Summer Internship Report On

AUTOMATED PRODUCTION OF MCB

In HAVELLS INDIA LTD.

BADDI, HIMACHAL PRADESH, INDIA

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In Fulfillment of

7TH Semester, B.Tech (Electronics Engineering)

Under the Guidance of

Ms. Nisha Kumari

Graduate Engineer Trainee (Havells India Ltd.)

University of Petroleum & Energy Studies

College of Engineering Studies, Energy Acres

Bidholi, Dehradun

Acknowledgement

The project bears the imprints of the efforts extended by many people to whom we are deeply indebted.

The eight weeks of working on this project under the guidance of our Project Leader has greatly influenced our way of thinking towards facing the challenges during day-to-day development of this project. This will help us a lot in future as we move further ahead in our professional lives in the days to come.

We would like to thank our mentor **Ms. Nisha Kumari** under whose able guidance we gained the insights and ideas without which the project could not have seen the light of the day. Her suggestions have been valuable and her teachings during the course of our discussions would continue to be a guiding principle in our works in the future as well.

We would like to thank the **University of Petroleum & Energy Studies** and **Havells India Ltd.** for providing us an opportunity to apply our technical knowledge in the form of this project.

Last but not the least we would also like to express my gratitude to Havells employees who helped us a lot throughout this project.

College of Engineering

University of Petroleum and Energy Studies

Dehradun

CERTIFICATE

This is to certify that the project work on **"Automated Production Of MCB"** submitted to the University of Petroleum and Energy Studies, Dehradun, by **Ankit Kumar(R790209014), Namit Mehta(R790209033)**, **Rohit Joshi(R790209048), Puneet Dobhal(R790209045)** a Summer internship project in Electronics Engineering Academic session 2012-13 is a bonafide work carried out by them under my supervision and guidance.

Date: 27/07/2012 ***Ms. Nisha Kumari***

Graduate Engineer Trainee (Havells India Ltd.)

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1. INTRODUCTION TO COMPANY:-

1.1. PROFILE:-

Starting off as an electrical trading company in 1958, Havells India Ltd. today is an emerging leader and an end-to-end solution provider in the Power Distribution Equipment industry. The company catering to the needs of domestic and industrial market has seven manufacturing units in India. Havells India Ltd, a billion-dollar-plus organization, and one of the largest & India's fastest growing electrical and power distribution equipment company, manufacturing products ranging from Building Circuit Protection, Industrial & Domestic Switchgear, Cables& Wires, Energy Meters, Fans, CFL Lamps, Luminaries for Domestic, Commercial& Industrial application and Modular Switches. Havells owns some of the prestigious global brands like Crabtree*, Sylvania, Concord, Luminance, Claude, Sylvania, Linolite, SLI Lighting & Zenith.

Havells reach stretches across 91 branch offices, over 2000 authorized dealers and thousands of approved retail outlets. The company has an enviable clientele, not only in the domestic market, but also in international markets like UK, Malaysia, Singapore, Bangladesh, Sri Lanka, Dubai, Africa, Iran and Iraq. The company is currently exporting to over 50 countries globally. Havells is acknowledged as a manufacturer & supplier of the widest range of quality low voltage electrical equipment. With a number of strategic alliances in place, Havells is the only company that has shown phenomenal growth rate with the help of various joint ventures, acquisitions, mergers and takeovers. Havells recently acquired Frankfurt headquartered, SLI Sylvania for $ 300 mn. The company is a leading global designer and provider of lighting systems for lamps and fixtures. Sylvania is one of the most globally recognized brands for over a century in the electrical industry with brands like Sylvania, Concord: marlin, Lumiance, Marlin, Claude and Linolite-Sylvania.

1.2. PROMOTERS:-

QRG Group is one of the fastest growing Electrical and Power Distribution Equipment Company in the country, manufacturing products ranging from building circuit protection, industrial & domestic switchgear, cables & wires, energy meters, fans, CFLs, luminaries, bath fittings and modular switches. The group comprises of 5 companies –

1) Havells India Ltd. (the flagship company)

2) Standard Electricals

3) Crabtree India Ltd

4) TTL

5) Sylvania

With 13 state of the art manufacturing plants, 24 branch offices and a strong backing of over 3000 professionals across India the group has achieved rapid success in the past few years. The group has recorded a turnover of Rs. 963 crores in the previous financial year and is poised for another quantum growth with projections suggesting a 50% increase over previous year. While the industry has been growing at a pace of 20% CAGR, QRG Enterprises has been marching faster at a compounded annual growth rate of 35% in the past decade.

1.3. BOARD OF DIRECTORS: -

1. Mr. Qimat Rai Gupta (Chairman and Managing Director)

2. Mr. Anil Gupta (Joint Managing Director)

3. Mr. Surjit Gupta (Director Operations)

4. Mr. Ameet Gupta (Director International Marketing)

5. Mr. Rajesh Gupta (Director Finance)

1.4. MANUFACTURING PLANTS:-

Their strategic alliances with some of the leading technology corporations in the world of electrical engineering, ensure constant access to the latest developments in the international markets, which are then adapted to the tough tropical conditions. Their manufacturing units are fully equipped with the latest and most sophisticated facilities in India. And in the hands of their highly qualified technical experts, this results in some of the most advanced product development in the country.

Location: Branch offices / zonal offices / manufacturing plants:-

•Haridwar, Uttarakhand: Products manufactured- Fans and CFLs

•Baddi, Himachal Pradesh: Products manufactured- MCBs, RCCBs and Switches

•Samepur Badli, Delhi: Products manufactured- MCBs, ELCBs and DBs

•Tilak Nagar, Delhi: Products manufactured- Energy Meters

•NOIDA, UP: Product manufactured- Fans

•Alwar, Rajasthan: Products manufactured- Cables & Wires

•Faridabad, Haryana: Products manufactured- CFLs and Industrial Products.

•Gurgaon, Haryana: Products manufactured- Luminaries and Lighting fixtures

•Jalandhar: Products manufactured- MCBs, ELCBs, DBs, Wires and Industrial Switchgear

•Gurgaon, Haryana: Products manufactured- Modular Plate Switches & Accessories

•Bhiwadi, Rajasthan: Products manufactured- Bathroom fittings & Accessories

•Sahibabad, UP: Products manufactured- Trivector Meters, Reference Standard Meters

•Hyderabad, AP: Products manufactured- Energy Meters

2. INTRODUCTION TO PROJECT:-

What is a Circuit Breaker?

A circuit breaker is an automatically-operated electrical switch designed to protect an electrical circuit from damage caused due to excess passage of current. Its basic function is to detect a fault and, by interrupting continuity, to immediately discontinue electrical flow. Unlike a fuse, which operates once and then has to be replaced, a circuit breaker can be reset (either manually or automatically) to resume normal operation. Circuit breakers are made in various sizes, from small devices used to protect an individual household appliance up to large switchgear designed to protect high voltage circuits to supply an entire city.

What is a MCB?

A MCB (Miniature circuit breaker) is a mechanical switching device which is capable of making, carrying and breaking currents under normal circuit conditions and also making, carrying for a specified time and automatically breaking currents under specified abnormal circuit conditions such as those of short circuit. In short, MCB is a device for overload and short circuit protection. They are used in residential & commercial areas. Just like we spend time to make a thorough check before buying appliances like washing machines or refrigerators, we must also research about MCBs. Also, if you are still using a fuse then you must replace it with MCB.

Need of MCB?

Electrical distribution needs are continuously evolving in residential, commercial and Industrial sectors. Improved operational safety, continuity of service, greater convenience and operating cost has assumed a tremendous significance. Miniature circuit breakers have been designed to continuously adapt to these changing needs.

Different Ranges OF MCB?

6A to 40A "B" Curve
0.5A to 63A "C" Curve
0.5A to 63A for "DC" Application

Types of Execution of MCB?

Single Pole (1P)
Single Pole & Neutral (1P+N)
Double Pole (2P)
Three Pole (3P)
Three Pole & Neutral (3P+N)
Four Pole (4P)

What are the features of MCB?

• Precise hammer action
• 15 Plates Arc Chute for effective arc quenching
• Longer electrical life
• Wide range
• Value for money
• Low power consumption, thus cost effective & energy saving

What is automation?

Automation is the use of machines, control systems and information technologies to optimize productivity in the production of goods and delivery services. The correct incentive for applying automation is to increase productivity, and/or quality beyond that possible with current human labor levels so as to realize economies of scale, and/or realize predictable quality levels. The incorrect application of automation, which occurs most often, is an effort to eliminate or replace human labor. Simply put, whereas correct application of automation can net as much as 3 to 4 times original output with no increase in current human labor costs. Incorrect application of automation can only save a fraction of current labor level costs. In the scope of industrialization, automation is a step beyond mechanization. Whereas mechanization provides human operators with machinery to assist them with the muscular requirements of work. Automation greatly decreases the need for human sensory and mental requirements while increasing load capacity, speed, and repeatability. Automation plays an increasingly important role in the world economy and in daily experience.

Automation has had a notable impact in a wide range of industries beyond manufacturing (where it began). Once-ubiquitous telephone operators have been replaced largely by automated telephone switchboards and answering machines. Medical processes such as primary screening in electrocardiography or radiography and laboratory analysis of human genes, sera, cells, and tissues are carried out at much greater speed and accuracy by automated systems. Automated teller machines have reduced the need for bank visits to obtain cash and carry out transactions. In general, automation has been responsible for the shift in the world economy from industrial jobs to service jobs in the 20th and 21st centuries.

The term *automation*, inspired by the earlier word *automatic* (coming from *automaton*), was not widely used before 1947, when General Motors established the automation department. At that time automation technologies were electrical, mechanical, hydraulic and pneumatic. Between 1957 and 1964 factory output nearly doubled while the number of blue collar workers started to decline.

Advantages and disadvantages:-

The main advantages of automation are:

- Increased throughput or productivity.
- Improved quality or increased predictability of quality.
- Improved robustness (consistency), of processes or product.

The following methods are often employed to improve productivity, quality, or robustness.

- Install automation in operations to reduce cycle time.
- Install automation where a high degree of accuracy is required.
- Replacing human operators in tasks that involve hard physical or monotonous work.
- Replacing humans in tasks done in dangerous environments (i.e. fire, space, volcanoes, nuclear facilities, underwater, etc.)
- Performing tasks that are beyond human capabilities of size, weight, speed, endurance, etc.
- Economy improvement: Automation may improve in economy of enterprises, society or most of humanity. For example, when an enterprise invests in automation, technology recovers its investment; or when a state or country increases its income due to automation like Germany or Japan in the 20th Century.
- Reduces operation time and work handling time significantly.
- Frees up workers to take on other roles.
- Provides higher level jobs in the development, deployment, maintenance and running of the automated processes.

The main disadvantages of automation are:

- Security Threats/Vulnerability: An automated system may have a limited level of intelligence, and is therefore more susceptible to committing an error.
- Unpredictable development costs: The research and development cost of automating a process may exceed the cost saved by the automation itself.
- High initial cost: The automation of a new product or plant requires a huge initial investment in comparison with the unit cost of the product, although the cost of automation is spread among many products.

In manufacturing, the purpose of automation has shifted to issues broader than productivity, cost, and time.

Applications:-

Automated video surveillance:-

The Defense Advanced Research Projects Agency (DARPA) started the research and development of automated visual surveillance and monitoring (VSAM) program, between 1997 and 1999, and airborne video surveillance (AVS) programs, from 1998 to 2002. Currently, there is a major effort underway in the vision community to develop a fully automated tracking surveillance system. Automated video surveillance monitors people and vehicle in real time within a busy environment. Existing automated surveillance systems are based on the environment they are primarily designed to observe, i.e., indoor, outdoor or airborne, the amount of sensors that the automated system can handle and the mobility of sensor, i.e., stationary camera vs. mobile camera. The purpose of a surveillance system is to record properties and trajectories of objects in a given area, generate warnings or notify designated authority in case of occurrence of particular events.

Automated highway systems:-

As demands for safety and mobility have grown and technological possibilities have multiplied, interest in automation have grown. Seeking to accelerate the development and introduction of fully automated vehicles and highways, the United States Congress authorized more than $650 million over six years for intelligent transport systems (ITS) and demonstration projects in the 1991 Intermodal Surface Transportation Efficiency Act (ISTEA). Congress legislated in ISTEA that "the Secretary of Transportation shall develop an automated highway and vehicle prototype from which future fully automated intelligent vehicle-highway systems can be developed. Such development shall include research in human factors to ensure the success of the man-machine relationship. The goal of this program is to have the first fully automated highway roadway or an automated test track in operation by 1997. This system shall accommodate installation of equipment in new and existing motor vehicles." [ISTEA 1991, part B, Section 6054(b)].

Full automation commonly defined as requiring no control or very limited control by the driver; such automation would be accomplished through a combination of sensor, computer, and communications systems in vehicles and along the roadway. Fully automated driving would, in theory, allow closer vehicle spacing and higher speeds, which could enhance traffic capacity in places where additional road building is physically impossible, politically unacceptable, or prohibitively expensive. Automated controls also might enhance road safety by reducing the opportunity for driver error, which causes a large share of motor vehicle crashes. Other potential benefits include improved air quality (as a result of more-efficient traffic flows), increased fuel economy, and spin-off technologies generated during research and development related to automated highway systems.

Automated manufacturing:-

Automated manufacturing refers to the application of automation to produce things in the factory way. Most of the advantages of the automation technology have its influence in the manufacture processes.

The main advantages of automated manufacturing are higher consistency and quality, reduced lead times, simplified production, reduced handling, improved work flow, and increased worker morale when a good implementation of the automation is made.

Home automation:-

Home automation (also called domotics) designates an emerging practice of increased automation of household appliances and features in residential dwellings, particularly through electronic means that allow for things impracticable, overly expensive or simply not possible in recent past decades.

Industrial automation:-

Industrial automation deals with the optimization of energy-efficient drive systems by precise measurement and control technologies. Nowadays energy efficiency in industrial processes are becoming more and more relevant. Semiconductor companies like Infineon Technologies are offering 8-bit microcontroller applications for example found in motor controls, general purpose pumps, fans, and e-bikes to reduce energy consumption and thus increase efficiency. One of Infineon`s 8-bit product line found in industrial automation is the XC800 family.

Agriculture:-

Now that we're moving towards automated orange-sorting [1] and autonomous tractors [2], the next step in automated agriculture is robotic strawberry pickers [3].

Agent-assisted Automation:-

Agent-assisted Automation refers to automation used by call center agents to handle customer inquiries. There are two basic types: desktop automation and automated voice solutions. Desktop automation refers to software programming that makes it easier for the call center agent to work across multiple desktop tools. The automation would take the information entered into one tool and populate it across the others so it did not have to be entered more than once, for example. Automated voice solutions allow the agents to remain on the line while disclosures and other important information is provided to customers in the form of pre-recorded audio files.

Specialized applications of these automated voice solutions enable the agents to process credit cards without ever seeing or hearing the credit card numbers or CVV codes.

The key benefit of agent-assisted automation is compliance and error-proofing. Agents are sometimes not fully trained or they forget or ignore key steps in the process. The use of automation ensures that what is supposed to happen on the call actually does, every time.

Automated production of MCB includes 3 major steps:-

1. SPOT WELDING
2. KNOB ASSEMBLY
3. MCB ASSEMBLY

These steps are discussed in detail further in our project report.

3. TECHNICAL SPECIFICATIONS:-

Standard Conformity		IS 8828 / IEC 60898-1 / EN 60898-1		
Type / Series		B	C	D
Rated Current (In)	A	6-40	0.5 - 63*	0.5 - 63*
Rated Voltage (Ue)	V~	240/415	240/415	240/415
Rated Frequency (f)	Hz	50		
No. of Poles (Execution)		1P, 1P+N, 2P, 3P, 3P+N, 4P		
Rated Short Circuit Breaking Capacity	kA	10	10	0.5 - 32A - 10 kA 40A - 63A - 4.5kA
Magnetic Release Setting		(3-5)In	(5-10)In	(10-20)In
Rated Insulation Voltage (Ui)	V	660		
Rated Impulse Voltage (Uimp)	kV	4		
Electrical / Mechanical Endurance (no. of operations) <32A >32A Ambient Working Temperature	(°C)	 20000 10000 -5°C to 55°C		
Terminal Capacity (max)	sq.mm	25		
Vibration	g	3		
Shock		40mm free fall		
Protection Class		IP-20		
Installation Position		Vertical / Horizontal		
Mounting		Clip on DIN Rail (35mm x 7.5mm)		
Case & Cover		Moulded, flame-retardant thermoplastic material.		

4. SPOT WELDING:-

Spot welding is a process in which contacting metal surfaces are joined by the heat obtained from resistance to electric current flow. Work-pieces are held together under pressure exerted by electrodes. Typically the sheets are in the 0.5 to 3 mm (0.020 to 0.12 in) thickness range.

The process uses two shaped copper alloy electrodes to concentrate welding current into a small "spot" and to simultaneously clamp the sheets together. Forcing a large current through the spot will melt the metal and form the weld. The attractive feature of spot welding is a lot of energy can be delivered to the spot in a very short time (approximately ten milliseconds). That permits the welding to occur without excessive heating to the rest of the sheet.

The amount of heat (energy) delivered to the spot is determined by the resistance between the electrodes and the amperage and duration of the current. The amount of energy is chosen to match the sheet's material properties, its thickness, and type of electrodes. Applying too little energy won't melt the metal or will make a poor weld. Applying too much energy will melt too much metal, eject molten material, and make a hole rather than a weld. Another attractive feature of spot welding is the energy delivered to the spot can be controlled to produce reliable welds.

Projection welding is a modification of spot welding. In this process the weld is localized by means of raised sections, or projections, on one or both of the work pieces to be joined. Heat is concentrated at the projections, which permits the welding of heavier sections or the closer spacing of welds. The projections can also serve as a means of positioning the work pieces. Projection welding is often used to weld studs, nuts, and other screw machine parts to metal plate. It's also frequently used to join crossed wires and bars. This is another high-production process, and multiple projection welds can be arranged by suitable designing and jigging.

Spot welding is typically used when welding particular types of sheet metal. Thicker stock is more difficult to spot weld because the heat flows into the surrounding metal more easily. Spot welding can be easily identified on many sheet metal goods, such as metal buckets. Aluminum alloys can be spot welded, but their much higher thermal conductivity and electrical conductivity requires higher welding currents. This requires larger, more powerful, and more expensive welding transformers.

Perhaps the most common application of spot welding is in the automobile manufacturing industry, where it is used almost universally to weld the sheet metal to form a car. Spot welders can also be completely automated, and many of the industrial robots found on assembly lines are spot welders (the other major use for robots being painting).

Spot welding is also used is in the orthodontist's clinic, where small scale spot welding equipment is used when resizing metal "molar bands" used in orthodontics.

Another application is spot welding straps to nickel-cadmium or nickel-metal-hydride cells in order to make batteries. The cells are joined by spot welding thin nickel straps to the battery terminals. Spot welding can keep the battery from getting too hot, as might happen if conventional soldering were done.

Good design practice must always allow for adequate accessibility. Connecting surfaces should be free of contaminants, such as scale, oil, and dirt, for quality welds. Metal thickness is generally not a factor in determining good welds.

PROCESSING AND EQUIPMENT

Spot welding involves three stages; the first of which involves the electrodes being brought to the surface of the metal and applying a slight amount of pressure. The current from the electrodes is then applied briefly after which the current is removed but the electrodes remain in place in order for the material to cool. Weld times range from 0.01 sec to 0.63 sec depending on the thickness of the metal, the electrode force and the diameter of the electrodes themselves.

The equipment used in the spot welding process consists of tool holders and electrodes. The tool holders function as a mechanism to hold the electrodes firmly in place and also support optional water hoses which cool the electrodes during welding. Tool holding methods include a paddle-type, light duty, universal, and regular offset. The electrodes generally are made of a low resistance alloy, usually copper, and are designed in many different shapes and sizes depending on the application needed.

The two materials being welded together are known as the work pieces and must conduct electricity. The width of the work pieces is limited by the throat length of the welding apparatus and ranges typically from 5 to 50 inches. Work piece thickness can range from 0.008in. to 1.25in.

Components used in Spot Welding are:-

- Bimetal
- Chord
- Bimetal Carrier
- Coil
- Moving Contact
- Pointer

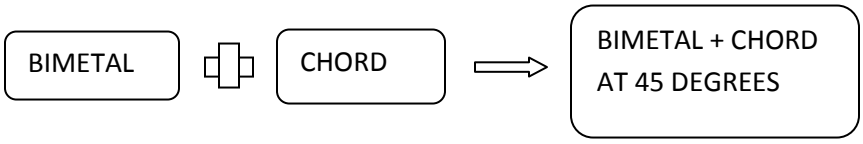
MCB's are produced of various ratings like 6A, 10A, 16A 20A, 25A etc.. Here we are taking an example of B10 model, i.e., 10A rating MCB. For such MCB, bimetal used must have following dimensions – 39mm X 5mm X 0.8mm (length X breadth X height).

Spot Welding is the initial stage of Automated MCB production. Here it incorporates following stages-

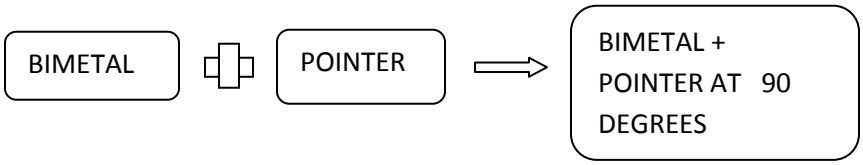
- Bimetal + Chord (45 degrees)
- Bimetal + Pointer (90 degrees)
- Bimetal Carrier + Bimetal
- Coil + Chord (180 degrees)
- Chord + Moving contact
- Final assembly (coil+chord and punching)

The above mentioned stages are better explained through following block diagrams-

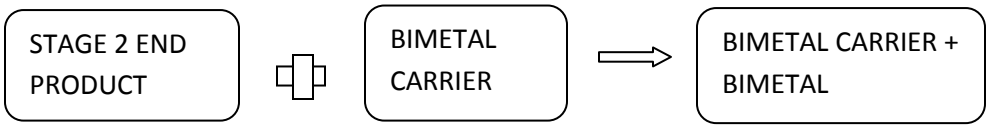
STAGE 1



STAGE 2



STAGE 3



STAGE 4

STAGE 5

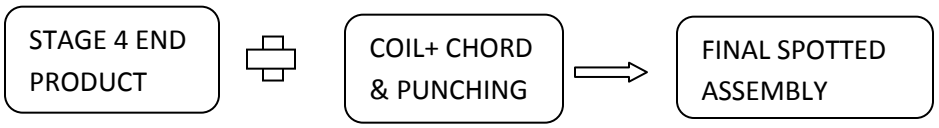
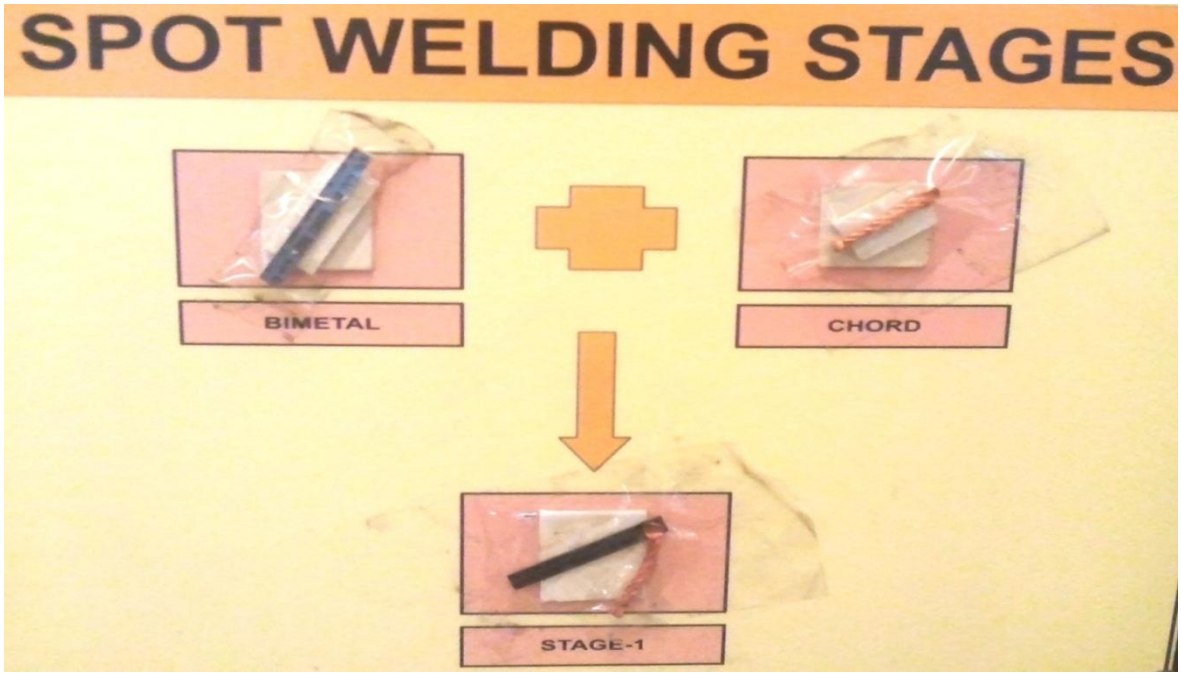
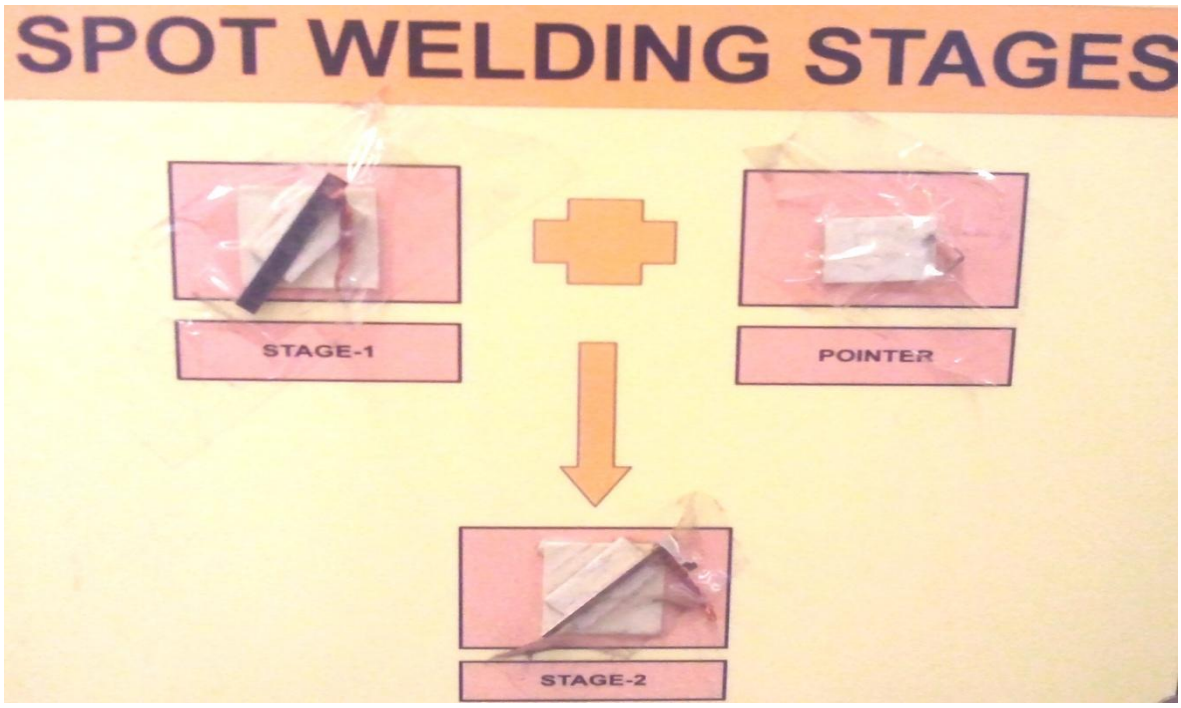


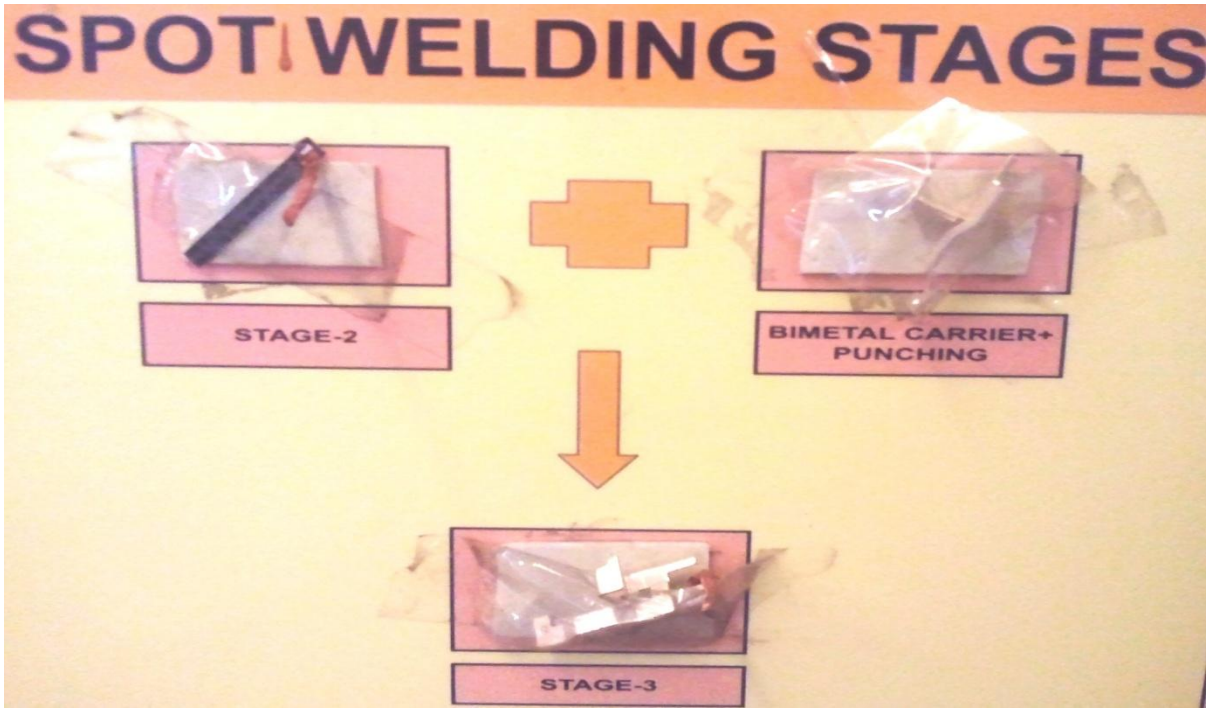
Fig. 1. Steps Of Spot Welding

The above steps clearly show how the process of spot welding is carried out. First we take a bimetallic strip and we attach a chord to it at 45 degrees. Then a pointer is attached to it at 90 degrees. Now we attach a bimetallic carrier to so far produced product and then a chord is attached to it at 180 degrees. Now we add a coil and chord and punching is done and hence we get final spotted assembly. The above steps are better explained in the pictures shown below with courtesy to Havells India Ltd. For allowing us to click those pictures

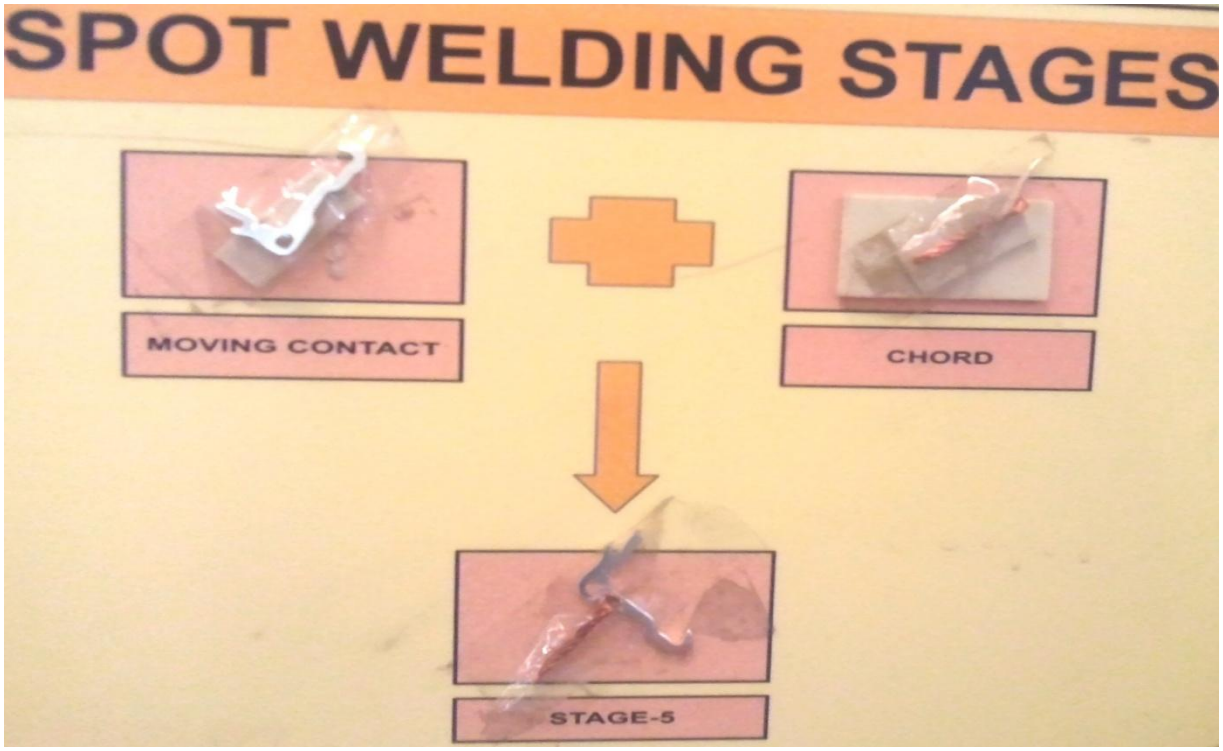
Fig. 2. Pictures: -

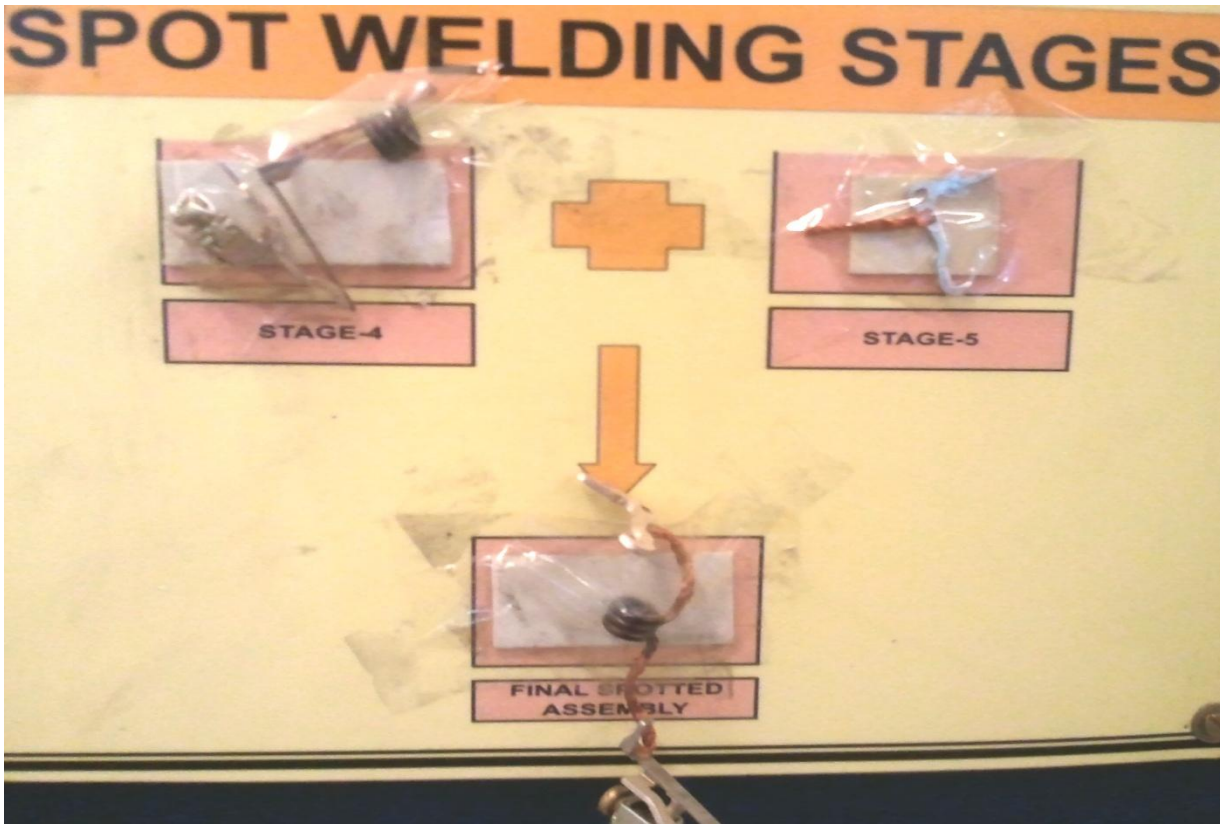





SPOT WELDING STAGES
STAGE-2
BIMETAL CARRIER+ PUNCHING
STAGE-3


SPOT WELDING STAGES
STAGE-3
COIL
STAGE 4

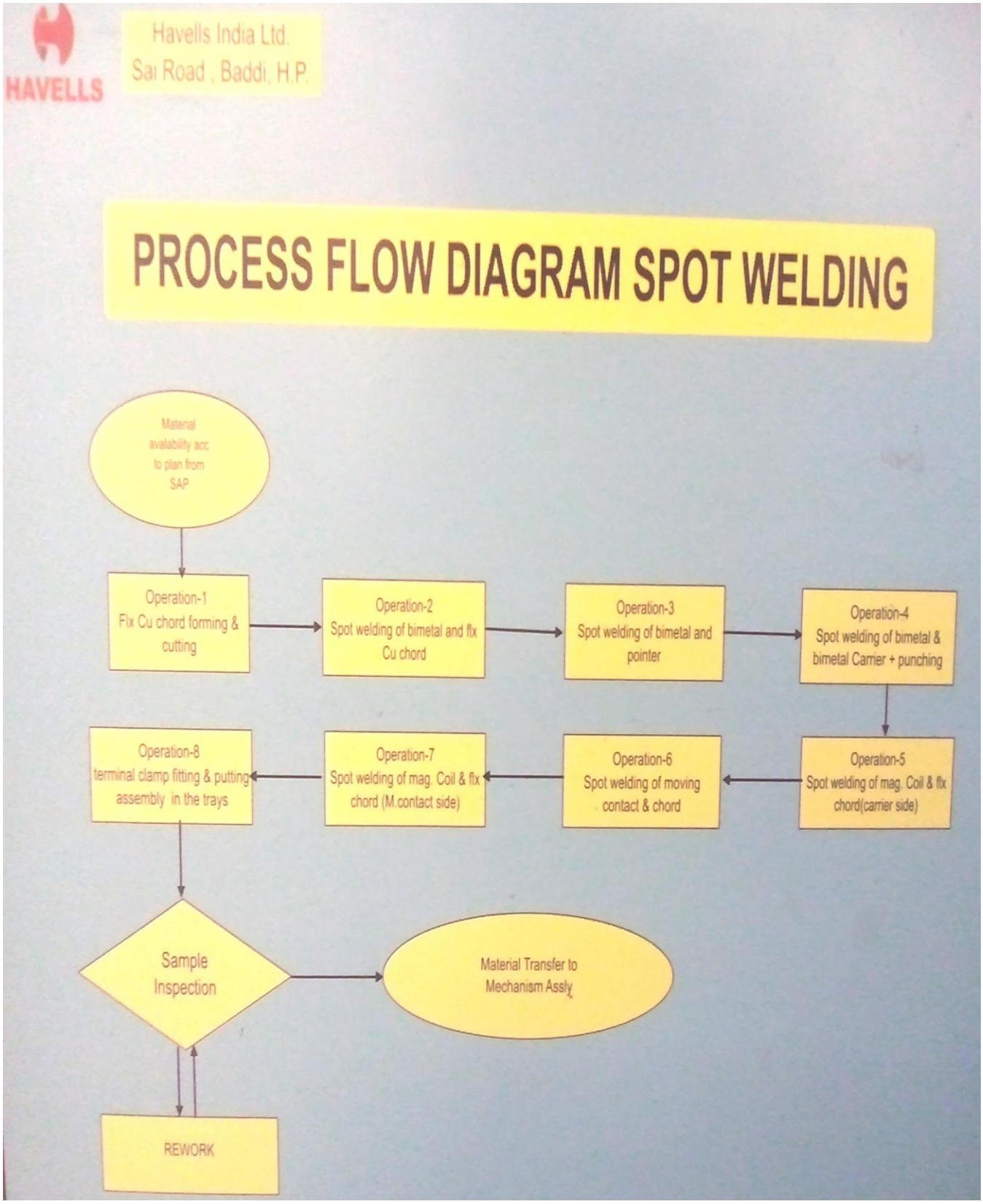

SPOT WELDING STAGES
MOVING CONTACT
CHORD
STAGE-5


SPOT WELDING STAGES
STAGE-4
STAGE-5
FINAL SPOTTED ASSEMBLY

Steps and Precautions in Spot Welding: -

- Fix Bimetal and carrier properly in SPM Fixture.
- For MCB's of rating between 6 and 32 amperes, use brass carrier.
- For 40 to 63 amperes MCB's use copper carrier.
- Check in Machine whether pressure pads are working properly.
- Use electrode copper chromium with flat vit.
- Use carrier only with proper flattening.
- Check that bimetal should not bend.
- Clean each fixture with air pressure after every 2hours.
- Check Electrode alignment.

Fig. 3. Process Flow Diagram for Spot Welding is shown below -:



Bimetal Used

The Bimetal used in Spot Welding Procedure is different for different kind of MCB's, in terms of their dimensions, which is identified from the chart in the following picture: -

MCB में प्रयोग होने वाली बाइमेटल के प्रकार व पहचान

रेटिंग	पहचान	लंबाई	चौडाई	मोटाई
6A	SBC-721-112	39 mm	4 mm	0.8 mm
10 A	SBC-206-1 SMC-AS-1577	39 mm	5 mm	0.8 mm
16 A	SBC-206-1 SMC-AS-1577	39 mm	5 mm	1 mm
20 A	SBC 206 Ni 25	39 mm	5 mm	0.8 mm
25 A	SBC 206 Cu 11	39 mm	5 mm	0.8 mm
32 A	SBC 206 Cu 6 SMC-AS6	39 mm	5 mm	0.8 mm
40 A	SBC 206 Cu 6 SMC-AS6	39 mm	5 mm	1 mm
63 A	SBC223Cu3TB1303 SMC-AS3	39 mm	5 mm	1 mm

Fig. 4. Bimetals

5. KNOB ASSEMBLY:-

Components used:

- Coil washer
- Yoke assembly
- Anchor spring
- Anchor assembly
- Arc Runner
- DT Spring
- Latch Assembly
- Knob link
- Latching Fork
- MS Pin
- Knob
- ST Spring
- Terminal clamp
- Terminal screw

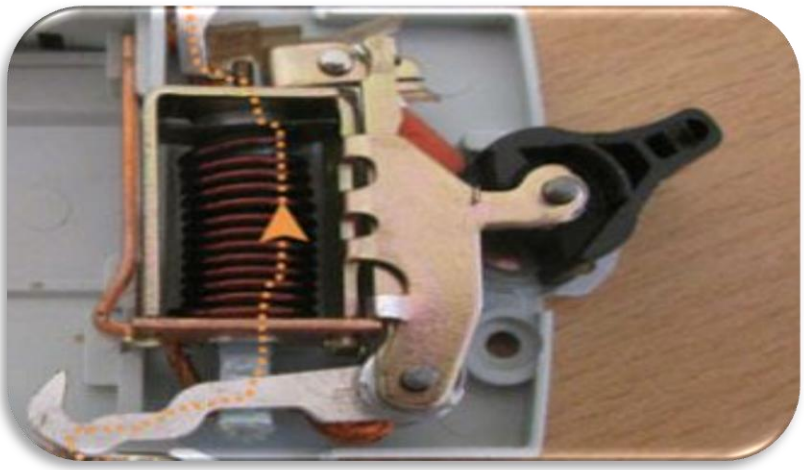
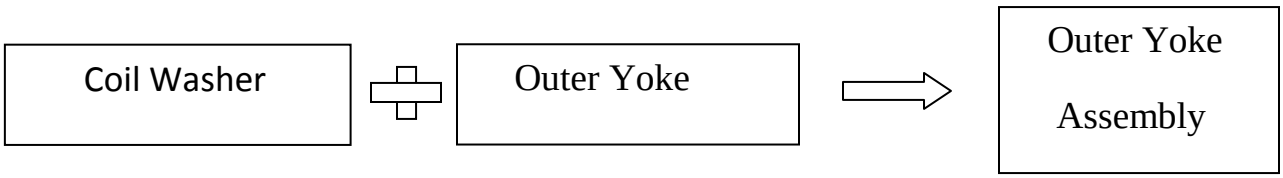


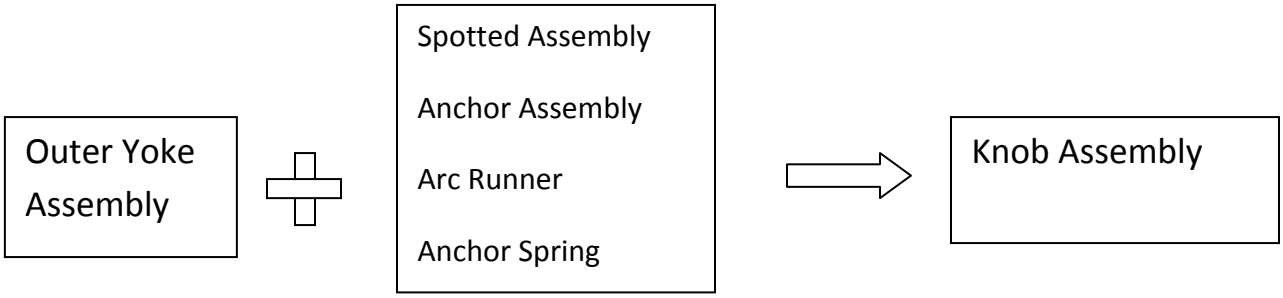
Fig. 5. Knob Assembly

Steps of Knob Assembly:-

- **STAGE 1:**



- **STAGE 2:**



Tools used:-

1. **Stage 1 :** Coil washer fixture
2. **Stage 2 :** Coil Assembly Fixture , Modified Screw Driver , Nozeplyer

Fig. 6. The process flow Diagram For knob Assembly is shown below: -

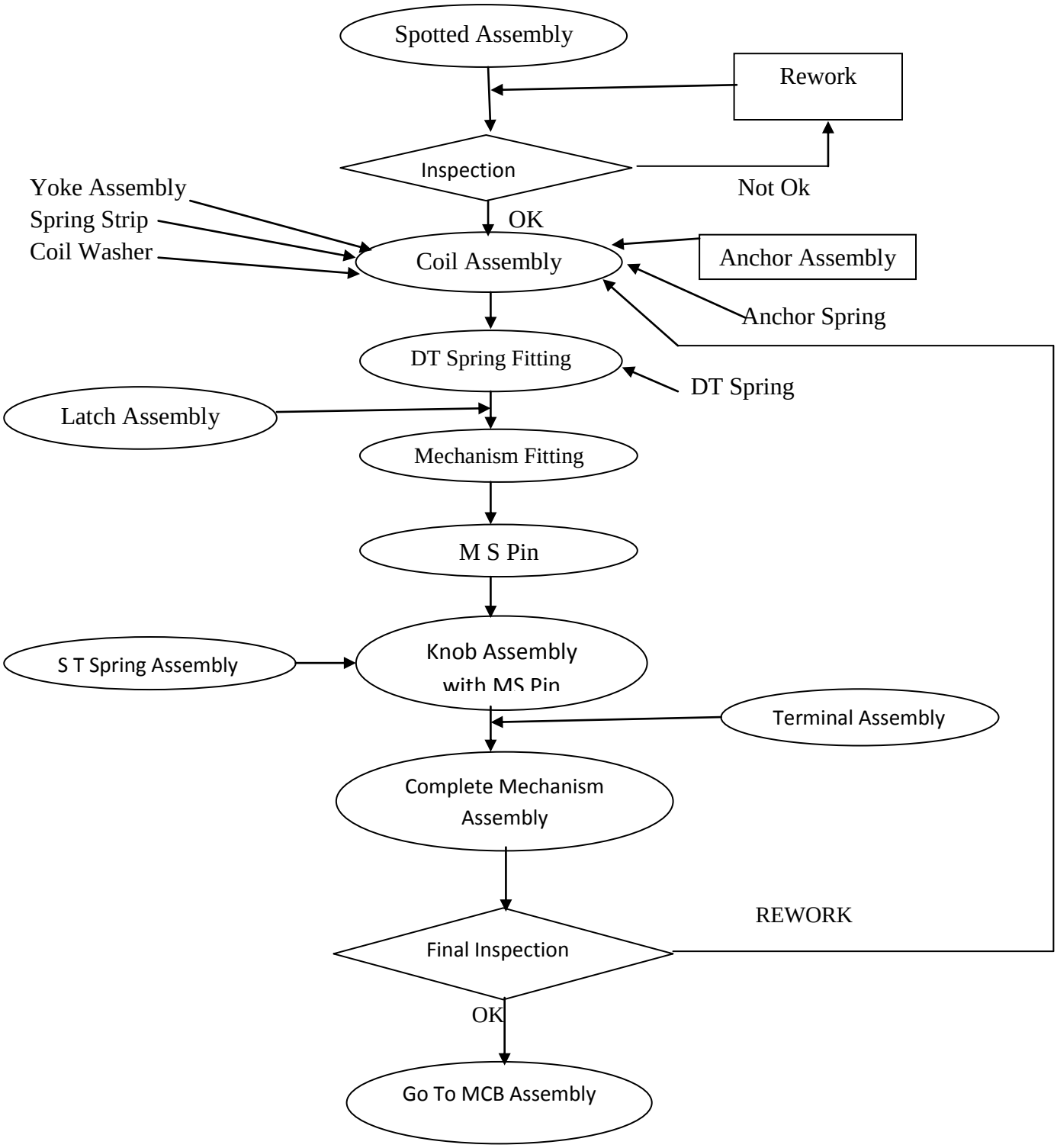


Fig. 7. The process of Knob Assembly is better depicted from the following pictures: -

6. MCB ASSEMBLY:-

Miniature Circuit Breakers have precisely formed moulded case & cover of flame retardant high strength thermo-plastic material having high melting point, low water absorption, high dielectric strength and temperature with stand.

The Switching Mechanism is independent, manual and trip free, i.e., the breaker trips internally even if the operating knob is held in ON position.

The Contact Mechanism comprises of fixed & moving contacts specially designed for reliability, long life and anti-weld properties.

The Arc Extinguishing Device comprises of 15 plates arc chute. The arc under the influence of the magnetic field and arc guide is moved into the
arc chute where it is rapidly split and quenched.

The tripping mechanism is Thermal Magnetic Type.

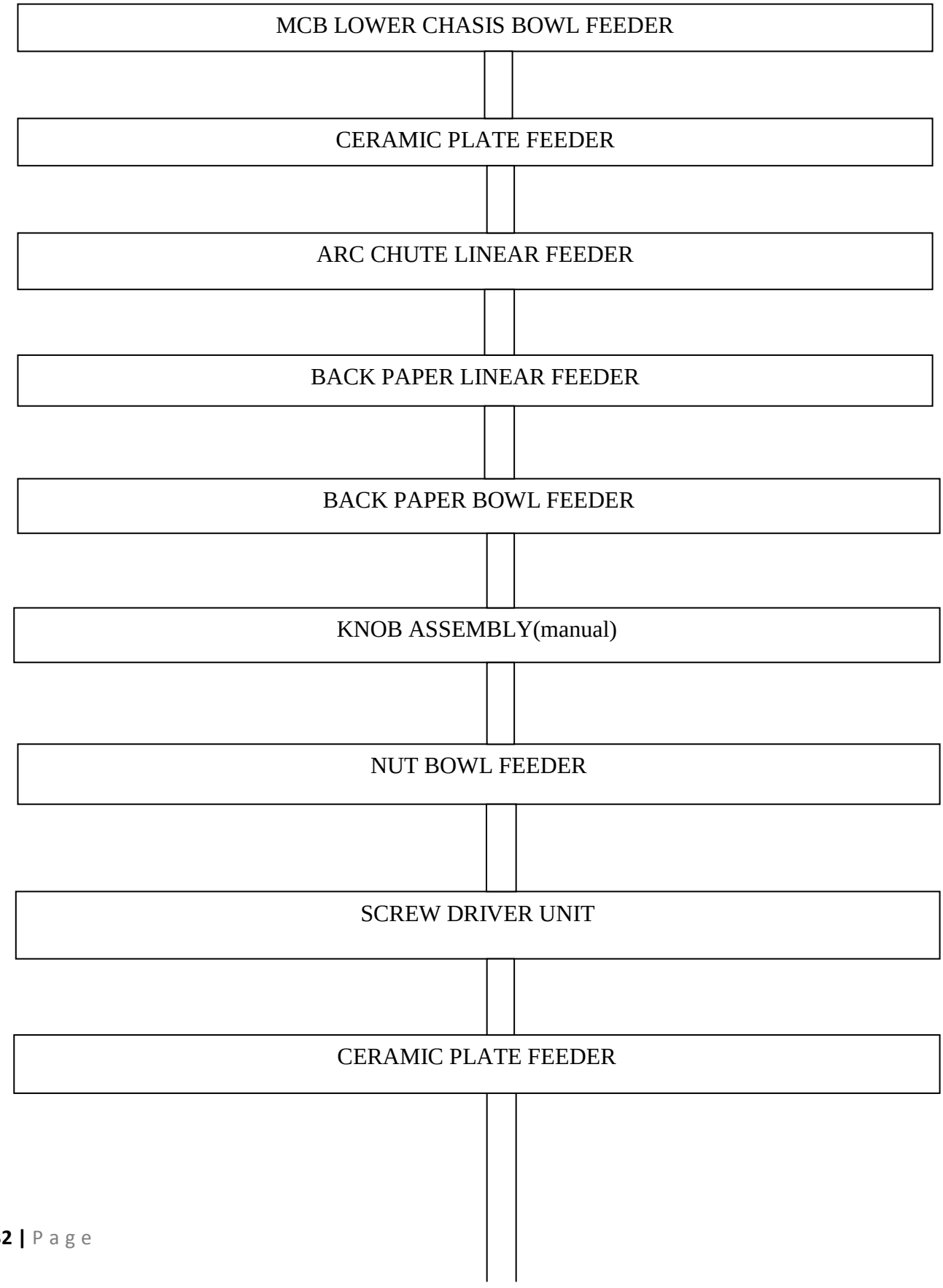
Thermal Operation:-

The thermal operation provides protection from moderate overloads. Under overload condition, a thermo-metallic element (bimetallic strip) deflects
until it operates a latching mechanism allowing the main contacts to open.

Magnetic Operation:-

In magnetic operation, large overloads or short circuit current actuates a solenoid causing a plunger to strike the latching mechanism rapidly opening
the main contacts.

Fig. 8. MCB ASSEMBLY AUTOMATION BLOCK DIAGRAM



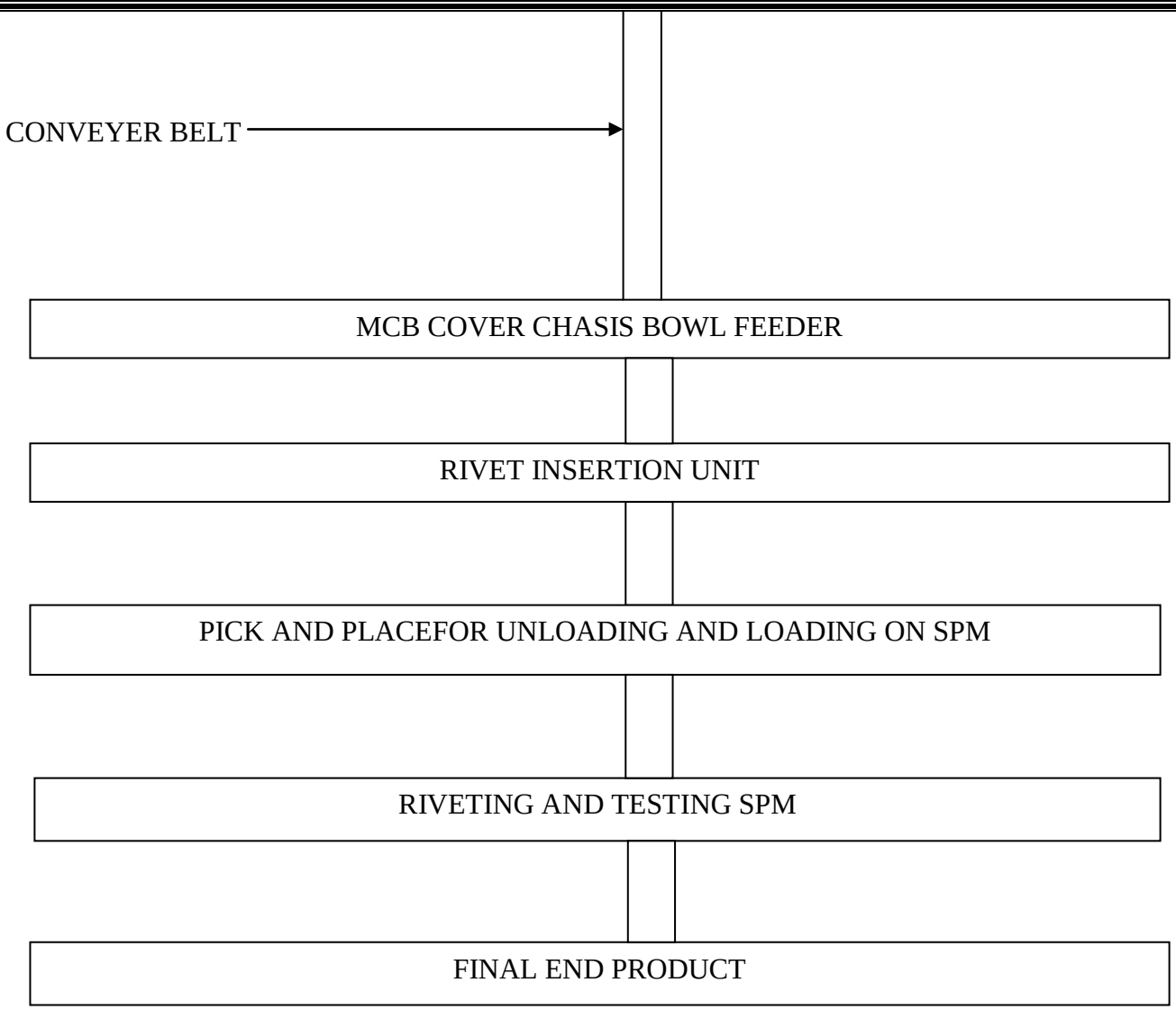
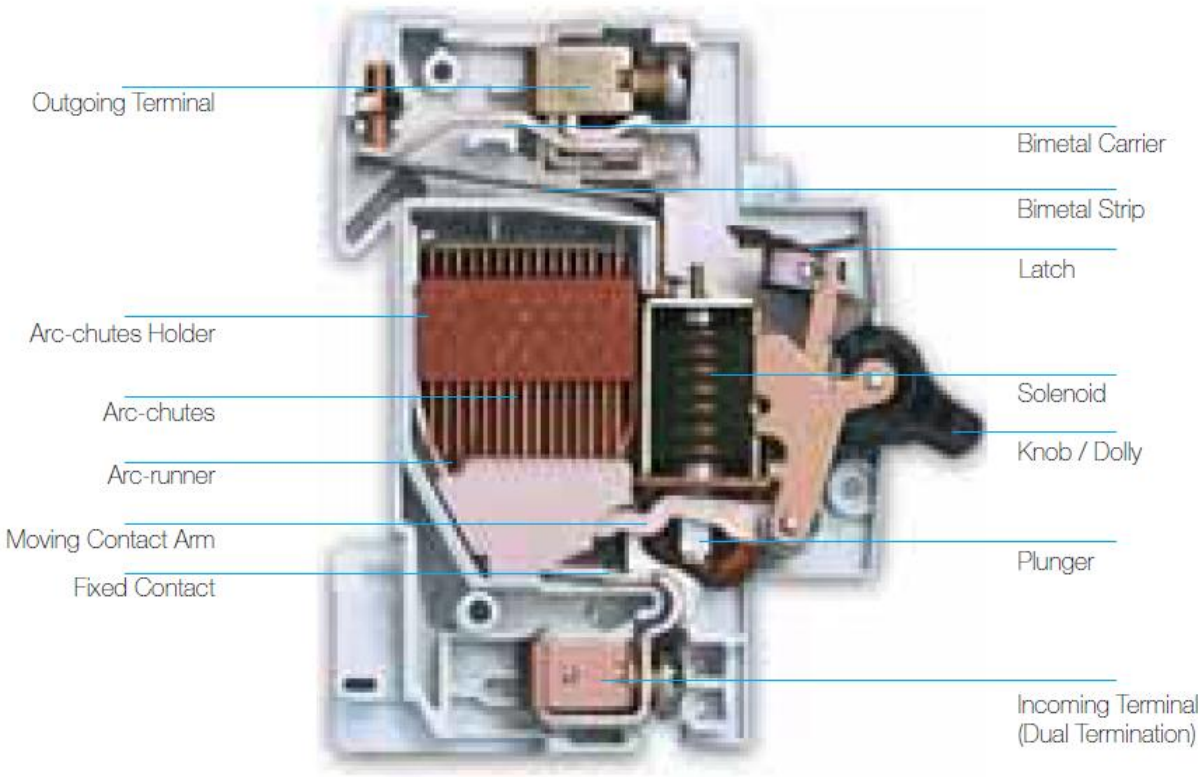

CONVEYER BELT
MCB COVER CHASIS BOWL FEEDER
RIVET INSERTION UNIT
PICK AND PLACEFOR UNLOADING AND LOADING ON SPM
RIVETING AND TESTING SPM
FINAL END PRODUCT

Fig. 9. INTERNAL VIEW OF MCB:-



7. CONSTRUCTION AND OPERATION OF MCB: -

Construction: -

Miniature Circuit Breakers have precisely formed moulded case & cover of flame retardant high strength thermo-plastic material having high melting point, low water absorption, high dielectric strength and temperature with stand.

Working: -

The Switching Mechanism is independent, manual and trip free, i.e., the breaker trips internally even if the operating knob is held in ON position.

The Contact Mechanism comprises of fixed & moving contacts specially designed for reliability, long life and anti-weld properties.

The Arc Extinguishing Device comprises of 15 plates arc chute. The arc under the influence of the magnetic field and arc guide is moved into the arc chute where it is rapidly split and quenched.

The tripping mechanism is Thermal Magnetic Type.

Thermal Operation: -
The thermal operation provides protection from moderate overloads. Under overload condition, a thermo-metallic element (bimetallic strip) deflects until it operates a latching mechanism allowing the main contacts to open.

Magnetic Operation: -
In magnetic operation, large overloads or short circuit current actuates a solenoid causing a plunger to strike the latching mechanism rapidly opening the main contacts.

Current Limiting Action: -

The high speed current limiting action ensures that the MCB operate before the full prospective fault current is allowed to develop. Under fault conditions, damage can be sustained to the installation and associated equipment due to the amount of energy that passes before the current is completely interrupted. The total energy let through depends on the value of current and the time for which it flows. The high speed current limiting action of MCB ensures that the energy let through and any subsequent damage is minimized. This reduced LET THROUGH ENERGY (Class 3 as per BSEN 60898) assists greatly with both backup and discrimination considerations.

Operating Mechanism: -

MCB have a quick make and break trip free mechanism. In the event of an over current or short circuit the MCB automatically interrupts all poles even if the MCB toggle is held in ON position, the handle always indicates the correct contact position.

Moderate Overload Condition: -

Detection of moderate Over load conditions is achieved by the use of a Bimetal Overload Relay, which deflects in response to the current passing through it The Bimetal Relay moves against the trip bar releasing the trip mechanism.

Short Circuit Conditions: -

When the current flowing through the MCB reaches a predetermined level, the solenoid in Magnetic coil directly pulls in the plunger, which releases the trip mechanism.

Perfect Connections: -

The design of terminals makes the wiring easier. A combination box type terminal with combination head screws on both sides with deep serrations ensures sparkles and firm connections.

8. CHARACTERISTICS CURVES AND TRIPPING CHARACTERISTICS

	Thermal Tripping			Magnetic Tripping		
As per IS:8828:96	No tripping current I_1	Tripping current I_2	Time limits t	Hold current I_4	Trip current I_5	Time limit t
B Curve	1.13 x IN		>1h	3xIN		>0.1s
		1.45 x IN	<1h		5 x IN	<0.1s
C Curve	1.13 x IN		>1h	5xIN		>0.1s
		1.45 x IN	<1h		10 x IN	<0.1s
D Curve	1.13 x IN		>1h	10xIN		>0.1s
		1.45 x IN	<1h		20 x IN	<0.1s

l3 = 2.55 x lN

1 s < t < 60s for lN < 32A
1 s < t < 120s for lN > 32A

TRIPPING CHARACTERISTICS

Based on the Tripping Characteristics, MCBs are available in 'B', 'C' and 'D' curve to suit different types of applications.

'B' Curve: for protection of electrical circuits with equipment that does not cause surge current (lighting and distribution circuits). Short circuit release is set to (3 - 5) In

'C' Curve: for protection of electrical circuits with equipment that causes surge current (inductive loads and motor circuits). Short circuit release is set to (5 - 10) In

'D' Curve: for protection of electrical circuits which causes high inrush current, typically 12-15 times the thermal rated current (transformers, X-ray machines etc.) Short circuit release is set to (10 - 20) In

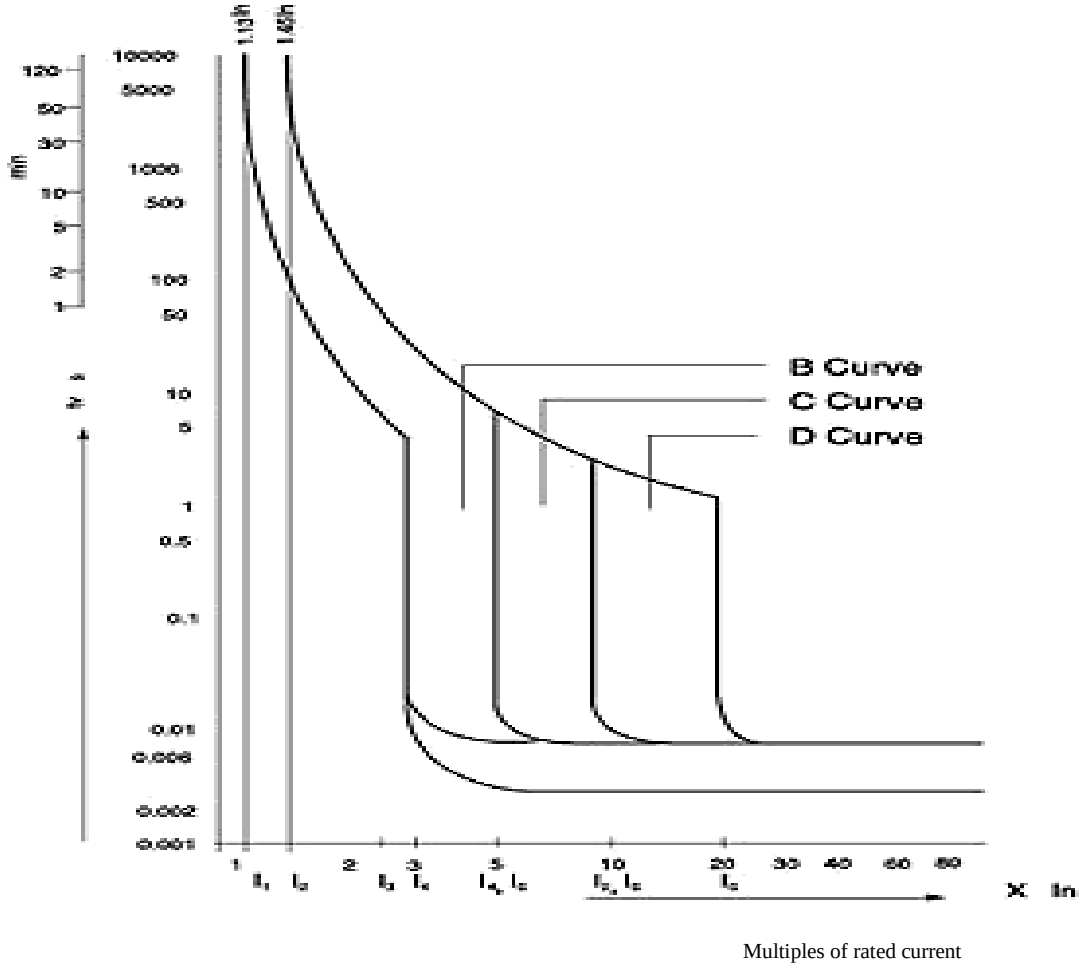


Fig. 10. Tripping Curves

Current Limiting Design: -

In a current limiting breaker, the tripping & arc control mechanism are so designed that under short circuit conditions, the contacts are physically separated and the electrodynamic forces set up by fault current, assist the extinction in less than half cycle.
The figure below shows the current limiting effect of circuit breakers.
Fault Traces for Voltage & Current
0 = Point of fault initiation
tx = Contact opening time (i.e., creation of arc)
t1 = Current / Voltage peak (i.e., current limitation)
t2 = Time to total extinction of arc
(i.e., complete shutdown of fault current)

Figure for the same is shown below.

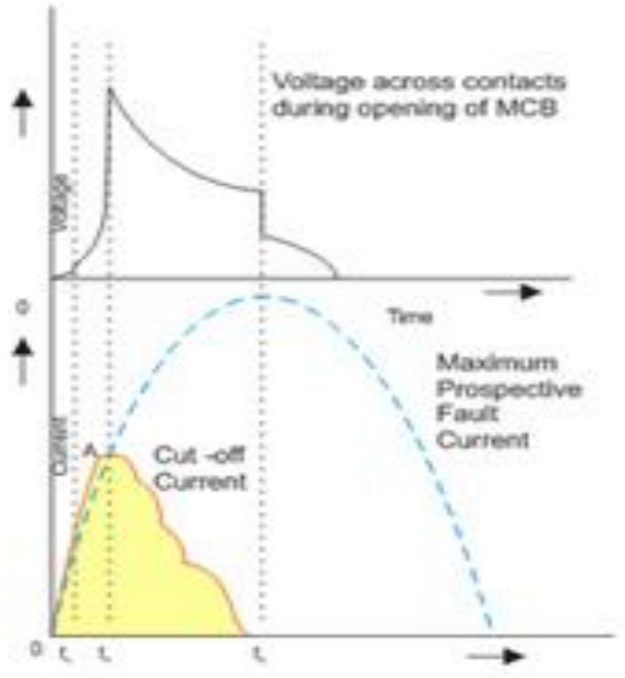


Fig. 11. Current Limiting curve

Hammer Trip Mechanism: -

Current Limiting design in itself may not fulfill the requirement of quick breaking (instantaneous action) mainly due to inertia of the Latch mechanism and interconnected sequence of operations. A Hammer directly connected to the plunger strikes the moving contact arm with a force proportional to the peak current thereby forcibly separating the moving contact from the fixed contact much before the latch mechanism operates. This further reduces the opening time of the circuit breaker.

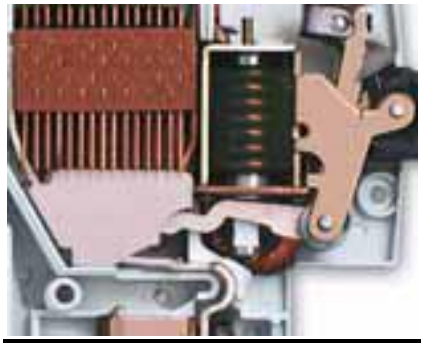


Fig. 12. Hammer Tripping

Shunt Trip

1. To trip the Circuit Breaker through Shunt Trip Coil, 70% to 110% of the rated voltage is to be applied across D1 & D2
2. The Shunt Trip coil is short time rated and it trips the breaker instantaneously. (i.e., continuous duty not required)

Effect of Frequency Variation: -

MCBs are designed to operate at AC frequency 50 / 60 Hz. However, MCBs specially suitable for DC applications and for frequencies upto 400Hz can be supplied on request.
These can be used on different frequencies in supply from 16 2/ 3 - 60 Hz without any duration.
For higher frequencies, normal MCBs can be used with a multiplication factor which shall only affect its magnetic trip current.

Supply	AC			DC
Frequency	100Hz	200Hz	400Hz	-
Multiplication Factor	1.1	1.2	1.5	1.5

9. DC APPLICATIONS: -

MCBs for DC application are specially designed to meet tough arc quenching conditions. While selecting circuit breaker for DC applications following parameters have to be taken into consideration.

Normal Circuit Currents:-

The rating and normal running temperature of the MCB are unaffected by DC. The MCB can be selected using the thermal section of the standard time / current curves. Magnetic tripping on DC is different from the equivalent AC by a peak factor of 1.4
i.e., for 'B' curve AC MCB, magnetic range = (3-5) ln
for DC MCB, magnetic range = 1.4(3-5)ln = (4-7)ln
for 'C' curve AC MCB, magnetic range = (5-10)ln
for DC MCB, magnetic range = 1.4(5-10)ln =(7-14)ln

Short Circuit Currents:-

The maximum short circuit current possible on a DC system is determined by the voltage of the battery and the total internal resistance of the cells.
It is given by Ohm's law :
Isc = Vb / Rb
Where, Isc is the Short Circuit Current
Vb is the voltage of the battery (with 100% charged battery)
Rb is the internal resistance of the battery cells (this is usually stated by the manufacturer)

Circuit Time Constant:-

The time constant is given by : L/R
where L is the inductance of the circuit
R is the resistance of the circuit
The time constant is usually given in milliseconds (ms.). Ideally, DC circuits would be mainly resistive (i.e. a low number), as inductive circuits produce a back emf when the current suddenly falls. This in turn tends to prolong arcing during switching operations, and so reduce contact life.

Circuit Voltage: -

The voltage of the circuit is dependent upon the power supply. The lower the voltage the easier switching operations will be, but the voltage makes no difference to the running of the MCBs.
Contact life can be significantly increased by reducing the voltage, drop accross each pole. This can be achieved by wiring poles in series.
MCBs have been successfully tested on DC and can be used under the following conditions:

L/R	15ms max
Voltage	12-130V

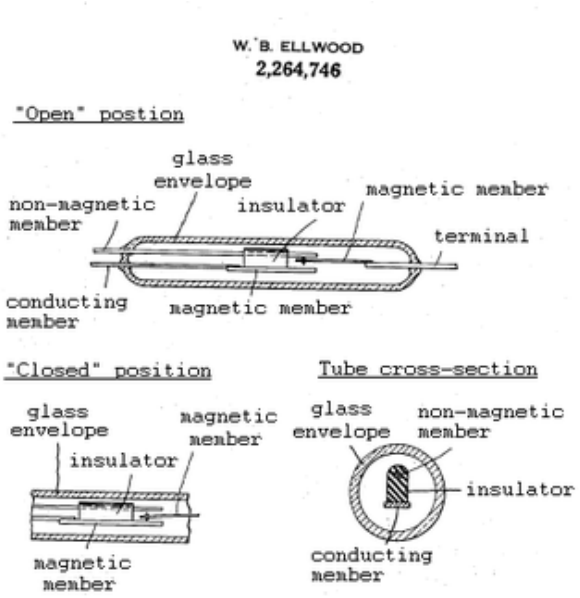
10. SENSORS USED IN MCB AUTOMATION MACHINE:-

1. REED SWITCH:-

The **reed switch** is an electrical switch operated by an applied magnetic field. It was invented at Bell Telephone Laboratories in 1936 by W. B. Ellwood. It consists of a pair of contacts on ferrous metal reeds in a hermetically sealed glass envelope. The contacts may be normally open, closing when a magnetic field is present, or normally closed and opening when a magnetic field is applied. The switch may be actuated by a coil, making a reed relay,[1] or by bringing a magnet near to the switch. Once the magnet is pulled away from the switch, the reed switch will go back to its original position.

An example of a reed switch's application is to detect the opening of a door, when used as a proximity switch for a burglar alarm.

The reed switch contains a pair (or more) of magnetizable, flexible, metal reeds whose end portions are separated by a small gap when the switch is open. The reeds are hermetically sealed in opposite ends of a tubular glass envelope.



A magnetic field (from an electromagnet or a permanent magnet) will cause the reeds to come together, thus completing an electrical circuit. The stiffness of the reeds causes them to separate, and open the circuit, when the magnetic field ceases. Another configuration contains a non-ferrous normally-closed contact that opens when the ferrous normally-open contact closes. Good electrical contact is assured by plating a thin layer of non-ferrous precious metal over the flat contact portions of the reeds; low-resistivity silver is more suitable than corrosion-resistantgold in the sealed envelope. There are also versions of reed switches with mercury "wetted" contacts. Such switches must be mounted in a particular orientation otherwise drops of mercury may bridge the contacts even when not activated.

Since the contacts of the reed switch are sealed away from the atmosphere, they are protected against atmospheric corrosion. The hermetic sealing of a reed switch make them suitable for use in explosive atmospheres where tiny sparks from conventional switches would constitute a hazard.

One important quality of the switch is its sensitivity, the amount of magnetic field necessary to actuate it. Sensitivity is measured in units of Ampere-turns, corresponding to the current in a coil multiplied by the number of turns. Typical pull-in sensitivities for commercial devices are in the 10 to 60 AT range. The lower the AT, the more sensitive the reed switch. Also, smaller reed switches, which have smaller parts, are more sensitive to magnetic fields, so the smaller the reed switch's glass envelope is, the more sensitive it is.

In production, a metal reed is inserted in each end of a glass tube and the end of the tube heated so that it seals around a shank portion on the reed. Infrared-absorbing glass is used, so an infrared heat source can concentrate the heat in the small sealing zone of the glass tube. The thermal coefficient of expansion of the glass material and metal parts must be similar to prevent breaking the glass-to-metal seal. The glass used must have a high electrical resistance and must not contain volatile components such as lead oxide and fluorides. The leads of the switch must be handled carefully to prevent breaking the glass envelope.

1. PHOTODIODE SENSORS:-

Photodiodes offer high sensitivity and low noise, enabling them to detect very low light levels. However, they saturate above approximately $1mW/cm^2$, so attenuating filters must be used when operating at higher powers, such as the Coherent 1000:1 accessory filter. Photodiodes also have a fast response time, so they can be convenient for tuning and peaking lasers. Photodiodes have a much more limited spectral range and lower spatial uniformity than thermal sensors. The latter can affect the measurement repeatability of non-uniform beams or of beams that wander over the detector surface between measurements. Photodiode sensors are not designed for use with pulsed lasers. Coherent photodiode sensors are calibrated using a monochromator for use over their full specified wavelength range.

The OP-2 sensors are directly compatible with the Coherent FieldMate, FieldMax II TO / TOP and LabMax TO / TOP laser power meters. The LM-2 sensors must be used in conjunction with the accessory SmartSensor adaptor. The OP-2 VIS sensor is available with selected meters at reduced prices as part of Coherent's power meter value package programme. For testing the power from optical fibres or fibre-coupled lasers, accessory fibre optic adaptors are available that screw onto the photodiode sensor heads.

11. MCBTesting and Verification:-

This is a totally Modular System for Automatic Calibration Verification of Thermal Trip characteristics of MCBs. The system is expandable from 1 station to 'n' stations and handles calibration of MCBs ranging from 0.5A to 120A. Each station is provided with one MTCM CU for controlling the operation of that station. The MCB under test (its type / set of calibration parameters) at each station is essentially independent of the other stations. Consequentially, the user is free to calibrate different types of MCBs simultaneously independent of each other. An interface module facilitates the communication between every station the Windows based software that governs the system. Each station operates automatically as soon as the MCB is switched ON after loading. The calibration i.e. adjustment of setscrew of the MCB is done with the help of Stepper Motor. The PC in real time collects the 'trip time' of MCB under test and the result as Early, OK or Late. The same system can be used for verification of the calibration wherein the tripping time with limits can be checked and hence the system is also available without fixtures for verification (with manual calibration) only. At the heart of the calibration system is the electronic DC Constant Current Source specially designed for thermal calibration of MCBs. This source is more accurate than conventional electrical source, designed for continuous duty, controlled by a dedicated micro-controller based module (that sets the correct test current instantly) and is proven to be extremely rugged and reliable. The architecture of the test system is modular and can be easily scaled up fast at a later point in time, should there be a sudden rise in production requirement; meaning – for 10 station bench, there would be 10 sources, 10 fixtures and 10 MTCMs. It is possible to add 1 or more stations as and when required, instead of directly buying another test system. This is cost-effective, guarantees zero down-time has many other benefits. The accompanying PC based Testware is intuitive, has secured database and exports reports easily for statistical analysis such as pare to analysis, bell-curve etc.

Magnetic Trip Test Bench

Test Bench will have:

1. Bench will enable checking instantaneous (Magnetic) Tripping of SP MCBs 0.5 to 63A. for B & C curves. (CL.9.10.2) (Test Current will be pass through one pole only at any given instant)
2. Test Current range will be from 3 In to 10 In i.e. 1.5A to 800 A settings.
3. Two independent variacs provided we will be able to set voltages for 'Holding Test' & 'Tripping Test' on two analog voltmeters provided.
4. CT Ranges will be 5-10-20-50-100-250-500-1000A.
5. Current will be measured through Transient Meter.
6. A Digital timer with 9.99 sec. range set for 0.2 sec. will be provided for current duration control.
7. A Swamp resistor will be in series with Test MCB to increase P.F. of test circuit & reduce asymmetry.
8. Current switching will be on secondary side to minimize asymmetry.
9. Transient meter will record current level through CT.
10. An auto ranging 4 digit DTIM will be provided to measure trip time with resolution of 1 msec.
11. Through 4 channel programmable time 4 SP, MCBs will be get tested in a very quick sequence first holding current will be pass one by one in all 4 poles & then trip current will be pass through one by one pole.
12. One toggle clamp operated fixture to be provided to accommodate 4 SP MCBs.
13. Bench will be floor standing.
14. A foot switch will be provided to initiate and stop the test.

Test Equipments for Circuit Breakers such as MCB, MCCB, ACB, VCB, RCCB & RCBO and Compliance Verification Benches for conformity assessment as per IEC 60898, IEC 60947, IEC 61008, IEC 61009 & other standards.

We design and manufacture test equipments and automation solutions for testing and production of circuit breakers such as Miniature Circuit Breakers (MCB), Molded Case Circuit Breakers (MCCB), Residual Current Operated Circuit Breakers (RCCB / RCBO), Earth Leakage Circuit Breakers (ELCB), Vacuum Circuit Breakers (VCBs), Air Circuit Breakers (ACBs) and other line protection devices.
Some of our recent solutions are listed here. These facilitate testing of breakers as per various standards such as IEC 60947, IEC 60898, IS 10322 and others. Please write to us for more details about our all test equipments for MCBs.

- **Testing Solutions for MCB:-**
    - Thermal Calibration & Test Bench for MCB
    - Thermal Trip Verification Test Bench for MCB
    - Magnetic Trip Test Bench for MCB
    - Time-Current Characteristics Test & Measurement System for Circuit Breakers (MCB & RCBO)
    - 3 Phase 28 days and Temperature Rise Test Bench for circuit breakers
    - Temperature Rise & Power Loss Test Bench for MCB
    - 3 Phase Endurance Test Bench for MCB
    - Impulse Voltage Test Equipment for MCB

12. Testing Solutions for Miniature Circuit Breakers:-

Thermal Calibration Test Bench for Miniature Circuit Breakers for Thermal Calibration:-

This is a totally Modular System for Automatic Calibration Verification of Thermal Trip characteristics of MCBs. The system is expandable from 1 station to 'n' stations and handles calibration of MCBs ranging from 0.5A to 120A. Each station is provided with one MTCM CU for controlling the operation of that station. The MCB under test (its type / set of calibration parameters) at each station is essentially independent of the other stations. Consequentially, the user is free to calibrate different types of MCBs simultaneously independent of each other. An interface module facilitates the communication between every station the Windows based software that governs the system. Each station operates automatically as soon as the MCB is switched ON after loading. The calibration i.e. adjustment of setscrew of the MCB is done with the help of Stepper Motor. The PC in real time collects the 'trip time' of MCB under test and the result as Early, OK or Late. The same system can be used for verification of the calibration wherein the tripping time with limits can be checked and hence the system is also available without fixtures for verification (with manual calibration) only.
At the heart of the calibration system is the electronic DC Constant Current Source specially designed for thermal calibration of MCBs. This source is more accurate than conventional electrical source, designed for continuous duty, controlled by a dedicated micro-controller based module (that sets the correct test current instantly) and is proven to be extremely rugged and reliable. The architecture of the test system is modular and can be easily scaled up fast at a later point in time, should there be a sudden rise in production requirement; meaning – for 10 station bench, there would be 10 sources, 10 fixtures and 10 MTCMs. It is possible to add 1 or more stations as and when required, instead of directly buying another test system. This is cost-effective, guarentees zero down-time has many other benefits. The accompanying PC based TestWare is intuitive, has secured database and exports reports easily for statistical analysis such as compared to analysis, bell-curve etc.

MAIN FEATURES AT A GLANCE:

- Fully Automatic 'Stand Alone' Option (i.e. with or without PC).
- ON line Loading of MCBs.
- Can test MCBs ranging from 0.5 Amp to 120 Amp with suitable model.
- Individual DC Constant Current Source with Fine Regulation; Multiplied Reliability and Graceful Degradation.
- Current setting: Automatic within +/- 0.3 % of set value.
- Pneumatically operated electro-mechanical fixtures with stepper motor for calibration of the MCB.
- PC based operation; Selection of MCB its parameters from PC and/or MTCM for stand alone option.
- Early, OK Late indication on each Individual Display Unit as well as on PC at same time.
- Data Acquisition on PC by Windows based Software for traceability and statistical analysis.

The solution comprises of:

1. Solid State DC Constant Current Source (with 0.2 % regulation) at each station.
2. Display & Control Unit for each station at each station.
3. Specially designed PC interface module.
4. Electro-pneumatically operated mechanical fixtures (test jigs) to hold MCB with Stepper Motor for calibration of MCB at each station.
5. PC running Windows
6. TestWare - SCADA for control and data acquisition from the test equipment.

Models available are:

- MTCM 20 A - With Current Range: 0.5A to 20A.
- MTCM 100 A - With Current Range: 5A to 100A.
- MTCM 200 A - With Current Range: 10A to 200A.
- MTCM 300 A – With Current Range: 20A to 300A.
- MTCM 400 A – With Current Range: 20A to 400A.

Thermal Trip Verification Test Bench for Miniature Circuit Breakers

The Thermal Trip Verification Test Bench is designed to perform thermal trip verification of Miniature Circuit Breakers as per clause 9.10 of the IEC 60898. The working of the test system is similar to the thermal trip calibration panel; however this system is to be used to verify the tripping characteristics simulating the actual working conditions.

1. Test Ware - SCADA for control and data acquisition from the test equipment.

Fig. 13. Test Bench

Magnetic Trip Test Bench for Miniature Circuit Breakers

The MCB magnetic characteristics verification test bench is designed to perform magnetic trip test on low voltage MCBs for short time over currents as per clause 9.10 of IEC 60898 (IS 8828). B, C, and D curve of MCBs of single pole as well as multi-pole having different magnetic characteristics can be measured on this test bench. The user can operate the entire test bench to conduct all the available tests & measurements on MCB with a PC based TestWare; All measurements are saved & reports (including current characteristics) can be generated. Decades of experience has helped us to design current source (transformer) in a special way such that good current regulation and enhanced accuracy is ensured. Our latest design has resulted in variable current output source (short time) without a single variable transformer in the system.

Main Features at a glance:

- Fully PC based test sequence with recording of all MCB measurements
- Can test single as well as multi pole MCBs
- Able to test B, C, D curve MCBs from 0.5 A to 63 A for holding test as well as magnetic trip test

- Pass/Fail Indication on PC screen for each pole on every test & measurement

- The exact graph for current v/s time characteristics for better readability of the MCB characteristics subjected to different tests
- Storage of all test data including every measurement with bar code traceability in database & built-in reporting for analysis - export option to Office/pdf/print.
- Transient meter for recording peak current on test bench for stand-alone operation

The Test Bench comprises of:

1. Specially designed constant current source (with high current power transformer) for accurate supply of current
2. PC to Test Bench interface card
3. Measurement system to measure instantaneous current
4. Test jig to load single/multi pole MCB
5. PC running TestWare
6. TestWare – SCADA with database & reporting for test & measurement of MCB magnetic trip characteristics

Characteristics Test & Measurement System for Circuit Breakers (MCB & RCBO)

The Time Current Characteristics Test Solution for Circuit Breakers is designed to test & measure the time v/s current waveforms for B, C, D curve MCBs for both thermal as well as magnetic trip. The panel is programmed to typically follow the Table 7 of clause 8.6.1 of IEC 60898. It is suitable for RCBO (IEC 61009) also. It has an inbuilt current source to source currents equivalent to those mentioned in the above mentioned table. All MCBs with range 0.5 Amp to 63 Amp can be tested on this panel. This panel has an in-built climatic chamber to maintain temperatures of up to 45oC, which closely resembles the operating temperatures in the environment where MCBs are installed in real world situations.

Main Features at a Glance:

- Auto/Manual Test Selection Option
- Constant current source of up to 500A continuous rating

- Short time current rating up to 1500A

- Both overload (thermal) trip test as well as instantaneous (magnetic) trip test is carried out.
- Servo Controller based output
- Current swamping through specially designed graded inductors
- Digital time interval meters to measure trip time
- Bypass arrangement for breakers that have tripped
- Transient recording meter to record exact tripping current for instantaneous (magnetic) trip test
- Control & Data Acquisition through PC based TestWare for traceability and statistical analysis

Temperature Rise & Power Loss Test Bench for Miniature Circuit Breakers

Adjustable Constant Current Source will have:

1. 0.5A to 100A at 30V open ckt. Voltage CT range 2A, 5A, 10A, 25A, 50A, 100A.
2. The CT range and resistance for MCB rating to be selected through shorting links: 0.5A, 1A, 2A, 4A, 6A, 10A, 16A, 20A, 25A, 32A, 40A, 50A, 63A at 30V open current voltage.
3. Panel shall be capable for testing three samples of same rating may SP/DP/TP/FP
4. True RMS sensing current controller shall maintain current better than class 1.0 accuracy throughout the range.
5. Digital Temperature Indicator min 28 Channels with minimum 28 No. Thermocouple bid, Teflon insulated shall be provided with sufficient length to connect it to product.
6. Channel selection by rotary switch.
7. Cooling shall be provided by means of Exhaust fans distributed all over to remove the hot air generated inside the panel cabinet.
8. Overall accuracy of the panel is better than class 1.0
9. The entire system will be housed in sturdy M-S Cabinet (Trolley)
10. Calibration certificate will be provided for individual meter and also for complete system.
11. Following meter indications will be provided:

    - Digital Temperature Indicator with 28 input for thermocouple.
    - Digital Volt Meter with 5 ranges (200mV, 2V, 20V, 200V, 250V) to measure open circuit voltage & mV drop across MCB
    - Digital Ammeter with CT (Indication on servo controller)

28 Days & Temperature Rise Test Panel for MCB (Single Phase)

The 3 station 28 days and temperature rise test panel is been developed to test MCBs, MCCBs, RCCBs and RCBOs as per IEC 60898-1, IEC 61008-1, IEC 61009-1. In this test the MCB is subjected to 28 cycles, each comprising 21hrs with rated Current at an open circuit Voltage of more than 30V and 3hrs without Current. It consists of adjustable constant Current source which provides constant Currents from 0 to 200A (180 A max.) at open circuit Voltage of more than 30V. Specially designed True RMS sensing Current controller maintains Current with the help of stepper motor within+/-1 % throughout the range. Digital display is provided for Current measurement. Microcontroller based sequential timer maintains the sequence of operation and displays the test status.

- Auto/Manual operation possible
- Servo controlled mechanism to control current
- Microcontroller based timer unit
- The panel is capable to generate accurate test results for a continuous period of 28 days as required in the 28 days test
- Cooling shall be provided by means of Exhaust fans distributed all over to remove the hot air generated inside the panel cabinet
- True RMS sensing current controller shall maintain current better than class 1.0 accuracy throughout the range
- 0.5A to 100A at 30V open circuit Voltage CT range 2A, 5A, 10A, 25A, 50A, 100A
- The CT range and resistance for MCB rating to be selected through shorting links: 0.5A, 1A, 2A, 4A, 6A, 10A, 16A, 20A, 25A, 32A, 40A, 50A, 63A at 30V open current voltage
- Overall accuracy of the panel is better than class 1.0
- Digital Temperature Indicator with 28 input for thermocouple.
- Digital Volt Meter with 5 ranges (200mV, 2V, 20V, 200V, 250V) to measure open circuit voltage & mV drop across MCB
- Digital Ammeter with CT (Indication on servo controller)

Temperature Rise & Power Loss Test Bench for Miniature Circuit Breakers

Adjustable Constant Current Source will have:

1. 0.5A to 100A at 30V open ckt. Voltage CT range 2A, 5A, 10A, 25A, 50A, 100A.
2. The CT range and resistance for MCB rating to be selected through shorting links: 0.5A, 1A, 2A, 4A, 6A, 10A, 16A, 20A, 25A, 32A, 40A, 50A, 63A at 30V open current voltage.
3. Panel shall be capable for testing three samples of same rating may SP/DP/TP/FP
4. True RMS sensing current controller shall maintain current better than class 1.0 accuracy throughout the range.
5. Digital Temperature Indicator min 28 Channels with minimum 28 No. Thermocouple bid, Teflon insulated shall be provided with sufficient length to connect it to product.
6. Channel selection by rotary switch.
7. Cooling shall be provided by means of Exhaust fans distributed all over to remove the hot air generated inside the panel cabinet.
8. Overall accuracy of the panel is better than class 1.0
9. The entire system will be housed in sturdy M-S Cabinet (Trolley)
10. Calibration certificate will be provided for individual meter and also for complete system.
11. Following meter indications will be provided:
    1. Digital Temperature Indicator with 28 input for thermocouple.
    2. Digital Volt Meter with 5 ranges (200mV, 2V, 20V, 200V, 250V) to measure open circuit voltage & mV drop across MCB
    3. Digital Ammeter with CT (Indication on servo controller)

3 Phase MCB Endurance Test Bench

The test setup consists of 2 sub-systems:

3 Phase Inductive Load*:*

Inductive Load has 0.85 Power factor for Testing of MCBs of ranges 0.5, 1, 1.6, 2, 3, 4, 6, 8, 10, 13, 16, 20, 25, 32, 40, 45, 50, 63Amps, selectable with Shorting Links. The working voltage is 230V for each phase. There will be 3 Loads, which could be connected either in Single Phase or 3 Phase schemes. The resistance is ceramic tube based and insulated industrial grade.

Metering & Safety Features:

1. Micro Controller Based Programmable timer to set ON / OFF Time 0 – 99.9sec.
2. Digital Voltmeter with selector switch. Digital Ammeter with selector switch.
3. Digital Power Factor Meter. Digital Frequency Meter.
4. Electro Magnetic Counter: It will count the number of operations.
5. Current Sensing Circuit: To detect contact weld & contact open. This will give a signal to cut off the Load, if fault persists for predefined time.
6. Electro Pneumatic Fixture. The ON / OFF Time & Sequence will be derived from Timer Unit provided on metering panel.

Impulse Voltage Test Equipment MCB (Single Phase)

Impulse voltage tests are recommended with the object to determine effect of voltage stress on insulating due to voltage surges of short durations, even when the switch (breaker) is off. A surge is a form of over voltage, which may be defined as an exceptional voltage in excess of peak voltage to earth at line or electrical system of which line forms a part (can be caused as a result of lightning strikes as well as other overvoltage spikes in the power system level).

SCR ELEKTRONIKS has developed impulse tester for carrying out the following tests:

- Low Voltage Switchgear and Control gear: IS/IEC 60947 -2004 Cl. No: 8.3.3.4.1
- Circuit Breakers: IS/IEC 60898:2002 Cl.no.: 9.7.6.1 & 97.6.2
- Residual Current Operated breakers: IEC 61008 & 61009 : Cl.no.: 9.20

Impulse Tester is designed to generate impulse voltage of 1.0 KV to 5 KV. The waveform generated has rise time of 1.2 micro second and 50 micro second duration as defined in IEC61180. The peak voltage can be adjusted continuously with the help of variac provided. The test sequence i.e. number of Impulse for Positive and Negative polarity, time between two subsequent impulses can be programmed through key pad with the help of dedicated PLC module. The entire sequence, for both positive and negative impulse is automatic. At the end of the test, the test results are displayed on LCD display. Output is provided for connecting an oscilloscope for displaying the Wave Form at the output Terminals.

In case any flash over occurs, it is detected by a circuit which stops the test sequence, and output PLC displays the number of cycles with polarities at which the failure has taken place.

Salient Features of the Impulse Voltage Tester:

- Impulse Voltage -1kV to 5kV adjustable
- Impulse Rise Time -1.2 micro sec. +/- 30%

- Impulse Duration : 50 micro sec. +/- 20%
- Sequencing : PLC module with setting of :
    1. Positive, Negative or both polarities
    2. No. of pulses for positive or Negative polarity
    3. Duration between two consecutive Impulses
- Selection of polarity: Automatic through PLC Unit
- Voltage Indication: Digital Meter to indicate peak voltage
- Output for Oscilloscope: Attenuated output 0 to 5V for 0 to 5kV
- Mains Supply : 230 V AC, +/- 10% - 50Hz
- Air Supply – Pressure – 5 Kg
- The sequence is fully programmable and automatic
- LCD Display for Indication of test parameters & result

Housed in extruded Aluminum Sections for better aesthetics

Unique Benefits of Thermal Calibration Test Bench for Miniature Circuit Breakers are:-

Aspect	This Solution	Conventional Equipment
Line & Load Current Regulation	Better than 0.3%	0.5% or 1%
Power Consumption	Low	Normal
Test Voltage / Operator Safety	No extra guards are required as Individual Station has its own P Source & maximum voltage is 7V	Higher Voltage is required for MCBs of lower rating which calls for special safety precautions
Flexibility	You can spread the system to different physical locations and can test different types of MCBs simultaneously	Fixed bench
Scalability	100%; System can have 1,2.3,...n stations as and when required	No change can be made on existing system
Reliability	Solid state components lead to long life and less fatigue, No interruption of current as there is no need of change-over after a breaker at a station trips	Interruption of current after a breaker trips
Maintenance / Breakdown	Individual Station can be replaced or shut down without affecting rest of the system;	Failure of any one component is the failure of complete system; skilled technician required for repairing

	Easy 'plug & use' possible	
Spares Required	Modular system leads to lesser spares / inventory	Different types of spares required
Size	Compact & Portable	Medium; Mounted on Castors
Cost	No increase in cost for the last 5 years	Price directly dependant on fluctuating cost of copper

13. SELECTION OF MCB

For household Applications

Appliances	Capacity / watt (Load) (240V~ 1ph)	Current Rating of MCB	Type of MCB
Air Conditioner	1.0 tonnes	10A	"C" series
	1.5 tonnes	16A	"C" series
	2.0 tonnes	20A	"C" series
Refrigerator	165 litres	3A	"C" series
	350 litre	4A	"C" series
Oven cum Griller	4500W	32A	"B" series
	1750W	10A	"B" series
Oven only	750W	6A	"B" series
Hot Plate only	2000W	10A	"B" series
Room Heater	1000W	6A	"B" series
	2000W	10A	"B" series
Washing Machine	300W	2A	"C" series
Washing Machine (with heater)	1300W	8A	"C" series
Water Heater (storage/instant)	1000W	6A	"B" series
	2000W	10A	"B" series
	3000W	16A	"B" series
	6000W	32A	"B" series
Electric iron	750W	6A	"B" series
	1250W	8A	"B" series
Auto Toaster (2 slices)	1200W	8A	"B" series
Electric Kettle	1500W	10A	"B" series

For Motor Protection

kW	HP	1 Phase 230V Full Load Current	1 Phase 230V MCB Selection C	3 Phase 400V Full Load Current	3 Phase 400V MCB Selection C	3 Phase 400V Assisted Star Delta Full Load Current	Assisted Star Delta MCB Selection C	Assisted Star Delta MCB Selection D
0.18	0.24	2.8	10	0.9	2	—	—	—
0.25	0.34	3.2	10	1.2	2	—	—	—
0.37	0.50	3.5	10	1.2	2	—	—	—
0.75	1.01	6.2	20	2.0	3	—	—	—
1.1	1.47	8.7	25	2.6	6	—	—	—
2.2	2.95	17.5	50	4.4	10	—	—	—
3	4.02	20.0	63	6.3	16	6.3	16	10
3.75	5.03	24.0	80	8.2	20	8.2	20	10
5.5	7.37	26.0	80	11.2	25	11.2	32	16
7.5	10.05	47.0	125	14.4	40	14.4	40	25
10	13.40	—	—	21.0	50	21.0	50	32
15	20.11	—	—	27.0	100	27.0	63	40
18.5	24.80	—	—	32.0	125	32.0	—	50
22	29.49	—	—	38.0	125	38.0	—	63
30	40.21	—	—	51.0	125	51.0	—	63

Calculation Formulae:

Incomer Current Rating, For Single Phase:

$$\frac{\text{Total Load in Watts}}{240V}$$

Incomer Current Rating, For Three Phase:

$$\frac{\text{Total Load in Watts}}{1.713X240V}$$

14. TYPES OF MCB

SINGLE POLE (1P)

SINGLE POLE & NEUTRAL (1P+N)

DOUBLE POLE (2P)

THREE POLE (3P)

THREE POLE - N (3P+N)

FOUR POLE (4P)

RAILWAY MCB

15. ERRORS AND CORRECTIONS:-

- HV FAIL DUE TO LESS GAP BETWEEN CHORD AND FIXED CONTACT
- MT FAIL DUE TO PLASTIC LATCH COLLIDES WITH POINTER
- MT FAIL DUE TO ANCHOR PROFILE NOT OK
- MT FAIL DUE TO ANCHOR JAM
- HOLD/MT FAIL DUE TO MIXED RATING
- HOLD FAIL DUE TO MCB TRIPPED OFF WITH THE JERKS OF TESTING PROBES
- HOLD FAIL DUE TO LATCHING FORK CD NOT IN RANGE
- HOLD/MT FAIL DUE TO WRONG RATING ANCHOR SPRING
- HOLD FAIL DUE TO NO CONTINUITY
- MT FAIL DUE TO PLUNGER MISSING
- HOLD FAIL DUE TO CHORD BROKEN WITH THE COIL
- MT FAIL DUE TO COIL NOT LOCKED WITH ARC RUNNER
- HOLD FAIL DUE TO IMPROPER FITTMENT OF ASSEMBLY
- MT FAIL DUE TO ALUMINIUM BUSH MISSING
- MT FAIL DUE TO GAP IN COIL TURNS
- MT FAIL DUE TO PLUNGER OUT OF ANCHOR ASSEMBLY
- MT FAIL DUE TO ANCHOR SHORT
- HOLD FAIL DUE TO NO CONTINUITY
- MT FAIL DUE TO ULATCH LEG BEND
- MT FAIL DUE TO COIL ENAMEL INSULATION REMOVED
- MT FAIL DUE TOOPERATING FORK BEND
- HOLD FAIL DUE TO SPOTTING BETWEEN BIMETAL AND CARRIER BROKEN
- MT FAIL DUE TO U-LATCH RIVET TIGHT

The corrections to the above errors can be made by carefully carrying out the tests and by completing all the respective steps involved in each test.

Abbreviations Used:-

HV: - High Voltage

MT: - Magnetic Tripping

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