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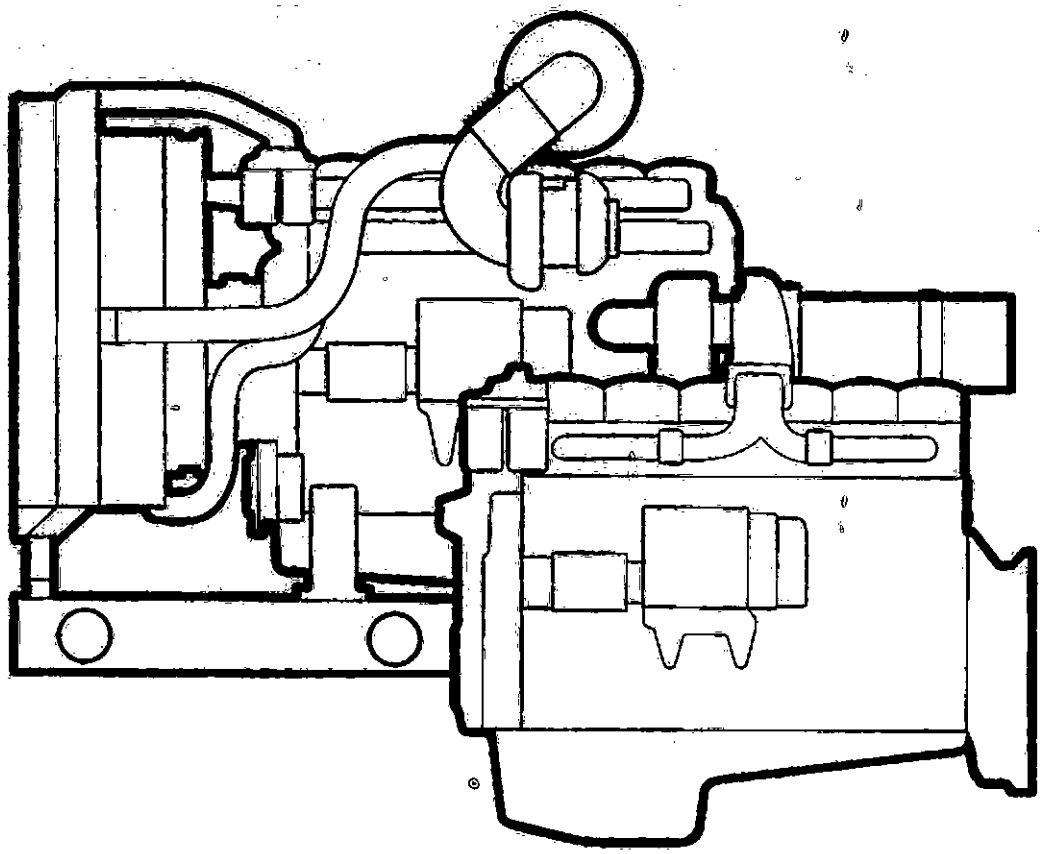
INSTALLATION

FUEL SYSTEM
AIR INTAKE
EXHAUST SYSTEM
VENTILATION



General instructions

VOLVO

Foreword

The instructions in this booklet apply for our industrial diesel engines and consist of general outlines that are mainly intended as a guidance for designers when designing engine installations.

In order to obtain an installation that is reliable, it is of the utmost importance that the given recommendations are followed and that the greatest of care is taken during the installation work. If problems arise that are not covered here, contact the Technical Marketing Service – Industrial Engines Sales, for further information.

VOLVO PENTA
Technical Publications Dept.

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General instructions

Contents

FUEL SYSTEM

The parts making up the fuel system must be installed with the greatest of care to avoid any leakage, and the careful planning of the location of the fuel tank(s) must be done before the installation work can proceed. Good quality components must always be choosen to avoid leakage. A leaking fuel system always involves a risk of interruptions in operation and fire.

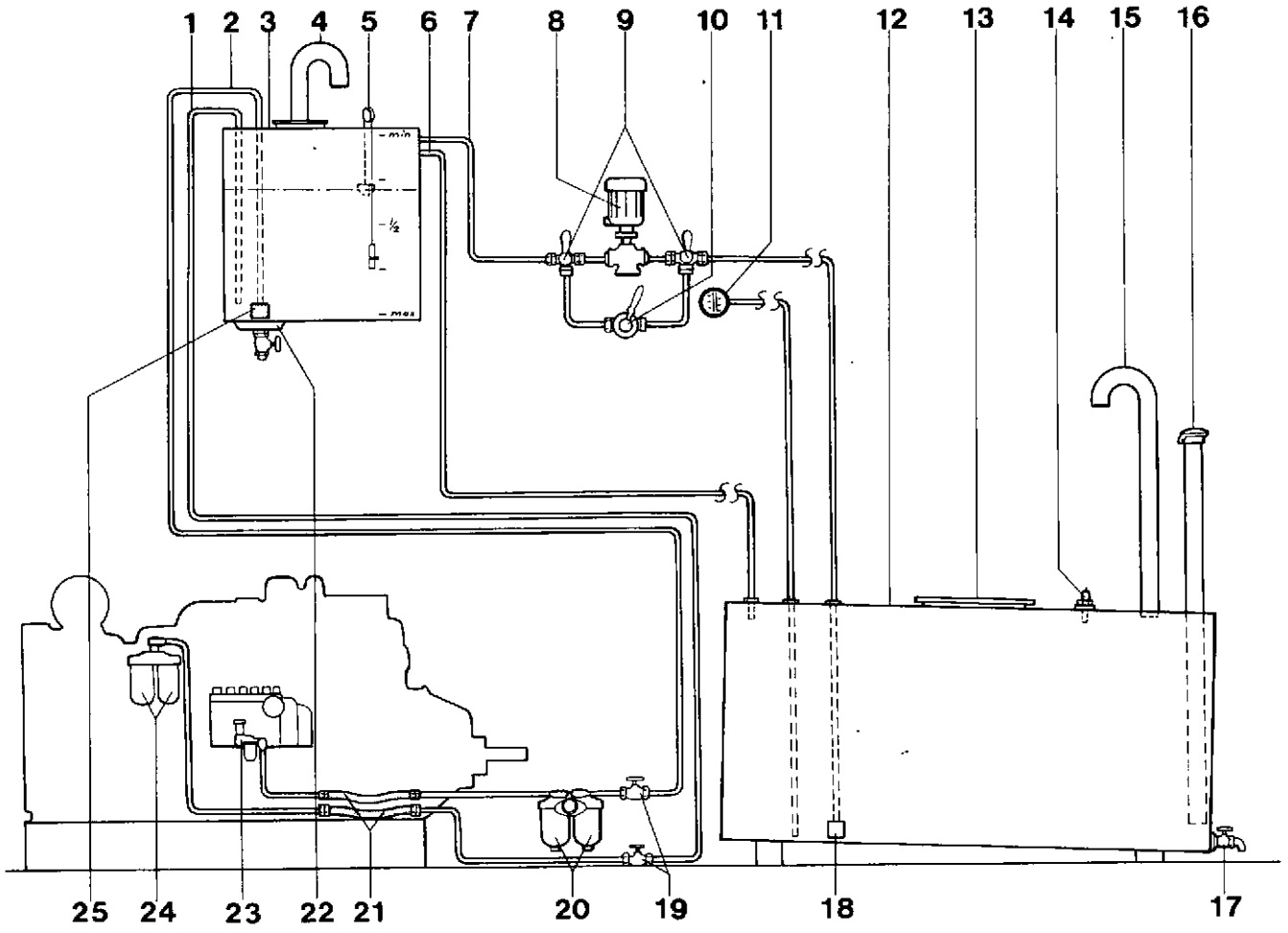


Fig. 1. Fuel system

1. Return pipe from engine
2. Suction line
3. Day tank
4. Venting pipe with inspection cover
5. Level marking
6. Return pipe to supply tank
7. Feed pipe from supply tank
8. Electrically driven pump
9. Cocks, 3-way
10. Hand pump
11. Fuel gauge
12. Supply tank
13. Inspection cover
14. Electronic overflow protection
15. Venting pipe
16. Filler pipe
17. Draining cock
18. Suction strainer
19. Closing cocks
20. Optional fuel filter
21. Flexible fuel hoses
22. Sludge and water separator with drain cock
23. Feed pump
24. Fuel filter
25. Suction strainer

Fuel tank

Location

If possible, the fuel tank should be located level with or just above the engine. If located lower, attention must be paid to the maximum suction height of the feed pump, which is *1 m (3.2 ft) for all engines. Note, that the suction height* shall be calculated from the bottom of the tank.

If the tank is located lower than the suction height permits, or if such a large tank is required that it must be located a long distance from the engine, a so called day tank must be fitted at the right height and distance from the engine, see fig. 1. The fuel transfer from the supply tank to the day tank is carried out by an electrical pump, which is connected so that it starts and stops at the same time as the diesel engine (the surplus fuel runs back to the supply tank). One can also use a level connector which starts and stops the pump. **If the return pipe is connected to the suction pipe operational problems can occur.**

Material

The fuel tanks should preferably be made of stainless steel or steel plate. Copper plate, galvanised or hot-zinced plate are completely unsuitable as material for diesel fuel tanks.

Construction

The tanks must be welded and for mobile installations fitted with baffle plates, which stop the fuel from being thrown around in the tank. The baffle plates also function as support plates, see fig. 2.

The filler pipe should have an inner diameter of at least 1 1/2" (38 mm). It should end about 50 mm (2") above the tank bottom. If the pipe is lengthened with a hose, this must be re-inforced and of a fuel resistant quality. The filler cap can be of the same kind that is used for diesel trucks or as such being used for tanks in private homes.

Further, the tanks must be fitted with venting pipe, sludge and water separator with draining possibilities and some kind of level marker (mechanical, electrical or pneumatic). Large tanks must be fitted with overflow protection and inspection covers that allow the tank to be cleaned inside. Instead of fitting large tanks with a sludge and water separator, they can be mounted so that they tilt somewhat (about 3°) in relation to the ground plane, see fig. 1.

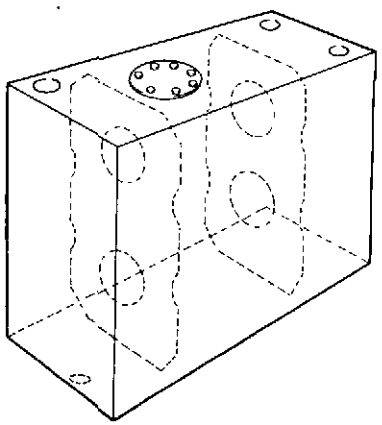


Fig. 2. Fuel tank with baffle plates (mobile installations)

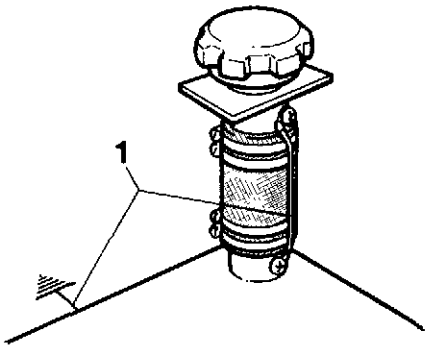


Fig. 3. Fuel tank with filler pipe

1. Earth cables

After manufacture, the tank must be thoroughly cleaned inside. The welding joints and plates must be brushed quite clean and vacuum cleaned, so that all oxide scales are removed. The tank should then be pressure-tested with at least 30 kPa (0.3 kp/cm^2/4.4 p.s.i.).

The outside of the tank is to be painted with rust protective paint. **The inside of the tank must not be given any rust protection treatment such as painting or galvanising.** If the tank is not being used at once it should be treated inside with a suitable rust protective oil, unless it is made of stainless steel.

Before fitting, the tank must be flushed with clean fuel oil.

To avoid sparks caused by static electricity (particularly in mobile installations), the fuel tank must be earthed. If the filler pipe is lenghtened with a hose and if the filler cap fitting is not earthed through the body, an earth wire must be fitted as per fig. 3.

Fuel lines

Bundy type steel pipes should preferably be used as material for fuel pipes. The pipes are connected to the engine by a type of fleixble fuel hose that is sold by Volvo Penta (fits pipes with 10 mm/0.4" outer diameter). If the engine has rubber mounts, flexible fuel hoses must unconditionally be used. The hoses are fitted with so called Ermeto connections and if the fuel pipes need joining, then either such connections can be used or the pipe ends must be flared with a special tool. Loose brass cones must not be used. If brass cones are used, which is not recommended, these must be brazed (common tin soldering will not hold). Classifiable engines are supplied with flexible fuel hoses.

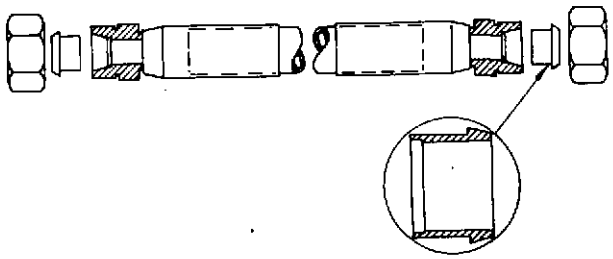


Fig. 4. Flexible fuel hose with Ermeto connections

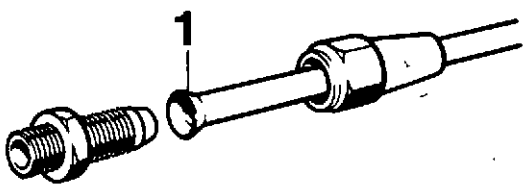


Fig. 5. Flared pipe end (1)

The fuel suction line to the engine should have an outer diameter of 3/8" (10 mm) for lengths up to about 6 m (20 ft). If the suction line is longer, a larger dimension is needed, preferably with an outer diameter of 1/2" (12 mm).

A fuel return line should be run from the engine's relief valve to the tank or day tank, if fitted. NOTE! It is forbidden to connect the suction line and the return line together. If this is done, the fuel pump will not be vented. Furthermore, the fuel will become heated which leads to reduced output and bad cooling of the injection pump. **The fuel return line must be of minimum 3/8" (10 mm) outer diameter.** If several engines are to be connected to the same fuel tank, a simplified fuel line installation is obtained if the engine's suction and return lines are joined to larger common lines to the tank.

The mouth of the suction line is located about 2.5 cm (1") above the bottom of the tank. The line is to be fitted with a suction strainer that is large enough to avoid the risk of stoppage in the fuel supply in cold weather due to paraffin depositing or that any condensation water freezes. The strainer should also be located about 2.5 cm (1") above the bottom of the tank. If the tank is located lower than the engine, the return line must run in below the lowest fuel level, as far away as possible from the suction line. In this way the fuel will not run out of the injection pump during long standstills.

If the difference in level in the fuel tank exceeds 2 m (6.6") and the tank is located higher than the engine, it is important that both lines are connected to the tank at the same height, so that there will be no difference in pressure between the lines. In this case the lines should be connected to the lower part of the tank.

Avoid locating the fuel lines in such a way that they will be exposed to high radiant heat.

At heights exceeding 1 m (3.3") the fuel lines must be fitted with cocks, as close as possible to the injection pump. It must be possible to shut off the fuel supply and thus avoiding that the fuel is pressed passed the pump elements and out into the engine lubrication oil during long standstills.

Optional fuel filter

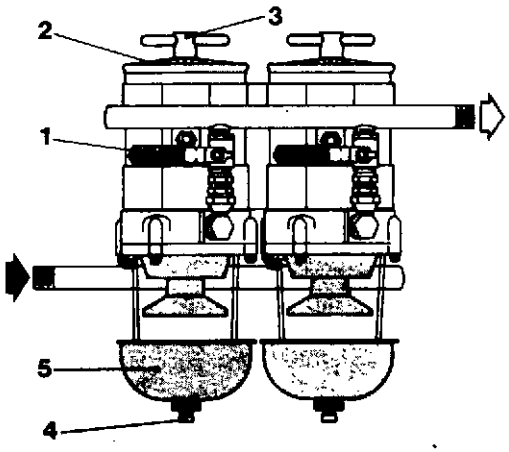


Fig. 6. Optional fuel filter
(available from Volvo Penta)

1. Valve lever (closed position)
2. Cover
3. Fixing bolt
4. Drain plug
5. Heat shield

Replacing of insert and cleaning can be carried out during running.

For installations placing greater demands of reliable running, an extra sludge and water separator fuel filter must be fitted.

Note, that all fuel filters that are fitted with water drains must be fitted low in relation to the fuel tank so that the fuel is pressed into the filter through the siphon effect. This makes the filter more effective, easier to vent and it prevents air from getting into the filter when the water is drained.

If the engine installation is exposed to low temperatures, any optional fuel filters should be located where the radiant heat from the engine will prevent the filters from freezing. **If there is a risk of freezing, any water in the filters must be drained when stopping the engine. This particularly applies for filters with a glass container, where the container could break through freezing allowing the whole fuel tank to be emptied.**

NOTE! Use winter fuel at low temperatures. At extremely low temperatures it might be necessary to heat the fuel.

EXHAUST SYSTEM

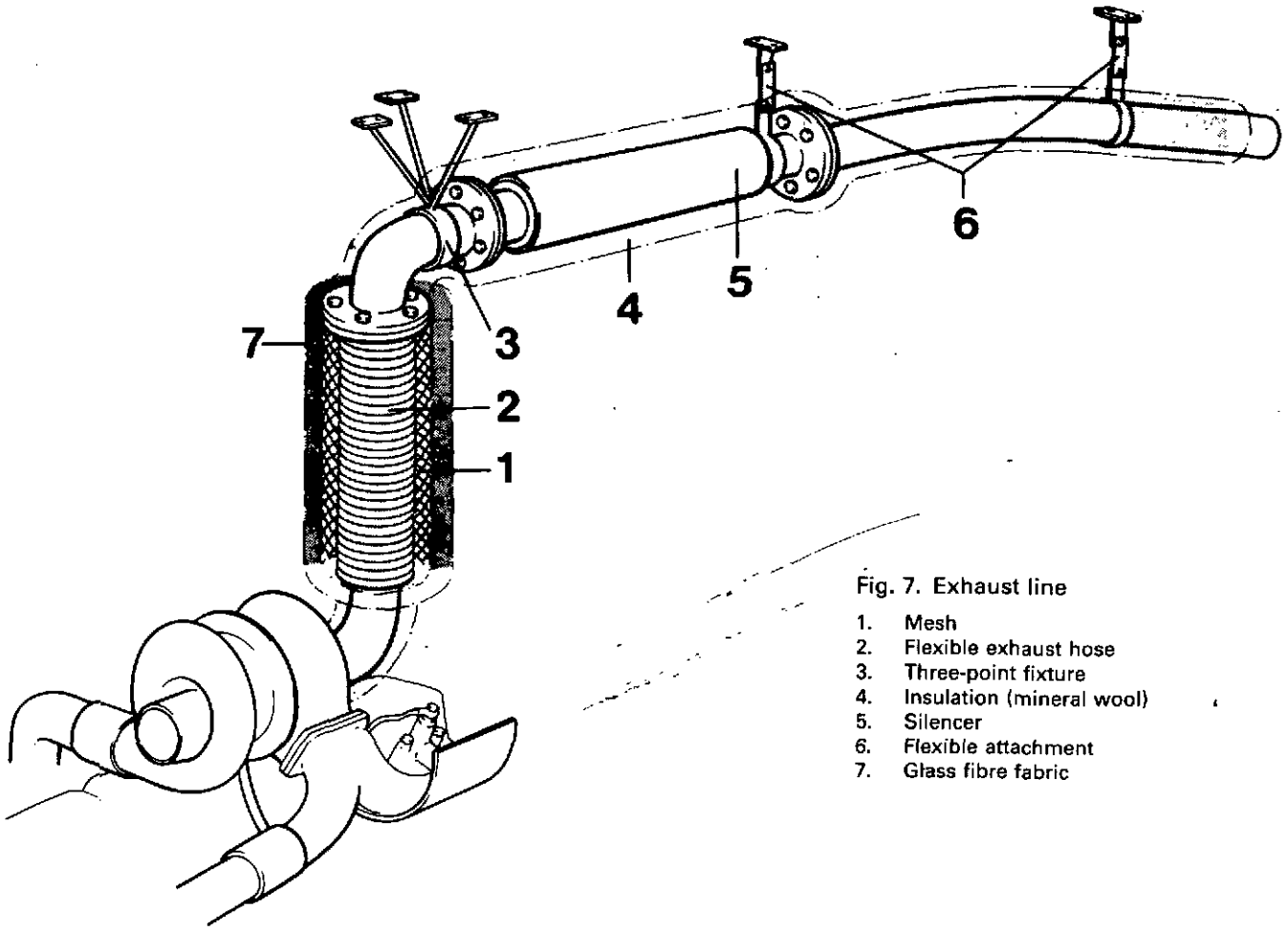


Fig. 7. Exhaust line

1. Mesh
2. Flexible exhaust hose
3. Three-point fixture
4. Insulation (mineral wool)
5. Silencer
6. Flexible attachment
7. Glass fibre fabric

The exhaust lines should be constructed so that the counter-pressure is as low as possible. The thickness must be determined in relation to the length of the line and the number of bends. The bends should have large bending radius, i.e. at least 2.5 times the diameter. See page 8 for dimensions.

A dry exhaust line is the most common and allows for a simple and cheap installation. To be able to use the energy from the exhausts for heating (of e.g. workshop), the engine can be fitted with a sheaved exhaust manifold and/or sheaved exhaust line, see the Installation Manual for heavy marine engines.

If several engines are connected to a common exhaust line, each branch connection should be fitted with an efficient closing device. Otherwise exhausts from running engines can enter into any engine not in use and cause corrosion damage there.

The outlet of the exhaust line should be directed so, or be fitted with such a device, that rain water cannot enter. The outlet must evidently not be located close to an air intake.

When a dry exhaust line is used, attention must be paid to the pipe's lengthwise expansion. This means that one or more compensators might be needed depending on the construction and length of the exhaust line, see fig. 8.

Long exhaust lines should be divided into sections where every section is suspended firmly at one end and fitted with compensator at the other end.

If the exhaust line is short, compensators are usually not needed if flexible suspension is used, see fig. 7.

In all installations, a flexible exhaust line should be fitted between the turbocharger and the exhaust line. The exhaust hose is only intended to absorb small radial movements.

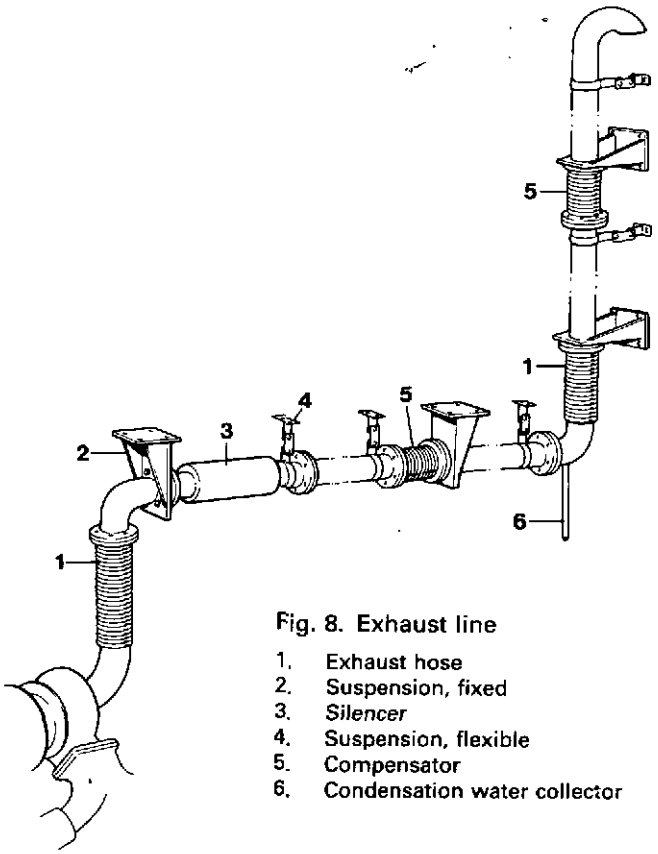


Fig. 8. Exhaust line

1. Exhaust hose
2. Suspension, fixed
3. *Silencer*
4. Suspension, flexible
5. Compensator
6. Condensation water collector

Exhaust hose

(available from Volvo Penta)

To prevent vibrations and thermal stresses from being carried from the exhaust system to the engine (the turbocharger is particularly sensitive), a flexible exhaust hose should be fitted between the turbocharger and the exhaust line, see figs. 7 and 8. This will also reduce the noise level. Note, that the exhaust hose is supposed to take up small radial movement, not any twisting or axial movement. It must not be bent. The hose can be fitted in different positions, but should preferably be fitted vertically. The fixture for the exhaust line should be located as close to the exhaust hose as possible to prevent this from being exposed to too large movements from the exhaust line's expansion process.

Exhaust line material

Steel pipe is used as material in the exhaust line. For several reasons this is regarded as the most suitable material. It is strong, robust and comparatively cheap. Steel pipes are available at standard dimensions and lengths, which generally makes it simple to obtain.

Compensator

(available from Volvo Penta)

Compensators are used for taking up the lengthwise expansion in exhaust lines and are available in different lengths. When fitting, the exhaust line's length both when cold and hot must be calculated so that the limits for the compensator's compensation limits are not exceeded. The compensator must under no circumstances bear the weight of the exhaust line or silencer.

Example of compensator data

Installed measurement mm (ins)	Compensation mm (ins)
185 (7.3)	+15–50 (0.6"–2") (from 185) (from 7.3")
85 (3.3)	+ 5–13 (0.2"–0.5") (from 85) (from 3.3")

Connection

For connection of the exhaust line to the engine a flange, which is welded to the line, is required, see fig. 9. The inner diameter of the connecting flange should be at least as large as the inner diameter of the exhaust line. If a pipe with large thickness of material is used, it is advisable to taper it at the contact surface against the flange.

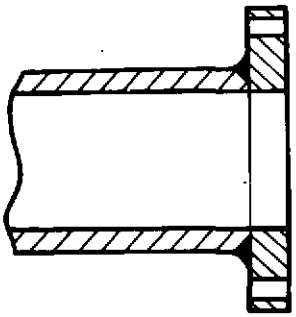


Fig. 9. Exhaust pipe with flange

Silencer

The silencer should be located as close to the engine as possible. If it is located too far away from the engine, the operating temperature will get too low, which can cause carbonization and thus increasing the counter-pressure.

Different kinds of silencers are stocked by Volvo Penta, of e.g. car type (with or without connecting flanges) and a heavier version (type Burgess). For counter-pressure measurements etc. see the binder "Sales Manual".

When choosing the silencer, regard must be taken to the counter-pressure caused by the silencer. The total counter-pressure in both the exhaust pipe and silencer must not exceed the maximum permissible value, see the respective engine broschures.

The silencer should be fitted so that its marking coincides with the gas flow direction.

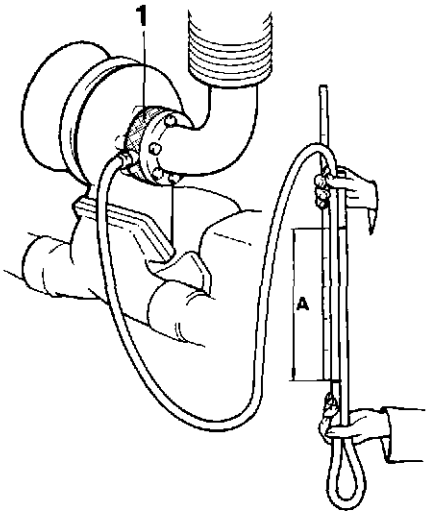


Fig. 10. Measuring the counter-pressure in exhaust line

1. Adapter flange

Measuring the counter-pressure

For installations requiring long exhaust lines, the diameter of the line must of course be calculated first, (see under "Dimensioning the exhaust line"). For checking the counter-pressure, the line must be fitted with an adapter for connecting a manometer or other measuring instrument. This adapter should be located as close to the engine as possible and preferably at a straight part of the line in order to give the utmost accuracy when measuring.

Volvo Penta stock special flanges for measuring the counter-pressure, which are bolted directly onto the turbocharger. The flanges have a threaded hole for connecting measuring equipment, see fig. 10.

A manometer with good sensitivity and graduation can be used when measuring. A simple, ordinary plastic hose can be used for measuring the counter-pressure. The hose is bent and partially filled with water, see fig. 10. The engine is then started and run at highest revs with full load. By measuring the level difference of the water, the counter-pressure in mm water column can be read off.

As a comparison between different units the following applies: 10000 mm water column = 100 kPa (1 kp/cm^2).

See the respective engine broschures for the max. permissible counter-pressure.

Condensation water collector

Condensation water that enters into the engine can cause severe damage. Long exhaust lines should therefore be fitted with condensation water collector, which should be located as close to the engine as possible.

Where the exhaust line is fitted vertically the amount of condensation water in the exhaust line is larger than when the line lies horizontally. The reason for this is that the condensation water runs back into the pipe when mounted vertically. For a horizontal mounting, however, a large amount of condensation water follows the exhausts out. In the latter case it could be suitable to let the line drop a little towards the outlet, where it is not necessary to fit a condensation water collector.

A condensation water collector could also be suitable to use in cases where small amounts of rain water might enter into the exhaust pipe.

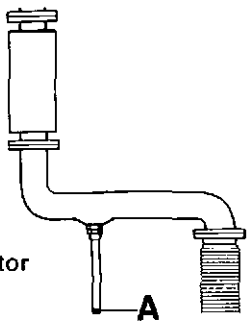


Fig. 11. Condensation water collector

Length = appr. 300 mm (12")
Diam. = appr. 1"
A = Cock or drain plug

Insulation

Due to the high temperatures that arise in a dry exhaust line (450–500°C/842–932°F) it is necessary to insulate it. Thereby the temperature in the engine room can be kept low and burns from touching can be avoided. The insulation also helps to keep the noise level low. **Insulate especially well at through-ways and where the line is close to inflammable materials.**

A suitable insulation material is mineral wool with a glass fibre fabric outside, see fig. 7. The flexible exhaust line and any compensator must be able to move freely and should therefore be covered with metal mesh or plate that is only attached at one end, and then the insulation can be placed outside the cover (see fig. 7). Outside the engine room it is possible to replace the insulation with some physical contact protection, e.g. a steel screen.

Rain protection

The outlet of the exhaust pipe must be constructed so that rain water cannot enter the exhaust system. Fit an elbow, hood or self-locking cover to the end.

Dimensioning the exhaust line

It is important that the exhaust line is dimensioned and constructed in such a way that any harmful counter-pressure is avoided. For this reason the exhaust line must be made as short as possible and with as few bends as possible. The bending radius should be at least 2.5 x the pipe diameter.

See the respective engine broschures for maximum permissible counter-pressure in the exhaust line after the turbocharger.

To be able to dimension the exhaust line so that the counter-pressure will not be too high, we recommend use of the nomogram on page 9.

Prior to reading off the alignment chart the permissible counter-pressure in pipe (without silencer) must be determined. This is done as follows. From the max. permissible counter-pressure for the whole system (see resp. engine broschure) the counter-pressure created in the silencer is deducted (information regarding this can be found in the binder "Sales Manual"). If the counter-pressure for a certain silencer is 200 mm water column and the total max. permissible counter-pressure is 500 mm water column, the permissible counter-pressure in the pipes is: 500–200 = 300 mm water column.

When using the nomogram the reading is started at "Pipe length in metres", and then one follows with a ruler through the different curves containing known values: Number of 90° elbows, exhaust gas volume (see resp. engine broschure) and permissible counter-pressure.

Example:
Length of line: 54 m (177 ft)
No. of 90° elbows: 0
Engine speed: 1800 r.p.m.
Engine type: TD 100 G
Exhaust gas volume: 2400 m^3/hour
Permissible counter-pressure totally: 700 mm water column
Permissible counter-pressure in silencer (842014): 180 mm water column
Max. permissible counter-pressure, without silencer: 700–180 = 520 mm water column.

With these conditions a diameter (inner) of 130 mm (5.1") is required for an insulated pipe.

SEVERAL ENGINES ON A COMMON EXHAUST LINE

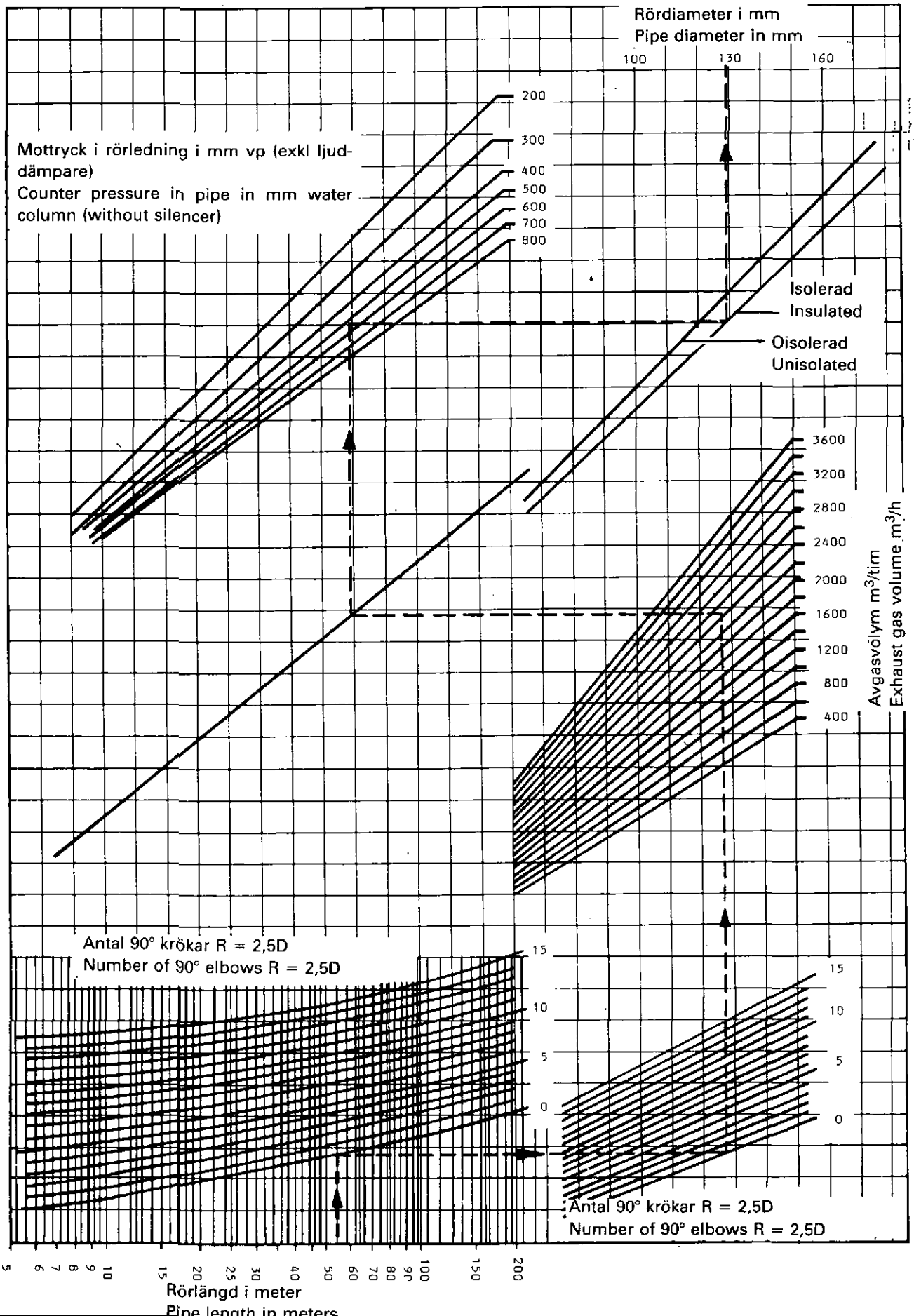
If several engines are connected to a common line the following is carried out: A suitable diameter (D) for one engine is established from the nomogram. By multiplying the given diameter by a factor (K), see the table, the diameter required for the number of engines in question (D') is obtained. D x K = D'.

Note! Every branch connection must have an effective closing device.

Number of engines	Factor K	
2	1.32	
3	1.55	
4	1.74	
5	1.90	
6	2.05	

Factor K = $\sqrt[5]{(\text{number of engines})^2}$

NOMOGRAM FOR CALCULATION OF PIPE DIAMETER IN EXHAUST LINE



AIR INTAKE AND VENTILATION

For radiator data and fan diagram, see "Sales Manual", No. 2.

Air intake and air outlet must be designed in order to produce good ventilation in the engine room. Locate the air intake where the air is as clean as possible and in a place where the engine's exhaust gases cannot be sucked in. Make also sure that the intake is designed so that water and/or snow cannot enter. If possible, avoid using air intakes that can be closed.

The intake's area should be 1.5 times the radiator's front area. If a radiator blind or mesh is fitted in front of the air intake, the area must be increased to 2 times the radiator's front area. The outlet's area must be as large as the intake's area.

If other oxygen consuming components are located in the engine room (e.g. heater), their air consumption must also be regarded.

To avoid re-circulation of the cooled air, an air escape must be fitted between the radiator and the hole in the wall, see figs 12 and 13.

If the temperature of the intake air is too high, the engine output is reduced and the exhaust gas temperature becomes too high.

As an example we can mention that if the intake air temperature increases from 30 to 50°C (86 to 122°F), the engine output is reduced about 3–6 %. The engine's exhaust gas temperature increases by 2.5 times the air's temperature rise (in Celsius), in this case: 2.5x20°C = 50°C. For an engine with intercooler the exhaust gas temperature increases 1.75 times. For exhaust gas temperature and air temperature, see "Sales Manual".

If the engine room temperature is high, the intake air should be led from the outside of the engine room direct to the engine's air filter through a suction pipe/intake manifold, see figs 12 and 13. Volvo Penta stock a 90° connecting elbow that is screwed onto the air filter (for measurements, see "Sales Manual").

NOTE! The pressure drop at the filter must not exceed 200 mm water column (0.002 kp/cm^2) and the measuring should be made immediately before the air filter. If air pipe is used the pressure drop is dependant on the pipe's diameter, length and number of elbows. If an air pipe is not used, any radiator blinds or protective covers can cause pressure drop.

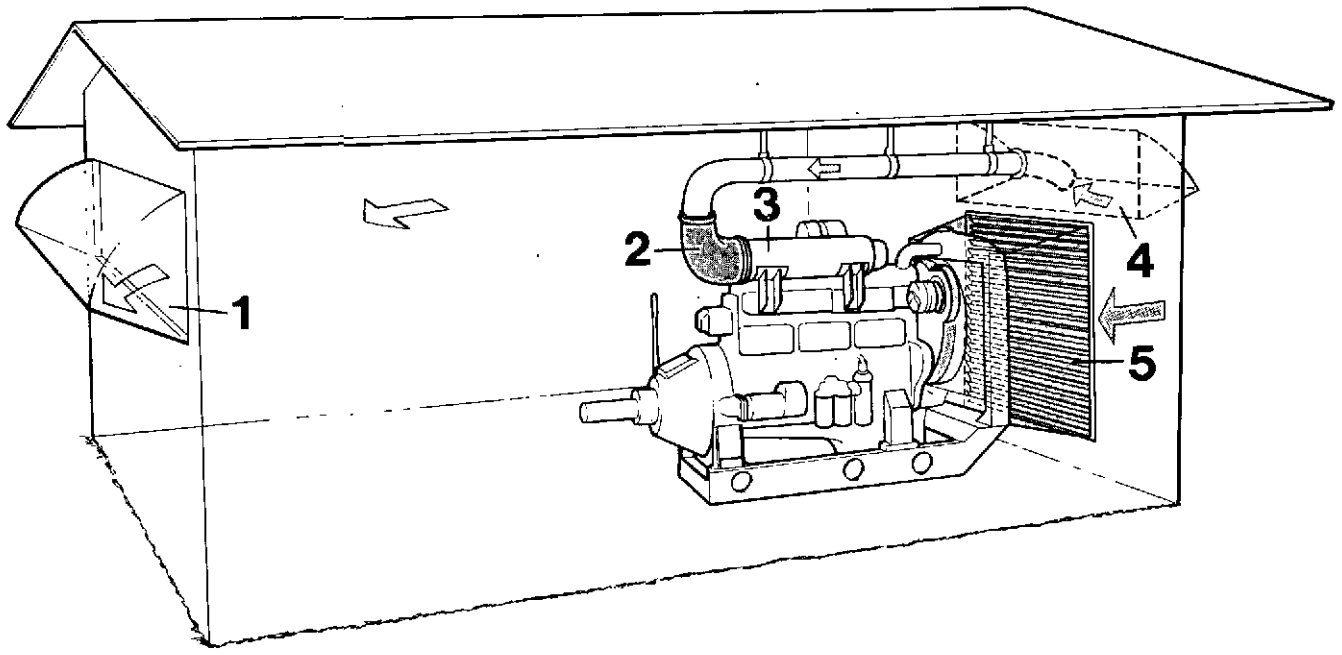


Fig. 12. Engine room with air intake and air outlet (suction fan)

1. Air outlet
2. Connecting elbow
3. Air filter
4. Protective cover
5. Air intake with air escape

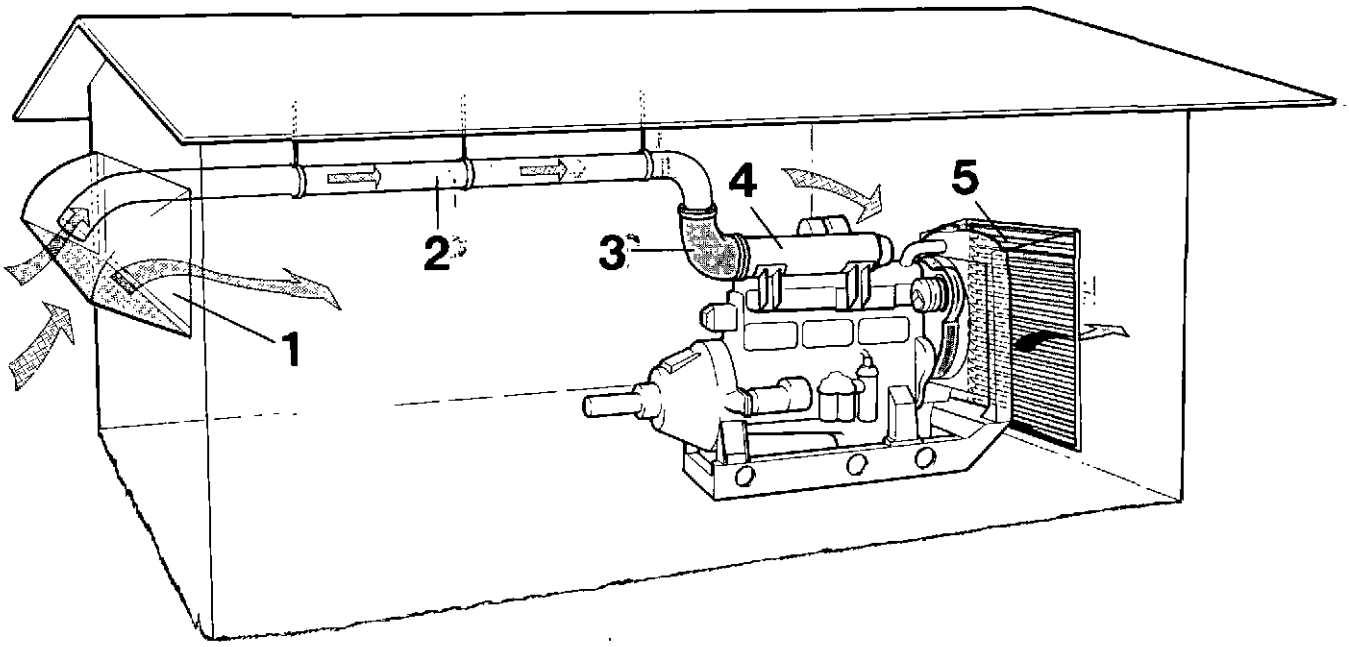


Fig. 13. Engine room with air intake and air outlet (pressure fan)

1. Air intake
2. Suction pipe
3. Connecting elbow
4. Air filter
5. Air outlet with air escape

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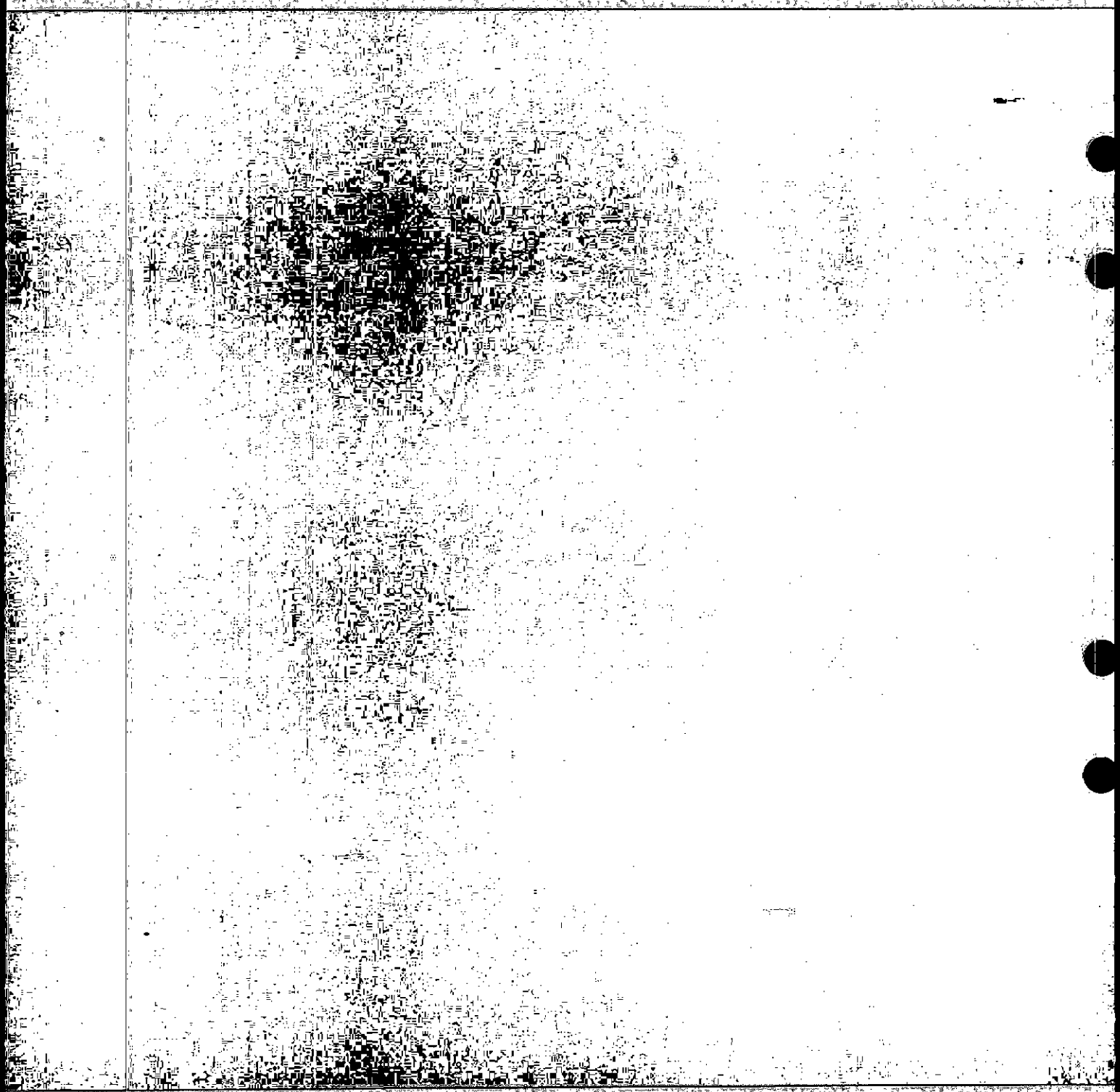

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