Unit 7

Hydraulic Excavators

液压挖掘机

7．1 Overview 概述

7.1.1 Basic Concept 基本概念

An excavator is an engineering vehicle consisting of an articulated arm (boom, stick), bucket and cab mounted on a pivot (a rotating platform) atop an undercarriage with tracks or wheels. Their design is a natural progression from the steam shovel.

挖掘机是一种由铰接臂杆（动臂和斗杆）、铲斗和安装于履带或轮式底盘上的转盘（一种旋转平台）所组成的工程机械（车辆）。挖掘机是在蒸汽铲的基础上自然发展起来的。

The history of heavy excavating machinery began in 1835 when the dipper shovel was invented to excavate hard soil and rock and to load trucks. Of course, with the invention of gasoline-and diesel-powered vehicles, construction equipment became even more adaptable. Most construction equipment is powered by diesel engines, although electric-power, battery power, and propane tanks are used on specialized equipment.

重型挖掘机的历史始于 1835 年，当时发明了拉铲式挖掘机用于开挖坚硬的土石方及装载卡车。当然，随着汽油机和柴油机车辆的发明，工程机械也变得越来越适用。虽然在一些专用设备上使用了电力驱动、蓄电池驱动和丙烷气罐，然而大多数工程机械仍然依靠柴油机驱动。

Design modifications are driven by customer demand. As of 2000, the two primary areas where customers would like to see more improvements are in the ease of operation and the operator's comfort. The need for simple operation is forced by the fact that there are fewer skilled operators in the marketplace. And operations and reliability are both improving because of the

continuing integration of electronics, automation, better engine technology, and on-board diagnostics. It is now up to the manufacturers to cost-effectively incorporate improvements.

客户要求推动着设计的改进。自从 2000 年以来，客户所期望改进的两个主要方面为操作方便性和操作舒适性。操作简单的要求迫于在市场中很难找到熟练操作人员的事实。由于电子技术、自动化、高性能发动机技术、在线诊断技术的不断集成，操作性和可靠性均得到了不断的改进。目前，制造商在进行各种成本效益方面的改进。

7.1.2 Applications 应用

1

2

3

4

5

6

7

8

9

10

11

12

13

14

1. digging and loading 挖掘装载；2. stonework 石方工程；3. mining engineering 采掘工程；4. port operation 港口作业；5. trench excavation 开挖坑槽；6. take down old buildings 建筑拆除；7. rock breaking 岩石破碎；8. under water operation 水下作业；9. pipe laying 铺设管道；10. hoisting heavy object 起吊重物；11.breaking pavement 破碎路面；12. clear up side slope 整理边坡；13. watercourse clearance 疏通水道； 14. removal treatment 清理作业

7.1.3 Types 类型

1

2

3

4

5

6

7

8

9

10

11

12

1. mini type excavator 微型挖掘机； 2.small type excavator 小型挖掘机； 3.medium type excavator 中型挖掘机；4.large type excavator 大型挖掘机；5. wheel excavator 轮式挖掘机；6. large type shovel（face excavator）大型正铲挖掘机；7. Ultra high demolition hydraulic excavator 超高层建筑物拆除液压挖掘机； 8. river channel dredging excavator 河道疏浚挖掘机； 9. telescopic boom excavator 伸缩臂式挖掘机； 10. wetlands excavator 湿地挖掘机； 11. wheel backhoe loader 轮式挖掘装载机；12. radio controlled excavator 无线控制型挖掘机

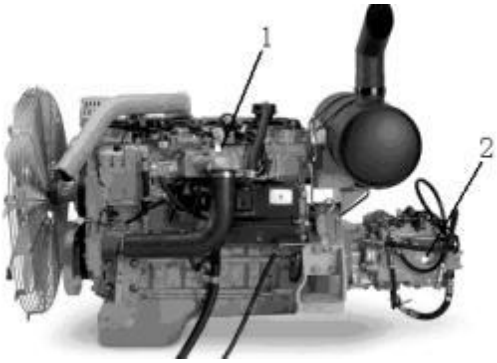
7.2 Components and Features **组成与特点**

7.2.1 Overall Structure **总体结构**

1. diesel engine and hydraulic system 柴油机及液压系统；2.undercarriage 行走支承机构；3. swing mechanism 回转机构； 4. work equipment assembly 工作装置总成； 5. steering and operating system 转向操纵系统

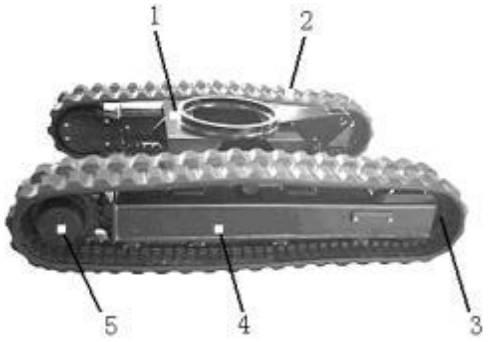
7.2.2 Major Components **主要部件**

7.2.2.1 Diesel Engine and Hydraulic System 柴油机及液压系统



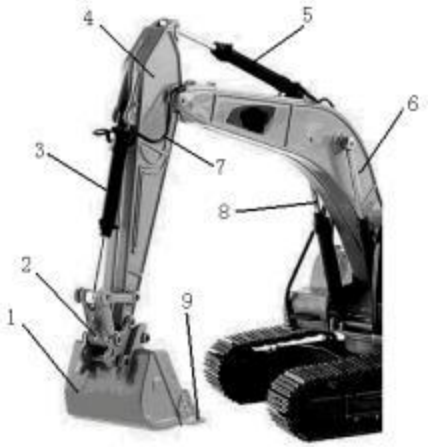
1. diesel engine 柴油机；2. hydraulic pump 液压泵

7.2.2.2 Undercarriage 行走支承机构



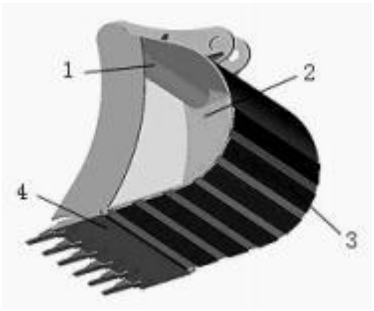
1. main frame 主机架；2. track 履带；3. track idler 导向轮；4. track frame 履带台车架；5. final drive(driving motor and drive sprocket)最终传动装置（液压马达与驱动链轮）

7.2.2.3 Work Equipment Assembly 工作装置总成



1. bucket 铲斗；2. bucket linkage 铲斗连接件；3.bucket cylinder 铲斗油缸；4. arm 斗杆；5. arm cylinder 斗杆油缸；6. boom 动臂；7. hydraulic pipeline 液压管路；8.boom cylinder 动臂油缸；9. bucket lip 斗齿

7.2.2.4 General Purpose Bucket 通用铲斗

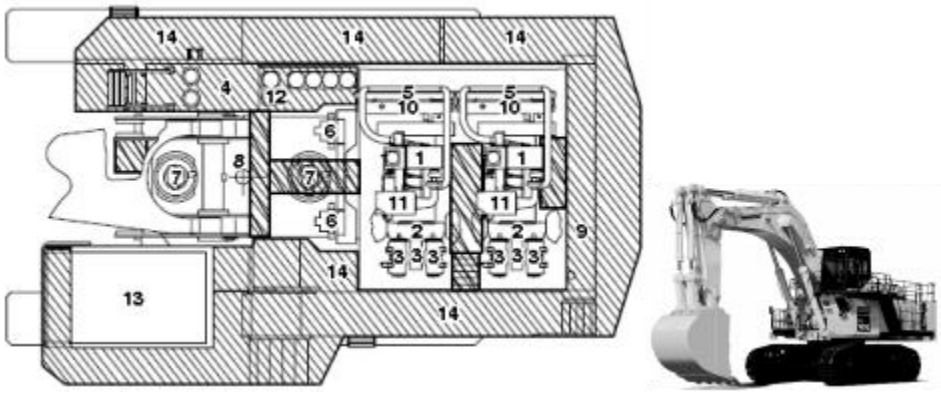


1.anti-torsion pipe fitted for increased strength 抗扭增强钢管；2.two piece side plates 两边侧板；3. wear straps fitted to increase base strength 斗底增强耐磨板条；4. cutting edge 切削刃

7.2.2.5 Steering and Operating System 转向操纵系统

1. driver's Seat 驾驶员座椅；2. arm rest 扶手；3.joystick control 操纵控制手柄；4. control pedal 操纵踏板；5. travel lever 行走操纵杆；6. monitor 工况监视器；7. console 仪表控制台

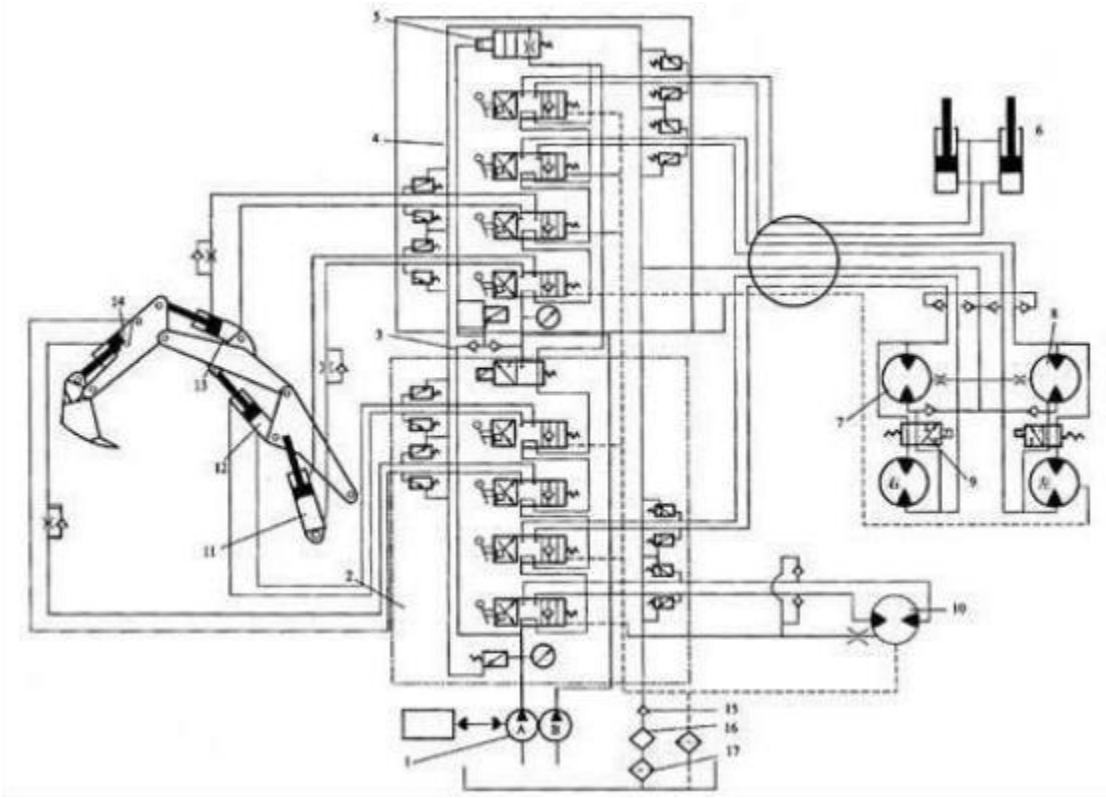
7.2.3 General Arrangement of Large Type Excavator 大型挖掘机总体布置



1. engines发动机；2. PTO分动箱；3. hydraulic pumps液压泵；4. hydraulic tank液压油箱；

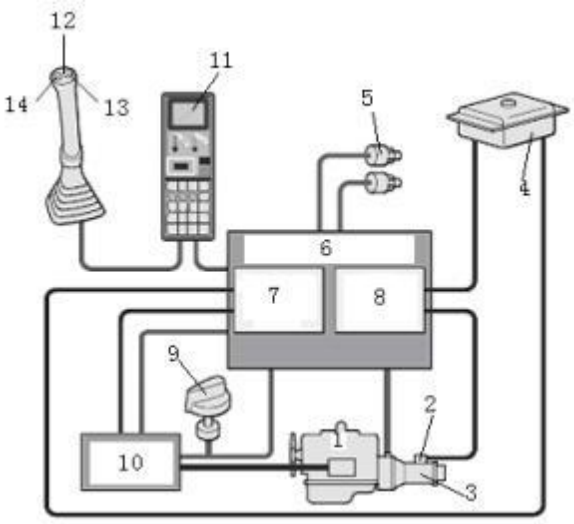
5. oil coolers液压油冷却器；6. control valves控制阀；7. swing motors回转马达；8. swivel joint旋转接头；9. fuel tank燃油箱；10. radiators散热器；11. air cleaners空气滤清器；12. hydraulic filters液压过滤器；13. operator cab驾驶室；14. walkways行走通道

7.2.4 Typical Hydraulic System 典型液压系统



1．hydraulic pump 液压泵；2、4．distributing valve group 分配阀组；3．check valve 单向阀；5．speed limit valve 速度限制阀；6．hydraulic cylinder 液压缸；7、8．traveling hydraulic motor 行走液压马达；9．double speed valve 双速阀 10．slewing hydraulic motor 回转液压马达；11．boom cylinder 动臂油缸；12．auxiliary cylinder 辅助油缸；13．arm cylinder 斗杆油缸；14. bucket cylinder 铲斗油缸；15．back pressure valve 背压阀；16．oil cooler 冷却器；17．oil filter 滤油器

7.2.5 APC System 自动功率控制系统



1. engine 发动机；2. APC control valve APC 控制阀；3. hydraulic pump 液压泵；4. APC & accelerator back up switch APC 与加速器备用开关； 5. pressure sensor 压力传感器； 6. APC controller APC 控制器；7. accelerator emergency circuit 加速器应急回路；8. APC emergency circuit APC 应急回路； 9. accelerator dial 加速器调节刻度盘； 10.ECU 电子控制单元；11.combination monitor 综合监视器； 12.lever switch 杠杆操纵开关； 13. high power switch 大功率开关； 14.quick accelerator switch 快速加速开关

7.2.6 Specifications **工作性能**

7.2.6.1 Standard Equipment Specifications 标准装置规格类型与性能参数

1. Engine**发动机**：Model型号；Type：Water-cooled, 4 cycle，Direct injection类型：水冷，四冲程，直喷式；Aspiration：Turbocharged充气形式：涡轮增压；Number of cylinders气缸数；Bore x stroke缸径×冲程；Piston displacement活塞排量；Governor： Mechanical, all-speed control调速器：机械式，全程调速；Net Flywheel horsepower净飞轮功率；To meet U.S. EPA Tier 3 emissions requirements符合美国3类环保排放标准；Net flywheel power advertised is the power available at the flywheel when the engine is equipped with fan, air cleaner, muffler and alternator.所标示的净飞轮功率是指发动机配备风扇、空气滤清器、消声器和发电机时飞轮所能输出的功率。

2. Hydraulic System**液压系统**：Max. pressure – Travel行走系统最大压力；Max. pressure – Swing回转系统最大压力； HydrauMind system.，Closed-center system with load-sensing valves and pressure-compensated valves智能液压系统，负荷感应阀与压力补偿阀中心闭锁系统；

selectable working modes可选工作模式；Main pump：Variable-displacement piston pump液压主泵：变量柱塞泵；Maximum flow最大流量；Sub-pump for control circuit控制回路辅助液压

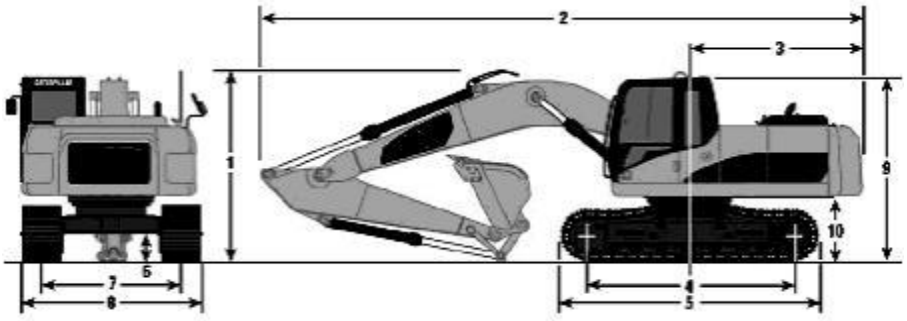
泵；Travel motors with parking brake驻车制动型行走液压马达；Swing motor with swing holding brake制动型回转液压马达；Axial piston motor轴向柱塞马达；Relief valve setting安全阀设定；Implement circuits执行回路；Travel circuit行走回路；Swing circuit回转回路；Pilot circuit控制回路；Service valve操纵阀；Number of cylinders – bore x stroke液压缸数量—缸径×行程；Service valves maximum flow操纵阀最大流量

3. Drives & Brakes**驱动和制动装置**：Steering control：Two levers with pedals转向控制：两组操纵杆和踏板；Drive method ：Fully hydrostatic驱动方式：全静液驱动；Travel motor：Axial piston motor，in-shoe design行走马达：轴向柱塞马达，滑靴设计；Reduction system：Planetary gear，double –reduction减速系统：行星减速，双级减速；Max. drawbar pull最大牵引力；Max. travel speed最大行驶速度；Service brake：Hydraulic lock行车制动：液压锁止；Parking brake ：Oil disc brake驻车制动：湿式盘式制动

4. Swing System**回转系统**：Driven by Hydraulic motor液压马达驱动；Swing reduction回转减速；Planetary double reduction行星双级减速；Swing circle lubrication：Grease-bathed回转圈润滑：油脂润滑；Swing lock回转锁定；Swing speed回转速度；Swing torque回转力矩

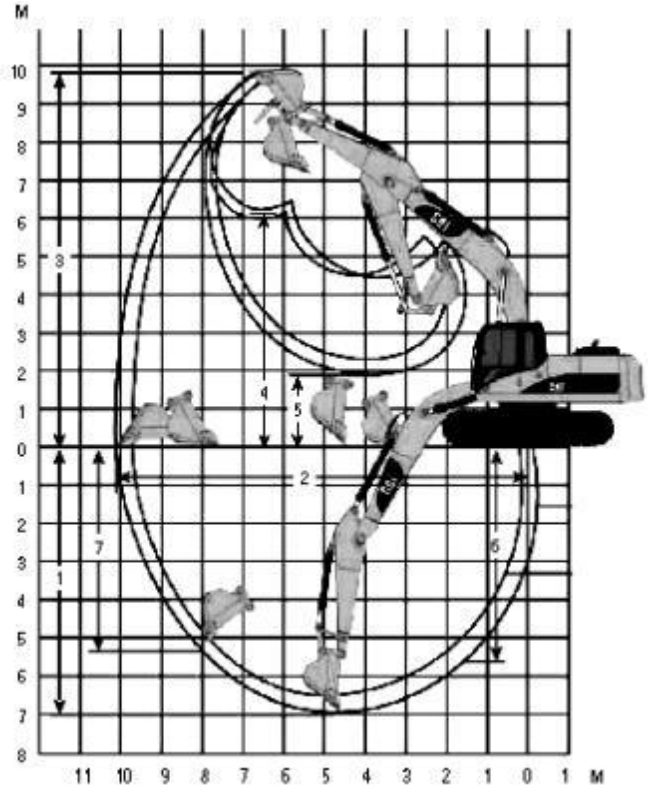
5. Undercarriage**下部支承（行走机构）**： Center frame ：X-frame中心机架：X型机架；Track frame：Box-section type履带台车架：箱型截面；Sealed track密封型履带；Track adjuster：Hydraulic type张紧装置：液压型；No. of shoes履带板数量；No. of carrier rollers托链轮数量；No. of track rollers支重轮数量

7.2.6.2 Dimensions尺寸规格



1. Shipping Height海运高度；2. Shipping Length海运长度；3. Tail Swing Radius尾部摆动半径；4. Length to Center of Rollers滚轮中心距离；5. Track Length履带长度；6. Ground Clearance离地间隙；7. Track Gauge轨距；8. Transport Width运输宽度；9. Cab Height驾驶室高度； 10. Counterweight Clearance配重离地间隙

7.2.6.3 Working Ranges工作范围



1. Maximum Digging Depth最大挖掘深度；2. Maximum Reach at Ground Level最大水平移动距离；3. Maximum Cutting Height最大挖掘高度；4. Maximum Loading Height最大装载高度；5. Minimum Loading Height最小装载高度；6. Maximum Depth Cut for Level Bottom最大水平切削深度；7. Maximum Vertical Wall Digging Depth最大垂直挖掘深度

7.2.7 Small Excavator Features小型挖掘机特点

1. Mustang introduces a new bucket series with innovative design improvements that achieve greater bucket volumes, higher breakout forces and improved vertical digging.

新型铲斗系列进行了改进设计，具有更大的斗容量、更强的破碎力和更好的垂直挖掘。

2. Standard headlights mounted on the boom and at the front of the cab provide excellent nighttime visibility.

安装于动臂上和驾驶室前方的标准照明灯提供了最佳的夜间视觉。

3. To help avoid damage and downtime, Mustang securely routes bucket cylinder hoses through the dipper stick. For faster attachment management and parts replacement, we connect boom and arm hoses on the outside of the machine.

为避免损坏和停机，沿杆臂安全布置液压缸软管。为快速处理附件和更换零件，在机器外部连接动臂和斗杆软管。

4. Independent right and left boom swing, for offset digging.

动臂左、右独立摆动，以适应侧向挖掘。

5. Special digging situations call for specialized digging machines, which allow vertical digging even on slopes up to 15 degrees.

特殊的挖掘环境需要专业的挖掘机械，即使在15°的坡道上也可进行垂直挖掘作业。

6. Mustang's chassis includes edges reinforced with cast iron — nearly indestructible. This heavy-duty reinforced bumper protects components against accidental collisions.

底盘进行了铸铁棱边强化，几乎不可损坏。这种重型保险装置可在碰撞事故中保护机械部件。

7.3 Attachments 工作附件

1

2

3

4

5

6

7

8

9

10

11

12

13

14

15

16

1.grapple 抓斗；2.thumb Bucket 拇指型铲斗；3.grab bucket 抓斗；4.excavator ripper 松土齿；5.rock digging 石料铲斗；6.ditching bucket 挖沟铲斗；7.tilting bucket 斜挖铲斗；8.clamshell bucket 蚌壳式抓斗；9.mud bucket 挖泥斗；10.clean up bucket 清扫铲斗；11. eliminator manual quick coupler 分离式手动快速连接器；12. hydraulic crusher 液压破碎器；13. universal compaction wheel 万能压实轮；14. vibro hammer 振动锤；15. hydraulic breaker 液压破碎锤；16. skeleton bucket 格栅铲斗

7.4 New Technology of Typical Hydraulic Excavator **典型液压挖掘机新技术**

7.4.1 Introduction**简介**

The Hitachi ZAXIS-3 series new-generation hydraulic excavators are packed with a host of technological features – clean engine, Hitachi advanced hydraulic technologies, with strong undercarriage and front attachment, plus well matching ofpower and speed. The ZAXIS-3 series can get the job done with proven productivity, durability, and reliability, especially in heavy-duty excavation and quarry operations.

日立ZAXIS-3系列新一代液压挖掘机具有一系列技术特点：清洁发动机，先进的日立液压技术，坚固耐用的行走底盘和工作装置附件，以及功率与速度的良好匹配。ZAXIS-3系列挖掘机所具有的生产率、寿命和可靠性得到了检验证实，特别是在重型挖掘和采石场作业更加适用。

To yield high production yet maintain low fuel consumption, such was the objective of the development of a new engine and hydraulic system .

以较低的燃料消耗获得更大的生产能力是新型发动机和液压系统研究的目标。

7.4.2 New-Generation Clean Engine**新一代清洁发动机**

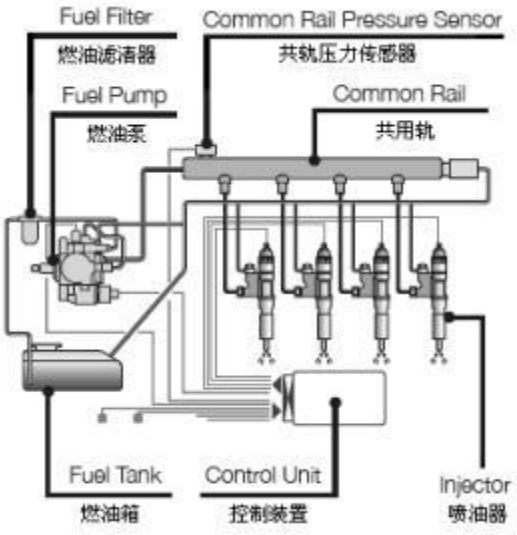
1. High Power Yet Low Fuel Consumption高功率输出低燃料消耗

4% Increase in output (vs. Conventional model). The new clean engine, complying with the emission regulations Tier 3 in US(EPA) and EU Stage III, can reduce fuel costs by electronic

control.

输出功率增加4%（与普通型号发动机比较）。新型清洁发动机符合美国环保局3级与欧III排放标准，并通过电子控制可降低燃料成本。

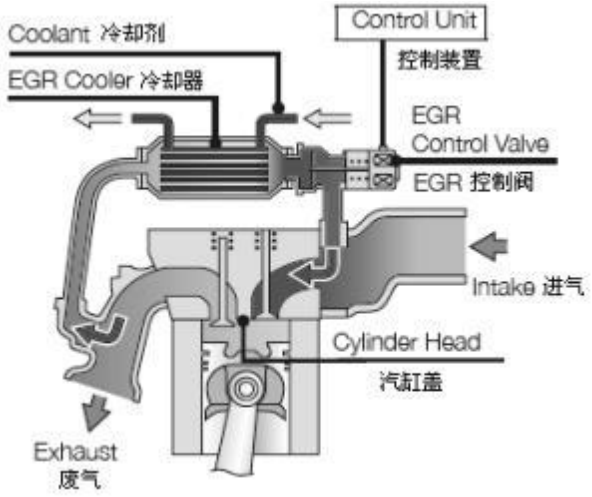
2. Common Rail Type Fuel Injection System共轨型燃油喷射系统



Electronic control common rail type fuel injection system drives an integrated fuel pump at an ultrahigh pressure to distribute fuel to each injector per cylinder through a common rail. This enables optimum combustion to generate big horsepower, and reduce PM and fuel consumption.

电子控制共轨型燃油喷射系统驱动集成燃油泵，通过一个共用轨以超高压方式将燃油分配给每个汽缸的喷油器。这种系统能够使燃烧过程得到优化，从而产生较大的功率，并降低微粒排放和燃料消耗。

3.Cooled EGR System冷却废气再循环系统



Exhaust gas is partially mixed with suction air to lower combustion temperature for reducing

NOx and fuel consumption. What's more, the EGR cooler cools down exhaust gas to increase air concentration for complete combustion, reducing PM.

排放废气与吸入空气进行部分混合以降低燃烧温度，从而减小氮氧化合物NOx与燃油消耗。此外，EGR冷却器使废气温度降低以增加空气浓度，达到完全燃烧和减少微粒排放的目的。

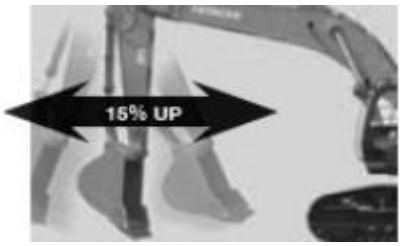
7.4.3 Advanced Hydraulic Technologies 先进的液压技术

1.Increased Digging Force 挖掘力增加

7% more bucket digging force and 8% more arm digging force.

铲斗挖掘力增加7%，杆臂挖掘力增加8%。

2. Enhanced Boom Recirculation System 加速型动臂再循环系统



In combined operation of boom lower and arm, arm speed can be increased by approximately 15% over the conventional. Pressurized oil from boom cylinder bottom side is delivered to boom cylinder rod side to lower the boom, assisted by boom weight. Conventionally, pressurised oil from pump is delivered to boom cylinder rod side to lower the boom. The new system also allows an efficient combined operation of swing and lowering the boom.

动臂下降与杆臂组合作业时，与常规挖掘机相比较杆臂速度大约可增加15%。动臂油缸底部一端的压力油被输送到动臂油缸的活塞杆一边，以降低动臂，动臂重量加速了降低过程。而在一般情况下，通过使来自液压泵的压力油流入动臂油缸活塞杆一端降低动臂。新系统也可以实现摆动与降低动臂的高效组合作业。

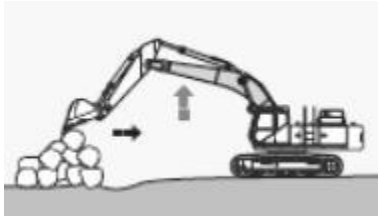
3. Boom Mode Selector 动臂工作模式选择

The amount the body can be lifted or pulled by the front of machine can be ON or OFF

selected. This helps to provide for more comfortable operation and contributes to longer component service life.

挖掘机前部工装提升或推移机体的力量大小可通过一个ON/OFF选择开关进行选择。这种选择有助于提高操作舒适性和延长部件工作寿命。

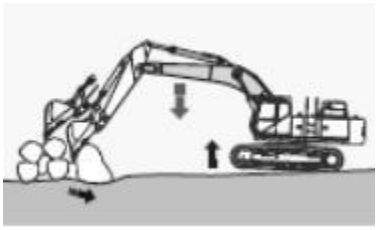
（1） ON Comfortable mode 舒适工作模式（开关位置ON）



There is little lifting or pulling of the body so there is less vibration and shock.

机体几乎没有提升或推移，因而振动和冲击较小。

（2） OFF Powerful mode 重型工作模式（开关位置OFF）



Much lifting and pulling of the body so there is more vibration and shock.

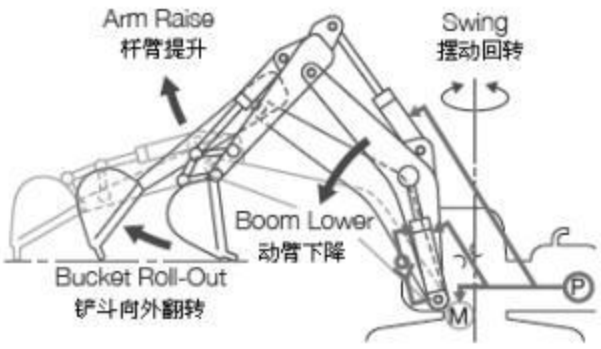
机体有较大的抬起和推移，因而振动和冲击较大。

4. Larger-Diameter Front Piping 大直径前部管路

Arm piping is increased in diameter to reduce hydraulic loss (theoretically 7%) for speedy front operation.

增加杆臂油管直径以减少液压损失（理论上为7%）提高作业速度。

5. Combined Operation of Boom and Arm 动臂与杆臂的组合作业



In combined operation of swing + boom lower + arm roll-out, or in leveling (boom lower + arm roll-out), arm roll-out speed can be increased greatly. Here's why. A variable throttle, provided in the arm circuit, adjusts the flow when needed to reduce hydraulic loss in combined operation with arm roll-out.

在回转+动臂下降+杆臂外伸的组合作业中，或者在平整作业（动臂下降+杆臂外伸）中，可大大提高杆臂外伸速度。原因在于，在杆臂外伸的组合作业中当需要减少液压损失时，杆臂回路中的可变节流阀将对流量进行调节。

6. New Bucket Regenerative System 新型铲斗再循环系统

Swift bucket actions can be done in combined operation for excavation through the new bucket regenerative circuit. When the load to the bucket is light, pressurized oil from bucket cylinder rod side is delivered through a regenerative valve to bucket cylinder bottom side for the effective use of hydraulic energy.

通过新型的铲斗再循环回路能够加快组合挖掘作业中铲斗的动作。当铲斗上的载荷较轻时，由铲斗油缸活塞杆一端产生的压力油通过再循环阀传输到铲斗油缸底端以便有效利用液压能量。

7.4.4 Strengthened Undercarriage 加强型行走机构

1.Increased Loading Capacity of Swing Bearing 回转轴承承载能力增强

The swing circle ball bearing ultilizes more balls to boost the loading capacity of the swing circle by approximately 6%, allowing stable swing even in tough operation.

回转循环滚珠轴承采用了更多的滚珠，使滚圈的承载能力大约提高了6%，即使在重载工况下也能稳定运行。

2.Strengthened Track Links强化履带链

The boss diameter of each track link is increased by approximately 19%. The thickness of each track link is also increased by approximately 57%. Thickened track links extend service life.

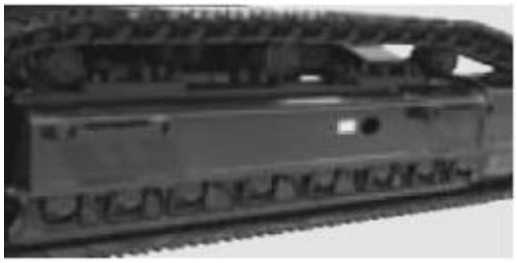
每一履带链条的凸台直径增加了大约19%。每一履带链条的厚度也增加了大约57%。加厚的履带链条延长了使用寿命。

3.Strengthened Upper Roller Bracket 强化了上托链轮支架

The upper roller bracket wall thickness is increased for higher strength.

增加上托链轮支架壁厚以提高强度。

4.Full Track Guard Provided Standard 全履带防护装置标准化



On the H-specification machines, full track guards are provided standard. Full track guards protect track links and lower rollers from damage and deformation. Moreover, they also keep out stones, preventing the overload to the undercarriage to reduce wear and damage.

在H型挖掘机上，提供了标准的全履带防护装置。全履带防护装置保护了履带链条和支重轮，避免了损坏与变形。而且， 履带防护装置也阻止了石块，防止了行走机构的过载，减少了磨损和损坏。

5.Pressed Master Pins 压力防松主销

The master pin of each track link is pressed, instead of master pin using a pin retention to avoid disengagement.

对每个履带链条主销进行加压，代替了使用钉型销的防松工艺。

6.Strengthened Idler Pedestal 增强型导向轮支座

The bearing length of the idler pedestal is extended by approximately 67% to increase durability and service life.

导向轮支座支承长度延长了大约67%以增加耐久性和寿命。

7.Strengthened Idler Bracket 增强型导向轮支架

The idler bracket is thickened for rigidity to prevent deformation and increase durability.

增加导向轮支架厚度以提高刚度， 防止变形并增加耐久性。

7.4.5 Strengthened Front Components增强型工作装置

1. 5% Increase in Strength with Stronger Pin Material 高强度销轴材料强度增加5%

The strength of pins, used in the arm and boom, is increased by 5%, using harder steel material.

应用高强度钢材，使杆臂和动臂上的销轴强度提高5%。

2.Strengthened General-Purpose Bucket 增强型通用铲斗

Bucket teeth are reshaped as Super-V teeth for smooth penetration and higher production.

Bushings are utilized at both ends of a bucket pin to eliminate clearances, preventing jerky operation.

铲斗斗齿改为超级V型齿，使铲入平稳、生产率提高。铲斗销轴两端均使用衬套，以便消除间隙， 防止急拉式作业。

3.Strengthened H-Bucket for Heavy-Duty H型重型强化铲斗

The heavy-duty bucket is reshaped, and bucket parts are strengthened to increase durability.

改进重型铲斗，增强铲斗零件，提高耐久性。

7.4.6 Enhanced Operator Comfort **提高驾驶员舒适性**

The spacious cab is ergonomically designed with excellent visibility to reduce operator fatigue and burden.

宽敞的驾驶室符合人机工程学设计，具有最佳的视野，减少了驾驶员工作疲劳与负荷。

1. Excellent Visibility 最佳的视野

The glass windows are widened for excellent visibility, especially improving right downward view during travel and excavation.

为获得最佳视野加宽玻璃窗，特别是改善了行走和挖掘时右下方的视野。

2. Ample Foot Space 宽敞的足下空间

Foot space is expanded forward, and pedals are reshaped for pleasant operation.

足下空间向前扩展，改进踏板形式保证愉快操作。

3.Short-Stroke Levers 短行程操纵杆

Fingertip control of short-stoke levers, with the help of armrests, allows long, continuous operation with less fatigue（30% reduction in lever control effort）.

短行程操纵杆的指尖控制在扶手帮助下能够长时间进行无疲劳连续操作（操纵杆操作力减小30%）。

4.Comfort-Designed Operato

The operator seat is ergonomically designed for long-hour pleasant operation. The seatback is widened to hold the operator securely, and the headrest is reshaped. The operator seat is strengthened to reduce vibration and shocks, and increase durability.

驾驶员座椅依照人机工程学原理设计， 以便使驾驶员长时间愉快操作。加宽座椅靠背，使驾驶员操作安全稳固，并且改进了座椅头靠的形状。对座椅进行增强以较小振动和冲击，并提高耐久性。

5. Fluid-Filled Elastic Mounts 充液弹性支座

The cab rests on fluid-filled elastic mounts that absorb shocks and vibration to enhance operator comfort.

驾驶室安装于充液弹性支座上，从而吸收了冲击和振动，提高了驾驶员工作舒适性。

6. Large Multilanguage, Multi Function Monitor 大界面多语言多功能监视器

7.Rear View Camera 后视摄像头

The large color LCD monitor, teamed up with the rear view camera (optional) on the counterweight, gives the operator unobstructed rearward view. This system enhances safety during swing and reversing.

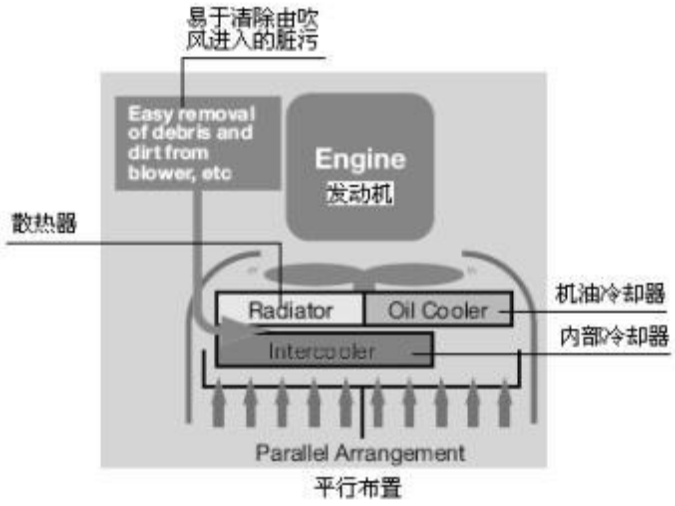
彩色大界面监视器与配重上方的后视摄像头（可选件）组合，为驾驶员提供了机械后方的无障碍视野。该系统提高了挖掘机回转与倒车时的安全性。

7.4.7 Simplified Maintenance 维护简单方便

Focusing on simplified maintenance, including easy inspection, service and cleaning.

维护保养简单，其中包括方便的检查、保养和清洁。

1. Simplified Cleaning around Engine 发动机清洁简单方便



The radiator and oil cooler are laid out in parallel arrangement for easy demounting, instead of conventional inline arrangement. This new arrangement significantly helps facilitate cleaning around the radiater and oil cooler.

与传统的内联布置方法不同，对散热器和机油冷却器进行并行布置，以方便拆卸。这一新型布置极大地方便了散热器和机油冷却器的清洁。

2. Dual Main Fuel Filters Provided Standard 标准化双主燃油滤清器

In addition to a pre-filter, dual main fuel filters are provided standard to reduce clogging of the fuel line to the engine.

除粗滤器外，设置了两个主燃油滤清器以减小发动机油路的堵塞。

3. Easy Draining 排油方便

The engine oil pan is fitted with a drain coupler. When draining, an associated drain hose is connected to the drain coupler. Unlike a cock, the drain coupler is reliable, avoiding oil spills and vandalism.

发动机油底壳设置有排油管接头。需要排油时，将排油软管与排油管接头连接。与旋塞不同，这种排油管接头使用可靠，避免了油的泄露和人为破坏。

4. Automatic Lubrication 自动润滑

The front attachment is automatically lubricated, except for bucket lubricating points at the top of arm that are repositioned for side lubrication.

前部工作装置采用自动润滑方式，将杆臂顶部的润滑点重新设置在侧面。

5. Extended Hydraulic Oil Filter Change Intervals 较长的液压油滤清器更换时间间隔

Hydraulic oil filter change intervals are extended from 500 hours to 1000 hours to help reduce running costs.

液压油滤清器更换时间间隔由500h延长至1000h以降低使用成本。

7.4.8 Environmental Preservation 环境保护

Boarding a clean engine complying with the rigorous emission regulations.

提供符合严格排放标准的清洁发动机。

1.Environmentally Friendly Designs 环境友好设计

（1）Boarding Clean Engine 提供清洁发动机

The clean engine complying with the emission regulations Stage III in EU and Tier 3 in US (EPA) is boarded to reduce emissions containing nitrogen oxide (NOx) and particulate matter (PM).

清洁发动机符合欧III与美国环保局(EPA)3级排放标准，减少了氮氧化物(NOx)和微粒(PM)的排放。

（2）Low Noise Engine 低噪声发动机

Engine noise is reduced by approximately 2 dB with the robust engine. It goes without saying that the engine meets the EU noise regulations.

发动机噪声大约减小了2 dB。不言而喻，该发动机符合欧洲噪声标准。

2. Variable-Speed Fan 变速风扇

The engine cooling fan is a large 1120 mm diameter variable-speed electro-hydraulic fan. This fan automatically starts when temperature comes into the high temperature range, ensuring low noise operation.

发动机冷却风扇为大直径（1120 mm）电液控制变速风扇。当温度达到高温区时，风扇自动启动，并保证低噪声运行。

3. Proven Muffler 合格消声器

A proven large muffler is provided to reduce sound and exhaust emissions greatly.

使用较大规格的消声器大大降低了噪声与排放。

4. Marking of Recyclable Parts 标记可再生零件

All resin parts are marked for the sake of recycling. This helps ease the separation of recyclable wastes.

标记树脂材料零件以便再生利用。这种做法有助于再生废料的分拣。

5. Reducing the Burden to the Environment 减轻环境负担

Lead-free design is achieved through the use of lead-free wire harness covering, radiator, oil cooler and others. No asbestos is used. The use of aluminum radiator, oil cooler and intercooler increases the durability of the machine.

通过使用无铅线束盖、散热器、机油冷却器等实现了无铅化设计。未使用任何石棉物。使用铝制散热器、机油冷却器和内置冷却器提高了机械的耐久性。

6. Biodegradable Hydraulic Oil 生物可降解液压油

Degradable hydraulic oil is ecological, which is decomposed into water and carbon dioxide in water and ground.

可降解液压油是生态环保性的，在水中和地下可分解为水与二氧化碳。

7.4.9 Enhanced Safety **高安全性**

1. CRES II Cab 不锈钢结构驾驶室

The CRES II cab is designed to help with “just in case” protection for the operator. Safety in case of tipping is improved. The cab top can withstand nine-fold loading.

CRES II型驾驶室设计为驾驶员提供了“ 以防万一 ”的保护。倾翻时的安全性得到了改善。驾驶室顶部可承受9倍载荷。

2. H/R Cab　H/R型驾驶室

The H/R cab utilizes the reinforced front window and FOPS at the roof for protection against falling objects. The front glass window, made of straight-laminated, is fixed to shut out dirt and debris. The cab provided with a full guard satisfies the OPG(Level II) cab requirements stipulated by ISO.

H/R型驾驶室利用增强型前窗和顶部落物保护结构以防下落物的破坏。由多层平面玻璃制做的前窗被固定，防止了污物和碎片的侵入。驾驶室具有完全防护功能，符合ISO对于二级OPG驾驶室的各项要求。

3. New Pilot Control Shut-Off Lever新型驾驶操纵锁定杆

The engine cannot start unless the lock lever is locked completely. This prevents unintended rapid lurching by unintended touching a control lever.

除非将锁杆完全锁定，否则发动机就不能启动。该设置防止了由于无意识碰上操纵杆时所产生的快速晃动。