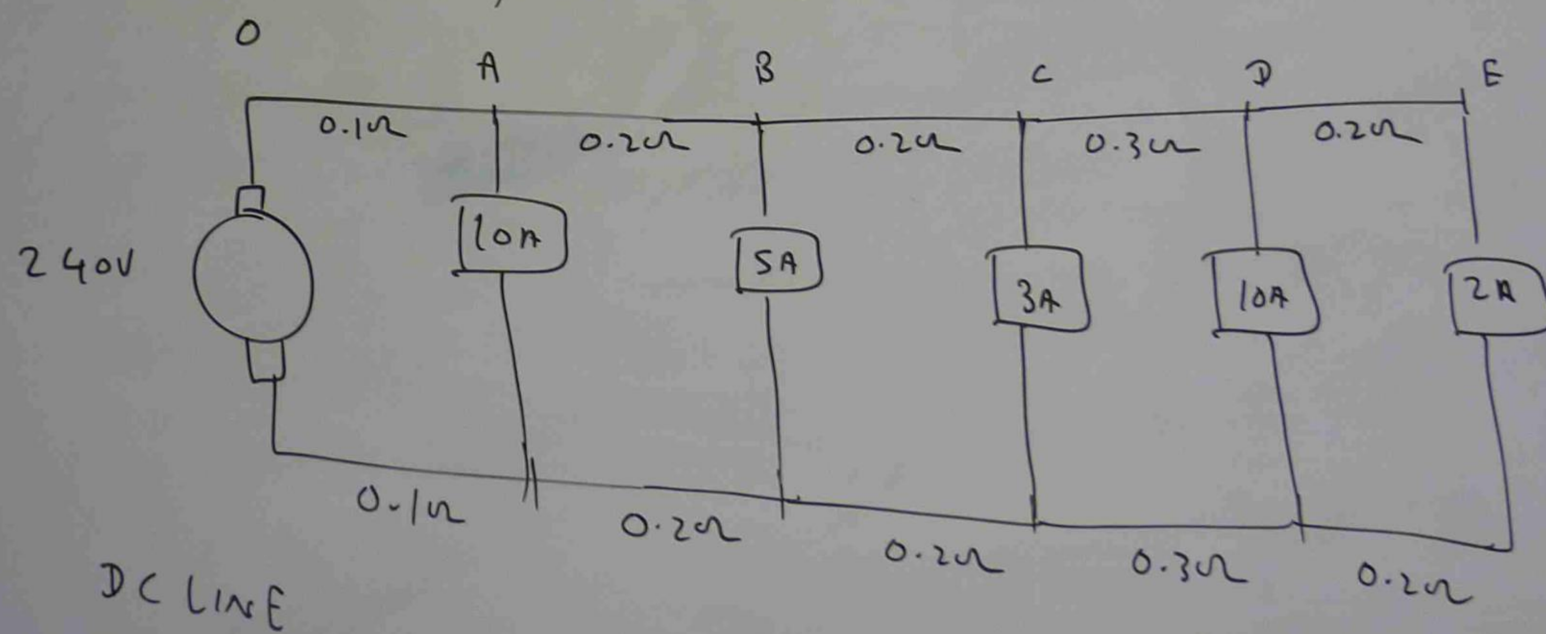
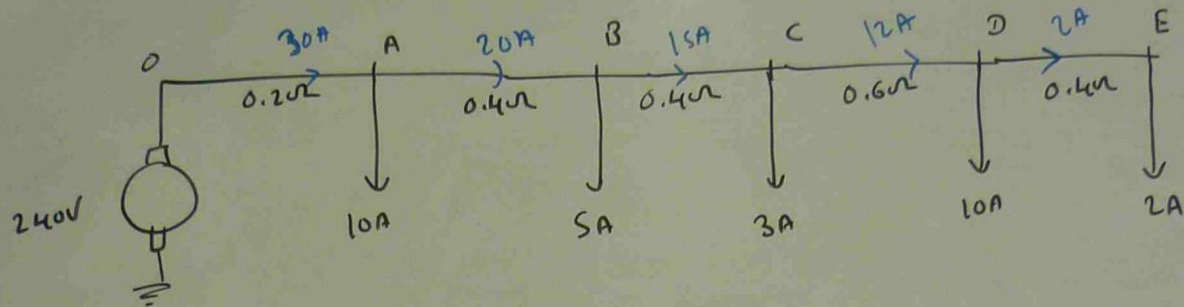
Q THE FOLLOWING IS THE ARRANGEMENT OF 240V DC SUPPLY SYSTEM.

POINT	O	A	B	C	D	E
COMPONENT	240V GENERATOR	$R_{oa} = 0.1\ \Omega$/WIRE 10 A LOAD	$R_{ab} = 0.2\ \Omega$ PER/WIRE 5 A LOAD	$R_{bc} = 0.2\ \Omega$/WIRE 3 A LOAD	$R_{cd} = 0.3\ \Omega$/WIRE 10 A LOAD	$R_{de} = 0.2\ \Omega$/WIRE 2 A LOAD

CALCULATE V_a, V_b, V_c, V_d, V_e AND LINE EFFICIENCY.



SINGLE LINE



$$V_A = 240 - I_{oa} \times R_{oa}$$

$$= 240 - 30 \times 0.2$$

$$= 240 - 6 = 234V$$

$$V_B = V_A - I_{AB} R_{AB}$$

$$= 234 - 20 \times 0.4$$

$$= 234 - 8$$

$$= 226V$$

$$V_C = V_B - I_{BC} R_{BC}$$

$$= 226 - 15 \times 0.4$$

$$= 226 - 6$$

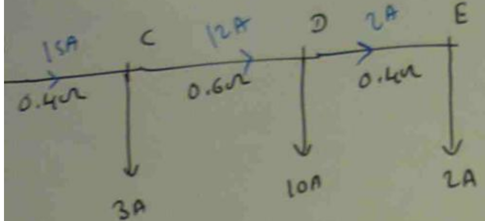
$$= 220V$$

$$V_D = V_C - I_{CD} \times R_{CD}$$

$$= 220 - 12 \times 6.6$$

$$= 220 - 7.2$$

$$= 212.8V$$



$$V_C = V_B - I_{BC} R_{BC}$$
$$= 226 - 15 \times 0.4$$
$$= 226 - 6$$
$$= 220V$$

$$V_D = V_C - I_{CD} \times R_{CD}$$
$$= 220 - 12 \times 6.6$$
$$= 220 - 7.2$$
$$= 212.8\ V$$

$$V_E = V_D - I_{DE} \times R_{DE}$$
$$= 212.8 - 2 \times 0.4$$
$$= 212.8 - 0.8$$
$$= 212\ V$$

TOTAL OUTPUT POWER $= V_A I_A + V_B I_B + V_C I_C + V_D I_D + V_E I_E$

$$= 234 \times 10 + 226 \times 5 + 220 \times 3 + 212.8 \times 10 + 212 \times 2$$
$$= 6682 \text{ WATT}$$

TOTAL INPUT POWER $= 240 \times 30 = 7200$ WATT

$$\text{EFFICIENCY} = \frac{\text{TOTAL OUTPUT POWER}}{\text{TOTAL INPUT POWER}} \times 100 = \frac{6682}{7200} \times 100$$
$$= 92.8\%$$

Q/ DC compound generator has 0.3 Ω armature resistance, 0.1 Ω series winding resistance and 100 Ω shunt winding resistance. It is supplying the following loads

(i) 10 HP 240V efficiency 80% DC motor

(ii) 10×80 watt lamps with 240V

(iii) 2000 watt water heater

Calculate (a) generated voltage of DC compound generator if it is connected in short shunt compound and H.P of prime mover if generator efficiency is 90%.

(b) generated voltage of DC compound generator if it is connected in long shunt compound and HP of prime mover if generator efficiency is 90%.

Load calculation

DC motor input power $= \dfrac{10 \times 746 \text{ watt}}{\frac{\%\text{Efficiency}}{100}}$

$= \dfrac{7460}{\frac{80}{100}} = \dfrac{7460}{0.8} = 9325\text{ W}$

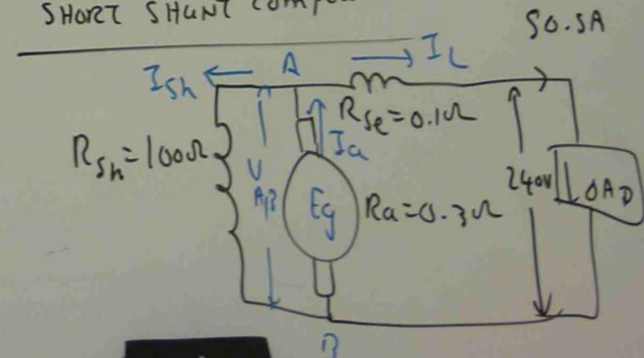
Lamp input power $= 10 \times 80 = 800$ watt

Water heater $= 2000$ watt

Total load power: $9325 + 800 + 2000$ watt

Total current $= \dfrac{9325 + 800 + 2000}{240} = 50.5$ Amp.

Short shunt compound



$$V_{AB} = V_{LOAD} + I_{LOAD} \times R_{se}$$

$$= 240 + 50.5 \times 0.1$$

$$= 245.5\ V$$

$$I_{sh} = \frac{V_{AB}}{R_{sh}} = \frac{245.5}{100} = 2.455\ \text{Amp}$$

$$I_a = I_L + I_{sh}$$

$$= 50.5 + 2.455$$

$$= 52.95\ A$$

$$E_g = V_{AB} + I_a R_a$$

$$= 245.5 + 52.95 \times 0.3$$

$$= 260.93\ V$$

GENERATED POWER $= E_g I_a$

$$= 260.93 \times 52.95$$

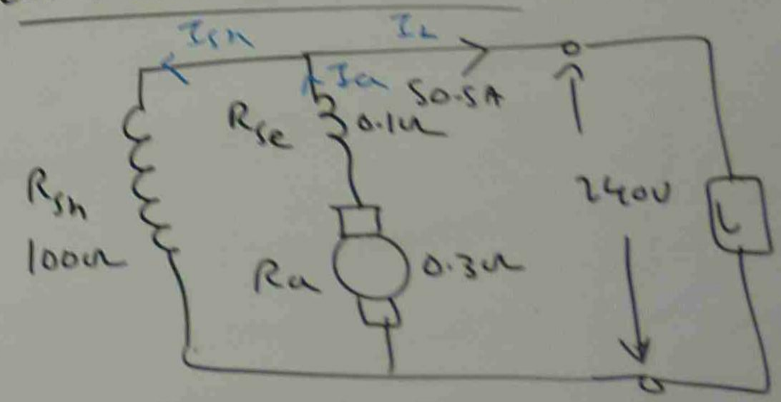
PRIME MOVER OUTPUT $= \dfrac{E_g I_a}{\text{GENERATOR EFFICIENCY}}$

$$= \frac{260.93 \times 52.95}{0.9}$$

$$= 18351\ \text{WATT}$$

PRIME MOVER HP $= \dfrac{18351}{746} = 24.5$ HP

LONG SHUNT COMPOUND



$$I_{sh} = \frac{V}{R_{sh}} = \frac{240}{100} = 2.4A$$

$$I_a = I_L + I_{sh} = 50.5 + 2.4 = 52.9 \text{ Amp.}$$

$$E_g = V + I_a R_a$$

$$= 240 + 52.9 \times 0.3$$

$$= 261.16V$$

$$\text{GENERATED POWER} = E_g I_a = 261.16 \times 52.9$$

$$= 13815W$$

$$\text{PRIME MOVER OUTPUT} = \frac{E_g I_a}{\text{GENERATOR EFFICIENCY}}$$

$$= \frac{13815}{0.9}$$

$$= 15350 \text{WATT}$$

$$\text{PRIME MOVER HP} = \frac{15350}{746}$$

$$= 20.57 \text{ HP}$$

TUTORIAL QUESTIONS

1. (a) SKETCH THE ARC OCCURS IN THE CIRCUIT BREAKER AND DESCRIBE THE FOLLOWINGS (a) ARC LENGTHENING (b) ARC COOLING (c) ARC SPLITTING (d) ARC CONSTRAINTING

2. DRAW THE GRAPH CONSISTING OF CIRCUIT VOLTAGE, RESTRIKING VOLTAGE, RATE OF INCREASE OF DIELECTRIC STRENGTH, ARC VOLTAGE AND ARC CURRENT

3. DESCRIBE THE FEATURES AND SUITABILITY OF FOLLOWING CLOSING SYSTEMS FOR CIRCUIT BREAKER
   (a) SOLENOID CLOSING (b) MOTOR CLOSING
   (c) SPRING WHEEL CLOSING (d) FLYWHEEL CLOSING.

4. SKETCH THE INSTALLATION OF RECLOSER AND EXPLAIN THE OPERATION.

(5) DEFINE THE FOLLOWING TECHNICAL TERMS
(a) CIRCUIT BREAKER
(b) BREAKING CAPACITY

(6) DESCRIBE THE TYPES OF CIRCUIT BREAKERS AND EXPLAIN THE COMPONENTS OF OIL CIRCUIT BREAKER

(1)

ARC LENGTHENING - THE ARC HAS TO BE LENGTHENED SO IT'S RESISTANCE IS INCREASED TO ASSIST IN EXTINGUISHING ARC

ARC COOLING

LENGTHENED ARC IS COOLED BY AIR

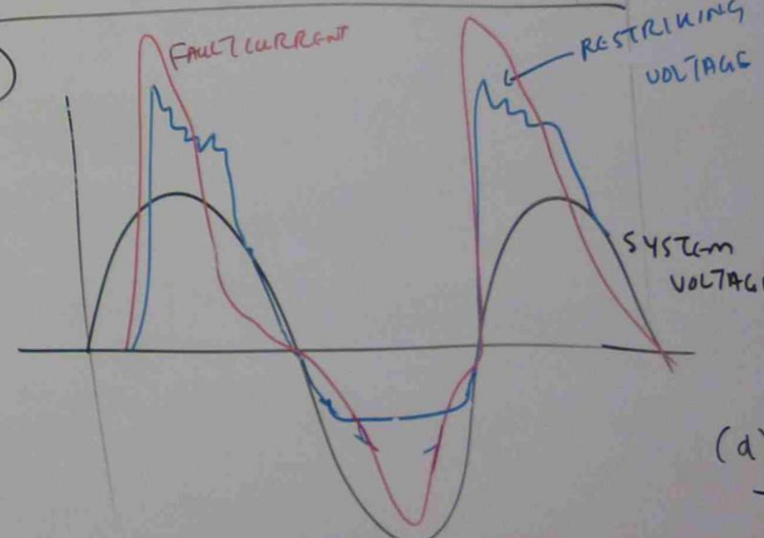
ARC SPLITTING

THE ARC CHUTE SPLITS THE ARC AS IT TRAVELS ALONG CHUTE

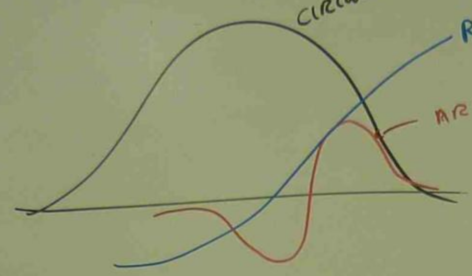
ARC CONSTRAINTING

THE ARC IS CONSTRAINED IN ARC CHUTE OF NARROW CHANNEL

(2)



(d)



RIKING VOLTAGE

YSTEM VOLTAGE

③ (a) SOLENOID CLOSING

PROVIDE VERY HIGH FORCE TOWARD THE END OF THE STROKE

(b) MOTOR CLOSING

NO DIRECT CLOSING. IT CHARGES A SPRING ON FLYWHEEL

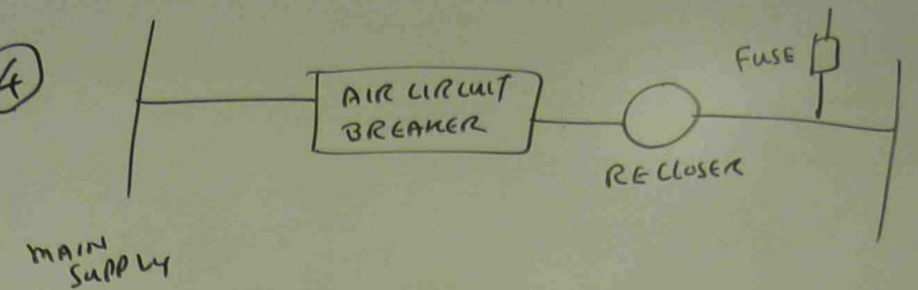
(c) SPRING WHEEL CLOSING

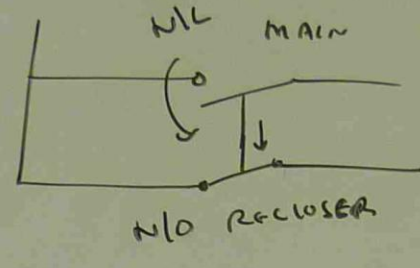
SPRING MAY BE COMPRESSED SLOWLY BY HAND OR SMALL MOTOR

(d) FLYWHEEL CLOSING

ORGANIZED BY SMALL MOTOR. ENERGY IS USED TO CLOSE CIRCUIT BREAKER.

4





THE RECLOSER COIL IS ENERGISED WHEN THE CIRCUIT BREAKER CONTACT IS OPENED.

THE RECLOSER CONTACT IS CLOSED AND IT ENERGIZES THE MAIN CONTACT TO RECLOSE.

WHEN THE SYSTEM FAULT IS CLEARED, RECLOSER COIL RECLOSES THE MAIN CONTACTS.

5 CIRCUIT BREAKER

A MECHANICAL SWITCHING DEVICE CARRYING AND BREAKING THE CURRENT UNDER NORMAL CIRCUIT AND UNDER PRE-DETERMINED CONDITIONS.
BREAKING AND MAKING THE CURRENT UNDER ABNORMAL CONDITION AND SHORT CIRCUIT.

BREAKING CAPACITY

THE VALUE OF THE BREAKING CURRENT, THE MAXIMUM VALUE OF CURRENT THAT THE CB CAN TRIP AND CLEAR THE FAULT

6 TYPES OF CIRCUIT BREAKERS

OIL CIRCUIT BREAKER
AIR CIRCUIT BREAKER
AIR BLAST CIRCUIT BREAKER
VACUUM CIRCUIT BREAKER
SULPHUR HEXA FLURIDE CIRCUIT BREAKER