



Basic Knowledge of Loader Electrical System

装载机电气系统基础知识

April 13, 2023

Main Content

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Suitable Group

This course is suitable for domestic and foreign junior technical service personnel

It also applies to...

Main Content

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Training Objectives

1. This training course is expected to have 6 hours.
2. After training of this course, students should master the following main knowledge points:
 - (1) Circuit diagram and failure analysis methods
 - (2) Storage battery diagnosis
 - (3) Structure of generator
 - (4) Failure diagnosis of starter
 - (5) Instrument and sensor
 - (6) Electrical system structure and principle of Lingong loader
 - (7) Common failure diagnosis and troubleshooting of loader electrical system

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起动机

5 Lighting Equipment, Auxiliary Circuit and Instrument
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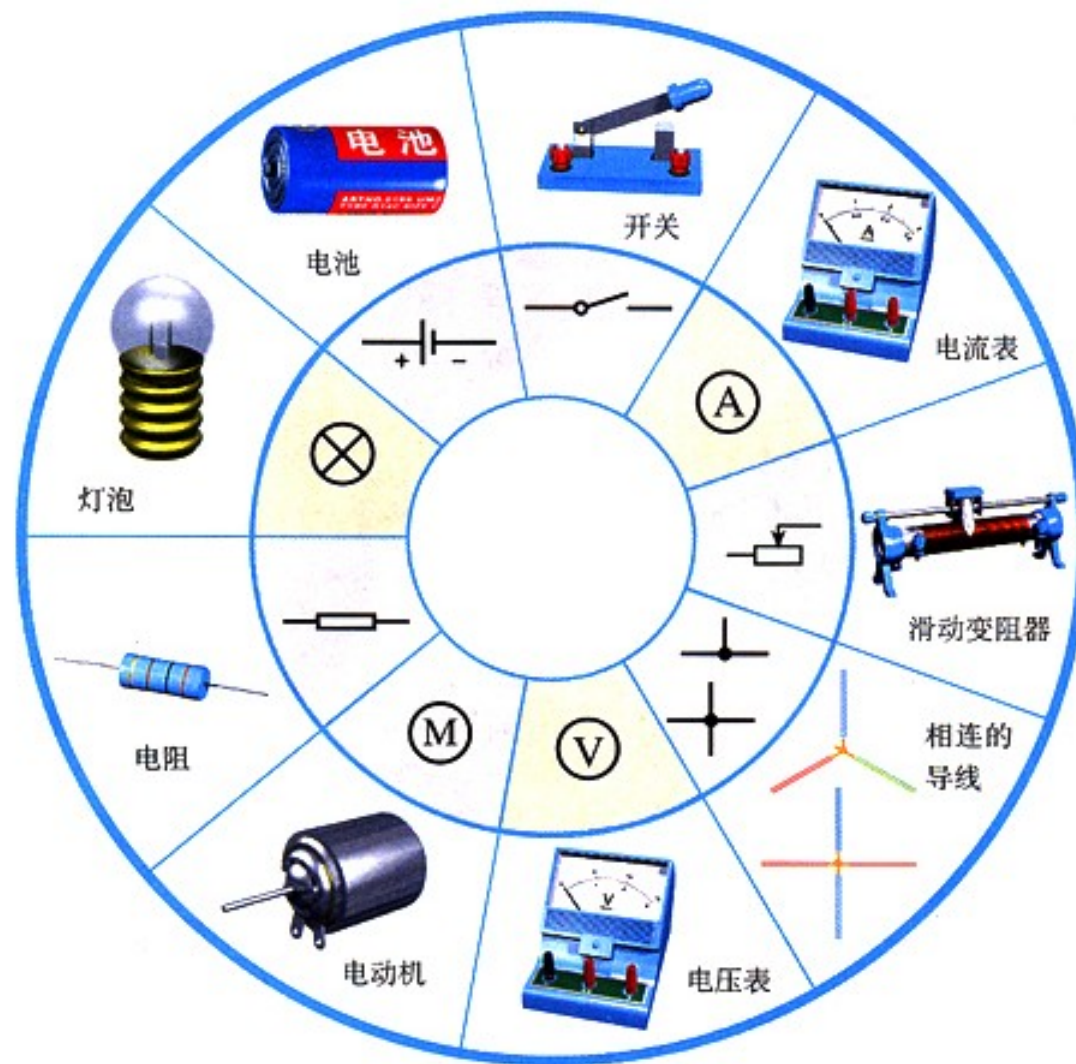
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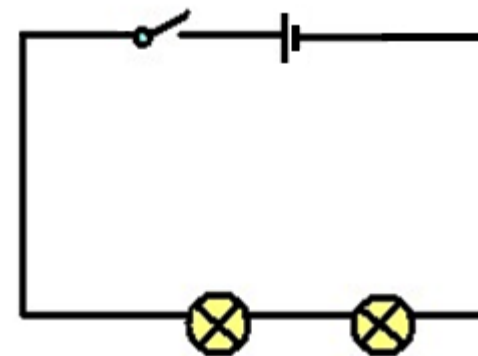
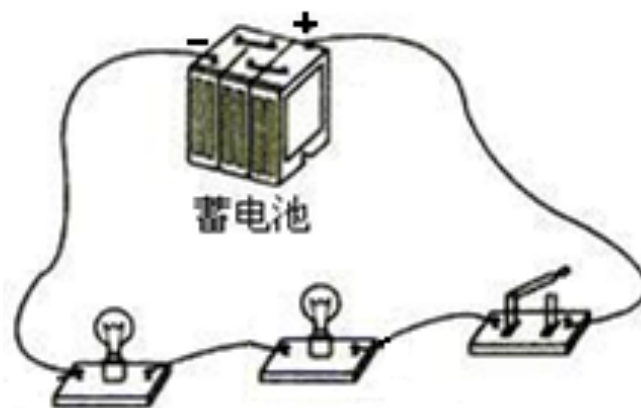
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一、电气基本原理

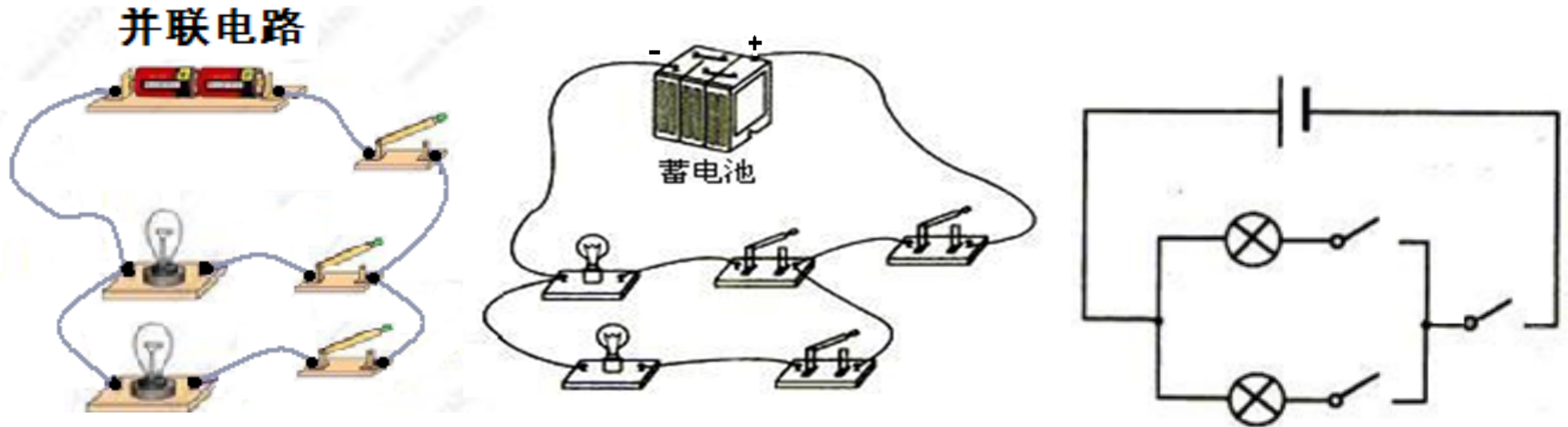


一、电气基本原理



串联电路 **series circuit**

一、电气基本原理



并联电路 **parallel circuit**

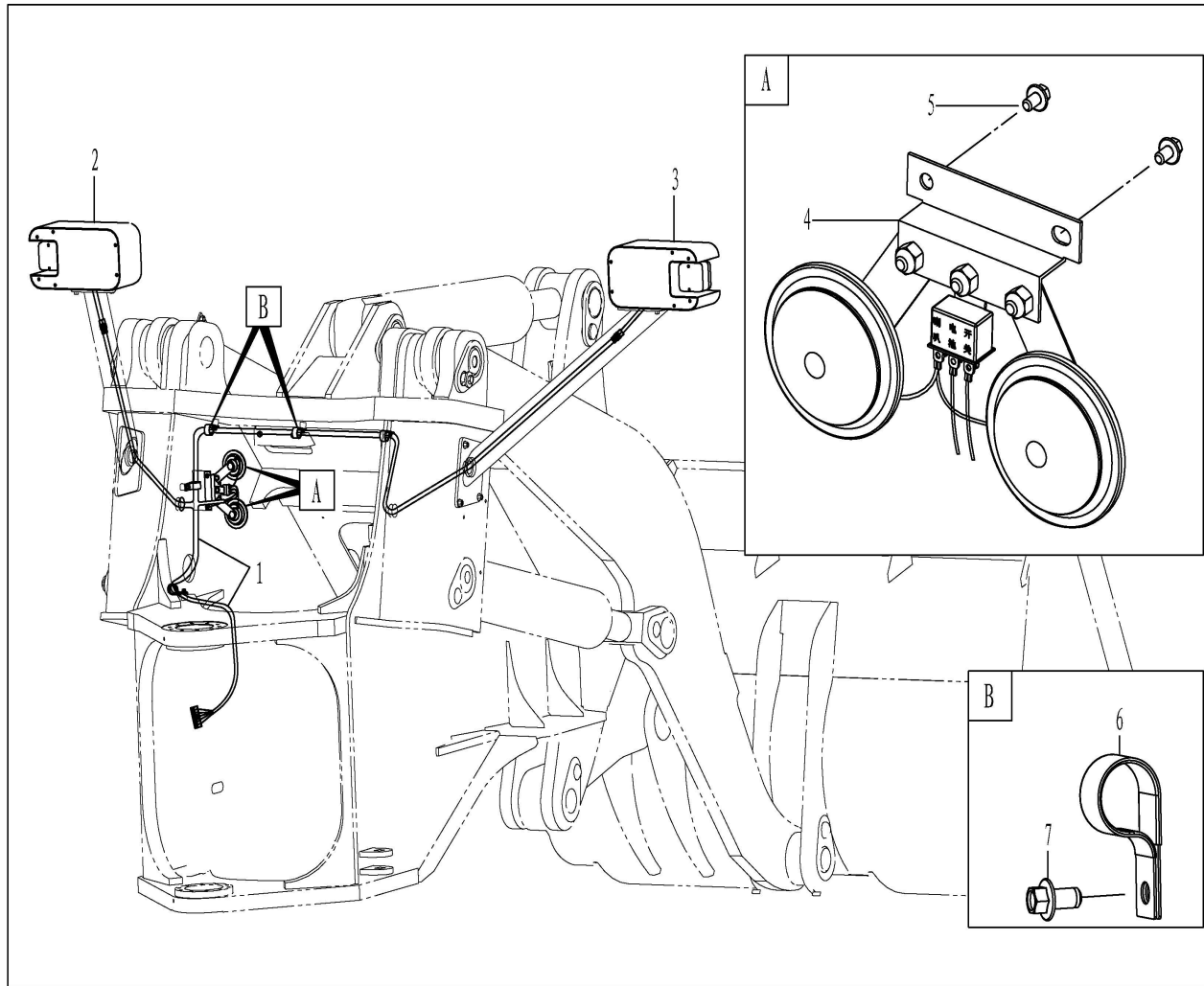
二、临工电气系统概述

电气

- 1、电源部分
 - 蓄电池
 - 发电机
- 2、启动部分 ——— 起动机
- 3、仪表及报警装置
- 4、照明及信号装置
- 5、控制部分
 - 控制开关
 - 继电器
 - 先导控制系统
 - 变速控制系统

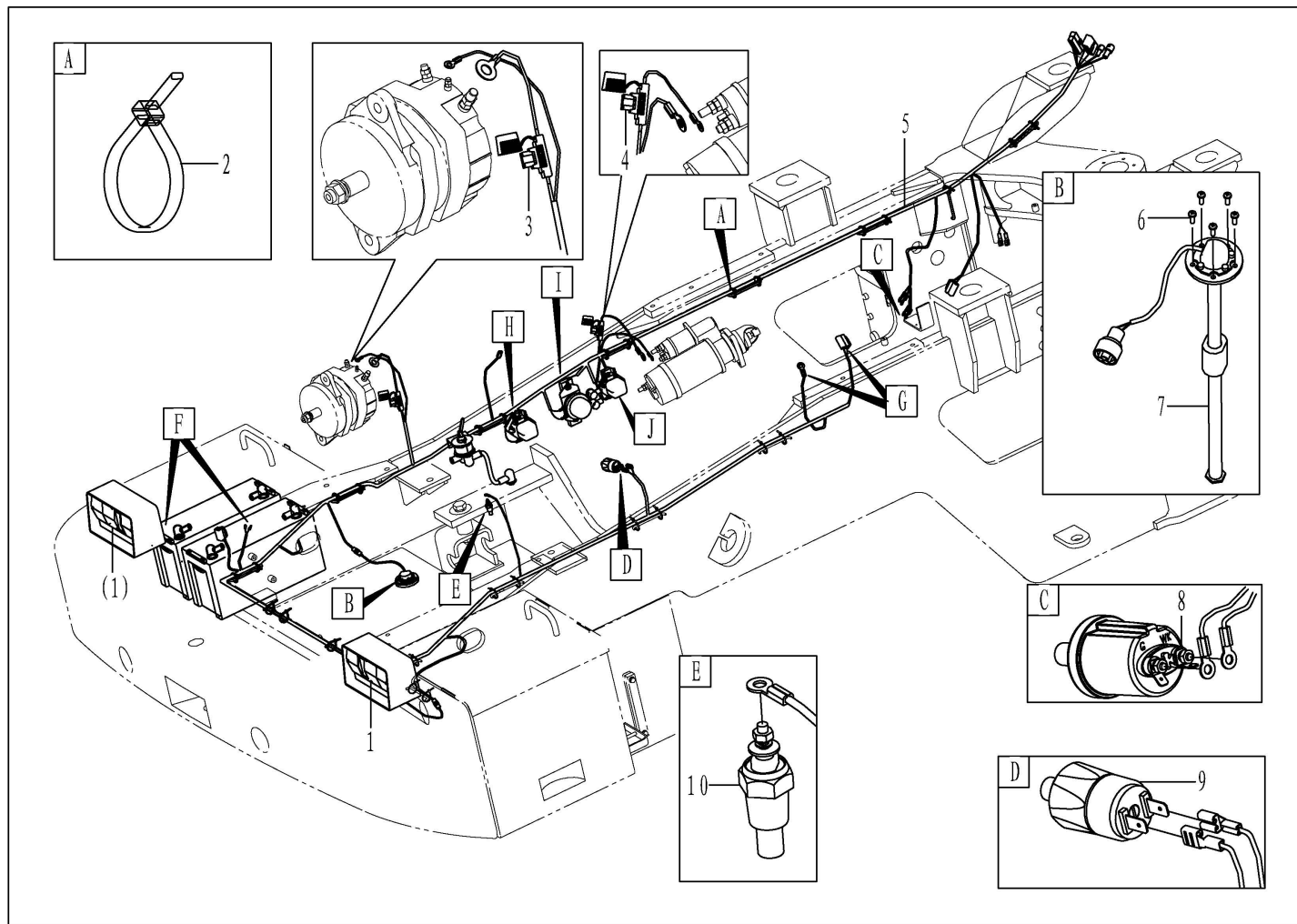


二、临工电气系统概述



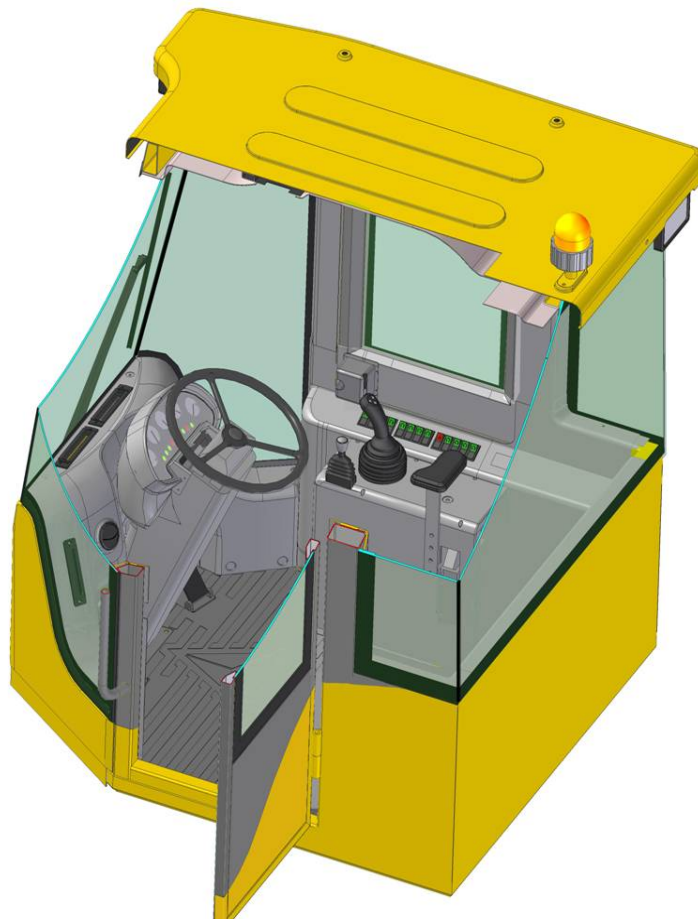
- 前车架线束
- 左、右前组合灯
- 双音盆型喇叭
- 固定件

二、临工电气系统概述



- 左、右后尾灯
- 扎丝
- 保险
- 后车架线束
- 油位传感器
- 气压传感器
- 压力开关
- 温度传感器

二、临工电气系统概述



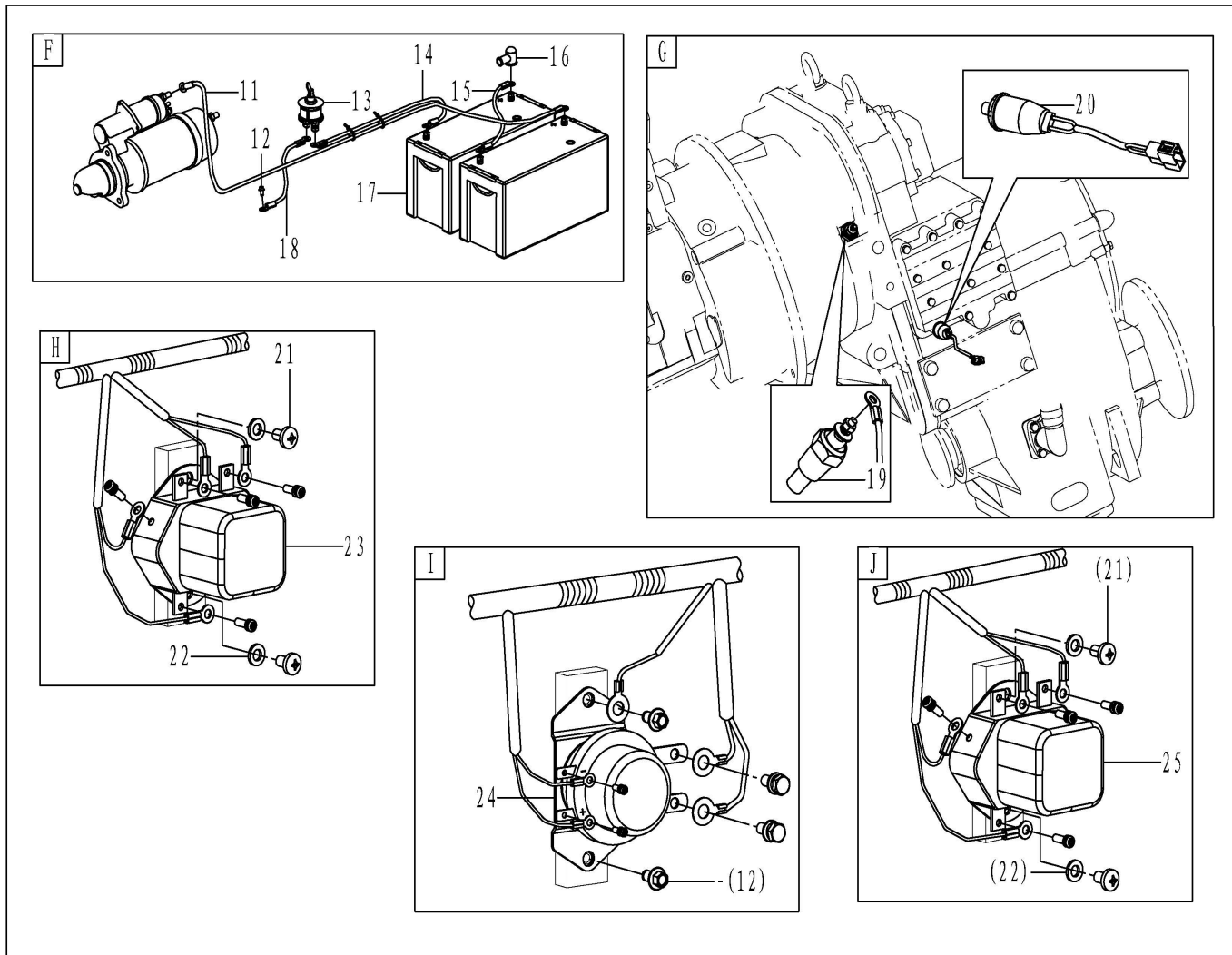
以**LG958L**电气系统为例

驾驶室部分

- 仪表盘
- 前、后照灯
- 旋转警示灯
- 音响系统(选装)
- 撬板开关
- 仪表台线束、驾驶室线束
- 保险组合

ction

二、临工电气系统概述



二、临工电气系统概述

二、特点

- 1、低电压：额定电压一般为12V或24V，有些工程机械的电系两种共存，以便向不同额定电压的电器供电。
- 2、直流电系：主要考虑到向蓄电池的充电必须是直流电源。
- 3、单线制：即的从电源到用电设备只用一根导线连接、而用机架、发动机等金属机体作为另一公共导线，采用单线制的优点是节省导线、线路清晰、安装和检修方便。
- 4、用电设备并联

三、搭铁方式

采用单线制时，蓄电池的一个电极必须接到公共导线上，俗称“搭铁”，若负极接公共导线则称为“负极搭铁”，反之为“正极搭铁”我国规定工程机械为负极搭铁。

三、电气元件

(一) 电源部分

1、蓄电池

功用：用于发动机启动、启动前及启动后怠速较低时全车照明及其他用电、发动机处于中速及高速运转时，储存电能。

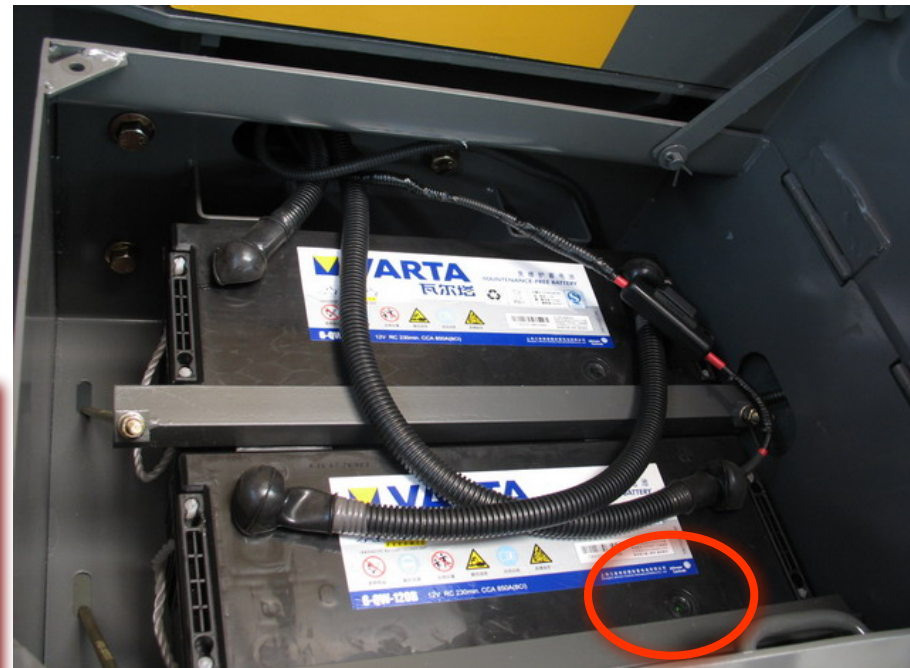
电量检查（以上海瓦而塔电池为例）：

检查蓄电池状态指示器(电眼)：

绿色：蓄电池电量充足，可以正常启动车辆。

黑色：蓄电池电量不足，蓄电池需补充电。

白色：蓄电池报废，需更换。



免维护蓄电池又称MF蓄电池，免维护是指在车辆合理使用期间，不需要对蓄电池进行加注蒸馏水、检测电解液液面高度、检测电解液密度等维护作业。

三、电气元件

（一）电源部分

电化学原理：

以二氧化铅为活性材料组成的正电极与以海绵铅为活性材料组成的负电极插入硫酸电解液中，可产生2.1V左右的电压。汽车用铅酸蓄电池一般由6个单格串联而成，因此开路电压约12.6V。

二氧化铅+(海绵)铅+硫酸

硫酸铅+水

放电

当蓄电池向汽车电气负载供电时，它处于放电状态

---化学能转化为电能；当汽车向蓄电池供电

充电

时，蓄电池处于充电状态---电能转化为化学能。

三、电气元件

（一）电源部分

2、发电机（包括发电机调节器）。

功用：发电机是将机械能转变成电能的装置。它是工程机械的主要电源，由发动机驱动。

工作时对启动电动机以外的一切用电设备供电，并向蓄电池充电。



三、电气元件

（一）电源部分

对发电机和调节器的基本要求

- A. 发动机怠速运转时，发电机输出电压应不低于蓄电池的端电压并具有一定的带载能力
- B. 发动机中高速运转时，发电机应能满足大多数用电设备同时用电的要求
- C. 发电机的负载和发动机的转速在正常范围内变化时，保持发电机输出电压既不低于蓄电池电压，又不高于用电设备的允许电压（充电电压28V）
- D. 发电机电枢电压低于蓄电池电压时，防止蓄电池通过发电机电枢放电

三、电气元件

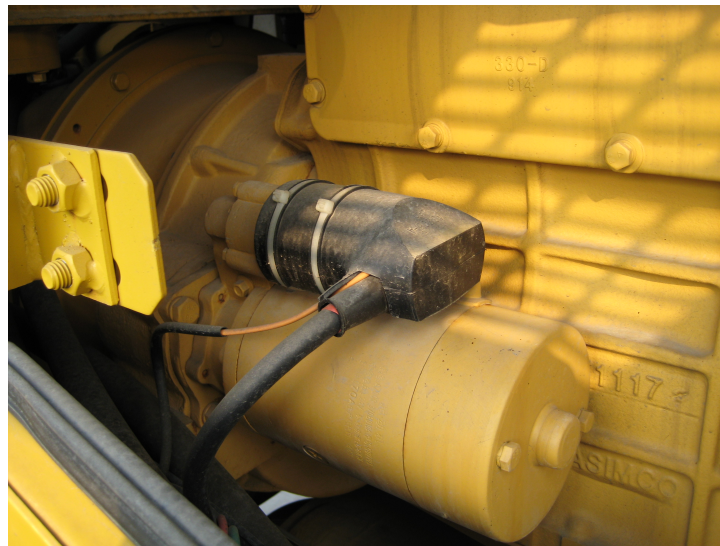
(二) 启动部分

组成：起动机

功用：用于启动发动机。

要使发动机由静止状态过渡到工作状态，必须用外力转动发动机的曲轴，使气缸内吸入(或形成)可燃混合气并燃烧膨胀，工作循环才能自动进行。曲轴在外力作用下开始转动到发动机开始自动地怠速运转的全过程，称为发动机的起动

发动机起动的方法很多，汽车发动机常用的电动机起动是用电动机作为机械动力，当将电动机轴上的齿轮与发动机飞轮周缘的齿圈啮合时，动力就传到飞轮和曲轴，使之旋转。电动机本身又用蓄电池作为能源。目前绝大多数汽车发动机都采用电动机起动



三、电气元件

(二) 启动部分

起动机一般由三部分组成：

1、直流串激式电动机，其作用是产生转矩

2、传动机构，其作用是：当发动机起动时，使起动机驱动齿轮与发动机飞轮齿圈啮合，将起动机转矩传给发动机曲轴；而在发动机起动后，使驱动齿轮打滑与飞轮齿环自动脱开。

3、控制装置(即开关)，用来接通和切断起动机与蓄电池之间的电路。（电锁）

三、电气元件

（三）仪表及报警装置

组成：制动气压表
变速压力表
工作计时表
发动机水温表
变矩器
油温表
发动机转速表（车速表）
机油压力
制动气压
充电等报警灯

功用：显示机器运行状态，为驾驶员和维修人员提供信息参考。

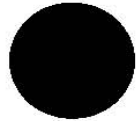
三、电气元件

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三、电气元件

(三) 仪表及报警装置

Preheat Indicator	Oil Pressure Alarm Lamp	Charging Indicator	Power off Indicator	Emergency Steering Indicator
预热指示灯	机油压力报警灯	充电指示灯	动力切断指示灯	应急转向指示灯
				
				
Parking Braking Indicator	Braking Low Pressure Alarm Lamp	Distance Light Indicator	Control Unit Working Indicator	Fuel Colating Indicator
驻车制动指示灯	制动气压低报警灯	远光指示灯	电脑盒工作指示灯	燃油粗滤指示灯

三、电气元件

（四）照明及信号装置

组成：前大灯、前照灯、后大灯、后照灯。

灯光信号装置：转向信号灯、示宽灯、制动灯、倒车灯、仪表灯、旋转警示灯，停车灯。

功用：照明设备是为了便于机器在夜间行使及安全作业。

灯光信号装置分为车外及车内两种，用于提醒机器周围的人员注意安全。

三、电气元件

(四) 照明及信号装置



三、电气元件

(四) 控制部分

1、控制开关

组成：翘板开关、电锁、转向开关、压力开关、行程开关、手制动开关。

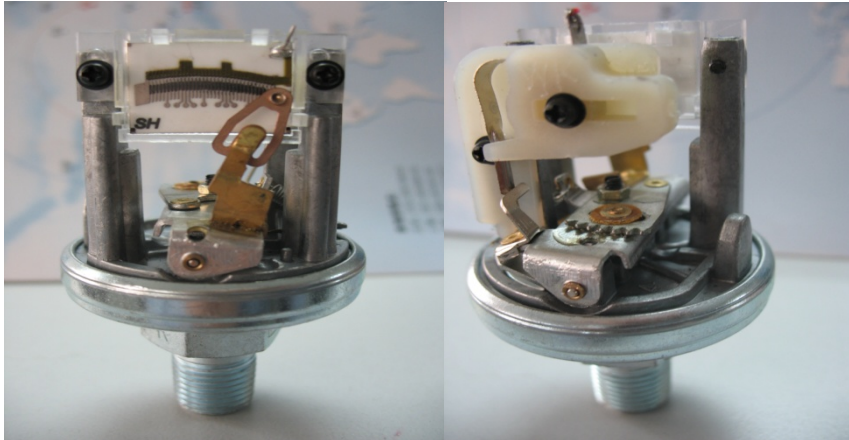
功用：启动、用电设备的手动控制，开关信号的采集。



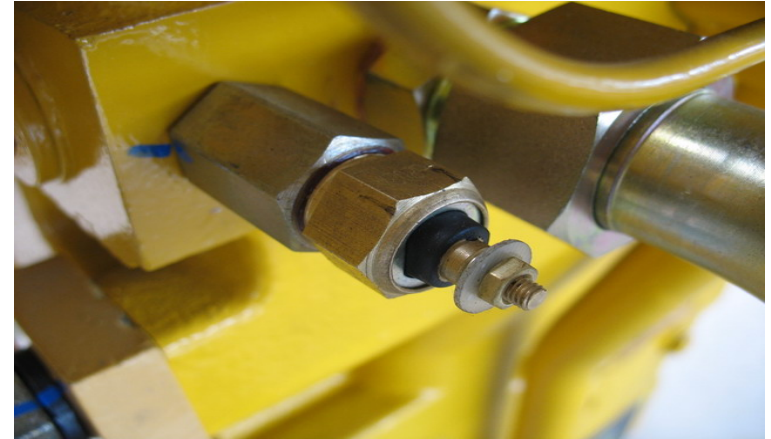
隔膜式压力开关（制动灯）

Lighting and Auxiliary Equipments(照明及辅助设备)

气压传感器



变矩器油温传感器



压力开关



机油压力传感器



三、电气元件

(四) 控制部分

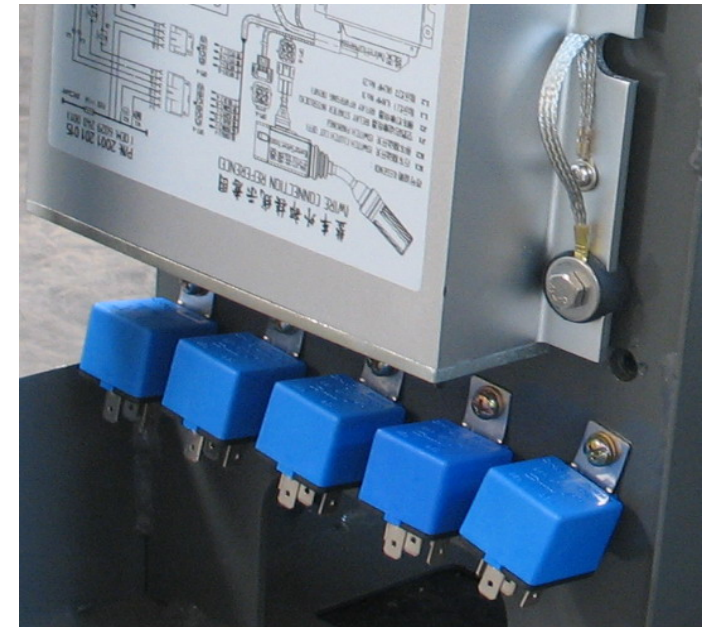
2、继电器用小电流或低电压或小功率控制大电流或高电压或大功率的设备

组成：电源继电器、启动继电器、中间继电器。

功用：利用了继电器小电流控制大电流原理。



断油电磁阀



中间继电器

三、电气元件

（四）控制部分

3) 先导控制系统

组成：接近开关、先导电磁阀。

功用：实现动臂举升限位、铲斗自动放平、浮动功能。主要是利用动臂及铲斗附近的接近开关采集信号控制先导电磁阀。



三、电气元件

（四）控制部分

4、变速控制系统

组成：电磁阀

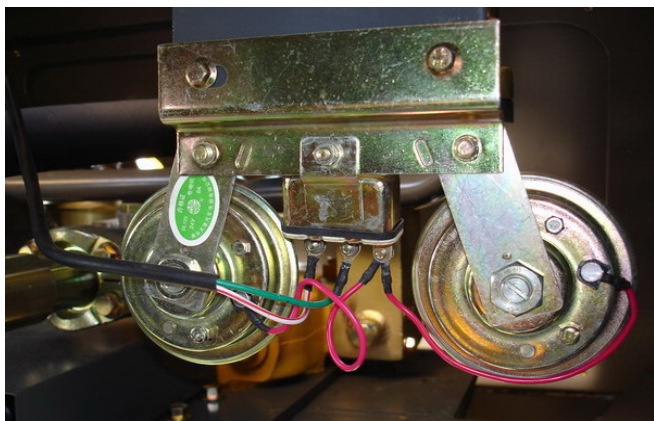
功用：档位切换采用手柄电信号控制电磁阀实现档位的平稳过渡。



三、电气元件

（四）控制部分

4、其他



双音盆型喇叭



倒车蜂鸣器（国内）



倒车蜂鸣器（出口）

Circuit Diagram and Failure Analysis Methods of Engineering Machinery (工程机械回路图和故障分析方法)

Expression Methods of Loader Circuit Diagram: In circuit diagram, power supply, cranking system, lighting, instrument and auxiliary device are connected by switches, wires and insurance devices according to their respective working characteristics and mutual inner link to make a whole.

(装载机回路图表示方法: 回路图是将电源、启动系、照明、仪表及辅助装置等, 按各自的工作特性及相互的内在联系, 通过开关、导线、保险器等连接起来, 构成的一个整体。)

I. Expression Methods of Loader Circuit Diagram

(装载机回路图的表达方法)

Expression methods include circuit diagram, principle diagram, wiring diagram and electrical component distribution map.

(表达方法有线路图、原理图、线束图和电器元件分布图。)

Circuit Diagram and Failure Analysis Methods of Engineering Machinery (工程机械回路图和故障分析方法)

II. Circuit Analysis (线路分析)

Principles followed by circuit (线路遵循的原则:)

1. Single wire system (单线制)

2. Electrical equipments are in parallel and controlled by their respective switches.

(各用电设备均并联并由各自的开关控制)

3. Low pressure. Appliances are designed under 24V (output voltage of generator is 28V).

(低压。用电器均按照**24V**设计 (发电机输出电压**28V**))

4. All the vehicles are equipped with insurance devices to prevent electrical equipment and wires from burning due to short circuit.

(各车均装有保险装置, 以防止短路而烧坏用电设备及线束)

5. Negative electrode of storage battery is connected to the ground. (蓄电池负极接地)

Circuit Diagram and Failure Analysis Methods of Engineering Machinery (工程机械回路图和故障分析方法)

III. Main Points in Reading Circuit Diagram

(读电路图的一般要领)

1、Read drawing statements vehicleefully for several times

(认真读几遍图注)

Drawing statements indicate name and number of all electrical equipments of the vehicle. By reading drawing statements, you can preliminarily understand electrical equipments equipped by the vehicle. And then find the electrical equipments in the circuit diagram with their number. And further explore mutual connections and control relationship.

(图注说明了该车所有电气设备的名称及其数码代号, 通过读图注可以初步了解该车都装配了哪些电气设备。然后通过电气设备的数码代号在电路图中找出该电气设备, 在进一步找出相互连线、控制关系。)

Circuit Diagram and Failure Analysis Methods of Engineering Machinery (工程机械回路图和故障分析方法)

2. Remember graphical symbols for electrical diagrams (牢记电气图形符号)

Circuit diagram shows structure and working principle with graphical symbols for electrical diagrams. Therefore, to understand schematic circuit diagram, you must remember meaning of graphical symbols for electrical diagrams. (电路图是利用电气图形符号来表示其构成和工作原理的。因此，必须牢记电路图形符号的含义，才能看懂电路原理图)

3. Remember circuit mark symbols (熟记电路标记符号)

To draw and read electric circuit diagram, some electrical devices or their terminals are given different symbols. (为了便于绘制和识读电器电路图，有些电器装置或其接线柱等上面都赋予不同的标志代号)

4. Remember circuit characteristics (牢记电路特点)

(1) Single wire system (单线制)

(2) Negative earth (负极搭铁)

(3) Electrical equipments are in parallel (用电设备并联)

Circuit Diagram and Failure Analysis Methods of Engineering Machinery (工程机械回路图和故障分析方法)

5. Remember closed-loop principle (牢记回路原则)

Any complete circuits consist of power supply, fuse, switch, control device, electrical equipment, wires, etc. Current must start from positive terminal of power supply. It reaches electrical equipment through fuses, switches, control devices, wires, etc. A return circuit can be formed after it goes back to negative electrode of power supply through wires (or by earth). Therefore, there are three kinds of ideas when reading circuit diagram.

(任何一个完整的电路都是由电源、熔断器、开关、控制装置、用电设备、导线等组成。电流流向必须从电源正极出发，经过熔断器、开关、控制装置、导线等到达用电设备，再经过导线（或搭铁）回到电源负极，才能构成回路。因此电路读图时，有三种思路）

Idea 1: Along current flow of circuit, start from positive electrode of power supply. Find electric equipment, switches, control devices, etc. And then return to negative electrode of power supply. (思路一：沿着电路电流的流向，由电源正极出发，顺藤摸瓜查到用电设备，开关、控制装置等，回到电源负极)

Circuit Diagram and Failure Analysis Methods of Engineering Machinery (工程机械回路图和故障分析方法)

Idea 2: Against current flow of circuit, start from negative electrode of power supply (earth). Go back to positive electrode of power supply through electric equipment, switches, control devices, etc. (思路二: 逆着电路电流的方向, 由电源负极(搭铁)开始, 经过用电设备、开关、控制装置等回到电源正极)

Idea 3: Start from electric equipment. Find its control switches, wires and control units in turn. Reach positive electrode of power supply and earth (or negative electrode of power supply). 思路三: 从用电设备开始, 依次查找其控制开关、连线、控制单元, 到达电源正极和搭铁(或电源负极)。

In practical application, different ideas can be selected for circuit. However, it 's worth noting that with extensive use of electronic control technology, most circuits of electrical equipment has main circuit and control circuit at the same time. Both of the two circuits have to be given consideration to when reading diagram.

(实际应用时, 可视具体电路选择不同思路, 但有一点值得注意: 随着电子控制技术的广泛应用, 大多数电气设备电路同时具有主回路和控制回路, 读图时要兼顾两回路)

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Common Failure and Troubleshooting of Electrical System
电气系统常见故障与排除方法



Storage Battery (蓄电池)



(1) Classification of Storage Battery (蓄电池的分类)

Storage battery is a chemical power, which stores electricity or supplies power to electrical equipment with its internal chemical reactions. Currently there are basically two kinds of storage batteries used in fuel automobile, which are lead-acid storage battery (hereinafter referred to as lead storage battery) and nickel-iron storage battery. Meanwhile, because of higher requirements to emission of fuel automobile and impact of energy crisis, all the countries are continuously exploring and developing electric vehicles, whose main power supply is new high-energy battery. The table below lists features of various batteries.

(蓄电池是一种化学电源，靠其内部的化学反应来储存电能或向用电设备供电。目前燃油汽车上使用的蓄电池主要有两大类：铅酸蓄电池（以下简称铅蓄电池）和镍碱蓄电池。同时，由于人们对燃油汽车排放要求的提高和能源危机的冲击，各国正在不断探索和研制电动汽车，其主要的动力源为新型高能蓄电池。下表列出了各种蓄电池特点)

(1) Classification of Storage Battery (蓄电池分类)

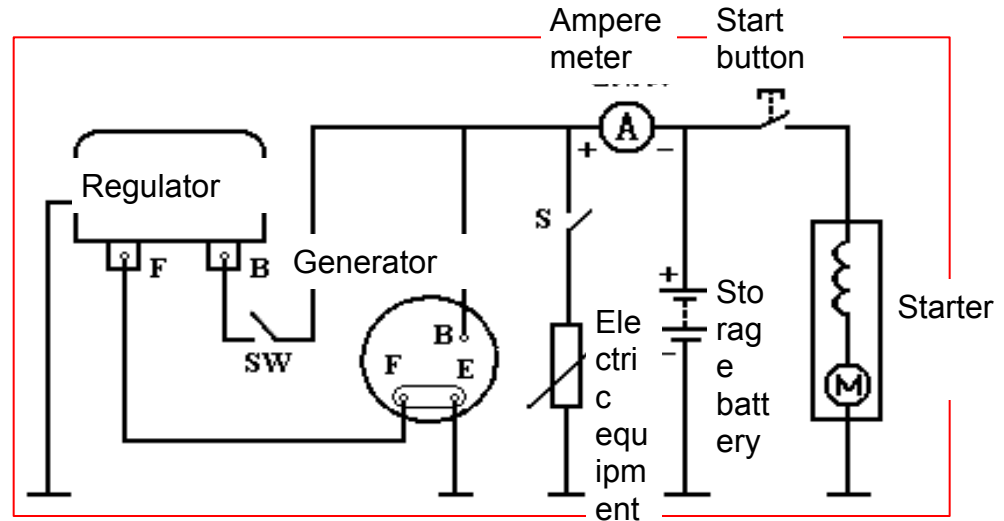
Type类型	Features特点
Common lead storage battery 普通铅蓄电池	Electrode plates of new storage battery are uncharged. Before using electrolyte should be added and first charge should be conducted according to provisions. First charge needs a long time. Regular maintenance is needed in use. 新蓄电池的极板不带电，使用前需按规定加注电解液并进行初充电，初充电的时间较长，使用中需要定期维护
Dry-charged lead storage battery 干荷电铅蓄电池	Electrode plates of new storage battery are in dry charging status. There is no electrolyte in the storage battery. If you want to use it within the specified preservation period, you just have to add electrolyte according to provisions. It can be used after standing for 20 ~ 30min. Regular maintenance is needed in use. 新蓄电池的极板处于干燥的已充电状态，电池内部无电解液。在规定的保存期内，如需使用，只需按规定加入电解液，静置 20~30min 即可使用，使用中需要定期维护

(1) Classification of Storage Battery (蓄电池分类)

Type类型	Features特点
Drained and charged lead storage battery 湿荷电铅蓄电池	Electrode plates of new storage battery are charged. There is little electrolyte in the storage battery. If you want to use it within the specified preservation period, you just have to add electrolyte according to provisions. It can be used after standing for 20 ~ 30min. Regular maintenance is needed in use. 新蓄电池的极板处于已充电状态，蓄电池内部带有少量电解液。在规定的保存期内，如需使用，只需按规定加入电解液，静置20~30min即可使用，使用中需要定期维护。
Maintenance free storage battery 免维护蓄电池	Maintenance is not needed in use. It can be used for 3 to 4 years. Distilled water doesn't need to be added. There is very little pile corrosion and self discharge. 使用中不需维护，可用3~4年不需补加蒸馏水，极桩腐蚀极少，自放电少

(2) Functions of Storage Battery (蓄电池的功用)

Wheel Loader is equipped with two DC power supply, which are storage battery and generator. The two power supply are in parallel. Electric equipments of the entire vehicle are in parallel.



装载机上装有蓄电池和发电机两个直流电源，这两个电源并联，全车的用电设备均为并联。

(2) Functions of Storage Battery (蓄电池的功用)

Functions of Storage Battery: 蓄电池的功用:

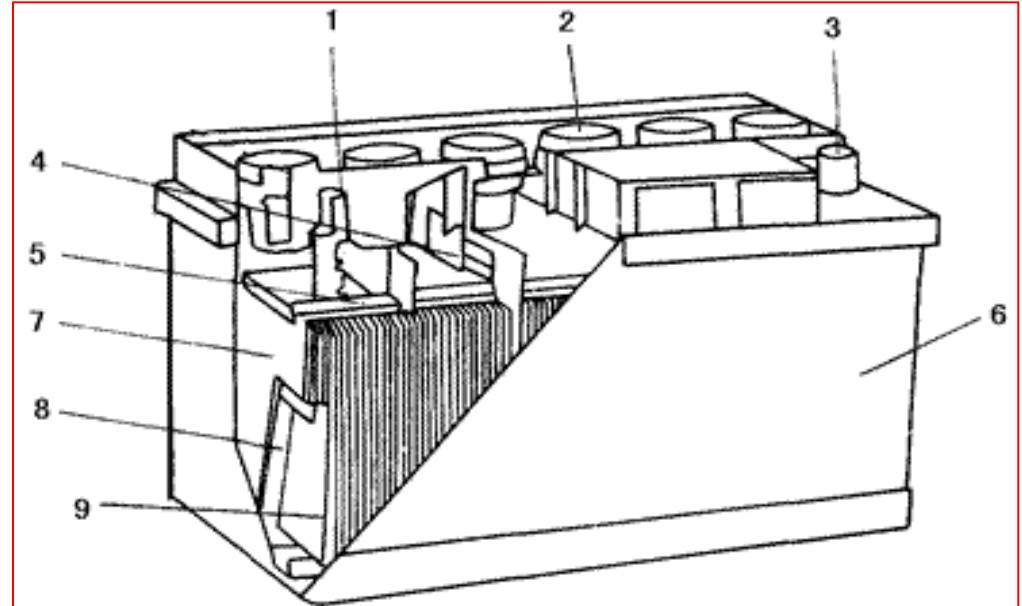
1) When engine starts, storage battery will supply power to starting system and ignition system. 2) When engine is running at low speed and voltage of generator is below charging voltage of storage battery, storage battery will supply power to electrical equipment. 3) When engine is running at middle or high speed and voltage of generator is higher than charging voltage of storage battery, storage battery will store the rest electricity of generator. 4) When generator overloads, storage battery will help generator supply power to electrical equipment. 5) Storage battery can also absorb transient overvoltage in the circuit, keep voltage of vehicle electrical system stable and protect electronic components. 1) 起动发动机时, 蓄电池向起动系和点火系供电。 2) 当发动机低速运转, 发电机电压低于蓄电池的充电电压时, 由蓄电池向用电设备供电。 3) 当发动机中、高速运转, 发电机电压高于蓄电池的充电电压时, 蓄电池将发电机的剩余电能储存起来。 4) 当发电机过载时, 蓄电池协助发电机向用电设备供电。 5) 蓄电池还可以吸收电路中的瞬时过电压, 保持汽车电器系统电压的稳定, 保护电子元件。

1. Structure of Lead Storage Battery 铅蓄电池铅蓄电池的结构

Lead storage battery is generally formed by the series connection of three or six single batteries. See figure for its structure

铅蓄电池一般由3个或6个单格电池串联而成, 结构如图所示:

- 1-Negative pole 负极柱
- 2-Liquid adding port lid 加液孔盖
- 3-Positive pole 正极柱
- 4-Wall connection 穿壁连接
- 5-Bus bar 汇流条
- 6-Shell 外壳
- 7-Negative electrode plate 负极板
- 8-Division plate 隔板
- 9-Positive electrode plate 正极板

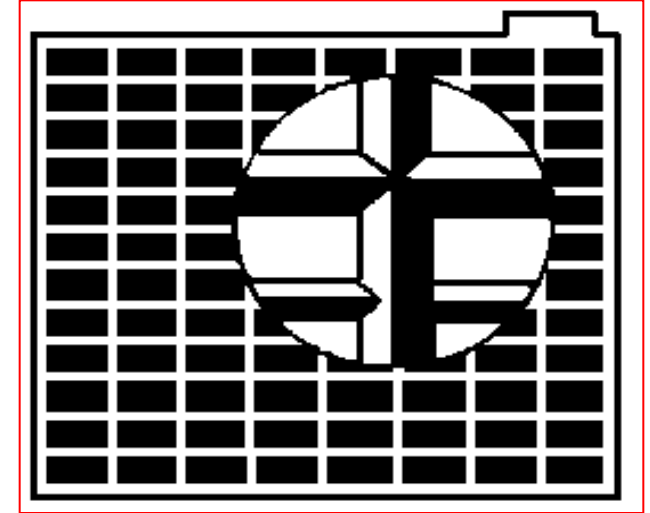


1. Structure of Lead Storage Battery 铅蓄电池铅蓄电池的结构

1) Electrode Plate 极板

Electrode plate is the core part of storage battery. Charging and discharging chemical reactions of storage battery mainly rely on active materials and electrolyte on the plate. There are positive and negative electrode plates, both consisting of grid frame and active substances.

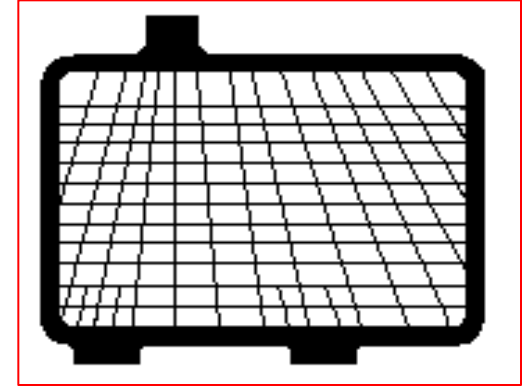
(极板是蓄电池的核心部分，蓄电池充、放电的化学反应主要是依靠极板上的活性物质与电解液进行的。极板分为正极板和负极板，均由栅架和活性物质组成。)



1. Structure of Lead Storage Battery 铅蓄电池铅蓄电池的结构

1) Electrode Plate 极板

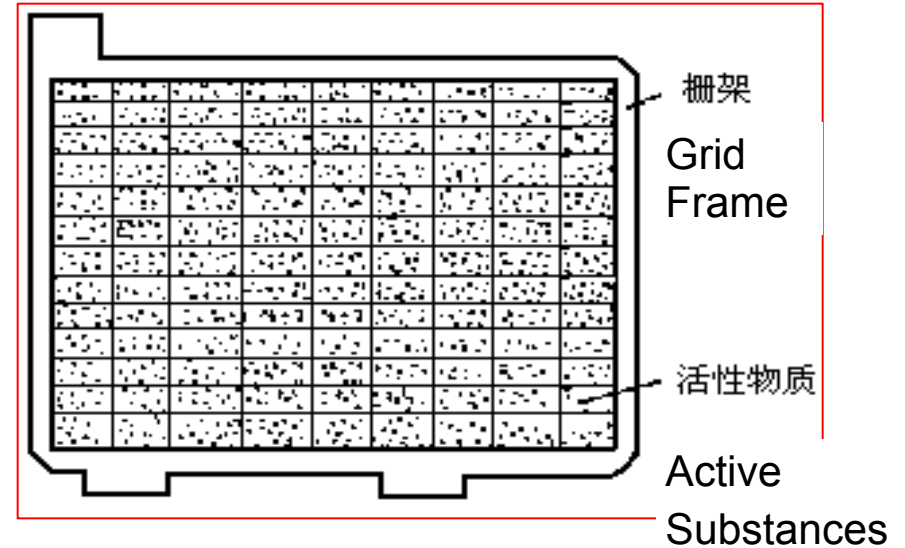
Function of grid frame is consolidation of active substances. Grid frame is generally cast by antimony alloy. It has good conductivity, corrosion resistance and mechanical strength. Structure of grid frame is shown in the top right figure. In order to reduce internal resistance and improve starting performance of storage battery, some lead storage batteries use radiate grid frame. The bottom right figure is radiate grid frame structure of storage battery for Santana vehicle.



栅架的作用是固结活性物质。栅架一般由铅锑合金铸成，具有良好的导电性、耐蚀性和一定的机械强度。栅架的结构右上图所示。为了降低蓄电池的内阻，改善蓄电池的起动性能，有些铅蓄电池采用了放射形栅架，右下图为桑塔纳轿车蓄电池放射形栅架的结构。

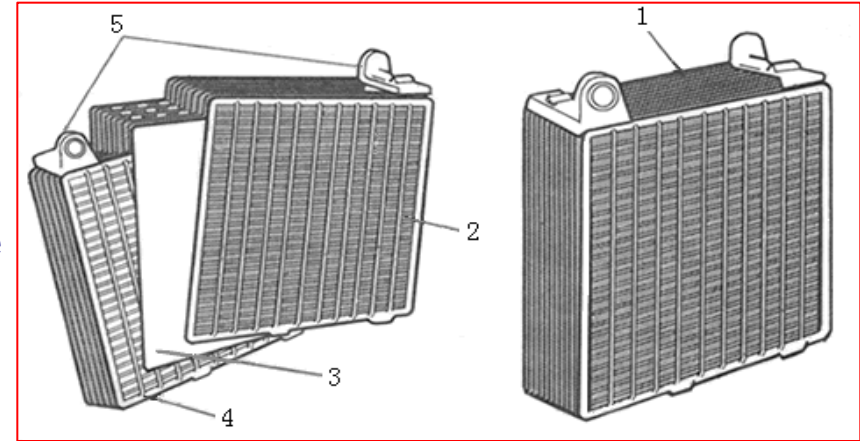
1. Structure of Lead Storage Battery 铅蓄电池铅蓄电池的结构

Active substance on positive electrode plate is dark brown PbO_2 . Active substance on negative electrode plate is spongy and grey pure lead (Pb). Tune active substances into a paste, fill in space of grid frame and dry. Electrode plate is formed. As shown in the top right figure. 正极板上的活性物质是二氧化铅 (PbO_2)，呈深棕色；负极板上的活性物质是海绵状的纯铅 (Pb)，呈青灰色。将活性物质调成糊状填充在栅架的空隙里并进行干燥即形成极板。如右上图所示。



1. Structure of Lead Storage Battery 铅蓄电池铅蓄电池的结构

Put a piece of positive electrode plate and a piece of negative electrode plate in electrolyte. About 2V of electromotive force can be obtained. In order to increase capacity of storage battery, many pieces of positive and negative electrode plates are often installed in parallel respectively to form positive and negative electrode plate group. As shown in the bottom right figure. In each single battery, positive electrode plate is 1 piece less than negative electrode plate, so that each piece of positive electrode plate is between two pieces of negative electrode plate. Discharging on both sides of positive electrode plate can be even to avoid bending of electrode plate due to uneven discharging. 将正、负极板各一片浸入电解液中，可获得2V左右的电动势。为了增大蓄电池的容量，常将多片正、负极板分别并联，组成正、负极板组，如右下图所示。在每个单格电池中，正极板的片数要比负极板少一片，这样每片正极板都处于两片负极板之间，可以使正极板两侧放电均匀，避免因放电不均匀造成极板拱曲。



- 1 – Plate group assembly 极板组总成
- 2 – Negative electrode plate 负极板
- 3 – Division plate 隔板
- 4 – Positive electrode plate 正极板
- 5 – Connector of electrode plate 极板联条

1. Structure of Lead Storage Battery 铅蓄电池铅蓄电池的结构

2) Division Plate (隔板)

Division plate is inserted between positive and negative electrode plate, to avoid short circuit caused by contact of positive and negative electrode plate. Division plate should be anti-acid and porous for electrolyte penetration. Commonly used materials for division plate include wood, microporous rubber, microporous plastic, etc. Among them, wooden division plate has poor acid resistance. Microporous rubber has the best division plate performance but high cost. Microporous plastic division plate has small hole diameter, high hole rate and low cost. Therefore, it is widely used.

(隔板插放在正、负极板之间，以防止正、负极板互相接触造成短路。隔板应耐酸并具有多孔性，以利于电解液的渗透。常用的隔板材料有木质、微孔橡胶和微孔塑料等。其中，木质隔板耐酸性较差，微孔橡胶隔板性能最好但成本较高，微孔塑料隔板孔径小、孔率高、成本低，因此被广泛采用)

1. Structure of Lead Storage Battery 铅蓄电池铅蓄电池的结构

3) Electrolyte (电解液)

In chemical reaction of storage battery, electrolyte conducts electricity among ions and participate in chemical reactions. Electrolyte is made of pure sulfuric acid (H_2SO_4) and distilled water in a certain proportion. Its density is generally from 1.24 to 1.30 g/cm³. (电解液在蓄电池的化学反应中，起到离子间导电的作用，并参与蓄电池的化学反应。电解液由纯硫酸 (H_2SO_4) 与蒸馏水按一定比例配制而成，其密度一般为1.24~1.30g/cm³)

Density of electrolyte has important influence on work of storage battery. Big density can reduce the danger of freezing and improve the capacity of storage battery. But if the density is too high, viscosity will increase, capacity of storage battery will decline, and its service life will be shortened. Density of electrolyte should be determined by region and climate conditions. The table below lists density of electrolyte in different regions and under different temperature. In addition, purity of electrolyte is also one of the important factors influencing on performance and service life of storage battery. 电解液的密度对蓄电池的工作有重要影响，密度大，可减少结冰的危险并提高蓄电池的容量，但密度过大，则粘度增加，反而降低蓄电池的容量，缩短使用寿命。电解液密度应随地区和气候条件而定，下表列出了不同地区和气温下的电解液的密度。另外，电解液的纯度也是影响蓄电池性能和使用寿命的重要因素之一

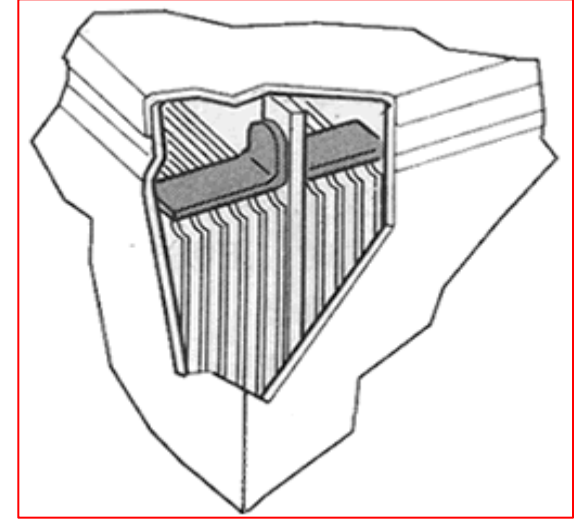
1. Structure of Lead Storage Battery 铅蓄电池铅蓄电池的结构

Weather Conditions 气候条件	Density of electrolyte of fully charged storage battery at 25°C (g/cm ³) 完全充足电的蓄电池25°C时电解液的密度 (g/cm ³)	
	Winter冬季	Summer夏季
Regions where temperature is below -40°C in winter 冬季温度低于-40°C地区	1.30	1.26
Regions where temperature is above -40°C in winter 冬季温度高于-40°C地区	1.28	1.25
Regions where temperature is above -30°C in winter 冬季温度高于-30°C地区	1.27	1.24
Regions where temperature is above -20°C in winter 冬季温度高于-20°C地区	1.26	1.23
Regions where temperature is above 0°C in winter 冬季温度高于0°C地区	1.24	1.23

1. Structure of Lead Storage Battery 铅蓄电池铅蓄电池的结构

4) Shell (壳体)

Shell is used as container of electrolyte and electrode plate group. It should acid-proof, heat resistant and shock-proof. Shell is usually made of hard rubber or polypropylene plastic. It is integral structure. There are raised ribs at the bottom for electrode plate group. The shell is divided by walls into three or six single compartments that are not connected. Single compartments are installed in series with lead chains. As shown in the right figure. Upper part of shell is sealed with battery cover of the same material. Battery cover is equipped with liquid adding holes corresponding to every single compartment to add electrolyte and distilled water, and measure density and temperature of electrolyte and height of liquid surface. Air vent on the liquid adding cover can smoothly discharge gas produced in chemical reaction of storage battery. 壳体用于盛放电解液和极板组，应该耐酸、耐热、耐震。壳体多采用硬橡胶或聚丙烯塑料制成，为整体式结构，底部有凸起的肋条以搁置极板组。壳内由间壁分成3个或6个互不相通的单格，各单格之间用铅质联条串联起来，如右图所示。壳体上部使用相同材料的电池盖密封，电池盖上设有对应于每个单格电池的加液孔，用于添加电解液和蒸馏水，以及测量电解液密度、温度和液面高度。加液孔盖上的通风孔可使蓄电池化学反应中产生的气体顺利排出。



2. Features of Maintenance Free Storage Battery

(免维护蓄电池的特点)

Maintenance free storage battery is also called MF storage battery. Maintenance free means during reasonable use period of vehicle, there is no need of adding distilled water for storage battery, detection of liquid surface height of electrolyte, detection of electrolyte density and other maintenance activities. Features of maintenance free battery include

(免维护蓄电池又称MF蓄电池，免维护是指在车辆合理使用期间，不需要对蓄电池进行加注蒸馏水、检测电解液液面高度、检测电解液密度等维护作业。免维护蓄电池特点)

2. Features of Maintenance Free Storage Battery

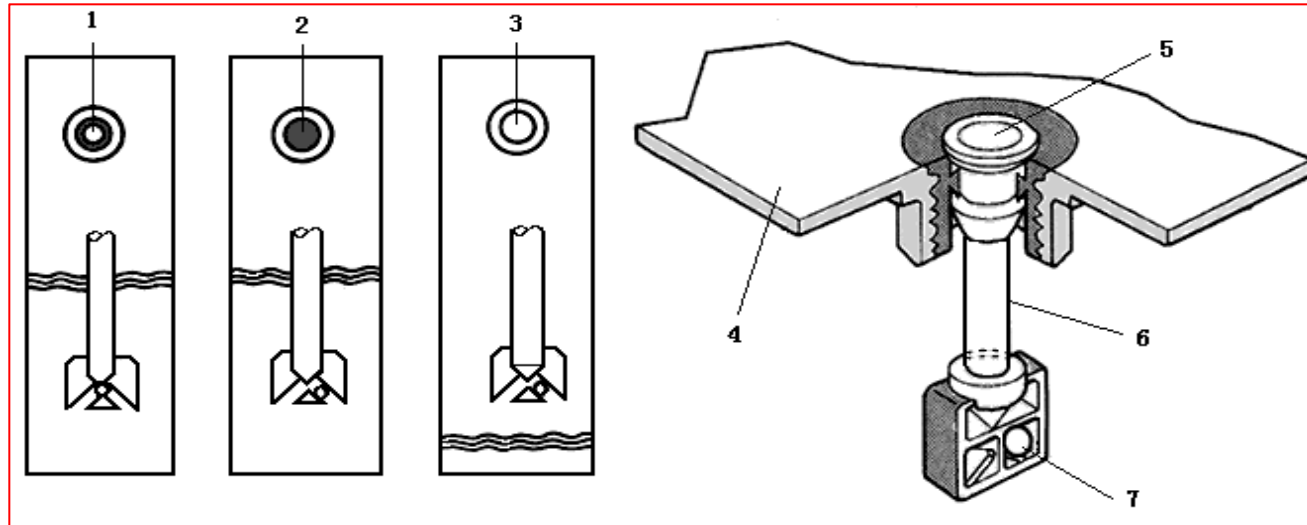
(免维护蓄电池的特点)

3) Electrolyte density meter installed in storage battery can automatically display energy of storage battery and surface height of electrolyte. If observation window of density meter is green, storage battery is fully charged and can be used normally. If it is dark green or black, storage battery doesn't have enough energy and needs additional charge. If it is light yellow, storage battery will be declared worthless. As shown in the figure.

蓄电池内部安装有电解液密度计，可自动显示蓄电池的存电状态和电解液液面的高低。如果密度计的观察窗呈绿色，表明蓄电池存电充足，可正常使用；若显示深绿色或黑色，表明蓄电池存电不足，需补充充电；若显示浅黄色，表明蓄电池已接近报废。如下图所示

2. Features of Maintenance Free Storage Battery

(免维护蓄电池的特点)



1 – Green (Charging degree is 65% or above) 2 – Black (Charging degree is below 65%)
3 – Light yellow (Storage battery has failure) 4 – Cover of storage battery 5 – Observation window 6 – Optic charge indicator 7 – Small green ball

1 – 绿色 (充电程度为65%或更高) 2 – 黑色 (充电程度低于65%) 3 – 浅黄色 (蓄电池有故障)
4 – 蓄电池盖 5 – 观察窗 6 – 光学的荷电状况指示器 7 – 绿色小球

2. Features of Maintenance Free Storage Battery

(免维护蓄电池的特点)

4) New security ventilation device and gas collector are used. a alumina filter installed in the port lid can prevent vapor and sulphuric acid gas from passing through, and allow hydrogen and oxygen to escape smoothly. Catalyst palladium installed in catalyst palladium can make hydrogen and oxygen ions to combine into water and return to the storage battery.

采用了新型安全通气装置和气体收集器，在孔盖内部设置了一个氧化铝过滤器，可阻止水蒸气和硫酸气体通过，同时又可以使氢气和氧气顺利逸出。通气塞中装有催化剂钯，可促使氢、氧离子重新结合成水回到蓄电池中

3. Capacity and Influencing Factors of Storage Battery 蓄电池的容量及其影响因素

C, capacity of storage batter, is equal to the product of discharge current I_f and discharge time (t_f 蓄电池容量C等于放电电流 I_f 与放电时间 t_f 的乘积)

$$C = I_f \cdot t_f$$

1) Rated Capacity(额定容量)

According to GB5008.1-91 *Lead-acid Starter Batteries—Technical Conditions*, when fully charged new storage batteries continuously discharge with the discharge current of 20 hourly rate (0.05C₂₀ amps) until average voltage of single battery reduces to 1.75 V under electrolyte temperature of 25 + 5 °C, the output electric quantity is called rated capacity of storage batteries, represented with C₂₀, whose unit

is A · h.据国标GB5008.1—91《起动用铅酸蓄电池技术条件》规定，将充足电的新蓄电池，在电解液温度为25±5℃的条件下，以20小时率的放电电流（即0.05C₂₀安培）连续放电至单池平均电压降到1.75V时，输出的电量称为蓄电池的额定容量，用C₂₀表示。单位为A · h

3. Capacity and Influencing Factors of Storage Battery 蓄电池的容量及其影响因素

for example:

When 6 - Q - 120 storage batteries continuously discharge with the discharge current of in 6A ($0.05 C_{20} = 0.05 \times 120 = 6A$) until average voltage of single battery reduces to 1.75 V, if the discharge time is greater than or equal to 20h, the capacity $C = I_f \cdot t_f \geq 120A \cdot h$, and rated capacity has been reached, it is qualified product. If discharge time is less than 20h and capacity is less than rated capacity, it is unqualified product. (6-Q-120型蓄电池以6A ($0.05 C_{20} = 0.05 \times 120 = 6A$) 的电流连续放电至单池平均电压降到1.75V时, 若放电时间大于等于20h, 则其容量 $C = I_f \cdot t_f \geq 120A \cdot h$, 达到了额定容量, 为合格产品; 若放电时间小于20h, 则其容量低于额定容量, 为不合格产品)

3. Capacity and Influencing Factors of Storage Battery

蓄电池的容量及其影响因素

2) Reserve Capacity(储备容量)

According to GB5008.1-91 Lead-acid Starter Batteries—Technical Conditions, when storage batteries continuously discharge with the constant current of 25A until average voltage of single battery reduces to 1.75 V, the discharge time is called reserve capacity of storage batteries, whose unit is minute.

(据国标GB5008.1-91《起动用铅酸蓄电池技术条件》规定，蓄电池在 $25 \pm 2^{\circ}\text{C}$ 的条件下，以25A恒流放电至单池平均电压降到1.75V时的放电时间，称为蓄电池的储备容量。单位为分钟)

Reserve capacity represents the capacity of storage batteries to provide constant current of 25A for lighting, start motor and other electric equipments in failure of charging system of vehicle.

(储备容量表达了在车辆充电系统失效时，蓄电池能为照明、启动电机等用电设备提供25A恒流的能力。)

3. Capacity and Influencing Factors of Storage Battery

蓄电池的容量及其影响因素

3) Starting Capacity(起动容量)

Starting capacity represents lead storage battery's capacity of electric power supply when the engine starts. It is one of the most important indexes for detection of quality of storage battery. Starting capacity is largely influenced by temperature. Therefore, it is divided into low-temperature starting capacity and normal-temperature starting capacity.

(起动容量表征了铅蓄电池在发动机起动时的供电能力，是检验蓄电池质量的重要指标之一。起动容量受温度影响很大，故又分为低温起动容量和常温起动容量两种)

(1) Low-temperature starting capacity: Under the electrolyte temperature of -18°C , when storage batteries continuously discharge with 3 times of rated capacity until voltage of single battery reduces to 1V, the discharged electric quantity is low-temperature starting capacity. The duration should be above 2.5 min.

(低温起动容量：电解液在 -18°C 时，以3倍额定容量的电流持续放电至单格电压下降至1V时所放出的电量。持续时间应在2.5min以上)

(2) Normal-temperature starting capacity: Under the electrolyte temperature of 30°C , when storage batteries continuously discharge with 3 times of rated capacity until voltage of single battery reduces to 1.5V, the discharged electric quantity is normal-temperature starting capacity. The duration should be above 5min.

(常温起动容量：电解液在 30°C 时，以3倍额定容量的电流持续放电至单格电压下降至1.5V时所放出的电量。持续时间应在5min以上)

3. Capacity and Influencing Factors of Storage Battery 蓄电池的容量及其影响因素

1) Structural Factors(结构因素)

If surface area of storage battery electrode plate is larger and the number of electrode plate is great, more active substances will participate in reactions and capacity will be greater. In addition, if the plate is thin, active substances will have better porosity, electrolyte will be easier to penetrate into plate, active material is higher, utilization ratio of active substances will be higher, and output capacity will be bigger.

(蓄电池极板的表面积越大，极板片数越多，参加反应的活性物质就越多，容量就越大。另外，极板越薄，活性物质的多孔性越好，则电解液向极板内部的渗透越容易，活性物质利用率就越高，输出容量也就越大)

3. Capacity and Influencing Factors of Storage Battery 蓄电池的容量及其影响因素

2) Use Factors(使用因素)

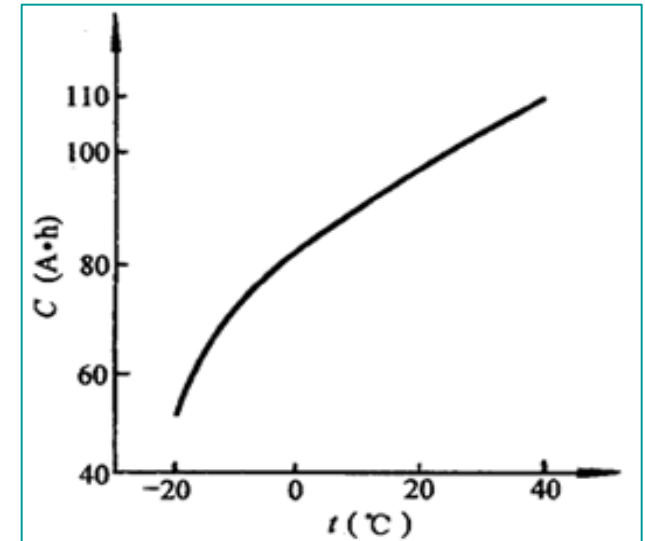
(1) Discharge current(放电电流)

(2) Temperature of electrolyte (see the right figure) (电解液温度 (见右图))

(3) Density of electrolyte(电解液密度)

Increasing the density of electrolyte properly can increase penetration rate of electrolyte and improve electromotive force and capacity of storage battery. But if density of electrolyte is too big, viscosity will be increased, resistance will increase, and capacity of storage battery will be reduced.

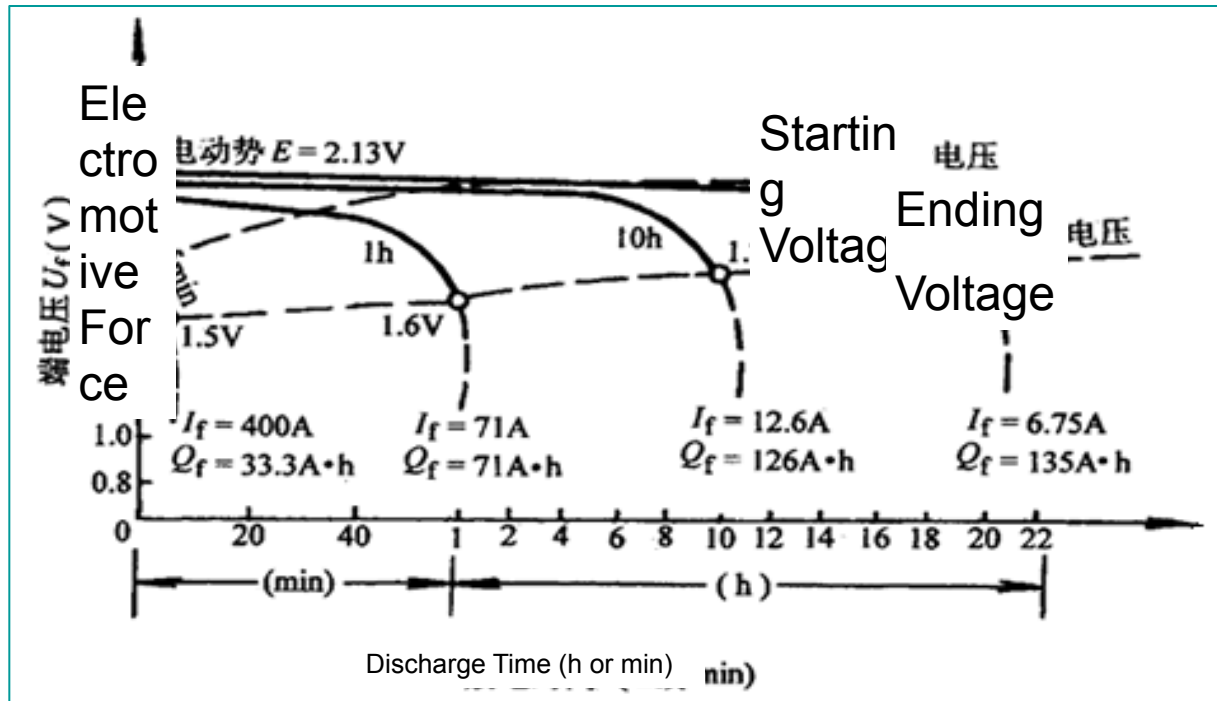
(适当提高电解液的密度, 可加快电解液的渗透速度, 提高蓄电池的电动势和容量。但电解液密度过大, 又将导致粘度增加, 内阻增大, 反而使蓄电池容量降低)



3. Capacity and Influencing Factors of Storage Battery 蓄电池的容量及其影响因素

(1) Discharge Current(放电电流)

The greater discharge current is, the smaller capacity of battery is. As shown in the right figure. When discharge current increases, the speed of chemical reactions will increase, and the speed for PbSO_4 to block holes will increase, so that many active substances in the inner layer of plate cannot participate in chemical reactions. Actual output capacity of storage battery will decrease.



放电电流越大，蓄电池的容量就越小，如右图所示。当放电电流增大时，化学反应速度加快， PbSO_4 堵塞孔隙的速度也越快，导致极板内层大量的活性物质不能参与反应，蓄电池的实际输出容量减小

3. Capacity and Influencing Factors of Storage Battery 蓄电池的容量及其影响因素

(1) Discharge Current(放电电流)

Meanwhile, electrolyte density will reduce rapidly. Voltage of storage battery will also drop sharply. Discharge time will be shortened. Therefore, in actual use, starting time must be strictly controlled. Starting time should not exceed 10s, and interval between two successive starting shall not be less than 2 minutes.

同时，电解液密度迅速下降，导致蓄电池的端电压也迅速下降，因而缩短了放电时间。因此 在实际使用中必须严格控制起动时间，每次起动的时间不应超过**10s**，且连续两次起动之间的时间间隔不应少于**2分钟**

4. Charging of Storage Battery 蓄电池的充电

1) Charging Equipment(充电设备)

Storage battery is DC power, which must be charged with DC power. When charging, positive electrode of charging power supply shall be connected to positive electrode of storage battery, and negative electrode of charging power supply shall be connected to negative electrode of storage battery. 蓄电池是直流电源，必须用直流电源对其进行充电。充电时，充电电源的正极接蓄电池的正极，充电电源的负极接蓄电池的负极。

Charging device on vehicle is ac generator driven by engine. Silicon rectifier charger, thyristor rectifier charger and intelligent charging machine are often used for charging. 汽车上的充电设备是由发动机驱动的交流发电机。充电间多采用硅整流充电机、晶闸管整流充电机和智能充电机等。

2) Charging Method(充电方法)

- (1) Constant-voltage charge(恒压充电)
- (2) Constant-current charge(恒流充电)
- (3) Quick charge(快速充电)

5. Common Failure of Storage Battery 蓄电池常见的故障

Failure 1: Vulcanization of Electrode Plate 故障1：极板硫化

Failure Symptom 故障特征	A layer of white coarse grain PbSO_4 is generated on the plate, which cannot turn into PbO_2 and Pb in normal charging.极板上生成一层白色粗晶粒的PbSO_4，在正常充电时不能转化为PbO_2和Pb的现象 (1) When sulfuretted batteries discharge, voltage sharply reduces and drops to end voltage too early. Capacity of batteries decrease.硫化的电池放电时，电压急剧降低，过早降至终止电压，电池容量减小 (2) When storage battery is charged, voltage of single compartment increases too fast, and temperature of electrolyte increases quickly, but density increases slowly, and bubbles are produced too early. There are even bubbles immediately the batteries are charged.蓄电池充电时单格电压上升过快，电解液温度迅速升高，但密度增加缓慢，过早产生气泡，甚至一充电就有气泡。
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5. Common Failure of Storage Battery 蓄电池常见的故障

Failure 1: Vulcanization of Electrode Plate 故障1: 极板硫化

Failure Cause 故障原因	(1) Storage battery is undercharged for a long time or fails to be charged timely after discharge. Part of PbSO_4 on the plate dissolves in electrolyte. The higher environment temperature is, the larger solubility is. When environment temperature decreases, solubility will decrease. Dissolved PbSO_4 will separate out, crystallize again on the plate, and form vulcanization. 蓄电池长期充电不足或放电后没有及时充电, 导致极板上的PbSO_4有一部分溶解于电解液中, 环境温度越高, 溶解度越大。当环境温度降低时, 溶解度减小, 溶解的PbSO_4就会重新析出, 在极板上再次结晶, 形成硫化。 (2) Liquid surface of electrolyte is too low. Upper part of the plate contacts with air and be oxidated. When the vehicle is running, electrolyte fluctuates and contacts with oxidation part of the plate. Big grain PbSO_4 hardening layer is generated, and upper part of the plate is vulcanized. 电解液液面过低, 使极板上部与空气接触而被氧化, 在行车中, 电解液上下波动与极板的氧化部分接触, 会生成大晶粒PbSO_4硬化层, 使极板上部硫化。 (3) Because of long-term over-discharge or deep discharge of small current, PbSO_4 is generated in holes of active substances deep in the plate. 长期过量放电或小电流深度放电, 使极板深处活性物质的孔隙内生成PbSO_4 (4) New storage battery is not completed charged. Active substances are not fully restored. 新蓄电池初充电不彻底, 活性物质未得到充分还原 (5) Density of electrolyte is too high. Composition is pure. External temperature changes dramatically. 电解液密度过高、成分不纯, 外部气温变化剧烈
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5. Common Failure of Storage Battery 蓄电池常见的故障

Failure 1: Vulcanization of Electrode Plate 故障1: 极板硫化

Troubleshooting Method 排除方法	Mild vulcanized storage battery can be treated with long charging of small current . Vulcanization of Serious vulcanized storage battery can be removed with desulphurization charging method. Particularly serious vulcanized storage battery should be scrapped. (轻度硫化的蓄电池，可用小电流长时间充电的方法予以排除；硫化较严重者采用去硫化充电方法消除硫化；硫化特别严重的蓄电池应报废)
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5. Common Failure of Storage Battery 蓄电池常见的故障

Failure 2: Falling of Active Substances 故障2: 活性物质脱落

Failure Symptom 故障特征	Mainly refers to falling off of PbO₂, the active substance on the positive electrode plate. 主要指正极板上的活性物质PbO ₂ 的脱落。 Battery capacity reduces. Brown substance can be seen in liquid adding hole while charging. Electrolyte is turbid. 蓄电池容量减小，充电时从加液孔中可看到有褐色物质，电解液浑浊
Failure Cause 故障原因	(1) Charge current of storage battery is too large. Temperature of electrolyte is too high. Active substances become expanded, soft and easy to fall off. 蓄电池充电电流过大，电解液温度过高，使活性物质膨胀、松软而易于脱落。 (2) Storage battery is often overcharged. A large amount of gas escapes from holes on the plate, making active substances fall off. 蓄电池经常过充电，极板孔隙中逸出大量气体，在极板孔隙中造成压力，而使活性物质脱落 (3) Electrode plate bents and deforms due to frequent low-temperature high-current discharge, which makes active substances fall off. 经常低温大电流放电使极板弯曲变形，导致活性物质脱落 (4) Bumping and vibration while vehicle is running 汽车行驶中的颠簸振动。
Troubleshooting Method 排除方法	If there are few sediments on lead storage battery whose active substances fall off, the battery can be used after removing. If there are many sediments, electrode plate and electrolyte should be replaced. 对于活性物质脱落的铅蓄电池，若沉积物较少时，可清除后继续使用；若沉积物较多时，应更换新极板和电解液

5. Common Failure of Storage Battery 蓄电池常见的故障

Failure 3: Corrosion of Grid Frame on Electrode Plate 故障3: 极板栅架腐蚀

Failure Symptom 故障特征	Mainly corrosion of grid frame on positive electrode plate. Plate is rotten. Active substances accumulate between division plates in the form of bulk. Output capacity of storage battery reduces. 主要是正极板栅架腐蚀，极板呈腐烂状态，活性物质以块状堆积在隔板之间，蓄电池输出容量降低
Failure Cause 故障原因	(1) Storage battery is often overcharged. O₂ generated on positive electrode plate oxygenizes grid frame. 蓄电池经常过充电，正极板处产生的O₂使栅架氧化 (2) Density and temperature of electrolyte is too high. Charging time is too long. Corrosion of plates will be accelerated. 电解液密度、温度过高、充电时间过长，会加速极板腐蚀 (3) Electrolyte is not pure. 电解液不纯
Troubleshooting Method 排除方法	For storage battery with lighter corrosion, if there are impurities in electrolyte, electrolyte shall be poured out, and cleaned with distilled water repeatedly. And then new electrolyte shall be added. The battery can be used after charging. 腐蚀较轻的蓄电池，电解液中如果有杂质，应倒出电解液，并反复用蒸馏水清洗，然后加入新的电解液，充电后即可使用 For storage battery with relatively severe corrosion, if density of electrolyte is too high, it can be adjusted to specified value. The battery can be used when it is not charged. 腐蚀较严重的蓄电池，如果是电解液密度过高，可将其调整到规定值，在不充电的情况下继续使用 For storage battery with severe corrosion, if grid gram is broken and active substances fall off in bulk, electrode plate needs to be replaced. 腐蚀严重的蓄电池，如栅架断裂、活性物质成块脱落等，则需更换极板

5. Common Failure of Storage Battery 蓄电池常见的故障

Failure 4: Short Circuit of Electrode Plate 极板短路

Failure Symptom 故障特征	Positive and negative electrode plate of storage battery directly contacts with each other or gets overlapped by other conductive materials. This is called short circuit of electrode plate. 蓄电池正、负极板直接接触或被其它导电物质搭接称为极板短路 For storage battery with short-circuit electrode plate, voltage is very low or zero while charging. Temperature of electrolyte soars. Density rises slowly. There are few bubbles while charging. 极板短路的蓄电池充电时充电电压很低或为零，电解液温度迅速升高，密度上升很慢，充电末期气泡很少
Failure Cause 故障原因	(1) Division plate is broken. Positive and negative electrode plate directly contacts with each other. 隔板破损使正、负极板直接接触 (2) Active substances largely fall off. Positive and negative plate are connected after sedimentation. 活性物质大量脱落，沉积后将正、负极板连通 (3) Electrode plate group bends. 极板组弯曲 (4) Conductive objects fall in the pool. 导电物体落入池内
Troubleshooting Method 排除方法	During short circuit of electrode plate, storage battery must be opened for inspection. 出现极板短路时，必须将蓄电池拆开检查 Change damaged division plate, eliminate deposition of active substances, correct or replace bended plate group, etc. 更换破损的隔板，消除沉积的活性物质，校正或更换弯曲的极板组等

5. Common Failure of Storage Battery 蓄电池常见的故障

Failure 5: Self Discharge 自放电

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Failure Symptom 故障特征	Under no-load condition, energy of storage battery disappears automatically. This is called self discharge. Capacity of fully charged storage battery reduces by more than 2% every day within 30 days. This is called fault self discharge. 蓄电池在无负载的状态下，电量自动消失的现象称为自放电。如果充足电的蓄电池在30天之内每昼夜容量降低超过2%，称为故障性自放电
Failure Cause 故障原因	(1) Electrolyte is not pure. There is potential difference between impurities and plates, and between different impurities on the plate. Partial discharge is produced through electrolyte. 电解液不纯，杂质与极板之间以及沉附于极板上的不同杂质之间形成电位差，通过电解液产生局部放电。 (2) Storage battery has been stored for a long time. Sulfuric acid sinks. Upper and lower part of electrode plate have potential difference, which causes self discharge. 蓄电池长期存放，硫酸下沉，使极板上、下部产生电位差引起自放电 (3) Electrolyte overflowing from storage battery accumulates on the surface of battery cover. Close circuit is formed between positive and negative pole. 蓄电池溢出的电解液堆积在电池盖的表面，使正、负极柱形成通路 (4) Active substances on electrode plates fall off. There is too much sediment on the lower part, which causes short circuit of electrode plate. 极板活性物质脱落，下部沉积物过多使极板短路
Troubleshooting Method 排除方法	Storage battery with a little self discharge can be normally discharged. And then pour out electrolyte, wash with distilled water repeatedly, and add new electrolyte. It can be used after fully charged. If self discharge is relatively severe, battery should be completely discharged. Pour out electrolyte, remove plate group, pull out division plate, wash with distilled water, reassemble and add new electrolyte. It can be used after charging. 自放电较轻的蓄电池，可将其正常放完后，倒出电解液，用蒸馏水反复清洗干净，再加入新电解液，充足电后即可使用；自放电较为严重时，应将电池完全放电，倒出电解液，取出极板组，抽出隔板，用蒸馏水冲洗之后重新组装，加入新的电解液重新充电后使用

5. Common Failure of Storage Battery 蓄电池常见的故障

Failure 6: Polarity Reversal of Single Battery 单格电池极性颠倒

Failure Symptom 故障现象	Original positive electrode plate of single battery changes into negative electrode plate. Negative electrode plate changes into positive electrode plate. At this time, voltage of storage battery drops rapidly. It cannot be used. 单格电池原来的正极板变成负极板，负极板变成正极板。此时，蓄电池电压迅速下降，不能继续使用
Failure Cause 故障原因	Faulted single battery is not found timely (such as short circuit of plate, falling of active substances, etc.). When storage battery is discharged, the single battery will be discharged to zero first due to its small capacity. When discharge is continued, discharge current of other single batteries will charge it and reserves its polarity. 没有及时发现有故障的单格电池（如极板短路、活性物质脱落等），当蓄电池放电时，该单格电池由于容量小，首先放电至零，再继续放电时，其他单格电池的放电电流对它进行充电，使其极性颠倒
Troubleshooting Method 排除方法	Electrode plates of single battery with polarity reversal should be replaced. 对极性颠倒的单格电池应更换新极板

6. Use, Maintenance and Inspection of Storage Battery

(蓄电池的使用维护与检测)

Storage of Storage Battery (蓄电池的储存)

(1) Storage of New Storage Battery (新蓄电池的储存)

The following points should be paid attention to during storage of storage batteries

保管蓄电池时应注意以下几点.

- ①Keep at room temperature of 5~30°C. Dry, clean and ventilated. (存放室温5~30°C, 干燥、清洁、通风)
- ②Avoid from direct sunlight. More than 2m away from heat source. (不要受阳光直射, 离热源距离不小于2m)
- ③Avoid from contact with any liquid and harmful gas. (避免与任何液体和有害气体接触)
- ④Shall not be inverted or lay. shall not be put together. Shall not bear heavy pressure
(不得倒置或卧放, 不得叠放, 不得承受重压)
- ⑤New storage battery shall not be stored for more than 2 years. (新蓄电池的存放时间不得超过2年)

(2) Storage of Unused Storage Battery暂时不用的蓄电池的储存

Wet storage method is used. Fully charge first. During this period color of electric eye shall be checked regularly.

If capacity reduces by 25%, the battery shall be immediately charged. It shall be fully charged before using. (采用湿储存方法, 即先充足电, 期间应定期检查电眼的颜色, 如容量降低25%, 应立即补充充电, 交付使用前也应先充足电)

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4 Starter 起动机

5 Lighting Equipment, Auxiliary Circuit and Instrument 照明设备、辅助电路及仪表

6 Air-conditioning System 空调系统

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Integrated Generator (整体式发电机)



(1) Overview (概述)

1. Functions of Generator and Regulator (发电机和调节器的作用)

❑ **As the main power supply of engineering machinery, generator has the following main functions:**

(发电机作为工程机械的主要电源, 其主要作用)

(1) Supply power for electrical equipments when engine operates with speed above idling speed.

(在发动机怠速以上转速运转时, 为用电设备供电)

(2) Charge storage batteries (给蓄电池充电)

❑ **Need for installation of regulator (安装调节器的必要性)**

In the process of operation, speed of engine and working conditions of electrical equipments change, so that rotate speed and load of generator change. To ensure that electrical equipments work normally during operation of engine, regulator must be installed.

(在工作过程中, 发动机的转速是变化的, 用电设备的工作状态是变化的, 决定了发电机的转速和负载是变化的。为保证发动机运转过程中电气设备正常工作, 故必须加调节器)

❑ **Basic functions of alternator regulator: (交流发电机调节器的基本作用)**

When load of generator and rotate speed of engine are within the normal range, keep average output voltage of generator within the prescribed scope. (当发电机的负载和发动机的转速在正常范围内时, 保持发电机输出电压平均值维持在规定范围内)

(1) Overview (概述)

2. Basic Requirements to Generator and Regulator (对发电机和调节器的基本要求)

- (1) When engine is idle running, output voltage of generator shall not be lower than terminal voltage of batteries and it shall have a certain load capacity. (发动机怠速运转时，发电机输出电压应不低于蓄电池的端电压并具有一定的带载能力)
- (2) When engine runs with middle or high speed, generator shall be able to satisfy electricity requirements of most electrical equipments. (发动机中高速运转时，发电机应能满足大多数用电设备同时用电的要求)
- (3) When load of generator and rotate speed of engine change within the normal range, output voltage of generator shall not below voltage of storage battery or above voltage allowed by electrical equipments. (发电机的负载和发动机的转速在正常范围内变化时，保持发电机输出电压既不低于蓄电池电压，又不高于用电设备的允许电压)
- (4) When armature voltage of generator is below the voltage of storage battery, armature discharge of storage battery through generator shall be prevented. (发电机电枢电压低于蓄电池电压时，防止蓄电池通过发电机电枢放电)

(1) Overview (概述)

3. Classification of AC Generator 交流发电机的分类

□ **Engineering machinery generator is divided into DC generator and AC generator. DC generator rectifies with rectifier. AC generator rectifies with diode rectifier. DC generator has been basically eliminated.** 工程机械发电机分为直流发电机和交流发电机。直流发电机通过换向器整流，交流发电机用二极管整流。直流发电机基本淘汰

1) By overall structure 按总体结构分

(1) Common AC generator. This generator doesn't have special device or special functional features. When using, it needs to be equipped with voltage regulator. 普通交流发电机。这种发电机即无特殊装置，也无特殊功能特点，使用时需要配装电压调节器

(2) Integral AC generator. Generator and regulator are made into a whole generator. 整体式交流发电机，发电机和调节器制成一个整体的发电机

(3) AC generator with pump. Generator and brake system of vehicle are installed together with vacuum booster. 带泵的交流发电机。发电机和汽车制动系统用真空助力泵安装在一起的发电机。

(4) Brushless AC generator. Generator without electric brush. 无刷交流发电机，不需要电刷的发电机

(5) Permanent magnet AC generator. Rotor poles are made of permanent magnet. 永磁交流发电机，转子磁极为永磁铁制成的发电机

(1) Overview (概述)



普通交流发电机

a)

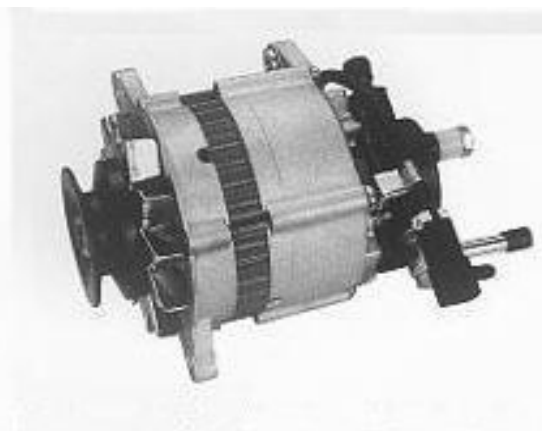
Common AC Generator



整体式交流发电机

b)

Integral AC Generator



带泵的交流发电机

c)

AC Generator with Pump

Figure 3.19

(1) Overview (概述)

2) By structure of rectifier (按结构分)

(1) 6-tube AC Generator (6管交流发电机)

(2) 8-tube AC Generator (8管交流发电机)

(3) 9-tube AC Generator (9管交流发电机)

(4) 11-tube AC Generator (11管交流发电机)

3) By type of magnet winding earth (按励磁绕组搭铁型式分)

(1) Internal-earth AC Generator (内搭铁型交流发电机)

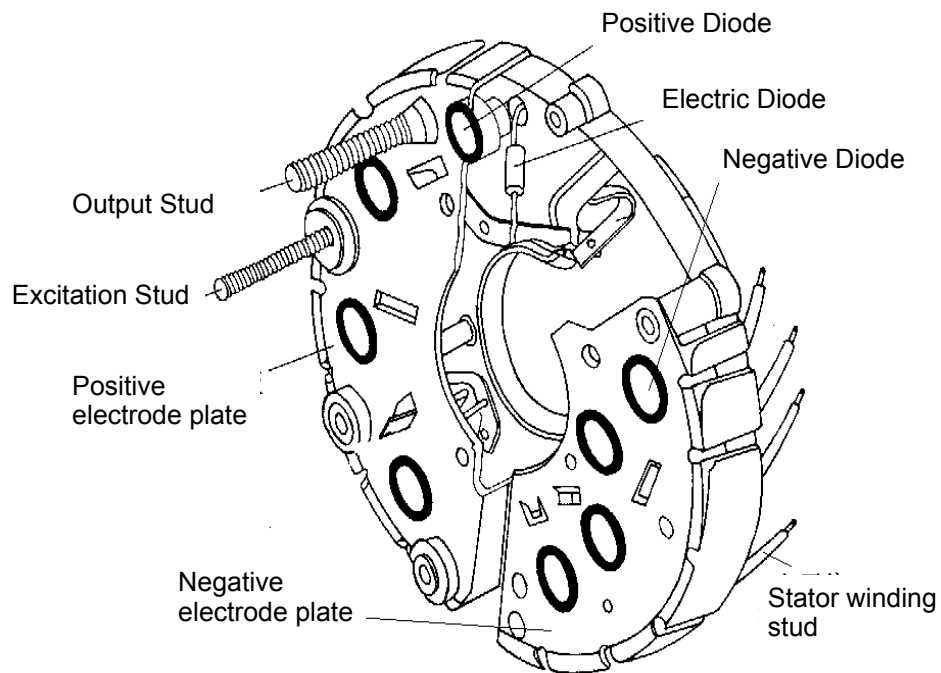
(2) External-earth AC Generator (外搭铁型交流发电机)

Notes (注意)

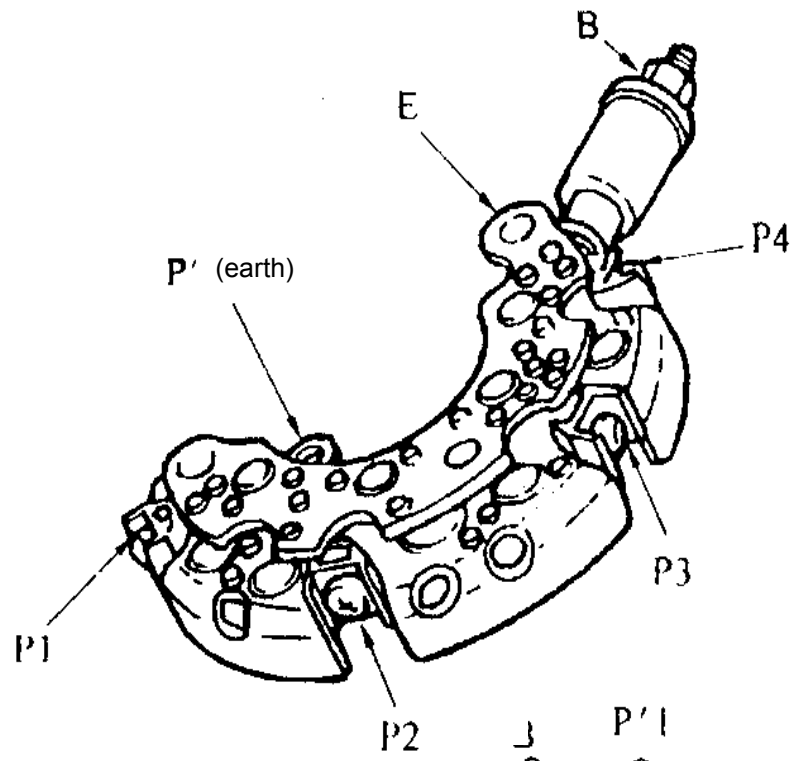
AC generators with different earth type have different regulator and wiring method. Failure inspection method of charging system is also different. It should be noticed when using, or generator will not generate electricity and regulator will not work.

(交流发电机搭铁型式不同，所配用的调节器及接线方法不同，充电系故障检查方法也不同，使用时应予以注意，否则发电机不发电，调节器不工作)

(1) Overview (概述)



Structure of Rectifier of 11-tube AC Generator



Structure of Rectifier of 8-tube AC Generator

(2) Structure of Generator 发电机结构

1. Structure of Common AC Generator (普通交流发电机结构)

- 1) **Rotor** (转子)
- 2) **Stator** (定子)
- 3) **Rectifier** (整流器)
- 4) **End cover and brush components** (端盖及电刷组件)

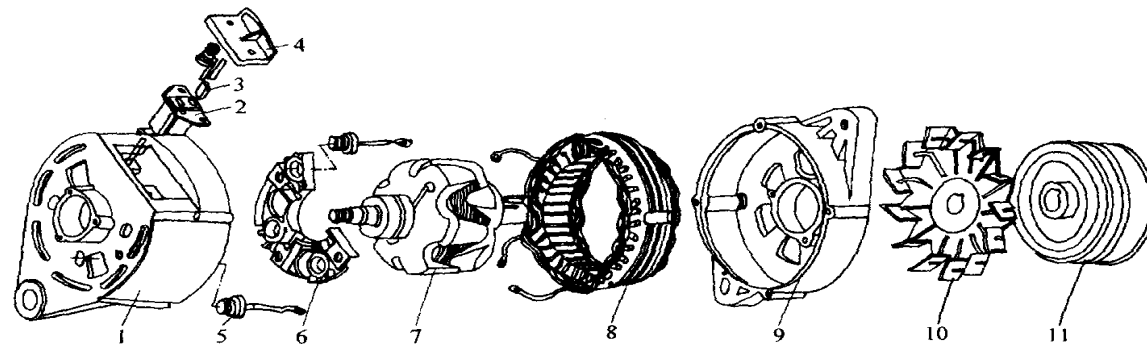


Figure 3.1

(2) Structure of Generator 发电机结构

1) Rotor (转子)

The function of rotor is generating magnetic field.转子的功用是产生磁场

Rotor consists of claw pole, magnetic yoke, magnet winding, slip ring, rotor spindle, etc.

转子由爪极、磁轭、励磁绕组、滑环、转子轴等组成

When two slip rings are energized with direct current, electric current will flow through magnet winding. Axial magnetic flux will be produced axial magnetic flux, magnetizing one claw pole into of N pole and the other into S pole. Six (or eight) pairs of interlinked poles will be formed.

当给两滑环通入直流电时，励磁绕组中就有电流通过，并产生轴向磁通，使爪极一块被磁化为N极，另一块被磁化为S极，从而形成六对（或八对）相互交错的磁极。

When rotor rotates, rotating magnetic field will be formed.当转子转动时，就形成了旋转的磁场

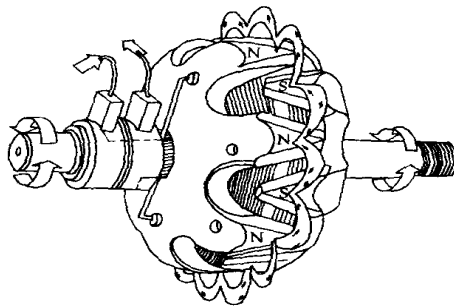


图3-3

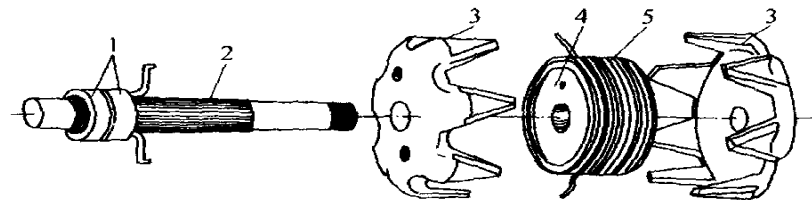


图3-4

(2) Structure of Generator 发电机结构

2) Stator (定子)

The function of stator is generating alternating current. 定子的功用是产生交流电

Stator core is made of insulating silicon steel plates with groove in the inner circle. 定子铁心由内圈带槽、互相绝缘的硅钢片叠成

Stator winding has three groups of coils, inlaid in groove of stator core symmetrically. 定子绕组有三组线圈，对称的嵌放在定子铁心的槽中。三相绕组的连接有星形接法和三角形接法两种。

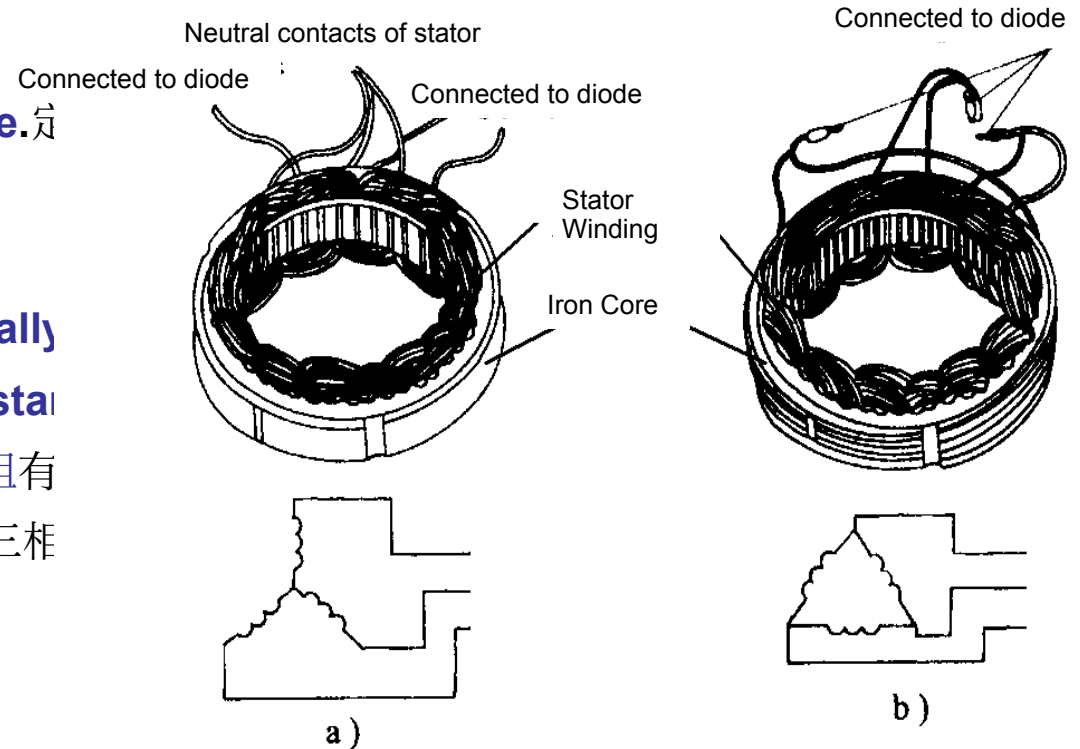


Figure 3.5

(2) Structure of Generator 发电机结构

3) Rectifier (整流器)

The function of rectifier is changing three-phase alternating current of stator winding into direct current.

整流器的功用是将定子绕组的三相交流电变为直流电

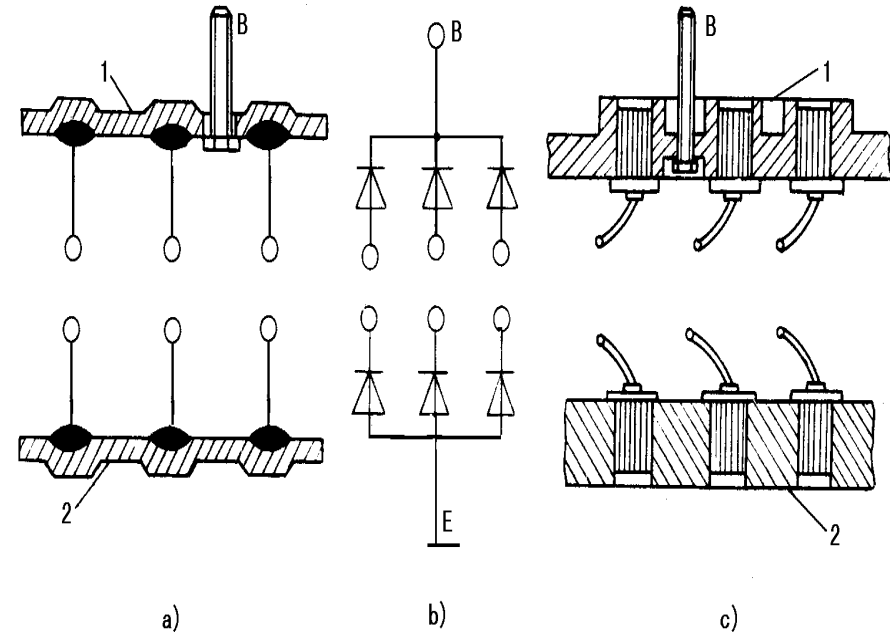


图 3.6

Figure 3.6

(2) Structure of Generator 发电机结构

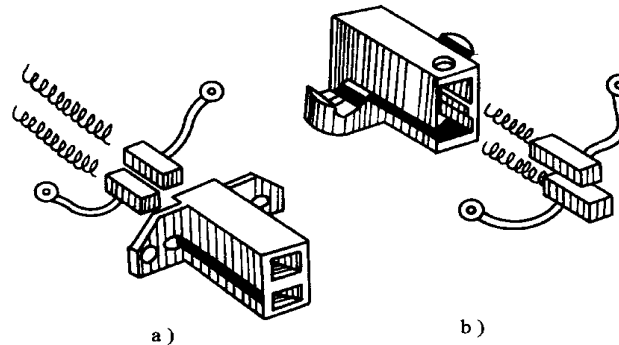
4) End Cover and Brush Components (端盖及电刷组件)

End cover general has 2 parts (front end cover and back end cover), which support rotor, stator, rectifier and brush components.端盖一般分两部分（前端盖和后端盖），起支撑转子、定子、整流器和电刷组件的作用

Brush components consist of brush, brush holder and brush spring. As show in Figure 2-11.电刷组件由电刷、电刷架和电刷弹簧组成，如图2-11所示。

Function of brush is bringing power supply into magnet winding through slip ring. 2 brushes installed in holes of brush holder keep contacting with slip rings with the pressure of spring.电刷的作用是将电源通过滑环引入励磁绕组。两个电刷分别装在电刷架的孔内，借助弹簧压力与滑环保持接触。

Brushes and slip rings shall be connected properly. Otherwise, generator will not generator enough electricity because field current is too small.电刷和滑环的接触应良好，否则会因为磁场电流过小，导致发电机发电不足



Brush
Components

(2) Structure of Generator 发电机结构

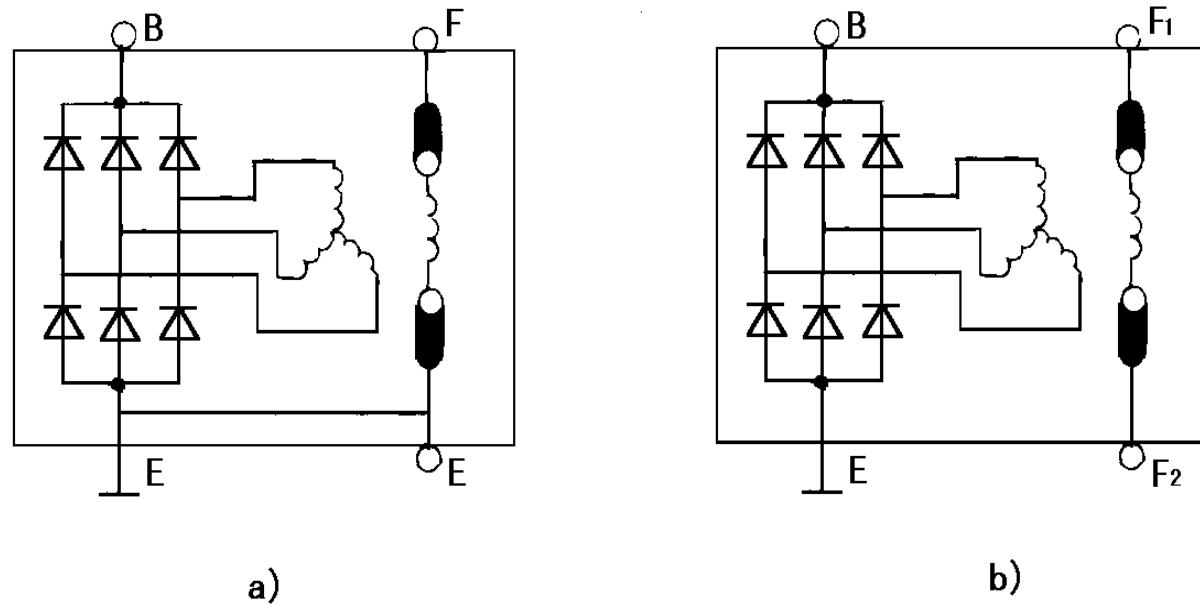


Figure 3.10

(3) Other Types of AC Generators 其他型式的交流发电机

1) **Brushless AC Generator** 无刷交流发电机

Due to lack of brush and slip ring, poor unstable excitation, no generation of power from generator and other failure will not be caused by wear and bad contact of brush and slip ring. At the same time, there is no spark while working, which also reduces radio interference.

由于没有电刷和滑环，所以不会因为电刷及滑环的磨损和接触不良造成励磁不稳定或发电机不发电等故障；同时工作时无火花，也减小了无线电干扰。

Brushless AC Generator is divided into claw pole type, exciter type and permanent magnet type. 无刷交流发电机分为爪极式、激磁机式和永磁式三种

(3) Other Types of AC Generators 其他型式的交流发电机

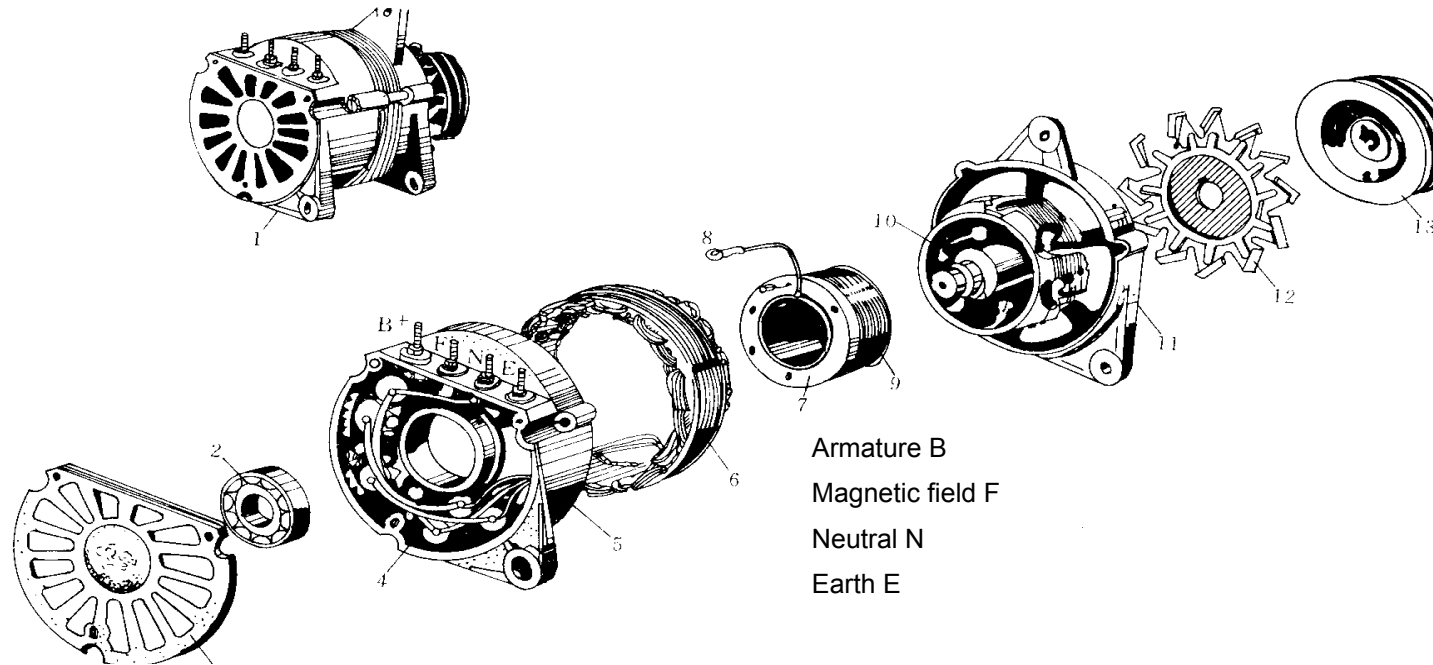
1) Brushless AC Generator 无刷交流发电机

(1) Structure and Working Principle of Claw Pole Brushless AC Generator 爪极式无刷交流发电机的结构及工作原理

As show in the figure below, magnet winding of claw pole Brushless AC Generator is static. It is fixed on back end cover by a magnetic yoke bracket. Therefore, it doesn't need brush. 如下图所示，爪极式无刷交流发电机励磁绕组是静止的，它通过一个磁轭托架固定在后端盖上，所以，不再需要电刷

In two claw poles, only one claw pole is directly fixed on rotor spindle of motor. The other claw pole is welded on the first claw pole with non magnetic material. When the rotor rotates, a claw pole will make the other claw pole rotate in the stator. When direct current passes through magnet winding, claw pole will be magnetized. Rotating magnetic field is formed. Magnetic circuit is shown as arrow in Figure 2-23. 两个爪极中，只有一个爪极直接固定在电机转子轴上，另一爪极则用非导磁焊接在前一爪极上。当转子旋转时，一个爪极就带动另一爪极一起在定子内转动，当励磁绕组中有直流电通过时，爪极被磁化，就形成了旋转磁场。磁路如图2-23箭头所示

(3) Other Types of AC Generators 其他型式的交流发电机



Structure of Claw Pole Brushless AC Generator

- 1 — Exterior 2 — Back bearing 3 — Hood 4 — Rectifier 5 — Shell 6 — Stator 7 — Magnet yoke
8 — Connector of magnet winding 9 — Magnet winding 10 — Claw pole 11 — Front end over
12 — Fan 13 — Belt wheel

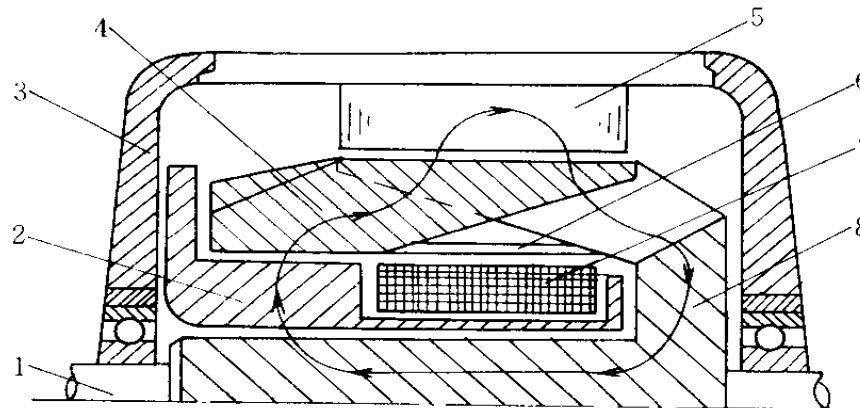
(3) Other Types of AC Generators 其他型式的交流发电机

(2) Features of Claw Pole Brushless AC Generator (爪极式无刷交流发电机的特点)

Advantages of Claw Pole Brushless AC Generator include simple structure, convenient maintenance, and reliable working. Generator will not generate unstably or fail to generate electricity due to poor contact of brush and slip ring. (爪极式无刷交流发电机的优点是：结构简单、维护方便、工作可靠，不存在电刷与滑环接触不良导致的发电不稳或不发电故障)

Disadvantage is connection difficulty between claw poles. Because gaps in magnetic circuit increase, excitation current should be increased under the same output power of generator.

(缺点是爪极间连接工艺困难，由于磁路中间隙加大，发电机相同输出功率下需加大励磁电流)



Structure and Magnetic Circuit of Claw Pole Brushless AC Generator
1 – Rotor spindle 2 – Magnet yoke bracket 3 – End cover 4 – Claw pole
5 – Stator core 6 – Non-magnetic coupling link 7 – Magnet winding
8 – Rotor magnet yoke

4/13/23

(4) Regulator调节器

1. Electronic Regulator电子调节器

With the development of electronic technology, at present almost all the AC generators use electronic regulators. Its advantage include high voltage control accuracy, no spark, light weight, small volume, long service life, high reliability, small radio frequency interference, etc.随着电子技术的发展，目前交流发电机几乎全部采用电子调节器。其优点是：电压调节精度高，且不产生火花，还具有重量轻、体积小、寿命长、可靠性高、电波干扰小等优点

Electronic regulator includes transistor regulator and integrated circuit regulator.电子调节器有晶体管调节器和集成电路调节器两种



Transistor Regulator and Integrated Circuit Regulator
a) Transistor Regulator b) Integrated Circuit Regulator

2. Classification of Electronic Regulator 电子调节器分类

Electronic regulator can be divided into two kinds by type of AC generator earth.

(电子调节器按所匹配的交流发电机搭铁类型可分两种)

(1) Internal Earth Regulator (内搭铁型调节器)

Electronic regulator suitable for internal earth AC generator is called internal earth electronic regulator.适用于内搭铁型交流发电机的电子调节器称为内搭铁型电子调节器

(2) External Earth Regulator (外搭铁型调节器)

Electronic regulator suitable for external earth AC generator is called external earth electronic regulator.

(适合用于外搭铁型交流发电机的电子调节器称为外搭铁型电子调节器)

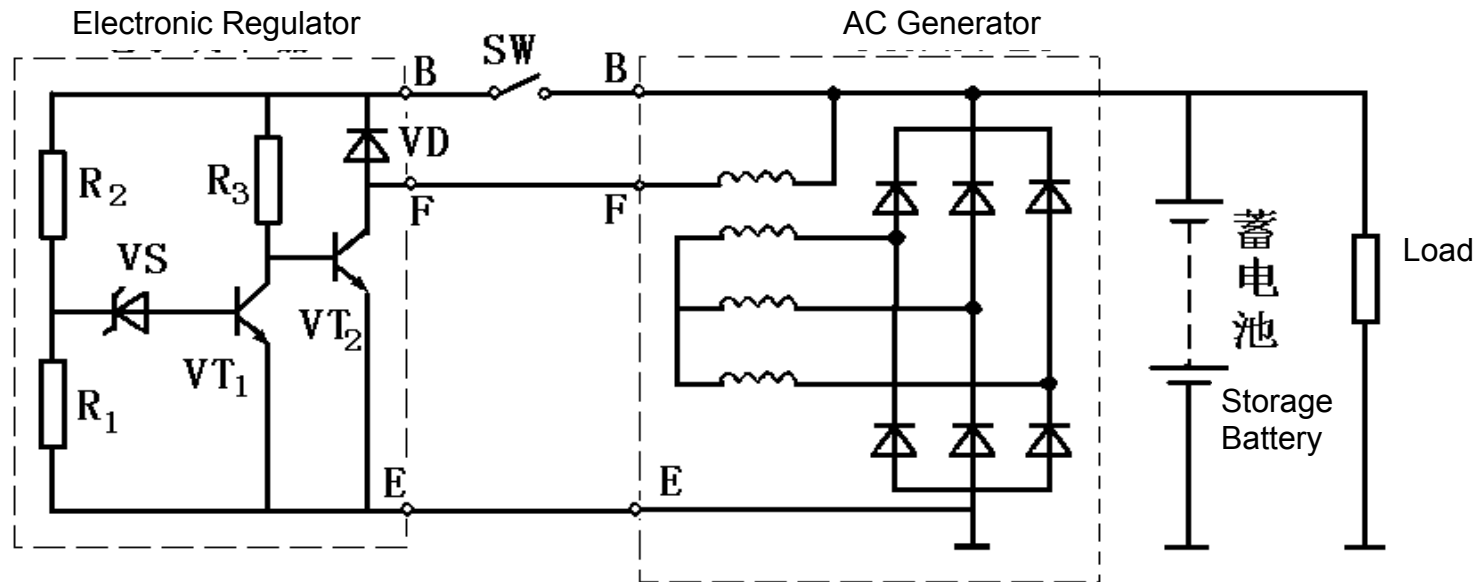
For transistor regulator, during use, it is best to use the regulator specified in vehicle manual. If replaced with other types, nominal voltage, power and other required parameters shall be same to those of the original regulator. The replaced regulator must have the same type of earth with the original regulator. Otherwise, generator may not work normally due to blocking of exciter circuit.(对于晶体管调节器, 在使用过程中, 最好使用汽车说明书中指定的调节器, 如果采用其他型号替代, 除标称电压、功率等规定参数与原调节器相同外, 代用调节器必须与原调节器的搭铁形式相同, 否则, 发电机可能由于励磁电路不通而不能正常工作)

3. Working Principle of Electronic Regulator (电子调节器的工作原理)

1) Working Principle of External Earth Electronic Regulator(外搭铁型电子调节器的工作原理)

(1) Basic Circuit(基本电路)

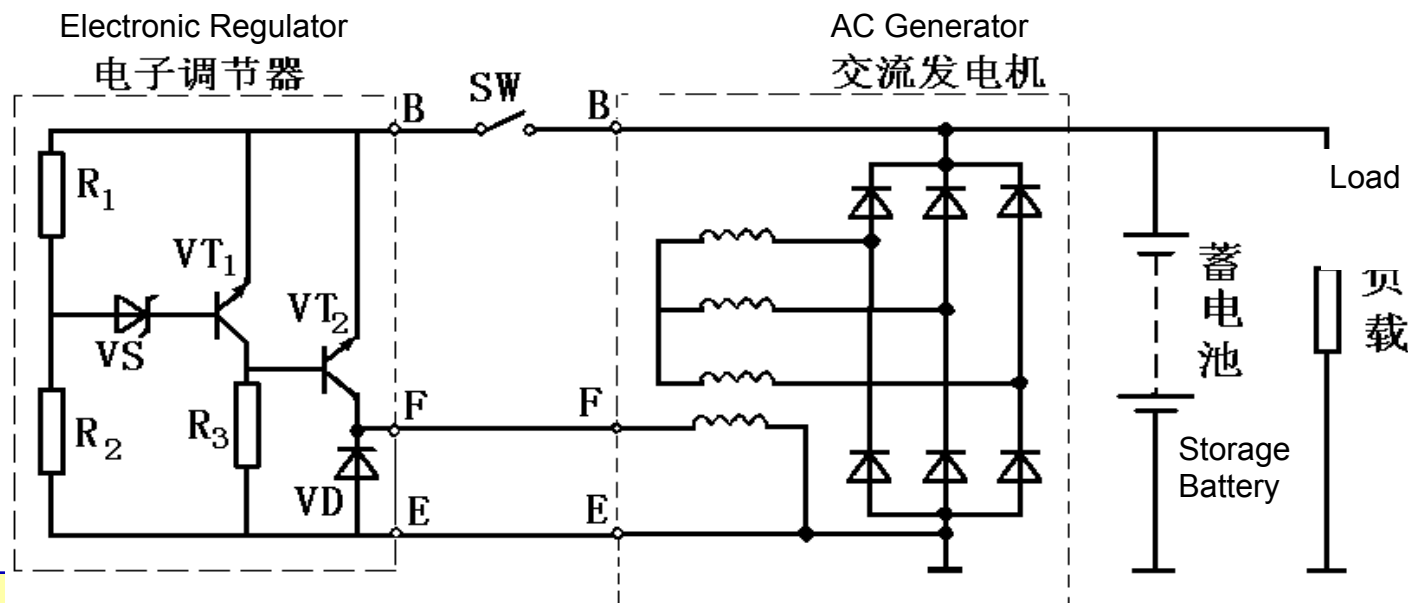
Electronic regulator has many types. They have different internal circuits, but working principle can be understood with the basic principle of basic circuit.(电子调节器有多种型式，其内部电路各不相同，但工作原理可用基本电路工作原理去理解)



3. Working Principle of Electronic Regulator (电子调节器的工作原理)

2) Basic Circuit of Internal Earth Electronic Regulator 内搭铁型电子调节器的基本电路

In basic circuit of internal earth electronic regulator, RNP VT1 and VT2 of transistor are used. Magnet winding of generator is connected between collector of VT2 and earth end, which is quite different from external earth electronic regulator. Working principle and structure are similar to those of external earth electronic regulator. 内搭铁型电子调节器基本电路的特点是晶体管VT1、VT2采用PNP型，发电机的励磁绕组连接在VT2的集电极和搭铁端之间，与外搭铁型电路显著不同，电路工作原理和结构与外搭铁型电子调节器类似



(5) **Fault Detection of AC Generator** 交流发电机的故障检测

When AC generator fails to generate electricity or fails to generate enough electricity, first we should decide whether the failure happens in external circuit or in generator. If it is preliminarily determined that the failure is inside generator, AC generator should be removed from the vehicle for inspection and repairing.交流发电机当发现发电机不发电或发电量不足等故障时，应首先判断故障发生在外电路还是发电机内部，若初步确定故障在发电机内部，就应将交流发电机从车上拆下来，对其进行检测、修理

AC generator should be tested first. The purpose is to determine whether AC generator has failure and where the failure occurs, in order to repair with a purpose.应先对交流发电机进行整机测试。目的是为了判定交流发电机有无故障和故障发生在哪个部位，以便有的放矢地修理

Machine test includes measurement of resistance between wiring terminals, no-load voltage and load current test on universal engine stand, and observation of waveform output by generator with an oscilloscope.整机测试包括：测量各接线柱之间的电阻、在万能试验台上进行空载电压和负载电流的试验、用示波器观察发电机输出波形

(5) Fault Detection of AC Generator 交流发电机的故障检测

1. Measurement of Resistance between Wiring Terminals

(测量各接线柱之间的电阻)

(1) Measure the resistance between output terminal B+ and earth end E of generator (shell or earth wiring terminal)

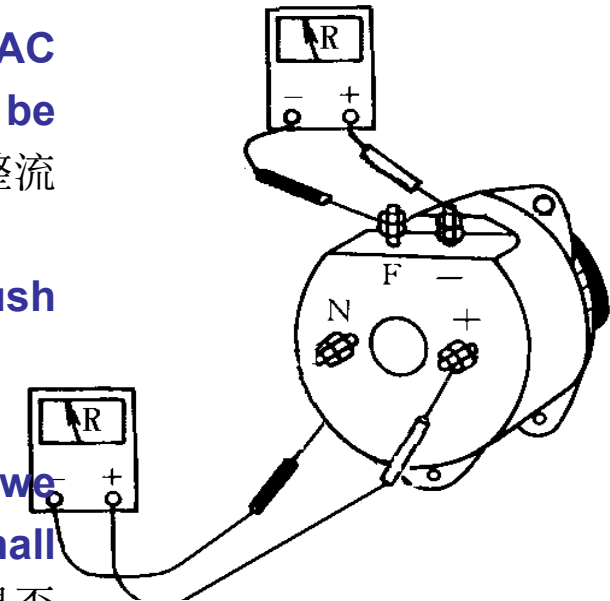
(测量发电机的输出端子B+和搭铁端E之间的阻值(壳体或搭铁接线柱))

Through measurement we can decide whether rectifier of AC generator has failure. If there is failure, the generator should be further disassembled for detection.(通过测量可以判断交流发电机整流器是否有故障,如有故障应将发电机解体进一步检测)

(2) Measure the resistance between F terminal of positive brush and negative brush E of generator

(测量发电机正电刷F接线柱和负电刷E之间的阻值)

Through measurement of resistance between wiring terminals, we cannot decide whether the generator has failure. Bench test shall be conducted.(通过测量各接线柱之间的阻值,不能确定交流发电机是否有故障时,应进行试验台试验)



Measurement of Resistance between Wiring Terminals

(5) Fault Detection of AC Generator 交流发电机的故障检测

2. Bench Test (试验台试验)

(1) No-load Test (空载实验)

No-load test is a test conducted when AC generator has no load (no external output of current). The purpose of no-load test is to preliminarily decide whether generator has failure.

（空载试验是在交流发电机不带任何负载（不对外输出电流）情况下的一种试验。空载试验的目的是：初步测定发电机是否有故障）

(2) Load Test (负载实验)

Load test is a test conducted when AC generator has load (external output of current). The purpose of no-load test is to further decide whether generator has failure.

（负载试验就是在交流发电机带有负载（对外输出电流）情况下的一种试验。负载试验的目的是：进一步测定发电机是否有故障）

Some failures of AC generator cannot show without current output. Therefore, if generator is normal in no-load test, load test shall be conducted.（交流发电机的有些故障，在没有电流输出的情况下是表现不出来的，所以如果交流发电机空载试验正常情况下，应再作负载试验）

(5) Fault Detection of AC Generator 交流发电机的故障检测

3. Inspection of Rotor (转子的检修)

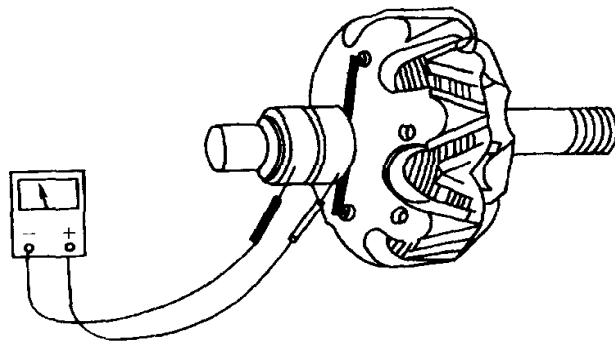
(1) Inspection of Magnet Winding (励磁绕组的检修)

Measurement of resistance of magnet winding with multimeter shall be up to standard

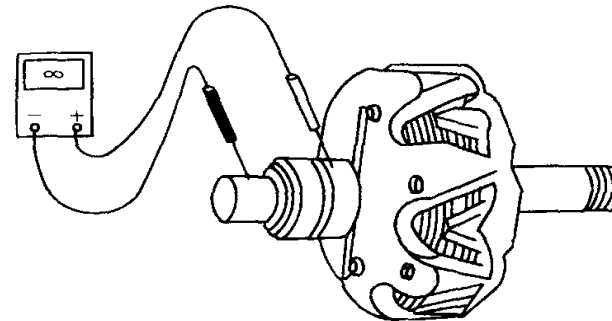
(用万用表测量励磁绕组的电阻，应符合标准)

Resistance between each slip ring and rotor spindle should be infinite.

(每个滑环与转子轴之间的阻值都应该是无穷大)



Inspection of short circuit
and open circuit of magnet winding



Inspection of earth of magnet winding

(5) Fault Detection of AC Generator 交流发电机的故障检测

(2) Inspection of Rotor Spindle and Slip Ring 转子轴和滑环的检修

Bending of rotor spindle will make the gap between rotor and stator too small and cause friction or collision. If it is found that resistance is too large or there is abnormal sound during operation of generator, we should check whether rotor spindle bends.

转子轴的弯曲会造成转子与定子之间间隙过小而摩擦或碰撞，如发现发电机运转时阻力过大或有异响，应检查转子轴是否有弯曲。

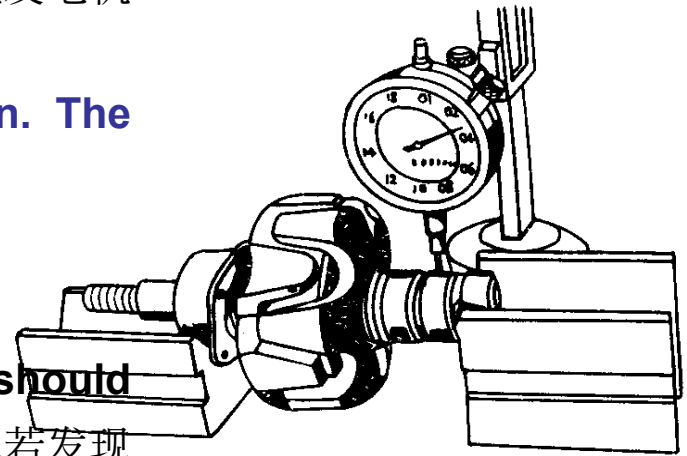
Surface of slip ring should be smooth and without erosion. The thickness shall be greater than 1.5mm.

滑环应表面光滑，无烧蚀，厚度应大于1.5mm

(3) Inspection of Bearing 轴承的检修

If abnormal sound is found during operation of generator, we should check vehicleefully whether it is caused by damage of bearing.若发现

发电机运转时有异响，应仔细检查是否因轴承的损坏而造成。

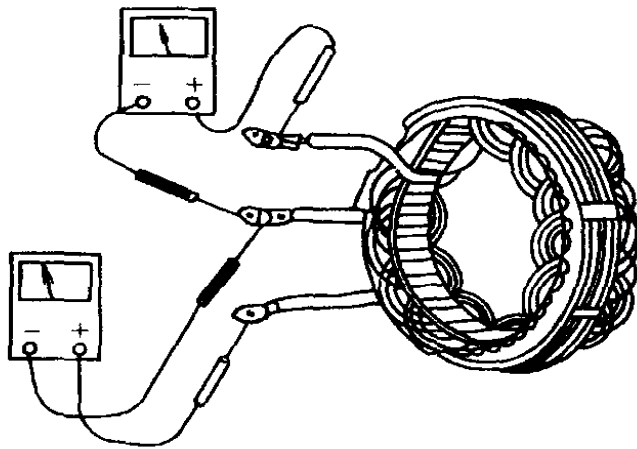


Inspection of Radial Run-out
Tolerance of Rotor Spindle

(5) Fault Detection of AC Generator 交流发电机的故障检测

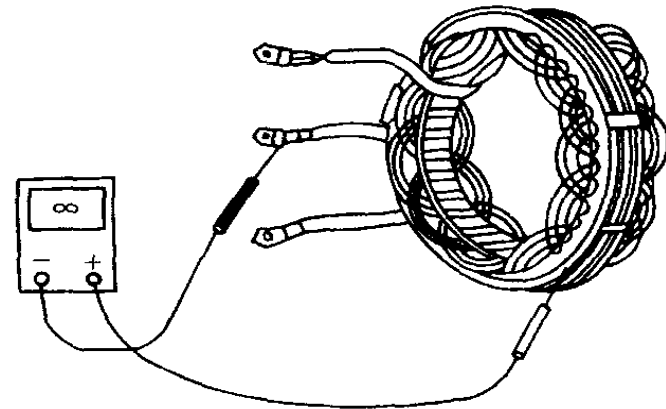
4. Inspection of Stator (定子的检修)

- (1) Inspection of open circuit and earth of stator winding (定子绕组的断路和搭铁故障检测)
- (2) Inspection of short circuit of stator winding (定子绕组的短路故障检测)



Inspection of open circuit of stator

定子断路故障的检测



Inspection of earth of stator

定子搭铁故障的检测

(5) Fault Detection of AC Generator 交流发电机的故障检测

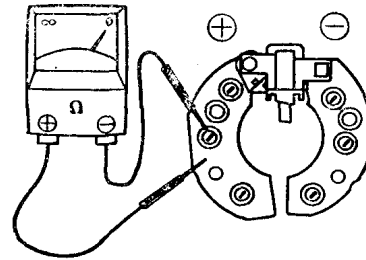
5. Inspection of Rectifier(整流器的检修)

(1) Inspection of Common Rectifier

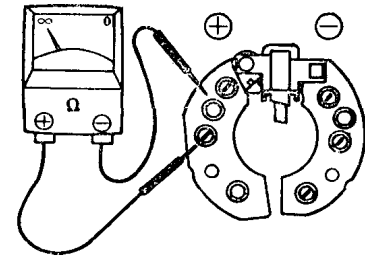
(普通整流器的检测)

Separate lead wires of diode from other connection. Connect two probes of pointer multimeter respectively to lead wire and shell of diode to measure positive and reverse resistance of diode. Positive resistance of diode shall conform to the standard value. Reverse resistance shall be above $10k\ \Omega$.

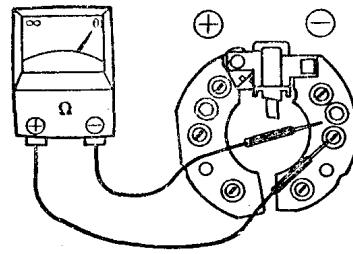
(将二极管的引线与其他连接分离，用指针万用表的两个表笔分别接到二极管的引线与壳体上，测二极管的正向与反向电阻。二极管的正向电阻应符合标准值，反向电阻应： $10k\ \Omega$ 以上)



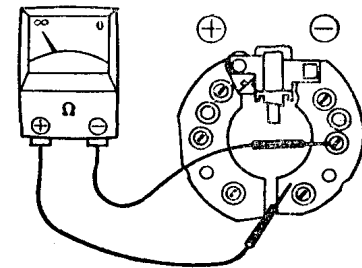
Inspection of positive resistance of positive diode



Inspection of positive resistance of reverse diode



Inspection of positive resistance of negative diode



Inspection of reserve resistance of negative diode

(5) Fault Detection of AC Generator 交流发电机的故障检测

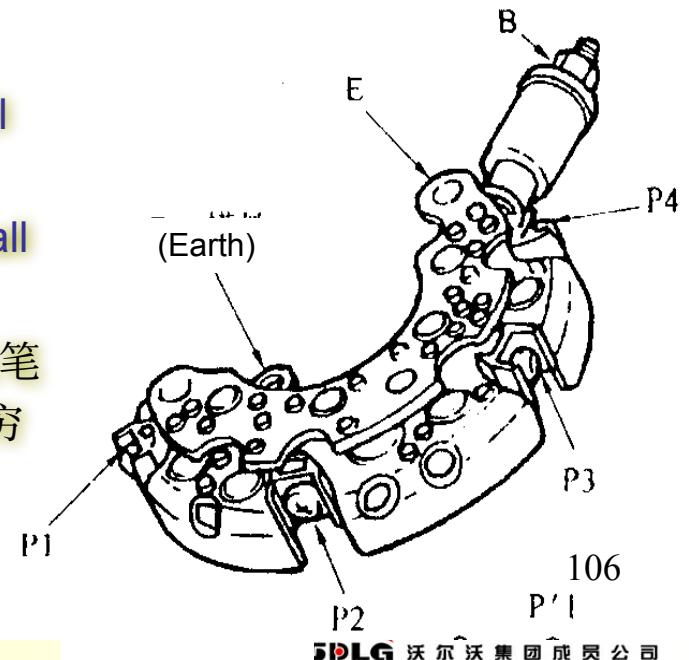
(2) Inspection of Rectifier with Integral Structure(整体结构的整流器检测)

Current plate, positive and negative diode of rectifier with integral structure are welded together and inseparable . The right figure is rectifier of AC generator of Honda Motor.(整体结构整流器的整流板、正、负硅二极管全部焊装在一起，不可分解。右图为本田汽车交流发电机的整流器)

In detection of positive diode, red probe of pointer multimeter shall be connected to B. Black probe shall be connected to P1, P2, P3 and P4 in turn, which should be all conductive. Measure after exchanging two probes. They should be all infinite. Otherwise, positive diode is damaged. Rectifier assembly needs to be changed.

(检测正极管时，将指针万用表的红表笔接B，黑表笔依次接P1、P2、P3、P4，均应导通；交换两表笔后再测，均应为无穷大，否则有正二极管损坏，需更换整流器总成)

In detection of negative diode, black probe of pointer multimeter shall be connected to P1, P2, P3 and P4 in turn, which should be all conductive. Measure after exchanging two probes. They should be all infinite. Otherwise, negative diode is damaged. Rectifier assembly needs to be changed.检测负极管时将指针万用表的黑表笔接E，红表笔依次接P1、P2、P3、P4，均应导通；交换两表笔后再测，均应为无穷大，否则有负二极管损坏，需更换整流器总成。



(5) **Fault Detection of AC Generator** 交流发电机的故障检测

6. **Inspection of Brush Components**(电刷组件的检测)

Brush and brush holder should not be damaged or cracked. Brush should move freely in brush holder. There should be no blocking. Length of brush exposed from brush holder is called brush length. Brush length should not exceed wear limit (1/2 of original length), or the brush should be replaced.

(电刷和电刷架应无破损或裂纹，电刷在电刷架中应活动自如，不得出现卡滞现象。电刷露出电刷架部分的长度叫电刷长度，电刷长不应超出磨损极限（原长的1/2），否则应更换)

Pressure of brush spring shall conform to the standards, which is generally 2 ~ 3N. Press brush into brush holder. The exposed part shall be about 2mm long. If spring pressure is too small, it should be replaced.

(电刷弹簧压力应符合标准，一般为2~3N，将电刷压入电刷架使之露出部分约2mm，弹簧压力过小应更换)

(6) Use and Maintenance of Charging System 充电系的使用和维护

AC generator and regulator with simple structure are convenient to maintain. If they are used correctly, there will be little failure and they will have long service life. If they are not used correctly, they will be damage soon. Therefore, in use and maintenance the following points should be paid attention to.

(交流发电机与调节器的结构简单，维护方便，若正确使用，不仅故障少而且寿命长。若使用不当，则会很快损坏。因此在使用和维护中应注意以下几点：)

1. Negative electrode of storage battery must be connected to earth. Otherwise, electronic components of generator or regulator may be burned.

(蓄电池的极性必须是负极搭铁，不能接反。否则，会烧坏发电机或调节器的电子元件)

2. Generator should be firmly connected to storage battery. If it is suddenly disconnected, overvoltage will damage electronic components of generator or regulator.

(发电机与蓄电池之间的连接要牢靠，如突然断开，会产生过电压损坏发电机或调节器的电子元件)

(6) Use and Maintenance of Charging System 充电系的使用和维护

3. During operation of generator, generator cannot be inspected with fire test. Otherwise, rectifier diode may be burned.

发电机运转时，不能用试火的方法检查发电机是否发电，否则会烧坏整流二极管)

4. Once failure of AC generator or regulator is found, they shall be inspected and repaired immediately to eliminate malfunction timely. Otherwise, greater failure or power lack of battery will be caused, so that vehicle can't run.

(一旦发现交流发电机或调节器有故障，应立即检修，及时排除故障，否则会引起更大故障或蓄电池亏电，致使车辆不能行驶)

(6) Use and Maintenance of Charging System 充电系的使用和维护

5. When choosing regulator for AC generator, voltage level of AC generator must be same to that of regulator. Earth type of AC generator must be same to that of regulator. Power of regulator shall be no less than power of generator. Otherwise, the system can not work normally.

(为交流发电机配用调节器时，交流发电机的电压等级必须与调节器电压等级相同，交流发电机的搭铁类型必须与调节器搭铁类型相同，调节器的功率不得小于发电机的功率，否则系统不能正常工作)

6. Circuit must be connected correctly. Currently different vehicles have different installation position of regulator and wiring method. Therefore, special attention has to be paid while wiring.

(线路连接必须正确，目前各种车型调节器的安装位置及接线方式各不相同，故接线时要特别注意)

(6) Use and Maintenance of Charging System 充电系的使用和维护

7. Regulator must be controlled by ignition switch. When generator stops turning, ignition switch shall be opened. Otherwise, magnetic circuit of generator will always be connected. Magnetic coil will be burned, and power lack of storage battery will be caused.

(调节器必须受点火开关控制，发电机停止转动时，应将点火开关断开，否则会使发电机的磁场电路一直处于接通状态，不但会烧坏磁场线圈，而且会引起蓄电池亏电)

8. When failure is found and generator or regulator has to be removed from vehicle for inspection, ignition switch and all electrical equipments shall be closed first. Cables on negative electrode of storage battery shall be removed. And then wiring connectors on generator shall be removed.

(当发现发电机或调节器有故障需要从车上拆下来检修时，首先关断点火开关及一切用电设备，拆下蓄电池负极电缆线，再拆卸发电机上的导线接头)

(6) Use and Maintenance of Charging System 充电系的使用和维护

Maintenance of Charging System (充电系的维护)

1.Check drive belt of generator

(检查发电机驱动皮带)

2.Check connection of wires

(检查导线的联接)

3.Check whether there is noise during operation

(检查运转时有无噪声)

4.Check whether generator generates electricity normally

(检查发电机是否正常发电)

5.Check whether storage battery is overcharged

(检查蓄电池是否有过充电现象)

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4 Starter 起动机

5 Lighting Equipment, Auxiliary Circuit and Instrument 照明设备、辅助电路及仪表

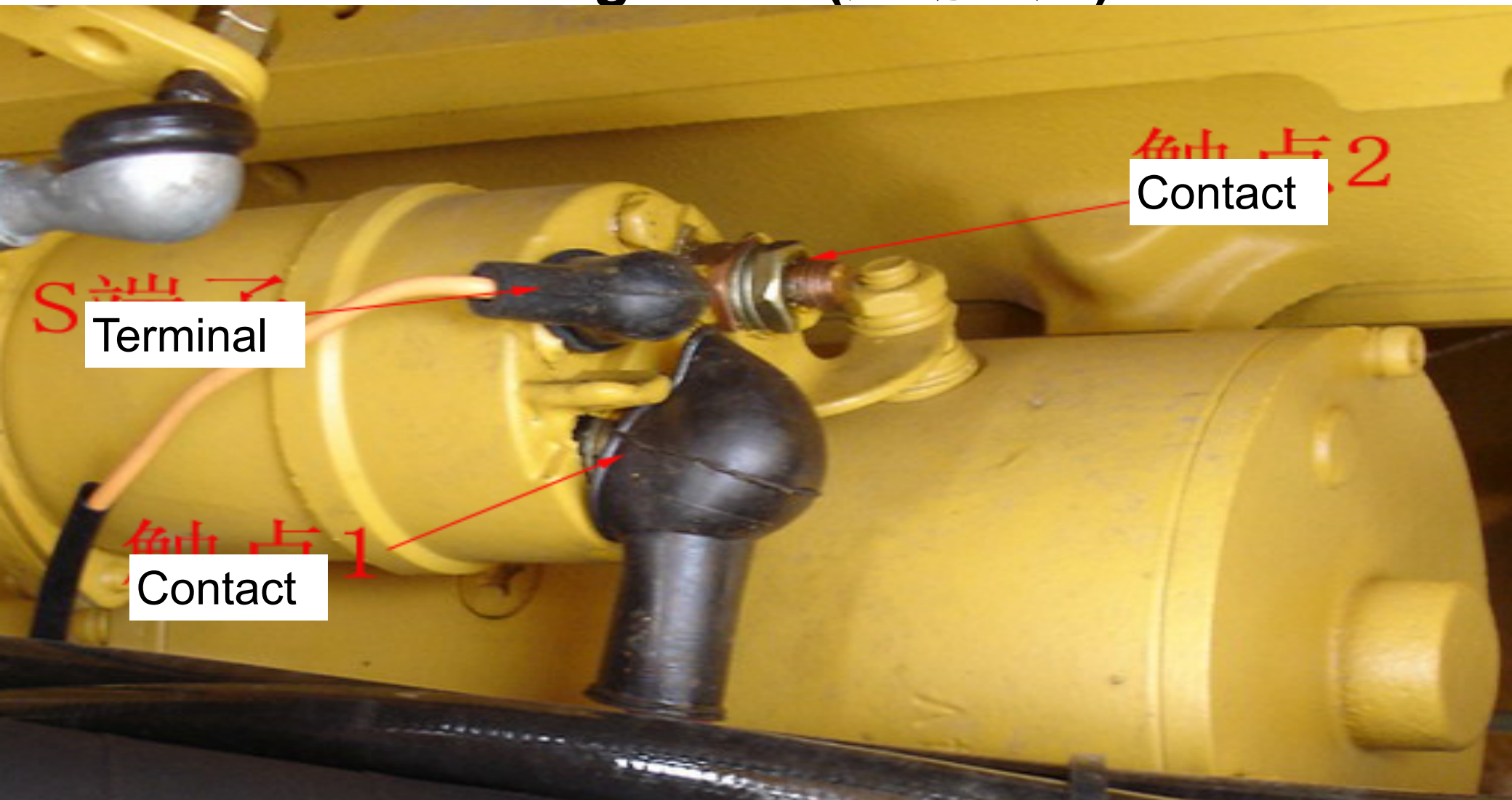
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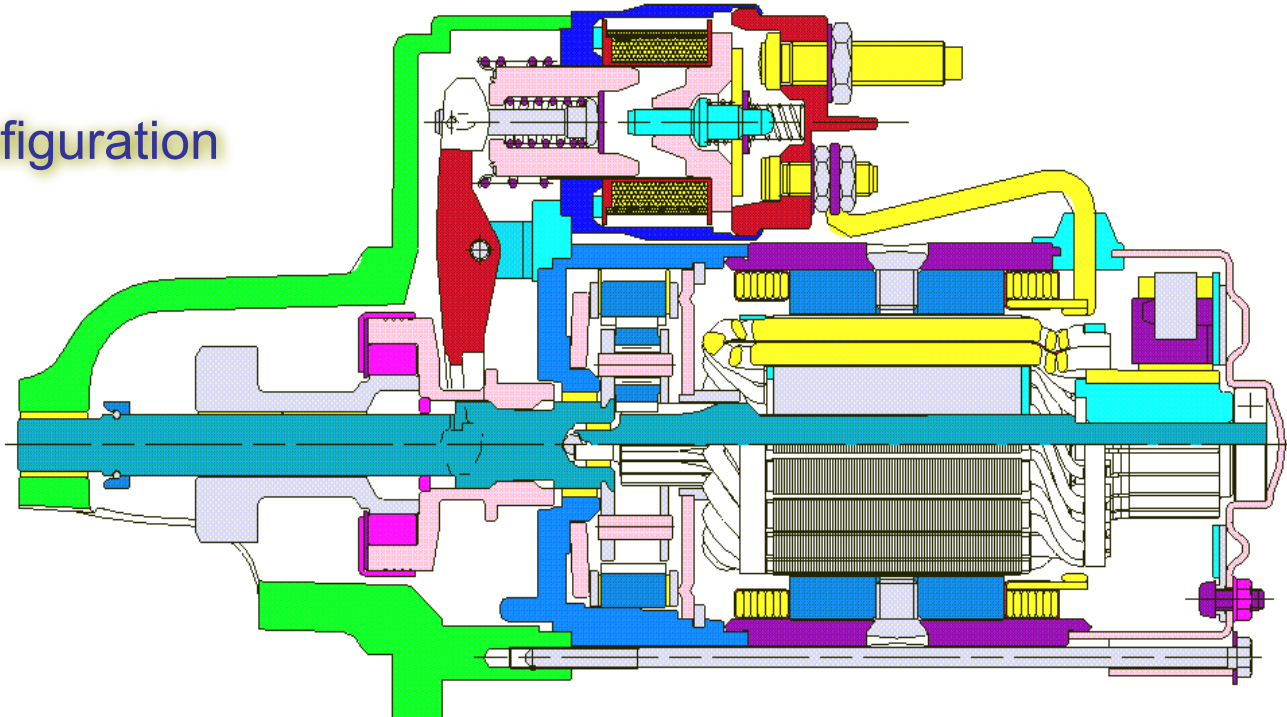


starting motor(起动马达)





Internal configuration



(1) Starting Principle of Engine 发动机起动原理

To make the engine change from static to working state, bent axle of engine must use rotated with external force, so that air cylinder will absorb (or form) flammable gas mixture, burn and expand. Working cycle will be conducted automatically. Under the action of external force, bent axle begins to turn. Engine starts idle running automatically. This process is called **starting of engine**. 要使发动机由静止状态过渡到工作状态，必须用外力转动发动机的曲轴，使气缸内吸入(或形成)可燃混合气并燃烧膨胀，工作循环才能自动进行。曲轴在外力作用下开始转动到发动机开始自动地怠速运转的全过程，称为发动机的起动

Engine has many starting methods. Commonly used motor starting of automobile engine uses motor as mechanical power. When gear on motor shaft and gear ring around flywheel of engine engage with each other, motive power will be delivered to flywheel and bent axle to make them rotate. Motor itself uses storage battery as energy. At present, most automobile engines use motor to start. 发动机起动的方法很多，汽车发动机常用的电动机起动是用电动机作为机械动力，当将电动机轴上的齿轮与发动机飞轮周缘的齿圈啮合时，动力就传到飞轮和曲轴，使之旋转。电动机本身又用蓄电池作为能源。目前绝大多数汽车发动机都采用电动机起动

(2) Composition of Starter 起动机结构

Composition of Starter

Starter generally consists of 3 parts. (起动机一般由三部分组成)

1. The function of DC series motor is to produce torque.

(直流串激式电动机，其作用是产生转矩)

2. The function of transmission mechanism (or engaging mechanism) is to make gear driving of starter and ring gear of flywheel engage with each other and deliver torque of starter to bent axle of engine when the engine starts; make driving gear slip and gear ring of flywheel automatically disconnect after the engine starts.

(传动机构(或称啮合机构)，其作用是：在发动机起动时，使起动机驱动齿轮啮入飞轮齿环，将起动机转矩传给发动机曲轴；而在发动机起动后，使驱动齿轮打滑与飞轮齿环自动脱开)

(2) Composition of Starter 起动机结构

Composition of Starter (起动机结构)

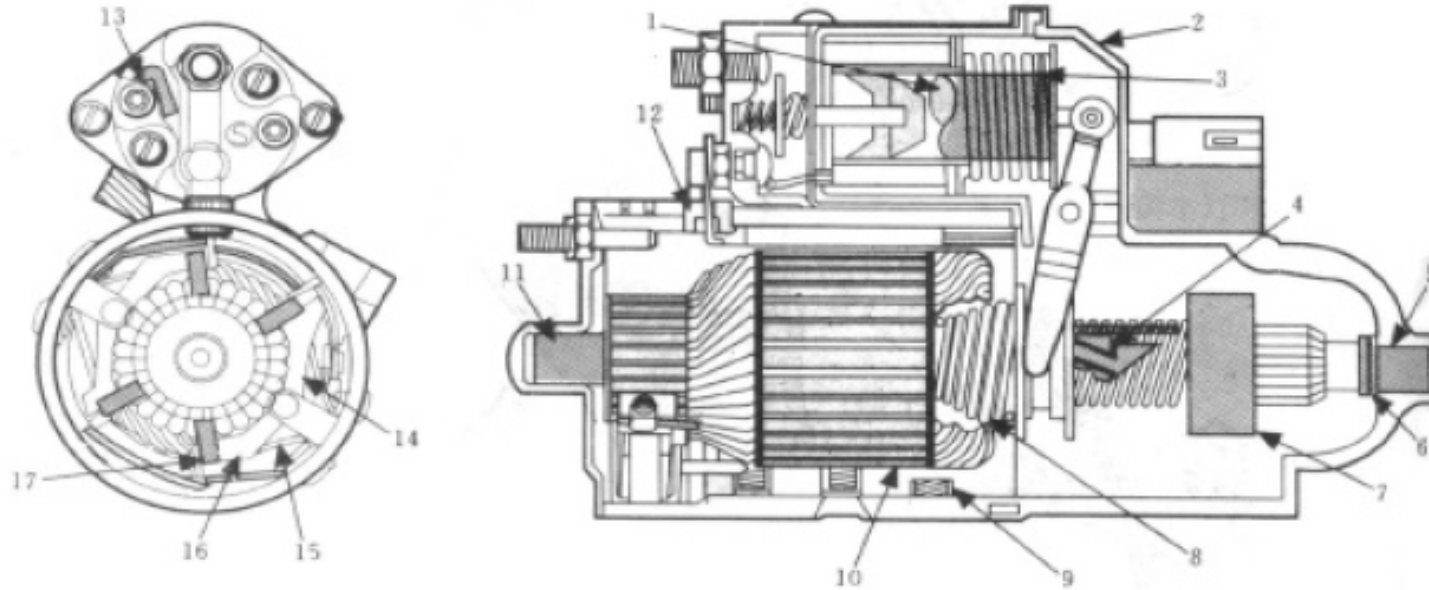
3. Control device (switch) is used to connect and clear the circuit between starter and storage battery. Some vehicles also have access and screening function of additional resistance of ignition coil. 控制装置(即开关). 用来接通和切断起动机与蓄电池之间的电路。在有些汽车上, 还具有接入和隔除点火线圈附加电阻的作用。

Function of Starter (起动机功用)

Function of starter is to deliver the electric energy of storage battery into mechanical energy with starter, and start the engine through transmission mechanism.

(起动机功用是: 利用起动机将蓄电池的电能转换为机械能, 再通过传动机构将发动机拖转起动)。

(2) Composition of Starter 起动机结构



- | | | | |
|-------------|----------|------------|---------|
| 1 一活动铁心 | 2 一电磁开关 | 3 一复位弹簧 | 4 一螺旋槽 |
| 5, 11 一滑动轴承 | 6 一小齿轮挡圈 | 7 一超越离合器 | 8 一辅助弹簧 |
| 9 一激磁绕组 | 10 一电枢 | 12 一绝缘孔圈 | 13 一接触盘 |
| 14 一绝缘的炭刷架 | 15 一炭刷弹簧 | 16 一搭铁的炭刷架 | 17 一炭刷 |

1-moving core 2-electromagnetic switch 3-return spring 4-spiral groove
5,11-sliding bearing 6-pinion check ring 7-overrunning coupler 8-auxillary spring
9-exciting winding 10-armature 12-insulation ring 13-contact disc
14-insulating vehiclebon brush holder 15- vehiclebon brush spring 16- vehiclebon brush holder
connected to earth 17- vehiclebon brush

1. DC Motor (Series) 直流电动机 (串激式)

1) Structure of DC Motor (直流电动机的构造)

DC motor consists of armature, pole, shell, brush, brush holder, etc. (直流电动机由电枢、磁极、外壳、电刷与刷架等组成)

(1) Armature Assembly (电枢总成)

The armature is used to produce electromagnetic torque. It consists of core, armature winding, armature shaft and commutator. Armature core is made up with many pieces of insulating silicon sheets. Armature winding is made of thick and flat copper wires with wave winding method. Copper sheets of commutator are thick. Adjacent copper sheets are insulated with mica sheets. (电枢用来产生电磁转矩，它由铁心、电枢绕组、电枢轴及换向器组成。电枢铁心由多片互相绝缘的硅钢片叠成；电枢绕组采用很粗的扁铜线用波绕法绕制而成；换向器的铜片较厚，相邻铜片之间用云母片绝缘)

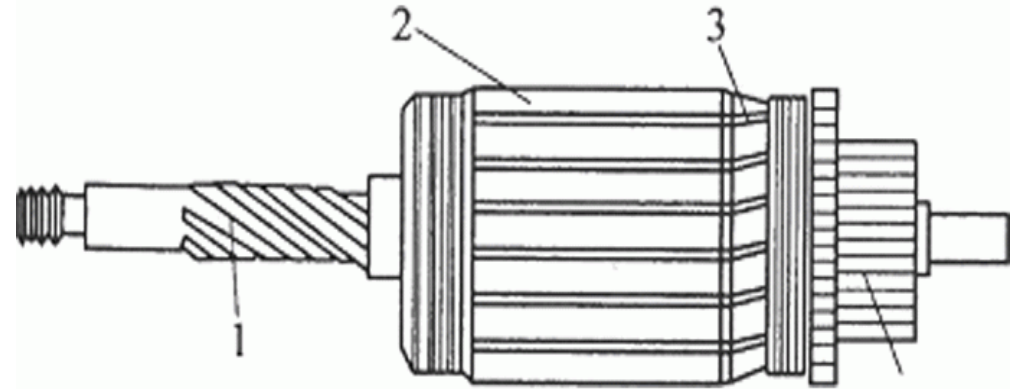


图 4-6 电枢

1- 电枢轴；2- 电枢铁心；3- 电枢绕组 4- 换向器

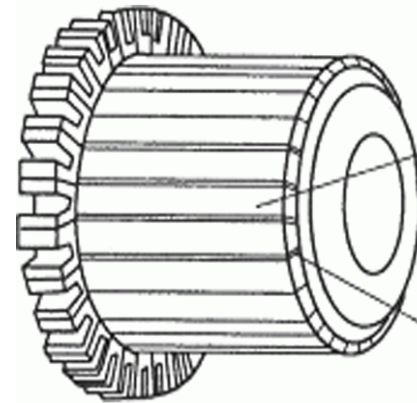


图 4-7 换向器

1- 铜片 2- 云母片

Figure 4-6 Armature

1- armature shaft 2- armature core 3- armature winding 4- commutator

Figure 4-7 Commutator

1- copper sheet 2- mica sheet

1. DC Motor (Series) 直流电动机 (串激式)

(2) Magnetic Pole (磁极)

Magnetic pole consists of core and armature winding. Its function is to produce magnetic field in motor. Pole core is generally made of low carbon steel, and fixed on shell of motor with screws. There are generally 4 poles. 4 exciting windings form two pairs of opposite poles. Common exciting winding is generally installed in series with armature winding in the circuit. Therefore, it is called series DC motor.

(磁极由铁心和激磁绕组构成，其作用是在电动机中产生磁场，磁极铁心一般由低碳钢制成，并通过螺钉固定在电动机壳体上。磁极一般是4个，由4个激磁绕组形成两对磁极，并两两相对，常见的激磁绕组一般与电枢绕组串联在电路中，故被称为串激式直流电动机)

1. DC Motor (Series) 直流电动机 (串激式)

(3) Brush and Brush Holder (电刷和电刷架)

Function of brush and brush holder is to bring current into armature and make armature continuous rotate. Brush is generally suppressed with copper and graphite, which can reduce resistance and increase abrasion resistance. Brush is installed on brush holder, suppressed tightly on commutator with spring pressure, and connected to the shell to form circuit earth, which is called earth brush. It is connected to exciting winding and armature winding, and insulated with shell, which is called insulation brush.

(电刷与电刷架的作用是将电流引入电枢，使电枢产生连续转动。电刷一般用铜和石墨压制而成，有利于减小电阻及增加耐磨性。电刷装在电刷架中，借弹簧压力紧压在换向器上。与外壳直接相连构成电路搭铁，称为搭铁电刷，与激磁绕组和电枢绕组相连，与外壳绝缘，称为绝缘电刷)

1. DC Motor (Series) 直流电动机 (串激式)

(4) Shell (外壳)

Shell is made of low carbon steel coil or cast iron. Working time of starter is very short, so sliding bearing is usually used. Because armature of reduction starter has high rotate speed, armature uses rolling bearing.

(外壳由低碳钢卷制而成，或由铸铁铸造而成。起动机工作时间很短，所以一般采用滑动轴承。减速起动机由于其电枢的转速很高，电枢轴承则采用滚动轴承)

2. Transmission Mechanism of Starter (起动机的传动机构)

Transmission mechanism of starter is actually a one-way clutch. The function of one-way clutch is one-way delivery of torque, which means torque of starter is delivered to bent axle of engine when the engine starts. After the engine starts, it can automatically slip. Ring gear of flywheel will not make armature of starter rotate to prevent damages to starter.

(起动机的传动机构实际上是一个单向离合器。单向离合器的作用是单方向传递转矩，即启动发动机时将起动机的转矩传给发动机曲轴，而当发动机启动后，它又能自动打滑，不使飞轮齿环带动起动机电枢旋转，以免损坏起动机)

One-way clutch includes roller type, friction plate type, spring type, ratchet type, etc. Among them, one-way clutch of friction plate type is usually used in high-power starter.

(单向离合器有滚柱式，摩擦片式、弹簧式、棘轮式等不同型式。其中，摩擦片式的单向离合器多用于大功率起动机)

2. Transmission Mechanism of Starter (起动机的传动机构)

1) Roller Type One-way Clutch(滚柱式单向离合器)

Make use of wedging and relaxing in wedge slot between 2 parts with roller. Realize delivery and slip of torque with roller.(利用滚柱在两个零件之间的楔形槽内的楔紧和放松作用，通过滚柱实现扭矩传递和打滑)

2) Friction Plate Type One-way Clutch

(摩擦片式单向离合器)

Make use of contact and separation of active friction plate and passive friction plate related to 2 parts respectively. Realize delivery and slip of torque with friction plate.

(利用分别与两个零件关联的主动摩擦片和被动摩擦片之间的接触和分离，通过摩擦片实现扭矩传递和打滑的)

3) Spring Type One-way Clutch(弹簧式单向离合器)

Make use of thickness change of torque spring related to 2 parts. Realize delivery and slip of torque with torque spring .(利用与两个零件关联的扭力弹簧的粗细变化，通过扭力弹簧实现扭矩传递和打滑的)

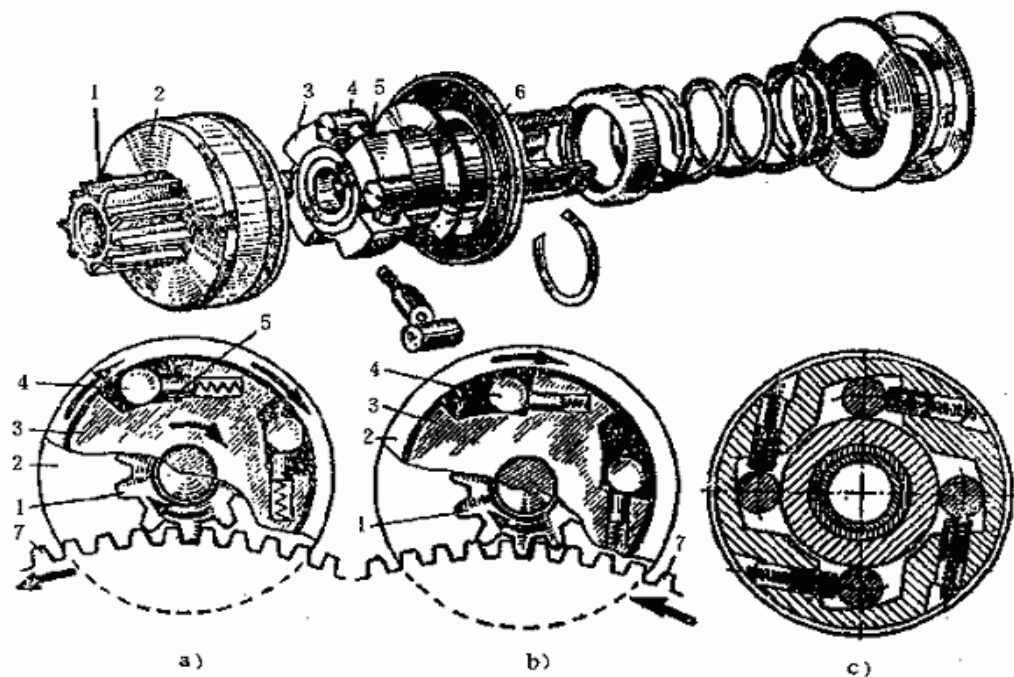


图 4-8 滚柱式离合机构

a) 开始啮合; b) 脱离啮合; c) 剖视图

1-起动机驱动齿轮; 2-外座圈; 3-内座圈; 4-滚子; 5-柱塞; 6-花键套筒; 7-飞轮齿圈

Figure 4-8 Roller Clutch Mechanism

Start engagement b) break away from engagement c) profile chart

1-driving gear of starter 2-outer race 3-inner race 4-roller 5-plunger 6-spline sleeve 7-gear ring of flywheel

3. Control Device of Starter(起动机的控制装置)

Control device usually consists of master switch, shifting fork, switching element, return spring, etc.(控制装置通常由主开关、拨叉、操纵元件和回位弹簧等组成)

Connection or disconnection of main circuit of starter is controlled by master switch through switching element and return spring. One-way clutch is controlled by shifting fork. gearshift fork to make driving gear enter and exit engagement with flywheel.

(通过操纵元件和回位弹簧，利用主开关，控制起动机主回路的接通和断开；利用拨叉，控制单向离合器，使驱动齿轮进入和退出与飞轮的啮合)

1) **Control Principle**(控制原则)

(1) The principle of engagement before connection (“先啮合后接通” 的原则)

(2) The principle of high starting rotate speed (“高起动转速” 原则)

(3) After disconnection of main circuit, driving gear can quickly demesh.

(切断主电路后，驱动齿轮能迅速脱离啮合)

3. Control Device of Starter(起动机的控制装置)

2) Structure and Principle(结构和原理)

Control device is divided into mechanical type and electromagnetic type.(控制装置分为机械式和电磁式两种型式)

(1) Mechanical control device

(机械式控制装置)

(2) Electromagnetic control device

(电磁式控制装置)

Electromagnetic control mechanism of starter mainly consists of sucking coil, holding coil, driving lever, starter switch contact, etc.

(起动机电磁操纵机构主要由吸引线圈、保持线圈、驱动杠杆、起动开关接触片等组成)

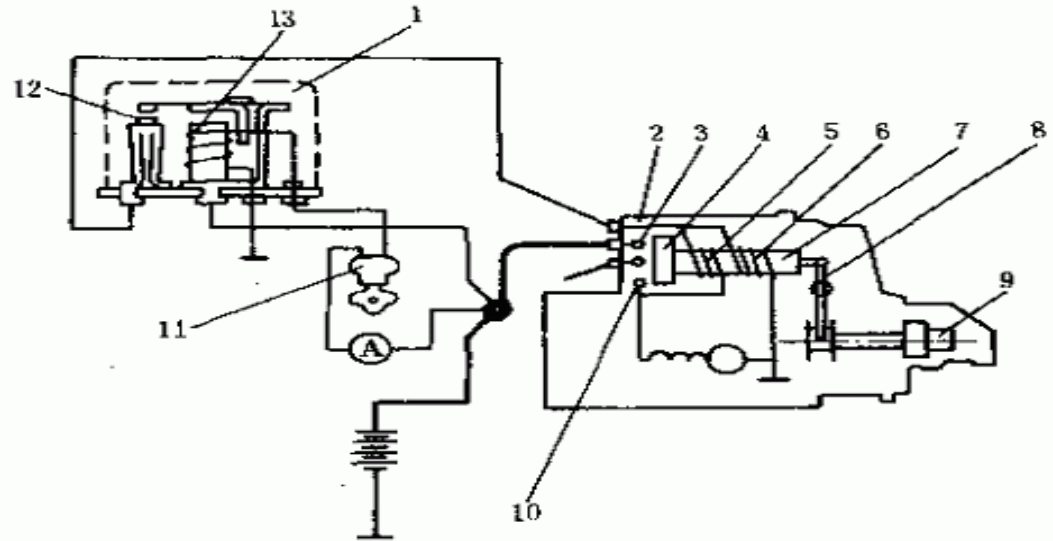


图 4-10 起动机电磁操纵机构电路图

1-起动继电器; 2-起动机; 3-起动机蓄电池接线柱; 4-接触片; 5-吸引线圈; 6-保持线圈; 7-铁芯; 8-驱动杠杆; 9-小齿轮; 10-电动机接线柱; 11-起动开关; 12-起动继电器触点; 13-起动继电器线圈

Figure 4-10 Circuit Diagram of Electromagnetic Control Mechanism of Starter
1-starting relay 2-starter 3-wiring terminal of storage battery on starter 4-contact piece 5-sucking coil 6-holding coil 7-iron core 8-driving lever 9-small gear 10-wiring terminal of motor 11-starting switch 12-starting relay contact 13-starting relay coil

(3) Inspection, Test and Maintenance of Starter (启动机的检修、试验及维护)

3. Use and Maintenance of Starter(起动机使用与维护)

1) Each starting time of starter shall not exceed 10s. The second starting shall be made after 1min, so that storage battery can recover. Three consecutive starting shall be made after 2min on the basis of inspection and troubleshooting.

(起动机每次启动时间不超过10s，再次启动时应间歇1min，使蓄电池得以恢复。如果连续第三次启动，应在检查与排除故障的基础上停歇2min以后进行)

2) Heat preservation measures shall be taken for storage battery while starting in winter or under low temperature.

(在冬季或低温情况下启动时，应对蓄电池采取保温措施)

3) After the engine starts, starter control circuit must be cut off immediately to stop starter.

(发动机启动后，必须立即切断起动机控制电路，使起动机停止工作)

(3) Failure Diagnosis and Inspection of Starting System (起动系故障诊断及检测)

Case 1 Starter doesn't turn (案例1 起动机不转)

1. Failure Symptom and Failure Cause (故障现象与故障原因)

While starting, starter doesn't turn. Possible failures include:

(起动时，起动机不转动，可能故障如下)

(1) Power failure(电源故障)

Serious power lack, vulcanization on plate, or short circuit of storage battery. Pole of storage battery doesn't contact well with cable clamp. Wire connection of starting circuit becomes loosen, which causes poor contact.

(蓄电池严重亏电或极板硫化、短路等，蓄电池极桩与线夹接触不良，起动电路导线连接处松动而接触不良等)

(2) Starter failure(起动机故障)

Commutator and brush doesn't contact well. Exciting winding or the armature winding has open circuit or short circuit. Insulation brush is connected to earth. Electromagnetic switch coil has open circuit, short circuit, earth connection or erosion of contacts, etc.

(换向器与电刷接触不良，激磁绕组或电枢绕组有断路或短路，绝缘电刷搭铁，电磁开关线圈断路、短路、搭铁或其触点烧蚀等)

(3) Failure Diagnosis and Inspection of Starting System (起动系故障诊断及检测)

Case 1 Starter doesn't turn

1. Failure Symptom and Failure Cause (故障现象与故障原因)

(3) Starter relay failure(起动继电器故障)

Coil of starter relay has open circuit, short circuit, earth connection or erosion of contacts.

(起动继电器线圈断路、短路、搭铁或其触点接触不良)

(4) Ignition switch failure(点火开关故障)

Poor wiring or internal poor contact of ignition switch(点火开关接线松动或内部接触不良)

(5) Circuit failure of starting system(起动系线路故障)

Starting circuit has open circuit, poor wiring or loosing.

(起动线路中有断路、导线接触不良或松脱等)

2. Failure Diagnosis Method(故障诊断方法)

(1)Check power(检查电源)

Sound the horn or open headlight. If sound of horn is small or hoarse and light is darker than usual, it shows power has problems.

(按喇叭或开大灯，如果喇叭声音小或嘶哑，灯光比平时暗淡，说明电源有问题)

(2)Check starter(检查起动机)

Make wiring terminal connected to storage batteries and conducting plate of motor on electromagnetic switch of starter short circuit with screw driver. If starter doesn't turn, it shows motor has problems. Starter should be overhauled.(用起子将起动机电磁开关上连接蓄电池和电动机导电片的接线柱短接，如果起动机不转，则说明是电动机内部有故障，应拆检起动机)

(3)Check electromagnetic switch(检查电磁开关)

Make wiring terminal connected to wiring terminal of starter relay and storage batteries on electromagnetic switch short circuit with screw driver. If starter doesn't turn, it shows electromagnetic switch of starter has problems. Electromagnetic switch should be overhauled.(用起子将电磁开关上连接起动继电器的接线柱与连接蓄电池的接线柱短接，若起动机不转，则说明起动机电磁开关有故障，应拆检电磁开关)

2. Failure Diagnosis Method(故障诊断方法续)

(4)Check starter relay(检查起动继电器)

Make wiring terminals of battery and starter on starter relay short circuit with screw driver. If starter turns, it shows starter relay has problems. Otherwise, further inspection should be conducted.(用起子将起动继电器上的“电池”和“起动机”两接线柱短接，若起动机转动，则说明起动继电器内部有故障。否则应再作下一步检查)

(5)Check ignition switch and circuit(检查点火开关及线路)

Directly connect battery of starter relay and ignition switch with wires. If starter can operate normally, it shows starter relay or ignition switch has failure. They can be inspected.

(将起动继电器的“电池”与点火开关用导线直接相连，若起动机能正常运转，则说明故障在起动继电器至点火开关的线路中，可对其进行检修)

Case 2 Poor starting of starter(案例2 起动机起动无力)

1. Failure Symptom and Failure Cause(故障现象与故障原因)

While starting, rotate speed of starter is obviously low or it even stops. Possible failures include:(起动时，起动机转速明显偏低甚至至于停转，可能的故障有)

(1)Power failure(电源故障)

Power lack of storage batteries, vulcanization and short circuit on plate, poor contact of starting power wiring, etc.(蓄电池亏电或极板硫化短路，起动电源导线连接处接触不良等)

(2)Starter failure(起动机故障)

Poor contact between commutator and brush, poor contact between contact disc and contacts of electromagnetic switch, local short circuit of motor exciting winding or armature winding, etc.

(换向器与电刷接触不良，电磁开关接触盘和触点接触不良，电动机激磁绕组或电枢绕组有局部短路等)

2. Failure Diagnosis Method(故障诊断方法)

If starter operates weakly, starter power should be checked first. If starter power doesn't have problem, starter should be overhauled. First contact of electromagnetic switch contact disc, commutator and brush. And then check exciting winding and armature winding.

(如出现起动机运转无力，首先检查起动机电源，如果起动电源无问题，则应拆检起动机，首先检查电磁开关接触盘、换向器与电刷的接触情况，其次检查激磁绕组和电枢绕组)

Case 3 Idling of starter 起动机空转

1. Failure Symptom and Failure Cause(故障现象与故障原因)

After starting switch is on, only starter rapidly rotates and bent axle of engine doesn't turn. Such symptom shows starter circuit is unblocked. Transmission device of starter or gear ring of flywheel have failure.

(接通起动开关后，只有起动机快速旋转而发动机曲轴不转。这种症状表明起动机电路畅通，故障在于起动机的传动装置和飞轮齿圈等处)

2. Failure Diagnosis Method(故障诊断方法)

(1) If there is crash of gear during idling of starter, it shows gear ring tooth of flywheel or small gear tooth of starter are badly worn or damaged, causing incorrect engagement. (若在起动机空转的同时伴有齿轮的撞击声，则表明飞轮齿圈牙齿或起动机小齿轮牙齿磨损严重或已损坏，致使不能正确地啮合)

(2) Failures of starter transmission device include one-way engage switch spring damage, serious wear of roller of one-way engage switch, and corrosion of spline groove of one-way engage switch sleeve. These failures will stop normal movement of small gear, so that it cannot be engage with gear ring of flywheel.

(起动机传动装置故障有：单向啮合器弹簧损坏；单向啮合器滚子磨损严重；单向啮合器套管的花键槽锈蚀，这些故障会阻碍小齿轮的正常移动，造成不能与飞轮齿圈准确啮合等)

(3) Some starter transmission devices use level-1 planet gear reducing device, which compact structure, large transmission ratio and high efficiency. But in use it is often burned or blocked due to excessive load. Some use friction plate clutch. If pressure spring is damaged, spline is blocked due to corrosion or friction plate clutch slides, idling of starter can also be caused.

(有的起动机传动装置采用一级行星齿轮减速装置，其结构紧凑，传动比大，效率高。但使用中常会出现载荷过大而烧毁卡死。有的采用摩擦片式离合器，若压紧弹簧损坏，花键锈蚀卡滞和摩擦离合器打滑，也会造成起动机空转)

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6 Air-conditioning System 空调系统

7 Electrical System Structure and Principle of Lingong Loader 临工装载机电气系统结构与原理

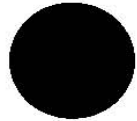
8 Common Failure and Troubleshooting of Electrical System 电气系统常见故障与排除方法



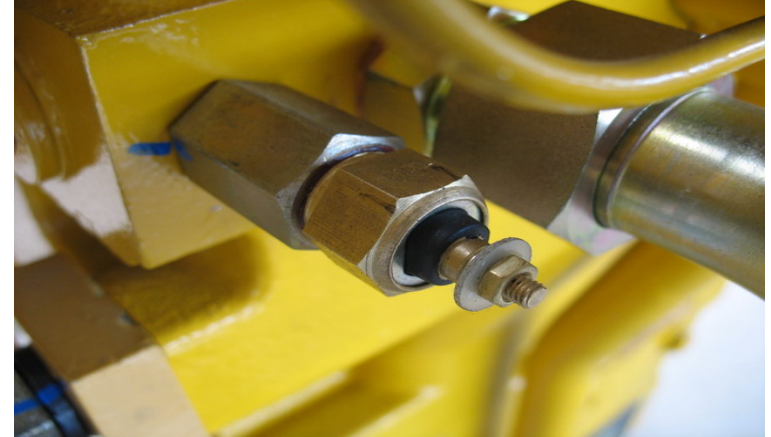
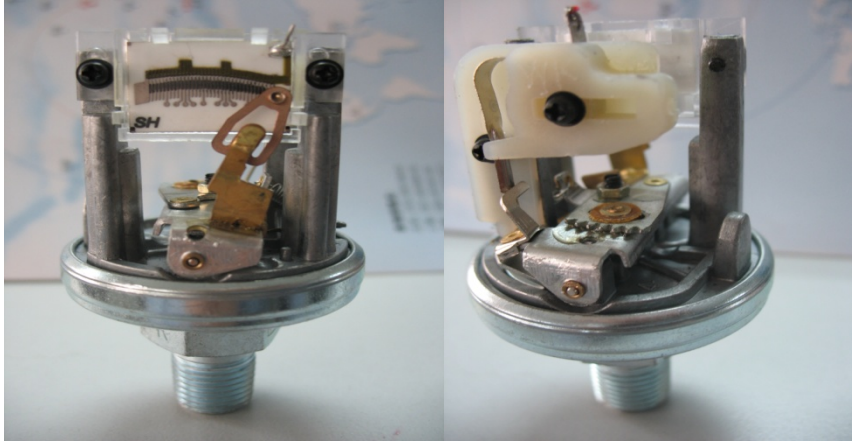
Lighting and Auxiliary Equipments(照明及辅助设备)



Lighting and Auxiliary Equipments(照明及辅助设备)

Preheat Indicator	Oil Pressure Alarm Lamp	Charging Indicator	Power off Indicator	Emergency Steering Indicator
预热指示灯	机油压力报警灯	充电指示灯	动力切断指示灯	应急转向指示灯
				
				
Parking Braking Indicator	Braking Low Pressure Alarm Lamp	Distance Light Indicator	Control Unit Working Indicator	Fuel Colating Indicator
驻车制动指示灯	制动气压低报警灯	远光指示灯	电脑盒工作指示灯	燃油粗滤指示灯

Lighting and Auxiliary Equipments(照明及辅助设备)



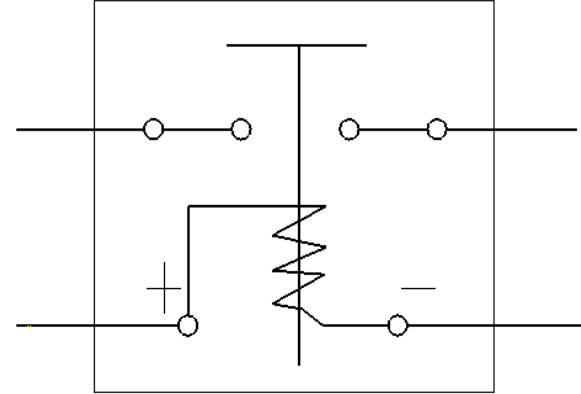
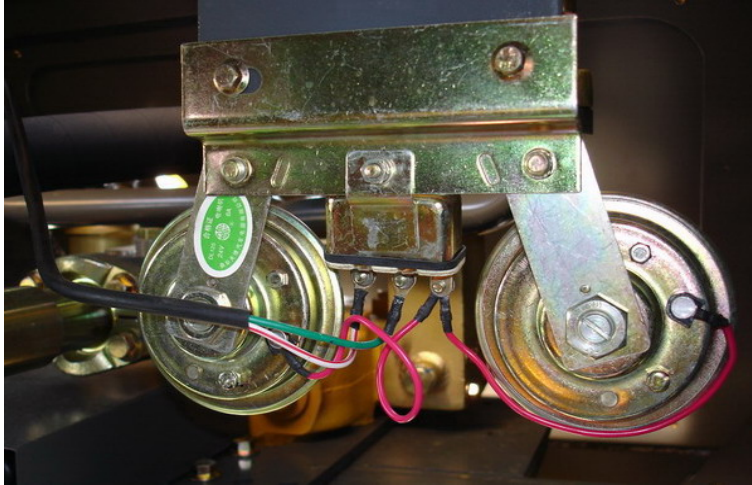
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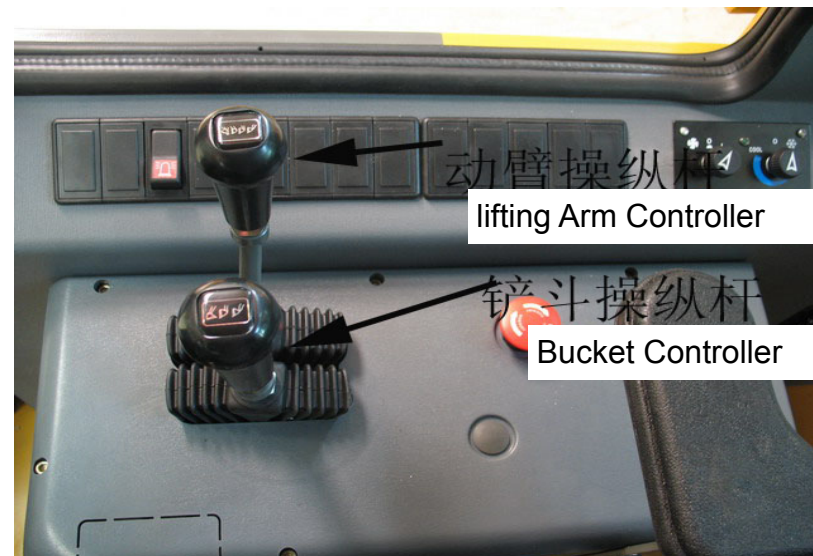
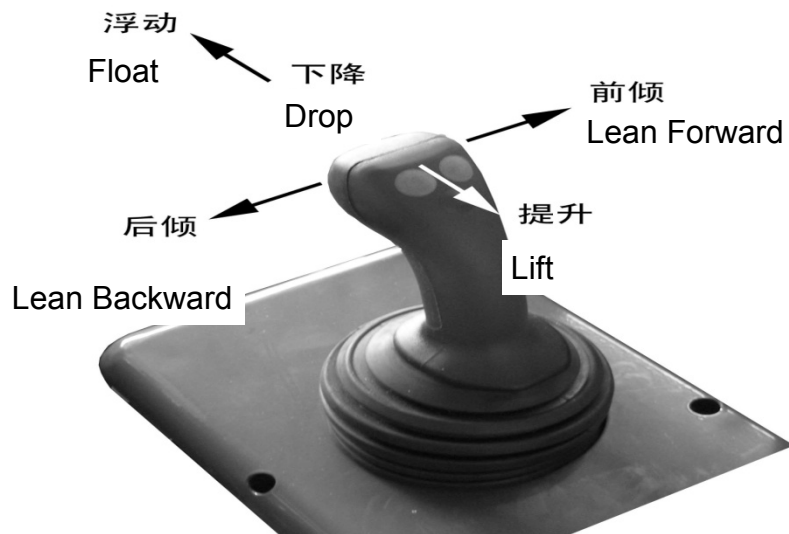
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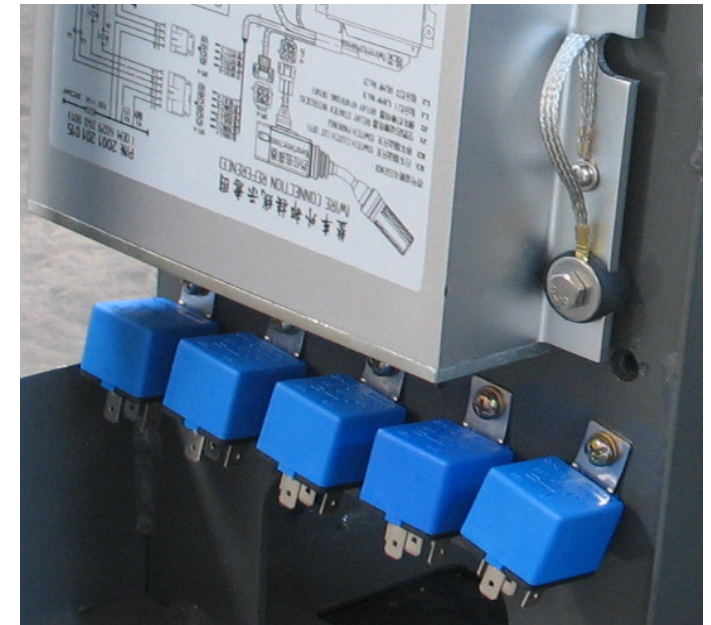
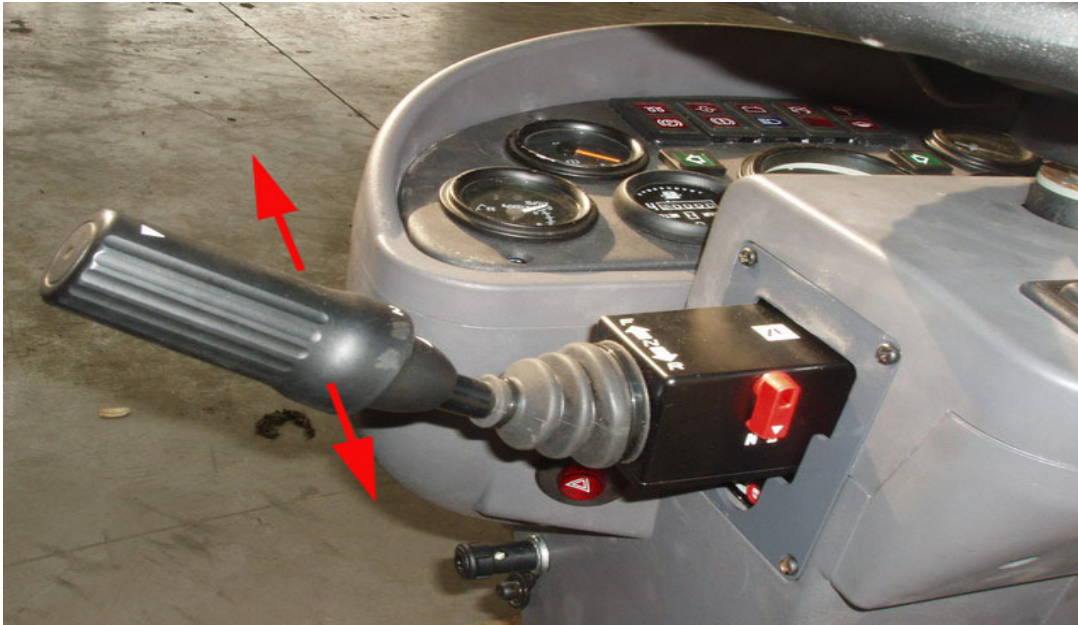
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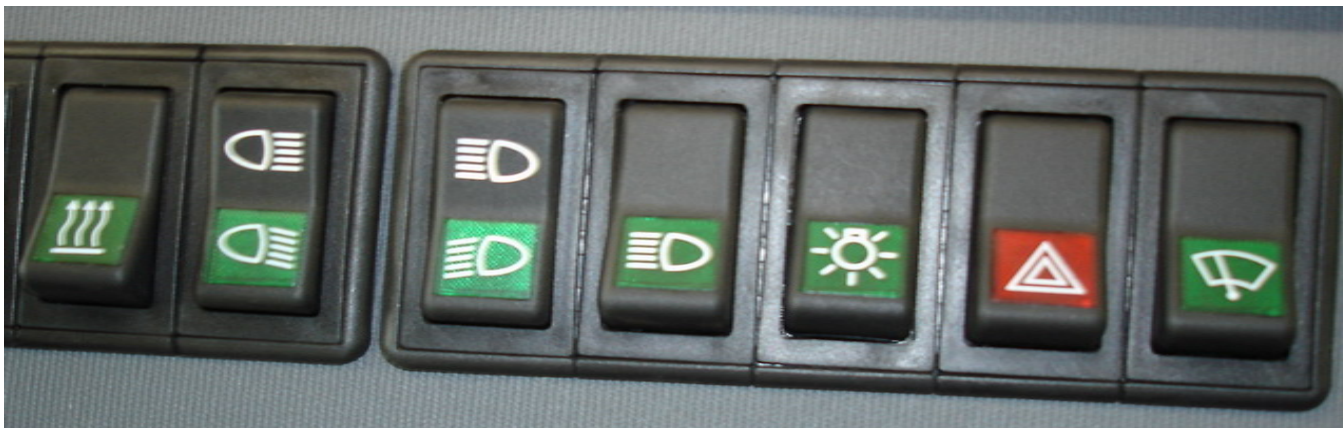
Lighting and Auxiliary Equipments(照明及辅助设备)



Lighting and Auxiliary Equipments(照明及辅助设备)

Position \ Terminal	B	B2	G1	G2	S	M
OFF	○—○					
HEAT	○—○—○					
ON	○—○					○
START	○—○			○—○	○—○	○

Position \ Terminal	B	BR	R1	R2	C	ACC
OFF	○					
HEAT	○—○—○					○
ON	○—○					○
START	○—○			○—○	○—○	○



(1) Lighting Equipments (照明设备)

vehicle lighting is necessary lighting equipment in driving and work at night of vehicles. In order to improve speed and ensure the safety in driving and work at night, the vehicle is equipped with various lighting equipments. vehicle lighting can generally be divided into external lighting device and internal lighting device by installation position and use.

(照明灯是车辆夜间行驶和工作必不可少的照明设备，为了提高行驶速度确保夜间行车和作业的安全，车上装有多种照明设备。汽车照明灯根据安装位置和用途不同，一般可分为：外部照明装置、内部照明装置)

Headlight should have anti-dazzling device to prevent accidents due to dazzling of other drivers in work at night or vehicle meeting.

(前照灯应具有防炫目的装置，以免夜间工作或会车时，使对方驾驶员目眩而发生事故)

(1) Lighting Equipments (照明设备)

Type (型号)	External Lighting (外照明)			Internal Lighting (内照明)		
	Headlight (前照灯)	Foglight (雾灯)	License plate lamp (牌照灯)	Toplight (顶灯)	Gauge lamp (仪表灯)	Baggage compartment lamp (行李箱灯)
Features when working (工作时特点)	White Normally on Distance and near light (白色常亮远近光变化)	Yellow or white Single cathode Normally on (黄色或白色单丝常亮)	White Normally on (白色常亮)	White Normally on (白的常亮)	White Normally on (白色常亮)	White Normally on (白的常亮)
Use (用途)	Provide security for safe driving (为驾驶员安全行车提供保障)	Ensure effective lighting and provide signal when it is wet, snowy or foggy (雨雪雾天保证有效照明及提供信号)	Used for lighting of license plate at rear of vehicle (用于照亮汽车尾部牌照)	Used for interior lighting at night (用于照亮汽车尾部牌照)	Used for lighting of gauge at night (用于夜间观察仪表时的照明)	Used for lighting of baggage at night (用于夜间拿取行李物品时的照明)

(2) Signal Lamp (信号灯)

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Except lighting, there are light signals to indicate other vehicles or pedestrians on the vehicle. These lights are called signal lamp.

(机器上除照明灯外，还有用以指示其他车辆或行人的灯光信号标志，这些灯称为信号灯)

Signal lamp is also divided into external signal lamp and internal signal lamp. External signal lamp refers to turning indicator, brake light, taillight, width lamp, and reversing lamp. Internal signal lamp refers to indicators of dashboard, mainly including steering, oil pressure, charging, braking, closing hint and other meter lamps. See the table below for features and use of signal lamps.

(信号灯也分为外信号灯和内信号灯，外信号灯指转向指示灯、制动灯、尾灯、示宽灯、倒车灯，内信号灯泛指仪表板的指示灯，主要有转向、机油压力、充电、制动、关门提示等仪表指示灯。各种信号灯的特点及用途见下表)

(2) Signal Lamp (信号灯)

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See the table below for features and use of signal lamps. (各种信号灯的特点及用途见下表)

Type (种类)	External signal lamp (外信号灯)					Internal signal lamp (内信号灯)	
	Steering lamp (转向指示灯)	Width lamp (示宽灯)	Parking light (停车灯)	Brake light (制动灯)	Reversing lamp (倒车灯)	Turning indicator (转向指示灯)	Other indicators (其它指示灯)
Features when working (工作的特点)	Amber Shine alternately (琥珀色交替闪亮)	White or yellow Normally on (白或黄色常亮)	White or red Normally on (白或红色常亮)	Red Normally on (红色常亮)	White Normally on (白色常亮)	White Shining (白色闪烁)	White Normally on (白色常亮)
Use (用途)	Inform passers-by or other vehicles about turning (告知路人或其他车辆将转弯)	Mark vehicle width (标志汽车宽度轮廓)	Indicate that vehicle has stopped (标明汽车已经停驶)	Indicate has slowed down or will stop (表示已减速或将停车)	Inform passers-by or other vehicles about reserving (告知路人或其他车辆将倒车)	Tell driver driving direction of vehicle (提示驾驶员车辆的行驶方向)	Tell driver status of vehicle (提示驾驶员车辆的情况)

(3) Electric Horn (电喇叭)

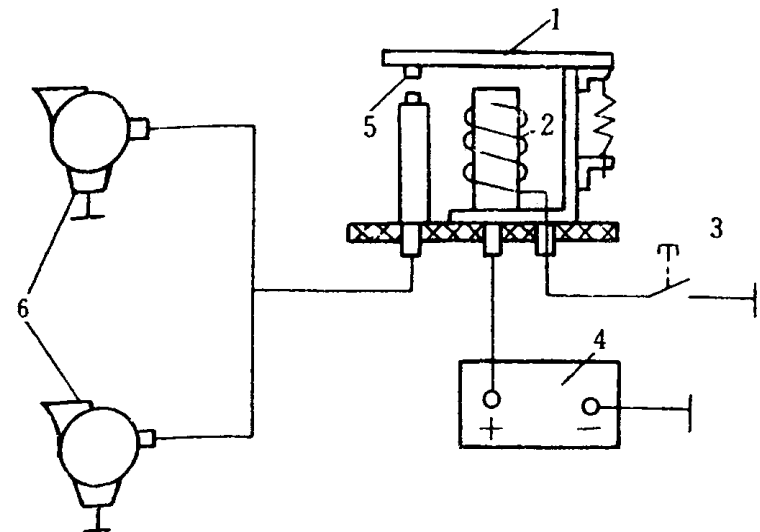
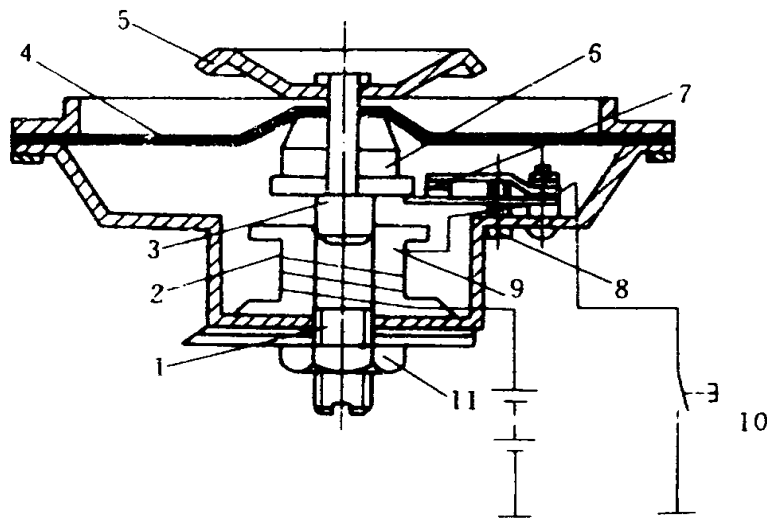
Currently most loaders use electric horn, which is mainly used for warning of pedestrians and other vehicles to attract attention and ensure safety. (目前所装载机上装用的喇叭多为电喇叭, 主要用于警告行人和其他车辆, 以引起注意, 保证行车安全)

Electric horn can be divided into spiral, cylinder and basin by appearance; high pitch and low pitch by audio frequency; single wire system and double wire system by wiring method. (电喇叭按外形有螺旋形、筒形、盆形之分; 按声频有高音和低音之分; 按接线方式有单线制和双线制之分)

Electric horn makes metal film vibrate and produce sound with electromagnetic force. With agreeable voice, it is widely used in various automobiles and engineering machinery. (电喇叭是利用电磁力使金属膜片振动产生音响, 其声音悦耳, 广泛使用于各种类型的汽车和工程机械上)

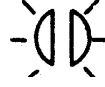
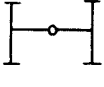
Electric horn can be divided into common electric horn and electronic horn by existence of contacts. Common electric horn controls vibration of magnetic coil incentive film and produce sound with connection and disconnection of contacts. Electronic horn doesn't have contacts. It produces sound with incentive film in transistor circuit. (电喇叭按有无触点可分为普通电喇叭和电子电喇叭。普通电喇叭主要是靠触点的闭合和断开, 控制电磁线圈激励膜片振动而产生音响的; 电子电喇叭中无触点, 它是利用晶体管电路激励膜片振动产生音响的)

(在中小型汽车上, 由于安装的位置限制, 多采用螺旋形利益形电喇叭。盆形电喇叭具有体积小重量轻指向好噪声小盆形电喇叭的发声效果更好些, 在没有扬声筒的情况下, 仍能够发出较大的声响。等优点目前在工程机械上也得到广泛应用)



(4) Alarm Lamp and Alarm Switch (报警灯和报警开关)

Alarm lamp is usually installed on dashboard in cab. Its power is 1 ~ 3W. There is light filter in front of the bulb, so that the light bulb is yellow or red. Light filter is often marked with graphic symbols to show its functions. See their meanings in figure, At present LED gradually replaces common light bulb. (报警灯通常安装在驾驶室内仪表板上, 功率为1 ~ 3W。在灯泡前有滤光片, 以使灯泡发黄或发红。滤光片上常刻有图形符号, 以显示其功能, 其含义如图, 目前随着LED普及, 逐步取代普通灯泡的趋势)

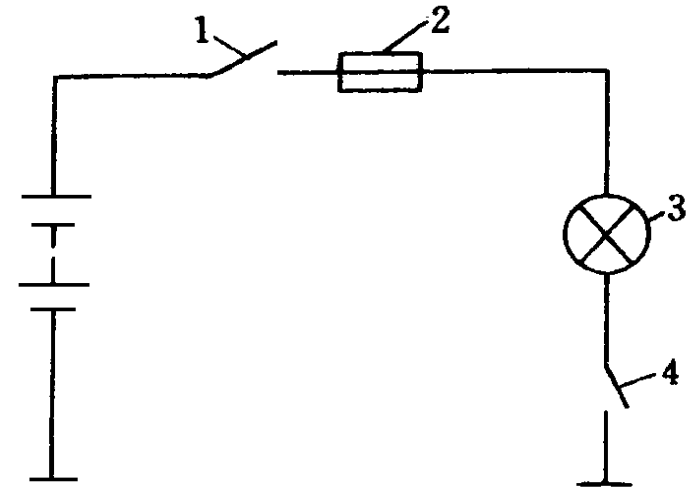
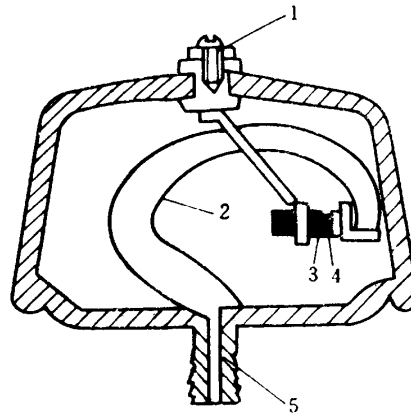
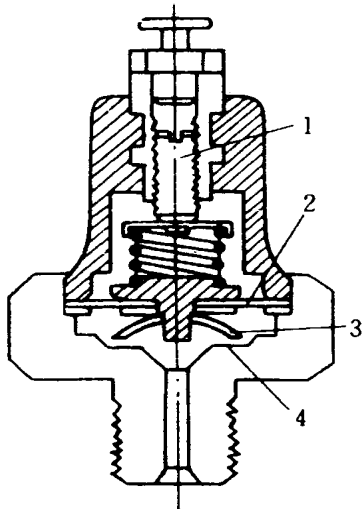
steering indicator					
					
fuel	(water) temperature	oil pressure	charging indicator	指示灯	distance light
					
passing light	foglight	hand braking	braking invalid	safety belt	oil temperature
					
Outline (width) marker lamp	vacuum degree	driving indicator	engine compartment	baggage room	parking light
					
emergency alarm	windshield defroster	fan	机 wiper/sprayer	wiper	sprayer
					
lighting switch	choke valve	horn	叭 cigar lighter	back wiper	back sprayer

1. Oil Pressure Alarm (机油压力报警)

Pressure Alarm: Whether oil pressure is normal directly Influences on performance and work reliability of vehicles. So, many vehicles are equipped with oil pressure alarm lamp. Spring oil pressure alarm lamp switch and film oil pressure alarm lamp switch are shown in the figure. When ignition switch is on but the engine has not started, hydraulic switch is connected and alarm lamp will be on. After the engine starts, pressure of main oil gallery will increase, contact of switch will be disconnected, and alarm lamp will be off. It shows that lubrication system works normally. If oil gallery is blocked or leaked during operation, which makes oil pressure below a certain value, switch will be connected and alarm lamp will be on to remind the driver to stop immediately for repairing. In addition, some vehicles have low pressure and high pressure. When oil pressure is below low pressure or above high pressure, low-pressure normally-off switch or high-pressure normally-on switch will be connected and alarm lamp will be on.

油压报警灯机油压力的正常与否，直接影响车辆的使用性能与工作的可靠性，因此许多车辆设置了油压报警灯。如图所示，为弹簧管式油压报警灯开关和膜片式油压报警灯开关。打开点火开关发动机尚未起动时，油压开关处于接通状态，报警灯点亮。发动机起动后，主油道压力升高，开关的触点断开，报警灯熄灭，表明润滑系统工作正常。如果运行过程中，油道出现堵塞、泄漏等情况，使得机油压力低于某一设定值，开关将接通，报警灯点亮，以提醒驾驶员立即停车修理。另外，有的车辆设有低压、高压两个压力值，当机油压力低于低压值或高于高压值时，低压常闭开关打开或高压常开开关接通，点亮报警灯

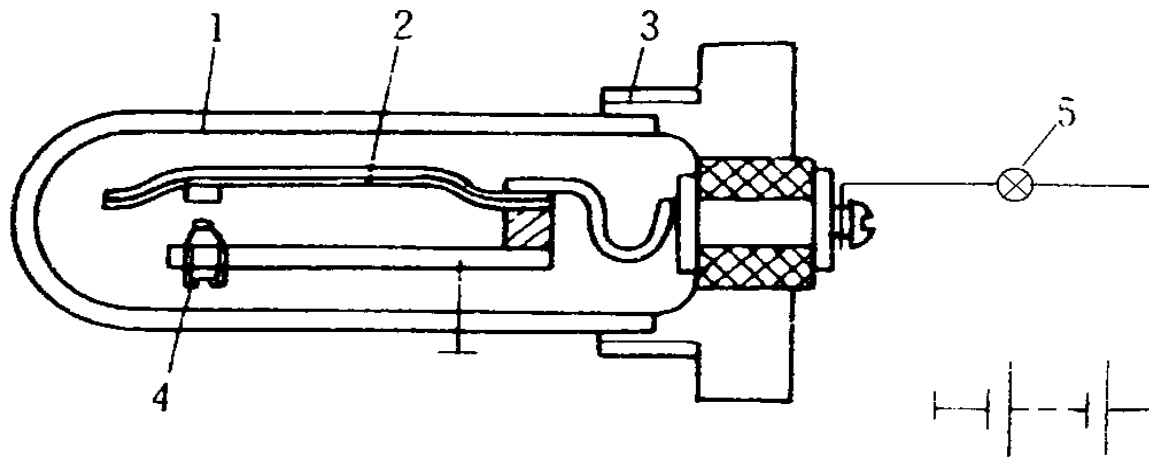
1. Oil Pressure Alarm (机油压力报警)



2. Coolant temperature Alarm (冷却液温度报警)

The function of coolant temperature alarm lamp is that the alarm lamp will be automatically on to alarm when coolant temperature rises to a certain limit. The circuit diagram is shown in Figure 5.37. Bar bimetallic strip is installed in enclosed tubular of sensor. Its free end is welded with movable contacts, which are connected to earth directly. When the temperature rises to limit value, due to different expansion coefficient of bimetallic strip, it bends to stationary contacts. Once the two contacts contact with each other, alarm lamp circuit will be connected. Red alarm light will be on. Loaders generally display with instrument.

(冷却液温度报警灯的作用是当冷却液温度升高至一定限度时，报警灯自动点亮，以示报警。其电路图如图5.37所示。在传感器的密封套管内装有条形双金属片，其自由端焊有动触点，而静触点直接搭铁。当温度升高至限定值时，由于双金属片膨胀系数的不同，向静触点方向弯曲，一旦两触点接触，便接通报警灯电路，红色报警灯点亮。装载机一般用仪表显示)

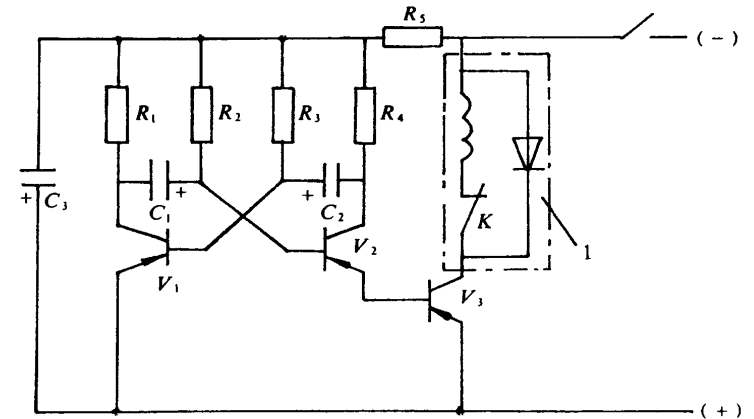
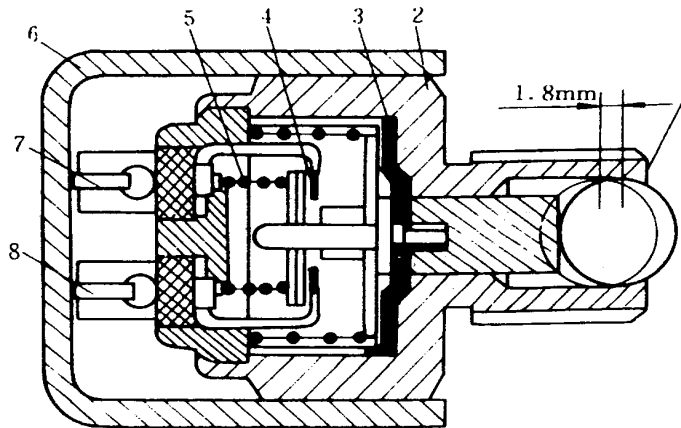


3. Reversing Switch and Back-Up Buzzer(倒车开关和倒车蜂鸣器)

When the vehicle reserves, to warn pedestrians and vehicles, vehicle drivers behind the vehicle, reversing light, back-up buzzer or voice reversing alarm device is installed at the rear of vehicle. They are automatically controlled by reversing switch on the transmission. (车辆倒车时，为了警告车后的行人和车辆驾驶员，在车辆的后部常装有倒车灯、倒车蜂鸣器或语音倒车报警装置，他们都由装在变速器上的倒车开关自动控制)

When the gear lever is moved to reverse gear, reversing light, back-up buzzer or voice reversing alarm device will be connected to the power. Reversing light will give off flashing signal. Buzzer will continuously call. Voice reversing alarm device will send out alarm prompt. (当把变速杆拨到倒挡时，倒车灯、倒车蜂鸣器或语音倒车报警器便与电源接通，使倒车灯发出闪烁信号、蜂鸣器发出断续鸣叫声，语音倒车报警器发出提示音)

Back-up buzzer is a audible device producing sound intermittently. Its voice part is equipped with a electric horn with small power. A switch circuit consisting of an astable circuit and an inverter controls the circuit. (倒车蜂鸣器是一种间歇发声的音响装置，其发声部分装用的是一只功率较小的电喇叭，控制电路是一个由无稳态电路和反相器组成的开关电路)



(5) Traditional Instruments (传统仪表)

1. Oil Pressure Gauge (机油压力表)

Function: Oil pressure gauge is used to detect and display oil pressure of main oil gallery of engine, in order to prevent major faults of cylinder bore scuffing and burning due to lack of oil. (作用: 机油压力表用来检测和显示发动机主油道的机油压力的大小, 以防因缺机油而造成拉缸、烧瓦的重大故障发生)

Composition: It consists of oil pressure sensor and oil pressure indicator.

(组成: 它由机油压力传感器和机油压力指示表两部分组成)

Classification: Oil pressure indicator can be divided into electrothermic type, electromagnetic type and spring type.

(分类: 机油压力指示表可分为电热式、电磁式和弹簧式三种)

(5) Traditional Instruments (传统仪表)

1. Oil Pressure Gauge (机油压力表)

Oil pressure sensor can be divided into bimetallic strip type and variable resistance type.

Electrothermic oil pressure indicator with bimetallic strip oil pressure sensor or electromagnetic oil pressure indicator with variable resistance oil pressure sensor are commonly used.

(机油压力传感器可分为双金属片式和可变电阻式两种。常用的是电热式机油压力指示表配双金属片式机油压力传感器和电磁式机油压力指示表配可变电阻式机油压力传感器)

1) Electrothermic oil pressure indicator and bimetallic strip oil pressure sensor

(电热式机油压力表与电热式机油压力传感器)

2) Electromagnetic oil pressure indicator and variable resistance oil pressure sensor

(电磁式机油压力表与可变电阻式机油压力传感器)

(5) Traditional Instruments (传统仪表)

1) Electrothermic oil pressure indicator and electrothermic oil pressure sensor.

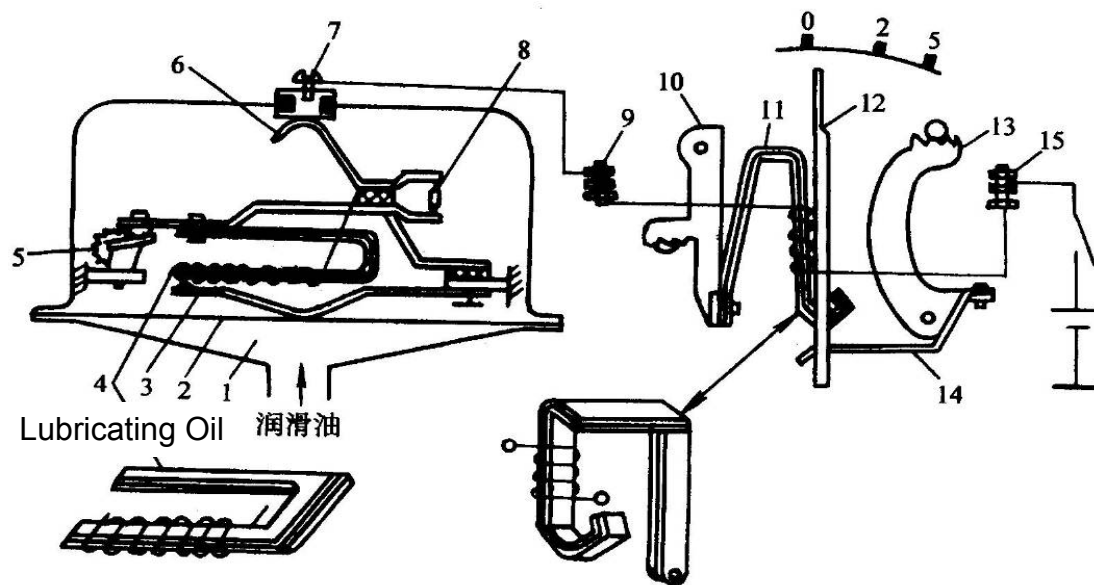
(电热式机油压力表与电热式机油压力传感器)

(1) Structure (机构)

Electrothermic oil pressure indicator is also called bimetallic strip oil pressure indicator.

Basic structure of electrothermic oil pressure indicator and electrothermic sensor are shown in the figure.

(电热式机油压力表也称双金属片式机油压力表，其与电热式传感器的基本结构如图所示)



(5) Traditional Instruments (传统仪表)

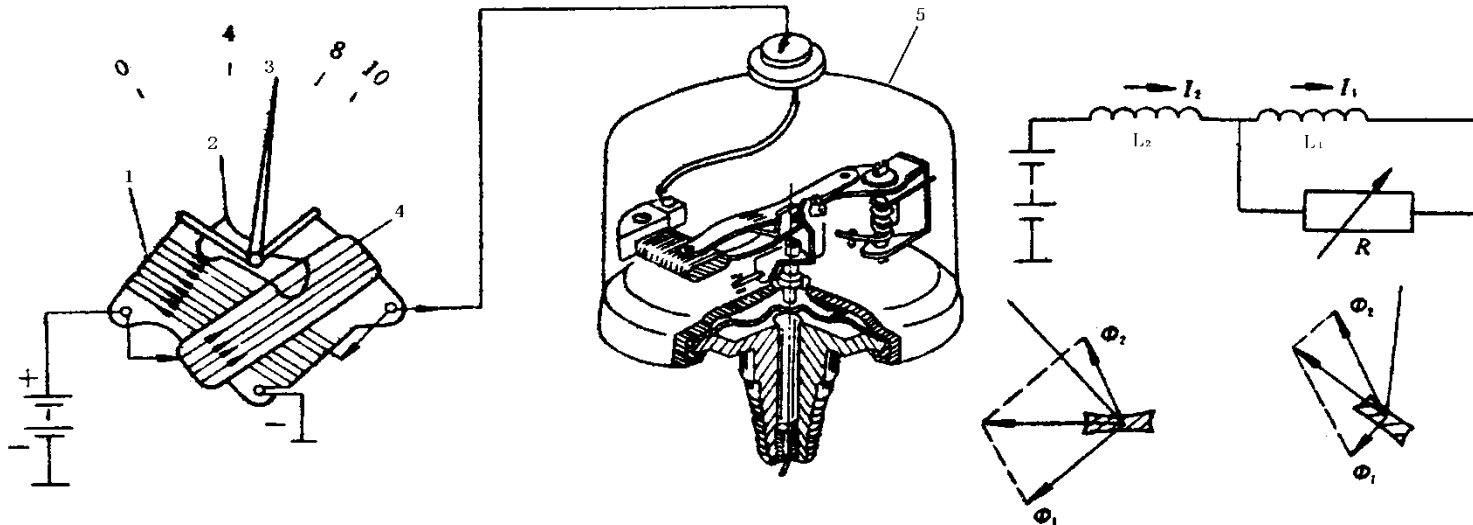
2) Electromagnetic oil pressure indicator and electromagnetic oil pressure sensor

(电磁式机油压力表与电磁式机油压力传感器)

(1) **Structure.** Structures of electromagnetic oil pressure indicator and variable resistance oil pressure sensor are shown in the figure.

(结构。电磁式机油压力表与可变电阻式机油压力传感器的基本结构如图所示)

Electrothermic oil pressure indicator is also called bimetallic strip oil pressure indicator. Basic structure of electrothermic oil pressure indicator and electrothermic sensor are shown in the figure. (电热式机油压力表也称双金属片式机油压力表，其与电热式传感器的基本结构如图所示)



(5) Traditional Instruments (传统仪表)

2. Coolant Temperature Gauge (冷却液温度表)

Function: Coolant temperature gauge is used to test and display working temperature of coolant in engine jacket, in order to prevent overheat of engine caused by excess temperature of coolant.

(作用：冷却液温度表用来检测和显示发动机水套中冷却液的工作温度，以防因冷却液温度过高而使发动机过热)

(5) Traditional Instruments (传统仪表)

Classification: Coolant temperature gauge can be divided into electrothermic type, electromagnetic type and moving-magnetic type. Coolant temperature sensor can be divided into bimetallic strip type and thermistor type. Electrothermic coolant temperature gauge with bimetallic strip sensor, electrothermic coolant temperature gauge with thermistor sensor and electromagnetic coolant temperature gauge with thermistor sensor are commonly used.

(分类：冷却液温度指示表可分为电热式、电磁式和动磁式三种，冷却液温度传感器可分为双金属片式和热敏电阻式两种。常用的是电热式冷却液温度指示表配双金属片式传感器、电热式冷却液温度指示表配热敏电阻式传感器和电磁式冷却液温度指示表配热敏电阻式传感器三种)

1) Electrothermic coolant temperature gauge and bimetallic strip sensor

(电热式冷却液温度表与双金属片式传感器)

2) Electrothermic coolant temperature gauge and thermistor sensor

(电热式冷却液温度表与热敏电阻式传感器)

3) Electromagnetic coolant temperature gauge and thermistor temperature sensor (电磁式冷却液温度表与热敏电阻式温度传感器)

(5) Traditional Instruments (传统仪表)

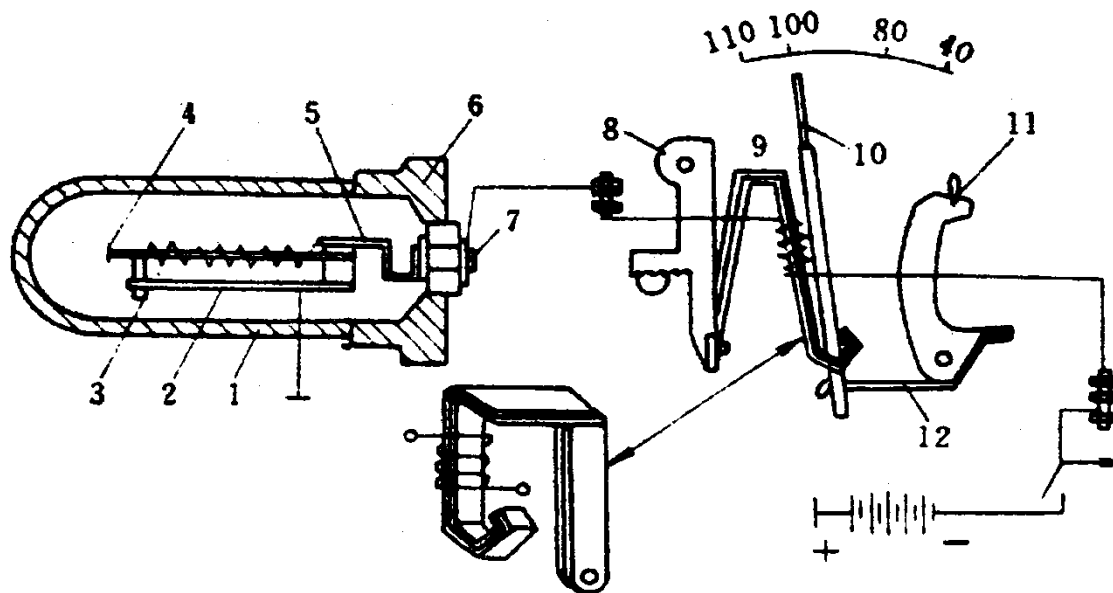
1) Electrothermic coolant temperature gauge and bimetallic strip sensor

(电热式冷却液温度表与双金属片式传感器)

(1) Structure (结构)

Basic structures of electrothermic coolant temperature gauge and bimetallic strip sensor are shown in the figure.

(电热式冷却液温度表与双金属片式传感器的基本结构如图所示)



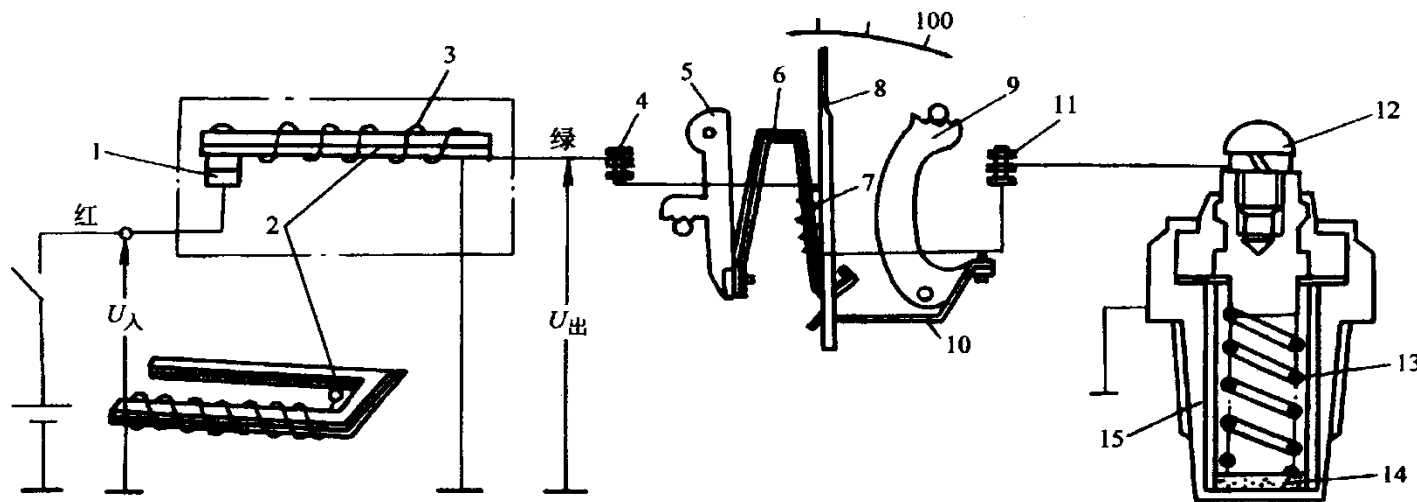
(5) Traditional Instruments (传统仪表)

2) Electrothermic coolant temperature gauge and thermistor sensor

(电热式冷却液温度表与热敏电阻式传感器)

(1) Structure. Basic structure is shown in the figure. Main element of thermistor sensor is thermistor with negative temperature coefficient.

(结构。其基本结构如图所示。热敏电阻式传感器的主要元件为负温度系数的热敏电阻)



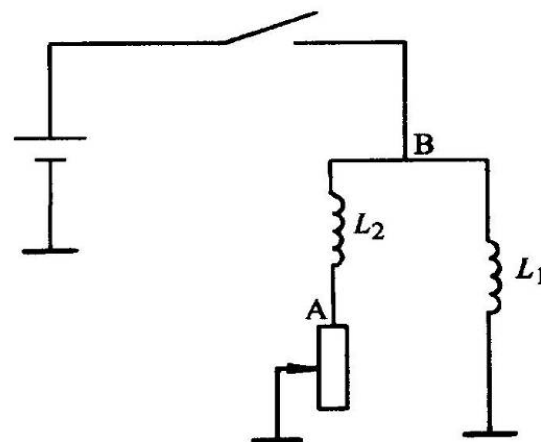
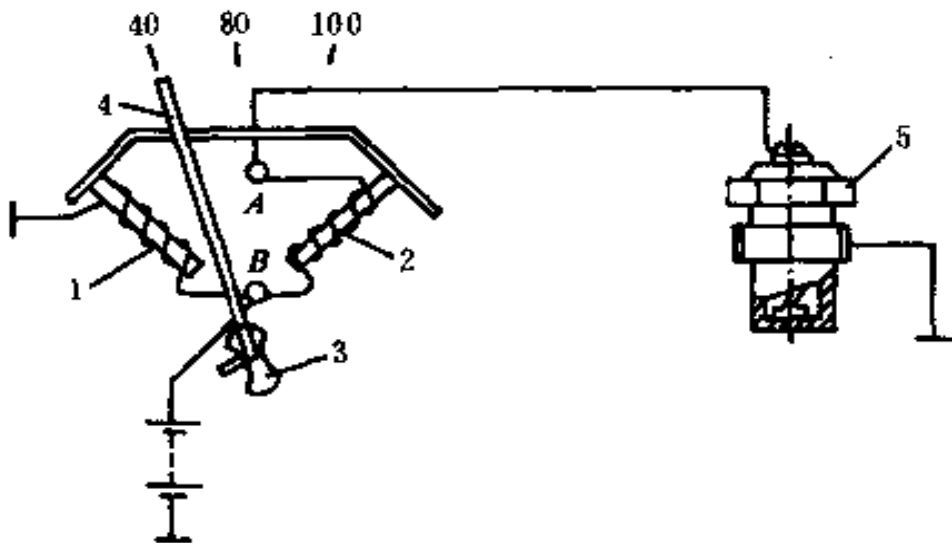
(5) Traditional Instruments (传统仪表)

3) Electromagnetic coolant temperature gauge and thermistor sensor

(电磁式冷却液温度表与热敏电阻式传感器)

(1) Structure. Basic structure is shown in the figure. Main element of thermistor sensor is thermistor with negative temperature coefficient.

(结构。其基本结构如图所示。热敏电阻式传感器的主要元件为负温度系数的热敏电阻)



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8 Common Failure and Troubleshooting of Electrical System 电气系统常见故障与排除方法



(1) Overview (概述)

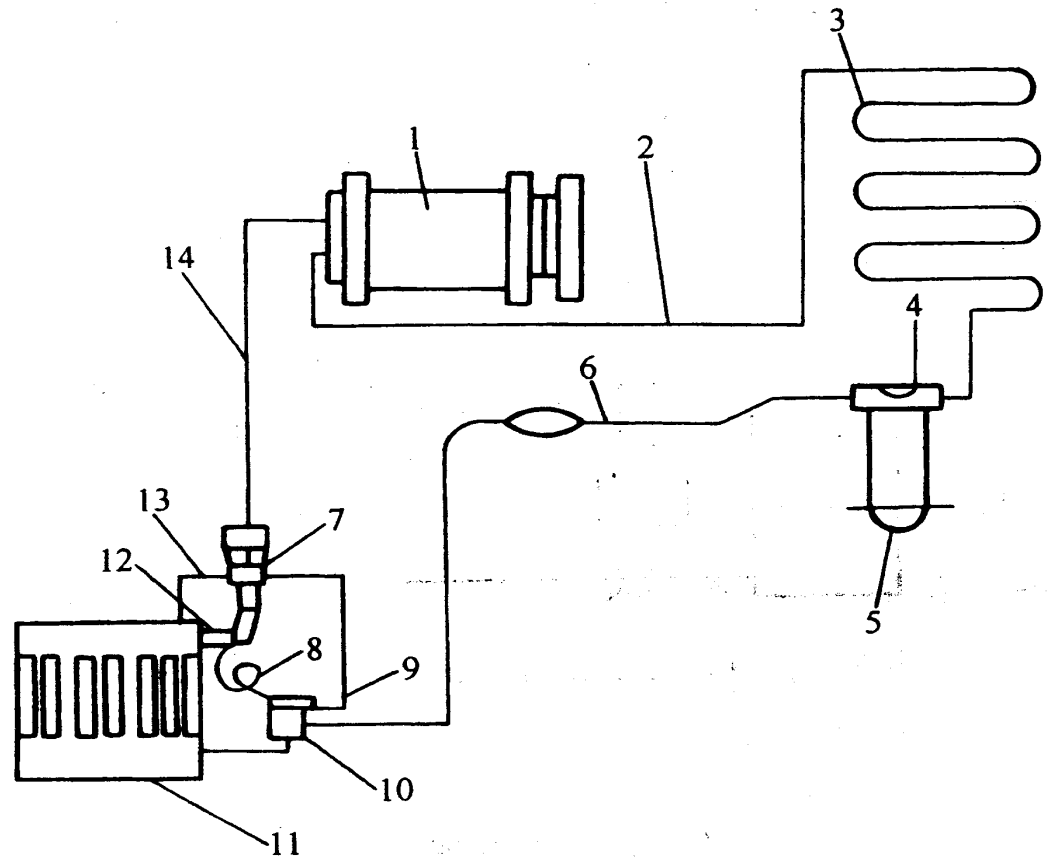
In order to improve working conditions and comfort of driver, a growing number of engineering machinery are equipped with air conditioning system. Automotive air conditioning system generally includes cooling device, heating device and ventilation device. Cooling device is used for air cooling and dehumidification in vehicle in hot weather. Heating device is used for heating in vehicle and defrosting of cab windscreen in cold weather. Ventilation device changes air to keep air in vehicle fresh and clean.

(为了改善驾驶员的工作条件，提高其舒适性，越来越多的工程机械设置了空调系统。车用空调系统一般包括制冷装置、采暖装置和通风装置。其中的制冷装置用于气温炎热时车内空气的降温 and 除湿。采暖装置用于天气严寒时车内的供暖与驾驶室挡风玻璃的除霜，通风换气装置进行强制性换气，保持车内空气新鲜、清洁)

(2) Structure (结构)

Air conditioner system consists of compressor, condenser, low pressure switch, liquid storing drying chamber, high-pressure valve, evaporator, thermal control switch, and expansion valve.

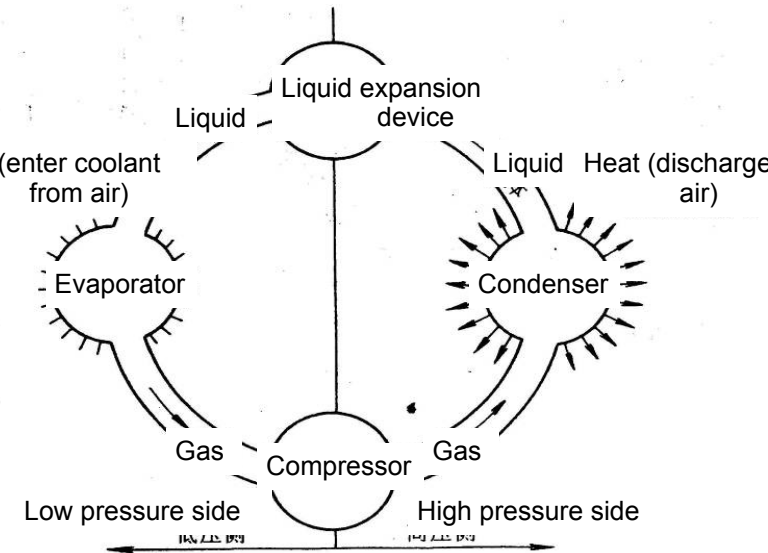
(空调系统由压缩机，冷凝器，低压开关，储液干燥罐、高压阀、蒸发器、热控开关、膨胀阀组成)



(3) Working Principle(工作原理)

Working process: Driven by the engine with belt, compressor absorbs low-temperature (5°C) and low-pressure refrigerant vapor which gasifies due to heat absorption in the evaporator, compresses it into high-temperature ($70\text{--}80^{\circ}\text{C}$) and high-pressure gas, delivers into condenser through high-pressure pipeline, and conducts heat exchange (release heat) with outside air. When the temperature drops to about 50°C , it will condensate into liquid. After moisture and impurities are removed in the liquid storage pot, it is delivered to expansion valve through high-pressure tube, whose throttling effect will make high-temperature and high-pressure cooling fluid into low temperature (about 5°C) and low-pressure (about 0.15 Mpa) mist.

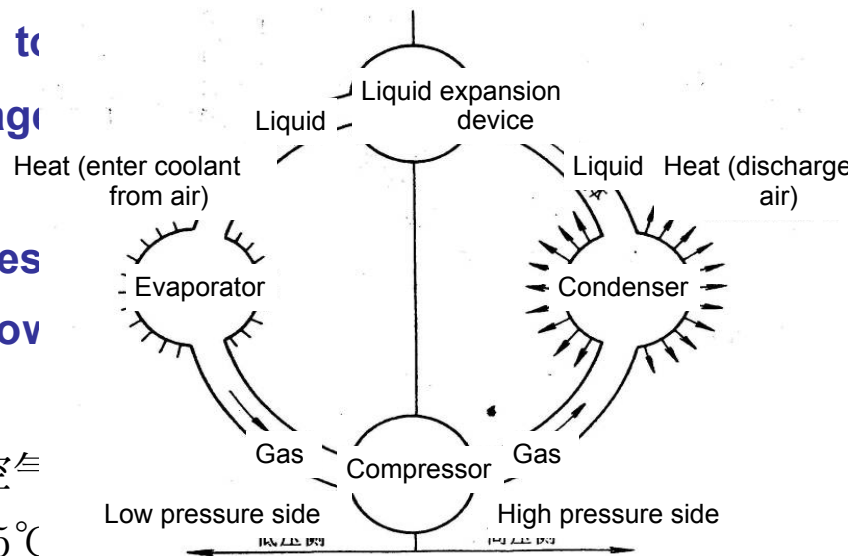
工作过程：压缩机由发动机用皮带驱动，吸入蒸发器中的吸收热量而气化的低温（ 5°C ）、低压制冷制蒸气，将其压缩成高温（ $70\text{--}80^{\circ}\text{C}$ ）、高压的气体，然后经高压管路送入冷凝器中，并与外界空气进行热交换（释放热量），当其温度下降至 50°C 左右时便冷凝成液体，进入储液罐除去水分和杂质后经高压管送至膨胀阀的节流作用，使高温高压的液冷剂变为低温（约 -5°C ）低压（约 0.15 Mpa ）的雾状



(3) Working Principle(工作原理)

And then it is sprayed into evaporator, boiled and gasified by absorbing heat of surrounding atmosphere, which will decrease the temperature of ambient air. For coolant gas at outlet of evaporator, because heat absorption temperature rises to about 5°C, when blower blows air around to evaporator surface, air will be delivered to cab and carriage after cooling. Coolant gasified after heat absorption absorbed by compressor. As the above process continues the place around evaporator will always remain low temperature.

(而喷入蒸发器，并吸收周围空气的热量而沸腾气化、使周围空气温度降低。在蒸发器出口处的制冷剂气体，由于吸热温度升至5℃左右，当鼓风机将附近空气吹过蒸发器表面时，空气被冷却后送入驾驶室及车厢。吸热气化的制冷剂有被压缩机吸入，上述过程连续不断的进行，蒸发器周围将始终保持较低的温度)



(4) Failure Diagnosis (故障诊断)

Common failures of refrigerating machinery are generally caused by electrical, mechanical, coolant and refrigerating machine oil. Its performance includes no refrigeration of refrigerating machinery , insufficient refrigerating output, abnormal noise, etc. (制冷装置常见故障一般由电气、机械、制冷剂和冷冻机油等所引起的, 它表现为制冷装置的不制冷、制冷量不足和异常噪音等)

Case 1: No refrigeration (案例1: 不制冷)

1) Fan of evaporator doesn't rotate due to failure of fuse, internal switch, connection, etc

(蒸发器风机不旋转, 可能是保险丝, 内部开关连接等)

2) Fan of evaporator rotates. Whether compressor rotates, belt is loosen, there is coolant, pipes are blocked, etc.

(蒸发器风机旋转: 压缩机是否旋转、皮带松弛、有无制冷剂、管道是否堵塞等)

(4) Failure Diagnosis (故障诊断)

Case 2: Insufficient refrigerating output (案例2: 制冷不足)

1) Coolant flow at outlet of expansion valve decreases. Temperature is too high or pressure is too low at high-pressure or low-pressure side of refrigerating machinery.

(膨胀阀出口的制冷剂流量下降, 制冷装置高压侧、低压侧温度过高或压力过低)

2) Lack of coolant. (缺少制冷剂)

3) Belt of compressor slide because it is too loosen. (压缩机皮带过松, 出现打滑)

Case 3: Abnormal noise (案例3: 异常噪音)

Generally mechanical failures, such as loosening of fastener, excessive wear of moving parts or bad lubrication.

(一般是机械方面的故障, 如紧固件松动, 运动件磨损超过极限或润滑不良)

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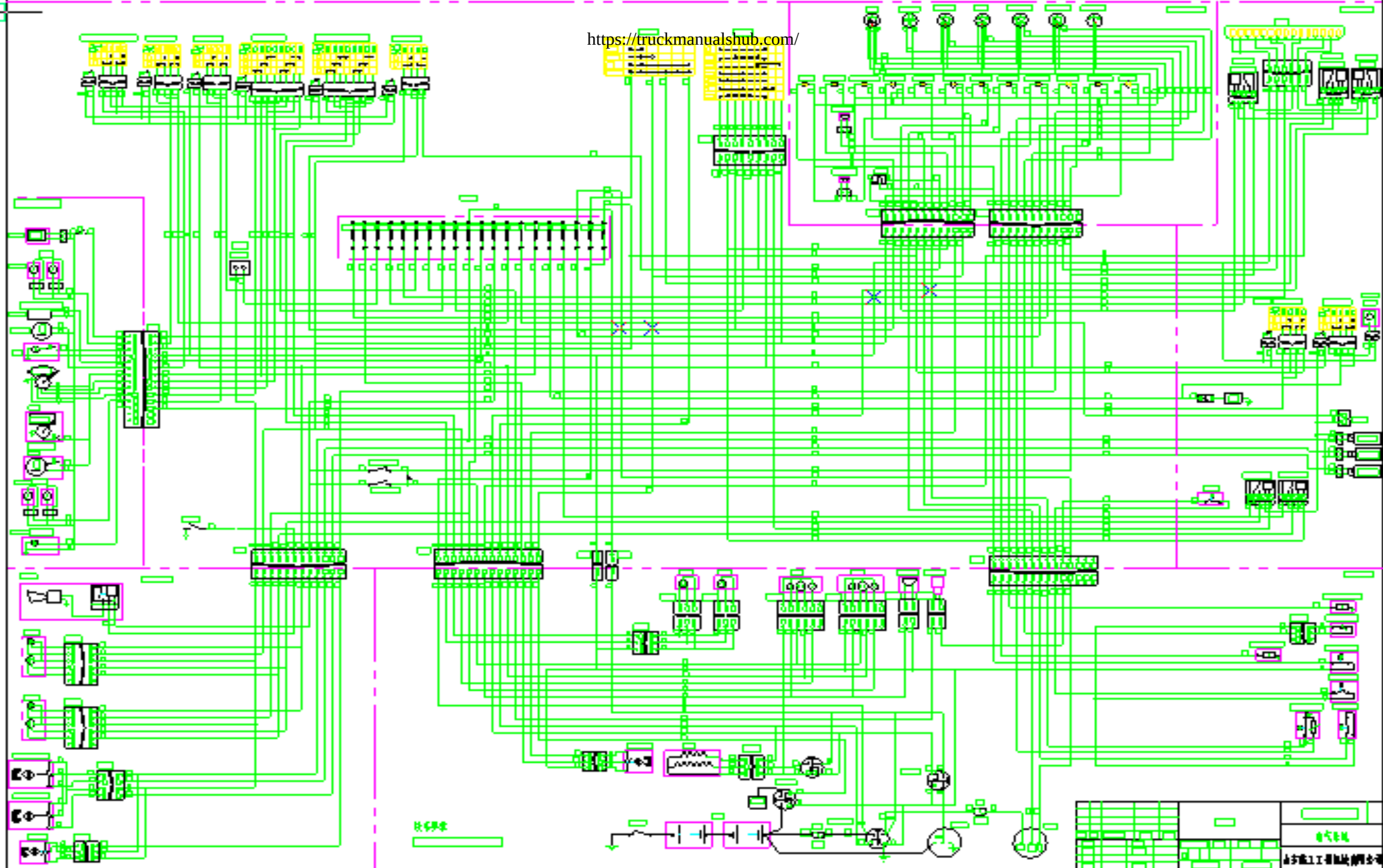
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Common Failure and Troubleshooting of Electrical System
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(1) Power Supply (电源部分)

1. Storage Battery (蓄电池)

20-hour discharge capacity of maintenance free storage battery is 120Ah.

(免维护蓄电池其20小时放电率容量为120Ah)

2. Generator (发电机)

integral AC generator

(整体式交流发电机)

3. Regulator (调节器)

PNP transistor regulator is used

(采用PNP型晶体管调节器)

4. Main switch (电源总开关)

Electromagnetic main switch

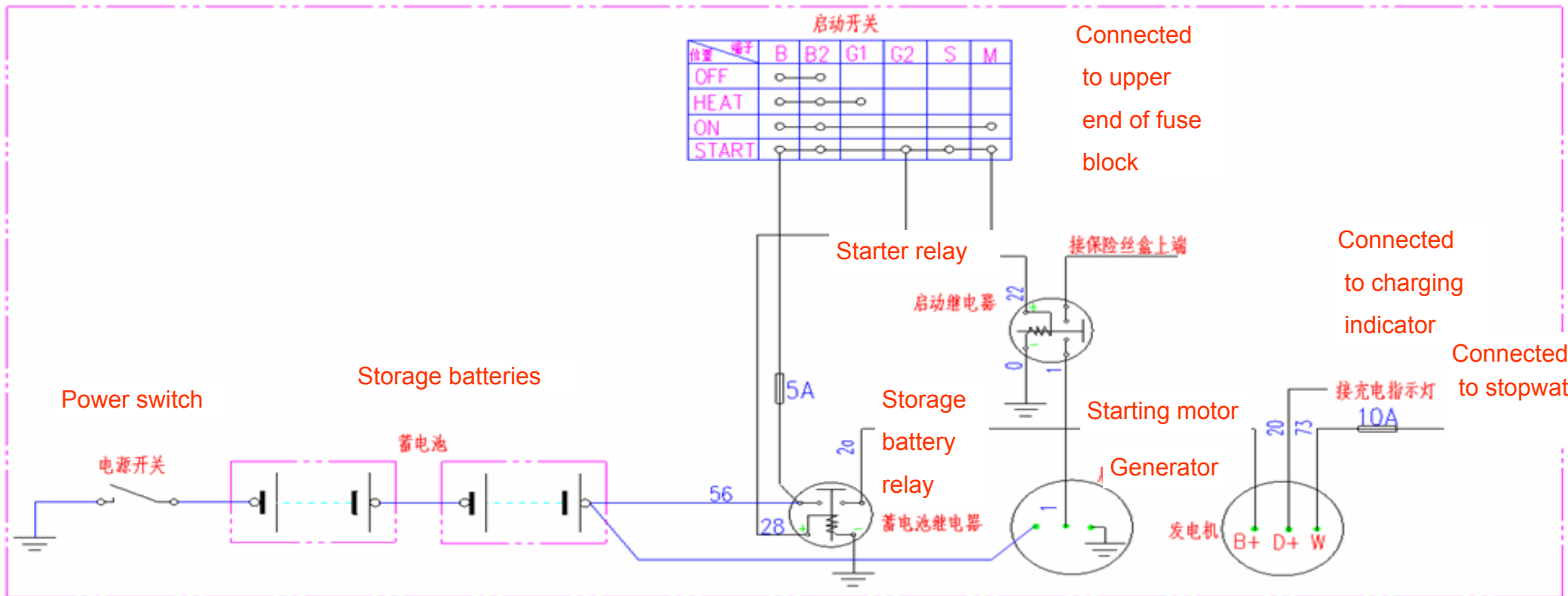
Some types are equipped with

mechanical main switch. (电磁式电源总开关。

有些机型同时配置机械式电源开关)



Starting switch



(2) Starting Section (起动系统)

1. Starter (起动机)

Series DC generator is used, whose power is above 7.5KW. So the starter has short-time design. Each starting time shall not be too long. 10s shall not be exceeded. Interval between two starting shall not less than 2 minute. If the vehicle cannot be started after three starting, please start after identifying causes. (采用串激式直流发电机, 功率7.5KW以上。故起动机是短时设计, 每次起动的的时间不易过长, 最好不要超过10S, 两次起动时间间隔不低于1分钟, 如果三次无法正常启动, 请查明原因后再起动)

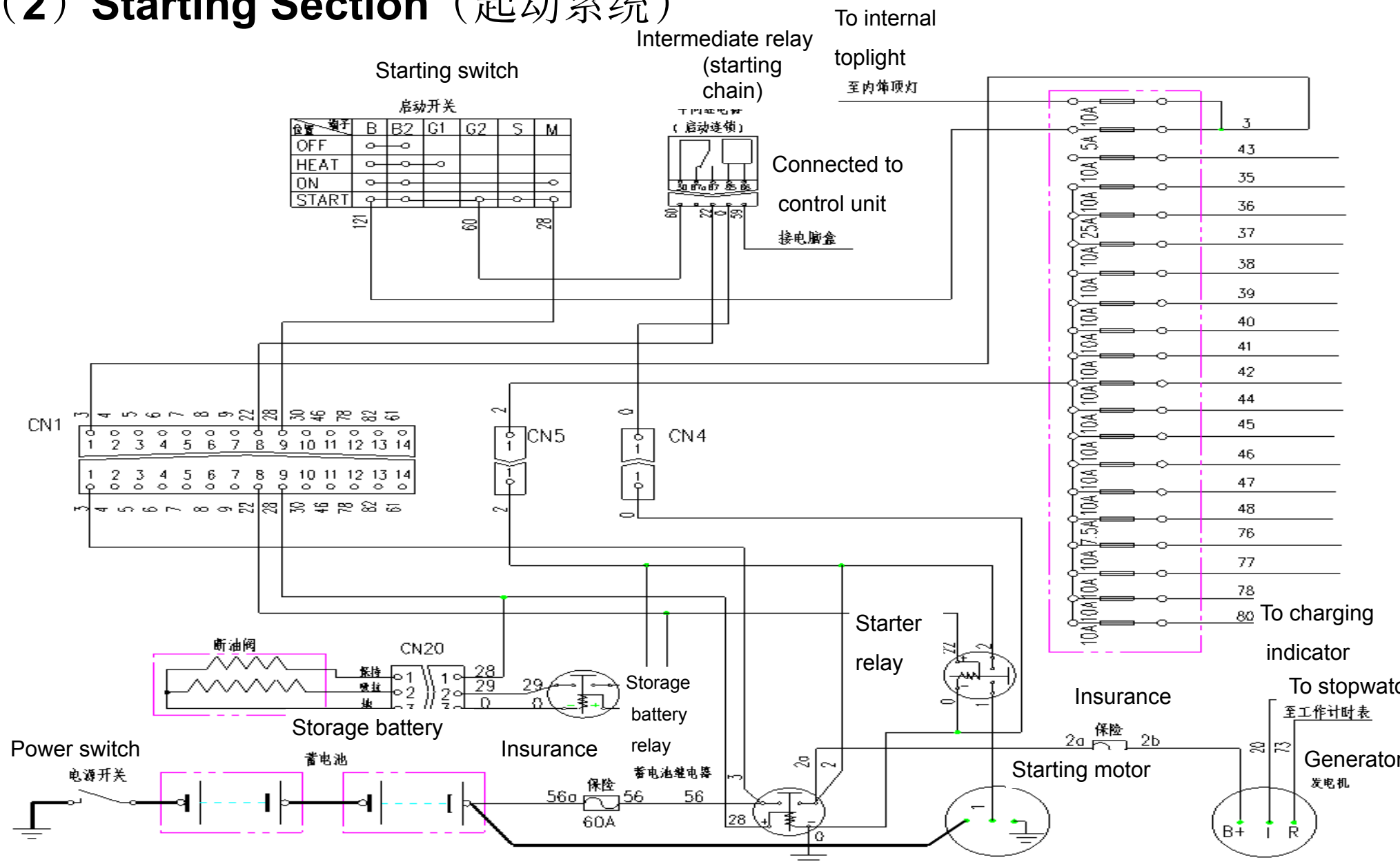
2. Starting Switch. JK406C can prevent error restart. It must be opened after the vehicle is closed by key and engine misses. Otherwise, it will be locked. Starting position cannot obtained. 启动开关。JK406C, 带有防止误重起功能, 发动机熄火后必须把钥匙关闭后再打开, 否则被锁住, 无法打在起动位置

3. Starter Relay (起动继电器)

JN3A-24

Power and starting system are shown as the figure below. (电源及起动系统图如下图所示)

(2) Starting Section (起动系统)



(3) Lighting and Auxiliary Circuit (照明及辅助电路)

1. Front and back headlights (前后照明大灯)
2. Working light and toplight of in cab (驾驶室顶照工作灯和顶灯)
3. Dashboard and wiring (仪表盘及线束)
4. gauge and sensor (仪表及传感器)
 - 1) Oil pressure of engine. Low-pressure alarm(发动机机油压力)

Pressure switch is used. Switch will connect alarm circuit when pressure is lower than specified value. Alarm lamp will be on. The machine must be stopped and can be used after identifying causes.(低压报警，采用压膜开关，压力低于规定值开关接通报警回路，报警灯亮，必须立即停机，查明原因后方可使用)

- 2) Water temperature gauge and sensor
(水温表及传感器)

Electromagnetic meter and electrothermic sensor are used.(采用电磁式仪表和电热式传感器)



(3) Lighting and Auxiliary Circuit (照明及辅助电路)

3) Torque converter oil temperature gauge and sensor(变矩器油温表及传感器)

Electromagnetic meter and electrothermic sensor are used.(采用电磁式仪表和电热式传感器)

4) Gas pressure sensor and gas pressure meter(气压传感器和气压表)

Electromagnetic meter and electrothermic sensor are used. (表采用电磁式仪表和电热式传感器)

5) Shifting pressure gage and sensor(变速压力表及传感器)

Direct feeling pressure gage is used. Durable, reliable and low-cost.

(采用直感式压力表。耐用可靠，成本低廉)

6) Wiper(刮水器)

7) Electric horn——Double basin electric horn is used(喇叭——采用双盆形电喇叭)

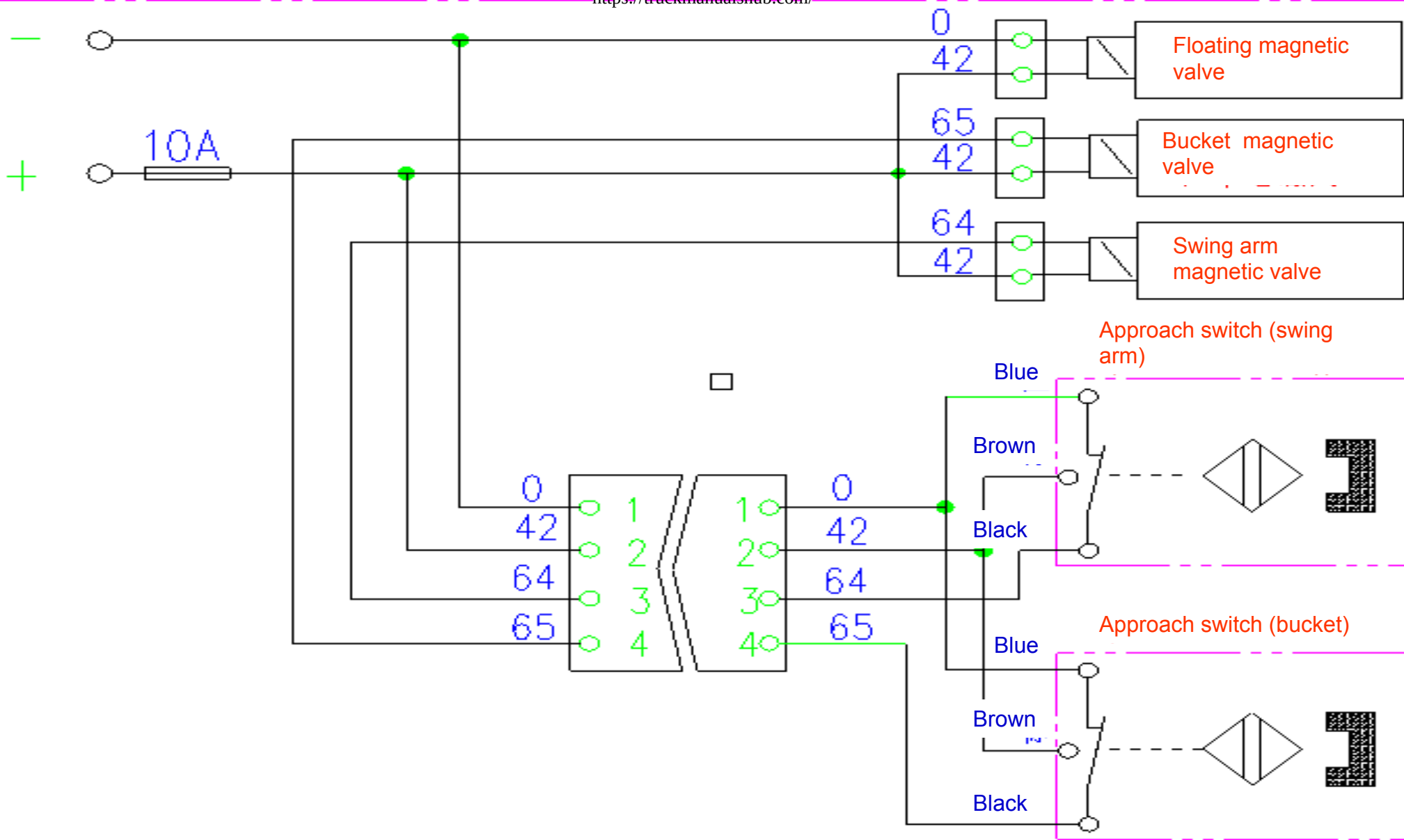
8) Back-Up buzzer and switch; Alarm lamp(倒车蜂鸣器及开关；警示灯)

9) Radio cassette recorder——Optional(收录机——选配)

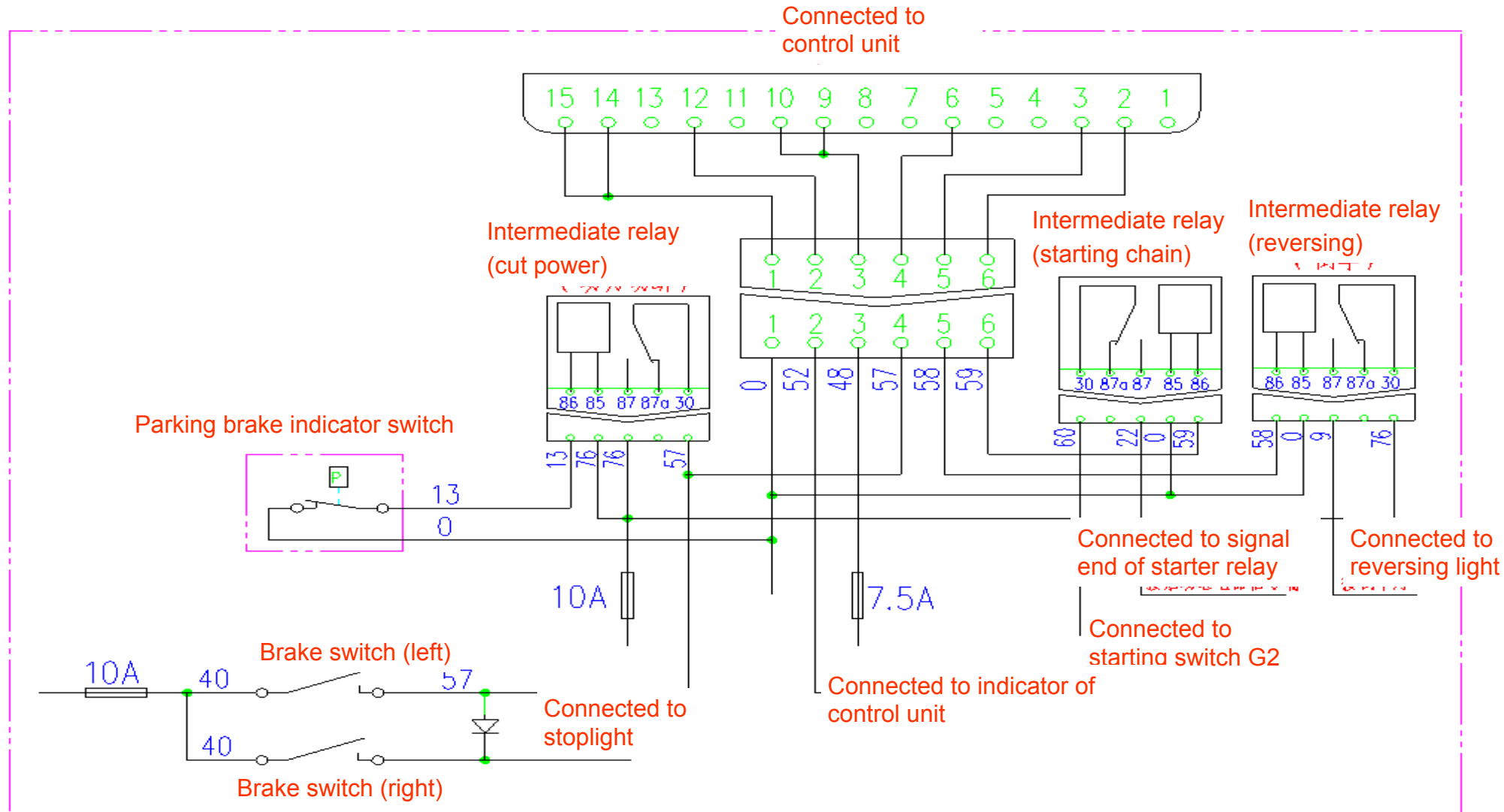
(4) Pilot Control Section(先导操纵部分)

1. Pilot
electromagnet
2. Approach
switch





Gearbox Control(变速箱控制)



Lingong Maintenance Free Storage Battery（临工免维护蓄电池）

I. Use Electric Eye and Open-circuit Voltage Technology（运用电眼和开路电压技术）

Electric eye indicating state on VARTA maintenance free storage battery is closely related to and consistent with its open-circuit voltage, but they should meet the following requirements（瓦尔塔免维护蓄电池上的电眼指示状态与其开路电压有着密切的联系和一致性，但要满足以下条件）

- 1. Let battery settle down for a period of time after charging or discharging to allow full mixing of sulfuric acid;**（电池在充、放电后，要稳定一段时间，让硫酸能够充分混合）
- 2. Shake batteries to expel bubbles in electric eye;**（摇动电池以逐出电眼中的气泡）

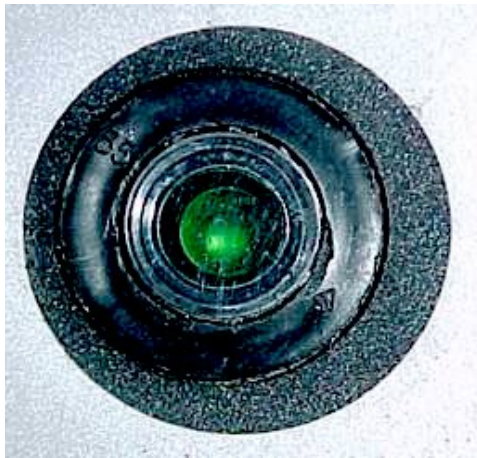
Lingong Maintenance Free Storage Battery（临工免维护蓄电池）

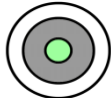
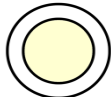
I. Use Electric Eye and Open-circuit Voltage Technology（运用电眼和开路电压技术）

3. Charged battery should discharge with load for 15 seconds to eliminate discharge on the surface. And then measure open-circuit voltage.（刚充过电的电池应先负载放电15秒钟，就会消除掉表面充电态，然后再测量开路电压）

(1) Electric Eye（电眼）

(2) Open-circuit Voltage（开路电压）



Color of Electric Eye	Electric Quantity
	Electric quantity is above 65%. Normal
	Electric quantity is below 65%. Charging needed
	Overcharge. Should be replaced

Lingong Maintenance Free Storage Battery（临工免维护蓄电池）

Green electric eye indicates: 电眼呈绿色可以告诉我们

1) When the vehicle is delivered to distributor, batteries have sufficient electricity. During transport process, vehicle can be started for several times;

（车辆在运往经销商的途中，电池电量充足，在运输过程中可以起动几次汽车）

2) Dealer-Under normal circumstances, battery can start vehicle within one week;

（经销商--在正常情况下，一周内电池可以起动车辆）

3) Service personal-Batteries have sufficient electricity. Load test can be conducted.

（服务人员--电池电量充足，可以进行负载试验）

4) Service personal-Batteries with sufficient electricity can be installed on vehicle or stop charging.（服务人员--电池电量充足，可以装入车辆或停止充电）

5) Service personal and driver-Charging system of vehicle operates normally.

（服务人员、司机—车辆充电系统运转正常）

6) Diver-Vehicle cannot start not because of batteries.

（司机—车辆不能起动的的原因可能不是电池原因）

7) Dealer-It is well stored. Can be sold to clients.（经销商--它的储存良好，可以卖给客户）

Lingong Maintenance Free Storage Battery（临工免维护蓄电池）

Black electric eye indicates（电眼呈黑色可以告诉）

1) Vehicle manufacturer - during production, vehicle has been significantly discharged. When the vehicle is delivered to distributor, batteries don't have sufficient electricity to start the vehicle.

（车辆制造商—车辆在制造过程中被显著放电，在运往经销商的途中，电池电量不足以起动车辆）

2) Vehicle dealer-Before vehicle is sold, batteries must be recharged. Otherwise, client cannot start the vehicle.（汽车经销商--汽车在卖出前，必须对电池进行充电，否则，顾客不能发动车辆）

3) Service personal-Batteries don't have sufficient electricity. Load test cannot be conducted or they cannot be installed on vehicle until batteries are recharged.

（服务人员--电池电量不充足，必须对电池充电，才可以进行负载试验或装入车辆）

4) Service personal/Driver-Charging system of vehicle may have problem (loosen belt or poor earth);（服务人员/司机--汽车充电系统可能有问题(皮带松弛，接地不良)）

5) Driver-Vehicle cannot start because of insufficient electricity of batteries.

（司机--汽车不能启动的原因可能是电池电量不足）

6) Dealer-Batteries have to be recharged before sold to client.（经销商--在把电池卖给客户前需对电池进行充电）

Lingong Maintenance Free Storage Battery（临工免维护蓄电池）

White electric eye indicates（电眼呈白色可以告诉）

1) Service personal/Driver-Charging system has problems.

（服务人员/司机--充电系统有问题）

2) Service personal/Driver-Batteries have to be replace (no need of test).

（服务人员/司机--电池需要更换(不需要测试)）

3) Service personal-If electric eye is black before charging, batteries are overcharged.

（服务人员--如果充电前电眼是黑色，说明电池过充电）

Lingong Maintenance Free Storage Battery（临工免维护蓄电池）

（2）Open-circuit Voltage（开路电压）

Can decide whether batteries are in good load state and whether vehicle can be delivered according to OCV test. Agents, service station, and user can also decide load state of batteries by measuring OCV.

（可以根据OCV的测定来判断电池是否处于良好的荷电状态，决定能否将车辆运出；代理商、服务站、用户也可以通过测量OCV确定电池的荷电状态）

Lingong Maintenance Free Storage Battery (临工免维护蓄电池)

Combination of Open-circuit Voltage and Electric Eye Technology (开路电压与电眼技术的结合)

1. When electric eye is black and $OCV > 12.2V$, battery can be fully charged with charging voltage of 16V and charging current of 25A within 4 hours;

(电眼为黑色, $OCV > 12.2V$ 时, 用16V的充电电压和25A的充电电流4小时内可将电池充足)

2. When electric eye is black and $OCV > 11.0V$, battery can be fully charged with charging voltage of 16V and charging current of 25A within 8 hours;

(电眼为黑色, OCV 大于11.0V时, 用16V的充电电压和25A的充电电流8小时内可将电池充足)

3. When electric eye is black and $OCV < 11.0V$, battery can be fully charged with charging voltage of 16V and charging current of 25A within 16 hours;

(电眼为黑色, OCV 小于11.0V时, 用16V的充电电压和25A的充电电流16小时内可将电池充足)

4. When electric eye is green and voltage is below 11.0V, battery has short circuit and has to be replaced. (电眼为绿色, 电压低于11.0V时, 说明电池内发生短路, 必须更换)

Lingong Maintenance Free Storage Battery（临工免维护蓄电池）

（3）Self Discharge of Battery（电池自放电）

Storage battery has self discharge in storage process, which increases as the temperature increases. Self-discharge rate will be doubled when the temperature increased by 10 degrees. Self-discharge rate is 6% ~8%, 3% ~ 4% and 1.5% ~ 3% monthly under 35 degrees, 25 degrees and 15 degrees. Under normal temperature, self discharge rate of large capacity battery is 4% and self discharge rate of small capacity battery is 3%.

（蓄电池在储存过程中一直存在自放电，且随温度升高而升高，每升高10度自放电率增加一倍。35度、25度、15度温度下自放电率分别为每月6%~8%、3%~4%、1.5%~3%。常温下，大容量电池自放电率为4%；小容量为3%）

Lingong Maintenance Free Storage Battery（临工免维护蓄电池）

（4）Load Discharge of Auxiliary Electric Elements（附属电气件的负载放电）

Load of auxiliary elements are mainly caused by vehicle clock, acoustics, alarm system and other auxiliary appliances. This load exists forever. Even if starting key is disconnected, the load still exists. If the vehicle is not used for a period of time, the vehicle may not be started.

（附件负载主要由车辆时钟、音响、防盗系统及其他附属电器件引起，这类负载永远存在，即使起动钥匙处于断开状态，这些负载也存在，当一段时间不用后，会发生汽车不能起动的现象）

Transition leakage of storage battery shall not reach 50% of battery capacity. If the vehicle is parked for a long time, negative electron ode connections of batteries shall be pulled up.（不要让蓄电池过渡漏电到50%的电池容量。车辆长期停放时，应将蓄电池上负极连接线拔掉）

Lingong Maintenance Free Storage Battery（临工免维护蓄电池）

（5）Charging of Storage Battery（蓄电池的充电）

Storage batteries stored for too long (eg, unused more than 6 months after leaving factory), vehicle charging system failure or other improper operation may cause excessive discharge of storage battery. When state indicator of storage battery is black, storage batteries shall be charged according to the following methods. Under room temperature, positive and negative electrode of storage battery shall be connected to positive and negative electrode of DC charger respectively, Storage battery shall be charged with constant voltage of 16.0 ± 0.1 V for 16 ~ 24 hours. If during constant charging process, temperature of storage battery exceeds 45 Celsius or charging current exceeds 25A, charging voltage shall be lowered or charging time shall be extended properly.（对搁置过久（如出厂超过6个月而未使用）的蓄电池或汽车充电系统失效及其它操作不当，引起蓄电池的过度放电，蓄电池状态指示器显示黑色时，建议根据下述方法对蓄电池进行充电：在室温环境下，将蓄电池的正、负极分别和直流充电机输出的正、负极相连接，以定电压 16.0 ± 0.1 V对蓄电池进行恒压充电16~24小时。若恒压充电过程中蓄电池温度超过45摄氏度或充电电流超过25A，则适当降低充电电压而延长充电时间）

Notes: Storage battery shall be charged in the area with good ventilation. Ensure safe electrical operation.（**注意：**蓄电池的充电应在通风良好的区域进行，并注意用电安全）

Lingong Maintenance Free Storage Battery（临工免维护蓄电池）

How shall we correctly check and judge maintenance free storage battery? Most of service personnel are facing these questions. why can't the vehicle start? Many people may misjudge due to lack of suitable tools and methods, which will cause unnecessary battery replacement without finding out root causes. This problem appears constantly.

（如何正确检查和判断免维护蓄电池？服务人员大都都会面临这样的问题：为什么车辆不能起动？许多人因为没有合适的工具和方法而作出误判，结果造成不必要的电池更换而没有找到根本原因，这样的问题仍然不断出现）

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1 Circuit Diagram and Failure Analysis Methods of Engineering Machinery 工程机械回路图和故障分析方法

2 Storage Battery 蓄电池

3 Generator and Regulator 发电机与调节器

4 Starter 起动机

5 Lighting Equipment, Auxiliary Circuit and Instrument 照明设备、辅助电路及仪表

6 Air-conditioning System 空调系统

7 Electrical System Structure and Principle of Lingong Loader 临工装载机电气系统结构与原理

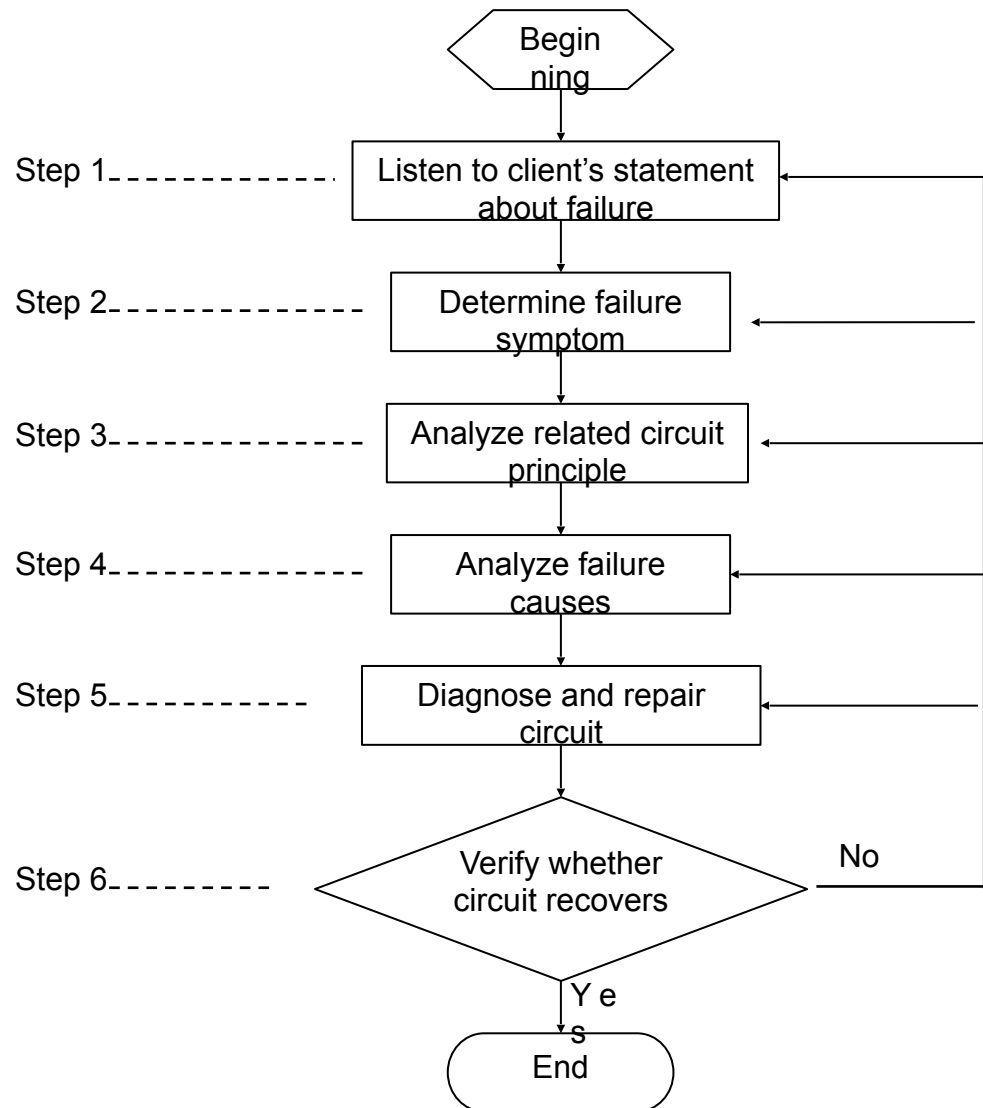
8 Common Failure and Troubleshooting of Electrical System 电气系统常见故障与排除方法



(1) Judgment Idea and Method(判断思路和方法)

General flow is good for cultivation of good fault diagnosis and inspection idea for beginners. Maintenance personnel with reasonable knowledge and working experience doesn't need to exactly follow the process steps in actual work. They can skip some steps according to actual situation or by experience, and overhaul the fault point directly, which can effectively improve work efficiency.

(一般流程对初学者按部就班，培养良好的故障诊断与检修思路大有裨益。对于具备相当的理论知识和工作经验的维修人员，实际工作中不必过分拘泥于流程步骤，可以视实际情况或凭经验略过一些步骤，直达故障点进行检修，可有效提高工作效率)



(2) Common Failures(常见故障)

1. Open circuit (disconnection) failure (Figure 1)
1) (断路)
2. Short circuit failure (Figure 2) (短路)
3. Poor contract (contact resistance is too large) failure (接触不良)

Figure 1

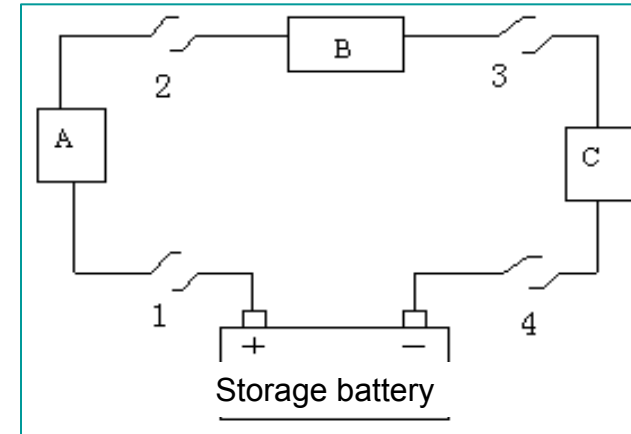
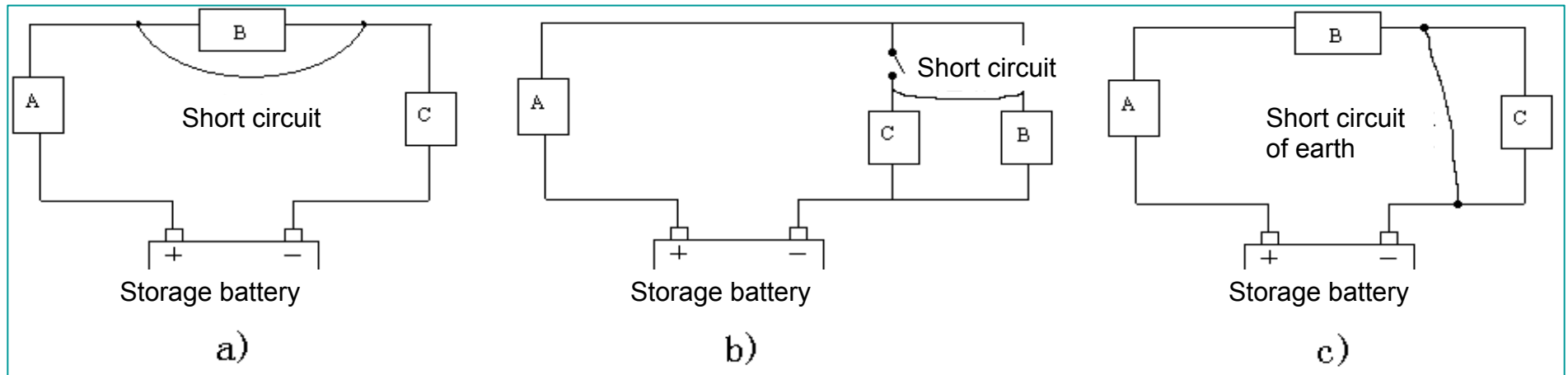


Figure 2



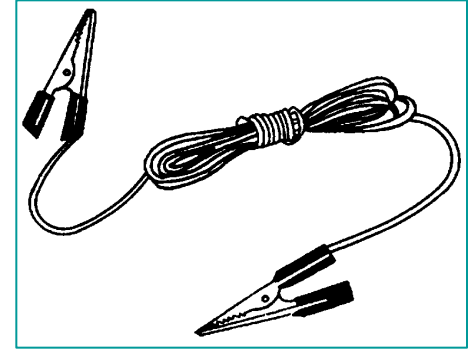
(3) Use of Common Inspection Equipments 常用检测设备的使用

1. Objectives (目标)

Master common inspection tools of automobile : correct use of jumper, testing lamp, multimeter (mechanical and digital), oscilloscope, malfunction diagnosis machine, etc. (掌握汽车电器常用检测工具：跨接线、试灯、万用表（机械式和数字式）、示波器、故障诊断仪等的正确使用)

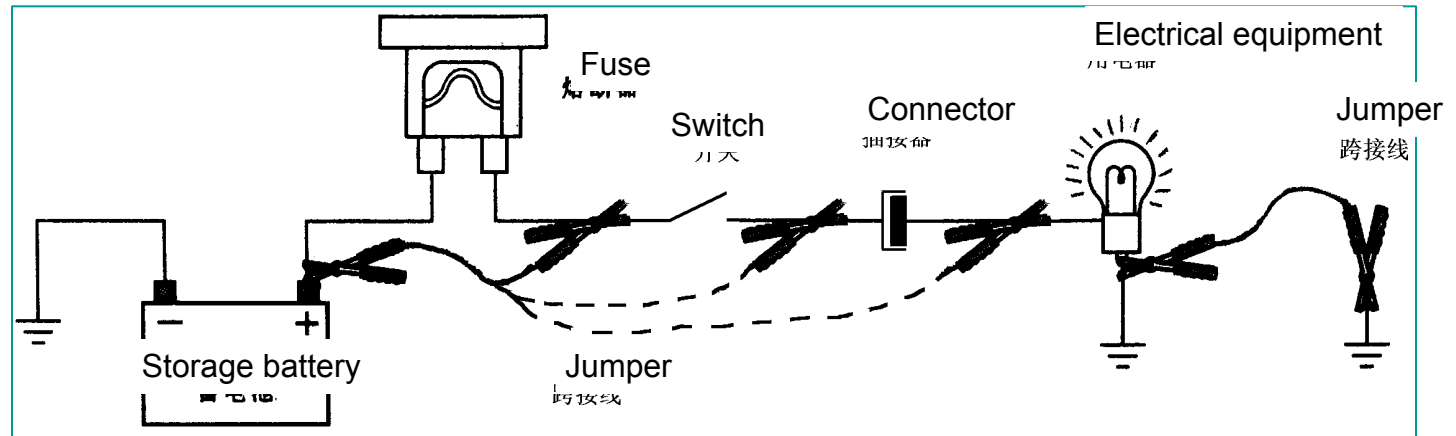
2. Instruments and Tools (仪器与工具)

Jumper, testing lamp, multimeter (mechanical and digital), oscilloscope, malfunction diagnosis machine, etc. (跨接线、试灯、万用表（机械式和数字式）、示波器、故障诊断仪等)



3. Content (内容)

Jumper (跨接线)



Warning: Don't connect jumper directly to two ends of storage battery or between positive electrode and earth of storage battery. (切勿将跨接线直接跨接在蓄电池的两端或蓄电池正极和搭铁之间)

(3) Use of Common Inspection Equipments 常用检测设备的使用

2. Testing Lamp (试灯)

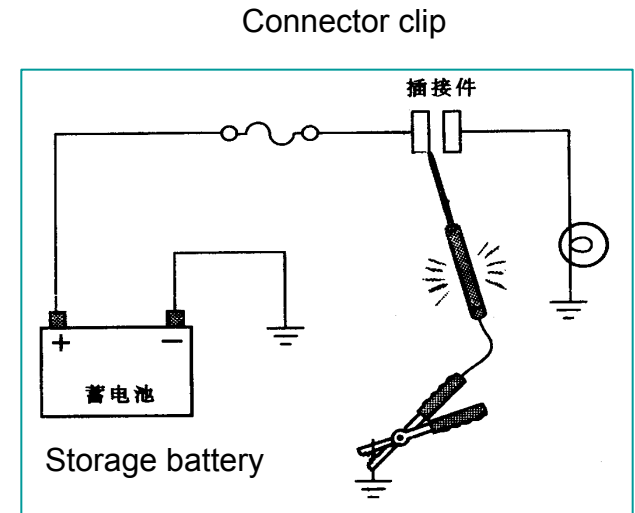
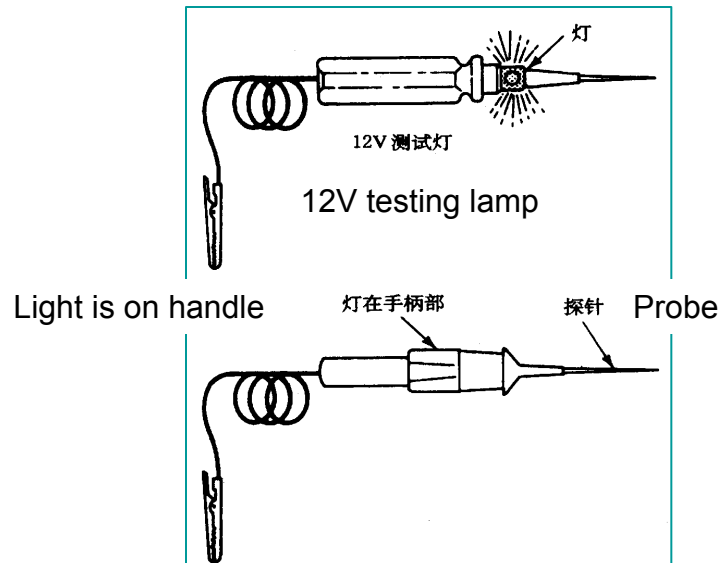
(1) Passive Testing Lamp (无源试灯)

Limit of testing lamp is that it cannot display voltage of detected circuit.

(试灯的局限性在于它不能显示出被检电路点的电压值是多少)

Warning: It is not suggested to detect circuit controlled by computer with testing lamp. (

警告：不提倡用试灯检测计算机控制的电路)



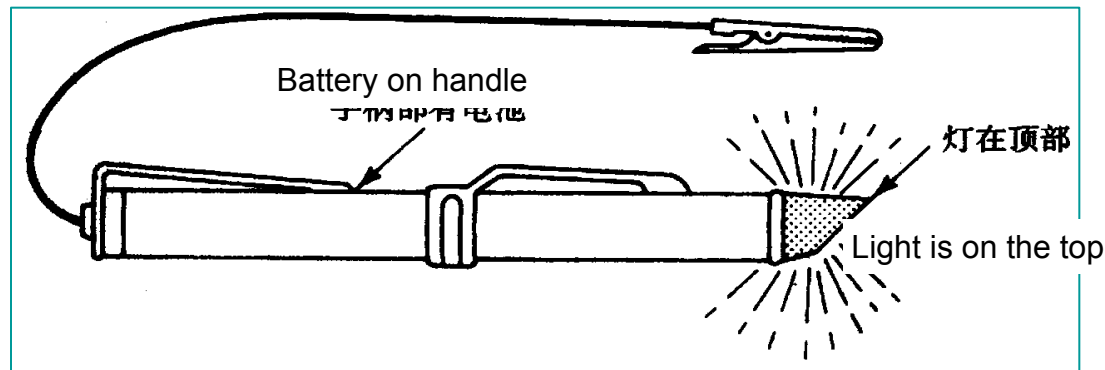
(3) Use of Common Inspection Equipments 常用检测设备的使用

(2) Active Testing Lamp (有源试灯)

Active testing lamp is similar to passive testing lamp. It has a battery supply. When connected to two ends of a wire, bubble in the testing lamp will be on. It can be used to test connection or disconnection of circuit.

(有源试灯同无源示灯类似，只是自带一个电池电源，连接到一条导线的两端上时，试灯内灯泡点亮，可用于测试线路的通、断)

Warning: Alive circuit cannot be tested with active testing lamp, or the lamp will be damaged. (警告：不能用有源示灯测试带电电路，否则会损坏试灯)



(3) Use of Common Inspection Equipments 常用检测设备的使用

3. Use steps of digital multimeter: (数字式万用表的使用步骤)

Choose the appropriate test gear. (选择合适的测量档位)

Put probe of multimeter in proper input end. (将表的测试头放在适当的输入端)

(1) Black probe is usually inserted in common port (COM) (黑表笔通常插在公共端 (COM))

(2) When measuring voltage, resistance or diode, red probe is usually inserted in the position end with mark of VΩ. (当测量电压、电阻或二极管时, 红表笔通常插在有“VΩ”标签的位置端)

(3) When measuring current, red probe is usually inserted in the position end with mark of A or mA. Choose the appropriate measuring range

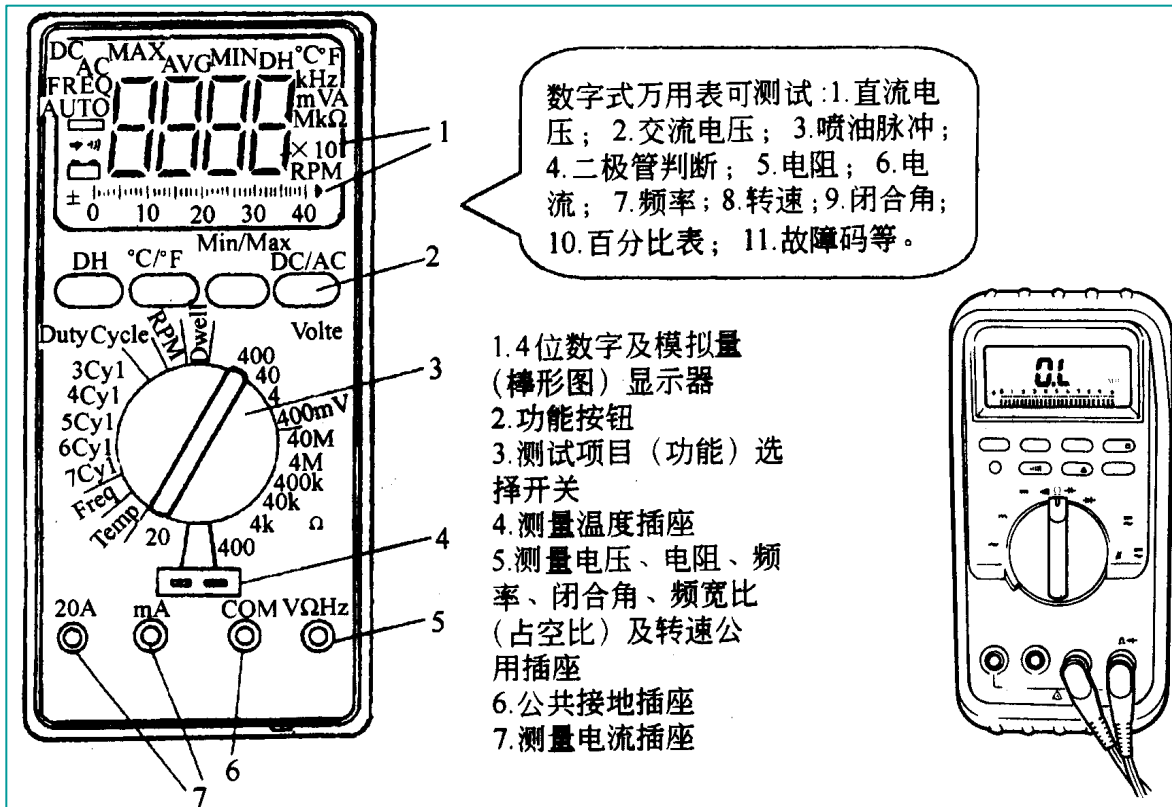
(当测量电流时, 红表笔通常插在有“A”或“mA”标签的位置端。 选用适当的量程)

Read correctly according to selected gear.

(注意根据选择的档位正确读数)



(3) Use of Common Inspection Equipments 常用检测设备的使用



Digital multimeter can measure: 1. DC voltage; 2. AC voltage; 3. oil injection pulse; 4. diode; 5. resistance; 6. current; 7. frequency; 8. rotate speed; 9. closed angle; 10. TECK; 11. fault code; etc.

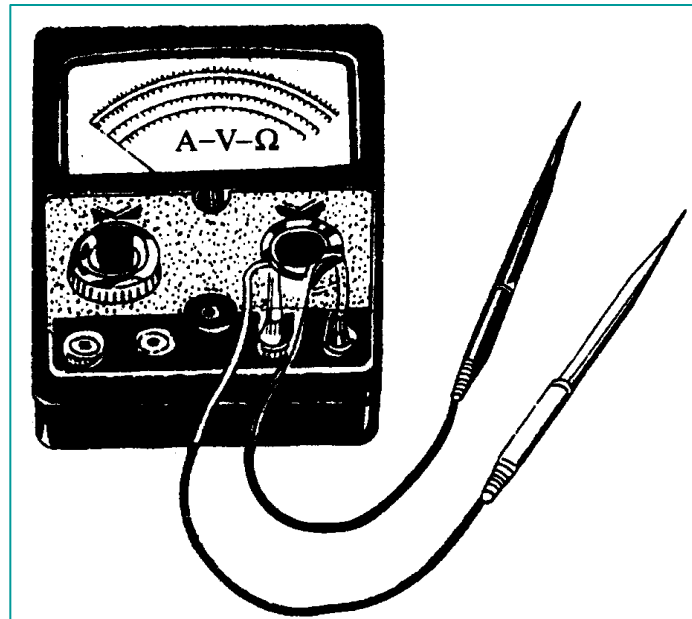
1. 4-digit number and analog quantity (bar charge) display
2. Function button
3. Test item (function) selecting switch
4. Temperature measurement socket
5. Public socket for voltage, resistance, frequency, closed angle, bandwidth ratio (duty ratio) and rotate speed measurement
6. Public earthing socket
7. Current measurement socket

(3) Use of Common Inspection Equipments 常用检测设备的使用

4. Universal Analogue Multimeter (通用模拟式万用表)

Because analogue multimeter has higher output than high-resistance digital multimeter, analogue multimeter is more accurate than digital multimeter when measuring resistance of diode and electronic components.

(由于模拟式万用表比高阻抗的数字式万用表有更高的输出，在测量二极管和电子元件的电阻值时模拟式万用表比数字式万用表更精确，但是要注意两点：)



(3) Use of Common Inspection Equipments 常用检测设备的使用

4. Universal Analogue Multimeter (通用模拟式万用表)

Note 1: At present most circuits on vehicle are transistor circuits. Meter of 10M Ohm or higher resistance should be used to measure voltage of these circuits.

(注意1: 当今车辆上的电路极大部分是晶体管电路, 当检查这些电路电压时, 要用10兆欧姆或更大阻抗的仪表)

Note 2: At present most circuits on vehicle are transistor circuits. Ohmmeter of 10M Ohm or higher resistance should be used to measure voltage of these circuits. In addition, decide whether the measured circuit is disconnected. Otherwise, circuit supplied by automotive electrical system may damage equipment or provide false readings

(注意2: 当今车辆上的电路极大部分是晶体管电路, 当检查这些电路电阻时, 要用10兆欧姆或更大阻抗的电阻表。另外, 要确认被测电路的电源已经断开。否则由汽车电气系统供电的电路会损坏装备或提供虚假读数)



Reliability
bears great
trust!