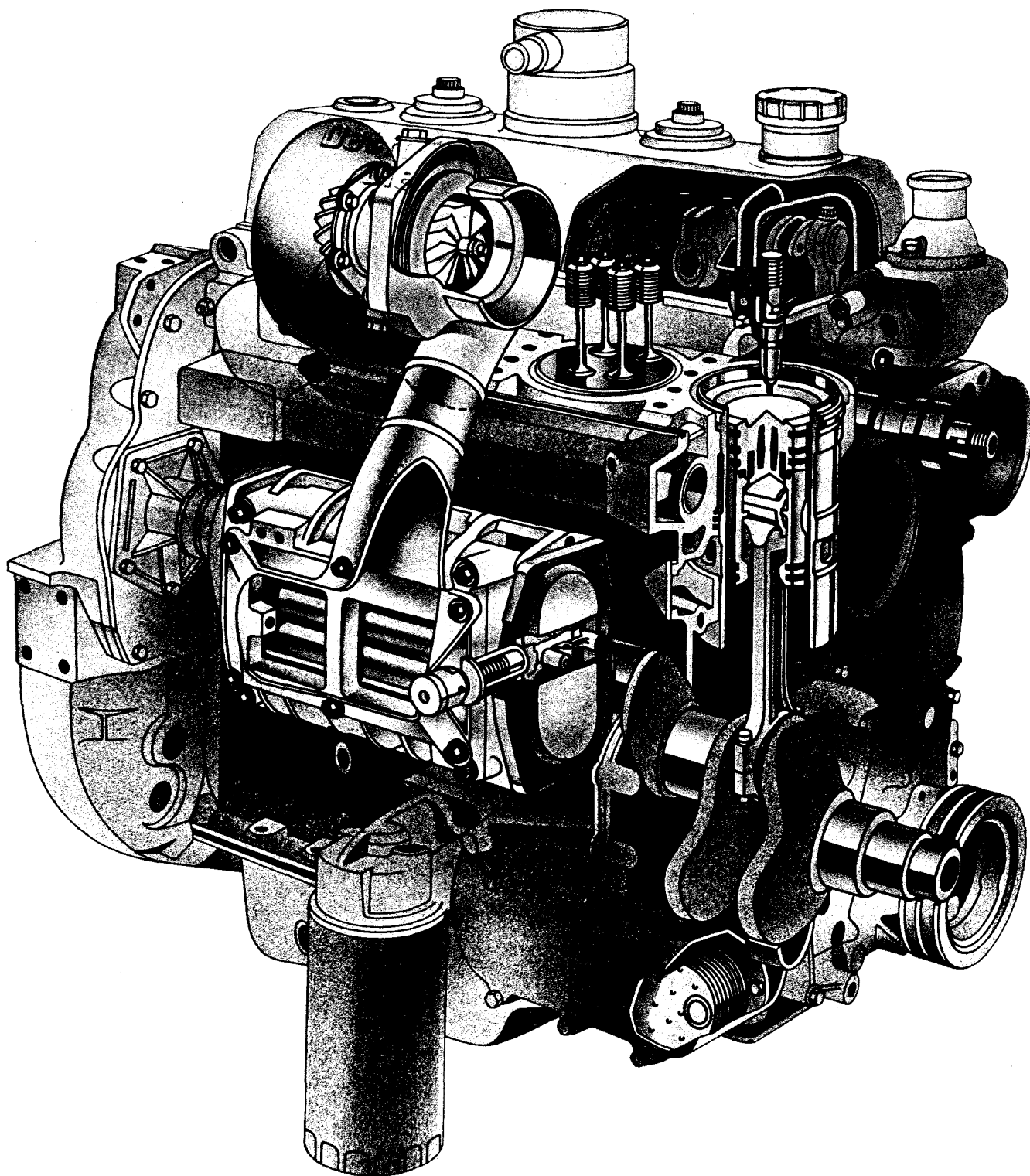
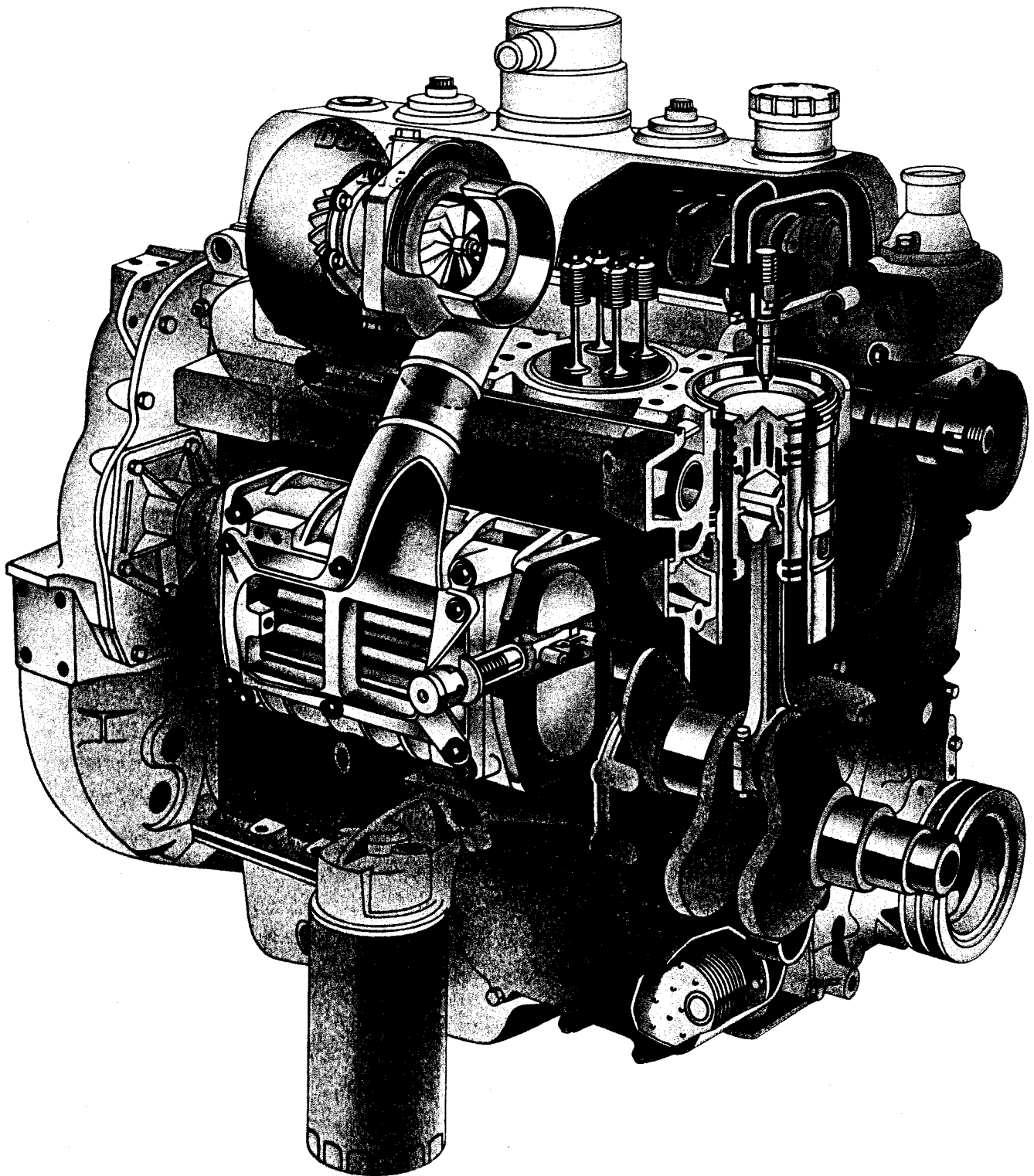


Forward **Plan** **53**





Forward Plan 53 a broad scale program to bring the latest diesel engine technology to Series 53 engines.

Manufacturers such as yourself helped to make the 53's the most widely used engines in the light and medium equipment industry. To meet your needs, three quarters of a million Series 53 engines were produced over the past 25 years. But the industry's requirements have changed. We've had a fuel crunch, noise legislation and new competition. The result was a demand for more in terms of performance and overall operating economy. Detroit Diesel Allison had to make a decision—design a totally new engine or technologically update the 53 to meet the requirements of the 1980's and 1990's.

Intent on remaining the dominant supplier of engines in the 100 to 300 horsepower class, DDA management has given full go-ahead for the implementation of "Forward Plan 53"—a broad-scale program to bring the latest technology to the Series 53 engines.

Even though DDA and General Motors had the resources to develop a totally new engine, we chose to apply advanced technology to an existing, proven engine design. Why? Here are some of the reasons:

User Acceptance

Foremost is user acceptance. 53's have been delivering outstanding performance for 25 years in a broad range of equipment applications. Users like the rugged construction and high quality components used throughout. Another major advantage is the fact that 53's are rebuildable. Components such as cylinder liners, valve guides and seats are replaceable at reasonable cost. The complete overhaul capability provides almost unlimited life when the engine is properly maintained.

Parts and Service Availability

Also important is parts and service availability. With almost three quarters of a million of these engines in use, parts and service for the 53's are available almost anywhere in the

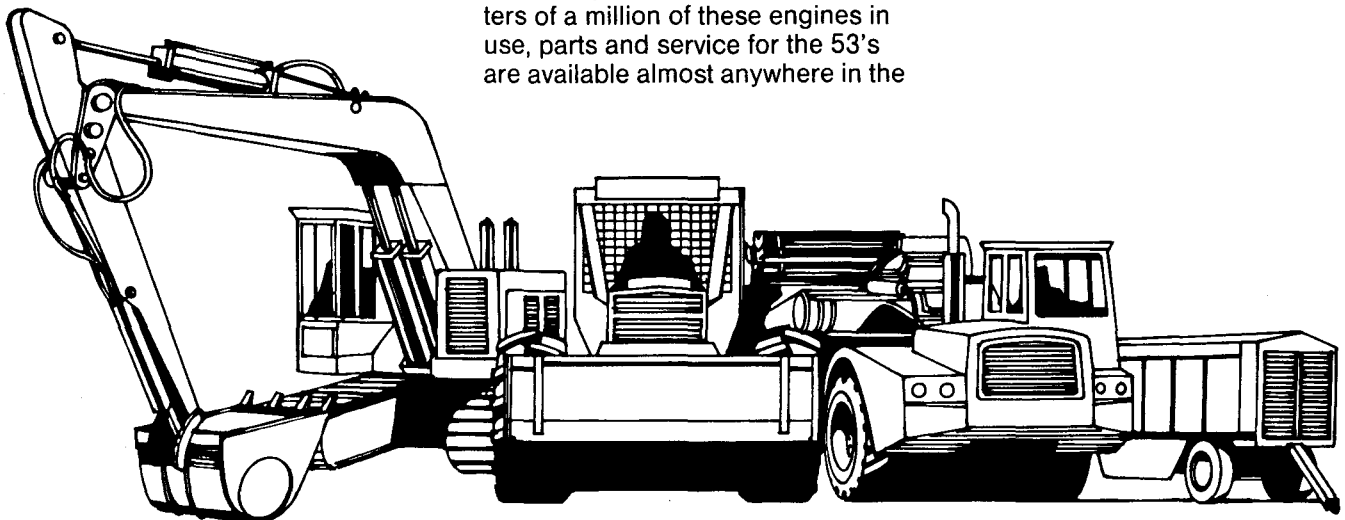
world. The 53's are easy to service, and mechanics everywhere are familiar with them. There is also a high degree of parts interchangeability within the Series which helps keep maintenance costs down.

Installation Flexibility

Installation flexibility is most important to OEM engineers; 25 years' worth of options and accessories make the 53 the most flexible engine in the industry. Development of new options for a new engine design would be very costly and time-consuming—for both of us.

Lower Engineering Cost

Associated with this is low engineering cost for OEM's. They already have mounts, radiators, drive systems and other equipment components designed around the 53. Not only would a new engine require expensive product redesign, it would also introduce the inevitable "growing pains" of any new design.



Development Capability

Detroit Diesel Allison is well-positioned to handle the challenge of the Forward Plan 53 because we are a world leader in engine development technology. The research and engineering staff at DDA—unequalled in technical knowledge and experience—is dedicated to the future—to the improvement of present products and meeting the power needs of tomorrow. They work in the most extensively equipped engine development facilities in the industry. Equipment includes photoelastic stress analysis, piston oil flow fixtures, a noise test "quiet room", an electron microscope, a computer controlled mass spectrometer, an optron valve motion study device, computer aided design equipment plus other sophisticated research and testing equipment.

DDA builds a wide variety of diesel engines, gas turbines and heavy duty transmissions used in thousands of different jobs throughout the world. The advantage to DDA and its customers is that new technology, materials and manufacturing techniques emanating from gas turbine and transmission programs can often be applied to diesel engines.

Then too, advancements in one diesel engine Series can usually be applied to another. For example, new developments in fuel/air management and durability now being applied to the Series 53, originated from Series 71 and 92 engine programs.



Plan Objectives

Using the "team" approach, experts from Engineering, Manufacturing, Quality Assurance and other areas worked together to apply the latest design technology to an existing proven engine design. The plan encompassed the complete Series 53 line—3- and 4-cylinder in-line models and the 6V version. All of the many advancements detailed on the following pages were designed to meet one or more of these plan objectives:

1. Reduce fuel consumption below any other engine in its class.
2. Reduce noise levels below any other engine.
3. Extend durability and reliability well beyond their present excellent levels.
4. Increase the horsepower output of each model, and provide more power/RPM flexibility.

Areas of Emphasis

Intensive research and development work was done in several areas to achieve Forward Plan 53 objectives:

■ Air Induction System

Significant changes were made in the air induction system to optimize air flow into the cylinders and reduce parasitic horsepower losses.

■ Combustion Efficiency

Modifications to improve combustion efficiency included new, more efficient turbochargers, optimized cylinder liner ports, changes in camshaft timing and new injectors.

■ Noise Reduction

Considerable work was done in the area of noise reduction. This involved redesign of a number of components that radiate noise.

■ Reliability and Durability Improvements

Components included in this segment of the program included pistons, cylinder heads, blower drive, blower seals, rear crankshaft seals, oil cooler, rocker covers and fuel connector lines.

The next few pages give a detailed description of the major modifications that will appear in the Forward Plan 53 engines.

Air Induction and Combustion Systems

Intensive engineering effort was applied to the air induction and combustion systems to optimize air flow into the cylinders, improve combustion efficiency and reduce parasitic horsepower losses.

The Forward Plan 53 air induction system, which incorporates a blower bypass valve and passage, reduces pumping losses and provides a savings of up to 7 horsepower. Bypassing the blower can provide fuel savings and additional performance. The system is essentially a spring-loaded bypass valve in the blower end plate which opens at a set air-box pressure level determined by the installed spring load.

At suitable engine speed and load, the valve opens, allowing air box pressure to equalize with blower inlet pressure. This reduces the air pumping load on the blower and the amount of horsepower required to turn the blower. The valve permits

a portion of the total air flow to either recirculate or bypass the blower and optimizes thermal efficiency through improved air-fuel ratio control.

Turbocharger

Forward Plan 53 engines feature a new, more efficient turbocharger that more closely meets the air delivery requirements of the specific engine and its application. This improvement aids combustion efficiency, fuel economy and response.

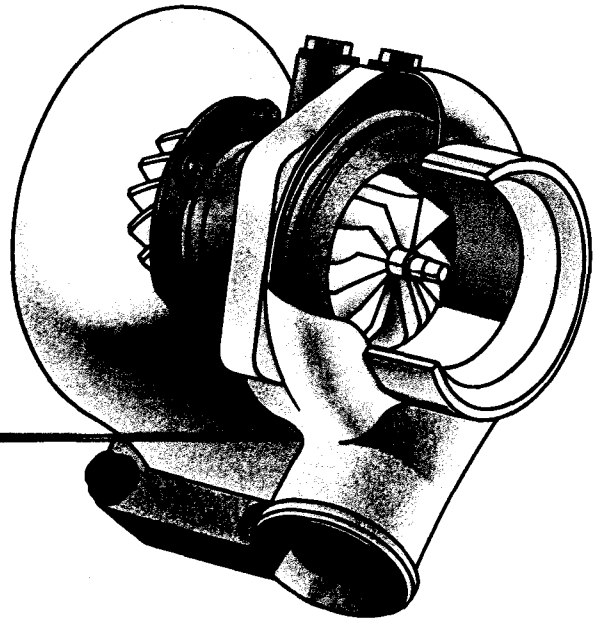
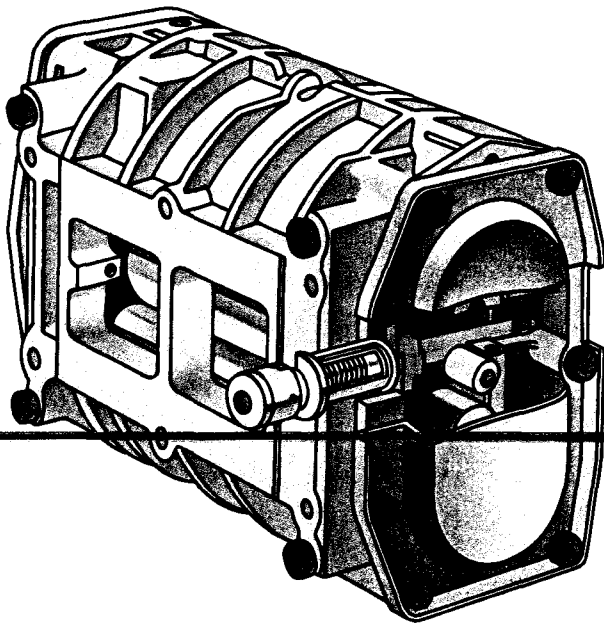
Additional Forward Plan 53 Combustion Efficiency Features

■ Air enters the cylinders through liner ports. The height and shape of these ports have been modified for optimum air inlet timing and maximum air swirl in the combustion chamber.

■ In addition, the latest technology in terms of camshaft lobe profiling and lift timing is being incorporated into the 53's.

■ A further boost in combustion efficiency comes with new injectors featuring modified plunger and bushing timing and spray tips.

These individual changes, engineered to work together, produce a very significant improvement in engine efficiency and fuel economy.

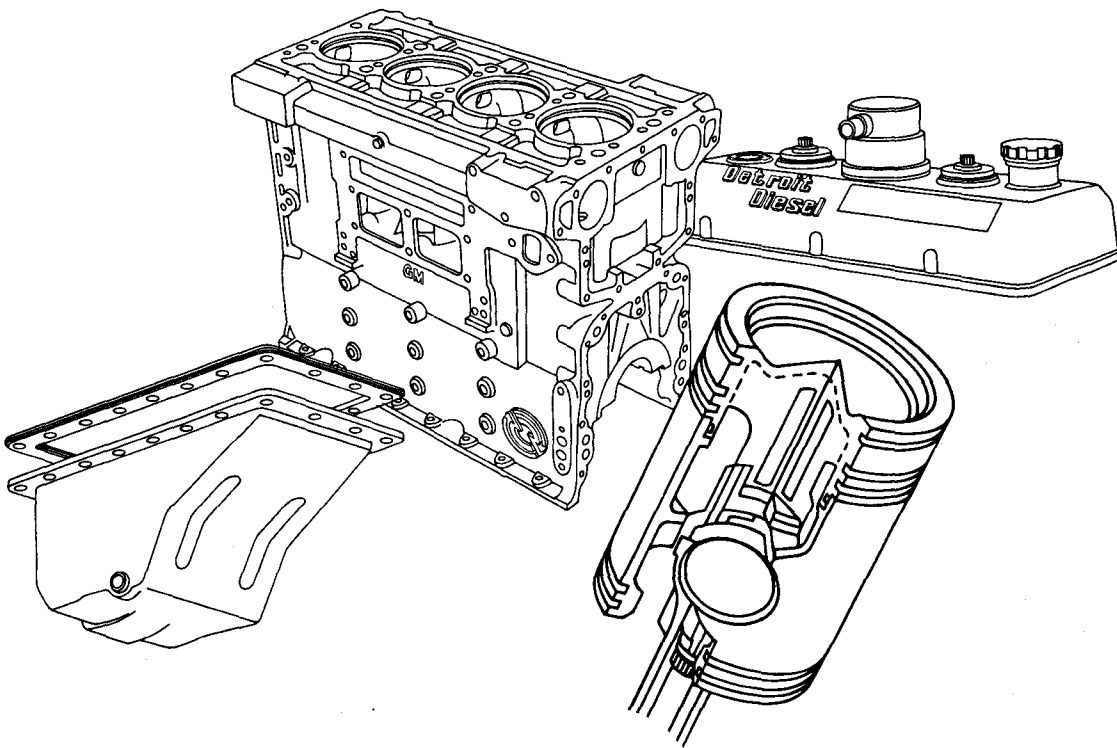


Noise Reduction:

The Noise Reduction Program involved the modification of a number of major components, such as the cylinder block, the upper front cover, the front pulleys, and other structural members of the engine that radiate noise.

The new crosshead pistons help here too, because they produce less piston slap. The new die cast rocker cover with isolation features is also part of the noise reduction program. These modified components, taken together, reduce noise

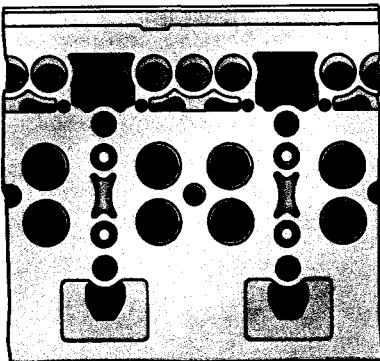
levels up to 3 dB(A) on 3 and 6V engines and 5.5 dB(A) on the 4. Such a reduction makes the Forward Plan 53's extremely quiet engines. Those noise reducing items that can be made standard on the product will be standard across the product line. Other items like an isolated oil pan are optional, to be used where there are additional noise reduction requirements.



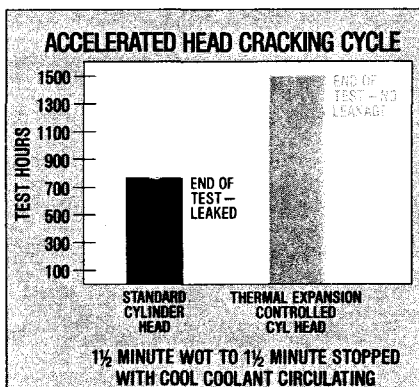
Reliability and Durability Improvements

Cylinder Head

Redesign of the cylinder head has dramatically extended the life of this major engine component. The new thermal expansion head, called a "dog bone" head because of the bone-shaped stress relief feature, allows the firedeck to expand much more before stresses are high enough to crack the firedeck between the valves.



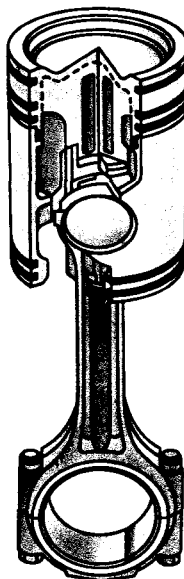
Severe thermal shock testing proved the extreme crack resistance of the new design. In the test, the engine was run at excessive horsepower for a minute and a half, then shut off with the cylinder head very hot. Cool water was circulated during the shutdown for a minute and a half, then the engine was started again, run another minute and a half, and so on. As shown, the standard



cylinder head cracked within 750 hours. With the thermal expansion head there was no leakage at 1500 hours where the test was ended. The test shows the thermal expansion head to be much more tolerant to user abuse or accidental overheating.

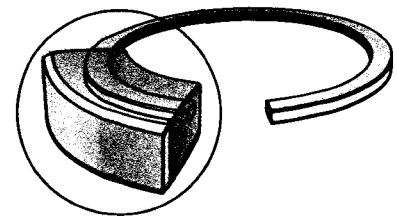
Crosshead Piston

A key durability improvement is the use of crosshead pistons in all Forward Plan 53 engines. This patented design features separate crown and skirt components that work independently of each other: the crown absorbs combustion forces while the skirt absorbs thrust loads. Proven in larger Detroit Diesel engines, crosshead pistons extend ring life and reduce cylinder bore wear.



New Piston Ring Designs

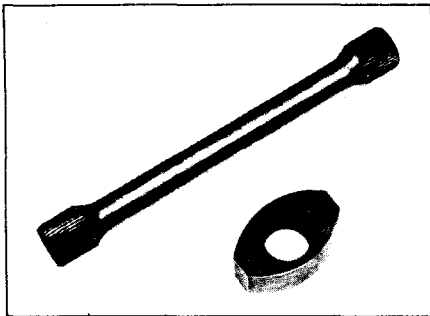
New, longer wearing piston rings feature barrel-faced grooveless compression rings with hard molybdenum coating replacing conventional rings. This new design which will become available in 1982, extends ring life by up to 40%. It also substantially reduces light-load air box slobber and exhaust wet stacking. The new rings reduce friction, thereby helping to improve fuel economy. Reduced oil consumption is an additional benefit.



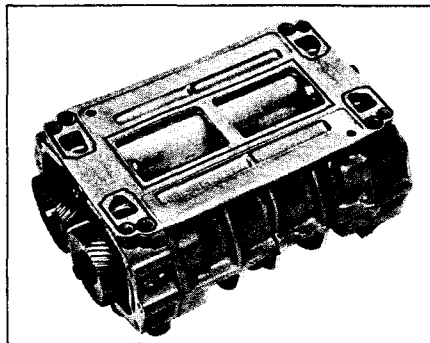
A further improvement, under test and evaluation, will again reduce ring wear, but more important, be more tolerant to high sulfur fuels. This advanced design ring is expected to be part of the Forward Plan package in 1984.

Reliability and Durability Improvements (Continued)

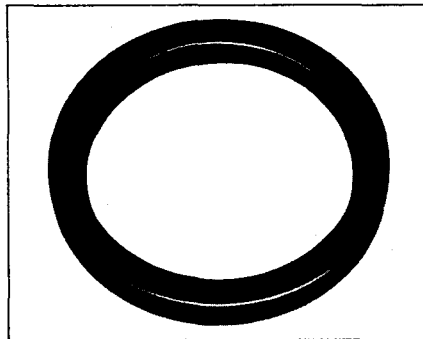
■ A new blower drive system with a carbo-nitrided hardened blower driveshaft and steel blower drive cam have been shown to reduce wear in this area by 60%.



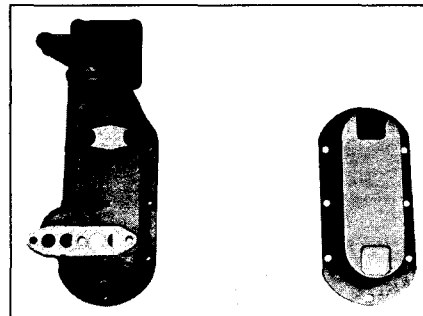
■ A modified blower base gasket and the addition of sealant between the end plate and housing will reduce oil seepage in this area. Test work is continuing on a dual lip blower seal aimed at reducing the leakage of oil into the air system.



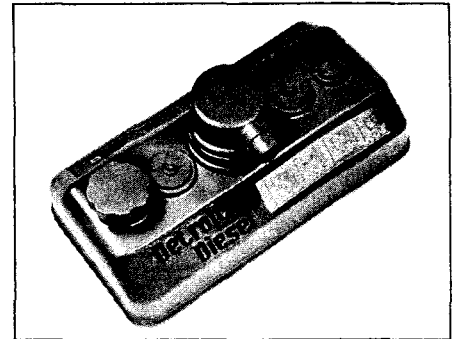
■ A new teflon rear crankshaft seal—more heat and wear resistant than the part it replaces—improves durability and should eliminate the need to ever have to replace the seal prior to overhaul.



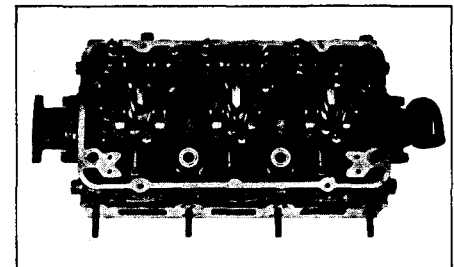
■ Forward Plan 53 engines feature a more durable stainless steel oil cooler. Improved oil cooler gaskets and adaptors reduce the possibility of oil leakage in this area.



■ An all-new die cast aluminum rocker cover helps eliminate oil leaks between the head and rocker cover. An isolation technique used in the gasket system also reduces radiated noise levels.



■ An improved fuel connector ("jumper line") design eliminates the flared ends, which were sensitive to assembly torque. The design also reduces the sensitivity to manufacturing tolerances in terms of angles and surface finish, providing a major reliability improvement.

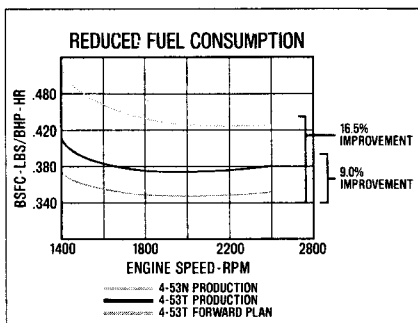


Benefit #1—Reduced Fuel Consumption

The primary benefit of the Forward Plan 53 design is reduced fuel consumption. The goal was to make the Series 53 engines the most fuel efficient in the industry, in their power range.

16.5% Improvement

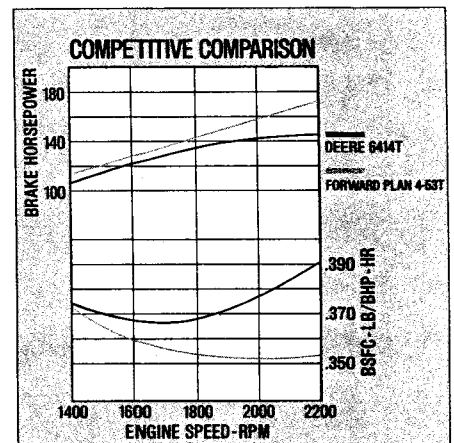
This chart on the 4-53 shows what's been accomplished. The current 4-53 engine rated speed B.S.F.C. of .425 is the lowest of our naturally aspirated 53 engines. The current 4-53T is at a competitive .390. The Forward Plan 53 engine runs at .355. This gives us a very significant 16.5 percent improvement over today's N engines and 9% over current T's. Also, the Forward Plan 53 demonstrates a very flat fuel curve throughout the engine speed range.



Forward Plan 53 Fuel Consumption Lower Than Competition

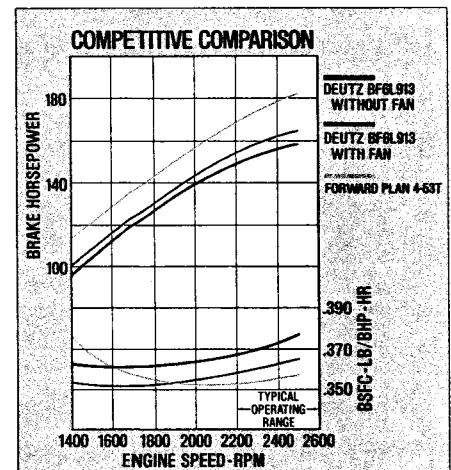
4-53T vs. John Deere 6-414T

Shown is the John Deere 6-414T at 142 horsepower, compared to the Forward Plan 4-53T. The Deere rated at 2200 RPM has a B.S.F.C. of .390 compared to the 4-53T at .355. As you can see, we out perform the Deere throughout the operating range.



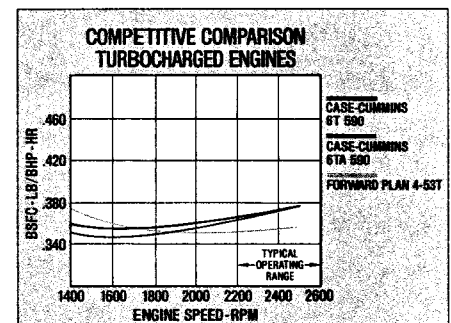
4-53T vs. Deutz BF6L913

Here the Forward Plan 4-53T is compared with the Deutz BF6L913 at 160 horsepower. The Deutz is shown with fan and without in an attempt to make a fair comparison since the air cooled Deutz requires a fan at all times. Detroit Diesel engines are rated at gross horsepower and Deutz uses net. As with John Deere, even with the Deutz fan horsepower removed, the Forward Plan 53 has a substantial fuel economy advantage over the Deutz in the typical operating range.



4-53T vs. Case-Cummins 6T590

Here the Forward Plan 4-53T is compared to the new Case-Cummins Model 6T590 scheduled for release in 1984. Information is from Cummins published data. We included curves for the Case-Cummins engine with and without aftercooling and in both cases the 53 is in a superior fuel position. The Forward Plan 53 engines are already running at fuel consumption levels better than the new Case-Cummins engines, based on their published data.



Benefit #2—Substantially Lower Noise Levels

The Effect of Turbocharging

These test results illustrate the effect of turbocharging. Comparing our current non-turbocharged engine to our current turbocharged engine, we get a substantial reduction in engine noise—up to 44% in the case of the 6V-53T. (Keep in mind a 3dB(A) reduction is half as much noise.)

All data is bare engine at one meter measured according to SAE J-1074 standards.

Lower RPM Reduces Noise

The noise levels of our Forward Plan 53 engines are substantially lower than the engines being produced today. Plus, the Forward Plan 53 is going to be offered at both 2200 and 2500 RPM. At 2200 RPM the noise levels are further reduced! In fact,

we do not know of another engine in this horsepower range that can demonstrate bare engine noise levels as low as these—91.0 dB(A) for the 3-53T, 95.0 dB(A) for the 4-53T and 94.0 dB(A) for the 6V-53T.

NOISE REDUCTION			
	NA dB(A) @ 2800 RPM	T dB(A) @ 2500 RPM	% REDUCTION IN SOUND LEVEL
3-53	99.0	96.6	42
4-53	103.2	101.3	35
6V-53	101.3	98.8	44
BARE ENGINE S.P.L. MEASURED @ 1 METER PER SAE J-1074			

Benefit #3—Extended Durability and Reliability

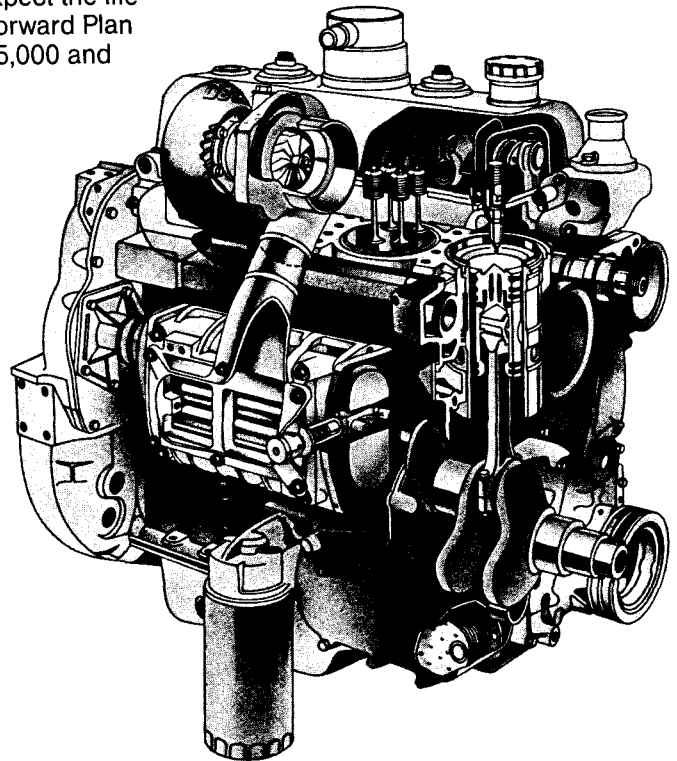
The following component improvements will contribute to the reliability as well as durability of the Forward Plan 53.

- Thermal expansion cylinder head
- Crosshead pistons
- New piston rings
- New blower drive system
- Modified blower gasket
- Teflon rear crankshaft seal
- Oil cooler gaskets and adaptor
- Die cast rocker cover
- Improved fuel connectors

The engine will also be much more tolerant of occasional operation beyond recommended conditions.

Based on component testing and experience with many of the same new developments in different engine series, we expect the life-to-overhaul of the Forward Plan 53's to be between 5,000 and

10,000 hours in average industrial applications. This range covers the variables of application severity, load factor, duty cycle, maintenance, and ambient conditions.

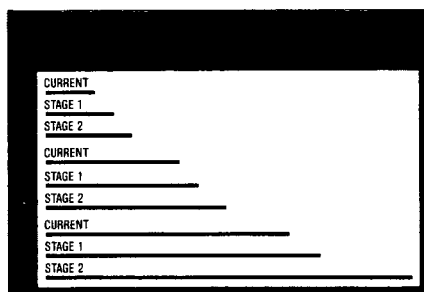


Benefit #4—Increased Power and RPM Flexibility

A specific objective of Forward Plan 53 was to increase the horsepower output of each engine and offer a broader range of RPM and power settings. There will be two stages of increase:

Stage 1 Stage One will be accomplished through engine operating efficiency alone—no additional fuel is being put in the engine. In Stage One, the Forward Plan 3-53T will produce a maximum of 140 hp; the 4-53T—185 hp; and the 6V-53T—250 hp.

Stage 2 Stage Two involves use of a larger capacity fuel injector and combustion refinements. This will enable the Forward Plan 53's to produce 50 hp per cylinder. The 3-53T will then provide 150 hp, the 4-53T—200 hp and the 6V-53T—300 hp.



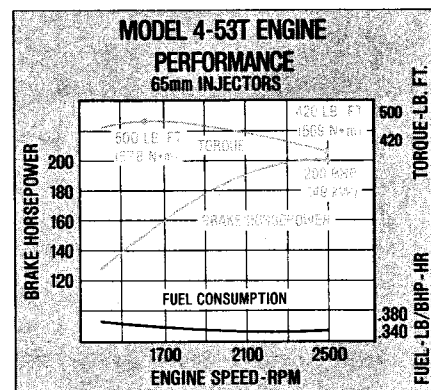
Forward Plan Engines At Two RPM Settings

Because there are many good reasons for operating at lower RPM—improved fuel economy, noise reduction and greater life-to-overhaul—the Forward Plan 53 engines are offered with 2200 RPM settings as well as the normal 2500 RPM setting. With Forward Plan 53 engines you have greater flexibility in choosing the power and RPM setting to suit each specific application.

FORWARD PLAN RATINGS			
	Injector Size	H.P. @ 2200 RPM	H.P. @ 2500 RPM
3-53T	50	105	110
	55	120	125
	60	130	140
	65	145	150
4-53T	50	145	160
	55	160	165
	60	180	185
	65	195	200
6V-53T	50	215	225
	55	235	250
	60	255	280
	65	280	300

50 Horsepower Per Cylinder

Forward Plan 53 provides an expanded range of 50 horsepower-per-cylinder engines. The engine performance chart for the 200 horsepower 4-53T illustrates the exceptional fuel economy and performance characteristics of these engines. Note the strong horsepower curve—200 horsepower at 2500 RPM, also the 500 lb. ft. of torque at 1600 RPM, and an excellent torque rise of 19.4%. And, most important, the outstanding flat fuel consumption curve throughout the operating range.



Improved Response

During the development of the Forward Plan 53 engines, engineers evaluated engine response capability. The test consisted of a full throttle acceleration against the inertia of a heavy motoring dynamometer. The time required to accelerate from 1000–2400 rpm was recorded. The acceleration

times were:

- Current production 4-53T—16.5 sec.
- Forward Plan 4-53T—9.0 sec.

This 45% improvement in response will speed up job cycle times, increase equipment productivity and improve operator acceptance.

Introduction Timetable

The test phase of the Forward Plan 53 is nearing completion and we will be prepared to ship pilot engines in September of this year—1982.

Production engines will be available in two stages.

Stage 1 engines produced in the spring of 1984 will include all the economy, noise and durability improvements, with horsepower increased by up to 7%.

Stage 2, moving us to the full 50 horsepower per cylinder level, will be available in mid-1985.

Major Benefits of Forward Plan 53

Fuel Economy Improvement

■ Based on an analysis of engines currently available in the marketplace and projections on engines available in the mid-80's, the Series 53 will be the most fuel efficient engine in its class.

Noise Reduction

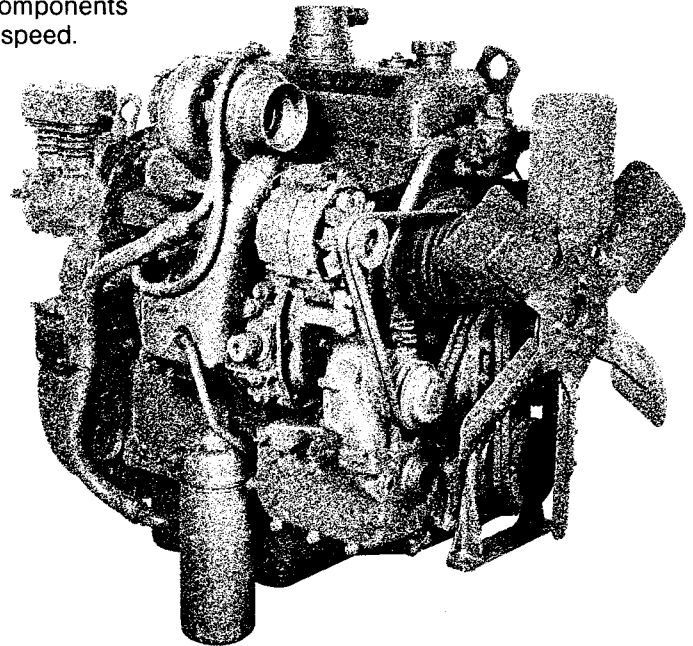
■ The Forward Plan 53's will be extremely quiet engines. A major reduction in engine noise has been accomplished with turbocharging, redesign of certain components and reduced engine speed.

Extended Durability and Reliability

■ The life-to-overhaul of the Series 53 engines with the changes described is expected to be 5,000 to 10,000 hours.

Increased Horsepower

■ An expanded range of engines rated at both 2200 and 2500 rpm, with ratings up to 50 horsepower per cylinder.



Forward Plan 53

Forward Plan 53... The Industry Standard Into the 1990's

As you've seen, Detroit Diesel Allison has taken a good engine and made it better. The Forward Plan 53's, we are convinced, will remain the industry standard into the 1990's. And we are not faced with the normal shakedown of an all-new design and the adjustment period that goes with it.

Plans call for a smooth transition to the more efficient, more durable design with very little change at the OEM level. All basic installation components—mounting, flywheel, and the thousands of options and accessories—remain the same.

What we will offer is state-of-the-art technology in a basic design proven over many years. Forward Plan engines give you outstanding fuel economy, low noise characteristics, greater durability, and a wider horsepower range with RPM flexibility.

