Survey of Engine Types

Type Off. Int.	Displacement	Cyl.	Engine characteristics	Type	Year	Engine installed in vehicle type	HP
2000 901/01	2.0 lits	6	Solex 40 PI		1965	911 E.No.900001-907000	130
2000 S 901/02	2.0 lits	6	Weber 40 IDA*	67	1966-1968	911 S from E.No.960001 etc.	160
2000 901/05	2.0 lits	6	Weber 40 IDA	67	1966	911 E.No. 907001-909927	130
2000 901/06	2.0 lits	6	Weber 40 IDA	67	1966-1968	911 from E.No. 911001**	130
2000 901/07	2.0 lits	6	Weber 40 IDA	68	1967-1968	911 L with Sportomatic	130
911 E 901/09	2.0 lits	6	Injection	69	1968	911 E with manual transmission	140
911 S 901/10	2.0 lits	6	Injection	69	1968	911 S with manual transmission	170
911 E 901/11	2.0 lits	6	Injection	69	1968	911 E with Sportomatic	140
2000 901/14	2.0 lits	6	Emission control	68	1967-1968	911 USA	130
2000 T 901/16	2.0 lits	6	Emission control	69	1968	911 T USA	110
2000 901/17	2.0 lits	6	Emission control	68	1967-1968	911 USA with Sportomatic	130
2000 T 901/19	2.0 lits	6	Emission control	69	1968	911 T USA with Sportomatic	110
901/20	2.0 lits	6	Weber 46 IDA		1965	906 (Carrera 6)	220
901/22	2.0 lits	6	Weber 46 IDA	68	1967-1968	911 R (spec. emission control system)	210
2000 R 901/30	2.0 lits	6	Weber 46 IDA	68	1967-1968	911 W. rallye motor (series)	150
911 E-C 911/01	2.2 lits	6	Injection	70	1969	911 E with manual transmission	155
911 S-C 911/02	2.2 lits	6	Injection	70	1969	911 S with manual transmission	180
911 E-C 911/04	2.2 lits	6	Injection	70	1969	911 E with Sportomatic	155

Type Off. Int.	Displace-ment	Cyl.	Engine characteristics	Type	Year	Engine installed in vehicle type	HP
911 T-C 911/07	2.2 lits	6	Zenith emisssion control	70	1969	911 T USA with manual transm.	125
911 T-C 911/08	2.2 lits	6	Zenith emission control	70	1969	911 T USA with Sportomatic	125

* = IDA carburetor modified up to use of Weber carburetor 40 IDS and marked with "S"

** = Engine with new heat exchangers and changed camshafts (Symbol 05)

CHANGES OF 911 ENGINES AS OF TYPE 70

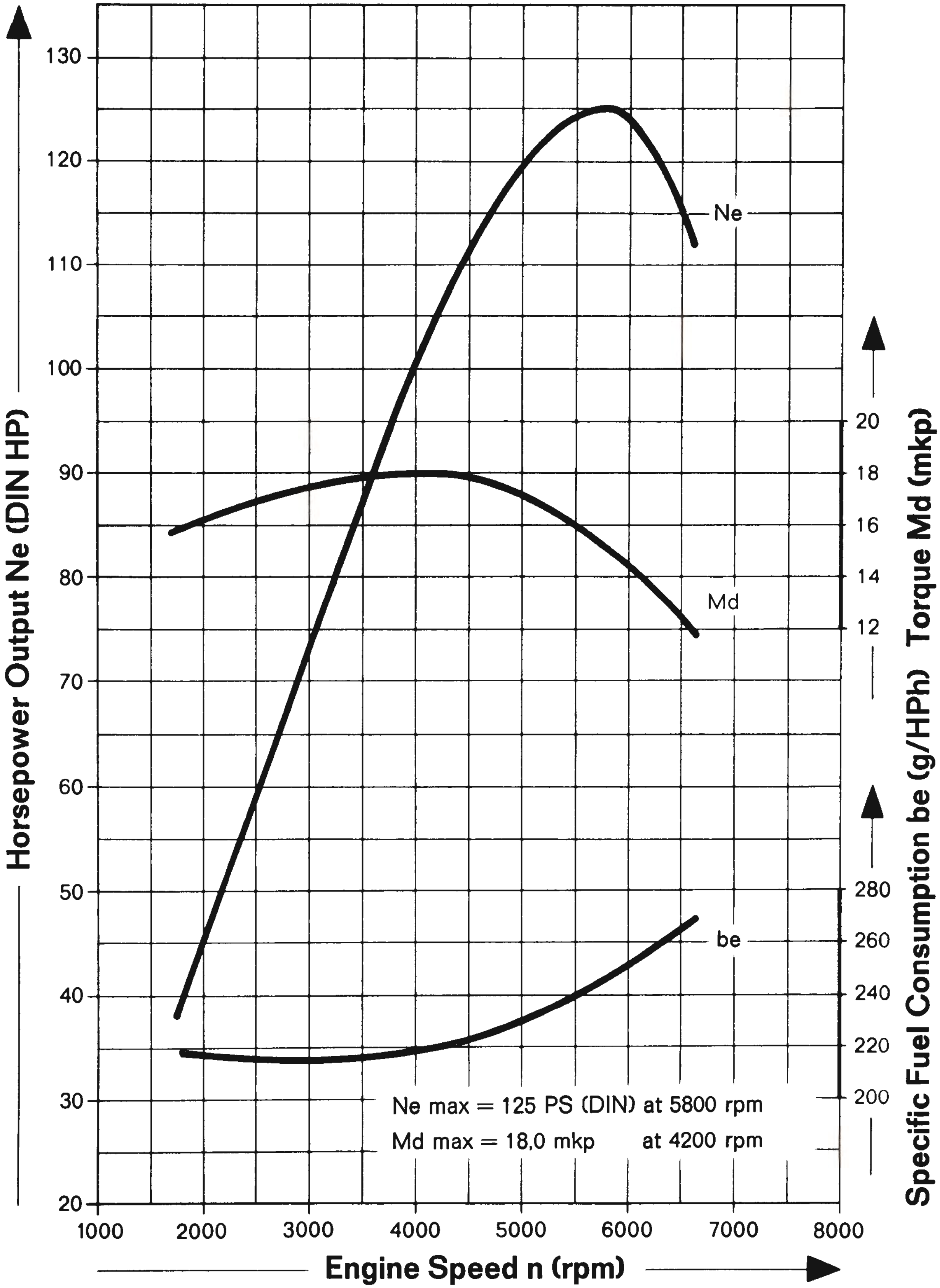
Description	911 T-C	911 E-C	911 S-C
Number of cylinders	6	6	6
Bore mm (in.)	84 (3.307)	84 (3.307)	84 (3.307)
Stroke mm (in.)	66 (2.2598)	66 (2.2598)	66 (2.2598)
Total piston displacement cc (cu.in.)	2195 (133.9)	2195 (133.9)	2195 (133.9)
Compression ratio	8.6 : 1	9.1 : 1	9.8 : 1
Engine output (DIN) HP	125	155	180
Engine output (SAE) HP	142	175	200
at engine speed (rpm)	5,800	6,200	6,500
max. torque mkp acc. to DIN	18	19.5	20.3
max. torque lb.ft.acc. to SAE	148	160	164
at engine speed (rpm)	4,200	4,500	5,200
Liter output (HP/l acc. to DIN)	57	70	82
Liter output (HP/l acc. to SAE)	65	79	91
Max. permissible speed (rpm)	6,500	6,700	7,200
Cutout speed of governor in ignition distributor (rpm)	6,500 ± 100	7,100 ± 100	7,300 ± 100
Fuel octane requirement (research method)	96	98	98
Engine weight (kp) (lb.)	approx. 176 (388)	approx. 182 (401)	approx. 182 (401)
Pistons	cast aluminum alloy	cast aluminum alloy	forged aluminum alloy
Cylinders	grey cast iron cylinder	Biral, with aluminum fins	Biral, with aluminum fins
Nominal dia mm (in.)	84 (3.307)	84 (3.307)	84 (3.307)
<u>Cylinder head</u>			
Intake port dia. mm (in.)	32 (1.26)	32 (1.26)	36 (1.42)
Exhaust port dia. mm (in.)	32 (1.26)	32 (1.26)	35 (1.38)
Intake valve dia. mm (in.)	46 (1.81) (not filled)	46 (1.81) (not filled)	46 (1.81) (not filled)
Exhaust valve dia. mm (in.)	40 (1.57) (filled)	40 (1.57) (filled)	40 (1.57) (filled)

Description	911 T-C	911 E-C	911 S-C
Installed dimensions of valve springs			
Intake valve mm (in.)	36 ± 0.3 (1.417 ± 0.012)	36 ± 0.3 (1.417 ± 0.012)	35.5 ± 0.3 (1.398 ± 0.012)
Exhaust valve mm (in.)	36 ± 0.3 (1.417 ± 0.012)	35 ± 0.3 (1.378 ± 0.012)	34.5 ± 0.3 (1.358 ± 0.012)
<u>Camshaft</u>			
Intake valve lift at TDC overlap mm (in.)	2.3 - 2.7 (0.091 - 0.106)	3.0 - 3.3 (0.118 - 0.130)	5.0 - 5.4 (0.197 - 0.213)
Cam height intake mm (in.)	36.25 (1.427)	36.50 (1.437)	37.20 (1.465)
exhaust mm (in.)	35.51 (1.398)	36.20 (1.425)	36.30 (1.429)
<u>Timing at 1 mm valve play</u>			
Intake valve opens	15° BTDC	20° BTDC	38° BTDC
Intake valve closes	29° ABDC	34° ABDC	50° ABDC
Exhaust valve opens	41° BBDC	40° BBDC	40° BBDC
Exhaust valve closes	5° BTDC	6° ABDC	20° ATDC
Suction manifold dia. mm (in.) top	40 (1.57)		
bottom	32 (1.26)		
Intake manifold dia. mm (in.) top		38 (1.50)	42 (1.65)
bottom		35 (1.38)	38 (1.50)
<u>Carburetor</u>			
Make	Solex		
Type	Zenith 40 TIN		
USA Type with supplementary mixing equipment			
<u>Exhaust gas ratings USA version</u>			
CO content	approx. 3 % at idle speed of 1200 rpm		
<u>Fuel injection system</u>			
Make		Bosch 0408126010	Bosch 0408126009
Part No.		911.110.221.00	911.110.222.00
Setting (end of delivery stroke)		40° ATDC overlap	40° ATDC overlap
<u>Air cleaner with cold starting system</u>			
Calibration of nozzles mm (in.)	0.5 (0.197)	0.3 (0.118)	0.3 (0.118)

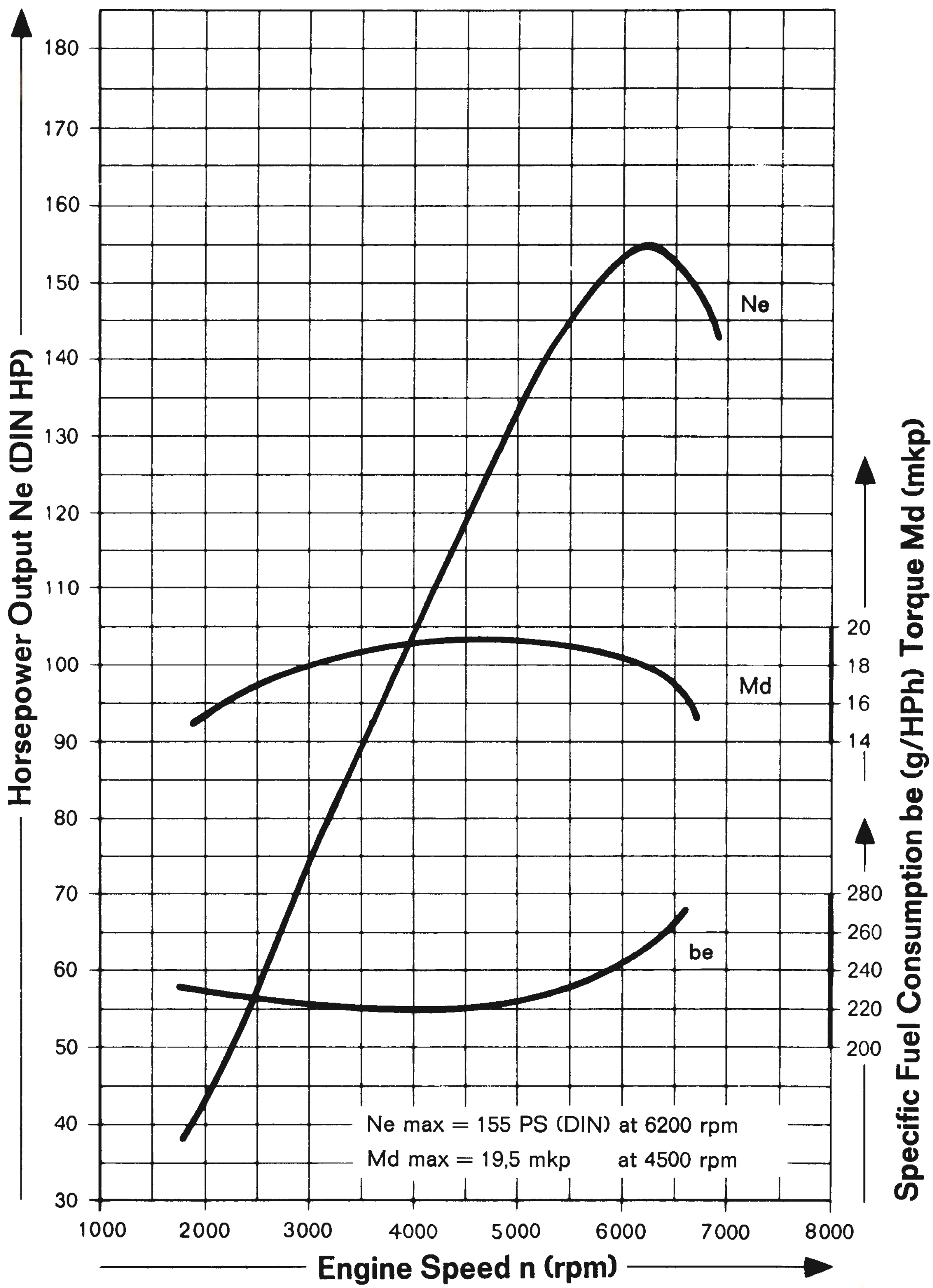
Description	911 T-C	911 E-C	911 S-C
Ignition system	Capacitor discharge system 770W	Capacitor discharge system 770W	Capacitor discharge system 770W
Battery voltage	12 V	12 V	12 V
Battery capacity	2x36 Ah	2x36 Ah	2x36 Ah
Ignition distributor			
Make	Marelli	Bosch	Bosch
Reference numbers	S 112 BX	JFDR6 0231159006	JFDR6 0231159007
Ignition timing	35^{o} at 600 rpm	30^{o} at 6000 rpm	30^{o} at 6000 rpm
Spark plugs			
Make (optional)	Beru 240/14/3 Bosch W 230/T 30 * Beru 250/14/3 P * Bosch W 250/P 21	Beru 265/14/ 3 P Bosch W 265/P 21	Beru 265/14/3 P Bosch W 265/P 21
Electrode gap mm (in.) all types	0.6 (0.024)	0.6 (0.024)	0.6 (0.024)
Upper air guide	with cooling air supply directed to oil cooler	with cooling air supply directed to oil cooler	with cooling air supply directed to oil cooler
Clutch			
Disk	225 GUD	225 GUD	225 GUD
Pressure plate	MFZ 225 KL	MFZ 225 KL	MFZ 225 KL

* must be used for 911 T USA Version

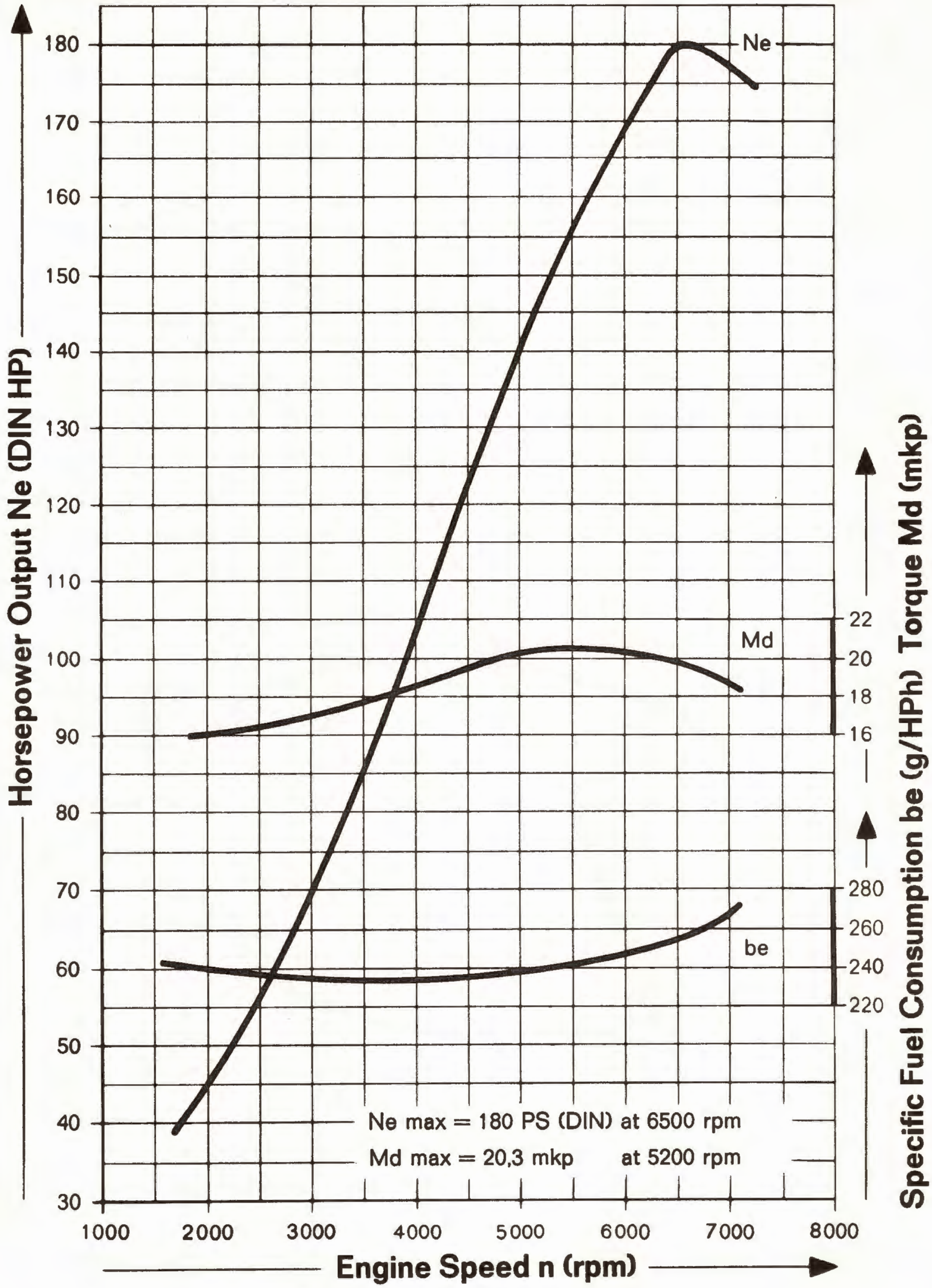
Engine Type 911 T-C Full-power Performance



Engine Type 911 E-C Full-power Performance



Engine Type 911 S-C Full-power Performance



The connecting rods are divided into weight groups.

The end number of the parts number indicates the respective weight group. This end number is marked on the shaft of the connecting rods which are supplied as spare parts.

2.0 Liter Engine

Weight above gr	Weight up to gr	Connecting rod spare part number	Connecting rod identification
551	560	901.103.011.21	21
560	569	901.103.011.22	22
569	578	901.103.011.23	23
578	587	901.103.011.24	24
587	596	901.103.011.25	25
596	605	901.103.011.26	26
605	614	901.103.011.27	27
614	623	901.103.011.28	28
623	632	901.103.011.29	29
632	641	901.103.011.30	30
641	650	901.103.011.31	31
650	659	901.103.011.32	32

2.2 Liter Engine

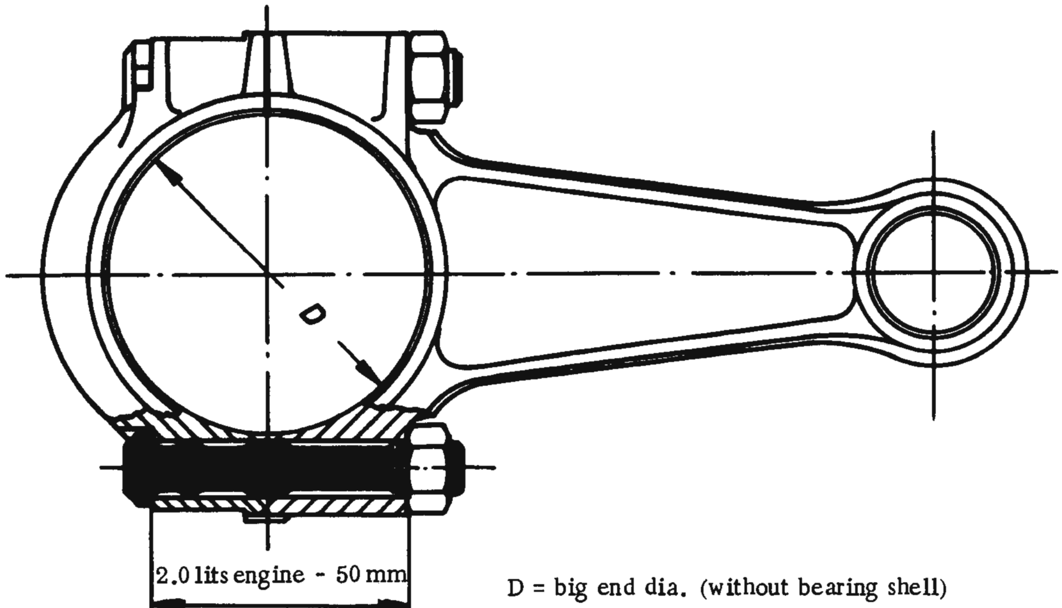
Weight above gr	Weight up to gr	Connecting rod spare part number	Connecting rod identification
700	709	911.103.013.21	21
709	718	911.103.013.22	22
718	727	911.103.013.23	23
727	736	911.103.013.24	24
736	745	911.103.013.25	25
745	754	911.103.013.26	26
754	763	911.103.013.27	27
763	772	911.103.013.28	28

Note

The difference in weight of connecting rods installed in one engine should not exceed 9 grams. For determining the weight group, weigh complete connecting rod, but without bearing shells.

General

From model year 1970, the 2.2 liter engines have changed connecting rods.



D = big end dia. (without bearing shell)
61.019 - 61.000 mm

The connecting rods of the 2.2 liter engines are reinforced at the big end and the big end cap (seat of bolt head to seat of nut 58 mm (2.283 in.); formerly 50 mm (1.969 in.). The connecting rod bolts have been lengthened from 65 mm (2.56 in.) to 73 mm (2.87 in.). These new connecting rods can only be assembled with the new nuts part number 900.103.171.00. The new big end nuts are marked on their faces.

Note

Insufficient space prevents installing the new connecting rods in the 2.0 liter engines.

Vehicle types 911 T, 911 E and 911 S (model year 1970) are equipped with a diaphragm spring clutch with a pull rod operating mechanism. The cable control is newly designed in order to reduce operating effort and ensure smooth engagement.

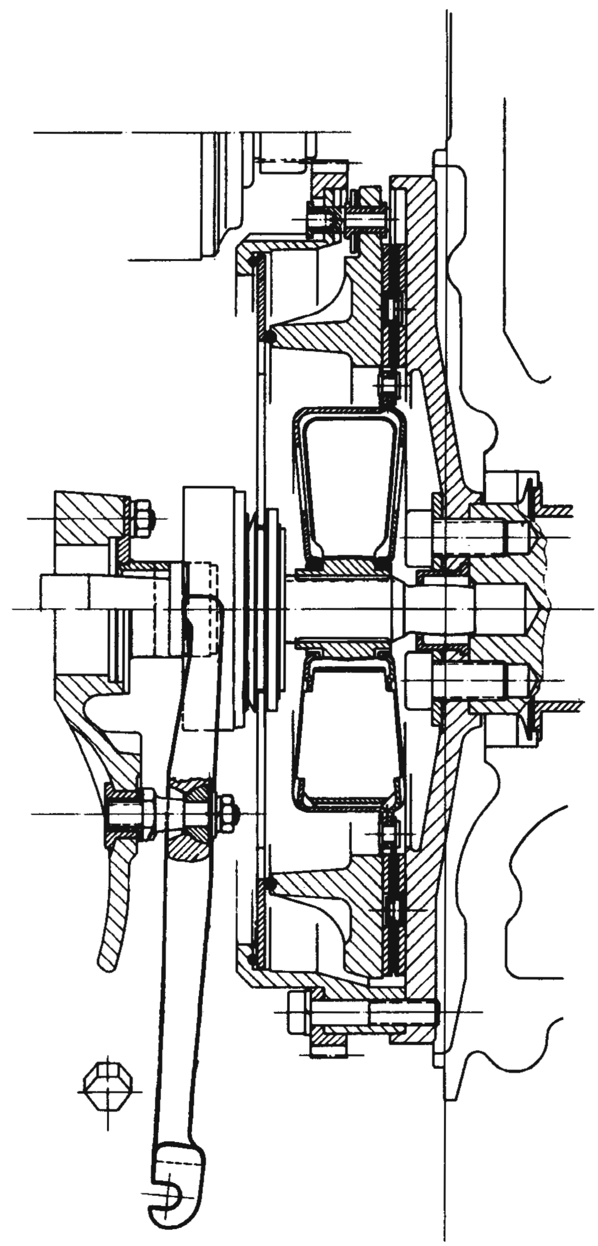
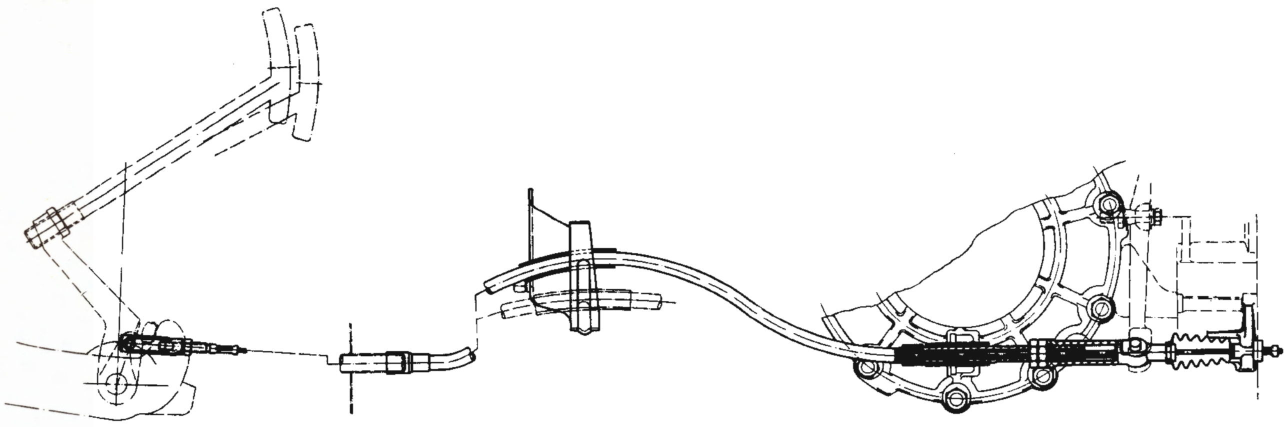


Diagram of Clutch Operation



Position and Attachment of Clutch Cable Control

The clutch cable is connected to the clutch pedal shaft by an adjustable fork piece. The end of the cable control is attached to an integrally cast lug on the transmission housing. The cable housing length is adjustable and is supported at the tunnel rear wall and at the throwout fork. The cable is routed in an upward arc thru a guide bracket. This bracket prevents side movement of the cable housing allowing motion only vertically and in the direction toward the throwout fork.

Clutch release

Stepping on the clutch pedal will tension the inner cable. Since it is tightly held at transmission housing, the inner cable will exert pressure on the cable casing. The casing reacts against the rear wall of the tunnel and moves in the direction of the clutch throwout fork. The cable casing will slide in its guide and approach its fully extended condition. As a result, the internal distance between the rear wall of the tunnel and the throwout fork will be extended by approximately 15 mm (0.6 in.), which is the length required by the throwout fork to release the clutch.

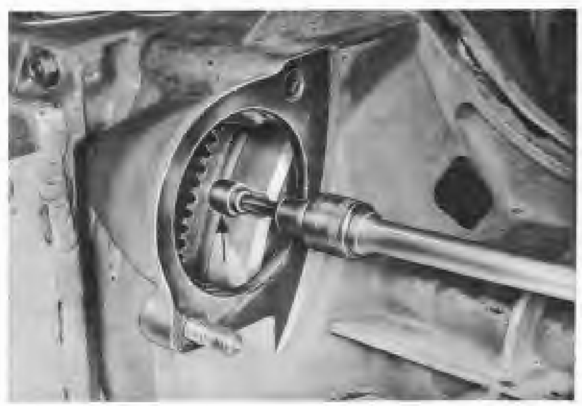
Engaging the Clutch

When the clutch pedal is released, the clutch inner cable will slacken. The pressure on the cable casing is reduced, the cable casing returns in its guide to its starting position (large arc in upward direction). The clutch re-engages.

SEPARATING TRANSMISSION AT FLANGE

1. Remove starter from transmission and rotate engine until the three rivet heads on the pressure plate (each offset 120°) are visible through the starter opening.

2. Install a spacer sleeve on each of the rivet heads and tighten with Fillister head screws, size M 6x12, part number 900.067.007.02. This will lift the diaphragm spring and release the tension on the throwout bearing.

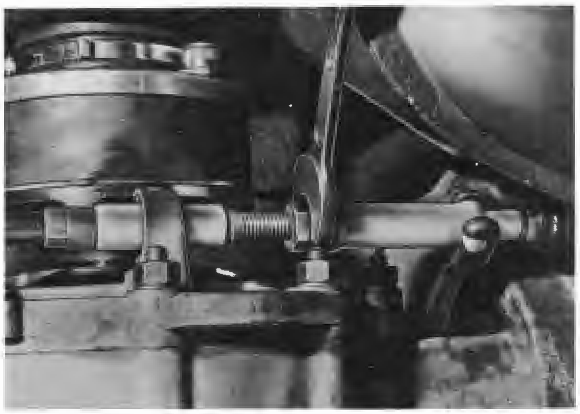


3. Turn throwout bearing with a screw driver (through the opening in the transmission housing) by 90°, until throwout fork can be slid past the throwout bearing.

4. Separate engine from transmission.

ADJUSTING THE CLUTCH PLAY

1. Loosen the cable casing lock nut.



2. Turn the adjusting nut until the clutch has the specified free play of 20 to 25 mm (0.8 to 1 in.). To check the play pull the clutch pedal back (as shown by arrow).

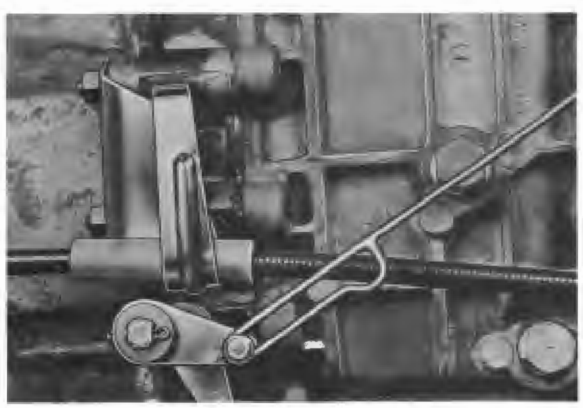
3. Tighten lock nut without turning adjusting nut on cable casing.

4. With the engine running, fully depress the clutch pedal. Check that reverse gear can be selected without gear noise.

Note
If the clutch throwout distance of approximately 15 mm (0.6 in.) is not reached and the clutch pedal stop needs adjusting, note the following:

When the clutch pedal is fully depressed, the cable casing must not be stretched or make contact with the bottom of the guide clamp on the side of the transmission.

If this occurs, the length of the inner cable must be adjusted accordingly at the yoke end.



If the clutch operating mechanism is to operate properly it is essential for the clutch length to be properly adjusted.

1. The basic adjustment of the clutch cable length measured from the face of the threaded insert to the face of the lock nut is approximately 17 - 22 mm (0.67 - 0.87 in.).

Note

If the tolerances of the cable casing support at the rear wall of the tunnel or at the pedal assembly are too great it may result in the following faults, in spite of the correct basic adjustment.

In its relaxed position the cable casing forms too large an arc and jumps out of guide bracket on transmission (cable must be shortened).

With the clutch pedal fully depressed, the cable casing begins to stretch before the full distance necessary for clutch release has been achieved (cable must be lengthened).

CONTENTS

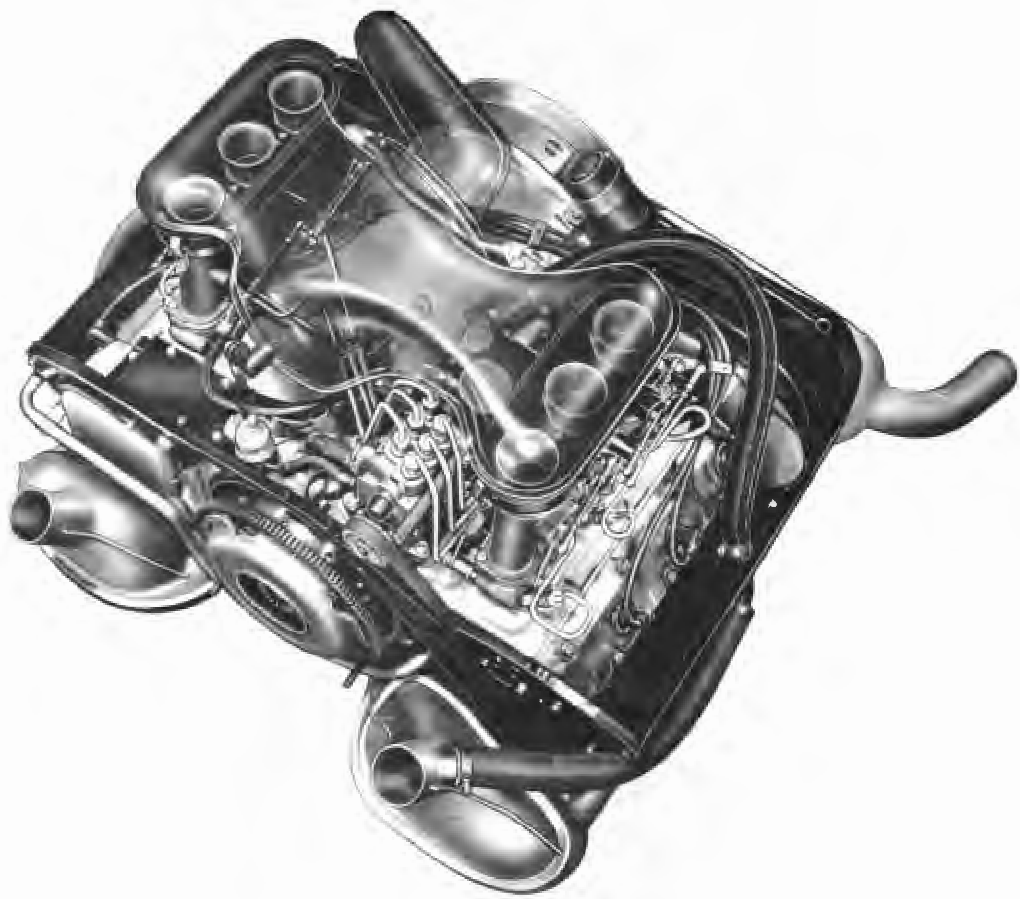
Supplements for Group F: Fuel System

Procedures:

General

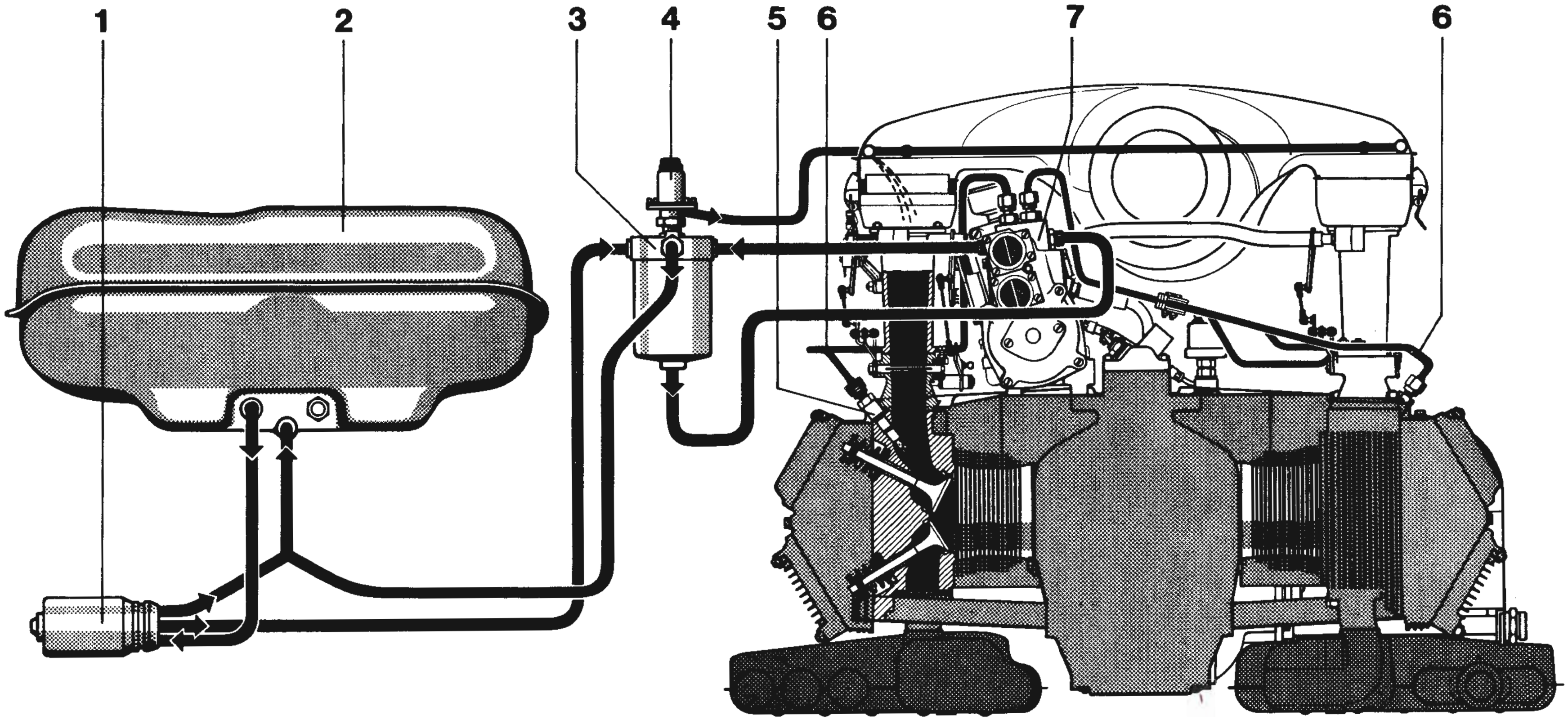
As of 1969, the 911 E and 911 S vehicles are provided with fuel injection.

The advantages of fuel injection are essentially an output increase of the engine, better transition during acceleration, good cold starting characteristics and low fuel consumption. In addition, the accurately balanced injected fuel quantity in relation to the inducted air permits a better combustion of the air fuel mixture.



The double row six-plunger injection pump is driven by the left engine camshaft by a toothed belt. The fuel is delivered from the tank to the injection pump by an electric fuel delivery pump via a fuel filter. Six injection plungers, actuated by the injection pump camshaft, force the fuel through six pressure lines of equal length to the injection valves in the cylinder heads. The injection valves open at a pressure of 15 - 18 atü (213-256 psi) and inject the fuel into the intake ports and onto the opening intake valves. This is known as a timed indirect injection system or manifold injection.

SCHEMATIC OF PORSCHE FUEL INJECTION SYSTEM



1 Fuel delivery pump
2 Fuel tank
3 Fuel filter
4 Solenoid for cold starting unit
5 Injection valve
6 Injection line
7 Injection pump

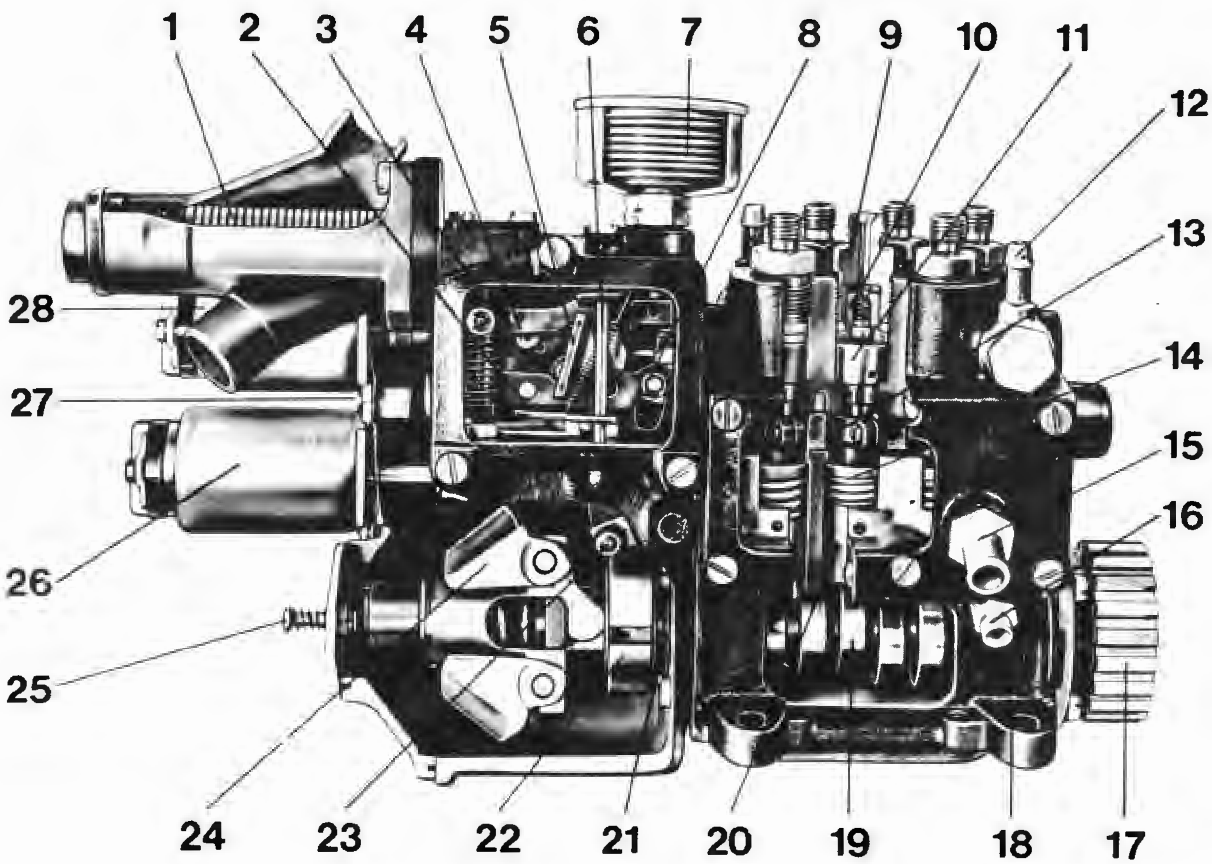
The air is drawn into the cylinders by the engine via a noise-dampening filter and two triple intake pipes which are fastened to the venturi control units. The throttle valves in the venturi control unit should always be synchronized with each other and in proper adjustment or correlated with the control lever on the injection pump. The throttle valves are connected to each other by linkages, and to the injection pump by means of the control lever.

Providing the air fuel mixture required for perfect combustion requires a ration of 14.8 kp air to 1 kp fuel. This is why the coordination of the throttle valves in relation to each other and in relation to the control lever of the injection pump is extremely important.

To obtain ideal combustion, the air fuel ratio should be constantly uniform. The climatic changes of the air, as well as the varying air quantities at different speeds and load conditions are corrected by the injected fuel in order to arrive at and maintain a ratio of 14.8 : 1. For this purpose, the injection pump is provided with a centrifugal governor and a correction device.

Description of Injection Pump

The fuel injection system consists of two main parts, the pump assembly and the control and compensating unit. The pump assembly contains the pump camshaft, roller tappets, injection plungers, and the plunger control rack. The control unit incorporates the fuel delivery controlling and compensating units. The injection pump is lubricated by the engine lubrication system. Lubricating oil supplied by the engine flows through a connecting line and filtering screen before reaching the camshaft compartment. Oil pressure build-up occuring in the camshaft compartment, is relieved through the roller tappets and delivery plunger springs. A drain passage allows the oil to return to the crankcase.

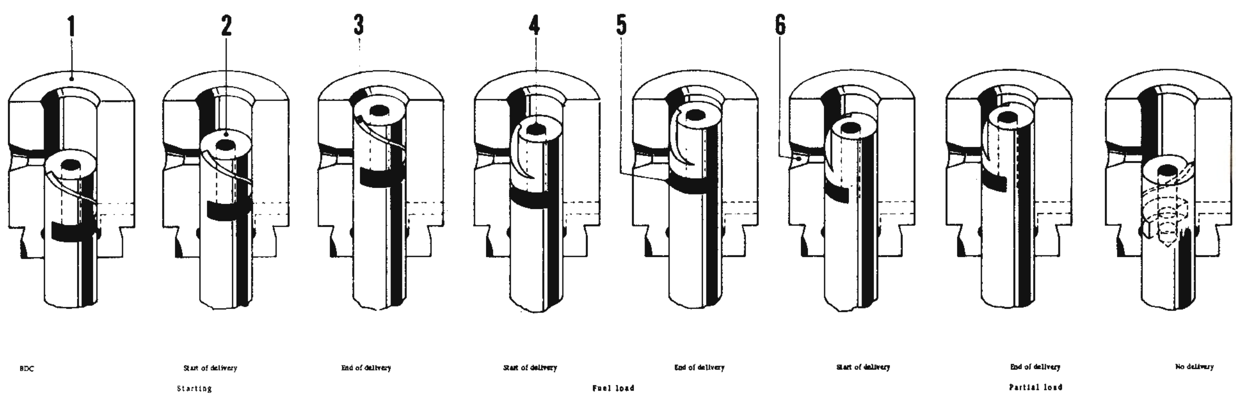


1 Thermostat
2 Compensating lever
3 Thermostat connecting sleeve
4 Cross-arm
5 Support
6 Guide stud
7 Barometric cell
8 Guide
9 Injector line fitting
10 Check valve
11 Plunger unit
12 Fuel inlet
13 Toothed segment
14 Plunger spring
15 Engine oil return
16 Engine oil inlet
17 Pump drive wheel
18 Support flange
19 Camshaft
20 Roller tappet
21 Contoured cam spring
22 Contoured cam
23 Sensor
24 Centrifugal governor weight
25 Idle speed adjustment
26 Shut-off solenoid
27 Access to control rack head
28 Enrichment solenoid

Operation of Injection Pump

1. Pump Assembly

The pump housing contains 6 pump units. Each unit consists of a cylinder and a plunger. Each plunger is connected to a roller tappet which rides on the cam lobe. The pump cylinders are fastened to the pump housing. Each cylinder is immersed in fuel which can enter the cylinder compression chamber through an inlet port. The camshaft exerts a force upon the roller tappet and causes it to move the delivery plunger up. As a result, fuel contained in the compression chambers is forced out through a check valve into pressure lines connected to injectors which spray the fuel into intake ports. Maximum lift of the delivery plungers is determined by camshaft design and remains constant. The injection quantity is regulated by turning the delivery plungers, thus resetting a metering land in each. The toothed control rack, engaging its toothed counterpart in each delivery plunger, can slide back or forth and to turn the delivery plungers as required. As a result, the slanted metering land closes the fuel inlet port at an earlier or later time, causing greater of smaller amounts of fuel to be delivered on each stroke, depending on the relative position of the injection plunger.

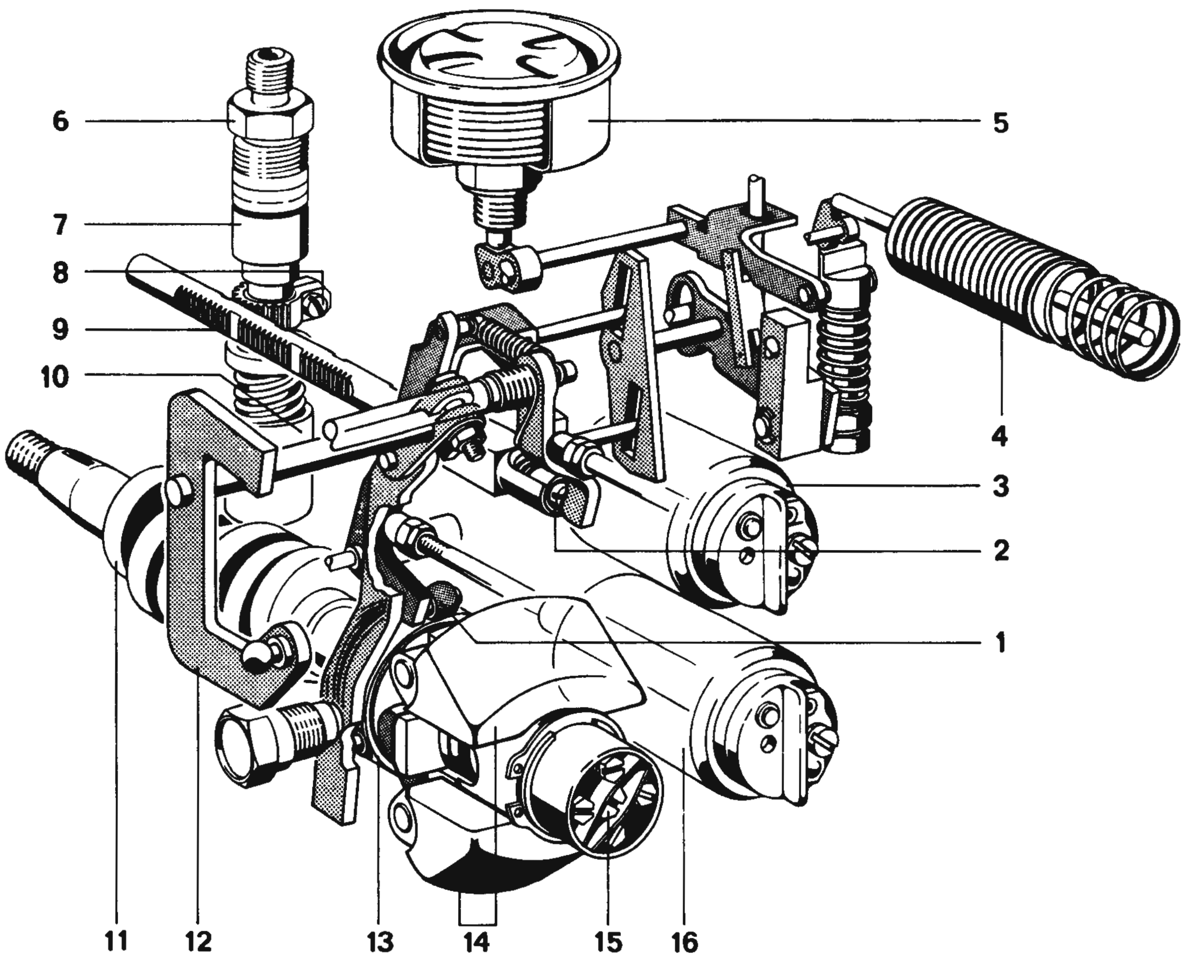


1 Pump cylinder
2 Pump plunger
3 Metering land
4 Oval orifice
5 Cross-slot
6 Inlet port

2. Control and Compensating Units

a. Control Unit:

To obtain the required air fuel mixture ratio, the engine must be supplied with different quantities of fuel under varying engine speed and loads. The engine performance graph illustrates the fuel quantities required under various operation conditions. This performance graph is represented by a contoured cam which is mounted on the cam shaft together with a centrifugal governor. The contoured cam can be moved axially by the centrifugal governor and rotated on its axis by the accelerator pedal in relation to given engine loads. Riding on the contoured cam is a sensor (roller) which transfers the appropriate fuel valume requirements to the control rack via a guide lever.



1 Sensor on contoured cam
2 Control rack head
3 Enrichment solenoid
4 Thermostat
5 Barometric cell
6 Check valve
7 Plunger unit
8 Toothed segment
9 Control rack
10 Roller tappet
11 Camshaft
12 Governor control lever
13 Contoured cam
14 Centrifugal governor
15 Idle adjusting screw
16 Shut-off solenoid

b. Compensating Unit:

Changes in air pressure and temperature require continued corrections in fuel metering. In addition, a supplemental mixture enrichment for cold and hot starting must be taken into consideration. This requires the following compensating units:

1. Barometric Cell: To compensate for changes in air pressure.
2. Thermostat: To compensate for varying engine operating temperatures (quantities required during engine warm-up).
3. Enrichment Solenoid: To enrich the combustion mixture in cold and hot starting (controlled by the thermo-limit switch and time-limit relay).
4. Shut-off Solenoid: For stopping fuel delivery from the injection pump when coasting in gear (controlled by the throttle valve microswitch and rpm transducer).

All corrective action indicated by the compensating devices is transfered to the control rack by means of connecting levers which cause the rack to slide forward or backward. The resulting rotation of the plungers in the pump cylinders changes the quantity of injected fuel.

1. Barometric Cell

The barometric cell works in the same way as a barometer. When the aneroid mechanism expands, a pin transfers the action to the compensating mechanism by means of a lever. This movement corrects the given position of the control rack so that the quantity of injected fuel is increased at high air pressures, and reduced when the pressure drops, such as in changing weather or when driving in the mountains. The barometric cell is a sensitive precision instrument and should be handled with care to prevent any damage. It cannot be replaced without adjusting the injection pump on a Bosch-Service test stand.

2. Thermostat

The thermostat is mounted on the control unit housing and responds to engine cooling air which comes from a heat exchanger and is ducted to the thermostat through hoses. The thermostat consists of several heat expansion elements which cause a certain amount of mechanical movement. A connecting lever transfers this movement to a compensating mechanism which, in turn, corrects the position of the plunger control rack. When the engine is cold, the control rack is moved into the "full load" position to appropriately enrich the combustion mixture. Increasing engine temperature progressibely reduced fuel enrichment. The thermostat does not influence the control rack position after a temperature of +45°C/+113°F has been reached (+53°C/+127°F for 1970 Models).

3. Enrichment Solenoid

Full mixture enrichment is required for starting the engine. For this reason, the enrichment solenoid has been incorporated in the fuel pump and acts directly on the plunger control rack, moving it beyond the full-power position with plunger aligning for starting-rate fuel delivery. The solenoid energizing circuit includes a time-limit relay and a thermo-limit switch. The time-limit relay closes the solenoid circuit for 2 seconds during each starting procedure, without regard to the air temperature in the crankcase. A thermo-limit switch keeps the energizing circuit closed over an appropriately longer period of time when the temperature ranges between $+10^{\circ}C$ $(+50^{\circ}F)$ and $-25^{\circ}C$ $(-14^{\circ}F)$. When the air temperature in the crankcase drops to between $-10^{\circ}C$ $(+14^{\circ}F)$ and $-30^{\circ}C$ $(-22^{\circ}F)$, an additional thermo-switch activates a supplemental cold-starting device.

The above described enrichment solenoid, the 2 second time limit relay, as well as the two thermo-time switches are no longer used on the 2.2 liter fuel injected engine.

The supplementary starting equipment is controlled by a new thermo-time switch, which is housed in the breather cover. During the starting operation, the cold starting device is turned on up to a temperature of $+45^{\circ}C$ $(+113^{\circ}F)$.

4. Shut-off Solenoid

Function of the shut-off solenoid is to move the plunger control rack to the "off" position and close the fuel delivery to the engine when the car is coasting in gear. The shut-off solenoid is controlled by a mircoswitch and an rpm-transducer. The microswitch is mounted on the intake stack and is actuated by the throttle valve linkage. The rpm-transducer closes the circuit when engine speed exceeds 1500 rpm. When the throttle is closed, the microswitch closes the circuit and current can flow from the rpm-transducer through the microswitch and on to the shut-off solenoid. This energized the solenoid and causes it to pull the control rack to the "off" position, stopping the flow of fuel to the engine. When the engine speed drops below 1300 rpm, the rpm-transducer interrupts the flow of current, causing the shut-off solenoid to return into its inactive position and release the plunger control rack. As a result, fuel flow to the engine is resumed, permitting the engine to idle when the vehicle is stopped. If the engine speed is again increased, the rpm-transducer becomes reactivated at 1500 rpm. However, the solenoid circuit will be interrupted by the mircroswitch. The rpm-transducer receives its control impulses from the ignition coil.

General

The fuel injection pump can only be adjusted with an exhaust emission analyzer. During the emission test, the CO components in the exhaust gases are measured.

The CO rating is also influenced by the general engine condition (timing, valve clearance, compression, spark plugs, etc.), by proper correlation of the throttle valves and injection pump, the operating temperature and the intake air temperature. Incorrect measurements will result if these conditions are not within tolerances.

Adjusting

1. Incorrect valve clearance will change the valve timing and thereby the fuel supply to the cylinders. The valve clearances should, therefore, be checked and adjusted if necessary (0.10 mm/0.004 in.) before making the exhaust emission test.

2. Make compression check between +60 and +80^{o}C (+140 and 176^{o}F). The compression should be the same for all cylinders from 9 - 11 kp/cm^{2} (128 - 156 psi). The cylinder leakage should not exceed 10 % per cylinder. Larger deviations will influence the quantity of intake air considerably even though the quantity of injected fuel will remain the same for all cylinders.

3. Adjust dwell angle and timing before making exhaust emission test. Adjust the dwell angle to 38^{o} $\pm$ 3^{o} at idle speed and the timing to 30^{o} BTDC at 6000 rpm.

Adjusting End of Delivery Stroke

1. Bring number 1 piston to Top Dead Center of compression stroke, then turn one complete revolution (360°) in the direction of engine rotation.
   Continue turning slightly beyond the Top Dead Center mark, approximately 40°, and align the "F - E" mark on the camshaft pulley with the notch in the blower housing.

2. The pump is then properly timed if the marking on the hub of the belt pulley lines up with the mark on the pump bearing cover. Check mark alignment with a mirror.

   If the marks do not line up the pump must be loosened, the spur belt removed and the camshaft pullex repositioned. By loosening the 3 socket head bolts, fine adjustments can be made.

3. Check correlation of throttle valves in relation to each other and in relation to the control lever of the injection pump.

4. Check function of fuel delivery pump (fuel pressure, fuel flow rate), the enrichment solenoid and shut-off solenoid (relay, thermo-time switch).

5. Check warm air supply hose to thermostat to ensure unrestricted air flow.

General

To obtain a constantly correct air fuel ratio under all operating conditions of the engine, the movements of the accelerator pedal are transmitted to the control lever of the injection pump and to the throttle valves by means of a linkage. The pump control lever regulates the quantity of fuel, the throttle valves control the quantity of intake air.

The movements of the pump control lever and those of the throttle valves should therefore always be in a definite ratio in relation to each other (correlation). Any change of the air fuel ratio results in irregular running of the engine during acceleration, white shifting etc. Correlation is important for proper operation of the injection system.

Checking and adjusting

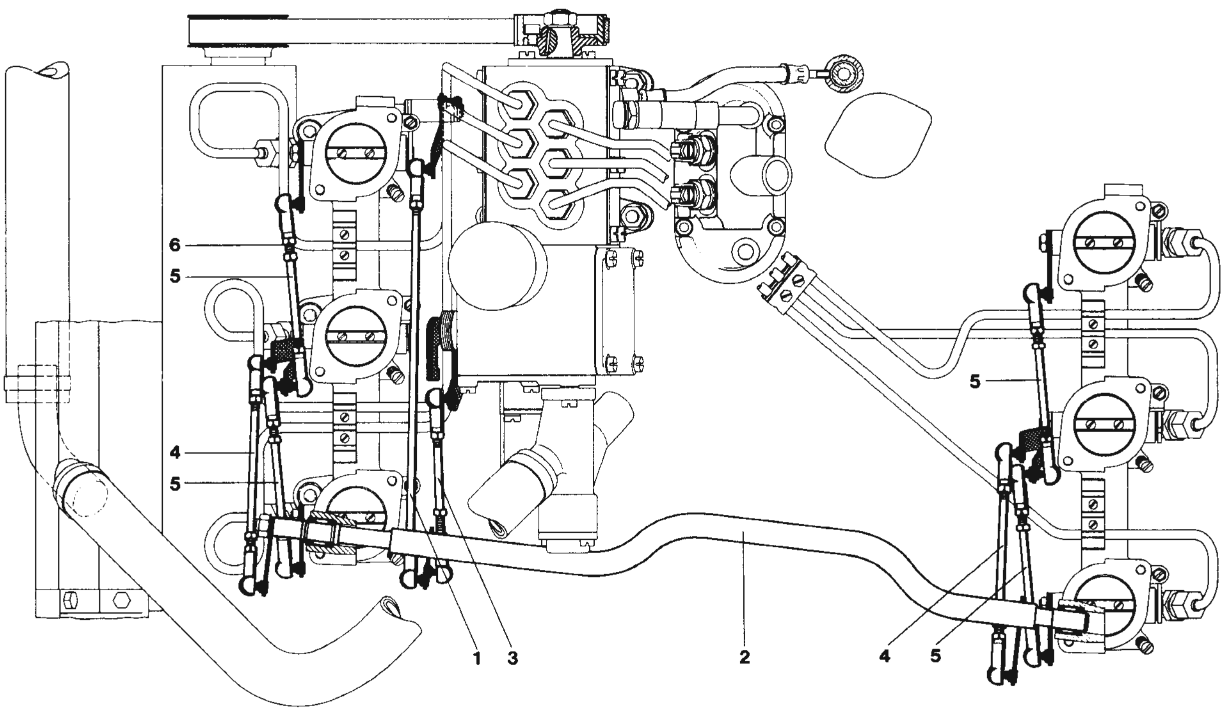
1. Adjust injection pump control lever to 114 mm ± 1 mm (4.49 in. ± .04 in.). Connect lever.

2. Adjust throttle valve push rods to 149.5 ± 1 mm (5.89 in. ± .04 in.). Connect rods.

3. Adjust pull rod which connects to the accelerator linkage bell crank with the cross shaft to a length of 275 mm (10.83 in.). Connect rod.

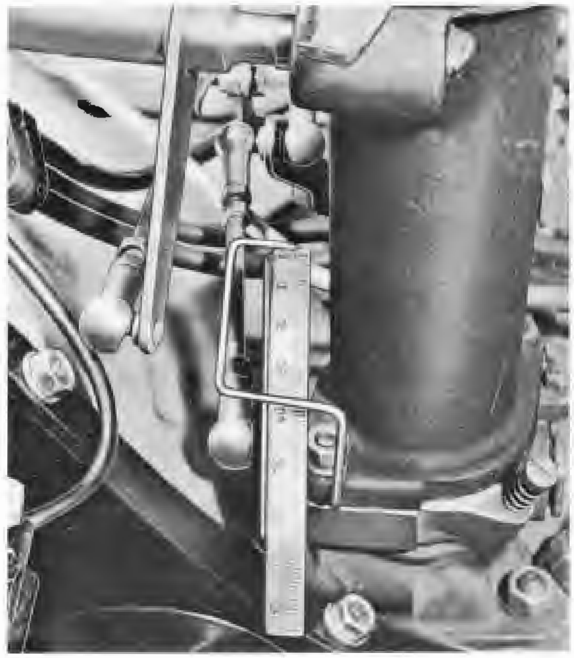
Note:

Dimensions are from ball head center to ball head center. If the permissible tolerance is insufficient, check that the operating lever of the cross shaft or the throttle valve push rods are not bent.



1 Pull rod
2 Cross shaft
3 Injection pump control lever
4 Throttle valve push rod
5 Throttle valve connecting rods
6 Paint seal

4. Check whether hand throttle lever rests against the bottom stop.



5. To adjust and correlate the linkage use special tool P 228b which consists of three protractors and three pointers.

6. Attach pertinent pointer using left upper faste fastening screw of enrichment solenoid.
Since there is no enrichment solenoid on the 2.2 liter engines, the pointers for the protractors of the fuel pump control lever can no longer be attached as before. A new pointer which can be made from brass is, therefore, attached to the upper left screw of the injection pump cover.

7. Attach protractors to the left and right rear throttle connecting rod valve levers. Then attach pointers to intake pipe studs.

8. Set pointers on the three scales to 0^o.

9. Actuate linkage manually and compare the readings with the values shown in the table.

Protractor at Pump	Protractor at Throttle valve	Max. deviation
0^o	0^o	$0,5^o$
5^o	3^o	
10^o	6^o	
15^o	$9,5^o$	
20^o	$13,0^o$	
30^o	$21,0^o$	
40^o	$30,0^o$	$\pm 1^o$
50^o	$40,5^o$	
60^o	$52,0^o$	
70^o	$65,0^o$	
79^o-82^o	80^o-85^o	Full throttle position

10. After adjusting linkage correlation, check hand throttle adjustment. With the engine warm and the hand throttle lever fully pulled, an engine speed of 4000 rpm should be obtained.

11. Set accelerator pedal to full throttle position with the pump lever on the pump approximately 1 mm (0.04 in.) away from its full load stop. Make necessary adjustments on accelerator pedal stop screw.

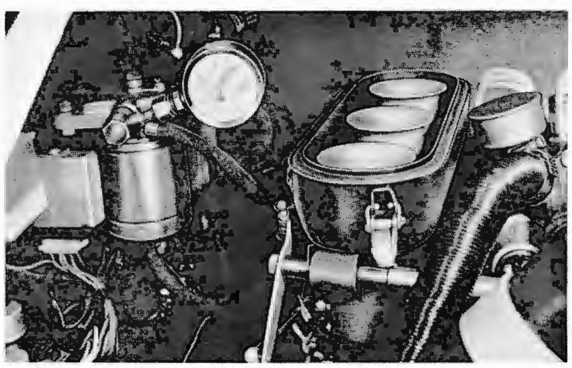
Description and Test Values of Fuel Delivery Pump

The roller-cell type fuel pump has a delivery capacity of approximately 110 liters/hr (29 gal. per hr.) up to 125 liters/hr (33 gal. per hr.). This delivery capacity is several times the amount of actual fuel consumption and is necessary to keep the fuel temperature in the injection pump as low as possible. The fuel delivery pump delivers the fuel via a fuel filter to the injection pump. The delivery pump is mounted by a bracket to the support member under the fuel tank.

The excessive fuel flows back to the tank via a return line. An overflow valve in the fuel filter will establish a pressure of 0.8 ± 0.2 atm (11.8 ± 3.0 psi) in the fuel system. When the pressure increases above approximately 1 atm (14 psi) some of the fuel is returned to the fuel tank via the bypass valve installed in the fuel pump. The bypass valve operates independent of the overflow valve.

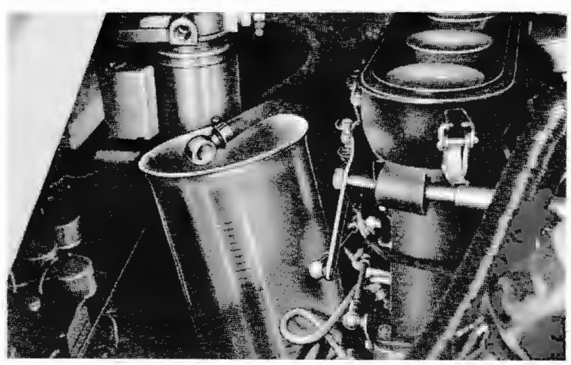
1. **Checking Fuel Deliver Pump Pressure.**
   Loosen hollow bolt on filter of injection pump return line.

   a. Attach pressure gauge special tool P 233b together with return line to fuel filter (long hollow bolt).



   b. Turn on ignition and read fuel pressure on pressure gauge. If the pressure is below 0.8 ± 0.2 atm (11.8 ± 3.0 psi), the filter must be replaced. If the specified pressure is still not attained, check the overflow valve, as well as the fuel pump electrical connection.

2. **Checking the Fuel Quantity Delivery by the Fuel Pump.**
   Loosen hollow bolt on filter of injection pump return line. Hold line into a 1000 cc measuring beaker.



a. Turn ignition on for 30 seconds; the delivered quantity should be 900 - 1000 cc. If this value is not attained, perform steps 1a and 1 b.

3. Checking Fuel Pump Current Draw.

a. Connect volt meter to pump and correct voltage. The voltage should be 11 volts ± 1 volt.

b. Connect ammeter to pump, turn on ignition. The current draw should be between 2.15 - 2.40 amps.

4. Checking Enrichment Solenoid.

a. Remove rubber cap on driving end of injection pump and insert a M 5x30 bolt into the plunger control rack. Pull control rack in driving direction. When released, the control rack should snap back to its original position.
If the control rack sticks or does not return to its original position, replace the injection pump.

b. Remove wires from enrichment solenoid. Connect a jump wire to fuse box terminal 15. While observing bolt M 5x30 touch solenoid with jump wire. The control rack should move in driving direction.

c. If the rack does not move, even though the rack is mechanically free, the enrichment solenoid must be replaced.
When replacing the enrichment solenoid adjust the plunger to the same length as the old solenoid.

d. As of model year 1970, fuel injected 2.2 liter engines do not have an enrichment solenoid. There are no threads in the control rack, therefore, a clean blunt tool must be used to push the control rack rearward (opposite to driving direction). When released, the control rack should automatically snap back to its starting position. If the control rack sticks or does not release to its original position, replace the injection pump. Reinstall rubber cap after check.

5. Checking the Time Limit Relay.

a. Connect test light to terminal on enrichment solenoid (other end to ground).

b. Start engine. The test light should stay on for two seconds. If not, replace time limit relay.

6. Checking the Thermo-Limit Switch.
Between -25°C (-14°F) to +2°C (+35°F) the thermo-limit switch will close the circuit to the enrichment solenoid for more than 2 seconds.

a. Connect test light to terminal enrichment solenoid.

b. Start engine. The test light should go on for more than two seconds.
Note!
The test can only be made at temperatures between -25°C (-14°F) to +2°C (+35°F).

7. Testing the Shut-off solenoid.
The test the shut-off solenoid remove the rubber cap on injection pump and insert a M 5x30 bolt into control rod.

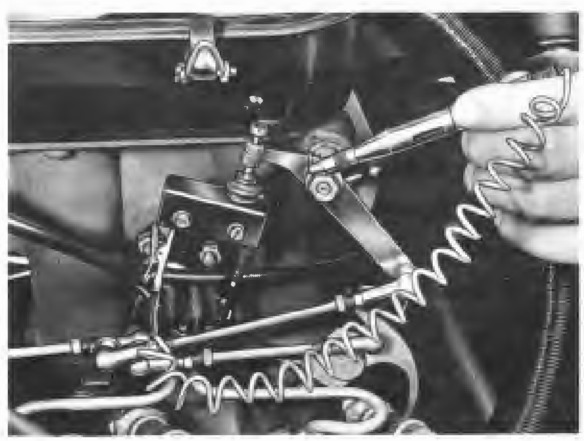
a. Start engine, run engine at 3000 to 4000 rpm, then decelerate. The control rod should move to the rear, i.e., opposite driving direction (zero delivery).

If the control rod does not move in the named direction, check rpm transducer and micro switch. If the switches are in order, replace shut-off solenoid.
This work can be done only by a qualified service shop.

8. Checking the rpm transducer (speed switch).

a. Connect test light to terminal 30b and ground.

b. Start engine and accelerate. The test light should go on at approximately 1500 rpm.



c. Decelerate. Test light should go out at approximately 1300 rpm. Replace rpm transducer if necessary.

9. Checking the Micro Switch.

a. Connect a hot wire to the terminal of the connection of micro switch.

b. Connect a test light from ground to terminal via a test lamp.

c. Turn on ignition and actuate switch. When pushing the actuating button, the test light should go on. The test lamp should go out when the actuating button is released. Replace micro switch if necessary.

10. Adjusting the Micro Switch.
The micro switch for interrupting the fuel supply under overrrunning conditions is adjusted as follows:

a. Release lock nut and loosen adjusting screw to the extent that the micro switch is not bridged in idling position.

b. From this position, turn adjusting screw down until the micro switch is barely bridged (audible clicking sound).

c. Turn adjusting screw in 1/2 to 3/4 of a turn and tighten lock nut.

Symptom	Cause	Remedy
Hard starting when engine is cold	Improper starting procedure	Pull hand throttle valve up to stop at all outside temperatures. Do not use accelerator pedal when starting vehicle. When the engine starts, run for a short period in the preset hand throttle position. Then step on accelerator pedal until engine is running at approximately 4500 rpm. Release accelerator pedal and push hand throttle lever back until engine runs at approx. 1200 - 1400 rpm. If the engine speed increases as the temperature increases, set the hand throttle lever back accordingly until it rests against the bottom stop. If the engine does not start after 10 - 15 seconds, wait for 10 seconds and start again.
	Enrichment solenoid does not activate. Starting relay defective, Time limit relay for enrichment solenoid defective or response period too short.	Check electrical connections and voltage. Replace enrichment solenoid starting relay, as well as time limit relay, if necessary.
	Thermo-limit switch for cold starting device at outside temperatures below $-10^{o}C$ ($+14^{o}F$).	Replace thermo-limit switch.
Hard starting when engine is hot	Improper starting procedure	Before starting a hot engine, the ignition should be turned on for approximately 5 seconds so that any vapor that may have formed in the system will be flushed out. Depress accelerator fully while starting.
	Enrichment solenoid does not activate.	Check connections and voltage on enrichment solenoid.
	Starting relay defective	Replace starting relay.
	Control rod remains in starting position.	Check to see that control rack is released after approximately 2 seconds. Check relay, enrichment solenoid and time limit relay, replace if necessary.
	Time control switch defective	Replace time control switch.

Symptom	Cause	Remedy
Rough engine idle	Idle air control on throttle valve housing incorrectly adjusted.	Adjusting air control screws with synchrometer P 235 (at 3000 rpm).
	Timing off.	Adjusting firing point (idling speed 0° to -2°, at 6000 rpm 30° - 32°).
	Restricted warm air flow to thermostat (engine excessively oily).	Eliminate restriction in lines, replace lines.
	Thermostat on injection pump defective (engine excessively oily).	Replace thermostat.
	Injection valves defective	Check injection jet, replace valve if necessary.
	Compression of individual cylinders varies	Check compression or pressure loss and make required adjustment.
	Cold weather starting device does not shut off.	Check cold weather starting device.
Engine won't start	Fuel delivery pump inoperative	Check power supply, replace pump if necessary.
	Fuel delivery pump running but with insufficient or no delivery	Check hose connections (suction-pressure-bypass), check voltage and current draw on electrical connections. Check fuel filter, replace if necessary.
	Starting relay defective	Replace starting relay
	Thermo-time switch defective	Replace thermo-time switch
	Control rack stuck	Replace injection pump
	Time limit relay switch defective	Replace time-limit relay
Engine won't start at temperatures below -10°C	Cold starting device not operating	Check electrical connections, check voltage on electrical connections.
Engine misfires	Ignition system not in order	Check ignition system
	Fuel filter contaminated	Replace filter element

Symptom	Cause	Remedy
	Injection valves not in order	Check injection valves, replace if necessary
	Insufficient delivery of fuel delivery pump	Check delivered quantity, check hose connections as well as electrical connections on pump, install new pump if necessary
Poor transition during acceleration with warm engine (jerking and backfiring)	Injection pump adjustment not in order	Check adjustment with exhaust gas tester, adjust if necessary
	Improper linkage correlation	Check coordination and linkage correlation, adjust if necessary
Backfiring under overrunning conditions	Throttle valve housing not synchronized	Synchronize throttle valve housing with synchrometer P 235
	Micro switch out of adjustment	Adjust micro switch, replace if necessary
	Rpm transducer defective	Replace rpm transducer (speed switch)

Removing Injection Pump

1. Disconnect battery.

2. Remove air filter.

3. Set engine to end of delivery stroke (F-E) by bringing number 1 piston to TDC of compression stroke and then turning one complete revolution (360°) in the direction of engine rotation. Continue slightly (about 40°) beyond the TDC mark and align the "F-E" mark on the crankshaft pulley with the notch on the blower housing.

4. Disconnect wires from micro switch.

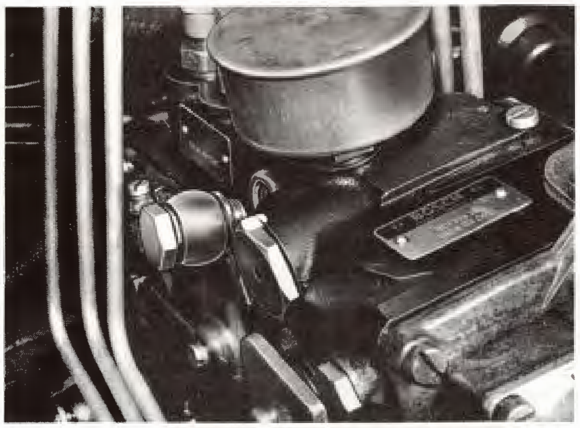
5. Remove wires from enrichment and shut-off solenoids (grey wire = enrichment solenoid; grey - red wire = shut-off solenoid).

6. Loosen warm air supply hose to thermostat.

7. Disconnect injector lines at injection pump, prevent lines from turning by using a 19 mm flare nut wrench on line pressure fittings.

8. Disconnect fuel inlet line on right side of injection pump.

a. Disconnect return line on left side of injection pump.



9. Detach oil inlet and return lines.
When disconnecting the inlet (lower) line hold fitting with wrench. Loosen clamp on return line and pull line from connection.

10. Remove linkage between guide shaft and governor.

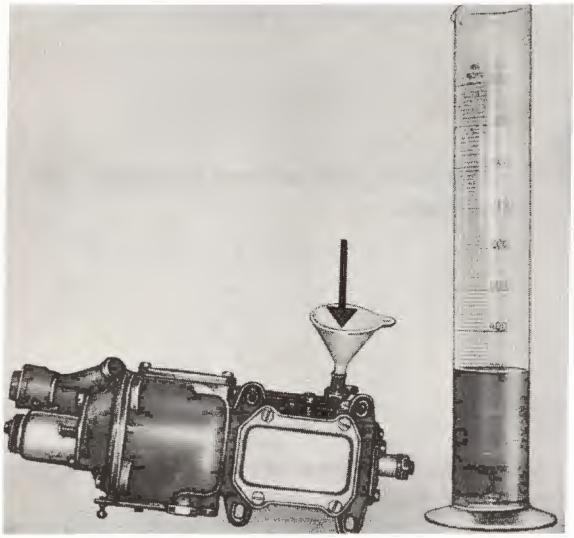
11. Remove injection pump retaining nuts on pump base with special tool P 120b.

12. Push spur belt off pump drive wheel. Secure spur belt (use rubber band) so that it does not fall off the driving wheel at the engine camshaft.

13. Remove injection pump from mounting bracket and lift out.
Note!
Do not lift pump by the barometric cell to prevent damage to unit.

Installing Injection Pump

1. Before installing injection pump place pump on side and fill through oil return flow connection (top hole) with approximately 300 cc (10 fl. oz.) oil (same as used in engine).

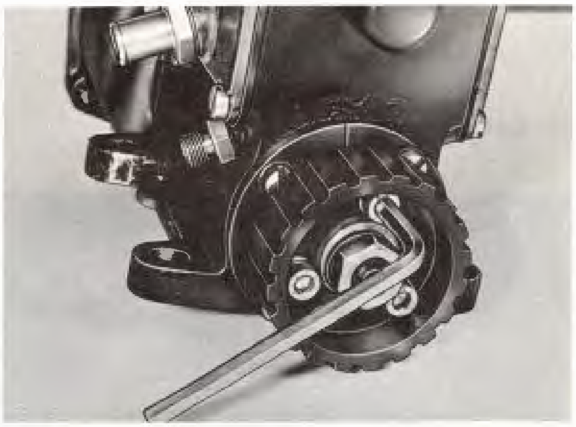


2. Set injection pump to end of delivery stroke (F-E mark). Align mark on crankshaft pulley with the notch on the blower housing.

3. Check F-E position of engine again.

4. After installing pump and tightening nuts slightly, push toothed belt on drive pinion. Be sure, that the delivery end is not misaligned.

5. If the teeth on the drive wheel do not mesh with those of the belt, remove the pump and reset the drive wheel by loosening the 3 Allen head bolts.

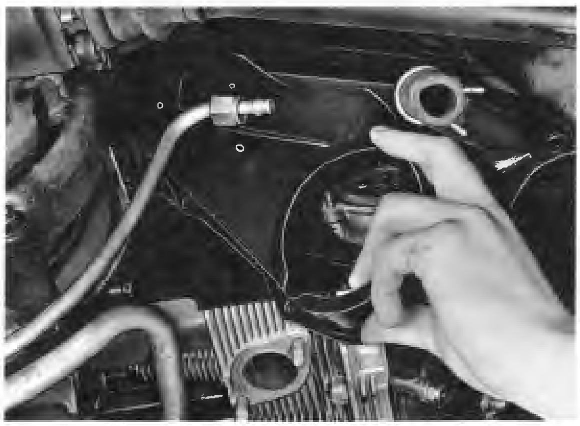


6. Slightly tighten pump retaining nuts. Push pump sideways, using special tool P 234b, until the spur belt is properly tensioned. With thumb pressure at the center, the belt should give 6 - 8 mm (1/4 - 1/3 in.).

1. Set engine and injection pump to end of delivery stroke (F-E mark).

2. Remove left heat exchanger.

3. Remove left front engine cover.



4. Loosen pump retaining nuts. Move pump to the left within range of oblong holes using special tool P 120b.

5. Remove belt from drive sprocket.

6. Install new spur belt. Slightly tighten pump retaining nuts. Push pump sideways, using special tool P 234b, until the spur belt is properly tensioned. With thumb pressure at the center, the belt should give 6 - 8 mm (1/4 - 1/3 in.).

7. Install cover plate and heat exchanger. Use new gasket.

Additional Steps for Replacing Spur Belt on Sportomatic Model

Removing

1. Remove pressure and suction lines on oil pump.

2. Remove oil pump mounting bolts and remove oil pump.

Installing

1. Use new gasket.

2. Mount cylindrical pin of oil pump shaft between clamping sleeves of camshaft.

3. Use new gaskets for heat exchanger and tighten fastening nuts alternately and uniformly.

ADJUSTING INJECTION PUMP WITH EXHAUST GAS ANALYZER

1. Bring engine to operating temperature, approx. +80°C (+175°F).

2. Connect the exhaust gas analyzer according to the manufacturer's instructions.

3. Attach tele-thermometer for intak air temperature.

4. Determine exhaust gas data by a driving test on the road or on a roller test stand.

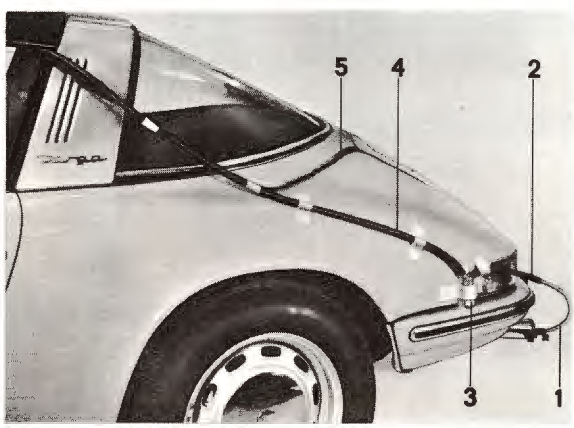
5. Determine exhaust gas data in partial load range at a throttle valve position of 7° and 2500 rpm in second gear. For adjusting data refer to tabel page SF 38 and 39.

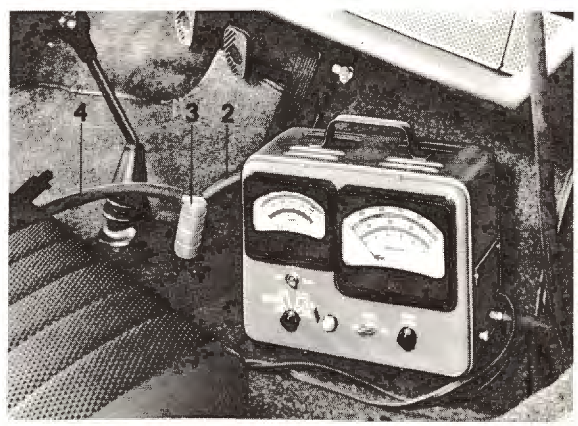
EXAMPLE OF DRIVING TEST WITH EXHAUST GAS ANALYZER SUN CCT 262

1. Insert flexible steel probe approximately 400 mm (15 in.) into muffler exhaust pipe.

2. Attach hoses and two water separators, refer to illustration.

3. Electrical connections of SUN tester: red terminal to live cable on fusebox; black cable to ground; blue cable to terminal 1 ignition distributor.

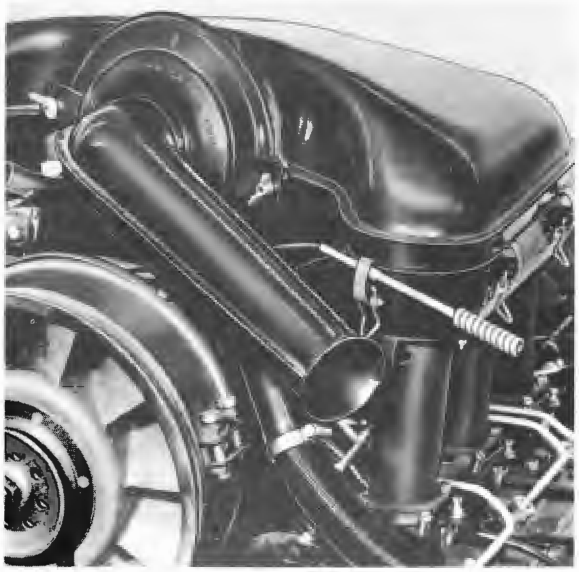




1 Flexible steel exhaust gas probe
2 Connecting hose, short
3 Water separator
4 Connecting hose, long
5 Cable for exhaust gas tester and thermometer

1 Hose to outside (unit-outlet)
2 Connecting hose, short
3 Water separator
4 Connecting hose, long

4. Attach tele-thermometer for intake air temperature (special tool P 237).



5. Attach protracter with pointer to left throttle valve lever. Set pointer to 0^o.
   Note!
   Hand throttle lever should be completely back.

6. Adjust hand throttle to 7^o, while actuating accelerator pedal several times to relieve tensions on the linkage.

7. Calibrate unit (with hose of probe removed).

8. Following the calibration, connect hose of probe to unit input, place hose from unit output to lead outside.

> Note!
> Be sure that exhaust gases do not enter the passenger compartment (danger of poisoning).

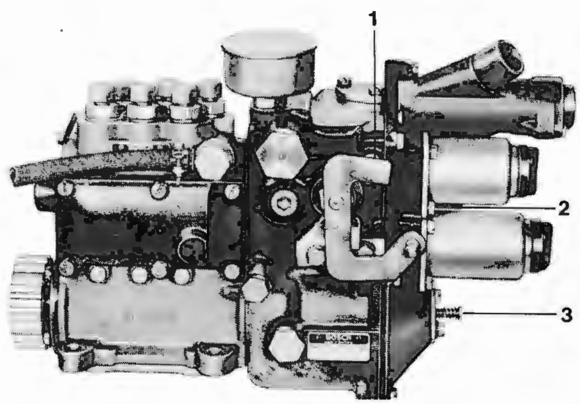
9. Run engine to operating temperature.

10. Shift to second gear, accelerate vehicle on road, brake engine with pedal brake until a speed of 2500 rpm is attained, Read exhaust gas data

11. If the exhaust gas readings are too high or too low, shift performance field on control rack head of injection pump.

Adjusting

a. Remove Allen head screw on inlet to control rack head.



1 Bolt 8 mm
2 Allen head screw at inlet of control rack head
3 Idle speed adjusting screw

b. Remove 8 mm bolt (transmission lever support) on the left rear housing of the injection pump to gain access to the adjustment screw inside the pump.
   Adjustment of the performance field is made with special screw driver P 229b.

c. Turn adjusting screw on control rack head with screw driver. Clockwise for "leaner", counter-clockwise for "richer" adjustment.

d. Depending on deviation from specified CO value, the adjusting screw should be shifted from 1 to 2 notches, then check exhaust gas values again during a driving test.
Note!
Tighten access bolt before starting engine (on 2 liter engines only).

Note!
Turning the adjusting screw on the control rack head will change the adjusted quantity of fuel and thereby the CO value in all ranges of the performance field. The idle speed adjustment should therefore be checked after each correction.

Adjusting Idle Speed

1. Run engine to operating temperature.

2. Check idle speed. If the idle speed is incorrect, adjust idle speed air screws on throttle valve housings accordingly. Turning in lowers idle, turning out increases idle. Then check air flow for individual cylinders at 3000 rpm, using synchrometer special tool P 235.

3. Connect exhaust gas analyzer and check CO content. If the CO quantity is not within specifications readjust idle speed injection quantity on pump.

4. For this purpose, stop engine, push elastic idle speed adjusting knob down with special tool P 230b until it locks.

5. For a leaner mixture turn adjusting screw counterclockwise; for a richer mixture turn clockwise.
Do not adjust by more than one notch at a time. Maximum of 3 notches may be adjusted toward either the right or left starting from the basic position.

6. Adjust idle speed again to specified value by idle speed air screws. Measure again with synchrometer for uniform vacuum in intake pipes.

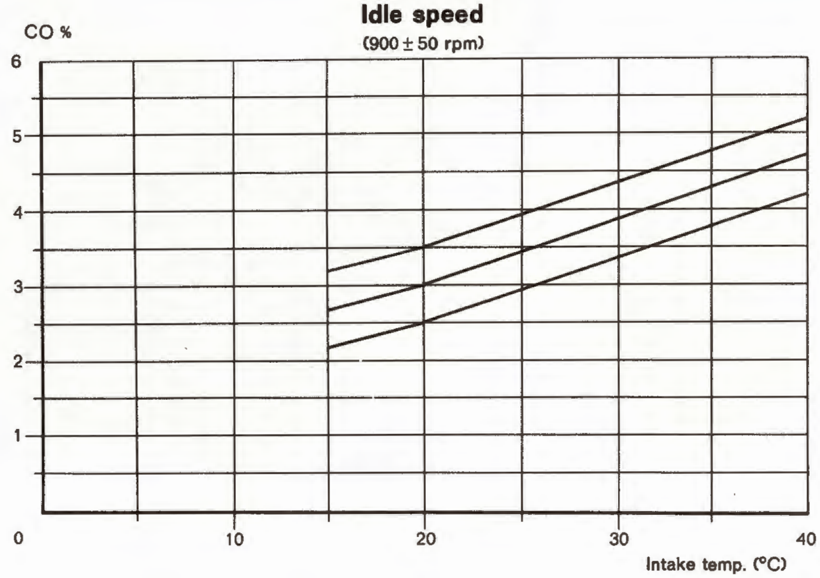
Note!
The adjustments in the partial load and idle range should be done as quickly as possible, so that the intake passages do not heat up. Prior to continuing exhaust gas measurements (road or roller test stand) drive vehicle for a short period or run at higher speed (approximately 3000 rpm), so that the intake passages will cool down.

Influence of intake air temperature on CO values

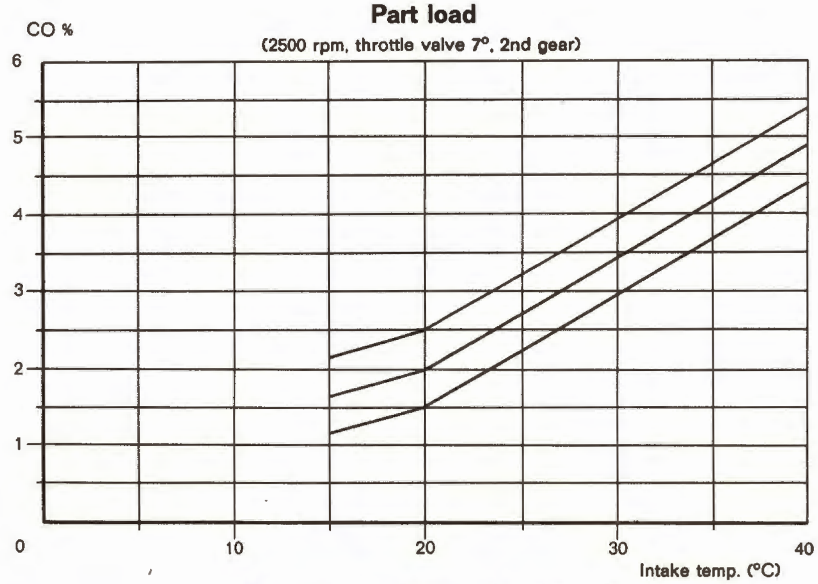
Oil temperature 80° C (176°F)

911 E

Idle speed
(900 ± 50 rpm)



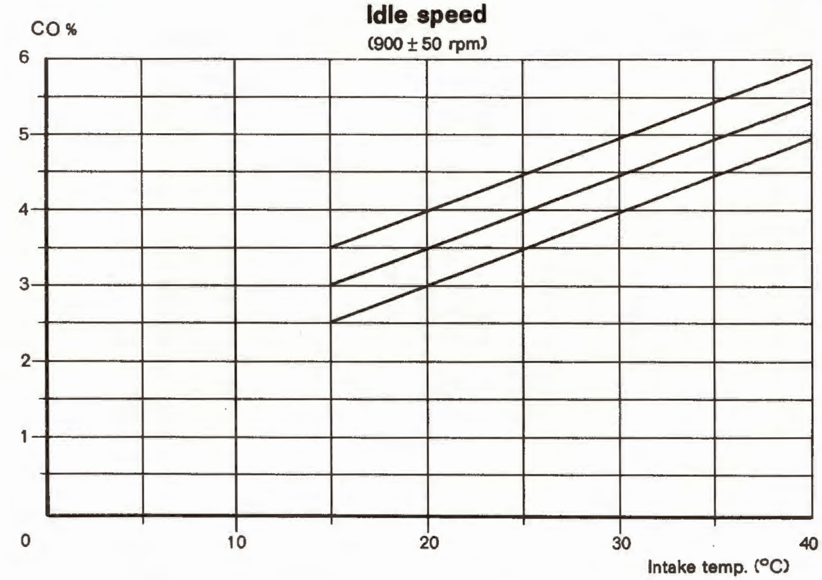
Part load
(2500 rpm, throttle valve 7°, 2nd gear)



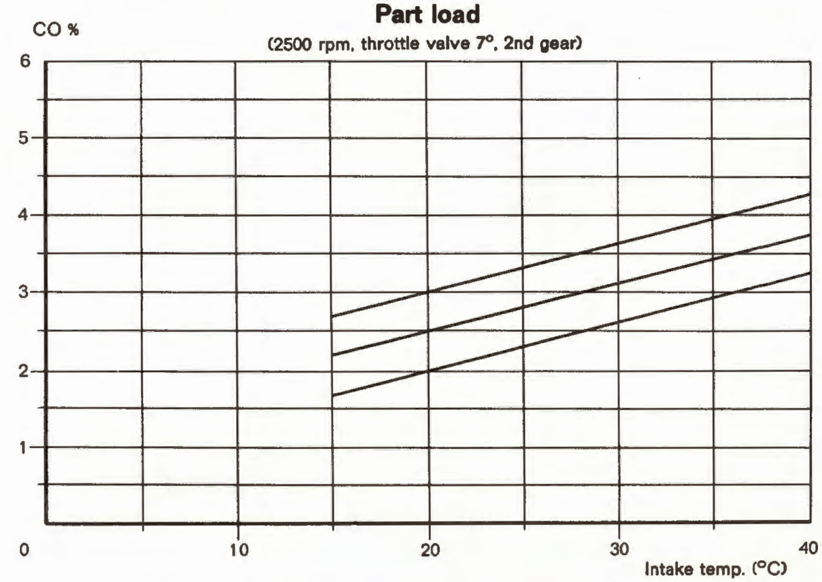
Full load, 3000 rpm, 4.5 - 6 % CO

911 S

Idle speed
(900 ± 50 rpm)



Part load
(2500 rpm, throttle valve 7°, 2nd gear)



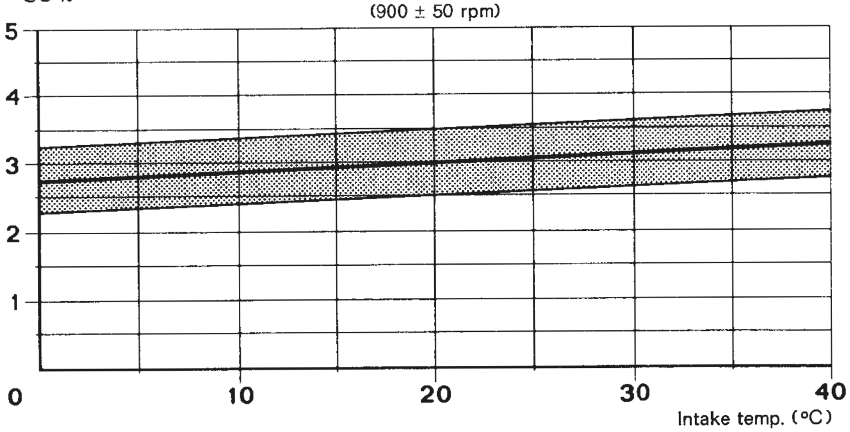
Full load, 3000 rpm, 5 - 6.5 % CO

Influence of intake air temperature on CO values of the 2,2 l engines

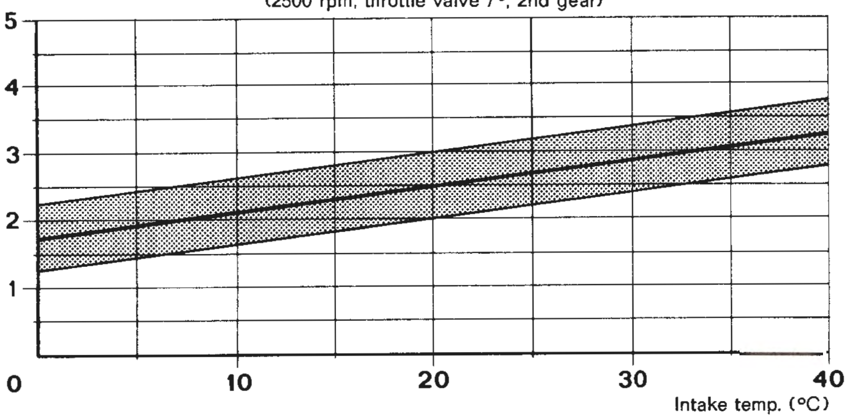
911 E-C Oil temperature 65 - 80° C (150 - 175° F) 911 S-C

911 E-C

Idle speed
(900 ± 50 rpm)

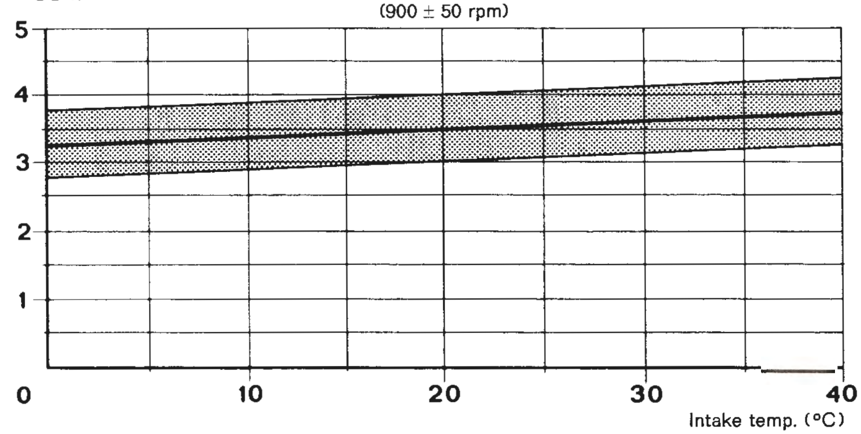


Part load
(2500 rpm, throttle valve 7°, 2nd gear)

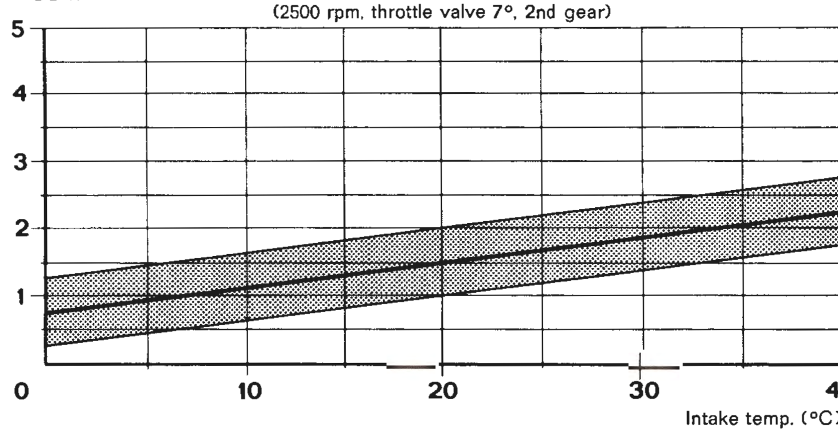


911 S-C

Idle speed
(900 ± 50 rpm)



Part load
(2500 rpm, throttle valve 7°, 2nd gear)



General

When the throttle valves are actuated, each intake pipe should have the same vacuum, so that each cylinder draws the same quantity of air.

If a cylinder draws in more air, this cylinder will have a leaner mixture. Since the same amount of fuel is injected into the cylinder, but the intake air volume is higher, the cylinder shows a backfiring and knocking tendency.

The air flow rate should therefore be measured with the throttle valves at partial load position. This requires the synchrometer special tool P 235. If the vacuum measuring instrument does not react when the air correction screws are turned, check and clean the air ducts in the throttle valve housing if necessary.

Adjusting

Measure as follows:

1. Run engine to operating temperature (60-80 $^{\circ}$C/ 140-176 $^{\circ}$F). Adjust engine speed with hand throttle to 3000 rpm.

2. Position rubber plug of measuring instrument in sequence on the individual intake funnels, read pertinent position of fluid column and record reading.

3. Add these values and divide by the number of cylinders (6). Then set each cylinder to this mean value by turning the air correction screws.

Synchrometer, Special Tool P 235

If no suitable nozzle tester is available, the injection vlave can be tested as follows:

1. Remove air filter.

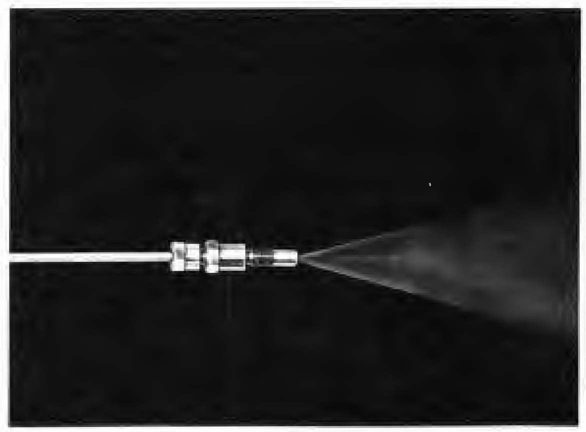
2. Loosen injection line on injection pump; present lines from twisting by holding a 19 mm flare nut wrench on line pressure fittings.

3. Remove injection valve to be tested from cylinder head and attach special tool P 236 to test line.

4. Connect test line to pump.

5. Run engine at idle speed and watch spray pattern of injection valve.
   The spray should be well atomized and uniform and should be a closed cone shape. A dripping, streaky and dispersed spray indicates that the valve is not in order.

   Replace injection valve, if necessary.



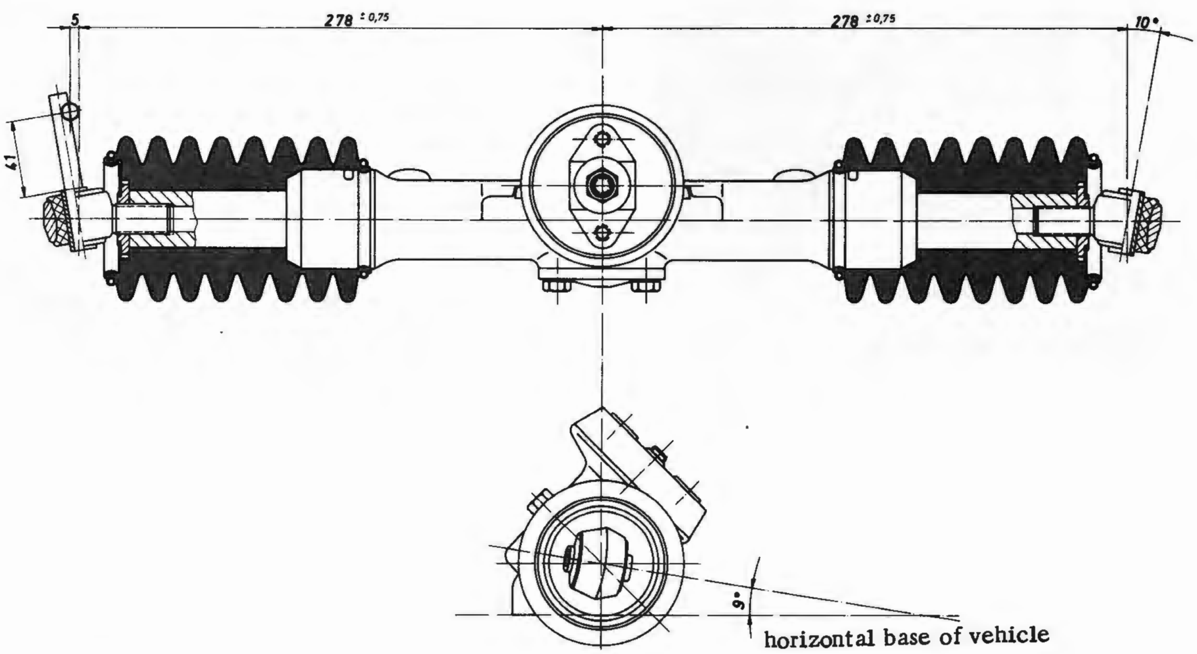
Note!
Danger of fire and injury. Catch dripping fuel, if required.

REMOVING AND INSTALLING JOINT BUSHING ON RACK AND PINION STEERING (FROM MODEL 70 ON)

Special tools:

P 285b Adjusting for steering gears

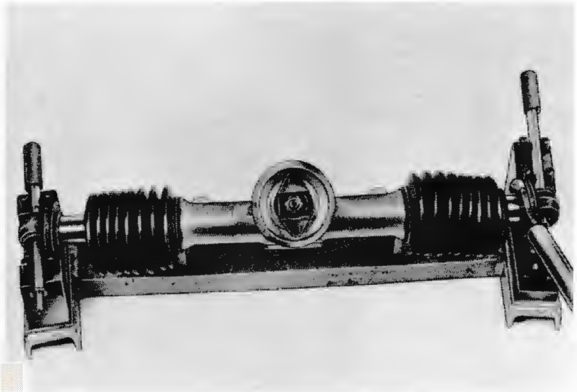
Note!
The measurements in the illustration below indicate the basic adjustments, which should be adhered to to ensure proper steering operations.



Removing

1. Clamp steering gear into special tool P 285b without 3 mm (0.12 in.) washers.

2. Remove spring clamp on outside of bellows. Pull bellows from holder. Loosen holder with 42 mm (1.65 in.) spanner wrench and unscrew joint bushing together with bellows holder.



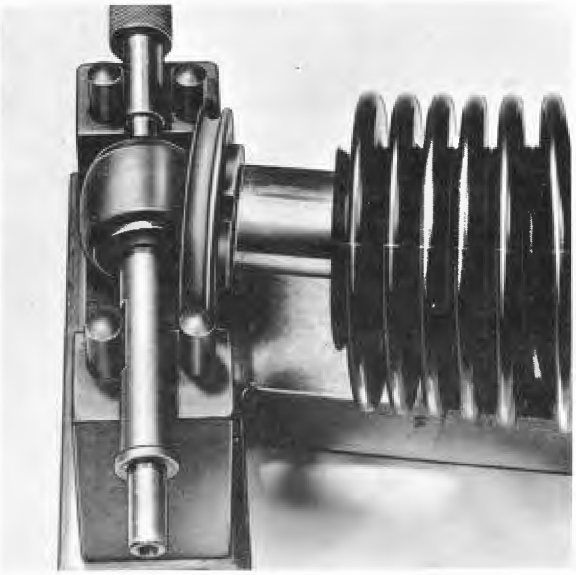
Checking Individual Parts

1. Check joint bushing for wear and replace if necessary.

2. Check bellows for cracks and leaks and replace if necessary.

3. Replace faulty spring clamps.

Installing



1. Mount both bellows on housing.

2. Screw bellows holder to joint bushings, coat threads of joint bushings as well as rack face end with sealing compound and mount together with joint bushings.

3. Attach steering gear to special tool P 285b without 3 mm washers. Locating bolts should easily slip into joint bushings with the flattened end of the locating bolts resting against the outer set pins with only slight clearance.

4. Tighten bellows holder (tightening torque approx. 7.0 mkp/50 ft.lbs.) and attach bellows to holder by means of holding spring.

CHANGES ON TRANSMISSION FROM MODEL 70 ON

From Model 70 on the following transmission types are installed as standard equipment.

Transmission Type 911/00 (4-Speed Transmission)

7:31 (11:34, 19:31, 25:26, 29:22)

For Vehicle Model: 911 T

Transmission Type 911/01 (5-Speed Transmission)

7:31 (11:34, 18:32, 23:28, 27:25, 29:22)

For Vehicle Model: 911 E and 911 S

Transmission Type 905/20 (Sportomatic Transmission)

7:27 (15:36, 20:31, 24:27, 28:24)

For Vehcile Model: 911 T and 911 E

Transmission Type 911/80/81/82/83/84 (5-Speed Transmission)

7:31 (14:37, 18:32, 22:29, 26:26, 28:23)

(12:34, 17:34, 20:31, 22:29, 23:28)

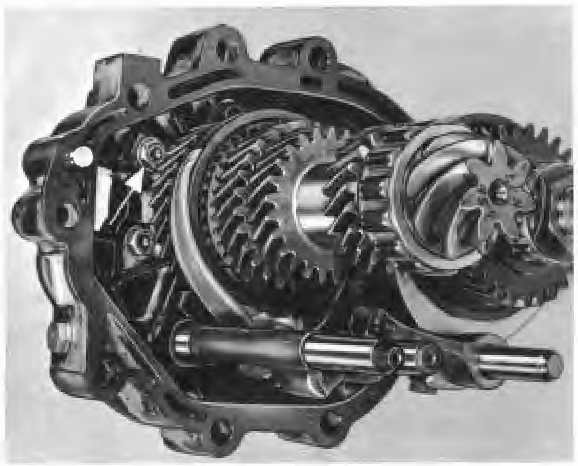
(12:34, 18:34, 21:31, 23:28, 25:26)

(15:36, 20:32, 23:28, 26:26, 28:23)

(14:37, 20:32, 22:29, 25:27, 27:25)

For Vehicle Model: 911 T, 911 E and 911 S (optional)

1. From model 70 on wider gear teeth are installed for 1st and 2nd gear. First gear width of teeth increased by 0.6 mm (0.024 in.); second gear width of teeth increased by 0.8 mm (0.032 in.).
   These gears can also be installed in former transmissions. On transmissions with pressure-cast housings prior to Model 70 - transmission type 902/14; 902/60; 902/16; 901/12; 901/13; 901/80; 901/81; 901/82; 901/83 and 901/84 - the wider gears may rub against the clamping plate or the fastening bolts of the clamping plate under load and unfavorable tolerance conditions.



If wider gears are installed in the transmissions named above, the following parts must be included:

Washer	Part number 901.301.255.13
Clamping plate	Part number 901.301.035.13
Discs	Part number 900.025.007.02
Cheesehead screws	Part number 999.509.010.00

2. The blueprint dimensions "R" for pinion shaft and ring gear adjustment for transmissions from Model 70 on were changed as follows:

Blueprint dimension "R" for manual transmission	63.20 mm/2.49 in. (formerly 63.50 mm/2.50 in.)
Blueprint dimension "R" for Sportomatic	54.20 mm/2.13 in. (formerly 54.50 mm/2.15 in.)

The deviation "r" is stated only in 1/100 mm + from now on as before on the pinion face. To prevent confusions, the deviation "r" + is now designated by the letter "N" ("N" means new).

Example:

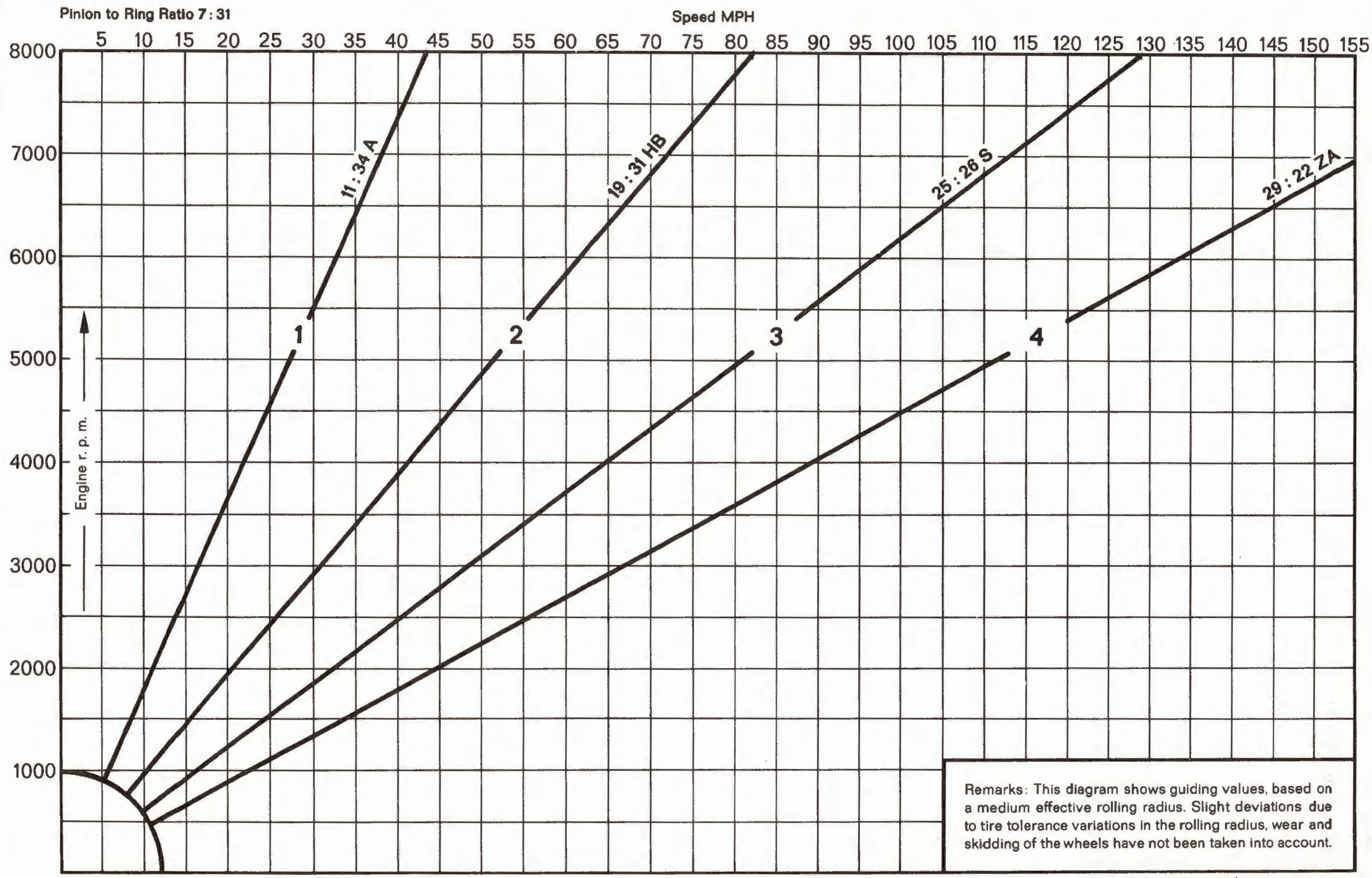
Blueprint dimension "R"	63.20 mm
Deviation "r" = N 18	+ 0.18 mm
Adjusting dimension (E)	63.38 mm

On pinion shaft ring gear sets which are obtained as spare parts and on which the deviation "r" is identified by the letter "N", the new blueprint dimensions "R" also apply and the deviation "r" is shown in 1/100 mm +.

PORSCHE

Transmission Diagram

(4-speed-transmission)



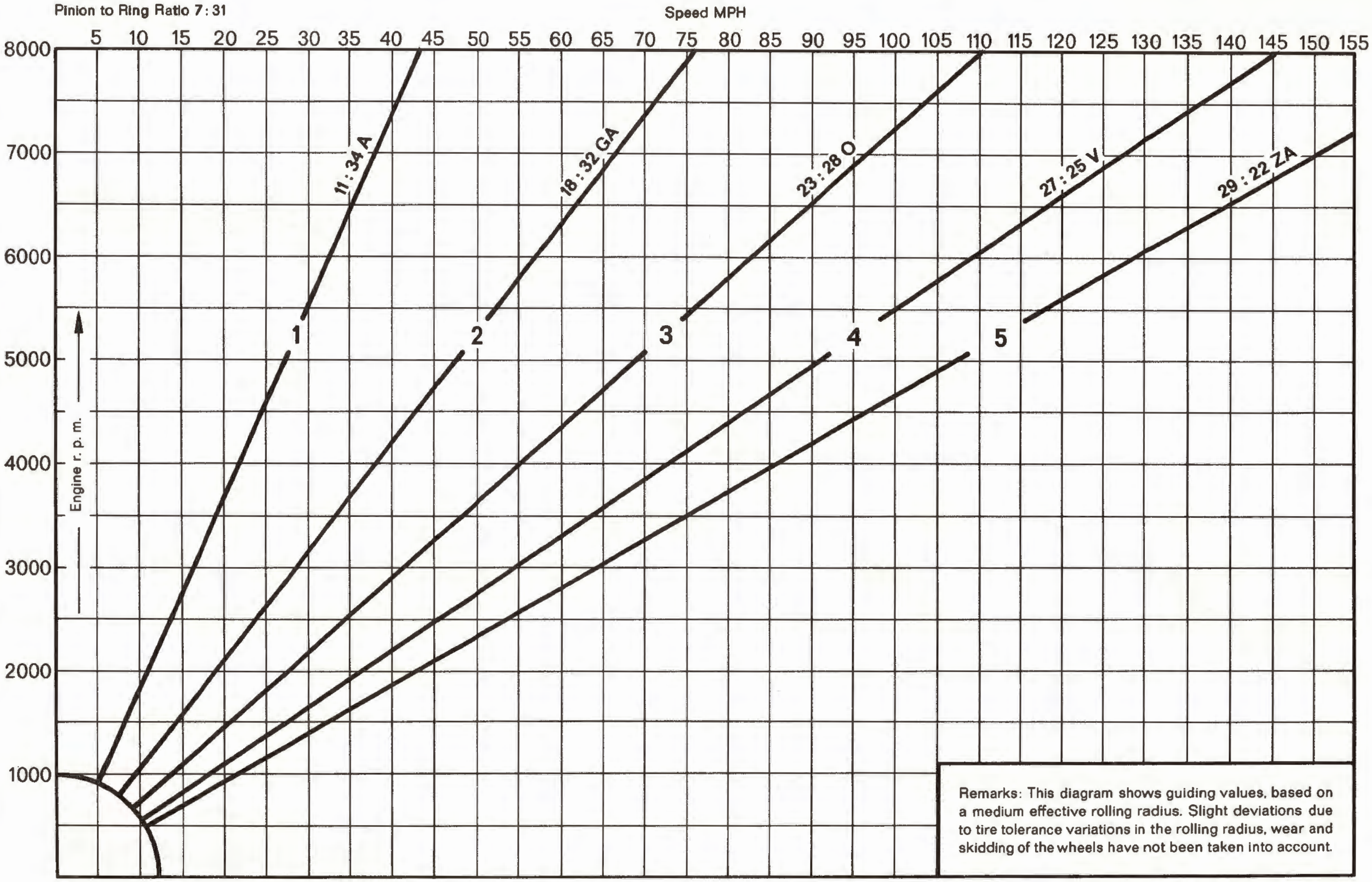
Remarks: This diagram shows guiding values, based on a medium effective rolling radius. Slight deviations due to tire tolerance variations in the rolling radius, wear and skidding of the wheels have not been taken into account.

Subject to change without notice

PORSCHE

Transmission Diagram

(5-speed-transmission)



Remarks: This diagram shows guiding values, based on a medium effective rolling radius. Slight deviations due to tire tolerance variations in the rolling radius, wear and skidding of the wheels have not been taken into account.

Subject to change without notice

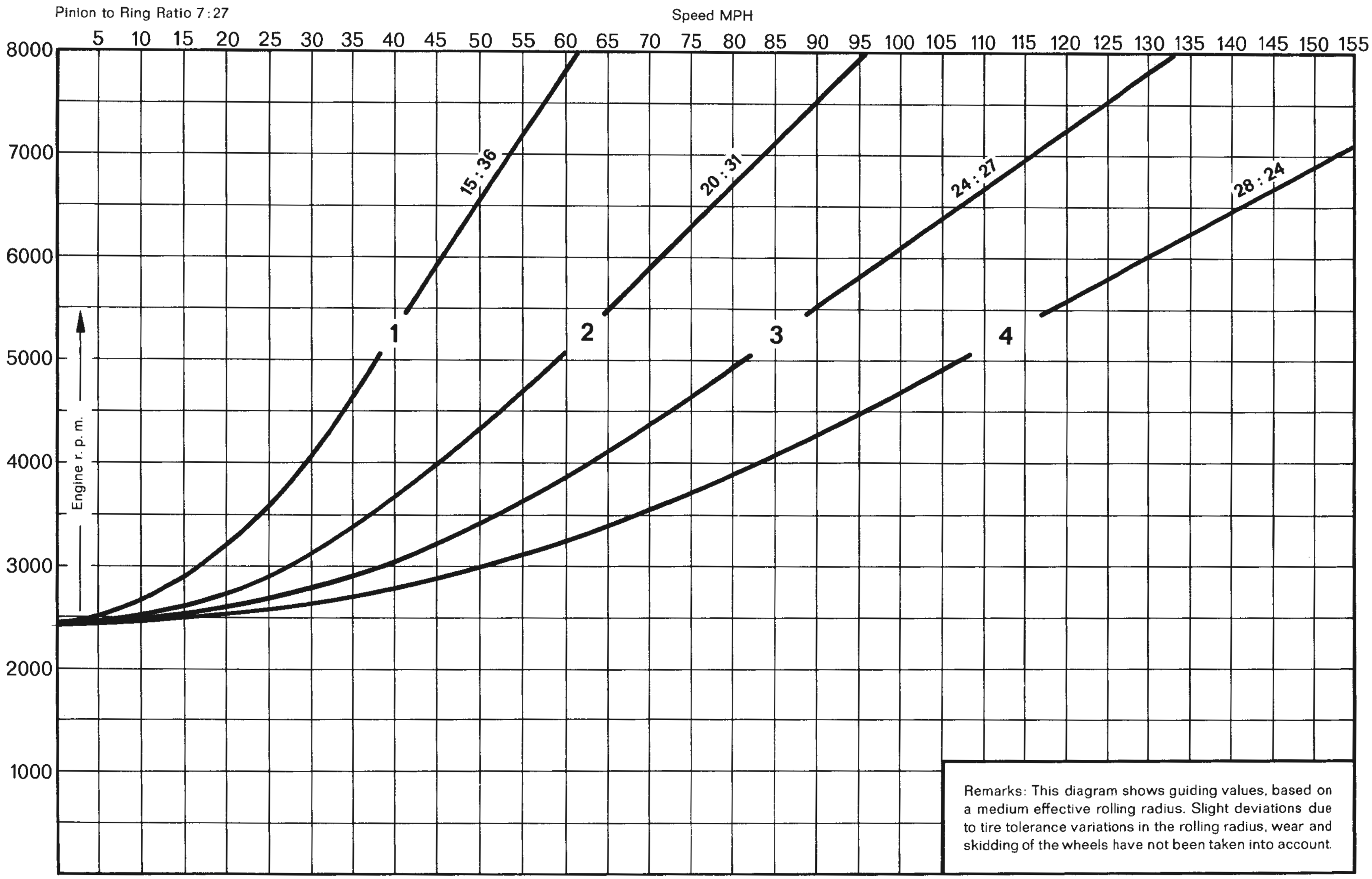
SR 163

SR 164

PORSCHE

SPORTOMATIC

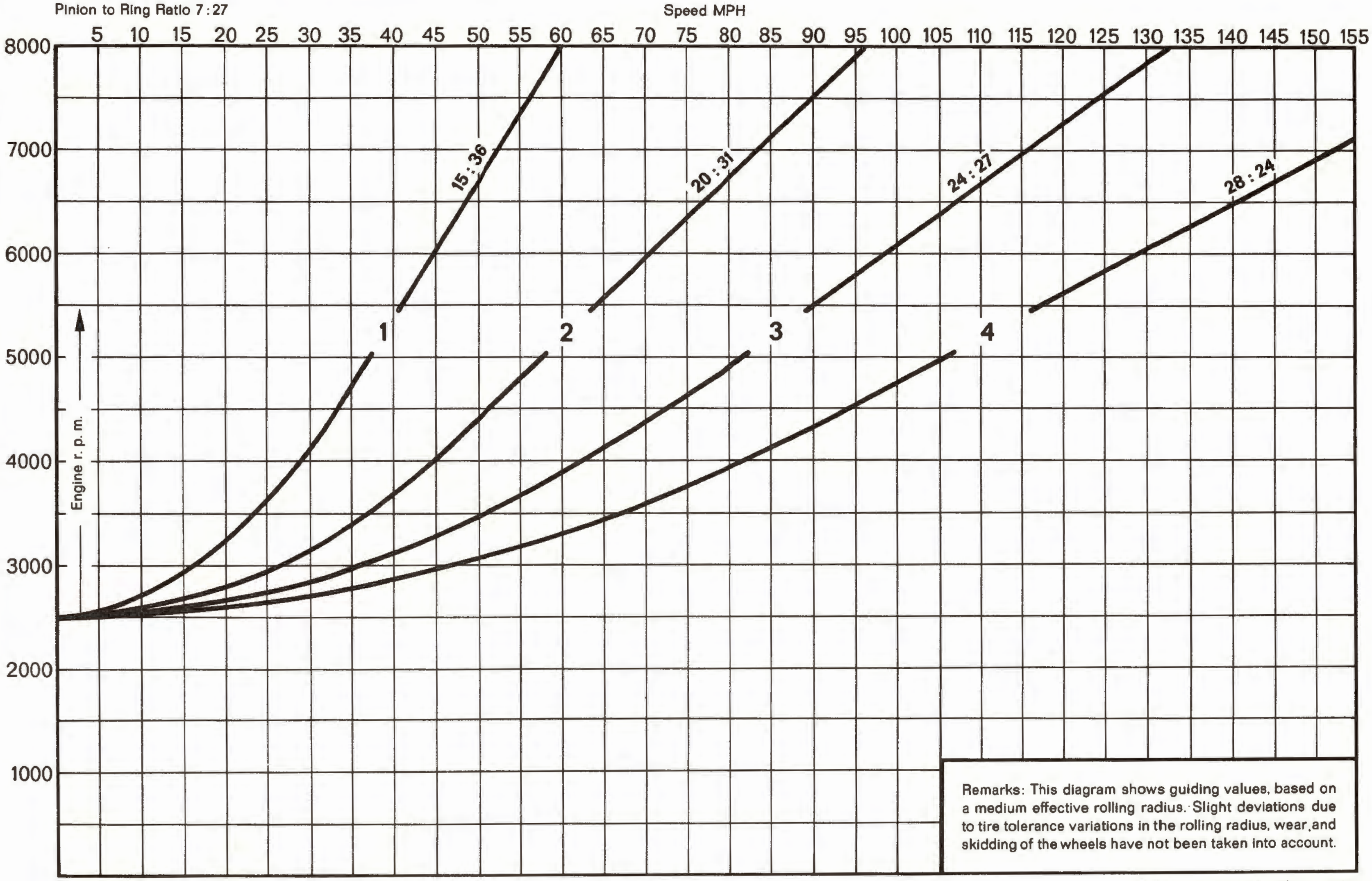
Type 911 T Transmission Diagram



Subject to change without notice

PORSCHE
SPORTOMATIC

Type 911 E Transmission Diagram



Remarks: This diagram shows guiding values, based on a medium effective rolling radius. Slight deviations due to tire tolerance variations in the rolling radius, wear, and skidding of the wheels have not been taken into account.

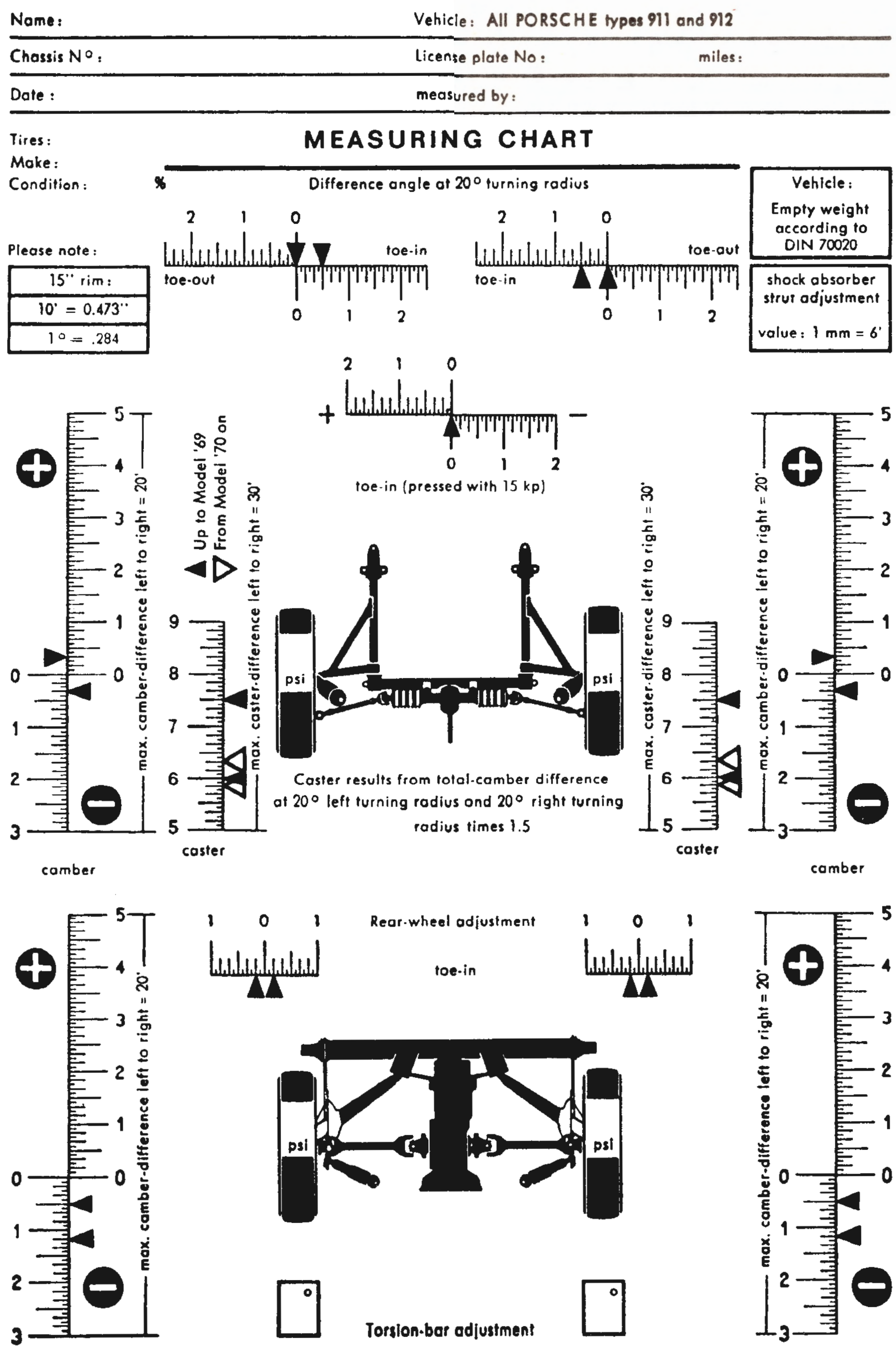
Subject to change without notice

SAMPLE OF DATA MEASURING CHART

(From Model 70 on)

General

The caster values of the front axle were changed from Model 70 on. The new data card shows the values up to and including Model 69 and from Model 70 on, so that the data card applies again for all Porsche Models 911 and 912.



4201.20 25 M II/70

Service Hints for Light-Alloy "S" Calipers

NOTE: Make sure that pistons do not cant in the light-alloy calipers when being pushed back. If resistance is met, first push the pistons out and then continue pushing back. To keep the pistons from coming out fully, place a piece of wood or a similar object between the piston and brake disc.

NOTE: Do not remove the caliper mounting plate or its retaining Allen head bolts from the light-alloy caliper. The caliper overhaul procedure remains unchanged.

A larger ATE 20° piston gauge, special tool P 84b, is required for adjusting the caliper pistons in light alloy calipers.

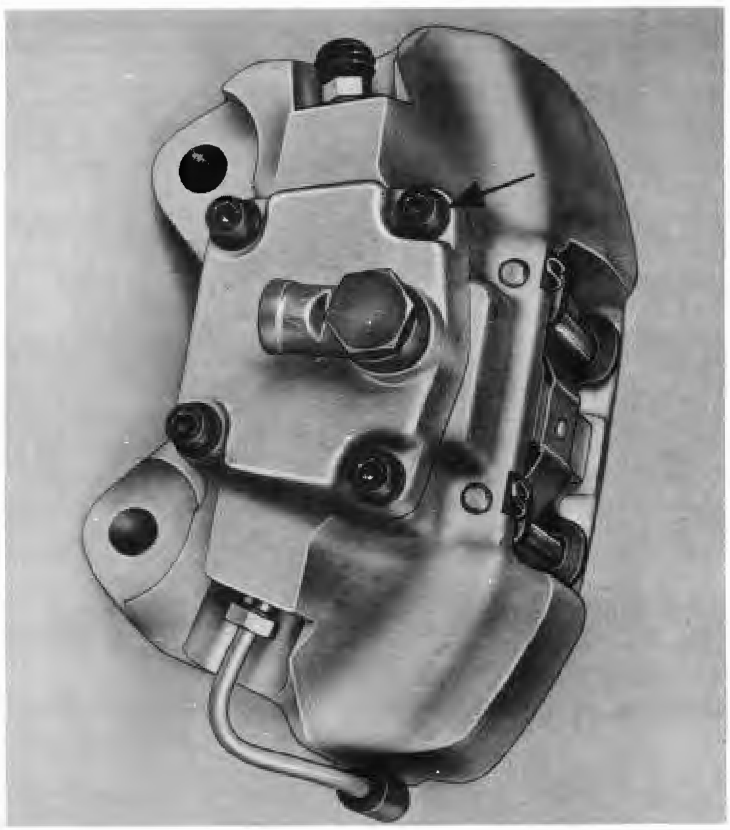


Fig. 1

Vehicle Model 911 T-C (incl. Sportomatic)

Technical Data

Brake discs OD front 282.5 mm (11.12 in.); rear 290 mm (11.42 in.)

Effective brake disc dia. front 235 mm (9.25 in.); rear 244 mm (9.60 in.)

Brake pad surface per wheel (pedal brake) front 52.5 sq.cm (8.14 sq.in.); rear 52.5 sq.cm (8.14 sq.in.)

Effective total brake surface (pedal brake) 210 sq.cm (32.55 sq.in.)

Effective total brake surface (hand brake) 170 sq.cm (26.35 sq.in.)

Hand brake drum dia. 180 mm (7.087 in.)

Brake pad width 25 mm (0.984 in.)

Master brake cylinder dia. 19.05 mm (0.75 in.); 18/13 stroke

Pressure cylinder dia. front 48 mm (1.89 in.); rear 38 mm (1.5 in.)

Front Wheel Brake

Design: Disc brake with vented brake discs

Major changes:

Vented brake discs

Grey-casting caliper "M" for vented brake disc

Rear Wheel Brake

Design: Disc brake with vented brake disc

Major changes:

Grey-casting caliper "M" for vented brake disc

Vehicle Model 911 E-C and 911 S-C

Technical Data

Master brake cylinder dia. 19.05 mm (0.75 in.); 18/13 stroke (formerly 20.64 mm (0.81 in.); 20/11 stroke)

General

As from Model 69, the engines of type 911 E and 911 S were provided with modified ignition distributors. The timing for both engine types is adjusted to 30° BTDC at 6000 rpm. This value applies both, for engines under load and under no-load conditions.

Note!

The adjusting curve of the ignition distributor may be tested on test stand with normal battery ignition only.

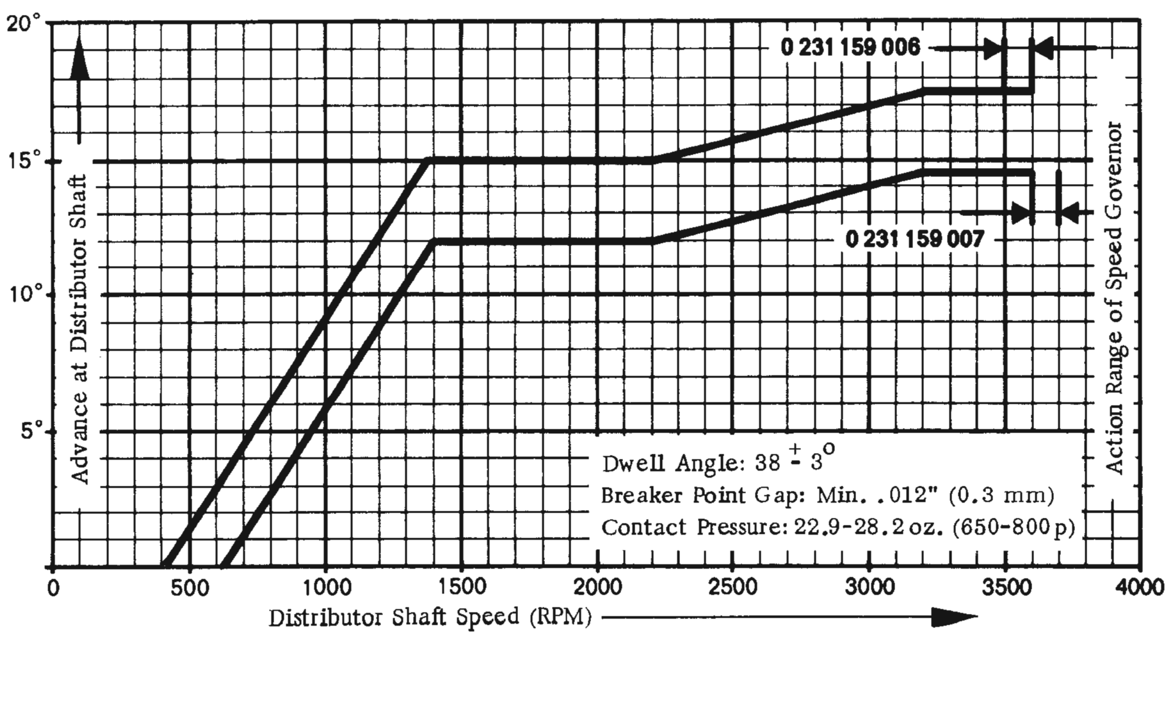
Test Values for Checking Adjusting Curve on Built-in Ignition Distributor

(Applicable to ignition distributors Type 0231 159 006 and 0 231 159 007)

Timing at:	6000 rpm	30° BTDC
	2800 - 4400 rpm	23° BTDC - 29° BTDC
	2000 rpm	10° BTDC - 18° BTDC
	1000 rpm	4° ABDC - 2° BTDC
	vehicle stopped	max. 4° ABDC

IGNITION ADVANCE CURVE FOR BOSCH DISTRIBUTORS

TYPE 0 231 159 006 (J FDR 6) FOR TYPE 911 E, 911 E-C ENGINES, AND
TYPE 0 231 159 007 (J FDR 6) FOR TYPE 911 S, 911 S-C ENGINES



SERVICE SCHEDULE, TYPE 911 T (FROM MODEL 70 ON)

300 to 600 miles	6 000 to 6 500 miles	Operation	then every miles
■	■	Engine: Make visual check for oil and fuel leaks.	6 000
	■	Air cleaner: Replace air filter cartridge.	6 000
	■	Check flame protection cartridge of crankcase breather and check hose connections for tightness.	6 000
	■	Exhaust system: Check exhaust system for demage.	6 000
■	■	Clutch: Check play and pedal free travel.	6 000
	■	Wheels: Check alignment and balance. *)	6 000
■	■	Engine: Check rocker arm shafts for tightness. Check valve clearance.	12 000
	■	Engine: Check compression.	12 000
	■	Ignition: Check points and timing. Check spark plug gap. Lubricate ignition distributor cam.	12 000
	■	Carburetor: Check carburetor adjustment with exhaust gas analyzer.	12 000
■	■	Check engine speed switch, micro switch and electro magnetic valves.	12 000
■	■	Alternator: Check alternator V-belt tension.	12 000
	■	Brake system: Remove brake pads, check and measure wear. Check master cylinder push rod free play. Check operation of brake pressure regulator. Inspect all brake lines and connections for damage. Check entire system for leaks. Check brake fluid level in reservoir. Check brake warning light. Check foot and hand brake.	12 000
	■	Steering: Check all connections and inspect rubber boots on steering gear for tightness and leaks.	12 000
	■	On vehicles with Sportomatic: Check control valve adjustment, clean airfilter. Clean contact switch points on shift lever and adjust.	12 000
■	■	Wheels: Check front wheel bearing play. Check tire pressures, and wheel lug nuts for tightness.	12 000
■	■	Electrical system: Check operation of battery and entire electrical system.	12 000

Note: The service intervals are based on "normal" driving. Tire and brake lining wear are heavily dependent on driving habits and should be checked at more frequent intervals. The vehicle should receive a complete maintenance service at least once a year, preferably before winter.

*) At extra cost, if necessary.

SERVICE SCHEDULE, TYPE 911 E and 911 S (FROM MODEL 70 ON)

300 to 600 miles	6 000 to 6 500 miles	Operation	then every miles
■	■	Engine: Make visual check for oil and fuel leaks.	6 000
	■	Air cleaner: Replace air filter cartridge.	6 000
	■	Check flame protection cartridge of crankcase breather and check hose connections for tightness.	6 000
	■	Exhaust system: Check exhaust system for demage.	6 000
■	■	Clutch: Check play and pedal free travel.	6 000
	■	Wheels: Check alignment and balance. *)	6 000
■	■	Engine: Check rocker arm shafts for tightness. Check valve clearance.	12 000
	■	Engine: Check compression.	12 000
	■	Ignition: Check points and timing. Check spark plug gap. Lubricate ignition distributor cam.	12 000
■	■	Check engine speed switch, micro switch and electro magnetic valves.	12 000
	■	Check full power and idle stop positions of fuel injection linkage. Replace fuel filter cartridge. Clean oil strainer in pump lubrication circuit. Check adjustment of fuel injection pump with exhaust gas analyzer.	12 000
■	■	Check tension of generator V-belt and injection pump spur belt.	12 000
	■	Brake system: Remove brake pads, check and measure wear. Check master cylinder push rod free play. Check operation of brake pressure regulator. Inspect all brake lines and connections for damage. Check entire system for leaks. Check brake fluid level in reservoir. Check brake warning light. Check foot and hand brake.	12 000
	■	Steering: Check all connections and inspect rubber boots on steering gear for tightness and leaks.	12 000
	■	On vehicles with Sportomatic: Check control valve adjustment, clean airfilter. Clean contact switch points on shift lever and adjust.	12 000
■	■	Wheels: Check front wheel bearing play. Check tire pressures, and wheel lug nuts for tightness.	12 000
■	■	Electrical system: Check operation of battery and entire electrical system.	12 000

Note: The service intervals are based on "normal" driving. Tire and brake lining wear are heavily dependent on driving habits and should be checked at more frequent intervals. The vehicle should receive a complete maintenance service at least once a year, preferably before winter.

*) At extra cost, if necessary.

CONTENTS

Group TRA: Technical Instructions, Accessories

Oil circulation

The type 2000 engine has dry-sump lubrication. The circuit contains two independent oil pumps, housed in the crankcase. One pump draws oil completely free from air bubbles from a separate oil tank, where it has been allowed to settle, and distributes it by the way of the main oil circuit to the main bearings. The other pump extracts contaminated oil from the crankcase through a strainer and delivers it to the oil tank via a filter. This pump is suitably enlarged to operate at lowered efficiency, since its function is to pump oil containing air bubbles.

A thermostat is placed at the entry to the main oil circuit, and regulates the flow of oil. If the oil temperature falls below $80^{O}C$ ($176^{O}F$) a flap operated by the thermostat closes to prevent oil from circulating through the oil cooler. When this occurs the oil passes directly to the bearings. When the temperature rises above $80^{O}C$ ($176^{O}F$) the flap opens and oil is passed through the cooler before reaching the bearings.

A pressure release valve (7) and safety valve (4) are built into the main oil circuit. The pressure release valve comprises a spring and piston located in the right half of the crankcase. If oil pressure in the circuit rises above 6.2 ± 0.8 atü (88.2 ± 11.3 p.s.i.) the pressure release valve opens and oil is allowed to pass directly into the crankcase.

In addition to the pressure release valve a safety valve is mounted in the left crankcase half immediately after the oil pump. This operates in the event of a defective pressure release valve to prevent damage to the oil cooler and possibly to the filter or lines.

Each main bearing is supplied with oil by a separate passage from the main oil circuit. Main bearings 1 and 8 are designed to supply oil continuously under pressure to the drilled passage in the center of the crankshaft so that oil can reach the connecting rod bearings.

Another oil passage leads to the front bearing of the intermediate shaft. From here a drilling through the center of the shaft supplies oil to the rear bearing. A small drillway on the rear face allows oil to reach and lubricate the axial location bearing.

The oil supplied to the camshafts is taken from the far end of the main circuit. An oil line leads to a central inlet point on each camshaft. The oil passes from the cylinder head to the rotating camshaft by way of an axial sealing ring.

The three camshaft bearings are supplied with oil under pressure from the central inlet point. Drillways in the cam faces provide lubrication at the points of contact between cams and rockers. Oil splashed from these points serves to lubricate the rocker shaft and valve stems.

Oil is collected in the lower part of the camshaft housing and returned to the crankcase by two oil return pipes. The extractor pump then returns it to the oil tank through a flexible line. A tube in the oil tank adjacent to the line connection point conveys the oil through a pipe to the base of the throwaway type oil filter.

Inside the filter the oil passes between the housing and the element, then flows under pressure through the element toward the center of the filter and is purified. It is then returned to the oil tank.

As a safety measure, bypass valves are built into the filter base and filter body. Should the flow pressure through the filter exceed 2 atü (28.4 p.s.i.) oil is directed by way of these valves directly into the oil tank, and any interruption in the oil supply caused by contamination ot the filter or blockage of the outlet passage is thereby avoided.

CHANGED LUBRICATION OF CAMSHAFTS AND ROCKER ARMS AS OF ENGINE NO. 903 070

(for oil Circulation refer to page M 51a)

Description

At the end of the main duct in the right and left crankcase halves are connecting points for oil lines, each leading to the camshaft housings. These lines supply the camshafts and the rocker arms with oil. In the camshaft housings are aluminum tubes with holes, three of which are approximately 3 mm (0.12 in.) dia. through which the oil flows to the camshaft bearings. Six holes of approximately 1 mm (0.04 in.) dia., splash oil on the cam lobes. The remaining three holes allow oil to splash against the inlet valve cover in such a manner that it will drip down on the rocker arm and valve stems.

CONTENTS

Supplements to Group E: Engine and Clutch

Engine

Clutch

Work Procedures:

Engine

Clutch

CONTENTS

Supplements to Group S: Front axle and steering

Repair operations:

Determine the adjustment value E from the blueprint value R = 63.50 by adding or subtracting the value of machined deviation r which is marked on the pinion face.

From model 70 on - R = 63.20 + deviation r "N" (refer to page R 42 and SR 160).

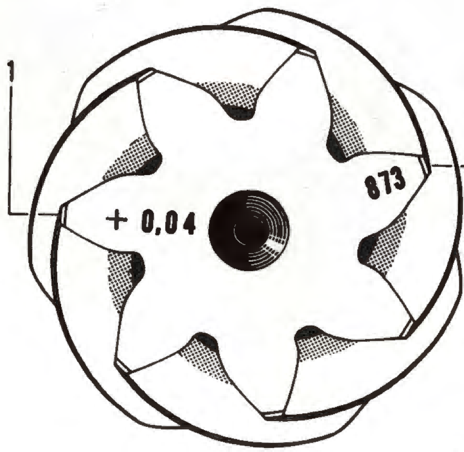


Fig. 50

1 Deviation r + (plus) or - (minus) values: shown as +4 is given in 1/100 mm; +0.04 is given in mm
Deviation r + in 1/100 mm, for example N 34
2 Mating identification number

Example:

If the machined deviation r is shown as +4 or +0.04, proceed as follows:

R	(blueprint value)	63.50 mm
r	(machined deviation)	0.04 mm
E	(adjustment value)	63.54 mm

From model 70 on

When machining deviation r, shown on the pinion face, is N 34

R	(Blue print value)	63.20 mm
r	(machined deviation)	+ 0.34 mm
E	(adjusted value)	63.54 mm

A basic approximation value (based on averages) of 64.70 mm makes it possible to predetermine the spacer thickness required. The difference between the adjustment value E and the approximation value (64.70 mm) indicates the spacer thickness needed.

Example:
When the adjustment value E is 63.54 mm, compute as follows:

Approximation value	64.70 mm
Less E (adjustment value)	63.54 mm
Difference	1.16 mm

1.16 mm = required thickness of spacers

The spacers are available in thicknesses of 0.25, 0.30, and 0.40 mm. The 0.10 and 0.15 mm spacers should no longer be used.

The values are always rounded off to the closet 0.05 mm.

The required spacers for the above example are: 3 x 0.30 mm, 1 x 0.25 mm.

Disassembly

1. Remove synchronizing ring retainer from clutch carrier using needle nose pliers.

2. Thorougly clean all parts in cleaning solvent.

3. Inspect parts for wear or damage. If the synchronization was no longer effective, install new synchronizing ring.

Reassembly

1. Place synchronizing ring into clutch carrier and insert brake band energizer, brake band stop, and brake bands.

Fig. 51

2. When assembling 1st speed synchronization, ensure that only one brake band is installed. The band should be placed exactly as shown in **Fig. 52.**

Fig. 52

3. Install synchronizing ring retainer using needle nose pliers.

Fig. 53

4. Check installed synchronizing ring for installed diameter (76.30 mm $\pm$ 0.18 mm).

5. Place ring gear onto differential carrier flange and tighten hex bolts to 9.5 - 10 mkp (69 to 72 ft.lbs.).

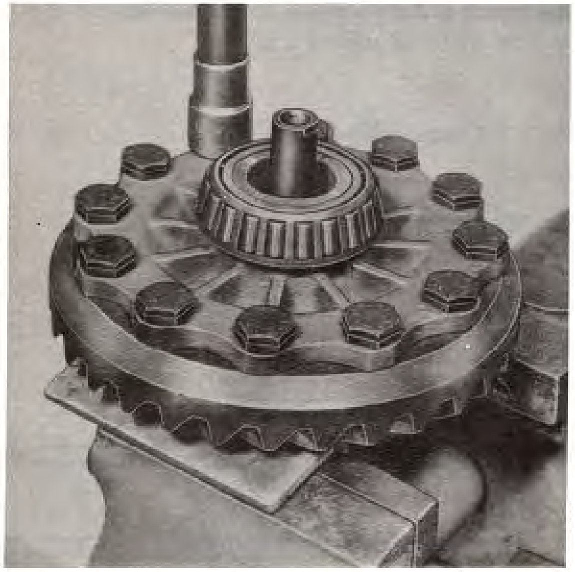


Fig. 94

6. Insert bolt locking plates into grooves in bolt heads, tighten open ends with pliers to firmly connect the plates with bolt heads, and secure bolts by bending plates down, over one of the hex bolt flanks.

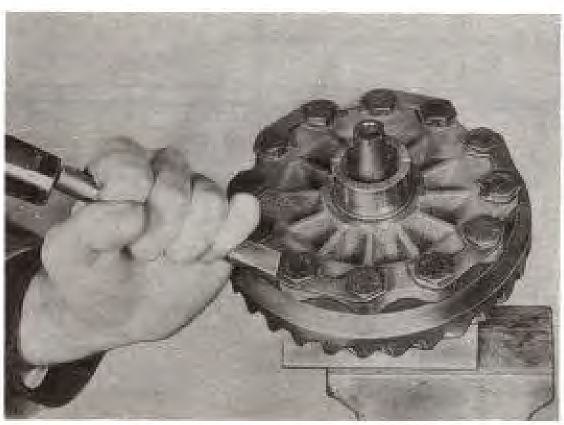


Fig. 95

7. Place appropriate spacers on trunnions and install side bearings with special tool P 264.

Fig. 96

8. When replacing outer races of side bearings, heat transmission housing or the cover, to approx. 120° C (248° F) and install outer races with an appropriate tool.

Note:
The ring gear must be readjusted whenever a new differential carrier is installed (see 10 RA and 12 RA).

Quiet operation and long service of the rear axle drive depends on proper adjustment of the ring gear and pinion. For this reason the pinion shafts and ring gears are matched during production on special test benches with the object of obtaining the best contact pattern and least possible noise in both directions of rotation. Minimum noise characteristics are achieved by resetting the pinion shaft axially while keeping the ring gear within tolerances of determined gear backlash of 0.12 to 0.18 mm. The deviation r from the designed adjustment position (blueprint value R) is established and etched into the pinion face. Every pinion ring gear set is marked with mating numbers and can be replaced only as a set.

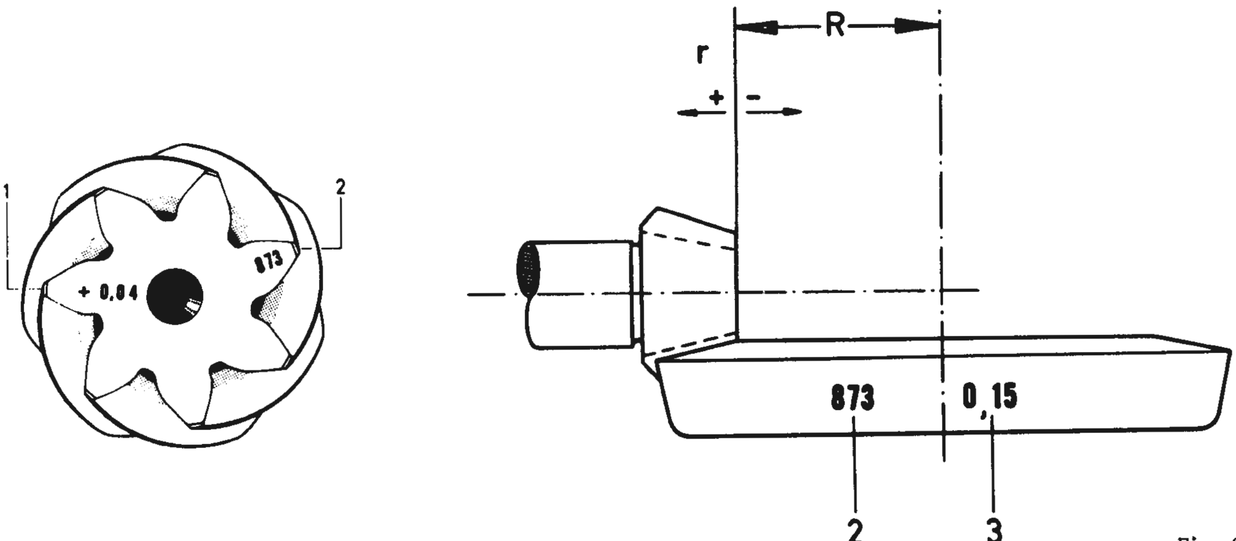


Fig. 97

R Blueprint value (63.50 mm)
r Deviation from R+ or - shown in 1/100 mm (+4) or in mm (+0.04)

1 Deviation r
2 Mating number
3 Backlash

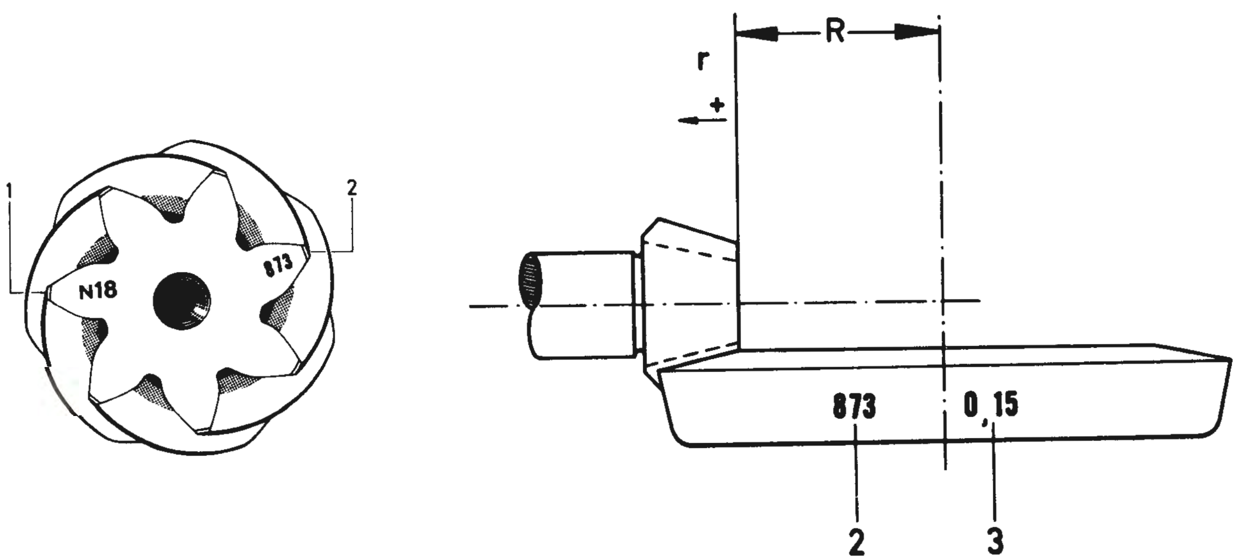


Fig. 97a

From model 70 on
R Blueprint value (63.30 mm)
r Deviation from R+ shown in ;/100 mm (N 18)

1 Deviation r
2 Mating number
3 Blacklash

5. Select ring gear side spacer (S 1) of thickness permitting a preload clearance of 0.15 mm (.006 in.); mount spacer using special tools P 263 and P 264.

Example:

Clearance determined with feeler gauge 0.40 mm
Minus desired preload clearance 0.15 mm
The installed 3.5 mm spacer (S 1) to be replaced with one 0.25 mm thinner, i.e., 3.25 mm

6. Tighten housing side cover; use 0.20 mm gasket.

Note:
All nuts must be tightened to 2.5 mkp (18 lbs/ft) to obtain the required effect.

7. Insert axle flange, place thrust washer and tighten stretchbolt a little.

8. Measure drag of the installed differential with special tool P 261

Note:
When measuring differential drag, the pinion shaft must not be engaged and the axle flange oil seal in housing side cover must be removed to exclude additional drag.

Fig. 101

The differential drag should be between 18 and 24 cmkp (15.6 and 20.8 lbs/in); this will indicate that the side bearing is under proper preload. If the above value has not been obtained, replace the spacer with one of proper thickness.

9. Withdraw differential, remove both side bearings, and measure thickness of all spacers using a micrometer and measuring each spacer at four different points. The total thickness of all spacers shows spacer thickness for the ring gear adjustment.
In preparation for the subsequent adjustment of the pinion and ring gear, the spacer S 1 should be 0.1 mm thinner than one-half of spacer total, and spacer S 2 should be 0.1 mm thicker.

Example:

Total thickness of spacers S 1 + S 2 = 6.25 mm

Thickness of spacer S 1 $\left(\frac{6.25\ \text{mm}}{2}\right) = 3.125$ mm
- 0.100 mm
= 3.025 mm

Thickness of spacer S 2 $\left(\frac{6.25\ \text{mm}}{2}\right) = 3.125$ mm
+ 0.100 mm
= 3.225 mm

Note:
The spacers are available in increments of 0.10 mm from 2.5 mm to 3.5 mm.
Due to a 0.25 mm washer, adjustments to nearest 0.05 mm are possible. The calculated thickness of spacers required should be rounded off to match actual (available) spacer thickness, although it should be ascertained that the rounding-off does not alter the value of total spacers required (S 1 + S 2).

Example:

Calculated spacer thickness
S 1 + S 2 = 3.025 + 3.225 = 6.25 mm
Rounded-off spacer thickness of
S 1 + S 2 = 3.0 + 3.25 = 6.25 mm

Measure spacer thickness at four points of each spacer using a micrometer. Permissible thickness variation is 0.02 mm. Before measuring, remove any burr that may be on the edges of spacers.

Special Tool

P 258 Dummy carrier with dial gauge

General

Determine adjustment value E from known blueprint value R (63, 50), plus or minus deviation r which is etched onto pinion face (see 3 RA).
From model 70 on - R = 63.20 + deviation r "N".
The shaft has been roughly preadjusted at time of reassembly through placement of appropriate spacers (see 3 RA).

Adjustment

1. Insert preassembled intermediate plate, with gears and selector shafts, into transmission housing, omitting the paper gasket; place spacer bushings onto 4 opposing housing studs and tighten nuts in cross-wise fashion.

   Note:
   The pinion shaft stretchbolt must be tightened to 11 - 12 mkp (79-86 lbs/ft) prior to taking measurements.

2. Place dummy carrier P 258 onto gauge setting plate and fasten dial gauge to a preload of 1 mm (small pointer to 1, large pointer to 0).

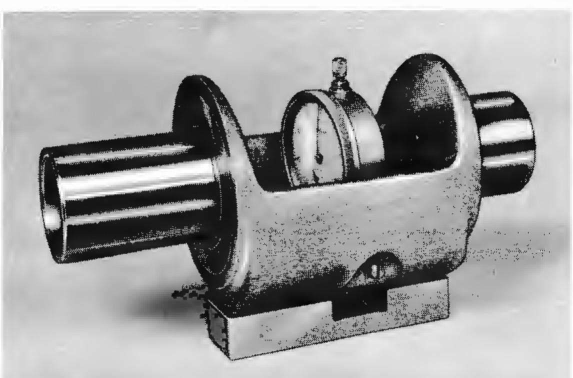


Fig. 102

3. Install dummy carrier P 258, with side bearings, into transmission housing. Make sure that the dummy carrier is under an axial preload of approx. 0.1 mm when the side cover has been installed. In no case should the dummy carrier be free to move axially when the measurements are being taken.

   The dummy carrier can be installed without axial play with the aid of differential spacers.

4. Carefully turn the dummy carrier until the gauge sensor pin comes to right angle with the face of the pinion. At this point, the gauge pointer will show the highest reading, i.e., the one to be noted.

   A notch in the flank of the dummy carrier shows the location of the gauge sensor pin (see Fig. 103).

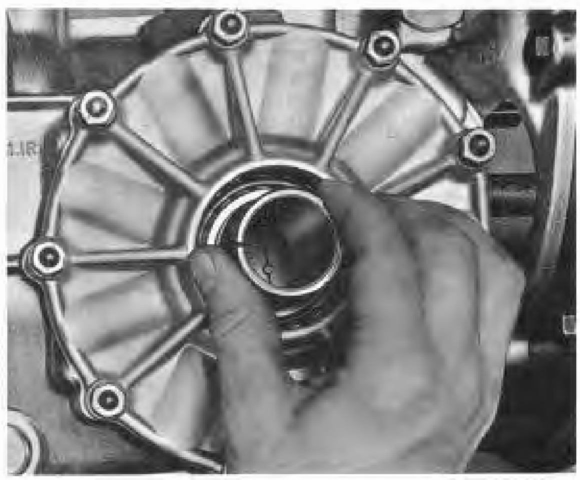


Fig. 103

CONTENTS

Supplements to Group R: Rear Axle and Transmission

Descriptions

Operations:

Operations: (for Sportomatic)

(For gearbox and transaxle with pressure cast housing)

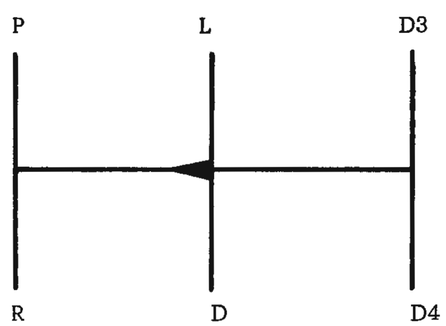
(For rear axle from 69 Model on)

Clutch: Hydrodynamic torque converter with vacuum controlled single disc dry clutch

Transmission: Porsche-synchronized

Number of gears: 4 forward, 1 reverse, parking lock

Sportomatic Gearshift Pattern



P	=	Parking lock
R	=	Reverse
L	=	Low (for steep inclines)
D	=	Drive (for city driving)
D3	=	Drive 3 (intermediate highway speeds)
D4	=	Drive 4 (high speed expressways)

Rear axle ratio: 7:27 (i=3.86)

Tow-start speed in "L": 35 kmh (21 mph)

Stall speed: approx. 2500-2700 rpm

Maximum torque ratio (at stall): 2.15 - from Model 70 on = 2.19

Clutch revolutions: approx. 3600 rpm

Converter oil capacity: approx. 2.3 liters (2.4 US qts)

Converter oil transfer rate: approx. 3 liters (3.2 qts.) per minute at max. pressure of 4 atm (56 psi)

Engine oil capacity (total including converter and lines): approx. 11.5 liters (12 US qts) premium HD oil, Summer SAE 30, Winter SAE 20

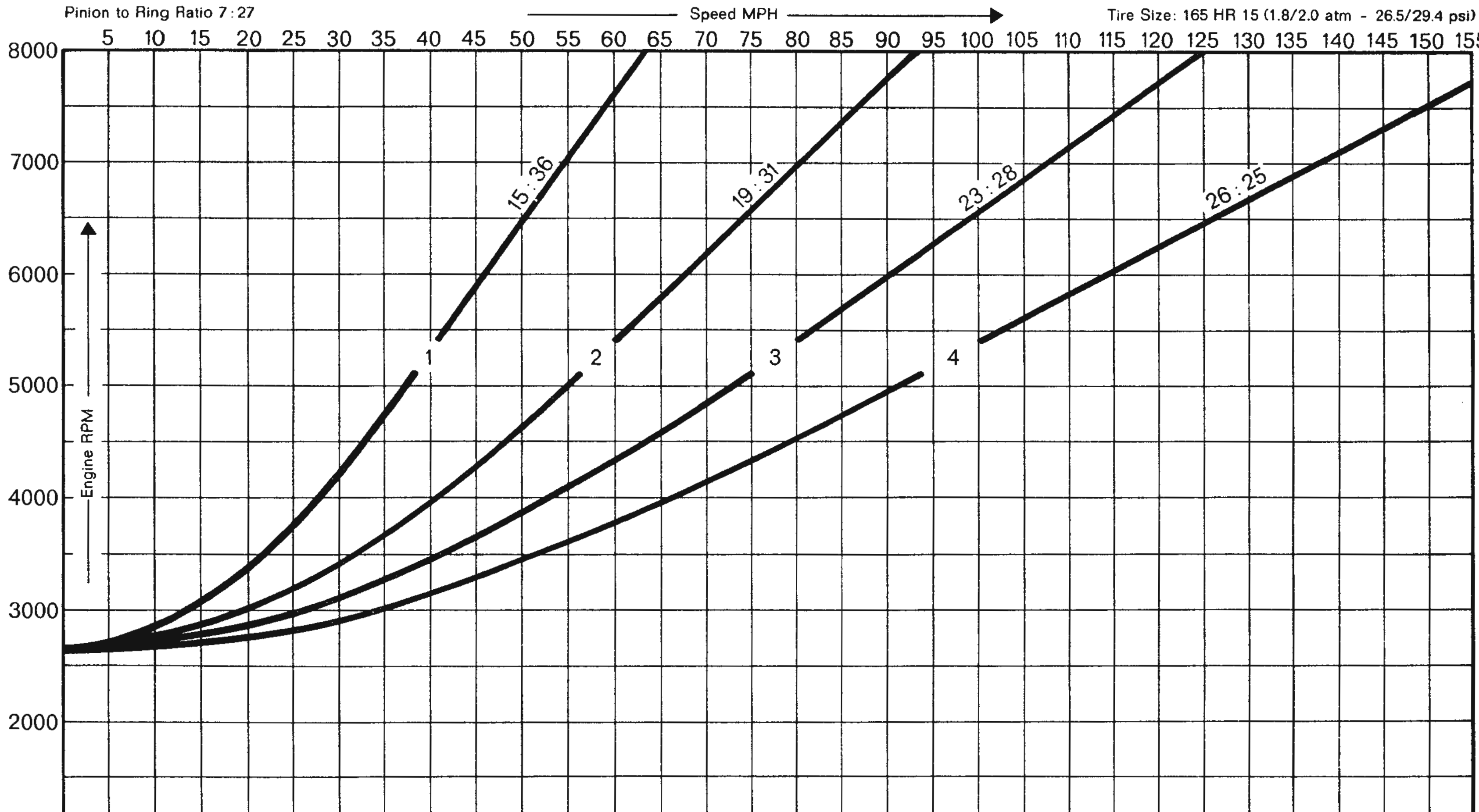
Transmission oil capacity: 2.3 liters (2.4 US qts) Hypoid SAE 90

SR 52

PORSCHE SPORTOMATIC

Type 911 (USA) and 911 L Transmission Diagram

Type 905/00 Transmission



Note: This diagram shows nominal values based on a mean effective rolling radius. Slight deviations due to tire size tolerances, variations in the rolling radius, tire wear, and wheelspin have not been taken into account. In addition, the chart is based on converter characteristics under full throttle conditions.

Subject to changes without notice

The adjustment value is determined by taking the blueprint value R=54. 50 and adding or subtracting the amount of machining deviation r which is shown on the face of the pinion.

From model 70 on - R = 54. 20 + deviation r "N" (refer to page SR 121 and SR 160).

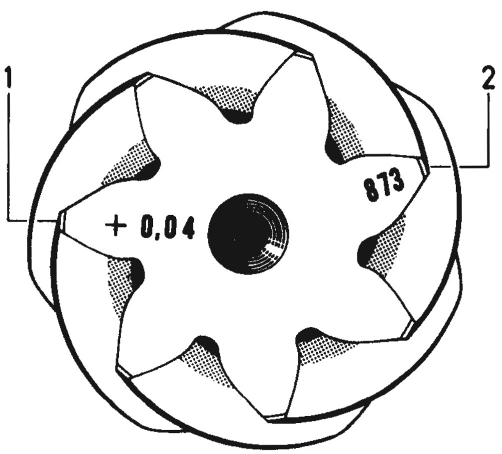


Fig. 147

1 Deviation r shown in (8) or (-) mm values (+0. 04)
From model 70 on: Deviation r shown in (+) 1/100 mm values, for example N 34

2 Mating identification number

Example:
When machining deviation r shown on the pinion face is +0. 04

R (blueprint value)	54. 50 mm
	+ 0. 04 mm
E (adjustment value)	54. 54 mm

From model 70 on

When machining deviation r shown on the pinion face is N 34

R (blueprint value)	54. 20 mm
	+ 0. 34 mm
E (adjustment value)	54. 54 mm

To predetermine the thickness of spacers required, a basic approximation value (based on experience) of 55. 70 mm is applied; the difference between the adjustment value E and the approximation value shows the thickness of spacers required.

Example:
When calculated adjustment value E is 54. 54 mm

Approximation value	55. 70 mm
Less E (adjustment value)	54. 54 mm
Difference	1. 16 mm

Thus, the required thickness of spacers is 1. 16 mm.

The spacers are available in thicknesses of 0. 25 mm, 0. 30 mm, and 0. 40 mm.

Required spacers are: 3 x 0. 30 mm, 1 x 0. 25 mm. The calculated values always should be rounded off to the nearest 0. 05 mm.

Disassembly

1. Remove synchronizing ring retainer from clutch carrier with needle nose pliers.

2. Thoroughly clean all parts in cleaning solvent.

3. Inspect parts for wear or damage. If the synchronization was no longer effective, install new synchronizing ring.

Reassembly

1. Place synchronizing ring into clutch carrier and insert brake band energizer, brake band stop, and brake bands.

Fig. 148

2. When assembling the 1st gear synchromesh parts, make sure that only one brake band is inserted. The band must be installed exactly as shown in Fig. 149.

Fig. 149

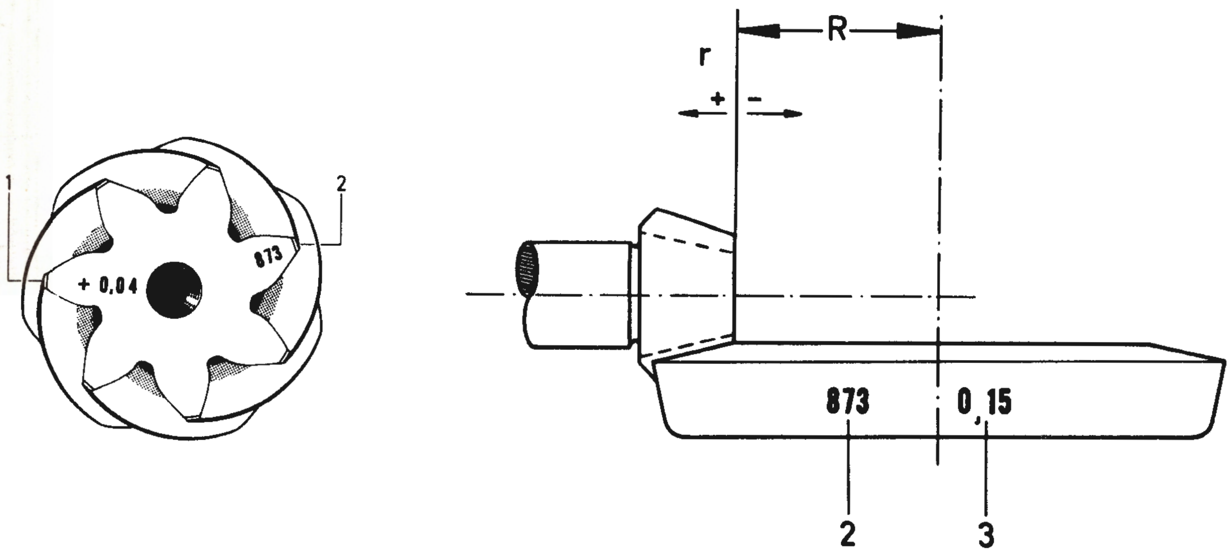
3. Install synchronizing ring retainer with needle nose pliers.

Fig. 150

4. Using a micrometer, check installed synchronizing ring for installed diameter (76.30 mm, ± 0.18 mm)(3.004", ± .007").

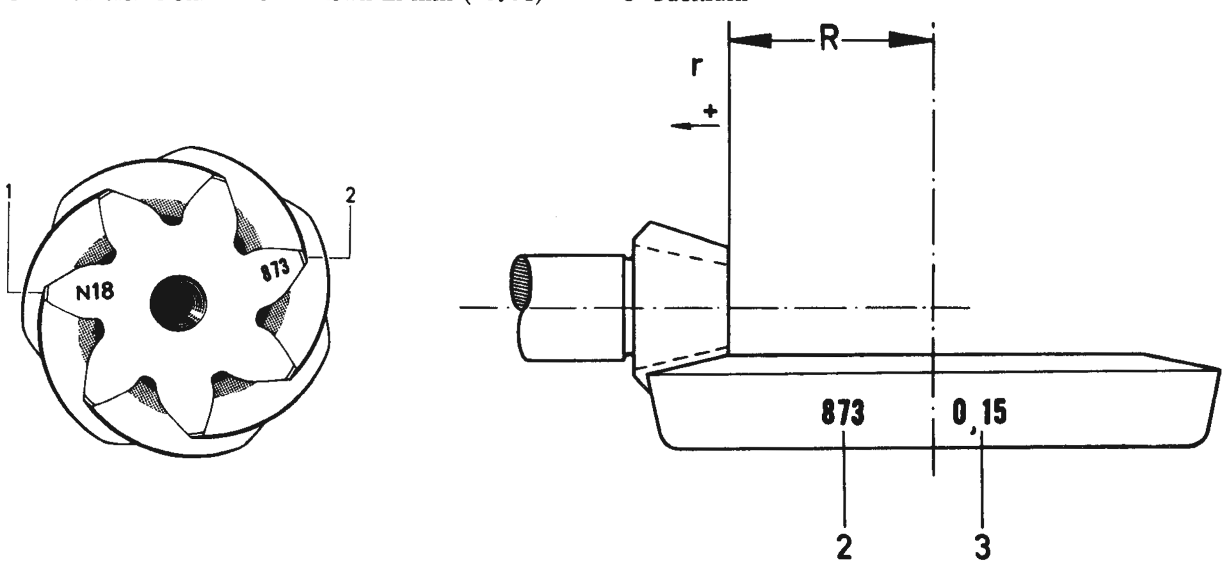
General

Quiet operation and long service of the rear axle drive depends on proper adjustment of the ring gear and pinion. For this reason the pinion shafts and ring gears are matched during production on special test benches with the object of obtaining the best contact pattern and least possible noise in both directions of rotation. Minimum noise characteristics are achieved by resetting the pinion shaft axially while keeping the ring gear within tolerances of determined gear backlash of 0.12 to 0.18 mm. The deviation r from the designed adjustment position (blueprint value R) is established and etched into the pinion face. Every pinion ring gear set is marked with mating numbers and can be replaced only as a set.



R Blueprint value (54.50 mm for Sportomatic transmission)
r Deviation from R + or - shown in mm (+0.04)

1 Deviation r
2 Mating number
3 Backlash



From model 70 on

R Blueprint value (54.20 mm for Sportomatic transmission)
r Deviation from R+ shown in 1/100 mm (N 18)

1 Deviation r
2 Mating numer
3 Backlash

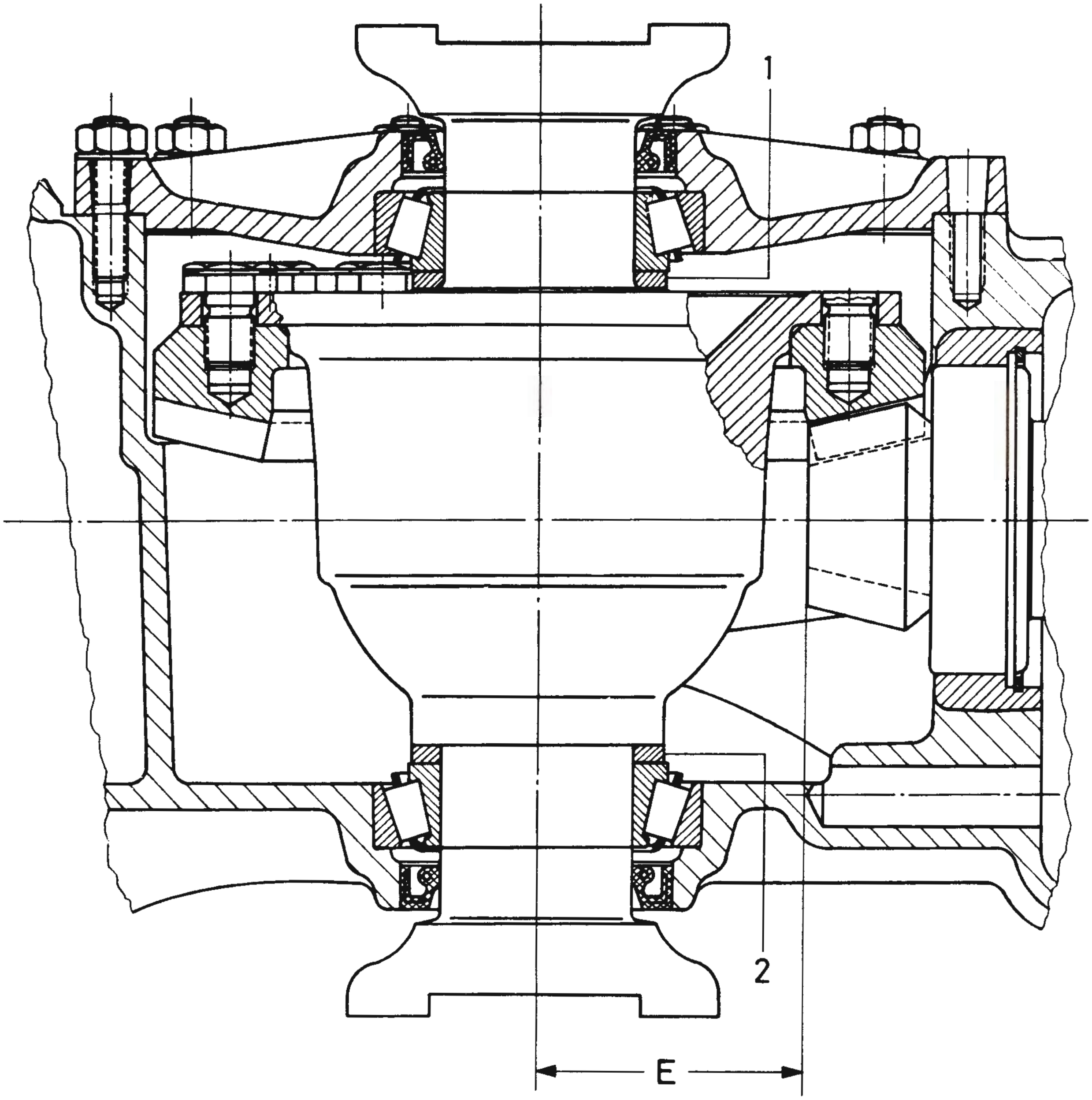


Fig. 177

1 Spacer S1
2 Spacer S2
E Adjustment value

Extreme care and cleanliness must be maintained throughout the course of assembly if proper results are to be expected.

Special Tools:

P 258 Dummy carrier

P 365 Dummy carrier sleeve

General

Determine adjustment value E from known blueprint value R (54.50) plus or minus the deviation r which is etched into the face of the pinion (see page SR 109).

From model 70 on - R = 54.20 + deviation r "N".

The pinion shaft undergoes a rough adjustment at time of assembly through the insertion of appropriate spacers (see page SR 109).

Adjustment

1. Insert preassembled intermediate plate, with gears and selector fork rods but without the gasket, into the transaxle housing. Place spacer bushings onto four opposing housing studs and tighten the nuts across.

   Note:
   The pinion shaft stretchbolt should be torqued to 11 - 12 mkp (80 - 87 lb-ft) prior to measuring.

2. Slide the dial gauge with sleeve P 365 into the dummy carrier P 258. Place the dummy carrier onto a trueing plate or similar straight surface and fasten dial gauge to the dummy carrier with a preload of 1.5 mm (small pointer to midway between 1 and 2, large pointer to zero).

3. Install dummy carrier, with side bearings, in the transaxle housing so that the dummy is under axial preload of approx. 0.1 mm (.004") when the cover is installed. In no case may the dummy carrier have axial play when measurements are being taken. (The dummy carrier can be installed in the housing without axial play through the use of differential spacers.)

4. Carefully rotate the dummy carrier until the dial gauge sensor comes to right angle with the face of the pinion. At this point, the dial gauge pointer will indicate the highest reading which is the one to be noted.

   A notch in the flank of the dummy carrier shows the location of the dial gauge sensor pin (see Fig. 182).

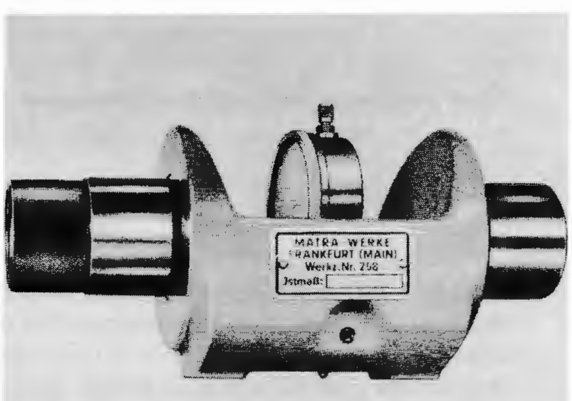


Fig. 181

Fig. 182

Note the following when reading the dial gauge:

The distance from the center axis of the dummy carrier to its resting base is indicated on the side of the dummy as actual value; for instance, Actual Value = 54.015. This value is that, to which the dial gauge is actually set.

If the gauge reading differs, in clockwise direction, from the originally set value (i.g., 54.015 mm), then the distance is smaller than 54.015 mm and that shortage must be deducted from the actually set value of 54.015.

Example:

The small pointer is between 1 and 2, the large one shows 0.02 mm:

Gauge setting	54.015 mm
Minus measured value	- 0.020 mm
Distance to face of pinion	53.995 mm

Adjustment value E (as example)	54.42 mm
Minus distance to face of pinion	-53.99 mm
Thickness of paper gaskets	0.43 mm

Thus the pinion shaft must be moved away from the ring gear center by 0.43 mm; this is accomplished by inserting paper gaskets of cumulative thickness of 0.45 mm. (Second digit decimal fractions to be rounded of to 5 from 3 and up, to 10 from 7 and up.)

If the gauge reading differs, in counter-clockwise direction, from the originally set value (i.g., 54.015 mm), then the distance is greater than 54.015 mm and that excess must be added to the actually set value of 54.015 mm.

Example:

The small pointer is somewhat past 1, the large one shows 0.24 mm:

Gauge setting	54.015 mm
Plus measured value	+ 0.240 mm
Distance to face of pinion	54.25 mm

Adjustment value E (as example)	54.54 mm
Minus distance to face of pinion	-54.25 mm
Thickness of paper gaskets	0.29 mm

It is permissible to install paper gaskets in thicknesses of 0.10 mm (.004") to 0.50 mm (.020") between the housing and intermediate plate. If this is not adequate for achieving proper adjustment, disassemble the pinion shaft and change the spacers as needed.

Paper gaskets are available in thicknesses of 0.1, 0.15, and 0.2 mm (.004", .006", .008").

After installation of the paper gaskets, recheck adjustment value E. Deviations of up to ± 0.03 mm (.001") are permissible. It is not necessary to check the gear tooth contact pattern again.

Disassembling and assembling intermediate plates

Disassembling

See page R 35, item 7 RA.
Note also the following procedure:

Fold up the lock plates for the hexagon bolts with internal splines for the clamping plate. Unscrew the bolts with special tool P 292 and remove the plates.

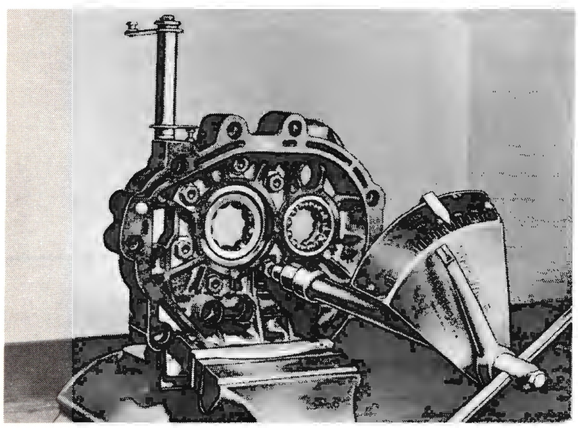


Fig. 6

Assembling

See page R 35, item 7 RA.
Note also the following procedures:

1. Install the clamping plate.

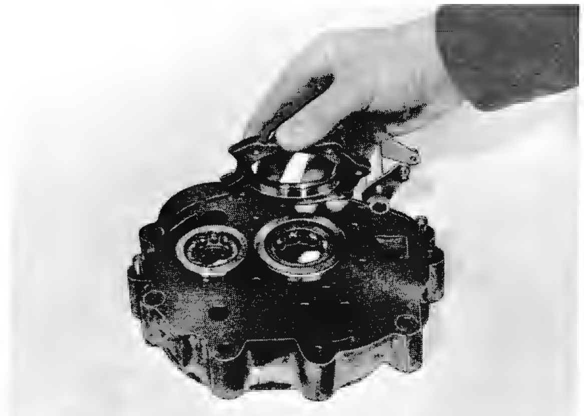


Fig. 7

2. A spring washer, spare part number 900.028.024.01 must be placed between each keeper plate and the clamping plate. Tighten the hexagon bolt with internal splines using special tool P 292 to 2.1 - 2.3 mkp (15.2 - 16.6 ft.lbs.). Check that the lock plates are correctly installed and lock by bending up.

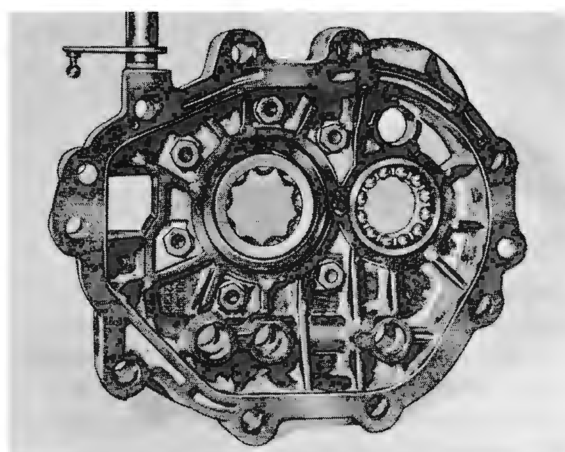


Fig. 8

3. The new clamping plates with self-locking heli-coil threaded inserts spare part number 901.301.035.13 require a base plate spare part number 901.301.255.13 between the clamping plate and the intermediate plate. In addition, washers spare part number 900.025.007.02 must be placed under the cheesehead screws. Tightening torque remains unchanged.

Differential - dismantling and reassembling

Dismantling and checking

See page SR 105.

Reassembling

See page SR 106.
Note also the following point:

Force on the taper roller bearing with special tool P 264b.

CROWNWHEEL - FITTING

Determining total thickness of spacing rings for crownwheel fitting.

See page R 44, item 10 RA.
Note also the following procedure:

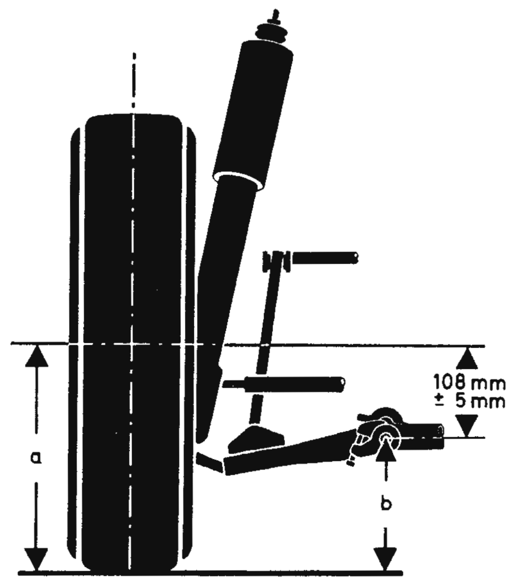
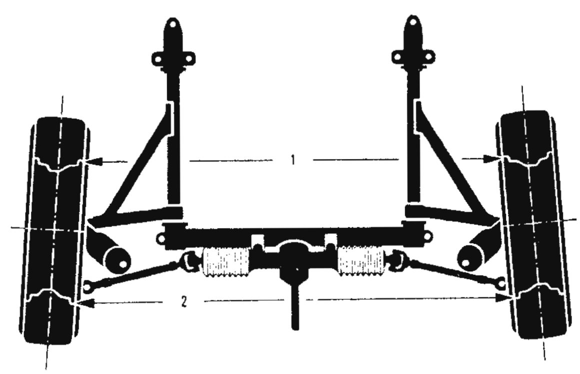
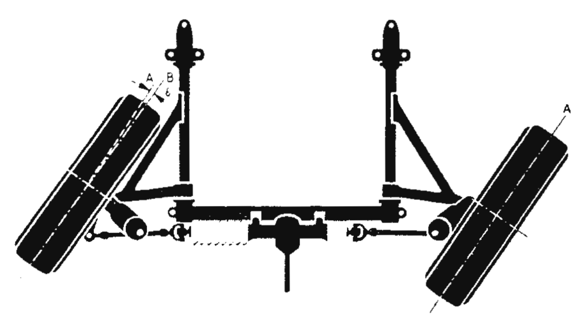
On the die cast transmission housing the axial interference fit of the tapered roller bearings for the differentail has been increased. The following torques must now be developed to produce the correct interference fit for the taper roller bearings.
SKF tapered roller bearings = 25 - 35 cmkp
FAG tapered roller bearings = 40 - 65 cmkp

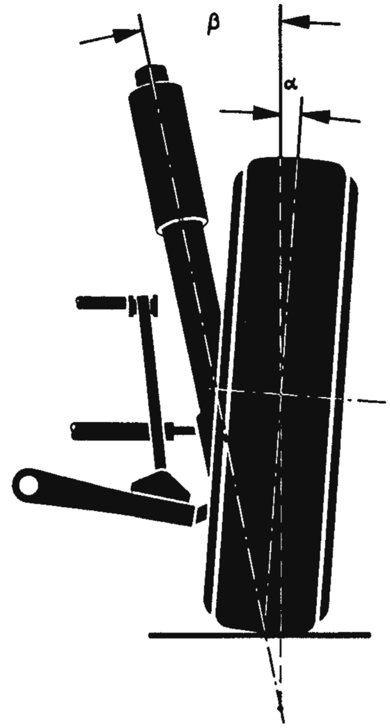
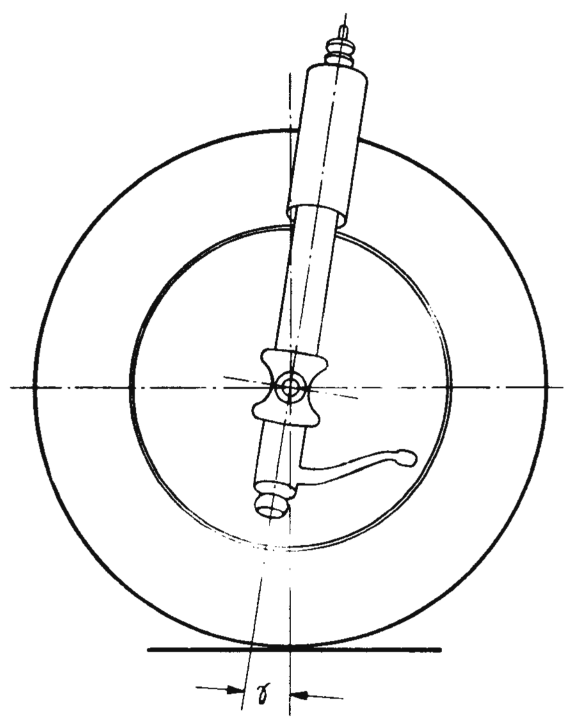
Fig. 9

Warning:
Push the disc of special tool P 357 on the joint flange and install the joint flange. Tighten the expansion bolt with washer slightly (prevent the differential from turning).

TOLERANCES AND ADJUSTMENT SPECIFICATIONS

(Type 911 vehicle in no-load condition, Empty Weight = DIN 70020)

Item	Nominal Value and Tolerances	Maximum Deviation left to right	
<u>Front Axle</u> Height adjustment: Rear center of front axle torsion bar lower than front wheel center	108 mm (4.25 in.) ± 5 mm (.2 in.)	 5 mm (.2 in.)	
Toe-in (pressed, preload 15 kp or 33 lbs) Total left plus right wheel Value 1 is smaller than value 2	+ 40' From model '68 on 0°	none	
Angle differential in 20° turn (with toe-in bias) A' = Parallel to A δ = Angle differential	40' to 1° 10' From model '68 on 0° to 30'	Corrections possible only through replacement of steering arms	

Item	Nominal Value and Tolerances	Maximum Deviation left to right	
Front wheel camber (in straight-ahead road wheel attitude) a = Camber angle	$0 \pm 20'$	20'	
Caster γ = Caster	$6^{\circ} 45' \pm 45'$ From model 70 on $6^{\circ}5' \pm 15'$	30'	

Checking Distributor:

The following values apply when checking the ignition advance curve in installed distributors:

at standstill	max.	3^{o} ATC
at 2000 rpm		15^{o} - 19^{o} BTC
at 3000 rpm		19^{o} - 23^{o} BTC
at 4000 rpm		24^{o} - 28^{o} BTC
at 5000 rpm		28^{o} - 32^{o} BTC
at 6000 rpm		35^{o} BTC

The speed governor ignition cut-off point must be between 6400 and 6600 rpm in installed distributors.

Checking Distributor on Test Stand:

The ignition advance curve can be checked on a test stand with the aid of the ignition advance curve diagram.

When tested on the test stand, the speed governor ignition cut-off point is between 3250 and 3350 rpm, i.e., 100 rpm higher than in distributors installed in the car (less vibrations).

IGNITION ADVANCE CURVE FOR MARELLI DISTRIBUTOR

TYPE S 112 AX

FOR TYPE 2000 T ENGINES

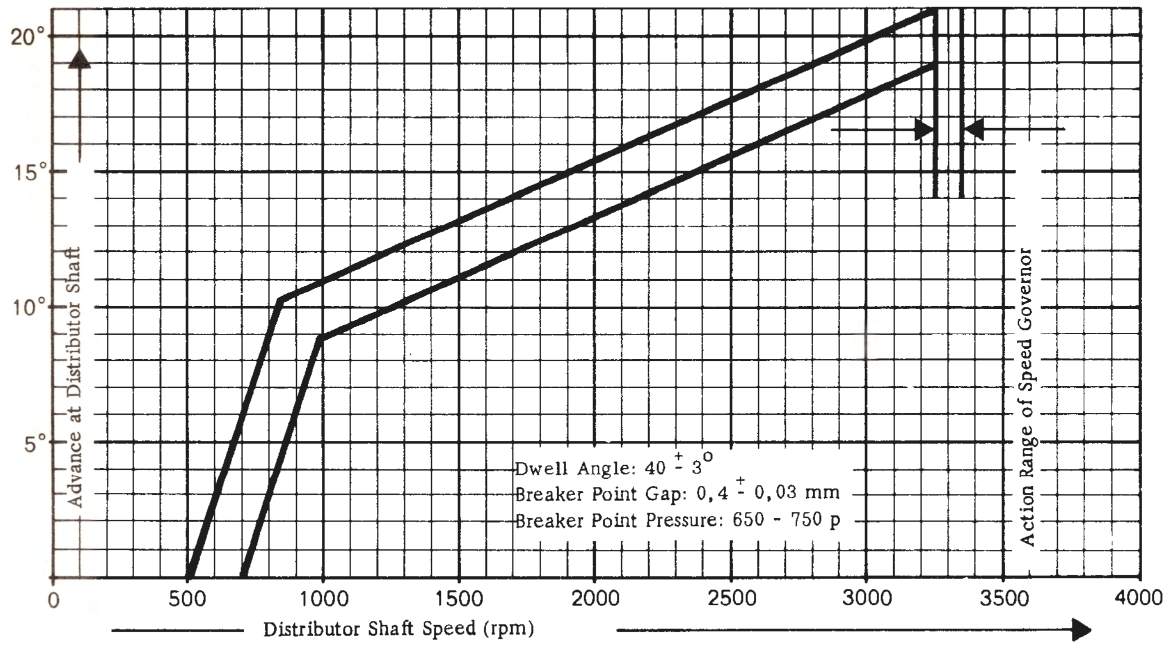


Fig. 6

General

From April 1970 on, the engines of Type 911 T-C are optionally provided with Bosch ignition distributors. The firing point is set to 35° BTDC at 6000 rpm as before. This value applies for the engine under load and under no-load conditions.

Note!

The adjusting curve of the ignition distributor may be tested on test stand with normal battery ignition only.

Test Values for Checking Adjusting Curve on Built-in Ignition Distributor

Firing point at:	6000 rpm	33° to 35° BTDC
	4600 rpm	27° to 29° BTDC
	3000 rpm	20° to 22° BTDC
Idling	900 ± 50 rpm	2° to 4° ATDC

IGNITION ADVANCE CURVE FOR BOSCH DISTRIBUTORS

TYPE 0 231 159 008 J FDR (R) FOR TYPE 911 T-C ENGINES