CMR UNIVERSITY

Private University Established in Karnataka State by Act No. 45 of 2013

School of Engineering and Technology

Department of Mechanical Engineering

Webinar Report

On

"Mechanical Aspects of High Voltage Circuit Breakers and Isolators"

Organized by

Department of Mechanical Engineering

Date: 25.05.2020 @ 10.30 AM

Resource Person:
Shri Dhanapal,
Chief Manager, Power Grid Corp

Coordinator
Prof. Arun Kumar K H
ME, SOET, CMRU

Convener
Dr. Rajashekar Patil
HOD, ME, SOET

Main Campus, Off Hennur - Bagalur Main Road,
Chagalahatti, Bengaluru – 562149, Karnataka, India

2019-20

Contents

2. Invitation

CMR UNIVERSITY

Private University Estd in Karnataka State by Act No.45 of 2013

Department of Mechanical Engineering

Cordially invite you to webinar

On

"Mechanical aspects of High Voltage Circuit Breakers & Isolators"

On Monday May 25th, at 10:30 am – 11:30 am

Shri Dhanapal S,
Chief Manager, Power Grid SR-II

Coordinator
Prof Arunkumar KH,
ME, SOET, CMRU
Ph: 9480003777
Email: arun.k@cmr.edu.in

Initiator
Dr Rajashekar Patil,
HOD, ME, SOET, CMRU

पावरग्रिड

Power Grid Corporation of India

3. Webinar Poster

4. About Resource Person

Name: Shri Dhanapal S

Designation: Chief Manager

Qualification: B-Tech in EEE

M-Tech in Power Electronics & drives.

Experience: 18 Years in High Voltage Class Equipments

E-mail: sdhanapal@powergridindia.com

Shri Dhanapal, He is working as Chief Manager in POWERGRID Corporation of India Limited, Southern region-II Headquarters, Bangalore. His areas of interest are Extra High voltage class equipments in Power sector, Power Electronics and Mechanical Drives. His expertise in circuit breakers and isolators has led him share his application knowledge in the industrial community through conferences and guest lectures/ webinars.

5. Vice Chancellor Inaugural Speech

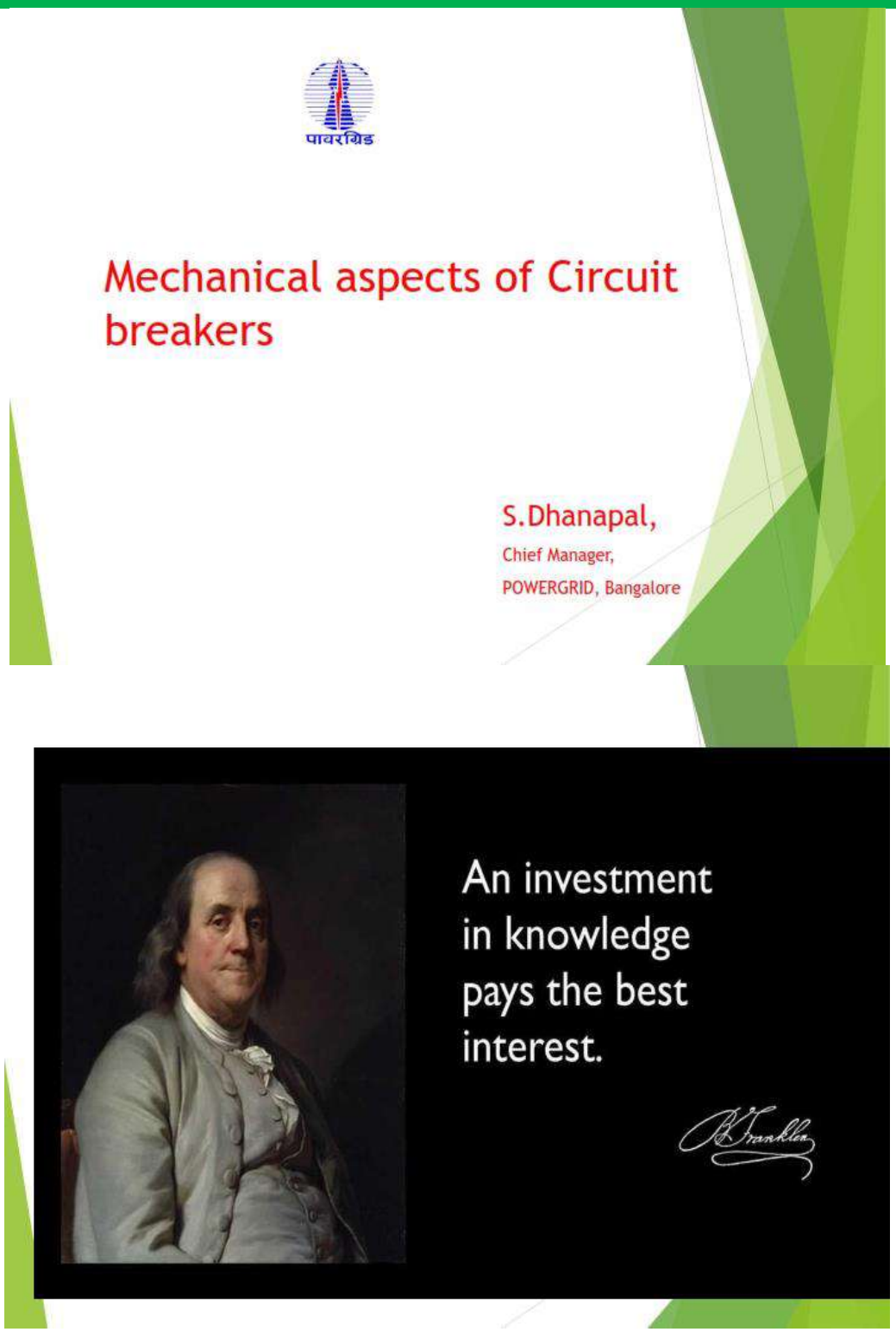
Honorable Vice Chancellor was glad to see the utmost proficient Shri Dhanapal as the expert speaker for today's session. VC sir was happy to share that he started his Bachelor's degree with Electrical Engineering. In mid, the Electrical Engineering streamed to Electronics and Communication Engineering. He was one among the first batch who completed the Bachelor's degree from Electronics and Communication Engineering, Mysore University. Vice Chancellor also expressed that two core engineering streams (Mechanical and Electrical) are getting together to share the knowledge to the younger generation through this webinar. By reminding the fact that Karnataka is the House of Power Industry. The first Power generation project of 25 Hz from Shivanasamudram was constructed by Chief Engineer, Sir Mokshagundam Visvesvaraya. Sir MV, planned to develop numerous Power Plants over the Western Ghats and all the power lines were connected to a single location and formed Grid, which resulted in the Power Grid Corporation of India Limited, which is an Indian state-owned Maharatna company headquartered in Gurugram, India. Vice Chancellor also gave an comparison of Grid as an Heart of our Indian Economy. Like the Heart supplies blood to different systems in our body, Grid supplies constant power to different locations for its safety consumption. Also Vice Chancellor, remembered the higher official engineers controlling the grid for its safety when our Honorable Prime Minister announced all the citizens not to consume the power for about 10 mins. This controlling will be done by Circuit breakers and isolators. He was very much happy that the relevant topic apt to the present situation which has been organized by Department of Mechanical Engineering for the benefit of the students and participants.

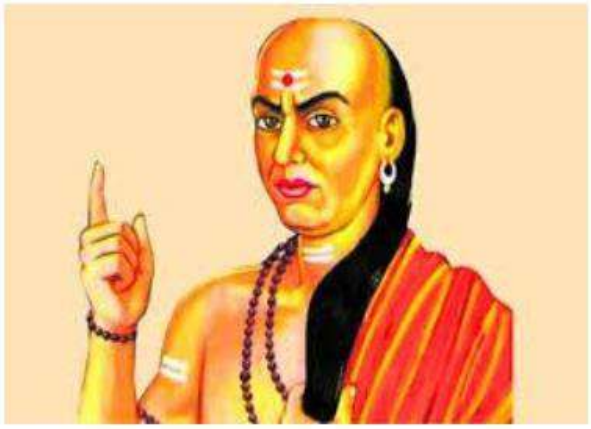
Sd/-
Vice Chancellor
Prof M S Shivakumar

6. Coordinator and Head of Department

Prof Arunkumar KH, Department of Mechanical Engineering, During the Departmental meeting it was discussed to conduct National Webinar and the same was informed to the University. Coordinator with the help of fellow collegues sent information to all the states of India. There was a overwhelming response from the southern states of India. Nearly 2 days worked online with fellow collegues to send information to all the participants, collected the feedback and also issued E-Certificate on the same day and reported to University. The coordinator organised the National Webinar successfully.	
Dr Rajashekar Patil, Head of Department, had series of discussions with coordinator and took permisison during SOET regular meeting to conduct the National Webinar and also contacted Honorable Vice Chancellor to inagurate the webinar by addressing the participants. The Honorable Vice Chancellor accepted the invitation, inspired by his inaugural address and also witnessed the session till end. Finally thanked the Resource Person and congratulated the Department of Mechancial Engineering for organizing and wished all the participants. The HOD, presented E-copy of appreciation letter to the expert speaker and thanked one and all.	

7. Topic and Presentation slides

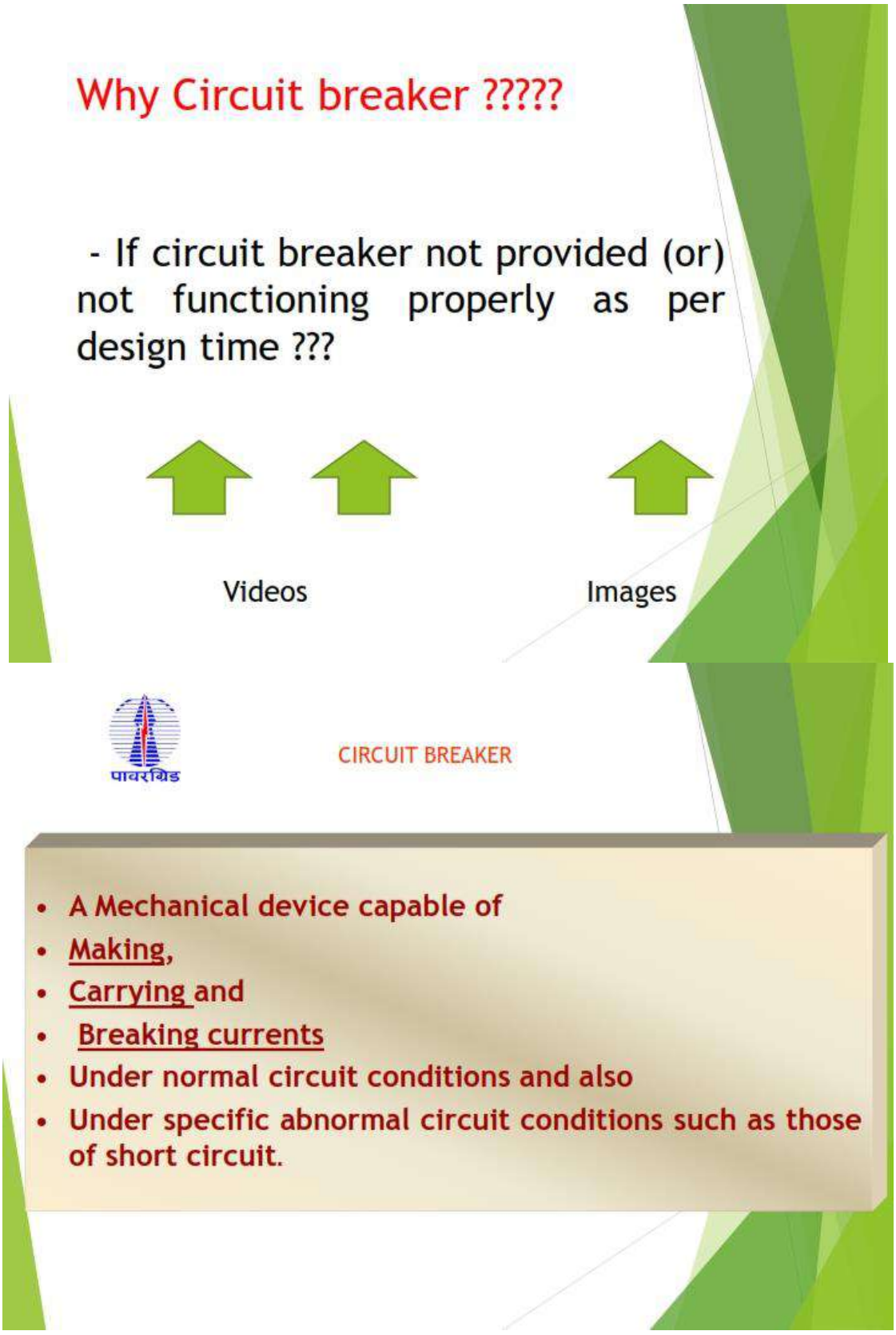




"KNOWLEDGE IS LOST WITHOUT PUTTING IT TO PRACTICE"

What is Circuit breaker

- Circuit breaker – "CIRCUIT" "BREAKER"-
- Most important & critical component of electrical system.
- Isolates the faulty system/equipment from the healthy one.
- ***Despite circuit breaker is named as an electrical device, it is predominantly a "mechanical" device used for achieving excellent electrical isolation during faults. "***


Why Circuit breaker ?????
- If circuit breaker not provided (or) not functioning properly as per design time ???
Videos
Images
पावरग्रिड
CIRCUIT BREAKER
A Mechanical device capable of
Making,
Carrying and
Breaking currents
Under normal circuit conditions and also
Under specific abnormal circuit conditions such as those of short circuit.

Electrical requirements of Circuit breaker

- Typically for a 400KV Circuit breaker

- Close time - Max. "150" ms
- Opening Time - Max. "25" ms
- Closing velocity - 2 to 4 m/sec
- Opening velocity - 7 to 8 m/sec

To be achieved "mechanically" through proper design of

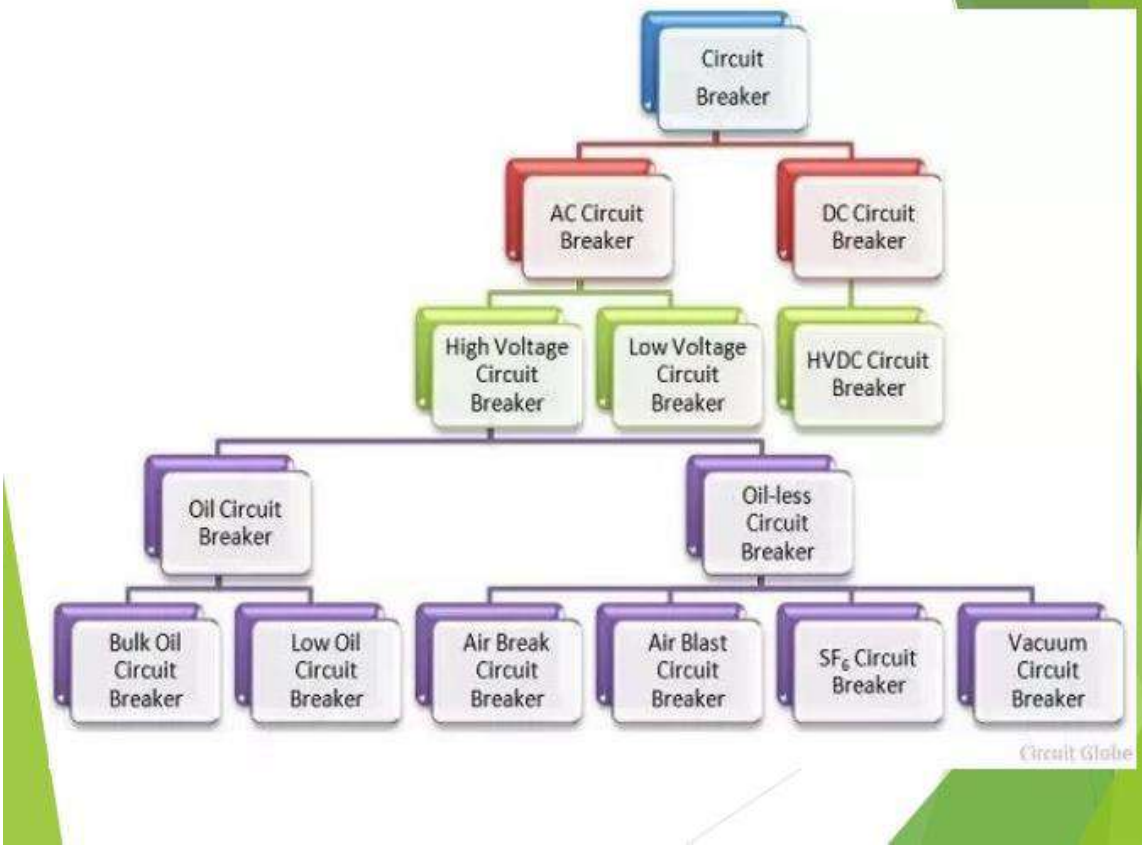
1. Arc Quenching media
2. Operating mechanism

Contact insertion/ speed

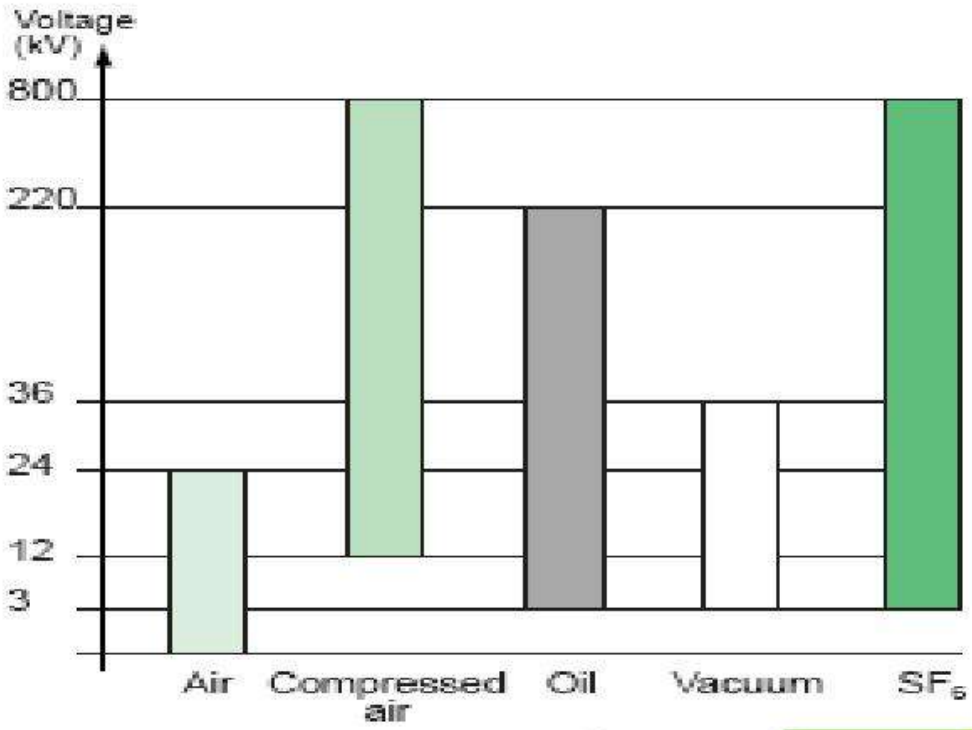
Make	Trip velocity	Close velocity
ABB	6-8 m/sec	3-4 m/sec
CGL	5-6 m/sec	3-4 m/sec
BHEL	6-8 m/sec	3-4 m/sec
AREVA	5-8 m/sec	2-4 m/sec

Why such fast acting time is required ??? For CBs

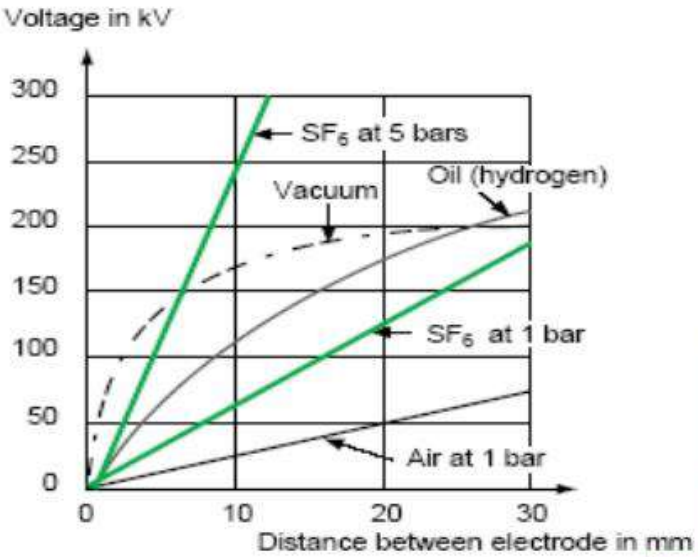
- Human Safety - Humans can withstand only "10 mA" current
- Equipment safety- Consequential damages & cost
- System safety - Economy. 1 to 256 times loss.



Type of CBs



Dielectric Strength of different mediums



Mechanical properties of SF6

Properties of SF6 Gas

- Chemical:
  - Stable upto 500 Deg. Centigrade.
  - Inert – Chemical inert – Metallic parts, contacts have longer life.
  - Electronegative.
  - Does not react with structural materials upto 500 Deg. Centigrade.
  - Products of decomposition SF2 & SF4 recombine on cooling.
  - Metallic Fluorides are good insulators.

Properties of SF6 Gas:

- **Physical:**
  - Colourless, odourless, nontoxic
  - Pure gas is not harmful to health, Non-inflammable
  - Gas at normal pressure & Temperature
  - Gas density - 5 times that of air at 20 deg.C and atmospheric pressure

- So due to its high dielectric strength and high cooling effect SF_6 gas is approximately 100 times more effective arc quenching media than air.
- Due to these unique properties of this gas, **SF_6 circuit breaker** is used in complete range of medium voltage and high voltage electrical power system.
- These circuit breakers are available for the voltage ranges from 33KV to 800 KV and even more.

Disadvantages of SF_6 CB

- The SF_6 gas is identified as a greenhouse gas, safety regulation are being introduced in many countries in order to prevent its release into atmosphere.
- Puffer type design of SF_6 CB needs a high mechanical energy which is almost five times greater than that of oil circuit breaker.
- SF_6 gas is suffocating to some extent. In the case of leakage in the breaker tank, the SF_6 gas being heavier than air and hence SF_6 are settled in the surroundings and lead to the suffocation of the operating personnel.

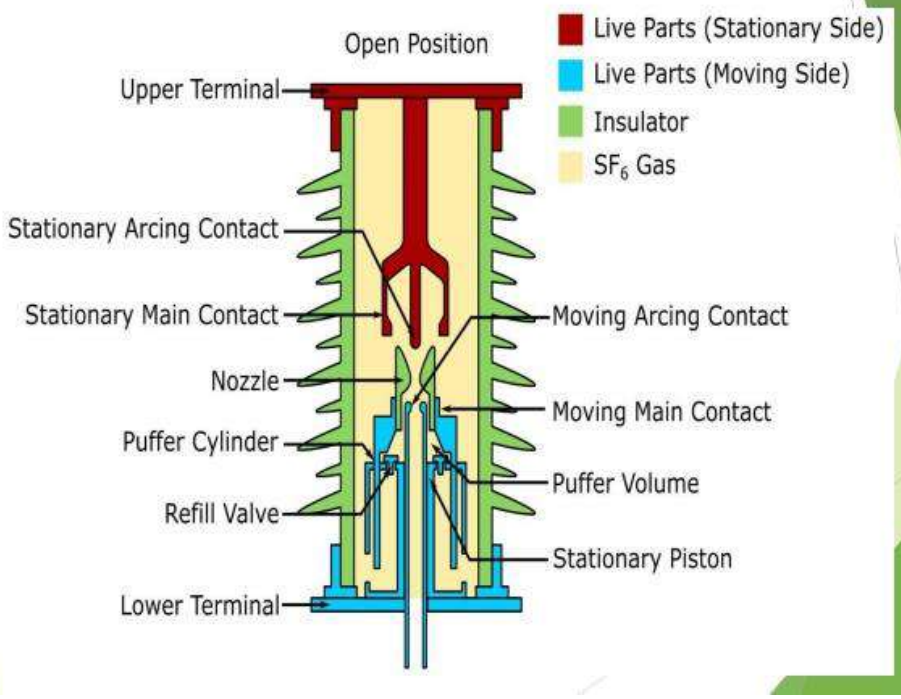
CIRCUIT BREAKER- Basics

- Basics of CB

VIDEO

400kV BHEL CB

CB Inside



INTERRUPTER DESIGN

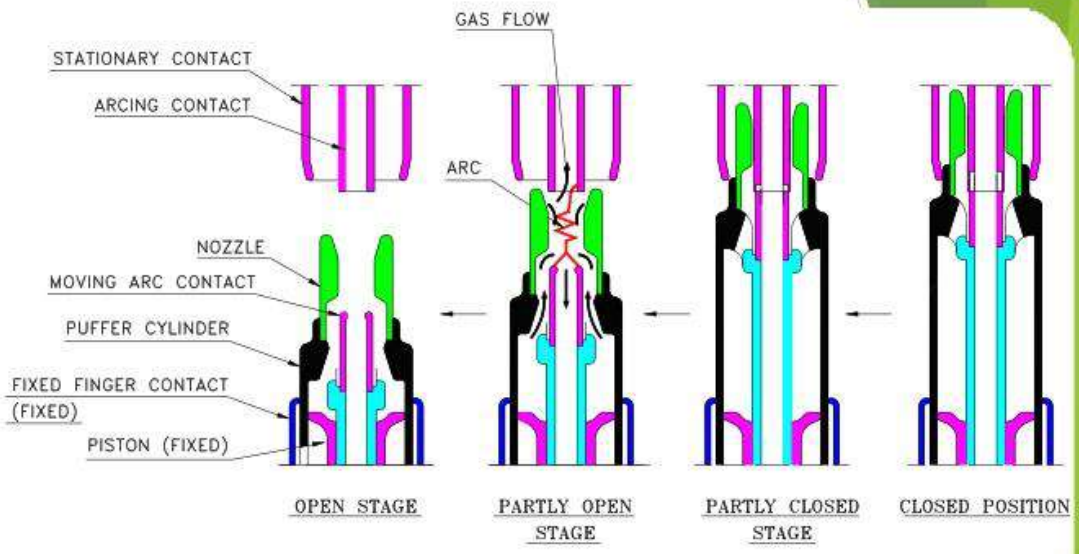
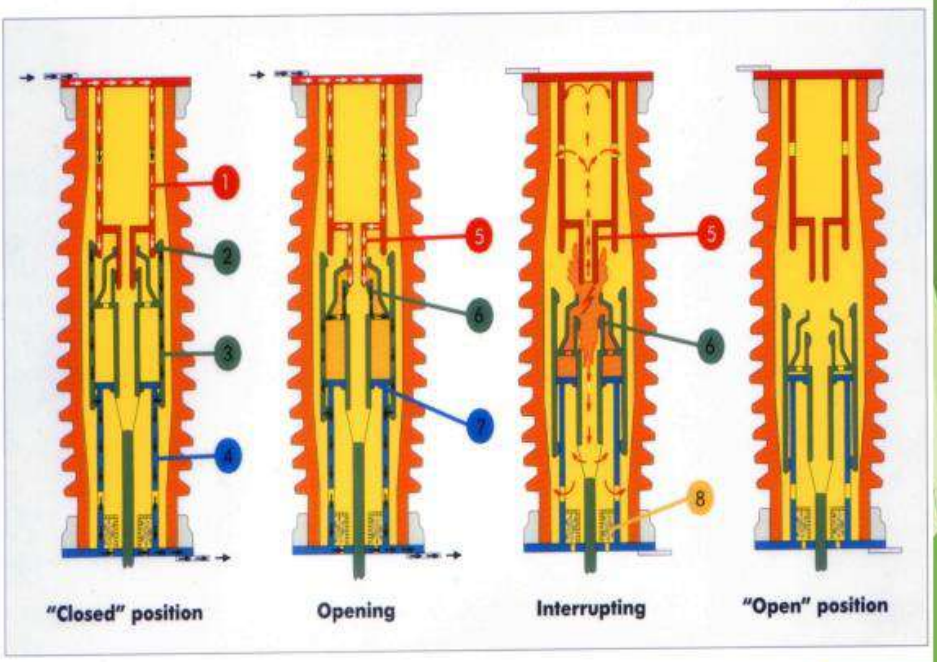


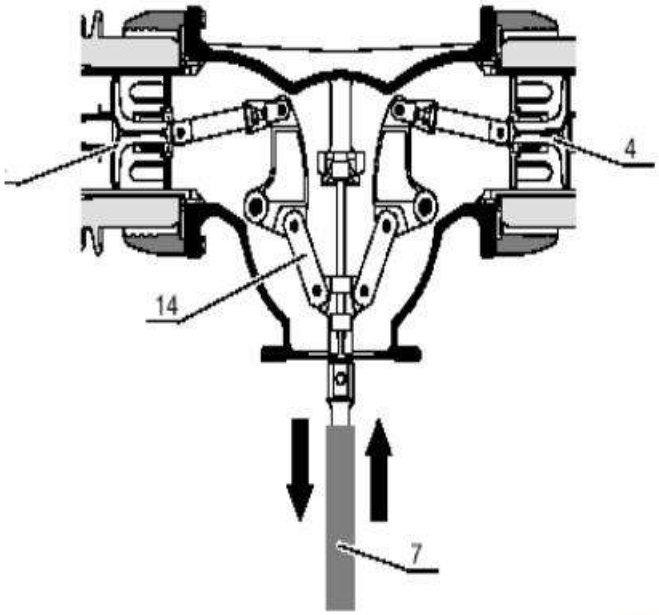
FIG.1.1 'PUFFER' PRINCIPLE OF INTERRUPTING UNIT

1

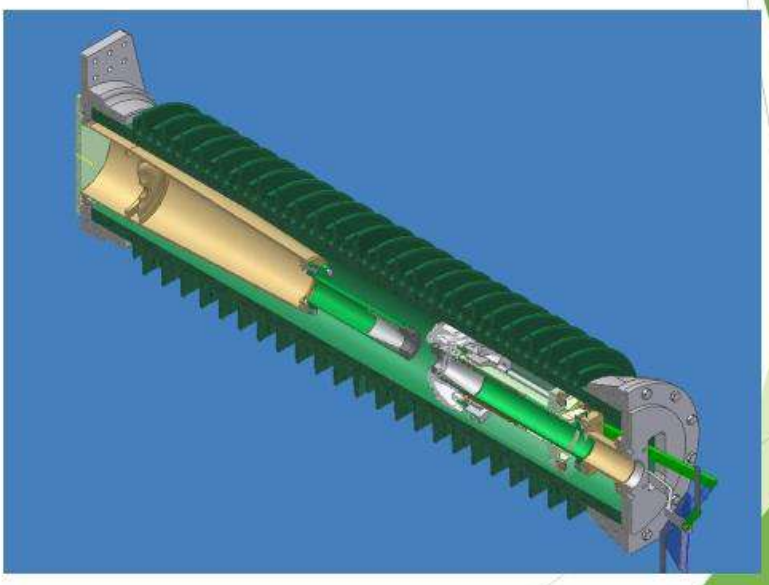
Main and Arcing Contacts



Operating Links



SECTIONAL VIEW OF INTERRUPTER



CB operation video

CB based on Operating mechanism

- Hydraulic – Uses fluid (Oil) pressure
- Pneumatic - Uses Air pressure
- Spring mechanism – Uses Spring pressure
- Hybrid- Pneumatic Spring
- Hybrid – Hydraulic Spring

HYDRAULIC CIRCUIT BREAKERS

145kV hydraulic mechanism operated SF6 gas breaker

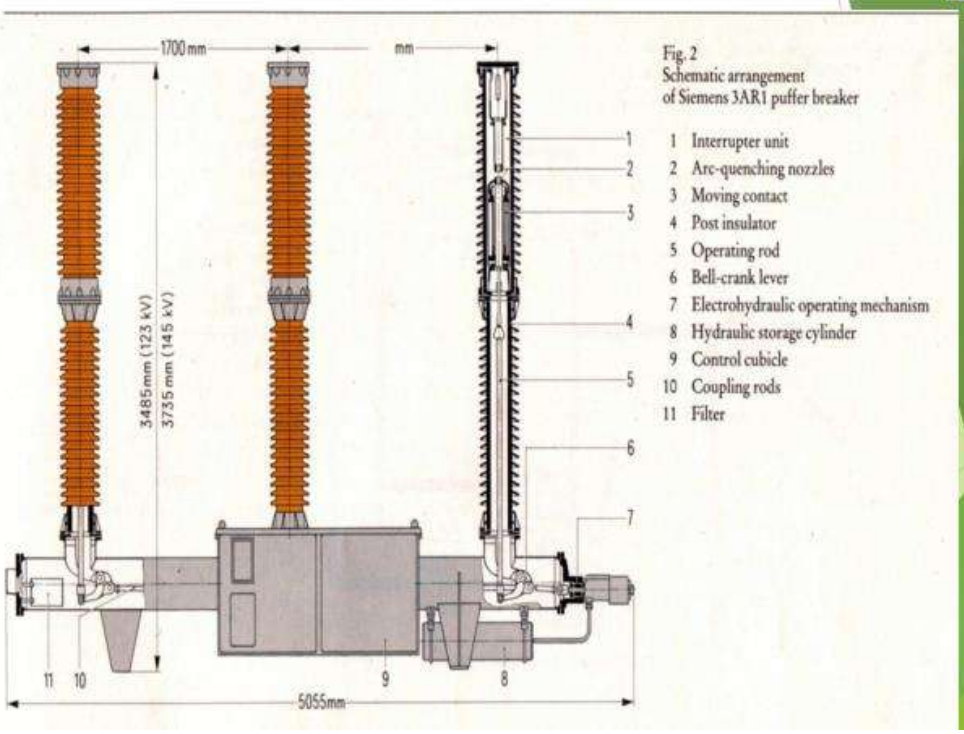
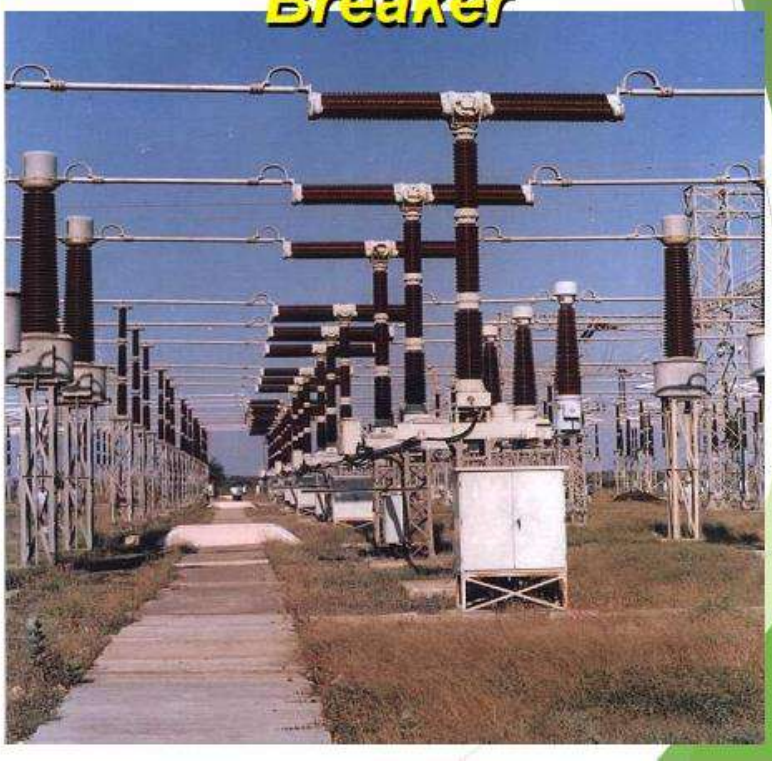


Fig. 2
Schematic arrangement
of Siemens 3AR1 puffer breaker

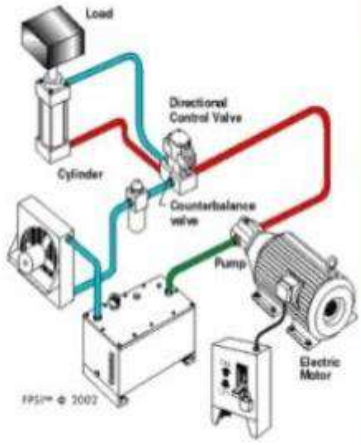
1 Interrupter unit
2 Arc-quenching nozzles
3 Moving contact
4 Post insulator
5 Operating rod
6 Bell-crank lever
7 Electrohydraulic operating mechanism
8 Hydraulic storage cylinder
9 Control cubicle
10 Coupling rods
11 Filter

400 kV SF6-Hydrauic Circuit Breaker



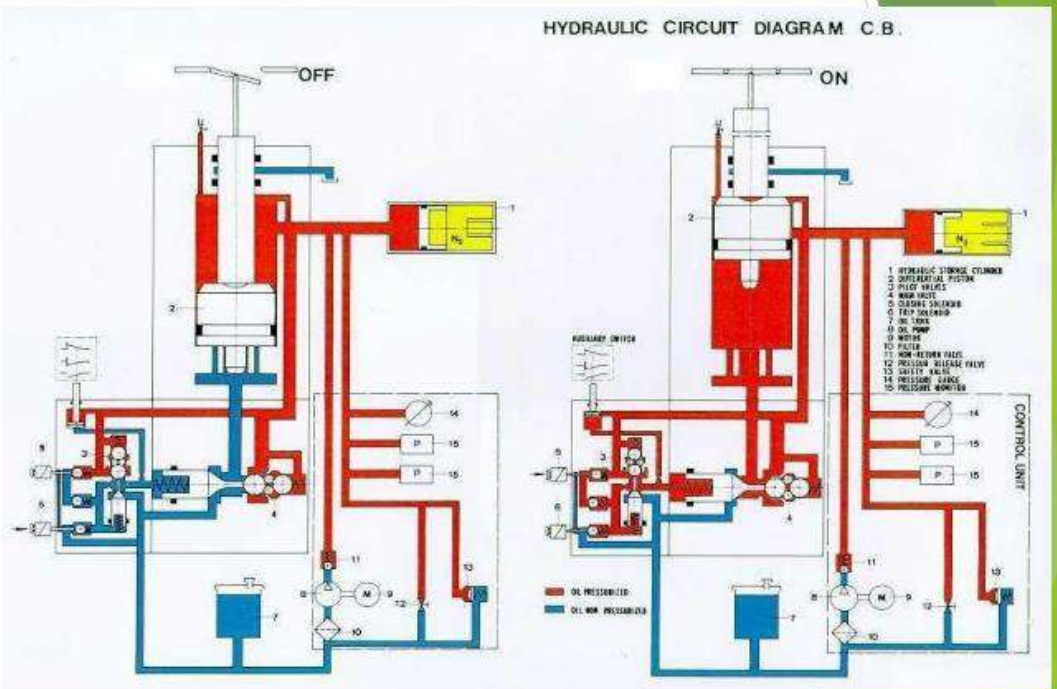
Fluid and fluid power

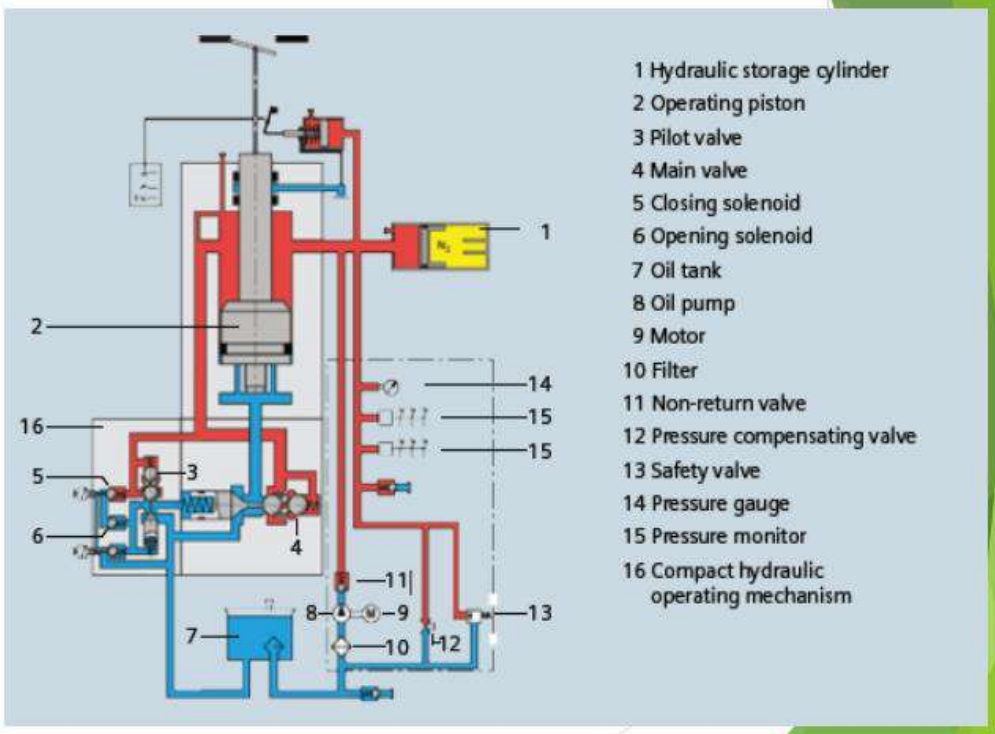
- Any material capable of flowing is a fluid
- Fluid can be a liquid or gas
- Fluid power systems involve
  - Power transmission
  - Control of power
- A fluid power system uses a fluid under pressure

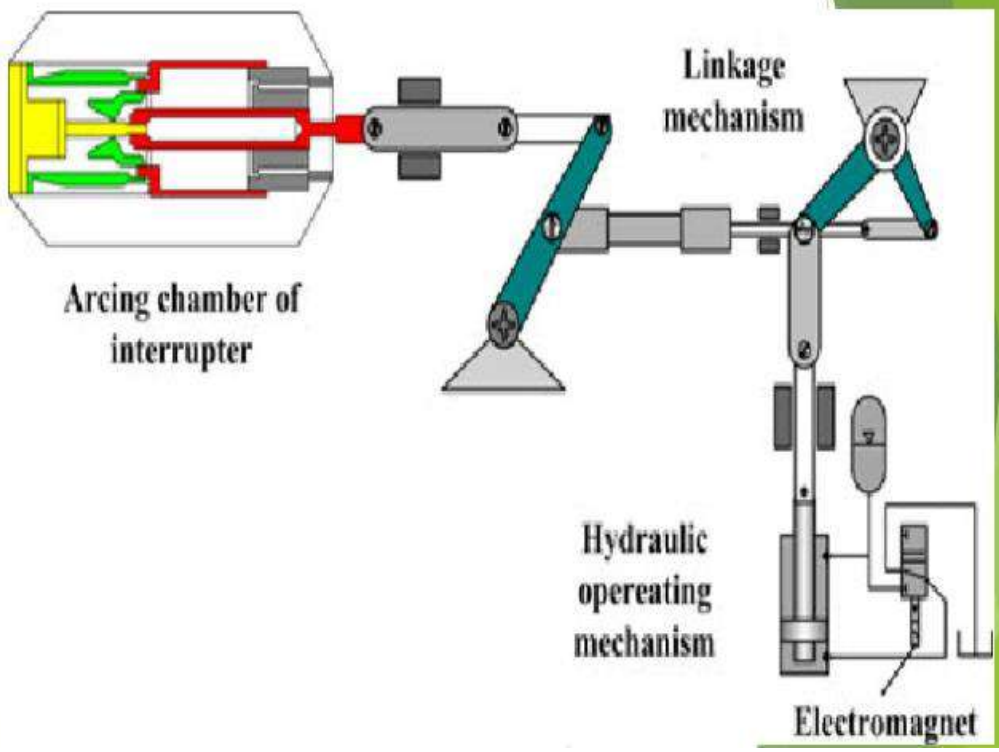


www.idc-online.com/slideshare Technology Training that works

BHEL make CB Operating Mechanism




1 Hydraulic storage cylinder
2 Operating piston
3 Pilot valve
4 Main valve
5 Closing solenoid
6 Opening solenoid
7 Oil tank
8 Oil pump
9 Motor
10 Filter
11 Non-return valve
12 Pressure compensating valve
13 Safety valve
14 Pressure gauge
15 Pressure monitor
16 Compact hydraulic operating mechanism


Linkage mechanism
Arcing chamber of interrupter
Hydraulic opereating mechanism
Electromagnet

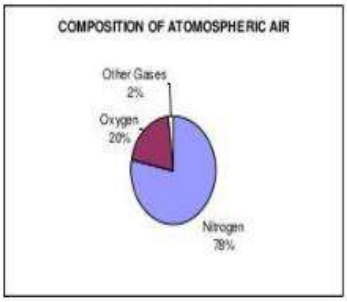
PNEUMATIC CIRCUIT BREAKERS

What is Pneumatics?

- Pneumatics is the transmission and control of power, using gas as the power transfer medium
- In most cases, air is the medium used
- Inert gases (ex: Nitrogen) used only in special cases)
  - When a liquid is used as the medium, it is known as a HYDRAULIC system

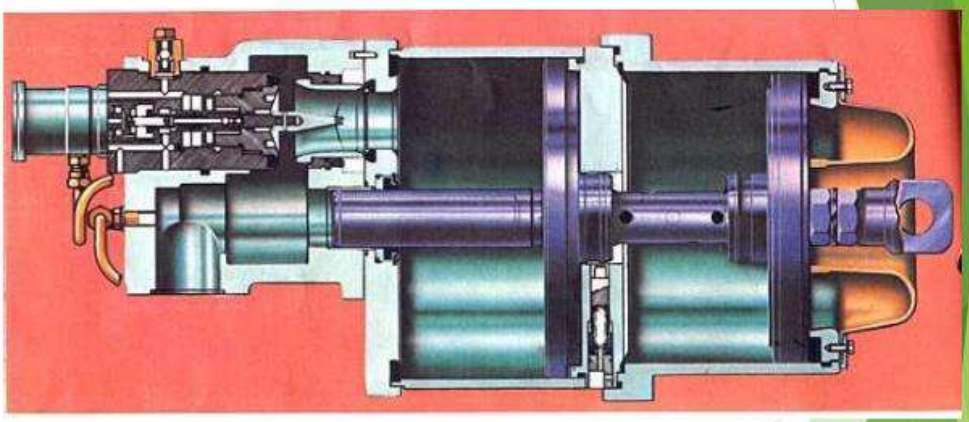
Air as pneumatic medium

- **Benefits**
  - Cheap, available at no cost
  - Compressible like any gas
- **Drawbacks**
  - Contains moisture
  - Can cause corrosion in system components in the presence of oxygen
  - Oxygen present in air can also aid combustion
  - Needs external lubrication (unlike hydraulic fluids)



www.idc-online.com/slideshare *Technology Training that works* IDC TECHNOLOGIES

Pneumatic mechanism

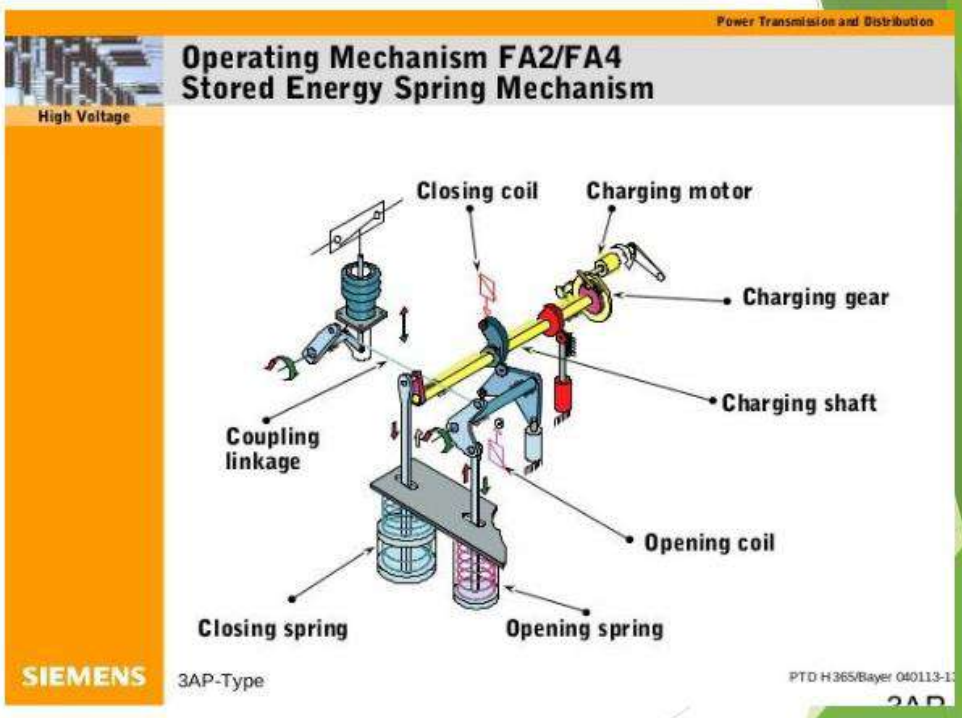


400KV Spring - Pnuematic Breaker

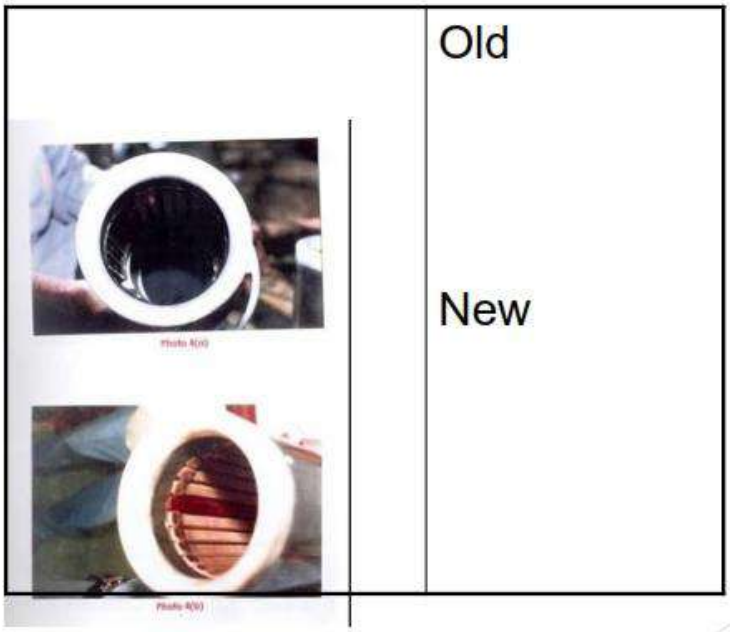
Spring – Pneumatic Driving Mechanism

VIDEO ON PNEUMATIC CB DRIVE

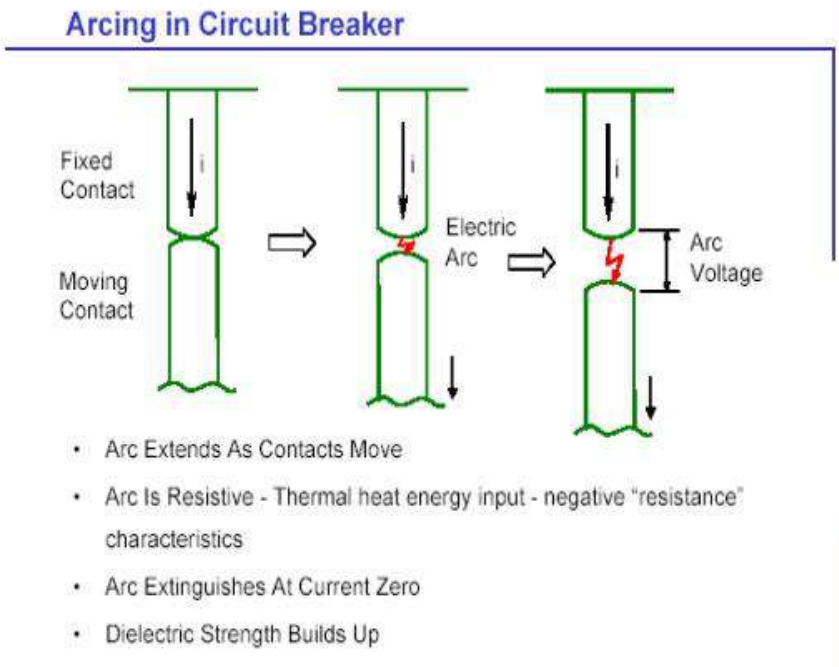
SPRING & SPRING HYDRAULIC OPERATED CIRCUIT BREAKERS



Eroded finger contact after 7-8 years



CB Operation



- Arc Extends As Contacts Move
- Arc Is Resistive - Thermal heat energy input - negative "resistance" characteristics
- Arc Extinguishes At Current Zero
- Dielectric Strength Builds Up

Reasons of CB Failures in POWERGRID

MECHANICAL - 74%
(OPERATING COMPONENTS FAILURES)

ELECTRICAL - 16%
(DIELECTRIC FAILURE)

OTHERS - 10%

Circuit Breaker Failures

- Due to manufacturing defects
- Due to design defects

PROBLEMS IN CB AFTER 7-8 YEARS

Photo 1(a)

Photo 1(b)

Thank you!

Knowledge is Power. Divide & Share it to Multiply

8. List of Participants

Professors from SOET:

Sl No	Name	Designation
1	Dr. Rajashekar Patil	Professor
2	Dr. Muralishankar	Professor
3	Dr. Anup	Asso.Professor
4	Dr. Bharath V G	Assist. Professor
5	Prof. Arunkumar K H	Assist. Professor
6	Prof.Bharath G	Assist. Professor
7	Prof. Varaprasad	Assist. Professor
8	Prof. Devaraj	Assist. Professor
9	Prof. Rupa	Assist. Professor
10	Prof. Mamatha	Assist. Professor
11	Prof. Hema	Assist. Professor
12	Prof. Manjunath	Assist. Professor
13	Prof. Shashidhar M	Assist. Professor
14	Prof. Puneeth	Assist. Professor

Students:

Sl No	Student Name	Sem	Sl No	Student Name	Sem
1	ANTHONY DARSHAN F	8	21	A V RAHUL	6
2	BHARATH KUMAR S		22	ANTON ANUBHAV RAJAN	
3	BRIONIN DENNIS		23	ARCHANA V	
4	CHENGAPPA K B		24	ASHOK KUMAR R	
5	KARAN		25	AVINASH KANNAN M G	
6	NAMITH RAJ N		26	CHARAN GOWDA S	
7	NIKHIL M		27	DHATHRI S RAO	
8	NITIN RAJIV B.S		28	G SHABREZ	
9	PRANAV D S		29	K B MALLIKARJUNA	
10	RAJESH		30	MANASSEH SAMUEL	
11	RAJESH KUMAR G		31	MOHAMMED FAAIZ	
12	SAGARKUMAR N		32	NIKHIL S NANDI	
13	SHAAB HASSAN V		33	P SACHIN SIYAL	
14	V. NISHANTH UDAY		34	PRAVEEN JADHAV	
15	VIVEK C		35	GHANASHYAM G	
16	MANIKANTA A R		36	MOHAMMED NEHAL	
17	RAFFI PASHA		37	SUPRITH G GOWDA	
18	RENUKA PRASAD		38	SUSHIL KUMAR M	
19	SHAIK JAMEER M				
20	MIRZA NAQUI ALI				

Sl No	Student Name	Sem
39	AMIRSOHAIL KAKANODI	4
40	ANIL BIJU PAREL	
41	ANJAN KUMAR	
42	BHARGAV S P	
43	HARI PRAMOD M	
44	JEEVAN G	
45	JEEVESH S	
46	MOHAMMED THASIN	
47	NAGENDRA S R	
48	PRAJWAL V BIRADAR	
49	PUNITH HS	
50	RAHUL S	
51	SIDDHARTH MISHRA	
52	SURESHA N	
53	THENNAVAN P M	
54	VISHNU SHARMA NANDA	

Others:

Sl No	Participants outside CMRU	University
1	Dr. Sivaramakrishnan N	Department of Mechanical Engineering, Royal Global University, Guwahati, Assam.
2	Dr. Abhijit Deka	HOD Department of Mechanical Engineering RSET, RGU
3	Mr. PENUMURU KUMAR	Sri Venkateswara College of Engg. & Tech., R.V.S Nagar, Chittoor
4	Student participants outside CMR totaling to **315**	From Karnataka, Andhra, Telangana, Tamil Nadu and Kerala

Number of Participants:

Description	Numbers
Dept. of ME	**10**
From SOET and Other Departments	**04**
Mechanical Engineering Students (4th, 6th and 8th sem)	**54**
Professors, Faculties and Students of other states	**318**
Total	**386**

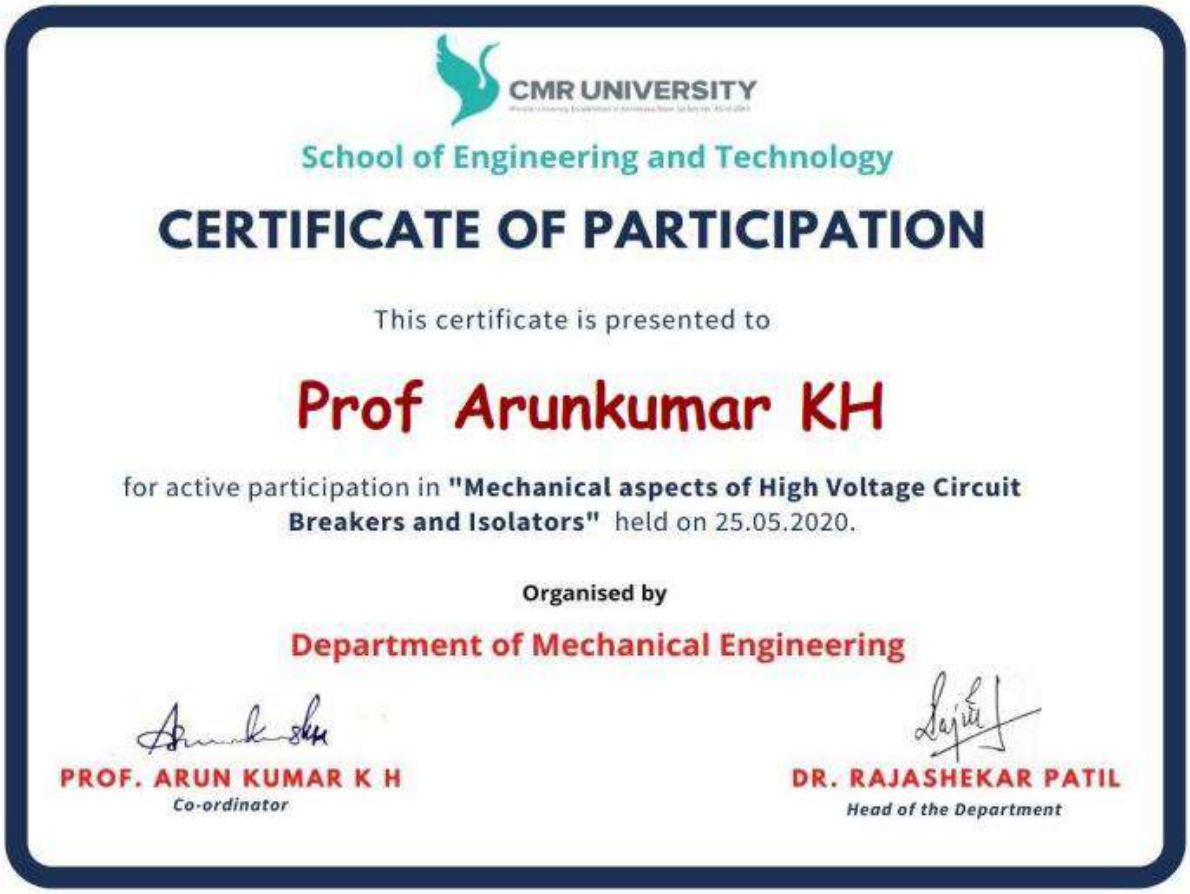
9. Webinar Link

Sl No	Description and Link	Operator	Work
01	Main Stream https://meet.google.com/jff-fnvv-xkf	Prof Arunkumar KH & Prof Bharath VG	Spotlight screen adjustment of the speaker and participant audio control and Participant Admit
02	Bridge Stream-1 https://meet.google.com/rtt-ebst-rzq Bridge Stream-1 https://meet.google.com/tne-nqtv-zbg	Prof Bharath G	Participant Admit and Audio Control
03	Feedback Link: https://forms.gle/kW7kbY3Hz79z26gJ9		

10. Session Video Record Link (Main Stream)

https://drive.google.com/file/d/1l-1Hs91H3YVf3nYjhLCuukNIALMk_IlD/view

11. E- Certificate Template



CMR UNIVERSITY

School of Engineering and Technology

CERTIFICATE OF PARTICIPATION

This certificate is presented to

Prof Arunkumar KH

for active participation in **"Mechanical aspects of High Voltage Circuit Breakers and Isolators"** held on 25.05.2020.

Organised by

Department of Mechanical Engineering

PROF. ARUN KUMAR K H
Co-ordinator

DR. RAJASHEKAR PATIL
Head of the Department

12. Conclusions

Session Conclusions:

Circuit breakers as the name emphasizes breaks the electrical circuit whenever required. These are most important and critical component of electrical system which isolates the faulty system/equipment from the healthy one.

"***Despite circuit breaker is named as an electrical device, it is predominantly a mechanical device used for achieving excellent electrical isolation during faults.*** "

The circuit breaker opens up the electrical circuit whenever need arises. The opening chamber is called interrupter which interrupts the circuit. The interrupting operation is carried out by a drive mechanism.

Also, the speed of opening and closing of circuit breaker contacts is the most important requirement/parameters for efficient operation.

The speed is achieved by different ways of operating drive mechanisms.

In the session the discussions on different types of Drives used in circuit breakers like:

- Hydraulic (Uses hydraulic oil pressure),
- Pneumatic (Uses air pressure),
- Spring (Uses resilience property of spring),
- Hybrid type (Spring – Pneumatic),
- Hybrid (Spring – Hydraulic), were discussed in details.

13. Appreciation Letter

CMR UNIVERSITY
Private University Estd in Karnataka State by Act No 45 of 2013

School of Engineering and Technology
Department of Mechanical Engineering
To whom so ever concern

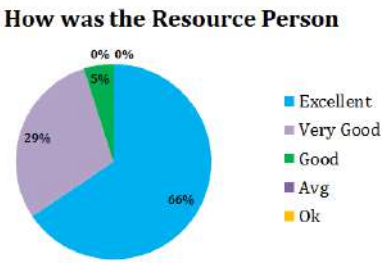
We appreciate **Shri Dhanapal S,** for delivering the lecture on
"Mechanical aspects of High Voltage Circuit Breakers and Isolators" at 10:30 AM
on 25th May 2020 through Google Meet.

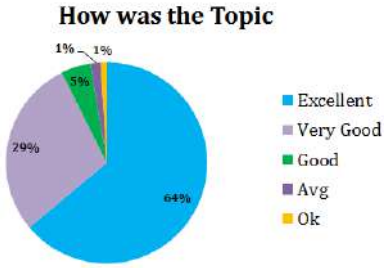
Prof Arunkumar KH
Co-Ordinator

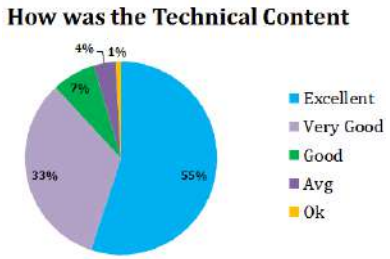
Dr Rajashekar Patil
Head of Department

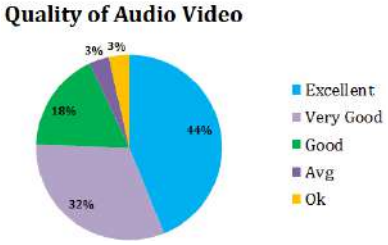
14. Feedback and Analysis

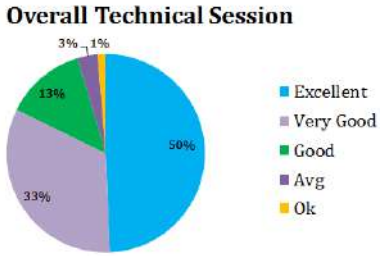
The feedback was collected from all participants using google forms.



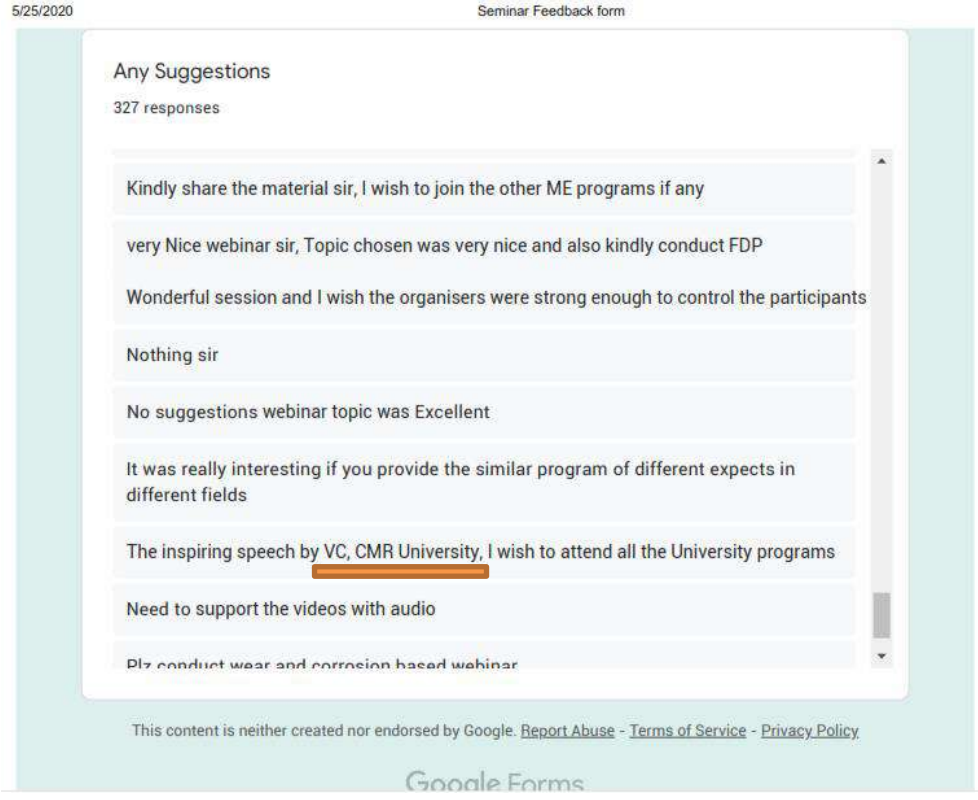








General Comments (327 Responses)



Overall feedback was excellent, and participants informed the coordinator and Head of the Department to conduct few more technical seminars to update the knowledge in current technology used in industries.

15. Acknowledgement

We thank Honorable Vice Chancellor, Pro Vice Chancellor, Registrar, and Dean SOET, CMR University for their continuous support to conduct the National Webinar during Covid-19 period.

We thank Resource Person, Shri Dhanapal S, Chief Manager, for sharing his experience and knowledge in the field of Power grids for our students and participants during COVID-19.

We thank all teaching and non-teaching faculty, Department of Mechanical Engineering for their valuable inputs for conducting National Webinar.

Coordinator
Prof. Arun Kumar K H

Convener and HOD
Dr. Rajashekar Patil