassis

Spot 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.
This 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 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.

Cleaning of the leatherette material

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.

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 an oil fluid. Lastly, rub the chromed parts with a clean woolen rag until every trace of oil is gone.

External Washing of the Car

The car is painted with an acrylic paint manufactured by GLIDDEN SALCHI.
It must be washed periodically and according to the amount of use and types of roads traveled.
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.