

Function:HDI Direct Injection System(SIEMENS SID 801)

1 - Components Common With The Document:"Operating Principle - HDI Direct Injection System (High Pressure Diesel Direct Injection)"

components common with the document :

- fuel high pressure common injection rail
- battery(BB00)
- accelerator pedal sensor(1261)
- engine speed sensor(1313)
- the camshaft position sensor (1115)
- engine coolant temperature sensor(1220)
- air temperature sensor(1310)
- fuel temperature sensor(1221)
- brake switch(2100)

2 - Components Common With The Document:"Operating Principle - HDI Direct Injection System (High Pressure Diesel Direct Injection)"(BOSCH ECD15 C2)-FAP System(Particle Filter)

components common with the document :

- redundant brake pedal switch(7308)
- clutch switch(7306)
- vehicle speed sensor(according to vehicle)

3 - Specific Elements

features of the DW10TD engine :

- high pressure fuel pump
- fuel flow actuator (1277)
- fuel high pressure regulator(1322)
- fuel high pressure sensor(1321)
- injection ECU(1320)
- diesel injectors(1331, 1332, 1333, 1334)

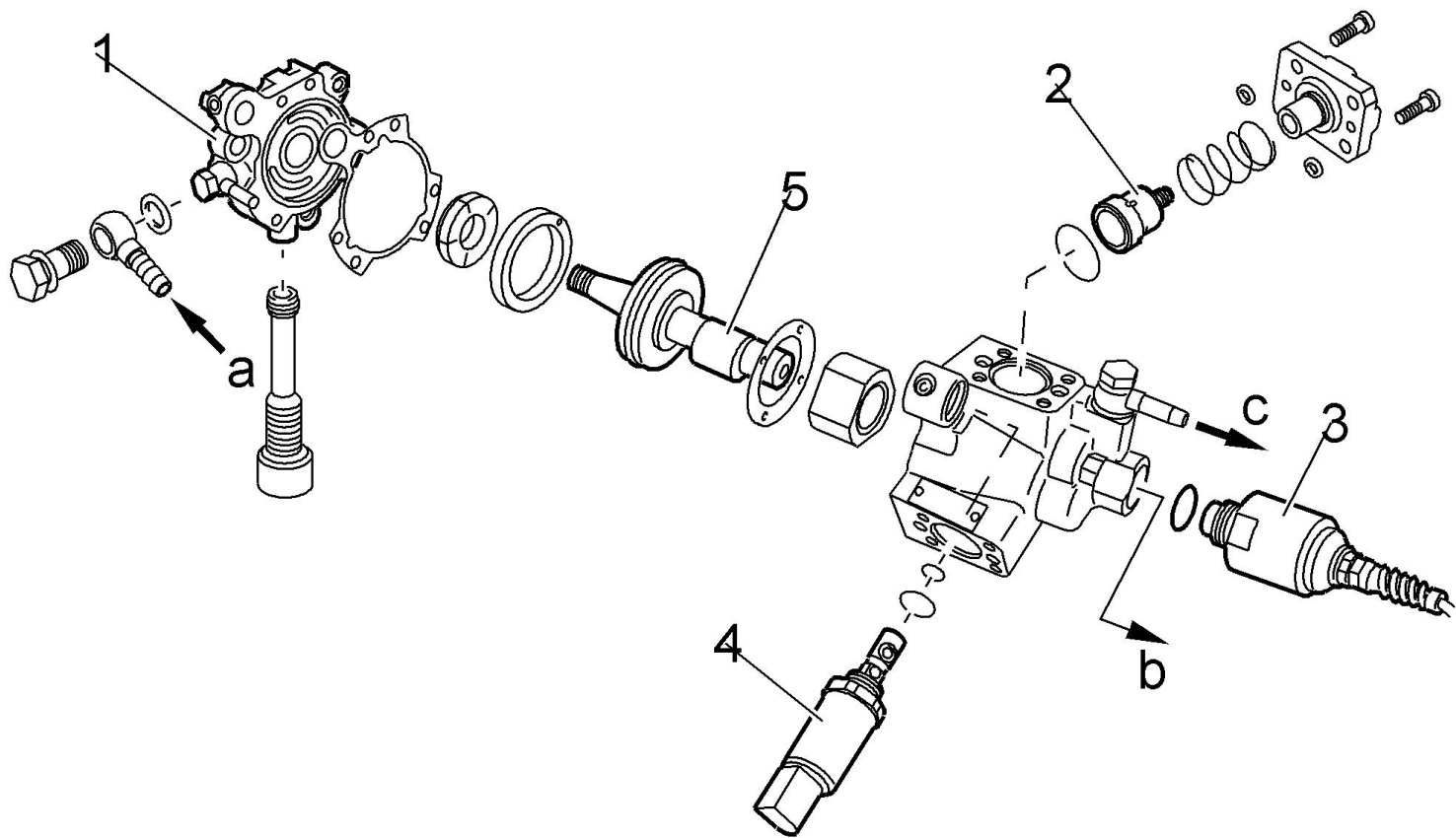
4 - High Pressure Fuel Pump

4.1 - Role

role of the high pressure fuel pump(SIEMENS CRV FT6186 type with 3 pistons) :

- the pumping of the fuel(integral transfer pump)
- to supply high pressure fuel
- to supply the diesel injectors through the high pressure common injection rail

4.2 - Description



(1)transfer pump(pre-supply)

(2)high pressure piston

(3)fuel high pressure regulator

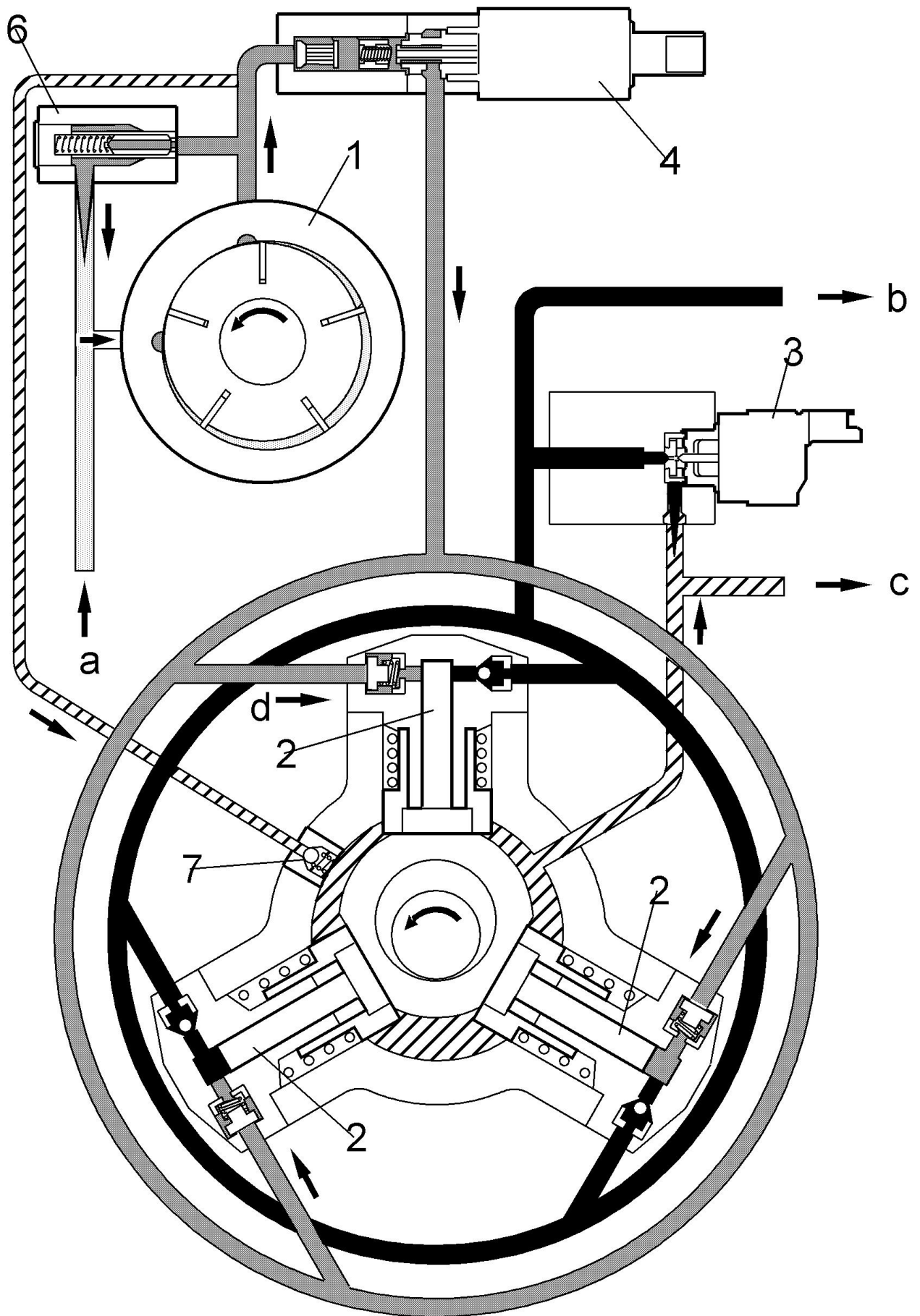
(4)fuel flow actuator

(5)eccentric pump shaft

" a ":fuel inlet(low pressure)

" b ":high pressure fuel outlet(to the common injection rail)

" c ":return to fuel tank



- (1)transfer pump(pre-supply)
- (2)high pressure piston
- (3)fuel high pressure regulator
- (4)fuel flow actuator
- (6)pressure limiter
- (7)lubricating valve
- " a ":fuel inlet(low pressure)

" b ":high pressure fuel outlet(to the common injection rail)

" c ":return to fuel tank

the high pressure fuel varies between 220 and 1500 bar

NOTE

the high pressure fuel is controlled by the high pressure fuel regulator

NOTE

the fuel flow entering the high pressure pump is controlled by the fuel flow actuator

components mounted on the high pressure fuel pump :

- high pressure fuel regulator (3)
- fuel flow actuator (4)

NOTE

the high pressure pump is not a distributing pump and does not need setting

the transfer pump (1) draws in fuel and delivers it to the following components(integral transfer pump) :

- lubricating valve (7)
- fuel flow actuator (4)

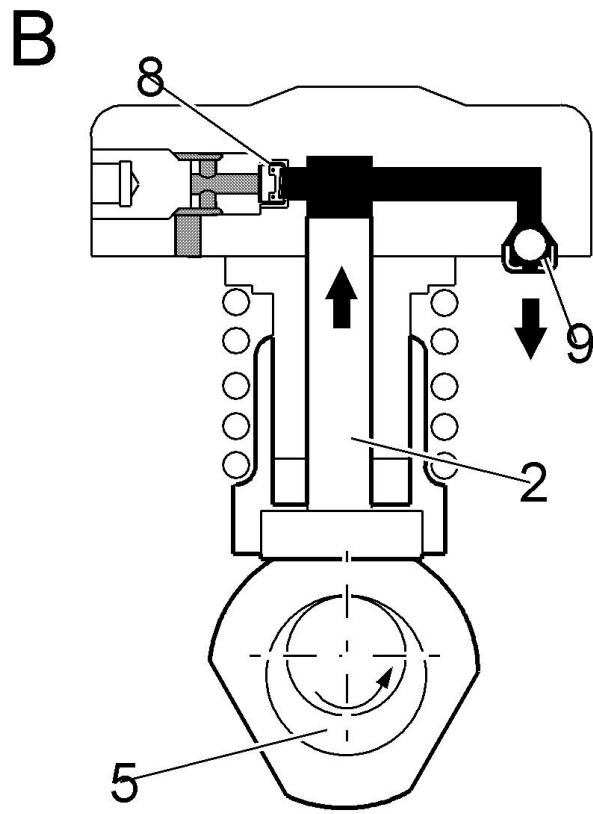
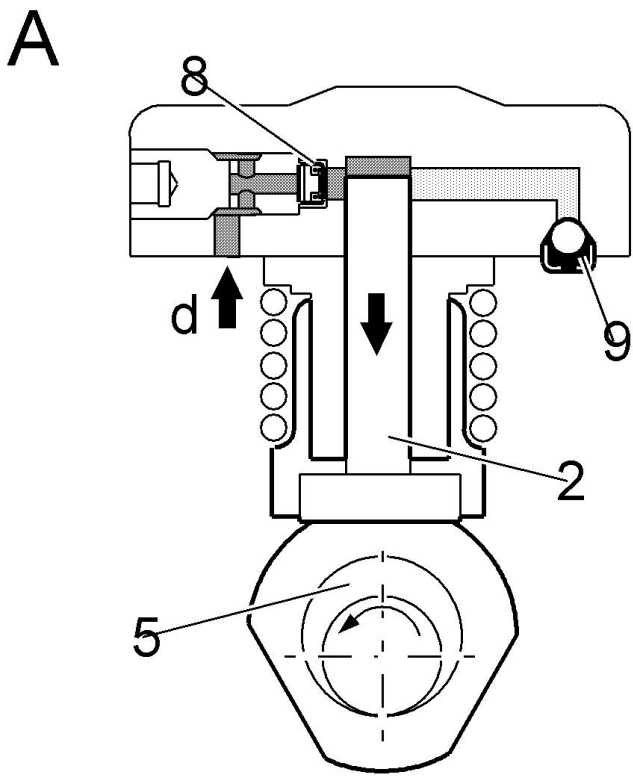
when the fuel flow actuator is not energised :

- the pressure limiter (6) opens
- the fuel is directed to the suction side of the transfer pump (1)

the lubricating valve (7) is used to lubricate the high pressure fuel pump

the fuel enters the fuel pump, passes through the lubricating valve (7) and returns to the tank,at " c "

4.3 - Creating The High Pressure



A-suction phase

B-delivery phase

(2)high pressure piston

(5)eccentric pump shaft

(8)fuel suction valve

(9)delivery ball valve

the shaft of the high pressure fuel pump contains a cam

the injection pistons are supplied with fuel by the low pressure circuit inside the high pressure pump

the fuel is drawn in by the piston during the suction phase

A-suction phase :

- the fuel from the flow actuator " d " is drawn in through the suction valve (8)
- the return spring pushes the piston back against the cam
- the piston creates a vacuum in the liner(the delivery valve (9) closes)

B-delivery phase :

- after bottom dead centre
- the fall in fuel pressure causes the suction valve to close (8)
- the fuel is blocked in the chamber
- the cam of the high pressure fuel pump pushes the piston
- the fuel pressure increases
- the fuel is delivered to the delivery valve
- the delivery valve (9) opens

after top dead centre, the delivery valve closes following the reduction in pressure

5 - Transfer Pump(Pre-Supply)

5.1 - Role

role of the transfer pump :

- to pump the fuel from the tank
- to supply the high pressure fuel pump(it compresses the fuel upstream of the fuel flow actuator)
- to lubricate and cool the high pressure fuel pump

5.2 - Description

transfer pump with 5 vanes, protected by the fuel pressure limiter (6)

the fuel pressure limiter (6) directs the fuel to the suction side of the transfer pump (1), if the fuel flow actuator (4) is closed

WARNING

no repair is authorised on the fuel high pressure pump

6 - Fuel Flow Actuator (1277)

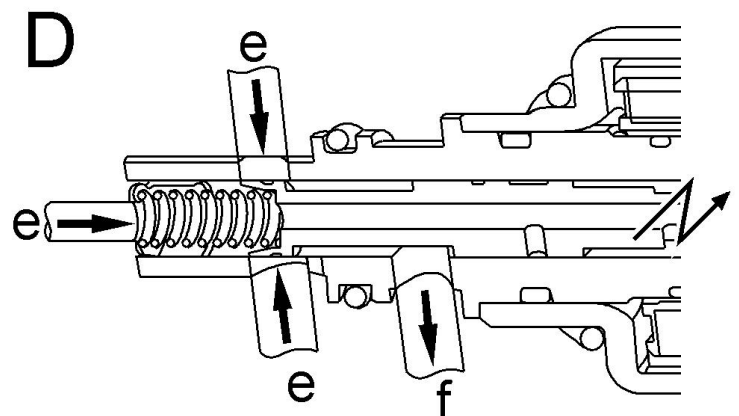
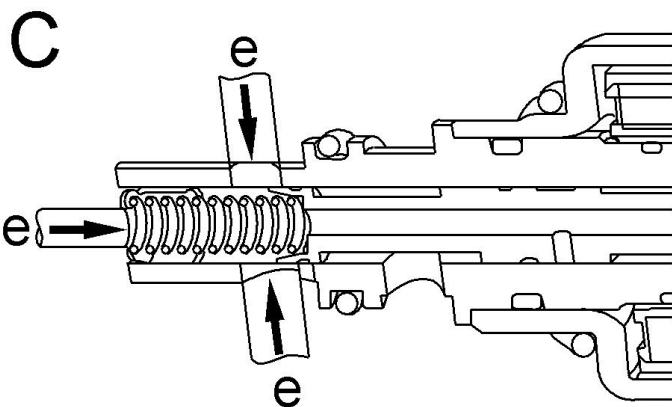
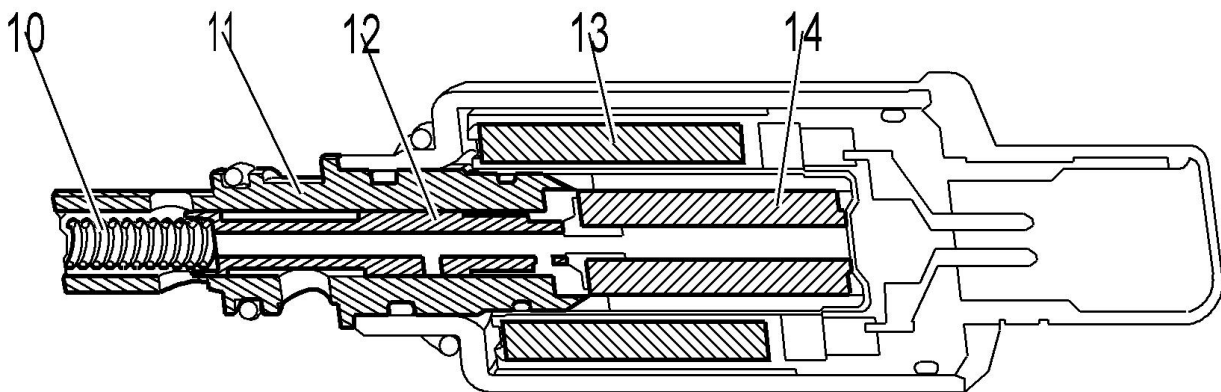
6.1 - Role

the fuel flow actuator :

- regulates the fuel flow allowed by the high pressure fuel pump
- admits the exact quantity of fuel required
- the transfer pump operates on reduced drive power compared to the BOSCH EDC15C2 system while still delivering the same quantity of fuel

the fuel flow is regulated by altering the cross section of the actuator nozzle

6.2 - Description



C-fuel flow actuator not energised

D-fuel flow actuator energised

(10)spring

(11)socket

(12)piston

(13)electric coil

(14)magnetic core

" e ":internal transfer pump supply

" f ": fuel to the high pressure stage of the high pressure fuel pump(fuel high pressure circuit)

when the fuel flow actuator (4) is not energised :

- the piston (12) is held at the end of its housing by the spring (10)
- the connection between the 2 pipes is closed
- the inlet to the high pressure stage of the high pressure fuel pump is closed
- the fuel is directed to the fuel pressure limiter (6), on the suction side of the transfer pump (1)

when the fuel flow actuator (4) is energised :

- the coil (13) of the fuel flow actuator moves the magnetic core (14)(magnetic force)
- the piston (12) moves
- the connection between the 2 pipes is open
- the fuel is directed to the high pressure stage of the high pressure fuel pump

6.3 - Electrical Features

the inlet to the high pressure fuel pump is closed when the fuel flow actuator is not controlled electrically

control:injection ECU(earth)

variable voltage control (OCR) :

- maximum voltage(OCR = 30 %)=maximum fuel flow
- minimum voltage(OCR = 0 %)=zero fuel flow

electrical specifications:resistor=2,4 ohms

NOTE

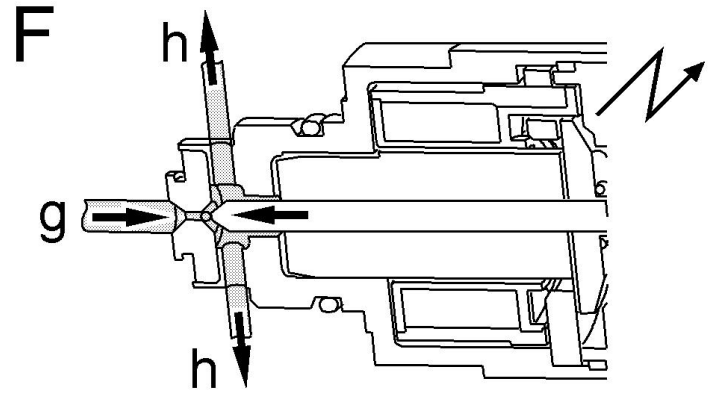
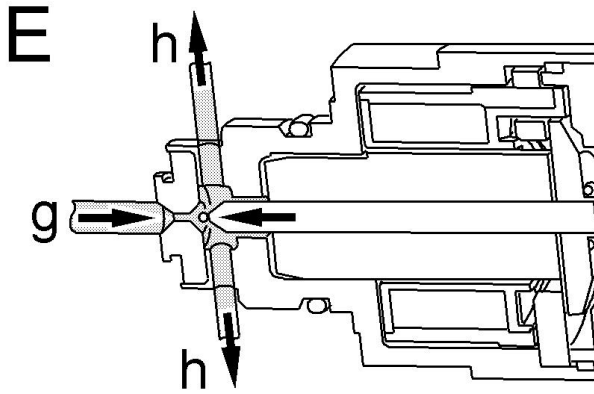
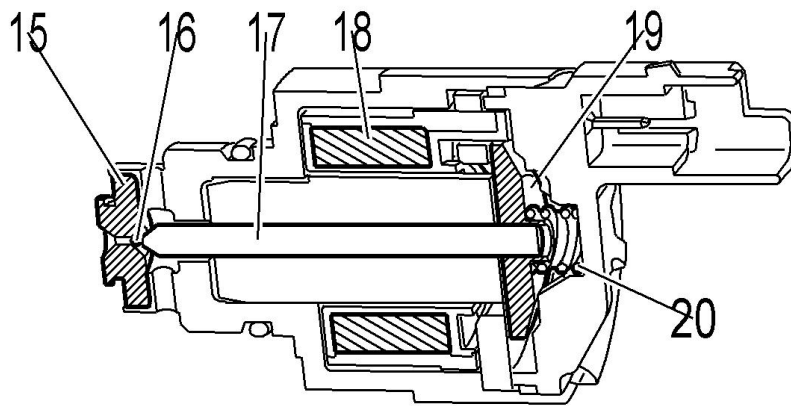
OCR : Open Cycle Ratio

7 - Fuel High Pressure Regulator(1322)

7.1 - Role

the high pressure fuel regulator regulates the pressure of the fuel at the outlet of the high pressure fuel pump

7.2 - Description



E-high pressure regulator not energised

F-high pressure regulator energised

(15)valve seat

(16)ball

(17)needle

(18)electric coil

(19)magnetic core

(20)spring

" g ":high pressure fuel circuit

" h ":return to fuel tank

the fuel high pressure is regulated by modifying the rating of the high pressure fuel regulator
the high pressure fuel regulator consists of 2 pressure control circuits :

- the electrical circuit which acts directly on the high pressure which controls the electromagnet of the high pressure fuel regulator(injection ECU)
- the mechanical circuit which provides a minimum pressure and dampens pulses

7.3 - Mechanical Operation

the high pressure fuel circuit is subject to pressure variations
the fuel high pressure increases when a pump piston delivers
the fuel high pressure decreases when a diesel injector is opened
the movement of the ball dampens pressure variations

7.4 - Electrical Operation

when the high pressure fuel regulator is not energised :

- the fuel high pressure opposes the mechanical action of the spring (20)
- the regulator opens for a high pressure which is greater than the spring pressure(+50 bar)
- the fuel released by the high pressure regulator returns to tank through the outlet " h "

NOTE

engine off for 30 seconds, there is no residual pressure in the high pressure fuel circuit

pressure rise control phases :

- the injection ECU supplies the high pressure fuel regulator with an OCR current
- the coil of the high pressure fuel regulator drives the magnetic core (magnetic force)
- the force applied to the ball is the sum of the spring force (20) and the magnetic force of the core
- the cut-out value of the high pressure regulator increases

pressure reduction control phases :

- the injection ECU reduces the OCR supplied to the coil of the high pressure fuel regulator
- the coil of the high pressure fuel regulator drives the magnetic core (magnetic force)
- the force applied to the ball reduces
- the cut-off valve of the high pressure regulator decreases

NOTE

OCR : Open Cycle Ratio

7.5 - Electrical Features

when the high pressure fuel regulator is not energised:the pressure is limited to +50 bar

control:injection ECU(earth)

variable voltage control (OCR) :

- maximum voltage(OCR = 30 %)=maximum pressure
- minimum voltage(OCR = 0 %)=minimum pressure

electrical specifications:resistor=2,7 ohms

IMPERATIVE

after switching off the engine, wait for 30 seconds before starting any repair work

8 - Battery (BB00)

the charge level of the battery is important for the HDI direct injection system to operate

WARNING

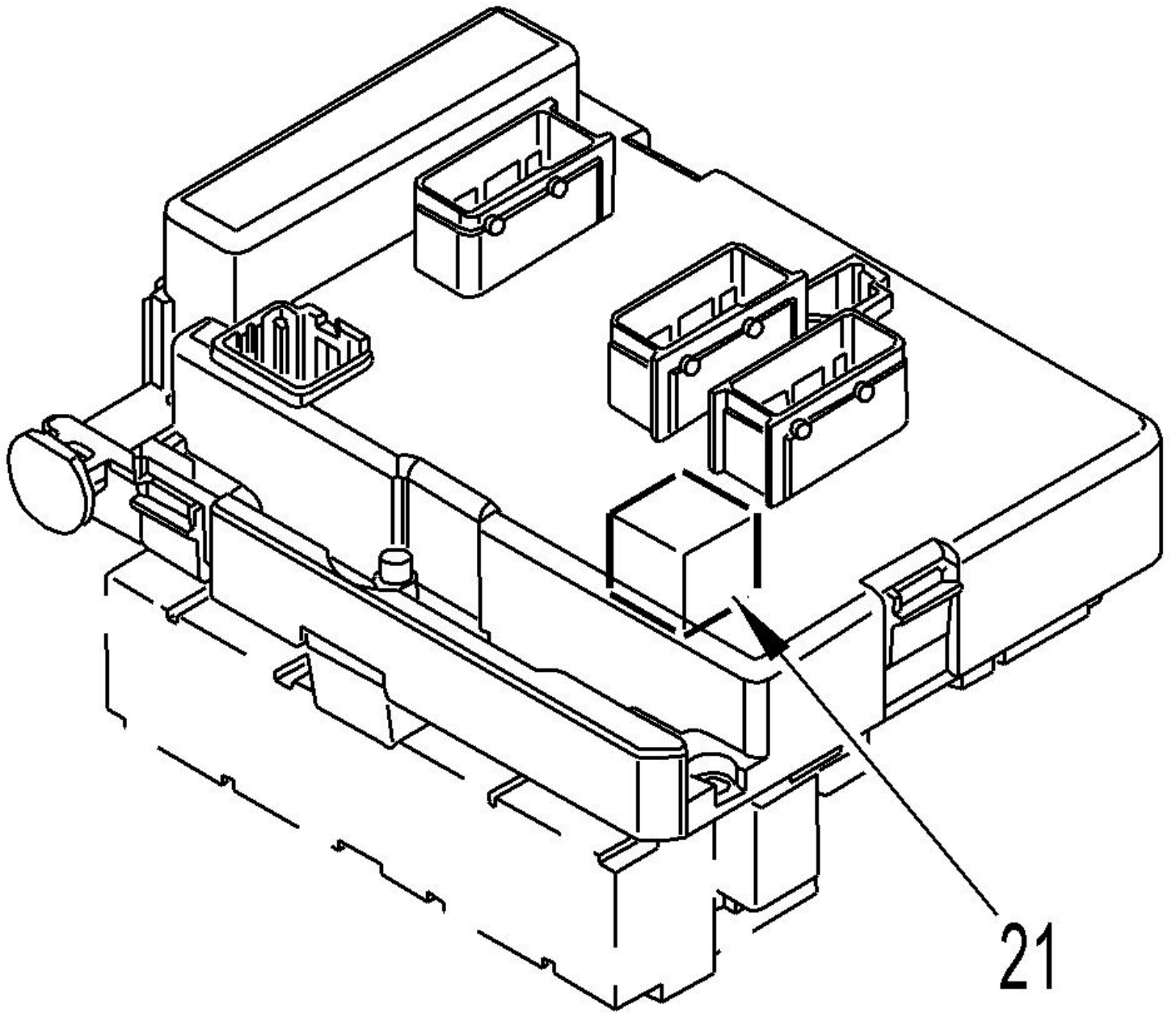
a battery voltage of less than 7 volts disturbs the operation of the HDI direct injection system

the ECU memorises a fault in the following cases :

- battery voltage greater than 18 volts
- battery voltage less than 6,5 volts

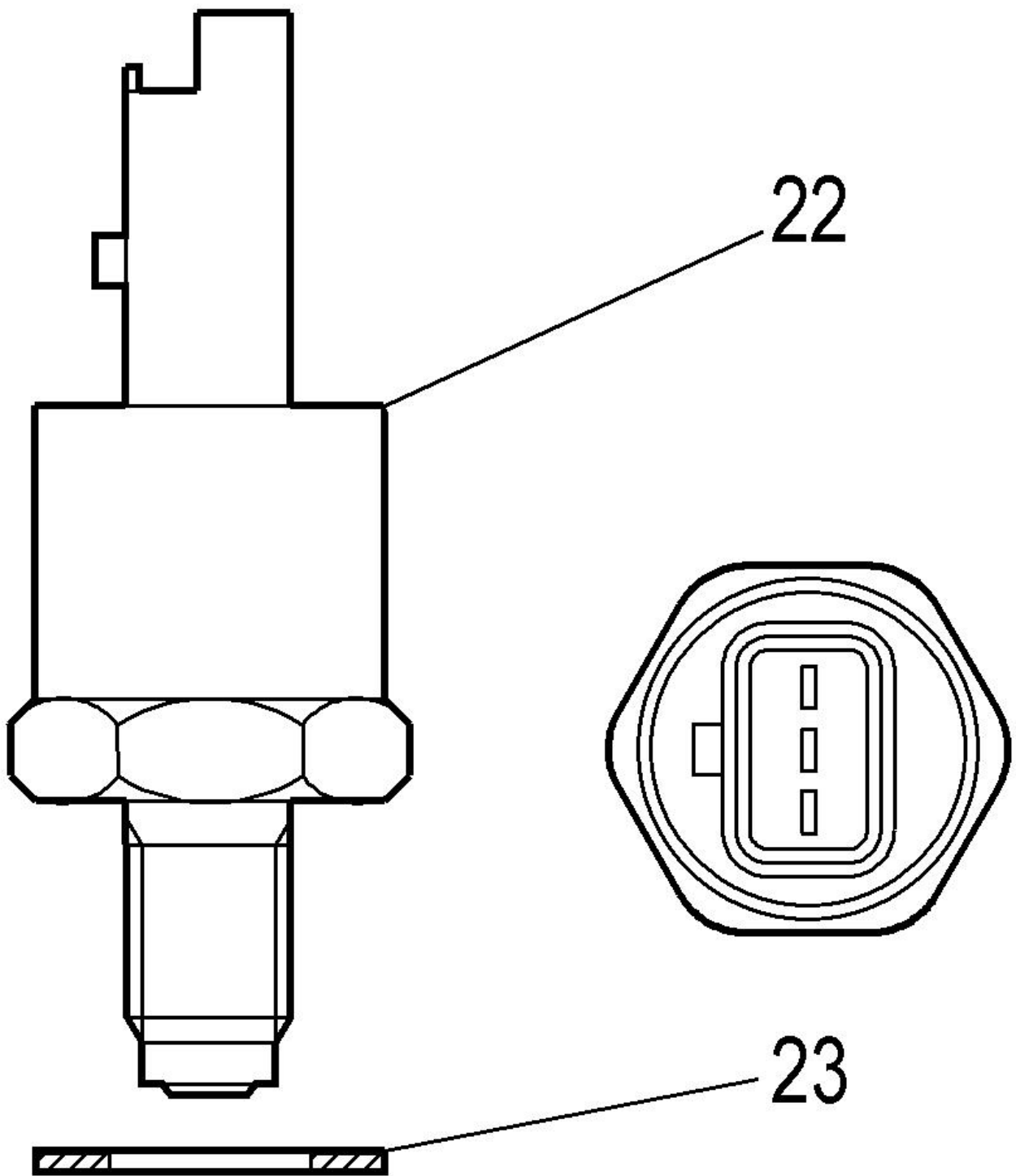
9 - Engine Fusebox Double Injection Relay-Special Feature

the double relay is incorporated into the engine relay unit(depending on the version)



(21)double relay

10 - Fuel High Pressure Sensor(1321)-Special Feature



(22)fuel high pressure sensor
 (23)metal seal

10.1 - Role

the sensor provides a voltage which is proportional to the fuel pressure in the high pressure common injection rail(50 to 1500 bars)

10.2 - Electrical Features

allocation of the connector channels :

- channel 1:pressure information (0 to 5 volts)
- channel 2: earth
- channel 3:+5 volts supply

voltage provided for a pressure of 300 bar:+1,2 volt
voltage provided for a pressure of 900 bar:+2,5 volts
special feature:channel allocation specific to the SIEMENS SID 801 injection system(channels 1 and 2 inverted compared to the BOSCH EDC 15C2 system)

11 - Injection ECU(1320)

11.1 - Role

the ECU controls the whole injection system

the ECU software integrates :

- check functionalities of injection and pollution control
- driving improvement strategies
- engine immobiliser function
- emergency strategies
- fan unit and warning lamp operating management(*)
- the diagnostic with memorisation of failures
- the cruise control function(*)

NOTE

(*)according to model

the ECU ensures the electrical control of the following elements :

- diesel injectors
- fuel high pressure regulator
- fuel flow actuator
- recycling regulation electrovalve (EGR)
- throttle control electrovalve (EGR)
- pre and post-heating control unit(post-heating cut-off)

the ECU supplies the following information :

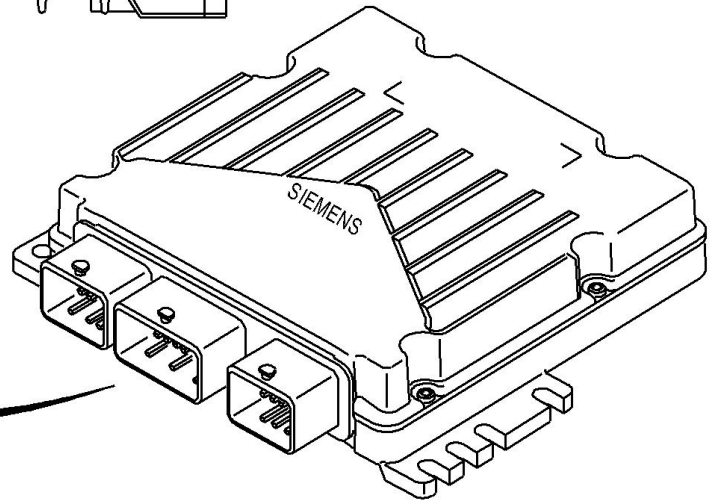
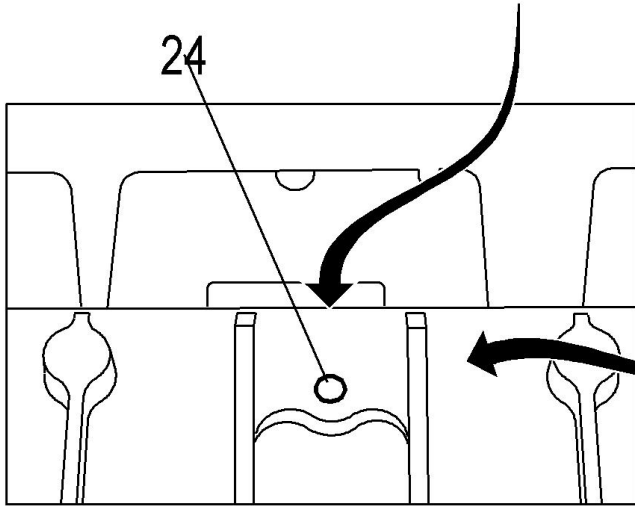
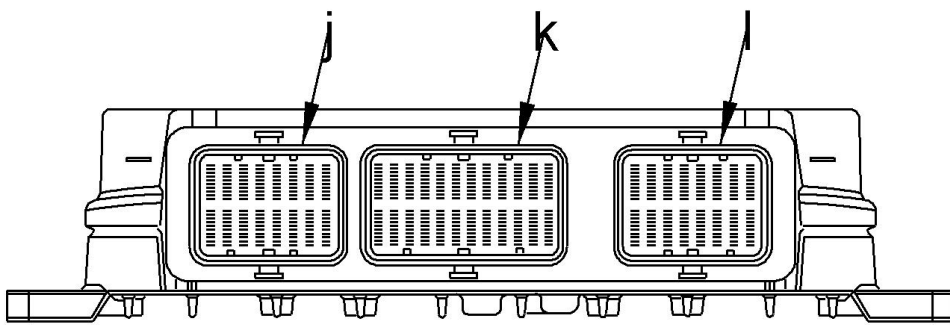
- engine speed:to the instrument panel
- consumption at any one time:to the on-board ECU
- air conditioning interruption

the atmospheric pressure sensor can not be separated from the injection ECU

the ECU contains a power stage which can supply the very high control current required for the diesel injectors to operate

the injection ECU software is updated by downloading(ECU fitted with a flash EPROM)

11.2 - Description



(22)atmospheric pressure sensor (1320)

" j " :connector CME(32 -way grey)

" k " :connector CMI(48 -way brown)

" l " :connector CH(32 -way black)

the injection ECU is linked to the injection harness by 3 modular connectors

connector assembly order :

- grey connector
- brown connector
- black connector

11.3 - Allocation Of The Connector Channels

channel No.	designation
A1	earth:camshaft position sensor
A2	-
A3	input:air flow signal(flowmeter)
A4	-
B1	input:vehicle speed(vehicle speed sensor)(according to equipment)
B2	-
B3	input:air flow signal(flowmeter)
B4	-
C1	output:control for preheating unit
C2	-
C3	-
C4	-

D1	input:camshaft sensor signal
D2	-
D3	input:fuel pressure
D4	-
E1	-
E2	-
E3	+12 volts supply
E4	output:air conditioning relay control(AC/OUT)
F1	-
F2	+12 volts supply(after double relay)(after engine fusebox double relay)
F3	+12 volts supply(after double relay)(after engine fusebox double relay)
F4	-
G1	output:recycling electrovalve control (EGR)
G2	-
G3	output:fuel flow actuator (VCV)
G4	-
H1	output:fuel high pressure regulator(PCV)
H2	power earth
H3	output:throttle housing electrovalve control (EGR)
H4	-

channel No.	description
A1	-
A2	-
A3	-
A4	-
B1	-
B2	-
B3	-
B4	-
C1	-
C2	-
C3	camshaft sensor supply(5 volts)
C4	-
D1	high pressure fuel sensor supply(5 volts)
D2	-
D3	-
D4	-
E1	earth:engine coolant temperature sensor
E2	output:control for preheating unit

E3	input:air temperature sensor(flowmeter)
E4	input:engine coolant temperature information
F1	output:double relay control(engine fusebox)
F2	earth:fuel high pressure sensor
F3	input:fuel temperature sensor
F4	-
G1	-
G2	earth:air flowmeter
G3	-
G4	battery +
H1	power relay control
H2	-
H3	-
H4	earth:fuel temperature sensor
J1	-
J2	-
J3	-
J4	input:engine speed sensor signal
K1	-
K2	power earth
K3	output:diagnostic LED control
K4	input:engine speed sensor signal
L1	output:control of injector N° 2
L2	output:control of injector N° 3
L3	output:control of injector N° 1
L4	output:control of injector N° 2
M1	output:control of injector N° 4
M2	output:control of injector N° 1
M3	output:control of injector N° 3
M4	output:control of injector N° 4

channel No.	description
A1	-
A2	-
A3	dialogue line: CAN L network
A4	dialogue line:CAN H network
B1	output 1:control of additional heating 1
B2	output:control of fan unit group 1(high speed)
B3	-
B4	diagnostic line K

C1	output 2:control of additional heating 2
C2	input:accelerator pedal sensor N° 2
C3	+12 volts supply(ignition switched +)
C4	diagnostic line for the coils of the fan unit control relays
D1	-
D2	-
D3	-
D4	output:control of fan unit group 2(low speed)
E1	-
E2	-
E3	input:clutch pedal switch
E4	input:unused brake switch
F1	-
F2	air conditioning circuit pressure sensor supply(5 volts)
F3	-
F4	earth:aircon circuit pressure sensor
G1	-
G2	accelerator pedal sensor supply(5 volts)
G3	input:accelerator pedal sensor N° 1
G4	power earth 1
H1	-
H2	air conditioning pressostat
H3	earthing of pedal sensor
H4	power earth 2

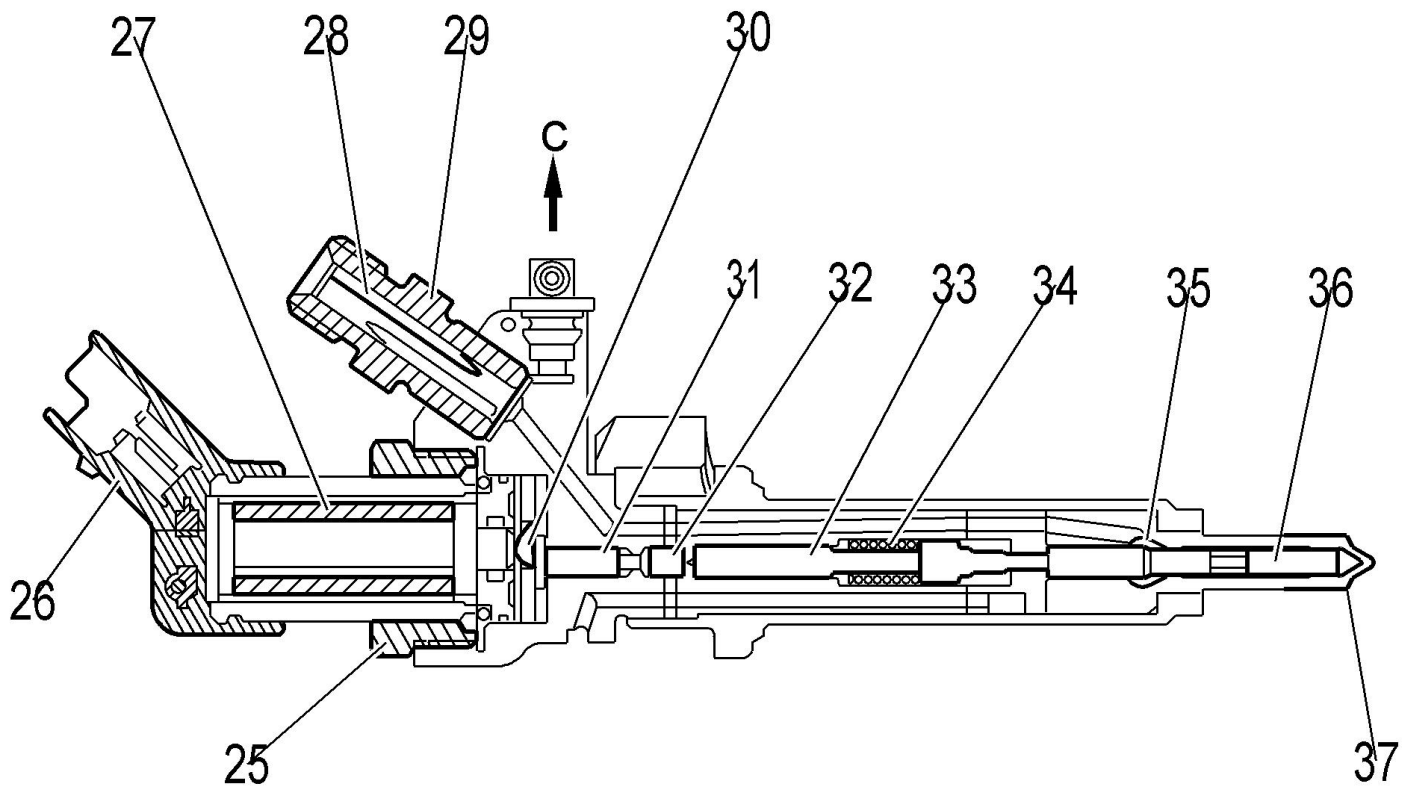
12 - Diesel Injectors(1331, 1332, 1333, 1334)

12.1 - Role

the diesel injectors inject the amount of fuel required for the engine to operate injecting the fuel directly into the top of the pistons improves engine efficiency the fuel can be injected in the following cases :

- pre-injection
- main injection

12.2 - Description



- (25)nut
- (26)electrical connector
- (27)Piezoelectric control element
- (28)laminar filter included in the connector (29)(0,03 to 0,05 mm)
- (29)high pressure fuel inlet connector
- (30)mechanical movement amplifier lever
- (31)opening control piston
- (32)diesel injector needle spring
- (33)diesel injector needle control piston
- (34)diesel injector spring
- (35)pressure chamber
- (36)diesel injector needle
- (37)diesel injector tip

" c ":return to fuel tank

the piezoelectric control element is located in the upper part of the diesel injector

the piezoelectric control element is secured to the body of the diesel injector by the nut (25)

the diesel injectors have 5 holes which encourage air/fuel mixing

NOTE

the diameter of the 5 holes of the diesel injectors are suited to the engine version(0,16 mm Ø)

IMPERATIVE

do not handle a diesel injector by means of its upper nut (25)(diesel injector will be damaged)

NOTE

the laminar filter requires no maintenance

the amount of fuel injected depends on the following parameters :

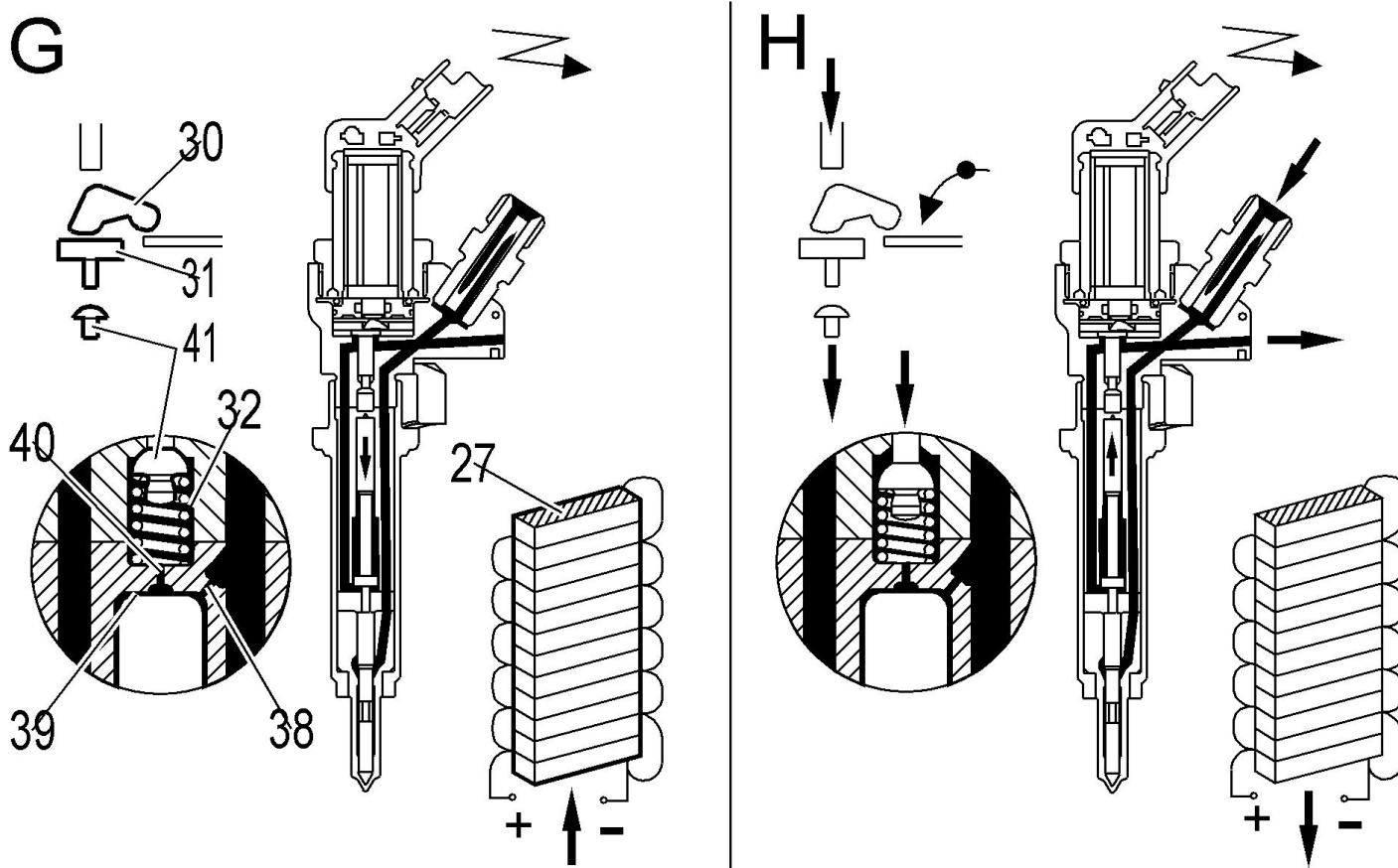
- duration of the electrical control(injection ECU)
- opening speed of the diesel injector
- hydraulic flow of the diesel injector (number and diameter of holes)
- fuel pressure in the fuel high pressure common injection rail

the fuel pressures used in the HDI direct injection system prevent the diesel injectors from being directly electrically controlled
the diesel injectors open due to the pressure difference between the control chamber (39) and the pressure chamber (35)
the diesel injector needle (36) is held against its seat by the spring (34)
the control piston (36) is fitted on top of the diesel injector needle (33)(the control piston is free within its bore)
the top of the control piston opens out into the control chamber (39)
the control chamber is connected to the following circuits :

- high pressure fuel circuit through the nozzle (38)
- fuel tank return circuit through the nozzle (40)

the control chamber (39) is isolated from the fuel return circuit by the opening control piston (31)
the diesel injector needle (36) is held against its seat by the spring (32)
the fuel is distributed evenly between chambers (35) and (39)
nozzle (40) is larger than nozzle (38)
the opening control piston (31) moves as soon as the piezoelectric control element (27) is supplied

12.3 - Lifting Principle Of A Diesel Injector



G-diesel injector closed

H-opening of a diesel injector

(27)Piezoelectric control element

(30)mechanical movement amplifier lever

(31)opening control piston

(32)diesel injector needle spring

(38)supply nozzle

- (39)control chamber
- (40)fuel return circuit nozzle
- (41)closure cap

12.4 - Diesel Injector Closed

the force exerted by the high pressure is the same between the control chamber (39) and the pressure chamber (35)
 the control piston is locked (held against the diesel injector needle)
 the rise in pressure in the fuel high pressure common injection rail encourages the diesel injector to close

12.5 - H-Opening Principle Of A Diesel Injector

the injection ECU supplies the piezoelectric control element
 the current applied distorts the piezoelectric control element, which extends(0,004 mm)
 the piezoelectric control element presses on the movement amplifier lever (30) which moves the opening control piston (31)
 operating phase when the opening control piston (31) moves under the action of the movement amplifier (30) :

- a fuel leak is created through the nozzle (40)
- fuel entering through the nozzle (38) does not compensate for the leak through the nozzle (40)(Ø of nozzle (40) different to the Ø of nozzle (38))
- there is no longer a pressure balance between chambers (39) and (35)
- the pressure in the pressure chamber (35) lifts the diesel injector needle
- the control piston lifts up
- the fuel is sent to the top of the piston

the injection ECU interrupts the supply to the piezoelectric control element:the charging current stops
 the fuel capacitor remains charged
 piezoelectric control element remains extended

NOTE

fuel injection lasts for as long as the piezoelectric control element is not discharged

NOTE

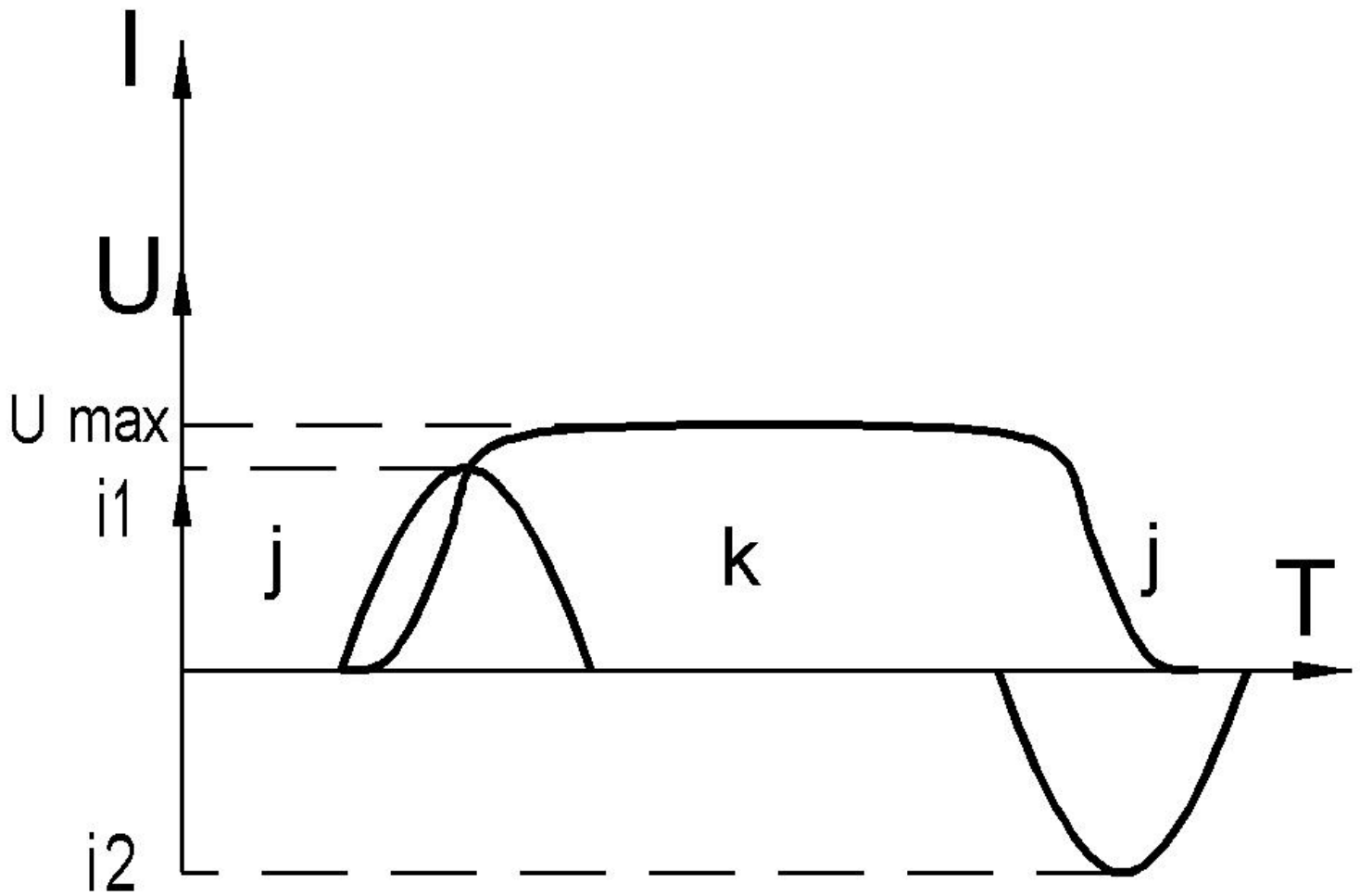
maximum control needle lift:+ 0,006 mm(0,004 x 1,5)

12.6 - G-Closing Principle Of A Diesel Injector

operating phase when the injection ECU supplies the piezoelectric control element of the diesel injector(with a discharge current) :

- the spring (32) holds the closure cap (41) against its seat
- the nozzle (40) is blocked
- the fuel leak to the return circuit stops
- the rise in pressure in the control chamber (39) causes the diesel injector to close
- the pressure balance is restored between chambers (39) and (35)
- the diesel injector is ready for a new cycle

12.7 - Control Of The Diesel Injectors ((1331, 1332, 1333, 1334))



diesel injector control current :

- T-duration
- I-amps
- U-volts
- " i1 " :charge current
- " i2 " :discharge current
- " j " :diesel injector closed
- " k " :diesel injector open

the piezoelectric control element is controlled in 2 phases :

- charging phase of the piezoelectric control element(extension = opening)
- discharging phase of the piezoelectric control element(retraction = closing)

Piezoelectric control element :

- consists of 250 layers
- polarised

12.8 - Features Of The Electrical Control

allocation of the connector channels :

- channel 1:+ polarity
- channel 2:- polarity

electrical specifications :

- resistor=200 000 ohms
- capacity=0,003 - 0,0038 farad

WARNING

given the presence of high voltages at the terminals of the ECU and diesel injectors, voltages should always be measured with the recommended equipment

WARNING

do not supply a diesel injector with 12 volts(diesel injector will be damaged)

WARNING

Inverting the polarity of the diesel injector control wires will destroy the piezoelectric control element(destructive retraction)

WARNING

do not operate a diesel injector, outside the cylinder head, unless its body is connected to the vehicle's earth(risk of electrostatic discharge)

IMPERATIVE

it is forbidden to disconnect a diesel injector while the engine is running(risk of damaging the engine)
