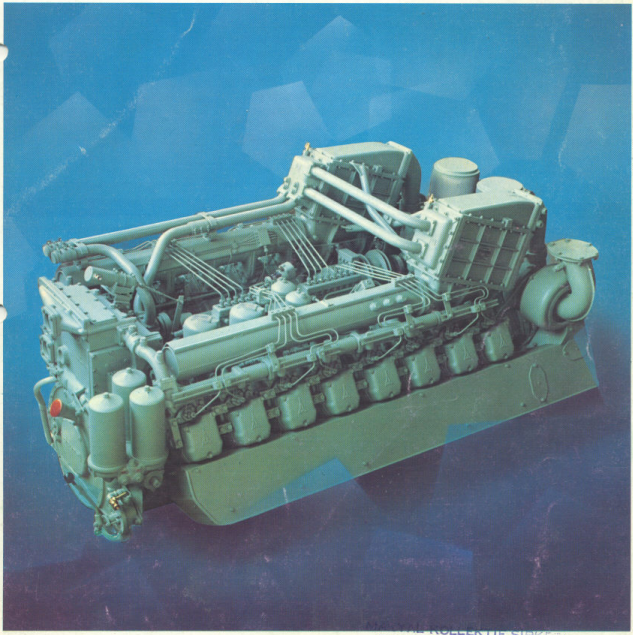
Water-Cooled Diesel Engines

BAM 816

DEUTZ



BAM 816—A Range of Compact High-Speed Diesel Engines Featuring Two-Stage Combustion—Covers a Vast Range of Applications

Mass-produced in Cologne to the high precision and quality standards symbolised by the DEUTZ trademark, the BAM modular engine range comprises turbocharged water-cooled 6 and 8-cylinder vertical as well as 12 and 16 cylinder inclined engines. This graduation of capacity coupled with a choice of turbocharger systems is designed to extend the output range so as to offer a number of economical and efficient alternatives to suit any application: ratings span the vast scale of 170 KW (231 DIN HP) to 970 KW (1320 DIN HP), operating speeds range from 1500 to 2000 RPM.

Reliable operation is ensured by advanced production technology, a straightforward engine build scheme and moderate piston speeds. For inlet and outlet valves and pre-combustion chamber liners, we use high-temperature resistant materials that will stand the extreme thermal stress typical of these areas, so as to extend component service life. The use of a special spheroidal-graphite-iron casting process developed by Deutz facilitates a light and compact construction of large engine components such as the crankcase etc. The compact build of the inclined engines in particular is due to the arrange-

ment of injection pumps, electric starter and coolant/lube oil heat exchangers within the "V" cavity formed by the two cylinder banks so as to make these engines as compact as possible. For the same reason, turbochargers are placed at the flywheel end where they fit into the engine profile, in order to shorten assemblies such as engine/transmission or engine/power generator combinations. Electric starters are standard. Alternatively the engine can be air-started via the cylinder heads. For special applications, the two systems can be combined.

The two-stage combustion system of these precombustion chamber type engines is designed to reduce engine wear and cut fuel consumption substantially for large-capacity engines. Furthermore, this system reduces contaminant emission to a level suitable for applications underground—i.e. mining locomotives—by meeting the 1977 limits of the California 13-mode cycle test, an extremely stringent standard frequently used for exhaust emission test evaluation.

rods. Each cylinder head is secured to the crankcase by means of 8 bolts. The two longer bolts located between two adjacent cylinder heads are holding both cylinder heads.

Injection Pump and Governor Assembly

The Bosch fuel injection pump and governor assembly, driven either direct or via a DEUTZ injection advance unit (incorporated in the drive gear) is fitted on the service side. The inlet valve seat oil pump and, where required, the distributor for the air starting system, are part of the valve gear mechanism. The oil filler neck, dipstick, full-flow oil filter, single or twin water pumps and the lube oil heat exchanger and—on 8-cylinder engines—the centrifugal oil filter, are also fitted on the service side of the engine. Six-cylinder engines have the centrifugal oil filter on the other side. The electric starter is fitted below the fuel injection pump. The fuel system comprises flexible feed and discharge hose connections, a manual lift pump, reversible two-stage filters, high-pressure-resistant injection pipes (standard or double-walled optional), complete safety equipment and automatic shut-off devices, if required.

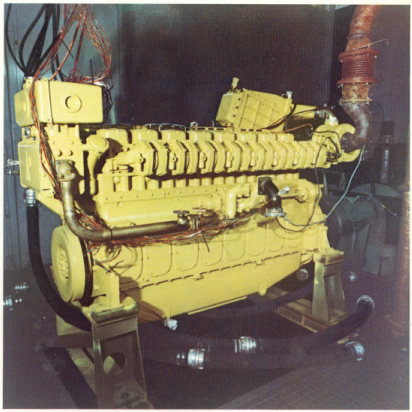
Turbocharger and Exhaust System

Vertical engines are equipped with a turbo-supercharger mounted at the flywheel end. Depending on the turbocharger capacity, an intercooler is fitted above the hot air duct at the flywheel end. The hot exhaust air can be re-cooled either by the engine cooling system or by a separate cooling system or by an untreated-water system, depending on the type of intercooling system and the maximum engine rating. Air ducts and turbocharger are fully insulated as standard. A water-cooling system is optional.

Lubricating System

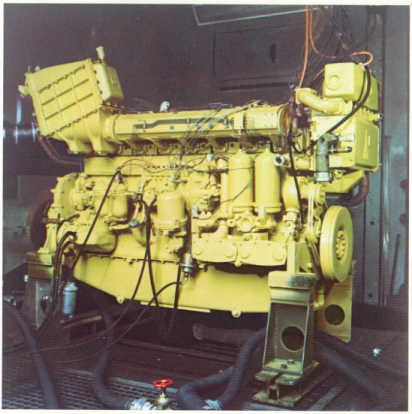
All bearings are lubricated by the force-feed lubricating system. The pump is rigid-mounted in the upper crankcase, pushing oil via a safety valve and the heat exchanger (flat section type) and the various by-pass valves through the combined full-flow coarse/fine filter and the by-pass centrifugal oil filter. Dry sump engines are equiped with an additional drain pump that has two suction points.
The force-feed lubrication system also supplies the turbocharger bearings, the fuel injection pump and governor assembly, the cooling water pump bearings as well as the inlet valve seat lubricating system and the piston spray cooling system. The engines can be equipped to meet any requirements issued by the classification societies regarding emergency cooling or monitoring devices. The lube oil filters are reversible for cleaning.

BA 8 M 816
Intercooled, with built-on heat exchanger and vibration damper, mounted on a test bench.



Piston and Connecting Rod Assembly

The pistons are light metal alloy and have moulded ring carrier groovers to take three compression rings and one oil control ring (helical expander type). For longer life, the piston crown has an oil-spray-cooled anulus. The heat-treated steel alloy connecting rods are drop-forged and feature big end bearings that are split at an angle so as to facilitate piston removal from above. Connecting rod shanks and bearing covers are held together by means of nuts and bolts. Gudgeon pin bush, crankshaft journal and main bearings have steel shells with lead-bronze liners protected by a thin film which will be rubbed off during the running-in period (three-metal bearing). All engine components fully comply with the requirements of all the leading classification societies.



Cylinder Heads

The individual spheroidal-cast-iron cylinder heads feature large size valves made from high-temperature-resistant materials and have a vertical precombustion chamber. The valve gear which is located above the cylinder head, is dust-sealed by an oil-tight light metal cover. The valves and valve gear are lubricated through hollow push-

Crankcase

The crankcase is a spheroidal graphite iron casting that continues far below the crankshaft centre line, thus stiffening the unit. The camshaft, fuel injection pump and auxiliary unit drive gears are mounted at the flywheel end of the engine and dust-sealed by means of a cast-iron cover with mountings for the rear support legs as well as the flange and locating block for flange outer bearing, clutch housing or transmission unit. These components can be mounted direct or by means of SAE adaptors where necessary. On the service side (opposite fuel injection pump) large-diameter service holes sealed by inspection covers permit easy access to big end and main bearings. Dynamos and alternators of various capacities, untreated-water pumps and bilge pumps where heat exchangers are fitted, built-on air compressors and hydraulic fluid pumps can be arranged at the locations provided for that purpose. Dynamos/alternators and pumps are either linked to the accessory drive by gears or vee belt driven off the vibration damper end of the crankshaft. The timing gears, too, are sealed by a cast-iron cover. The crankcase breathing system, fan and idler pulley mountings or heat exchanger adaptor and header tank (optional) are located here, too. A cast-iron sump is standard.

Engine

The heavy-duty crankshaft made of high-grade tempered steel alloy has induction-hardened journals. Timing gear and flywheel flange are a shrink fit on the crankshaft which has a forged-on flange for the vibration damper mounting with its screwed-on counterweights. The flywheel and ring gear assembly is secured to the flange by means of 12 anti-fatigue bolts, and
there are various power adaptors for couplings, universal shafts or direct drive adaptors for single-bearing generators. The pulleys for water pump and fan (if fitted) and other accessories and vibration dampers (fluid or rubber type, depending on operating speed and engine rating) are mounted at the crankshaft front end.

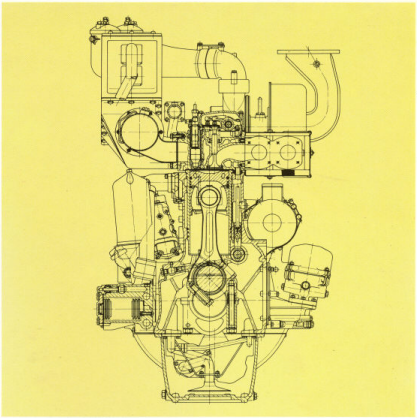
Camshaft and Valve Gear

The induction-hardened camshaft is bronze-bush-mounted in the crankcase. The bearing at the timing gear end is an anti-friction type locating bearing. The inlet and outlet valves (one each per cylinder head) are actuated by special-case-hardened mushroom type tappets via pushrods, adjustable rocker arms and wear resistant ball thrust pads.

Cylinder Barrels

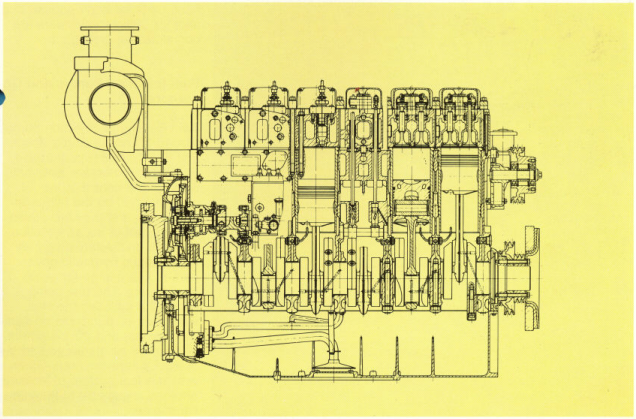
The water-jacketed and fully bonderized centrifugal-cast alloy cylinder barrels are inserted into the crankcase from above. The water jacket is sealed from the oil compartment by means of three rope seals. The cooling water is pumped by the water pump to each cylinder from a distributor pipe running along one side of the engine which can take an electric preheater if required.

BA 6 M 816
Transverse and Longitudinal Sections



Engine Mounting System

The engine has a four point mounting system, either rigid or flexible as required. At the flywheel end, the engine is mounted on support legs secured to the end cover. At the front end the engine can be supported by various cross-beams which are also secured to the end cover.



Crankcase

The two cylinder banks are arranged in a 120 degree "V" formation which is designed to accommodate the main accessories such as fuel injection pump and governor assembly, starter motor, dynamo/alternator, water pump, heat exchanger centrifugal oil filter and fuel filter so as to facilitate access to these accessories from above. The upper crankcase which is a spheroidal graphite iron casting, continues far below the crankshaft centre line. The main bearing covers are secured to the crankcase by two vertical and two horizontal bolts. On both sides along the crankcase, there are large size service holes sealed by inspection covers designed to facilitate access to the main and big end bearings. The pistons are removed from above together with the connecting rods which feature bis end bearings that are split at an angle. The flywheel end cover seals the camshaft timing gear train which drives both camshafts, the fuel injection pump, the lube oil pump and the accessories. The front end cover seals the fluid vibration damper. Both end covers have centre bores and adaptors to take various transmission and intermediate housings. The latter (SAE adapter housing) facilitates direct mounting of SAE units. The cast-iron sump forms the base of the crankcase. The sump volume can be increased by means of special ancillary tanks, if required, for instance for high inclination applications or to ensure trouble-free prolonged continuous operation.

Engine

The heavy-duty, seven-bearing (12-cylinder engine) or nine-bearing (16-cylinder engine) crankshaft is made from high-grade tempered steel alloy. The connecting rods are arranged in pairs so that two connecting rods from opposite cylinders share one crankshaft journal. The big end bearings and pistons of the inclined engines are identical to those of our vertical engines. Also, the crankshaft flanges at both ends are identical and can take various flywheels to suit a range of clutch, universal shaft and shaft extension units at the front end (e.g. trawler net winch drive), or special pulleys some of which are suitable for full-power take off. All engine components fully comply with the requirements of all the leading classification societies so that they can be classified accordingly.

Cylinder Barrels

Cylinder barrels of inclined engines are identical to those of vertical engines, being water-jacketed by a highly efficient cooling system, and they are fitted to the crankcase from above.

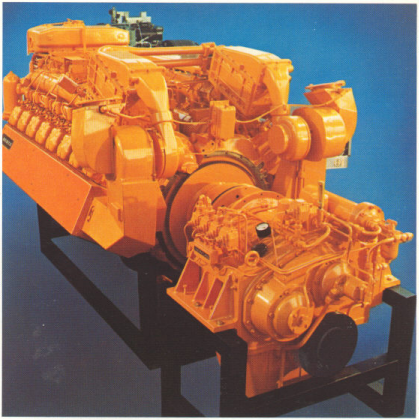
Cylinder Heads

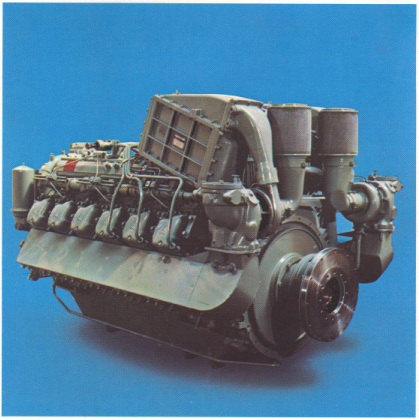
The individual cylinder heads and valve gear as well as tappets and pushrods of inclined engines are identical to those of vertical engines, except that on inclined engines cylinder head bolts located opposite one another between cylinders are connected by crossbars.

Fuel Injection Pumps and Governors

Twin Bosch fuel injection pumps (BA 16 M) or the single Bosch unit (BA 12 M 816) controlled by one governor, are accommodated in the centre of the "V" cavity formed by the two cylinder banks, and they are driven either direct or via an injection advance unit. Alternatively we offer various hydraulic governors to suit a large range of applications. The fuel pump drive gear includes the inlet valve seat oil pump (as on vertical engines) and the distributor unit for the air starter control system where required. Otherwise the fuel system of inclined engines is identical to the vertical engines.

BA 16 M 816
Marine engine and reversing gear





BA 12 M 816
Main engine of Venezuelan trawler featuring water-cooled exhaust manifolds and turbo-superchargers.

Turbocharger Systems and Exhaust Manifolds

"V" engines have two turbo-superchargers mounted at the flywheel end. Turbochargers of inclined engines, whether intercooled or not, correspond to the units fitted to vertical engines. The exhaust manifolds/hot air ducts are arranged on the outside so as not to overheat accessories such as the fuel injection pump(s) and fuel lines. The air ducts are supplied fully insulated as standard, water-cooling is optional.

Lubricating System

The lube oil system of inclined engines also follows the system used for vertical engines. Heat exchanger, oil filter and lube oil pump, however, are larger commensurate with the higher output ratings of "V" engines. 16-cylinder engines have one or two centrifugal oil filters. The lube oil system also supplies any intermediate bearings of the accessory drive, thus rendering the accessory section almost totally maintenance-free. Reversible two-stage filters (12-cylinder engines) or three-stage filters (16-cylinder engines) are fitted at the vibration damper end where the sump drain pump is also mounted.

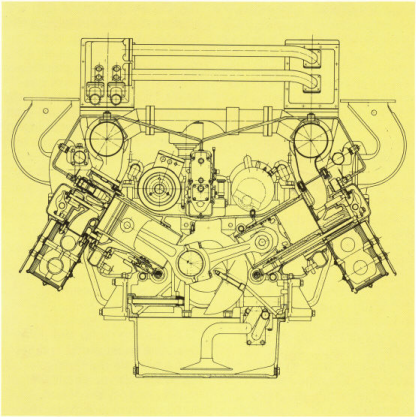
Cooling System

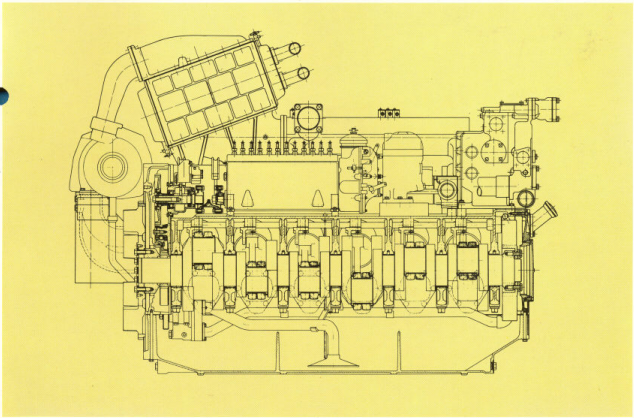
"V" engines, too, are provided with a re-cooling unit (header tank optional). The associated untreated-water pump (coupled with a bilge pump where necessary) is driven by a vee belt and mounted on one side near the front end of the engine. A front-mounted fan bearing is optional. Honeycomb radiator adapters can also be used for connecting outboard cooling systems, block cooling systems etc. For marine applications, all the necessary emergency controls can be placed on the freshwater side or on the untreated-water side.

Engine Mountings

The engine can be provided with rigid or flexible mountings. The upper crankcase has a number of tapping along both sides so that the support legs can be mounted in a position that takes into account the centre of gravity of the complete power plant.

BA 12 M 816
Transverse and Longitudinal Sections.





Lube Oil Circuit

The lube oil is drawn by the lube oil pump (26) from the sump (18) through screen filter (20) which is connected to the suction pipe, pushed through the pressure pipe (19) and into the heat exchanger (15) fitted with a by-pass link to two centrifugal oil filters.

From the separator of the water-cooled heat exchanger, the oil flows into the full-flow two-stage (or three-stage) filter (12). Each filter element can be shut off separately for cleaning.

From the filters, the oil flows through the main oil gallery (42) and connecting pipe (16) into the various feed pipes. From the main oil pipe (3), the oil runs into the crankshaft journal passages (24), through the crankshaft and to the big end bearings (4).

The camshaft bearings (28) are lubricated by way of two parallel galleries (9) and (21).

The tappets (29) are pulse-lubricated via a number of passages from small notches in the camshaft bearings. The oil then flows to the rocker arms through hollow inlet valve pushrods (34) and rocker arm shaft, then via the rocker arm thrust pads (7) to the valve stems (2).

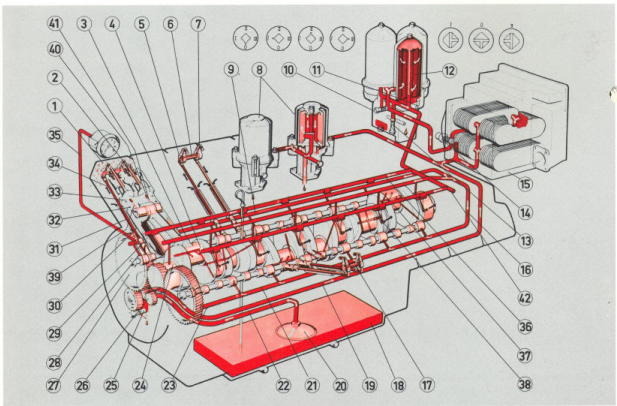
Oil that has accumulated in the rocker arm compartments (1) returns to the sump via the pushrod and outlet bores (31 and 30 resp.) that are recessed into the cylinder head and crankcase.

The injection pump and pump gear, the water pump and the turbochargers are connected up to the lube oil circuit via pipes fitted on top of and, for turbochargers alongside, the crankcase. From the accessories, the oil returns to the sump through the return pipes.

The inlet valve seats are lubricated from the injection pump drive gear side, the oil being ducted to each inlet valve via oil galleries and separate feed pipes. For details, please refer to Service Instructions.

The timing gears (27) are lubricated from the rear crankshaft bearing (24) and by oil returning to the sump from the injection pump gear.

The piston crown is oil-cooled by oil being sprayed from oil pipes (26) and (37) through nozzle (38) into gallery (39) and associated anulus (40) inside the piston (33). The oil returns to the sump by force of gravity via a return bore (41) on the other side of the piston (33).



Oil splashing from the big end bearing oil ports (4) lubricates the pistons (33) which have one grooved oil control ring (32) each.

The lube oil pump (26) is protected by a pressure relief valve (25).

When the lube oil is too cold and highly viscous or when the heat exchanger is clogged, the short circuit valve (14) in the lube oil heat exchanger (15) provides a direct connection to the oil filter (12).

The oil pressure control valve (13) is situated in the oil filter housing.

Both screen and fine filter sections of each filter unit have a short circuit valve (11) to allow an emergency supply of unfiltered oil to reach the lubricating points, if necessary.

The two-stage or three-stage oil filters are reversible so that one filter element can be shut off for cleaning with the engine on, if necessary.

The markers on the two-stage filter, viewed on the reversing device, denote the following:

0 = both filter elements on
I = L.H. filter element off
II = R.H. filter element off

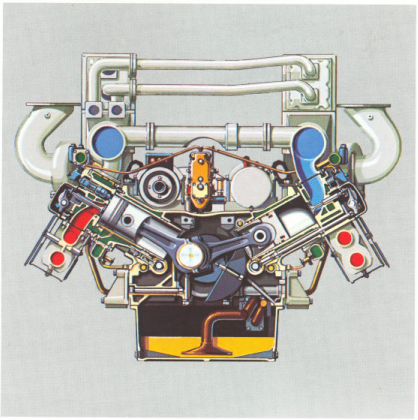
The markers on the three-stage filter, viewed on the reversing device, denote the following:

0 = all filter elements on
I = R.H. front filter element off
II = L.H. front filter element off
III = R.H. rear filter element off

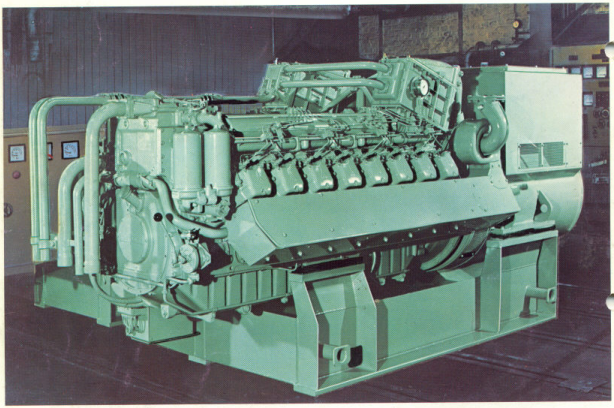
Any excess pressure arising from cutting out one filter element will be compensated by the safety valve (10) fitted in the three-way valve.

The turbocharger lube oil ducts are connected to the oil ports (23) along both sides of the crankcase.

Oil pressure gauge link (35).



In the 120 degree "V" cavity, all accessories are easily accessible.



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