Development and Application of the Loader Electrical Test Bench

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Abstract

Engineering machinery electricity structure and service are the engineering machinery class personnel training core programs, the associativity of its theory and practice is very strong, the development union colleges cultivating target of car loader electrical test stage, the development draws close to the production actual car loader electrical test stage, overcomes the engineering machinery electricity CNC practice project and production cannot the present situation of very good union, may satisfy car loader the electrical system principle, electric appliance structure, system wiring and repair and other project of the studies that improves the quality of engineering machinery class personnel training.

Keywords: Loader; Electrical test rig; Breakdown maintenance

1. Introduction

With the continued increase in China's construction machinery market holdings, the quantity and quality of construction machinery demand service personnel has been greatly improved. Electrical faults are one of the major failures of construction machinery, engineering machinery parts with the degree of electrification increasing as curriculum teaching colleges and universities, the urgent need to develop a fit actual production of mechanical and electrical engineering test-bed, applied to construction machinery class of relevant professional training.

The car loader is the integration of technologies product of machine, electricity and fluid integration, the performance-to-price ratio is high, applied field are many, is playing the pivotal role in the road, railroad, electric power, water conservation and other engineering constructions, applies the most widespread construction equipment. The higher vocational colleges take the training base of engineering machinery highly skilled personnel, shoulders is creating the heavy responsibility of the high-quality and high-level skilled worker for the society. Through to my institute graduate investigation recent, 27% students is engaged in car loader the complete machine and spare part sale, technical service, equipment maintenance and other work. In the practical work, must have machinery, hydraulic pressure and electrical system fault diagnosis and maintenance skill. And the technical personnel universally reflected that is weak in the electrical system fault diagnosis and maintenance ability, therefore enhances the student's skill in electrical system service is the issue that must be solved immediately.

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By developing a loader electrical training platform to realize the principle of professional course presentation and electrical structure, convenient observation system each device, control circuit connection between relations, realize the vehicle electrical fault analysis and ruled out, complete course for examination and assessment of training content. Through the development of this test rig, added education technology and equipment, construction machinery, it may improve the professional cultivation and the production practice and strengthen the cultivation of seamless docking.

2. Systematic Design and Implementation

Loader electrical test bench as the training of professional engineering machinery and equipment required to meet the daily needs of teaching, ease of operation and re-use. The test rig consists of the following three parts: the entire vehicle electrical training sets, circuit boards and fault simulation system settings.

2.1 Training platform design

Test bench with horizontal entire vehicle electrical bench, bench set below the trigger switch failure, fault assessment settings. The test bench circuit assembly loader to mainstream models as a template, including three systems namely, power systems, starting systems, instrumentation, signal lighting and wiper systems, the system according to their actual relationship to connect the loader, original car horizontal position is fixed to the entire vehicle electrical bench. The test station is integrated into the vehicle circuit bench to facilitate student research study, easy to operate, not only to see the kind of wiring schematic comparison can be carried out to understand, but the fault trigger switch is designed to meet the teacher and task settings evaluation requirements. Test rig assembly is configured as follows.

- **Power system**: batteries, generators, insurance, relays, power switch, key switch, connector, insurance and conductor, whose role is to give the entire vehicle electrical equipment supply. Where the battery is mainly used when the generator is started in a short time to start the machine power, the engine is working properly by the generator to supply power to the entire vehicle electrical equipment, while the remaining electricity to charge the battery, ensure that the battery has enough power regulator guarantee its output on the generator voltage stable within a certain range, to prevent voltage fluctuations too large to burn electrical equipment.

- **Start system**: starter, start relay, flameout solenoid valve, connector, insurance and wire, its role is to start the engine after the engine starts, the starter immediately stopped.

- **After lighting signal system**: headlamps components, according to pieces, horn, buzzer, insurance and wire, etc., the system to ensure the safety of engineering mechanical drive and work at night, improve work efficiency.

- **Instrument sensors**, pressure gauge, thermometer, tachometer, and corresponding to various types of sensors, the driver to provide necessary data and information in the
operation of engineering machinery, as well as the fault code reading, vehicle positioning and dynamic information.

- Electrical accessories: wiper assembly, fan, rain, snow, and used to remove the dust on the windshield temperature adjustment, ensure the safe and efficient operation in adverse weather and environment.

2.2 Simulation design of circuit boards

The vehicle electrical test bench has completed the project practice to the education and teaching of seamless connection, but also has the following shortcomings.

- High training cost. In the real line to set up a fault, there must be a loss of lines and components, in particular, the setting of short-circuit fault may also cause damage to multiple components, increased training costs.

- Line to students understands laborious. Due to dispersion of vehicle electrical layout and electric components, more complex caused by vehicle lines, wiring harness. Students rely on physical connections that understand the electrical components of the control circuit are difficult, and time-consuming to find target lines.

In order to avoid the above shortcomings, this test-bed design the circuit simulation panel, the panel design greatly simplifies the teaching practice, failure case of setting and practice teaching through the analog electronic circuit implementation, as the principle to destroy the light of lamp to demonstrate that the setting and fault diagnosis through the switch control and string and resistance and implementation. Convenient for students to appliances working principle and circuit to the understanding of the car body, at the same time to avoid the direct online set breakdown on the road, lead to damage of components and the wiring is shot, greatly saving the cost of the training. Analog circuit boards use vertical layout, using flip fixed manner, the principle of electrical connections between components in a vertical figure shows the analog boards, presentation at diagnosis fixed vertically placed in the test rig side when not in use, so easy to visit students and hands and testing, without disrupting the cable system, the use of tools such as multimeter for testing. In the figure one, we show the architecture.

![Figure one. Analog part of the circuit board.](image-url)
2.3 Functional Design

Combination with the engineering machinery service jobs skills, this test rig the main function of loader principle of electrical system, electrical wiring and fault structure, system maintenance and so on four modules.

(1) the principle of electrical system of loader and students can read the first test of electrical schematic diagram, then the parts on the test bench test and control system directly relationship, at the same time in the horizontal training platform and circuit simulation controlled demonstrations on the panel.

(2) the electrical structure, students cannot remove the case, know the electrical equipment of loader structure, such as starter, generators, wiper motor and the appearance of various control and sensor structure.

(3) the system wiring, the test-bed subsystem, such as start-up system of all attachment, by the students according to the vehicle circuit diagram conductor selection, the operation of the system wiring and cabling, tested for the ability to read and wiring of the principle of the circuit.

(4) the breakdown maintenance, service personnel main skills is according to the customer's fault description of remote fault diagnosis and troubleshooting, and development of this test bed, can simulate the scene most of the fault cases, satisfy students study found failure, malfunction diagnosis.

(5) training students' ability of a summary, participants in the provisions of this test-bed to complete all field project, independent operation manual written test rig, as the inspection project, training students' ability of self-induction and expression.

3. Fault detection

Electrical fault is one of the common faults of the loader, can occur in any electrical components on the vehicle or line, fault cannot be started, not charging, lighting or signal system failure, according to the law of the electrical fault can be summarized as following: the main fault circuit fault and short circuit fault and leakage fault etc.. Taking the open circuit fault as an example, the common cause of the equipment is not normal for a wire or connecting point, as well as poor connection column contact (such as corrosion).

Electrical fault diagnosis following the first simple and complex, after the first external internal principle and the methods used include: ask the user method, visual inspection method, inspection method, temperature resistance measurement test method, inspection method, power supply voltage measurement method, short circuit check off branch check method, element substitution method, reconnection or welding inspection method and
comparative method etc.. There are three kinds of conventional fault diagnosis project in this test station, including power system, lighting signal, instrument system and starting system.

3.1 Power system fault diagnosis

In the following example, the power system fault diagnosis, figure 2 for the loader power system circuit diagram.

![Load machine power system circuit diagram.](image)

Failure phenomenon: the key switch to the ON file, start the engine, the charging indicator is not extinguished.

Causes of failure: according to the principle diagram, the possible reasons are summarized as:

(1) the transmission belt (2) generator and regulator fault (3) relay or line fault.

Fault diagnosis and Troubleshooting: the fault diagnosis to follow the general electrical troubleshooting steps, first outside, after the first easy to difficult, the fault diagnosis process as shown in figure 3.
3.2 Start-up system fault diagnosis.

Engineering machinery start fault common system startup machine does not turn, start the machine running weakness, idling start machine and drive gear and flywheel gear meshing not issued abnormal sound fault, the test rig can complete the startup diagnostic machine does not turn and run to troubleshooting.

(1) The starter does not turn

Phenomenon: when the key switch to the start position, the starter does not turn.

Common reasons are: ① serious loss of battery power or battery positive and negative column cable connector loose or poor contact, or even fall off; ② start relay contacts cannot be closed or ablation, dirty and poor contact or coil break; ③ suction motor electromagnetic switch coil and holding coil has pulled Ground, open circuit, short circuit; the main contact or a contact surface is no longer a serious erosion in the same plane, so that the contact plate cannot be two contacts effective contact. ④ DC motor inside the field winding or armature winding open circuit, short circuit or grounding fault; commutator serious erosion or brush spring pressure is too small or the brush in the brush holder commutator cause death card poor contact; brush lead disconnected or electrically isolated brush (i.e. positive brush) Ground; ⑤ external line short circuit, open circuit or loose terminals.

Troubleshooting: According to the above reasons, follow a simple electrical fault diagnosis after the first complex, the first principle of the internal external, step excluded.
(2) Inability to start the machine running

Phenomenon: the ignition switch is turned on startup file or start button to start the machine speed is too slow (so that the engine does not start).

Common reasons are: ① battery to save electricity or short circuit supply capability to reduce it or lose battery positive and negative column, oxidation or corrosion of the power supply circuit so that it cannot be normal conduction; ② electromagnetic switch fault, such as the contact plate and the main terminal column ablation or grease cause poor contact; ③ DC motor internal faults, such as dirt or ablation commutator, brush wear serious cause poor contact; field winding or armature winding partial short so that the starter output power decreases.

Troubleshooting: analyze the causes and find the point of failure.

4. Application Performance

The development of car loader electrical test stage, has succeeded to be applied in the quality engineering machinery class specialized teaching practice, after the practice, greatly enhances the study enthusiasm of student, improves the professional accomplishment, trained the student to analyze the issue, to solve the problem independently the ability.

The comparison curriculum knowledge cultivating target, this test platform may complete following three contents of aspects: First, completes to the understanding that the entire car electric appliance line work moves toward, contrasts the electric appliance schematic diagram and wiring chart in system discovers various current collector arrangement positions; Next, completes to the entire car automated electric appliance the analysis of principle of work and electric circuit; Finally, completes to the examination and elimination of this test platform car loader circuit fault, and may realize the artificial establishment breakdown, trains the ability and analysis capability to the breakdown of student.

5. Conclusion

Along with the development of technology, the service of engineering machinery equipment no longer the simple replacement of mechanical part, the high-efficient operation of equipment more and more had tended to the automatic control, the massive utilization of especially integrated electronic control on engineering machinery equipment, the technical position of electrical appliance, directly affected the working efficiency of equipment, the engineering machinery services area urgently needs the high skill talented person. The development and application of this test platform, trained to enhance the hardware support for the teaching and student, may realize the same stage demonstration of theory and reality exercise, greatly improved the personnel training efficiency and quality.

While the test bed teaching with good results, but there are still shortcomings improved updated difficult. Once the market the product upgrades, in this test bed in function and details
on the actual production of touch. The next step will focus on the electrical test bench modular development, research vehicle to achieve low-cost electrical function update.

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Reference


