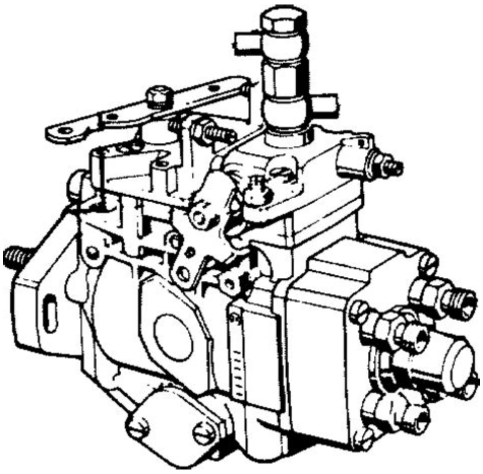

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bosch ve fuel injection pump manual

Regarding exhaust\ngas emissions, the diesel engine is just\nas good as a gasoline engine with\ncatalytic converter. In some cases, it is\neven better. It was \nalso possible during the past few years\nto considerably lower the particulate\nemissions which are typical for the\ndiesel engine. \nThe popularity of the highspeed diesel\nengine in the passenger car though,\nwould have been impossible without \nthe diesel fuelinjection systems from\nBosch. The very high level of precision\ninherent in the distributor pump means\nthat it is possible to precisely meter\nextremely small injection quantities to\nthe engine. And thanks to the special\ngovernor installed with the VEpump in\npassengercar applications, the engine\nresponds immediately to even the finest\nchange in acceleratorpedal setting. The\ncylinder charge heats up even further\nand the cylinder pressure increases\nagain. For this rea\nson, DI engines are used in all commer\ncialvehicles and trucks. On the other\nhand, due to their lower noise level,\nprechamber engines are fitted in passen\nger cars where comfort plays a more im\nportant role than it does in the commer\ncialvehicle sector. In addition, the\nprechamber diesel engine features con\nsiderably lower toxic emissions HC and\nNOX, and is less costly to produce than\nthe DI engine. The fact though that the\nprechamber engine uses slightly more\nfuel than the DI engine 10.15% is\nleading to the DI engine coming more\nand more to the forefront. Compared to\nthe gasoline engine, both diesel versions\nare more economical especially in the\npartload range. \n \n Diesel engines are particularly suitable\nfor use with exhaustgas turbochargers\nor mechanical superchargers. Using an\nexhaustgas turbocharger with the diesel\nengine increases not only the power\nyield, and with it the efficiency, but also\nreduces the combustion noise and the\ntoxic content of the exhaust gas.http://alkhalil-eg.com/userfiles/canon-f1-new-manual.xml

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\n \n Dieselengine exhaust\nemissions\n A variety of different combustion deposits\nare formed when diesel fuel is burnt.\nThese reaction products are dependent\nupon engine design, engine power out\nput, and working load.\nThe complete combustion of the fuel\nleads to major reductions in the forma\ntion of toxic substances. Complete com\nbustion is supported by the careful\nmatching of the airfuel mixture, abso\nlute precision in the injection process,\nand optimum airfuel mixture turbulence.\nIn the first place, water H2O and carbon\ndioxide CO2 are generated. This is\nof particular importance in commercial\napplications.As the name implies, this com\nprises the pump barrel and the corre\nsponding plunger. The pump camshaft\nintegrated in the pump and driven by the\nengine, forces the pump plunger in \nthe delivery direction. The plunger is re\nturned by its spring. \nThe plungerandbarrel assemblies are\narranged inline, and plunger lift cannot\nbe varied. By way of an actuator shaft,\nthis can vary the plunger lift to port closing,\n \n and with it the start of delivery and the start\nof injection. Compared \nto the standard PE inline injection pump\ntherefore, the controlsleeve version fea\ntures an additional degree of freedom.\n \n Distributor fuelinjection\npumps\n Distributor pumps have a mechanical\nflyweight governor, or an electronic\ncontrol with integrated timing device. Pressure generation, and distribu\ntion to the individual engine cylinders, is\nthe job of a central piston which runs on\na cam plate. For one revolution of the\ndriveshaft, the piston performs as many\nstrokes as there are engine cylinders.\nThe rotatingreciprocating movement is\nimparted to the plunger by the cams on\nthe underside of the cam plate which ride\non the rollers of the roller ring.http://www.amerpolauto.pl/upload/canon-fax-730i-user-manual.xml

\nOn the conventional VE axialpiston dis\ntributor pump with mechanical flyweight\ngovernor, or electronically controlled\nactuator, a control collar defines the\neffective stroke and with it the injected\nfuel quantity. On the conventional solenoid\nvalvecontrolled axialpiston distributor\npump, instead of a control collar an \nelectronically controlled highpressure\nsolenoid valve controls the injected fuel\nquantity. A radialpiston pump with cam ring\nand two to four radial pistons is responsible\n \n Diesel fuel\ninjection\n \n systems\nAn overview\n \n 6 \n\n \n for generation of the high pressure and for\nfuel delivery. The injected fuel quantity is\nmetered by a highpressure solenoid\nvalve. They have no camshaft of\ntheir own, although they correspond to\nthe PE inline injection pumps regarding\ntheir method of operation. In the case of\nlarge engines, the mechanicalhydraulic\ngovernor or electronic controller is at\ntached directly to the engine block. The\nfuelquantity adjustment as defined by\nthe governor or controller is transferred\nby a rack integrated in the engine. \nThe actuating cams for the individual PF\nsingleplunger pumps are located on the\nengine camshaft. This means that injec\ntion timing cannot be implemented by\nrotating the camshaft. It is a modular highpressure in\njection system. Similar to the UIS, the\nUPS system features one UPS single\nplunger injection pump for each engine\ncylinder. The use\nof a highspeed electronically triggered\nsolenoid valve enables the character\nistic of the individual injection process,\nthe socalled rateofdischarge curve, to\nbe precisely defined. \n \n Accumulator injection\nsystem\nCommonRail system CR\n Pressure generation and the actual injec\ntion process have been decoupled from\neach other in the Common Rail accumu\nlator injection system.

The injection pres\nsure is generated independent of engine\nspeed and injected fuel quantity, and is\nstored, ready for each injection process,\nin the rail fuel accumulator. A rotat\ningreciprocating movement is imparted\nto the distributor plunger by way of the\ncam plate which is driven by the input\nshaft and rides on the rollers of the \nroller ring. The plunger moves inside \nthe distributor head which is bolted to the\npump housing. If the distributor pump is also\nequipped with a mechanical fuel shutoff\ndevice this is mounted in the governor\ncover.\nThe governor assembly comprising the\nflyweights and the control sleeve is \ndriven by the drive shaft gear with \nrubber damper via a gear pair. The \ngovernor linkage mechanism which\nconsists of the control, starting, and\ntensioning levers, can pivot in the\nhousing.\nThe governor shifts the position of the\ncontrol collar on the pump plunger. The governor cover\nforms the top of the distributor pump, and\n \n also contains the fullload adjusting\nscrew, the overflow restriction or the\noverflow valve, and the enginespeed\nadjusting screw. For 4stroke engines, the\npump is driven at exactly half the engine\ncrankshaft speed, in other words \nat camshaft speed. Distributor pumps\nare available for clockwise and for \ncounterclockwise rotation, whereby the\ninjection sequence differs depending\nupon the direction of rotation. \nThe fuel outlets though are always \nsupplied with fuel in their geometric \nsequence, and are identified with the \nletters A, B, C etc.It delivers a\nvirtually constant flow of fuel per\nrevolution to the interior of the injection\npump. A pressurecontrol valve is fitted\nto ensure that a defined injectionpump\ninterior pressure is maintained as a\nfunction of supplypump speed. Using\nthis valve, it is possible to set a defined\npressure for a given speed. Some of the\nfuel flows through the pressure\nregulating valve and returns to the\nsuction side.

Some fuel also flows\nthrough the overflow restriction and \nback to the fuel tank in order to pro\nvide cooling and selfventing for the\ninjection pump Fig. 2. An overflow valve\ncan be fitted instead of the overflow\nrestriction.\n \n Fuelline configuration\n For the injection pump to function ef\nficiently it is necessary that its high\npressure stage is continually provided\nwith pressurized fuel which is free of \nvapor bubbles. Normally, in the case of\npassenger cars and light commercial \nvehicles, the difference in height between\nthe fuel tank and the fuelinjection \nequipment is negligible. Furthermore, the\nfuel lines are not too long and they have\nadequate internal diameters. As a result,\nthe vanetype supply pump in the\n \n injection pump is powerful enough to draw\nthe fuel out of the fuel tank and to build up\nsufficient pressure in the interior of the in\njection pump.\nIn those cases in which the difference \nin height between fuel tank and injection\npump is excessive and or the fuel line\nbetween tank and pump is too long, a\npresupply pump must be installed. This\novercomes the resistances in the fuel \nline and the fuel filter. Gravityfeed \ntanks are mainly used on stationary\nengines.\n \n Fuel tank\n The fuel tank must be of noncorroding\nmaterial, and must remain free of leaks \nat double the operating pressure and in\nany case at 0.3 bar. Suitable openings or\nsafety valves must be provided, or \nsimilar measures taken, in order to\npermit excess pressure to escape of \nits own accord. Fuel must not leak past\nthe filler cap or through pressure\ncompensation devices. The fuel tank and the\nengine must be so far apart from each\nother that in case of an accident there is\nno danger of fire.

In addition, special\nregulations concerning the height of the\nfuel tank and its protective shielding\napply to vehicles with open cabins, as\nwell as to tractors and buses\n \n Fuel lines\n As an alternative to steel pipes, flame\ninhibiting, steelbraidarmored flexible\nfuel lines can be used for the low\npressure stage. This means that a fuel filter \nspecifically aligned to the requirements\nof the fuelinjection system is absolutely\nimperative if troublefree operation and \na long service life are to be achieved.\nFuel can contain water in bound form\nemulsion or unbound form e.g.,\ncondensation due to temperature\nchanges. If this water gets into the\ninjection pump, corrosion damage can be\nthe result. Distributor pumps must\ntherefore be equipped with a fuel filter\nincorporating a water accumulator from\nwhich the water must be drained off at\nregular intervals. At the same time, some of the\nfuel flows through a second passage to\nthe pressurecontrol valve.\n \n Pressurecontrol valve\n The pressurecontrol valve Fig. 5 is\nconnected through a passage to the \nupper outlet kidneyshaped recess, and\nis mounted in the immediate vicinity of\nthe fuelsupply pump. It permits a variable \namount of fuel to return to the fuel tank\nthrough a narrow passage. The\npressurized fuel then travels to the\ninjection nozzles through the delivery\nvalves and the fuelinjection tubing.\n \n Distributorplunger drive\n The rotary movement of the drive shaft \nis transferred to the distributor plunger\nvia a coupling unit Fig. 7, whereby the\ndogs on cam plate and drive shaft\nengage with the recesses in the yoke,\nwhich is located between the end of the\ndrive shaft and the cam plate. The distributor plunger \nis forced upwards to its TDC position \nby the cams on the cam plate, and the\ntwo symmetrically arranged plunger\nreturn springs force it back down again to\nits BDC position.

\nThe plungerreturn springs abut at one\nend against the distributor head and at\nthe other their force is directed to the\nplunger through a link element. These\nsprings also prevent the cam plate\njumping off the rollers during harsh\nacceleration. The lengths of the return\nsprings are carefully matched to each\nother so that the plunger is not displaced\nfrom its centered position Fig. 8.\n \n Cam plates and cam contours\n The cam plate and its cam contour in\nfluence the fuelinjection pressure and \nthe injection duration, whereby cam\nstroke and plungerlift velocity are the\ndecisive criteria. Considering the different\ncombustionchamber configurations and\ncombustion systems used in the various\nengine types, it becomes imperative that\nthe fuelinjection factors are individually\ntailored to each other. For this reason, a\nspecial camplate surface is generated for\neach engine type and machined into the\ncamplate face. This defined cam plate is\nthen assembled in the corresponding\ndistributor pump. Small\nleakage losses are nevertheless un\navoidable, as well as being desirable for\nplunger lubrication. For this reason, the\ndistributor head is only to be replaced \nas a complete assembly, and never the\nplunger, control collar, or distributor\nflange alone.\n \n Fuel metering\n The fuel delivery from a fuelinjection\npump is a dynamic process comprising\nseveral stroke phases Fig. 9. The\npressure required for the actual fuel \ninjection is generated by the highpres\nsure pump. It has the \njob of relieving the pressure in the line \nby removing a defined volume of fuel \nupon completion of the delivery phase.\nThis ensures precise closing of the in\njection nozzle at the end of the injection\nprocess. At the same time, stable\npressure conditions between injection\npulses are created in the highpressure\nlines, regardless of the quantity of fuel\nbeing injected at a particular time.\n \n The delivery valve is a plungertype\nvalve.

During delivery, \nthe pressure generated in the high\npressure chamber above the plunger\ncauses the delivery valve to open. This\nthough generates pressure waves \nwhich are reflected at the delivery \nvalve. These cause the delivery valve \nto open again, or cause vacuum phases\nin the highpressure line. These pro\ncesses result in postinjection of fuel with\nattendant increases in exhaust emis\nsions or cavitation and wear in the injec\ntion line or at the nozzle. To prevent such\nharmful reflections, the delivery valve is\nprovided with a restriction bore which is\nonly effective in the direction of return\nflow. The highpres\nsure lines connect the injection pump \nto the injection nozzles and are routed \nso that they have no sharp bends. Apart from this, upon driving off\nthe engine must not tend to stall. The\nengine must respond to accelerator\npedal changes by accelerating or decel\nerating smoothly and without hesitation.\nOn the flat, or on a constant gradient,\nwith the accelerator pedal held in a given\nposition, the vehicle speed should also \nremain constant. When the pedal is \nreleased the engine must brake the\nvehicle. It is a sensitive control\ndevice which determines the position \nof the control collar, thereby defining \nthe delivery stroke and with it the injected\nfuel quantity. Depending upon type, the gov\nernor is also responsible for keeping\ncertain engine speeds constant, such \nas idle speed, or the minimum and\nmaximum engine speeds of a stipulated\nenginespeed range, or of the complete\nspeed range, between idle and maxi\nmum speed. Within \ncertain limits, these governors can also\nmaintain the engine speeds between \nidle and maximum constant. Within the\nspeedcontrol range, the increase in \nengine speed is not to exceed a given \nfigure. This is stipulated as the high idle\nspeed. This is the engine speed which\nresults when the diesel engine, starting\nat its maximum speed under full load, is\nrelieved of all load.

For instance, on an\nengine used to power an electrical gen\nerator set, a small speed droop is re\nquired so that load changes result in \nonly minor speed changes and there\nfore minimal frequency changes. On the\nother hand, for automotive applications\nlarge speed droops are preferable\nbecause these result in more stable\ncontrol in case of only slight load\nchanges acceleration or deceleration\nand lead to better driveability. The variablespeed governor \nis also often fitted in commercial and\nagricultural vehicles tractors and\ncombine harvesters.\n \n Design and construction\n The governor assembly is driven by the\ndrive shaft and comprises the flyweight\nhousing complete with flyweights.\nThe governor assembly is attached to \nthe governor shaft which is fixed in the\n \n governor housing, and is free to rotate\naround it. When the flyweights rotate \nthey pivot outwards due to centrifugal\nforce and their radial movement is\nconverted to an axial movement of the \nsliding sleeve. The slidingsleeve travel\nand the force developed by the sleeve\ninfluence the governor lever assembly.\nThis comprises the starting lever, ten\nsioning lever, and adjusting lever not\nshown. The interaction of spring forces\nand slidingsleeve force defines the \nsetting of the governor lever assembly,\nvariations of which are transferred to \nthe control collar and result in adjust\nments to the injected fuel quantity.\n \n Starting\n With the engine at standstill, the fly\nweights and the sliding sleeve are in their\ninitial position Fig. 3a. The start\ning lever has been pushed to the start\nposition by the starting spring and has\npivoted around its fulcrum M2. At the\nsame time the control collar on the dis\ntributor plunger has been shifted to its\n \n Axialpiston\ndistributor\n \n pumps\n \n 24\n \n Variablespeed governor.It can be\nshifted by the fueldelivery adjusting\nscrew not shown in Figure 3.

Similarly,\nthe start lever and tensioning lever are\nalso able to rotate in the adjusting lever.\nA ball pin which engages in the control\ncollar is attached to the underside of \nthe start lever, and the start spring to \nits upper section. The idle spring is \nattached to a retaining pin at the top \nend of the tensioning lever. Also \nattached to this pin is the governor\nspring. The connection to the engine\nspeed control lever is through a lever and\nthe controllever shaft.\nIt only needs a very low speed for the \nsliding sleeve to shift against the soft\nstart spring by the amount a. In the \nprocess, the start lever pivots around\nfulcrum M2 and the start quantity is auto\nmatically reduced to the idle quantity.\n \n Lowidlespeed control\n With the engine running, and the\naccelerator pedal released, the engine\nspeed control lever shifts to the idle \nposition Figure 3b up against the idle\nspeed adjusting screw. The idle speed \nis selected so that the engine still runs\nreliably and smoothly when unloaded or\nonly slightly loaded. At speeds\nabove idle, the spring has been\ncompressed by the amount c and is no \nlonger effective. Using the special idle\nspring attached to the governor housing,\n \n this means that idle speed can be\nadjusted independent of the accelerator\npedal setting, and can be increased or\ndecreased as a function of temperature\nor load.\n \n Operation under load\n During actual operation, depending \nupon the required engine speed or\nvehicle speed, the enginespeed control\nlever is in a given position within its \npivot range. This is stipulated by the \ndriver through a given setting of the \naccelerator pedal. At engine speeds \nabove idle, start spring and idle spring\nhave been compressed completely and\nhave no further effect on governor\naction.

As a result of \nthis adjustment of the controllever \nposition, the governor spring is ten\nsioned by a given amount, with the \nresult that the governorspring force \nexceeds the centrifugal force of the \nflyweights and causes the start lever and\nthe tensioning lever to pivot around \nfulcrum M2. As a result, the \ndelivery quantity is increased and the\nengine speed rises. This\nmeans that during operation, and as long\nas the engine is not overloaded, every\nposition of the enginespeed control lever\nis allocated to a specific speed range\nbetween fullload and zero. The \nresult is that within the limits set by its\nspeed droop, the governor maintains the\ndesired speed Fig. 4.\nIf the load increases to such an extent\nfor instance on a gradient that even\nthough the control collar is in the full\nload position the engine speed con\ntinues to drop, this indicates that it is \nimpossible to increase fuel delivery any\nfurther. This causes\nthe flyweights to move outwards so that\nthe sliding sleeve presses against the\ntensioning and start levers. Both levers\nchange their position and push the\ncontrol collar in the direction of less fuel \ndelivery until a reduced fueldelivery \nfigure is reached which corresponds to\nthe new loading level. At the extreme,\nthe delivery figure is zero. The speed range between these\npoints is directly controlled by the ac\ncelerator pedal Fig. 6.\n \n Design and construction\n The governor assembly with flyweights,\nand the lever configuration, are com\nparable with those of the variablespeed \ngovernor already dealt with. The main\ndifference lies in the governor spring and\nits installation. It is in the form of \na compression spring and is held in a\nguide element. Tensioning lever and \ngovernor spring are connected by a\nretaining pin.\n \n Starting\n With the engine at standstill, the fly\nweights are also stationary and the \nsliding sleeve is in its initial position.

This\nenables the starting spring to push the\nflyweights to their inner position through\nthe starting lever and the sliding sleeve.\nOn the distributor plunger, the control\ncollar is in the startquantity position.\n \n Idle control\n Once the engine is running and the\naccelerator pedal has been released, the\nenginespeed control lever is pulled back\nto the idle position by its return spring.\nThe centrifugal force generated by the\nflyweights increases along with engine\nspeed Fig. 7a and the inner flyweight\nlegs push the sliding sleeve up against\nthe start lever. The idle spring on the\ntensioning lever is responsible for the\ncontrolling action. The\nstarting and idle springs are no longer\neffective and the intermediate spring \ncomes into effect. If the engine\nspeed control lever is pressed even \nfurther in the fullload direction, the \nintermediate spring is compressed until\nthe tensioning lever abuts against the\nretaining pin Fig. 7b. The intermediate\nspring is now ineffective and the\nuncontrolled range has been entered.\nThis uncontrolled range is a function of\nthe governorspring pretension, and in\nthis range the spring can be regarded as \na solid element. The acceleratorpedal\nposition enginespeed control lever is\nnow transferred directly through the \ngovernor lever mechanism to the control\ncollar, which means that the injected \n \n fuel quantity is directly determined by the\naccelerator pedal. Example Fig. 1\nStart of delivery FB takes place after\nthe inlet port is closed. The high pres\nsure then builds up in the pump which, \nas soon as the nozzleopening pres\nsure has been reached leads to the \nstart of injection SB. The period\nbetween FB and SB is referred to as the \ninjection lag SV. The increasing\ncompression of the airfuel mixture in the\ncombustion chamber then initiates the\nignition VB. The period between SB\nand VB is the ignition lag ZV.

As soon\nas the cutoff port is opened again the\npump pressure collapses end of pump\ndelivery, and the nozzle needle closes\nagain end of injection, SE. This is \nfollowed by the end of combustion VE.\n \n Assignment\n During the fueldelivery process, the\ninjection nozzle is opened by a pressure\nwave which propagates in the high\npressure line at the speed of sound. \nBasically speaking, the time required for\nthis process is independent of engine\nspeed, although with increasing engine\nspeed the crankshaft angle between\nstart of delivery and start of injection \nalso increases. This must be\ncompensated for by advancing the \nstart of delivery. The interval\nrepresented by this propagation time is\ntermed the injection lag. In other words,\nthe start of injection lags behind the start\nof delivery. As a \nrule, the ignition lag is in the order \nof 1 millisecond. This means that pre\nsuming a constant start of injection, the\ncrankshaft angle between start of\ninjection and start of combustion\nincreases along with increasing engine\nspeed. In other\nwords, the roller ring has been rotated\nthrough a defined angle with respect \nto the cam plate and the distributor \nplunger. In other words,\nthe engine should receive precisely the\namount of fuel it needs. The \nfueldelivery curve of an injection pump\nwithout torque control is shown in Fig. 3.\nAs can be seen, with the same setting of\nthe control collar on the distributor\nplunger, the injection pump delivers\nslightly more fuel at high speeds than it\ndoes at lower speeds. Performance would be below\noptimum. Fullload\ntorque control using the governor lever\nassembly is applied in those cases in\nwhich the positive fullload torque control\nwith the delivery valve no longer suffices,\nor a negative fullload torque control has\nbecome necessary.\n \n Positive torque control\n Positive torque control is required on\nthose injection pumps which deliver too\nmuch fuel at higher engine revs.

When this speed\nis reached, the slidingsleeve force F M\nand the spring preload must be in \nequilibrium, whereby the torquecontrol\nlever 6 abuts against the stop lug 5 \nof the tensioning lever 4. The free end\nof the torquecontrol lever 6 abuts\nagainst the torquecontrol pin 7.\nIf engine speed now increases, the \nslidingsleeve force acting against the\nstarting lever 1 increases and the \ncommon pivot point M4 of starting \nlever and torquecontrol lever 6 \nchanges its position. Torque control ceases\nas soon as the torquecontrolpin collar\n10 abuts against the starting lever 1.\n \n Negative torque control\n Negative torque control may be \nnecessary in the case of engines which\nhave blacksmoke problems in the \nlower speed range, or which must \ngenerate specific torque characteristics.\nSimilarly, turbocharged engines also\nneed negative torque control when the\nmanifoldpressure compensator LDA\nhas ceased to be effective. In this case,\nthe fuel delivery is increased along with\nengine speed Fig. 3.\n \n Negative torque control using the\ngovernor lever assembly Fig. 4b\nOnce the starting spring 9 has been\ncompressed, the torquecontrol lever \n6 applies pressure to the tensioning \nlever 4 through the stop lug 5. The\ntorquecontrol pin 7 also abuts against\nthe tensioning lever 4. If the sliding\nsleeve force F M increases due to rising\nengine speed, the torquecontrol lever\n \n presses against the preloaded torque\ncontrol spring. As soon as the slid\ningsleeve force exceeds the torque\ncontrol spring force, the torquecontrol \nlever 6 is forced in the direction of the\ntorquecontrolpin collar. As a result, the\ncommon pivot point M4 of the starting\nlever and torquecontrol lever changes its\nposition. This means that the brake \nhorsepower can be increased corre\nsponding to the increase in air mass \nFigure 6. In addition, it is often possible \nto also reduce the specific fuel con\nsumption.

This is performed\nby the manifoldpressure compensator\nwhich, below a given selectable\nchargeair pressure, reduces the fullload\nquantity.\n \n Design and construction\nThe LDA is mounted on the top of the\ndistributor pump Fig. 7. In turn, the top\nof the LDA incorporates the connection\nfor the chargeair and the vent bore. The \ninterior of the LDA is divided into two \nseparate airtight chambers by a dia\nphragm to which pressure is applied by \na spring. The initial\nsetting of the diaphragm and the sliding\npin is set by the adjusting screw in the top\nof the LDA.\n \n Method of operation\nIn the lower enginespeed range the\nchargeair pressure generated by the\nexhaust turbocharger and applied to the\ndiaphragm is insufficient to overcome the\npressure of the spring. The diaphragm\nremains in its initial position. As soon as\nthe chargeair pressure applied to the\ndiaphragm becomes effective, the dia\nphragm, and with it the sliding pin and\ncontrol cone, shift against the force of the\nspring. Fuel\ndelivery is adapted in response to the\nincreased air mass in the combustion\nchamber Fig. 8. On the other hand,\nwhen the chargeair pressure drops, \nthe spring underneath the diaphragm\npushes the diaphragm upwards, and with\nit the sliding pin. The compensation\naction of the governor lever mechanism\nnow takes place in the reverse direction\nand the injected fuel quantity is adapted\nto the change in charge pressure. Should\nthe turbocharger fail, the LDA reverts to\nits initial position and the engine operates\nnormally without developing smoke. If this speed is reached and the\nload is less than full load, the speed \nincreases even further, because with a\nrise in speed the flyweights swivel\noutwards and shift the sliding sleeve. On\nthe one hand, this reduces the delivery\nquantity in line with the conventional \ngoverning process. If the position of the control\nlever remains unchanged and the load\nincreases again, the engine speed drops.