American International University- Bangladesh
Department of Electrical and Electronic Engineering
EEE4227: Power System Protection Laboratory

Title: Study of different components and their functions of an Air Circuit Breaker (ACB)

Introduction:

Based on the arc quenching medium circuit breakers are classified into several types. Air circuit breaker is one of the types. In ACB air is used to clear arc from the arcing zone. In this experiment construction of ACB is examined properly and following things are observed:

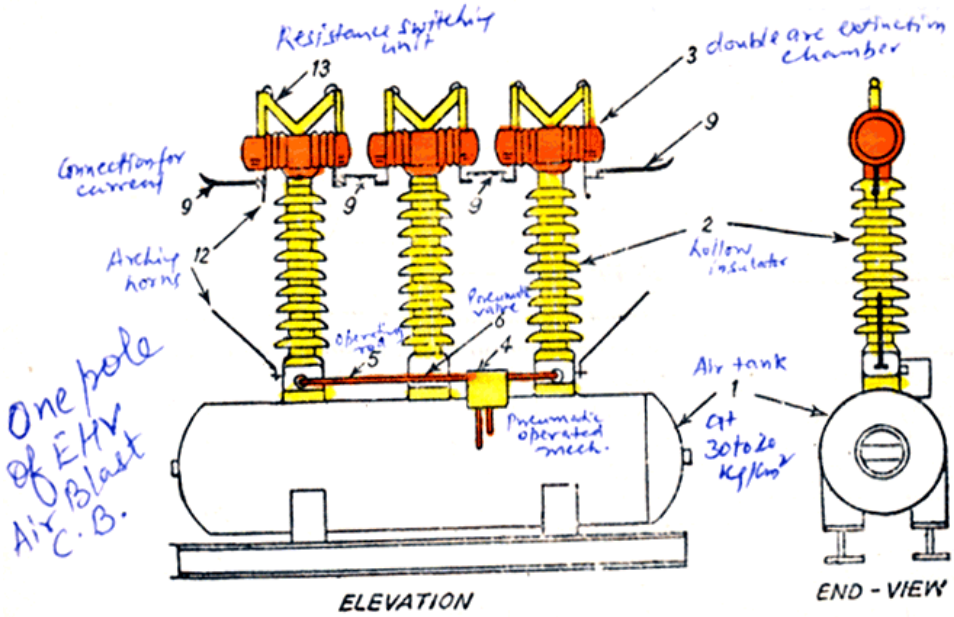
1. Observe the contact closing operation manually
2. Observe the contact closing operation automatically
3. Observe the tripping mechanism
4. Observe the under voltage shunt tripping mechanism

Theory and Methodology:

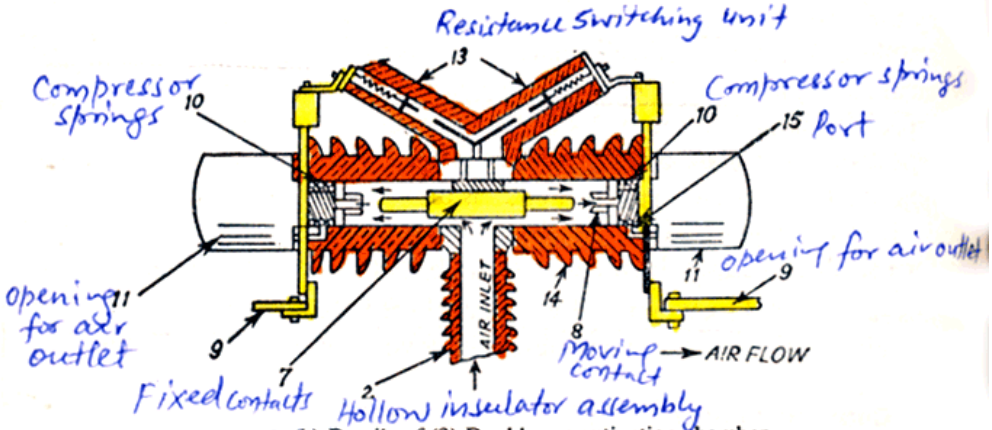
In the ACB under discussion the over current relays and their corresponding CTs in three lines are built inside the ACB. The under voltage relay coils are also built inside the ACB.
There is a spring charging motor in the ACB. When the motor is supplied from a single phase 230 V, the motor is started and the contact of the ACB are closed keeping the spring fully charged and latched. When there is any over current in all the phases or in any of the phases, the built in over current relay closes its trip circuit and the trip coil unlatch the fully charged spring, then the contacts are opened by the mechanical energy charged in the spring. The arc is extinguished in the medium of normal atmospheric air.
If the voltage in any of the three phases or in all three phases, supplied to the load through the ACB, are reduced below a preset level, the under voltage relay will be picked up and closes the trip circuit; consequently the trip coil will unlatch the fully charged spring and the contacts will be opened.
The closed contacts of the ACB can be manually opened by pushing the OFF button, which closes the trip circuit, then trip coil is energized and unlatch the spring to open the contacts.

Figure 5.1

Fast operations, suitability for repeated operation, auto reclosure, unit type multi break constructions, simple assembly, modest maintenance are some of the main features of air blast circuit breakers. A compressors plant necessary to maintain high air pressure in the air receiver. The air blast circuit breakers are especially suitable for railways and arc furnaces, where the breaker operates repeatedly. Air blast circuit breakers is used for interconnected lines and important lines where rapid operation is desired.



One pole of an extra-high voltage air blast circuit-breaker.



(b) Details of (3) Double arc extinction chamber.

High pressure air at a pressure between 20 to 30 kg/ cm2 stored in the air reservoir. Air is taken from the compressed air system. Three hollow insulator columns are mounted on the reservoir with valves at their basis. The double arc extinguished chambers are mounted on the top of the hollow insulator chambers. The current carrying parts connect the three arc extinction chambers to each other in series and the pole to the neighbouring equipment. Since there exists a very high voltage between the conductor and the air reservoir, the entire arc extinction chambers assembly is mounted on insulators.

Since there are three double arc extinction poles in series, there are six breaks per pole. Each arc extinction chamber consists of one twin fixed contact. There are two moving contacts. The moving can move axially so as to open or close. Its position open or close depends on air pressure and spring pressure.

The operating mechanism operates the rod when it gets a pneumatic or electrical signal. The valves open so as to send the high pressure air in the hollow of the insulator. The high pressure air rapidly enters the double arc extinction chamber. As the air enters into the arc extinction the pressure on the moving contacts becomes more than spring pressure and contacts open.

The contacts travel through a short distance against the spring pressure. At the end of the contact travel the port for outgoing air is closed by the moving and the entire arc extinction chamber is filled with high pressure air as the air is not allowed to go out. However, during the arcing period the air goes out through the openings and take away the ionized air of the arc.

While closing, the valve is turned so as to close connection between the hollow of the insulator the reservoir. The valve lets the air from the hollow insulator to the atmosphere. As a result of the pressure of air in the arc extinction chamber is dropped down to the atmospheric pressure and the moving contacts close over the fixed contacts by virtue of the spring pressure.

The opening is fast because the air takes a negligible time to travel from the reservoir to the moving contact. The arc is extinguished within a cycle.

Therefore, air blast circuit breaker is very fast in breaking the current.
Closing is also fast because the pressure in the arc extinction chamber drops immediately as the valve operates and the contacts close by virtue of the spring pressure

Pre-Lab Homework:

As it is a very important lab of protective system, students are asked to study detail of different types of air type circuit breakers. Different manufacturers are there. In PSP lab ACB of ABB Company is used. Detail of ACB of the ABB Company is available in internet. Data can be collected from there. Most importantly it is very necessary to study operating principle of ACB and its ratings.

Apparatus:

1. ACB
2. DC source
3. Clamp Meter

Precautions:

1. Do not touch the bare conductors or connecting junctions.
2. Do not connect/disconnect anything to/from the circuit without turning off main power.
3. Be careful of handling small equipment /instruments inside the relay device.
4. Be careful when power is supplied to the apparatus and any casing is kept open.

Experimental Procedure:

For energizing the charging motor, closing the contacts, opening the contacts and under voltage tripping, the terminals of control circuits for the motor are connected as shown in the diagram. One incandescent lamp is connected across one of the three phases of the contacts and the neutral.

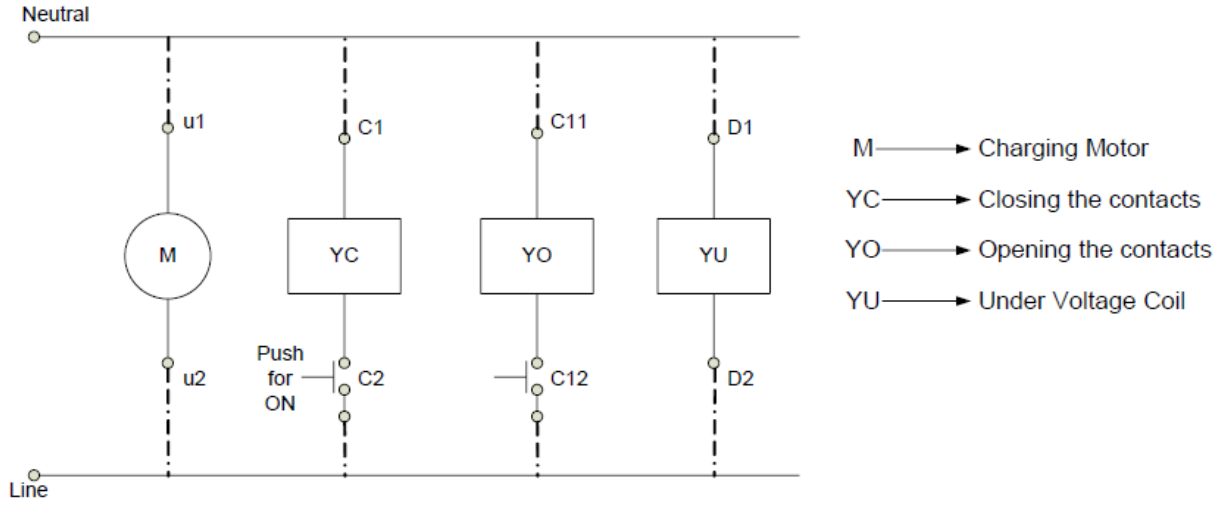


Figure 5.2

When the ON switch is pushed the contacts will be closed and the lamp will glow and when the "OFF" switch is pushed the contacts will be opened and the lamp will stop glowing. It is important to keep in mind that the voltage across the under voltage coil (i.e D1 and D2) should be maintained at about 220 V (ac) otherwise contacts cannot be closed by pushing the ON switch. If the voltage across the under voltage coil is reduced below 200 V (approax.) the breaker will automatically be tripped.

Simulation and Measurement:

Measurement:

1) Determine the tripping current for which relay operate.
2) Suggest a protection scheme for a 10HP motor.

Conclusion:

The air circuit breaker, operated within the voltage level 1KV, does not require any arc control device. Mainly for heavy fault current on low voltages (low voltage level above 1 KV) ABCs with appropriate arc control device, are good choice. Any kind of difficulties during the experiment must be discussed with reasons.

Reference(s):

1. "Electric Power Systems: A Conceptual Introduction" by Alexandra Von Meier
2. "Switchgear Protection and Power Systems" by Sunil S Rao
3. PSP previous lab sheet
4. Internet