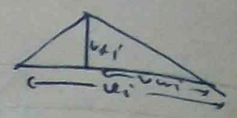


$\frac{V_{fi}}{V_{fo}} = \frac{r_i}{r_o}$ (Inward)

$\frac{V_{fi}}{10} = \frac{20}{30}$ $\quad V_{fi} = \frac{200}{30} = \frac{6.67}{} = 6.67$ ft/sec

$\alpha = \tan^{-1}\frac{6.67}{31.6} = \tan^{-1}.209 = 11.9°$

$\theta = 180 - \tan^{-1}\frac{6.67}{31.6 - 49.2}$

$= 180 - \tan^{-1}\frac{6.67}{-17.5} = 180 - 20.14 = 159.86°$

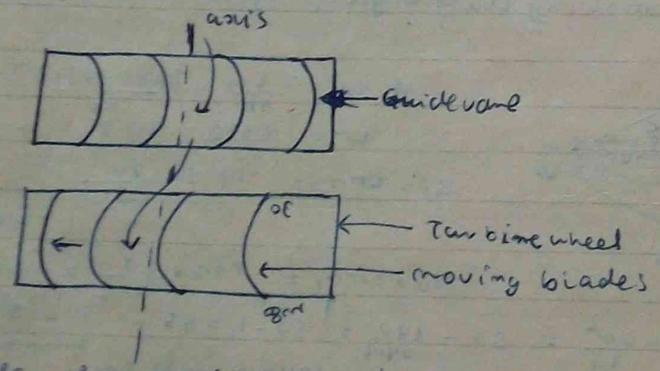
* H.P = act. effy × $\frac{w_1/l_h}{550}$ × Total weight

w_1/l_h = H overall effy.

* $\frac{V_{wi}v_i}{g} = H - \frac{v_o^2}{2g}$ → V_{wi} ↗ * HP = 60% × $\frac{V_{wi}v_i}{g \times 550}$ × Total weight

* Hydraulic effi = $\frac{H}{H - \frac{v_o^2}{2g}}$ Hydraulic efficiency → V_{wi} ↗ → V_{wi} ↗ * HP = 60% × $\frac{H - \frac{v_o^2}{2g}}{550}$ × WT

Axial flow Reaction Turbine



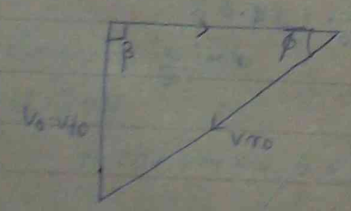
$v_1 = v_0 = v$ (= same radius)

$v_{fi} = v_{fo}$

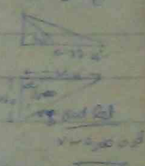
Energy supplied per sec = $\frac{V_{wi} + V_{wo}}{g} \times v$

Axial discharge = $\beta = 90°$

$V_{wo} = 0$

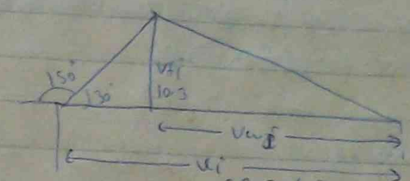


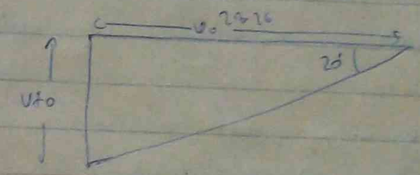
③ Axial flow reaction turbine-ல் R.P.M ஆனது 20 முறை சுழல்கிறது. Turbine blade-ன் நடுப்பகுதியில் உள்ள ஆரம் 18 ft முறை சுழல்கிறது. moving blade-ன் நுழைவாயில் உள்ள ஆரம் 9 ft. Velocity of flow ஆனது 10 ft/sec ஆக இருக்கிறது. Turbine H.P-ஐ கண்டுபிடி. (Axial area = 300 ft²)



$\frac{2\pi N}{60}$ $\quad v_i = \omega r = 3.14 \times 9 = 28.26$ ft/sec $\quad V_{fi} = V_{fo}$

$= \frac{6.28 \times 30}{60} = 3.14$





$V_{fo} = v_o \tan 20° = 28.26 \times \tan 20° = 28.26 \times .364 = 10.3$ ft/sec

$V_{fo} = V_{fi} \therefore V_{fi} = 10.3$ ft/sec

$V_{wi} = v_i - \frac{V_{fi}}{\tan 30} = 28.26 - \frac{10.3}{.577} = 28.26 - 17.83 = 10.43$ ft/sec

$WD = \frac{V_{wi} v_i}{g} = \frac{10.43 \times 28.26}{32} = 10.43 \times .883 = 9.12$ ft-lb/lb

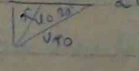
$Q = V_{fi} \times A_I = 10.3 \times 300 = 3090$ ft³/sec

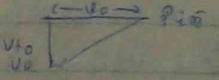
Weight of fluid = $3090 \times 62.4 = 193000$ lb/sec

Energy supplied = $\frac{193000 \times 9.12}{550} = 9.12 \times 350 = 3230$ H.P

effy = $\frac{WD}{WD + \frac{V_{fi}^2}{2g}} = \frac{9.12}{9.12 + \frac{10.3^2}{64}} \times 100 = \frac{9.12 \times 100}{9.12 + 1.66} = 84.2\%$

① * Hydraulic $\frac{WD}{WD + \frac{V_{fi}^2}{2g}}$ efficiency

② *  Velocity V_{wo} V_{fo} V_o ஆகியவை



Impulse Turbine (or) velocity Turbine

$H = \frac{V_I^2}{2g}$

$V_I = \sqrt{2gH}$

$V_I = K\sqrt{2gH}$ = (Nozzle Efficiency ഉൾപ്പെടുത്തി)

$K < 1$

Impulse ൽ efficiency: മറ്റു turbine കളിൽ നിന്നും വ്യത്യസ്തമായി Impulse ൽ total head നെ velocity head ആയി മാറ്റുന്നു. velocity head ന്റെ ഏതു ഭാഗമാണ് blade ൽ work ചെയ്യുന്നത് എന്നതിനെ ആശ്രയിച്ചിരിക്കും efficiency.

$$\eta = \frac{\frac{V_I^2}{2g} - \frac{V_o^2}{2g}}{\frac{V_I^2}{2g}} \times 100$$

$$= \left(1 - \frac{V_o^2}{V_I^2}\right) \times 100$$

മൂന്നു തരം Impulse turbine കളുണ്ട്.

1. Girard ന്റെ turbine: Impulse [Axial flow]
2. Pelton wheel turbine [Axial flow]

1. Axial flow Impulse Turbine

curved vane ന്റെ രണ്ടറ്റത്തും, രണ്ടാമത്തെ ചക്രത്തിന്റെ axis ന്റെ മറുപുറത്ത് 180° ൽ ഇരിക്കുന്നതിനാൽ, ഇതിനെ annular ring എന്നും പറയുന്നു.

$v_i = v_o = v$

$V_{ri} = V_{ro}$

2. Radial flow Impulse turbine

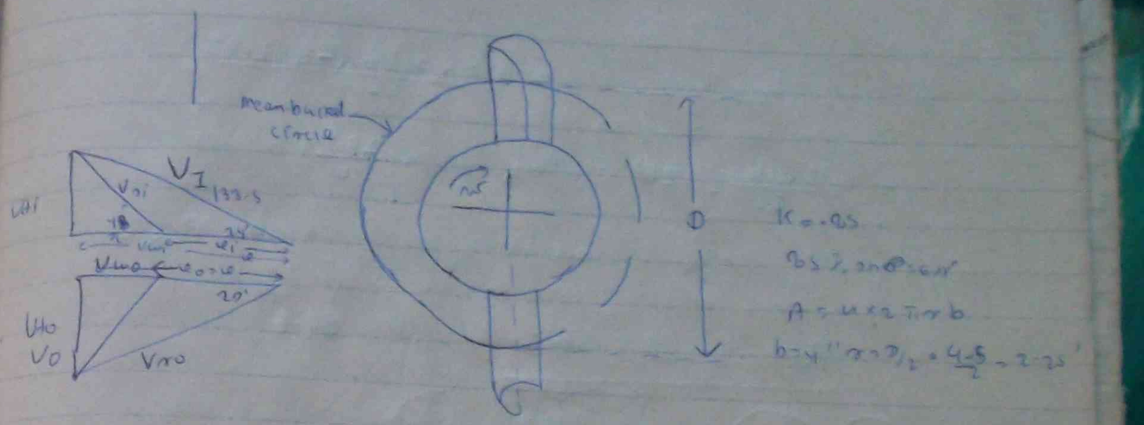
Centrifugal head: $\frac{v_i^2 - v_o^2}{2g}$

$= \frac{V_{ri}^2 - V_{ro}^2}{2g}$ (ഇതിൽ നിന്നും turbine ന്റെ work കണക്കാക്കാം)

$V_{ri} = V_{ro}$ $v_i = v_o$

3. Girard ന്റെ turbine: axial flow Impulse Turbine

ഇതിൽ 2 ചക്രമാണുള്ളത്. mean guide circle diameter ഏകദേശം $4\frac{1}{2}$' ഉം guide blade ന്റെ inlet angle ഏകദേശം 48° ഉം outlet angle ഏകദേശം 20° ഉം moving blade ന്റെ inlet angle ഏകദേശം 41° ഉം outlet angle ഏകദേശം 20° ഉം ആണ്. Turbine ന്റെ centrifugal head 200' ൽ operate ചെയ്യുന്ന turbine ന്റെ guide blade ന്റെ velocity 800 ft/sec ൽ താഴെയും blade velocity ഏകദേശം 400 ft/sec ൽ താഴെയും ആയിരിക്കണം. Turbine ന്റെ H.P കണ്ടുപിടിക്കുക.



$V_I = \sqrt{2gH} = \sqrt{2 \times 32 \times 200} = \sqrt{17920} = 133.5$ ft/sec

$V_{ri} = V_I \cos 24 = 133.5 \times .914 = 122$ ft/sec

$V_{fi} = V_I \sin 24 = 133.5 \times .407 = 54.5$ ft/sec

$x = \frac{V_{fi}}{\tan 48} = \frac{54.5}{1.11} = 49$ ft/sec

$v_i = 122 - 49 = 73$ ft/sec

$v_i = 2\pi r$

$73 = \frac{2 \times 3.14 \times N}{60} \times 2.25$

$N = \frac{73 \times 60}{6.28 \times 2.25} = \frac{4380}{14.15} = 309$ r.p.m

$\frac{V_{wi} v_i + V_{wo} v_o}{g} H - \frac{V_o^2}{2g} = w D$ $\qquad V_o = V_{a_o} \sin 20 = 73 \times .34 = 24.8$ ft/sec

$\frac{122 \times 73 + V_{wi} v_i}{32} 200 - \frac{V_o^2}{64} = w D$ ① $\qquad = e$

$w \to 278 = 200 - \frac{v_o^2}{64}$ $\qquad V_o = \sqrt{178} =$

ഉപയോഗപ്പെടുത്തിയ ഊർജ്ജം $= \frac{V_{wi} v_i}{g} = 278$ ft-lb/lb

ഉപയോഗപ്പെടുത്തിയ ഊർജ്ജം $= Q \times 2s = V_{fi} \times A_i \times .85 \times G 2.4$

$= 54.5 \times 2 \times \pi r \, b \times .85 \times 62.4$

$= 109 \times 3.14 \times 2.25 \times \frac{4}{12} \times .85 \times 62.4$

$Q = w = 109 \times 7.03 \times \frac{1}{3} \times 53.2$

$= 772 \times 17.7$

$= 13650$ lb

$\therefore V_{ri} = \frac{V_{fi}}{\sin 48} = \frac{54.5}{.748} = 73$ ft/sec

$\therefore V_{ri} = V_{ro}$ (axial flow Impulse)

V_{wo} or $v_o = V_{ro} \cos 20 = 73 \times .94 = 68.6$ ft/sec

$V_{wo} = 68.6 - v_o = 68.6 - 73 = -4.4$ ft/sec

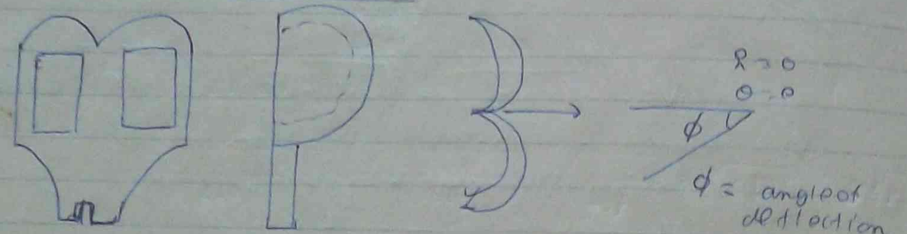
Axial flow: $v_i = v_o$ Axial flow impulse: $v_i = v_o$, $V_{ri} = V_{ro}$ $\qquad V = \sqrt{2gh}$

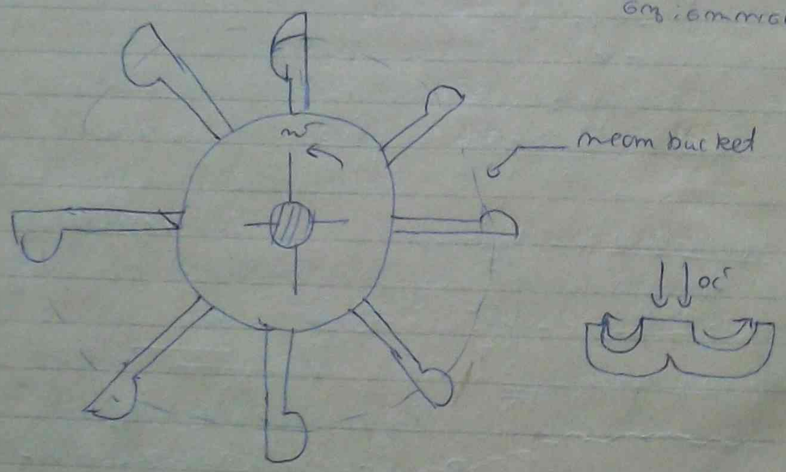
$$W.D = \frac{V_{wi}v_i + V_{wo}v_o}{g} = \frac{122 \times 92 + (-44) \times 73}{32}$$

$$= \frac{73 \times 117.6}{32} = 268 \text{ ft-lb/lb} \quad HP = \frac{268}{550} HP$$

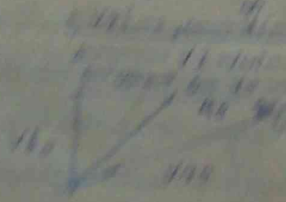
$$HP = \frac{268}{550} \times 13650 = .487 \times 13650 = 6550 \text{ H.P}$$

Pelton wheel Turbine





Pelton wheel turbine ২২৮ Axial flow impulse turbine ৫৫ ৪৪: ৩৩ ৫৯ mean ৫৫০০ ৭ ৪৮ ৯৯ ৪৪: ৫৫ ৫৫ turbine ৪৮ overall efficiency ৭৮ ৯২ ৯৯ ৫৫ ২২ ৭৮ ৫৫: turbine ৪৮ ৫৫ ৫৫ ৫৫



Revision

Pump

Prob① Kubota motor pump ಅನ್ನು ಬಳಸಿ ಕೊಂಡು ಕೃಷಿ ಭೂಮಿಗೆ 30' ಶಿರಸ್ಸಿನ ಎತ್ತರಕ್ಕೆ ನೀರನ್ನು ಎತ್ತಲು ಪಂಪ್ ಸೆಟ್ ಅನ್ನು ಬಳಸಿಕೊಳ್ಳಲಾಗಿದೆ. ಪಂಪ್ ಸೆಟ್ ನಿಂದ ಹೊರಡುವ ನೀರಿನ ಪ್ರಮಾಣ 200 gallons/min ಆಗಿದೆ. ಪೈಪ್ ಲೈನ್ ನ ಉದ್ದ 100 ಅಡಿಗಳು ಆಗಿದ್ದು ಪೈಪ್ ನ ಘರ್ಷಣಾ ಅಂಶ f = .008 ಆಗಿದೆ. ಪಂಪ್ ಸೆಟ್ ಅನ್ನು ಚಲಾಯಿಸಲು ಬಳಸಿರುವ Diesel Engine ನ overall efficiency 65.25% ಆಗಿದೆ. Engine ನ H.P ಅನ್ನು ಅಂದಾಜಿಸಿ.

$Q = 200$ gallons/min

$= \frac{200 \times 10}{62.4 \times 60} = 0.535 ft^3/sec$

$V = \frac{Q}{A} = \frac{.535}{\frac{\pi}{4}(\frac{3}{12})^2} = \frac{.535}{\pi} \times 4 \times 16 = \frac{64 \times .535}{3.14} = \frac{34.25}{3.1} = 10.92$ ft/sec

$V = 10.92$ ft/sec

$h_f = \frac{4fLv^2}{2gd} = \frac{4 \times .008 \times 100 \times (10.9)^2}{2 \times 32 \times 2 \times 3/12} = \frac{3.2 \times 119.2}{16.1} = \frac{381}{16.1} = 23.6'$

∴ ಕೊಳವೆ ಶಿರಸ್ಸಿನಲ್ಲಿನ ಘರ್ಷಣೆಯಿಂದ ಉಂಟಾಗುವ ಶಿರಸ್ಸಿನ ನಷ್ಟ = H_f

$H_T = 30 + 23.6 = 53.6'$

∴ Required H.P $= \frac{wQH_T}{550} = \frac{62.4 \times .535 \times 53.6}{550}$

$= .1135 \times 2.87 = 3.26$ H.P

Engine efficiency = 65.25%

∴ H.P of diesel engine $= \frac{3.26}{.6525} = 5$ H.P KNDS

***

Prob② ಪಂಪಾಗಿ ಬಳಸಿರುವ 10' ವ್ಯಾಸದ ಅಡ್ಡ ಕತ್ತರಿಯ ಪ್ರದೇಶವುಳ್ಳ ಸುರಂಗದಲ್ಲಿ 8 ft/sec ವೇಗದಲ್ಲಿ ನೀರು ಹರಿಯುತ್ತಿದೆ. ಸುರಂಗದ ಕೊನೆಯಲ್ಲಿ 6" ವ್ಯಾಸದ ಕೊಳವೆಯನ್ನು ಅಳವಡಿಸಿ ಅದನ್ನು 150' ಎತ್ತರಕ್ಕೆ ನೀರನ್ನು ಎತ್ತಲು ಬಳಸಲಾಗಿದೆ. ಕೊಳವೆಯಲ್ಲಿ ಹರಿಯುವ ನೀರಿನ ವೇಗ 12 ft/sec ಆಗಿದೆ. ಪೈಪ್ ನಲ್ಲಿ Friction ನಷ್ಟವು ಶಿರಸ್ಸಿನ 10% ಆಗಿದೆ. ಪಂಪ್ ನ H.P ಅನ್ನು ಕಂಡುಹಿಡಿಯಿರಿ. ($f = .01$)

$Q = 12$ ft^3/sec $\quad V = \frac{12}{\frac{\pi}{4}(\frac{6}{12})^2} = \frac{12}{\pi/16} = \frac{192}{\pi} =$

$V = 3$ ft/sec //

$Q = A \times V \quad \therefore A = 6$

$R = A \times 2$

$V = 12$ ft/sec

$H_f = \frac{4fLv^2}{2gd} = \frac{4 \times .01 \times 150 \times 12^2}{2 \times 32.2 \times 1/2} = \frac{6 \times 4}{32.2} = \frac{24}{32.2}$

$V = \frac{12}{\frac{\pi}{4}(\frac{6}{12})^2} = \frac{12}{\frac{\pi}{4} \times \frac{1}{4}} = \frac{192}{3.14} =$

Solution ⇒ static head = friction head + delivery head

$H_T = H_f + H_d = 10 + 100 = 110'$

Kinetic head generated $= \frac{(12)^2}{2g} - \frac{(8)^2}{2g}$

$= \frac{1}{64}(144 - 64)$

$= \frac{1}{64} \times 80 = 1.24$ ft

pipe's friction loss $= \frac{4fLv^2}{2gd} = \frac{4 \times .01 \times 150 (12)^2}{64.4 \times .5}$

Friction loss $= \frac{6 \times 144}{64.4 \times .5} = \frac{864}{64.4 \times .5} = \frac{13.9}{5}$ ft

$= 27.83$ ft //

Head developed by the pump = Static head + delivery head + friction head

" $= 110 + 1.243 + 27.83$

" $= 139.07$ ft

Vol. of water discharged $= \frac{22}{7 \times 4}(\frac{6}{12})^2 \times 12 = 2.357$ ft^3/sec

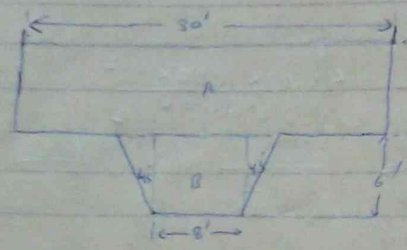
wd by the pump/sec = wt. of water discharged × total head

$= 62.4 \times 2.357 \times 139.07$

∴ HP $= \frac{62.4 \times 2.357 \times 139.07}{550}$

$= 37.18$ HP Answer

③



section A এর জন্য $Q = \frac{2}{3} cd\, b \sqrt{2g}\, H^{3/2}$

$= \frac{2}{3} \times .62 \times 30 \sqrt{2 \times 32} \times 6^{1.5}$

$= 12.4 \times 8 \times 14.7$

$= 99.3 \times 14.7$

$= 1460\ ft^3/sec$

section B এর discharge $= \frac{2}{3} cd \sqrt{2g}\, b \times H^{3/2} + 2 \times \frac{8}{15} cd \sqrt{2g} \tan\frac{\theta}{2} H^{5/2}$

$= \frac{2}{3} \times .62 \times 8.88 \times 6^{1.5} + \frac{8}{15} \times .62 \times 8 \times \tan\frac{2 \times 15}{2} \times 6^{2.5}$

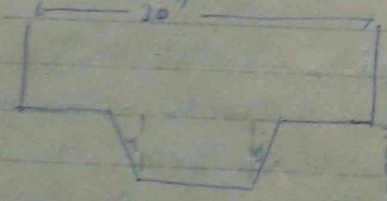
$= .414 \times 64 \times 14.7 + \frac{3.97}{15} \times 98$

$= .414 \times 992 + 2.648 \times 98$

$= 437 + 269$

$= 706\ ft^3/sec$

Total $= 1460 + 706 = 2166\ ft^3/sec$



এখানে notch এর height 6" (0.5') ধরে discharge নির্ণয় করতে হবে।

$Q = \frac{2}{3} \times .62 \times 30/12 \sqrt{2 \times 32} \times (6/12)^{1.5}$

$= \frac{2}{3} \times .62 \times \frac{2}{12} \sqrt{2 \times 32} \times (6/12)^{1.5}$

$= \frac{2}{3} \times .62 \times \frac{2}{12} \sqrt{2 \times 32} (6/12)^{1.5} + \frac{8}{15} \times .62 \times \sqrt{2 \times 32} \tan 2 \times \frac{45}{2} (6/12)^{2.5}$

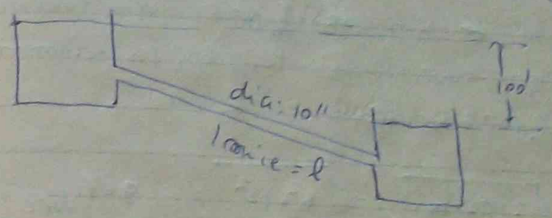
$\therefore$ Required discharge $= \square + \triangle = \frac{2}{3} \times .62 \times \frac{20}{12} \sqrt{2 \times 32} (6/12)^{1.5} + \frac{2}{3} \times .62 \times \frac{8}{12} \sqrt{2 \times 32} (6/12)^{1.5} + \frac{8}{15} \times .62 \sqrt{2 \times 32} \tan 2 \times 45/2 (6/12)^{2.5}$

$= .414 \times 2.5 \times 2 \times .354 + .414 \times .667 \times 2 \times \frac{8}{12} \times .354 + \frac{2.42}{15} \times 2$

$= 2.928 \times .354 + .277 \times 2 \times .354 + .533 \times .553$

$= 2.93 + .831 + .2984 = 3.96\ ft^3/sec$

④ চিত্রে দেখানো জলাধার হতে 10" ব্যাস ও 1 mile দীর্ঘ একটি pipe দ্বারা জল সরবরাহ করা হচ্ছে। pipe এর friction factor $f = .008$ হলে, pipe দ্বারা friction head loss কত হবে? সরবরাহকৃত জলের পরিমাণ নির্ণয় কর।



$h_f = \frac{4flv^2}{2gd}$

$100 = \frac{4 \times .008 \times 5280 \times v^2}{2 \times 32 \times \frac{10}{12}}$

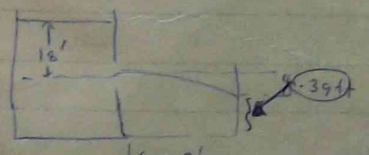
$v^2 = \frac{100 \times 64 \times \frac{10}{12}}{.032 \times 5280} \times \frac{1}{.032 \times 63360} = \frac{64000}{2030} = 31.5$

$\therefore v = \sqrt{31.5} = 5.6\ ft/sec$

$Q = A \times v = \frac{\pi}{4} (\frac{10}{12})^2 \times 5.6$

$= \frac{.7854 \times 100}{144} \times 5.6 = .4 \times .695 = 3.06\ ft^3/sec$

⑤ চিত্রে দেখানো কাঠের তৈরি V-notch এর 6" উচ্চতা বিশিষ্ট অংশের coefficient of discharge নির্ণয় কর। এখানে notch এর vertex হতে horizontal ও vertical coordinate এর ছেদ বিন্দুর দূরত্ব 39" এবং উক্ত বিন্দুতে discharge $.111\ ft^3/sec$ হলে notch এর coefficient of discharge নির্ণয় কর।



$C_v = \sqrt{\frac{x^2}{4gH}}$

$C_v = \sqrt{\frac{8 \times 8}{4 \times .39 \times 18}} = \frac{8}{\sqrt{72 \times .39}} = \frac{8}{\sqrt{28.1}} = \frac{8}{5.3}$

$\therefore C_v = .941$

Theo: discharge $= A \times v = \frac{\pi}{4} (\frac{1}{12})^2 \times \sqrt{2 \times 32 \times 18}$

$= \frac{.7854}{144} \times \sqrt{1152} = \frac{.7854 \times 33.9}{144}$

$= .235 \times .7854 = .1845$

$$cd = \frac{\cdot 111}{\cdot 1845} = .602$$

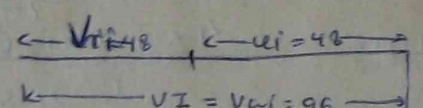
$$\therefore C_c = \frac{cd}{C_v} = \frac{\cdot 602}{\cdot 944} = .64$$

1974 Final

⑤ Pelton wheel ~~ಅನ್ನು~~ ಒಂದು ಪ್ರಚೋದಕ ಚಕ್ರವನ್ನು ~~ಹೊಂದಿದೆ~~ ಇದರ ಜೆಟ್ ವೇಗ 48 ft/sec ~~ಆಗಿದೆ~~ ಆಗಿದ್ದು ಒಟ್ಟು head 144' ಇದೆ. ಚಕ್ರವು 160 gallons ನೀರನ್ನು ಪಡೆಯುತ್ತದೆ. ಒಂದು bucket ನ ಜೆಟ್ water ಜೆಟ್ನ 155° ಕೋನದಲ್ಲಿ ~~ಹೊರಹೋಗುತ್ತದೆ~~ ಹೊರಹೋಗುತ್ತದೆ. ಘರ್ಷಣೆಯನ್ನು ಗಮನಿಸಿ ಇದರ ಗುಣಾಂಕ 0.1 ಆಗಿದೆ. ಚಕ್ರದ ಕಾರ್ಯಕ್ಷಮತೆ ಮತ್ತು water ಜೆಟ್ನ ಶಕ್ತಿಯನ್ನು ಕಂಡುಹಿಡಿಯಿರಿ.

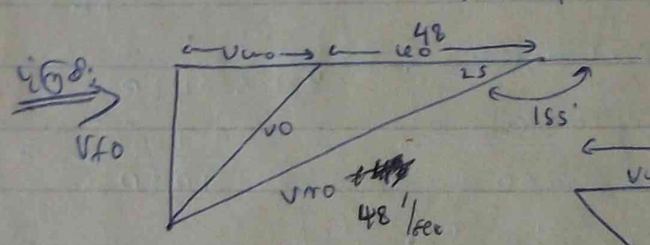
$$V_I = \sqrt{2gH} = \sqrt{2\times 32\times 144} = \sqrt{8^2\times 12^2} = 96 \text{ ft/sec}$$

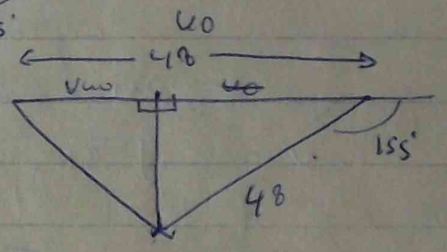
$u_i = 48$ ft/sec



$u_i = u_o = 48$

$\therefore u_o =$





$V_{wo} = V_{ro}\cos 25 - u_o$

$= 48\cos 25 - 48 =$

$= 48\times .907 - 48 = 43.5 - 48 = -4.5$ ft/sec

$W_J = \frac{V_{wi}u_i + V_{wo}u_o}{g} = \frac{96\times 48 + 48\times(-4.5)}{32} = \frac{48\times 91.5}{32} = 137.2$

$\theta = V_I \times \pi/4\, d^2 \times 62.5$

$1600 = 96\times \frac{\pi}{4}(d^2)\times 62.5 \quad \therefore d = \sqrt{\frac{1600\times 4}{96\times\pi\times 62.5}} =$

$HP = \frac{1600\times 137.2}{550} = 399$ HP

$\text{effcy} = \frac{137.2}{144} = 95.3$ %

(7) Pelton wheel ના ઉપયોગ: ગુરુત્વાકર્ષણ. ઊંચાઈ ના કારણે 42'/sec ની ઝડપ ધરાવે છે. total head 144' છે. 1 sec 160 gallons પાણી ધરાવે છે. 620 ફેરા ની speed ધરાવે છે. 2 jet water ની 15° ઢાળ: 6mm ડાયા: 60 ધરાવે છે: 2 બકેટ: 2 પ્રકાર = 11P, m, water jet 2 ભાગ: નીચે ના ભાગ

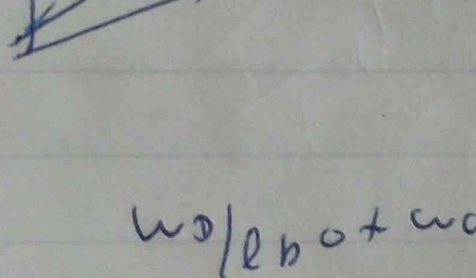
inlet vel: dia:

$$V_Z = \sqrt{2gH} = \sqrt{2\times32.2\times144} = 96.24 \text{ ft/sec}$$

$$V_Z = V_{wi} = 96.24 \text{ ft/sec}$$

$$V_{ri} = V_Z - e_i = 96.24 - 42 = 54.24 \text{ ft/sec} = V_{ro}$$

out let vel: diag..



બકેટ નો angle = $\phi = 180 - 155 = 25°$

$$V_{wo} + e = V_{ro}(\cos\phi = 54.24 \cos 25$$

$$V_{wo} + e = 49$$

$$\therefore V_{wo} = 49 - 42 = 7$$

$$\text{Wp/lb of water} = \frac{(V_{wi} + V_{wo})e}{g}$$

$$= \frac{(96.24 + 7) \times 42}{32.2}$$

$$= 103.24 \times 1.3 = 134.5 \text{ HP} //$$

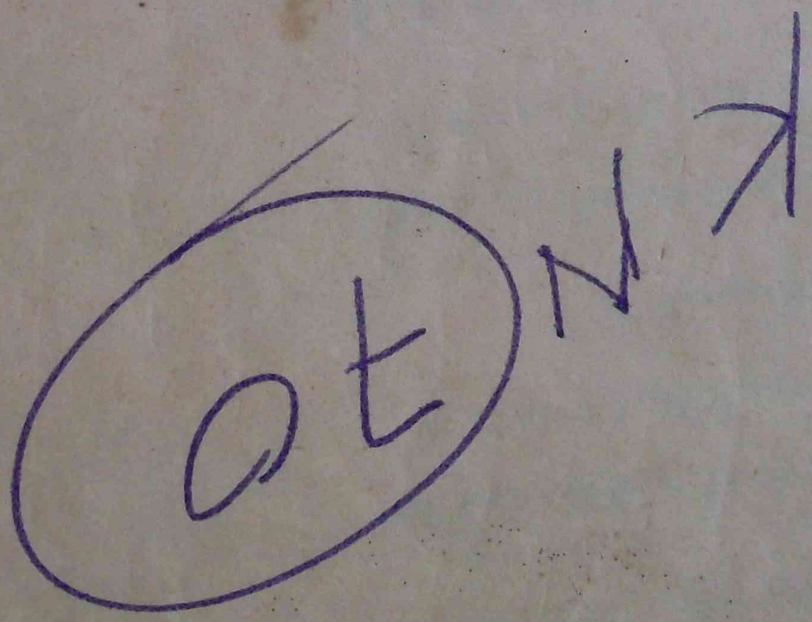
$$\text{Effcy} = \frac{134.5}{144} = 93.5\%$$

$$1600 = V_f \times \frac{\pi}{4} d^2 \times 62.5$$

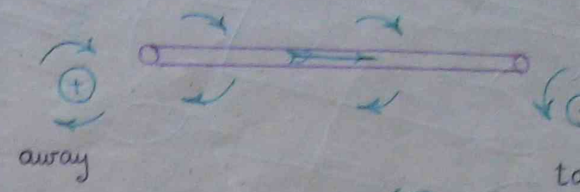
$$1600 = 96.24 \times .7854\, d^2 \times 62.5$$

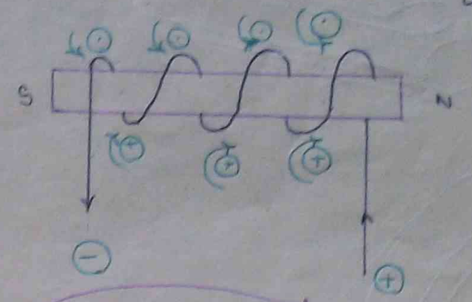
$$d = \sqrt{\frac{1600}{96.24 \times 49.2}} = \sqrt{\frac{1600}{4730}} = \sqrt{.339} = .591'$$

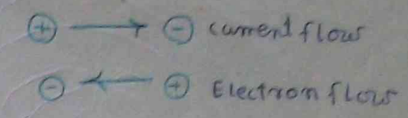
$$HP = \frac{134.5}{550} \times 1600 = 391 \text{ HP}$$

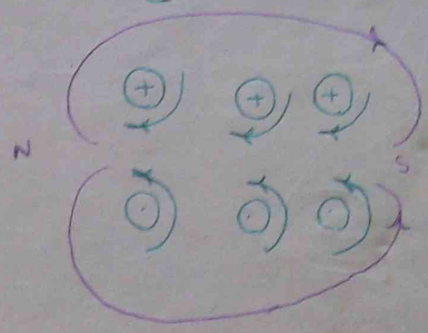


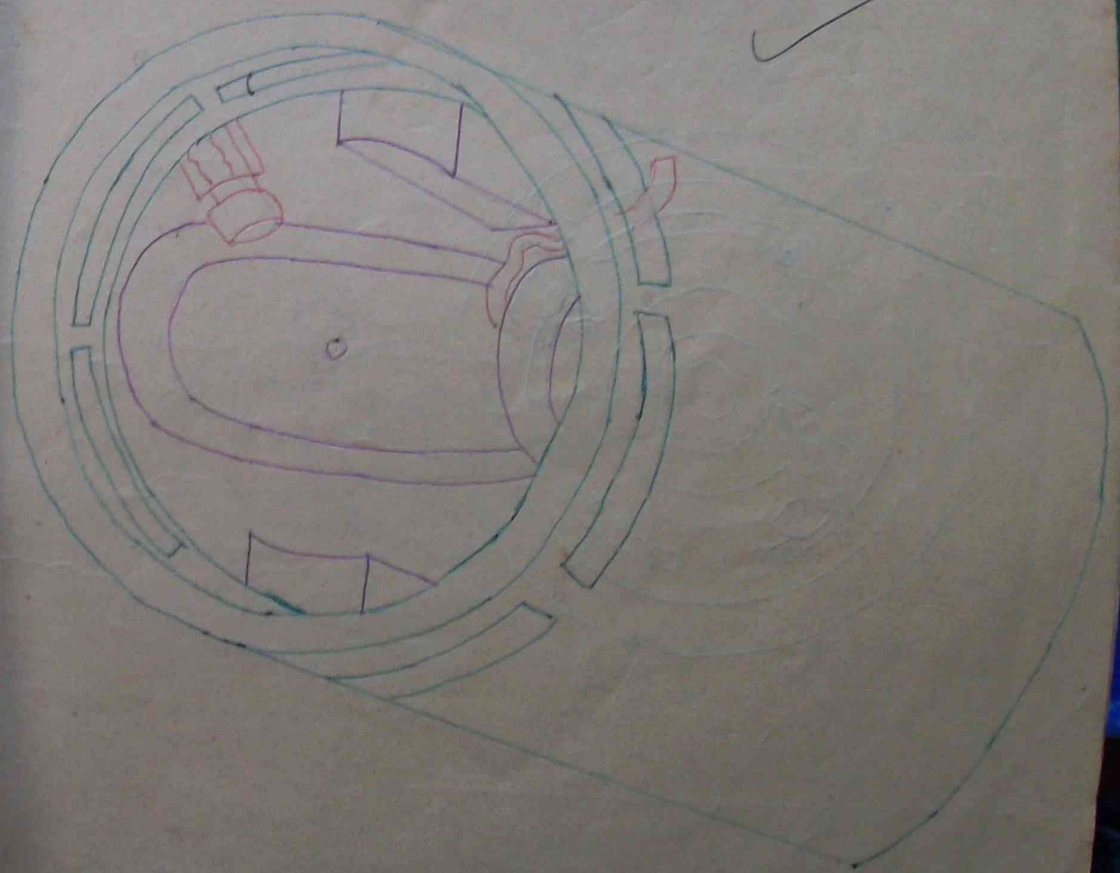
အမှာစဉ်	သင်ခန်းစာအမည်အကြောင်းအရာ	ကိုယ်တိုင်ဖေးမှုနှင့်လက်တွေ့လုပ်ဆောင်ချက်	ဆရာဖေးမှုနှင့်လက်တွေ့လုပ်ဆောင်ချက်	ကျောင်းသားဖေးမှုနှင့်လက်တွေ့လုပ်ဆောင်ချက်	
1	Disassemble and assemble machine to study its construction	—	✓	✓	3/14/80
2	connect and operat ~~ed~~ Seperately excited generator	✓	✓	1/2	
3	Run a saturation test on a shunt generator	✓	✓	1/2	
5	connect and operate Shunt generator	✓	✓	3/4	
6	connect and operate a series generator	✓	✓	✓	
7	connect and operate a D.C compound generator	✓			
8	Parallel operation of DC compound generator	✓			8/7/81

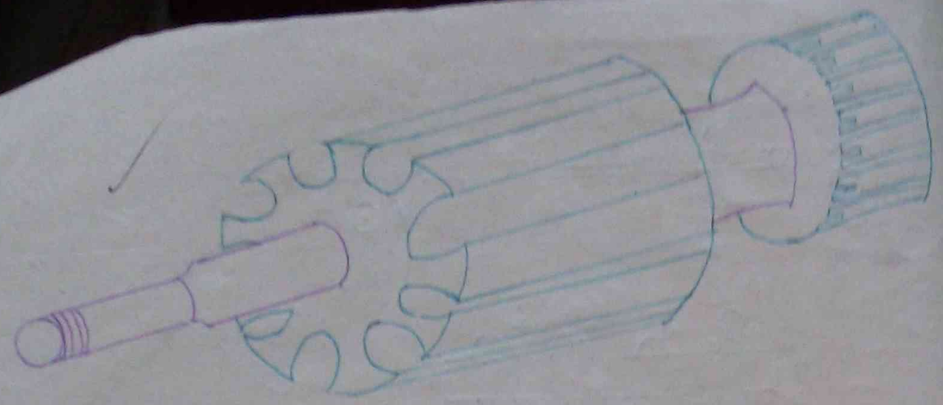

away
toward

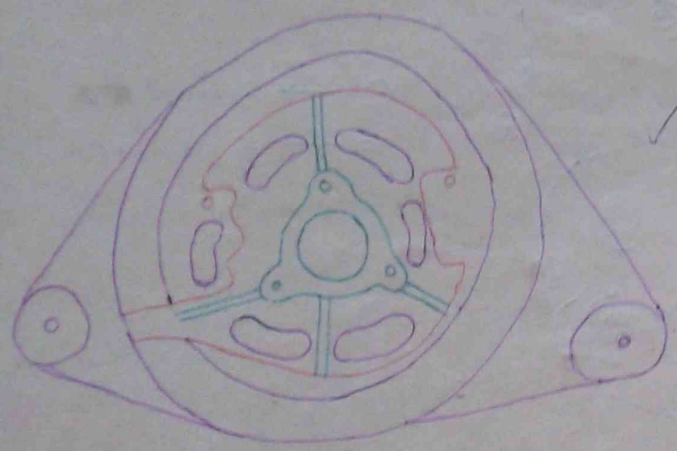

S
N

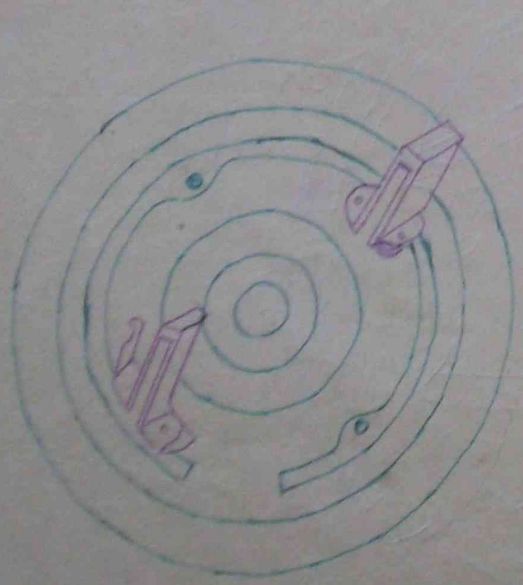

current flow
Electron flow

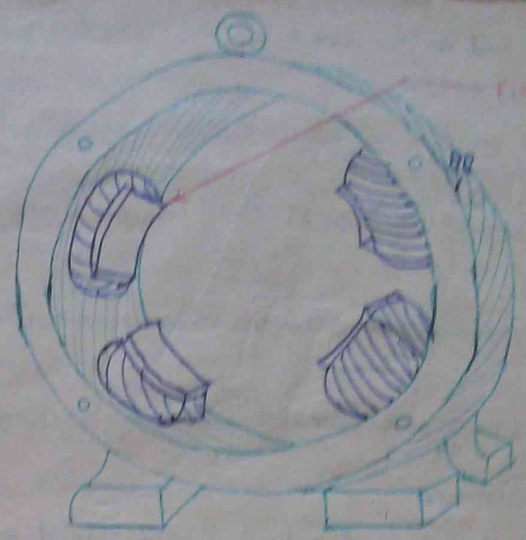

N
S

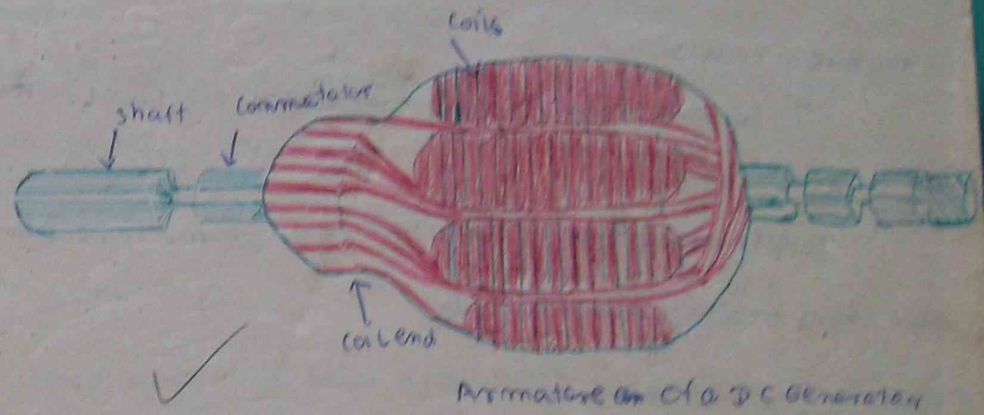




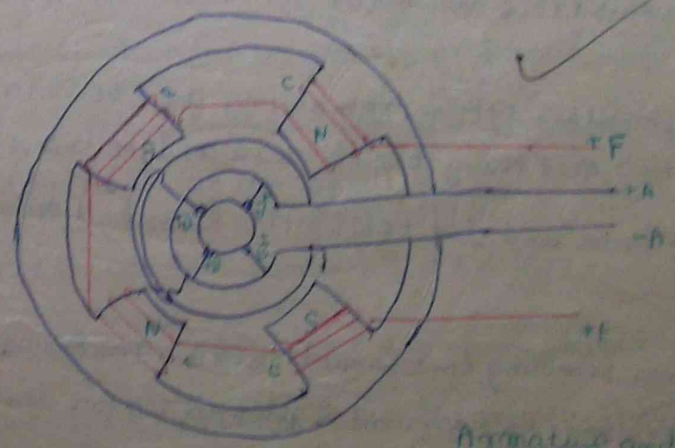








Armature of a DC Generator



Armature and field (

its construction

objectives

To study the construction of poles, field coil and armature core.

To determine the pressure of the carbon brush and how it can be varied.

To study various Type of bearings and bearing housing and method of Inbrieating bearings.

To learn how to identify the leads from field and armature circuits.

To become familiar with internal electrical connecting of a Dc machine.

To determine the air gap between armature core and pole shoes of a DC ~~Arm~~ machine.

General Instruction

use an adjustable spanner or socket wrench on all nuts and cup screws.

use only mallets when removing and bells from armature Shaft. Don't give heavy blow because and bells are mostly made of cast iron and due to its brith leness and bells will break.

Drawing reassembing, care should be taken that the end are seated in their original position and lighten all screws down together other wise the bearings will be skeewed.

Equipment, Tools, and ~~Ma~~ materials

DC machine (Assigned by Teacher)
one mallet (wooden ~~hamm~~ hammer)
one centre punch
one medium size adjustable spanner or socket wrench set.
One screw driver.
Pully extractor (If necessary)
Steel rule cut side caliper, feeler gauge and one small spring scale.
One multirange chrometer.

Pre cautions

Besure wrench fits nuts and cup screw heads.

Handle armature carefully, and keep it in a dry and clean Place. Don't lot the armature to fall on a pole when end bells are removed

Keep all small parts in a small tray to avoid mislaying. After reassembling, check all wire leads and see that all parts are in their reap active position

Operating sTeps

① Record name plate dalta of a giving machine.
② Removed the pully using the pulley remover.
③ Identification marks on the end bells and the frame by giving punch. So that when reassembling, original position of the fitting may be contained.
④ Remove the prushes from their holders
⑤ Removed the end bell at the commutator end
⑥ Remove the armature carefully so as not to injure the commutator and winding insulation
⑦ Study the brush holder assembly. Note the provisions made for brush Shiftin and varying brush tensions.
⑧ Study the construction and name the parts of the machine.
⑨ Measure and record the diameter of the armature end the

commutator.

⑩ note the type of bearings used and the method of bearing lubrication.

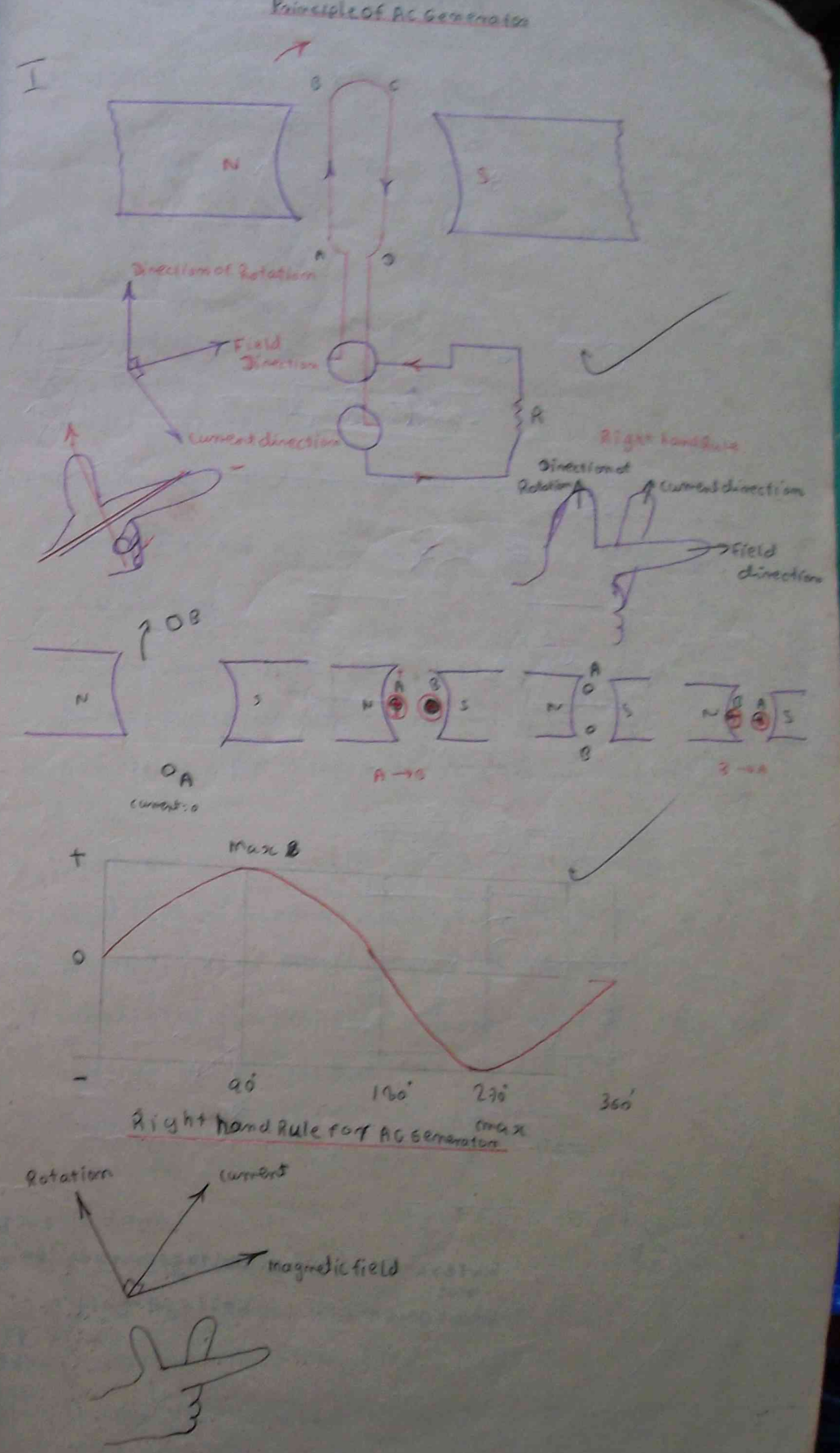
⑪ measure and note the resistance of the armature by low range ohm meter. So low resistance will be indicated usually by less than one ohm.

⑫ measure and note the resistance series field by low range ohm meter. which will indicator less than one ohm. (note series field consists of a ~~few~~ few turns of wire having large cross sectional area wound on the field poles and connected in series with the armature.

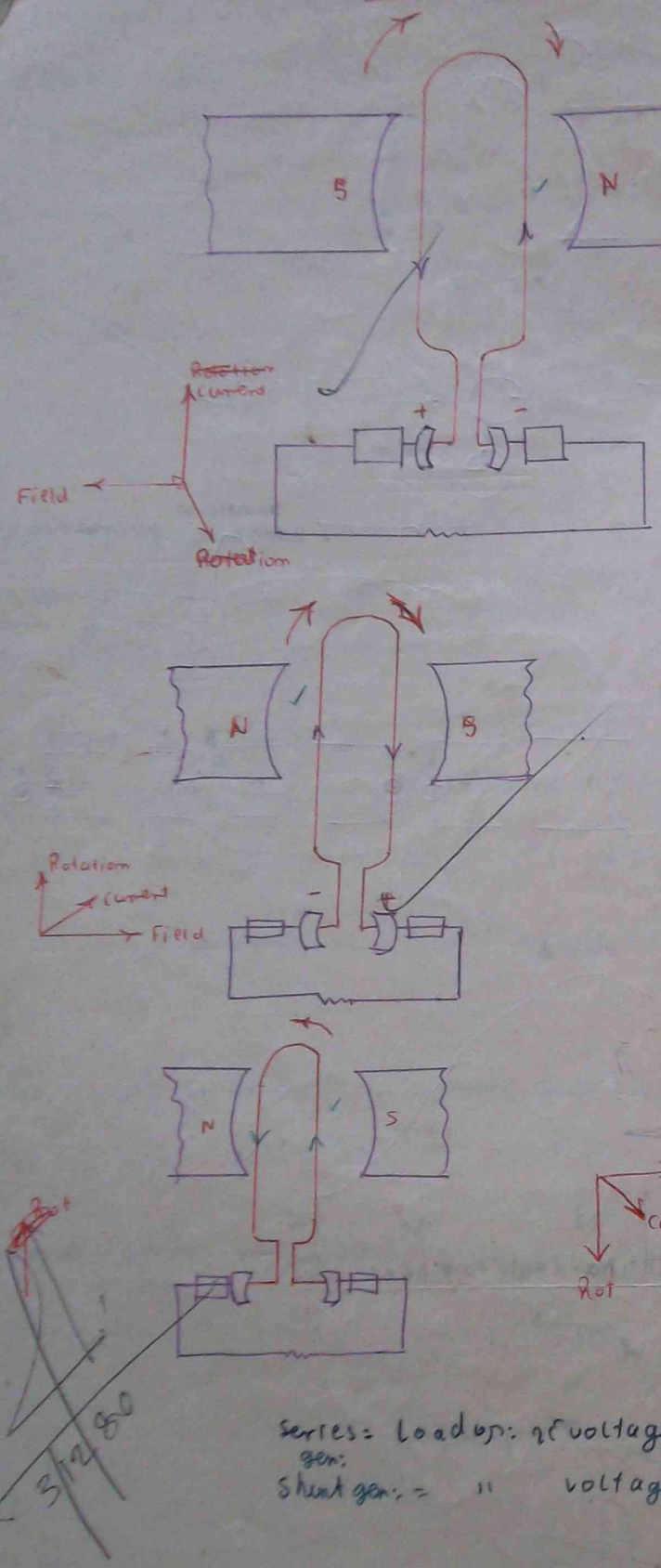
⑬ measure and note the resistance of the shunt field by high range ohm meter, because it has high resistance shunt field poles and connected in parallel to the armature see the circuit diagram of different machine shown below.

⑭ Reassemble the machine. Be~~ing~~ sure the end bells and bearing are in their original positions.

⑮ measure the air ~~the~~ gap between each pole face and the armature using the feeler gauge.



Principle of D.c Generator



series: load ఎక్కువ: ఉన్నప్పుడు voltage తగ్గుతుంది.

Shunt gen: = " voltage పెరుగుతుంది.

Induced e.m.f రావడానికి

① Strength of magnetic field
② Number of conductors
③ Speed of cutting
④ Angle of cutting

Bearings

① Ball bearings
② Bush Bearings
③ Needle Roller bearings

Armature దగ్గర ఎందుకు ఉపయోగిస్తారు:

కాపర్ వైండింగ్ ఎక్కువ వేడి అవుతుంది, ఫీల్డ్ కాయిల్స్ కంటే ఎక్కువ కరెంట్ ఉంటుంది.

Questions

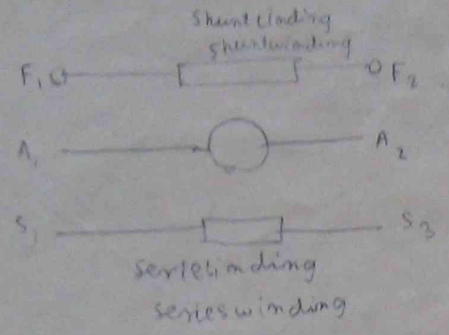
1. How many poles are there in the given machine? 2 poles
2. Are the poles pieces solid or Laminated? why? Laminated
3. Are the pole pieces seperate from or while piece with the frame?
4. Is the Armature core solid or laminated? why? Laminated
5. what type of bearing is used in this machine?
6. Name types of bearings used in dic machine.
7. what is the function of the brushes in the dic machine? and what materials are they made off? brass
8. ~~Material~~ What are the different between series field and Shunt ~~fei~~ field windings? Shunt parallel + - series series gen - switch
9. How many field windings has a compound machine? Name them? shunt, field Armature series, interwinding
10. ~~Exam~~ Explain the ~~terms~~ turns long Shunt and short Shunt of the compound generators?
11. For what Purpose are fields windings, provided in dic ~~mc~~ machine.
12. What is the normal pressure of the carbon brushes of the given machine

26-11-80

Likstrom smaskin

DC Machine

Maquina cc



Nameplates

I

ASEA

Gen shunt	catno
La132	NO2157863
1.9kw	1400r/min
60min D	ClassB
220v	8.6A
Exc V	Exc A
Sea2501 IEC34-1	5 Kg

b

ASEA

Gen - comp	
La132	NO2157863
1.9kw	1400r/min
60min D	ClassB
Magan V	Magan A
220 V	8.6A

Lubricate	Lubricate when
when first starting up and after a few days operation until grease is forced out of the grease outlet	Running with about 15 g bail bearing grease as follows service max lubrication interval

service	Max lubrication interval
24 hr	
8 hr	4 months
	12 months

Asea

Motor shunt	catno
La132	NO 2157863
1.5kw	1100 r/min
60min D	class B
220v	9,0A
Exc V	Exc A
seq 501	IEC34 5

Asea

motor serie	catno
La132	NO2157863
1.5kw	960r/min
60min D	class B
220v	9,0A
Exc V	Exc A
Sea 2501	IEC34 5 kg

(-) A_1 - + A_2 = Armature

+ F_1 -(-)F_2 = shunt field

+ S_1 (-)S_2 = interpole winding

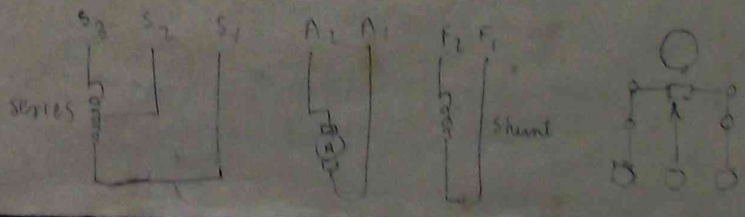
+ S_2 -S_3 = seriesfield

varideresistor

variable Resistor

220w

60HM 5A



x10 scale

series field $S_1 - S_2 = 20\Omega$

Interpole winding $S_2 - S_3 = 20\Omega$

Armature $A_1 - A_2 = 38\Omega$

shunt field $F_1 - F_2 = 30\Omega$

x10 scale

Interpole $S_1 S_2 =$ 5Ω

series field $S_2 S_3 =$ 5Ω (1to10) range

$A_1 A_2 =$ 40Ω (10to100) range

$F_1 F_2 =$ 320Ω 100 range

Title

To become familiar with methods of identifying generator leads

To show the relationship between terminal voltage and speed of a seperately generator.

To show the effect of armature-reaction and armature drop on terminal voltage when machine is supplying load

To study the external characteristic of seperately excited generator.

General Instructions 25-11-80

Read the job sheet carefully and connect the machine according to the given circuit diagram. use flexible leads for meter connections when ready to operate check all parts of the machine.

Equipment Tools and materials

seperately excited generator (assigned by teacher)

Two ammeter range 0 — 20

one voltmeter range 0 — 250

one techometer or speed indicator.

one bell tester.

one multi range ohmmeter.

An adjustable load bank

Screw driver and insulated plier

Flexible leads and two knife switch

ഒപ്പം ചെയ്യേണ്ടവ.

① ഒപ്പം: ഓരോന്നിന്റെയും Pole കൃത്യമായിരിക്കണം.

② ഓ: Pole കളിൽ limited ആയിരിക്കണം. ആവശ്യത്തിന് solid വയർ ഉപയോഗിക്കണം. ഓരോന്നിന്റെയും ഇടയിൽ ആവശ്യത്തിന് ഗ്യാപ്പ് ഉണ്ടായിരിക്കണം. ഇല്ലെങ്കിൽ ഫ്ലക്സ് short ആയിപ്പോകും. ഓരോന്നിന്റെയും ചുറ്റിലും ആവശ്യത്തിന് ഗ്യാപ്പ് ഉണ്ടായിരിക്കണം. ഇല്ലെങ്കിൽ limited ആയിരിക്കണം.

④ Armature ന്റെ limited ആയിരിക്കണം. ആവശ്യത്തിന് ഗ്യാപ്പ് ഉണ്ടായിരിക്കണം. ഇല്ലെങ്കിൽ ഫ്ലക്സ് short ആയിപ്പോകും.

⑤ ഒപ്പം: ഓരോന്നിന്റെയും Bearing ആയി: ഉപയോഗിക്കുന്നു: ① Ball Bearing ② Bush Bearing ③ Needle or Roller bearing തിരഞ്ഞെടുക്കാം.

⑤ ഒപ്പം: ഓരോന്നിന്റെയും Ball Bearing തിരഞ്ഞെടുക്കണം.

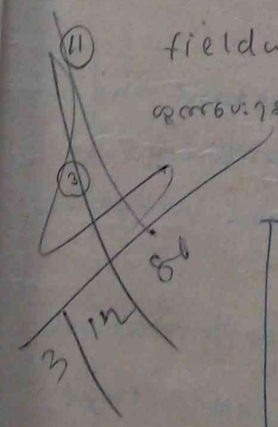
⑦ Brush ആയി: ഇടുമ്പോൾ ഫുൾ current കിട്ടുന്നതിനായി ഒപ്പം ആയി ചേർ: current ആയി ഒരു പോയിന്റ് കിട്ടുന്നതിനായി commutator winding ന്റെ ഒത്ത നടുക്ക് ഇടണം. ഓരോന്നിന്റെയും ഇടയിൽ ആവശ്യത്തിന് ഗ്യാപ്പ് ഉണ്ടായിരിക്കണം. ഇല്ലെങ്കിൽ ഒപ്പം ആകുന്നതാണ്. Brush ആയി commutator ന്റെ Armature ന്റെ ഒത്ത നടുക്ക് തിരിച്ചിടണം. ഇല്ലെങ്കിൽ ഒപ്പം ആകുന്നതാണ്. ഇല്ലെങ്കിൽ current ആയി Brush ന്റെ commutator ന്റെ ഒത്ത നടുക്ക് തിരിച്ചിടണം. ഇല്ലെങ്കിൽ ഒപ്പം ആകുന്നതാണ്. ഇല്ലെങ്കിൽ ഒപ്പം ആകുന്നതാണ്.

⑦ ഓ: Brush ആയി തിരഞ്ഞെടുക്കുന്നതിനും ഒപ്പം ആകുന്നതാണ്.

⑧ Shunt field ആയി generator ന്റെ parallel ആയി series field ആയി Generators ന്റെ switch ന്റെ ഓരോന്നിന്റെയും series ആയി ചേർ.

⑨ compound machine ന്റെ shunt winding, field winding Armature winding series winding ന്റെ pole winding തിരിച്ചിടണം. ഓരോന്നിന്റെയും ഒപ്പം ആകുന്നതാണ്.

⑪ field winding ആയി ഉപയോഗിക്കുന്ന വയർ ആവശ്യത്തിന് കട്ടിയുള്ളതായിരിക്കണം. ഇല്ലെങ്കിൽ ഒപ്പം ആകുന്നതാണ്.



series field	$S_2 S_3 =$ 5Ω	x1 range ഓ:
Interpole	$S_1 S_2 =$ 5Ω	x1 range ഓ:
Shunt field	$F_1 F_2 =$ 320	x100 range ഓ:
armature	$A_1 A_2 =$ 40	x10 range ഓ:

Precaution

Check the polarity and the range of the instrument to be used. Besure that connection of your circuit is correct. Do not open shunt field circuit while in operation. Do not run the machine above its rated load. Do not operate the machine before checking made by the ~~instrumental~~ instructor.

Operation steps

① Check and indensity the leads for armature and shunt field by using Ohmmeter

② connect the circuit according to the diagram provided

③ Close the field circuit switch and adjust the ~~oc~~ excitation by the field rheostat.

④ Run the machine ~~with~~ without load at the lowest speed for which a satisfactory voltmeter reading is obtained. The speed and voltmeter reading is recorded.

⑤ Increase the speed of the generator by about ten equal increment up to normal voltage. Record the ~~voltage and~~ speed and voltage at each increment in table

⑥ Draw the curve to indicate changes in open circuit (Terminal voltage) (vertical axis) with variation in speed and under no load conductor)

⑦ The speed of the machine is maintained constant and load is applied gradually upto 125 percent of rated load. At each load record the load current and terminal voltage and put in table NO. 2

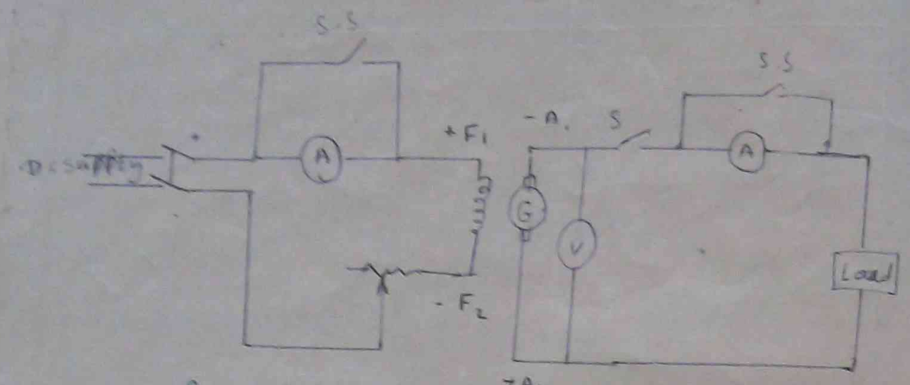
⑧ Remove the load gradually and record the terminal voltage at each time of load change upto no load voltage

⑨ plot a curve between the load and the terminal voltage of a separately excited generator load current as a base.

Questions

	Field current	voltage
1	0	15
2	120mA	70
3	150mA	80
4	180mA	100
5	210mA	120
6	240mA	140
7	290mA	160
8	330mA	180
9	370mA	200
10	415mA	220

	Load	Load current Armature	Load voltage
1	~~0~~ 43w	0.2	215
2	107.5w	0.5	215
3	109.6w	0.8	212
4	253.2w	1.2	211
5	315.0w	1.5	210
6	378w	1.8	210



objective - Run a saturation test on a shunt generator

To show the effect of field current upon the generator

To show the effect of magnetic saturation upon terminal voltage

To show by magnetic field ~~gen~~

General Instruction

Read the given Job sheet carefully connect the generator as a Shunt generator without load connection ammeter a field rheostat and single pole switch in the field circuit connect Suitable voltmeter across the machine terminal

Equipment tools and materials.

motor - generator (Shunt type)

Two single pole switches

Rheostats.

Graph paper and pencils

field Ammeature

voltmeter

Techo - meter

Screw driver, adjustable spanner, and insulated plier

Precaution

check Instrument polarities

when it is necessary to open the field circuit be sure the ~~arm~~ ammeter shunt circulating switch is closed and open the field circuit switch ~~or~~ Slowly Never use use low range ammeter and voltmeter.

operating step:

(1) connect equipment according to the given diagram.

(2) Run the machine at normal speed and with the field switch open, the voltmeter reading is rated

(3) maintaining the speed constant the field is ~~excited~~ excited at a low current, and note reading of voltmeter and ammeter.

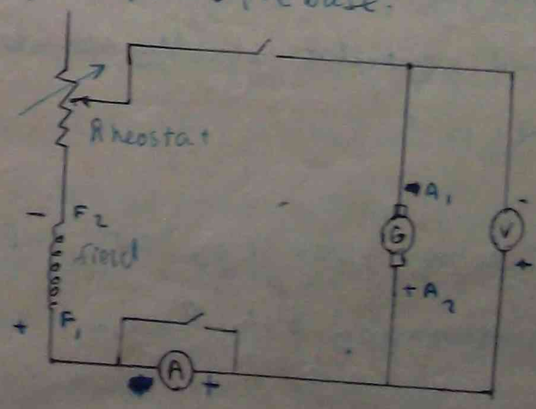
(4) The excitation is increased by a short ten equal ~~in~~ increment's up to normal value, the voltage being observed and noted in each case

(5) Do not raise field current above 150% of that required for rated terminal voltage

(5) After reaching maximum voltage, reduce field current in steps. again recording reading

(6) Take last reading with field circuit open.

(7) Plot the two sets of amp, and volt ~~ages~~ reading using amps as the base.



Field current	Volt	Ia	Vg

Questions

① why does the carve rise ~~for~~ quickly as field current is increased

② why does the voltage values differ with the same value of field cament as cending and descending.

③ what is meant by residual magnetism?

④ why are shunt generators designed to operate some what above the knee of the curve

⑤ why are compound generators usually operate at a lower point on the curve

Refrences

Industrial Electricity vol: 1 by Pauls Experimental Electrical Engineering by E.A. Rapson.

1	0	15 V
2	.06 A	50 V
3	.12 A	90 V
4	.2 A	125 V
5	.25 A	150 V
6	.3 A	180 V
7	.31 A	190 V
8	.33 A	200 V
9	.39 A	220 V
10	.44 A	250 V

Jobs

Title - connect and operate shunt generator.

objectives - To become familiar with connecting a generator to a ~~suitable~~ switchboard.

To become familiar with board operation.

To learn the external characteristic of the machine.

General Information -

Before the load is applied the machine will generate an e.m.f where value is decide by the salting of the regulator resistance (ie, Rheostat). The no load point will thus be the point A on the voltage axis see the diagram (a). where OA is equal to this no load voltage.

If there were no armature reaction effect and no terminal drop in volts, the voltage characteristic would be the horizontal through A, curve No 2. Actually the armature reaction causes a reduction in flux, this reduction

increases as the armature current increases and so the actual graph of induced e.m.f is the slightly dropping curve. From the circuit diagram we see that the armature I_a is the sum of the load current I and shunt current I_{sh}. This is taken in to account as follows. A resistance line OB is drawn to represent the armature resistance plus the resistance of the interpoles, ie, the total series resist:. The slope of this latter is small because of the low value of the resistance of the series circuit.

For any load current OI, add the appropriate shunt current $\frac{IC}{I}$ Its length OC then represent the total armature current The perpendicular DC thus represent the voltage drop in the series circuit For the load current OI the induced emf is given by the ordinate FI, and therefore if we mark off FG equal to DC, the remainder GI will be the terminal p.d and G a point on the voltage characteristic similarly other points can be obtained and the graph of terminal p.d drawn curve B.

From the shape of the curve we see that the shunt generator gives its greatest voltage on no load the voltage falling of same what as the output current is increased

Actually the fall from no load to normal full load is small and full voltage can be maintained by a suitable adjustment of the shunt regular Rm for this reason the shunt generator can be classed as a constant voltage machine.

Equipments, Tools & materials.

1. motor. generator set (assigned by instructor)
2. Two ammeter
3. volt meter.
4. Kenife switches
5. Field rheostats
6. Resistance load box
7. Screw driver and insulated plier.
8. One multi range ohm-meter

Precaution

Check the polarity of the field leads and direction of rotation of the machine. Make sure that all connections are all tight. Don't forget to provide a shunt switch across the amp-meter. Don't open the shunt field circuit while in operation Don't allow the load to remain on the generator longer than is necessary to make the test.

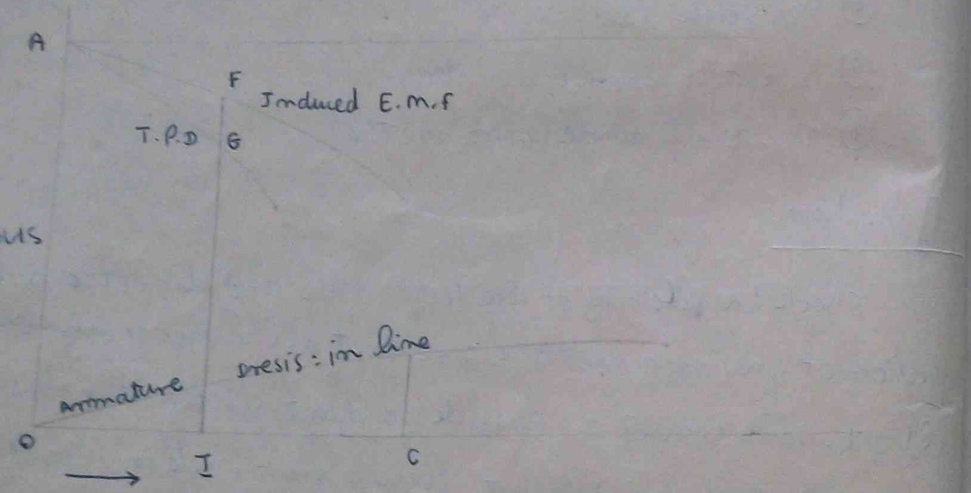
operating Steps

1. Check the mechanical parts of the generator (including bearings.
2. Test and identify the leads from gererator and measure the resistance value of armature and shunt field.
3. connect the machine as a shunt generator as shown connection diagram.
4. Run the machine up to the rated constant speed and note the build up of voltage
5. Adjust the field rheostat rheostat gradually to obtain

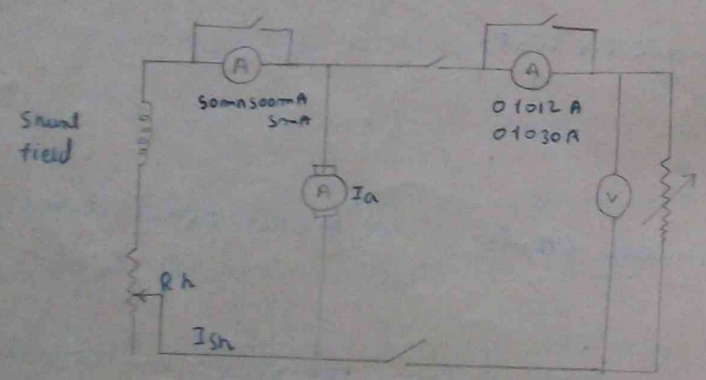
⑥ connect a variable and increase the load gradually from note the voltmeter, ammeter, readings at each increase and speed of the machine.

⑦ using these reading plot the external characteristic load current curve as the base and voltage as vertical

⑧ calculated generated voltage at each of load.



diagram(a)



diagram(b)

Job 6

Title - connect and operate a series generator

objectives -

To learn how to indentify the terminal of a compound generator.

To learn how to connect and operate the machine as a series generator.

To study the characteristics of a series generator.

General Information -

In the series generator the armature, field and load are all connected and series and therefore all carry the same current Refer the diagram (a) If the load is of variable Resistance which can be adjusted to any desired value when the Resist: of the load is very high the residual magnetism will idere a small e.m.f. in the armature, and this e.m.f will set up a current around the circuit, but owining to the high Resistance of the load, the current will be small and no further increase in e.m.f may take plane. Diagram (b) shows the magnetization characteristic obtained by separate excitation. For any point A the ordinate (A.m) Represents the voltage and the abscissa ON the current

$$\therefore \frac{Am}{ON} = \frac{\text{voltage}}{\text{current}} = \text{resistance.}$$

But, $\frac{Am}{ON}$ gives the slope of the line OA, from which we see that if we draw a series of straight line Through the origin each will be a line of resistance represented by its slope. If such a line cuts the external charasteristic, then the point of intersection

such A will give the resulting terminal voltage and current for the particular value of resistance represented by A If a line does not have any point of intersection with the curve as in the case of o.c then the machine will not be able to operate.

The slope of the tangent line oB thus represent the maximum possible resistance for the machine to operate this resistance is called the critical resistance for the machine. Therefore in series ~~resis~~ generator the total circuit must be less than the critical Resistance when this is shown the initial induced e.m.f will set up a small current which can increase the flux and increase the e.m.f. The terminal ~~volta~~ voltage of a generator is equal to the e.m.f generated E, less the ohmic drop of volts in the machine. If Rse and Ra are the Resistance of the series field and armature ~~to~~ respectively, then each carries the load current I the ohmic drop is (Ra + Rse) I

Therefore terminal ~~volt~~ voltage V = E - I(Ra + Rse)

Equipment, Tools and materials

compound generator (assigned by the teacher)
One 3.P.S main switch
Arm adjustable load bank
One multi range ohmmeter and bell tester
One plier (insulated) and medium size

Preraution

Check all parts of the machine. Make sure of (the ~~terminal~~ correct) polarity of the instrument. Check all connection see the direction of rotation of the machine worked on the frame.

Operating ~~sfe~~ steps

① Identifying the leads of the compound generator for series field armature then measure their resistance and connect as fig(c)

② Run the machine without load at constant speed and ansure the voltmeter.

③ Close the switch of an adjustable load and increase the load gradually to obtain the rated voltage. Record the ~~armature~~ ammeter and voltmeter at each increasement of load in result the sheet

④ Draw a curve for external characteristic with load current as horizontal and terminal ~~as~~ voltage as vertical.

⑤ plot a curve for field and armature drop on the same graph paper

⑥ To obtain the terminal characteristic of a series ~~gener~~ generator add field and armature drop vertically to the external drop curve

Questions

①

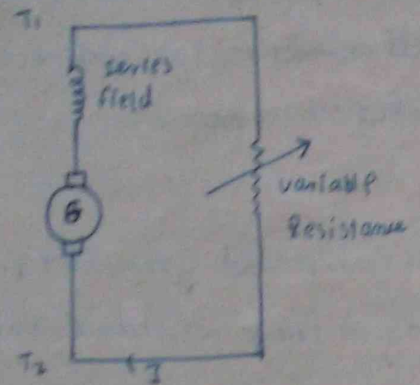


Fig (a)

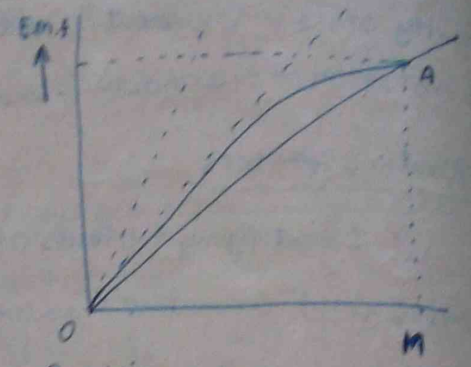


Fig (b)

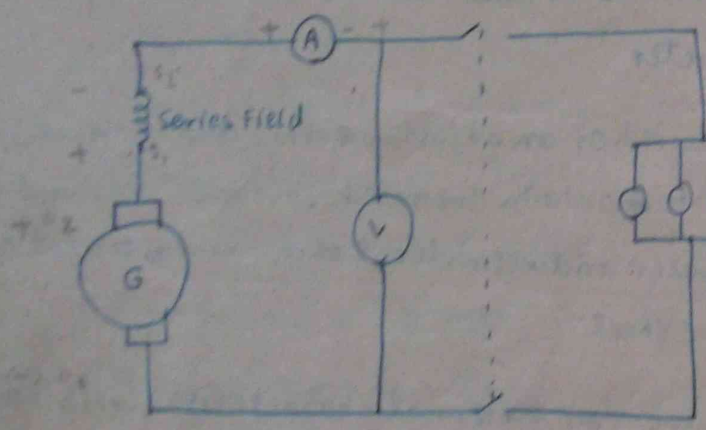


Fig (c)

No: of obs	Terminal voltage	Load current	I (Rse+Ra) drop	Generated voltage.

Title - connect and operate a DC compound generator

objectives - To learn how to indentify the Terminal of a compound generator

To learn how to connect ~~the~~ the terminals of a compound generator.

to a switch board.

To learn how to operate a compound ~~generat~~ generator.

To learn how to ~~operate~~ obtain and interpret characteristic curves of a compound generator with various degree of compounding.

General Instruction

study this job sheet ~~care~~ fully in order to have a ~~carefully~~ full view of its objective and the proper procedure to use in obtaining them. Study each set ~~of~~ of reading made before progressing to the test to ~~deter~~ determine if they ~~are~~ are consistent and reasonable. Have the readings checked before disconnecting the equipment.

Equipment Tools and materials -

Bell test set
Series field shunt
Tachometer.
Switchboard
Switchboard with instrument.

Precaution

Check name plate data and do not over load machine.
Shut down machine to make any connection changes.

operating steps.

① study and record name plate of data of the generator

② check the mechanical parts of the motor and generator and the bearings for oil. Note their condition

③ Test out the terminals from the generator and mark the leads.

④ Make a diagram of the internal circuit of the generator and of the connections which are to be make for this job

⑤ connect the armature leads to the switch board.

⑥ Start the machine check the oil rings for operation and note the residual voltage.

⑦ Shut down the machine and connect the shunt field.

⑧ Start the machine and raise the voltage to name plate value at no-load.

⑨ Shut down the machine and connect the series field start-shunt.

⑩ Start the machine raise the voltage to name plate value and add load to test for commutative connections. Adjust rheostat and load until generator is delivering full load at normal plate voltage.

⑪ Remove load, adjust voltage to name plate rating add load in steps, and record the voltage current and speed for each step of load.

⑫ Study these readings. On compounding must be obtained. If the readings indicate flat or an under compounding start again at a slightly lower voltage at full load. add load and volt the voltages obtained. Repeat until over compounding is obtained.

⑬ Record the voltage, current and speed readings in steps as the load is added, for the rheostat which gives over compounding.

⑭ Shut down the machine and connect the series field Shunt.

⑮ Start the machine and raise the voltage to the same Starting voltage from which over compounding was obtained.

⑯ Apply full load and adjust the series field shunt so that flat compounding is obtained. Test by adding load, comparing voltages and adjusting shunt.

⑰ Record the voltage, current and speed readings in steps as load is removed for the flat compounding settings.

⑱ Adjust the series field shunt again while operating at full load so there will be an under compounding of approximately 5 volts.

⑲ Record the voltage, current and speed readings in steps as load is added for the under compounding settings.

⑳ Shut down the machine in the proper manner.

㉑ Have the instructor check to data obtained.

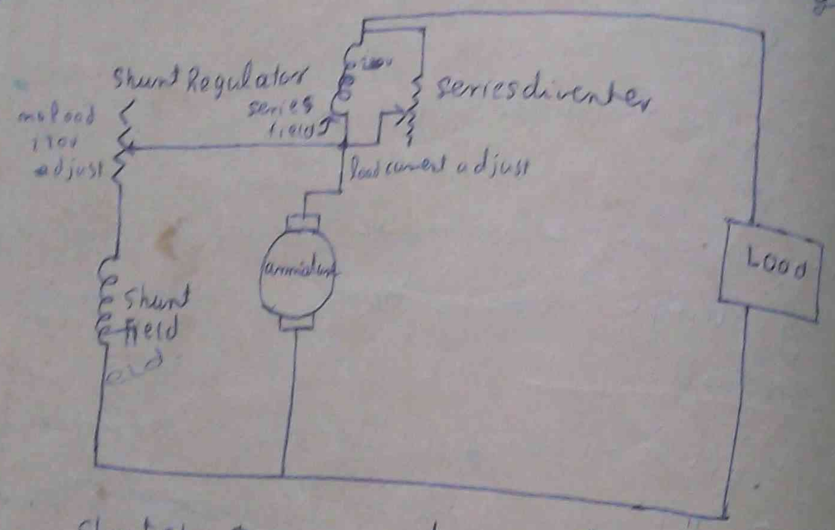
㉒ After disconnecting the setup, plot the voltage

Load amps

(1)(2)(3) calculate the voltage ~~Regulation~~ Regulation with reference to full load voltage for each type of compounding, from the formula.

$$\%\ \text{Regulation} = \frac{\text{no load voltage} - \text{full load voltage}}{\text{Full load voltage}}$$

(3)



(4)(5)(6) Short shunt compound generator.

(7) Table I

(8)	Flat compound			under compound			over compound		
	volts	Amps	R.p.m	volts	Amps	R.p.m	volts	Amps	R.p.m
1	220	.2		215	.12				
2	220	.3		215	.3				
3	220	.45		215	.45		225	.3	
(9) 4	220	.6		215	.6		225	.62	
5	220	.8		215	.8				
6	220	1		"	.95		225	1	
(10) 7	220	1.1		"	1.1				
8	220	1.3		"	1.25		225	1.3	
9	220	1.45		"	1.45				
10	220	1.6		"	1.52		215	1.6	
11	220	1.72		"	1.8				
12	220	1.9		"	2		225	1.9	
	% Reg: full load			% Reg: full load			% Reg: full load		

(11)

Questions

(1) For this machine rated over, flat or under compounded? see name plate:

(2) What effect does speed have on out put voltage as load increased?

(3) what load conditions would demand a flat compound generator?

(4) Under what condition would over compounding be required?

(5) Generators are designed for various degree of compounding what factor is changed to vary this amount of compounding?

(6) what is meant by "voltage regulation" and how is it determind?

(7) In a compound generator, which would be more satisfactory short shunt or long shunt. why?

(8) Iron the value of resistance of the field, armature and series field what would be the e.m.f generated at the load of 10 amps the terminal voltage is 200 volts (long shunt)

Parallel

objectives - To learn the necessary connection for parallel operation of shunt generators.

To study the characteristics of shunt generator

To practice load shifting from machine to machine.

General Instructions

Read this job sheet and your reference carefully this job should make you familiar with connecting and ~~operati~~ operating shunt generators parallel. If the generator you use is compound ~~wo~~ wound do not use the series field in the job.

Equipment, Tools and Materials

Two generators for shunt connection.

Two complete switch Boards to handle generator output

0-250 volt portable volt meter D.C

Precautions

check all connections

Make sure of the correct portarity.

Do not try to parallel without load.

Operating steps

1. check the mechanical undition of the machines and make sure they are properly oiled.
2. Draw a diagram of the connections you plan to make.
3. Test and mark all leads and lines to the switch board.
4. Connect all leads to the corresponding switch boards.
5. Start each generator and note the voltmeter and ammeter polarities.
6. with a portable d.c voltmeter measuring up to 250 volts indentify the (+) and (-) leads of to the circuit breaker note this necessary unless the switch board has been arranged for parallel operation.
7. connect (+) to (+) and (-) to (-) on the two switch board so that they will provide protection.
8. Test each machine independently, to find out if it will carry rated load when testing each machine keep the main switch on the other switch board open. Do not exceed rated load of the generator you are operating.
9. start up board generators - main switches open, close one of the main switches and put full load on ~~the~~ the generator.
10. Bring the other generator to the same voltage as the one with load by flipping the parallel voltmeter switch ~~to~~ left and right.
11. Take a portable voltmeter and test the open main switch for voltage between blades and clip

~~pre~~caution:-

use a scale large enough to handle the voltage of one machine. Your voltmeter should read 0 to 1 volt or 2. If it read more than that your connection is wrong and if you close the switch there will be a short circuit.

12. If ~~not~~ portable voltmeter reads near zero close the switch adjust the load between machines by means of the field rheostats.

caution:-

Do not motor either of the generators as you will open the protection in the loaded motor circuit

Transfer the load over to the other machine by the use of the field rheostat watch ammeters when the second generator is carrying all the load you may open the main switch of the other machine.

(14) Repeat steps 12 and 13 several times

(15) Parallel the two machine and load the combination to full load by keeping their load adjusted. So that each machine is carring its proportionate share.

(16) without changing the field rheostats of the either machine take the load of the combination in twelve or more steps and record them in table I

(17) - plot load - voltage curves of the two generators using total load amps as the base.

(18) Again with a combination supplying a certain fixed load transfer the load from generator I to II keeping the voltage also constant. Record in table II

(19) Repeat step 18 with generator loads from II to I and record in table II

(20) plot a curves from generator I and II on opposite sides with the total load as the base

Note

If good results are not obtained with name plate full load voltage reduce the voltage and try again.

Sketches

(1) Why is the same polarity necessary for connecting two machines in parallel and what would happen if the polarity were reversed?

(2) - Is it necessary to have both machines of the same size? speed and make for parallel operation. How would these machines function if their characteristics were alike

(3) If switch board voltmeters were ~~bad~~ faulty what are the possible troubles.

(4) What happens when machines are parallel only when they warm up

(5) Should the speed characteristics of the prime movers be alike for parallel operation of DC generators why?

(6) List the operating step needed for shutting down a DC generator from sharing loads with other generators

(7) What makes load shuning of DC shunt generators automatic

(8) Two shunt generators in parallel in supply together 2000A the machines have armature resistance of .04 and 0.025 ohms, field resistance of 25 and 20Ω induced e.m.f's 440 and 420 v respectively. Determine the output of each machine.

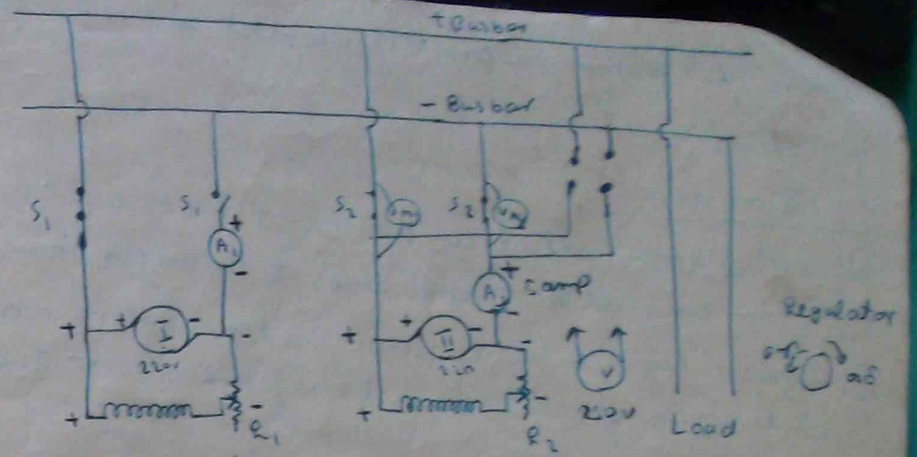
(9) If E_t = 220 volts, measure R_{a_1} and R_{a_2} and then R_{f_1} and R_{f_2} and find the out put of the two generators for a load of 50 amp.

Case II

Transfer of load from m/c I to m/c II Transfer of load from m/c II to m/c II

No	m/c I volts	m/c II volts	m/c I Amp	m/c II Amps	Total Load	No	m/c II volts	m/c I volts	m/c II Amps	m/c I Amp
1	190	190	1.7	0	1.7	1	200	200	1.75	0
2			1.5	.18	1.68	2			1.5	.2
3			1.2	.5	1.7	3			1.2	.5
4			1	.65	1.65	4			1	.5
5			.5	.17	.67	5			.5	1.2
6			0	1.7	1.7	6			0	1.75

No	volts	m/c I amps	m/c II amps	Totals
1	202	0	0	0
2	209	.11	.19	.3
4	199	.23	.32	.58
6	197	.37	.45	.82
8	195	.49	.63	1.12
10	194	.65	.8	1.45
11	193	.75	.84	1.59



Title connect and operated two compound Generators in parallel

objectives

To learn proper methods in parallling compound generator and to learn the students hour to shift load from one generator To another

General Instruction

In parallleing 2 d.c compound generators unlike shunt generators a third bus known the equalizing bus bar has to be incorporated in the switch board. The propose of the equalizers connection is to prevent circulating current from flowing through the series winding otherwise the polarities of one of the generators would be buersed due to the e.m.f of the other

If the generators have interpoles, the interpole field winding should carry the same current as the armature as the armature, therefore the equalizing bar is connected to the junction of series and interpole fields.

Equipment ~~tools~~ and materials

Two compound generators and their panels 230volts DC portable voltmeter.

precautions

Be sure to check the polarity before paralleling them connect series field and consequently the equalizer another negative side of the armature of each machine

This is just a common practies rheostat and insulation problems.

Operating steps

① Check the mechanical condition of the m.G sets.

② Test and all leads and lines to the switch board.

③ connect the m.G sets as given in the figure making at the series generator is on the negative side of the armature.

④ start each generator and check the polarities of the ~~armature~~ ammeter and voltmeter.

⑤ connect (+) to (+) and (-) to (-) on the circuit breaker so they will proide the protection

⑥ Test each machine independently to find out if it will carry rated load when operating step 6 keep the main switch on the other board open.

⑦ connect the equalizer circuit using enough wire to give a low resistance ~~limit~~

⑧ start up both generators, main switches open close one main switch and put full load on generator.

⑨ Bring other generator to same voltage as the one carrying load.

⑩ With ~~not~~ portable voltmeter check voltage across clips of the open switche and then across blades. Check for correct polarity.

⑪ close main switch of incoming machine

⑫ By means of the field rheostat, carefully shift part of the load to the second generator.

⑬ Increase the load by closing additional load switches

⑭ If one machine persists in taking more than its share of the load shut down the machine place a low adjustable resistance in series with its series field.

⑮ Repeat loading process and if necessary adjust series ~~generator~~ resistor until proper distribution of load is obtained.

⑯ Take the load off in 10 steps, reading and recording amps and volts.

⑰ shift the entire load to the second machine.

⑱ Repeat this load shifting several times and shut down machine 1 after opening it's main switch and equalizer.

⑲ plot a curve of total load and voltage

⑳ On the same shift of individual generator load against the total amps as a base.

Notes :-

The voltage of the incoming machine should never be less than the machine on bus a volt or two higher should do no harm.

In fact it is

Sketches :- See attached sheet

Questions :-

① How would difference in prime mover speed characteris - tics effect the generator

② what difficulties may result from paralleling a

③ Explain carefully why an equalizer connection makes it possible for this compound generator to operate in parallel in stable equilibrium.

④ A long shunt compound generator has a shunt field with 1,200 turns per pole and a series with 4½ turns per pole. If the shunt field and series field amp-turns are respectively 1,200 and 196 calculate the power delivered to a load when the terminal voltage is 230

⑤ Two shunt generators A and B are to be operated in parallel to supply a common load. generator A has a no load voltage of 240 and a voltage of 220 when its delivers a load of 60 amps. generator B has a no load voltage of 230 and a voltage of 210 when it delivers the same current as A. Assuming straight line characteristics for both machines. calculate (a) a line voltage and a total load in kilo watts when generator B is floating. (b) The total load delivered by both machines when the line voltage is 225

References:

Electrical machines by Sisikind

Electricans Hand Book by Croft

Alternating current electrical Engineering – Philip Kemp

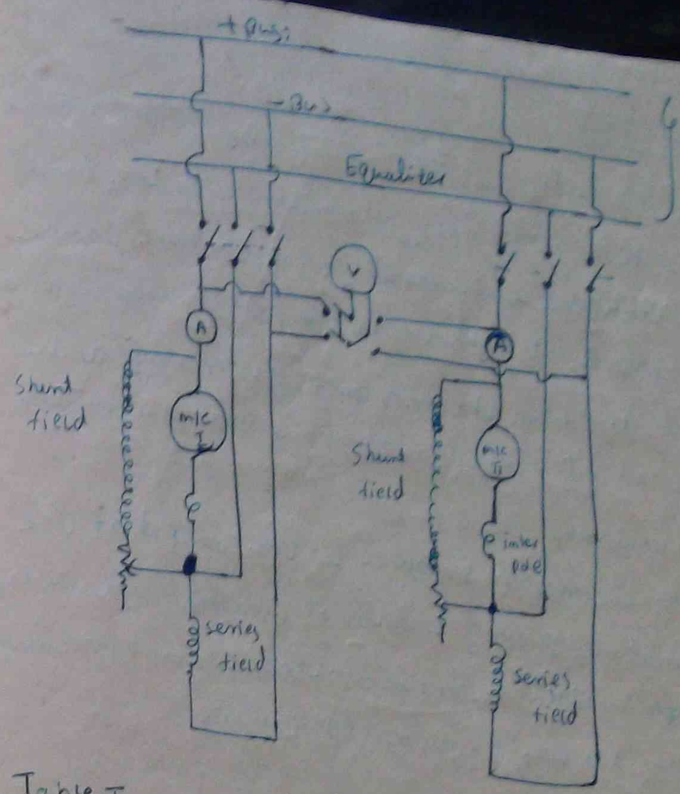


Table I

NO	volts	amp I	amp II	Total amp

Title — connect and operate a series motor on load

objective — To teach the student how to start a series motor and to show that the series motor should not be started light.

General instructions

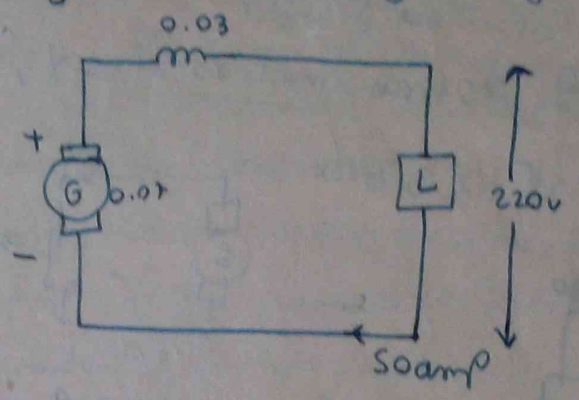
The speed of a series motor is inversely proportional to the flux and flux is directly proportional to the load and therefore the speed is inversely proportional to the Load current, so that at light Loads the speed is very high as the load increases the drops the series motor is driving a dc generator whose out put is one as used means of a voltmeter and ammeter methods.

The out put of the motor is equal to the in put of the generator. so that neglecting the losses (strophe and windage etc:) of the generator the torque of the series motor can be calculated from the following formulars.

① ဤ generator သည် သူ့အလိုလို residual e.m.f ဖြစ်ပေါ်စေခြင်း field current စီးဆင်းစေသည်။ armature ဆက်နေသော ဆိုလို့ load voltage သည် ပြောင်းလဲသွားခြင်း ဖြစ်ပေါ်စေသည်။

② Load current သည် ~~armature~~ Terminal voltage ကို လျော့နည်းသွားစေသည်။ Load current တိုးများလာလျှင် Terminal voltage ကျဆင်းသွားသည်။ Load current တိုးများလာလျှင် Ise ဖြင့် flux တိုးများလာသည်။ သည်အတွက်ကြောင့် voltage ကျဆင်းမှုပမာဏ များလာသည်။

⑤



Generator voltage ကိုရှာခြင်း

Generator voltage = Load voltage + (Armature Resis + Series Resis) × I

= 220 + (.03 + .07) × 50

= 220 + 50 × .1

= 225 volts

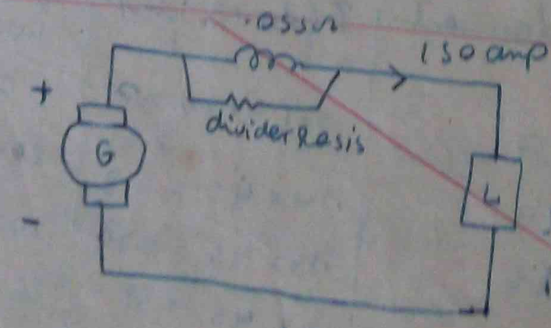
Internal ohmic drop ကိုရှာခြင်း

Armature drop = .07 × 50 = 3.5 volts

Series field drop = .03 × 50 = 1.5 volts

∴ Total ohmic drop = 3.5 + 1.5 = 5 volts (Ans)

⑥



no load amp turns/pole = ဘာမှမရှိ

full load amp turns/pole = $\frac{120}{100} \times \frac{6}{5}$

= $\frac{6}{5} \times 150$

= 180 amps

∴ series field amp

② ~~series generator~~ ගැන:

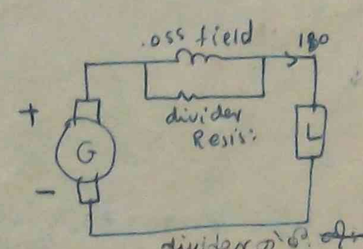
③ field current රෙගියුලේට් කරන්නේ ෂන්ට් ෆීල්ඩ් රියස්තාවෙනි.

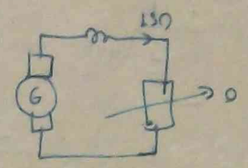
④ series generator එකේ ලෝඩ් කරන්නේ නැහැ

③ field current එක ~~Regulate~~ කරන්නේ ෂන්ට් fieldwinding එකේ divider එකට parallel විදිහට රියස්තාවක් දාලයි. Load එක වැඩි වෙනකොට රියස්තාව අඩු කරලා field current එක වැඩි කරනවා.

④ ~~දෙ~~ series generator එක DC transmission line එකේ booster එකක් විදිහට ~~volt~~ lamps වල supply එකට භාවිත කරනවා.

⑥





Load එකේදී ~~දෙ~~ se = 150 amp

divider ~~ෂන්ට්~~ එකේ ධාරාව $I = \frac{120}{100} \times 150$

= 180 amps

අභ්‍යන්තර current = 150 amps

divider ~~shunt~~ එකේ ධාරාව current = 180 − 150 = 120 amps

divider drop = series field drop

30 × R_d = 1.80 × .055

R_d = .22 Ω

ගණනය කිරීම:

	Terminal voltage	Load current	I(R_{se} + R_a) drop	Generated voltage
①	13	0	0 × (5+40) = 0	0
②	14.1	.14	.14 × 45 = 6.3	20.4
③	14.2	.15	.15 × 45 = 6.75	20.95
④	17	.2	.2 × 45 = 9	26
⑤	19	.3	.3 × 45 = 13.5	32.5
⑥	21	.4A	.4 × .45 = 18	39
⑦	24	.6A	.6 × .45 = 27	51 V
⑧	49	1.4	1.4 × 45 = 63	112

ගණනය කිරීම:

① compound generator කැඩි විදිහට හඳුනාගන්නවා.

② compound generator හදන්න අවශ්‍ය වන්නේ සාමාන්‍ය ෂන්ට් generator එකක් seriesfield divider එකක් විතරයි.

③ compound generator වැඩ කරන්න ඕනේ විදිහ කියලා දෙන්න. ඒ වගේම ඒකේ circuit diagram එකත් අඳින්න.

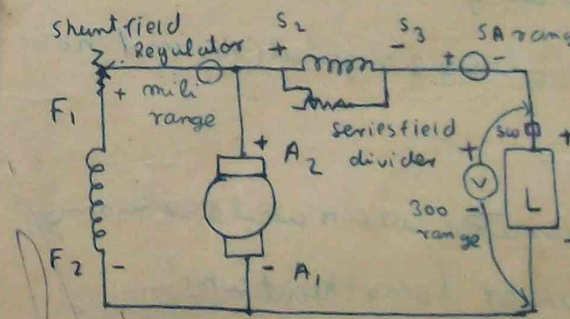
① compound generator එකේ විදුලි බාධාව shunt field එකයි, series field, seriesfield divider එකයි. ඒ නිසා ඒක generator එකක් විදිහට වැඩ කරනවා. shunt field එක armature එකට, parallel විදිහට series field එක armature එකට, series විදිහට

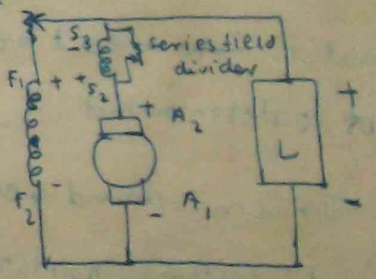
② compound generator එක ලෝඩ් වෙද්දී load එක වැඩි වෙනවා. load current එක වැඩි වෙද්දී series field current එකත් වැඩි වෙනවා. series field current එක වැඩි වෙද්දී ඒ නිසා series field එකේ ඇතිවෙන flux එකත් වැඩි වෙනවා.

③ compound generator වර්ග දෙකක් තියෙනවා. over compound, under compound, flat compound කියලා.

under compound

over compound





A_2 කෝයිල් armature coil එක positive පැත්තට A_1 කෝයිල් armature coil එක negative පැත්තට

S_2 කෝයිල් series field coil එක positive පැත්තට S_3 කෝයිල් series field coil එක negative පැත්තට.

F_1 කෝයිල් shunt field coil එක positive පැත්තට ~~F_2~~ F_2 කෝයිල් shunt field coil එක negative පැත්තට.

Shunt field current එක shunt field Regulator එකෙන්, series field current එක series field divider එකෙන් සීරුමාරු කරනවා.

Armature ഉള്ളപ്പോൾ current ഫ്ലോ shunt ന്റെ, series field coil ന്റെ, ഇൻഡ്യൂസ്ഡ് ഫ്ലക്സ് ഫ്ലോ: induced e.m.f ഉണ്ടാവുന്നു. അതിന്റെ current ഫ്ലോ: load ലൂടെ ഫ്ലോ ചെയ്യുന്നു.

no load voltage ന്റെ, full load voltage ന്റെ ഇടയിൽ generator ഫ്ലാറ്റ് compound generator ആയിരിക്കും.

Full load ലുള്ള voltage ഉം no load voltage ഉം തുല്യം ആണ് over compound ആയാൽ ആണ് under compound ആയാൽ ആണ്.

① what effect dis speed have on output voltage as load increased?

② What load condition demand a flat compound generator

③ what condition would cover comperending be required

④ Generator are designed for various degree of compounding what factor is changed to various or any this amount of compounding

⑤ what is meant by voltage regulation and how is it determind

⑥ In a compound generator which would be more satisfactory short shunt or long shunt why?

⑦ From value of resistance of the field, armature and series field what would be the emf generated at the load of 10 amps; armature voltage is 200v long shunt.

① Load ൽ ഉള്ളപ്പോൾ output voltage

Flat compound generator ൽ output voltage

under ″ ″ കുറയുന്നു

over ″ ″ കൂടുന്നു

② Flat compound generator ന്റെ ഫീൽഡ് കോയിൽ supply ഇല്ലാതെ no load ലും, on load ൽ ഉള്ളപ്പോൾ ഫീൽഡ് കോയിൽ ഫ്ലോ ചെയ്യുന്നു

③ over compound ന് ഫീൽഡ് കോയിൽ ഫ്ലോ ചെയ്യുന്നതിന്റെ ഇരട്ടി current ഫ്ലോ ചെയ്യുന്നു. അതിനാൽ ഫീൽഡ് കോയിൽ ടേൺസ് കൂടുതൽ ആയിരിക്കും

④ generator ന്റെ ഓരോ degree of compounding നും 50 ടേൺസ് series field ന് divider ഉം, parallel ആയി series field current നെ regulate ചെയ്യുന്നു.

⑤ voltage regulation എന്നാൽ no load voltage ഉം full load voltage ഉം തമ്മിലുള്ള വ്യത്യാസം full load voltage ന്റെ ഇത്ര: ആയി percentage ൽ കാണിക്കുന്നു

$$\text{voltage regulation} = \frac{V_{NO} - V_{FL}}{V_{FL}} \times 100 \%$$

⑥ compound generator ൽ short shunt compound ആണ് long shunt compound നേക്കാൾ കൂടുതൽ ഉപയോഗിക്കുന്നു. Load ൽ നിന്നുള്ള ഫ്ലക്സ് ഉം Ise ൽ നിന്നുള്ള flux ഉം induced Emf ൽ വ്യത്യാസം വരുന്നു

(3) Overload: ഇതുകൊണ്ട് generator or motor എടുക്കുന്ന current rated current നേക്കാൾ കൂടുതലായാൽ overload എന്നു പറയുന്നു.

(5) ഒന്നിലധികം generator ഒരു load ലേക്ക് ഒരേ സമയം engine ഉപയോഗിച്ച് ഓടിച്ച് parallel ആയി connect ചെയ്യുന്നതിനെ ആണ് generator parallel operation എന്നു പറയുന്നത്.

(6) ഒരു generator ന്റെ load current ന്റെ അളവ് ഒരു നിശ്ചിത അളവിൽ കൂടുതലായാൽ ഉണ്ടാകുന്ന അപകടത്തിൽ നിന്നും generator നെ സംരക്ഷിക്കുന്നതിനുള്ള ഉപകരണമാണ് overload protection.

(7) DC Shunt generator ന്റെ ഒരു പ്രധാന characteristic ആണ് ~~load~~ voltage regulation.

(1) ഒരു generator ന്റെ load current കൂടുമ്പോൾ terminal voltage കുറയുന്നു. ഇതിന് കാരണം armature current ന്റെ load ന്റെ കൂടുതൽ ആണ്. armature current കൂടുമ്പോൾ armature resistance ന്റെ voltage drop കൂടുന്നു. അതുകൊണ്ട് terminal voltage കുറയുന്നു.

(4) ഒരേ load ൽ ഒന്നിലധികം generator parallel ആയി connect ചെയ്യുമ്പോൾ ഓരോന്നിന്റെയും terminal voltage തുല്യമായിരിക്കണം. അല്ലെങ്കിൽ ~~motor~~ generator motor action ഉണ്ടാകുന്നു.

(5) ~~EMF~~ ന്റെ Eg = $\frac{\phi Z N}{60} \times \frac{P}{A}$ ആണ്. ഒന്നിലധികം generator ഒരു load ലേക്ക് ഒരേ സമയം engine ഉപയോഗിച്ച് ഓടിച്ച് parallel ആയി connect ചെയ്യുന്നതിനെ ആണ് generator parallel operation എന്നു പറയുന്നത്. ഒരു generator ന്റെ generated e.m.f ഒരു parallel ആയി ~~connect~~ connect ചെയ്യുമ്പോൾ ഉണ്ടാകുന്നു.

(6) Parallel ആയി connect ചെയ്തിരിക്കുന്ന generator ന്റെ load current ന്റെ അളവ് ഒരു നിശ്ചിത അളവിൽ കൂടുതലായാൽ load ൽ നിന്നും switch ഓഫ് ചെയ്യുകയും field regulator ന്റെ shunt field current കുറച്ച് generator stop ചെയ്യുകയും ചെയ്യുന്നു.

(7) ഒരു generator ന്റെ terminal voltage ഒരു നിശ്ചിത അളവിൽ കൂടുതലായാൽ load ൽ നിന്നും ഓഫ് ചെയ്യുന്നു. ഇതിനെ overload protection എന്നു പറയുന്നു. ഇതിനായി shunt field regulator ൽ ഉള്ള ~~resistance~~ resistance ന്റെ അളവ് കൂട്ടുന്നു.

(8) ഒരു generator ന്റെ load current കൂടുമ്പോൾ terminal voltage കുറയുന്നു. ഇതിനെ ~~equalizer~~ equalizer busbar ഉപയോഗിച്ച് ശരിയാക്കുന്നു. generator ന്റെ ~~equalizer~~ equalizer busbar ഉം load ന്റെ busbar ഉം ആണ് ~~equalizer~~ equalizer busbar ൽ connect ചെയ്തിരിക്കുന്നത്. load ന്റെ terminal voltage ന്റെ അളവ് കൂടുമ്പോൾ ~~equalizer~~ equalizer busbar ന്റെ voltage കൂടുന്നു. ഇതിനനുസരിച്ച് generator ന്റെ shunt field regulator ന്റെ resistance കൂട്ടുന്നു. അപ്പോൾ generator ന്റെ terminal voltage കുറയുന്നു.

(9) ഒരു generator ന്റെ characteristics ആണ് speed ന്റെ load current ന്റെ ഉള്ള variation. load കൂടുമ്പോൾ ~~generator~~ motor speed കുറയുന്നു.

(10) parallel ആയി connect ചെയ്തിരിക്കുന്ന generator ന്റെ load current ന്റെ അളവ് ഒരു നിശ്ചിത അളവിൽ കൂടുതലായാൽ load ൽ നിന്നും switch ഓഫ് ചെയ്യുകയും field regulator ന്റെ shunt field current കുറച്ച് generator stop ചെയ്യുകയും ചെയ്യുന്നു.

(11) ഒരു generator ന്റെ terminal voltage ഒരു നിശ്ചിത അളവിൽ കൂടുതലായാൽ load ൽ നിന്നും ഓഫ് ചെയ്യുന്നു. ഇതിനെ overload protection എന്നു പറയുന്നു. ഇതിനായി shunt field regulator ൽ ഉള്ള resistance ന്റെ അളവ് കൂട്ടുന്നു. അപ്പോൾ generator ന്റെ terminal voltage കുറയുന്നു. ഇതിനനുസരിച്ച് overload ൽ നിന്നും load ഓഫ് ചെയ്യുന്നു.

(12) Two shunt generator are to be operated in parallel so supplying a common load. A have no load voltage 230 and full load voltage 220 when it is load current 50 amp and B have no load voltage 230 and full load 220 when it delivers the same current as A. calculate the line voltage and total load when B is floating (ii) total load delivered by both machine when load voltage is 225

B floating ആയിരിക്കുമ്പോൾ load current = 50 amp

Load power = VI = 220 × 50

= 13200 watt

= 13.2 kw

$= 2.455 \times .185 + j\,2.455 \times .983$

$= .455 + j\,2.41$

$I_T = 2.52 - j4.75 + .455 + j2.41$

$= 2.675 - j2.35$

$= 3.56 \angle -41.3$

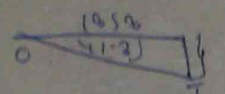
$P.f = \cos 41.3 = .753$ lagging

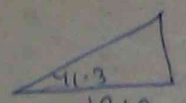
$\text{Power} = \sqrt{3}\, E\, I \cos\theta$

$= \sqrt{3} \times 398 \times 3.56 \times .753$

$= 689 \times 2.695$

$= 1858$ watts





$\frac{1858}{OT} = \cos 41.3$

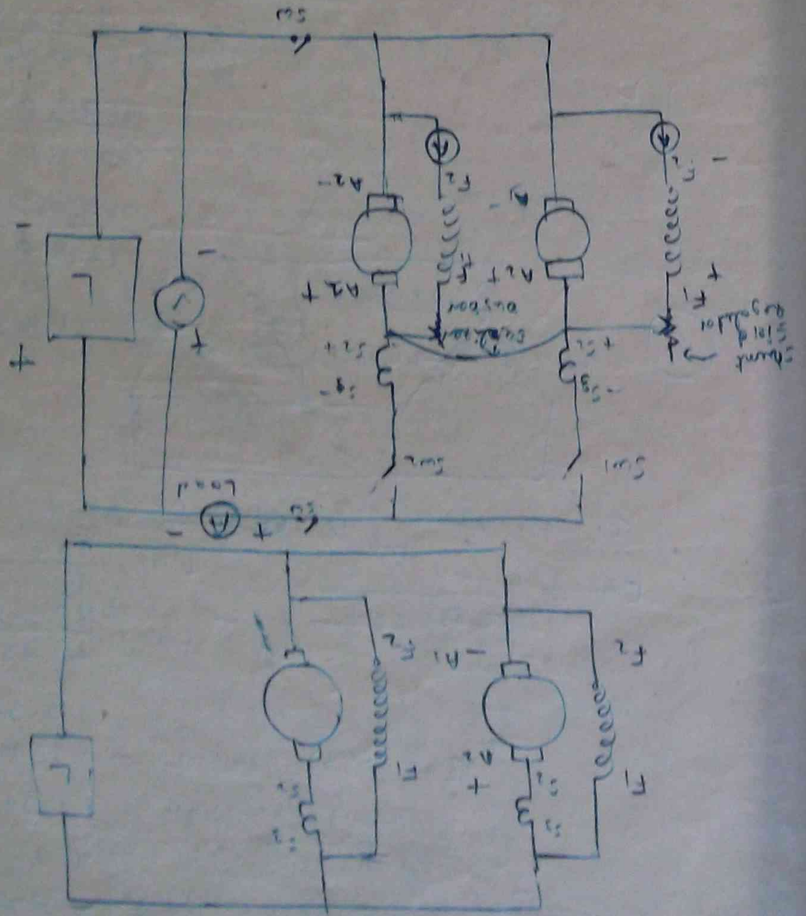
$OT = 1858 \tan 41.3$

$= 1858 \times .88 = 1635$ V.AR

$OT = \frac{1858}{\cos 41.3} = \frac{1858}{.753}$

$= 2470$ VA

Parallel operation of compound generators



A 4 pole motor voltage 220 parallel

$\omega = 0$ rad

$V_{drop} = 220 - 210 = 10$ volts

$I_{sh} = \frac{V_d/_{amp}}{R_{sh}} = \frac{10}{60} = \frac{1}{3}$

$I_a = \frac{E_g - V}{R_a + V_d/_{amp}}$

$= \frac{230 - 225}{\frac{1}{3}}$

$= 5 \times 3 = 15$ amp

$T_a = \frac{\text{motor output} \times 2\pi}{\text{speed}}$ full load $= 1200$ rpm

$= \frac{\text{motor output} \times 2\pi}{\text{speed}}$ speed $= 60$

$V_{drop} = 230 - 220 = 10$ volts

$V_{drop}/_{amp} = \frac{10}{60} = \frac{1}{6}$

$I_2 = \frac{E_g - V}{V_d/_{amp}}$

$= \frac{230}{\frac{220}{15}} = 230 \times \frac{15}{220} = 15.68$ amp

KN 74

Heat Engine

Thermodynamics applied to Heat Engines

Heat Engine

Heat Engine ဆိုသည်မှာကရိယာတစ်ခုဖြစ်သည်။ ၄င်းကိုဝေးစေသည့်စွမ်းအင်ကို
ဖြင့် ၄င်းလောင်စာတွင် ရှိသည့်အပူစွမ်းအင်အချို့သည် အလုပ်အဖြစ်ပြောင်းလဲ
သည့် ဒဲ့သို့ဟာတစ်ခုသည်။ ပေးသွင်းရသော အပူအင်းကို အလုပ်အဖြစ် သို့ပြောင်းလဲ
နိုင်သော Engine သည် ထိထားနိုင်သော Engine ဖြစ်ရန် သည်။ သို့သော်၄င်း Engine ဖြစ်
လောက်တဲ့အားဖြင့် မဖြစ်ပါ။

ထို့ကြောင့်ဆိုသော် Heat Engine ဆိုသည်မှာ ၄င်းတွင်အပူသည် အဖြစ်အစဉ်အဆက်ပြောင်း
၄င်းအပူစွမ်းအင်ကို အလုပ်အဖြစ် သို့ပြောင်းလဲပေးနိုင်သော ကရိယာတစ်ခုဖြစ် ဖြစ်ရ
သည်။

Heat Engine

A Heat Engine is a device in which energy is applied in form of heat and some of this energy is transformed in to work It would be indeal, of course if all the energy supplied was transform in work unfortanately no such engine complete transformation from exists

Thermodynamics

Thermodynamics ဆိုသည်မှာ အပူစွမ်းအင်ကို အလုပ်အဖြစ်
ပေါ်တွင် မှီခိုပြောင်းလဲပေးခြင်း ရှိမရှိကို အဓိကထား ဖြစ်သည်။

1st Law of Thermodynamics

1st law Thermodynamics သည် စွမ်းအင်ကွဲ
သည် အပြန်အလှန်ပြောင်းလဲသည်။ အလုပ်နှင့်အပူ ကို ပြောင်းလဲနိုင်သည်။

Joule's ကအဓိပ္ပါယ် သတ်မှတ်ချက်မှာ ဒါပဲ :—

1. Centigrade Heat amit (C.H.U) သည် 1400 ft-lb အလုပ်နှင့်
ညီမျှသည်။
1 British Thermal amit (B.Th.U) သည် 778 ft-lb အလုပ် ကို
ပေါ်တွင် Mechanical Energy နှင့်ညီမျှသည်။

Clausius ဆိုရာတွင်ပူသောအရာမှ အေးသောအရာသို့ အပူစီးဆင်းခြင်းအကြောင်း ပြောဆိုခဲ့သည်။
According to clausius's statement အပူစွမ်းအင်သည် အပူချိန်မြင့်သောအရာမှ အပူချိန်နိမ့်သောအရာသို့ စီးဆင်းသည်။

ဤနည်းဥပဒေသသည် အပူစွမ်းအင်နှင့် အလုပ်ကြား ဆက်နွယ်မှုကို ပြသထားသည်။

Heat and work

Fahrenheit unit -

Freezing point of water = 32° F

Boiling point of water = 212° F

Freezing point of water = 0° c

Boiling point of water = 100° c

Absolute unit of Temperature

absolute temperature in °C = Thermometer reading +273 = °K

absolute temperature in °F = Thermometer +460 = °R

Relation between centigrade Fahrenheit scales :-

$$\text{centigrade Thermometer Reading} = \left[\text{Fahrenheit Thermometer reading} - 32\right] \times \frac{100}{180}$$

$$C = (F-32) \times \frac{100}{180}$$

$$\therefore \boxed{C = (F-32)\frac{5}{9}}$$

Absolute temp: in degrees centigrade "°c" are known as are degree Kelvin °K (Thermo reading + 273°c = °K)

absolute temp: in degree fahrenheit are known as degree Rankine °R (Thermometer reading + 460° F) = °R)

ဥပမာ:- အပူချိန် 63°F ကို စင်တီဂရိတ် unit ဖြင့် မည်သို့ပြောင်းမလဲ။

① °c

② Cabs

③ Fabs

* Cabs (K) = °c + 273

* Fabs (R) = °F + 460

$$C = (F-32)\frac{5}{9}$$

$$C = (63-32) \times \frac{5}{9}$$

$$C = 31 \times \frac{5}{9} \quad \therefore C = 17.22c$$

Cabsolute = 17.22 + 273 = 290.22°K

F° absolute = 63 + 460 = 523°R

Specific heat of gases and liquidat

* 1 CHu = 1.8 Btu

① constant pressure

② constant volume

Liquid နှင့် solid တို့၏ specific heat တန်ဖိုးသည် အနည်းအကျဉ်းသာ ကွာခြားသည်။

specific heat

specific heat ဆိုသည်မှာ အပူချိန် အတိုးအလျော့တွင် 1°F ကို မြှင့်ရန် 1 lb အလေးချိန်ရှိသော အရာတစ်ခုအား ပေးရသော အပူစွမ်းအင်ပမာဏကို ဆိုလိုသည်။

အင်္ဂလိပ်စနစ်တွင် 1°F အပူချိန်ကို မြှင့်ရန် အပူစွမ်းအင် ပမာဏကို 1 Btu ဟုသတ်မှတ်သည်။

Θ = cm.st Θ = Btu m = lb t = °F

ရေတွက်စနစ်တွင် 1°c အပူချိန်ကို မြှင့်ရန် အပူစွမ်းအင် ပမာဏကို 1 CHu ဟုသတ်မှတ်သည်။

Θ = cm.st m = lb t = °c

gases တွင်တွေ့ရသော:

Up or cp = specific heat at constant pr : Θ = cm.st Θ = cal, m = gm, t = °c

တည်ဖိအား တွင် 1 lb ကို 1°c အပူချိန်မြင့်ရန် လိုအပ်သော အပူစွမ်းအင် ပမာဏဖြစ်သည်။

Kv or cv = specific heat at constant vol

တည်ထိုထုထည်တွင် 1 lb ကို 1°c အပူချိန်မြင့်ရန် လိုအပ်သော အပူစွမ်းအင် ပမာဏဖြစ်သည်။

$$\boxed{\frac{Up}{Kv} \text{ or } \frac{cp}{cv} = \gamma}$$

ရသည့် specific heat at constant pr နှင့် specific heat at constant vol တို့၏ အချိုးဖြစ်သည်။

for air ဖြစ်သည့် အတွက်:-

cp or Up = .24 Btu / lb°F or CHu / lb°c

cv or Kv = .171 Btu / lb°F or CHu / lb°c

$$\therefore \gamma = \frac{cp}{cv} \text{ or } \frac{Up}{Kv} = \frac{.24}{.171} = 1.4$$

[Pv^{γ} : constant] Pv^{n} : constant

Joule's equivalent:—

1 BThu = 778 ft-lbs

1 C.H.u = 1400 ft-lbs

Ex: 4 lbs of gas at a temp: 17°c are heated to a temp of 89°c The Sp: heat at const: pr: & const: vol: are .2404 and .1718 respd: find the heat absorbed by the gas for each of the following method of heating.

I const: pr:

II const: vol

Find also the value of const: r for the gas.

weight = W = 4 lbs

cp = .2404

cv = .1718

T_2 = 89°c

T_1 = 17°c

Heat absorbed at const pr: = $W c_p (T_2 - T_1)$

= 4 × .2404 (89 − 17)

= .9616 × 72

= 69.2352

Heat absorbed at const vol = $W c_v (T_2 - T_1)$

= 4 × .1719 (89 − 17)

= .6872 × 72

= 49.47

$\gamma = \frac{69.2352}{49.47} = 1.39$

Sensible heat:—

The amount of heat absorbed by the water in being to heated from the freezing point to the boiling point is known as the ~~tot~~ total heat of water and is approximately equal to the sensible heat of water

The preliminary heating of the liquid comes to ~~rise~~ rise in temp: and since temp can be detected by the range, the heat absorbed in raising temp: from freezing to boiling in known so the sensible heat of water.

Latent heat

The heat absorbed is now being utilized is converting the water to steam and is known as latent heat.

Ex: 5 lbs of water is heated from 180 BTU to 100 CHU find the temp of the steam and the heat absorbed.

Total heat = Q = $m.S.t$ = $5 \times 1 \times (t_2 - 50)$ F*

where m = 5

S = 1

t = ?

180 Btu = $5 \times 1 (t_2 - 50)$

36 = $t_2 - 50$

$\therefore t_2 = 86$ F

* BThu ~~is~~ of 'F' is used

CHu is of 'C' is used

unit of mass is taken

50 F = 10 C

Q = const

CHu = $5 \times 1 \times (t_2 - 10)$ C*

100 = $5 (t_2 - 10)$

20 = $t_2 - 10$ $\therefore t_2 = 30$ C*

Prob 36 cuft of hydrogen is compressed under a constant pr: of 40 lb/□" until its vol is 15 cu ft. find the W.D is compressing

const pr work done = $p(V_2 - V_1)$ ← formula

V_1 = 15 cuft

V_2 = 36"

pr = 40 lb/□

const WD = $p(V_2 - V_1)$

= 40 × 144 (36 − 15)

= 40 × 144 × 21

WD = 120960 (ft-lbs)

A vol: of 10 cuft of air at a pr: of 150 lbs/□" is expanded in a cylinder until it occupies a vol of 35 cuft If the equation for the expansion is $pv^{1.4}$ = const find the final pr of the air

$v_1 = 10$ cuft

$v_2 = 35$ cuft

$P_1 = 150$ lb/□" $= 150 \times 144$ lb/ft^2

$P_2 = ?$

$$P v^{1.4} = P_1 v_2^{1.4}$$

$$P_2 = \frac{P v^{1.4}}{v_2^{1.4}}$$

$$P_2 = 150 \times 144 \times \left(\frac{v_1}{v_2}\right)^{1.4}$$

$$= 150 \times 144 \times \left(\frac{10}{35}\right)^{1.4}$$

$$= 150 \times 144 \ (.2857)^{1.4}$$

$$= \log 150 + 1.4 \log .2857$$

$$\log P_2 = 2.1761 + 1.4 \times \overline{1}.4559$$

$$= 2.1761 + .173$$

$P_2 = 26$ lbs

Ans:

$$P_2 = P \left(\frac{v_1}{v_2}\right)^{1.4}$$

$$P_2 = 150 \left(\frac{10}{35}\right)^{1.4}$$

$$= 150 (.285)^{1.4} = 150 \times .174 = 26.2 \text{ lbs}$$

A Fluid in at a pr: of 100 lbs/□" in a cylinder It is expanded at const. pr: from a vol: of 1 ft^3 to a vol of 6 ft^3 Determine the WD in ft-lbs

$P = 100$ lb/in$^2 = 100 \times 144$ lb/ft^2

$v_1 = 1$ ft^3

$v_2 = 6$ ft^3

$\therefore$ WD $= P (v_2 - v_1)$

$= 144 \times 100 (6 - 1) =$

$= 144 \times 100 \times 5$

$= 14400 \times 5$

$= 72000$ ft lbs

② 0.5 ft^3 of gas at a pr: of 250 lbs/□" in contained in a cylinder The gas is expanded at constant pr: until its vol become 4.5 ft^3 Determine the WD by the gas in ft-lbs

$P = 250 \times 144$ lbs/ft^2

$v_1 = 0.5$ ft^3

$v_2 = 4.5$ ft^3

$\therefore$ WD $= P (v_2 - v_1)$

$= 250 \times 144 \ (4.5 - 5)$

$= 250 \times 144 \times 4$

$= 144000$ ft-lbs (Ans)

Convert the following centigrade Thermometer reading into readings as they would appear on a fahrenheit thermometer

① 5°C ④ 110°C

② 15°C ⑤ 150°C

③ 75°C

① $C = (F - 32) \frac{5}{9}$

$5 = (F - 32) \frac{5}{9}$

$9 = F - 32$

$\therefore F = 41°F$

② $15 = (F - 32) \frac{5}{9}$

$27 = F - 32$

$\therefore F = 59$

③ $75 = (F - 32) \frac{5}{9}$

$135 = F - 32$

$\therefore F = 167°F$

④ $110 = (F - 32) \frac{5}{9}$

$198 = F - 32$

$\therefore F = 230°F$

⑤ $150 = (F - 32) \frac{5}{9}$

$270 = F - 32$

$\therefore F = 302°F$

⑤ $250 = (F - 32) \frac{5}{9}$

$450 = F - 32$

$\therefore F = 482°F$

④ Convert the following Fahrenheit thermometer readings into readings as they would appear on a centigrade thermometer reading

① 40°F ⑤ 300°F

② 60°F

③ 140°F

④ 185°F

Ans: 04

cylinder

formula

① $C = (F-32)\frac{5}{9}$

$C = (40-32)\frac{5}{9}$

$C = \frac{8\times5}{9}$

$C = 4.44°C$

② $C = (60-32)\frac{5}{9}$

$C = \frac{28\times5}{9}$

$= 15.5°C$

③ $C = (140-32)\frac{5}{9}$

$= \frac{108\times5}{9}$

$= 60°C$

④ $C = (185-32)\frac{5}{9}$

$= \frac{153\times5}{9}$

$= 85°C$

⑤ $C = (300-32)\frac{5}{9}$

$= \frac{268\times5}{9}$

$= 148.8°C$

Methods of heating & Expanding gases

No	Type of expansion	Remarks	work done = W J	Change of Internal Energy (E)	heat absorbed or rejected = Q
①	const vol		0	$mc_v(T_2-T_1)$	$mc_v(T_2-T_1)$
②	const pr:		$\frac{P(v_2-v_1)}{J}$	$mc_v(T_2-T_1)$	$mc_p(T_2-T_1)$
③ ④	const: temp and Hyperbolic	Isothermal Boyles Law pv = const	$\frac{P_1v_1\log_e\frac{P_1}{P_2}}{J}$	0	W
⑤	General Law pv^n = const:		$\frac{P_1v_1-P_2v_2}{(n-1)J}$	$mc_v(T_2-T_1)$	W + E
⑥	adiabatic	pv^γ = const	$\frac{P_1v_1-P_2v_2}{J(\gamma-1)}$	$mc_v[T_2-T_1]$	0
⑦	Free Expansion	no importance			
⑧	or throttling	Gas passes	0	0	0

Temp of const

Loge = 2.303 CMPlog > Hyperbolic

γ = ratio

$v_1 = 5$

$v_2 = 25$

$\therefore \frac{v_2}{v_1} = \frac{25}{5} = 5 = r$

$r = \frac{v_2}{v_1}$

P = pressure in N/m² Loge = 2.303

$\therefore W = \frac{P_1v_1\log_e r}{J}$

$W = \frac{150\times10^3\times5\times2.303\times\log_e5}{J}$, and

$r_1 = \frac{P_2}{P_1} = \frac{P_2v_2}{P_1v_1}$

Isothermal Temp

The determination of the value of n

If the two initial and final volumes and pressures are known for expansion of the form pv^n = const, the value of n may be easily calculated from the logarithm of these values.

Let $P_1v_1^n = P_2v_2^n$

Taking the Logarithms of both sides of this equation:-

$$\log_{10}P_1 + n\log_{10}v_1 = \log_{10}P_2 + n\log_{10}v_2$$

hence $n\log_{10}v_1 - n\log_{10}v_2 = \log_{10}P_2 - \log_{10}P_1$

$$\therefore n = \frac{\log_{10}P_1 - \log_{10}P_2}{\log_{10}v_2 - \log_{10}v_1}$$

$$\therefore n = \frac{\log_{10}\frac{P_1}{P_2}}{\log_{10}\frac{v_2}{v_1}}$$

(For an adiabatic expension, the value of γ may be obtained from the same equation by substituting for n)

A vol: of cylinder for the

2 cu ft of gas at a pr: of 100 lbs/□" are expanded in a cylinder to a vol of 9 Scu ft and pr: of 15 lbs/□" Assuming the expansion follows the law pv^n = const: find the value of the index n

$P_1 = 100$ lbs/□" $\quad v_1 = 20$ cu ft

$P_2 = 100$ lbs/□" $\quad v_2 = 20$ cu ft

$$\therefore n = \frac{\log_{10}\frac{P_1}{P_2}}{\log_{10}\frac{v_2}{v_1}} = \frac{\log_{10}\frac{100}{15}}{\log_{10}\frac{95}{200}}$$

$$= \frac{\log_{10} 6.66}{\log_{10}} = \frac{\log_{10} 6.66}{\log_{10} 4.75} = \frac{0.82}{T.836}$$

$$\frac{P_1}{P_2} = \left(\frac{v_2}{v_1}\right)^n \qquad n = \frac{.824}{.6769}$$

$$\frac{100}{15} = \left(\frac{95}{20}\right)^n \sim 1.22$$

$6.67 = (4.75)^n \quad \therefore n = 1.22$ Ans

Laws of perfect gas

Normal Temp and pressure (N.T.P)

the temp: is taken as 0°c and pr: = 14.7 lbs/□" = atmospheric pressure

Example ①

At N.T.P 1 lb of air occupies a vol of 12.39 cu ft Find the value of c for ① centigrade units ② Farenheit units

$$pv = CwT \qquad \text{or } Pv = RwT$$

*** T = absolute

Ans. 96, 53.3

centigrade unit

① $P = 14.7$ lbs/□"

$T = 273°$ abs

$$c = \frac{144\,pv}{wT} \text{ for 1 lb}$$

$$= \frac{144 \times 14.7 \times 12.39}{273 \times 1}$$

$= 96$ ft-lb centigrade unit

$T = 32 + 460 = 492°$ abs

$$c = \frac{144 \times 14.7 \times 12.39}{492 \times 1}$$

$= 53.3$ ft-lb Farenheit unit

* N.T.P.
(i) centigrade scale 0°C – 273°A
(ii) Farenheit scale 32°F – 460 + 32
** N.T.P **
t = 273°A
C = 96 ft-lb of CGS
53.3 ft-lb FPS
T = abs
P = 14.7 lbs/□"

② Find the weight of 100 cu ft of air at a pr: of 15 lbs/□" and a temp: of 60° F, C for air is 53.3 in Farenheit units.

$pv = CwT$

hence: $p = 15$ lbs/□" $\rightarrow 15 \times 144$ lbs/ft²

$v = 100$ cu ft

$T = 60 + 460 = 520$

$$\therefore w = \frac{pv}{CT}$$

$$\therefore w = \frac{15 \times 144 \times 100}{53.3 \times 520} = \frac{216000}{27800}$$

$= 7.7$ lbs

(7.793)

*③**

Find the vol: occupied by 3.5 lbs of gas a pr: of 35 lbs/□" and a temp: of 312°C If this gas is expanded adiabatically to a pr: of 15 lbs/□" find the final temp of this gas Assume c = 46 γ = 1.4

$T_1 = 312 + 273 = 585°C$ abs $c = 96$ $\gamma = 1.4$

$P_1 V_1 = CW T_1$

$V_1 = \frac{CW T_1}{P_1}$

$= \frac{96 \times 3.5 \times 585}{35 \times 144}$

$= 39$ cu ft

for abs expension :—

$P_1 v_1^{m} = P_2 v_2^{m}$

$\left(\frac{P_1}{P_2}\right) = \left(\frac{v_2}{v_1}\right)^{m}$

$\therefore \left(\frac{P_1}{P_2}\right)^{1/m} = \frac{v_2}{v_1}$

$\left(\frac{P_1}{P_2}\right)^{1/m} v_1 = v_2$

$v_2 = \left(\frac{P_1}{P_2}\right)^{\frac{1}{1.4}} \times v_1$

$= \left(\frac{35}{15}\right)^{\frac{1}{1.4}} \times 35$

$= 71.4$ cu ft (71.4)

again $P_2 V_2 = CW T_2$

$T_2 = \frac{P_2 V_2}{CW}$

$T_2 = \frac{144 \times 15 \times 71.5}{96 \times 3.5}$

$= 460°$ c abs

$t_2 = 460 - 273 = 187°C$ #

The density of a gas at NTP is .005 lb/cu ft find the value of C for this gas. If the value of γ for this gas is 1.4 and up and μv for this gas

$Pv = C.W.T$

$C = \frac{Pv}{WT} = \frac{144 \times 14.7 \times 1}{.005 \times 273} = 1550$ ft-lbs centigrade unit

$\mu v = C = (\mu p - \mu v) J$

$\gamma = \frac{\mu p}{\mu v} = 1.4$

$\therefore C = \mu v (1.4 - 1) J$

$C = \frac{1550}{.4 \times 1400} = 2.77$

$\therefore \mu p = \gamma \times \mu v$

$= 1.4 \times 2.77 = 3.88$

$C = (\mu p - \mu v) J$

$\gamma = \frac{\mu p}{\mu v} = 1.4$

$\therefore \mu p = 1.4 \mu v$ Thereby

$C = (1.4 \mu v - \mu v) J$

$C = \mu v (1.4 - 1) J$

μv of gas

***

Prob 4 lbs of air at a pr: of 100 lbs/□" occupies a vol: of 10 cu ft; this air is then expanded to a vol: of 50 cu ft. Find the final temp: the work done and the heat absorbed or rejected by this air for each of the following method of expansion

① constant p

② Isothermally

③ adiabatically

④ according to the law $pv^{1.2} = \text{const}$

(work in centigrade unit and assume = 96 ft-lb, $\mu p = .238$ (c)" = 'c $\mu v = .169$ and $\gamma = 1.4$)

$W = 4$ lbs $p = 100 \times 144$ lbs/ft² $v_1 = 10$ cu ft $v_2 = 50$ cu ft

$T_2 = ?$

① const p ~~$Pv = CWT$~~

$P_1 v_1^{1.4} = P_2 v_2^{1.4}$

$P_1 \left(\frac{v_1}{v_2}\right)^{1.4} = P_2$

$100 \times 144 \left(\frac{10}{50}\right)^{1.4} = P_2$

$14400 \times (-2)^{1.4} = P_2$

$14400 \times .106 = P_2$

$P_2 = 1530$ lb/ft²

$P_2 v_2 = CW T_2$

$T_2 = \frac{P_2 v_2}{CW}$

$T_2 = \frac{76500}{384}$

$= 199$ abs

$= -74°C$

A vol: of 1 (cylinder for the e

① Const pr

$W_D = \frac{P(V_2 - V_1)}{J}$

$= \frac{100 \times 144 \times (50-10)}{1400}$

$= \frac{144 \times 40}{14} = 411.4$ ft-lb

② To Isothermal

Const temp $W_D = \frac{P_1 V_1 \log_e r}{J}$ $= \log_e r$

$= 2.303 \log r$

$= \frac{10 \times 100 \times 144 \log_e \times r}{1400}$

$W_D = \frac{144000 \times 2.303 \times 5}{1400}$

$= \frac{1440 \times 2.303 \times .699}{14} = 152$ ft lb Btu

③ $W_D = \frac{P_1 V_1 - P_2 V_2}{J(\gamma - 1)}$

$= \frac{50 \times 144 \times 100 - 1530 \times 10}{}$

$W_D = \frac{100 \times 144 \times 10 - 1530 \times 50}{1400 (5-1)}$

$= \frac{144000 - 76500}{1400 \times 4} = \frac{67500}{1400 \times 4} = \frac{675}{56} = 12.1$ ft lb / Btu

or $\frac{67500}{4} = 16875$

④ $W_D = \frac{P_1 V_1 - P_2 V_2}{J(n-1)}$

$= \frac{100 \times 144 \times 10 - 1530 \times 50}{1400 (1.2 - 1)}$

$= \frac{67500}{1400 \times .2} = \frac{67500}{280} = 242$ ft-lb Btu

or $\frac{67500}{.2} = 337500$ ft-lb

A flu at const. the W_D

Const P:

① $W_D = P(V_2 - V_1)$

$= 144 \times 00 (50-10)$

$= 144 \times 00 \times 40$

$= 576000$ ft-lb

Const temp or Isothermal

② $W_D = P_1 V_1 \log_e r$

$= 144 \times 00 \times 10 \times \log_e \times 5$

$= 144 \times 00 \times 10 \times 2.303 \log 5$

③ $\frac{P_1 V_1 - P_2 V_2}{\gamma - 1} = 1530 \times$

$= \frac{144 \times 00 \times 10 - 1530 \times 50}{5-1}$

$= \frac{144000 - 76500}{4} = \frac{67500}{4} = 16875$ ft-lb

④ $\frac{P_1 V_1 - P_2 V_2}{1.2 - 1} = \frac{67500}{.2} = 337500$ ft-lb

$P_1 V_1 = C W T_1$

$T_1 = \frac{144 \times 100 \times 10}{96 \times 4} = 375$ abs

$P_2 V_2 = C W T_2$

$\therefore T_2 = \frac{144 \times 100 \times 50}{96 \times 4}$

$= 1875$ cabs

Change in Internal energy: —

$= W \times v (T_2 - T_1)$

$= 4 \times 169 (1875 - 375)$

$= 1014$ C.H.U

Heat absorbed = W + E

$= \frac{57600}{J} + 1014$

$= 411 + 1014 = 1425$ C.H.U

Isothermal = $T_2 = T_1$

$E = 0$

$W_D = 100 \times 144 \times 2.303 \times .699$

$= 232000$ ft-lbs

$H = W + E$

$= \frac{232000}{J} + 0 = 165.7$

adiabatically —

$P_1 V_1^{\gamma} = P_2 V_2^{\gamma}$

$= 10.5 \times 100 = 10.5$ lb/D"

$P_2 v_2 = cwT_2$

$T_2 \Rightarrow \frac{P_2 v_2}{cw} = \frac{144 \times 10.5 \times 50}{cw}$

$= \frac{144 \times 1.5 \times 50}{96 \times 50} = 197°c$

$W_D = \frac{P_1 v_1 - P_2 v_2}{\gamma - 1} = \frac{144 \{(100 \times 10) - (10.5 \times 50)\}}{1.4 - 1}$

$= \frac{144 \{1000 - 525\}}{1.4 - 1}$

$= \frac{144 \times 475}{.4}$

$P_1 v_1^{1.2} = P_2 v_2^{1.2} = 17 1000$

$P_2 = \left(\frac{v_1}{v_2}\right)^{1.2} \times P_1$

$= 100 \times \left[\frac{10}{50}\right]^{1.2}$

$= 100 (.2)^{1.2}$

$= 100 \times .145 = 14.5$

$W_D = \frac{P_1 v_1 - P_2 v_2}{n - 1} = \frac{144 \times 14.5 \times 50}{96 \times 4}$

$= 272.2$ ans

$W_D = \frac{144 \{(100 \times 10^2) - (14.5 \times 50)\}}{13 - 1}$

$= \frac{144 \{10000 - 725\}}{.2}$

$= \frac{144 \times 275}{.2} = 144 \times 1375$

$= 720 \times 275 = 198000$ ft-lb

$T_2 = \frac{144 \times 14.5 \times 50}{96 \times 4} = 272°c$ abs

$E = w c_v (T_2 - T_1)$

$= 4 \times .169 (272 - 375)$

$= -69.6$ CH.U

$H = w + 6$

$= \frac{192000}{J} - 69.6 = 141.4 - 69.6$

$= 71.86$ CH.U

* Rejected heat = w + E

① $E = w c_v (T_2 - T_1)$

$H = w + 6$

$\therefore w = 8$ th $-$ 6 Chu 207

② $E = w c_v (T_2 - T_1)$ T = absolute

Prob: 2

4cuft of gas has a pr: of 20 lbs/D" It is compressed to 100 lb/D" according to adiabatic law determine the new vol of the gas

$V_1 = 20$ cuft $P_1 = 20$ lbs x 144 $P_2 = 100$ lbs x 144

$V_2 = ?$

$P_1 v_1^{\gamma} = P_2 v_2^{\gamma}$

Since the gas is compressed $P_1 v_1^{\gamma} = C$ then, $\gamma = 1.4$

$P_1 = 20$ lbs/D"

$P_2 = 100$ lbs/D"

$V_1 = 4$ cuft

$V_2 = ?$

$P_1 v_1^{\gamma} = P_2 v_2^{\gamma}$

$\therefore v_2 \left(\frac{P_1}{P_2}\right) = \left(\frac{V_2}{V_1}\right)^{\gamma}$

$= \left(\frac{P_1}{P_2}\right)^{1/\gamma} v_1 = V_2$

$V_2 = \left(\frac{20}{100}\right)^{\frac{1}{1.4}} \times 4$

$= (.2)^{.714} \times 4$

$\therefore 357 \times 4$

$= 1369$

The determination of the value of n

[illegible]

If the initial and final ~~vol~~ volumes and press are and known for an expression of the term pv^n = const: the value of n may be calculated from the logarithms of these value:-

Let $P_1 v_1^n = P_2 v_2^n$

taking the logarithms of both sides of the equations

$$\log_{10} P_1 + n \log_{10} v_1 = \log_{10} P_2 + n \log_{10} v_2$$

$$n \log_{10} v_1 - n \log_{10} v_2 = \log_{10} P_2 - \log_{10} P_1$$

$$n \{ \log_{10} v_1 - \log_{10} v_2 \} = \log_{10} P_2 - \log_{10} P_1$$

$$\therefore n = \frac{\log_{10} P_2 - \log_{10} P_1}{\log_{10} v_1 - \log_{10} v_2}$$

or

$$n = \frac{\log_{10} P_1 - \log_{10} P_2}{\log_{10} v_2 - \log_{10} v_1}$$

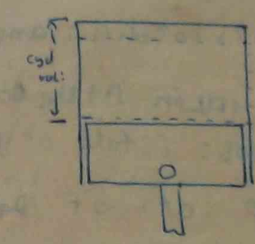
$$n = \frac{\log_{10} \frac{P_1}{P_2}}{\log_{10} \frac{v_2}{v_1}}$$

For ~~the~~ an adiabatic expansion, the value of (r may be obtain) ~~from~~ from the same eq: by substituting r for n

**

The compression Ratio of a gas engine is 4.5 and the pr: at the end of compression 77 lb/□" above atmospheric (14.7 lb/□")
If the pr: and temp: at 0.2 of the stroke were atmospheric and 80c find the temp: at the end of compr: and the index n for the compression stroke.

(cylinder stroke Pl·2 cylinder
T = 353 P = 14.7 lb/in²
Then: compr P1 P = 91.7 lb/in²
Find T2 Find n



$$\frac{\text{Cylinder vol}}{\text{Cl vol:}} = \text{Compr: Ratio}$$

petrol

let clearence vol: $V_2 = 1$

then cylinder vol: $= 4.5 V_2 = 4.5$

and Stroke vol: $= 4.5 - 1 = 3.5$

let vol: at .2 of compr: of Stroke $= V_1$

$= 4.5 - (.2 \times 3.5)$

$= 3.8$

let abs: temp: at .2 of stroke $= T_1 = 80 + 273 = 353^\circ C$ abs

let abs pr: " $= P_1 = 14.7$ lb/in²

let P_2 and T_2 = pr: and abs: temp ab to end of compression.

$$P_2 = 77 + 14.7 = 91.7 \text{ lb/in}^2$$

Then $\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$

$$T_2 = \frac{91.7 \times 1 \times 353}{14.7 \times 3.8} = \frac{31400}{55.8} = 579^\circ C$$

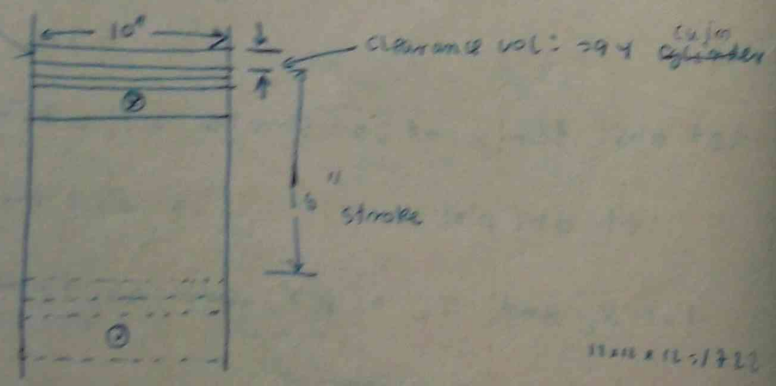
$$n = \frac{\log_{10}\left(\frac{p_2}{p_1}\right)}{\log_{10}\left(\frac{v_1}{v_2}\right)} = \frac{\log_{10}\left(\frac{91.7}{14.7}\right)}{\log_{10}\left(\frac{7.8}{1}\right)}$$

$$= \frac{\log_{10} 6.23}{\log_{10} 7.8} = \frac{.795}{.58} = 1.371$$

Prob: The cylinder of an Engine is 10" dia: and the Stroke is 15". The clearance vol: is 94 cu in At the commencement of the working stroke the cl: vol: is full of gas at a pr: of 650 lbs/□" and a temp: of 600°F During the first $\frac{1}{10}$ of the working stroke the gas expand at const: pr find the temp of the gas. The work done and the heat absorbed by the gas at the end of this period.

Assume $\gamma = 1.4$ $C = 5$ ft lbs units

$P = 650$ lbs/□" $T_1 = 600°F$ (cylinder engine $W = p[T_2 - T_1] = 11$



$T_1 = 600 + 460 = 1060°$ abs

let the clearance vol: $v_1 = \frac{94}{1728}$ cu ft

$= .0544$ cu ft

vol: = area × stroke

vol: $= \frac{22}{7 \times 4} \times \left(\frac{10}{12}\right)^2$ stroke

$= \frac{22}{7 \times 4} \times \left(\frac{10}{12}\right)^2 \times 1.25$

$\frac{1}{10}$ of vol: $= \frac{22}{7 \times 4} \times \left(\frac{10}{12}\right)^2 \times 1.25 \times \frac{1}{10}$ cu ft

$= \frac{3.1416}{4} \times \frac{100}{144} \times .125$

$= .7854 \times .694 \times .125$

$= .546 \times .125$

$= .0682$ cu ft

vol: of gas at the end of constant pr: stroke

$v_2 = v_1 + .0682$

$= .1226$ cu ft

$P_1 v_1 = C_w T_1$

$w = \frac{650 \times .0544 \times 144}{54 \times 1060} = \frac{3539.14}{57300}$

$= \frac{52400}{57300} = .089$

$P_2 v_2 = C_w T_2$

$T_2 = \frac{P_2 v_2}{C_w} = \frac{650 \times .1226 \times 144}{54 \times .089}$

$= \frac{93600 \times .1226}{4820}$

$= \frac{11470}{482} = 2388°$ f abs

$W_D = P(v_2 - v_1)$

$= 650 \times 144 (.1226 - .0544)$

$= 6336$ ft-lbs

$C = (\mu_p - \mu_v) J$

$\gamma = \frac{\mu_p}{\mu_v}$

$\frac{C}{J} = 4 p \left(1 - \frac{1}{\gamma}\right)$

$\mu_p = \frac{C_p}{J} = \frac{\gamma}{\gamma - 1}$

$= \frac{5}{778} \times \frac{1.4}{.4} = .0$

Heat absorbed = $w_k p (T_2 - T_1)$

$= -.08 \times 4 \times .243 (2388 - 1060)$

$= 28.7$ Btu.

Prob (1) The total vol: of a gas Engine cylinder is 15 cu in and the clearance vol:-e is 270 cu in. If the beginning of the compression stroke the mixtim of gas and air is at a pr: of 15 lbs/□" find its vol: pr: at the end of the compression stroke if the law for the compression is $pv^{1.85} = const$ Ans = 138.2 lb/□"

(2) There 3 cu ft of a gas an expanded in a cylinder which causes the pr: to fall from 100 lbs/□" to 35 lbs/□" If the expression follows the law $pv^{1.1} = const$ find final vol: of the gas Ans: 7.2 cu ft

(1) 1350 sq in — 2 sq in

$P_1 = 15$ lb/in² $P_2 = ?$

$v_1 = 1350 \times$ cu in $v_2 = 270$ cu in

$P_1 v_1^n = P_2 v_2^n$

$15 \times (1350)^{1.35} = P_2 (270)^{1.35}$

$P_2 = 15 \left\{\frac{1350}{270}\right\}^{1.35}$

$P_2 = 15 \times 5^{1.35}$

$= 15 \times 8.794$

$= 131.9$ lb/in²

① $v_1 = 3$ cu ft $v_2 = ?$

$P_1 = 100 \times 144$ lb/ft² $P_2 = 35 \times 144$ lb/ft²

$P_1 v_1^n = P_2 v_2^n$

$100 \times 144 \times (3)^{1.1} = 35 \times 144 (v_2)^{1.1}$

$\frac{100}{35} = \left(\frac{v_2}{3}\right)^{1.1}$

$\left(\frac{100}{35}\right)^{\frac{1}{1.1}} \times 3 = v_2$

$10 \left(2.8599\right)^{.9099} \times 3 = v_2$

$2.6 \times 3 = v_2$

$v_2 = 7.8$ cu ft

(3) steam occupying a vol: of 1.3 cu ft is expanded in an Engine cylinder from an absolute pr: of 160 lb/in² to an abs: pr: of 3 lb/□" Find the final vol: of the steam and the work done on the piston of the expansion that follows the law $pv^{1.13} = const$

{ 4.3 cu ft, 85300 ft-lb }

$P_1 = 160 \times 144$ lb/ft² $P_2 = 3 \times 144$ lb/ft²

$v_1 = 1.3$ cu ft $v_2 = ?$

$P_1 v_1^n = P_2 v_2^n$

$160 \times 144 \times \{1.3\}^{1.13} = 3 \times 144 (v_2)^{1.13}$

$\frac{160}{3} = \left(\frac{v_2}{1.3}\right)^{1.13}$

$\left(\frac{160}{3}\right)^{\frac{1}{1.13}} \times 1.3 = v_2$

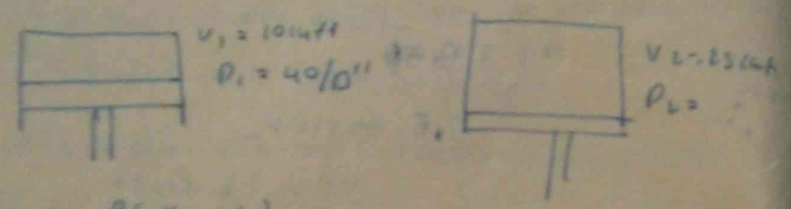
$(53.33)^{.885} \times 1.3 = v_2$ $v_2 = 33.5 \times 1.3$

$= 43.7$ cu ft

Prob:

10 cu ft of air at 40 lb/in² is expanded to a vol 25 cu ft. Find the work done during the expansion for each of the following methods of expansion:-

1. constant pressure
2. Isothermal
3. adiabatic
4. following the law $pv^{1.2} = \text{const}$
5. hyperbolic
6. Free



① const: p:

$W_D = p(v_2 - v_1)$

$= 144 \times 40 \times 15$

$= 86400 \text{ ft-lb}$

② Isothermal

$W_D = p_1 v_1 \log_e r \qquad r = \frac{v_2}{v_1}$

$= 144 \times 40 \times 10 \times 2.303 \log \frac{25}{10}$

$= \text{[illegible]}$

$= 144 \times 40 \times 10 \times 2.303 \times .3979$

$= 57000 \times .916 = 52230 \text{ ft-lb}$

52230

Isothermal

$W_D = p_1 v_1 \times 2.303 \log \frac{v_2}{v_1}$

Hyperbolic

$W_D = p_1 v_1 \log_e r$

$= p_1 v_1 2.303 \log \frac{v_2}{v_1}$

$= 144 \times 40 \times 10 \times 2.303 \log \frac{25}{10}$

$= 52230 \text{ ft-lb}$

Free

$W_D = 0$

$p_1 v_1^{\gamma} = p_2 v_2^{\gamma}$

adiabatic

$W_D = \frac{p_1 v_1 - p_2 v_2}{\gamma - 1}$

$p_1 v_1^{1.4} = p_2 v_2^{1.4}$

$144 \times 40 \times (10)^{1.4} = p_2 \times (25)^{1.4}$

$= \frac{57600 \times 10 - 1595 \times 25}{.4}$

$p_2 = 144 \times 40 \times \left(\frac{10}{25}\right)^{1.4}$

$= 5760 \times (.4)^{1.4}$

$= 5760 \times .2770$

$= 1595 \text{ lb/ft}^2$

$= \frac{57600 - 39800}{.4}$

$= \frac{17800}{.4} = 44500 \text{ ft-lb}$

$= \frac{17700}{.4}$

44000

Followed the law $pv^{1.2} = \text{constant}$

$p_1 v_1^{1.2} = p_2 v_2^{1.2}$

$5760 \times (10)^{1.2} = p_2 \times (25)^{1.2}$

$5760 \times \left(\frac{10}{25}\right)^{1.2} = p_2$

$5760 \times (.4)^{1.2} = p_2$

$5760 \times .333 = p_2$

$p_2 = 1918 \text{ lb/ft}^2$

$W_D = \frac{p_1 v_1 - p_2 v_2}{n - 1} = \frac{5760 \times 10 - 1918 \times 25}{.2}$

$= \frac{57600 - 47900}{.2}$

$= \frac{9700}{.2} = \frac{9500}{.2}$

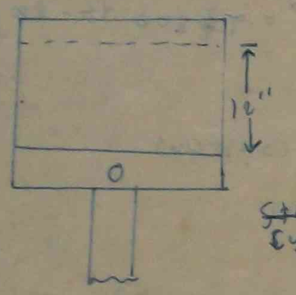
$= 47500 \text{ ft-lb}$

52230
44000
47500

47500

A gas engine has a cylinder dia: 7" and stroke 12". The ratio of expression is 5 the pr: of the mixture is 15 lb/□" at the beginning of compression and 90 lb/□" at the end of the compression. Find the index n for the compression stroke and the weight of mixture in cylinder. if the temp: at the beginning is 100°

c = 96 ft-lb r = 1.4



cylinvol: = Area × Stroke

$\frac{\text{cylinvol:}}{\text{cl vol:}} = 5$

Stroke vol: = Cylin: vol: $= \frac{\pi}{4} \times d^2 \times 12''$

$= \frac{\pi}{4} \times 49 \times 12$

$= \frac{147\pi}{144}$ ft³

cylinvol const: pr: cylin: = .267 ft³

$P_1 = 15 \times 144$ lb/ft² $P_2 = 90 \times 144$ lb/ft²

$\frac{\text{Cylinvol}}{\text{clearance vol:}} = 5$

$\frac{.267}{5}$ = clearance vol:

clearance vol: = .0534 ft³

$P_1 v_1^n = P_2 v_2^n$

$90 \times (.0534)^n = 15 \times 144 \times (.267)^n$

$\frac{(.267)^n}{(.0534)^n} = 6$

$\frac{.0534}{.267} \left(\frac{.267}{.0534}\right)^n = 6$

$(4.999)^n = 6$

$n = 1.114$

clearance vol: = .9 Stroke
P: 15 lbs/sq in
Cylin vol: = Stroke vol: + clearance vol:
clearance vol: = .9 Stroke P: 15 lbs/sq in
Cylinvol = Stroke × A

w = ? $P_1 v_1 = C_w T_1$

$w = \frac{P_1 v_1}{C_w T_1}$

$= \frac{15 \times 144 \times .267}{96 \times 373}$

$= \frac{216 \times .267}{35800} = .0042$

n = 1.112

w = 0.0197

$= .0750 \times .267 = .01975$ lb // Ans

cylinvol: = Area × stroke

$\frac{\text{Cylinvol:}}{\text{Clearance vol:}}$ = Compression Ratio

Prob: 4 cuft of air at a pr: of 60 lbs/□" are expanded Isothermally in a cylinder to 11.5 cuft. Find the interchange of heat through the cylinder walls and the w.D

$WD = P_1 v_1 \text{ Loge}$

$= 60 \times 144 \times 4 \times 2.303 \text{ Log } \frac{11.5}{4}$

$= 8640 \times 9.212 \text{ Log } 2.875$

$= 8640 \times 9.212 \times .459$

$= 36600$ ft-lb

Inter Change heat = $\frac{WD}{J} = \frac{36600}{1400} = 26.15$ CHU (26.2) FPS sys:

(or) " $\frac{WD}{J} = \frac{36600}{778} = 47$ Bthu (47.3) CGS sys:

(Ans)

Prob: 20 lb ... 90°F ... 6 ... 90 cuft ... (1) Gauge pr: ... (2) ... 100 lb/in² ... 300°F ...

$R_c = 53.37$ ft-lb/f

W = 20 lb

T = 90°F = 80 + 460 = 540° abs

V_1 = 90 cuft

$PV = CWT$

$P \times 9 = 53.37 \times 20 \times 540$

$P = \frac{53.37 \times 1080}{9}$

$= 53.37 \times 120 = 6404$

$P = 100 \times 144$, $T = 30 + 460 = 760$

$PV = CWT$

$V \times 100 \times 144 = CWT$

$\therefore V = \frac{CWT}{P} = \frac{53.37 \times 20 \times 760}{14400}$

$= 56.31 \text{ ft}^3$

Air Compression

Single stage compressor

Compressor work done $= W_D = P_1 v_1 \frac{n}{n-1} \left\{ \left(\frac{P_2}{P_1}\right)^{\frac{n-1}{n}} - 1 \right\}$

compressor H.P $= \frac{WN}{33000}$

where N = number of Revolution / min if single stage.

= " " Stroke / min if double acting

① single acting single cylinder air compressor এর cylinder dia 6" ও stroke 9" ঘুরলে volume কত? ঐ cylinder এর inlet pressure 15 lbs/□" ও temp 60°F হলে ঘুরলে কত? adiabatic ভাবে compress করলে কত lb/□" হবে এবং compressor এর H.P কত হবে? compressor এর speed 100 R.P.M ঘুরলে কত?

Cylinder dia $= 6''$

Stroke $= 9''$

$P_1 = 15 \text{ lb/□}''$ HP = ?

$P_2 = 90 \text{ lb/□}''$ weight w = ?

Vol: $= \text{Area} \times \text{stroke} = \frac{\pi}{4} \times 6^2 \times 9 = 81\pi \text{ in}^3 = \frac{81\pi}{1728} \text{ ft}^3$

adiabatic এর ক্ষেত্রে $\gamma = 1.4$

$W_D = P_1 v_1 \left(\frac{\gamma}{\gamma - 1}\right) \left\{ \left(\frac{P_2}{P_1}\right)^{\frac{\gamma-1}{\gamma}} - 1 \right\}$

$W_D = 15 \times 144 \times \frac{81\pi}{1728} \left(\frac{1.4}{1.4-1}\right) \left\{ \left(\frac{90 \times 144}{15 \times 144}\right)^{\frac{1.4-1}{1.4}} - 1 \right\}$

$= \frac{405\pi}{4} \times \frac{1.4}{.4} \left\{ \{6\}^{\frac{.4}{1.4}} - 1 \right\}$

$= .7854 \times 405 \times 3.5 \left\{ \{6\}^{.2858} - 1 \right\}$

$= 2.75 \times 405 \times \{1.687 - 1\}$

$= 2.75 \times 405 \times .687$

$= 1.8139 \times 405 = 745 \text{ ft-lb}$ (774)

$P_1 v_1 = CWT_1$

$w = \frac{P_1 v_1}{CT_1} = 15 \times 144 \times \frac{81\pi}{1728} \times \frac{1}{96} \times \frac{1}{520}$

$= \frac{15 \times 144 \times 81\pi}{1728 \times 96 \times 520}$

Centigrade এর $= \frac{27\pi}{128 \times 104} = \frac{84.9}{13310} = 9.95 \times 10^{-3}$

$= .00995 \text{ cft}$

$= \frac{15 \times 144 \times 81\pi}{1728 \times 53.3 \times 520} = .0114 \text{ lb}$

100 R.P.M এর $= .0114 \times 100 = 1.14 \text{ lb}$

$\therefore HP = \frac{W_D \times N}{33000} = \frac{774 \times 100}{33000} = 2.26 \text{ HP}$

⑤ A single stage single acting air compressor compresses air at 15 lb/in² and at a pr: of 200 lb/in². The dia: of the cylinder is 9" and the stroke is 6". If the speed of the compressor is 150 R.P.m find the actual HP required to drive it. Assume adiabatic compression.

Cylin: vol: = $\frac{\pi}{4} d^2 \times$ stroke

$= \frac{\pi}{4} \times \frac{9 \times 6}{1728} = \frac{54 \times .7854}{1728} = \frac{42.4}{1728}$

$= .02455$ ft³

$W_D = P_1 v_1 \left(\frac{n}{n-1}\right) \left\{ \left(\frac{P_2}{P_1}\right)^{\frac{n-1}{n}} - 1 \right\}$

$= 15 \times 144 \times .02455 \times \frac{1.4}{1.4-1} \left\{ \left(\frac{200 \times 144}{15 \times 144}\right)^{\frac{1.4-1}{1.4}} - 1 \right\}$

$= 2160 \times .02455 \times 3.5 \left\{ (13.32)^{.2857} - 1 \right\}$

$= 185.8 \left\{ 2.095 - 1 \right\}$

$= 185.8 \times 1.095 = 203.5$ ft-lb

$w = \frac{P_1 v_1}{C T_1} = \frac{15 \times 144 \times .02455}{53.3 \times 520} = \frac{2160 \times .02455}{27700}$

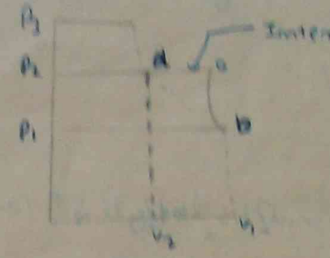
$= \frac{53.1}{27700} = 1.915 \times 10^{-2} = .01915$ lb

$= 1/915$

$\therefore$ 1502 rpm $\quad HP = \frac{W_D \times N}{33000}$

$H = \frac{203.5 \times 150}{33000} = .926$ HP

Two stage compressor



$W_D = P_1 v_1 \frac{n}{n-1} \left\{ \left(\frac{P_2}{P_1}\right)^{\frac{n-1}{n}} + \left(\frac{P_3}{P_2}\right)^{\frac{n-1}{n}} - 2 \right\}$

If the intercooling incomplete, the point d will be on the Isothermal line $P_1 v_1 = P_2 v_2$

Heat rejected to inter cooler = $Q = m c_p (T_c - T_d)$

Efficiency of compressor

Isothermal W_D per cycle = area of P-v diagram

Isothermal HP $= \frac{P_1 v_1 \log_e r \times N}{33000}$

N = number of cycles per minute

compression efficiency = $\frac{\text{Isothermal H.P}}{\text{I.H.P}}$

Isothermal efficiency = $\frac{\text{Isothermal H.P}}{\text{Shaft H.P}}$

adiabatic efficiency = $\frac{\frac{\gamma}{\gamma-1} P_1 v_1 \left\{ \left(\frac{P_2}{P_1}\right)^{\frac{\gamma-1}{\gamma}} - 1 \right\} \frac{N}{33000}}{\text{B.H.P required to drive the compressor}}$

volumetric efficiency = $\frac{\text{Vol: of air in rated disp}}{\text{swept vol: of piston}}$

(Free air at S.T.P = 1/13 lb/ft³

$$= 9000$$

Steam Boilers (ಬಾಯ್ಲರ್ಸ್)

ಬಾಯ್ಲರ್ ಎಂದರೆ ಉಷ್ಣಶಕ್ತಿಯನ್ನು ಉಪಯೋಗಿಸಿ ಹೆಚ್ಚಿನ ಒತ್ತಡದಲ್ಲಿ ಆವಿಯನ್ನು ಉತ್ಪಾದಿಸುವ ಸಾಧನ. ಬಾಯ್ಲರ್‌ನಲ್ಲಿ ಉತ್ಪಾದಿಸಿದ ಆವಿಯನ್ನು ಸ್ಟೀಮ್ ಎಂಜಿನ್, ಸ್ಟೀಮ್ ಟರ್ಬೈನ್ ಮುಂತಾದ ಕಡೆಗಳಲ್ಲಿ ಉಪಯೋಗಿಸಲಾಗುತ್ತದೆ. ಬಾಯ್ಲರ್‌ನಲ್ಲಿ ಉತ್ಪಾದಿಸಿದ ಆವಿಯ ಒತ್ತಡ ಮತ್ತು ಉಷ್ಣತೆಯನ್ನು ಅವಶ್ಯಕತೆಗೆ ತಕ್ಕಂತೆ ಹೆಚ್ಚಿಸಲಾಗುತ್ತದೆ. ಬಾಯ್ಲರ್‌ನಲ್ಲಿ ಉತ್ಪಾದಿಸಿದ ಆವಿಯನ್ನು ಸ್ಟೀಮ್ ಎಂಜಿನ್, ಸ್ಟೀಮ್ ಟರ್ಬೈನ್ ಮುಂತಾದ ಕಡೆಗಳಲ್ಲಿ ಉಪಯೋಗಿಸಲಾಗುತ್ತದೆ. ಬಾಯ್ಲರ್‌ನಲ್ಲಿ ಉತ್ಪಾದಿಸಿದ ಆವಿಯನ್ನು ಸ್ಟೀಮ್ ಎಂಜಿನ್, ಸ್ಟೀಮ್ ಟರ್ಬೈನ್ ಮುಂತಾದ ಕಡೆಗಳಲ್ಲಿ ಉಪಯೋಗಿಸಲಾಗುತ್ತದೆ.

ಬಾಯ್ಲರ್‌ನಲ್ಲಿ ಉತ್ಪಾದಿಸಿದ ಆವಿಯನ್ನು ಸ್ಟೀಮ್ ಎಂಜಿನ್, ಸ್ಟೀಮ್ ಟರ್ಬೈನ್ ಮುಂತಾದ ಕಡೆಗಳಲ್ಲಿ ಉಪಯೋಗ

Boiler

Boiler ಎಂದರೆ ಒಂದು ಮುಚ್ಚಿದ ಪಾತ್ರೆ. ಇದರಲ್ಲಿ Boiler ಅನ್ನು ಬಿಸಿ ಮಾಡಿ ಉತ್ಪತ್ತಿಯಾದ ಉಗಿಯನ್ನು ಅಗತ್ಯವಿರುವ ಕಡೆಗೆ ಕಳುಹಿಸಲಾಗುತ್ತದೆ.

classification and type.

Boiler ಅನ್ನು ಮುಖ್ಯವಾಗಿ ಎರಡು ವಿಧಗಳಾಗಿ ವಿಂಗಡಿಸಲಾಗಿದೆ. Fire tube Boiler ಮತ್ತು water tube Boiler ಎಂದು ಹೆಸರಿಸಲಾಗಿದೆ.

Fire tube Boiler

ಇದರಲ್ಲಿ ಬಿಸಿ ಅನಿಲಗಳು ಅಥವಾ ಜ್ವಾಲೆಗಳು (Flue gases) ಹಾದು ಹೋಗುವ ಕೊಳವೆಗಳನ್ನು tube ಎಂದು ಕರೆಯಲಾಗುತ್ತದೆ. ಈ tube ಗಳ ಸುತ್ತಲೂ ನೀರು ಇರುತ್ತದೆ. ಈ ಕೊಳವೆಗಳಲ್ಲಿ ಬಿಸಿ ಅನಿಲಗಳು ಹಾದು ಹೋಗುವಾಗ ಅವುಗಳಲ್ಲಿರುವ ಉಷ್ಣವು ಸುತ್ತಲಿನ ನೀರಿಗೆ ವರ್ಗಾವಣೆಯಾಗುತ್ತದೆ. ಈ ಬಾಯ್ಲರ್‌ಗಳು ಸಾಮಾನ್ಯವಾಗಿ 200 lb/in² abs ವರೆಗಿನ ಒತ್ತಡವನ್ನು ಉತ್ಪಾದಿಸಲು ಬಳಸಲಾಗುತ್ತದೆ.

water tube Boiler

ಈ ಬಾಯ್ಲರ್‌ನಲ್ಲಿ tube ಗಳಲ್ಲಿ ನೀರು ಇರುತ್ತದೆ ಮತ್ತು ಬಿಸಿ ಅನಿಲಗಳು tube ಗಳ ಹೊರಭಾಗದಲ್ಲಿ ಹಾದು ಹೋಗುತ್ತವೆ. ಈ tube ಗಳು ಒಂದು ಅಥವಾ ಹೆಚ್ಚಿನ steam drum ಗಳಿಗೆ ಸಂಪರ್ಕ ಹೊಂದಿರುತ್ತವೆ. ಈ drum ಗಳಲ್ಲಿ ಉಗಿ ಮತ್ತು ನೀರಿನ ಮಿಶ್ರಣವನ್ನು ಬೇರ್ಪಡಿಸಲಾಗುತ್ತದೆ. area ಸಮೃದ್ಧವಾಗಿರುವ ಕಡೆಗಳಲ್ಲಿ ಈ ಬಾಯ್ಲರ್‌ಗಳು ಫೈರ್‌ಟ್ಯೂಬ್ ಬಾಯ್ಲರ್‌ಗಳಿಗಿಂತ ಹೆಚ್ಚು ಜನಪ್ರಿಯವಾಗಿವೆ. ಏಕೆಂದರೆ ಇವುಗಳಲ್ಲಿ tube ಗಳು ಹೆಚ್ಚಿನ ಒತ್ತಡವನ್ನು ತಡೆದುಕೊಳ್ಳಬಲ್ಲವು.

Boiler mountings (ಬಾಯ್ಲರ್ ಅಳವಡಿಕೆಗಳು)

1. water level Indicator
2. ~~wat~~ Boiler pressure gauge
3. safety value
4. lever safety value
5. Dead weight safety ~~v~~ value
6. stop value
7. Fusible plug
8. condenser (surface Type)
9. Super heater
10. Feed pump
11. Feed water heater
12. Economiser ಅಳವಡಿಸಲಾಗಿರುತ್ತದೆ.

expression

P_1 ಮತ್ತು V_1 ಸ್ಥಿತಿ

P_2 ಸ್ಥಿತಿ V_2 ಮತ್ತು

compression

P_1 ಸ್ಥಿತಿ V_1 ಮತ್ತು

P_2 ಮತ್ತು V_2 ಸ್ಥಿತಿ

* *

A gas Engine has a cylinder dia 7" and stroke of 12" the ratio of ~~com~~pression is 5 the pr: of the mixture is 15 lb/in² at the beginning of compression and 80 lb/in² at the end of the ~~com~~pression Find the indexion for the compression stroke and the weight of mixture in cylinder if the temp at the beginning is 100°C $c = 96 ft - lb$ $\gamma = 1.4$

$$\text{compression Ratio} = \frac{\text{cy lin vol:}}{\text{cle: vol:}}$$

$$5 = \frac{\text{cle vol:} + \text{stroke vol:}}{\text{cle vol:}}$$

$$5 = 1 + \frac{V_S}{V_C}$$

$$\text{stroke vol:} = \frac{\pi}{4} \times \frac{49 \times 12}{1728} = .267$$

$$4 = \frac{.267}{V_C}$$

$$V_C = .06675$$

A vol: of
cylinder
for the

Total vol: = .06675 + .267

= .33375

$15 \times (.33375)^n = 90 (.06675)^n$

$(4.981)^n = 6$

$n = 1.112$

$P_1 V_1 = C W T_1$

$w = \frac{15 \times 144 \times .33}{98 \times 373}$

$= \frac{.714}{35600} = .0197$ #

Ans The cylinder dia: of Diesel engine is 12" and stroke is 18". The compression is 13.5. At the beginning of compression. It absorbed pure air of 14.7 lb/in² and pressed it to the clearance vol:. The compression method is adiabatic. Find the compression WD.

Stroke vol: = $\frac{\pi}{4} \times d^2 \times$ stroke

$= \frac{\pi}{4} \times 144 \times 18$

$= \frac{\pi \times 36 \times 18}{4} = \frac{3\pi}{8} = \frac{9.44}{8} = 1.18$

Compression Ratio = $\frac{\text{cylin vol:}}{\text{cle: vol:}}$

$13.5 = \frac{\text{cle: vol: + Stroke vol:}}{\text{cle: vol:}}$

$13.5 = 1 + \frac{1.18}{\text{cle vol:}}$

∴ cle: vol: = $\frac{1.18}{12.5} = .0944$ ft³

∴ Total vol: = .0944 + 1.18

= 1.2744 ft³

$P_2 V_2 = C W T_2$

$P_2 \times .0944 = 9$

$P_1 V_1^{1.4} = P_2 V_2^{1.4}$

$14.7 \times 144 \times (1.2744)^{1.4} = P_2 \times (.0944)^{1.4}$

$P_2 = 14.7 \times 144 \left[\frac{1.2744}{.0944}\right]^{1.4}$

$= 2118 \ [13.51]^{1.4}$

$= 2118 \times 14 = 29600$ lb/ft³

$WD = \frac{P_1 V_1 - P_2 V_2}{n-1}$

$= \frac{2118 \times 1.2744 - 29600 \times .0944}{.4}$

$= \frac{2695 - 2795}{.4} = \frac{1550}{4} = 275$ ft-lb

single stage single acting compressor এর Belt দিয়ে Flat motor দিয়ে ঘুরানো হবে motor এর speed 400 rpm এবং cylinder dia: হবে 6" এবং stroke 7" এবং air 15 lb/in² এ 105 lb/in² এ compress করা হবে $PV^{1.3} = C$ হলে motor এর HP কত motor & compressor এর Transmission 97% এবং compressor এর mechanical eff: 90% হলে।

compressor cylin vol: = $\frac{\pi}{4} d^2 \times$ stroke

$= \frac{\pi}{4} \times \frac{6^2 \times 7}{1728}$

$= .1147$ ft³

A vol: of cylinder for the

$$W_D = P_1 V_1 \frac{n}{n-1}\left[\left(\frac{P_2}{P_1}\right)^{\frac{n-1}{n}} - 1\right]$$

$$= 15 \times 144 \times 1147 \times \frac{1.3}{1.3-1}\left[\left(\frac{105}{15}\right)^{\frac{1.3-1}{1.3}} - 1\right]$$

$$= 1063 \quad [7^{.231} - 1]$$

$$= 1063 \quad [1.567 - 1]$$

$$= 1063 \times .567 = 605 \text{ ft-lb}$$

compressor input $= \frac{605}{.9}$

Transmission Belt input $= \frac{605}{.9 \times .97} = 693$ ft-lb

$$HP = \frac{W_D N}{33000}$$

$$= \frac{400 \times 693}{33000} = 8.9 \text{ HP}$$

A Flow at const. & the W_D in

Ans:-

② Nitrogen of vol. 25 ft³ at 15 lb/in² pr: is compressed to 300 lb/in² pr: Find the work done if the compression follows the law $PV^{1.3} = \text{const}$: Find the work done

$$W_D = P(V_2 - V_1)$$

$$250000 = P(25 - 5) \qquad P = 12500 \text{ lb/ft}^2$$

or $\frac{12500}{144} = 86.8 \text{ lb/in}^2$

② $P_1 V_1^{1.3} = P_2 V_2$ Nitrogen of vol. at 15 lb/in² pr: is compressed to 300 lb/in² pr: Find the work done if the compression follows the law $PV^{1.3} = \text{const}$: Find the work done

$$P_1 V_1^{1.3} = P_2 V_2^{1.3}$$

$$15 \times 144 (35)^{1.3} = 300 \times 144 (V_2)^{1.3}$$

$$(.05)^{.769} \times 35 = V_2 \qquad V_2 = 3.5 \text{ ft}^3$$

③ 6 lb 2 of 13.0° m: 100 lb/in² cylinder Find the work done if the pr: is 15 lb/in² Find the work done when the compression is carried out

(1) Hyperbolic (3) follows the law $PV^{1.2} = \text{const}$

(2) adiabatic $\gamma = 1.4$

Hyperbolic $W_D = P_1 V_1 \log_e r$

$$= P_1 V_1 \times 2.303 \times \log r$$

$$= 14400 \times 20 \times 2.303 \log \frac{V_2}{V_1}$$

$$\frac{P_1 V_1}{T} = \frac{P_2 V_2}{T_2}$$

$$\frac{100 \times 144 \times 20}{T} = \frac{15 \times 144 \times V_2}{T_2}$$

$$V_2 = 133.2$$

$$W_D = 2880000 \times 2.303 \log \frac{133.3}{20}$$

$$= 6640000 \log 6.66$$

$$= 5470000 \text{ ft-lb}$$

adiabatic $P_1 V_1^{1.4} = P_2 V_2^{1.4}$

$$100 \times 20^{1.4} = 15 \times V_2^{1.4}$$

$$V_2 = 20 \times 3.67 = 73.4 \text{ ft}^3$$

$$W_D = \frac{P_1 V_1 - P_2 V_2}{n-1} \times 144$$

$$= \frac{100 \times 20 - 15 \times 73.4}{1.4 - 1} \times 144$$

$$= 3010000 \text{ ft-lb}$$

Follow the law $PV^{1.2} = \text{const}$:

$$P_1 V_1^{1.2} = P_2 V_2^{1.2}$$

$$100 \times (20)^{1.2} = 15 \times V_2^{1.2}$$

$$V_2 = 6.67^{.833} \times 20 = 97 \text{ ft}^3$$

A vol: of cylinder for the

$$WD = \frac{P_1V_1 - P_2V_2}{n-1} = \frac{100\times20 - 15\times97}{\cdot2}\times144$$

$$= 545\times720 = 392500 \text{ ft-lb}$$

ഏതൊരു 0.5 cu ft ഉൾക്കൊ. 300 lb/in² ഉൾപ്പെടുത്തിയതിന്റെ. അതായത് പൊസ്: 30 lbs/in² ആയിരുന്നു 6 ft. നമ്മുടെ $PV^{1.35} = \text{constant}$ ആയതിനാൽ ഉപയോഗിച്ചതിന്റെ. ഇവിടെ work done കണ്ടുപിടിക്കുക.

$$WD = \frac{P_1V_1 - P_2V_2}{n-1} \qquad P_1V_1^{1.35} = P_2V_2^{1.35}$$

$$300\times144\times.5^{1.35} = 30\times144\times V_2^{1.35}$$

$$10 = \left(\frac{V_2}{.5}\right)^{1.35}$$

$$10^{\frac{1}{1.35}} \times .5 = V_2$$

$$10^{.741} \times .5 = V_2$$

$$5.5 \times .5 = V_2 \qquad V_2 = 2.75 \text{ ft}^3$$

$$WD = \frac{300\times144\times.5 - 30\times144\times2.75}{1.35-1}$$

$$= \frac{144\left[150 - 30\times2.75\right]}{.35}$$

$$= \frac{144\left[150 - 82.5\right]}{.35}$$

$$= \frac{144\times67.5}{.35}$$

$$= \frac{9725}{.35} = 27750 \text{ ft-lb}$$

27750 ft-lb

1/ ഒരു engine ന്റെ fuel consumption: മണിക്കൂറിൽ 45 lbs ആണ്. fuel ന്റെ calorific value 18500 Btu/lb ഉം efficiency: 20% ഉം ആയാൽ Horse Power out put കണ്ടുപിടിക്കുക. Heat Rejected കണ്ടുപിടിക്കുക.

2/ oxygen cylinder ന് 10 ft³ കപ്പാസിറ്റിയുണ്ട്. പൊസ്: 450 lb/in² ൽ ഇതിൽ 65°F ൽ oxygen നിറച്ചിരിക്കുന്നു. ഇതിന്റെ stop value തുറന്നപ്പോൾ oxygen ചോർന്നു തുടങ്ങി. ഇതിന്റെ പൊസ്: 250 lb/in² ൽ താഴുമ്പോൾ 60°F ൽ നിലനിർത്തുന്നതിന് ചോർന്നുപോയ oxygen ന്റെ അളവ് എത്രയാണ്? ഇതിന് ശേഷം stop valve അടച്ചിട്ടിരിക്കുന്നു. ഈ സമയത്ത് cylinder ൽ നിന്നും oxygen ന്റെ താപനില 65°F ആയിരുന്നു. cylinder wall ൽ കൂടി ചോർന്നുപോയ oxygen ന്റെ അളവ് കണ്ടുപിടിക്കുക. atmospheric pressure 14.7 lb/in² ഉം ആണ്.

Density of oxygen at 32°F of 14.7 lb/in² = .0894 lb/ft³

oxygen ന്റെ $\gamma = 1.4$

① Full consumption / hr = 45 lbs

$= \frac{45}{60}$ lbs/min = .75 lb

heat liberated / lb of fuel

= 18500 Btu

Mass of gas = Vol of gas

∴ heat generated / min = 18500 × .75 Btu

of this only 20% is used successfully.

∴ 18500 × .75 × .2 Btu

$$\therefore \text{HP of the Engine} = \frac{18500\times.75\times.2\times778}{33000}$$

$$= \frac{185\times.15\times778}{330}$$

$$= \frac{27.75\times778}{330} = \frac{21650}{330} = 65.3$$

Heat rejected = (1 − thermal efficiency) × heat supplied

$$HP = \frac{\text{Btu/min}\times778}{33000}$$

$= (1 - .2) \times .75 \times 18500$

$= .8 \times .75 \times 18500$

$= .6 \times 18500 = 11100$ Btu/

A vol: of cylinder for 1 lb

$V = 10\ ft^3$

$P = 450\ lb/\square''$

$F = 65°F$

Density $= .089\ lb/ft^3$

$P_1 v_1 = C w T_1$

$P = C \frac{w}{v} \times T_1$

$144 \times 450 = C \times .089 \times 525$

$C = \frac{450}{144} \times \frac{1}{.089 \times 525}$

$= \frac{3.125}{46.7} = .0668$

$P_2 v_2 = C w T_2$

$144 \times \frac{250}{144} = C \times \frac{w}{v_2} \times T_2$

$\frac{250}{144} = .0668 \times \frac{w}{v_2} \times 520$

$1.737 = 34.8 \times \frac{w}{v_2}$

$\frac{w}{v_2} = \frac{1.737}{34.8}$

$w = 10 \times$

(2)

$Pv = mRT$

$R = \frac{Pv}{m_2} = \frac{14.7 \times 144 \times 10}{.089 \times 452} = 48.3\ ft\ lb/°$

again $P_1 v_1 = m R T_1$

$m_1 = \frac{150 \times 10 \times 144}{48.3 \times 525} = 25.6$

again $P_2 v_2 = m R T_2$

$\therefore m_2 = \frac{P_2 v_2}{T_2 R} = \frac{250 \times 144 \times 10}{47.3 \times 520}$

$= 14.8\ lbs$

again $= H = w + E$

$=$ work done + Internal energy

O_2 at vol: const: temp: const, $w = 0$ (const: vol: $\therefore w = 0$)

$\therefore H = E$

$E = m_2 \mu_v (T_2 - T_1)$

$= 14.7 \times \mu_v (525 - 520)$

$\frac{R}{J} = (\mu_p - \mu_v)$

$R = J (\mu_p - \mu_v)$

$R = J \left(\frac{\mu_p}{\mu_v} - 1\right) \mu_v$

$R = J \mu_v (\gamma - 1)$

$\mu_v = \frac{R}{J(\gamma - 1)} = \frac{48.3}{778 (.4)} = \frac{48.3}{311.2} = .156$

$E = 14.3 \times .156 (525 - 520)$

$= 14.3 \times .156 \times 5$

$= 11.15\ Btu$

Properties of steam

32° F vapours of 0° C at 273

212° F 373 100° C

Total heat of water

This heat is the heat absorbed by the water being heated at const: pressure from the freezing point to the temp: of steam of the said. latter temp: will depend on the pressure.

Let T_1 = temp: of formation of steam at pr: considered.

μ = specific heat of water

Total heat $h_{wt} = \mu (t_1 - 0)$ in centigrade units

$h_{wt} = \mu (t_1 - 32)$ in Fahrenheit units

For Engineering purpose it is of sufficient accuracy to assume the value of u to be unity at low pr: in which the total heat of water will be temp: of formation in the centigrade unit and formation temp: minus 32 in Farenheit unit

---

Dryness Fraction (q_s)

Dryness fraction of wet steam is defined as the ratio of the ~~water~~ weight of dry steam to the total weight of wet steam containing it.

$$q = \frac{w_s}{w_s + w} = \frac{\text{mass}}{\text{mass of m}}$$

Example

A mass of 3 lb of wet steam containing a mass of 0.15 lb moisture in ~~steam~~ suspension is made up of $3 - 0.15 = 2.85$ lb of dry steam and 0.15 lb of water

The dryness fraction of steam in the ~~form~~ form: -

$$\frac{2.85}{3} = 0.95$$

$\therefore q = 0.95$ or 95 %.

2/ 1 lb of wet steam containing 0.16 lb of moisture in Suspension calculate the dryness fraction of this steam.

weight of dry steam = $1 - 0.16 = 0.84$ lb

$\therefore$ Dryness fraction = $q = \frac{0.84}{0.84 + 16} = .84 = 84$ %.

Wet steam

To produce 1 lb of wet steam having dryness fraction (q_s) the energy required for generation from water at 32°F into wet steam at absolute pr: p would be

wet steam $H_{wet} = h_w + qL$ { h_w = freezing point to Boiling point ; q = dryness fr:

h_w = total heat or external Py of water at abs: pr: p

L = latent heat of steam at pr: p

H_{wet} = wet steam heat

volume of wet steam

$V_q = q v_s$

V_q = vol: of wet steam (lb) at absolute pr: p

V_s = vol: of dry dry saturated steam (lb) at abs: pr: p

q = dryness faction

Dry steam $H_s = h_w + L$; h_w: freezing point to boiling point

t: -

Superheated steam

Superheated steam ~~ste~~ remains at the pr: of the boiler but increases in temp: as further heat is added. The ~~spec~~ specification of superheated steam is either by the ~~actual~~ actual temp: (t) after superheating or by the degree of superheat ($t' - t_s$) thus being the temp: rise of the steam above the saturation temp: at the particular pr: at which the superheating taken place.

The total heat (H^1) of superheated steam is the sum of the total heat of dry saturated steam and the additional heat due to superheating thus is: —

$$H^1 = H_s + S^1 (t^1 - t_s)$$

$$S^1 = \text{.45 to .5}$$

Example Saturated steam: Enter total heat/pound

Superheated steam at ... lbs/in² mass of ... degrees of superheat ... $S^1(t^1-t_s)$

Superheated steam: Enter total heat ...

$H^1 = H_s + S^1(t^1 - t_s)$ ...

$S = .53$

$(t^1 - t_s) = 100°F$

$H^1 = 1188 + .53 \times 100 = 1241$ BTU/lb

$= 1188 + 53 = 1241$ BTU/lb

External work during evaporation

The latent (internal) energy of steam, during evaporation, includes an amount of external work of large amount when changing from water to steam.

Let V_w = vol. of 1 lb of water in cu. ft.

p = abs. pressure in lbs/sq. ft.

V_s = vol. of 1 lb of dry steam at p lbs/sq. ft.

In evaporation the water to steam the vol. increases from V_w to V_s, a constant pressure p. The external work (E) that done by the steam in increasing its vol. and energy for performing this work is obtained during the absorbation of the latent heat. This work is known as the external work of evaporation.

(ft. lbs/lb)

External work done per 1 lb of steam = $144\ p(V_s - V_w)$ ft. lbs

$$= \frac{144\ p(V_s - V_w)}{J} \text{ heat unit}$$

At low pressure the vol. of 1 lb of water is very small compared with vol. of the steam it forms thence. The term V_w in the equation may be neglected as small

The the equation may be written: $= 144\ pV_s$ or

$$\frac{144\ pV_s}{J} \text{ heat unit}$$

If the steam raised is wet, with a dryness fraction of q the final vol. of the 1 lb of steam is qV_s

$$\text{work done for 1 lb of wet steam} = \frac{144\ pqV_s}{J}$$

The internal Energy of steam i.e.

The internal energy of steam is the total energy stored in the steam. The latent heat of steam consists of the internal latent heat plus the external work of evaporation, while the total heat of steam or the sensible heat plus internal latent heat, plus the external work of evaporation

A vol: of 1
cylinder
for the

Thus, the internal energy of steam is the actual heat energy above the freezing point of water, stored in the steam it may be found by substracting the external work of evaporation from the total heat.

Let. E = Internal Energy of 1lb of dry steam

H_s = Total heat of 1lb of dry steam at a pr: P

$\frac{144 P v_s}{J}$ = External work of evaporation of 1lb of steam at a pr: P

∴ Total heat of steam = External work of evaporation + internal energy

$$\text{Total heat of steam } (H_s) = \frac{144 P v_s}{J} + E$$

If the steam is wet with a dryness fraction of q

$H_w = h + qL$

$E = H_w - \frac{144 P v_s q}{J}$

If the steam is superheated to a vol: of v' ft³ per lb :-

$H_{sup} = h_w + L + S(t_s - t_1)$

$E = H_{sup} - \frac{144 P v'}{J}$

Equations

① $H_{wet} = h + qL$
② $H_{dry} = h + L$
③ $H_{sup} = H_{dry} + S'(t' - t_s)$
④ External work = $\frac{P(v_s - v)}{J}$ or $\frac{P v_s}{J}$ (dry) $\frac{P v_s q}{J}$ (wet)
⑤ Internal energy = E
$H_{wet} = E + \frac{P v_s q}{J}$
$H_{dry} = E + \frac{P v_s}{J}$
$H_{sup} = E + \frac{P v'}{J}$
⑤ $H_{sup} = H_s + S(t_s - t_1)$
$= (h + L) + S(t_s - t_1)$

P, v = ft³ per lb/ft²
t = ans: unit

Problems

① Wt: 100 lbs to begin a certain amount steam obtaining External work done of pressure with dryness friction of 0.9 find

(1) centigrad unit (2) B.Th.u unit

Pressure abs = gauge + atmospheric

Wt: P = 100 lbs/□" gauge = 115 lbs/□" abs
= 100 + 14.7 = 115

dryness friction = .9

External work done = $\frac{144 P q v_s}{J}$ heat unit

$= \frac{144 \times 115 \times .9 \times 3.82}{1400} = \frac{16550 \times 3.42}{1400}$

$= \frac{57700}{1400} = 41.2$ C.H.U

External work done = $\frac{144 \times 115 \times .9 \times 3.82}{778}$ ft lb unit

$= \frac{57700}{778} = 74.2$

= 144 × 100 × .9 × 4.44 / 1400 = 51600/1400 = 41.2 C.H.U

Problem

2 0.95 dryness friction ফল 0.5 lb steam এর 5 lb পানির সাথে মিশ্রণ করা হলো atmospheric pressure এ। তাহলে মিশ্রণে কতটুকু পানি গরম হবে এবং কতটুকু steam ঘনীভূত হবে: মিশ্রণের তাপমাত্রা কত হবে: তা নির্ণয় কর।

dryness fraction = 0.95

wt: of steam = .5 lb
water = 5 lb

মিশ্রণের তাপমাত্রা = 68° F

Total heat of steam = $H_w = h_w + qL$

এখানে h_w এর মান negligible ধরলে $H_w = qL$

$H_w = .95 \times 970.5$
$= 923$

Prob

4 Dry saturated steam at 200 lb/in² abs is superheated at constant pressure to 450°F. Calculate the heat supplied per lb of steam. Take mean specific heat of superheated steam as 0.55 Btu/lb°F.

Total heat of superheated steam = $H' = H_1 + C_p(t' - t_1)$

$= 1199.3 + 0.55(450 - 387.9)$

$= 1199.3 + 34.1$

$= 1233.4$ Btu/lb

Heat supplied = $1233.4 - 1199.3 = 34.1$ Btu/lb

5 Steam at 200 lb/in² abs pressure is superheated at constant pressure to 450°F. Calculate the heat supplied per lb of steam. Take mean specific heat of superheated steam as 0.55 Btu/lb°F.

Pressure = 200 lb/in² abs

Temp = 450°F

Total heat of superheated steam = $H' = H_1 + C_p(t' - t_1)$

$= 1199.3 + 0.55(450 - 387.9)$

$= 1199.3 + 34.1$

$= 1233.4$ Btu/lb

Heat supplied = $1233.4 - 1199.3 = 34.1$ Btu/lb

$$1156.2 - \frac{14400 \times 4434}{778}$$

$$1156.2 - \frac{63800}{778}$$

$$1156.2 - 82$$

$$= 1106.2$$

Dryness fraction

$$h_f + x h_{fg} + g l$$

$$= 298.5 + .8 \times 889.7$$

$$= 298.5 + 711.1$$

$$= 1009.6 \text{ Btu}$$

$$E = h_w - g l$$

$$= 1009 - \frac{144 \times 100 \times .5 \times 4.7 \times 34}{778}$$

$$= 1009.5 - 82 \times .5$$

$$= 94.39 \text{ Btu}$$

6 Heater of 0.95 dryness steam ~~to~~ to 100°C and pressure of steam 40 ft/sec heater ~~to~~ 20°C

Specific of steam $= \eta_3 v_3$

$$= .95 \times 1.434 = 4.21 \text{ ft}^3/\text{lbs}$$

$$= 4.21 \text{ ft}^3/\text{lbs}$$

$$1 \text{ lbs} = 4.21 \text{ ft}^3$$

$$1800 \text{ lbs} = ? = 186.2 \text{ lbs/hr}$$

Volume of steam/sec $= \frac{\pi}{4} (\frac{1}{12})^2 \times 40$

$$= \frac{\pi}{4} (\frac{1}{12})^2 \times 40 \times 3600 \text{ ft}^3/\text{hr}$$

$$= \frac{\pi}{4} \times \frac{1}{144} \times 10 \times 3600$$

$$= \frac{\pi \times 3600}{12}$$

$$= \pi \times 150 = 471$$

Mass of steam entering heater

$$= \frac{\pi \times 1 \times 1 \times 40 \times 60 \times 60}{4 \times 12 \times 12 \times 4.21}$$

$$= 165.5 \text{ lb/hr}$$

(b) Steam entering treated

$$h_f + \eta_3 h_{fg} = 165.4 + .95 \times 474.3$$

$$= 165.8 + 450.87$$

$$= 634.85 \text{ Btu/lb}$$

Enthalpy required by water = Enthalpy heat by steam

$$186.5 \times 492.7 + 186.5 \times (164.3 - 90) = m \times (90 - 70)$$

$$m = 1490 \text{ lb/hr}$$

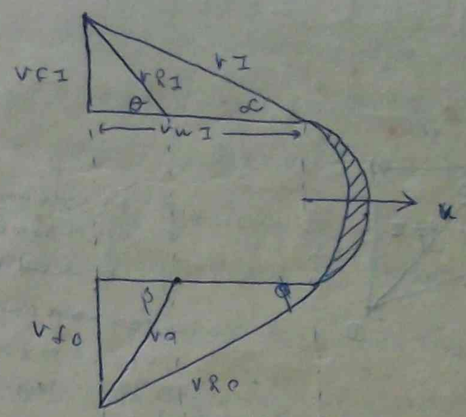
$$m \times (90 - 70) = 186.5 \times (634.8 + 20) - 186.5 \times 10$$

$$m = \frac{145.5 \times 634.8 \times 186.5}{90 - 20} = \frac{1865 + 1865}{70}$$

$$= \frac{186.5 \times 544.8}{70} = \frac{120065}{70}$$

$$= 1450 \text{ lb} = 1715 \text{ lb}$$

Steam Turbines



velocity diagram for moving blades

v = velocity of blade in ft/sec

vs = absolute velocity of steam entering the moving blade in ft/sec

vo = velocity of whirl at exit of moving blade

V_{f1} = velocity of flow at entrance of moving blade = axial component of V1

V_{f0} = " exit " Va

V_{R1} = Relative velocity of steam to moving blade at entrance

V_{R0} " " " at exit

θ = angle entering steam makes with ~~the~~ tangent of wheel at entrance of moving blade

= exit angle of fixed blade or nozzle angle

β = angle discharging steam makes with tangent of wheel at exit of moving blades

θ = entrance angle of moving blade

ϕ = exit angle of moving blade

Θ = vol. of steam over blade in ft^3/sec

w = weight of steam flowing over blade

7 steam 350°F pr 140 lb/in² ~~a~~ Temp

of ~~m~~ pr: 40 lb/in² abs ~~s~~ dryness

pr Internal ~~energy~~ ~~superheated~~

At 140 lb/in² saturation Temp = 353°F

∴ Steam is superheated

∴ degrees of superheat = 483 - 353

= 60°F

From steam tables:—

h = 1228.2 Btu/lb superheated Total heat

Now V_1 = 1.253 (T_{sup} − 353) / P = (from table)

= 1.253 (1228.2 − 633) / 140

= 1.253 × 373.2 / 140

E_1 = $h_1 - P_1 v_1$

= 1228.2 − 144 × 3.52 / 778

= 1228.2 − 1444 × 3.52 / 778

= 1137 Btu

E_2 = $h_f + q_L - P_0 v / 778$

Steam turbine = 736 + 9 × 934.6 − 144 × 40 × 9 × 10.46 / 778

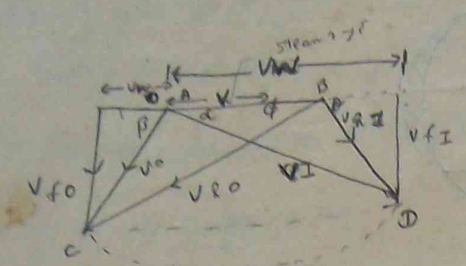
= 1006.2 Btu

∴ Change in energy = $E_1 - E_2$ = 1137 − 1006.2

= 131.0

For 3 lb = 131 × 3 = 393 Btu ✱ (Ans)

A vol: of 10
cylinder in
for the ex



α - Nozzle angle
v = blade speed
φ = blade out angle
V0 = whirl (ಸುಳಿ) velocity
Vf1 = flow velocity
V1 = Steam ಜೆಟ್ ವೇಗ

$V_{R0} = V_{R1}$ (without friction) V_{R0} "

Algebraic different of velocity of whirl $= V_{w_1} + V_{w_0}$

= Sum horizontal projections

work done on blade

$= \frac{w}{g}(V_{w_1} + V_{w_0})$

$= \frac{w}{g} \times CD$

work done on blade / sec = force × distance moved / sec

$WD = \frac{w}{g} \times (V_{w_1} + V_{w_0})$

$HP / \text{blade ring} = \frac{w(V_{w_1} + V_{w_0})v}{g \times 550}$

work done on blade / lb of steam $= \frac{(V_{w_1} + V_{w_0})v}{g}$

Energy supplied to blade per 1 lb of steam } = K.E of jet at entrance per 1 lb of

$= \frac{V_1^2}{2g}$

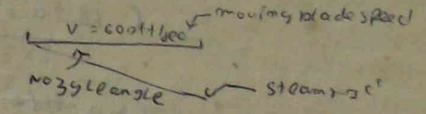
Prob

Steam Turbine ಯಲ್ಲಿ Nozzle ನ 2 lb/sec steam ಅನ್ನು 2400 ft/sec speed ನಲ್ಲಿ ಪ್ರವಹಿಸಲು: ಹಿಗೆ moving blade speed 600'/sec ಆಗಿದ್ದರೆ Nozzle ಅನ್ನು 16° ಕೋನದಲ್ಲಿ Blade ಗೆ velocity co-efficient 0.72 ಕೊಡಲಾಗಿದೆ

(a) blade efficiency
(b) H.P developed by the blade
(c) The energy lost in the blade / sec ಅನ್ನು ಕಂಡುಹಿಡಿಯಿರಿ

Blade out let angle 25° ಕೊಡಲಾಗಿದೆ

Scale 1" = 600'/sec 2400 ft/sec = 4"



$V_{R1} = 3.05'' = 1830$ ft/sec

$V_{R0} = 2.25'' = 1350$ ft/sec

$V_{w_1} = 3.85'' = 2310$ ft/sec

$V_w = 1.05'' = 630$ ft/sec

$\therefore CD = V_{w_1} + V_{w_0} = 2310 + 630 = 2940$ ft/sec

blade effcy: $= \frac{w(V_{w_0} + V_{w_1})v/g}{w V_1^2/2g} \times 100$

$= \frac{2vCD}{V_1^2}$

$= \frac{2 \times 600 \times 2940}{2400 \times 2400} \times 100$

$= 61.2\%$

(b) H.P developed by the blade —

$$= \frac{W\,V_R\,(v_{w_1} + v_{w_0})}{g \times 550}$$

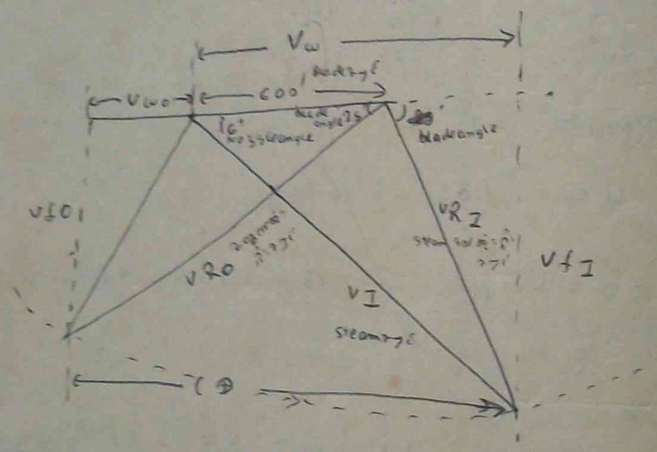
$$= \frac{2 \times 60 \times 2 \times 40}{32.2 \times 550} \times$$

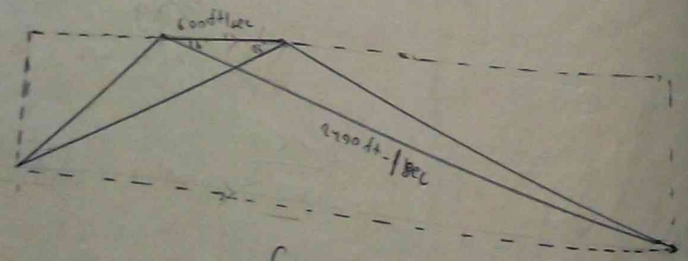
$$= 198 \text{ H.P}$$

(c) effcy: loss blade $/_{sec} = \frac{V_{RI}^2 - V_{Ro}^2}{2g}$

$$= \frac{(1830)^2 - (1350)^2}{2 \times 32.2}$$

$$= 24800 \text{ ft-lb}$$





(Steam diagram)

Prob:

Steam at a velocity of 1500 ft/sec enters impulse wheel having a nozzle angle of 25°. The exit angle of the moving blade is 20° and the relative velocity of steam may be assumed constant over the moving blade. If the blade speed is 600 ft/sec, find the moving blade angle at entrance the exit relative and the direction of the stream flow. D/lb of steam and diagram efficiency.

If the turbine discharges with 400 lbs of steam/sec Find the H.P of the wheel and the axial Thrust

From the information -

$V = 600'/\text{sec}$

$V_I = 1500 \text{ ft/sec}$

$\alpha = 25°$

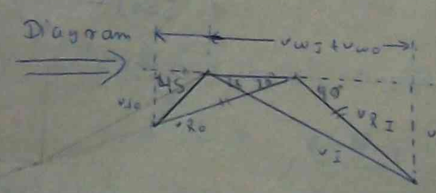
$\phi = 20°$

$V_{Ro} = V_{RI}$, The velocity diagram can now drawn from there data and the following the values can be scaled off the diagram

$\theta = 40$ $\quad V_o = 470'/\text{sec}$ $\quad V_{f_o} = 335'/\text{sec}$

$\beta = 45$ $\quad V_{f_I} = 630'/\text{sec}$ $\quad (V_{w_I} - V_{w_o}) = 1600'/\text{sec}$

Scale = 1" = 1000 ft/sec = 1"



Scale 1000'/sec = 1"

Here $\theta = 90°$ $\beta = 45°$ $v_0 = 470$ ft/sec $v_{f0} = 335$ ft/sec

$v_{f1} = 630$ ft/sec $(v_{w1} - v_{w0}) = 1690$ ft/sec

$$\text{work done of steam} = \frac{(v_{w1} - v_{w0})\,v}{g}$$

$$= \frac{1690 \times 600}{32.2} = 31500 \text{ ft-lb}$$

$$\eta \text{ Pot wheel} = \frac{w(v_{w1} - v_{w0})\,v}{550 \times g}$$

$$= \frac{4 \times 1690 \times 600}{550 \times 32.2} = 279$$

$$\text{Axial thrust} = \frac{w(v_{f1} - v_{f0})}{g}$$

$$= \frac{4(630 - 335)}{32.2}$$

$$= 37.3 \text{ lb}$$

$$\text{Diag: effcy} = \frac{\text{WD/lb}}{\frac{v_1^2}{2g}}$$

$$= \frac{31500}{\frac{1500 \times 1500}{64.4}}$$

$$= \frac{31500 \times 64.4}{(1500)^2}$$

$$= 90\%$$

Scale $= 1000'/\text{sec} = 1''$

$$\frac{v}{g}(v_{w1} - v_{w0}) \times \frac{2g}{v_{f1}^2}$$

$$\frac{2v(v_{w1} - v_{w0})}{v_{f1}^2}$$

Prob Steam with a velocity of 2000 ft/sec enter a impulse turbine row of blades (nozzle angle) at an angle of 25° to a place of rotation of the blades. The mean blade speed is 850 ft/sec. The exit (side) angle from the blades is 30°. There is a 10% loss in relative velocity due to friction in the blades. Determine
(a) the entry angle of the blade
(b) the work done / lbs of steam / sec
(c) the diagram efficiency
(d) the end thrust / lbs steam

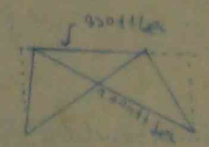
const: of the diagram.

let u = mean blades speed 850'/sec

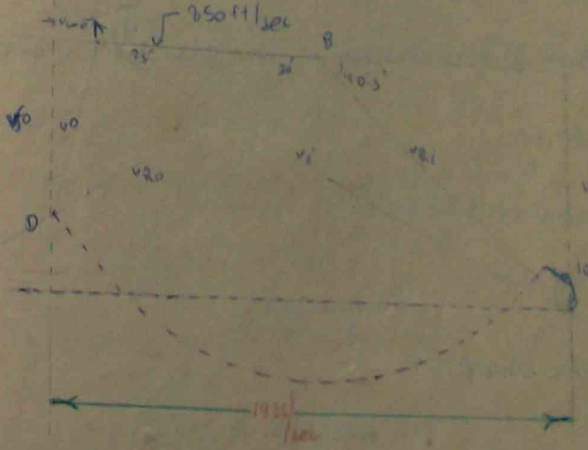
1. set off AB = u = 850'/sec to a suitable scale
2. From A set off AC = v_1 = 2000'/sec to the same scale and at angle 25° to AB
3. join BC which is v_{r1}
4. measure BC and set off length CE (which is 10% of BC
5. with centre B and radius BE joined an ED
6. set off BD at 30° to AB to cut arc ED in D
7. Join AD

ABC is the inlet Δ

ABD is the exit Δ



Scale 500'/sec = 1"



Angle FBC = entry angle of Blade

$$\text{WD on Blade} = \frac{v(v_{w1} + v_{w0})}{g} \quad \text{ft lb/sec}$$

From the diagram the change is velocity of wheel

$= v_{w1} + v_{w0} = 1915'/\text{sec}$

$\therefore$ WD on the Blade $= \frac{850 \times 1915}{32.2}$

$= 50500 \text{ ft-lb/lb}$

diagram effcy: $= \frac{2V(V_{w1}+V_{w2})}{v_1^2}$

$= \frac{2 \times 350 (1915)}{2000^2}$

$= .817 = 81.7\%$

(b) End Thrust = $V_{f0} - \frac{V_{f1}}{g}$ lb

From the diagram, the change in velocity of flow = $V_{f0} - V_{f1} = -235$

∴ End Thrust = $-\frac{235}{32.2} = -7.29$ lb/lb

① Introduction to Thermodynamics ✓

② Heat gain + heat losses ✓

* ③ Expension & compression of ~~heat~~ gases ④ Expansion + compression ✓

④ steam Boilers ✓

⑤ Steam Turbines + Nozzles ✓

⑥ Diesel Engine ✓

⑦ Any one chapter

① Heat Engine 1st law 2nd law clausius law Joules equivalent

~~4 hours~~

Nozzles

① convergent nozzle

② divergent nozzle

The velocity of expending nozzle

The velocity of steam due to an adiabatic expending through nozzle may be calculated by equating the loss of heat of steam to the increase of kinetic Energy

The initial velocity of the steam entering the nozzle may be ~~negalected~~ as relatively small

H_1 = Total heat of steam entering nozzle

H_2 = " " at any section

V = velocity of steam

u = heat drop during expansion = $H_1 - H_2$

Then assuming a frictionless adiabatic flow and ~~for~~ considering 1 lb of steam

gain of kinetic energy = heat drop

$\frac{v^2}{2g} = u$

$v = \sqrt{2guJ}$

when u is ~~F~~ = centigrade unit

$V = \sqrt{2 \times 32.2 \times 1400} \times \sqrt{u}$

$= 300\sqrt{u}$

when u is in Btu $V = \sqrt{2 \times 32.2 \times 778} \times \sqrt{u}$

$V = 224\sqrt{u}$

Throat pr: for max: discharge

Nozzle may designed for max: discharge by discharging for expansion through pr: which will produce this condition.

Let p_1 = initial pr: of steam

- v_1 = " vol: of 1 lb of steam at pr p_1
- p_2 = pr: of steam at throat nozzle
- V_2 = vol: of 1 lb of steam at pr: p_2
- A = area of cross section of nozzle at throat in sq ft.

There is only one value of the ratio $\frac{p_2}{p_1}$ which will produce a maximum discharge for the nozzle this value can be found by differentiating the volume for the wt: of discharge.

W is a function of $\left[\left(\frac{p_2}{p_1}\right)^{\frac{2}{n}} - \left(\frac{p_2}{p_1}\right)^{\frac{n+1}{n}}\right]$

differentiating this expression and equating to zero for a maximum discharge

$$\frac{p_2}{p_1} = \left(\frac{2}{n+1}\right)^{\frac{n}{n-1}}$$

The equation gives the ratio between the throat pr: for max: discharge through the nozzle. The throat of steam nozzle should be ~~discharge~~ designed on this ratio

For the steam which is initially superheated the value of n will be approximately = 1·3 then putting

$$\left(\frac{p_2}{p_1}\right) = \left(\frac{2}{n+1}\right)^{\frac{n}{n-1}}$$

$$\frac{p_2}{p_1} = \left[\frac{2}{2 - 1·3}\right]^{\frac{1·3}{1·3-1}}$$

$$\frac{p_2}{p_1} = ·545$$

Using the mollier's diagram find the velocity of steam assuming in which the steam has been expanded from a initial condition 150 lbs/□" dry to a pr: of 10 lb/in² and dryness ~~for~~ fraction ·95 (neglect friction and check with steam table)

$H_1 = 1196$ $H_2 = 996$

$\therefore H_1 - H_2 = 1196 - 996$

$\therefore u = 200$

$V = 214\sqrt{u}$

$= 214 \times \sqrt{200}$

$= 3160'/sec$

*

Steam engine a ... 240° steam ... exhaust ... steam ... drying friction ... condenser ... 1·5 lb/in² abs: ... condenser ... 62 ... Steam engine ... exhaust ... steam ... 62 ... $m s (119 - 64)$

(b) steam engine ... exhaust ... steam ... 95°C ... condensery ...

(a) Steam ... = 62 ...

$m_s h_{fg} = m . s . t$

$240 \times .8 \times 1028.1 = m \times 1 \times (119 - 64)$

$\frac{240 \times 823}{54} = m = \frac{197500}{54} = 3660$ lb/hr

(b) Steam required = 0.72 kg

$h_w + m \times 8 \times h_{fg} = m_s h_{st}$

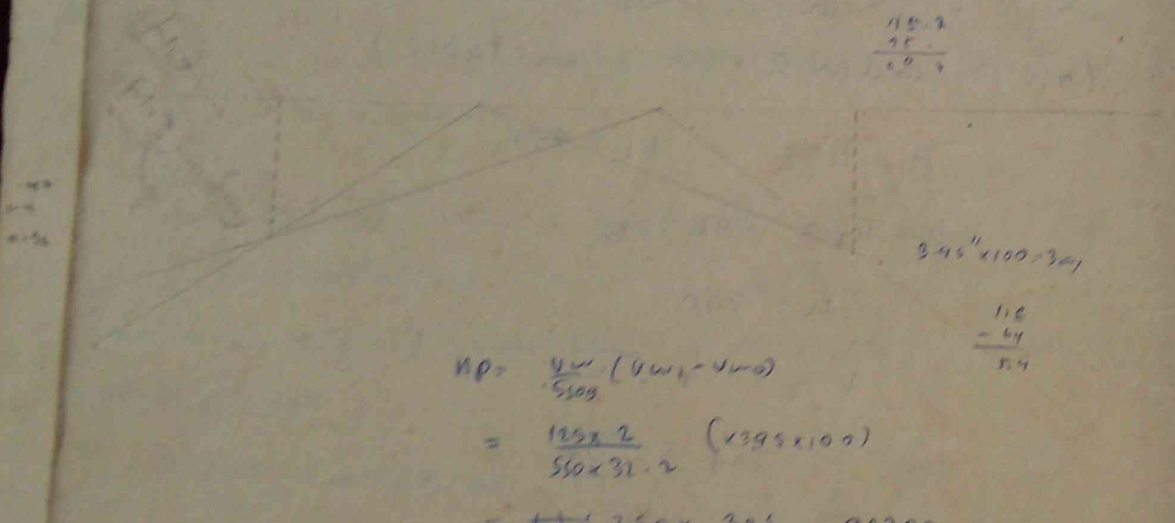
$m_s \times s \times (t_g - t_L) + m \times 8 \times h_{fg} = m_s h_{st}$

$240 \times 1 \times (115.7 - 95) + 240 \times .8 \times 1022 = m \times 1 \times (1148 - 54)$

$240 \times 20.7 + 240 \times 843.7 = 54\,m$

$m = \frac{240 \times 843.7}{54}$

$= \frac{202488}{54} = 3749$ #



$HP = \frac{W}{550} (v_{w_1} - v_{w_0})$

$= \frac{125 \times 2}{550 \times 32.2} (x 395 \times 100)$

$= \frac{250 \times 395}{550 \times 32.2} = \frac{98750}{17700}$

$= 5.57\,HP$

$m = \frac{V}{g} \times \frac{(v_{w_1} - v_{w_0})}{J_L}$

$= \frac{125}{32.2} \times \frac{395}{778 \times 1400} = \frac{49350}{35700} = .823$

$= 82.3\%$

$100'/sec = 1''$ $125'/sec = 1.25''$

60 - 20 = 100 rejected = 72 η_s = 72

∴ rejected 72 - 1822 (o/p)

20000 — ? $= \frac{72 \times 20000}{72}$

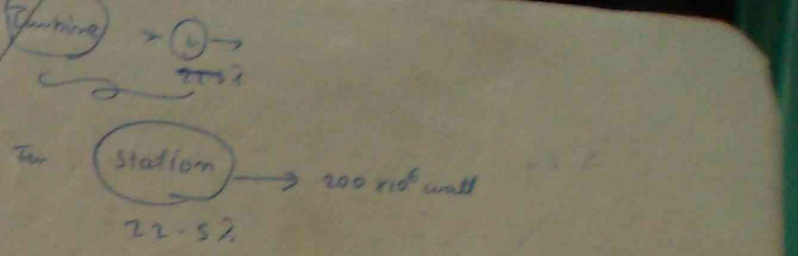
$= \frac{4464000}{72} = 5640$ Btu/min

$HP = \frac{Btu/min \times 778}{33000} = \frac{5640 \times 778}{33000}$

$= \frac{4389000}{33000} = 133\,HP$

rejected 72 = 100

20000 — ? $= 20000.00$



Electrical o/p of Turbine o/p = 100

200x10^6 — ?

$= \frac{200 \times 10^6 \times 100}{95}$ watt

$= \frac{200 \times 10^6}{95 \times 746}$ HP

1 ft-lb = 3.088 Btu

1 HP = 1400 ft-lb

$= \frac{200,000,000}{71000} = 282500\,HP$

The station I/P = $\frac{200 \times 10^6}{.225} = 890 \times 10^6$ HP

$= 890 \times 10^6 \times 550$ ft-lb/sec

$= 890 \times 10^6 \times 550 \times 3600$ ft lb/hr

$= \frac{890 \times 10^6 \times 3.50 \times 3600}{778}$ Btu/hr

$= \frac{890 \times 10^6 \times 550 \times 3600}{778 \times 12000}$ lb/hr

$= \frac{890 \times 10^6 \times 550 \times 3600}{778 \times 12000 \times 2240}$ ton/hr → 43 ton/hr

$P_1 v_1 \frac{m}{m-1} \left(\left(\frac{P_2}{P_1}\right)^{\frac{m-1}{m}} + \left(\frac{P_3}{P_2}\right)^{\frac{m-1}{m}} - 2 \right)$

(incomplete $P_2 = \sqrt{P_1 P_3}$

(2) $P_1 v_1 \frac{m}{m-1} \left(\left(\frac{P_2}{P_1}\right)^{\frac{m-1}{m}} - 1 \right]$ complete mystery

$P_1 v_1^m = P_2 v_2^m$

$C = (u_p - u_v) \times J$

$\frac{T_2}{T_1} =$

ဒီကမှာ ကျွန်တော်တို့ Number of turns (T) ရှိတဲ့ coil တစ်ခုမှာ
သံလိုက်စက်ကွင်းထဲမှာ လှည့်ပတ်ရမှာဖြစ်ပြီး coil ရဲ့ဖြစ်တွေ့မှုဟာ (e.m.f)

$$E = 2TBLV \text{ volts}$$

(mks system)

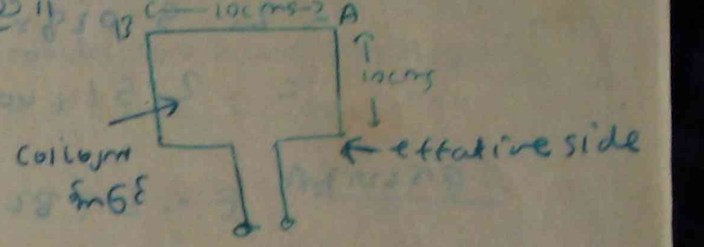
T = Number of turns

coil တစ်ခုမှာ conductor ဘယ်နှစ်ကြိမ်ပတ်ထားသလဲဆိုတာကို ပြောတာပါ။

Prob ✓ BTK

① Number of turns 20 ရှိတဲ့ တစ်ခုတည်းရှိတဲ့ coil တစ်ခုဟာ တစ်စင်တီမီတာ အချင်းဝက်ရှိတဲ့ 10cms ဝန်းကျင်မှာ coil ဟာ Flux density 2000 lines/cm² ရှိတဲ့ သံလိုက်စက်ကွင်းထဲမှာ ပတ်ရမှာဖြစ်ပြီး N = 1200 r.p.m (r/min) အမြန်နှုန်းနဲ့ လှည့်ပတ်ပေးတဲ့အခါ ဖြစ်ပေါ်လာမယ့် e.m.f ကို ရှာပါ။

coil တစ်ခုမှာ ကွေးကွေးလေးတွေ ဖြစ်နေတာကို သတိမထားမိပါနဲ့။ (ဒီ) 30° (ဂ) 60° (ဃ) 90° ဘယ်ဟာကို ရွေးချယ်ရမလဲ။



T = 20

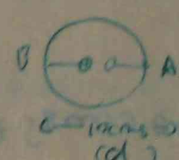
N = 1200 r/min

l = 10cm = .1m

B = 2000 lines/cm²

T = 20

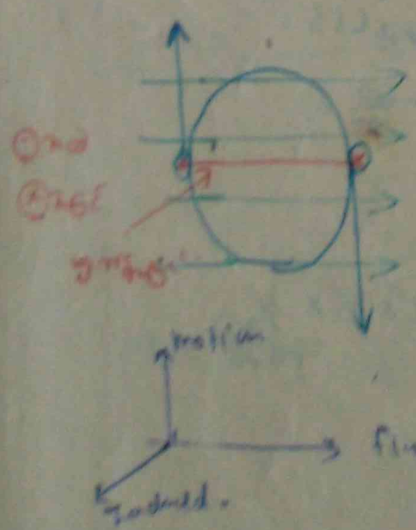
$= \frac{2000}{10^4}$ wb/m²



$E_{av} = 2TBLV$

$V = \frac{\pi dN}{60}$

$= \frac{\pi \times .1 \times 1200}{60} = 2\pi$ m/sec

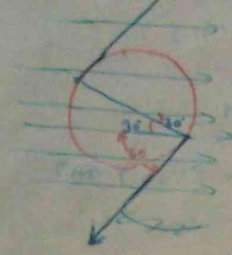


$\theta = (90 - \alpha)$

$\alpha = 30°$

$E_{av} = 2TBLV \sin\theta$

$= 2 \times 20 \times \frac{2000}{10^4} \times .1 \times 2\pi \times \sin 60°$



$\theta = 90 - \alpha$

$= 90 - 30$

$= 60°$

$E = 2TBLv \sin 60°$

$E = \frac{2 \times 20 \times 2000}{10^4} \times .1 \times 2\pi \times \frac{\sqrt{3}}{2}$

$E = 2 \times 2 \times .1 \times 2\pi \times 1.7321$

$= 4 \times .1 \times 8\pi \times 1.7321$

$= 43.5$ volts

ဒုတိယအဖြေ

$E = 2TBLv \sin 30°$

$= 2 \times 5.012 \times \frac{1}{2}$

$= 2.514$ volts

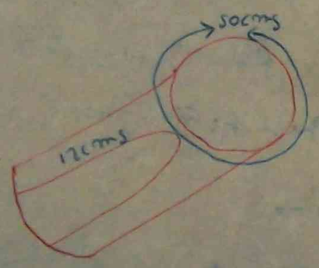
တတိယအဖြေ

$E = 2TBLv \sin 0$

$= 0$ volts

② πd ကိုသုံး

ဖြေရှင်း: 50 cons ဖွဲ့ထားသော Armature ချထားတဲ့ Number ဖွဲ့ထားသော coil တစ်ခု ကို 60 ပတ်ရသည်။ Armature ဟာ Flux Density 1 wb/sqm ဖြတ်သွားသော သံလိုက်စက်ကွင်းထဲတွင် coil ကို အမြန်နှုန်းဘယ်လောက်ဖြင့် လှည့်ပတ်ရမည်နည်း။ ဟုတ်ဖြေထောင့် သည် 60° ဖြစ်သောအခါ coil တွင်ရရှိသော e.m.f သည် 36 volts ဖြစ်လျှင် coil ရဲ့ အလျား ကို ရှာပါ။ Armature ရဲ့ အချင်းသည် 10cms ဖြစ်သည်။



$N = 5$

$B = 1 wb/sq\,m$

$L = \frac{10}{100.}\ m$

$E = 36$ volts

$V = \frac{\pi \times 50}{100} \times$

ဆိုလိုသောအဓိပ္ပာယ်: conductor တစ်ခုတွင် ဖြစ်ပေါ်သော e.m.f. ဟုဆိုလိုသည်

$E = 2TBLv \sin 30°$

$36 = 1 \times \frac{10}{100} \times V \times 2 \times 5 \times \frac{1}{2}$

$V = 72\ cm/sec$

$= \frac{72}{100}$ မီတာ/စက္ကန့် $= .72$ m

1 ——— ? : $\frac{72 \times 100}{\pi \times 50}$

$= \frac{144}{5}$

$= 46.20$ r/min

$V = \frac{\pi dN}{60}$

$72 = \frac{.5 \times N}{60}$

$\therefore N = \frac{72 \times 60}{.5} = \frac{72 \times 600}{5}$

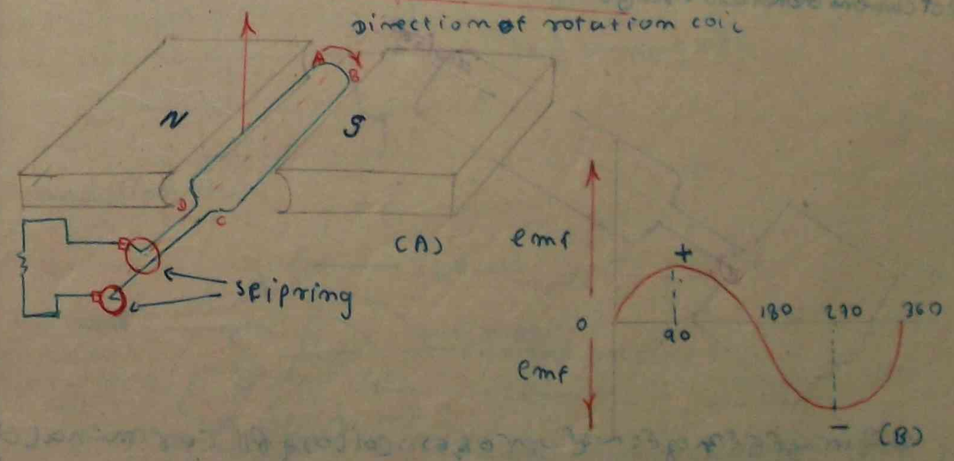
~ 864 r/min

* $E_{av} = 2TBLv$ B, L, v = MKS system
* $E_{av} = 2TBLv \sin\theta$ T = conductor ဘယ်နှစ်ခုရှိသလဲ N = တစ်စက္ကန့်ကို ဘယ်နှစ်ပတ်လည်သလဲ
* $V = \frac{\pi dN}{60}$ m/sec ← N = 1 minute ကို ဘယ်နှစ်ပတ် ဆိုသလဲ ဖြေရှင်းရမည်
* $N = \frac{V \times 60}{\pi d}$ r/min
* ဖြေရှင်းနည်း: တွင်းမြေထဲတွင် conductor ဘယ်နှစ်ခုရှိသလဲ ဖြေရှင်းရမည်

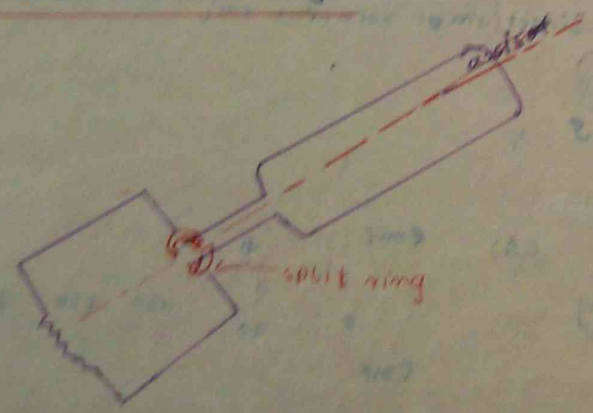
Voltage in A Rotating coil

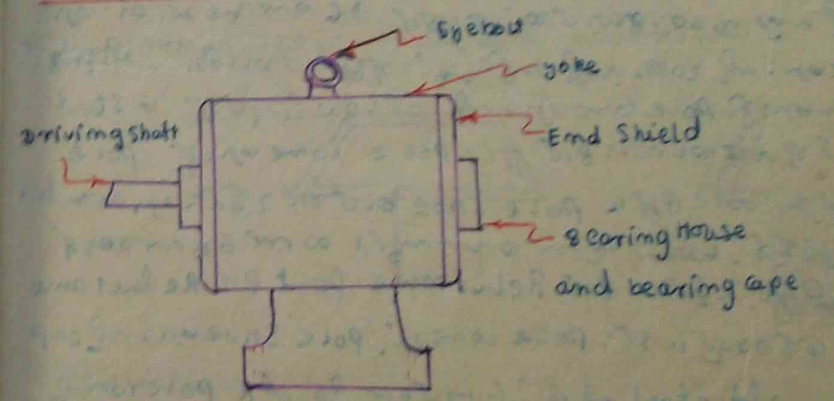
voltage in a rotating coil

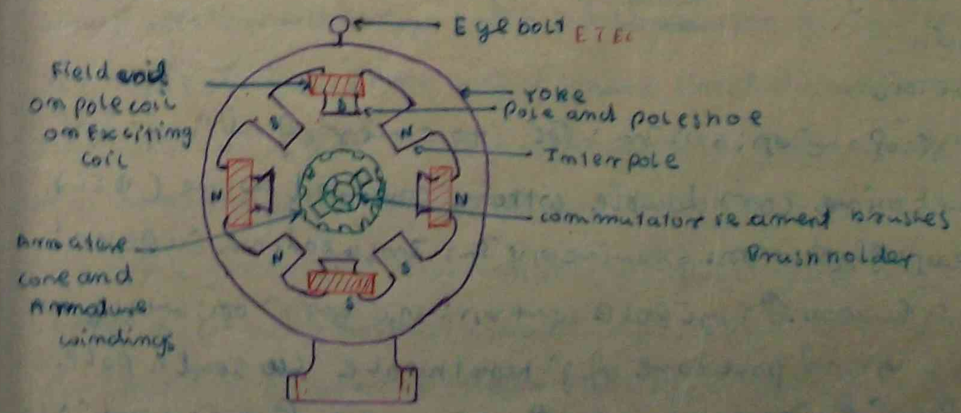
(principle of AC Generator



AD နှင့် BC တို့: သည် coil ရဲ့ slider (ဘယ်: ညာ: ဖြတ်သွားသော)


axis
split ring


Eyebolt
yoke
Driving shaft
End Shield
Bearing house
and bearing cape
Foundation Base


Eye bolt
Field coil
or pole coil
or Exciting
coil
yoke
Pole and poleshoe
Interpole
commutator
Brush holder
Armature
core and
Armature
windings

1. Yoke (or) main Body or frame
2. Polepieces and poleshoe
3. Polecoil (or) megnet (Sling coil or) exciting
4. armature core and armature win (Rotating Part)
5. commutator segments
6. Brushes and brash holder (brushgear)
7. End bell (or) End Shield
8. Bearie (Ball bearie, Rollerbearie, bushbearie)
9. Bearie housing
10. Outer cap Inner cap
11. grease cap and tube for lubricating.

ETEC

① Yoke (or) main body (or) frame

Yoke ගේ ප්‍රධාන කාර්යභාරයන්ගෙන් එකක් වන්නේ cast Iron හෝ mild steel වැනි ද්‍රව්‍ය භාවිතා කරමින් pole core වලට අවශ්‍ය ප්‍රබල චුම්බක ක්ෂේත්‍රය සපයා දීමයි.

ETEC

② Polecoil (or) Pole core (or) pole shunts

pole coil හා pole core යන දෙකම yoke සමඟ සම්බන්ධ කර ඇත. pole coil හරහා D.C ධාරාවක් ගලා යන විට pole core වල චුම්බක ක්ෂේත්‍රය ඇති වේ. pole core වල yoke සම්බන්ධ කරන කොටස bolt හෝ stud මගින් සිදු කරයි. pole core වල pole shoe සවි කර ඇත. pole shoe වල කාර්යභාරය armature core වෙත ක්ෂේත්‍රය ඒකාකාරව බෙදා හැරීම සහ armature reluctance අඩු කිරීම වේ. pole core වල reluctance part වල reluctance අඩු කිරීම සඳහා pole core, pole shoe හෝ cap iron (හෝ) mild steel වලින් සාදනු ලබයි. pole core හි eddy current loss අඩු කිරීම සඳහා laminate test කරනු ලබයි.

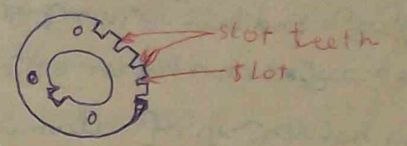
③ pole coil

pole coil එක former මත ඔතා සාදනු ලබයි. former මත ඔතන wire වර්ග enamel wire (or) double cotton covered wire (DCC) වේ. wire ඔතා අවසන් වූ පසු insulation tape මගින් pole core එක ආවරණය කරයි. pole coil එක pole core මත සවි කිරීමෙන් පසු pole core වල north pole හා south pole ඇති වේ. current ගලා යන විට magnetic flux හා

සම්පූර්ණ pole coil එක field exciting coil ලෙස හැඳින්වෙන අතර field coil මගින් field winding ලෙස හැඳින්වේ.

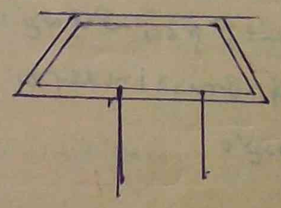
④ Armature core ETEC

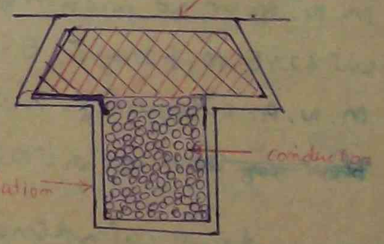
Armature core යනු DC යන්ත්‍රයේ ප්‍රධාන කොටසක් වන අතර එය සිලින්ඩරාකාර හැඩයෙන් යුක්ත වේ. එය සාදා ඇත්තේ සිලිකන් ප්‍රතිශතය $\frac{1}{2}$% ක් පමණ වූ යකඩ තහඩු භාවිතා කරමිනි. armature conductor ගලා යාමේදී armature core එකේ ඇති වන eddy current loss අඩු කිරීම සඳහා තහඩු එකිනෙකින් වෙන් කිරීමට insulation භාවිතා කරයි. shaft එක මත armature core එක සවි කරනු ලබයි.



Armature winding ETEC

Armature core එක මත ඔතා ඇති coil එක armature winding ලෙස හැඳින්වේ. coil එක සාදා ඇත්තේ enamel, single cotton (S.C.C) cover or Double cotton cover wire වලිනි. former එක ඉවත් කරනු ලබන්නේ D.C.C) පසු Insulation paper වලින් ආවරණය කිරීමෙන් armature slot තුළ තබනු ලබයි. armature core එක high speed භ්‍රමණය වන නිසා slot වල තබනු ලබන armature conductor වලට central centrifugal force action එක නිසා බැහැර විසි වීම වැළැක්වීමට fibre හෝ "wedge" වලින් තබනු ලබයි.





ETEC

Commutator

Armature core එකේ භ්‍රමණ චලිතය shaft එක මගින් ලබා ගනී. commutator එක hard drawn copper segments වලින් සාදා ඇත. segments අතර mica insulation මගින් පරිවරණය කරනු ලබයි. commutator එකේ segment එක armature winding එකේ coil එකට electrical connection ලබා දීම සිදු කරයි. D.C generator එකක armature එකේ ප්‍රේරණය වන්නේ alternating current වේ. එය A.C current එක commutator මගින් D.C current බවට පත් කරනු ලබයි.

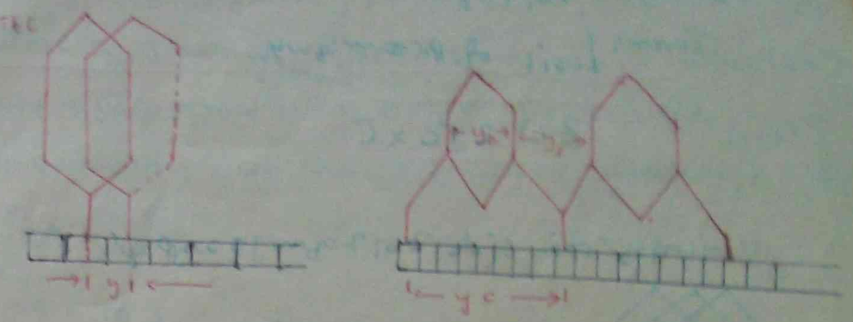
Brush Gear

Brush ဆိုသည် commutator ပေါ်တွင် လျော်ညီစွာ D.C current ကို ပြင်ပ circuit သို့ ပေးပို့ခြင်း ဖြစ်သည်။ Brush များ ကို carbon ဖြင့် ပြုလုပ်ထားသော်လည်း Hardcarbon ဟုခေါ်သော carbon mixture ကို အသုံးပြုကြသည်။ Hardcarbon ဆိုသည်မှာ carbon brush ကို Hardcarbon, Natural carbon graphite Electrographite and metal mixture ကို ရောနှောပြုလုပ်ထားသည်။ Brush များ ကို သတ်မှတ်ထားသော အဓိက ဂုဏ်သတ္တိများ ကတော့ - contact Resistance, specific and - coefficient of friction တို့ ဖြစ်သည်။ carbon brush များ ကို commutator များ ပေါ်တွင် ဖိကပ်ထားသည့် အတွက် တွန်းအားတစ်ခု ရှိသည်။ End bell တွင် ပတ်ထားသော ကြိုးတစ်ခုဖြင့် ပြုလုပ်ထားသော spindle များ ပေါ်တွင် တပ်ဆင်ပေးထားသည့် brush holder များ အတွင်း၌ brush များ ကို ထိန်းသိမ်းထားပေးသည်။ brush holder များ ကို aluminium alloys (သို့မဟုတ်) ဝါယာကြိုး (သို့မဟုတ်) brass ပြားတို့ဖြင့် ပြုလုပ်ထားသည်။ commutator များနှင့် brush များကြားတွင် ဖိကပ်မှုအား ကို Tensite spring များ ပြုလုပ်သည်။ ထို spring များ ကို pressure ကို ချိန်ညှိအောင် ပြုလုပ်ရန် အတွက် တံတောင်ပုံ (lever) များ ပြုလုပ်သည်။ brush များ အတွက် pressure များ 1 lb/in² သို့မဟုတ် 2 lb/in² ထိပေးထားသည်။

Brush holder များ ကို Magnetic Neutral Axis (M.N.A) တွင် ထားရှိပေးရသည်။ အကယ်၍ Brush holder Position များ သည် M.N.A တွင် မဟုတ်ပဲ E.M.F ထုတ်လုပ်သော coil circuit ကို ဖြတ်ပေး ရပေမည်။ Brush များ ကို M.N.A ပေါ်တွင်ထားရှိရန်အတွက် Brush holder များ အား Rocker Ring ~~Rear end~~ တွင် တပ်ဆင်ပေးထားသည်။

Armature winding ETC

DC စက်များ အား ကွိုင်ပတ်ထားသော နည်းလမ်းအလိုက် Armature winding ခွဲခြားနိုင်ပါသည်။ ထို့ များ ကတော့ lapwinding နှင့် wavewinding တို့ ဖြစ်ပါသည်။ ထို winding နှစ်မျိုး ခွဲခြားနိုင်ရန် အတွက် winding များ တွင်ပတ်သော coil များ ရဲ့ အဆုံး၊ အစ ကို commutator segment များ တွင် အဆက်အသွယ် ပြုလုပ်ထားခြင်း ဖြစ်သည်။



Lap winding

wave winding

Y_b = back pitch

Y_f = Front pitch

Y_C = commutation pitch

c = coil side

C_s = coil side

$C_s = Q \times C$ →

$Z = 2 T_c \times C$ →

$P = C = m_s$ →

(lap) $a = P$ →

(wave) $a = 2 \times m$ →

simplex တွင် $m = 1$

Double တွင် $m = 2$

Triple တွင် $m = 3$

C_s = coil side C = coil

Z = conductor အရေအတွက်

T_c = Turn/coil

(coil တစ်ခုတွင် အကွေ့အတက် ဘယ်နှစ်ခု ပါသလဲ)

C ~ coil အရေအတွက် ဖြစ်သည်

a = armature circuit ရဲ့ အခွဲအလိုက်

P = DC စက်၏ pole အရေအတွက်

S = slot အရေအတွက် (coil ထိုးသွင်းရန်)

B = commutator

ETC. Lap winding

(a) simplex Lap winding

$B = C = S$

$a = P$

(b) Double Lap winding

$B = C = 2S$

$a = 2P$

(c) Triple Lap winding

$B = C = 3S$

$a = 3P$

Wave winding

(a) simplex wave winding

$B = C = S$

$a = 2$

(b) Duplex (wave winding

$B = C = 2S$

$a = 2 \times 2$

(c) Triple wave winding

$B = C = 3S$

$a = 2 \times 3$

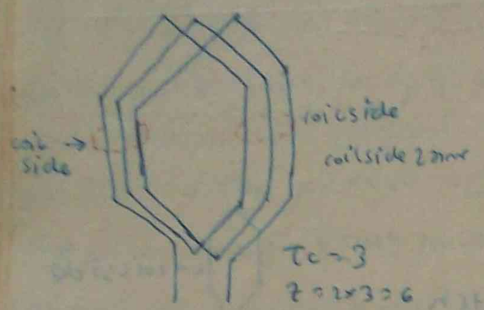
coil ရဲ့ ဂျိုးတိုးအား = coil တစ်ခုတွင် ပါဝင်သော အကွေ့အတက် × T_c

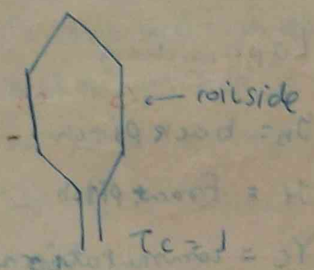
conductor ကို coil side ကို ပြောင်းသည်။

Turns/coil ရှိ. ပြောင်းလဲခြင်း

$$Z = 2Tc \times C$$

coil တစ်ခုတွင် coil side ကို ပြောင်းလဲခြင်း





conductor/coil side = 3

$\frac{\text{conductor}}{\text{coil side}} = \frac{6}{2} = 3$

conductor/coil side = 1

$C/CS = \frac{CQ}{CS} = \frac{2}{2} = 2$

Z/CS = 3

Tc = 3

ETR

① 36 slot armature တွင် ၁ ခု 5 turns/coil ဖြင့် ပြုလုပ်ထား သော armature တွင် conductor ကို coil side/slot တိုင်း ရရှိအောင် winding ပေးပါ။ winding ပေးပုံမှာ simplex lap winding ဖြစ်သည်။ ထို့ပြင် pole ၄ ခု ရှိသော armature circuit တွင် ပေးရမည့် winding ပေးပုံကိုလည်း ဖော်ပြပါ။

S = 36 Tc = 5 , Z = ? CS/S = ? a = ? P = 4

Z C = B = mS

C = mS

C = 1 × 36 = 36

Tc Z = 2 Tc × C

Z = 2 × 5 × 36 = 360

C = 36 ∴ CS = 2C = 72

CS/S = 72/36 = 2

a = pm = 4 × 1 = 4

ETR

② 27 commutator segment, 9 slot, 2 pole, 3 conductor ပါသော armature တွင် 3 turns/coil ဖြင့် ပြုလုပ်ထားသော conductor များ ပေးပုံနှင့် coil side/slot တိုင်း ရရှိပုံ၊ coil side/slot တိုင်း ရရှိသော winding ပေးပုံ၊ ပေးပုံမှာ wave winding ဖြစ်သော

Z = ?

B = 27 S = 9 P = 2 , Tc = 3 CS/Slot = ?

a = ?

C = B = mS

27 = m × 9 m = 3 ∴ Triplelex wave winding ဖြစ်သည်။

Tc = ? C = mS

C = 3 × 9 = 27

∴ CS = 27 × 2 = 54

CS/S = 54/9 = 6

Z = 2 Tc × C

Z = 2 × 3 × 27 = 162

a = 2m = 2 × 3 = 6

∴ Ans a = 6, Z = 162, CS/Slot = 6

ETR

(b) coil တစ်ခုပတ်ရ ပျမ်းမျှ ကြိုးအလျား 30 cms ရှိသော 9 ပေါက် ကွင်းတွင် ပတ်ထားသော coil များ၏ ခုခံအား $\frac{5}{3}$ မြောက်-cm ဖြစ်သော ကြေးနီကြိုးဖြင့် coil တစ်ခုစီ၏ ခုခံအား ရှာပါ။ ထိုကြိုး၏ ဖြတ်ပိုင်းဧရိယာမှာ area မှာ 2.5 cm² ဖြစ်သည်။

coil ခုခံအား = Tc × coil တစ်ခုပတ်ရ ပျမ်းမျှ ကြိုးအလျား

coil တွင် = 3 turn

တစ်ခုပတ်ရ ပျမ်းမျှ ကြိုးအလျား = 30 cms

∴ = 3 × 30 = 90 cms

$R = \frac{\rho L}{A} = \frac{5/3 \times 90 \times 10^{-6}}{2.5} = \frac{150}{2.5} \times 10^{-6}$

$= 60 \times 10^{-6}$

= 60 μΩ or .00006 Ω

(c) ဆိုင်းမ်းတွင်းရှိ ကြိုးအလျား စုစုပေါင်းသည် coil တစ်ခုတွင် ရှိသော ကြိုးအလျား ပေါင်းလဒ်နှင့် ညီမျှသည်။ ဆိုလိုသည်မှာ armature တစ်ခုလုံးတွင် ရှိသော ကြိုးအလျားကို ရှာပါ။

ဆိုင်းမ်းတွင်းရှိ ကြိုးအလျား = 6 Z

conductor အရေအတွက် = 162 ∴ coil side အရေအတွက် = 162

conductor 27 ——— coil 1 coil
27 ——— ? = 54 coil

(∴ armature coil = 54 coil) coil side = 30 cms

∴ armature = 30 × 27 = 1620 cms

$R = \frac{\rho L}{A} = \frac{5}{3} \times \frac{1620}{2.5}\ \mu\Omega = \frac{5 \times 540}{2.5}\ \mu\Omega$

$= \frac{50 \times 540}{25}$

$= 1080\ \mu\Omega$

∴ coil ∥ armature = 1080 μΩ

∥ armature = $\frac{1080}{6} = 180\ \mu\Omega$

∴ armature = 180 μΩ

∥ armature 6 coil 27 coil:

1 ——— ? = $\frac{27}{6} = \frac{9}{2}$ a

coil 1 = 90 cms

coil 9/2 = $\frac{9}{2} \times 30 = 135$ cms

3 × 135 cms = 3L = $R = \frac{\rho L}{A} = \frac{5}{3} \times \frac{135}{2.5} = \frac{50}{3} \times 135 \times \frac{1}{25} = \frac{270}{3}\ \Omega$

$= 90\ \Omega$

$R = \frac{180}{6} = 30\ \mu\Omega$

(c)

1 turn = 30 cms

∥ armature 2 coil 27 = 27 × 3 = 81 cms

(2 × 3 cm)

$= 27 \times 90$ cms

$R = \frac{\rho L}{A} = \frac{5}{3} \times \frac{27 \times 30}{2.5} = \frac{150 \times 27}{2.5}$

$= 60 \times 27\ \mu\Omega$

∥ armature $= \frac{60 \times 27}{6} = 270\ \mu\Omega$

$R_c = .00005\ \Omega$ $C = 27$ $a = 6$

$C/path = \frac{27}{6} = 4.5$

$R/path = 4.5 \times .00005$

$R_a = \frac{R/path}{a} = \frac{4.5 \times .00005}{6} = 4.5 \times .00001\ \Omega$

$= 45\ \mu\Omega$

32 slot 4 poles dc armature: armature of 4 arms/coil, coil side/slot = 2, armature resistance = 0.02 Ω, wire area = 0.02 cm², resistivity = 5/3 μΩ-cm, winding = lap winding, armature resistance?

$R_a = ?$

$R_a = \frac{R/path}{a}$ $\quad R/path = R_c \times \frac{C}{a}$

$C_s/slot = 2$

$C_s = 2 \times 32 = 64$ $\quad C_s = 2C$

$64 = 2C$

$\therefore C = 32$

$C = 32 > S$ $\quad \therefore$ simple lap winding

$\therefore a = mp$

$a = 1 \times 4 = 4$

1 turns = 60 cms

4 ——— ? = 240 cms (1 coil)

$C = 32$ $\quad a = 4$ $\quad \therefore \frac{C}{a} = \frac{32}{4} = 8$ coil

(∥ armature coil)

1 coil = 240 cms

8 ——— ? = 240 × 8 = 1920 cms

$R = \frac{\rho L}{A} = \frac{5}{3} \times \frac{1920}{.02} = \frac{5 \times 640 \times 50}{2}$

$= 250 \times 640\ \mu\Omega$

∴ ∥ armature = $250 \times 640\ \mu\Omega / 160$

4 ——— ? = $\frac{250 \times 640}{4} = 250 \times 160$

$= 40000\ \mu\Omega$

④ 6 Poles 12 slots DC armature ගෙ: ල් 2 Turns/coil, 12 conductor/slot ලිපිදැල් වරකා: ගේ coil ගෙ වර්ගඵලය කීයද? යු ද: ගා 20cms ලී ගැඹුරු ය. ඒ සඳ: ගිය ගෙ: ලී ලිපි: ඔබ්බේ ගිය ලී ඝනඵලය කීයද? area ගා . 26cm² ලී ගැඹුරු ගෙ: ලී ඔබ්බේ ද: ගා 5/3 μΩ -cm ලී winding ගෙ ලී: ඒ ද: ගා wave winding ලිපිදැල් DC armature ඔබ්බේ ගැඹුරු.

$Z/S = 12$

$Z = 12S$

$Z = 2Tc \times C$

$12S = 2 \times 2 \times C$

$\therefore C = 3S$ $\therefore$ Triple lex wave winding ලිපිදැල්.

$= 3 \times 12 = 36$

$\therefore a = 2 \times 3 = 6$

$Z = 2Tc \times C$

$Z = 2 \times 2 \times 3 \times 12$

$= 144$

$\therefore C/a = 36/6 = 6$ coils

$\therefore$ coil ගෙ වර්ගඵලය = 20cms

— 2 ——— ? = 40cms

1 coil ගේ = 40cms

6 ——— ? = 240cms

$R = \frac{\rho L}{A} = \frac{5/3 \times 240}{.25} = \frac{400}{1/4} = 1600 p\Omega$

$\therefore$ ~~coil~~ Path ගෙ ප්‍රතිරෝධය = 1600 pΩ

— 6 ——— ? = $\frac{1600}{6}$

= 266.6 pΩ

= .000266 Ω

⑤ 4 Poles 16 slot DC armature ගෙ: ල් 8 conductor/slot ලිපිදැල් වරකා: ගේ coil ගෙ වර්ගඵලය කීයද? යු ද: ගා 30cms ලී ගැඹුරු ය. ඒ සඳ: ගිය ගෙ: ලී ලිපි: ඔබ්බේ ගිය ලී ඝනඵලය කීයද? area ගා .2 sqcm ලී ගැඹුරු ගෙ: ලී ඔබ්බේ ද: ගා 5/3 μΩ -cm ලී winding ගෙ ලී: ඒ ද: ගා simple wave wound ලිපිදැල් DC armature ඔබ්බේ ගැඹුරු.

$P = 4$ $Z/S = 8$ $\therefore Z = 8S$

$Z = 8 \times 16 = 128$

$Z = 2Tc \times C$ $P = C = B = 1 \times S$

$C = 1 \times 16 = 16$

$\therefore 128 = 2 \times Tc \times 16$

$Tc = 4$ $\therefore \frac{C}{a} = \frac{16}{2} = 8$

$a = 2 \times 1 = 2$

$\therefore$ coil ගෙ වර්ගඵලය 30cms

— 4 ——— ? = 120cms

$\therefore$ coil ගේ ප්‍රතිරෝධය = 120 × 8 = 960cms

$R = \frac{\rho L}{A} = \frac{\frac{5}{3} \times 320}{.2} = \frac{1600}{1/5} = 8000 p\Omega$

$\therefore$ ~~Number~~ ප්‍රතිරෝධය = $\frac{8000}{2} = 4000 p\Omega$

$= .004 \Omega$ (Ans)

* simple — Double-Tripple

2 cs/slot — 4 cs/slot — 8 cs/slot

Tc = ~~Cs~~ Z/cs = 2 $\therefore$ Tc = Z/cs (coil ගේ conductor ගණන = Turn/coil)

CTEC

E.M.F Equation of a DC generator

$$E_g = \frac{\phi Z N}{60} \times \frac{P}{a} \text{ volts} \quad \text{——— *}$$

E_g = Generated e.m.f (volt)

ϕ = useful flux per pole (weber)

Z = no: of armature conductor

N = speed ගැස්සීම (r.p.m) rev/min

P = no of pole

a = no of parallel path

$\phi = B \quad a = p = 4$

$Z = 720 \quad N = 1200 \text{ r.p.m}$

$\phi = 0.05 \text{ wb}$

$E_g = ?$

$$E_g = \frac{\phi Z N}{60} \times \frac{p}{a}$$

$$= \frac{0.05 \times 720 \times 1200}{60} \times \frac{4}{4}$$

$$= 1200 \text{ volts}$$

A 4 pole simplex wound armature has 45 slots each containing 8 conductors. The flux per pole is 0.016 wb. What is the speed at which the armature must be driven to generate an e.m.f of 432 volts?

$p = 4 \quad a = 2 \times 1 = 2$

$Z = 2TC \times C$

$Z = 2 \times 9 \times 8 \times 5$

$Z = 72 \times 45$

$N = 1200 \text{ r.p.m}$

$\phi = 0.016$

$$E_g = \frac{\phi Z N}{60} \times \frac{p}{a}$$

$$= \frac{0.016 \times 72 \times 45 \times N}{60} \times \frac{4}{2}$$

$$= 0.64 \times 810 = 518.4 \text{ volts}$$

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③ A 4 pole generator armature has a simplex wave winding containing 720 conductors. The flux per pole is 0.05 wb. Find the e.m.f generated when the speed is 1200 r.p.m. If the armature winding is changed to duplex wave, what will be the e.m.f generated for the same flux and speed?

$p = 4 \quad a = 2 \quad N = 1200 \text{ r.p.m} \quad \phi = 0.05 \text{ wb}$

$Z = 720$

$E = ?$

$$E = \frac{\phi Z N}{60} \times \frac{p}{a}$$

$$= \frac{0.05 \times 720 \times 1200}{60} \times \frac{4}{2 \times 4}$$

$$= 600 \text{ volts}$$

$Z = 2TC \times C$

$720 = 2 \times TC \times 4 \quad TC = 90$

$S = 24 \quad C_S = 20$

$C_S = 2 \times 4 \times 5$

$C_S/\text{slot} = \frac{2 \times 4 \times 5}{24} = 4$

$Z/S = 18$

④ A generator armature has 4 poles and 43 slots each slot containing 18 conductors which are connected in simplex wave. The generator is driven at 700 r.p.m and generates an e.m.f of 500 volts. Find the flux per pole. If the generator armature is changed to duplex wave, what will be the e.m.f generated for the same flux per pole and speed?

$p = 4 \quad N = 700 \text{ r.p.m} \quad E = 500 \text{ volts}$

$Z = 43 \times 18 = 774$

$\phi = ?$

$$E = \frac{\phi Z N}{60} \times \frac{p}{a}$$

$$500 = \phi \times \frac{774 \times 700}{60} \times \frac{4}{4} \times 43$$

$$\phi = \frac{500 \times 60}{43 \times 774} = \frac{2.93}{43} = 0.068 \text{ wb}$$

$Z/S = 18$

$Z = 18 \times 5$

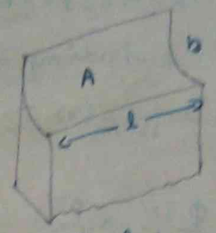
$$E = \frac{\phi Z N}{60} \times \frac{p}{a}$$

$$E = \frac{2 \times 10^{-2} \times 18^{5} \times 700}{60} \times \frac{4}{4} \times 43$$

$$= \frac{4343.4}{10} = 5.4 \text{ volts} \times 43 = 232.2$$

$\phi_t = B \times A$

$= B \times \frac{\pi d^2}{4}$

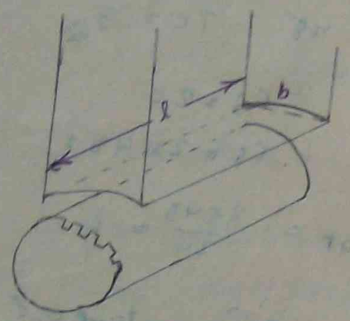


$A = l \times b$

$\boxed{\phi_t = B_f \times A}$

ϕ_t → l = effective length of conductor or length of armature core or length of pole shoe

b = length of pole arc



(1) generated e.m.f 250 volts ഉള്ള 250 r.p.m ൽ 6 poles wave wound DC generator ന്റെ armature core ന്റെ 40 cms നീളമുള്ള ഒരു conductor 30 cms ഉള്ള pole shoe ന്റെ കീഴിൽ ഉണ്ട്. pole arc ന്റെ armature നിന്റെ ഏത്ര ഭാഗമാണ്? ഓരോ armature winding ലും 11 turns/coil Duplex winding ഉള്ള ഒരു dynamo ന്റെ commutator segment നിന്റെ എണ്ണം 72 ഉം ഓരോ flux density യും കണ്ടുപിടിക്കുക.

$E_g = 250V$

$N = 250$ r/m

$a = 2 \times 2 = 4$

$d = 30$ cms $= .3$m

$P = 6$

length $= 40$ cms $= .4$m

$T_c = 11$

$B_s = 72$

$B_f = ?$

① commutator ന്റെ ϕ_μ

② pole ന്റെ കീഴിൽ വരുന്ന armature area

③ ϕ_t = pole ന്റെ B_f ഉള്ള flux

$\frac{\phi_t}{\phi_\mu}$ = leakage factor

$E_g = \frac{\phi Z N}{60} \times \frac{P}{a}$

$250 = \frac{\phi \times 72 \times 11 \times 2 \times 250}{60} \times \frac{6}{4}$

$\phi = \frac{10}{30 \times 11}$

$B = \frac{\phi}{A} = \frac{10 \times 30}{30 \times 11 \times 4 \times 72} = \frac{300}{30 \times 4 \times 72}$

$= \frac{300}{45 \times 4 \times 72} = \frac{300}{498}$

$= .603$

* leakage factor or leakage coefficient = $\frac{\text{Total flux}}{\text{Useful flux}}$

leakage factor = $\frac{\phi_t}{\phi_\mu}$

(2) 4 poles DC generator ന്റെ armature winding ഉം simple wave winding ഉള്ള conductor നിന്റെ എണ്ണം 720 ഉം 250 volts ഉത്പാദിപ്പിക്കുന്ന armature winding ഉം simple wave winding ഉള്ള conductor നിന്റെ എണ്ണം 720 ഉം pole ന്റെ flux ഉം .015 ഉം ആയാൽ leakage coefficient കണ്ടുപിടിക്കുക.

$E_g = \frac{\phi Z N}{60} \times \frac{P}{a}$

$240 = \frac{\phi_\mu \times 720 \times 72\phi}{6\phi} \times \frac{4}{2}$

$\frac{1440}{720 \times 150 \times 2} = \phi_\mu$

Leakage coefficient = $\frac{\phi_t}{\phi_\mu} = \frac{.015}{\frac{1440}{720 \times 150}}$

$= \frac{.015}{\frac{1 \times 720}{240 \times 150}} = \frac{.015}{.012} = 1.25$

③ 6 Poles 1000 r.p.m DC generator armature simple lap winding ... conductor ... 288 ... pole ... area 100 sq.in ... flux density 50000 lines ... air gap ... generated e.m.f ... (240 volts)

④ 8 Poles simple wave wound armature ... conductor ... 40 cms ... pole core ... air gap ... flux density 15000 lines/sq.in ... leakage factor 1.2 ... 300 r.p.m ... generated e.m.f ... (618 volts)

⑤ 4 Poles simple wave wound DC armature ... bore diameter 28" ... conductor ... 320 ... pole arc / pole pitch = 0.63 ... flux 1.6 wb/m² ... 720 r.p.m ... generated e.m.f ... 61 conductor ... 8"

③ $P=6 \quad N=1000 \quad Z=288 \quad A=100 \text{ sq.in}$

$B = \frac{50000}{10^8} = \frac{5}{10^4}$ wb/in²

$\therefore \phi = BA = \frac{5}{10^4} \times 100 = 500$ wb

$= \frac{5}{100} = \frac{1}{20}$ wb

$Eg = \frac{\phi Z N}{60} \times \frac{P}{a}$

$= \frac{\frac{1}{20} \times 288 \times 5}{60} \times \frac{6}{6}$

$= 240$ VOLTS

④ $P=8 \quad Z=200 \quad B = 15000$ lines/cm² $= \frac{15000}{10^8} = 1.5$ wb/cm²

$d = .4$ m $\quad N = 300$ rpm

$\frac{\phi_t}{\phi_u} = 1.2 \quad Eg = ?$

$\phi_t = B \times A$

$= 1.5 \times \frac{\pi}{4} \times .16 = 1.5 \times .04 \times \pi$

$= .06\pi$

$\frac{.06\pi}{\phi_u} = 1.2$

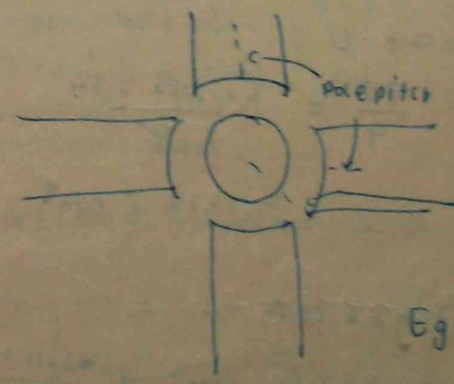
$\frac{.06\pi}{1.2} = \phi_u$

$\frac{6\pi}{120_{20}} = \phi_u \quad \therefore \phi_u = \frac{\pi}{20}$

$Eg = \frac{\phi Z N}{60} \times \frac{P}{a}$

$= \frac{\frac{\pi}{20} \times 200 \times 300}{60} \times \frac{8}{2} = 618$ VOLTS

⑤ $P=4 \quad Z=520 \quad l = 8" \quad N = 720$ rpm $\quad Eg = ?$



$Z = ?$

$\phi = B \times A$

$Eg = \frac{\phi Z N}{60} \times \frac{P}{a}$

$\phi = ?$

$\frac{1 \text{ pole arc}}{1 \text{ pole pitch}} = 0.63$

1 pole arc $= .63 \times 1$ pole pitch

$= \frac{.63 \times \pi \times (8")^2}{4}$

$= .63 \times \frac{\pi \times 28}{4}" = 7\pi \times .63"$

$$\phi = \frac{1.6 \times (2.54)^2}{10000} \text{ wb/in}^2 \times \pi \times .63 \times 8$$

$$Eg = \frac{\frac{1.6 \times (2.54)^2}{10000} \times \pi \times .63 \times 8 \times 520 \times 720}{60} \times \frac{4}{2}$$

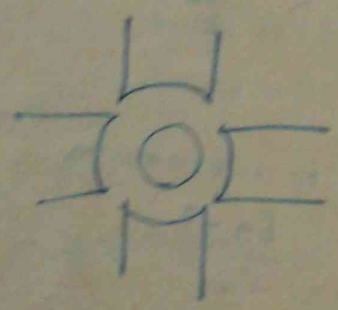
$$= \frac{1.6 \times 2.54 \times 2.54 \times \frac{22}{7} \times .63 \times 8 \times 520 \times 720 \times 4}{10000 \times 60 \times 2}$$

$$= \frac{51.2 \times 4 \times 1 \times \pi \times 2.54 \times 2.54 \times 520 \times 720}{120000}$$

$$= \frac{2250 \times 2644 \times 6.46 \times \pi}{12000}$$

$$= \frac{820 \times 20.3}{12} = \frac{16650}{12}$$

$$= 1$$



P=4 Z=520

N=720 rpm

a=2

$$\text{Pole arc} = \frac{\pi d}{4} = \pi \times \frac{28}{4} \times 2.54$$

$$\frac{\text{Pole arc}}{\text{Pole pitch}} = .63 \qquad = 17.78\ \pi \text{ cm}$$

Pole arc = .63 × 17.78 π cm

$$A = .63 \times 17.78 \pi \times 8 \times 2.54 \text{ cm}^2 = \frac{.63 \times 17.78 \times 8 \times 2.54 \times \pi}{100 \times 100}$$

$$\phi = \frac{1.6 \text{ wb/cm}^2}{x} =$$

$$\phi = \phi A = \frac{1.6 \times .63 \times 17.78 \times 8 \times 2.54 \times \pi}{10000} \text{ wb}$$

$$Eg = \frac{\phi Z N}{60} \times \frac{P}{a}$$

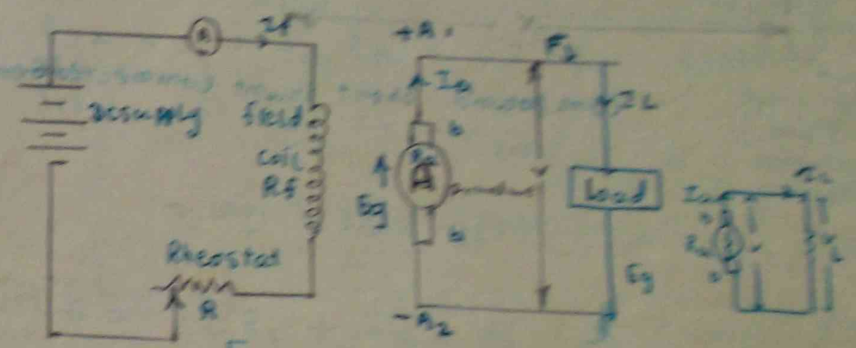
$$= \frac{1.6 \times .63 \times 18.78 \times 8 \times 2.54 \times 520 \times 720}{10000 \times 60} \times \frac{4}{2}$$

$$= \frac{25.6 \times 2644 \times 3.98 \times 4}{60000}$$

$$= \frac{236.5 \times 2644}{6000} = \frac{625000}{60} = 1042.5 \text{ volts}$$

Type of generator

① separately excited generator



$V_{A_1-A_2}$ = V = Terminal voltage

V_L = Load voltage

Eg = generated e.m.f

I_a = Armature current

I_L = Load current

I_f = Field current

R_a = Armature resistance

R_f = field winding resistance

R_L = Load resistance

R_f = Rheostat resistance

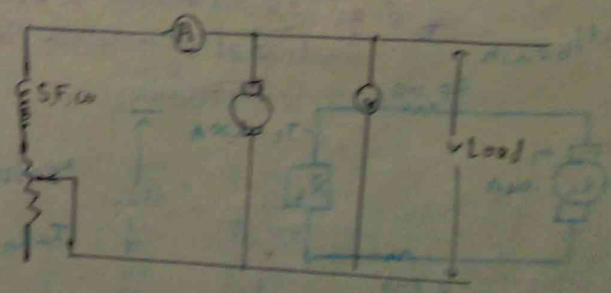
$I_a = I_L$

$V_{A_2-A_1} = V_L + 2I_L R_f$

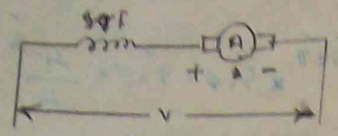
$$Eg = I_L R_L + I_a R_a + I_a R_b + I_a R_c - I_L + 2 I_L R_f$$

$$\therefore Eg = V + I_a R_a + 2 I_a R_b$$

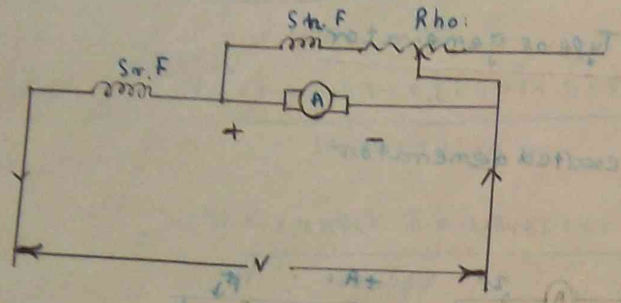
② Self excited generator



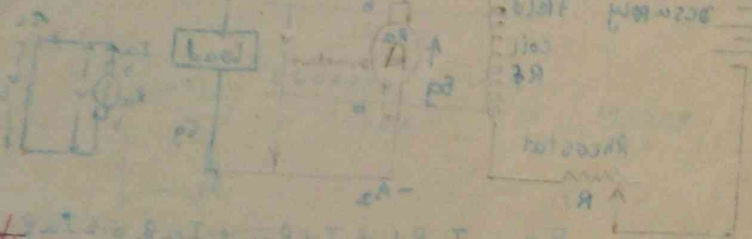
Shunt generator



Seriesgenerator

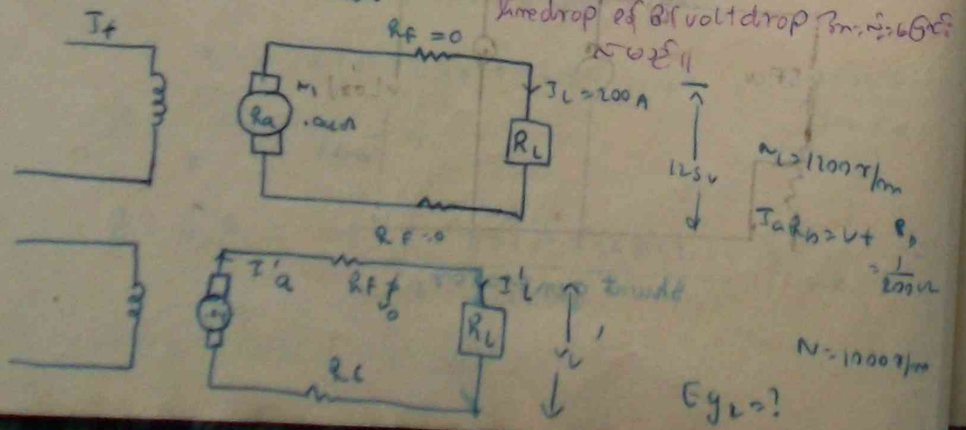


compound short shunt connected generator



ETR

ဝန်ပေါ်တွင် ဖိုးအား ကျဆင်းသွားသောအခါ ဗို့အားကို မူလအတိုင်း ပြန်ရောက်အောင် ပြုလုပ်ပေးသော ကိရိယာကို ဗို့အားထိန်းစက် ဟုခေါ်သည်။ ဗို့အားထိန်းစက်တွင် 125volt 200 amp ထုတ်ပေးသော ဂျင်နရေတာကို အသုံးပြုသည်။ ဂျင်နရေတာ၏ field current သည် ပတ်ပတ်လည် ခုခံအား 1000 Ω ဖြင့် ထိန်းညှိထားသည်။ $R_a = .04\ \Omega$ ဖြစ်ပြီး brush drop = 1 volt/brush ဖြစ်သည်။



* ဒီအခြေအနေတွင် current ထုတ်ပေးရသော brush drop နှင့် line drop တို့ကြောင့် ဗို့အားကျဆင်းမှုကို ပြန်လည်ထိန်းညှိပေးရမည်။

$Eg_1 = V + I_a R_b + 2 I_a R_b$

$Eg_1 = V + I_{a_1} R_a + 2$

$Eg_1 = 125 + 200 \times .04 + 2$

$= 135\ V$

$Eg \propto \phi N$

$\frac{Eg_1}{Eg_2} = \frac{\phi_1 N_1}{\phi_2 N_2}$ (Field current နှင့်အချိုးကျ ϕ နှင့်အချိုးကျ)

$\frac{Eg_1}{Eg_2} = \frac{N_1}{N_2}$

$\frac{135}{Eg_2} = \frac{1200}{1000}$

$Eg_2 = \frac{1350}{12} = 112.5\ V$

$I_a R_b = 1$

$I_a = 200\ amp \therefore R_b = \frac{1}{200}\ \Omega$

$I_L R_L = 125$

$200 R_L = 125$

$\therefore R_L = \frac{125}{200}$

$Eg_2 = V' + I'_a R_a + 2 I'_a R_b$ (Load ဘက်ရှိ brush volt drop နှင့် armature drop တို့ကိုပါ ထည့်တွက်ရန်)

$112.5 = V' + I'_a (.04 + 2 \times \frac{1}{200})$

$= V'_L + I'_a (.05)$

$112.5 = I'_L R_L + I'_a \times .05$

$= I'_a (\frac{125}{200} + .05)$

$I'_a = \frac{112.5}{(.625 + .05} = \frac{112.5}{.675} =$

$I'_a = 166.66\ amp$

$\frac{\phi}{l} = \frac{4\pi I z}{10 l}$ * $\phi = \frac{P A 4\pi I z}{10 l}$

$\frac{\phi}{r} = \frac{4\pi I z}{10 l}$ field current နှင့်အချိုးကျ ϕ ပြောင်းလဲသွားမည်။

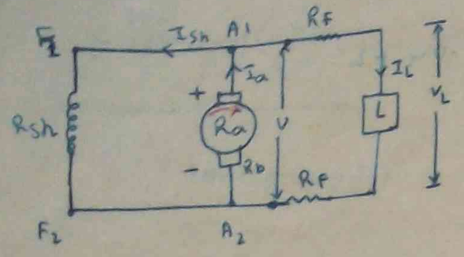
$\phi = \frac{P A 4\pi I z}{10 l}$

$\frac{Eg_1}{Eg_2} = \frac{\phi_1 N_1}{\phi_2 N_2}$

$\frac{Eg_1}{Eg_2} = \frac{\phi_1 N_1}{2\phi_1 N_2}$

$\therefore Eg_2 = 2 Eg_1$

Shunt Generator



$I_a = I_L + I_{sh}$ ——*

$I_L = \frac{R_L}{V_L} = \frac{V_L}{R_L}$ ——*

$I_{sh} = \frac{V_{F_1-F_2}}{R_{sh}} = \frac{V_{A_1-A_2}}{R_{sh}} = \frac{V}{R_{sh}}$ ——*

$V = V_L + 2\,I_L R_F$ ——*

$E_g = V + I_a R_a + 2\,I_a R_b$ ——*

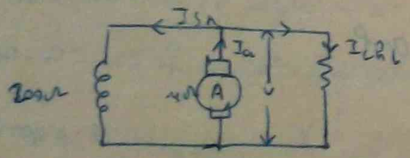
V = Terminal voltage

P_L = Load ಗಿರ Power (watts)

R_{sh} = Shunt field ತಾಂತ್ರ (Ω)

ex① BTCL

4pole 750r.p.m simple wave wound shunt generator ಅಂಕಿ: ಅದ $R_a = .4\Omega$ $R_{sh} = 200\Omega$ ಇವಿಂಕಿ: ಪ್ರತಿ ಕಂಡಕ್ಟರ್ ಇಂದ ಇಂಡಿಯ ಆಗುವ 720 ಫ್ಲಕ್ಸ್ conductors ಇಂದ ಇಂಡಿಯ ಆಗುವ 720 ಫ್ಲಕ್ಸ್ Flux/Pole 28.95 millilines ಫ್ಲಕ್ಸ್ ಆಗುತ್ತದೆ. ಇದಾಗ generator ಕಿ ಎಷ್ಟು load ಆದಾಗ ಅದರ Terminal voltage ಅನ್ನು ಲೆಕ್ಕ ಹಾಕಿ.



P=4 N=750 r/min

a=2 R_a=0.4Ω

R_{sh}=200Ω Z=720

$\phi = 28.95 \times 10^{-3}$ wb

R_{sh}=10 V=?

$E_g = I_a R_a + 2\,I_a R_b + 2\,I_a R_F + I_L R_L$

Terminal voltage ಆಗಿ V

$= I_a R_a + 2\,I_a R_b + V_L$

$E_g = I_a R_a + V_L$

$V = 2\,I_a R_F + I_L R_L$

$\therefore V = I_L R_L = V_L$

$\therefore V_L = E_g - I_a R_a$

ex. $E_g = \frac{\phi Z N}{60} \times \frac{P}{a}$

$= \frac{28.95 \times 10^{-3} \times 720 \times 750 \times 4}{60 \times 2}$

$= 521$ volts

$I_a = I_L + I_{sh}$

$= \frac{V_L}{R_L} + \frac{V_L}{200}$

$V_L = 521 - \left(\frac{V_L}{10} + \frac{V_L}{200}\right) \times .4$

$= 512 - \frac{21\,V_L}{200} \times .4$

$V_L + \frac{8.4\,V_L}{200} = 521$

$V_L = \frac{521}{208.4} \times 200 = 500$ volts //Ans

E_g = Load + line + brush + armature

brush drop ಕಿ armature drop ಅನ್ನು ಕಂಡು ಹಿಡಿಯಬೇಕು

feeder drop + load drop = V_{sh}

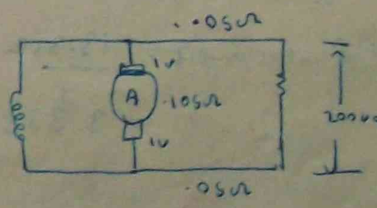
Exercise

① Shunt generator ಅಂಕಿ: ಟರ್ಮಿನಲ್ ವೋಲ್ಟ್ 200 volts, 20 kw load ಆಗಿದೆ. Resistance .05Ω ಇರುವ feeder ಮೂಲಕ ಲೋಡ್ ಗೆ ಕರೆಂಟ್ ಕೊಡಲಾಗುತ್ತಿದೆ. R_{sh} = 100Ω R_a = .1Ω volt drop/brush = 1 volt ಆಗಿದ್ದರೆ generated e.m.f ಕಂಡು ಹಿಡಿಯಿರಿ.

(222.7205 volts)

② 4pole shunt generator ಅಂಕಿ: ಆದ simple lap winding ಆಗಿದೆ. ಇದರ field Resistance 150Ω armature ನಿರೋಧಕ .1Ω ಆಗಿದೆ. ಜನರೇಟರ್ ಆದ 200 volts, 40 watts ಔಟ್ ಪುಟ್ ಕೊಡುತ್ತಿದೆ. ಇದಕ್ಕೆ ಅನ್ವಯವಾಗುವ brush ಗಳಲ್ಲಿ 1 volt ಡ್ರಾಪ್ ಆಗುತ್ತದೆ. generated e.m.f armature ನಲ್ಲಿ ಎಷ್ಟು ಕರೆಂಟ್ ಉತ್ಪತ್ತಿ ಆಗುತ್ತದೆ ಎಂದು ಕಂಡು ಹಿಡಿಯಿರಿ.

(203.339), (3.33 amp)



① I_{sh} = 20

$I_L = \frac{20 \times 1000}{200}$ = 100 amp

Eg = ?

$I_{sh} = \frac{200}{100} = 2$ A

$I_a = 1.1 + 100 = 102.1$

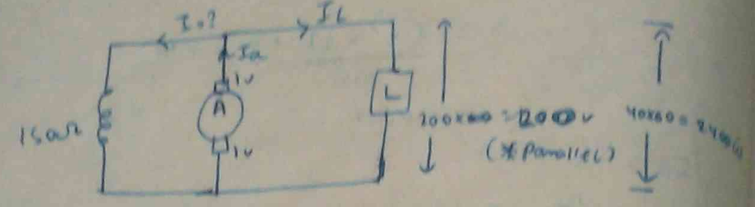
$E_g = V_L + 2 \times I_L R_F + 2 \times I_a R_b + I_a R_a$

$E_g = 200 + 2 \times 100 \times .05 + 2 \times 1 + .1 \times I_a$

$= 200 + 10 + 2 + .1 \times 102.1 = 222.71$

$= 210 + 2 + .1 \times 102.1 = 233.21$

(2)



Load power = 40×60 = 2400 watts

Load drop = 200×60 = 12000 200V

∴ Load current = $\frac{2400}{200}$ = 12 amp

∴ Field voltage = 200V

∴ Field current = $\frac{200}{150}$ = 1.332 amp

∴ I_a = 1.332 + 12 = 13.332 amp

∴ Eg = brush drop voltage + armature voltage + load drop voltage

= 2 + 13.332 × .1 + 200

= 2 + 1.332 + 200

= 203.332 volts //

$E_g = \frac{\phi Z N}{60} \times$ P = 4

a = 4 × 1 = 4 wave

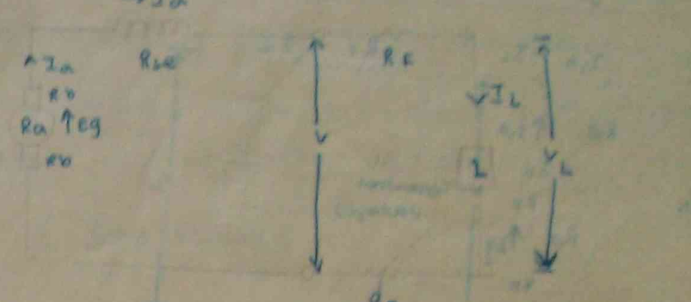
Number = 42

Number of pole current = I_a

Number of pole current = $\frac{13.332}{4}$

= 3.333 #

Series Generator



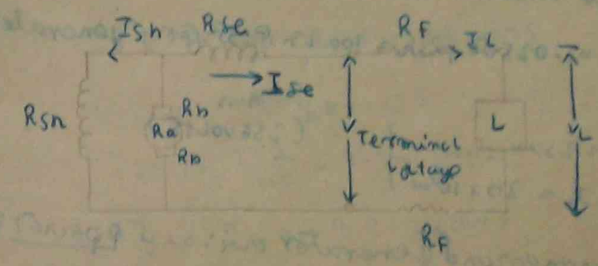
$I_a = I_{se} = I_L = \frac{P_L}{V_L} = \frac{V_L}{R_L}$ ——— *

$V = V_L + 2 I_L R_f$ ——— *

$E_g = V + I_a R_a + I_{se} R_{se} + 2 I_a R_b$ ——— *

compound Generator

(a) short shunt compound generator



$I_{se} = I_L$

$I_a = I_L + I_{sh}$

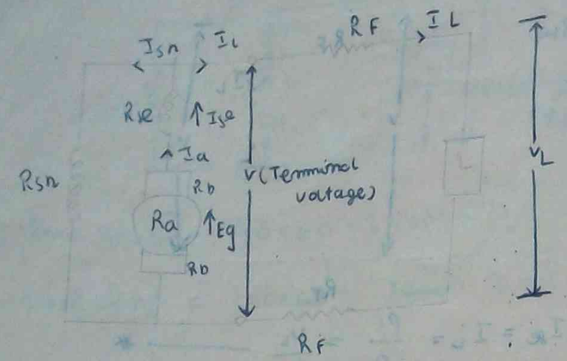
$I_L = \frac{P_L}{V_L} = \frac{V_L}{R_L}$

$I_{sh} = \frac{V_{sh}}{R_{sh}} = \frac{V + I_{se} R_{se}}{R_{sh}}$

$V = V_L + 2 I_L R_f$

$E_g = V + I_{se} R_{se} + I_a R_a + 2 I_a R_b$

(2) Long shunt compound generator



$$I_{sh} = \frac{V_{sh}}{R_{sh}} = \frac{V}{R_{sh}} = V_L + 2\frac{I_L R_f}{R_{sh}}$$

$$I_L = \frac{P_L}{V_L} = \frac{V_L}{R_L}$$

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

$$E_g = V + I_a R_a + I_{se} R_{se} + 2 I_a R_b$$

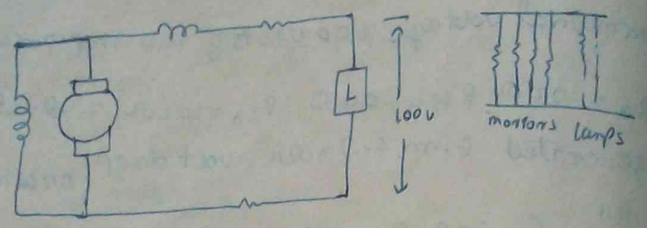
IL
Ish
Ia
Eg

(1) 250volts, 20kw short shunt compound generator ని: ఉన్నది Ra = .05 Ω, Rse = .025Ω, Rsh = 100Ω ని: ప్రా: లో generated e.m.f ఎంత?

$$\left[\begin{array}{l} V = 250v \\ V \times I_L = 20 \times 10^3 w \end{array}\right]$$ Ams (256 volts)

(2) Short shunt compound generator ని: ని ప్రధాన: ఫీడర్ లో ప్రధాన Feeder లో ని ప్రధాన ని ని: ని ని ని: ని ని: ని ని ని: ని ని: ని ని ని:

Load

② 

Motor 4ai: current = 40×4 = 160 amps

Net supply watts = 60×200
= 12000 watts

∴ current = $\frac{12000}{100}$ = 120 amps

∴ I_L = 160 + 120 = 280 amps

Terminal voltage = 280×.05 + 100 = 114 Ans

& line + Resdrop = (.05 + .05) × 280

= .1 × 280 = 28 volts

∴ V = 100 + 28 = 128 volts

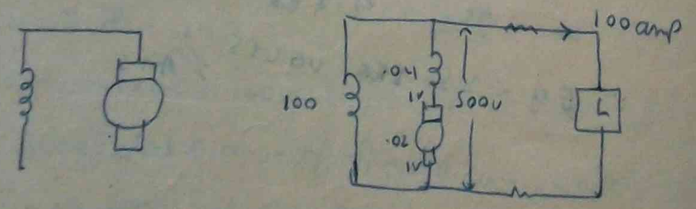
∴ V_{sh} = 128 volts

$I_{sh} = \frac{128}{50}$ = 2.56 amps

∴ I_a = 2.56 + 280 = 282.56 amps

Eg = 128 + 282.56 × .02 + 2

= 130 + 5.6 = 135.6 volts // Ans

③ 

Eg = ?

$I_{sh} = \frac{500}{100}$ = 5 amps

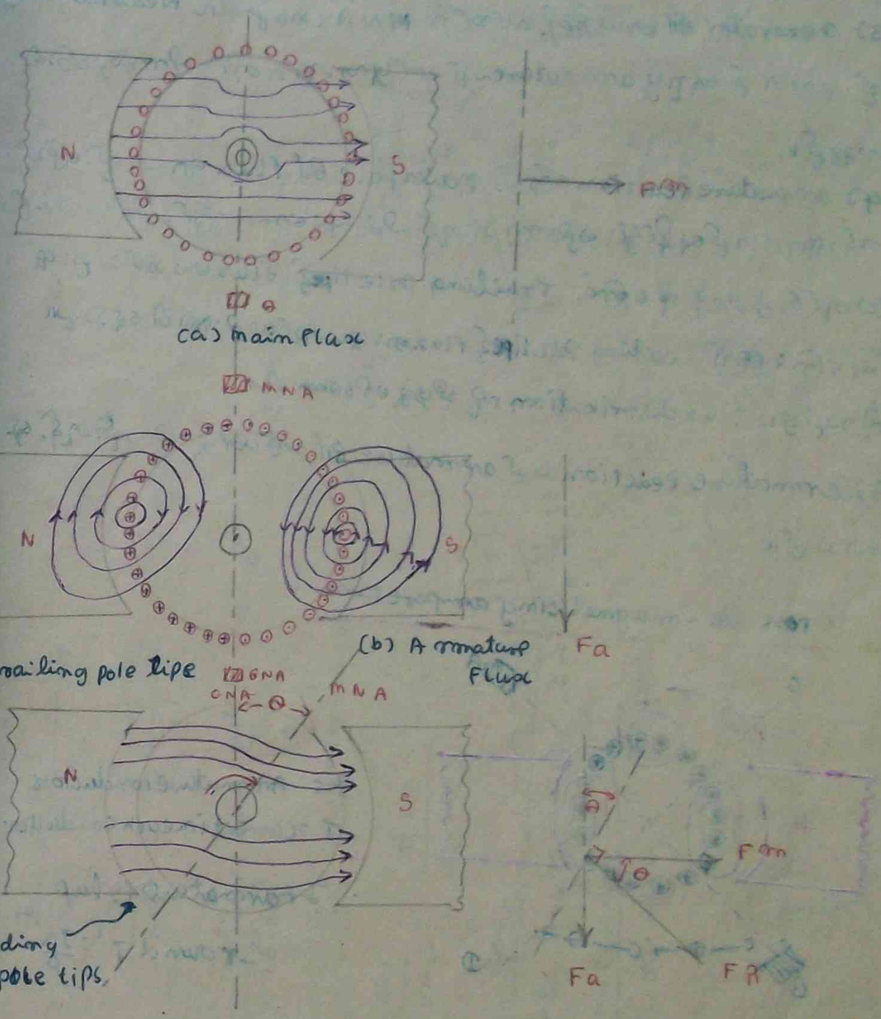
∴ I_a = 100 + 5 = 105 amps

Eg = 500 + 2 + .02 × 105 + .04 × 105

= 502 + 105 × .06

= 502 + 6.3 = 508.3 volts // Ans

Armature Reaction



(c) Resultant flux distribution when load

Armature Reaction ဆိုတာကတော့ Armature ဟာလည်း သံလိုက်စက်ကွင်း (Electromagnet) တို့ ဖြစ်ပြီး ဘေးက main pole တို့ရဲ့ magnetic field နဲ့ armature conductor တို့ရဲ့ current စီးလာလို့ ဖြစ်ပေါ်လာတဲ့ magnetic field တို့ ဆွဲဖျက်ပြီး ရုပ်သွားတဲ့ ဖြစ်စဉ်ကို ခေါ်တာပါ။ ဒီလို ဆွဲဖျက်ပြီး ရုပ်သွားတဲ့ အတွက်ကြောင့် (c) main pole ရဲ့ စီးသွားမယ့် flux တွေ

ကို ဖြစ်စေတယ်။

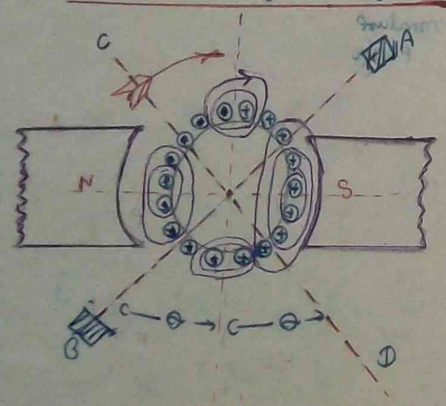
(2) cross magnetising effect ကြောင့် ပြင်းထန်တဲ့ flux ဆွဲအားကို ကွင်း, ဒီဟာ ဖောက်ကားတဲ့ magnetic field ရဲ့ flux ဆွဲအားကို ကွင်းစေတယ်။ ဒီတော့ ကွင်းတဲ့ field ဟာ ပြောင်းသွားတယ်။

(3) Generator ရဲ့ brush တွေကို တည်ထားတဲ့ MNA (magnetic Neutral Axis) သည် ရှေ့တက် ဖြစ်နေပြီး armature ဟာ လှည့်နေတဲ့ ဘက်ကို လိုက်ပြီး ဖိအားကို ဖြစ်စေတယ်။

(4) armature Reaction ကြောင့် main pole ရဲ့ flux ဟာ ပြောင်းသွားတဲ့ ဘက်ကို ကွင်းစေတယ်။ ဒီဟာက ဘယ်ကွင်း, ဒီဘက်ကို ဖောက်ကားတဲ့ ကွင်းကြောင့် ဖြစ်ရတာပါ။ ဒီတော့ leading pole tip ဆီကို flux ဟာ သွားသည်ထက် trailing pole tip ဆီကို flux ဟာ သွားသည်က ပိုများသွားတယ်။ ဒီတော့ leading pole tip ဆီကို flux ဟာ သွားသည်ထက် trailing pole tip ဆီကို flux ဟာ သွားသည်က ပိုများသွားတယ်။ ဒီတော့ flux distribution ကို ပြောင်းလဲစေတယ်။

(5) armature Reaction သည် armature ရဲ့ လှည့်ပတ်နှုန်းကို လျော့နည်းစေတယ်။

cross de-magnetising ampere turn



Z = Armature conductor
I = current in each conductor

If armature is lap
wound $I' = \frac{I_a}{P}$

Z = armature conductor
I' = current in each conductor

$I' = \frac{I_a}{P}$ (∵ simple lap wound)

$I' = \frac{I_a}{2}$ (∵ simple wave wound)

P = no: of pole

θ_m = for wound lead in mechanical degree

∴ LAOC နှင့် LBOD အတွင်း ရှိသော conductors = $\frac{4\theta_m}{360} \times \frac{Z}{2}$

∴ LAOC နှင့် LBOD အတွင်း ရှိသော turns = $\frac{4\theta_m}{360} \times \frac{Z}{2}$

" = $\frac{2\theta_m}{360} \times Z$

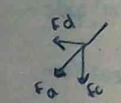
∴ 1 c magnetising ampere turns / pair of pole = $\frac{2\theta_m}{360} \times t \times I'$

∴ 1 c magnetising amp-turns / pole = $\frac{2\theta_m}{360} \times Z \times \frac{Z'}{2}$

= $\frac{\theta_m}{360} \times Z I'$

or

$\theta_m = \frac{2\theta_e}{P}$



$$ATd/pole = \frac{\theta_m}{360} \times ZI'$$ ——*

LAOD နှင့် LBOC အတွင်း ရှိသော conductor တွေ သည် သူတို့ တွေ့ magnetising conductors တွေ ဖြစ်သည်။

$$\therefore ATc/pole = ZI'\left(\frac{1}{2P} - \frac{\theta_m}{360}\right)$$ ——*

Electrical degree နှင့် mechanical degree အကြားဆက်

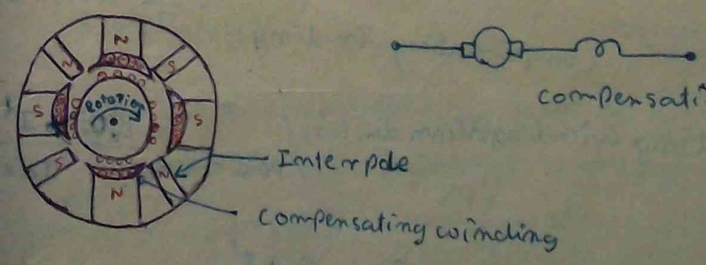
$$\theta_m = \frac{2\theta_e}{P}$$

Armature Reaction ကို နှိမ်နင်းဖို့ ပြုလုပ်ထားတဲ့ နည်းလမ်းများ

① compensating winding ကို pole face တွေ အတွင်း ထည့်သွင်းခြင်း

② Inter pole တွေ အကြား ကြိုးတွေ ချိတ်ဆက်ခြင်း ဖြစ်ကြသည်။

① compensating winding

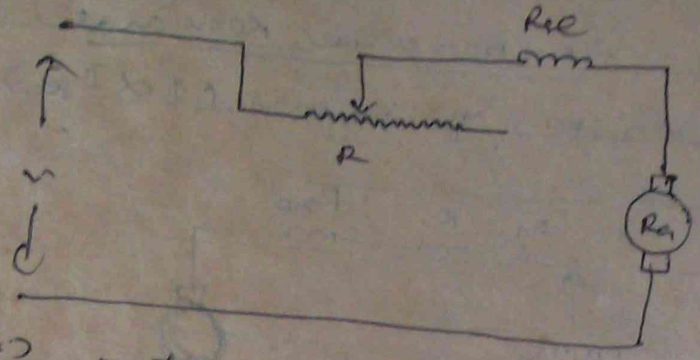


ဒီနည်းလမ်းတွေက armature reaction ကို နှိမ်နင်းဖို့ ဒီဇိုင်းဆွဲတုန်းကတည်းက ထည့်သွင်းထားတာ ဖြစ်ပါတယ်။ armature reaction ကို ဖြစ်ပေါ်စေတဲ့ armature current ရဲ့ တန်ဖိုးအတိုင်း ဒီ compensating winding ကို ချိတ်ဆက်ထားတာ ဖြစ်ပါတယ်။

6.8.80

D.C

(a) Armature control or Rheostatic control

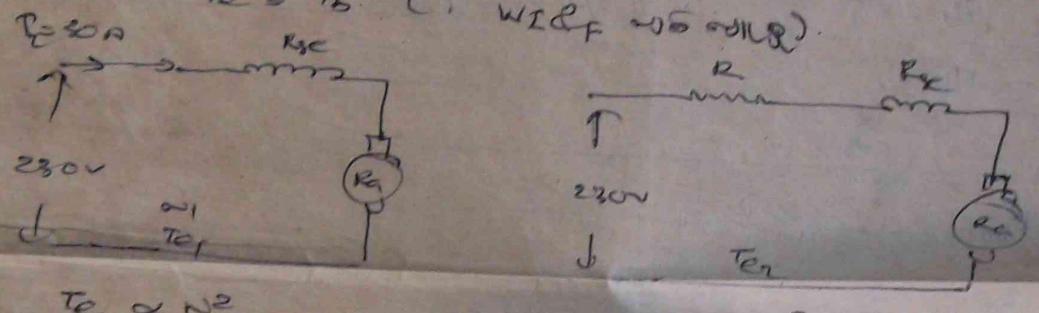


$$N \propto \frac{V - I_a R_{am}}{\phi}$$

$$R_{am} (R_f + R_{se} + R_a)$$

ပုံစံ (၁) motor စဝင်ချက် ၆ ကိုသော၊ series motor ကို ၂၃၀V dc supply line မှ ၃၀ amp: ယူသုံးစဲ့၊ တိုက်ဆိုင်သော အိုးမှုပမာဏကို ပေးနိုင်ရန် လုပ်ဆောင်ရသည့် load torque သည် လည်ပြီး နှုန်းသည်ကို ကိုယ်တိုင်ရေးဆွဲပြီး၊ မူလတွဲ့ လည်နှုန်းအား ၄၀% လောသွားစေရန် armature နှင့် series ဆက်ထားရန် resistance တန်ဖိုးကို ကိုယ်တိုင်ရွေး။ $\phi \propto I_{se}$ ဟုယူဆ၍ Iron and friction losses များကို လျစ်လျူရှုပါ။

$T_e = T_b$ (ဆိုလိုသည်မှာ WIRE ဟု ဆိုလိုသည်)



$T_{e1} \propto N_1^2$

$T_{e2} \propto N_2^2$

$R_{am}(R_{se} + R_a) = 0.6\,\Omega$

$N_2^2 = 0.6 N_1$

$R = ?$

$$\frac{E_{b1}}{E_{b2}} = \frac{\phi_1 I_{a1}}{\phi_2 I_{a2}}$$

$$\frac{N_1^2}{N_2^2} = \frac{30 \times 30}{I_{a2} \times I_{a2}} \quad (\because \phi_1 \propto I_{se_1},\ \phi_2 \propto I_{se_2})$$

$$\frac{N_1^2}{.6^2 \times N_1^2} = \frac{30^2}{I_{a2}^2} \quad (\because .6 \times .6 N_1 = 40\%\ \text{of}\ N_1)$$

$I_{a2} = .6 \times 30 = 18\,A$

$$\frac{E_{b1}}{E_{b2}} = \frac{\phi_1 N_1}{\phi_2 N_2}$$

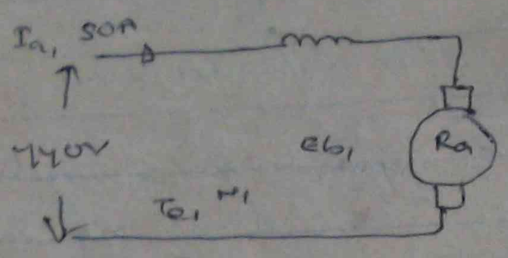
$$\frac{V - I_a R_{am}}{V - I_{a2}(R_{am}+R)} = \frac{30 \times N_1}{18 \times .6 N_1}$$

$$\frac{230 - 30 \times .6}{230 - 18(.6+R)} = \frac{1}{.6}$$

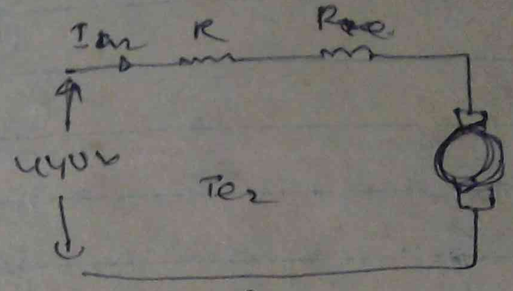
$R = 7.74\,\Omega$

series motor ಅನ್ನು flux ಅನ್ನು series field ಅಂಕುಡೊಂಕಿನ ಮೇಲೆ ಅವಲಂಬಿಸಿರುತ್ತದೆ

(I) series motor ಅನ್ನು ಒಂದು ಮೋಟಾರ್ ತೆಗೆದುಕೊಳ್ಳಿ 440V ಮತ್ತು armature ನಲ್ಲಿ 50A ಹರಿಯುತ್ತಿದೆ ಎಂದು ಇಟ್ಟುಕೊಳ್ಳಿ. ಈಗ load Torque ಅನ್ನು ಎಷ್ಟು ಆದರೆ ಅಷ್ಟು armature ನಲ್ಲಿ 50A. ಆಗುವಂತೆ ಮಾಡಿ. ಈಗ ಮೋಟಾರ್ ವೇಗ 50% ಆಗಬೇಕು ಎಂದರೆ ಮೋಟಾರ್ ಗೆ series Resistance ಅನ್ನು ಸೇರಿಸಬೇಕು. ಆಗ Rm ಮತ್ತು WF losses ಅನ್ನು ಸಹ ಅಷ್ಟೇ ಇರುತ್ತದೆ. ($\phi \propto I_{se}$)



$T_{e_1} \propto N_1^3$



$T_{e_2} \propto N_2^3$

$N_2 =$ [illegible] N_1

Rm = ಮೋಟಾರ್ ಅಲ್ಲಿ

$$\frac{T_{e_1}}{T_{e_2}} = \frac{\phi_1 I_{a_1}}{\phi_2 I_{a_2}} \quad (\phi \propto I_{se})$$

$$\frac{N_1^3}{(.5N_1)^3} = \frac{50 \times 50}{I_{a_2} \times I_{a_2}}$$

$$I_{a_2} = 50 \times 50 \times .5^3$$

$$= 50 \times .5 \times \sqrt{.5} = 25 \times \sqrt{.5} = 25 \times .7065$$

$$= 17.66 \text{ Amps}$$

$$\frac{E_{b_1}}{E_{b_2}} = \frac{\phi_1 N_1}{\phi_2 N_2}$$

$$\frac{440 - 50 \times 0}{440 - 17.66 (R_{se})} = \frac{50 \times N_1}{17.66 \times .5 N_1}$$

$$50(440 - 17.66 R_{se}) = 440 \times 17.66 \times .5$$

$$440 - 17.66 R_{se} = \frac{440 \times 17.66 \times .5}{50} = 77.6$$

$$17.66 R_{se} = 362.4$$

$$R_{se} = 20.6 \ \Omega$$

Example.

① 8 Pole generator ಯಲ್ಲಿ 612 Armature ಇದೆ simplex lap winding ಪ್ರಕಾರ 1152 conductor ಇವೆ. Full load current ಯು 800 amps ಪ್ರತಿ full load ನಲ್ಲಿ armature ಯು 15% ಆಗಿ GNA ಆಗಿ 1 pole pitch ಆಗಿರುವಂತೆ ಇರಲು ಎಷ್ಟು ampere turns/Pole ಗೆ ATd/Pole ಮತ್ತು ATc/Pole ಅನ್ನು ಲೆಕ್ಕಿಸಿರಿ.

1 Pole pitch — 180 (e)

1 Pole pitch ಆಗಿರುವ 15% — $180 \times \frac{15}{100} = 18 \times \frac{3}{2} = 27$ (e)

$\therefore \theta_m = \frac{20}{P}$

$I' = \frac{I_a}{P} = \frac{800}{8}$

$\theta_m = \frac{2 \times 27}{8} = \frac{54}{8} = \frac{27}{4}$

$\therefore ATd/Pole = \frac{\theta_m}{360} \times Z I'$

$= \frac{99^3}{\cancel{360}} \times \frac{1}{\cancel{99}} = 1152 \times \frac{3}{\cancel{800}}$

$= \frac{3456}{8} = 2160$ AT

$ATc/Pole = Z I' \left(\frac{1}{2P} - \frac{\theta_m}{360} \right)$

$= \frac{Z I'}{2P} - \frac{\theta_m Z I'}{360}$

$= \frac{576 \times 100}{4 \times 8} - 2160$

$= \frac{57600}{8} - 2160 = 5400$

$= 7200 - 2160 = 5040$ AT

② 4 Poles ಸಂಯೋಜನೆಯ wave wound 220 V shunt generator ಒಂದರಲ್ಲಿ full load current 200 amps. Shunt field current 2 amps ಆಗಿದೆ. full load ನಲ್ಲಿ brush ಗಳನ್ನು GNA ಯ commutator segment ಗಳ ಮೇಲೆ ಇರಿಸಲಾಗಿದೆ. full load ನಲ್ಲಿ demagnetising amp turns/pole ಮತ್ತು cross amp turns (commutator segment ನಲ್ಲಿರುವ conductor ಗಳಲ್ಲಿ) ಎಷ್ಟು? (444)

($I' = \frac{I_a}{2} = \frac{200}{2} = 100$ A $\theta_m = \frac{2}{4} = 0.5$)

③ 6 Poles ಇರುವ dc generator ಒಂದರಲ್ಲಿ armature ಮೇಲೆ 360 conductor ಗಳಿವೆ. ಇದರ cross amp-turns/pole (a) $\frac{AT_c}{Pole}$ (b) backamp turns/pole $\frac{AT_d}{Pole}$ ಅನ್ನು ಲೆಕ್ಕಿಸಿರಿ. ಮತ್ತು series turns/pole ಅನ್ನು ಲೆಕ್ಕಿಸಿರಿ.

360 conductor, 6 poles, 200 rpm, simplex wave wound. Total current 600 A, angle of lead 10° (mech) leakage coefficient 12 { ATc = 3333.33 amp turns }

ATC/pole = 7 Ia (1/2p - Θm/360)

series AT/pole = ATd/pole = 7I' Θm/360

200 rn = "

mx lf =

compensating winding

Ia x Nc = I' x Z/2p x 0.7

Nc = I'/Ia x Z/2p x 1/Ia

Zc = I'/Ia x Z/2p x 1/Ia / 2

① I' = (IL + Ish)/2 = (2 + 20)/2 = 11

Θm = 2/111 x 360°

Atd/pole = 7I' Θm/360

= 22/2 x 11 x 2/111 x 360 x 1/360

= 44 (Ans)

③ ATc/pole = ZI'(1/2p - Θm/360)

= 500 x 200/2 (1/2x6 - 10/360)

= 50000 (1/12 - 1/36)

= 50000 x (3-1)/36

= 50000 x 1/18

= 2777.78

ATd/pole = Θm/360 x 7I'

= 10/360 x 500 x 100

= 50000/36

∴ Nc x 2ϕ = 500ϕ/36

Nc = 500/72

∴ N = 500/72 x 1.9 (L.f)

= 650/72

= 9 turns

(Ans)

Notes

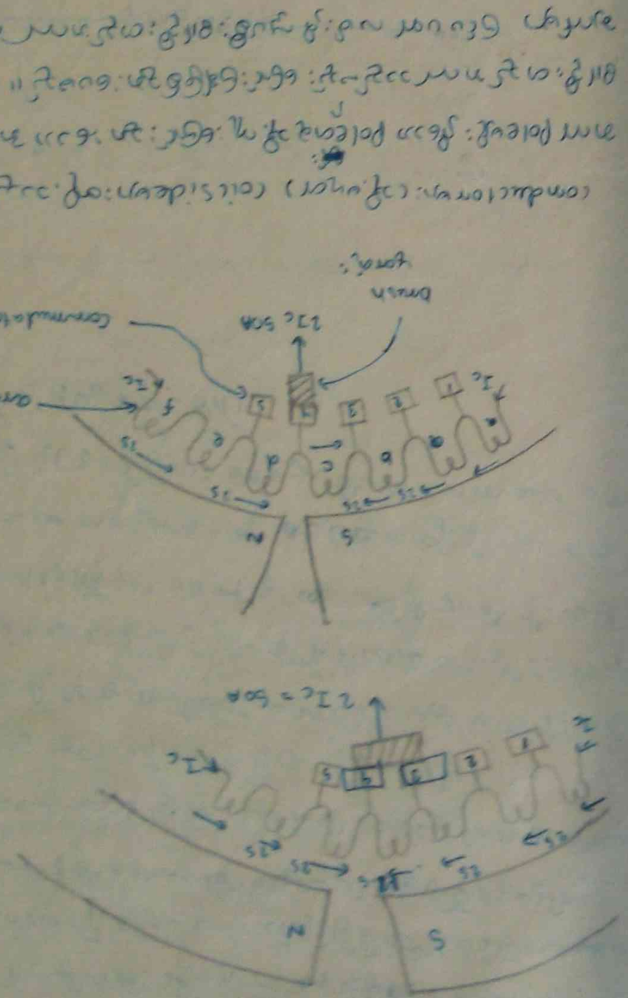
Cross magnetising/pole ko nikalne ke liye compensating winding

Ia x Nc = I' x Z/2p x 0.7 (ATc/pole)

Nc = I'/Ia x Z/2p x 0.7

Zc' = I'/Ia x Z/2p x 0.7 / 2

demagnetising poles ko nikalne ke liye = Shunt field + series field



armature coil: কুণ্ডলী। commutator bar: কমিউটেটর দণ্ড। brush: ব্রাশ। pole piece: মেরু।

ব্রাশ: এই দুটি ধাতব বা কার্বন নির্মিত স্থির অংশ যা কমিউটেটর বা স্লিপ রিংয়ের সাথে ঘর্ষণের মাধ্যমে সংযুক্ত থাকে এবং বাইরের বর্তনীর সাথে সংযোগ স্থাপন করে।

ব্রাশ ধরক: ব্রাশ ও কমিউটেটরের মধ্যে ঘর্ষণজনিত বাধা। ব্রাশ ধরকের কারণে ক্ষয়: ব্রাশ ও কমিউটেটর উভয়ের ক্ষয় হয়। ব্রাশ ধরক কমানোর উপায়: ব্রাশের চাপ কমানো, মসৃণ কমিউটেটর ব্যবহার করা, উপযুক্ত গ্রেডের ব্রাশ ব্যবহার করা।

ব্রাশ ধরক = $I_c^2 R$ watt

ব্রাশ ধরক = $2I_c \times 50A$

I_c = 25A

ব্রাশ ধরক = $2 \times 25 \times 50$ watt

= 2500 watt

= 2.5 kW

কমিউটেটর ও ব্রাশের কাজ: (Commutator & Brush)

armature coil: কুণ্ডলী। commutator bar: কমিউটেটর দণ্ড। brush: ব্রাশ। pole piece: মেরু।

ব্রাশ: এই দুটি স্থির অংশ যা কমিউটেটর বা স্লিপ রিংয়ের সাথে ঘর্ষণের মাধ্যমে সংযুক্ত থাকে এবং বাইরের বর্তনীর সাথে সংযোগ স্থাপন করে। ব্রাশ ধরক: ব্রাশ ও কমিউটেটরের মধ্যে ঘর্ষণজনিত বাধা। ব্রাশ ধরকের কারণে ক্ষয়: ব্রাশ ও কমিউটেটর উভয়ের ক্ষয় হয়। ব্রাশ ধরক কমানোর উপায়: ব্রাশের চাপ কমানো, মসৃণ কমিউটেটর ব্যবহার করা, উপযুক্ত গ্রেডের ব্রাশ ব্যবহার করা।

ব্রাশ ধরক = $I_c^2 R$ watt

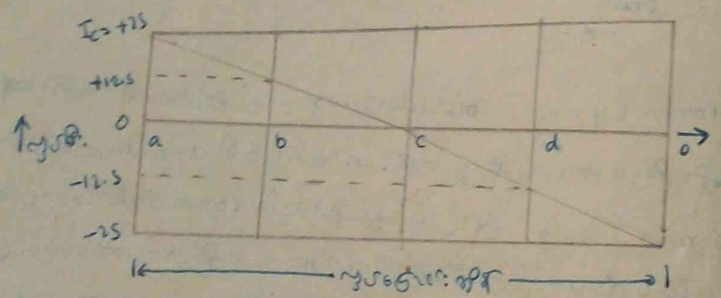
ব্রাশ ধরক = $2I_c \times 50A$

I_c = 25A

ব্রাশ ধরক = $2 \times 25 \times 50$ watt

= 2500 watt

= 2.5 kW



Time of commutation

or

Time of Short circuit

Linear commutation

Reactance voltage = $L \times \frac{2I_c}{t}$ or $\frac{L \times 2I'}{t}$ (ရှိ)

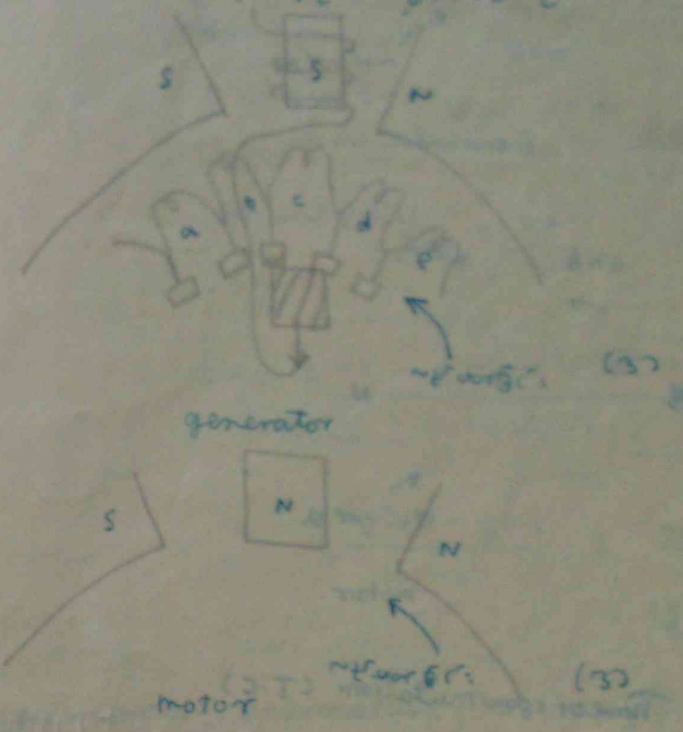
L = self inductance (Henry)

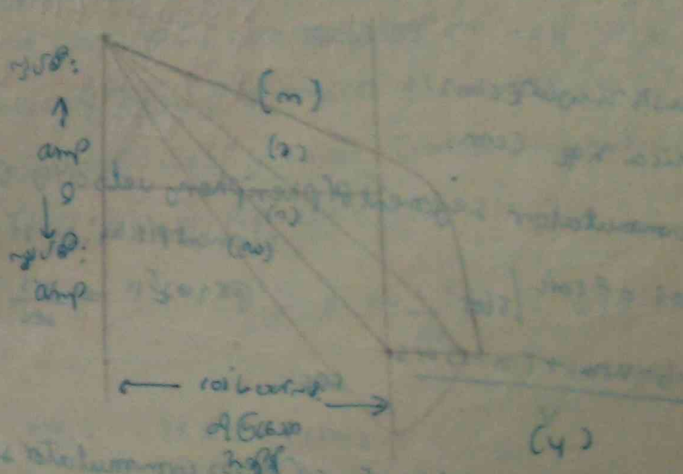
t = time of commutation (sec)

$I_c = I'$ = လျှပ်စီး (amp)

(2)(ब) Inter Pole (commutating pole)

ইন্টার পোল (কমুটেটিং পোল):

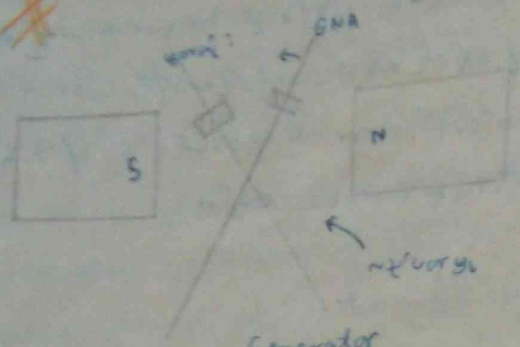




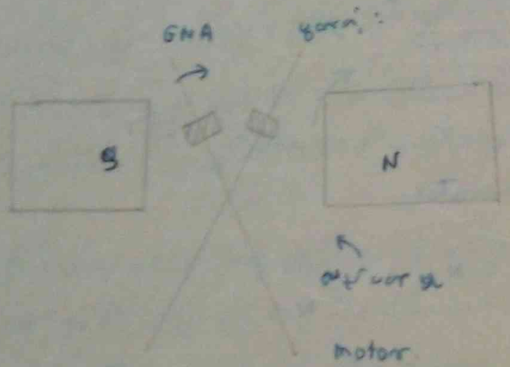
(m) = মূখর (Interpole ব্যবহার করা হয়নি এমন অবস্থায়)

(n) = মূখর (Interpole ব্যবহার করা হয়েছে এমন অবস্থায়)

(o) = মূখর (Interpole ব্যবহার করা হয়েছে কিন্তু Interpole)



Generator



motor

Time of commutation (T.C)

w_b = brush ಅಗಲ (cm)

w_m = mica ಅಗಲ (cm)

V = commutator segment ಅ periphery velocity (cm/sec)

n = no: of coil/slot

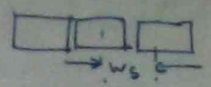
$$t = \frac{w_b - w_m + (n-1)w_s}{V} \text{ sec}$$

w_s = commutator ಮೇಲೆ ಸರಿಯಾದ ಕೆಳಗಿನ ಪ್ರದೇಶ commutator segment Pitch (cm)

ಉದಾ ①

2 coils/slot ಹೊಂದಿರುವ armature ಒಂದು: ಅದರ 900 r.p.m ತಿರುಗುವಂತೆ ಮಾಡಲಾಗಿದೆ. commutator ಅಗಲ ಅಥವಾ 120, brush ಅಗಲ $\frac{1}{8}$ commutator segment Pitch / mica ಅಗಲ $\frac{1}{8}$ commutator Pitch ಅಷ್ಟಿದೆ. Time of short circuit ಹೇಳಿರಿ.

commutator pitch = seg: pitch



$$t = \frac{w_b - w_m + (n-1)w_s}{V}$$

$w_b = \frac{3}{2} w_s$ $w_m = \frac{1}{8} \times w_s$ $n = 1$ (1 commutator ಗೆ 1 coil ಇರುವುದರಿಂದ)

900 r.p.m ∴ 60 sec

900 rev: ಗೆ 60 secs

1 ——— ? = $\frac{60}{900} = \frac{1}{15}$ secs

Segment Pitch/sec = $\frac{\text{seg: }}{\text{time}} = \frac{120 w_s}{\frac{1}{15}} = 1800 w_s$

$$t = \frac{\frac{3}{2} w_s - \frac{1}{8} w_s + (1-1) w_s}{1800 w_s}$$

$$= \frac{\frac{5}{2} w_s - \frac{1}{8} w_s}{1800 w_s} = \frac{20-1}{8} \times \frac{1}{180}$$

$$= \frac{19}{8} \times \frac{1}{180} = \frac{19}{1440} \text{ secs}$$

② ಒಂದು generator ನಲ್ಲಿ: armature ಗೆ 60 slots ಇದ್ದು 2 coils/slot ಇರುವಂತೆ ಮಾಡಲಾಗಿದೆ. commutator ಗೆ 120 segments ಇದ್ದು: ಅವು 60" ಸುತ್ತಳತೆಯಲ್ಲಿ ಹರಡಿವೆ. segment ಗಳ ನಡುವೆ ಇರುವ mica thickness .03" ಇದ್ದರೆ time of commutation ಅನ್ನು ಕಂಡುಹಿಡಿಯಿರಿ. ಅದು 875 r.p.m ತಿರುಗುತ್ತಿದೆ.

seg: w_s

$$V = \frac{\pi d N}{60} = \frac{60 \times 875}{60} = 875 \text{ in/sec}$$

$$= 875 \times 2.54 \text{ cm/sec}$$

$w_b = .75 \times 2.54$ cms

$w_m = .03 \times 2.54$ cms

$w_s = ?$

60 ——— 2 = 120 coils

1 slot = 2 coils

B=C = 120

120 brush segment = 60"

1 ——— ? = .5" = $.5 \times 2.54$ cms

w_s

$$t = \frac{w_b - w_m + (m-1)w_s}{v}$$

$$= \frac{.75 \times 2.54 - .03 \times 2.54 + (2-1) \times .5 \times 2.54}{875 \times 100 \; 2.54}$$

$$= \frac{2.54 \times (.75 - .03 + .5)}{875 \times 100 \; 2.54}$$

$$= \frac{2.54 \times 1.22}{875 \times 100 \times 2.54} = \frac{1.22}{875} \text{ secs} \quad \text{//Ans}$$

$$= \frac{13.25}{87500} \text{ secs} \quad \text{//Ans}$$

$$= .0600$$

$$v = \frac{\text{commutator surface} \times N}{60} \times \text{im/sec or com/sec}$$

$$v = \frac{\text{segment pitch surface} \times N}{60} \quad \text{segment pitch/sec or ws/sec}$$

* Lap wound లో ఉన్నది:

① 4 poles simple wave wound DC generator లో armature conductors: 120 ఉన్నాయి. Commutator surface: 12" ఉన్నది. 1500 r.p.m తో armature current 150 amps ఉంది. ఒక్కో coil లో 3 turns ఉన్నాయి. Armature coil self induction 0.07 milli Henarys ఉన్నది. Brush contact drop: 1 volt ఉంది. Reactance voltage ని కనుగొనండి. (ఒక్కో conductor కు 1 volt drop అవుతుంది)

(19.8V)

Simple wave wound లో a = 2 × m = 2 × 1 = 2

$$I' = \frac{I_a}{2} \quad \text{(simple wave wound)}$$

$$I' = \frac{150}{2} = 75 \text{ amps}$$

$$t = \frac{w_b - w_m + (m-1)w_s}{v_{sb}} = \frac{.5 - w_m + (1-1)w_s}{0 \; v}$$

$$v = \frac{\pi dN}{60} \quad = \frac{\pi \times 12 \times 1500}{60}$$

$$= 300\pi$$

$$t = \frac{.5}{300\pi} = \frac{5}{3000\pi} = \frac{1}{600\pi}$$

$$= \frac{.07 \times 10^{-3} \times 2 \times 75}{600 \; \frac{1}{600\pi}}$$

$$= .07 \times 10^{-3} \times 150 \times 600\pi$$

$$= .07 \times 150 \times 6\pi$$

$$= 90 \times .07\pi = 6.3 \times \pi = 19.8 \text{ V}$$

Efficiency of DC Generator

DC generator యొక్క సామర్థ్యం: దీనిని 2 రకాలుగా చెప్పవచ్చు

$$\text{సామర్థ్యం } \eta = \frac{\text{output power}}{\text{input power}}$$

$$\eta = \frac{\text{out put power}}{\text{out put power + losses}}$$

Losses (నష్టాలు) రెండు

① copper losses,

(a) armature copper loss ($I_a^2 R_a$)

(b) shunt field copper loss ($I_{sh}^2 R_{sh}$)

(c) series field copper loss ($I_{se}^2 R_{se}$)

(d) Brush copper loss ($I_a^2 R_b$)

(e) Inter pole winding copper loss ($I_a^2 R_i$)

(f) compensating winding copper loss ($I_a^2 R_c$)

② magnetic losses or Iron losses

(a) వస్తువులలోని అణువుల నష్టం (Hysteresis loss)

(b) Eddy current loss (ఎడ్డీ కరెంట్ నష్టం)

(2) mechanical loss కూడా స్థిరం

(3) Friction loss (బేరింగ్స్, bearing తో కలిగినవి) స్థిరం

(4) windage loss (గాలి ఘర్షణ) స్థిరం : air friction

(5) stray load loss కూడా స్థిరం

కాబట్టి స్థిర భాగం: B: ఫ్రిక్షన్ & windage

Load current పై ఆధారపడి B: ఫ్రిక్షన్ & windage తప్ప మిగిలినవి అన్నీ మారే అంశాలు : వేరియబుల్

B.E:

constant (లేదా) స్థిరం : iron loss

స్థిరం: iron loss (2) + mechanical loss (3) + shunt field copper loss

variable loss

వేరియబుల్: armature copper loss + series field copper loss + interpole copper loss + compensating winding copper + brush copper loss

ఉత్పత్తయ్యే విద్యుత్ లో ఏదైతే variable అవుతుందో దాన్ని మనం వేరియబుల్ అంటాం

~~Condition for~~ condition of maximum efficiency

(గరిష్ట సామర్థ్యం కొరకు కండిషన్)

Shunt ~~motor~~ generator కొరకు -

$$I_a^2 R_a = I_{sh}^2 R_{sh} + W/I$$

compound generator కొరకు -

$$I^2(R_a + R_{se}) = I_{sh}^2 R_{sh} + W_I$$

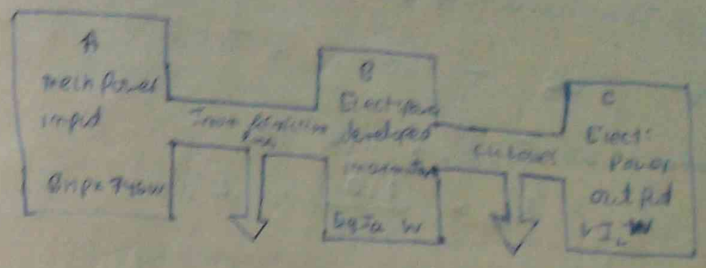
W_c = Iron loss + mechanical loss

I_L లేదా I_a ఎప్పుడు

Electrical power developed

Armature loss = $E_g \times I_a$

The Power stages



A - B = Iron & friction loss

B - C = cu loss

$\eta_c = \frac{C}{A}$ — full load eff: = overall eff:

$\eta_{cm} = \frac{B}{A}$

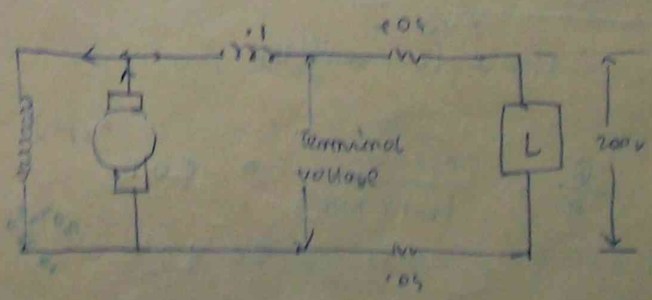
$\eta_e = \frac{C}{B}$

η_c = commercial effy: or overall effy:

η_{cm} = mechanical effy:

η_e = electrical effy:

(1) shunt/compound generator 200 V, 10 kW లోడ్ ని ఇస్తుంది. armature resistance 0.1 Ω, shunt field resistance 52.5 Ω, series field resistance 0.1 Ω, Iron & friction losses = 631 watts అయితే copper losses, Terminal Pd., Emf generated, Cu losses, Brake Horse Power of driving Engine, commercial and electrical effy: లు కనుక్కోండి.



$I_L = \frac{10 \times 1000}{200} = 50$ amp

$V_{term} = V_L + I_L R_F$

$V = 200 + 50 \times 0.1 =$

E_g = Terminal voltage + $I_{se}R_{se}$ + I_aR_a

= 200 + 50 × .1 + I_aR_a

I_aR_a $V_T = I_{sh}R_{sh} = 210$

$\therefore I_{sh} = \frac{210}{52.5} = 4$ amp

$\therefore I_aR_a = (50+4) \times .01$

$= .54$

$\therefore = 210 + .54 = 210.54$ V

Cu losses

Cu losses = B − C

Cu losses = series field loose + Shunt field loss + armature loss

or $E_g \times I_a - VI_L = 210.54 \times 54 - 200 \times 50$

$= 1114$ w

B.H.P

$A = BHP \times 746$

$\therefore BHP = \frac{BHP \times A}{746}$

$\left(B + \frac{\text{Iron and fix loss}}{746}\right) \times 746 = BHP$

$\left(\frac{210.54 \times \text{eff } 631}{746}\right) \times 746 = BHP$

$\therefore BHP = 16.1$ HP

$\eta_c = \frac{C}{A} = \frac{203 \times 50}{16.1 \times 746} = .901$

$\therefore 90.1\%$

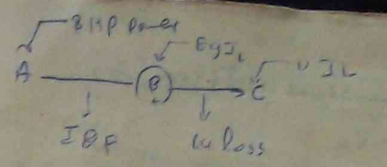
Full load

output 100 w = load — Full load output 100 w = load power

250 volt 200 w = load — 250 v = load voltage

200 amp = load — 200 amp = power

Power



$A = B + W_{I\&F}$ $\quad \therefore W_{I\&F} = A - B$

$B = C + \text{Cu loss (w)}$ $\quad \therefore \text{Cu loss} = B - C$

ex (2)

Shunt generator ... 220 ... full load current 196 amp ... full load eff ... 88% ... stray losses (Iron & friction loss) 720 ... $R_{sh} = 55\Omega$ ... armature ... load current ...

$I_L = 196$ amp

$V = 220$ V

$W_{I\&F} = 720$ w

$R_{sh} = 55\Omega$

$\eta_c = 88\%$

Cu losses = $I_a^2R_a + I_{sh}^2R_{sh}$

$R_a = ?$

$\eta_c = \frac{C}{A}$

$.88 = \frac{196 \times 220}{A}$

$A = \frac{196 \times 220}{.88}$ watts

$\therefore B = \frac{196 \times 220}{.88} - 720$

$B = \frac{98000}{.88} - 720$

$= 49000 - 720$

$= 48280$ watt

$\therefore I_a = \frac{B}{E_g}$

$I_a = E_g - \frac{?}{I_a}$

$E_g = \frac{48280}{196 + 4}$

$= \frac{48280}{200}$

$= 241.4$ volts

$I_{sh} = \frac{220}{55} = 4$

$\therefore R_a = \frac{241.4}{200} = 0.$

$E_g = V + I_aR_a$

$241.4 = 220 + 200R_a$ $\quad \therefore R_a = .107\ \Omega$

I_{max} = ... load current

$I_{max}^2 R_a = WC$

$I_{max} = \sqrt{\frac{VI_L}{R_a}} = \sqrt{\frac{W_{I\&F} + Cu\ I_{sh}^2R_{sh}}{R_a}}$

$I = \sqrt{\frac{220 \times 196 + 10 \times 55}{.107}}$ $= 642$ amp

$$I_a = \sqrt{\frac{\text{copper loss + Shunt loss + Stray loss}}{R_a}}$$

$$I_{shunt} \sqrt{\frac{(\text{Friction + armature loss}) + I^2 R_{sh}}{R_a}} = \sqrt{\frac{720 + 5sh^2 \times R_{sh}}{.107}}$$

$$= \sqrt{\frac{720 + 4^2 \times 55}{.107}}$$

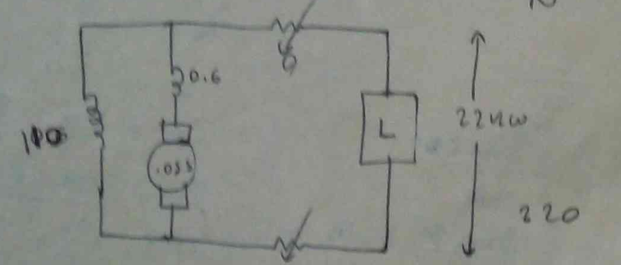
$$= 132.8 \text{ amp}$$

(5) Long shunt compound generator ல் terminal voltage 220 volt operation ல் armature current 100 amp ஆக இருக்கும் போது shunt field resistance 110Ω series field resistance 0.6Ω armature resistance 0.055Ω

(i) cu loss

(ii) I & F loss

(iii) Engine torque



$$I = \frac{22 \times 1000}{220} = 100 \text{ amp}$$

Load ல

Load ல power = 100 × 220

= 22000 watts

= 22 kw

$$I_{sh} = \frac{220}{110} = 2$$

$$I_a = 100 + 2 = 102$$

$$E_g = 220 + 102 \ [0.055 + 0.6]$$

$$= 220 + 102 \times .655$$

$$= 220 + 66.8$$

$$= 286.8$$

Eg Engine Power = 286.8 × 102

cu loss = 292.10

29.24 kw − 22 = 7.24 kw

$\therefore \frac{29.24}{.86} = 34$ kw

I & F friction = 34 − 29.24

= 4.76 watts

Torque = $\frac{7.04 \times 102}{1000}$

= $\frac{718}{1000}$ = .718 N-M

$$I = \frac{220 \times 1000}{220} = 1000$$

$$I_{sh} = \frac{220}{110} = 2$$

$$E_g = 220 + 102 \times 0.655$$

$$= 220 + 229.4$$

Engine Power = 440.4

Eg

Engine power = 440.4 × 1002

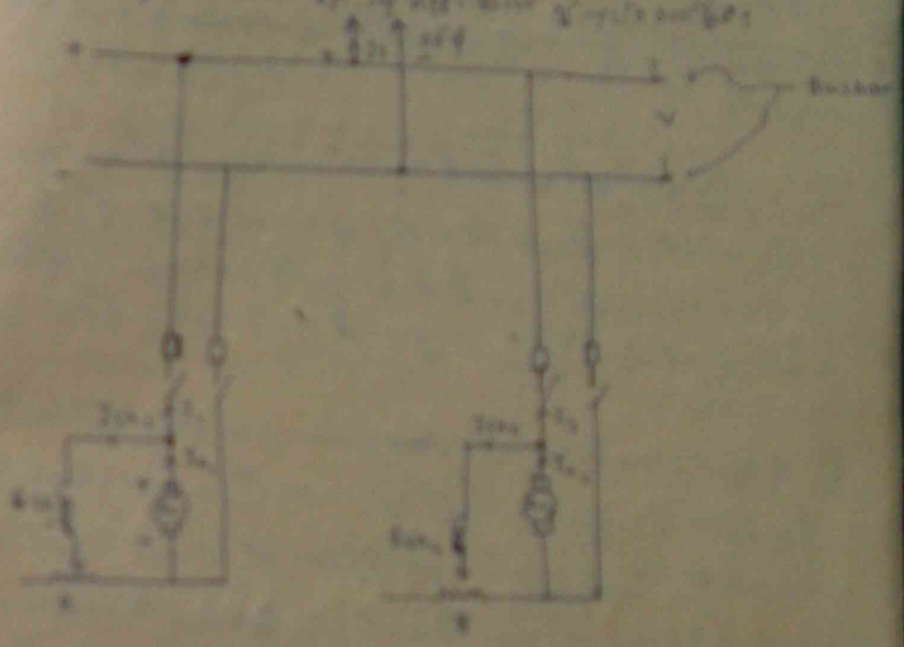
= 4420000

= 4420 watts

(4) 110volt shunt generator ல் full load current 100amp ஆக இருக்கும் shunt Resistance 55Ω series field resistance 0.055Ω stray losses 500watts ஆக இருக்கும் full load efficiency 88% ஆக இருக்கும் armature Resistance, full load ல் copper loss, efficiency ஐ காண்க

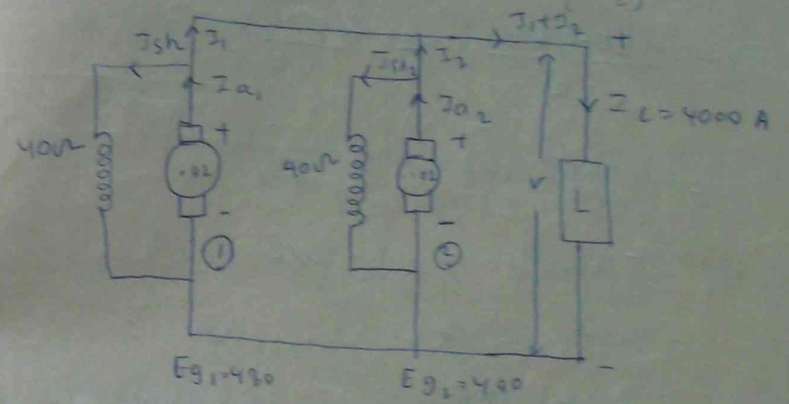
stray loss 500watt ஆகக் கொண்டால் மாறுபடும் மாறிலி

$\frac{\text{stray loss 500watt}}{I_{sh}^2 R_{sh} + I}$



ပုစ္ဆာ

Q: shunt generator နှစ်လုံးအား load current 4000 amp ကို ဘေးချင်းယှဉ်ပြီး 600 volt bus bar ကို ထောက်ပံ့ပေးနေသည်။ ဓာတ်အားပေးစက်တစ်လုံးစီ၏ armature ခုခံအား 0.02Ω ဖြစ်ပြီး field resistance မှာ 40Ω စီ ဖြစ်သည်။ ဓာတ်အားပေးစက်တစ်လုံးစီ၏ induced e.m.f မှာ 490V နှင့် 490V ဖြစ်သည်။ ဓာတ်အားပေးစက်တစ်လုံးစီ၏ bus bar voltage နှင့် output kilowatt ကို ရှာပါ။



$I_1 + I_2 = I_L$

$I_1 + I_2 = 4000$ —①

$I_1 = \frac{E_{g_1} - V}{R_{a_1}} - \frac{V}{R_{sh}}$

$= \frac{490 - V}{.02} - \frac{V}{40}$

$I_2 = \frac{E_{g_2} - V}{R_{a_2}} - \frac{V}{R_{sh_2}}$

$= \frac{490 - V}{.02} - \frac{V}{40}$

$\frac{490 - V}{.02} - \frac{V}{40} + \frac{490 - V}{.02} - \frac{V}{40} = 4000$

$\frac{980 - 2V}{.02} - \frac{2V}{40} = 4000$

$49000 - 100V - .05V = 4000$

$100.05V = 49000 - 4000$

ဖြေရှင်းချက်။ ။

① generator No 2 ထက် speed ပိုများသည်ဖြစ်၍ ရလာသော current သည် generator No ② ထက် ပိုများသည်ဖြစ်ပြီး generator No ① ထက် နည်းသည်ဖြစ်၍ generator No ① သည် motoring ဖြစ်သွားသည်။

② generator 2 လုံး၏ polarity တို့သည် တူညီသောကြောင့် ဘေးချင်းချိတ်ဆက်ရာတွင် ပြဿနာမရှိပါ။

③ operating engineer သည် generator No ① ကို motoring ဖြစ်သွားသည်ကို သိရှိသောအခါ generator No ① ကို ပြန်လည်ချိတ်ဆက်ရန် ဆုံးဖြတ်ပြီး ထိုသို့ပြုလုပ်ရန် ပြင်ဆင်ကြသည်။

④ ထိုအတွက် line ဘက်ရှိ (Busbar ဘက်ရှိ) field Regulator မှ ကြိုးကို ဖြုတ်ပြီး generator ① ၏ shunt field current ကို နှုတ်ပြီး generator ② ၏ shunt field current ကို ဖြည့်ပေးလိုက်သည်။ ထိုသို့ဖြစ်ရခြင်းမှာ generator ① ၏ generated voltage ကို ပြန်ပို့ပေးခြင်းဖြင့် generator ② ၏ generated voltage ကို ပြန်ပို့ပေးခြင်းဖြင့် generator ② ၏ output current ကို နှုတ်ပြီး generator ① ၏ output current ကို ဖြည့်ပေးလိုက်သည်။ ထိုသို့ပြုလုပ်ရာတွင် generator ① ၏ field current ကို နှုတ်ပြီး generator ② ၏ field current ကို ဖြည့်ပေးလိုက်သည်။ ထိုသို့ပြုလုပ်ရာတွင်

$$V = \frac{320 \times 1000}{[21500 - 9V][18400 - 4V]}$$

$$V = \frac{320 \times 1000}{40900 - 9V}$$

$$40900V - 9V^2 = 320{,}000$$

$$2V^2 - 40900V + 320000 = 0$$

$$V^2 - 20450V + 160000 = 0$$

$$V = -(-20450) \pm \frac{\sqrt{(20450)^2 - 4 \times 160000}}{2 \times 1}$$

$$= 446.8$$

ရှာနည်း:

$$V^2 + 160000 = 20450V$$

$$V^2 + (400)^2 = 20450V$$

$$V^2 - 800V + (400)^2 = 20450V - 800V$$

$$(V - 400)^2 = 19650$$

$$(V - 400)^2 = 1965 \times 100$$

$$V - 400 = \sqrt{1965} \times 10$$

$$V = 46.8 + 400$$

$$= 446.8$$

$$V^2 + 454V = 3555$$

$$V^2 + 454V + (232.5)^2 = (232.5) + 3155$$

$$V^2 + 465 + (V + 227.5)^2 = 54000 + 3155$$

$$(V + 227.5)^2 = 57455$$

$$V = \frac{20450 \pm \sqrt{418000000 - 640000}}{2}$$

$$= \frac{20450 \pm \sqrt{417360000}}{2}$$

$$= 20450 \pm \sqrt{417.64 \times 10^6}$$

$$= \frac{20450 \pm 20443.6}{2}$$

$$\frac{20450 \pm 20.46 \times 1000}{2}$$

6 ခေါင်းရှိ generator က 60Hz frequency ဖြင့် Load current 2400 amp ကို ဖြန့်ပေး
နေသည်။ 240V နှင့် 336V အသီးသီးတွင် အသီးသီး operate လုပ်နေသော generator
နှစ်လုံး၏ armature ခုခံအား 0.02Ω shunt field ခုခံအား 40Ω ဖြစ်ပါက
ဖြန့်ပေးသည့် busbar voltage နှင့် o/p current တို့ကို ရှာပါ။

$$I = 2400$$

$$I_1 + I_2 = 2400 \quad \text{——} (1)$$

$$P_1 = \frac{I_1 V}{1000}$$

$$240 = \frac{I_1 V}{1000}$$

$$\frac{240{,}000}{V} = I_1$$

$$336 = \frac{I_2 V}{1000}$$

$$\frac{336000}{V} = I_2$$

$$\frac{240{,}000}{V} + \frac{336000}{V} = 2400$$

$$\frac{576000}{2400} = V$$

$$240 = V \text{ (Busbar voltage)}$$

$$240 = \frac{I_1 \times 240}{1000}$$

$$I_1 = 1000 \text{ amp}$$

$$I_2 = 1400 \text{ amp}$$

$$Eg_1 \quad I_1 = \frac{Eg_1 - V}{2a_1} - \frac{V}{2sh_1}$$

$$1000 = \frac{Eg_1 - 240}{.02} - \frac{240}{40}$$

$$1000 = \frac{Eg_1 - 240}{.02} - 6$$

$$.02 \times (1006) = Eg_1 - 240$$

$$20.12 = Eg_1 - 240 \quad \therefore Eg_1 = 260$$

Eg $I_2 = \frac{Eg_2 - V}{Ra_2} - \frac{V}{Rsh_2}$

$1400 = \frac{Eg_2 - 240}{.02} - \frac{240}{40}$

$1406 = \frac{Eg_2 - 240}{.02}$

$28.12 = Eg_2 - 240$

$Eg_2 = 268.12$

①

$P_1 + P_2 = 320,000$

$P_1 = V \times \left(\frac{Eg - V}{Ra}\right)$

$= \frac{450V - V^2}{.02}$

$P_2 = V\frac{(460 - V)}{.02}$

$= \frac{460V - V^2}{.02}$

$\frac{450V - V^2}{.02} + \frac{460V - V^2}{.02} = 320,000$

$450V - V^2 + 460V - V^2 = 6400$

$910V - 2V^2 = 6400$

$455V - V^2 = 3200$

$V^2 - 3200 = 455V$

$V^2 - 455V = -3200$

$V^2 - 455V + (227.5)^2 = -3200 + (227.5)^2$

$(V - 227.5)^2 = -3200 + 51800$

$(V - 227.5)^2 = 48600$

$V - 227.5 = 100 \times 2.1937$

$V = 446.8$

$\therefore VI = \left(\frac{480 - 446.8}{.02}\right) \times 446.8 \times \frac{1}{1000}$

$= 74.1 kw$

$VI = \frac{(460 - 446.8)}{.02} \times 446.8 \times \frac{1}{1000}$

$= 247.1 kw$

ଦ୍ୱିତୀୟ generator ଟି ଦ୍ୱାରା ଉତ୍ପାଦିତ ହେଉଥିବା current ର ପରିମାଣ 150 amp ଏବଂ ଏହାର terminal voltage 460 volts ଅଟେ। generator ର Terminal voltage ଯଦି open circuit ଅବସ୍ଥାରେ 230 volts ଏବଂ 80 amp ରେ 218 volts ହୁଏ, ତେବେ ଏହାର armature ର Terminal voltage ଯଦି open circuit ରେ 236 volts ହୋଇଥାଏ ଏବଂ 80 amp ରେ 220 volts ହୁଏ, ତେବେ ଏହାର armature ର Terminal voltage ଯଦି open circuit ରେ 236 volts ହୋଇଥାଏ ଏବଂ 80 amp ରେ 220 volts ହୁଏ, ତେବେ ଏହାର generator ର Out put current ଏବଂ Busbar volt ର ମୂଲ୍ୟ କେତେ ହେବ।

$I_L = 150 A$

$I_1 + I_2 = 150 A$

① ଅବସ୍ଥା

$Eg_1 = 230V \quad I = 0A$

$V_1 = 218V \quad I = 80A$

80A ରେ = (230 − 218) volt drop

1A ——— ? = $\frac{12}{80}$

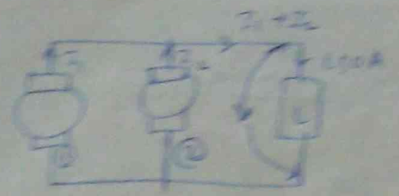
volt drop / Aamp = $\frac{12}{80}$

② ଅବସ୍ଥା

$Eg_2 = 236V \quad I = 0 amp$

$V_2 = 220V \quad I = 80A$

volt drop / amp = $\frac{236 - 220}{80} = \frac{16}{80}$



$v = ?$ $I_1 = ?$ $I_2 = ?$

$$I_1 = \frac{E_{g_1} - v}{\text{volt drop/amp}}$$

$$I_2 = \frac{E_{g_2} - v}{\text{volt drop/amp}}$$

$$I_1 + I_2 = 150$$

$$\frac{E_{g_1} - v}{\text{volt drop/amp}} + \frac{E_{g_2} - v}{\text{volt drop/amp}} = 150$$

$$\frac{230 - v}{\frac{12}{20}} + \frac{235 - v}{\frac{16}{20}} = 150$$

$$v = 219.7v \Longleftarrow$$

$$I_1 = \frac{230 - 219.7}{\frac{12}{20}}$$

$$= 68.6A$$

$$I_2 = 150 - 68.6 = 81.4A$$

Y

① ... $E_{g_1} = 130v$ ... $I = 0$

$v = 115$ ... $R = \frac{50 \times 1000}{115}$

$$\text{volt drop/amp} = \frac{50}{1000} \quad 5 \times \frac{115}{50 \times 1000}$$

$$= \frac{5}{400}$$

② ... $E_{g_2} = 135v$ ... $I = 0$

$v_2 = 115v$ ... $I = \frac{7.5 \times 10^3}{115}$

$$\text{volt drop/amp} = \frac{10}{1000} \times \frac{115}{7.5 \times 10^3}$$

$$= \frac{10}{200}$$

$$I_1 = \frac{E_{g_1} - v}{\text{volt drop/amp}} = \frac{130 - 115}{\frac{5}{400}}$$

$$= 1600A$$

$$I_2 = \frac{E_{g_2} - v}{\text{volt drop/amp}} = \frac{135 - 115}{\frac{10}{200}}$$

$$= 140A$$

$$I_L = 140 + 160 = 300A$$

... $E_{g_1} = 130v$ ... $I_L = ?$ $I_1 = ?$ $I_2 = ?$

$$I_1 = \frac{E_{g_1} - v}{\text{volt drop/amp}} = \frac{130 - 130}{v/amp} = 0$$

$$I_2 = \frac{135 - 130}{\frac{10}{200}} = 5 \times \frac{200}{10} = 100$$

$$I_T = 100 + 0 = 100A$$

Gr. Load current 200 amp ... terminal voltage ... volt ...

$$I_1 + I_2 = 0$$

$$\frac{Eg_1 - v}{v/amp} + \frac{Eg_2 - v}{v/amp} = 0$$

$$\frac{130 - v}{\frac{5}{400}} + \frac{135 - v}{\frac{10}{200}} = 0$$

$$(130 - v)\frac{80}{5} + (135 - v)\frac{200}{10} = 0$$

$$10400 - 80v + 2700 - 20v = 0$$

$$100v = 13100$$

$$v = 131 \text{ volt}$$

$$I_1 = \frac{130 - 131}{\frac{1}{80}} = \frac{-1}{\frac{1}{80}} = -80 \text{ amp}$$

$$I_2 = \frac{135 - 131}{\frac{10}{200}} = 4 \times \frac{200}{10} = 80 \text{ amp}$$

1980 Final Exam

② Shunt generator ...

No I gen:- 110 kw, 220 v

No II gen:- 88 kw, 220 v

No I gen: ... Terminal voltage no load ... 230 v ... full load ... 220 v ...

... (Characteristics)

230
88.88 kw
71.04

$Eg_1 = 230$ $I = 0$

$v = 220$ $I = \frac{110 \times 1000}{220} = 500 \text{ amp}$

$v/amp = \frac{10}{500} = \frac{1}{50}$

$Eg_2 = ?$ $I = 0$

$v = 220$ $I = \frac{88 \times 1000}{220} = 400 \text{ amp}$

$v/amp = \frac{Eg_2 - 220}{400}$

$I_1 : I_2 = 110 : 88$

$= 10 : 8$

$= 5 : 4$

$I_1 = \frac{Eg_1 - v}{v/amp}$

$I_1 = \frac{230 - 220}{\frac{1}{50}} = 500$

$I_2 = \frac{4}{5} I_1 = \frac{4}{5} \times 500 = 400$

$I_2 = \frac{Eg_2 - v}{v/amp}$

$400 = \frac{Eg_2 - 220}{\frac{Eg_2 - 220}{400}}$

$400 = \frac{400}{(Eg_2 - 220)} \; Eg_2 - v$

$Eg_1 = 230$ $I = 0$

$v = 220$ $I = \frac{110 \times 10^3}{220}$

$Eg_2 = ?$ $I = 0$

$v = 220 \text{ v}$ $I = \frac{88 \times 10^3}{220}$

$I_1 : I_2 = 110 : 88$

... volt drop/amp = $\frac{\frac{220}{110 \times 1000}}{220} = \frac{1}{500}$

... $= \frac{Eg - 220}{400}$

$I_1 = \frac{Eg_1 - v}{v/A}$

$I_2 = \frac{Eg_2 - v}{v/A}$

$\frac{I_1}{I_2} = \frac{40}{220-v}$

$I_1 = \frac{5}{4} I_2$

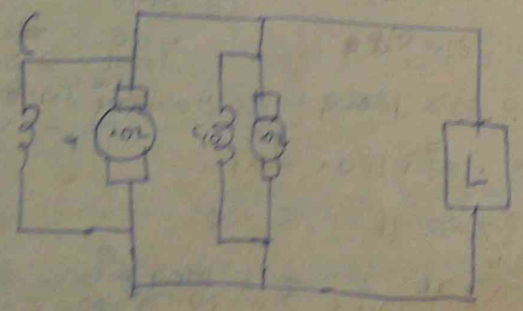
$\frac{Eg_1 - v}{v/A} = \frac{5}{4} \cdot \frac{Eg_2 - v}{v/A}$

$\frac{230 - 220}{\frac{1}{500}} = \frac{5}{4} \cdot \frac{Eg_2 - 220}{v/A}$

$10 \times 500 = \frac{5}{4} \times \frac{Eg_2 - 220}{v/A}$

$4000\ v/A = Eg_2 - 220$

①



$P_1 + P_2 = 310{,}000$

$P_1 = v \times I_a \quad I_a = \frac{Eg - v}{R_a} = \frac{v}{\frac{1}{50}}$

$= \frac{450 - v}{.02}$

$\left(\frac{450 - v}{.02}\right) v + \left(\frac{460 - v}{.02}\right) v = 310{,}000$

$40900v - 40v^2 = 310{,}000$

$90v^2 - 40900v + 310{,}000 = 0$

$v^2 - 455v + 3515 = 0$

$v^2 - 455v = -3515$

$v^2 - 455v + (227.5)^2 = -3515 + (227.5)^2$

$(v - 227.5)^2 = -3515 + 51800$

$(v - 227.5) = \sqrt{48285}$

$v - 227.5 = 219.7$

$v = 447.2$ volts //

$v^2 + 160000 = 20 \times 50v$

$v^2 + (400)^2 = 20 \times 50v$

$v^2 + 800v + (400)^2 = 20 \times 50v + 800v$

Simple Example

NOI $Eg_1 = 230v \quad I_1 = 0$

$v = 220 \quad I = \frac{22 \times 1000}{220} = 500$

$500amp = 10v$

$1 \text{ ——— } 2 = \frac{10}{500} = \frac{1}{50}\ v/A$

NOII $Eg_2 = ? \quad I_1 = 0$

$v = 220 \quad I_2 = \frac{400 \times 22 \times 1000}{220}$

$= 400amp$

$400amp = Eg_2 - 220$

$1 \text{ ——— } ? = v \quad \frac{Eg_2 - 220}{400}$

$I_1 = \frac{Eg - v}{v/A} = \frac{230 - 220}{\frac{1}{50}} = 500amp$

$I_1 + I_2 = 720$

$I_2 = 720 - 500 = 220\ amp$

$I_2 = \frac{Eg - v}{v/A}$

$220 = \frac{Eg - 220}{\frac{Eg - 220}{400}}$

$220Eg - 4840 = 40Eg - 8800$

$180Eg = 3960 \quad Eg = 220v$

KN (7)

KN (7)

Notes on Engineering Works

(2) သင်တန်းသားများ လုပ်ငန်း ဆိုင်ရာ မှတ်စု

(သင်တန်းသားစဉ်ဆက်ခံသော တွေ့ ကြုံရန် များ)

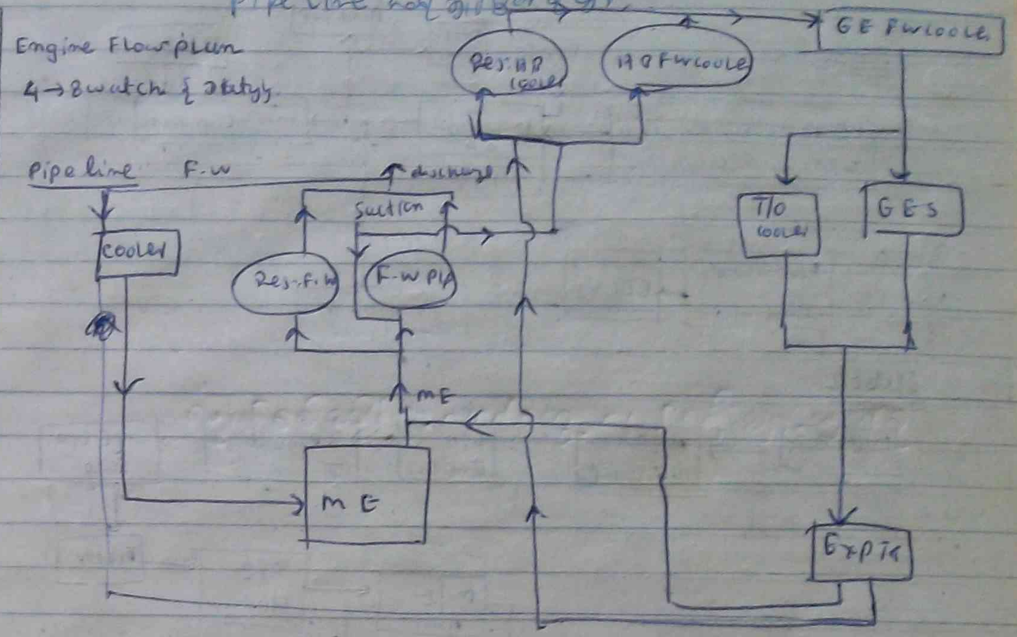
1. General Electrical Knowledge Book (1)

သင်တန်းစာအုပ်ဆိုသည်မှာ စာအုပ်ချုပ်လုပ်ငန်းစဉ်များ

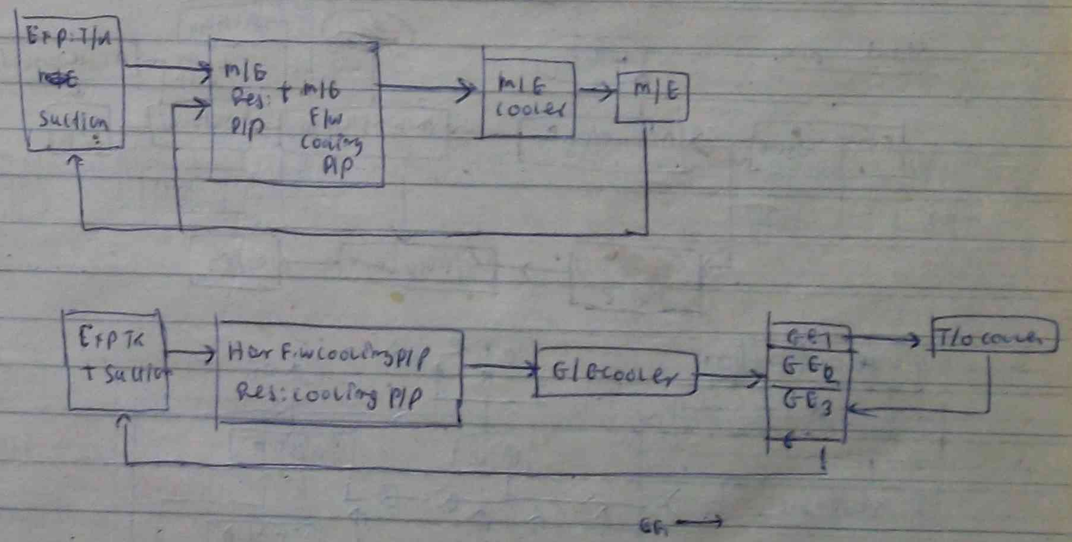
Generation Transmission & Distribution [E.T.E.C]
of Electrical power

Engine Flowplan

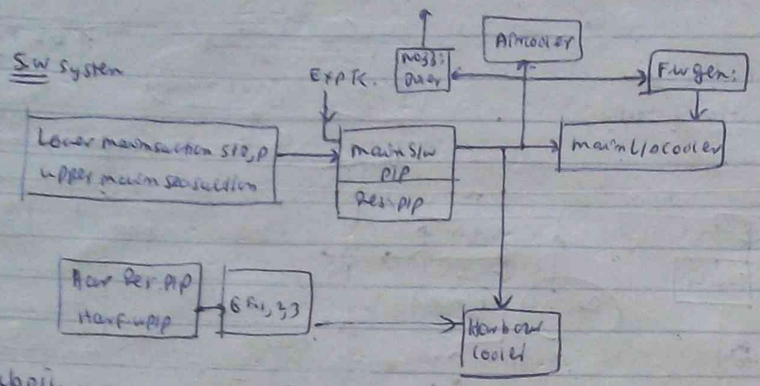
4 → 8 watch & 3 duty.



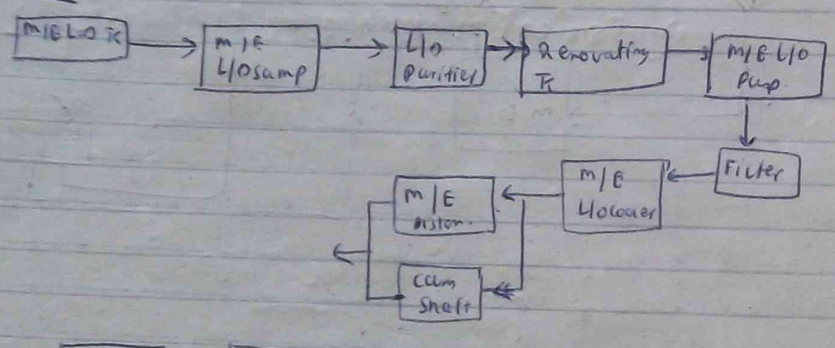
(F.W system)



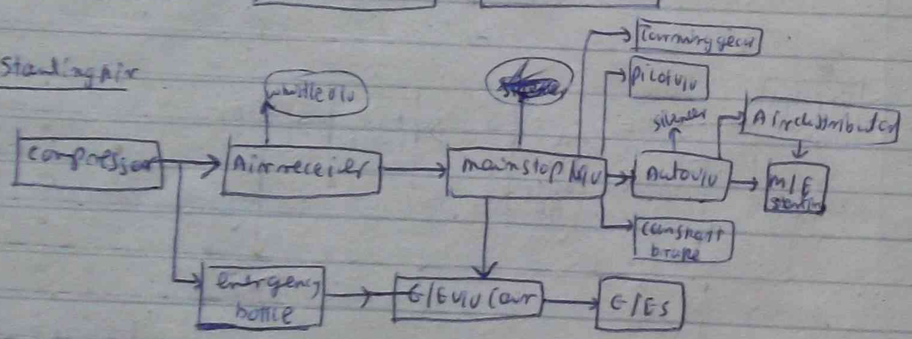
SW System



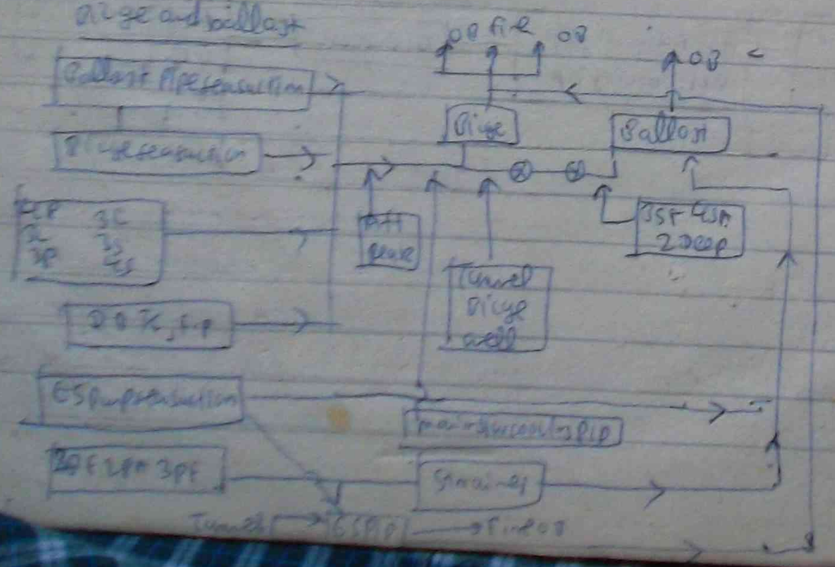
L/uboil



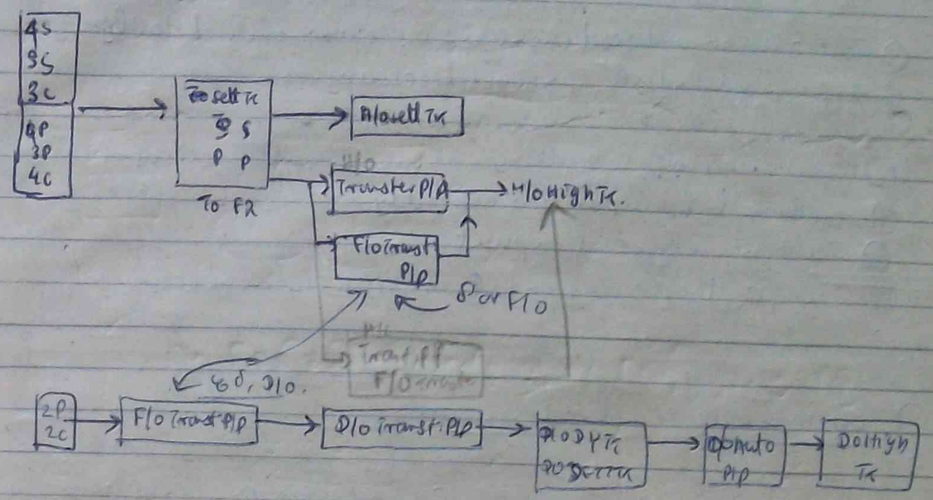
Starting Air

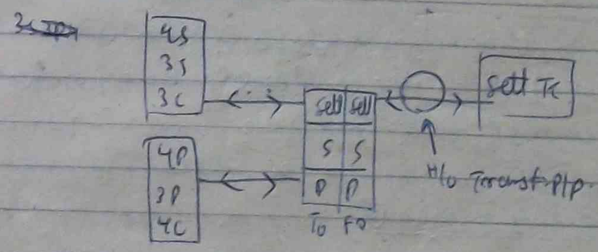


Purge and ballast

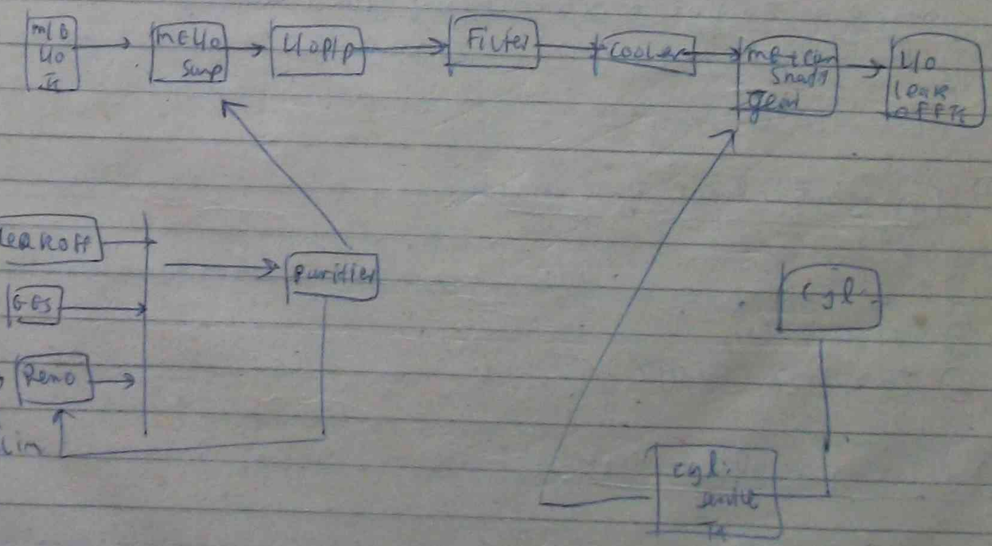


H/O Transfer





M.E L/O



4 to 8 watch

① To test water and feed chemicals as recommended daily
② To pump out sludge Tanks as necessary.
③ To take weekly sounding of lub oil and greases
④ To clean lub oil purifier everyday
⑤ To check refrigeration plant
⑥ To check the steering engine and fill oil as necessary

① Checking of boiler and feed chemicals

- manhole ഉൾഭാഗത്തുള്ള ഓപ്പണിങ്ങുകൾ ഓരോന്നായി തുറന്ന്, ഉള്ളിലുള്ള സാധനങ്ങൾ പരിശോധിക്കുന്നു.
- water test cock ഉപയോഗിച്ച്, boiler ന്റെ ഉള്ളിലുള്ള വെള്ളം പരിശോധിക്കുന്നു.
- boiler gauge glass നോക്കി water level ശരിയാണോ എന്ന് ഉറപ്പുവരുത്തുന്നു. salinometer ഉപയോഗിച്ച് ഉപ്പിന്റെ അംശം പരിശോധിക്കുന്നു. blow off cock ഉപയോഗിച്ച് ~~test~~ check valve പരിശോധിക്കുന്നു. Hotwell ലെ water level ഉം പരിശോധിക്കുന്നു.
- ~~test~~ boiler mounting ഉപകരണങ്ങൾ പരിശോധിക്കുന്നു.

- Safety valve, main stop valve, bottom blow down valve, main check master valve തുടങ്ങിയ ഉപകരണങ്ങൾ പരിശോധിക്കുന്നു. ആവശ്യമുള്ളിടത്ത് gland ചേർക്കുന്നു.
- water level ഉയർത്തുന്നതിനായി feed pump ഓടിക്കുന്നു.

② Paping out sludge tanks necessary

① Bilge ഉപയോഗിക്കുന്നു.
② Sanitary ഉപയോഗിക്കുന്നു.
③ Tank drain വിൽവ് തുറക്കുന്നു.

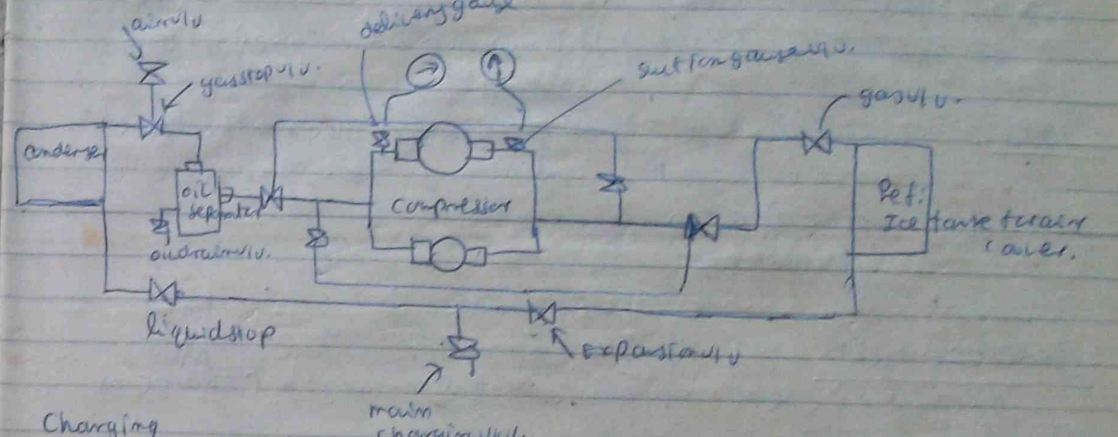
③ Taking weekly sounding

M/E lub oil tank, GE's lub oil, cylinder oil, carus oil, W.T. oil തുടങ്ങിയവയുടെ അളവ് പരിശോധിക്കുന്നു.

④ Cleaning lub oil Purifier

ഉപയോഗം: വെള്ളം

⑤ Checking refrigeration plant.



Charging

- gas ചാർജ് ചെയ്യുന്നതിനു മുൻപ് drain valve ഉം ഗ്യാസ് valve ഉം gasket ഇട്ട് ടൈറ്റ് ചെയ്യുന്നു.
- charging valve ഉം stop valve ഉം തുറക്കുന്നു.

water circulation ഉറപ്പുവരുത്തുന്നു: water suction ഉം discharge valve ഉം തുറന്നിടുന്നു. Free circulating ഉറപ്പാക്കുന്നു.

lubrication

every bearing ഉം, machine, auxiliaries ഉം ആവശ്യത്തിനുള്ള ഓയിൽ നൽകുന്നു.
compressor gland ൽ, pressure lubricator ഉപയോഗിച്ച് ഓയിൽ നൽകുന്നു.

Blowing out of air

Joint ഉം ഓയിൽ separator ഉം ഓയിൽ ഇട്ട് ടൈറ്റ് ചെയ്യുന്നു. bubbles ഉണ്ടാകുന്നതിനനുസരിച്ച് air ഉം ഗ്യാസും purge ചെയ്യുന്നു.

correct running

evaporator gauge ഏകദേശം 20 F
condenser gauge temp = ambient + 10 F.

ഈ പറഞ്ഞിരിക്കുന്ന regulator ഉപയോഗിച്ച് നിയന്ത്രിക്കുന്നു.

(Testing of Joints) - - compressor gland packing, stop valves, every gas joint, valve spindle, ഇവയിലെ leakage ഉം leakage detector ഉപയോഗിച്ച്.

Fault finding of refrigeration system

Fault finding is a very important part of refrigeration system.

Compressor fault

Gas quantity is not circulated as required

Causes → valve leakage, piston & piston ring wear
- valve cage joint - joint ring damage, tension spring broken
- Piston & piston ring wear
- cylinder wear.

Condenser fault

Evaporator, compressor heat of refrigerant charge in cooling water is not proper,
higher temp. liquid flow is less

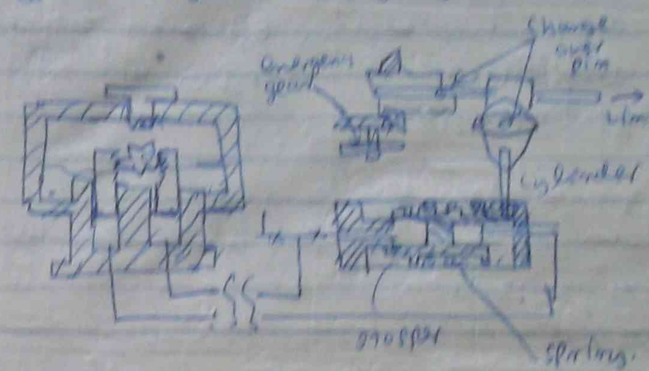
Causes - Heat transmission troubles
condenser gives non liquid at usual temp.
Heat transmission is (1) dirty coils (2) corrosion (3) failure of water supply (4) stoppage of flow (5) air, oil vapour
Quantity of condenser coil reduced

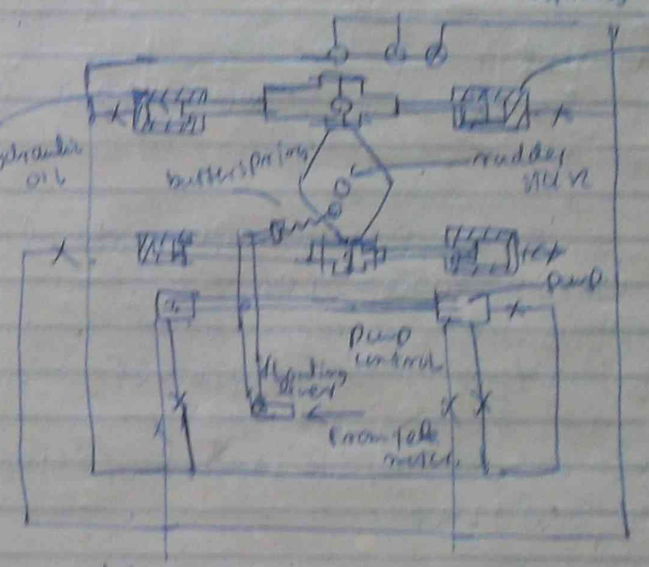
Evaporator fault
- loosen joint of power unit

Testing of gas for leak detection

Loss of Charge → joint, spindle, compressor gland
gas testing

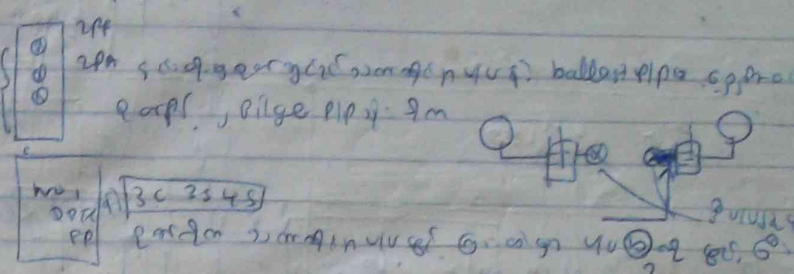
④ Checking of steering engine and fluid oil pressure





Telemotor pump is used to supply hydraulic cylinder pressure to control,
Check → valve leakage, oil level, pump working condition, oil level, control valve

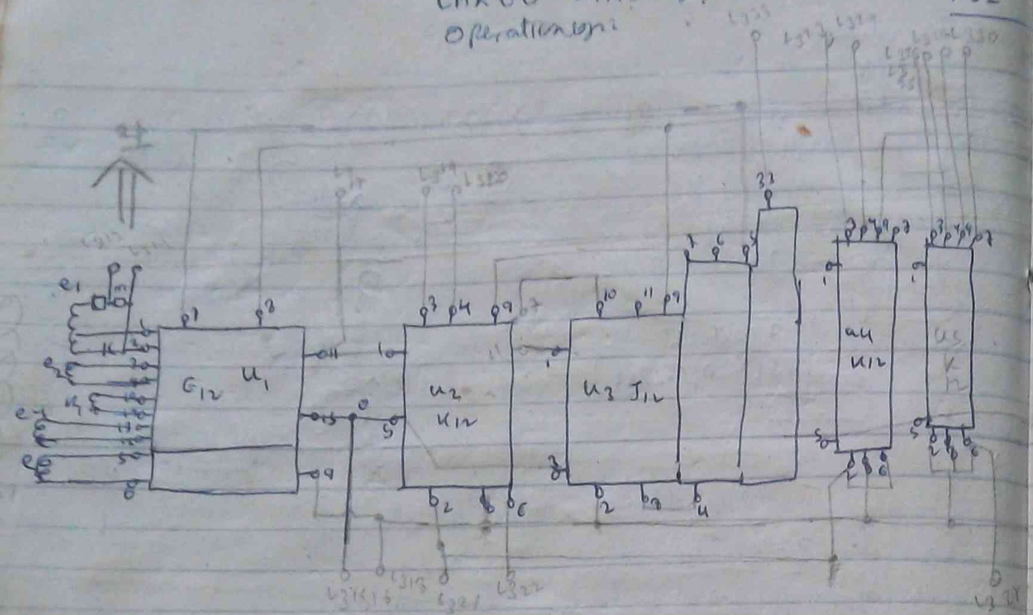
Precautions
Pump is not working, Before starting the pump, Lubrication


Tunnel
Bilge pipe
Ballast pipe
Bilge pipe
Ballast pipe

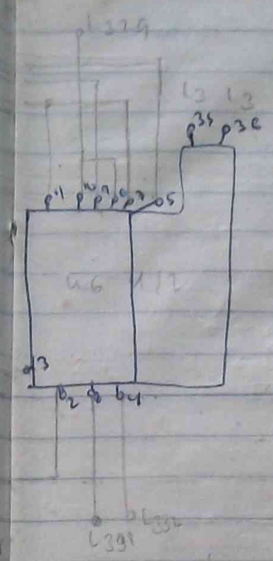
CARGO WINCH & CRANE सुरक्षा

NO2

operation सुरक्षा:



Crane CRT: (Jib power pack)



Controller को power सुरक्षा Con line → 13-14

runner motor को generator को power सुरक्षा Con [16 → 17] = 0.4V

For runner

Power pack result (Jib)

7 → 15 ⇒ 12 V

8 → 15 → -12V

9 → 15 → 16 V

11 → 15 → ~~16V~~ -12V.

Jib power pack को testing result सुरक्षा:

17 → 19 = ~~8.5~~ 12V

~~17 → 25 = 28.5~~

17 → 25 = ~~3.3~~ -12V

Idle को power सुरक्षा Con 31-32 = ~~3.8V~~ (2.5)

15 → 21 = ~~0.45~~ V - 12V

15 → 27 = 0.45V - 12V

runner control Drawing

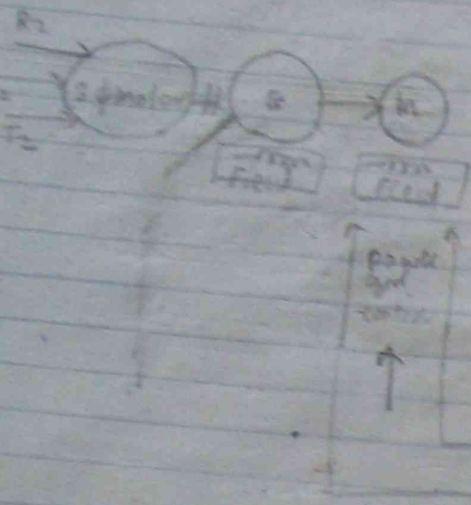
मा Jib power pack को runner motor gen: को control को coil voltage result सुरक्षा:

Jib converter motor (Runner)

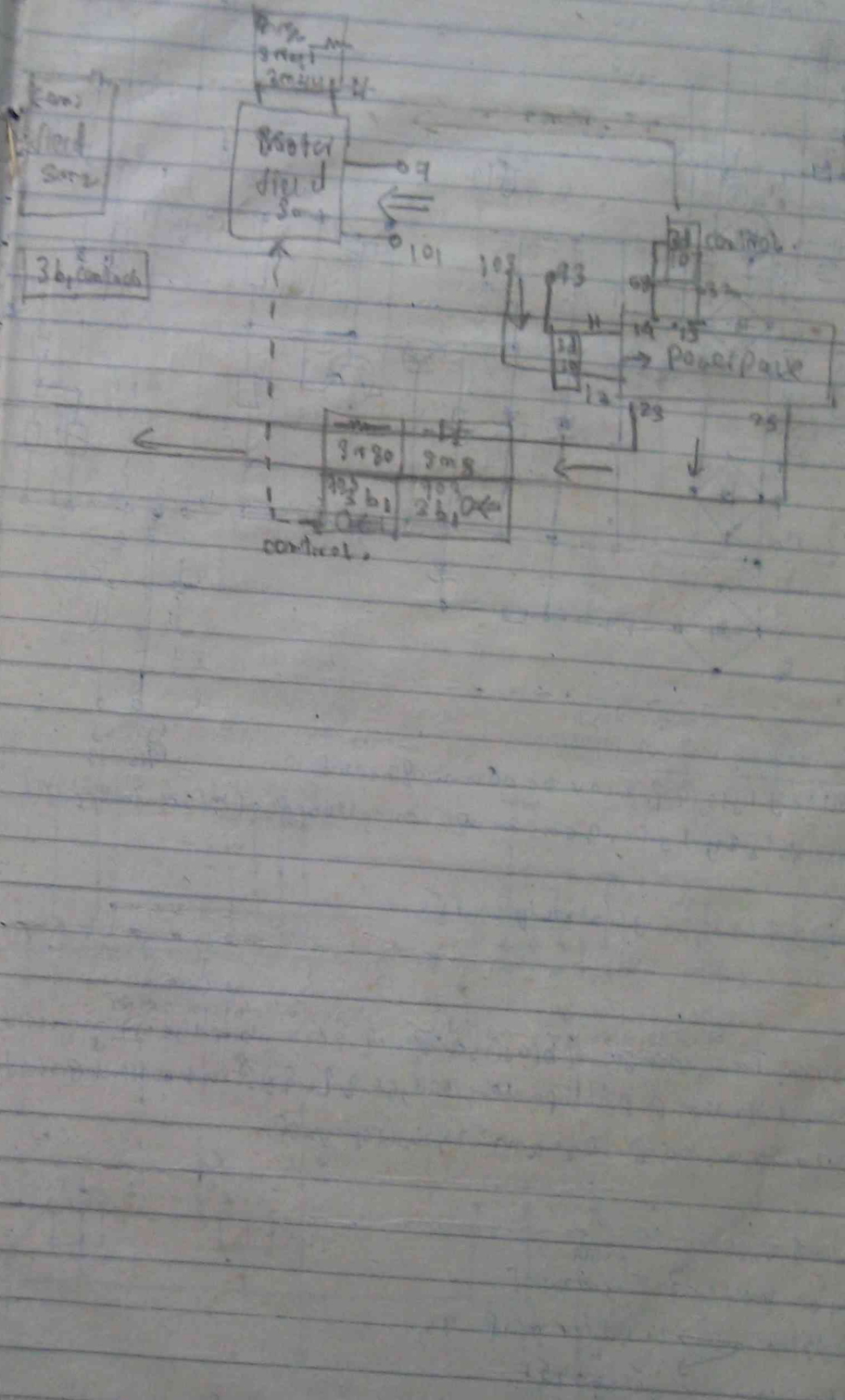
37 A, 8-5 kW, 2860 rpm

Jib motor, 22 Amp, 110V, ~~EX~~ EX, 99V.

Turning

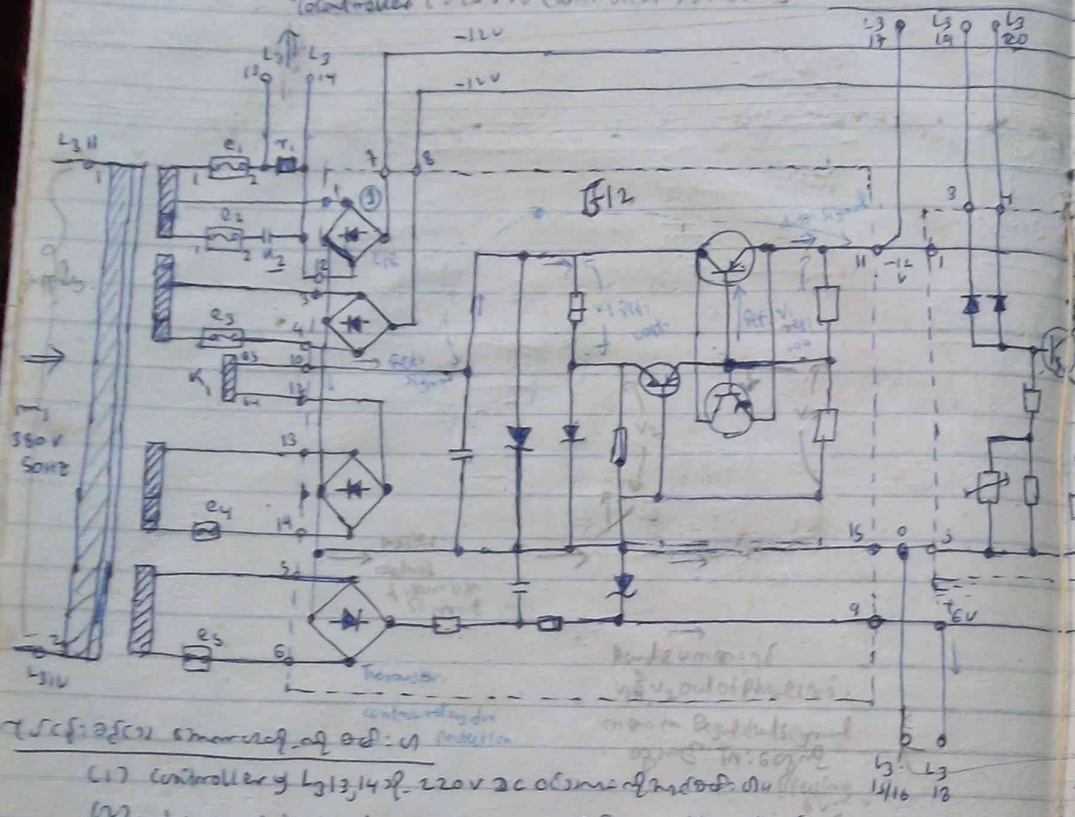


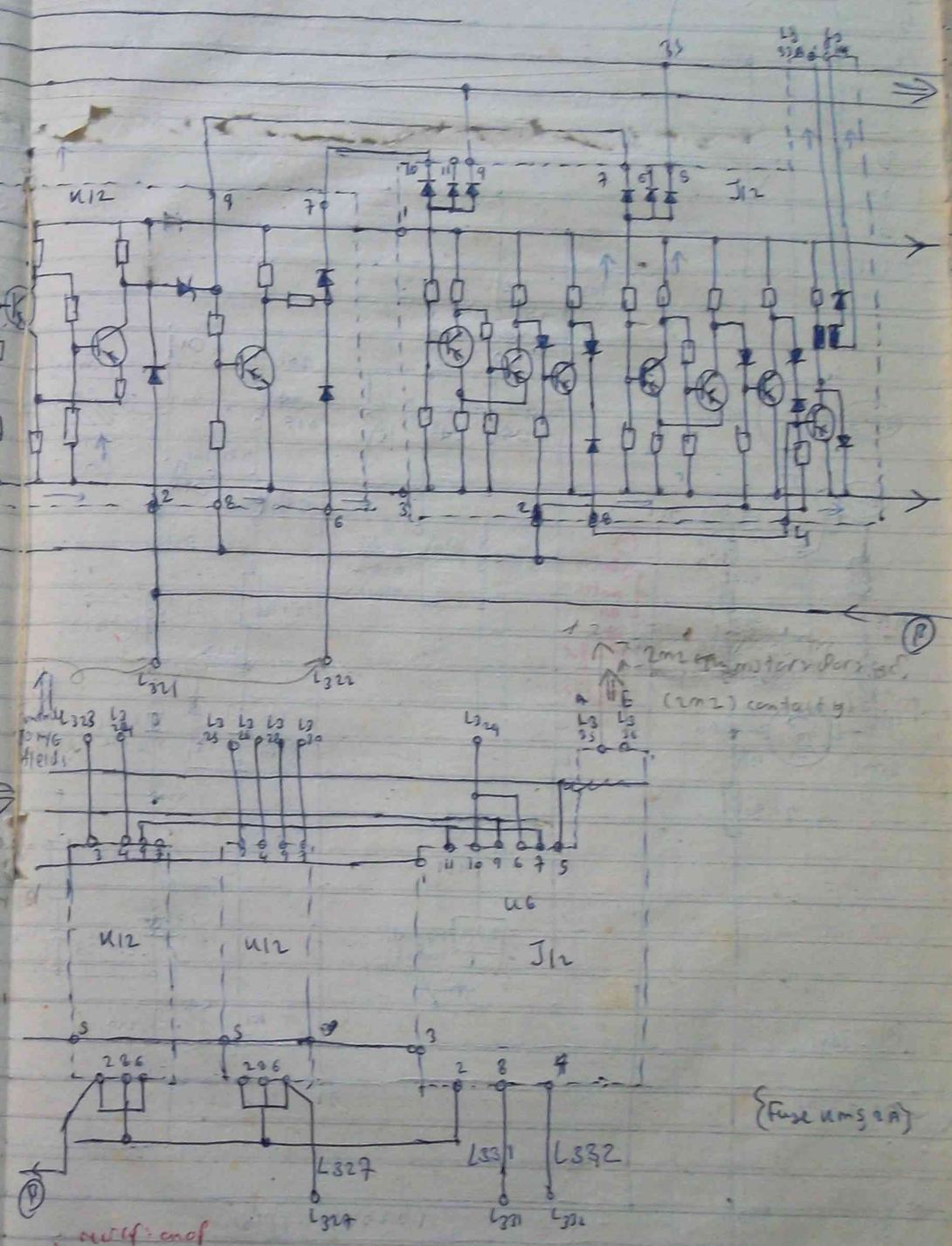
Electrical Control Circuits



JIB MOTOR ની control circuit power path circuit operation

To controller (220V to controller to motor)





circuit operation:-

(1) controller ને L3 13,14 પર 220V AC supply આપવામાં આવે છે.

(2) L3 15/16 પર, L3 21, L3 22 પર 6 ના આસપાસ voltage પર M/C controller ને આપે છે.

(3) Thyristor પર, L3 35, 36 ને control કરે છે.

(Gen: L3 15,16, L3 21, આપેલ voltage અને start ની operation માટે
35,36 ને Thyristor પર control કરે છે. motor ને controller
9,6 ને L3 13,14 ને controller પર control કરે છે. motor ને for or
(4) 380V ના Transistorised bridge ને DC માં bridge ને convert કરી
6 & 6 ના speed ને motor ના pot પર operate કરવા, તેની speed control કરવા
220 volt ના AC supply ને DC માં convert કરી 35, 36 ને આપે છે.

circuit operation:-

(1) 13, 14 controller ને 220 V supply આપે છે.

(2) 15/16 → 21 voltage ને 35,
→ 22

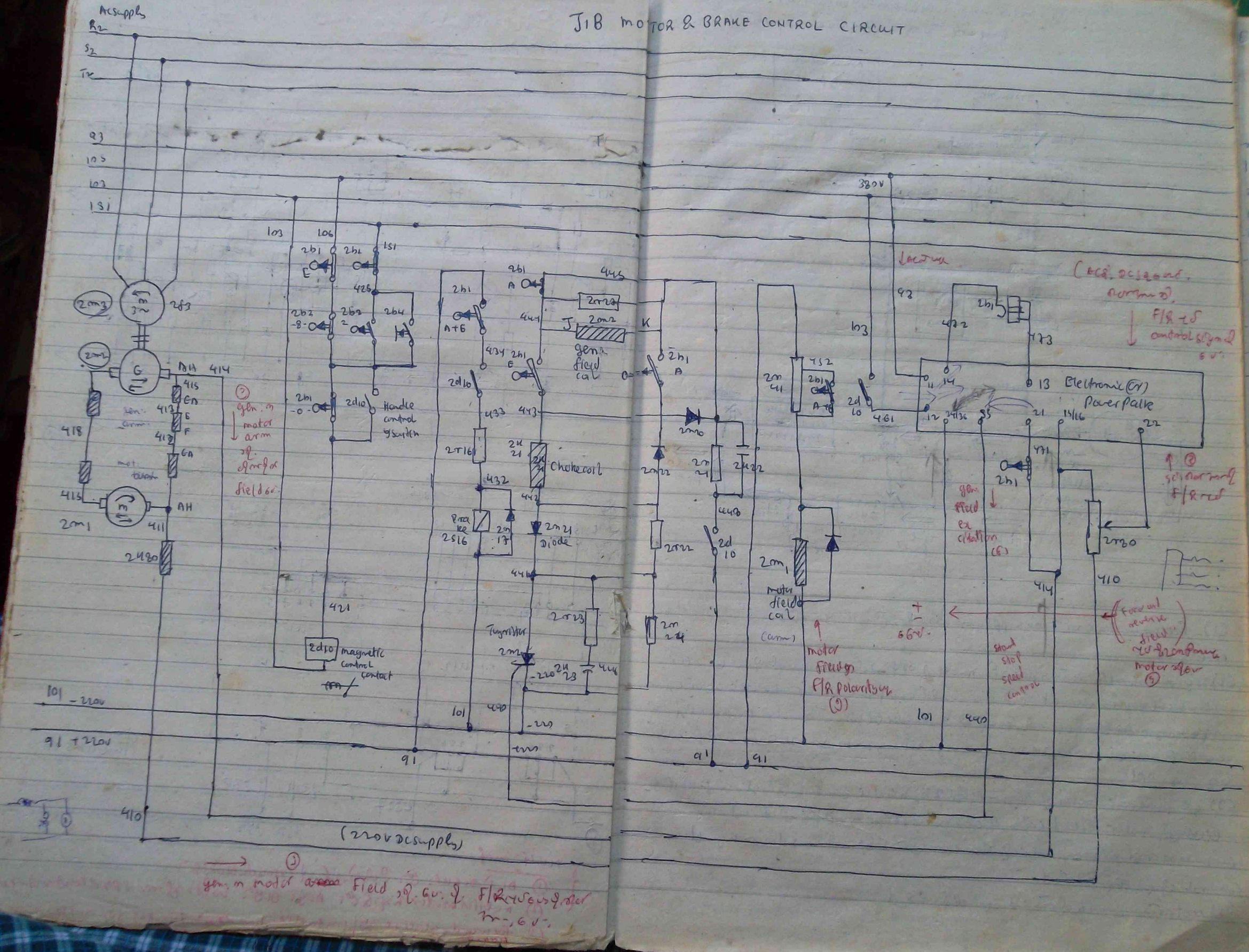
(3) 35, 36 ને આપેલ voltage ને control કરે છે.

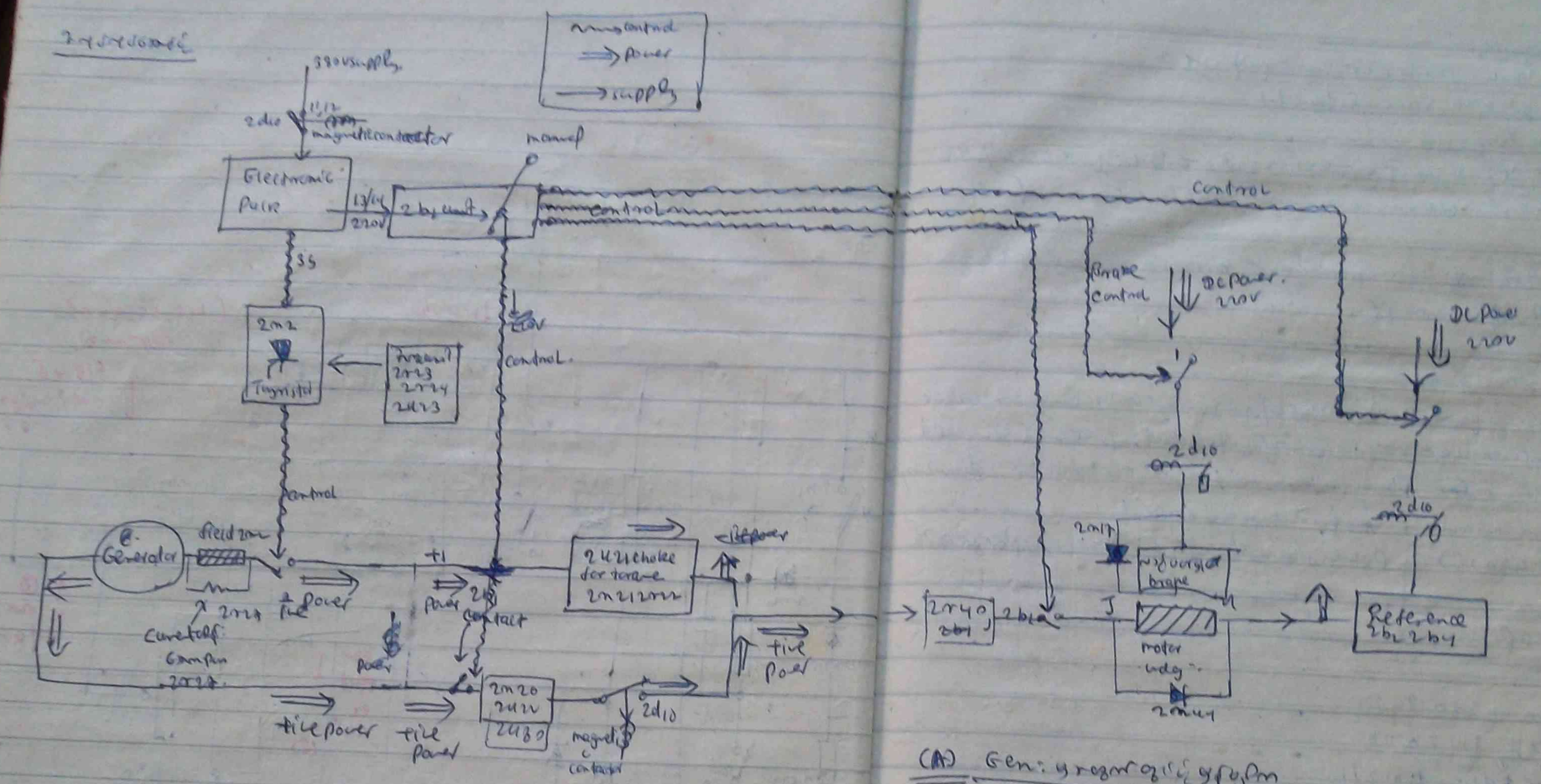
Fuse ના supply પર 13, 14, 20, ની supply ને control કરે છે.

circuit operation:-

(1) AC ને DC માં convert કરવા Bridge ની Transistor ને
(2) multivibrator ની frequency ને Adj. કરે છે. Adj. કરવા variable speed control માટે
(3) forward-reverse ને controller ની help થી forward કરવા

JIB MOTOR & BRAKE CONTROL CIRCUIT





(1) Electronic Pack ನಿಂದ 3ϕ supply ಯ 3ϕ ವಿದ್ಯುತ್ ಅನ್ನು ಸಂಪರ್ಕಕ 13/14 ಮೂಲಕ ಪಡೆಯಲಾಗಿದೆ

(2) 3ϕ control ನಿಂದ 2m2 Thyristor ಗಳ on-off ಆಗುವ ಅವಧಿಯನ್ನು ನಿಯಂತ್ರಿಸಲಾಗಿದೆ. ಇದು field ವಿದ್ಯುತ್ concernet ಅನ್ನು ಬದಲಾಯಿಸಿ ಜನರೇಟರ್ ನ output power ಅನ್ನು ನಿಯಂತ್ರಿಸುತ್ತದೆ. ಇದಕ್ಕಾಗಿ 2b, handle ಅನ್ನು ಬಳಸಲಾಗಿದೆ. Thyristor ಗಳನ್ನು ರಕ್ಷಿಸಲು 2r20, 2421, 2422 choke, 2r21, 2r22 ಅನ್ನು ಬಳಸಲಾಗಿದೆ.

(3) ಟೈ power ನ motor ನ ಅಪೇಕ್ಷಿತ 2b, handle ಅನ್ನು ಬದಲಾಯಿಸಿ, ಸರಿಯಾದ field coil ನ ಮೂಲಕ voltage ಅನ್ನು ಪಡೆಯಲಾಗಿದೆ

(4) motor ನ brake power ನ ಸರಿಯಾದ ಸಮಯಕ್ಕೆ 2b, switch 2dio magnetic control ಅನ್ನು ಬಳಸಲಾಗಿದೆ

(5) motor ನಿಲ್ಲಿಸುವ ಸಮಯಕ್ಕೆ 2dio ಅನ್ನು ಬಳಸಲಾಗಿದೆ

ಜಿಪ್ motor ನಲ್ಲಿ ಅಳವಡಿಸಿರುವ ಬ್ರೇಕ್ ಅನ್ನು ಹೇಗೆ ನಿಯಂತ್ರಿಸಲಾಗಿದೆ ಎಂಬುದನ್ನು ಸಂಕ್ಷಿಪ್ತವಾಗಿ ವಿವರಿಸಿ.

brake ನಿಯಂತ್ರಣವನ್ನು ಹೇಗೆ ಮಾಡಲಾಗಿದೆ ಎಂಬುದನ್ನು ಸಂಕ್ಷಿಪ್ತವಾಗಿ ವಿವರಿಸಿ.

(A) Gen: ಅನ್ನು ಪ್ರಾರಂಭಿಸುವ ವಿಧಾನ

① ಪ್ರಾರಂಭ ಸ್ಥಿತಿ ② ಸಂಚಯನ

generater field ಪ್ರವಾಹವನ್ನು ನಿಯಂತ್ರಿಸಲು ಬಳಸಿರುವ ಸಾಧನಗಳು:

Resistor → 2r24, 2r21, 2r24

Diode → 2m20

Chonecoil 2421, 2422 | capacitor 2422

controller 2b, A, 2b, B, contactor 2d10 (4452, 91)

ಅನ್ನು ಬಳಸಿ choke ಸುರುಳಿ

(B) Generater ನ ಪ್ರಾರಂಭ ಸ್ಥಿತಿ:

2m2 wdg: ಲ್ಲಿ, ಸಿಲಿಕಾನ್ 2r24 ಮತ್ತು 2m2 ಸಿಲಿಕಾನ್ ಅನ್ನು ಬಳಸಿ ಸಂಪರ್ಕಿಸಲಾಗಿದೆ.

series ——— 2r21 ——— voltage ಅನ್ನು ಪಡೆಯಲಾಗಿದೆ

ಪ್ರಾರಂಭ, ಸಂಚಯನ ಪ್ರಕ್ರಿಯೆಯನ್ನು ಮಾಡಲಾಗಿದೆ

(C) ಸಂಚಯನ ಸಮಯದಲ್ಲಿ open ಮಾಡಲಾಗಿದೆ

(c) motor ನಿಂದ voltage ಅನ್ನು ಪಡೆಯುವುದು

(1) motor terminal ಲ್ಲಿ, ಸಿಲಿಕಾನ್ contact 452, A ಇಂದ ಪಡೆಯಲಾಗಿದೆ

magnetic

2 dio ক) কী কাজ control contactor switch-এর?

(i) contact ঝোলা (mechanical fault)

(ii) সার্কিট থেকে Holding coil

(iii) ডি: ফ্রি সার্কিটে overcurrent-এ current বাড়লে coil-এ ভোল্টেজ কমে যায় ফলে coil-এ চুম্বকত্ব কমে যায় ফলে contact খুলে যায়।

Brake

ডি: 2 dio-র brake-এ সার্কিট operate করার brake-এ current প্রবাহিত হয় 2 dio, 2 না 6, 2 b, কী কাজ করে।

Torque control: → coil-এ কী ধরণের

কী কারণে Thyristor-এ gate signal Thyristor কী কাজ করে control-এ contactor ডি: কী কাজ করে, 2 b, controller সার্কিটের কী ভূমিকা পালন করে ডি: ফ্রি, result: কী ধরণের ডি: power pack সার্কিটে controller 2 b, ছাড়া motor চালানো যায় না ডি: controller ছাড়া কী ধরণের power pack ব্যবহার করা যায়।

Operating-এ motor ডি: control করার জন্য:

(1) power pack ⊖ 440 2480 3480

(2) Handle control switch, 1b, 2b, 3b

(3) magnetic contactor 1 dio, 2 dio, 3 dio,

(4) Thyristors (1 no ⊖, 2 no −, 3 no −)

(1) ডি: power pack-এ কী কী কাজ করে motor-এ কী কী কাজ করে ডি: ফ্রি 2 ডি

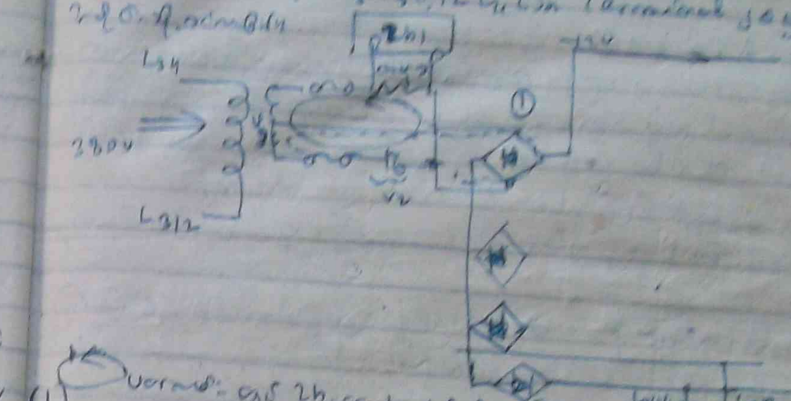
(ii) Thyristor ডি: Thyristor-এ কী control করে ডি: কী কাজ করে ডি:

(iii) Rheostat, Timing power pack-এ কী control করে ডি: কী কাজ করে ডি:

ডি: ফ্রি. 2 ডি: কী কী কাজ করে ডি: কী কাজ করে ডি:

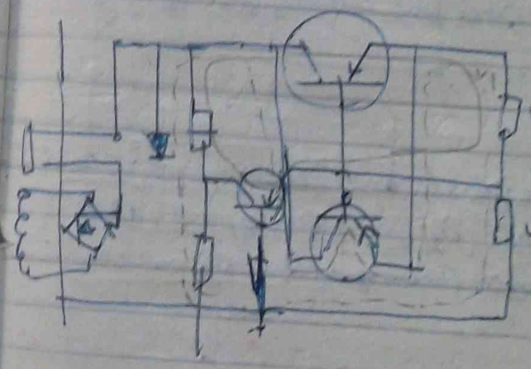
Power pack-এর কাজ:

380V supply-এর L_3 ও L_1 12 no. terminal-এ power pack-এ ডি: ফ্রি. করা হয়।



(1) Varistor-এর 2b, contact-এ ডি: V_1 ও V_2 ফলে V_2 কী ডি: ফ্রি V_3 ডি: ফ্রি ডি: ফ্রি bridge rectifier-এ rectifier 2 ডি: ফ্রি. current ডি: ফ্রি ডি: rectified (variable) L_3 15, 16 ডি: ফ্রি generator-এ stator winding excitation ফ, separately excited motor-এ stator excitation ডি: ফ্রি।

(2) কী



controller-এ gate signal ফ. 380 V gate signal V_1, V_2 ডি: ফ্রি G_1, G_2 ফ ডি: amplifier 2 stage ডি: ফ্রি. gate ডি: ডি: resultant signal ডি: ফ্রি ডি:

resultant signal ডি: V_1, V_2 ডি: ফ্রি, JK flip flop 2 stage 2 ডি: ফ্রি। 2 ডি gain ফ, ডি: ফ্রি. gate ডি: step resistor ফ, ডি:, BS ও 2 no Thyristor ফ. ডি: control 2 ডি

(3) gen: 2 no ডি: excitation (stator) ডি: ফ্রি, motor ডি: ডি: JK flip flop ডি: ফ্রি 2 b, 2 no choke coil 2 no ফ. ডি: ডি: motor ডি: ফ্রি. ডি: ডি: contact ডি: ফ্রি. 2 dio ডি: control ডি: ফ্রি. holding coil current ডি: 2 b, contact ফ্রি, ডি: 380 V ফ control ডি: ডি।

(4) ডি

Drive system of 220V shunt motor is controlled by 2 methods.

Runner ckt is fed from gen: armature through motor terminals through thyristor bridge circuit. The power part is controlled by the firing signal given to the Thyristor bridge circuit. The firing signal is fed from Thyristor control circuit. The control circuit is supplied by a separate power pack and is not fed from the load.

gen: → Power → Handle circuit → motor

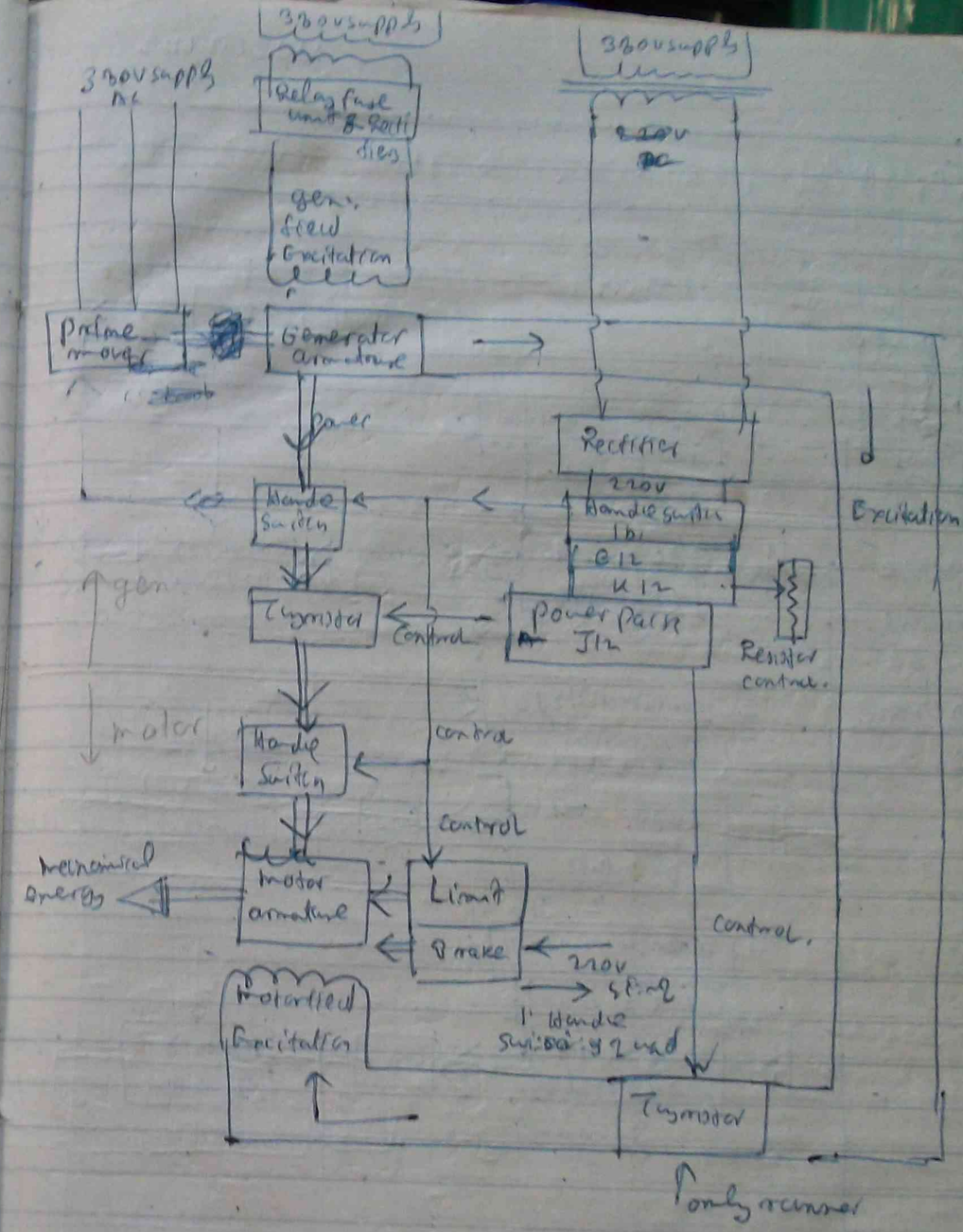
Handle circuit is used to control the speed of the motor.

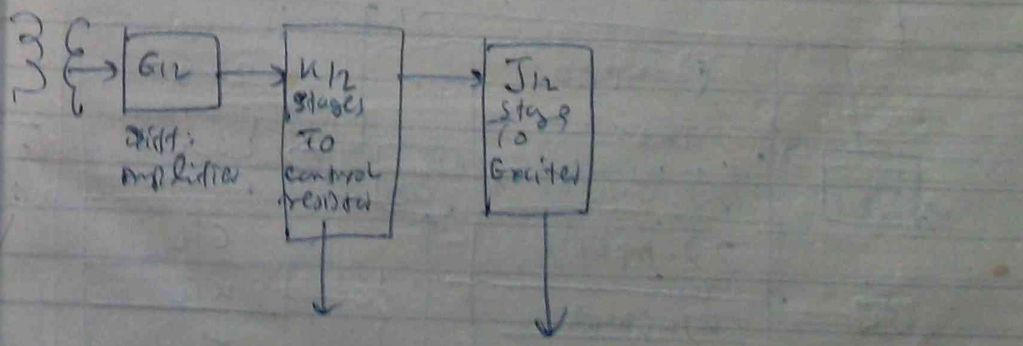
Control circuit:
- (i) Thyristor control circuit
- (ii) Manual / mechanical
- (iii) Control circuit is used to control the speed of the motor

Power circuit:
- contactors, diodes, resistors, relays are used.

Protection circuit:
- Short circuit protection
- Over load protection
- Over current protection

Note: Power circuit should be controlled by control circuit.





Control system Block Diagram. (Ref.)

NO2 crane control circuit

control

Powerline

380V AC supply

Power

Relay

Prime movers 3φ AC rotor 3 unit

Contactor & idle

Excitation

Degenerated 220V

Rheostat

Thyristor

Contactors AC contact

Contactor AC contact

Thyristor

Excitation

Limit

Brake

motor

Contactor & idle

Excitation

Degenerated 220V

Rheostat

3 Jib

Contactor & idle

Excitation

Degenerator 220V

Rheostat

3 Turning

Contact

AC contact

contact

H/L contact

Excitation

Limit

Brake

motor

Power pairs

1 set

Diff: Amplifier

G.L

H.L Amplifier

J.L amplifier

2 set

Power pair

G.L

H.L

J.L

3 set

Power pair

G.L

H.L

J.L

speed

Electronic control system