IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 2, August 2026
Impact Factor: 8.2

Design and Implementation of Relay in Power System Protection

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Abstract: *This industrial internship report presents the practical study of relay manufacturing and assembly at SK Enterprises, F-26 MIDC Ahmednagar. The study covers the manufacturing and assembly of MK1, MK2 and MU-2 Pole relays, with emphasis on the materials, components, production operations and quality-control practices observed during the internship. The major relay components studied include the relay box, fixed contact, silver button, stop contact, start contact, Kanthal wire, bimetallic coil, terminal and screw. The manufacturing process includes relay box moulding, fixed contact preparation and riveting, silver button fixing, relay slide assembly, safety relay assembly, stop and start contact assembly, Kanthal wire winding, bimetallic coil winding, spot welding, coil joining and terminal screw assembly. Quality control activities include terminal and screw checking, spot-welding inspection, heating and current checking, coil colour and heating inspection, mechanical adjustment, spacing and contact-force checking, continuity testing and final inspection. The internship provided practical understanding of how electrical and mechanical components are accurately assembled, adjusted and tested to obtain a reliable finished relay. The study also highlights the importance of proper manufacturing sequence, consistency, inspection and industrial safety in relay production.*

Keywords: Relay Manufacturing, Relay Assembly, MK1 Relay, MK2 Relay, MU-2 Pole Relay, Kanthal Wire, Bimetallic Coil, Contact Assembly, Spot Welding, Continuity Testing, Quality Control

I. INTRODUCTION

Relays are electrically operated switching devices used to control electrical circuits. The industrial internship at SK Enterprises, F-26 MIDC Ahmednagar, provided practical exposure to relay manufacturing and assembly activities. The internship focused on the study of MK1, MK2 and MU-2 Pole relay variants and their manufacturing operations. The training helped in understanding the relay as a complete manufactured assembly consisting of electrical, mechanical and thermal components. The observed manufacturing activities included moulding, contact preparation, winding, welding, assembly and inspection operations carried out in a systematic sequence. [1]

The construction of a relay involves several components, each having a specific function in the final assembly. The major components recorded during the internship include the relay box, fixed contact, silver button, stop contact, start contact, Kanthal wire, bimetallic coil, terminal and screw. The relay box provides mechanical support and enclosure, while the fixed contact and silver button provide contact surfaces. Stop and start contacts form part of the switching arrangement, whereas the terminal and screw provide external electrical connection and mechanical fixing. Kanthal wire is used as the winding material and the bimetallic coil provides thermal and mechanical response. [2]

Relay manufacturing is carried out through a sequence of production operations in which individual components are assembled to form the finished relay. The process observed during the internship included relay box moulding, fixed contact preparation and riveting, silver button fixing, relay slide assembly, safety relay assembly and stop/start contact assembly. Further operations included Kanthal wire winding, bimetallic coil winding, spot welding and coil joining, followed by terminal screw assembly. Each operation requires proper positioning and handling of components so that the completed relay can perform its intended switching operation. [3]

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Mechanical accuracy is an important part of relay assembly because the contacts and moving components must operate correctly. The relay slide is assembled as part of the mechanical switching arrangement and must move freely without interference. Stop and start contacts are positioned according to the relay mechanism, while correct contact spacing is maintained through mechanical adjustment. The winding operation also requires consistent handling of Kanthal wire, and the bimetallic coil must be formed properly because its thermal response depends on the behaviour of its two different metals. These observations show the importance of maintaining both electrical and mechanical accuracy during assembly. [4]

Quality control is carried out at different stages of relay manufacturing to identify defects and verify the condition of the assembled product. The testing activities recorded in the internship included terminal and screw checking, spot-welding quality checking, heating and current checking, coil colour and heating inspection, mechanical adjustment and spacing, contact-force checking and continuity testing. Continuity testing verifies that the intended electrical path is complete, while mechanical inspections verify movement, spacing and contact behaviour. The final inspection combines the results of mechanical and electrical checks before the relay is accepted. [5]

The internship provided practical understanding of how theoretical electrical concepts are applied during industrial relay manufacturing. Concepts such as current, heating, resistance, switching and electrical continuity are involved together during the manufacturing and testing of a relay. The interaction between contacts, windings, thermal elements, mechanical parts and terminals demonstrates that relay performance depends on the correct assembly of all these components. The practical observation of manufacturing and inspection operations helped in understanding the importance of proper component positioning, secure joining, correct spacing and systematic testing. [6]

Overall, the study of relay manufacturing and assembly provided practical knowledge of relay construction, production operations, testing and quality control. The internship demonstrated that a reliable relay depends on consistent manufacturing practices, accurate component assembly, proper mechanical adjustment and electrical verification. It also provided knowledge of industrial safety, process discipline and inspection procedures. The complete manufacturing sequence, from relay box moulding and component preparation to final inspection, helped connect theoretical knowledge with actual industrial practices and provided a better understanding of the manufacturing of reliable relay products. [7]

Motivation

The main motivation for undertaking this industrial internship was to gain practical knowledge of relay manufacturing, assembly and testing processes and to understand how theoretical electrical concepts are applied in an actual industrial environment. The internship provided an opportunity to study different relay components such as contacts, Kanthal wire, bimetallic coil, terminals and mechanical parts, along with their manufacturing and assembly operations. Practical exposure to winding, riveting, spot welding, mechanical adjustment, continuity testing and quality inspection helped

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develop a better understanding of the importance of accurate assembly and systematic testing in achieving reliable relay performance.

Objectives

1. To study the manufacturing and assembly process of MK1, MK2 and MU-2 Pole relays.
2. To understand the construction and functions of different relay components.
3. To gain practical knowledge of relay manufacturing and assembly operations.
4. To study the winding, riveting, spot welding and coil joining processes.
5. To understand the mechanical adjustment, contact spacing and contact-force requirements.

II. LITERATURE SURVEY

1. Relay Manufacturing and Assembly Study

The industrial report presents a practical study of relay manufacturing and assembly, covering MK1, MK2 and MU-2 Pole relay variants. It describes the major components, manufacturing operations and assembly procedures involved in producing relay units. The study emphasizes the importance of proper component selection, accurate assembly and systematic production processes for obtaining reliable relay products [4].

2. Relay Components and Construction

The report describes the construction of relays using components such as the relay box, fixed contact, silver button, stop contact, start contact, Kanthal wire, bimetallic coil, terminal and screw. Each component is assembled according to the required mechanical and electrical arrangement. The study highlights the importance of correct positioning and fixing of these components during relay assembly [5].

3. Relay Manufacturing Process

The manufacturing process described in the report includes relay box moulding, fixed contact preparation and riveting, silver button fixing, relay slide assembly, safety relay assembly, stop and start contact assembly, Kanthal wire winding, bimetallic coil winding, spot welding, coil joining and terminal screw assembly. The report shows that relay production involves a sequence of interconnected operations that must be performed accurately to achieve the required final assembly [7].

4. Relay Testing and Quality Control

The report presents various quality-control and testing activities performed during relay manufacturing. These include terminal and screw checking, spot-welding inspection, heating and current checking, coil colour and heating inspection, mechanical adjustment, spacing and contact-force checking and continuity testing. These inspections help verify the electrical and mechanical condition of the relay before final acceptance [10].

5. Practical Industrial Training in Relay Production

The internship study provided practical exposure to relay manufacturing, assembly, testing and inspection activities. It helped in understanding the relationship between theoretical electrical concepts and actual industrial production practices. The report also emphasizes the importance of proper assembly, quality inspection, safety practices and systematic testing in achieving reliable relay production [11].

Existing system

1. Relay Manufacturing and Assembly

The existing system studied during the internship is based on the manufacturing and assembly of MK1, MK2 and MU-2 Pole relays at SK Enterprises. The system involves a series of electrical, mechanical and assembly operations through which individual relay components are converted into a complete finished product. The manufacturing activities include relay box moulding, fixed contact preparation, riveting, silver button fixing, relay slide assembly, safety relay assembly, stop and start contact assembly, Kanthal wire winding, bimetallic coil winding, spot welding, coil joining and terminal

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screw assembly. Each stage is performed as part of a systematic production sequence, and proper handling of components is required to obtain the desired relay assembly.

2. Component Preparation and Assembly

The existing system uses several components for the construction of the relay, including the relay box, fixed contact, silver button, stop contact, start contact, Kanthal wire, bimetallic coil, terminal and screw. These components are prepared and assembled according to their respective positions and functions in the relay. Fixed contacts are prepared and riveted, silver buttons are fixed to the required contact arrangement, and the stop and start contacts are assembled with the relay mechanism. Kanthal wire and the bimetallic coil are also processed through their respective winding operations. Accurate component preparation and assembly are important for maintaining the required mechanical arrangement and electrical connection of the finished relay.

3. Manufacturing Process

The existing manufacturing process follows a defined sequence of operations beginning with relay box moulding and continuing through various component preparation and assembly stages. Fixed contact preparation and riveting are followed by silver button fixing, relay slide assembly and safety relay assembly. The stop and start contacts are then assembled, followed by Kanthal wire winding and bimetallic coil winding. Spot welding and coil joining are carried out to establish the required connections, after which terminal and screw assembly is completed. The sequence ensures that the different electrical and mechanical parts are progressively combined to form the complete relay assembly before testing and final inspection.

4. Mechanical Adjustment and Inspection

Mechanical adjustment forms an important part of the existing relay assembly system. During assembly, the relay slide, stop contact and start contact require proper positioning so that the mechanism operates correctly. The system includes checking of mechanical movement, contact spacing and contact force to ensure that the assembled components are positioned according to the required arrangement. Proper adjustment is necessary because the relay contains moving and fixed components that must work together during operation. Mechanical inspection therefore helps identify incorrect positioning, unsuitable spacing or other assembly-related issues before the relay proceeds to the final inspection stage.

III. PROPOSED SYSTEM

1. Improved Relay Manufacturing and Assembly

The proposed system focuses on improving the existing relay manufacturing and assembly process by maintaining a systematic sequence for component preparation, assembly, testing and inspection. The manufacturing of MK1, MK2 and MU-2 Pole relays can be carried out with greater emphasis on accurate component positioning, proper assembly and consistent inspection at each stage. The major operations such as relay box moulding, fixed contact preparation, riveting, silver button fixing, relay slide assembly, contact assembly, Kanthal wire winding, bimetallic coil winding, spot welding, coil joining and terminal screw assembly are retained as the basic manufacturing activities.

2. Proper Component Handling

The proposed system gives importance to proper handling and positioning of relay components during assembly. Components such as the relay box, fixed contact, silver button, stop contact, start contact, Kanthal wire, bimetallic coil, terminal and screw should be assembled according to their required positions. Careful handling during winding, riveting, welding and fixing operations can help maintain consistency in the assembled relay and reduce the possibility of assembly-related defects.

3. Controlled Manufacturing Process

The proposed system emphasizes systematic execution of the manufacturing operations from the initial component preparation to the final assembly. Operations such as Kanthal wire winding, bimetallic coil winding, spot welding and coil joining require proper attention to the condition of the components and connections. Maintaining the required sequence and checking the work at appropriate stages can help ensure that the relay assembly is completed correctly before it is subjected to final testing.

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4. Improved Mechanical Inspection

The proposed system places greater emphasis on mechanical inspection during relay assembly. The relay slide, stop contact and start contact should be checked for proper positioning and free movement. Contact spacing, mechanical adjustment and contact force should be verified during the assembly process. Regular checking of these parameters can help identify mechanical problems at an early stage and support consistent operation of the completed relay.

5. Systematic Electrical Testing

The proposed system includes systematic electrical testing of the assembled relay before final acceptance. Heating and current checking, coil colour and heating inspection and continuity testing should be carried out as part of the testing procedure. These checks help verify the electrical condition of the relay and identify problems related to heating, current flow, coil condition or continuity before the finished product is accepted.

IV. SYSTEM DESIGN

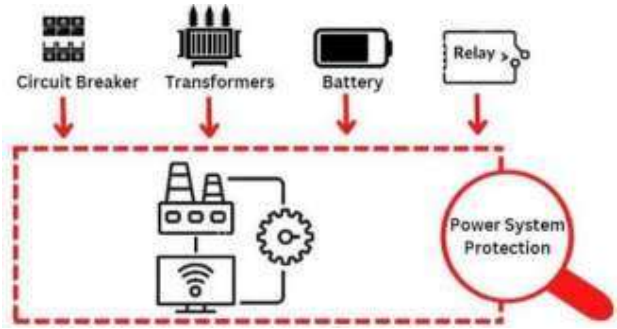

Fig. 1 Block Diagram

System Design

1. Relay System Structure

The system design is based on the manufacturing and assembly structure of MK1, MK2 and MU-2 Pole relays. The relay is designed as an assembly of electrical, mechanical and thermal components including the relay box, fixed contact, silver button, stop contact, start contact, Kanthal wire, bimetallic coil, terminal and screw. The components are arranged and assembled according to their respective positions to form the complete relay unit.

2. Component Assembly Design

The component assembly design consists of sequential operations for preparing and joining the individual relay components. Fixed contacts are prepared and riveted, silver buttons are fixed, and the relay slide, stop contact and start contact are assembled. Kanthal wire and bimetallic coils are wound according to the required assembly, followed by spot welding, coil joining and terminal screw assembly. The design therefore combines mechanical fixing, electrical connection and winding operations into one complete relay assembly.

3. Mechanical Arrangement

The mechanical design includes the relay slide, stop contact, start contact and other supporting components. These parts are positioned so that the relay mechanism can move correctly during operation. Mechanical adjustment, spacing and contact-force checking form important parts of the design, as proper positioning of the moving and fixed components is required for the required relay operation.

4. Thermal and Winding Arrangement

The winding arrangement consists of Kanthal wire and a bimetallic coil. Kanthal wire is used for the winding operation, while the bimetallic coil consists of two metals having different thermal expansion characteristics. The winding and coil assembly are therefore designed to provide the required thermal and mechanical response. Proper winding and coil joining are important parts of the relay construction and are followed by inspection of coil colour and heating condition.

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5. Electrical Connection Design

The electrical connection design includes the fixed and moving contacts, silver button, coil, terminal and screw arrangement. The components are assembled to establish the required electrical path within the relay. Terminal and screw checking, heating and current checking and continuity testing are used to verify the electrical condition of the completed assembly.

6. Testing and Quality Design

The final system design incorporates both mechanical and electrical inspection. Mechanical adjustment, spacing and contact-force checking are combined with spot-welding inspection, heating and current checking, coil inspection and continuity testing. This integrated inspection arrangement ensures that the assembled relay is checked for both mechanical and electrical conditions before final acceptance.

VI. OUTCOMES FROM THE SYSTEM

1. Improved Understanding of Relay Manufacturing

The system provided practical understanding of the complete manufacturing and assembly process of MK1, MK2 and MU-2 Pole relays, from component preparation to final inspection. It helped in understanding how different manufacturing operations are combined to produce a complete relay assembly.

2. Better Knowledge of Relay Components

The study provided detailed practical knowledge of major relay components such as the relay box, fixed contact, silver button, stop contact, start contact, Kanthal wire, bimetallic coil, terminal and screw. It also helped in understanding their role in the overall relay assembly.

3. Practical Manufacturing Skills

The system provided practical exposure to important manufacturing operations including moulding, riveting, silver button fixing, winding, spot welding, coil joining and terminal screw assembly. This helped develop an understanding of the sequence and importance of individual production operations.

4. Understanding of Mechanical Inspection

The study provided practical knowledge of mechanical adjustment, contact spacing, contact-force checking and relay slide movement. These activities helped in understanding the importance of accurate mechanical assembly for proper relay operation.

5. Understanding of Electrical Testing

The system provided practical exposure to heating and current checking, coil inspection and continuity testing. These tests helped in understanding how the electrical condition of the assembled relay is verified before final acceptance.

6. Improved Quality-Control Knowledge

The study provided practical knowledge of quality-control activities such as terminal and screw checking, spot-welding inspection, mechanical adjustment, spacing, contact-force checking and electrical testing. This demonstrated the importance of systematic inspection throughout relay manufacturing.

7. Industrial Practical Experience

The overall system provided practical industrial experience in relay production, assembly, testing, inspection and safety practices. It helped connect theoretical electrical knowledge with actual industrial manufacturing activities and improved understanding of systematic production and quality practices.

VIII. CONCLUSION

The industrial internship at SK Enterprises, F-26 MIDC Ahmednagar, provided practical knowledge of relay manufacturing, assembly, testing and quality-control procedures. The study covered MK1, MK2 and MU-2 Pole relays and provided understanding of components such as the relay box, fixed contact, silver button, stop and start contacts, Kanthal wire, bimetallic coil, terminal and screw. Practical exposure to moulding, riveting, winding, spot welding, coil joining, mechanical adjustment, continuity testing, heating and current checking and final inspection helped in

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understanding the complete relay manufacturing process. The internship also demonstrated the importance of accurate component assembly, proper mechanical adjustment, systematic electrical testing and quality inspection for producing reliable relay assemblies.

IX. FUTURE SCOPE

The future scope of the relay manufacturing system includes further improvement in manufacturing consistency, component assembly, testing and quality-control practices. The existing process can be developed by giving greater attention to accurate component positioning, winding quality, spot-welding quality, mechanical adjustment, contact spacing and contact force. Testing procedures such as heating and current checking, coil inspection and continuity testing can also be strengthened to improve the reliability and consistency of finished relay assemblies. Further improvement in systematic inspection and process control can support better production quality and help in developing more efficient relay manufacturing practices. These possibilities are based on the manufacturing, assembly and testing activities described in the internship report; the report itself does not specify particular future technologies or automation systems.

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