

## Introduction of Products

# Introduction of D85EX-15/D85PX-15 Bulldozers in GALEO Series

Yuuichi Nagahiro

Yoshitake Yamaguchi

Hiroshi Nakagami

*As part of its efforts to meet the increasingly sophisticated customer needs, KOMATSU recently remodeled D85-21 Bulldozer, which it put on the market in 1987, for the first time in 15 years, and has come up with D85EX-15/D85PX-15 Bulldozers which incorporate a number of leading-edge technologies.*

**Key Words:** *Bulldozer, GALEO Series, Electronically-controlled Hydraulic Fan, PCCS, HSS, Electronically-controlled Transmission.*

### 1. Introduction

As the company's main bulldozer of intermediate size, Model D85-21 has been very well received by the market for its high performance, reliability, and durability. However, more than 15 years have passed since it was put on the market in 1987. Therefore, compared with its sister models (D65/D155) and competitors' new models of the same class, it has become rather mediocre in terms of amenity of the cab, maneuverability of the machine, etc.

On the other hand, there is ever growing demand for conservation of the global environment and respect for humanities.

Under those conditions, the company has developed and introduced to the market D85EX-15/D85PX-15 Bulldozers that are efficient, user and environment-friendly bulldozers incorporating a number of most advanced technologies (**Photo 1**).



**Photo 1** Appearance of D85EX-15

**2. Objectives of development**

With “friendliness to the user and environment” and “high levels of basic performance and quality” as the fundamental concepts and with the aim of giving complete satisfaction to all our customers in the world, we developed the new bulldozers with the following points as the primary objectives:

- (1) Reducing impact on the environment
- (2) Improving amenity of the cab and maneuverability of the machine
- (3) Enhancing work efficiency
- (4) Improving serviceability and reliability of the machine.

In particular, special emphasis was placed on reducing machine noise and improving cab amenity and machine maneuverability. By making the most effective use of electronics and employing advanced new technologies, we could achieve remarkable improvements.

**3. Salient characteristics**

**3.1 Consideration for the environment**

- (1) Reduction of ambient noise

By employing a new engine whose rated speed is 5% lower than that of the conventional engine, an electronically-controlled hydraulic fan, air suction ducts installed in the engine hood and side covers, etc., the ambient noise could be reduced significantly (10 dB lower as compared with the former model) (Table 1).

**Table 1** Comparison of ambient noise

		D85EX-15	D85A-21
Ambient noise (measured at point 15 m away from machine)	dB(A)	70	80

In order for the former model to clear the new EU Noise Regulations (2000/14/EC), it was necessary not only to install a sound-absorbing blade in front of the radiator but also to reduce the cooling fan rated speed and apply sound-absorbing material to suitable parts of the engine compartment. The new model of standard specifications meets the requirements, even though it is without sound-absorbing material (measured value 110 dB vs. control 112 dB).

(1-1) Electronically-controlled hydraulic fan system

The electronically-controlled hydraulic fan system employed for the new model controls the fan speed according to engine cooling water temperature, hydraulic oil temperature, and power-train oil temperature, thereby reducing the fan speed and noise and the loss of engine power.

In addition, the motor for driving the fan is equipped with the function of reversing the direction of fan rotation so as to permit changing the direction of fan rotation easily at the touch of a switch near the operator’s seat. This facilitates cleaning the core of the fan.

The scheme and effect of this system are shown in Fig. 1 and Fig. 2.

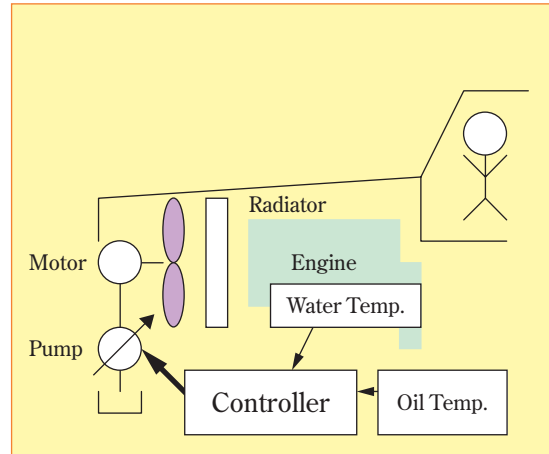
(1-2) Installation of air suction ducts

By installing air suction ducts in the engine hood and side covers, it became possible to improve the flow of cooling air, increase the amount of air suction (+5%), and lower the temperature of air let in (−3°C). This in turn made it possible

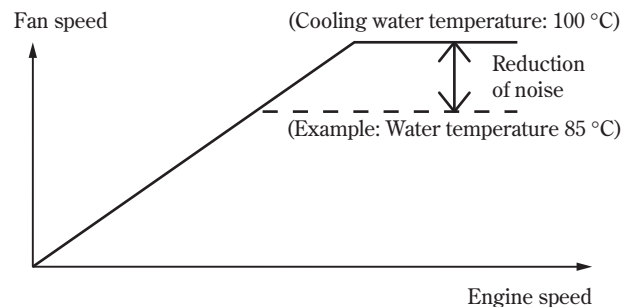
to improve the heat balance, lower the fan speed, reduce the noise from the engine compartment, and hence reduce the ambient noise significantly (Fig. 3).

- (2) Conformance to the second phase of gaseous emission regulations

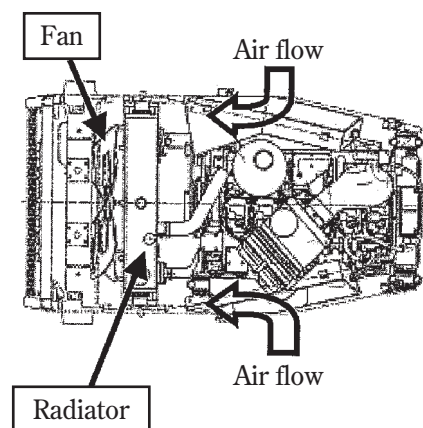
Thanks to a newly-developed, electronically-controlled, common-rail fuel injection engine, the new model meets the second phase of gaseous emission regulations of North America, Europe, and Japan.



**Fig. 1** Electronically-controlled hydraulic fan system



**Fig. 2** Effect of hydraulic fan system



**Fig. 3** Scheme of air suction ducts

**3.2 Improvement of cab amenity**

(1) Cab damper mount

The long-stroke cab damper mount which is filled with silicone oil and provided with spring rubber has dramatically reduced the vibration during ordinary run and the shock during off-road run. This has not only improved the riding quality. It has also reduced the noise reaching the ears of the operator by restraining the sound propagation along solid objects (Fig. 4 and Table 2).

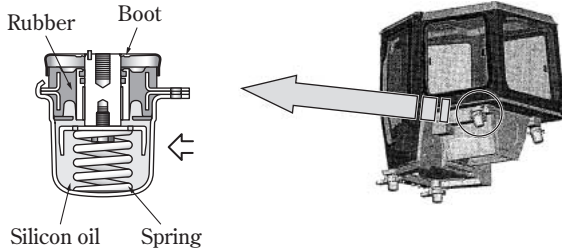


Fig. 4 Cab damper mount

Table 2 Comparison of operator's seat vibration and noise

		D85EX-15	D85A-21
Operator's seat vibration (F2/R2 level ground)	VL(dB)	88/94	99/100
Noise at operator's ears (measured level)	dB(A)	75	82

(2) Newly-designed large cab

The large cab adopted for the new model has a wide window area, offering good visibility. In addition, the seal of the sliding windows and doors has been improved to make the cab much more airtight and prevent entry of dust and dirt into the cab.

Furthermore, a large-capacity air conditioner has been installed in the cab to afford a comfortable space for the operator (Fig. 5 and Table 3).

Comparison of field of vision

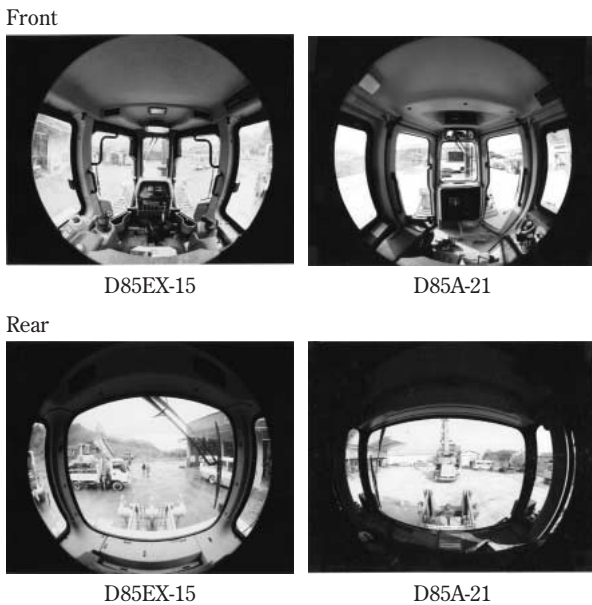


Fig. 5 Comparison of field of vision

Table 3 Comparison of cab specifications

		D85EX-15	D85A-21
Cab volume	m <sup>3</sup>	3.2	3.15
Visible area ratio	%	57	51
Air conditioner	Cooling capacity	kcal/h	4500
	Heating capacity	kcal/h	5500
Pressurization	mmAq	10	2.0

**3.3 Improvement of Maneuverability**

(1) Adoption of palm command control system (PCCS)

The new model employs a single electronically-controlled palm command control lever which just fits the human hand and which can be manipulated with minimum operator strain. This is a product of human engineering.

With this single lever, the operator can perform all the machine operations – move forward/backward, change speed, turn right/left.

The controller performs optimum control of the transmission valve and HSS motor according to signals from the potentiometer (forward, reverse, turn) and switch (shift) built in the lever. Therefore, the operator can maneuver the machine easily and efficiently.

The scheme of this system is shown in Fig. 6, Fig. 7, and Fig. 8.

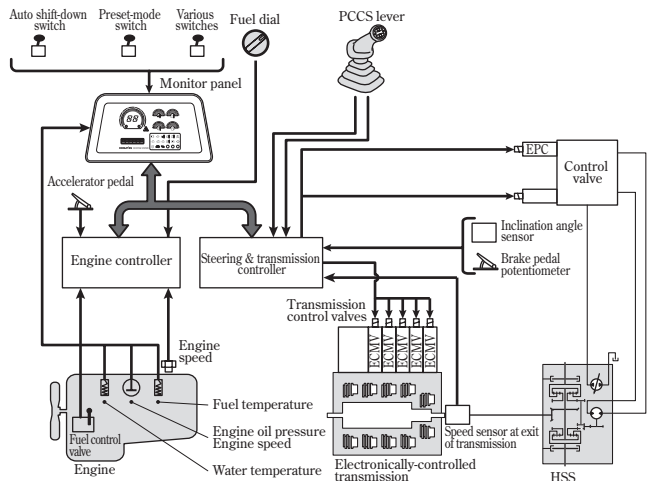


Fig. 6 Scheme of PCCS

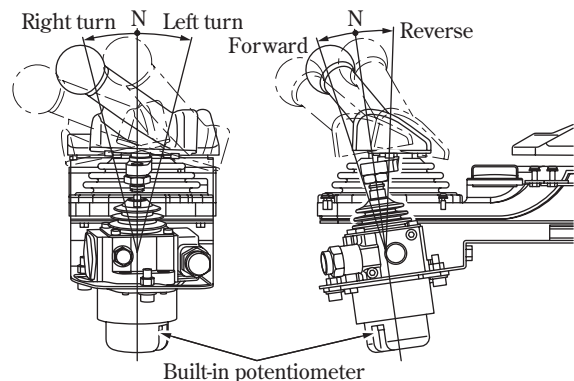


Fig. 7 Structure of PCCS lever

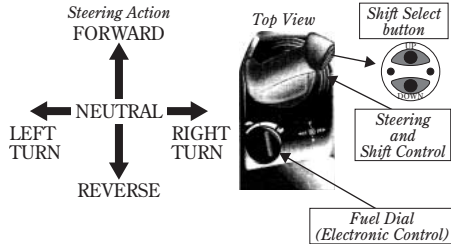


Fig. 8 PCCS lever

The console to which the PCCS lever is installed can be shifted forward/backward by up to 90 mm (in nine steps) and shifted up/down by up to 60 mm (continuous). This arrangement, together with the adjustable operator's seat, permits an operator of any physical build to manipulate the PCCS lever easily and positively (Fig. 9).

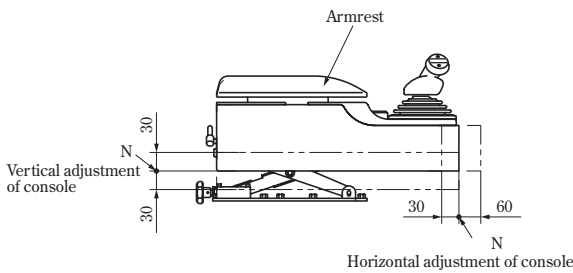


Fig. 9 Adjustable range of PCCS console

For the work equipment, pressure proportional control (PPC) which is capable of minute control is employed.

(2) Adoption of hydrostatic steering system (HSS)

The HSS consists of a steering pump, steering motor, steering planetary gear, and PCCS lever/controller/EPC valve which control them (Fig. 10).

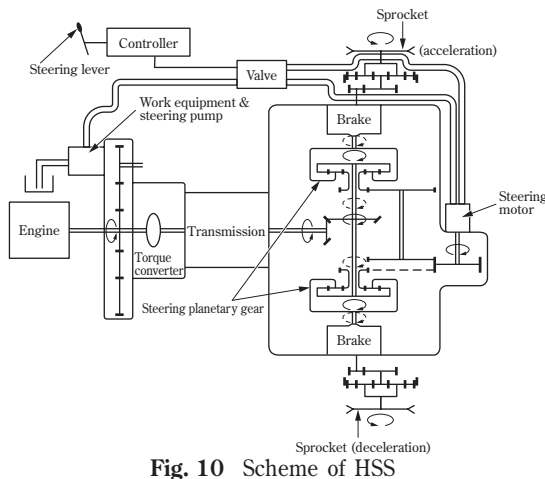


Fig. 10 Scheme of HSS

The HSS uses the differential mechanism of the planetary gear to give the power for forward movement, from the transmission, and the power for turning, from the hydraulic motor, a difference in output rotation between right and left, and thereby turns the machine (Fig. 11 and Fig. 12).

When turning the machine, the HSS always transmits the power to both the inner and outer belts, rather than cuts out the power to the inner belt. Therefore, the machine can turn smoothly and positively (Fig. 12).

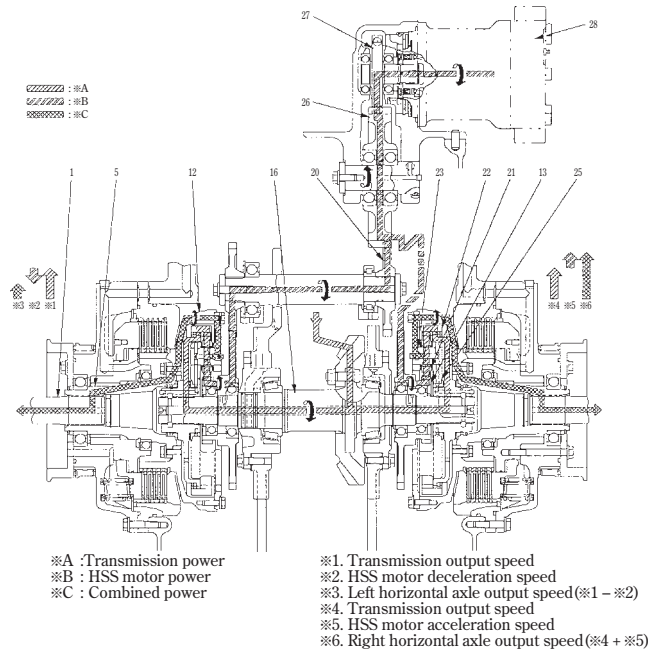


Fig. 11 Flow of power during left turn

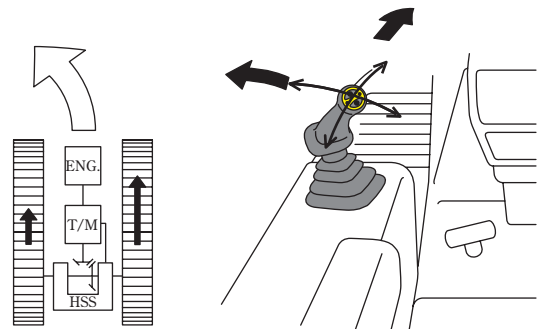


Fig. 12 Lever manipulation and power flow during left turn

(3) Electronically-controlled transmission

The transmission adopted for the new model is equipped with an electronically-controlled modulation valve which is capable of modulating the individual speed stages independently of one another.

It varies the modulation according to hydraulic stage, engine speed, load, etc., thereby allowing for smooth clutch control subject to minimum shock.

- ① The hydraulic wave form is varied as required.
- ② Before changing the speed, the clutch pressure for the present speed stage is maintained until engagement of the clutch to prevent the time lag and torque loss (Fig. 13).

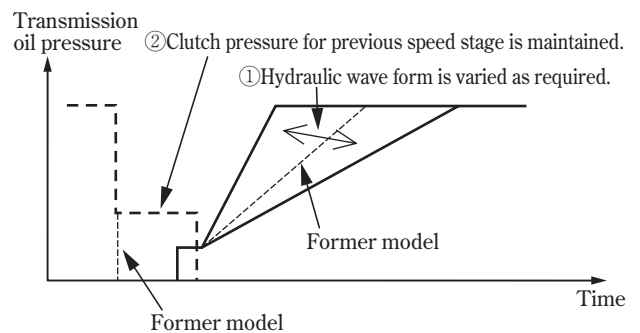


Fig. 13 Control of transmission oil pressure

In addition, the electronically-controlled transmission is equipped with the following functions as standard to reduce the frequency of speed change and improve the work efficiency.

- ① Speed stage presetting function which permits previously setting a forward/reverse speed stage selected from among three candidates
- ② Auto shift-down function which, when the machine speed comes down due to an increase in load, automatically shifts down the gear to ensure that the machine always works at highest efficiency.

**3.4 Improvement of productivity**

Thanks to the 5% increase in engine output (compared with the former model) and the introduction of advanced new technologies (e.g., the electronically-controlled hydraulic fan), the new model has attained higher productivity (8% in terms of hourly workload) and better fuel efficiency (5% than the former model (Fig. 14).

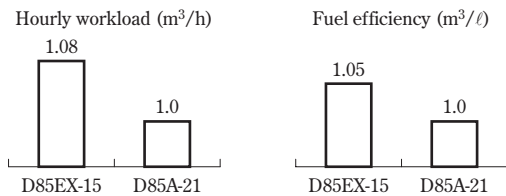


Fig. 14 Comparison of dozing workload

**3.5 Improvement of serviceability**

- (1) Adoption of new monitor panel equipped with self-diagnostic function

When some trouble occurs with the machine, the new monitor panel displays the content of the trouble by the associated error code. It is also possible to have the monitor panel display the condition of maintenance of the machine (Fig. 15 and Fig. 16).

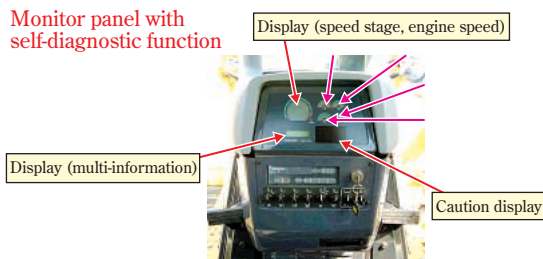


Fig. 15 New monitor panel

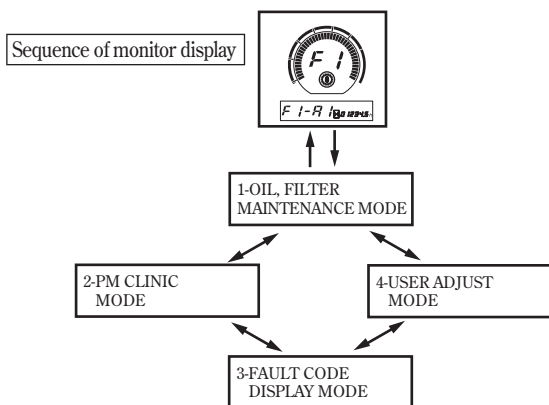


Fig. 16 Content of information

- (2) Modularized design of power train

The modularization of the power train (closed units) has made it possible to perform clean work with minimum oil leak and dramatically reduce the time and labor for disassembling/reassembling the individual units (about one-third that of the former model) (Fig. 17).

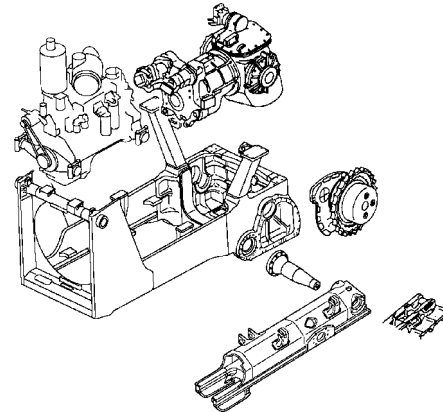


Fig. 17 Modularized power train

- (3) Prolonged time intervals of change of engine oil filter element, hydraulic oil, and hydraulic oil filter element (twice that of the former model).
- (4) Adoption of a disc brake to reduce the maintenance burden (band brake was used in the former model).
- (5) Adoption of a hydraulic fan to eliminate the need of belt inspection and to facilitate cleaning the radiator (because the direction of fan rotation can be reversed).

Thus, the serviceability has been improved dramatically.

**3.6 Improvement of reliability**

- (1) Improvement of reliability of undercarriage

The wear resistance of undercarriage parts has been appreciably improved by increasing the link height, subjecting the materials to more effective heat treatment, and increasing allowance for wear (Fig. 18).

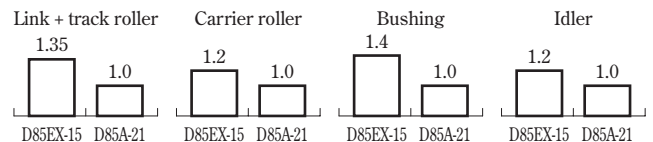


Fig. 18 Comparison of undercarriage durability

- (2) Improvement of reliability of electrical parts

For connection of the main harnesses, a highly reliable DT connector is used. In addition, the branches within harnesses have been subjected to potting treatment (covering with fork tube) to improve corrosion resistance and durability (Fig. 19).

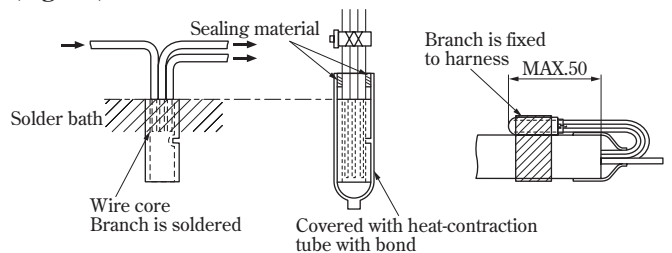


Fig. 19 Potting

(3) Separation of power train from frame

A hull frame construction has been employed for the main frame to permit separating rubber-mounted power train units from the frame, thereby preventing the power train from being influenced by external force and improving its reliability.

(4) The blade tilt piping has been completely built in the blade.

**3.7 Improvement of transportability**

Based on a review of the machine-body construction, the machine height has been significantly reduced to clear the domestic transportation regulation on maximum machine height of 3,800 mm with the cab kept on (when transported by a trailer whose floor height is 600 mm) (Table 4 and Fig. 20).

Table 4 Comparison of cab height

		D85EX/PX-15	D85A/P-21
Cab height (H) 3,800 mm limit set by domestic transportation regulations	mm	3163/3200 Within limit	3380/3420 Beyond limit

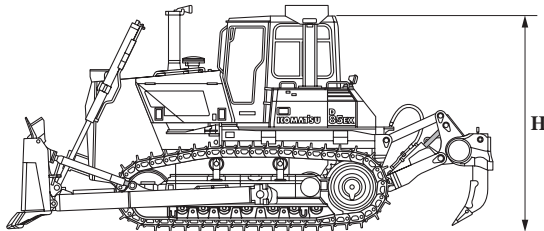


Fig. 20 Cab height

**3.8 Reduction of Cost**

In the present development, the departments concerned (Development, Manufacturing, and affiliated companies) made a concerted effort to rationalize the machine construction, reduce the number of parts, employ low-cost materials, and so on. As a result, the machine cost could be cut significantly (10% lower than the former model).

Examples of cost-cutting measures taken with the main frame are shown in Fig. 21.

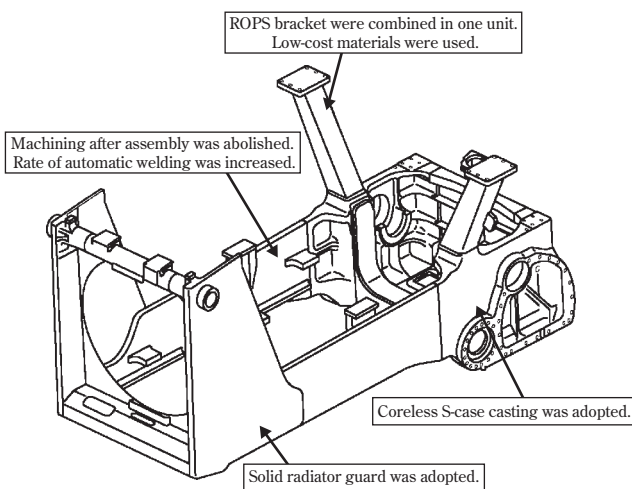


Fig. 21 Cost-cutting measures taken with main frame

**4. Conclusion**

In the present development of the new model, we could improve the machine performance and quality by introducing a number of most advanced technologies and cut the machine cost significantly (10% lower than the former model).

As the company's first product holding the unquestioned lead, the new model was put on a mass-production line in January 2003. The reputation that the new model is a surprisingly quiet, easy-to-operate machine is already becoming widespread.

**Introduction of the writers**



**Yuuichi Nagahiro**

Entered Komatsu in 1970. Currently working in Quality Assurance Department, Osaka Plant, Production Division, Komatsu.



**Yoshitake Yamaguchi**

Entered Komatsu in 1971. Currently working in Construction Equipment Technical Center 1, Development Division, Komatsu.



**Hiroshi Nakagami**

Entered Komatsu in 1973. Currently working in Construction Equipment Technical Center 1, Development Division, Komatsu.

**[A few words from the writers]**

Right from the start, we organized a project team to come up with a new model with development emphasis on cutting the cost drastically and improving the cab amenity dramatically (sticking to gorgeousness).

It was the first time for us to extensively apply 3D-CAD in the development of a bulldozer. We implemented various measures and made various improvements to efficiently carry out the entire process from development to mass production.

And now, we could deliver to the world the new model as one which has attained Q.C.D as planned.

In the future, we intend to strive to stabilize the quality and promote the sales of the new model.