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Erection and Commissioning of Pretreatment Cathode Electro-deposition (PT-CED) System

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ABSTRACT:Earlier electro-deposition processes were being pursued primarily for quality control in mass production. However, from the point of view of harmony between the natural environment and the human living environment, painting efficiency was treated as a successive problem, and the recovery and use of paints was seriously considered. This trend has led to the development of various fields of technology and system designed to treat the two-wheeler frame and componentbefore the actual Painting on the body. New technologies have been developed related to energy saving. In the paint and varnish industry, further improvement in anti-corrosion performance is urgently required. This need is also linked to the development of new body materials and even to the designof the body structure. The Phosphate Treatment and Cathode Electro-deposition (PT-CED) method gives Better Corrosion Resistance and Effectivesurfacepreparation for Coating of body. This article provides information regarding erection and Commissioning of Phosphate Treatment and Cathode Electro-deposition (PT-CED) System.

KEYWORDS: Electro-deposition, Phosphate, Electro-coating.

I.INTRODUCTION

The development of electro-deposition painting technology for the automobile body industry began around 1964 in Japan. At that time, automotive parts were coated with water-based paint dip coating after metal pre-treatment, but it was confirmed that the vehicle adheres to the electrode when voltage is applied. This was the beginning of electro-deposition coating. However, while unpublished work is underway, the nature of this technology is poorly understood.

Until 1963, small products, mostly made with latex emulsions, were produced on an industrial scale. In the UK, the first major industrial use of electro-deposition systems was in 1963, when the Pressed Steel Company began filling gasoline tanks at its Oxford plant. A patent for an electro-deposition system for car bodies and components such as wheels was published by the Ford Motor Company in 1963.

The process can be divided into two major categories as per industrial use - First is the Phosphate Treatment where the frame body get cleaned and be ready for paint application. The second process type is Electro-Deposition, As the name implies, actual paint coating work will be carried out on frame body with the help of Rectifier.

Erection of the PT-CED line work is the major activity while installing process equipments. As the complete process is sequential, it is necessary to place each and every field equipment's on proper position. Erection process of complete PT-CED line comprises of designing, drawings and placement of components on proper position.

Commissioning process of PT-CED line is second major activity to carry out performance of each equipment's individually. Commissioning process of PT-CED line involves Energization of complete plant and each equipment, analysis of behaviour of every equipment's installed.

The body (the Items to be processed for coating) shall be manually loaded on the C hanger on conveyor System at loading Stage. It will be processed on the line as per the predetermined operational logic and get pretreated& electro deposited. The body shall be travelled through CED bake oven to get baked as per the baking window of the process and unloaded after cooling at unloading station.

At the outlet of the oven the Body will be naturally cooled to bring the temperature down before the next operating station. Further this body will be unloaded at the end of the Oven conveyer for further process.

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II.PRE-TREATMENT

A. Basics

Pre-treatment is a chemical surface treatment that takes place in various process steps that are aligned with each other. Itis the basis for the corrosion resistance of the coating processes that follow.Corrosion resistance and adhesion of the paint coating depend on the result of the pre-treatment.

B. Process steps

Pre-treatment process is divided into the following main steps:

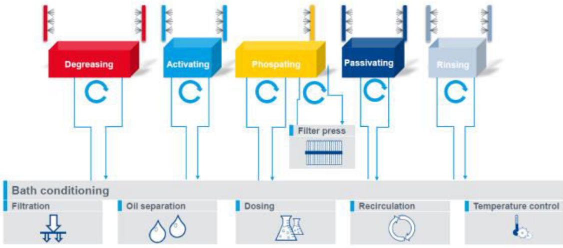

Fig.1. Pre-treatment Process Steps

a) Cleaning and Degreasing:

In the body shop and during the temporary storage, contamination occurs on the surface of the frame body. For good paint quality the frame body must be free from dirt, dust and grease

b) Activation:

In before of the phosphating process, the frame body surface is activated. In this process the surface is uniformly wetted with activating chemicals, seeds of crystallization (nuclei) are created to ensure a uniform, finely crystalline formation of a phosphate layer. This is necessary to ensure a high painting quality

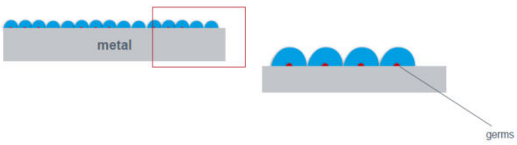

Fig.2. Germs founding on body surfaces

c) Phosphating:

The phosphating process serves for increasing the adhesive qualities of paint layers. The phosphating layer adheres verywell to the metallic surface and enables a perfect adhesion of the following coatings, due to the structure ofmicro-capillaries. The frame body is dipped into a tank with zinc, nickel, manganese and phosphate ions. A crystalline conversion layer begins to grow on the surface.

Role of Phosphating:

- To make non conducting bond between the base metal & paint to provide chemically inert surface to prevent the reaction between the metal surface & paintingredients.
- To improve the paint properties like adhesion, impact, corrosion resistance.

Fig.3. Phosphating Process

Major components of Phosphating:

a) Zinc - coating component
b) Phosphoric acid - coating component
c) Sodium nitrite – Accelerator

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a) Filter press

Phosphate sludge is filtered and desiccated under high pressure in the filter press. The clear phase flows back to the phosphating tank. If filter press attains the maximum pressure, the filtration is stopped and the press is emptied. After emptying the filtration starts all over again.

b) Passivation:

For the passivation process the frame body is dipped into a tank. During the passivation process the pores between the phosphate crystals are closed with smaller crystals. Thereby a smooth surface is created.

c) Rinsing:

There are several rinsing processes at the pretreatment, e.g. after degreasing and phosphating. The rinsing serves as preparation of the frame body for the next process step and prevents the transfer of dirt and chemicals between the tanks.

d) Spray Rings:

Adjustment of the spray rings.

The nozzles of spray rings have to be adjusted properly. Wrong adjusted nozzles may cause that …

− chemicals from different zones are mixed

− process tanks are contaminated.

− The process parameters, e.g. chemical concentration,
differ from set points.

− the cleaning effect is reduced.

Fig. 4. Spray Rings

III. CATHOD ELECTRO-DEPOSITION

Overview:

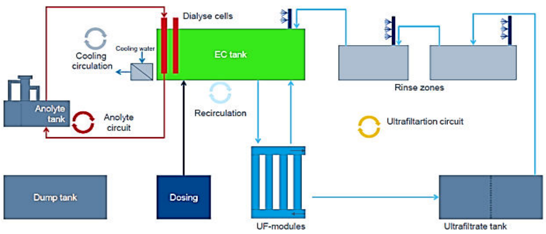

Fig. 5. Cathode Electro-deposition Cycle

A. Operating principle

The electrocoating is a coating method which is based on electrochemical processes, and it is based on the "mutual attraction" principle.

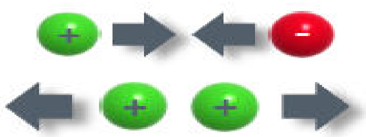

Fig. 6. (a) Oppositely electrical charged particles attract

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(b) Likely electrical charged particles repel

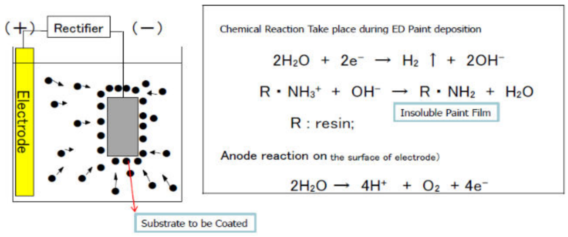

Fig. 7. Electrolysis Process

Electrolysis:

Decomposition of a conductive liquid by the passage of an electriccurrent

- **Anode:** $2H_2O \rightarrow O_2 \uparrow + 4H+ + 4e-$
- **Cathode:** $2H_2O + 2e- \rightarrow H_2 \uparrow + 2OH-$

Electro-Phoresis:

Migration of electrically charged colloidal particles in a conductive medium underthe influence of an electrical potential (voltage)

$$CH_3COO^- H+ + R^-NH_2 \rightarrow CH_3COO^- + R^-NH_3^+$$

- **Anode:** $CH_3COO^- + H^+ \rightarrow CH_3COOH$
- **Cathode:** $R^-NH_3+ + 2OH^- \rightarrow R^-NH_2 + H_2O$

Electro Deposition:

Precipitation of paint particles at an electrode.Positively-charged particles willcoagulate at the cathode, and negatively-charge particles will collect at the anode.

- **Cathode:** $R^-NH_3+ + 2OH^- \rightarrow R^-NH_2 + H_2O$

Electro -Osmosis:

(Motion of liquid induced by applied voltage or potential across aporous material (ED Coating)Final process to be discussed, Water is driven from the vicinity of the cathodethrough the deposited film, causing the dehydration of the film.

The negatively charged frame body is dipped into the paint with positively charged particles.

Paint particles are attracted by the frame body, where they are deposited to form a uniform coating film over the entire surface.

Table. 1. Parameters

Parameter	Unit (conditions)	Anodic ED 1965	Anodic ED 1975	Cathodic ED 1975	Cathodic ED 2000
Solids	(1 h/130 °C)	8 – 15 %	12 – 18%	15 – 20%	15 – 20%
Solvents in tank	%	10 – 15	5 – 10	3 – 5	0,5 – 2
Film thickness	µm	30 – 40	25 – 35	15 – 20	18 - 22
Lead	Yes/No	Y	Y	Y	N
pH		7 – 9	7 – 9	6 – 8	5 – 7
Bath temperature	°C	20 – 25	20 – 25	25 – 30	28 – 35
Deposition time	S	120 – 200	120 – 200	120 – 200	120 – 200
Voltage	V	150 – 250	150 – 250	250 – 350	300 – 450
Electr. equivalent	mg/C	60 – 80	50 – 70	30 – 50	30 – 40

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B. Simplified principle of cathodic coating

Fig. 8. Cathode when No voltage applied
The base coat is not attracted by the metallic surface

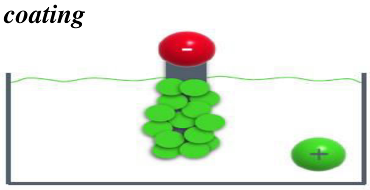

Fig. 9. Cathode when Electrical voltage is applied
The base coat is attracted by the metallic surface.

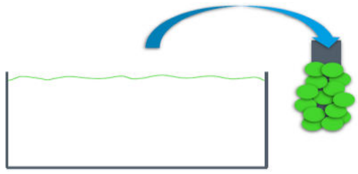

Fig. 10. Painted metal object.

- **Rectifier system:**

It is used for DC Voltage application during ED coating. Paint Film thickness easily control byvoltage up & down.

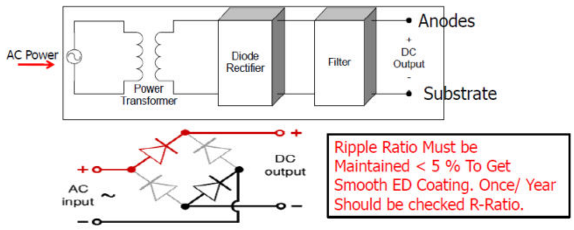

Fig. 11. Rectifier System

Rectifier Capacity Calculation:

- Assume Area per Hr in Sqm = 1200 Sqm
- Avr DFT micron = 20 micron
- Film sp.gr = 1.3
- Columbic yield of ED for rectifier capacity calculation = 30 mg/Q

1) Average current = Area X DFT X film sp gr X 1000
Columbic yield X 3600 (3600 seconds of
1 hr.)
= 1200 X 20 X 1.3 X 1000 X 30 X 3600
= 222.22 Amps
2) Peak current = Average current X 1.5
= 222.22 X 1.5 = 333.33 Amps
3) Rectifier current capacity including safety factor
= Peakcurrent X 1.3
= 333.33 X 1.3 = 433.33 Amps
4) Voltage for parts line = Max 350 V
5) Voltage for automobile body line = Max 400 V
This is indicative calculation.

- **Ultrafiltration System:**

Basics of ultrafiltration:

UF systems are an essential part of Cathodeselectro deposition (CED) painting processes, andcontribute to ensuring painting quality, costreduction (DI Water paint), and reduction inenvironmental impact.

Ultrafiltration is a cross flow membrane process to separate substances in the molecular weight range (such as pigmentsand binding agent) from a liquid.Small molecules pass the membrane. Using a thin, semi-permeable membrane filtrate and concentrate are separated. Water and solvents pass the membrane and form the ultra-filtrate. Pigments and binding agents are retained and form the concentrate that can be returned to the EC tank.

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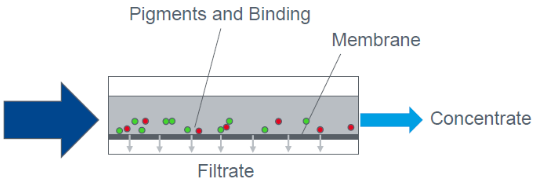

Fig. 12.Ultrafication System

- **Filtrate tank with sealing water system:**

The sealing water tank is filled with filtrate from the ultrafiltration system. The sealing liquid is required to ensure the functionality of the double acting mechanical seals on the paint recirculationpumps. The sealing liquid fills the space between the inner and outer mechanical seal. Frictional heat can be dissipatedand ingress of the pumped liquid into the seal gap is prevented.The sealing water is recirculated in the system by high pressure pumps. The pumps are connected to the emergency power supply.

Merit of UF System for E-Coat

➢ Reduction of paint consumption via recovery

➢ Reduction of DI water in final rinse

➢ Reduction of ED drops (Paint marks) after baking
(Sanding process reduction)

➢Saving waste water treatment cost

➢ Easily bath health restore if any contamination
from PT or bad quality of water.

➢ Environmental impact by reduction of paint contentin the wastewater

- **Anolyte system:**

Task and function of the anolyte system:

To keep the paint parameters constant, the produced acid must be removed from the system. Free acid leads to scratch and corrosion of the anode plates. Therefore, the anode plates are mounted in dialysis cells. Demineralizedwater is used as the anolyte and flows around the anode plates.The semipermeable membrane of the dialysis cells separates the paintfrom the anode plates.Paint particles are retained and negative acid residues pass themembrane into the anolyte circuit.Thus, the conductivity in the anolyte continuously increases.If the conductivity reaches a specific value, DI water is added into theanolyte tank.

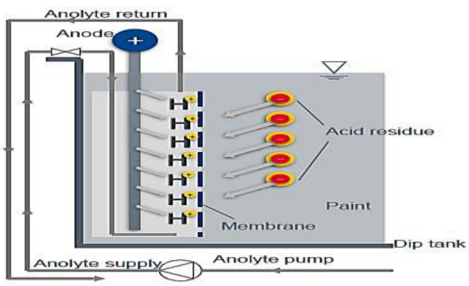

Fig.13.Anolyte System

- **ED oven:**

This equipment is the oven to bake ED Coated body/parts from the ED process.

1)Camelback oven with chain conveyor.

2)The CED Oven is set for the required Temperature for the Baking of the Body for getting the EMT as per the CED paint supplier's requirement.

3)These set points are resettable as per the system requirement and the oven operates on PID Control for the Temperature monitoring.

4)Filter is furnished to each Oven the hot air circulation is through the filter to reduce the dust level inside the Oven.

4)The combustion chamber is equipped with the filter.

5)The Oven inside temperature is controlled by the return air temperature of Oven.

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6)The Oven burner is Gas fired and the temp is maintained by the Logic set at Oven Burner,
7)The Burner is directly heated with the Burner chamber arrangement
8)As a safety measure, temperature sensor to detect abnormal high temperature is equipped to the outlet side duct of the re-circulation fan at zones to prevent burner's abnormal combustion.

Limits of Electro coating:

Limitations respective to frame body material.

- The electro coating process is possible only on an electrically conductive surface.
- No color variations possible. The application of different paint colors would require different dip tanks.
- The color of the EC paint is specified by the chemical supplied and is the same for all produced units.

IV. COMMISSIONING DATA

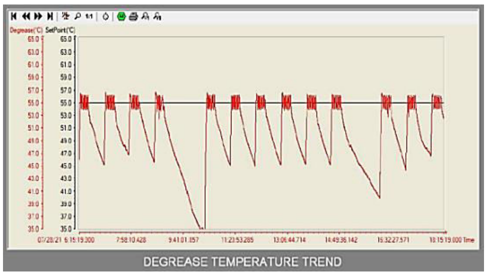

Fig. 14. Degrease Temperature Trend

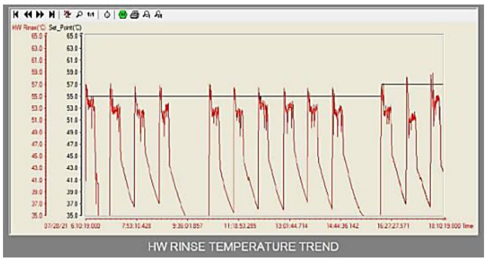

Fig. 15. HW Rinse Temperature Trend

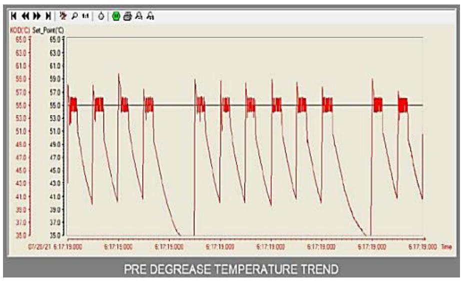

Fig. 16. Pre Degrease Temperature Trend

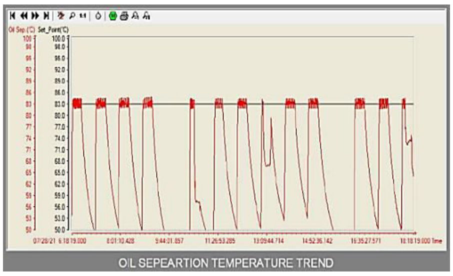

Fig. 17. Oil Sepearation Temperature Trend

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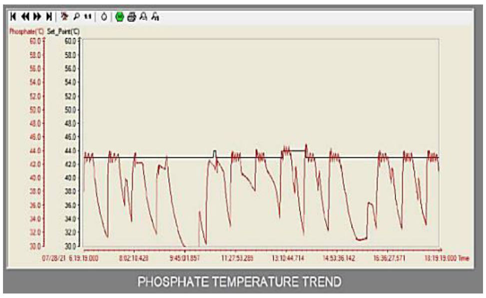

Fig. 18. Phosphate Temperature Trend

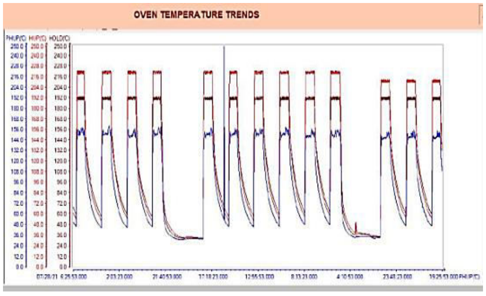

Fig. 19. Oven Temperature Trends

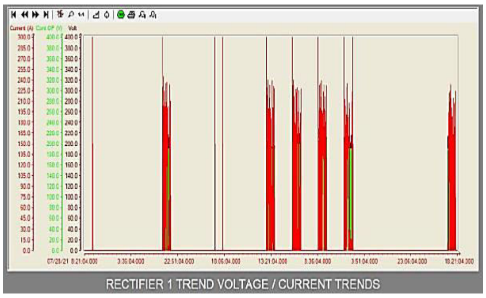

Fig. 20. Rectifier 1 Trend Voltage/Current Trends

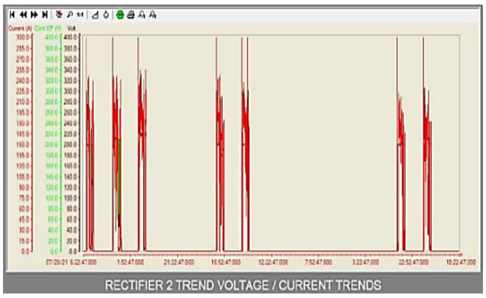

Fig. 21. Rectifier 2 Trend Voltage/Current Trend

Table. 2. Daily recorded Data

DATE	ELECTRICITY CONSUMPTION (KWh)								GAS CONSUMPTION (m^3)					WATER CONSUMPTION (m^3)		TOTAL PRODUCTION
	PT	ED	OVEN	ASU & BOOTH	RECT 1	RECT 2	HWG	CHILLER	HWG-1	HWG-2	PRE HEAT	HEATUP	HOLD	IND	DI	
7/28/2021	951.00	1788.00	700.00	56.00	0.00	136.00	325.00	442.00	246.00	192.52	6.96	213.98	150.24	19.95	17.59	0.00
7/29/2021	1048.00	1844.00	746.00	59.00	0.00	232.00	323.00	479.00	396.87	71.29	7.16	252.01	174.12	15.83	20.97	0.00
7/30/2021	991.00	1818.00	874.00	58.00	0.00	244.00	323.00	484.00	64.15	381.97	6.71	261.45	177.52	15.09	46.74	0.00
7/31/2021	984.00	1835.00	768.00	56.00	191.00	0.00	323.00	467.00	143.88	353.40	8.17	270.30	189.57	22.07	22.67	0.00
8/01/2021	274.00	1572.00	23.00	57.00	0.00	0.00	121.00	380.00	3.75	2.32	0.00	0.00	0.00	28.19	31.80	0.00
8/02/2021	1048.00	1769.00	899.00	58.00	0.00	204.00	239.00	438.00	297.00	258.99	10.08	293.65	196.11	11.85	18.87	0.00
8/03/2021	993.00	1751.00	715.00	58.00	0.00	196.00	325.00	459.00	206.58	324.93	8.00	265.11	176.52	9.66	18.77	0.00
8/04/2021	992.00	1819.00	757.00	58.00	202.00	0.00	324.00	464.00	31.12	470.33	7.44	279.23	191.12	10.67	46.24	0.00
8/05/2021	1100.00	1827.00	799.00	54.00	220.00	0.00	325.00	475.00	65.65	511.22	7.82	293.62	200.18	11.35	20.01	0.00
8/06/2021	1049.00	1841.00	790.00	56.00	239.00	0.00	322.00	498.00	66.88	466.95	8.59	298.41	195.74	12.56	49.45	0.00
8/07/2021	1077.00	1862.00	824.00	55.00	182.00	0.00	276.00	494.00	63.51	501.38	7.45	296.41	206.21	14.86	19.18	0.00
8/08/2021	199.00	1559.00	41.00	54.00	0.00	0.00	0.00	425.00	0.00	0.00	0.00	0.00	0.00	12.01	31.38	0.00
8/09/2021	1058.00	1782.00	803.00	56.00	0.00	197.00	265.00	498.00	97.34	461.92	10.90	257.45	227.42	9.44	22.12	0.00
8/10/2021	1029.00	1822.00	772.00	56.00	0.00	194.00	323.00	494.00	0.00	533.54	7.84	238.48	220.07	11.17	19.79	0.00
8/11/2021	989.00	1799.00	704.00	55.00	187.00	0.00	320.00	485.00	58.58	426.66	8.06	227.80	203.62	12.31	17.59	0.00
Total	**13782.00**	**26688.00**	**10215.00**	**846.00**	**1221.00**	**1403.00**	**4134.00**	**6982.00**	**1741.31**	**4957.42**	**105.18**	**3447.89**	**2508.45**	**217.01**	**403.17**	**0.00**

V. CONCLUSION

In this work, Erection and commissioning of PT-CED Line is carried out. Performance analysis observed for each and every field equipments. All the results collected from SCADA system after process parameter achieved, and results are results are compared with designed parameters. From analysis carried out it can be concluded that, Erection and commissioning of the PT-CED line system is working as per designed parameters. This system implies many different approachable things and developed as fully automated system.

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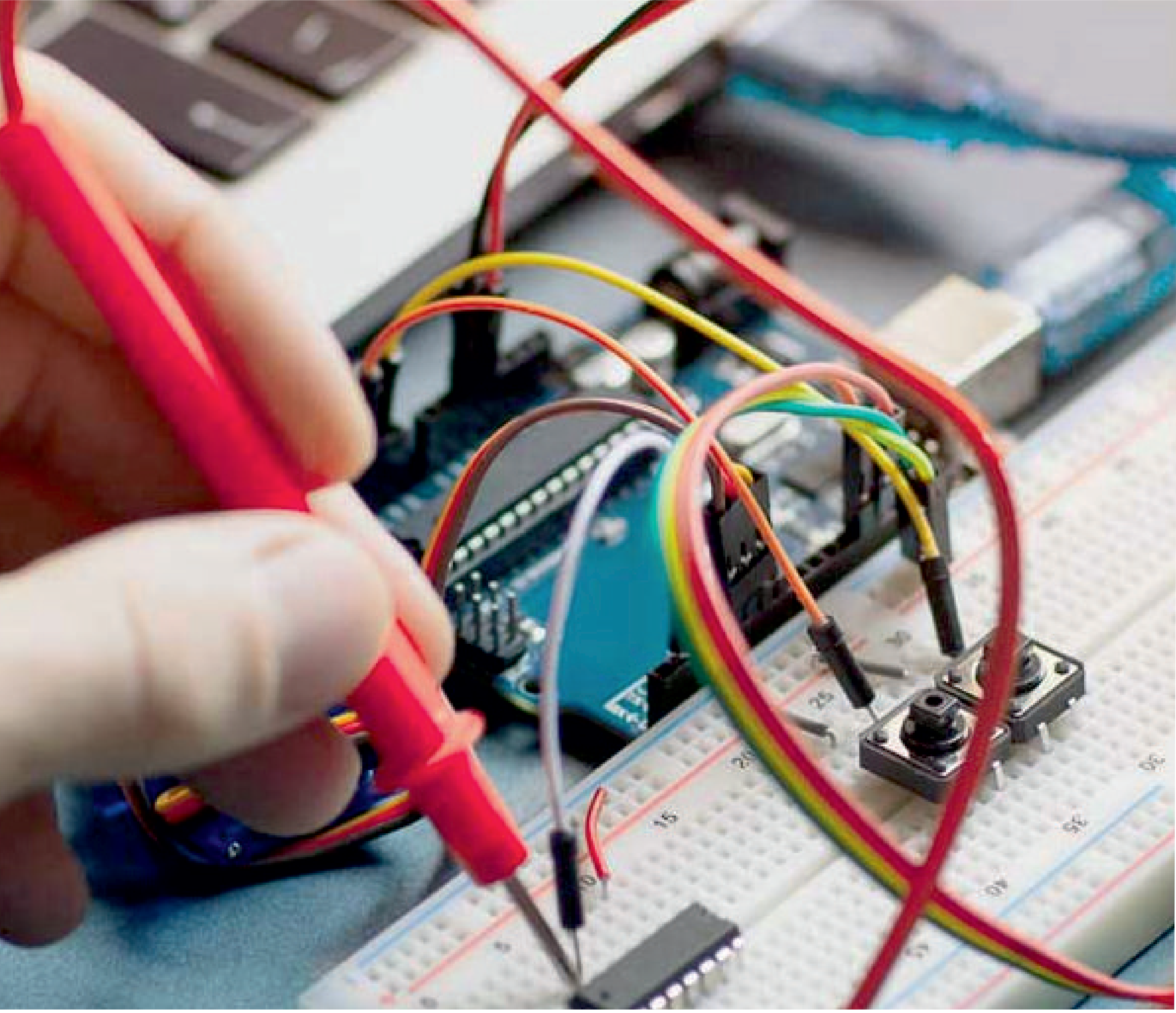

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