(2) cooling fresh water spaces.

liner
Scavenge Trunk. (Inside)
Engine: Cylinder jacket of pipe, Rod (only 2 Stroke
2 Stroke ~~2 Stroke~~ Air Inlet / out - Cyl: block + exhaust
4 " " Cyl: Head manifold

(3) Black Engine Sump: Crankcase Engine Sump: Part
Sump: Engine Lubricating oil ~~Pump~~ Part

Certificate

Cadet - 1 year (9 month Dock services) } Dock Service 4 year
Dockyard - 3 year 3 months
Exam Eligible = M.O.T (2nd class Part A)
(Part B) 1½ year sea service (or) 18 months sea service
Servicing J.E after Part B
JE → 5th Eng: → 4th Eng:
Junior Engineer

M.O.T Part A after 3rd Eng: Officer
2nd: Part (B) After exam 2nd: Eng: Officer

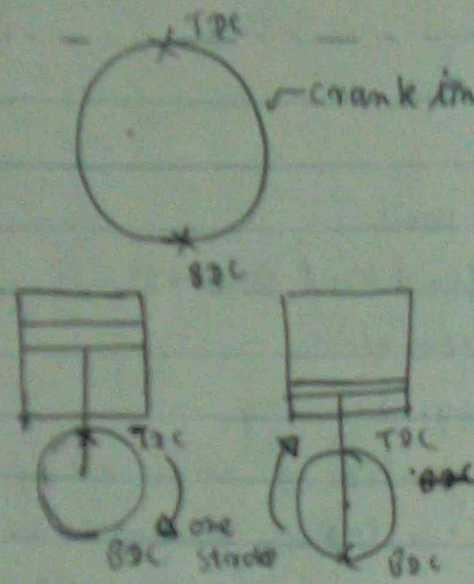
1½ year
2nd: Part A (or) Part B → I Part A → I Part B → Steam + motor combined → extra 1st class A extra 1st class B
2 months 1½ year later 2nd 9 months

CE → 1300
1st → 1200

2nd class part A - ① mechanics
② Heat and Heat Engines
③ mathematics
④ Engg. Drawing

2nd class part B * ① General Engg. Knowledge (GEK)
② motor Engine knowledge (or) Steam
* ③ Shipconstruction and Naval Architecture
④ Electro Technology.

4 Stroke Engine



TDC → BDC = stroke

BDC → TDC = stroke

(Top Dead Centre) TDC

compression pressure = 500 lb/in² } minimum

comp. Temp = 1000°F

combustion Pressure = 900 lb/in²

Exhaust gases: H_2, C, N_2, SO_2, O_2

H_2 C — O_2 ⇒ Exhaust gases

N_2

C

4th stroke, { Piston moves upward
Exhaust valve opens
Products of combustion pass through the exhaust valve

Small Engine — Inlet - 1
Exhaust - 1

Exhaust Big Engine — Inlet - 2
Exhaust - 2

1st stroke - { Inlet valve opens
piston moves downward
crankshaft moves from TDC to BDC

2nd stroke { Inlet and exhaust valves are closed
Piston moves from BDC to TDC
Crankshaft moves from BDC to TDC

Two stroke Engine

Scavenging - (fresh air inlet exhaust gases exhaust)

1st stroke.

(A) Piston moves upwards air compressed fuel inject } combustion valves are closed (Power)

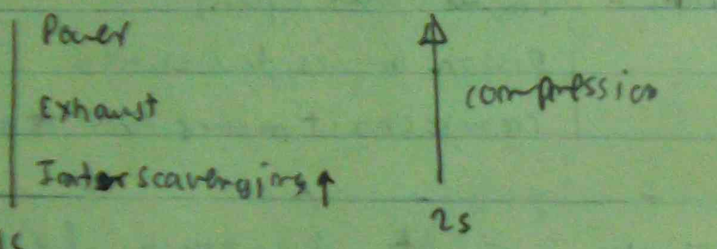
(B) Piston moves downwards Piston down Ex: valves opened

Products of combustion passes through Ex: valves

— Scavenging

① — piston moves upwards
air suction
valves of gases open

② compression of new air charges



excursion

① Main Engine
② Generator engine
③ Control system
④ Starting system
⑤ Freshwater system
⑥ water supply system
⑦ Fire Fighting
⑧ Air condition system
⑨ Bridge
⑩ Fuel pump nozzle
⑪ Freshwater supply/generator
⑫ Bilge system
⑬ Ballast system
⑭ load line Bridge line
⑮ ~~rectifier~~ purifier
HC, 30, LO

⑫ Fire Fighting system ; sl
steering system
: Air condition system

* shore leave expire - 09:00 HR
* control Test - 10:00 HR
(Telegraph ಅಂದ್ರೆ)
Telegraph Testing
Bridge ನಲ್ಲಿ, Engine room ನಲ್ಲಿರೋ ಅಂದ್ರೆ
Stop - Stop
Stand by - Stand by
Ie Steering testing
- Stern part, Bridge ನಲ್ಲಿ, steering room ನಲ್ಲಿರೋ ಅಂದ್ರೆ

CPP testing
controlable pitch propeller

ಇದು test, ಬೇರೆ ಬೇರೆ position ಅಲ್ಲಿ ಅಂದ್ರೆ (30, 20, 10 ಅಲ್ಲಿ ಅಂದ್ರೆ)

* Stand by - (Bridge ನಲ್ಲಿ tele: ಇರುವ Eng: room ನಲ್ಲಿ
10-30 Hrs ಆಗಿರುತ್ತೆ)

ఇంజిన్ stand by లో: - (4-8) watch ✓
10 ఇంజిన్లకి " (8-12) watch ✓
(12-4) watch ✓

ఈవిధంగా watch లు stand by ఇంజిన్లకి ఇవ్వడం: stand by లు ఎలా ఈవడం జరుగుతుంది.

Stand by ఇంజిన్ 1st move అయినప్పుడు మళ్ళీ 2 గంటల తర్వాత మళ్ళీ 1st move అవ్వడం జరుగుతుంది.

Full away

Manoeuvering speed

Duty watch లలో ఉన్నప్పుడు ఇంజిన్ లో ఉన్న oil level: ని తీసుకోవడం జరుగుతుంది.

Checking చేయడం జరుగుతుంది.

CHE "A" to "C"

"A" లో diesel oil

full away Heavy oil ఉంటుంది.

Heavy oil లో ఉన్నప్పుడు Boiler steam లో 100°C, 110°C లో heating ఇవ్వడం జరుగుతుంది (Change oil)

1 Hr Notice (ఇంజిన్ ని stop చేయడానికి ముందు 1 hr ముందు Notice ఇవ్వడం జరుగుతుంది)

Change oil "C" to "A"

Stand by → ఇంజిన్ ని ఆపడం:

Stop

F.W.E ← ఇంజిన్ ని stand by లో ఉన్నప్పుడు Eng: ని ఆపడం:

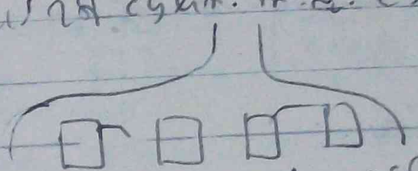
ఆపడం: చూస్తూ ఉండాలి.

Day work

filter, store keeper

Duties

① ~~exh~~ cylin: ల: exhaust pipe temp: ని check చేయడం cylin: ల: exhaust temp: లు ఒకే విధంగా ఉండేటట్లు చూడాలి.



② sea water, atmospheric temp: ని బట్టి water, lubri: oil temp: ని, pre: ని adjust చేయాలి.

③ pre: ని, temp: ని 4 గంటలకి ఒకసారి logy లో రాయాలి.

4 గంటలకి ఒకసారి ఇవ్వాల్సిన వాటిని ఇవ్వకపోతే ఇంజిన్ కి ప్రమాదం జరిగే అవకాశం ఉంది.

④ temp: diff, pre: diff, noise diff లని cylin:, crank case లలో గమనించి end of the watch లో రాయాలి.

⑤ లీకేజీలు ఉన్నట్లయితే చూసి చేయడం జరుగుతుంది.

⑥ crank case లో oil: ని ఎప్పటికప్పుడు చెక్ చేస్తూ ఉండాలి.

~ ... over haul ... overhaul ... ...
... temp ...

① crankcase ... engine ...
② Engine ... ...
③ crankcase ... ...
④ ... ...
⑤ ... piston ring ... ...

moulmein

Main Engine

8 cylinder HP = 5400 HP
vertical in line r.p.m = 425

1	2	3	4	5	6	7	8

V

Gyro compass = master Gyro, magnetic
offical NO = 1669
Derrick = 5
L.B = 2 L.B = 506 mm L.B = 426 mm
propeller ... shaft ... : Engine ... oil
... drawing ...
call sign = X Y N J

12/24 = Free NO 25
tons
Turbo ~~carbon~~ charger = Engine exhaust ... high pr:
... ...

Exhaust gas
Blower — shaft — Turbine blade
to suct the air
... generator ...
... Pressure ... lower limit
upper limit.
Gross tonnage = 7567 tons by volume
net = 5282 tons
deadweight = ...
lightweight
~~1 ton = 1~~
... L (or) LB = ~~438 meter~~ 438' 11 7/8" 133.8 metre
Breadth B = 69' 2 9/16" 21 metre
Height = 48.35 m
draught = 24 ft and 2"
Cool Room = 32
Head cover Hydraulically operated.
maker = mac Gregor west Germany.

anchor = 2 ২

11 Portable fire extinguisher.

A = ordinary fire ex: (...)

B = oil fire ex: (...)

C = Electorical fire ex: (...)

... High Pre: ... Low Pre: ...

... ...

rate, duration,

Ship particular - ...

...

dead weight = 11660

Draft = gravity davity

LBP marking = length, depth, breadth

Type

propeller = 4700 mm propellerpitch = [Pitch x rev = dist ... by Prop

anchor chain = 9 shackle

1 shackle = 15 fathoms ... propeller slip = theo: dist - dist:]

superstructure = 1 deck

wheel house; 2 Room

E' S 2 nos set out

DF

R

W/C Wash ... Saloon

... 2/0 /0 Fuse ... Coal

Full = 425 rpm 15.52 knot

full 350 rpm 13.58 knot

Half 300 r.p.m = 10.45 knot

Slow = 240 rpm = 3 knot

Deadslow = 150 r.p.m = 5.48 knot

... = Sliding cover

General Engine

Firstell

adjusting Table

spiel Top clearance = 2.30 mm (suction ... clearance)

② spiel Einlassventil

... Exhaust ...

③ spiel Auslassventil

Exa - valve cle = 0.3 mm

④ Fim sprit t Begin Grad voro. T

Fael Injection ... BTDC 11 ≃ 16 grand Deg

⑤ Zund Folge s

Firing order 1-5-3-6-2-4

⑥ ... motoroung s druck

fuel injection ... press 16 ong/cm²

model 6 AL - ST Yanmar

Port side : 8.4 Bar

Starboard : 8.8 Bar

warm water P.T : 25 bar

cap : 15 m³ - 24 hr

unit No -

Type - Imt 3512 S desmel

main motor main :

5400 BHP (4250 a.p.m)

High point above the keel - 45.35 m

3 Een 400 KVA 60 Hz

Gravity davit

Built - 1929 Flensburger.

Schiff Ran - Eesel schaft

Flensburg

		Gross ton	net
International (close)		7567	3282
	(opened)	4604.38	3783
Panama	~~8277~~	8219	
Suez		~~8244~~	6388
		7244	6381

depth moulded to main deck 30' 1 1/16" / m

" " 24' 11 2/32 / 76 cm

draught (full : cant ling) 27' 2" 8/76 cm

" (Tonnage mark) 23' 22/32 / 72'

pressure ~~for~~ of S - ~~for~~ of 4 ~~for~~ m

Pipe ~~for~~ ~~for~~ filter ~~for~~ ~~for~~ ~~for~~

~~for~~ ~~for~~ ~~for~~ of ~~for~~ ~~for~~ ~~for~~

simple values

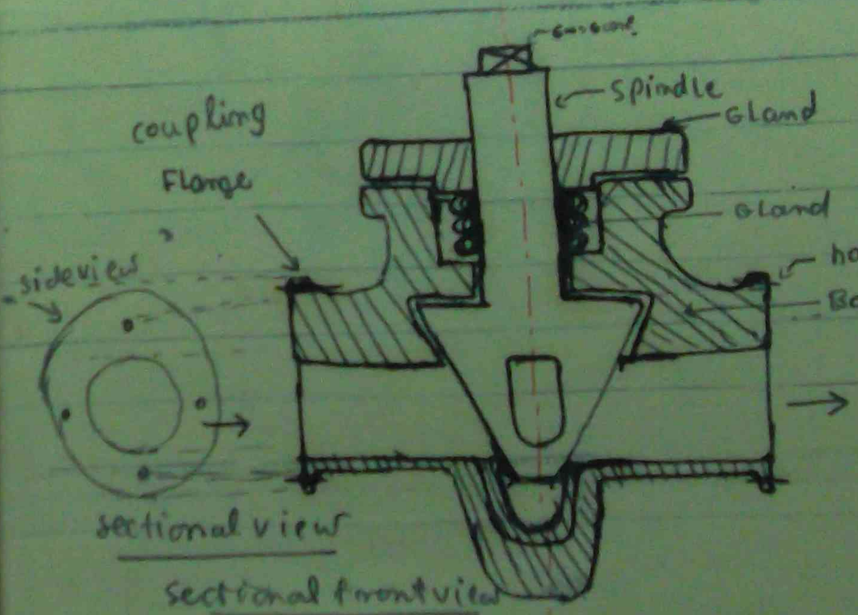
simple values can be grouped under the following headings.

(a) cocks

→ Port

→ go 180°

× Non Sm. Gen. Valves



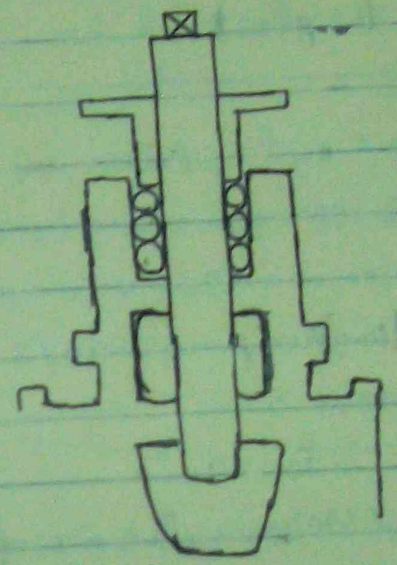
casting = ...

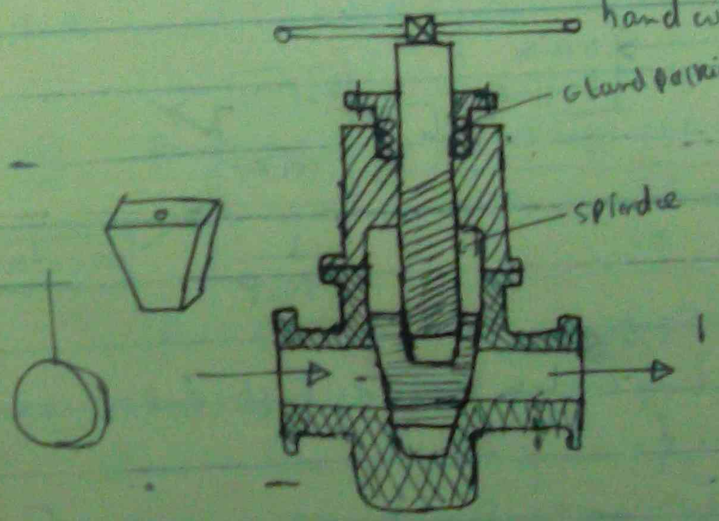
The cock plug is ~~formed~~ permanentaly seated in the pipe and has an opening running through it. to permit flow when the cock is opened

The cock plug can be turned around in place so as to cut off flow.

(b) Gate valves sluice valve V/v value

A wedge shaped gate stand outside the line of flow, but can be moved across the flow to cut it off.





O B - oil gauge
Tank

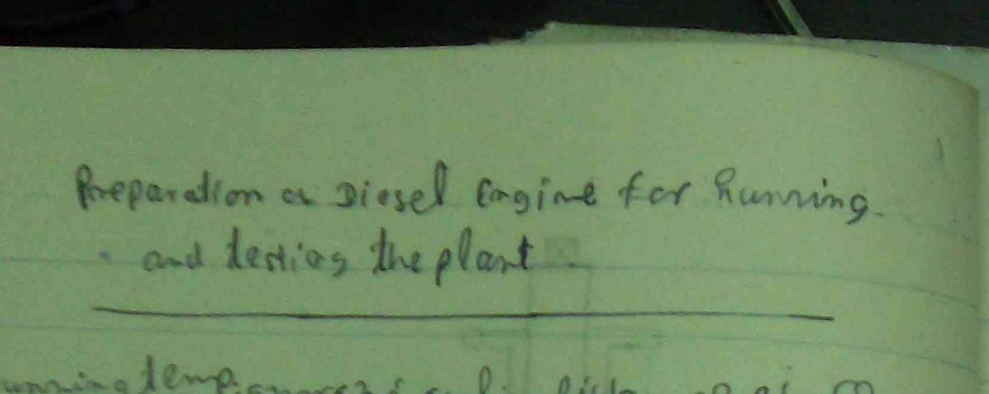
Packing of G.V valve

Preparation of Diesel Engine for Running and testing the plant.

② running temperature of cyl: liner, piston, & thr heat is carried away by the fresh water cooling system to main engine. It is then passed through pipes to steam operated circulating pump & returned to the fresh water cooling system.

Freshwater cooling system

* main engine inlet line has steam valve operated by S.W = sea water



Block diagram

* Expansion tank level watch ~~of~~ cooling line ~~of~~ has.
* seawater = pipe → Freshwater ~~of~~ pipe
freshwater = pipe
cooler sea water temp inlet = 28°c
" outlet = 35°c

main engine
Freshwater out let temp = 60°c
" in let " = 40°c

vent:

cylinder cover ~~of~~ 5°:6-6 ~~of~~, ~~of~~ : air manifold

Exhaust → Turbo charger
→ head

** ~~coo~~ ~~of~~ cooler ~~of~~ ~~of~~ ~~of~~
By pass ~~of~~
* * ~~of~~ cooler ~~of~~ ~~of~~

② Paritier = Fuel, Heavy oil ~~of~~ ~~of~~
HO and DO — DO = ~~of~~
HO = ~~of~~

Paritier oil tank ~~of~~ required temp ~~of~~
service tank = ~~of~~ = (85°c) } Heavy oil
setting tank = ~~of~~ (65°c) }
Paritier = 80°c

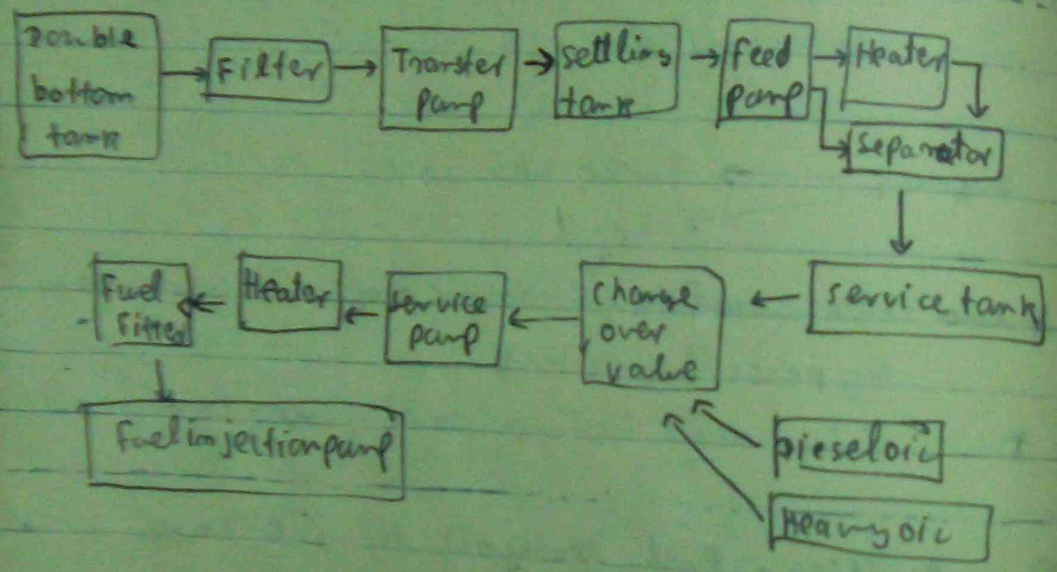
setting tank (65°c) → Paritier (80°c) → service tank (75°c)

* steam ~~of~~ adjust ~~of~~

Fuel oil system

D.B = Double bottom tank. (ballast, Freshwater, sea water)

* settling tank: ballast, fresh water, sea water



Block diagram

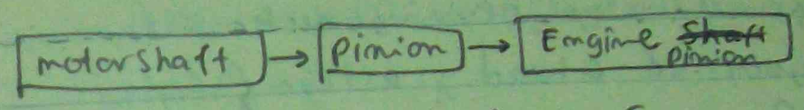
change over valve

Diesel & Heavy oil change ചെയ്യുന്നു.

1. Double bottom tank ൽ നിന്നും
2. Purifier & settling tank ൽ നിന്നും

3. crank case ൽ നിന്നും ഓയിൽ
oil sump ൽ clean ചെയ്യുന്നു

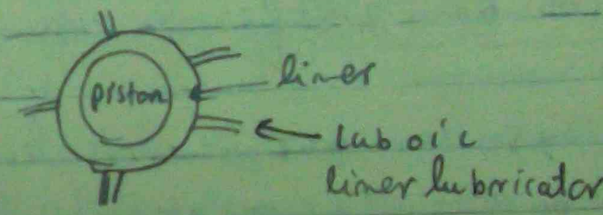
4.



turning gear ഓണാക്കുന്നു
nut clip ഓഫ് ചെയ്യുന്നു. working equipment ഓണാക്കുന്നു
ഓഫാക്കുന്നു.

5. Lub oil pump ൽ നിന്നും working oil ൽ ഓയിൽ
bearing ലേക്കുള്ള pressure 2.5 kg/cm²

6.



ഓയിൽ ഓണാക്കുന്നു → ഓയിൽ ഓഫാക്കുന്നു

7. turning gear ൽ നിന്നും ഓയിൽ ഓണാക്കുന്നു.
crank case ൽ നിന്നും ഓയിൽ check ചെയ്യുന്നു

8. ഓയിൽ പമ്പ് ൽ ഓയിൽ ഓണാക്കുന്നു
ഓയിൽ pressure 25 kg/cm²
ഓയിൽ ലെവൽ കുറഞ്ഞാൽ ഓയിൽ ചേർക്കുന്നു

⑨ Priming

Fuel system ന്റെ ഉള്ളിൽ വായു കയറിയാൽ:

⑩ Thrust, tunnel, lub: bearings ഇവ ന്റെ Checker ചെയ്യണം

⑪ reversing and control gear ന്റെ Checker ചെയ്യണം

⑫ Stand by വരുമ്പോൾ ahead ൽ, astern ൽ: ചെയ്യണം

ഓരോ: ന്റെ: ശേഷം indicator cock ന്റെ Position: മാറ്റണം

Generator engine starting Procedure

— gen. engine ന്റെ ഫ്ലൈ: വീൽ winch, motor ഓടിക്കുന്നതിന്, ആവശ്യമായ power ഉണ്ടാക്കുന്നു.

— ഒരു ദിവസം ആദ്യം 3 പ്രാവശ്യം ഓടിക്കണം 2 പ്രാവശ്യം ഫ്ലൈ: വീൽ തിരിച്ചു കൊടുക്കണം

① lub: oil, cooling system ഉള്ളതാണോ, Sump oil level നോക്കണം

② lub oil cooler by pass ന്റെ ഉള്ളിൽ, ചെയ്യുവാൻ

③ Indicator cock

jacket cooling pump

fuel ~~pump~~ valve } ഇടണം

④ lub oil valve ഇടണം - engine ഓടുവാൻ തുടങ്ങുമ്പോൾ

pump valve തുറക്കണം

④ starting air valve ന്റെ ഉള്ളിൽ

⑥ ~~ഓടുവാൻ~~ തുടങ്ങുവാൻ തുടങ്ങുമ്പോൾ

⑦ Indicator cock തുറക്കണം

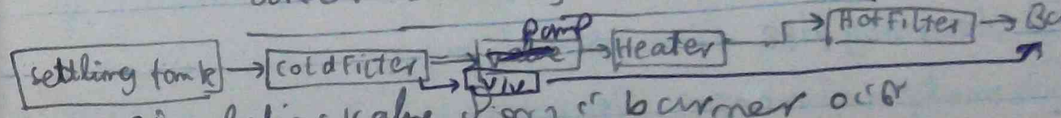
⑧ Fuel ൽ, ൽ: ചെയ്യണം

⑨ air valve തുറക്കണം drain ഇടണം

⑩ inlet temp: 40 ഡിഗ്രിയിൽ lub oil cooler by pass valve ന്റെ തുറക്കണം

⑪ 5 minutes without load ഇടണം, ~~load~~ ൽ: ..ൽ: ചെയ്യണം

Boiler Burning Fuel system



circulating valve തുറന്നാൽ burner ഓഫ്

" ഇടണം burner ഓണ്

ഈ ഓയിൽ temp ന്റെ വ്യത്യാസം അനുസരിച്ച് V/V തുറക്കണം

" പ്രവർത്തിക്കണം " ഇടണം

ഓയിലിന്റെ pressure reg: ~~ചെയ്യണം~~ ചെയ്യണം

{ ഫ്യൂവൽ ഇടുമ്പോൾ pressure ~~ഉയർത്തുവാൻ~~ പ്രവർത്തിക്കണം

പ്രവർത്തിക്കുമ്പോൾ pressure ന്റെ ഓർഡർ

{ temp: regulation ചെയ്യണം

Steam

oil tank cleaning ചെയ്യുമ്പോൾ steam ഉപയോഗിക്കുന്നു, gas free ചെയ്യുവാൻ

service tank ও steam heating coil এর উপর।

** steam দ্বারা ফুটন্ত অবস্থায় diesel তেল H/O (Heavy Oil) ও steam দ্বারা গরম করা হয়।

D/O = diesel oil H/O = Heavy oil

Chief engineer log Book

* watch গুলোতে engine log লিখতে হবে *

* ১. ① funnel এর উপরে
② Boiler এর safety valve
③ steering pipe line এ
④ material room, fish room
⑤ -12°c -15°c Fish room এ

12টায় duty শেষে engine log এ chief Engineer কে, Forth engineer log লিখবে।

sea water temp (S.W)
গ্রীষ্মে 15°c, 12°c
শীত = 30°c

F.W (Freshwater)
cooler outlet এ 16°c
cooler inlet এ 32°c

Lub. oil (L.O)

(cyl. dis) (cylinder discharge) (cyl. এর temp এর উপর নির্ভর করে)

(pist CLR) (Piston cooler)

(Pist cool dis) (Piston cooling discharge)

Exhaust temp এর উপর নির্ভর করে

EMER - Emergency

২. Temp in °c

Pressure ৭ kg cm/cm2 (unit)

* Freshwater pressure এর sea water pressure

* Lub oil pressure এর sea water pressure

Turbo Blower

engine এর temp এর উপর নির্ভর করে blower এর fan speed ৪০% এ রাখতে হবে।

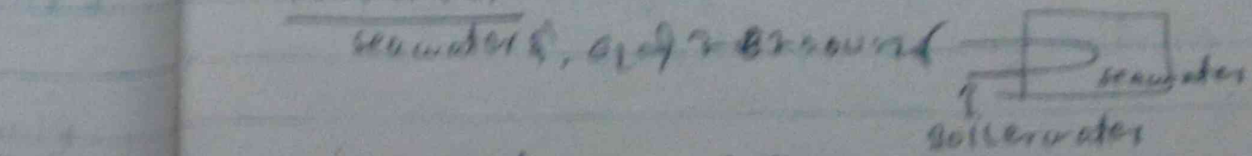
Exhaust temp

Turbo Charger এর temp মাপা হয়।

Flow meter

oil এর flow মাপা হয়

Hot tank 12.1 m3 (approx) oil এর temp ধরে রাখে
Do tank


seawater
boilerwater

Precipitated - ...

(I) ... temporary hardness salt

$CaCO_3$, $Mg(HCO_3)_2$

$Ca(HCO_3)_2$ / $Mg(HCO_3)_2$ → Δ → CO_2 ..., CO_3 ...

Sludge - ...

CO_2 ... steam ..., ... $CaCO_3$ ..., $Mg(HCO_3)_2$ ... Boiler ... Boiler ... soft scale (...): ... heating surface ... Boiler heating ..., ...

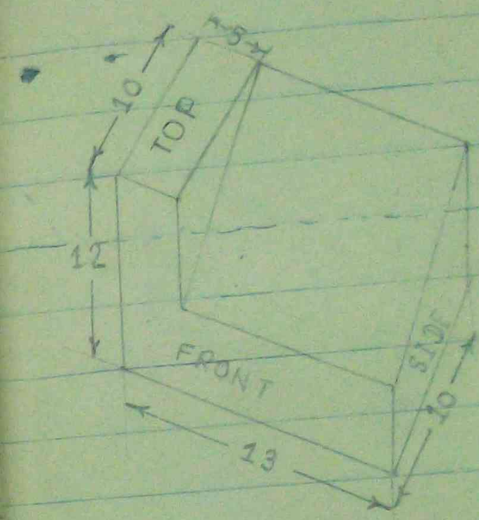
(II) permanent hardness salt

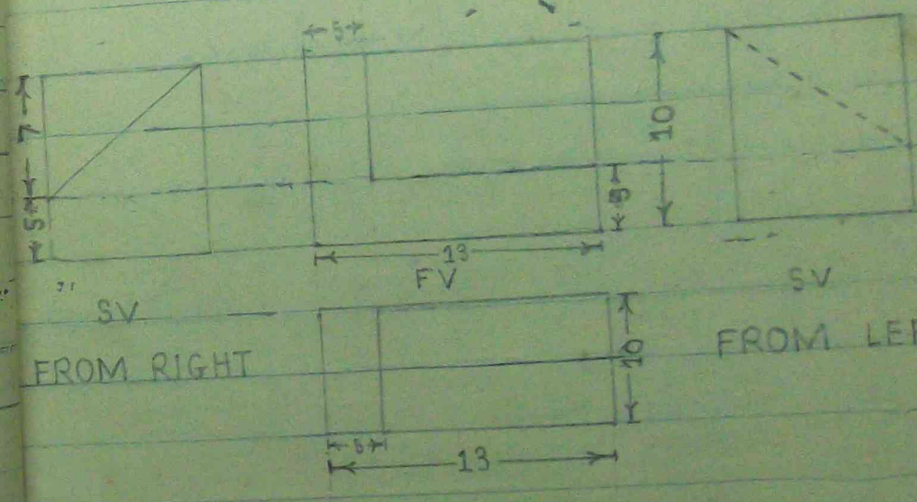
$CaSO_4$, $CaCl_2$, $MgSO_4$, $MgCl_2$

... - ... crystal ...

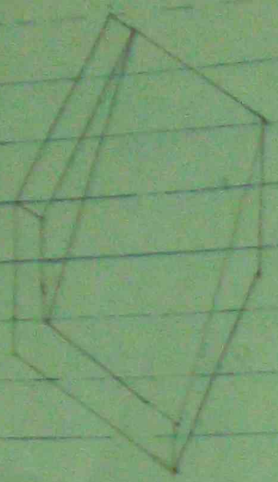
... heating surface ... heat transfer ... low heating ...

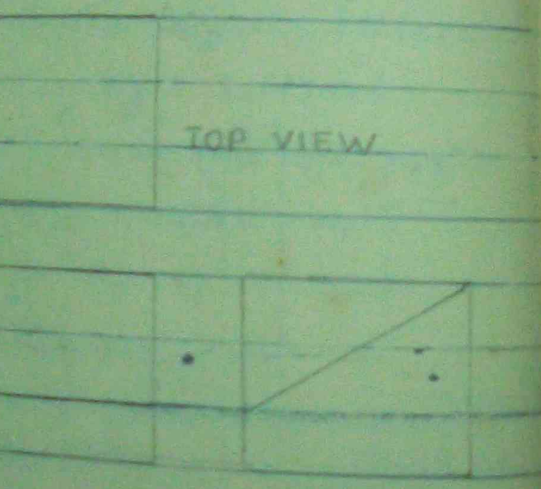
BASIC ENGG DRAWING



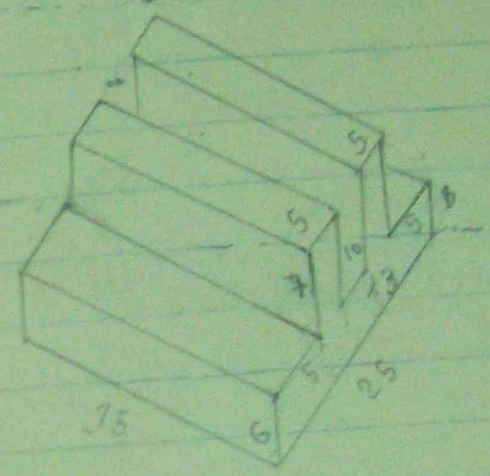


FIRST ANGLE METHOD

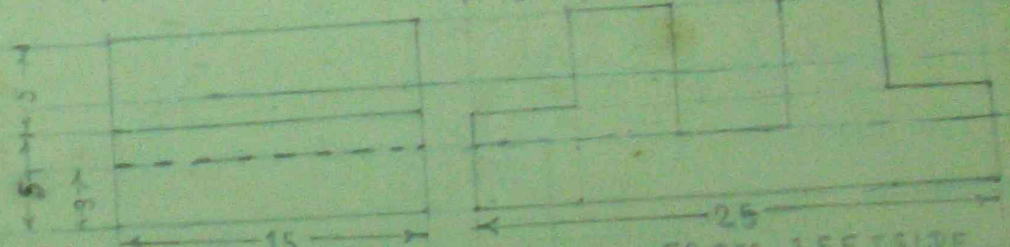


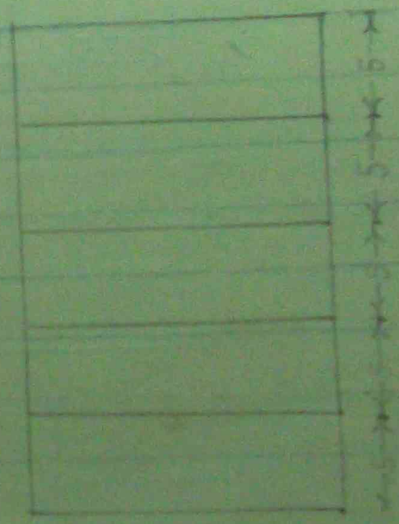


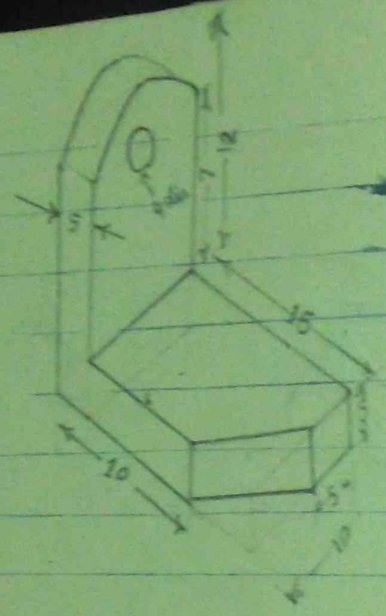
→ THIRD ANGLE METHOD

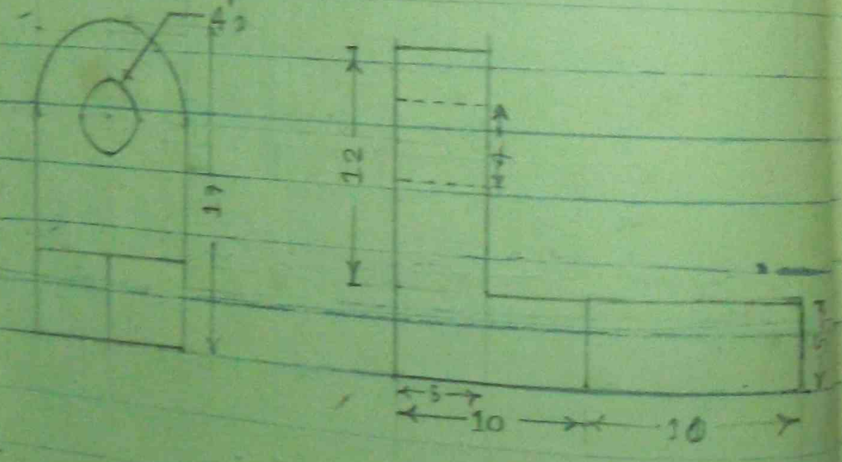


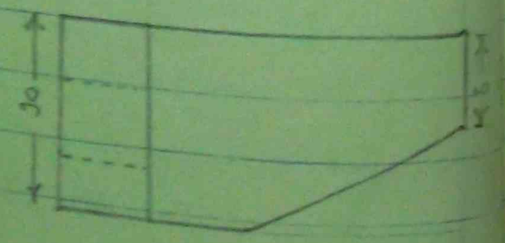
SCALE 10 → 1"

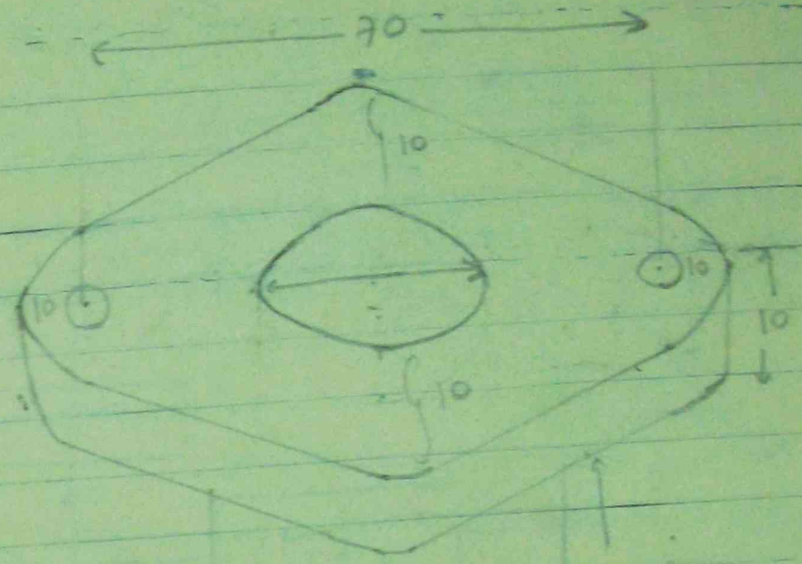


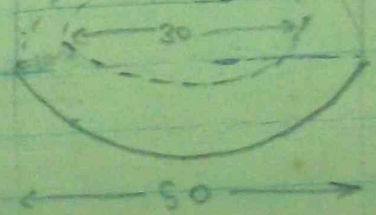


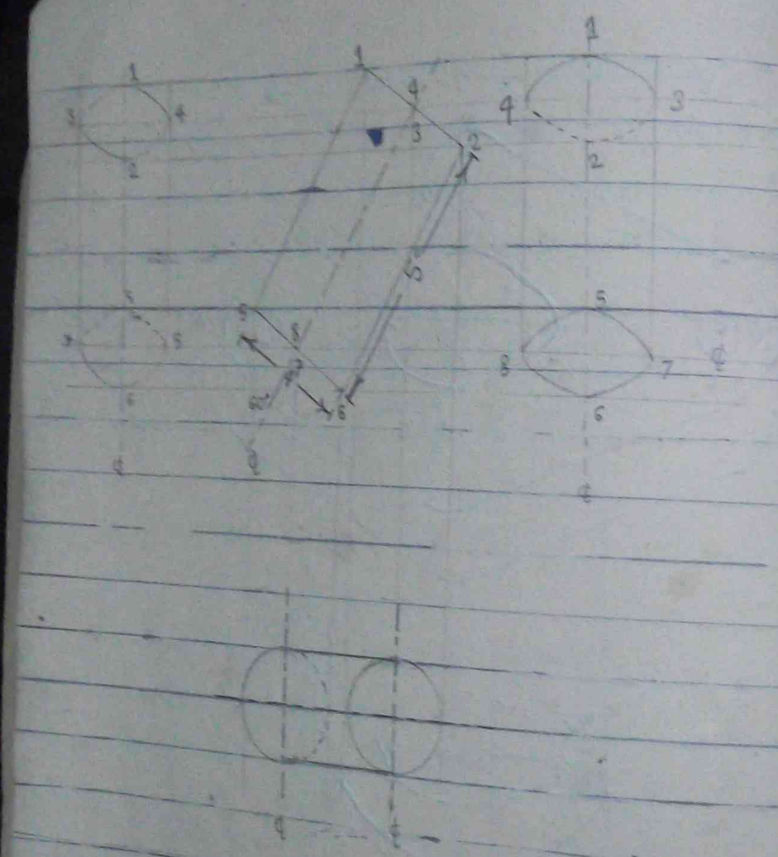

5
15
10
5
10


4½
12
5
10
10


30

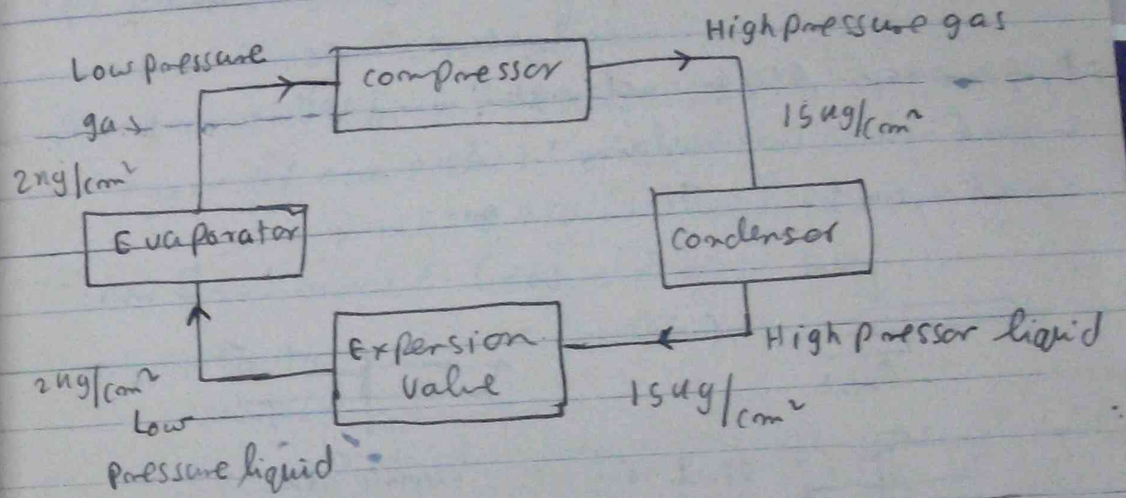

70
10
10
10
10
10
40


30
50



welding
machine
Fitting

Block Diagram for Air conditioning System



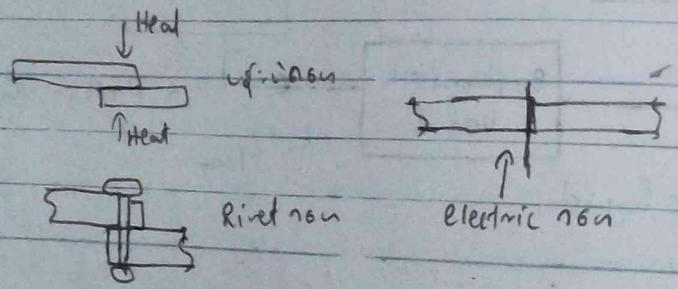
Basic Principles

① When pressure drops boiling point drops
② When liquid evaporates, latent heat of evaporation is taken from the surrounding.

Welding

- ...
- ...

1) ...
2) ...
3) ...



metallurgy
Electrical
drawing
maths
machine
} + welding

- fitting
- welding
- machine

...

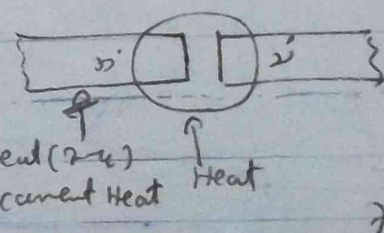
① ...
② ... (Gas cutting)
Oxygen + Acetyline
③ machine cutter
...

③ ... (Gas welding)

$O_2 + C_2H_2$

(...)

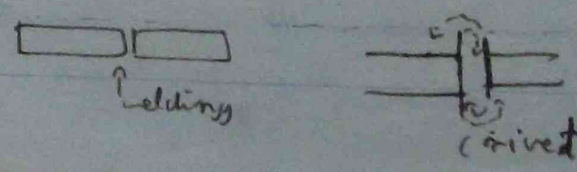
Electrical



7000°F → 10000°F

- welding electrode ... current (ampere) ...
- ...

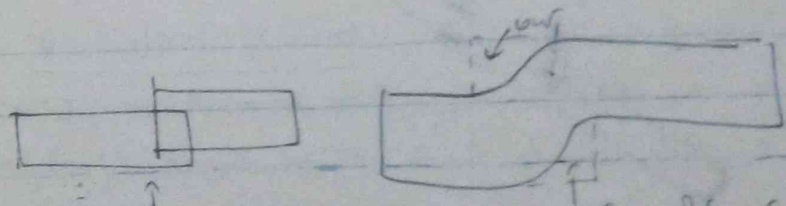
(...)



welding machine

- welding machine ಯಲ್ಲಿ volt ಕಡಿಮೆ, ಹೆಚ್ಚು amp ಇರುವುದರಿಂದ
- bottom | Engine ಇರುವುದರಿಂದ ಇದನ್ನು ಸುಲಭವಾಗಿ ಸಾಗಿಸಬಹುದು
- ಸಾಗಿಸಲು ಸುಲಭವಾಗಿರುವುದರಿಂದ welding ಯಲ್ಲಿ DC welding machine
  - ಹೆಚ್ಚು amp ಬರುತ್ತದೆ
  - ಬೆಲೆ ಕಡಿಮೆ
- motor ಗೆ Engine ಅವಶ್ಯಕ | Engine ಗೆ diesel ಅವಶ್ಯಕ
  petrol ಗೆ ಬೆಂಕಿ ಅವಶ್ಯಕ

ಬದಲಾವಣೆ AC → DC
DC → AC



ಮೇಲ್ಭಾಗ ಕೆಳಭಾಗಕ್ಕಿಂತ ಎತ್ತರವಾಗಿರುತ್ತದೆ

ಕೆಳಭಾಗ: ಬೆಸೆಯಬೇಕಾದ ಭಾಗ
ಮೇಲ್ಭಾಗ welding holder ಅನ್ನು ಹಿಡಿಯಲು

(J) ಕೈ ಚೀಲ ಮತ್ತು ಶೂ

welding ಕೈ ಚೀಲ ಮತ್ತು ಕಾಲಿನ ಚೀಲವನ್ನು ಬಳಸಲಾಗುತ್ತದೆ.

- ಚರ್ಮದಿಂದ ಮಾಡಿದ ಚೀಲವನ್ನು ಬಳಸಬೇಕು | Boiler suit | ಹತ್ತಿ ಬಟ್ಟೆಯಿಂದ ಮಾಡಿದ ಬಟ್ಟೆ ಅಲ್ಲ | ಮತ್ತು ಚರ್ಮದಿಂದ ಮಾಡಿದ ಚೀಲವನ್ನು ಬಳಸಬೇಕು | ಹತ್ತಿ ಬಟ್ಟೆಯಿಂದ ಮಾಡಿದ ಚೀಲವನ್ನು ಬಳಸಬಾರದು | ಏಕೆಂದರೆ ಬೆಂಕಿ ಹಿಡಿಯುವ ಸಾಧ್ಯತೆ ಇರುತ್ತದೆ
  hand ~~sheet~~ Shoe
  head Shoe -

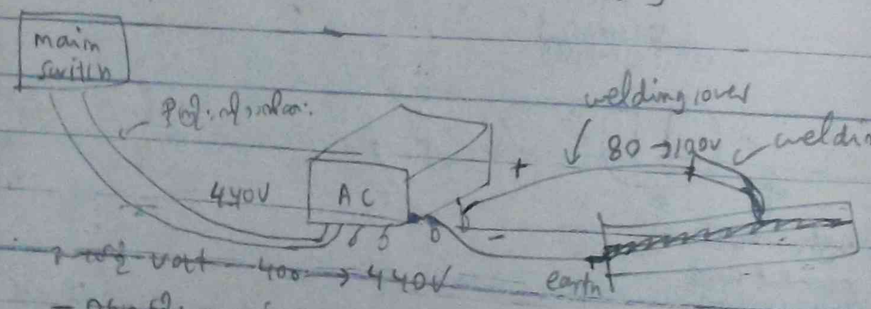
ಸುರಕ್ಷತೆ:(1)

ಅಪಘಾತಗಳು ಸಂಭವಿಸಲು ಕಾರಣಗಳು:

(1) ಸುರಕ್ಷತಾ ಕ್ರಮಗಳನ್ನು ಪಾಲಿಸದೆ ಇರುವುದರಿಂದ
(2) ಕೆಲಸದ ಬಗ್ಗೆ ಅಜ್ಞಾನ
(3) ಯಂತ್ರೋಪಕರಣಗಳ ದೋಷಪೂರಿತ ಕಾರ್ಯನಿರ್ವಹಣೆ
(4) ಕಾರ್ಯಕ್ಷೇತ್ರದ ಅಸುರಕ್ಷಿತ ಪರಿಸರ
(5) ಅಸಮರ್ಪಕ ಉಪಕರಣಗಳ ಬಳಕೆ
(6) ಅಸಮರ್ಪಕ ಕೆಲಸದ ವಿಧಾನ.

ಸುರಕ್ಷತಾ ಕ್ರಮಗಳು:(1)

- ಅಪಘಾತಗಳಾಗದಂತೆ ತಡೆಗಟ್ಟಲು ಕೈಗೊಳ್ಳಬೇಕಾದ ಕ್ರಮಗಳನ್ನು ಸುರಕ್ಷತಾ ಕ್ರಮಗಳು ಎನ್ನುವರು.



- ~~ಸಾಧಾರಣ volt 400 → 440V~~
- ಸಾಧಾರಣವಾಗಿ ಉಪಯೋಗಿಸುವ ಕೇಬಲ್ ಅಳತೆಗಳು ಇಂತಿವೆ
- welding cable - { copper wire - current ಗೆ ಅನುಗುಣವಾಗಿ ಇರಬೇಕು
  cover - rubber - } ಇದನ್ನು ಇನ್ಸುಲೇಷನ್ ಟೇಪ್‌ನಿಂದ ಬಿಗಿಯಬೇಕು
- ~~ಫ್ಯೂಸ್ ಪೆಟ್ಟಿಗೆಯಲ್ಲಿ ಫ್ಯೂಸ್ ತಂತಿಯನ್ನು ಬಳಸಬಾರದು~~ ಫ್ಯೂಸ್ ತಂತಿಯನ್ನು ಪೆಟ್ಟಿಗೆಯಲ್ಲಿ ಬಳಸಬೇಕು.

main switch → welding machine
ತಾಮ್ರದ ತಂತಿ
welding machine → welding holder
ತಾಮ್ರದ ತಂತಿ

mild steel electrode

(चित्र:1 आवश्यक मोटाई)

पेंसिल या पेन जैसा गोल छड़ जिसे ढकने के लिए प्रयोग किया जाता है।

आवश्यकता : धातु को वायुमंडलीय ऑक्सीजन से बचाने के लिए।

प्रयोग : मुख्यतः माइल्ड स्टील की वेल्डिंग के लिए।

गुण : (कम शुद्धता के कारण)

- वेल्डिंग के समय धुआँ अधिक निकलता है।
- वेल्ड की मजबूती कम होती है।
- वेल्ड पर स्लैग की परत बनती है।

(2) प्रयोग : कृषि यंत्रों की हल्की मरम्मत के लिए।

- वेल्डिंग के समय हेलमेट का शीशा काला होना चाहिए।
- वेल्डिंग के समय दस्ताने पहनना आवश्यक है।

(3) प्रयोग : घरेलू लोहे के फाटक बनाने में।

- वेल्डिंग के समय आँखों की सुरक्षा आवश्यक है।

(4) प्रयोग : कृषि यंत्रों की हल्की मरम्मत के लिए।

- वेल्डिंग के समय हेलमेट का शीशा काला होना चाहिए।
- वेल्डिंग के समय दस्ताने पहनना आवश्यक है।

(5) प्रयोग : घरेलू लोहे के फाटक बनाने में।

- वेल्डिंग के समय आँखों की सुरक्षा आवश्यक है।

(6) प्रयोग : कृषि यंत्रों की हल्की मरम्मत के लिए।

- वेल्डिंग के समय हेलमेट का शीशा काला होना चाहिए।
- वेल्डिंग के समय दस्ताने पहनना आवश्यक है।

(7) प्रयोग : घरेलू लोहे के फाटक बनाने में।

- वेल्डिंग के समय आँखों की सुरक्षा आवश्यक है।

(8) प्रयोग : कृषि यंत्रों की हल्की मरम्मत के लिए।

- वेल्डिंग के समय हेलमेट का शीशा काला होना चाहिए।
- वेल्डिंग के समय दस्ताने पहनना आवश्यक है।

(9) प्रयोग : घरेलू लोहे के फाटक बनाने में।

- वेल्डिंग के समय आँखों की सुरक्षा आवश्यक है।

(10) प्रयोग : कृषि यंत्रों की हल्की मरम्मत के लिए।

- वेल्डिंग के समय हेलमेट का शीशा काला होना चाहिए।
- वेल्डिंग के समय दस्ताने पहनना आवश्यक है।

(11) प्रयोग : घरेलू लोहे के फाटक बनाने में।

- वेल्डिंग के समय आँखों की सुरक्षा आवश्यक है।

(12) प्रयोग : कृषि यंत्रों की हल्की मरम्मत के लिए।

- वेल्डिंग के समय हेलमेट का शीशा काला होना चाहिए।
- वेल्डिंग के समय दस्ताने पहनना आवश्यक है।

(13) प्रयोग : घरेलू लोहे के फाटक बनाने में।

- वेल्डिंग के समय आँखों की सुरक्षा आवश्यक है।

(14) प्रयोग : कृषि यंत्रों की हल्की मरम्मत के लिए।

- वेल्डिंग के समय हेलमेट का शीशा काला होना चाहिए।
- वेल्डिंग के समय दस्ताने पहनना आवश्यक है।

(15) प्रयोग : घरेलू लोहे के फाटक बनाने में।

- वेल्डिंग के समय आँखों की सुरक्षा आवश्यक है।

(16) प्रयोग : कृषि यंत्रों की हल्की मरम्मत के लिए।

- वेल्डिंग के समय हेलमेट का शीशा काला होना चाहिए।
- वेल्डिंग के समय दस्ताने पहनना आवश्यक है।

(17) प्रयोग : घरेलू लोहे के फाटक बनाने में।

- वेल्डिंग के समय आँखों की सुरक्षा आवश्यक है।

(18) प्रयोग : कृषि यंत्रों की हल्की मरम्मत के लिए।

- वेल्डिंग के समय हेलमेट का शीशा काला होना चाहिए।
- वेल्डिंग के समय दस्ताने पहनना आवश्यक है।

(19) प्रयोग : घरेलू लोहे के फाटक बनाने में।

- वेल्डिंग के समय आँखों की सुरक्षा आवश्यक है।

(20) प्रयोग : कृषि यंत्रों की हल्की मरम्मत के लिए।

- वेल्डिंग के समय हेलमेट का शीशा काला होना चाहिए।
- वेल्डिंग के समय दस्ताने पहनना आवश्यक है।

(21) प्रयोग : घरेलू लोहे के फाटक बनाने में।

- वेल्डिंग के समय आँखों की सुरक्षा आवश्यक है।

(22) प्रयोग : कृषि यंत्रों की हल्की मरम्मत के लिए।

- वेल्डिंग के समय हेलमेट का शीशा काला होना चाहिए।
- वेल्डिंग के समय दस्ताने पहनना आवश्यक है।

(23) प्रयोग : घरेलू लोहे के फाटक बनाने में।

- वेल्डिंग के समय आँखों की सुरक्षा आवश्यक है।

(24) प्रयोग : कृषि यंत्रों की हल्की मरम्मत के लिए।

- वेल्डिंग के समय हेलमेट का शीशा काला होना चाहिए।
- वेल्डिंग के समय दस्ताने पहनना आवश्यक है।

(25) प्रयोग : घरेलू लोहे के फाटक बनाने में।

- वेल्डिंग के समय आँखों की सुरक्षा आवश्यक है।

(26) प्रयोग : कृषि यंत्रों की हल्की मरम्मत के लिए।

- वेल्डिंग के समय हेलमेट का शीशा काला होना चाहिए।
- वेल्डिंग के समय दस्ताने पहनना आवश्यक है।

(27) प्रयोग : घरेलू लोहे के फाटक बनाने में।

- वेल्डिंग के समय आँखों की सुरक्षा आवश्यक है।

(28) प्रयोग : कृषि यंत्रों की हल्की मरम्मत के लिए।

- वेल्डिंग के समय हेलमेट का शीशा काला होना चाहिए।
- वेल्डिंग के समय दस्ताने पहनना आवश्यक है।

(29) प्रयोग : घरेलू लोहे के फाटक बनाने में।

- वेल्डिंग के समय आँखों की सुरक्षा आवश्यक है।

(30) प्रयोग : कृषि यंत्रों की हल्की मरम्मत के लिए।

- वेल्डिंग के समय हेलमेट का शीशा काला होना चाहिए।
- वेल्डिंग के समय दस्ताने पहनना आवश्यक है।

(31) प्रयोग : घरेलू लोहे के फाटक बनाने में।

- वेल्डिंग के समय आँखों की सुरक्षा आवश्यक है।

(32) प्रयोग : कृषि यंत्रों की हल्की मरम्मत के लिए।

- वेल्डिंग के समय हेलमेट का शीशा काला होना चाहिए।
- वेल्डिंग के समय दस्ताने पहनना आवश्यक है।

(33) प्रयोग : घरेलू लोहे के फाटक बनाने में।

- वेल्डिंग के समय आँखों की सुरक्षा आवश्यक है।

(34) प्रयोग : कृषि यंत्रों की हल्की मरम्मत के लिए।

- वेल्डिंग के समय हेलमेट का शीशा काला होना चाहिए।
- वेल्डिंग के समय दस्ताने पहनना आवश्यक है।

(35) प्रयोग : घरेलू लोहे के फाटक बनाने में।

- वेल्डिंग के समय आँखों की सुरक्षा आवश्यक है।

(36) प्रयोग : कृषि यंत्रों की हल्की मरम्मत के लिए।

- वेल्डिंग के समय हेलमेट का शीशा काला होना चाहिए।
- वेल्डिंग के समय दस्ताने पहनना आवश्यक है।

(37) प्रयोग : घरेलू लोहे के फाटक बनाने में।

- वेल्डिंग के समय आँखों की सुरक्षा आवश्यक है।

(38) प्रयोग : कृषि यंत्रों की हल्की मरम्मत के लिए।

- वेल्डिंग के समय हेलमेट का शीशा काला होना चाहिए।
- वेल्डिंग के समय दस्ताने पहनना आवश्यक है।

(39) प्रयोग : घरेलू लोहे के फाटक बनाने में।

- वेल्डिंग के समय आँखों की सुरक्षा आवश्यक है।

(40) प्रयोग : कृषि यंत्रों की हल्की मरम्मत के लिए।

- वेल्डिंग के समय हेलमेट का शीशा काला होना चाहिए।
- वेल्डिंग के समय दस्ताने पहनना आवश्यक है।

(41) प्रयोग : घरेलू लोहे के फाटक बनाने में।

- वेल्डिंग के समय आँखों की सुरक्षा आवश्यक है।

(42) प्रयोग : कृषि यंत्रों की हल्की मरम्मत के लिए।

- वेल्डिंग के समय हेलमेट का शीशा काला होना चाहिए।
- वेल्डिंग के समय दस्ताने पहनना आवश्यक है।

(43) प्रयोग : घरेलू लोहे के फाटक बनाने में।

- वेल्डिंग के समय आँखों की सुरक्षा आवश्यक है।

(44) प्रयोग : कृषि यंत्रों की हल्की मरम्मत के लिए।

- वेल्डिंग के समय हेलमेट का शीशा काला होना चाहिए।
- वेल्डिंग के समय दस्ताने पहनना आवश्यक है।

(45) प्रयोग : घरेलू लोहे के फाटक बनाने में।

- वेल्डिंग के समय आँखों की सुरक्षा आवश्यक है।

(46) प्रयोग : कृषि यंत्रों की हल्की मरम्मत के लिए।

- वेल्डिंग के समय हेलमेट का शीशा काला होना चाहिए।
- वेल्डिंग के समय दस्ताने पहनना आवश्यक है।

(47) प्रयोग : घरेलू लोहे के फाटक बनाने में।

- वेल्डिंग के समय आँखों की सुरक्षा आवश्यक है।

(48) प्रयोग : कृषि यंत्रों की हल्की मरम्मत के लिए।

- वेल्डिंग के समय हेलमेट का शीशा काला होना चाहिए।
- वेल्डिंग के समय दस्ताने पहनना आवश्यक है।

(49) प्रयोग : घरेलू लोहे के फाटक बनाने में।

- वेल्डिंग के समय आँखों की सुरक्षा आवश्यक है।

(50) प्रयोग : कृषि यंत्रों की हल्की मरम्मत के लिए।

- वेल्डिंग के समय हेलमेट का शीशा काला होना चाहिए।
- वेल्डिंग के समय दस्ताने पहनना आवश्यक है।

(51) प्रयोग : घरेलू लोहे के फाटक बनाने में।

- वेल्डिंग के समय आँखों की सुरक्षा आवश्यक है।

(52) प्रयोग : कृषि यंत्रों की हल्की मरम्मत के लिए।

- वेल्डिंग के समय हेलमेट का शीशा काला होना चाहिए।
- वेल्डिंग के समय दस्ताने पहनना आवश्यक है।

(53) प्रयोग : घरेलू लोहे के फाटक बनाने में।

- वेल्डिंग के समय आँखों की सुरक्षा आवश्यक है।

(54) प्रयोग : कृषि यंत्रों की हल्की मरम्मत के लिए।

- वेल्डिंग के समय हेलमेट का शीशा काला होना चाहिए।
- वेल्डिंग के समय दस्ताने पहनना आवश्यक है।

(55) प्रयोग : घरेलू लोहे के फाटक बनाने में।

- वेल्डिंग के समय आँखों की सुरक्षा आवश्यक है।

(56) प्रयोग : कृषि यंत्रों की हल्की मरम्मत के लिए।

- वेल्डिंग के समय हेलमेट का शीशा काला होना चाहिए।
- वेल्डिंग के समय दस्ताने पहनना आवश्यक है।

(57) प्रयोग : घरेलू लोहे के फाटक बनाने में।

- वेल्डिंग के समय आँखों की सुरक्षा आवश्यक है।

(58) प्रयोग : कृषि यंत्रों की हल्की मरम्मत के लिए।

- वेल्डिंग के समय हेलमेट का शीशा काला होना चाहिए।
- वेल्डिंग के समय दस्ताने पहनना आवश्यक है।

(59) प्रयोग : घरेलू लोहे के फाटक बनाने में।

- वेल्डिंग के समय आँखों की सुरक्षा आवश्यक है।

(60) प्रयोग : कृषि यंत्रों की हल्की मरम्मत के लिए।

- वेल्डिंग के समय हेलमेट का शीशा काला होना चाहिए।
- वेल्डिंग के समय दस्ताने पहनना आवश्यक है।

(61) प्रयोग : घरेलू लोहे के फाटक बनाने में।

- वेल्डिंग के समय आँखों की सुरक्षा आवश्यक है।

(62) प्रयोग : कृषि यंत्रों की हल्की मरम्मत के लिए।

- वेल्डिंग के समय हेलमेट का शीशा काला होना चाहिए।
- वेल्डिंग के समय दस्ताने पहनना आवश्यक है।

(63) प्रयोग : घरेलू लोहे के फाटक बनाने में।

- वेल्डिंग के समय आँखों की सुरक्षा आवश्यक है।

(64) प्रयोग : कृषि यंत्रों की हल्की मरम्मत के लिए।

- वेल्डिंग के समय हेलमेट का शीशा काला होना चाहिए।
- वेल्डिंग के समय दस्ताने पहनना आवश्यक है।

(65) प्रयोग : घरेलू लोहे के फाटक बनाने में।

- वेल्डिंग के समय आँखों की सुरक्षा आवश्यक है।

(66) प्रयोग : कृषि यंत्रों की हल्की मरम्मत के लिए।

- वेल्डिंग के समय हेलमेट का शीशा काला होना चाहिए।
- वेल्डिंग के समय दस्ताने पहनना आवश्यक है।

(67) प्रयोग : घरेलू लोहे के फाटक बनाने में।

- वेल्डिंग के समय आँखों की सुरक्षा आवश्यक है।

(68) प्रयोग : कृषि यंत्रों की हल्की मरम्मत के लिए।

- वेल्डिंग के समय हेलमेट का शीशा काला होना चाहिए।
- वेल्डिंग के समय दस्ताने पहनना आवश्यक है।

(69) प्रयोग : घरेलू लोहे के फाटक बनाने में।

- वेल्डिंग के समय आँखों की सुरक्षा आवश्यक है।

(70) प्रयोग : कृषि यंत्रों की हल्की मरम्मत के लिए।

- वेल्डिंग के समय हेलमेट का शीशा काला होना चाहिए।
- वेल्डिंग के समय दस्ताने पहनना आवश्यक है।

(71) प्रयोग : घरेलू लोहे के फाटक बनाने में।

- वेल्डिंग के समय आँखों की सुरक्षा आवश्यक है।

(72) प्रयोग : कृषि यंत्रों की हल्की मरम्मत के लिए।

- वेल्डिंग के समय हेलमेट का शीशा काला होना चाहिए।
- वेल्डिंग के समय दस्ताने पहनना आवश्यक है।

(73) प्रयोग : घरेलू लोहे के फाटक बनाने में।

- वेल्डिंग के समय आँखों की सुरक्षा आवश्यक है।

(74) प्रयोग : कृषि यंत्रों की हल्की मरम्मत के लिए।

- वेल्डिंग के समय हेलमेट का शीशा काला होना चाहिए।
- वेल्डिंग के समय दस्ताने पहनना आवश्यक है।

(75) प्रयोग : घरेलू लोहे के फाटक बनाने में।

- वेल्डिंग के समय आँखों की सुरक्षा आवश्यक है।

(76) प्रयोग : कृषि यंत्रों की हल्की मरम्मत के लिए।

- वेल्डिंग के समय हेलमेट का शीशा काला होना चाहिए।
- वेल्डिंग के समय दस्ताने पहनना आवश्यक है।

(77) प्रयोग : घरेलू लोहे के फाटक बनाने में।

- वेल्डिंग के समय आँखों की सुरक्षा आवश्यक है।

(78) प्रयोग : कृषि यंत्रों की हल्की मरम्मत के लिए।

- वेल्डिंग के समय हेलमेट का शीशा काला होना चाहिए।
- वेल्डिंग के समय दस्ताने पहनना आवश्यक है।

(79) प्रयोग : घरेलू लोहे के फाटक बनाने में।

- वेल्डिंग के समय आँखों की सुरक्षा आवश्यक है।

(80) प्रयोग : कृषि यंत्रों की हल्की मरम्मत के लिए।

- वेल्डिंग के समय हेलमेट का शीशा काला होना चाहिए।
- वेल्डिंग के समय दस्ताने पहनना आवश्यक है।

(81) प्रयोग : घरेलू लोहे के फाटक बनाने में।

- वेल्डिंग के समय आँखों की सुरक्षा आवश्यक है।

(82) प्रयोग : कृषि यंत्रों की हल्की मरम्मत के लिए।

- वेल्डिंग के समय हेलमेट का शीशा काला होना चाहिए।
- वेल्डिंग के समय दस्ताने पहनना आवश्यक है।

(83) प्रयोग : घरेलू लोहे के फाटक बनाने में।

- वेल्डिंग के समय आँखों की सुरक्षा आवश्यक है।

(84) प्रयोग : कृषि यंत्रों की हल्की मरम्मत के लिए।

- वेल्डिंग के समय हेलमेट का शीशा काला होना चाहिए।
- वेल्डिंग के समय दस्ताने पहनना आवश्यक है।

(85) प्रयोग : घरेलू लोहे के फाटक बनाने में।

- वेल्डिंग के समय आँखों की सुरक्षा आवश्यक है।

(86) प्रयोग : कृषि यंत्रों की हल्की मरम्मत के लिए।

- वेल्डिंग के समय हेलमेट का शीशा काला होना चाहिए।
- वेल्डिंग के समय दस्ताने पहनना आवश्यक है।

(87) प्रयोग : घरेलू लोहे के फाटक बनाने में।

- वेल्डिंग के समय आँखों की सुरक्षा आवश्यक है।

(88) प्रयोग : कृषि यंत्रों की हल्की मरम्मत के लिए।

- वेल्डिंग के समय हेलमेट का शीशा काला होना चाहिए।
- वेल्डिंग के समय दस्ताने पहनना आवश्यक है।

(89) प्रयोग : घरेलू लोहे के फाटक बनाने में।

- वेल्डिंग के समय आँखों की सुरक्षा आवश्यक है।

(90) प्रयोग : कृषि यंत्रों की हल्की मरम्मत के लिए।

- वेल्डिंग के समय हेलमेट का शीशा काला होना चाहिए।
- वेल्डिंग के समय दस्ताने पहनना आवश्यक है।

(91) प्रयोग : घरेलू लोहे के फाटक बनाने में।

- वेल्डिंग के समय आँखों की सुरक्षा आवश्यक है।

(92) प्रयोग : कृषि यंत्रों की हल्की मरम्मत के लिए।

- वेल्डिंग के समय हेलमेट का शीशा काला होना चाहिए।
- वेल्डिंग के समय दस्ताने पहनना आवश्यक है।

(93) प्रयोग : घरेलू लोहे के फाटक बनाने में।

- वेल्डिंग के समय आँखों की सुरक्षा आवश्यक है।

(94) प्रयोग : कृषि यंत्रों की हल्की मरम्मत के लिए।

- वेल्डिंग के समय हेलमेट का शीशा काला होना चाहिए।
- वेल्डिंग के समय दस्ताने पहनना आवश्यक है।

(95) प्रयोग : घरेलू लोहे के फाटक बनाने में।

- वेल्डिंग के समय आँखों की सुरक्षा आवश्यक है।

(96) प्रयोग : कृषि यंत्रों की हल्की मरम्मत के लिए।

- वेल्डिंग के समय हेलमेट का शीशा काला होना चाहिए।
- वेल्डिंग के समय दस्ताने पहनना आवश्यक है।

(97) प्रयोग : घरेलू लोहे के फाटक बनाने में।

- वेल्डिंग के समय आँखों की सुरक्षा आवश्यक है।

(98) प्रयोग : कृषि यंत्रों की हल्की मरम्मत के लिए।

- वेल्डिंग के समय हेलमेट का शीशा काला होना चाहिए।
- वेल्डिंग के समय दस्ताने पहनना आवश्यक है।

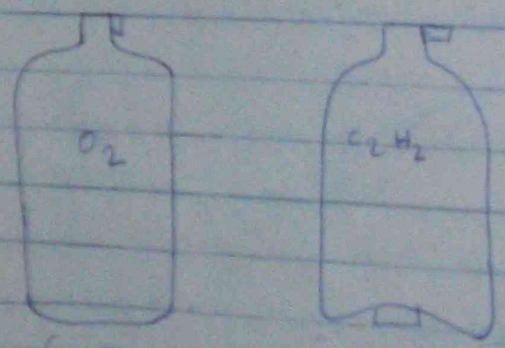
(99) प्रयोग : घरेलू लोहे के फाटक बनाने में।

- वेल्डिंग के समय आँखों की सुरक्षा आवश्यक है।

(100) प्रयोग : कृषि यंत्रों की हल्की मरम्मत के लिए।

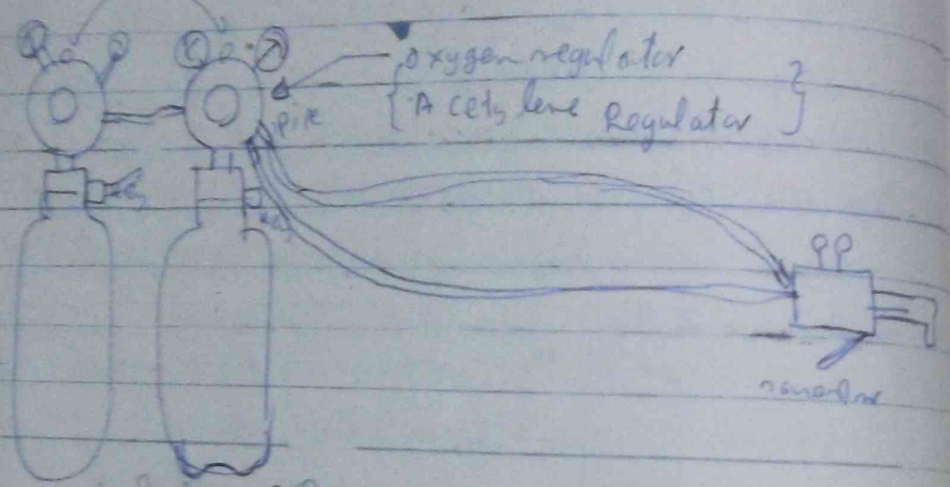
- वेल्डिंग के समय हेलमेट का शीशा काला होना चाहिए।
- वेल्डिंग के समय दस्ताने पहनना आवश्यक है।

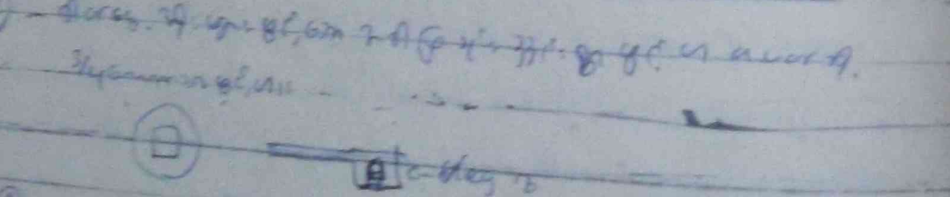
O_2 C_2H_2

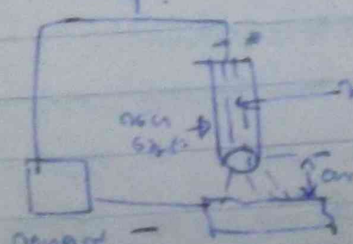


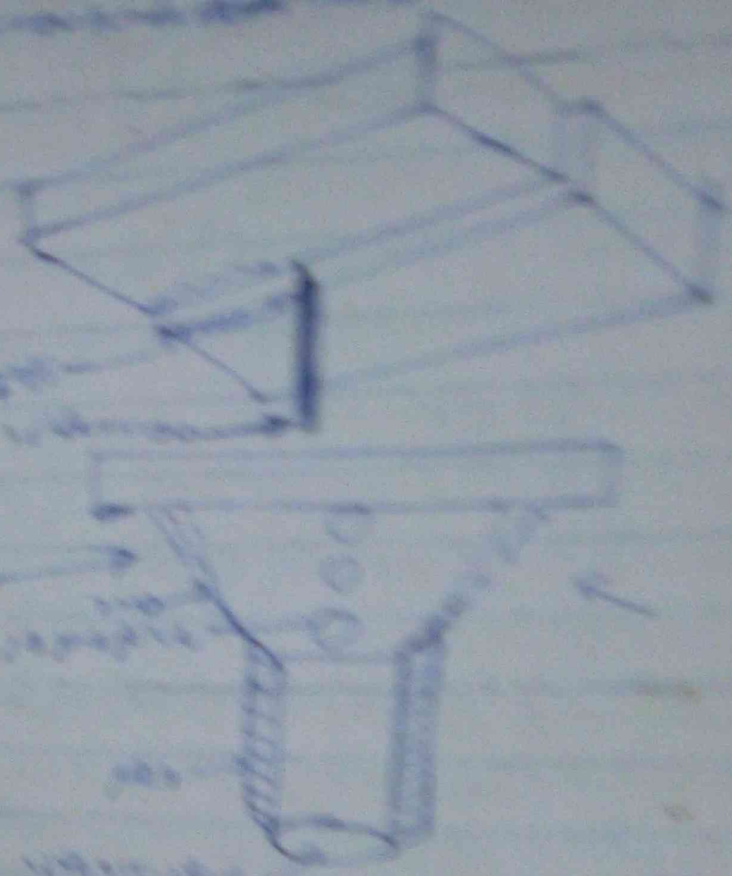
(f) (g) (h)

(i) (j)

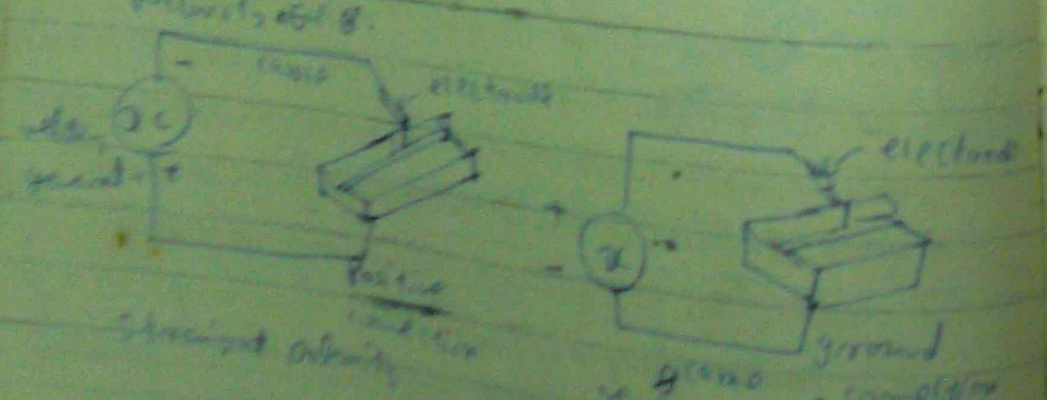

Safety valves
Oxygen regulator
Acetylene Regulator
Pipe
Hose pipe



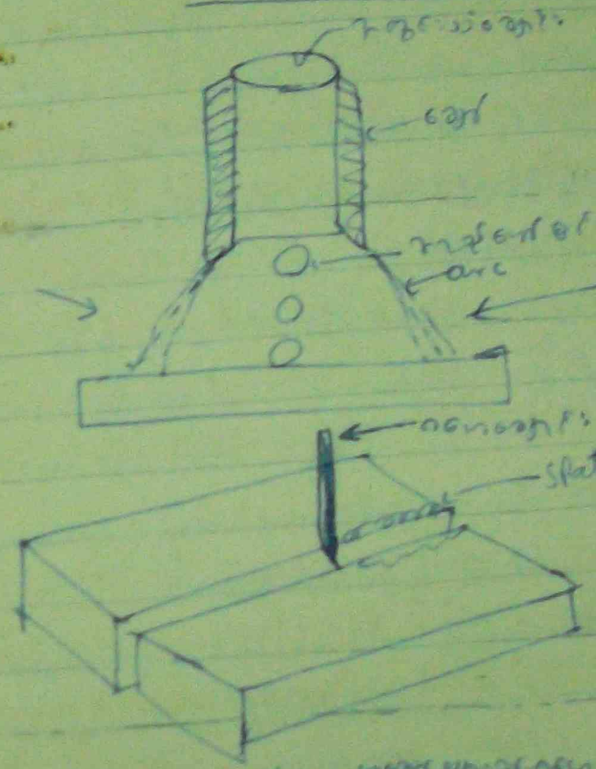

Arc
Work piece
Electrode
+
-



Arc blow



Spatter



ထိုသို့ဖြစ်ရသည်

(၁) [illegible]

(၂) arc blow ဖြစ်ပေါ်ခြင်း [illegible]

(၃) [illegible] (Short arc)

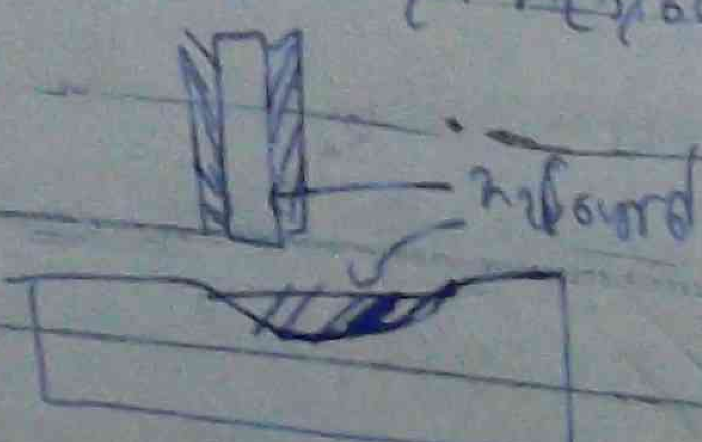
(ခပ်ဝေးဝေး [illegible])

သံချေးဖြေရှင်းပုံ

(၁) [illegible]

~~(၂) [illegible]~~

[illegible]



(၃) [illegible]

[illegible]

(၄) [illegible]

[illegible]

(၅) [illegible]

[illegible]

(၆) [illegible] (cover coating [illegible])

([illegible])

(၇) [illegible]

[illegible]

(၈) [illegible] overhead [illegible]

[illegible]

([illegible])

အခန်း (၃)

လျှပ်စစ်သံဂဟေဆော်စက်များ

(Electric welding machines)

[illegible]

(၁) ဒီစီ (တိုက်ရိုက်လျှပ်စီး)

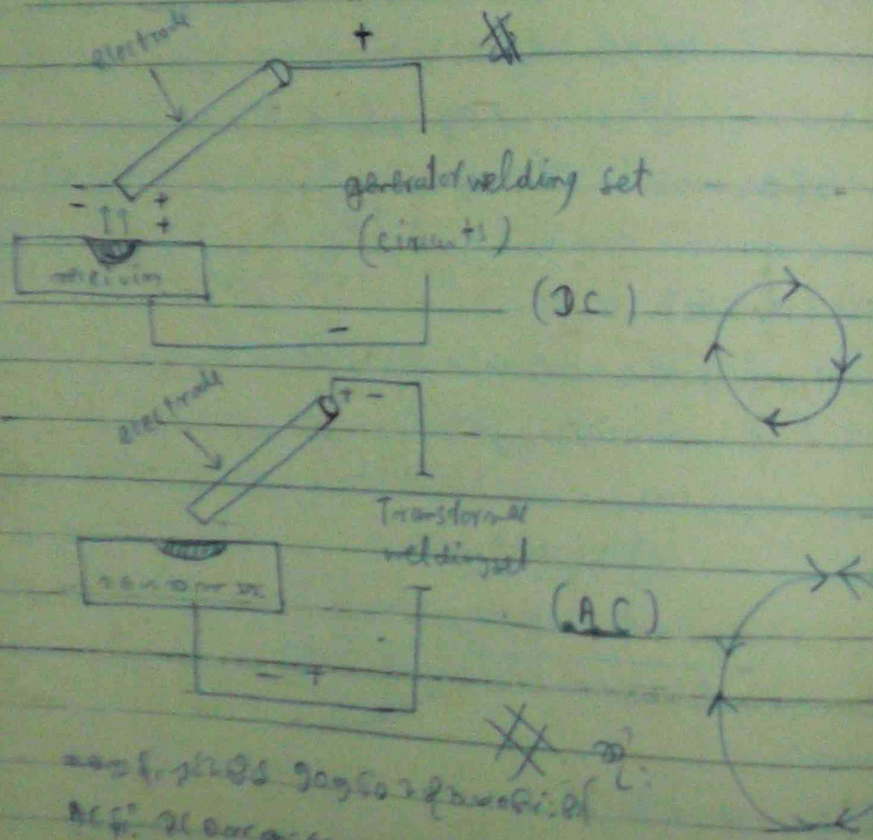
(၂) အေစီ (ပြောင်းလဲလျှပ်စီး) ၂ မျိုးရှိပါ၏

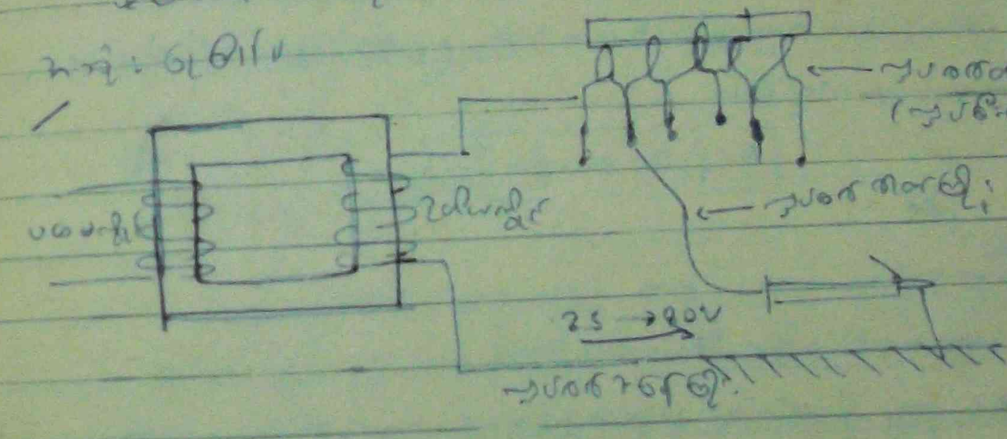
DC — Petrol engine

Diesel engine

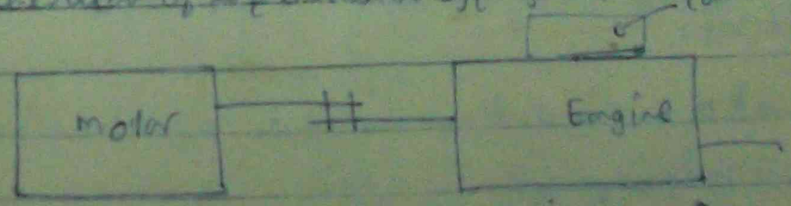
AC — [illegible] ([illegible])

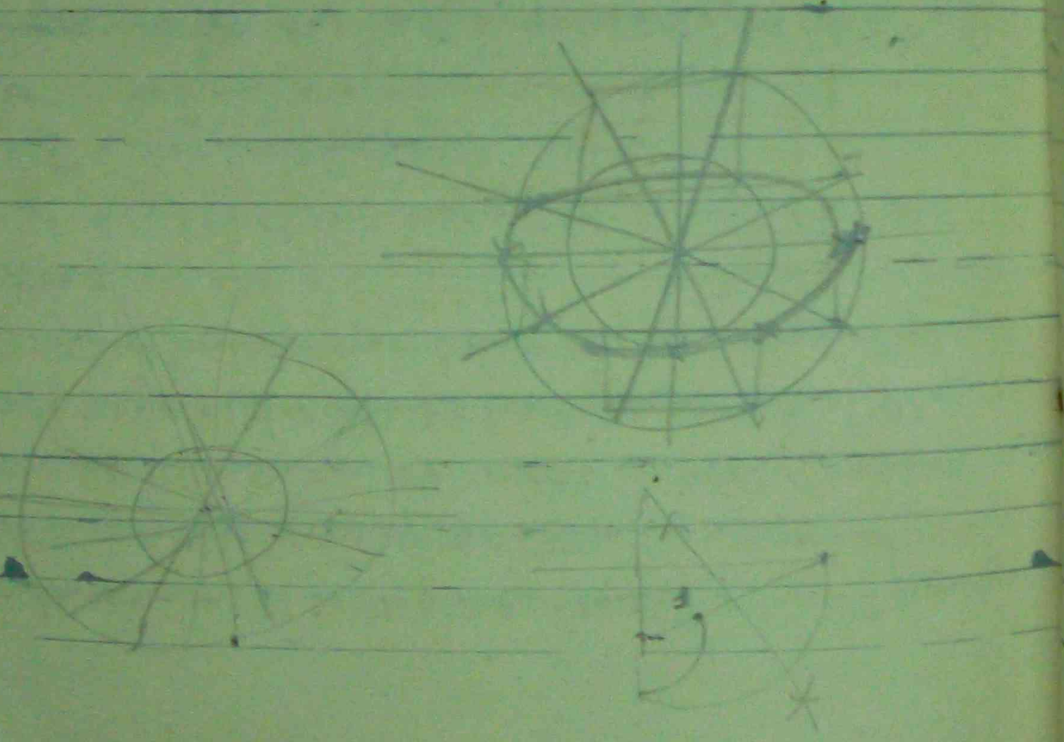
[illegible]





AC Transformer





DC ವಿದ್ಯುತ್ — ನೇರ ವಿದ್ಯುತ್ ಪ್ರವಾಹ ಒಂದೇ ದಿಕ್ಕಿನಲ್ಲಿ ಹರಿಯುವ ವಿದ್ಯುತ್ ಪ್ರವಾಹ

AC ವಿದ್ಯುತ್ — ಪರ್ಯಾಯ ವಿದ್ಯುತ್

welding machine, lathe machine.

DC — ಒಂದು ಧ್ರುವದಿಂದ ಮತ್ತೊಂದು ಧ್ರುವಕ್ಕೆ ಹರಿಯುವ ವಿದ್ಯುತ್

AC — ಪರ್ಯಾಯವಾಗಿ ಧ್ರುವಗಳನ್ನು ಬದಲಾಯಿಸುವ ವಿದ್ಯುತ್ ಪ್ರವಾಹ

ಪ್ರಶ್ನೆ: (5)

ಸುಲಭವಾಗಿ ಗುರುತಿಸುವಿಕೆಗಾಗಿ:

ವಿದ್ಯುದ್ವಾರಗಳನ್ನು ಬಣ್ಣಗಳಿಂದ ಗುರುತಿಸಲಾಗಿದೆ.

① mild steel electrode (M.S electrode) **

② Bronze coated electrode

③ cast Iron electrode

④ Aluminium electrode

⑤ ~~manganese~~ hardening manganese ಉಕ್ಕು.

⑥ ವಿಶೇಷವಾದ ಉದ್ದೇಶಗಳಿಗಾಗಿ ಬಳಸುವ ವಿದ್ಯುದ್ವಾರಗಳು.

~~Ro~~ electrode

* ಬಣ್ಣಗಳಿಂದ ಗುರುತಿಸಲಾದ electrode ಗಳನ್ನು Bare coded electrode ಎಂದು ಕರೆಯಲಾಗುತ್ತದೆ

* ಬಣ್ಣಗಳಿಂದ coded electrode ಗಳನ್ನು ಗುರುತಿಸಲಾಗಿದೆ.

Bronzoid — ...

cast Iron — ...

function of coating

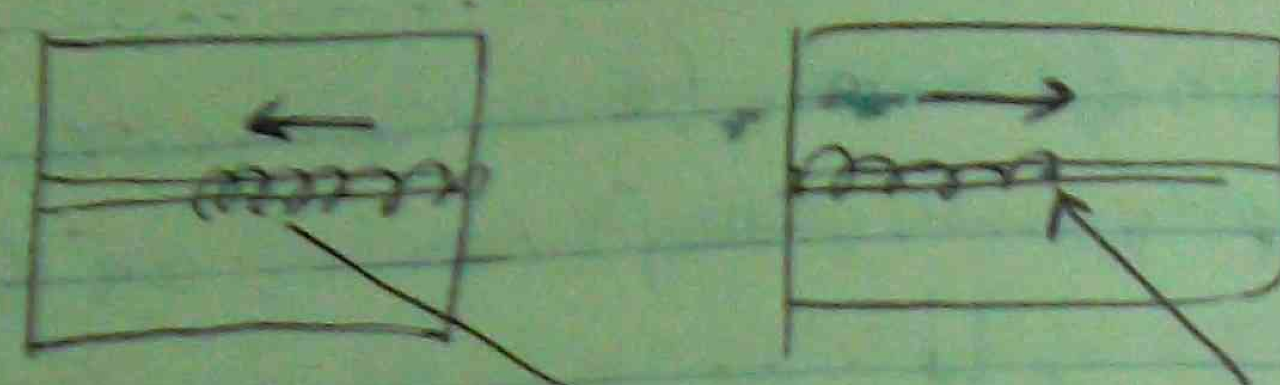
- cover coated electrode

...

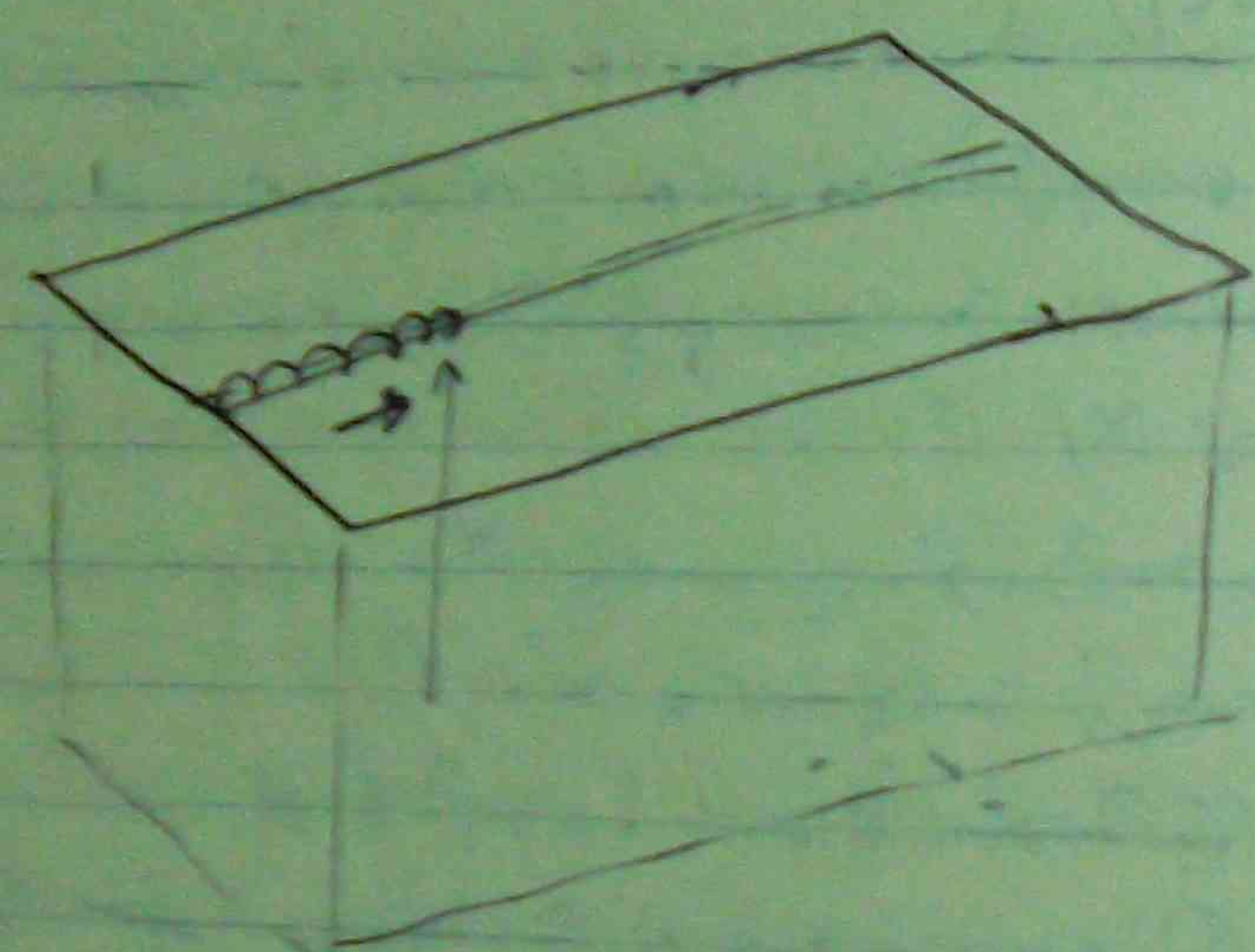
...

...

[illegible]

(၂)  (H)

(၃)



[illegible]

(၇) [illegible]

[illegible]

[illegible]

mild steel, cast iron [illegible]

[illegible]

[illegible] current [illegible]

[illegible]

(၅) [illegible]

[illegible]

mild steel [illegible]

[illegible]

[illegible]

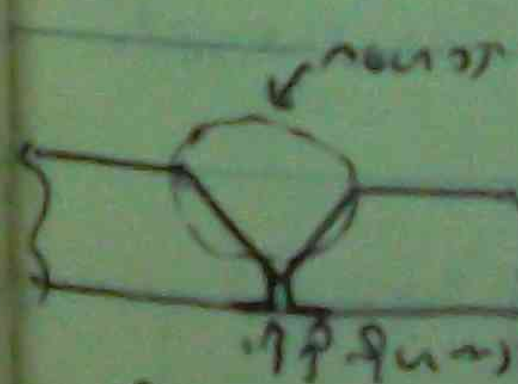
(၆) [illegible]

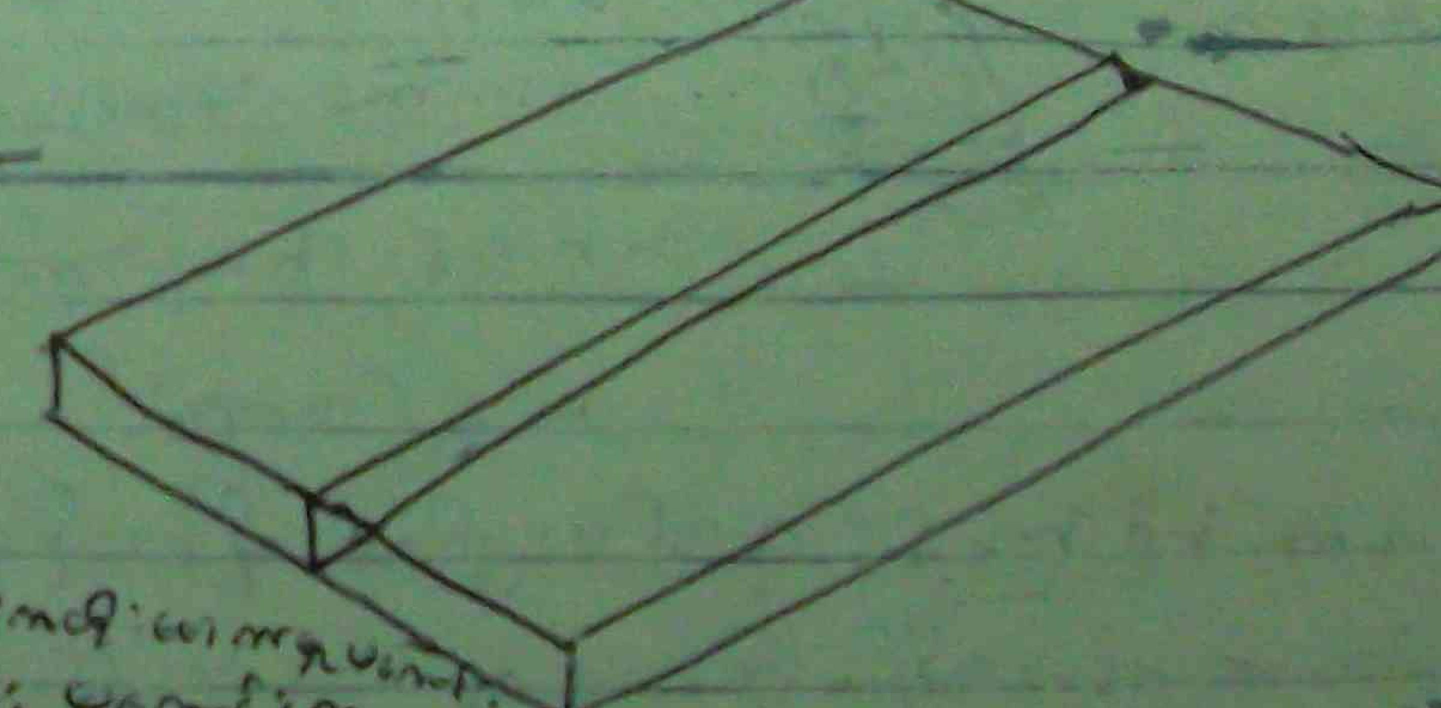
[illegible]

[illegible] current [illegible]

[illegible]

[illegible]



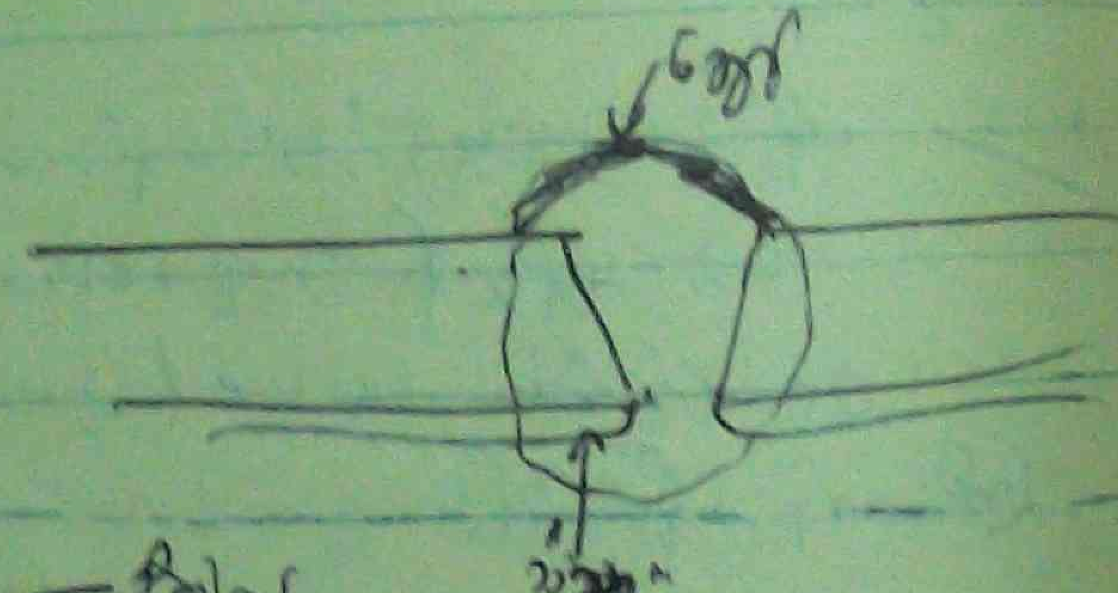


[illegible]

[illegible]

[illegible] / Penetration [illegible]

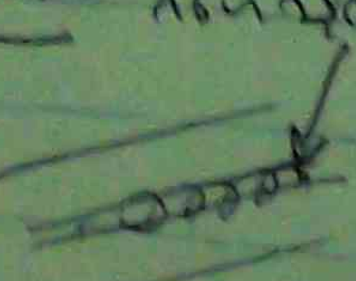
[illegible] line [illegible] x ray [illegible]
[illegible] penetration [illegible]
[illegible]
[illegible]
(၁) [illegible] slug [illegible]
[illegible] oxygen [illegible] Hydrogen, Nitrogen
[illegible]
(၂)

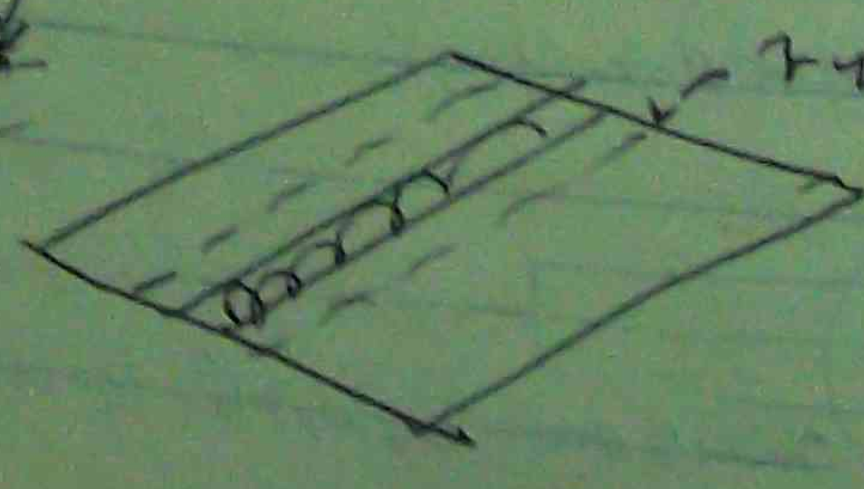


oxygen [illegible]

[illegible] oxygen
[illegible]

(၃) [illegible]
[illegible]

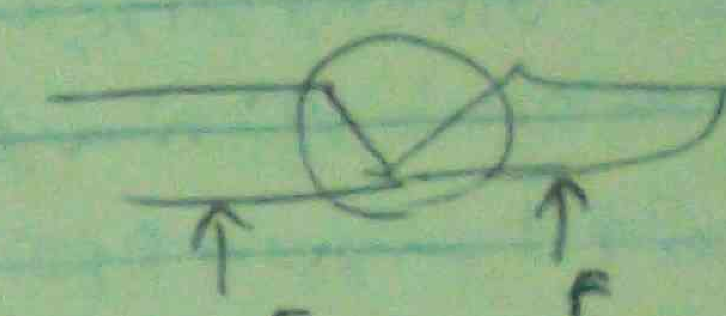




[illegible]

[illegible]
[illegible] cover [illegible]

[illegible]



[illegible]

[illegible]
[illegible]
[illegible]

[illegible]
[illegible]
Iron oxside, hematite, magnesetite ([illegible]
(၁) [illegible]
[illegible]
arc steabliser [illegible]
[illegible] (Calcareous spur) [illegible]
(၃) oxygen [illegible] (~~ferromagnetite~~)
Ferro magnese (20% Fe - 80% mn)
Ferro siliken (55% Fe - 45% si)

Ferro Titanium (75% Fe - 25% Ti)

(c) [illegible]

(d) [illegible]

Steel wire gauge No 10 → 3.25mm
Swg No 8 → 4mm
Swg No 6 → 5mm

Standard wire gauge size.

mm size ও SWG size এর মধ্যে।

[illegible]

① [illegible] (extraction) [illegible]

② [illegible] (extraction with reinforcement)

③ [illegible] (Dipping)

Kinds of Electrodes (ইলেকট্রোড এর প্রকারভেদ)

① Acid Type

② [illegible]

③ [illegible] (Low Hydrogen)

④ [illegible] (iron powder contact) [illegible]

Acid Type

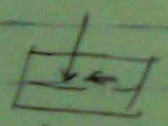
① [illegible] down hand [illegible] flat [illegible] Horizontal [illegible] fillet

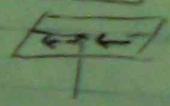
{ down hand → [illegible]
horizontal fillet - [illegible] }

ಇದು ಸೂಚಿಸುವುದು AC - DC ಯಲ್ಲಿ ಬಳಸಲು ಸೂಕ್ತವಿದೆ ಎಂದು Straight polarity (ಋಣ ಧ್ರುವಕ್ಕೆ ಸಂಪರ್ಕ ಎಂದರ್ಥ) [electrode ಗೆ (-) ಧ್ರುವವನ್ನು ಜೋಡಿಸುವುದಕ್ಕೆ A.W.S (American welding society) ನ "E" "E6020 or 7020 ಇದರ 7 year ನಂತರ on ಬರುತ್ತದೆ"

③ **Cellulose**

ಎಲ್ಲಾ vertical ಮತ್ತು overhead ಸ್ಥಾನಗಳಲ್ಲಿ ಬೆಸುಗೆ ಮಾಡಲು ಸೂಕ್ತ

① Down hand,  (ಮೇಲಿನಿಂದ ಕೆಳಕ್ಕೆ)

② overhead  (ಕೆಳಗಿನಿಂದ ಮೇಲಕ್ಕೆ)

④ All Position - ಎಲ್ಲಾ ಸ್ಥಾನಗಳಲ್ಲಿ ಸಹ ಬೆಸುಗೆ ಮಾಡಲು

ಯಾವ ರೀತಿಯ welding current

AC (ಅಥವಾ) DC

AWS NO → E 6010 (ಅಥವಾ) E 6011

③ **Rutile**

wet vertical, down hand, overhead All position

DC ಗೆ ಸಹ ಸೂಕ್ತ straight (ಋಣ ಧ್ರುವಕ್ಕೆ ಸಂಪರ್ಕ)

polarity

ಬಳಕೆಯ (ST)

AWS NO E6012 (ಅಥವಾ) E 6013

ಸಹ ಸೂಕ್ತವಾದ ಮತ್ತು ಸುಲಭವಾಗಿ Quick setting ಮತ್ತು Slow setting (ಸಹಜ ಮತ್ತು ಕಡಿಮೆ ಸಹಜ) ಆಗಿ ಕೆಲಸ ಮಾಡುತ್ತದೆ

④ **Low Hydrogen**

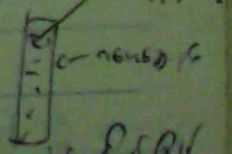
Hydrogen ಅಂಶವನ್ನು ಕಡಿಮೆ ಮಾಡಲಾಗಿರುತ್ತದೆ. AC & DC ಯಲ್ಲಿ ಬಳಸಲು ಸೂಕ್ತವಾಗಿದೆ. ಇದು ಎಲ್ಲಾ ಸ್ಥಾನಗಳಲ್ಲಿ ಸಹ ಬೆಸುಗೆ ಮಾಡಲು ಸೂಕ್ತವಾಗಿದೆ. ಇದರಲ್ಲಿ overhead ಮತ್ತು vertical ಸ್ಥಾನಗಳಲ್ಲಿ ಬೆಸುಗೆ ಮಾಡಲು ಸೂಕ್ತವಾಗಿದೆ All positions ಗಳಲ್ಲಿ ಸಹ ಬೆಸುಗೆ ಮಾಡಲು ಸೂಕ್ತವಾಗಿದೆ. DC ಯಲ್ಲಿ ಬಳಸಲು reverse (Re) polarity ಸೂಕ್ತವಾಗಿದೆ (ಋಣ ಧ್ರುವಕ್ಕೆ electrode ಸಂಪರ್ಕ)

AWS NO E 6015 and E 6016

Boiler ಮತ್ತು ಸಹ ಸೂಕ್ತವಾಗಿದೆ. Starting ಮತ್ತು ಸಾಮಾನ್ಯವಾಗಿ ಸಹ ಸಾಮಾನ್ಯವಾಗಿ ಬಳಸಲಾಗುವ ಬೆಸುಗೆ ಮತ್ತು ಸಾಮಾನ್ಯವಾಗಿ ಸಹ starting ಮತ್ತು ಸಾಮಾನ್ಯವಾಗಿ ಸಹ ಸಾಮಾನ್ಯವಾಗಿ

⑤ **Iron Powder Contact**

ಸಾಮಾನ್ಯವಾಗಿ ಬಳಸಲಾಗುವ ಪುಡಿಯ ಮತ್ತು ಸೂಕ್ತವಾದ ಸಂಖ್ಯೆ 50% ಆಗಿದೆ coating ಮತ್ತು ಸಾಮಾನ್ಯವಾಗಿ ಬಳಸಲಾಗುವ ಬೆಸುಗೆ. AC DC ಯಲ್ಲಿ ಬಳಸಲು ಸೂಕ್ತವಾಗಿದೆ



ಎಲ್ಲಾ ಸ್ಥಾನಗಳಲ್ಲಿ (All position) ಸೂಕ್ತವಾಗಿದೆ

AWS NO E 6024 and E 6027

A.W.S, ASTM (American society of testing of material)
BS (Dutch, Japan, German
A.W.S ... E ... (1) (2) (3) (4) (5)
E ... x x x x (1) (2) (3) (4) (5)

E → E
x → 1 → 60, 70, 80 (Higher)
x → 2 → 1 → all position
x → 2 → Horizontal (H) and Downhand (D)
x → 3 → Downhand (only)
x → 4 → 1 → 60 → 60000psi tensile strength
x → 4 → 2 → 70 → 70000psi
x → 4 → 3 → 80 → 80000psi
x → 5 → 1 → 20 → AC or DC
x → 5 → 2 → 30 → AC or DC
x → 5 → 3 → 10 → DC reverse polarity

E 60 1 0
2
3

E 60 10 { tensile strength: 60000psi, all position, DC reverse polarity, }
E 60 30 { tensile strength: 60000psi, all position, AC or DC }
E 60 27 { tensile strength: 60000psi, horizontal, downhand, AC, DC (both) }

E 60 11 (1) → 60000psi, all position, cellulose 15%, Titanium 30%, AC or DC, DC reverse
E 60 12 (2) → 60000psi, all position, Rutile titanium, sodium, AC or DC, DC straight polarity
E 60 13 (3) → 60000psi, all position, Rutile Titanium, lower hydrogen, AC or DC, DC straight polarity
E 60 14 (4) → 60000psi, all position, Titanium, AC, DC
E 60 15 (5) → 60000psi, all position, Low hydrogen sodium, AC; DC (Reverse)
E 60 16 (6) → Low hydrogen, pot ... AC–DC (DC → Reverse)
(7) → ...

E 60 11 { tensile strength: extraction, 60000psi, all position, cellulose; AC or DC, DC reverse }

E6013 - mild steel (only) / BS-E207

Approved Company -

E → electric electrode

60 → 60000psi

1 → all position

3 → Rutile Titanium Coated

Ac - Dc (St) Dc(+ve) ব্যবহার করা যায়

সাধারণ 4mm (size) ব্যবহার করা হয়

Flat → Down hand flat এর ক্ষেত্রে amp - 105 → 170

vertical overhead এর amp 120 → 130

Chinese Electrode

Heavy Coating থাকে

amp নির্বাচন size অনুযায়ী, 6টি

	Flat	vertical (F)	O (overhead
3.2 mm (1/8") →	amp 90 → 130	80 → 100	80 → 105
4 mm (5/32") →	130 → 190	120 → 170	110 → 130
5 mm (3/16") →	190 → 240	160 → 210	160 → 210

90 → 130

↳ 90, 105, 110 → 130

~~Size~~ ২য় (9) এমারজেন্সিতে ব্যবহার করা হয়

Rapidly

M. T 20 — corresponding to BS E316

for chinese

~~Size~~ in

9-3-1927 এ এমারজেন্সিতে ব্যবহার করা হয় → যে Gas

Gas পরিবর্তন → যে ধরনের

ব্যবহার করা হয়

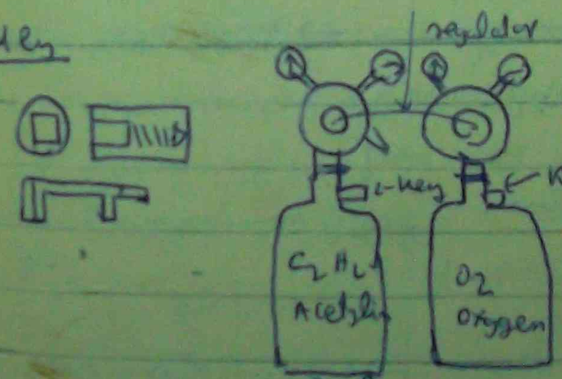
(1) ব্যবহার করা হয় নতুন ধরনের

(2) সবচেয়ে বেশি ব্যবহার করা হয়

(3) ব্যবহার করতে হলে (নতুন করে) ট্রেনিং নিতে হয়

(4) ব্যবহার করা হয় → যে ধরনের

Key



C.I. এ ব্যবহার করা হয়

(5) ফ্লেম ধরানোর জন্য

(6) ব্যবহার করা হয়

(7) ব্যবহার করা হয়

(8) ব্যবহার করা হয়

(9) ব্যবহার করা হয়

(10) ব্যবহার করা হয়

(c) regulator (ప్రెషర్ గేజ్) ఆక్సిజన్ (ఎరుపు) ఎసిటిలీన్ (నలుపు)

* ఆక్సిజన్ మరియు ఎసిటిలీన్ కలిపినప్పుడు explosive అవుతుంది

(a) ఆక్సిజన్ 1/4 (ఒక భాగం) ఎసిటిలీన్ 1 (ఒక భాగం)

(b) ఆక్సిజన్ 1 (ఒక భాగం) ఎసిటిలీన్ 1 (ఒక భాగం)

ఆక్సిజన్ ఫ్లేమ్ (Neutral flame) ఫ్లేమ్ లో ఆక్సిజన్ మరియు ఎసిటిలీన్ సమానంగా ఉంటాయి

ఆక్సిజన్ : ఎసిటిలీన్ (ఒక భాగం : ఒక భాగం)

ఆక్సిజన్ 1 psi వద్ద 330 psi → 2200 cm³ C_2H_2

ఎసిటిలీన్ 1 psi వద్ద 2 lb (or) 1 kg/cm² → 1 kg/cm² వద్ద 1 kg

ఉపయోగాలు

ఆక్సిజన్ → ఆక్సిడైజింగ్ ఫ్లేమ్ → ఆక్సిడైజింగ్ ఫ్లేమ్ → ఇనుము

(1) ఫ్లేమ్ తీవ్రత
(2) ఆక్సిడైజింగ్ ఫ్లేమ్ use for Burning.
(3) తక్కువ C_2H_2 + ఎక్కువ ఆక్సిజన్.

ఎసిటిలీన్ → ఆక్సిడైజింగ్ ఫ్లేమ్ → ఇనుము

ఎక్కువ ఎసిటిలీన్ + తక్కువ ఆక్సిజన్

ఫ్లేమ్ తీవ్రత తక్కువ

ఉపయోగాలు: Hard facing, Welding of cast iron, Welding of non ferrous metals

ⓑ

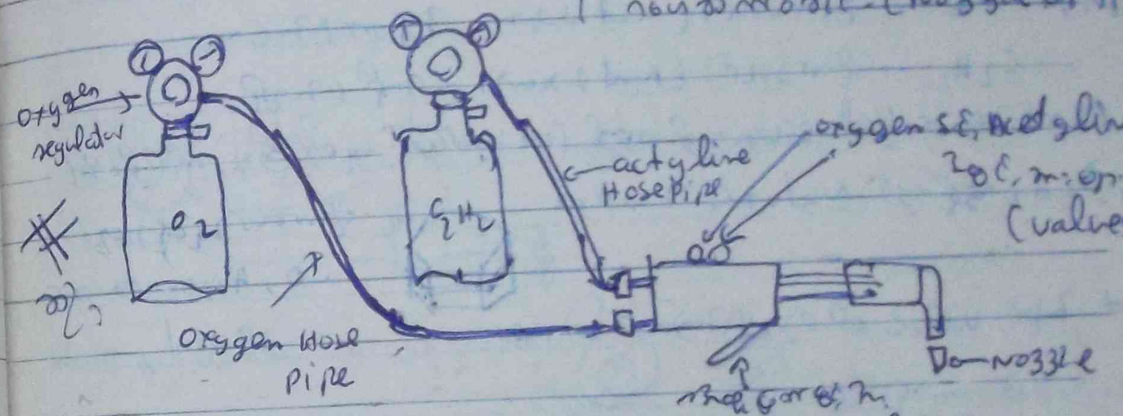
* ఫిట్టింగ్ అయ్యే విధానం:

- ఆక్సిజన్ సిలిండర్ కి: (Oxygen cylinder)
- ఎసిటిలీన్ సిలిండర్ కి: (Acetylene cylinder)
- ఆక్సిజన్ రెగ్యులేటర్ కి: (Oxygen regulator)
- ఎసిటిలీన్ రెగ్యులేటర్ కి: (Acetylene regulator)
- ఆక్సిజన్ సిలిండర్ కి: (Oxygen hose pipe)

ఎసిటిలీన్ సిలిండర్ కి:
- (Acetylene hose pipe)
- ఇంజెక్టర్ కి: { welding blow pipe or torch / gas cutter }
- ముక్కు కి: (Nozzle)
- స్పిండిల్ కీ: (Spindle key)
- గాగుల్స్: (goggle)

స్పానర్
లెదర్ గ్లవ్స్ (leather hand glove)
స్పార్క్ లైటర్ (spark lighter)

సెపరేటర్ (separator)
టిప్ క్లీనర్: (Tip or Nozzle cleaner)
నాజిల్ లేదా టిప్: (Nozzle or tip)



Fitting of oxygen acetyline welder.

* ఆక్సిజన్ రెగ్యులేటర్ మరియు ఎసిటిలీన్ రెగ్యులేటర్ ని: ఆక్సిజన్ రెగ్యులేటర్ ఎడమ వైపు, ఎసిటిలీన్ రెగ్యులేటర్ కుడి వైపు

(ii) → ఇంజెక్టర్ మరియు ముక్కు ని స్క్రూ (Nut) ద్వారా బిగించాలి

ⓒ

ని. – ని.ని. ⓒ ని.ని ⓑ ని.ని ⓐ ని.ని

Oxygen [illegible] = [illegible]

[illegible] – O_2 – [illegible] – regulator ([illegible])

C_2H_2 – [illegible] → 〃 ([illegible])

pipe O_2 → [illegible] (Nut [illegible]) – [illegible]

C_2H_2 – [illegible] (Nut) [illegible] – [illegible]

[illegible] valve [illegible]

C_2H_2 [illegible] Nut [illegible]

[illegible]

0, A [illegible]

[illegible]

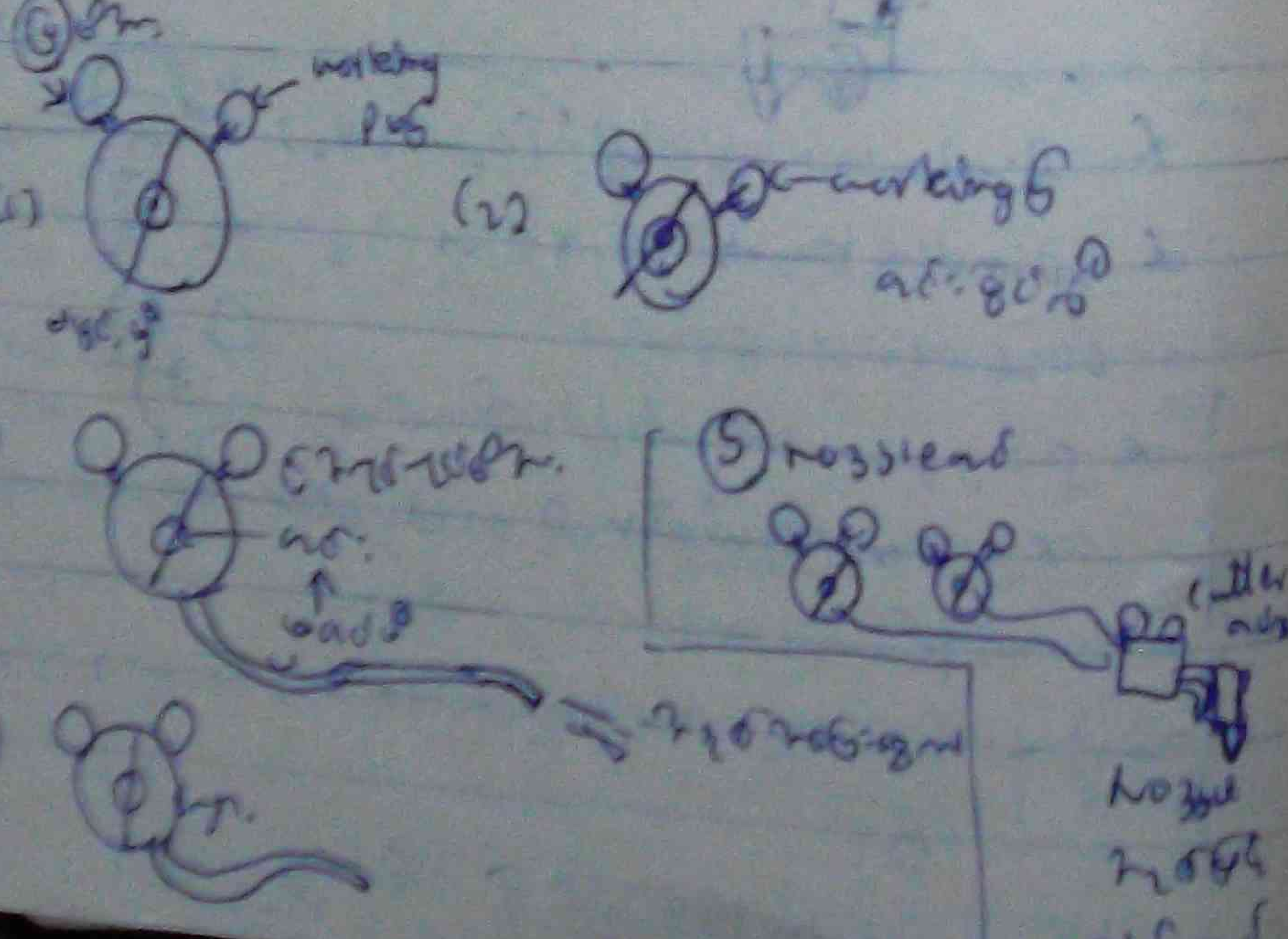
* [illegible] valve [illegible]

* [illegible] C_2H_2 [illegible]

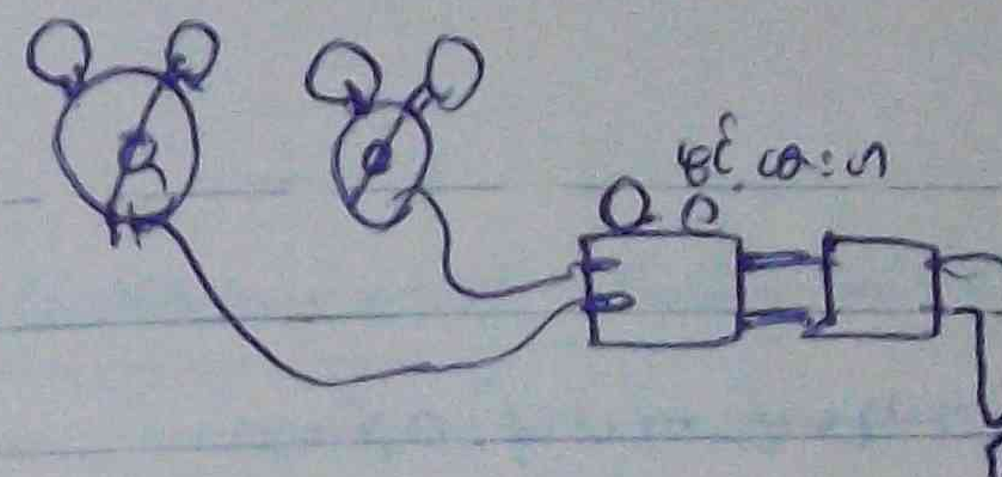
C_2H_2 regulator [illegible]

* Key [illegible]

* Regulator (5) [illegible]

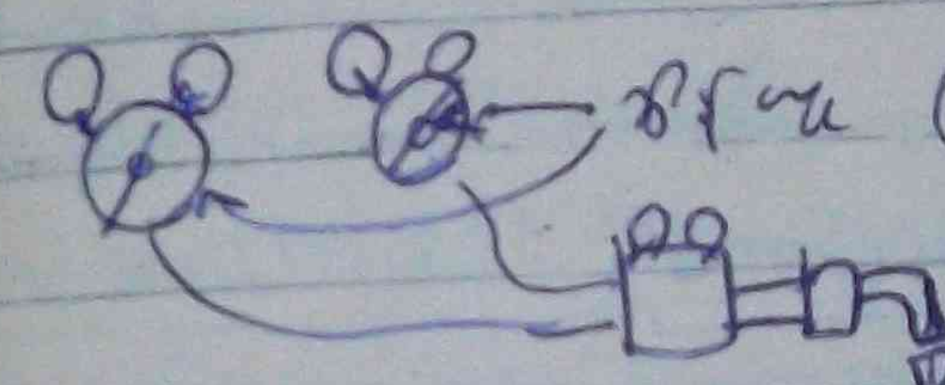


[illegible] valve [illegible]



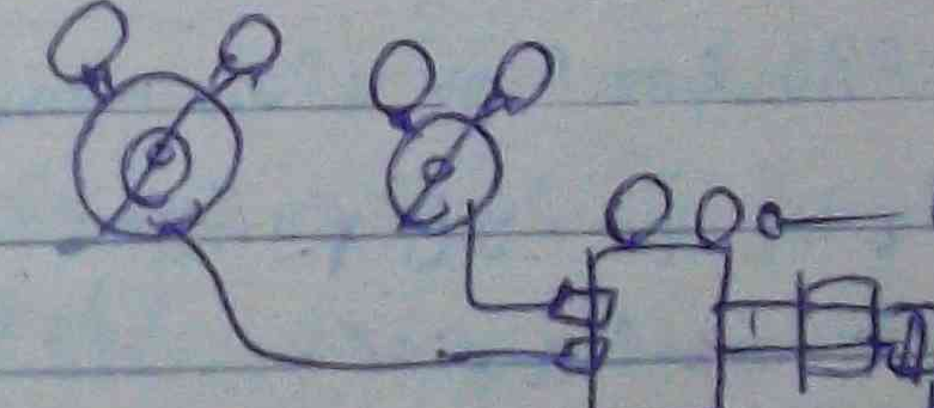
* Regulator [illegible] working pressure [illegible]

[illegible]

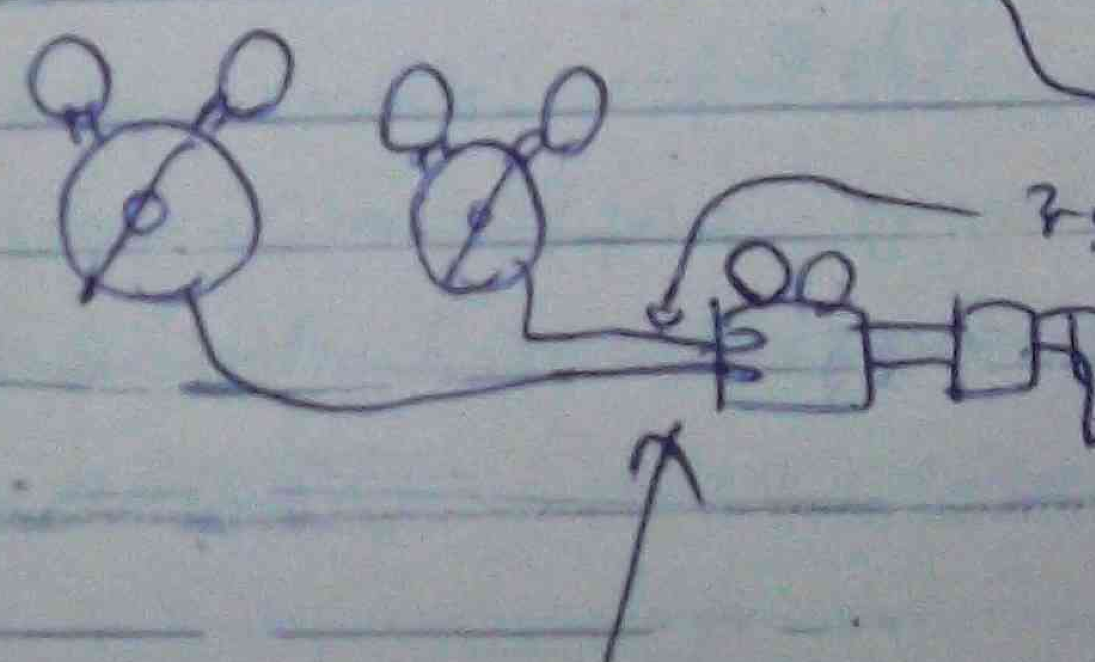


[illegible] ([illegible]

* [illegible] valve [illegible]



*



[illegible]

[illegible]

~ [illegible] safe [illegible]

[illegible]

[illegible] C_2H_2

[illegible]

– [illegible] – [illegible]

[illegible] – C_2H_2 [illegible]

[illegible]

[illegible]
[illegible]

[illegible] gas [illegible]

- Nozzle [illegible]
- C_2H_2 [illegible]
- Nozzle [illegible]
- [illegible]
- Nozzle [illegible]

Backfire ([illegible])

၁။ [illegible] regulator [illegible]
[illegible] → [illegible]

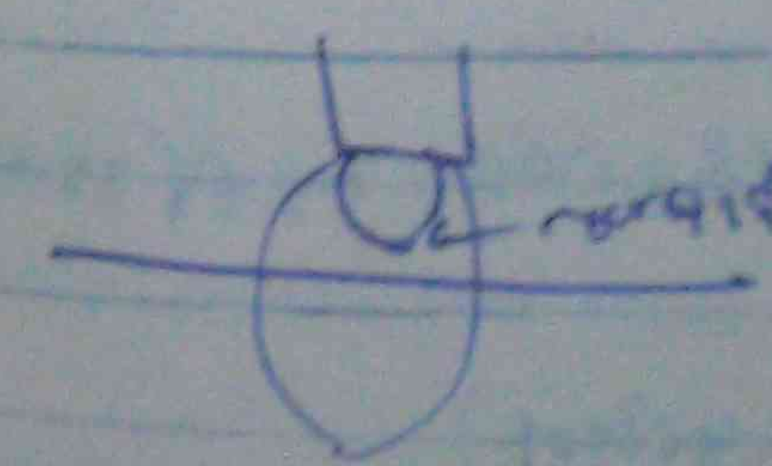
၂။ [illegible] ([illegible]
[illegible] ([illegible])

၃။ [illegible]
[illegible]
(Flash Back) { [illegible] }

၄။ Regulator [illegible]
[illegible]

၅။ [illegible] ([illegible]) [illegible] (Nozzle) [illegible]
[illegible] (nozzle on tips)

၆။ [illegible]



၇။ [illegible] Nozzle [illegible]
(Nozzle [illegible])

၈။ [illegible]
[illegible] Value [illegible]

[illegible] (Pressure [illegible])

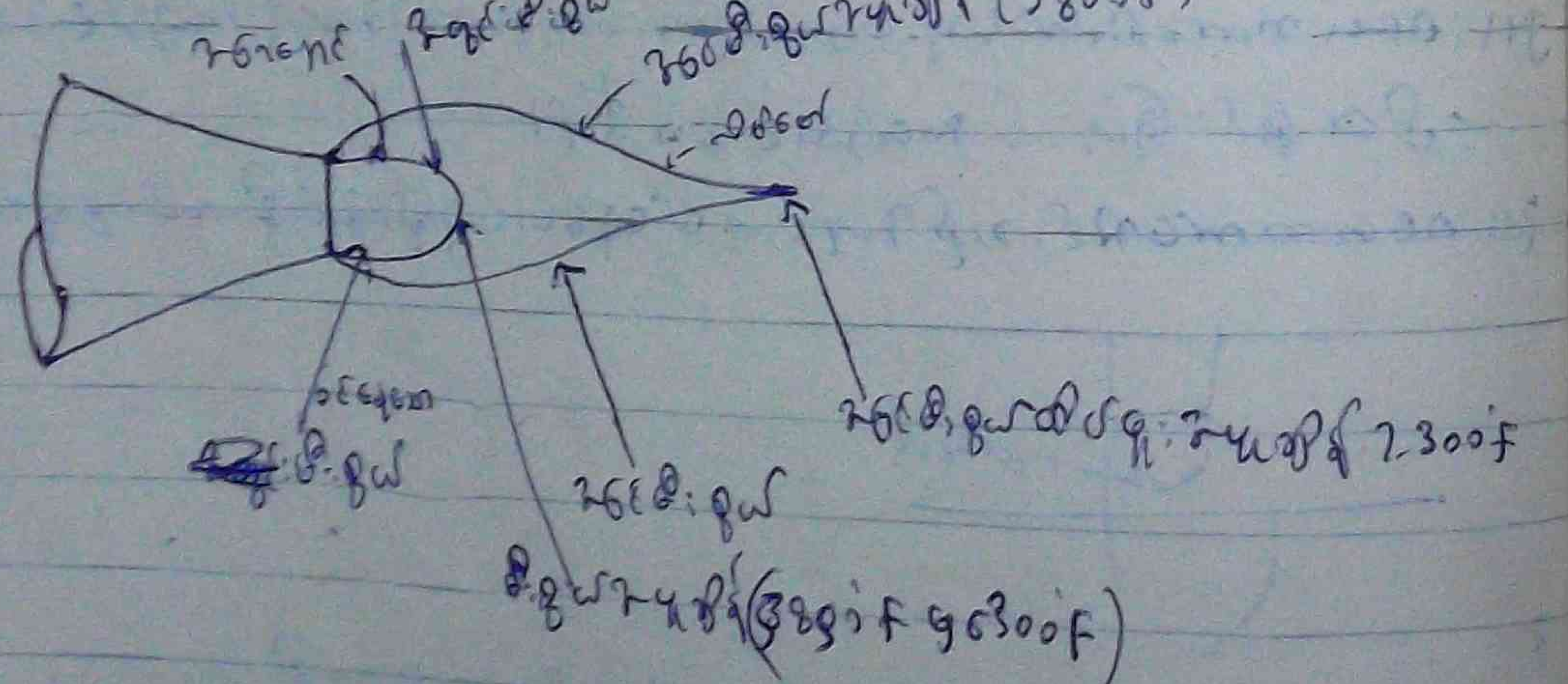
[illegible]

* [illegible]

* [illegible]

* [illegible]

မီးလျှံ [illegible]



[illegible] → heat [illegible]

[illegible] → [illegible] undercutting [illegible]

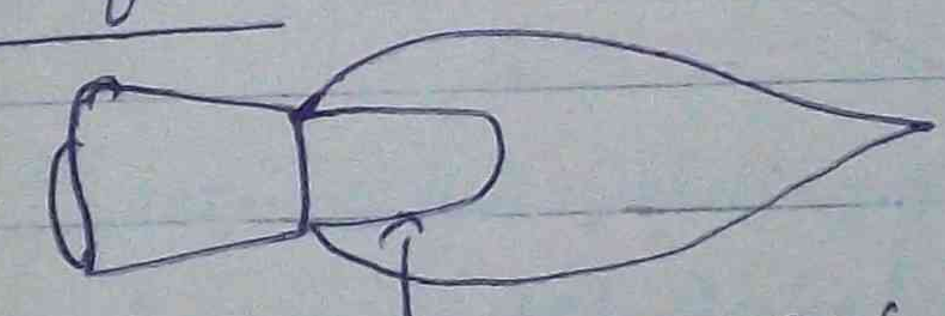
မီးလျှံ ၃ မျိုး (3 types of flame)

(၁) ပုံမှန်မီးလျှံ (natural flame)

(၂) ကာဗွန်ဓါတ်များသော မီးလျှံ ([illegible]) [illegible] (carburizing flame)

(၃) အောက်ဆီဂျင်များသော မီးလျှံ (oxidizing flame)

(၁) ပုံမှန်မီးလျှံ



[illegible]

[illegible]

[illegible] special lever [illegible]

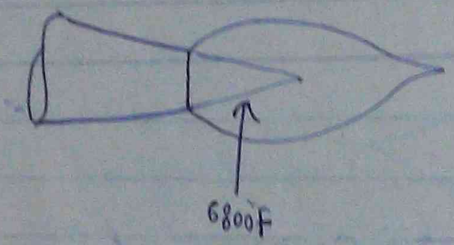
([illegible] cast iron, cast steel, steel) → [illegible]

(၂) ကာဗွန်များသော မီးလျှံ

([illegible])

- High carbon steel, Alloy steel s. Stainless steel
- Nickel & Chromium.
- Cast steel, -
- ?

2. Gas welding



- Bronze (copper + zinc) brass
-
-
-

There can be minimized if the structure is suitably prepare and the correct sequence of welding is follow.

Usual welding Process

① manual metal arc welding

A fusion weld is one where there is actual melting of the material being joined although the weld metal is composed very largely of added material which generally has the same characteristics as the parent metal. The heat necessary for making fusion welds is usually supply by electrical means. The most common of welding processes is still the one in which a manual metal arc welding with coated steel electrode.

② Automatic Arc welding.

Early attempt at automation of the metal arc welding process included devices which deposited a bare electrode in a prepared joint, and the limitation of this above technique for continuous welding is the difficulty of transferring the arc from one electrode to next without incurring corosity in the weld. The answer to the problem was found by using a coated electrode in coil form and this is usually the commonly done.

submerged arc process

This method employ a coiled bare wire and welding flux which is supply separately, as a free flowing powder. The flux is deliver from a hopper and deposited on the joint to be welded ahead of the electrode wire. The arc is completely shielded and hidden from view and is very quite and there is no alloy and no from fume or glare.

welded connections

The two basic types of welded connection are. The butt and fillet and variation of these type weld be described.

fig(1) shows a general type of butt weld and the preparation of this ones shows in fig: (2) The angle of chamfer and the gap between the plates and the nosing, may be cliding, and different yards, These are generally prove by local Surbuoys of the classification societies are before welded began. The preparation of plate edges is done by either planning or by burning machine in the shop built on the ship during construction the chamfer are either hand machine chipodar burned.

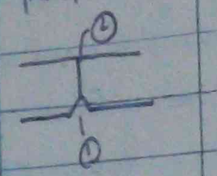
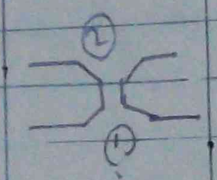
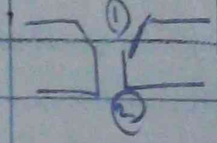
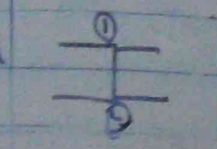
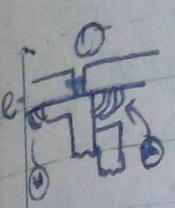
	Preparation	Plate thickness	Job	Method
a		under 0.63"	Plate at bottom shell seams and butts to plate deck seams bulk head seams and butt	weld (1) and (2) manual or machine.
b		over 0.63"	Bottom shell and side seams or butts bulk head deck seam and butt Tank Top seams	"
c		under 0.63"	Shell seams and butt marking and tank top centre line strake butt Bulk head seams and butts	weld (1) manual.
d		under 0.28 manual under 0.56" machine	Bulk head deck and any seams or butts to be completed with Plates Horizontal	weld (1) and (2) manual or machine.

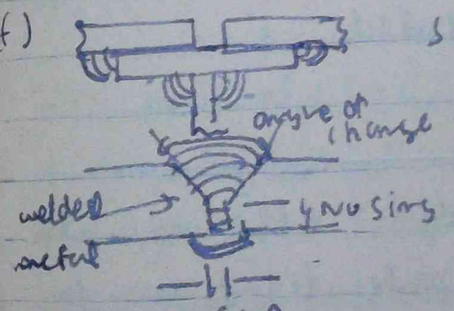
Plate thickness | Preparation



under 0.56" Plate edges are strength over 0.56" Plate are chamfered.

Tank top butts deck butts deck house side butts

weld (1) manual or machine continuous weld if floors are watertight or oil tight intermediate otherwise.

(f) 

some as (e) | MS (e) | ase.

angle of flange

welded on flat

4 No Sizes

gap

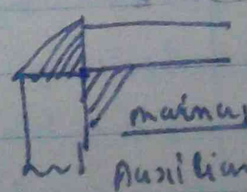
throat thickness

weld metal

weld size

fig (3)

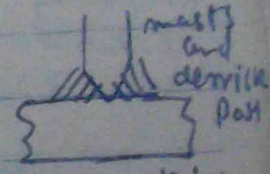
fig (1)



main use

Auxiliary use

fig (4) (a) corner fillet



main use mast and derrick post

marking Plate to shell

fig 4 (c) Heavy plate fillet

main use pillar heads and keels

fig 4 (b) Inaccessible fillet Plate chantered to allow deep fine fixation.

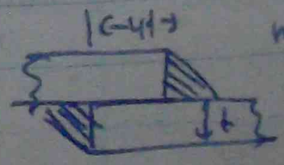
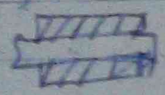
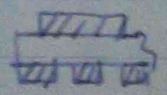


fig 4 (d) top weld.

main use bulkhead collars Brackets etc

Fig (1) Shows the basic fillet weld and weld is generally done by hand vibration of the arc Shown in fig (a) The factor governing the leg length of the type of weld is the thickness of the two plate making the joint join the rules of the classification societies give the leg length in relation (important of connection and state also whether the weld is continuous or intermitted width intermitted weld the spacing of weld also stated.

Plan of weld	Type	Job
(a) 	continuous weld both sides of plate	All main water tight strength work eg bulkhead Tank top vertical centre keel Beam knees etc
(b) 	continuous weld one side inter mittent weld the other	Secondary watertight and gas tight work eg wcs galley Deck houses retri: space.

(c)	Intermittent weld both sides - staggered	Girders, Beams bulkhead, stiff frame, floor etc.
	Intermittent weld both side - chain.	

Fig (5) fillet weld spacing

Fig 5(a) to (d) show the various continuous and intermittent weld and where they are used. Before a fillet weld is begin it should be seen that the gap between the plate is never greater than $\frac{1}{16}$" If a larger gap occur the size of the gap should be sealed by welding and then the opposite side gouged to meet the weld, before before completing the weld of the second side

The strength of welded joint depend particular (y upon the skill and reliability of the welder who must be ~~one~~ careful in cleaning the joint keeping it dry, and clearing away the slag or flux in a multirun weld. The tight, sides and shape of weld also are important. If all these points are considered, there is no reason while a first class attachment should not be produced. If there

excessive loading of any particular welded joint
brake down usually occur in the plating adjacent
to joint and only in the weld itself if the above
points have not been followed. In both butt and
fillet weld it is important that they are run
towards where end, otherwise locked up
stresses occur which calls cracking of weld and
distortion of plating. Therefore if it is impend
the two the joint is suitably prepared and
fastened and the sequence of welding checked
before the operator allowed to begin.

welding ಉಪಯೋಗಗಳು:

Ship building, Railways, Motorcar & aircrafts, reventing
gears, repair & maintance

fussion welding (F.F.C)

ಇದರಲ್ಲಿ ಎರಡು ಲೋಹಗಳನ್ನು ಜೋಡಿಸಲು, ಅವುಗಳ ಅಂಚುಗಳನ್ನು
ಕರಗಿಸಿ surface ಅಥವಾ edge ಗಳಲ್ಲಿ metal gas flame ಅಥವಾ
ಎಲೆಕ್ಟ್ರಿಕ್ ಆರ್ಕ್ ಮೂಲಕ ಕರಗಿಸಲಾಗುತ್ತದೆ. ಇದನ್ನು ಎರಡು ವಿಧ
ಮಾಡಲಾಗಿದೆ (1) Fussion without mechanical press (2) fusion with
mech. press ಮತ್ತು ಈ ಕೆಳಗಿನ ಎರಡು ವಿಧಾನಗಳಲ್ಲಿ ಮಾಡಲಾಗುತ್ತದೆ

Fusion without pressure ಗಳಲ್ಲಿ ಎರಡು ವಿಧಾನಗಳಿವೆ:

(I) gas Process (a) oxy acetylene (b) oxy Hydrogen
(c) oxy-Hydrocarbon (d) Air Acetylene
Gas welding ಗೆ ಎರಡು ವಿಧಾನಗಳಿವೆ. Borax ಅನ್ನು ಬಳಸಿ ಕರಗಿಸಲಾಗುತ್ತದೆ
ಇದರ ಉಷ್ಣತೆ 800°. Butane ಗಿಂತ ಇದರ ಉಷ್ಣತೆ ಹೆಚ್ಚು

(II) Arc process
(1) metal arc (3) Atomic arc (5) Submerged arc
(2) carbon arc (4) Inert gas arc (6) Electro slag.
Arc welding ಎರಡು ವಿಧ ಇದೆ. Electrode ಮೂಲಕ: electric Arc
or arc ಇಲ್ಲದೆ. ಇದರಲ್ಲಿ ಕೆಲಸ ಮಾಡಲು ಅನುಕೂಲ: ಅನುಭವ.
ಇದು, ಇದರಲ್ಲಿ 2 ವಿಧಗಳಿವೆ ಇದನ್ನು ಕೆಲಸ ಮಾಡಲಾಗುತ್ತದೆ: ಇದು ಎರಡು
ಇದನ್ನು ಇಲ್ಲಿ: ಅ. ಇದು. ಇದರ ಮೂಲಕ ಕರಗಿಸಲಾಗುತ್ತದೆ: ಇದು ಎರಡು
ferrous & non ferrous metal
ಇದನ್ನು ಬಳಸಲಾಗುತ್ತದೆ: ಇದನ್ನು ಕರಗಿಸಲಾಗುತ್ತದೆ

oxy-acetylene welding

Gas welding ಅಥವಾ oxy acetylene welding ಇದನ್ನು ಕರಗಿಸಲು
oxygen ಮತ್ತು acetylene ಗಳನ್ನು ಬಳಸಲಾಗುತ್ತದೆ: ಇದರ ಉಷ್ಣತೆ: 6000°C, ಇದನ್ನು
ಕರಗಿಸಲು ಇದನ್ನು ಬಳಸಲಾಗುತ್ತದೆ: ಅಲ್ಲಾಯ್ ಮತ್ತು ಕರಗಿಸಲು: ಇದರ ಉಷ್ಣತೆ 3500°C
ಇದನ್ನು ferrous metal ಗಳಲ್ಲಿ: ಕೆಲಸ ಮಾಡಲು ಇದನ್ನು ಬಳಸಲಾಗುತ್ತದೆ. ಇದನ್ನು ಕರಗಿಸಲಾಗುತ್ತದೆ
metal ಅನ್ನು ಕರಗಿಸಿ, ಇದನ್ನು ಬಳಸಲಾಗುತ್ತದೆ: ಇದನ್ನು ಕರಗಿಸಿ
filler wire or metal Rod ಆಗಿ ಬಳಸಲಾಗುತ್ತದೆ

ಈ ವಿಧಾನದಲ್ಲಿ ಕೆಲಸ ಮಾಡಲು ಇದನ್ನು ಬಳಸಲಾಗುತ್ತದೆ: ಇದನ್ನು molten metal
ಇದನ್ನು ಬಳಸಲಾಗುತ್ತದೆ, ಇದನ್ನು ಕರಗಿಸಿ ಇದನ್ನು ಬಳಸಲಾಗುತ್ತದೆ: ಇದನ್ನು ಕರಗಿಸಿ
ಈ ವಿಧಾನದಲ್ಲಿ. nitrides & oxides ಇದನ್ನು ಬಳಸಲಾಗುತ್ತದೆ: ಇದನ್ನು ಕರಗಿಸಿ
Joint ಇದನ್ನು: ಇದನ್ನು: ಇದನ್ನು: ಇದನ್ನು ಬಳಸಲಾಗುತ್ತದೆ

(ii) carburising flame -

carburising cone(r)

lary with pointed or regged end

with Excess Acetylene Flame or Reducing Flame and with the use of Acetylene gas. Intermediate cone of Acetylene feather or luminous

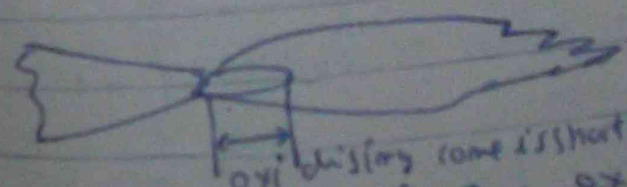
2nd stage. 1st combustion stage gives dull yellowish white cone

1st combustion stage gives dull yellowish white cone

feathery or outer edge surrounding the particular zone of molten metal

carbon content

(2) oxidising Flame



oxidising cone is short

molten metal

with Excess oxygen

Flame of Acetylene gas

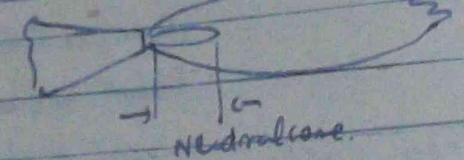
oxygen and Acetylene

part of flame oxygen

point of flame

brass, bronze

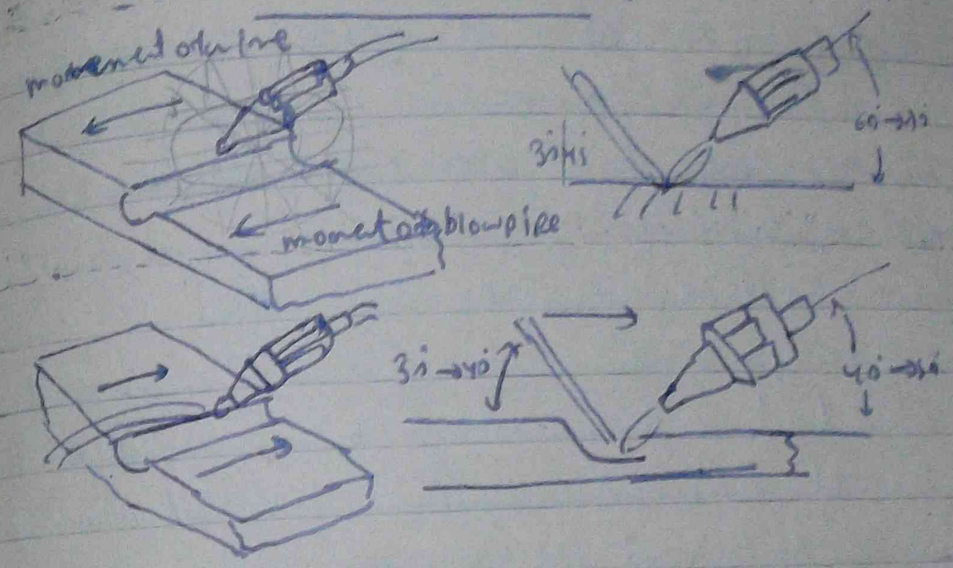
(3) Neutral flame



oxygen & acetylene ની સરખી માત્રા બંને ભેગા થાય ત્યારે neutral flame બને. આમાં બંને ગેસ પૂરેપૂરા વપરાય છે. આ flame ની temperature સૌથી વધારે હોય છે.

metal	flame
mild steel	Neutral flame
stainless steel	"
cast Iron	"
copper	"
Aluminium	"
Nickel	"
monel	"
Brass	oxidising flame
Bronze	"
Aluminium Alloy	slightly carburising
magnesium Alloy	"
Zinc Brass Alloy	"

Method of welding



welding ની બે method છે. (1) leftward or forward method (2) rightward or Backward welding method.

Leftward or forward method માં welding ની જમણી બાજુથી શરૂ કરી ડાબી બાજુ જવાય છે. flame ની direction welded portion તરફ રહે છે. આમાં welding ની speed ઓછી હોય છે. distortion ઓછું થાય છે. molten metal ને સારો support મળે છે. metal plate ની જાડાઈ 60° ના ખૂણે 60° ની V shape માં cut કરેલી હોય છે. metal plate ની જાડાઈ $\frac{1}{4}$" steel plate કરતાં ઓછી હોય છે. Non-ferrous metal ને આ method વધારે ઉપયોગી છે.

Backward method માં welding ની ડાબી બાજુથી શરૂ કરી જમણી બાજુ

[illegible] welded portion of morse
[illegible] 1/16" [illegible]
[illegible] joint [illegible] molten
[illegible]

Blowtorch soldering irons can be heated in various ways, but the gasoline blowtorch is one of the most convenient ones aboard ships. As shown in figure 8, blowtorches are usually equipped with a hook and swivel to hold the soldering iron while the copper is exposed to the flame of the torch.

Before using a blowtorch it is advisable to consider the danger of fire. Do not light or use the torch near openings where explosive gases may be present, where gasoline has been spilled, or where [illegible] material may be ignited. As a good practice have a fire extinguisher handy whenever a blowtorch is used.

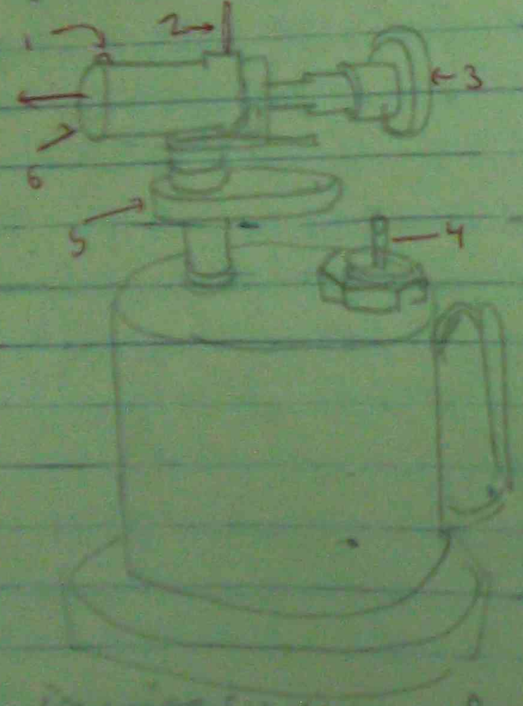
In order to use a blowtorch, fuel tank must contain kerosene, white (unleaded) gasoline, and the pump on the tank must be operated to build up sufficient pressure to cause the gasoline to spray through the burner tube when the valve is opened. Make certain that the filler and relief valves are closed tightly before pumping pressure into the tank.

tube and the valve is opened slightly, allowing liquid gasoline to collect in the fuel pan.

With the valve closed and the blowtorch placed so as not to cause fire or damage to material and so as not subject it to violent currents, ignite the gasoline in the fuel pan and permit the flame from the burning gasoline to envelop and heat the burner tube. When the burner tube is hot, open the valve slightly to permit a fine stream of gasoline to be discharged from the tube. The gasoline should vaporize immediately and burn with an almost colorless, slightly blue flame. Before proceeding, be sure the valve is open wide enough to permit satisfactory operation. Once the torch is burning satisfactorily, the valve can be opened or closed slightly in order to adjust the flame to the desired intensity. A blue flame indicates good combustion conditions, while dark or yellow flames indicate that the pump should be operated periodically in order to maintain pressure in the tank.

- To extinguish a blow torch, close the v/v after the torch has been extinguished - it is good practice to loosen the filling plug and release the pressure within the tank. When the pressure has been relieved, the filling plug is tightened again.

The v/v is then opened slightly and left open. If the v/v is not left open the metal around the v/v will contract and the v/v spindle is so tight by that it will be damaged



1/ soldering iron rest
2/ soldering iron hook
3/ v/v
4/ fuel pump
5/ fuel pan
6/ burner tube

→ Use wire solder, paste fluxes, commercially manufactured are available in tins of various sizes. These fluxes which contain grease for counter acting corrosion, are suitable for all

{ Please Pass me ——
may I have ~~tea~~ water
waiter
yes

Fluxes A flux is a chemical preparation (powder, paste or liquid) used to keep the metal clean so that the solder will stick to it. When a flux is heated, the heat will cause oxides to form on the metal surface and prevent the solder from adhering properly. A list of common fluxes and the metals on which they are used is given in the following:-

Metals	Fluxes
Copper, brass	Resin
Lead	Tallow, resin
Iron, steel	Soldering fluid, zinc chloride

Fluxes are either corrosive or non-corrosive. The commonly used corrosive fluxes is zinc chloride, and ammonium chloride, made the metal It allowed to remain on it after soldering They should therefore be completely removed by washing after the work is done. It After soldering is washing, after the work is done. It After soldering is washing, after the work is done. It

Tinning - Spreading a thin layer of solder on the surface of the metals that are to be soldered together causing the solder to adhere to the metal and make a firm union with it. The purpose of tinning is to prepare the surfaces so that they will unite readily in the process of soldering, and make a firm joint. All recommended that all metals except lead & tin, be tinned before soldering, lead & tin need only to be scraped clean.

Copper brass and ungalvanized iron can be prepared to receive solder by cleaning the surface and applying zinc chloride. Galvanized iron or steel should be cleaned with muriatic acid before the solder is applied. Where a metal has become tarnished it is necessary to remove the tarnish and expose the base, clean metal before tinning it, otherwise the solder ordinarily will not adhere to the metal.

Tinning the soldering iron. The point of a soldering iron must be tinned before it will do a good job of soldering, tinning in this instance refers to the process of coating the point with solder to prevent oxidation when heated - The general steps in tinning procedure are as follow.

① File the faces of the point clean & bright with emery cloth, and leave smooth and flat

② Heat the point hot enough to melt the solder readily, but do not heat it red hot

③ Rub the faces of the point of sal-ammoniac or borax, applying occasionally contact of solder to the point as it is rubbed on the salt - ammoniac. The solder will form a thin bright film on the faces of the point

④ If a sal-ammoniac brick is not available, the point can be tinned by rubbing it in pulverized rosin and solder. When a soldering iron is over heated the tinning is destroyed - If this happens the point should be allowed to cool and then should be filed and retinned.

Dipping Solution. When soldering iron is heated the scale is apt to form on the point can be removed by dipping the point in a dipping solution made of one part of sal-ammoniac powder mixed with 4 parts of water. Only the tip of the point should be dipped in the solution and it should be withdrawn quickly. The tinned point will then be bright and clean.

A soldering iron should never be dipped into zinc chloride or muriatic acid solution, as the acid during sputter is apt to the eyes or on the skin and clothing, and possibly cause blindness or severe burns.

F.F.A (Fire Fighting Appliances)

Extinguishing Aids (নির্বাপক সরঞ্জামাদি)

1. Fire Axe.
2. Asbestos jacket (অগ্নিরোধক জামা)
3. Asbestos pant
4. Helmet
5. Gloves (হাত মোজা)
6. Boot (বুট)
7. Gas mask

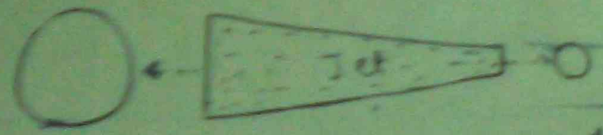
↳ 7. F/F Dress

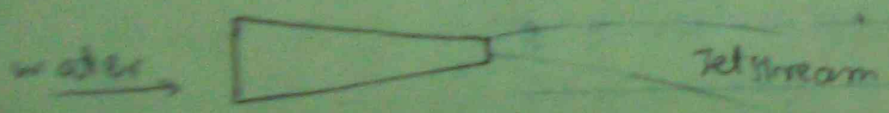
8. Bread Thing Apparatus (ভারী সরঞ্জাম)
9. Fire pump (পাম্প মেশিন)
10. Fire nozzles and Hose pipe (পাইপ ও নজেল)
11. Extinguishers (নির্বাপক যন্ত্র)
12. Drill and Bits (ড্রিল মেশিন ও ড্রিল বিট)
13. Padlock opener (তালা খোলার যন্ত্র)

Nozzles

① Jet nozzle
② Spray nozzle
③ curtain nozzle
④ Triple purpose nozzle

① Jet (ஜெட்: நீரின் திசை வேகம்)





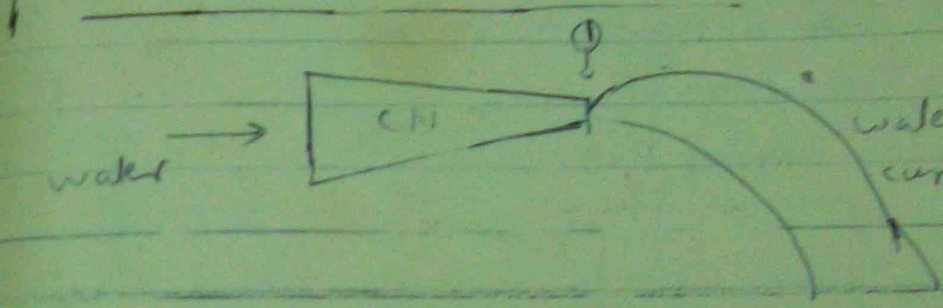
main purpose of jet nozzle

To extinguish the fire directly.

② Spray nozzle

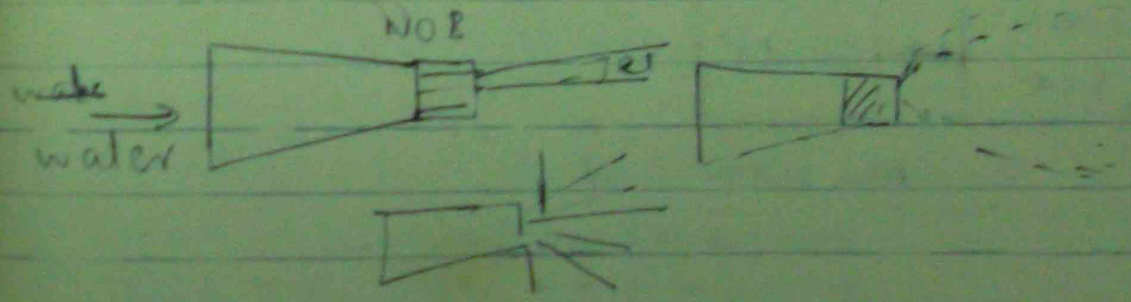
To cool the surrounding

③ curtain nozzle (திரை முனை)



To prevent the heat and smoke

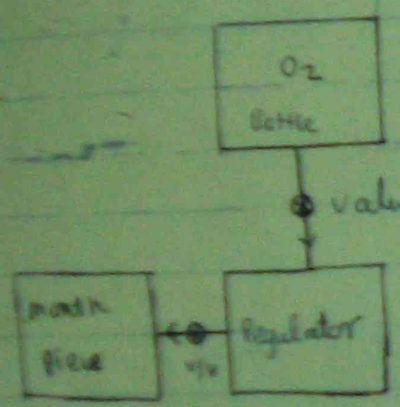
④ Tripple purpose nozzle



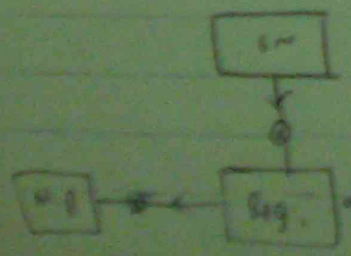
Breathing apparatus

① oxygen B.A
② compressed B.A
③ Bellow Type B-A

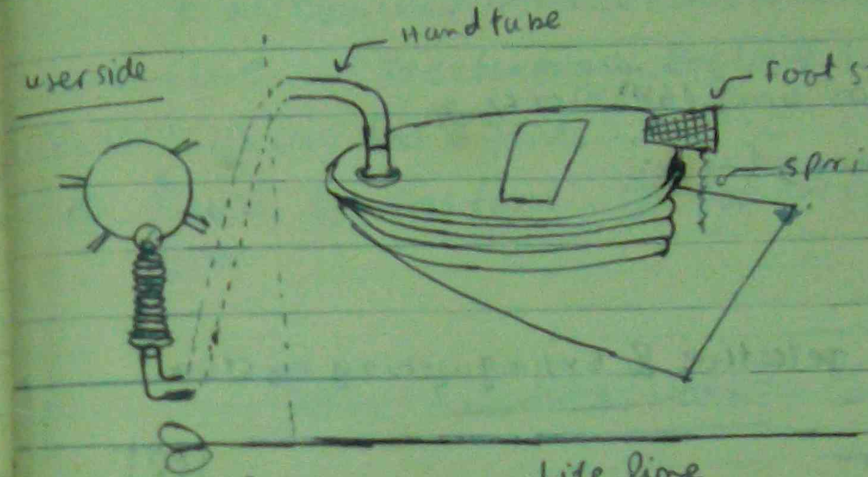
Oxygen B.A



compressed air B.A



Bellow Type B.A

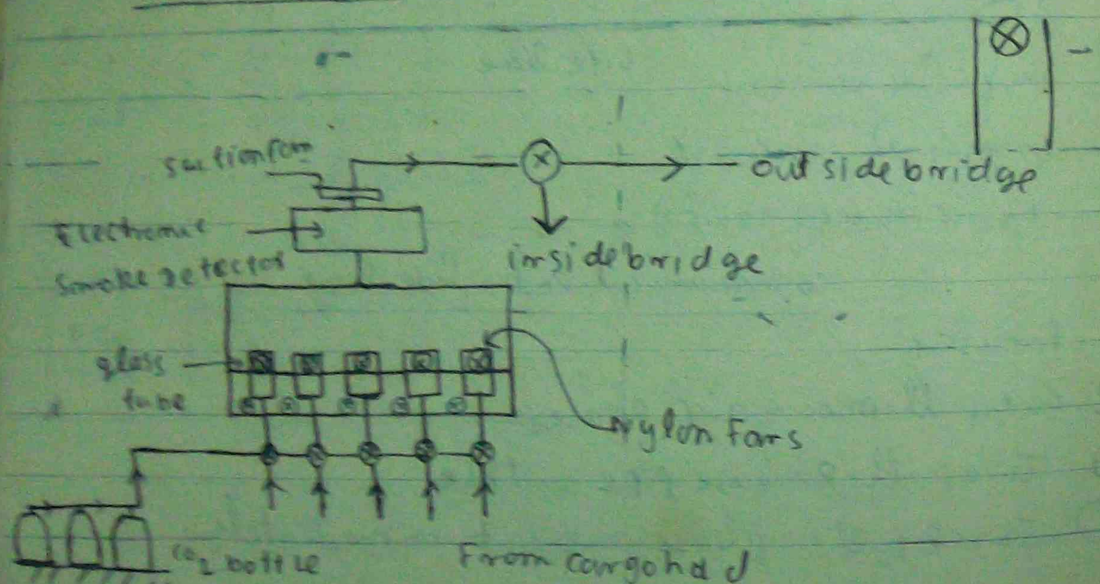


communication by life line

For user
① one pull - move air please
② Two pull - Release pipe and bie
③ Three pull : Please one out immediately.

For helper
① Three pull - come out immediately

Automatic detective & Extinguishing system



Extinguishers = ঃ: ২ or ২:

Extinguisher means which can extinguish the fire. (To extinguish the fire by using the extinguishing the agents).

① liquid ② Gas form ③ powder form ④ foam form
form (ঃ ৬ ৫ ৫)

Types of Extinguishers

① liquid expelled Type Extinguisher
② Soda acid ~~Ty~~ expelled type extinguisher
* ③ CO_2 / water expelled type extinguisher
④ Gas expelled type extinguisher
CO_2 type * (২ঃ২ঃ২৩ঃ২ঃ)
⑤ CTC expelled type extinguisher (CCl_4)

Powder expelled type extinguisher

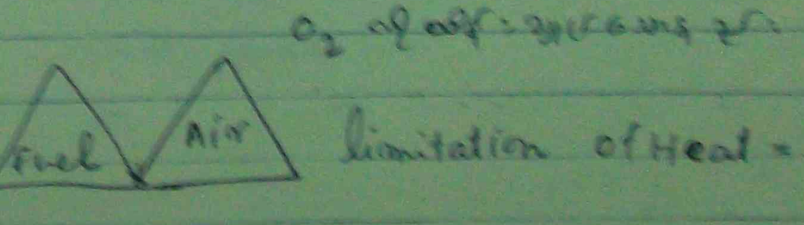
Dry chemical powder extinguisher ($NaHCO_3$)
* $NaHCO_3$ = non conductive, non acid,

Principle of Fire

(a) ઇંધણ Fuel

(b) હવા air

(c) ઉષ્ણતા Heat



Fire fighting methods

1.

limitation of Fuel = Starvation method

2.

limitation of Air = Smothering method

3.

limitation of Heat = cooling method

Foam expelled type extinguisher

Chemical foam extinguisher

Air / foam extinguisher

Chem foam

Air foam

Foam

Chemical froth for fire fighting purposes.

CTC

In case of Fire.

① Locate — ([illegible])

② confine

③ extinguish

Locate

- annum ൽ, Fire station ഒഴിവാക്കുക [illegible]
- [illegible]
- Fire station ന്റെ boat deck ൽ: ഒരു [illegible] പ്രത്യേക [illegible]

[illegible]

Need to locate when, where, how

~~Firefighting~~ Type of fire — ⓐ ⓑ and ⓒ

carbon [illegible] - Type a or class a

oil [illegible] - Type B - liquid fire.

Electrical fire - Type C

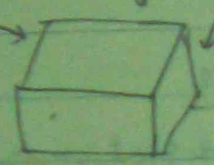
[illegible]

condition of fire

confine

[illegible] not to spread the fire

spray method →



liquid - flash point - fire point

solid - [illegible] temp [illegible]

Heat [illegible] Ignition temperature [illegible]

Extinguish

① [illegible]

② [illegible]

To Fight the Fire Properly

* which is the best extinguishing method?
prevention is the best method for fire fighting purpose.

Important factors for to prevent the fire.

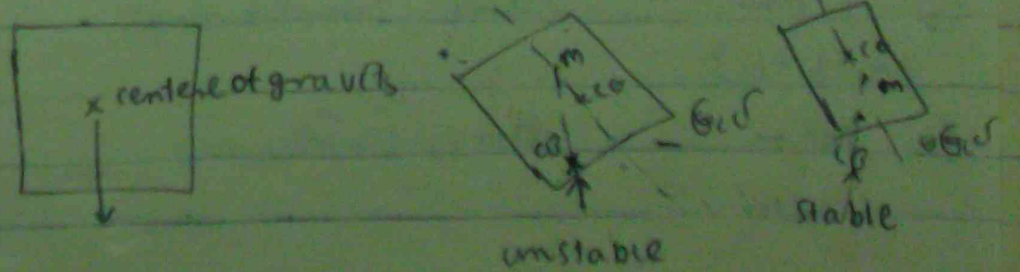
1. Ventilators
2. Buoyancy.
3. Heat conductivity.

1. ventilation

To ventilate the air inside the holes. circulation of fresh air.

2 Buoyancy

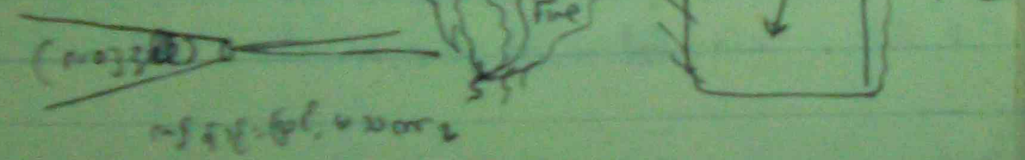
How a ship float on the sea.



Extinguishing agents

These are the agents to face and fight the fire directly we call them as extinguishing agents. They have their own respective physically properties for fire fighting purpose.

① water - wetting, cooling



② water fog - wetting, cooling, smothering

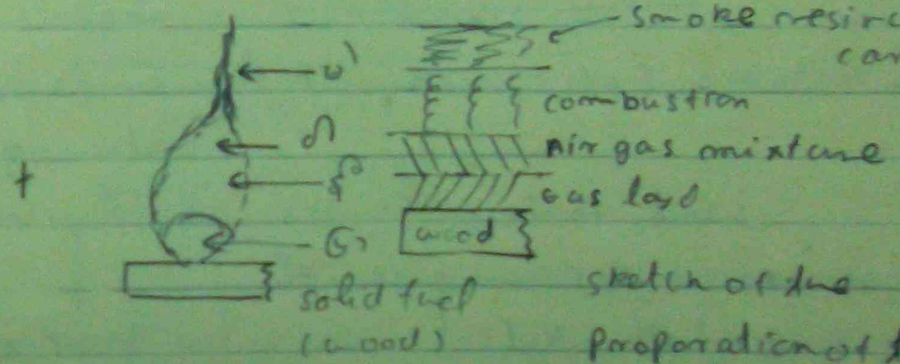
③ steam - wetting, smothering

④ Foam - wetting, smothering

⑤ Pounder - smothering
(NaHCO3)

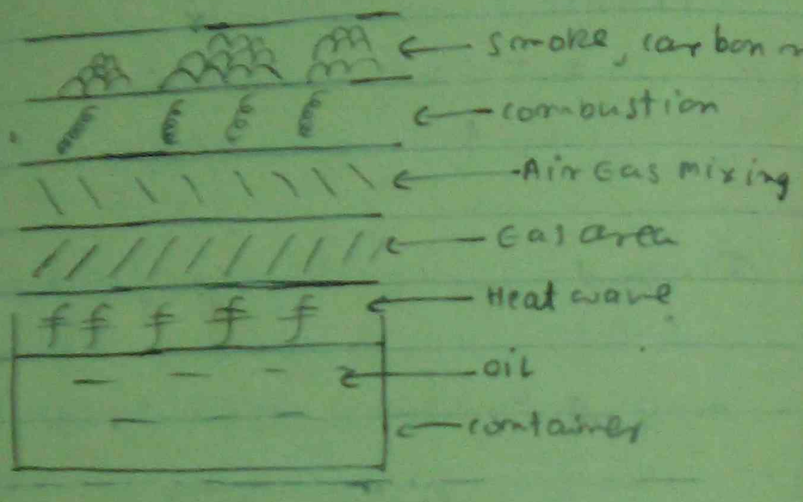
⑥ Inert Gas - smothering
(CO_2 ↑) ... / ...

⑦ sand - smothering / ...
(...)



sketch of the proporation of the solid fire.

Sketch of the propogation of Liquid Fire



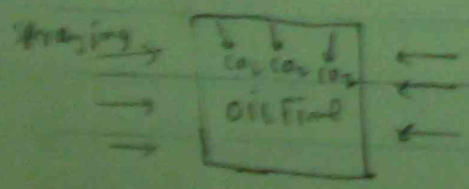
- suitable Extinguish method - ওপরের ছবির জন্য

Smathering method.

Sand, Foam, CO_2 gas, powder ব্যবহার করা যায়

Air gas mixing stop করলে আগুন নিভে যায়

- গ্যাসের সংযোগ বন্ধ করে দিলে Gas আর Air মিশতে পারে না।
- cooling method এর ক্ষেত্রে পানি ব্যবহার করা হয়।

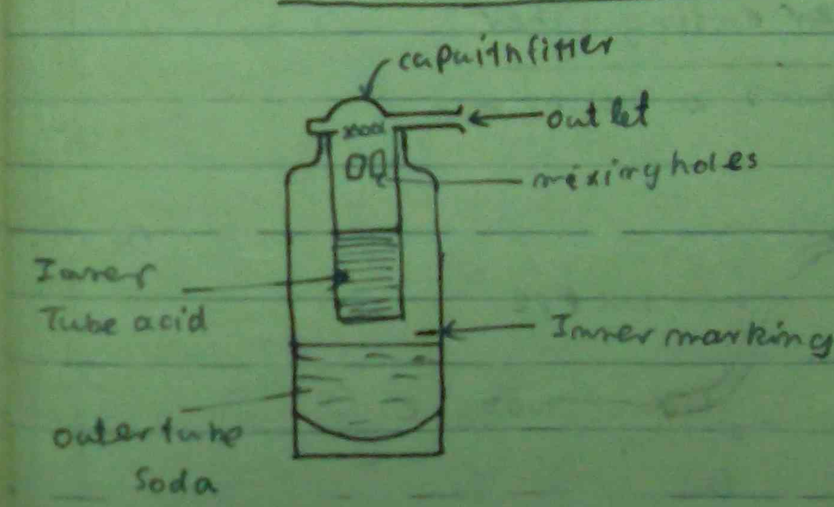


To prevent the Fire

(i) Cleanliness
(ii) Vigilance
(iii) common sense

vigilance - ~~not~~ watch fullness (সতর্কতা)
common sense = ভালো বুদ্ধি

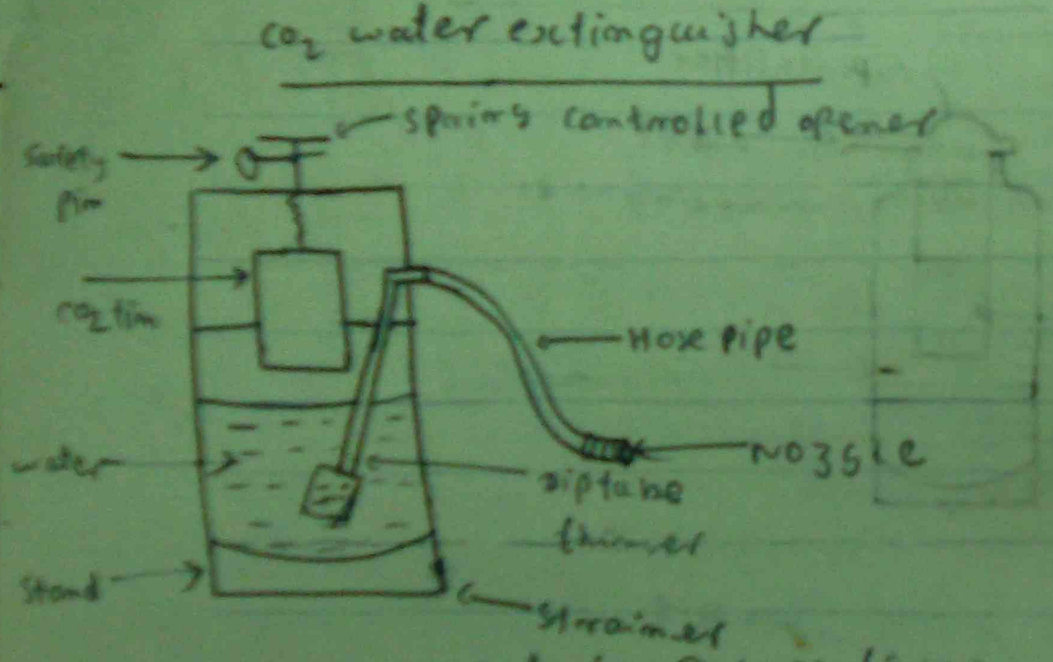
Soda acid Extinguisher



① construction.
② content
③ operation
④ performance

Hydraulic test of 250 on ⊖ of ×(∨ ⅋
at last pressure must be 300 psi
only for Ⓐ Fire (solid)
don't use for Ⓑ and Ⓒ Fire
Liquid expelled type

CO_2 water extinguisher



only for Ⓐ type fires
Don't use for Ⓑ and Ⓒ
liquid expelled type

PASSENGER MANIFEST

OWNER OR OPERATOR: BURMA AIRWAYS CORPORATION FLIGHT No _____ DATE _____

POINT OF EMBARKATION _____ POINT OF DISEMBARKATION _____

NAME OF PASSENGER	TKT. No.	I/R.	REG.	EB	TAG No.	PAX. WG.	REMARKS

KN 36

Maung Kyaw Naing

Final Year Electrical Power

Electrical Estimating

① ગણતરી કરો: નીચેની Electrical installation ના 250 Light Points
* (each 60watt) 100 Fan Points (each 40watts) ની. નીચેની માહિતી
ની. મી ના 24 hr માટે: 6 hour ની માહિતી પરથી: માંગેલ: ગણતરી
જેમ (1) Daily Load factor (2) maximum demand (3)
Demand Factor ની. મી ગણી ॥

10 fan 50 lights from 6 AM to 7 AM
60 fan from 7 AM to 9 AM
100 fan 9 AM to 4 P.M
30 Fans 4 PM to 7 P.M
20 Fan 50 light from 7 P.M to 8 P.M
20 fan, 200 light from 8 P.M to 10 P.M
10 fan, 75 light from 10 P.M to 12 MN

10 fan, 50 light - $10 \times 40 \times 1 + 50 \times 60 \times 1 = 3400$ Kwh
50 fan, $50 \times 40 \times 2 = 4000$ Kwh
100 Fan $100 \times 40 \times 7 = 28000$ Kwh
30 Fan $30 \times 40 \times 3 = 3600$ Kwh
20 fan 50 light - $20 \times 40 \times 1 + 50 \times 60 \times 1 = 3800$ Kwh
20 fan 200 light - $20 \times 40 \times 2 + 200 \times 60 \times 2 = 25600$ Kwh
10 fan 75 light - $10 \times 40 \times 2 + 75 \times 60 \times 2 = 9800$ Kwh

78200 Kwh

2 maximum demand = ~~780~~ 12800 Kwatts
Load factor = $\frac{\text{Unit generated}}{\text{max} \times \text{time}} = \frac{78200}{12800 \times 24} = \frac{78200}{307000} = .255$
$= 25.5\%$

Demand Factor = $\frac{\text{connected load}}{\text{maximum demand}}$

$= \frac{250\times60+100\times40}{12500}$

$= \frac{19000}{12500} = 1.485$

Demand Factor = $\frac{\text{maximum demand}}{\text{connected load}}$

$= \frac{12500}{19000} = .674$

Turbine power hp output.

$= 3\times10^6 \times 10$ lb x h ft /hr

$= 3\times10^7 \times h$ ft-lb/hr

$= \frac{3\times10^7 \times h}{3600}$ ft-lb/sec

$= \frac{3\times10^7 \times h}{550\times3600}$ HP

$= \frac{3\times10^7 \times h \times 746}{550\times3600}$ kw

$\therefore \frac{1.5\times10^3}{8760} = \frac{3\times10^7 \times h \times 746}{550\times3600\times10^3}$

$h = \frac{.5\times550\times3600}{8760\times746}\times10^3 = \frac{1800\times550}{6540000}\times1000$

$= \frac{990000}{654} = 151.2$ ft

Head: 25×10^6 gal/min ft

$= \frac{25\times10^7\times151.2\times746}{550\times3600\times10^3}$

$= \frac{3735\times746\times10^7}{1980\times10^6} = \frac{2785000\times10^7}{1980\times10^6}$

$= 1425\times10$

$= 14250$ kw

[illegible] 1.5×10^3 kwh [illegible]

3×10^6 gal/hr [illegible]

[illegible] Turbine house [illegible]

[illegible] gal/min [illegible]

[illegible] $\frac{1.5\times10^3 \text{ kwh}}{8760 \text{ hr}}$

$= \frac{\text{[illegible]}\times15000000}{8760} = 1712$ Kw

③ ಕೆಳಗಿನ ಉದಾಹರಣೆಯಲ್ಲಿ maximum demand ಮತ್ತು 15000 kW ಆಗಿದೆ, load factor 30% ಮತ್ತು ಪ್ರತಿ ಕೆಳಗಿನ ಉದಾಹರಣೆಯಲ್ಲಿ typical demand factor ಮತ್ತು connected load ಆಗಿದೆ ಮತ್ತು ಪ್ರತಿ ಕೆಳಗಿನ ಉದಾಹರಣೆಯಲ್ಲಿ annual energy ಮತ್ತು diversity factor ಆಗಿದೆ

S/S a	demand factor	0.65	connected load	8000 kW
b	"	0.6	"	7500
c	"	0.7	"	9000

$$\text{Demand factor} = \frac{\text{maximum demand}}{\text{connected load}}$$

$$\text{ಅಥವಾ Demand factor} = \frac{\text{maximum demand}}{\text{connected load}}$$

(A) Maximum demand = Demand factor × connected load

$$= .65 \times 8000$$

$$= 5200 \text{ kW}$$

(B) $m_2 = .6 \times 7500$

$$= 4500 \text{ kW}$$

(C) $m_3 = .7 \times 9000$

$$= 6300 \text{ kW}$$

$$\text{Diversity factor} = \frac{\text{sum of individual M.D}}{\text{M.D of entire group}}$$

$$= \frac{5200 + 4500 + 6300}{15000} = \frac{16000}{15000}$$

$$= 1.066$$

$$= \text{load factor} = \frac{\text{Unit generated}}{\text{maximum demand} \times \text{hours not time}}$$

$$\text{U.G} = .3 \times 15000 \text{ kW} \times 8760$$

$$= 4500 \times 8760$$

$$= 39400000 \text{ kWh} \quad 39400 \times 10^3$$

39400 mu.

✓

④ ಇಲ್ಲಿ ಅವಶ್ಯಕತೆಗಳು ಏನಾದರೂ ಇದ್ದರೆ ಅದನ್ನು supply system ಎಂದು ಕರೆಯಲಾಗುತ್ತದೆ.

(a) H.V supply ಗಾಗಿ ಆಗುವ US 48/kVA of MD/annum + 1.5 P/unit

(b) L.V supply ಗಾಗಿ ಆಗುವ US 50/kVA of MD/annum + 1.8 P/unit

H.V supply ಗಾಗಿ T.R, switch gear ಗಾಗಿ ಆಗುವ cost ಅನ್ನು US 35/kVA ಕೊಡಬೇಕು. full load ನಲ್ಲಿ T.R ನ losses 2% ಕೊಡಬೇಕು. H.V ಗಾಗಿ annual fixed charge ಅನ್ನು capital cost ನ 25% ಕೊಡಬೇಕು. ಅಂದರೆ ಎಷ್ಟು full load 100 ಗಂಟೆಗಳು ಪ್ರತಿ ಕೆಲಸದ ದಿನಗಳು 50 weeks 1 week ನಲ್ಲಿ 36 ಗಂಟೆಗಳು ಬರುವಂತೆ ಇದ್ದರೆ ಅದನ್ನು supply system ಎಂದು ಕರೆಯಲಾಗುತ್ತದೆ.

ഒരു മാസത്തെ unit: = 100 KW x 50 x 36 hrs
= 5000 x 36
= 180000 KWh

H.V supply

input = 180000 / .98 = 183500 KWh

input = 100 / .98 = 102 KW
KVA ൽ വേണ്ടത് = 102 / 1 = 102 KVA

KVA ക്കുള്ള charge = 43 x 102 = 4400 /-
KW ക്കുള്ള charge = 1.5 / 100 x 183500 = 2750 /-

ഒരു മാസത്തെ മൊത്തം charge = 85 x 102 = 3570 /-
ഈ തുകയുടെ annual fixed charge = 25/100 x 3570 = 893 /-

Total cost = 4400 + 2750 + 893 = 8043 Rupees

L.V supply

KVA ക്കുള്ള charge = 100 x 50 = 5000 /-
KW ന് = 1.9 / 100 x 120000 = 2240
= 8240 /-

L.V മോട്ടോറുടെ power factor 1 ആയി എടുക്കുന്നു

✓
⑤ ഒരു ഗ്രാമത്തിലെ ഗാർഹിക വൈദ്യുതി ആവശ്യത്തിന്റെ Tariff കണ്ടെത്തുക:
Jan 1979
ജനുവരി H.V supply ഉള്ള ഒരു ഗാർഹിക ഉപഭോക്താവിന് KS KS/KVA MD/annum
1.5 Rupees/unit L.V supply ഉള്ള ഒരു ഗാർഹിക ഉപഭോക്താവിന് KS 0/KVA MD/annum
1.8 Rupees/unit H ഉപയോഗിക്കുന്ന T.R. switch, gear തുടങ്ങിയവയുടെ
മൊത്തം cost ന്റെ ഏകദേശം 35/KVA ന് F.L ഉള്ള T-R loss
2% നും H.V plant ഉള്ള annual fixed charge
ഏകദേശം ~~capital~~ capital cost ന്റെ 25% നിരക്കിലാണ്.
ഒരു വർഷം FL ൽ, ഏകദേശം 50 weeks ഗാർഹികോപയോഗത്തിനായി ഒരു ദിവസം
ഏകദേശം 2 മണിക്കൂർ working hour ഉണ്ടെന്ന് കണക്കാക്കുന്നു.
ഒരു വർഷം: FL = 100 KW unity P.f
ഒരാഴ്ചയിൽ 6 ദിവസം, working hour = x hrs ആണെന്ന് കരുതുക.
ഒരു വർഷത്തെ unit = 100 KW x 50 x = 5000 x KWh
H.V system ന്: ചെലവ്

I/P KVA = 5000x / .98 = 5100x KVA

ഓരോ ഭാഗത്തിന്റെയും = 5100x x 45
= 229500x /-

MD = 100 / .98 = 102 KW

MD ക്കുള്ള ഓരോ ഭാഗത്തിന്റെയും = 1.5 / 100 x

MD = 100 / .98 = 102 KW
KVA ൽ വേണ്ടത് = 102 / 1 = 102 KVA

ഓരോ ഭാഗത്തിന്റെയും (MD) = 5100x x 102 x 45
= 4590 /-

ഒരു unit ന്റെ: ഒരു ഓരോ ഭാഗത്തിന്റെയും = 5100 x KWh x 1.5 / 100
= 76.5 x Rupees

T.R switch এর বছর cost = 35×102
= 3570 টা

annual fixed charge = $\frac{25}{100} \times 3570 = 893$ টা

Total cost = 893 + 4590 + 76.5x Rs
= 76.5x + 5483 Rs

L-V supply বিভাগ

সরবরাহ সংযোগ = 100 × 50 = 5000 টা

মোট চাহিদা: প্রতি সংযোগ = 500W × $\frac{1.8}{1kW}$
= 90x

∴ Total = 90x + 5000 Rs

প্রতিযোগিতা বিন্দুতে আয় ব্যয় সমান —

76.5x + 5483 = 90x + 5000
13.5x = 483
x = 35.7 = 36 km (approx)
সুতরাং: 36 km দূরে হবে।

1981 Final Exam

⑥ সমস্যা: একটি বৈদ্যুতিক সরবরাহ কোম্পানি: প্রতিদিন সর্বোচ্চ load 1500kW 0.8 pf lagging ভিত্তিতে, মোট চাহিদা: 20 জন গ্রাহক মোট সংযোগ নিয়েছেন: মোট 100 kW demand pf সমান: বিল ধার্য: প্রতি মাসে Tariff হবে (a) প্রথম 200 kVA of max demand প্রতি Rs 1.20/kVA
(b) পরবর্তী 300 " Rs 1.10/kVA
(c) অতিরিক্ত 500 " Rs 1.00/kVA
(d) kWh মিটারিং of max demand প্রতি Rs 0.9/kVA
(e) প্রথম 150 kWh/kVA of max demand/month প্রতি 0.3p
পরবর্তী 150 kWh/kVA of month প্রতি 0.6p
বাকি: প্রতি kWh এবং power factor সংশোধন: প্রতি kVA সমান মূল্যহ্রাস: 3% হারে pf 0.8 থেকে 0.95 করা। কিন্তু: বিনামূল্যে Rs 100/month পর্যন্ত, Loss free capacitor প্রথমে ব্যবহার করবে। সুতরাং সর্বনিম্ন মূল্যে কত kVA ক্ষমতার capacitor ব্যবহার করা যাবে?

~~0.8 pf এ~~ 0.8 pf এ kVA = $\frac{1500}{0.8}$ = 1875 kVA

pf 1 এ kVA = $\frac{100}{1}$ = 100 kVA

∴ Total kVA = 1875 + 100 = 1975 kVA

প্রথম 200 kVA এর = 1.20 × 200 = 240 Rs
পরবর্তী 300 " = 1.10 × 300 = 330 "
বাকি 500 " = 1.00 × 500 = 500 "
বাকি (1975 − 1000) = .9 × 975 = 877.5 "
1947.5 Rs

Power factor 1500 kW × 8×20 hr
= 1500 × 160 kWh
= 240000 kWh

Lighting factor = 100 watt = 0.1 kW
Fan if 10 no's for 24 hr

Total = 20×8 + 10×24
= 360 + 240 = 600 hrs
Energy = 600 × 100 = 60000 kWh

case Power 180 kWh - 1 kVA = .7 pf
240,000 — ? = 240,000 kVA
180

Cost = $\frac{240,000}{180} \times .7 = \frac{168000}{180} = \frac{160}{180}$
= 9.33%

Energy 180 kWh - 1 kVA = .6 pf
60000 — ? = $\frac{.6 \times 60000}{180}$
= $\frac{36000}{180}$ pf
= $\frac{360}{180}$ = 2%

case 240,000 kWh = $\frac{240,000}{.8}$ = 300,000 kVA

180 kWh / kVA of MD / month = .7 pf
In 1 MD 1 kVA of 180 kWh Energy .7 pf cost 6 rs
" 1875 " 240000 — ? = $\frac{7}{10} \times 1875 \times \frac{240000}{180}$ rs
= 28 × 625 = 17500%

180 kWh / kVA of MD / month = .6 pf
In 1 MD 1 kVA of 180 kWh Energy .6 pf cost 6 rs
— 100 — 600,00 — ?
= $\frac{6}{100} \times \frac{60000}{180} \times 1$ = 200%

∴ Total cost = 200 + 17500 + 1447.5 = 19647.5%
pf .95 of — kVA = $\frac{1500}{.95}$ = 1580

Demand = Energy = 240 + 330 + 500 + (1580 − 1000) × .9
= 1070 + 580 × .9
= 1592%

In 1 kVA — 180 kWh — .7 pf
— 1580 — 1400,00 — ? = $\frac{.7 \times 240000 \times 1580}{180}$
= $\frac{7}{10} \times \frac{24000 \times 1580}{18}$ = 28 × 826
= 14720%

~~[illegible] = 1657.5 + 13200 ——— 17 so.~~

~~[illegible]~~ = 1500 + 1447.5 − (1320 + 1972.5 + 100)

= ~~4200 + 1447.5 − 100~~

= ~~4447.5 − 100~~ = ~~2380~~ /

(7) [illegible] generating cost / unit

minimum reversed capacity of the station [illegible]

installed plant capacity 150 mw Annual load factor 60% capacity factor 50%, capital cost Rs 150×10^6 ~~[illegible]~~ annual cost of load oil, taxation wages salaries = Rs 18.5×10^6, rate of interest and dep: 10%, units consumed by station Auxiliaries = 5%.

Load factor = $\frac{\text{average load}}{\text{maximum demand}}$ ~~capacity factor~~ ~~M.D~~ connected Load

Capacity factor = $\frac{\text{average load}}{\text{installed capacity}}$

average Load = capacity factor × installed capacity

= .5 × 150

= 75 mw

MD = $\frac{\text{average load}}{LF} = \frac{75}{.6} = 125$ MW

Unit generated = ?

Load factor = $\frac{\text{unit. generated}}{\text{maximum} \times \text{length of time}}$

$.6 = \frac{\text{unit generated}}{125 \times 10^3 \times 8760}$

unit generated = $.6 \times 125 \times 8760 \times 10^3$ units

= $75 \times 8760 \times 10^3$

= 657000×10^3 units

= 657×10^6 units

[illegible] consumer [illegible] unit = $.95 \times 657 \times 10^6$

= 625×10^6 units

interest and dep: = $\frac{1}{10} \times 150 \times 10^6$ = 15×10^6 Rs

taxation wages salaries ——— = 18.5×10^6

33.5×10^6 Rs

cost / unit = $\frac{33.5 \times 10^6}{625 \times 10^6} = \frac{3350}{625} = 5.36$ P/unit

Reversed capacity = 150 − 125 = 25 mw

(8) maximum demand 50000kw ခန့် ရှိသည့်စက်ရုံတစ်ရုံသည် load factor 50% ဖြင့် လည်ပတ်နေသည်။ ထိုစက်ရုံသည် 8760 kwh ကို P/s တစ်ခုတွင် ထုတ်လုပ်ပေးသည်ကို တွက်ချက်ပါ။
Steam Power station သည် ဓာတ်အားတစ်ခုလျှင် 50p/kwh ခန့် ကုန်ကျပြီး အခွန်အတွက် 0.5d/kwh ပေးဆောင်ရသည်။ Thermal efficiency = 25% interest and depreciation 12% , 1kwh = 3409 Btu ဖြစ်ကြောင်း၊ coal ၏ calorific value = C.V = 14000 Btu/lb ဖြစ်ကြောင်း တွက်ပြီး 1 ton coal ခန့်ဖြင့် မည်သည့် ဓာတ်အားပမာဏ ထုတ်လုပ်နိုင်သည်ကို တွက်ပါ။

Load factor = $\frac{\text{unit generated}}{\text{maximum demand} \times \text{Length of time}}$

unit generated = $.5 \times 50000 \times 8760$
$= 25000 \times 8760$
$= 219,000,000$ kwh

capital cost = $50 \times 500,00 = 2500000$ £
interest & dep:- $= 2500000 \times .12 = 300,000$ £
coal cost = $\frac{.5}{240} \times 219 \times 10^6 = 3 \times 10^5$ £
$= \frac{219}{480} \times 10^6$
$= .456 \times 10^6 = 4.565 \times 10^5$ £
Total cost = $(3 + 4.565) \times 10^5$
$= 7.565 \times 10^5$ £

$1/p = \frac{219 \times 10^6}{.25} = 876 \times 10^6$ kwh
$= 876 \times 10^6 \times 3409 = 2900000 \times 10^6$
$= 290 \times 10^{10}$ Btu
lb coal = $\frac{290 \times 10^{10}}{11 \times 10^3} = 26.4 \times 10^7$ lb
ton coal = $\frac{264,000,000}{2240} = 117800$ tons
$= 1.178 \times 10^5$ tons
1 ton ဖြင့် ထုတ်လုပ်နိုင်သည့် ပမာဏ = $\frac{7.565 \times 10^5}{1.178 \times 10^5} = 6.42$ £

(9) Two system of tariff are available for a factory working 8 hrs in a day for 300 days in a year. (a) H.v supply at rs 4.5/month/kVA of MD + 5 pas/unit (b) L.v supply at rs 5/month/kVA of MD + 5.5 pas/unit
The factory has an average load of 200kw at 0.8 pf and max: Demand of 250kw at the same pf. H.v equipment cost rs 50/kVA and losses can be taken 4% inst & dep: 12% calculate the difference in cost between the two system.

Unit consumed = 200 × 8 × 300
= 480000 kWh

LV supply ಗೆ ಬಿಲ್: ಪೈಸೆ

unit ಗೆ ಬರುವ ವೆಚ್ಚ = 5.5/100 × 480000
= 26400 Rs

maximum demand = 250/0.8 = 312.5 kVA

maximum demand ಗೆ ಬರುವ ವೆಚ್ಚ = 312.5 × 5
= 1562.5 Rs

Total cost = 26400 + 15625 × 12 ⟸ for year
= 279625 Rs
45150 Rs

H.V supply ಗೆ ಬಿಲ್: ಪೈಸೆ

maximum demand ಗೆ ಬರುವ ವೆಚ್ಚ = 4.5 × 312.5/0.96
= 1464/0.96 Rs

If Energy = 480000/0.96 = 5000000 Rs

unit ಗೆ ಬರುವ ವೆಚ್ಚ = 5/100 × 5000000

= 25000 Rs

HV equipment cost = 50 × 312.5/0.96 = 15625/0.96 Rs
inst & dep = .12 × 15625/0.96
= 1875/0.96
Total cost = 25000 + 1875 + 1406.25 × 12 / 0.96
= 48765 Rs
difference = 48765 − 47062.5 = 3702.5 Rs
= 45150 − 44900 = 250 Rs

(10) Base load station ಅಂದರೆ ಹೆಚ್ಚಿನ installed capacity ಇರುವ (18mw) ಸ್ಥಾವರ ಅಥವಾ ಯಾವಾಗಲೂ ಹೆಚ್ಚಿನ ಲೋಡ್ ಇರುವ ಸ್ಥಾವರ. stand by station ಅಂದರೆ installed capacity 20mw ಇದ್ದು 8mw load ಸಪ್ಲೈ ಮಾಡುವ ಸ್ಥಾವರ. station ಇಂದ ಅಂತರ 2500m ಇರುವ interconnection ಮಾಡಲಾಗಿದೆ. base load station ನ annual output 125×10^6 kWh, stand by station ನ annual output 7.5×10^6 kWh ಆಗಿರುತ್ತದೆ. station ನ annual load factor, Plant capacity factor ಮತ್ತು Plant used factor ಅನ್ನು ಕಂಡುಹಿಡಿಯಿರಿ

Base load station ನ capacity factor = Average load / install capacity × Length of line / Length of line

= 1 / install capacity × Length of line / Length of line

capacity factor = $\frac{125 \times 10^6}{18 \times 10^3 \times 8760}$

= 125000/157800 = .793

Standby station or capacity factor = $\frac{7.5 \times 10^6}{20 \times 10^3 \times 2500}$

$= \frac{7.5 \times 10^6}{50 \times 10^6}$

$= .15$

annual load factor = $\frac{\text{unit generated}}{\text{maximum demand} \times \text{length of time}}$

Base load station ~~for~~ or

Annual L.F = $\frac{125 \times 10^6}{80 \times 10^3 \times 8760}$

$= \frac{125000}{8760 \times 8} = \frac{125000}{701000} = .178$

Standby station ~~for~~ or

Annual L.F = $\frac{7.5 \times 10^6}{10 \times 10^3 \times 2500}$

$= \frac{75 \times 10^6}{25 \times 10^6} = .3$

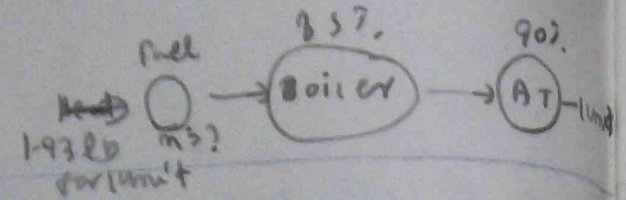
Plant used factor = $\frac{\text{Unit generated (Plant used unit gen:)}}{\text{maximum demand} \times \text{length of time}}$

2500 hr ~~for~~ or ~~for~~ Length of time = 2500

maximum demand = 20×10^3 kw

~~Pub~~ = Puf = $\frac{7.5 \times 10^6}{20 \times 10^3 \times 2500} = \frac{7.5}{50} = .15$

(11) ~~62~~ ~~for~~ ~~for~~ ~~for~~ generating station ~~for~~ ~~for~~ ~~for~~



(11) 1 unit के लिए आवश्यक coal = 1.93 lb

Load factor = $\frac{\text{unit generated}}{\text{maximum demand} \times \text{length of time}}$

unit generated = load factor × Maximum demand × Length of time

= .4 × 20,000 × 8760

= 8000 × 8760

= 70100000 kwh

~~70100000~~ unit के लिए coal = 701 × 10^5 × 1.93

= 1352 × 10^5 lb

ton में coal = $\frac{1352 \times 10^5}{2240}$ = .604 × 10^5

= 60400 ~~kg~~ ton

coal cost = 60400 × 30

= 1812000 rs

1 unit के लिए required 1.93 lb

~~1.93 × fuel के I/P~~

Input of Boiler = $\frac{1 \text{ unit}}{.765}$ = 1.308 unit

1.93 lb — 11500 × 1.93 Btu → $\frac{11500 \times 1.93}{3440} = \frac{22200}{3440}$

Thermal Effy = ~~6.45~~ $\frac{1.308}{6.45}$ = 6.45

= 20.25%

(12) Load factor = $\frac{\text{unit generated}}{\text{maximum demand} \times \text{length of time}}$

unit generated = load factor × maximum demand × length of time

= .3 × 25000 × 8760

= 7500 × 8760

= 6570,0000 kwh

आवश्यक coal per year = 657 × 10^5 × 2.55 = 1675 × 10^5 lb

ton में coal = $\frac{1675 \times 10^5}{2240}$ = .748 × 10^5 tons

coal bill for year = .748 × 10^5 × 500

= 374 × 10^5 rs

I/P of fuel = $\frac{1 \text{ unit}}{.765}$ = 1.308 unit

1 unit के लिए 2.55 lb = 2.55 × 11500 = 29350 Btu

kwh में coal = $\frac{29350}{3440}$ = 8.53 kwh

Thermal Effy = = $\frac{1.308}{8.53}$ = .1532 = 15.32%

A diesel generating set supplies an output of 2 MW
the calorific value of fuel oil used is 11500 kcal
r kgms. If the thermal effy: of the unit is 35%
) calculate the mass of oil required / hr
) The energy generated / ton of the fuel
(1 ton 1000 kgm)

[illegible] Reservoir & Turbine house [illegible]
[illegible] 4.5×10^10 kgm Hydraulics System [illegible] Head loss 30
[illegible]: station [illegible] overall effy: 85% [illegible]
generation station bus bar [illegible] energy [illegible]
[illegible] maximum demand 45 MW [illegible] supply [illegible]
[illegible] stock [illegible] 2 [illegible]: 616 [illegible] steel pipe [illegible] dia [illegible]
[illegible] 2 [illegible]: [illegible] [illegible]

$= 45\times10^{10}$ kgm / year

H = [illegible] = 230 − 30 = 200 meter / year

∴ [illegible] = $45\times10^{10}\times200$ kgm-meter / year
$= 9000\times10^{10}$ kgm-meter / year

1 lb = 453.6 gm = .4536 kgm
1 ft = .3048 meter
∴ 1 ft-lb = .4536 × .3048 = .1381 kgm-meter

[illegible] $= 45\times10^{10}$ kgm $= 45\times10^{3}\times10^{10}$ gms $= 45000\times10^{10}$ gms

$\text{lbs/year} = \frac{45000\times10^{10}}{453.6} = 99.4\times10^{10}$ lb

$\text{ft}^3/\text{year} = \frac{99.4}{62.5}\times10^{10} = 1.59\times10^{10}$ ft³/year

31.5×10^{6} ft³/year = 1 cusec
1.59×10^{10} ——— ? $= \frac{1.59\times10^{10}}{31.5\times10^{6}} = 505$ ft³ cusec

$Hw = \frac{\text{cusec}\times h}{11.8}\times\text{effy}$: $h = 230-30 = 200$ meter

$= \frac{505\times200\times100}{11.8\times12\times2.54}\times.85$

$= \frac{505\times200{,}00\times.85}{11.8\times30.48} = \frac{10100{,}000\times.85}{360} = \frac{8585000}{360} = 23850$ H.P

45 MW supply

$45\times10^{3} = .85\times\frac{\text{cusec}\times h}{11.8}$

$45000 = .85\times\frac{\text{cusec}\times200\times100}{11.8\times30.48}$

$\text{cusec} = \frac{45000\times11.8\times30.48}{200{,}00\times.85} = \frac{5324000\times30.48}{17000} = \frac{16200000}{17000}$
$= 953$ ft³/sec

$V = \sqrt{2gH}$

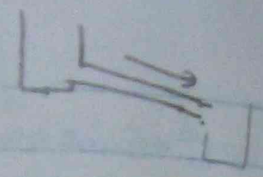
$V = \sqrt{2\times32.2\times\frac{200\times100}{30.48}} = \sqrt{64.4\times656} = \sqrt{42250} = 205.5$ ft/sec

$Q = A\times V\times2$

$953 = 205.5\times2\times\frac{\pi}{4}\times d^2$

$d = \sqrt{\frac{953}{411\times.7854}} = \sqrt{\frac{953}{322.5}} = \sqrt{2.95} = 1.717$ ft
or $1.717\times30.48 = 52.4$ cm

$Q = AV$



$Q = A \times V$

$\cdot 3048 \times \frac{1330}{\cdot 85}$ cu ft/sec $= \frac{\pi}{4} \times d^2 \times V$ ft/sec

$H = \frac{v^2}{2g}$ $\cdot 3048$ meter = 1 ft

$200 - \frac{202}{\cdot 3048}$

$V = \sqrt{2gH}$

$= \sqrt{2 \times 32.2 \times 200 \div \cdot 3048}$

$= \sqrt{400 \times 32.2 \div \cdot 3048}$

$= 20 \times \frac{5.68}{\sqrt{\cdot 3048}} = \frac{103.8}{\cdot 552}$ ft/sec

$\frac{\cdot 3048 \times 1330}{\cdot 85} = \cdot 7854 \times d^2 \times \frac{103.8}{\cdot 552}$

$d^2 = \frac{\cdot 552 \times 1330 \times \cdot 3048}{\cdot 85 \times 81.6} = \frac{16.3 \times \cdot 552 \times \cdot 3048}{\cdot 85}$

$d = \sqrt{16.3 \times \cdot 552} = \sqrt{9} = 3'$

$d = \sqrt{16.3 \times \cdot 552 \times \cdot 3548} = \sqrt{16.3 \times 1498} = 1.79$

(15) A hydro P/s has a catchment area of 2558 sq-mile and the runoff is 70%. The average annual rainfall is 48" & head 6500 ft. Find the available power if the over all η 80%.

sq-mile-ft $= 25 \times \frac{48}{12} \times \cdot 7$

$= 25 \times 2.8$

$\Rightarrow$ 70 sq-mile-ft/year

1.13 sq-mile ft/year = 1 cu-sec

70 ? $= \frac{70}{1.13} = 62$ cu-sec

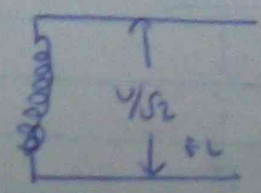
$\eta_w = \frac{\text{cu-sec} \times \text{head of water}}{11.8} \times \text{efficiency}$

$= \frac{62 \times 6500}{11.8} \times .9 = \frac{93000}{11.8} \times .8$

$= \frac{403000}{11.8} = 27300$ hw o/p

o/p = ~~$8 \times 78720 = 63$ lakh kW~~

(16) Load 25000 kw over head 2 wire system of, max 1% loss in copper of wire. Find cross sectional area of wire if 1ϕ 2 wire system, 3ϕ 3 wire system, supply voltage & line voltage & losses constant for 3ϕ system. Supply voltage & load of each unit = units



$I = \frac{W_1}{E \cos\theta} = \frac{W_1}{\frac{V}{\sqrt{2}} \times 1} = \frac{\sqrt{2} W_1}{V}$

$\frac{P}{2} = I^2 R$

$\frac{P}{2} = \frac{2 W_1^2}{V^2} \times \frac{\rho \times 2L}{A}$

$P = 8 \frac{W_1^2 \times \rho L}{V^2 A} \frac{100}{\eta_1}$ — (1)

$I = \frac{W_2}{\sqrt{3} E \cos\theta} = \frac{W_2}{\sqrt{3} \times \frac{\sqrt{3} V}{\sqrt{2}} \cos\theta} = \frac{\sqrt{2} W_2}{3 V \cos\theta}$

$\frac{P}{3} = I^2 R \rightarrow P = \frac{2 W_2^2}{V^2} \times \rho \frac{L}{A} = \frac{\sqrt{2} W_2}{\sqrt{3} V}$

$$\% \text{ loss} = \frac{8 w_1^2 \rho L}{V^2 A} \times \frac{1}{4}$$

$$P = \frac{2 w_2^2 \rho L}{V^2 A} \qquad \% \text{ loss} = \frac{2 w_2^2 \rho L}{V^2 A} \times \frac{1}{100}$$

losses are equal

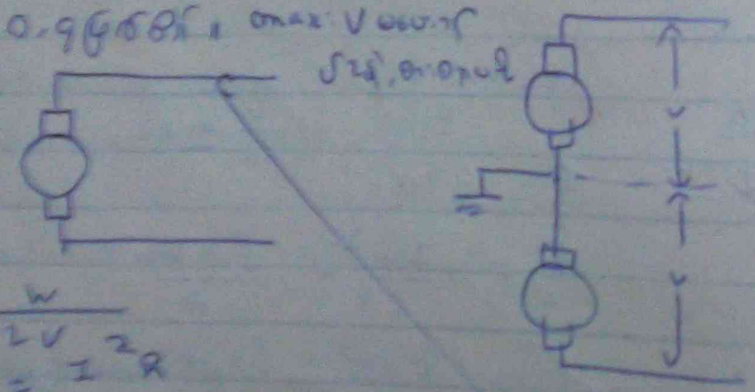
$$\frac{8 w_1^2 \rho L}{V^2 A} = \frac{2 w_2^2 \rho L}{V^2 A}$$

$$4 w_1^2 = w_2^2 \qquad 2 w_1 = w_2$$

$$w_2 = 2 \times 25000$$

$$= 50,000 \text{ watts}$$

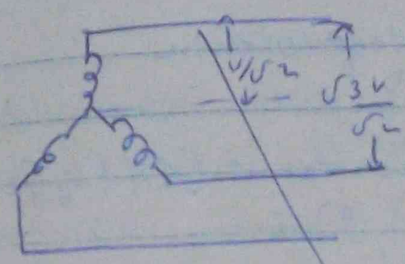
(17) DC 2 wire system mid point earthed, outer wire 6V
ક્યારેક ગામડાઓમાં મોટા વિસ્તારમાં AC 3 ફેઝ 4 wire
ફીડર supply આપવામાં આવે છે. load ની બાજુમાં consumer
ની બાજુમાં losses ની ગણતરી બેલેન્સ લોડ ઉપર છે. AC ના power
factor = 0.9 ધારવામાં આવે છે.



$$I = \frac{w}{2V}$$

$$\frac{P}{2} = I^2 R$$

$$P = 2 \times \frac{w^2}{4V^2} \times \frac{\rho \times 2l}{A} = \frac{w_1^2 \rho l}{V^2 A}$$ ... (1)



$$I = \frac{w}{\sqrt{3} E \cos\theta} = \frac{w}{\sqrt{3} \times \frac{\sqrt{3} V}{\sqrt{2}} \cos\theta}$$

$$= \frac{\sqrt{2} w}{3 V \cos\theta}$$

$$\frac{P}{3} = I^2 R$$

$$P = 3 \times \frac{2 w^2}{9 V^2 \cos^2\theta} \times R = \frac{2}{3} \frac{w^2 R}{V^2 \cos^2\theta}$$

$$= \frac{2}{3} \frac{w^2}{V^2 \cos^2\theta} \frac{\rho \times l}{A}$$

$$P = 2 \frac{w^2}{V^2 \cos^2\theta} \frac{\rho l}{A}$$

$$\therefore \frac{w_1^2 \rho L}{V^2 A} = \frac{2 w_2^2 \rho L}{V^2 \cos^2\theta A}$$

$$w_1^2 \cos^2\theta = 2 w_2^2$$

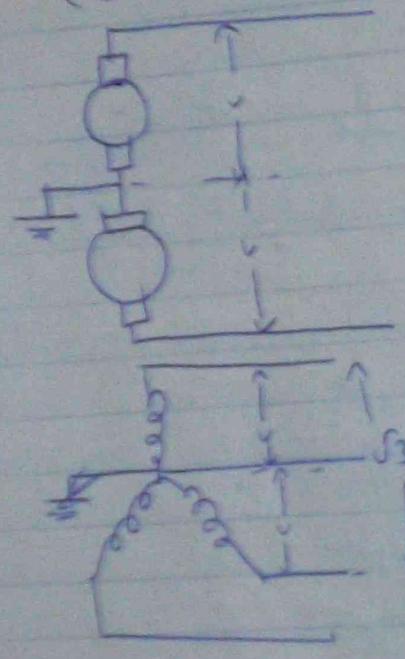
$$w_1 \cos\theta = 1.4142 w_2$$

$$w_1 \times \frac{.9}{1.4142} = w_2$$

$$w_1 =$$

[...]

① mid point earth এর - Voltage to earth
② Vonx এতটুকু
③ efficiency বেশি, loss exist করে
④ % loss কম 100% এর কাছাকাছি



$I = \frac{W}{2V}$

$P_2 = I^2 R$

$P = \frac{8 W^2}{4V^2} R = \frac{W^2 R}{2V^2}$

$I = \frac{W}{\sqrt{3} E \cos\theta}$

$= \frac{W}{\sqrt{3} \times \sqrt{3} V \cos\theta} = \frac{W}{3V\cos\theta}$

$P = 3 I^2 R$

$= 3 \times \frac{W^2}{9V^2\cos^2\theta} \times R$

$= \frac{W^2 R}{3V^2\cos^2\theta}$

$\eta \sim W_1$ এর $= \frac{W_1^2 R}{2V^2}$

$100 \text{ ——— } 2 = \frac{W_1^2 R}{2V^2} \times \frac{100}{W_1} = \frac{W_1 R \times 100}{2V^2}$

$\eta \sim W_2$ এর $\frac{W_2^2 R}{3V^2\cos^2\theta}$

$100 \text{ ——— } 2 = \frac{W_2 R}{3V^2\cos^2\theta} \times 100$

% loss সমান $\frac{W_1 R \times 100}{2V^2} = \frac{W_2 R}{3V^2\cos^2\theta} \times 100$

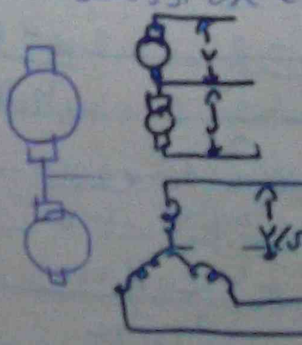
$\frac{W_1}{2} = \frac{W_2}{3 \times .81}$

$1.215 W_1 = W_2$

$\therefore \eta \sim W_1$ এর $.215 W_1$ কম

$100 \text{ ——— } ? = 21.5\%$ কম

(18) DC 3 wire system এর 2 wire এর outer wire এর cs.A এর কত গুণ হলে line এ AC 3ϕ wire PF 0.9 lagging হলে same power % এর ক্ষেত্রে system এর power % এর কত গুণ হবে। 4 তারের ক্ষেত্রে same max. voltage to earth same transmission efficiency.



$P = 2 I^2 R$ $\quad I = \frac{W_1}{2V}$

$P = 2 \times \frac{W_1^2}{4V^2} R = \frac{W_1^2 R}{2V^2}$ ——— ①

$P = 3 I^2 R$ $\quad I = \frac{W_1}{\sqrt{3} \times \frac{\sqrt{2}V}{\sqrt{2}} \times 4} = \frac{\sqrt{2} W_1}{2.7V}$

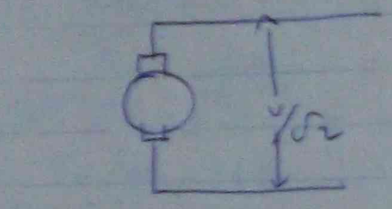
$P = 3 \times \frac{2 W_2^2}{2.7 \times 2.7 V^2} R$

$P = \frac{2 W_2^2}{2.43 V^2} R$ ——— ②

$\frac{W_1^2 R}{2V^2} = \frac{2 W_2^2 R}{2.43 V^2}$ $\quad W_1^2 = \frac{4}{2.43} W_2^2$ DC 3 wire এর 2 এর কত গুণ

$W_1 = 1.28 W_2$

(19) load 25000 ဖြစ်ရင် over head 2 wire system တွင် တပ်ဆင်ရမည့် ဝယ်ယူရမည့် copper wire ပမာဏ ရှာပါ။ ဤသည်မှာ 1φ 3 wire ပြင်ဆင်မှုတွင် supply ပေးနိုင်သည်။ ပြင်ဆင်ရမည့် voltage နှင့် ၎င်းတွင် ပါဝင်သော constant တို့ဖြင့် 3φ system တွင် supply ပေးနိုင်သည့် ပမာဏ load ကို တွက်ချက်ပါ။ pf unity ဖြစ်သည်ဟု ယူဆသည်။



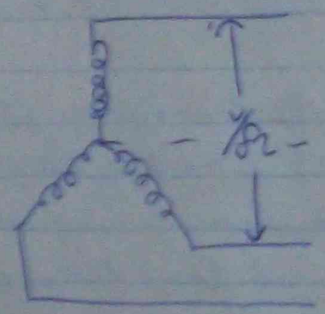
$I = \frac{W}{V/2}$

$P = 2I^2R$

$= 2 \times 2\frac{W^2}{V^2} \times R$

$\% \text{ loss} = 2 \times 2\frac{W_1^2 R}{V^2} \times \frac{100}{W_1}$

$= 2 \times 2\frac{W_1 R \times 100}{V^2}$



$I = \frac{W}{\sqrt{3} E \cos\theta} = \frac{W}{\sqrt{3} \frac{V}{\sqrt{2}} \cos\theta}$

$= \frac{\sqrt{2} W}{\sqrt{3} V \cos\theta}$

$P = 3I^2R$

$= 3 \times \frac{2W^2}{3V^2\cos^2\theta} R = \frac{2W^2 R}{V^2\cos^2\theta}$

$\% \text{ loss} = \frac{2W_2^2 R}{V^2\cos^2\theta} \frac{100}{W_2}$

$= \frac{2W_2 R \times 100}{V^2\cos^2\theta}$

$\therefore 2 \times \frac{2W_1 R \times 100}{V^2} = \frac{2W_2 R \times 100}{V^2\cos^2\theta}$

$\therefore 2W_1 = W_2$ $\quad \therefore W_2 = 25000 \times 2$

$= 50,000$

အစီအစဉ်: တောင်ကုန်းကြီးမှ ဒဂုံတောင်: ဘာကို load ပါသလဲ 0.8 pf lagging ဖြစ်ပြီး 2 ကြောင်း 20 ရှည်လျားသော 2 ကြောင်း 30 ဝန်ဆောင်မှုပေးသည်။ 100 ယူနစ် ယူသုံးသူ pf ကဲ့သို့ ရှိပါသည်။ ဝန်ဆောင်မှုပေးသည့် ဘာများပါသလဲ Tariff ဖွဲ့ပါ။

(က) ပမာဏ 200 kVA ထက်မြင့်သော ကြေးနှုန်း KS 1-2 / kVA

(ခ) ဆက်လက် 300 " KS 1.10/kVA

ရှိသော 500 " KS 1.00/kVA

အနည်း kVA ထက်မြင့်သော ကြေးနှုန်း KS 0.9/kVA

ပမာဏ 180 kWh / kVA of MD/month ဆောင်ရွက်ခ 0.7p

ဆက်လက် 180 kWh / kVA of MD/month ဆောင်ရွက်ခ 0.6p

ကြေးနှုန်းများ ဆောင်ရွက်ခ နှင့် ပုံစံများ: ကြေးနှုန်း

pf 0.8 to 0.95 အကြားရှိပါက KS 100/month ထိ loss free capacitor ပေးသွင်းရမည်ဟု ဆိုထားသည်။

Total MD $= \frac{1500}{.8} = 1875$ kVA

MD2 $= \frac{100}{1} = 100$ kVA

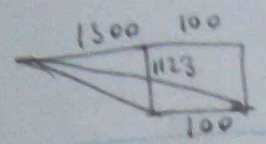
$\therefore$ MD$_T$ = 1975

Total cost $= 200 \times 1.2 + 300 \times 1.1 + 500 \times 1 + 975 \times 0.9$

$= 240 + 330 + 500 + 877.5$

$= 1947.5$ KS

ဤတွင် 0.8 pf lagging ဖြစ်သည်။



$KVA_1 =$

Total MD: ~~1500 + 100~~

$KVA = 1600 + j1123$

$= 1955$

$= ~~1875 + 100~~$

$= 1975$ KVA

Total cost $= 200 \times 1.2 + 300 \times 1.1 + 500 \times 1 + 975 \times .9$

$= 240 + 330 + 500 + 877.5$

$= 1925$ Rs ——— (1)

200 to 200 m units $= 1500 \times 160$

$= 240000$ kwh

100 to 200 $= 100 \times 240 = 24000$ kwh

Total units $= 240000$

24000

Total units $= 264000$ kwh

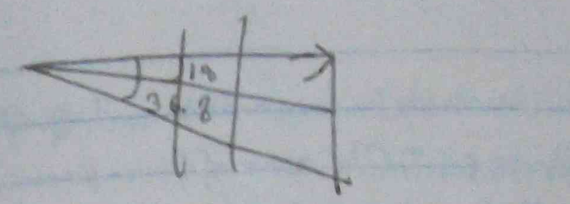
$\begin{cases} 1000 \text{ KVA} = 180 \text{ kwh} \rightarrow .7 \text{ Rs} \\ 200 \text{ KVA} \quad 180 \rightarrow \frac{.7}{100} \text{ Rs} \end{cases}$

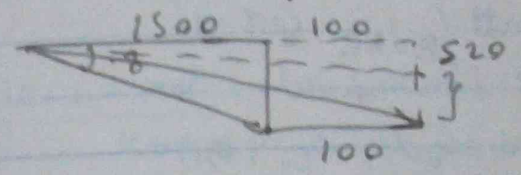
$1000 \text{ KVA} - 180 \text{ kw} = \frac{.7}{100}$ Rs

$180 \text{ kwh/KVA} = \frac{.7}{100}$ Rs

$\frac{264000}{1875}$ kwh/KVA $\rightarrow = \frac{.7}{100} \times \frac{240000}{1875} \times \frac{1}{180}$

$= 169$





$KVAR_d = 1500 \tan\theta - 1600 \tan 19°$

$= 1500 \times .748 - 1600 \times .325$

$= 1123 - 520$

$= 603$ KVAR

mf ~~capacitor~~ $= mf \times KVAR = 1123 - 603$

$= 520$ KVAR

$KVAR = KVA \sin 18°$

$520 = KVA \times .309$

$KVA = 1680$ KVA

Total cost $= 200 \times 1.2 + 300 \times 1.1 + 500 \times 1 + 680 \times .9$

$= 1070 + 612$

$= 1682$ Rs

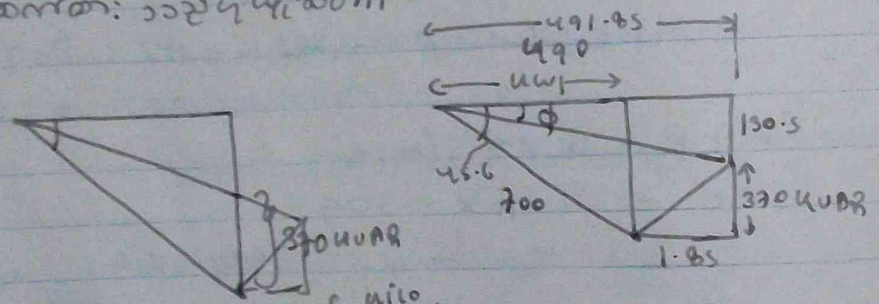
$\therefore$ मी बचत झालेले पैसे $= 1925 - 1682 = 243$

म्हणजे $\therefore$ बचत झालेले पैसे $= 243 -$ capacitor चा खर्च

$= 243 - 100 \rightarrow 143$

एवढे unit consumed झाल्यावर बचत

(20) Pf 0.7 lagging load 700 kVA maximum demand of 370 kVAR static condenser of capacitor loss 5 watt/kVAR (a) kVA and pf factor improved (b) annual net saving of, if annual tariff 5 ৳/kVA of capacitor initial cost 500 ৳ of inst: dep: 5% of energy of 1 ৳/kWh of capacitor supply ৳, find out:



1 kVAR = $\frac{5}{1000}$ kilo watts

370 ——— ? = $\frac{5 \times 370}{1000} = \frac{1850}{1000} = 1.85$ kW

kW_1 = kVAR of θ

= $700 \times .7 = 490$ kW

$kW_2 = 490 + 1.85 = 491.85$ kW

$\theta = \cos^{-1}.7 = 45.6°$

$kVAR_1 = 700 \sin 45.6 = 700 \times .715 = 500.5$ kVAR

$kVAR_2 = 500.5 - 370 = 130.5$ kVAR

$\tan\phi = \frac{kVA_2}{} = \frac{491.85 + J130.5}{} = 507.5 \angle 14.9$ kVA

capacitor এর

kVA of cap = $700 \times 5 = 3500$ ৳

kWh = $490 \times 8760 = 4290000$ kWh

cost for kWh = $\frac{1}{240} \times 4290000$

= 17900 ৳

Total cost = 17900 + 3500 = 21400 ৳

capacitor এর

kVA of cap = $507.5 \times 5 = 2540$ ৳

cost for kWh = $491.85 \times 8760 \times \frac{1}{240}$

= $\frac{4310000}{240} = 17950$ ৳

cost = 2540 + 17950 = 20490 ৳

cap: এর cost = 555 ৳

Total cost = 20490 + 555

= 21045

annual saving = 21400 − 21045

= 355 ৳

(Ans)

(21) ಅಂಕಿ-ಅಂಶ: ಸರಾಸರಿ average load ಯಾವುದೇ 500 kw ಗೆ PF 0.91 Lagging ಇದ್ದು ಗರಿಷ್ಠ 2000 hrs ಗಳಲ್ಲಿ: ಕೈಗಾರಿಕೆಗಳಿಗೆ max: demand meter ಗಳ ಅಳವಡಿಕೆ: ಇದ್ದಲ್ಲಿ max: load ಯಾವುದೇ average load ಗಳ ಇಷ್ಟಾರ್ಥ 30% ಇದ್ದಲ್ಲಿ Tariffs ಪ್ರಕಾರ us 70/kVA of max: demand +3 Ps as/unit ಪ್ರಕಾರ ಪಾವತಿಸಬೇಕು. phase advancing plant ಗಳ ಅಳವಡಿಕೆ us 100/kVAR ಹೆಚ್ಚಳ: ಇದ್ದಲ್ಲಿ ಅಂಶ ಗಳನ್ನು ಸರಿಪಡಿಸಲು Lagging ಇರುವಲ್ಲಿ: ಇದ್ದಲ್ಲಿ ಸರಾಸರಿ ಪವರ್ ಫ್ಯಾಕ್ಟರ್ ಅನ್ನು 0.9 ಕ್ಕೆ ಏರಿಸಲು ಬೇಕಾಗುವ capacitor bank ಗಳ interest ಮತ್ತು depreciation ಅನ್ನು 10% ಗಳ additional losses ಅನ್ನು ಸೇರಿಸಿ ಲೆಕ್ಕ ಹಾಕಿರಿ.

kVA ಅನ್ನು ಲೆಕ್ಕ = 500 kw

$$kVA_{average} = \frac{500}{.71} = 705\ kVA$$

Tariffs for MD = $705 \times 70 = 49350$ Rs

Unit consumed = 500 kw × 2000 = 10,00000 kwh

cost for unit consumed = $100000 \times \frac{3}{100}$ = 30000 Rs

Total cost = $30000 + 49350 \times 1.3$

= 94455 Rupees

$\alpha = \cos^{-1}.71 = 44.75°$

$\phi = \cos^{-1}.9 = 26°$

Load factor = $\frac{\text{average load}}{\text{maximum demand}}$

$= \frac{1}{1.3} = .77$

PF improved ಆಗಿರುವಾಗ = $\frac{\text{average demand}}{\text{load factor}} = \frac{500}{.71} = 705\ kVA$

max: demand = $\frac{705}{.77} = 915\ kVA$

Total cost: $915 \times 70 + \frac{3}{100} \times 500 \times 2000$

$= 64050 + 300000$ Rs

PF improved ಗೆ ಬೇಕಾದ

kVAR d = $500 (\tan 44.75 - \tan 26°)$

= 252 kVAR

cost for cap: = $252 \times 100 = 25200$

inst / dep = 2520 Rs

average demand = $\frac{500}{.9} = 555\ kVA$

MD = $1.3 \times 555 = 722\ kVA$

cost for MD = 722×70

= 50540 Rs

energy cost = 30000 Rs

annual saving = cost$_1$ − (cost$_2$ + cap: cost)

= 64050 + 30000 − (50540 + 2520 + 20000)

= 64050 − 58060

= 10990 Rs

(5) (22) ... average load ... 500 kW ... pf 0.71 lagging ... 2000 hrs ... max: demand meter ... max: load ... average load ... Tariff ... 370/kVA of max: demand + 3 Paisa/kWh ... phase advancing plant ... 100/kVAR ... lagging ... plant ... 10 watt/kVAR ... inst: dep: ... 10% ... annual saving ... pf improved ... pf

Average demand = $\frac{500}{.71}$ = 704 kVA

max: demand = 1.3 × 704 = 915 kVA

unit consumed = 500 × 2000

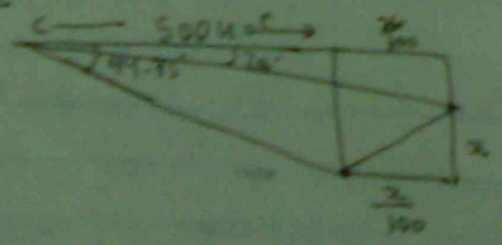
= 1000000

Total cost = 915 × 70 + 1000000 × $\frac{3}{100}$

= 64050 + 30000

= 94050 Rs

pf improved



$\left(500 + \frac{x}{100}\right)$ tan 26° = 500 tan 44.75 − x

$\left(500 + \frac{x}{100}\right)$ × .4875 = 500 × .993 − x

243.75 + .004875x = 496.5 − x

1.004875x = 252.75

x = 252.75 kVAR

cost for kVAR = 252.75 × 100

= 25275 Riyals

dist: + dep: = 25275 × $\frac{1}{10}$ = 2527.5 Riyals

* average demand = $\frac{\left(500 + \frac{252.75}{100}\right)}{.9}$

= $\frac{502.75}{.9}$ = 558 kVA

MD = 558 × 1.3

= 726 kVA

Total cost = 726 × 70 + $\left(502.75 \times 2000 \times\right) \times \frac{3}{100}$

= 50800 + 502.75 × 60

= 50800 + 30200

= 81000

Total cost = 81000 + 2527.5

= 83527.5

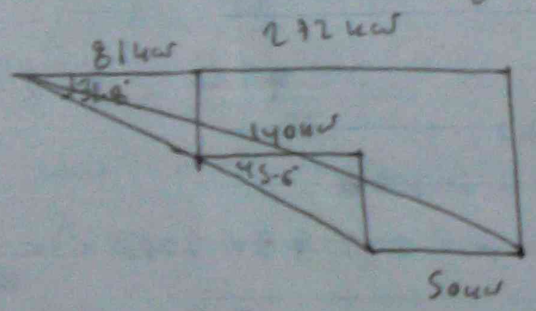
annual saving = 94050 − 83527.5

= 10522.5 Riyals.

(23) ...: ... load ...: 100HP ...: motor ...:
average 150HP at pf lagging effy 80% & Induction
motor at:
Average sour Lighting ... ...
... Tariff ... us110/unit at MD/annum ...
100HP
... : motor ... pf 0.85 lagging effy: 92% ...
pf 0.85 leading effy ... ...
...

① 100HP motor I/p = $\frac{100 \times .746}{.92} = \frac{74.6}{.92} = 81$ kw

150HP " I/p = $\frac{150 \times .746}{.8} = 140$ kw



kwT = 81+140+50 = 272kw

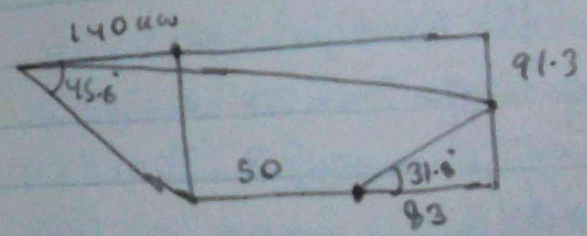
kVART = 81tan31.8 + 140tan45.6
= 81x.62 + 140x1.02
= 50.25 + 142.8
= 193.05 kVAR

kVA = $\sqrt{272^2 + 193.05}$ = 333 KVA

cost = 333x110 = 36630 ugxs

100HP motor I/p = $\frac{100 \times .746}{.9} = \frac{74.6}{.9} = 83$ kw

150 " = 140kw



kwT = 140+50+83 = 273 kw

kVART = 140tan45.6 − 83tan31.8
= 142.8 − 83x.62
= 142.8 − 51.5
= 91.3 kVAR

kVA = $\sqrt{273^2 + 91.3^2}$
= 288.2 kVA

cost = 288.2x110
= 31700

... = 36630 − 31700
= 4930 ugxs ...

(3a)

3φ 25 HP motor ... Rs 60/unit of max demand / annum + 5P/unit ... annual inst. dep. 10% ... motor ... (1981, Final)

	motor A		motor B	
	Full	Half	Full	Half
Load				
efficiency	0.80	0.83	0.82	0.8
P.F.	0.9	0.85	0.88	0.75

... Full load ... 300 days ... Tariff ... max demand ...

Motor A

$$\text{Full load} = \frac{25 \times .746}{.89 \times .9} = \frac{18.65}{.8} = 23.3 \text{ kVA}$$

$$\text{Half load} = \frac{12.5 \times 746}{.83 \times .85} = \frac{9.325}{.705} = 13.2 \text{ kVA}$$

motor A ... MD ... 23.3 kVA ...

cost for MD = $23.3 \times 60 = 1398$ paise

Full load ... units = $\frac{25 \times .746}{.89} \times 5 \times 300$

Half load ... units = $\frac{12.5 \times .746}{.83} \times 3 \times 300$

Total units = $\frac{25 \times .746}{.89} \times 5 \times 300 + \frac{12.5 \times .746}{.83} \times 3 \times 300$

$$= \frac{25 \times .746}{.89} \times 5 \times 300 + \frac{25 \times .746}{1.66} \times 3 \times 300$$

$$= \frac{25 \times .746 \times 300}{} \left[\frac{5}{.89} + \frac{3}{1.66} \right]$$

$$= .7500 \times .746 \left[5.62 + 1.807 \right]$$

$$= 5600 \left[7.427 \right]$$

$$= 41600 \text{ units}$$

cost for units = $41600 \times \frac{5}{100} = 2080$ paise

Interest = x ... ∴ Total cost = $x + 400$

inst. dep. = $\frac{x + 400}{10}$ paise

Total cost = $1398 + 2080 + 40 + \frac{x}{10}$

$= 3518 + \frac{x}{10}$ paise

Motor B

$$\text{Full load} = \frac{25 \times .746}{.82 \times .88} = \frac{18.65}{.775} = 24.1 \text{ kVA}$$

$$\text{Half load} = \frac{9.325}{2 \times .75} = \frac{9.325}{.6} = 15.55 \text{ kVA}$$

motor B ... MD ... 24.1 kVA ...

cost for MD = $24.1 \times 60 = 1445$ paise

Full load ... units = $\frac{25 \times .746}{.88} \times 5 \times 300$

Half ... = $\frac{12.5 \times .746}{.8} \times 3 \times 300$

Total work = $\frac{25\times.746}{.88}\times5\times300+\frac{12.5\times.746\times3\times300}{.8}$

$= \frac{25\times.746}{.88}\times5\times300+\frac{25\times.746}{1.6}\times3\times300$

$= 25\times.746\times300\left[\frac{5}{.88}+\frac{3}{1.6}\right]$

$= 7500\times.746\left[5.68+1.875\right]$

$= 5600\times7.555 = 42300$ watt h

cost for work $= 42300\times\frac{5}{1000} = 211.5$ naya paisa

Total cost $= 211.5+144.5 = 356$ naya paisa

Total cost $= 3560+\frac{x}{10}$ (B) $\quad 3518+\frac{x}{10}$ (A)

$3560+\frac{x}{10} > 3518+\frac{x}{10}$

∴ motor A ಆಯ್ಕೆ ಮಾಡಬೇಕು

Interest and depreciation

(25) ಯಾಂತ್ರೀಕರಣದ ಪೂರ್ವ ಸಾಲ ಗಿರಣಿಯು ಪ್ರಸ್ತುತ ವರ್ಷದಲ್ಲಿ 5 crores [5 ಕೋಟಿ] ಲಾಭ ಗಳಿಸಿದೆ ಮುಂದಿನ 20 year ಗಳಲ್ಲಿ ಪ್ರತಿ ವರ್ಷ ಲಾಭವು ಸಮಾನ ಪ್ರಮಾಣದಲ್ಲಿ ಹೆಚ್ಚಾಗುತ್ತದೆ ಎಂದು ಅಂದಾಜಿಸಲಾಗಿದೆ. ಯಾಂತ್ರೀಕರಣಕ್ಕಾಗಿ ಮಾಡಿದ ಖರ್ಚಿನ salvage value ಸೊನ್ನೆಯಾಗಿರುತ್ತದೆ. ಹೆಚ್ಚುವರಿ ಲಾಭದ ಒಂದು ಭಾಗವನ್ನು 10 ವರ್ಷಗಳ ಅವಧಿಯಲ್ಲಿ ಮರುಪಾವತಿಸಲು ಸಿಂಕಿಂಗ್ ಫಂಡ್ ವಿಧಾನದಲ್ಲಿ ಎಷ್ಟು ಮೊತ್ತವನ್ನು ಪ್ರತಿ ವರ್ಷ ಮೀಸಲಿಡಬೇಕು ಎಂಬುದನ್ನು (a) straight line method ಮತ್ತು (b) sinking fund method ನಲ್ಲಿ 8% compound interest ದರದಲ್ಲಿ ಲೆಕ್ಕ ಹಾಕಿ.

(a) Straight line

$x = \frac{S-P}{n} = \frac{5\times10^7-1\times10^7}{20} = \frac{4\times10^7}{20} = .2\times10^7$ units

10 years ಅವಧಿಯಲ್ಲಿ $= .2\times10^7\times10 = 2\times10^7$ units

ಉಳಿಕೆ ಮೊತ್ತ $= 5\times10^7-2\times10^7 = 3\times10^7 = 3$ crores

(b) sinking fund method

$x = \frac{Sr}{(1+r)^n-1} = \frac{4\times10^7\times.08}{(1.08)^{20}-1} = \frac{.32\times10^7}{4.66-1}$

$x = \frac{.32\times10^7}{3.66} = \frac{32\,00000}{3.66} = 874000$ units

$S = \frac{x\left[(1+r)^n-1\right]}{r} = \frac{874000\left[(1.08)^{10}-1\right]}{.08}$

$= \frac{874000\left[2.16-1\right]}{.08} = \frac{874000\times1.16}{.08} = \frac{1015000}{.08}$

$S = \frac{.1015\times10^7}{.08} = 1.27\times10^7$ rs

ಉಳಿಕೆ: $5\times10^7-1.27\times10^7 = 3.73\times10^7$

Transformer choice

(26)

ಕೆಳಗಿನವುಗಳಲ್ಲಿ Transformer ಬಳಸಲಾಗಿರುವ ಸಂಸ್ಥೆಯ ವಿವರಗಳು ಕೆಳಕಂಡಂತಿವೆ.

Full load ಇದ್ದಾಗ 3000 kW

½ load ಇದ್ದಾಗ 3000 kW ಮೊತ್ತ ಸಂಸ್ಥೆಯು full load ಇರುತ್ತದೆ.

cost of energy losses = 1.3 d/kWh (inst: dep: = 10% ಮೊತ್ತದ)

Transformer ಬಳಸಲಾಗಿರುವ ಸಂಸ್ಥೆಯ ಅಂದಾಜು ಆದಾಯ ಮತ್ತು ಖರ್ಚಿನ ವಿವರಗಳನ್ನು load factor ಅನ್ನು ಕಂಡು Transformer ಆಯ್ಕೆಯಲ್ಲಿ ಯಾವುದು ಲಾಭದಾಯಕ ಎಂಬುದನ್ನು ಬರೆಯಿರಿ.

T-R	core material	Initial cost	Iron loss	F.L Cu losses
A	Hot Rolled silicon steel	₹ 1250	2.5 kW	8 kW
B	cold Rolled grain oriented steel	₹ 1500	1.6 kW	6 kW

Transformer A

Inst: dep: = $\frac{10}{100} \times 1250 = 125$ ₹

Total Iron loss = $2.5 \times 8760 = 21900$ kWh

Total copper loss = $8 \times 3000 + (\frac{1}{2})^2 \times 8 \times 3000$

$= 24000 + \frac{1}{4} \times 24000$

$= 24000 + 6000 = 30,000$ kWh

Total kWh = $21900 + 30,000 = 51900$ kWh

cost for kWh = $\frac{51900 \times 1.3}{240} = \frac{67500}{240} = 281$ ₹

Total cost = $125 + 281 = 406$ ₹

load factor = $\frac{\text{kWh total}}{\text{load} \times \text{no. of hrs in a year}}$

$= \frac{*750 \times 3000 \times \cos\phi + \frac{1}{2} \times 750 \times 3000 \cos\phi}{750 \times \cos\phi \times 8760}$

$= \frac{3000 + 1500}{8760} = \frac{4500}{8760} = .514$

Transformer B

Inst: dep: = $\frac{1}{10} \times 1500 = 150$ ₹

Total Iron loss = $1.6 \times 8760 = 14000$ kWh

Total copper loss = $6 \times 3000 + (\frac{1}{2})^2 \times 6 \times 3000$

$= 1.25 \times 18000$

$= 22500$ kWh

Total kWh = $14000 + 22500 = 36500$ kWh

cost for kWh = $\frac{36500 \times 1.3}{240} = \frac{47500}{240} = 197.8$ ₹

Total cost = $197.8 + 150 = 347.8$ ₹

load factor ಇಷ್ಟಿದ್ದಾಗ ಲಾಭದಾಯಕ ಆಗಿರುತ್ತದೆ. $(406 - 347.8) = 58.2$ ₹ ಉಳಿತಾಯ

∴ Annual saving = 58.2 ₹

(27) Transformer A has a constant losses of 1600 kwh and a load losses of 1440 kwh daily, while the corresponding losses of B are 800 and 2400 kwh If annual charges are 12.5% (inst: & depr. and cost of energy loss 0.75 d/kwh. what should be the difference in cost so that the two T.R are equally economical

T.R A & T.R B capital cost ஒரே - ஒரு value, (60: ரூபாய்)
∴ inst: dep: ஒரே: ஒரு BIR x
inst: dep: ஒரே: ஒரு 6% ஒரே, kwh losses ஒரே: வித்தியாசம்

T.R A

A ன் constt losses for year = 160 × 365 = 58500 kwh
A ன் load losses for year = 1440 × 365 = 51200 kwh
∴ A ன் total losses = 109700 kwh
cost for losses = $\frac{109700 \times .75}{240} = \frac{82300}{240}$ = 343 ₹

T.R B

constt losses for year = 800 × 365 = 29200 kwh
Load losses for year = 2400 × 365 = 87600 kwh
B ன் total losses = 116800 kwh

cost for losses = $\frac{116800 \times .75}{240} = \frac{87600}{240}$ = 365 ₹

A ன் annual saving = 365 − 343 = 18 ₹
∴ A தான் மலிவு

(28) 250 kVA ஒரு Transformer ஒரு ஆண்டு. யூனிட் BIR 60 பைசா: ஆண்டு முழுவதும் ஒரே: 2 யூனிட்: ஒரே: Transformer நாளுக்கு: 250 kVA 0.8 PF lagging load cycle ஒரு day க்கு 10 மணி BIR load cycle ஒரு 250 kVA 0.8 PF lagging ஒரே, மற்ற நேரம் 100 kVA 0.8 PF lagging ஒரே, மற்ற நேரம் 8 hrs/day. 100 kVA 0.8 PF lagging ஒரே, மற்ற நேரம் 6 hrs/day
மாறாத நிலை: மற்ற நேரம் 8 hrs/day
(a) annual load factor
(b) T.R x ன் all day efficiency: ஐ காண்
(c) T.R x ன் ஆண்டு BIR annual running cost ஐ கண்டுபிடி
Inst: dep = 10%. Energy cost = 417 Paise

T.R	Initial cost	Iron loss	Full load copper loss
x	Rs 1600	1 kW	4 kW
y	Rs 1540	2 kW	2.5 kW

(a)

load factor = $\frac{\text{Unit consumed}}{\text{Load ஒரு max supply power (kW)} \times \text{ஒரு நாளில்: மணி}}$

$= \frac{250 \times .8 \times 8 \times 250 + 100 \times .8 \times 8 \times 250 + 50 \times 8 \times 250}{250 \times .8 \times 8760}$

$= \frac{250 \times .8 \times 8 \,[250 + 100 \times 2.5]}{200 \times 8760}$

$= \frac{250 \times 6.4 \times 512.5}{1752000} = \frac{6.4 \times 103500}{1752000} = \frac{662500}{1752000}$
$= 0.378$

(ii) Alldayeffy: = $\frac{\text{all day o/p}}{\text{alldayo/p + alldaylosses}} \times 100$

alldayo/p = 250x.8x8 + 100x.8x8 + 50x1x8
= 200x8 + 80x8 + 50x8
= 8 [200+80+50]
= 8x330 = 2640 Kwh

T.R 03rm

Allday Ironloss = 1x24 = 24Kwh

alldayculoss = $4\times8 + (\frac{100}{250})^2 \times 4 \times 8 + (\frac{50}{250})^2 \times 4 \times 8$

= 4 [8 + 16 + .04]

= 8.64 = 32.8Kwh

= 4x8 [1 + .16 + .04]

= 32 x 1.2 = 38.4Kwh ✓

Alldyeffy = $\frac{2640}{2640+38.4+24} = \frac{2640}{2702.4} \times 100 = 97.7\%$

T.R 03rm

Allday Ironloss = 2x24 = 48Kwh

Alldaycopperloss = 2.5x8 + $(\frac{100}{250})^2$ x2.5x8 + $(\frac{50}{250})^2$ x 2.5x8

= 20 [1 + .16 + .04]

= 20x1.2 = 24 Kwh

alldayeffy: = $\frac{2640}{2640+24+48} \times 100 = 97.5\%$

T.R

Culoss (Kwh) for year = 38.4 x 250 Kwh

Ironloss for year = 24 x 250 Kwh

total loses [38.4 + 24] x 250 = 15600 Kwh

Cost. dep: = $\frac{1}{10}$ x 1600 → 160 Usds

Total cost = $\frac{1}{10}$ x 1600 = 160 Usds

Total cost = 160 + 65.2 = 225.2 Usds

T.R 03rm

Culoss for year = 24 x 250 Kwh

Ironloss for year = 48 x 250

Total loses = [24 + 48] x 250 = 72 x 250 = 19100

cost for loses = 19100 x .417/100 = 79.8 Usds

Cost: dep: = $\frac{1}{10}$ x 1540 → 154 Usds

Total cost = 154 + 79.8 = 233.8 Usds

∴ Diff in cost = 233.8 − 225.2

= 8.6 Usds

(29) A certain daily load varies as follows.
250 kVA at 0.8 pf lagging for 8 hrs
100 kVA at 0.8 pf lagging for 8 hrs
50 kVA at unity pf for 8 hrs
Determine the all day effcy of each of the following 250 kVA supply T.R.

T.R	Iron loss	Full load cu losses
A	1 kW	4 kW
B	2 kW	3.5 kW

what would be the tariff saving effect div 10 weeks (7 days per week) with the more economical T.R if the charge for Electrical Energy is 0.417 Pyas per unit.

All day output = $250 \times 0.8 \times 8 + 100 \times 0.8 \times 8 + 50 \times 8$

$= 8[200 + 80 + 50]$

$= 8 \times 330 = 2640$ kWh

A type

all day Iron loss = $1 \times 24 = 24$ kWh

Total Cu loss = $4 \times 8 + \left(\frac{200}{250}\right)^2 \times 4 \times 8 + \left(\frac{50}{250}\right)^2 \times 4 \times 8$

$= 32\,[1 + .16 + .04]$

$= 32 \times 1.2 = 38.4$ kWh

Losses total = $24 + 38.4 = 62.4$ kWh

All day effcy = $\frac{2640}{2640 + 38.4 + 24} \times 100 = \frac{2640}{2702.4} \times 100 = 97.6$

B type

Total Iron loss = $2 \times 24 = 48$ kWh

Total Cu loss = $3.5 \times 8 + \left(\frac{100}{250}\right)^2 \times 3.5 \times 8 + \left(\frac{50}{250}\right)^2 \times 3.5 \times 8$

$= 3.5 \times 8\,[1 + .16 + .04]$

$= 28 \times 1.2 = 33.6$ kWh

kWh total = $33.6 + 48 = 81.6$ kWh

All day effcy = $\frac{2640}{2640 + 33.6 + 48} \times 100 = \frac{2640}{2721.6} \times 100 = 97.0$

Saving per annum = 82.4 − 81.6 = 19.4 kWh

Saving for 10 weeks = $19.4 \times 10 \times 7$

$= 19.4 \times 70 = 1358$ kWh

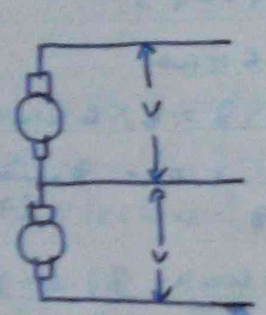
Saving = $\frac{1358 \times .417}{100} = 13.58 \times .417 = 5.67$ Rupees

comparison of load

(34) calculate the relative weight of copper required for the distribution cable in a low voltage system with (a) 2 ϕ 3 wire system (b) AC 3ϕ 4 wire system Assume the same voltage at consumer's terminal the total losses on the same power losses, unity p.f balance load the middle wire which one half of the CSA of corresponding outer.

$$\frac{l}{a} = \frac{I^2 R}{} \qquad I = \frac{W}{\alpha \frac{V}{x} \cos\theta}$$

DC 3 wire



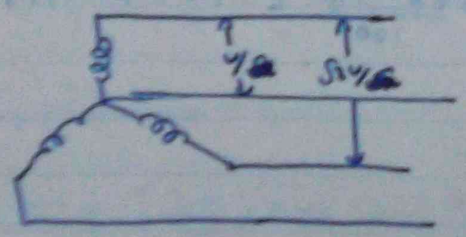
$$P = 2 I^2 R_1$$

$$I = \frac{W}{2V}$$

$$\therefore P = 2 \times \frac{W^2}{4V^2} R_1$$

$$R_1 = \frac{4\rho v^2}{2w^2} = \frac{2\rho v^2}{w^2} \quad \text{—— (1)}$$

AC 3ϕ 4 wire



$$P = 3 I^2 R_2$$

$$I = \frac{W}{\sqrt{3} \times \frac{\sqrt{3}V}{\sqrt{2}}}$$

$$I = \frac{\sqrt{2} W}{3V}$$

$$P = 3 \times \frac{2 W^2}{9 V^2} \times R_2$$

$$P = \frac{2}{3} \frac{W^2}{V^2} \times R_2$$

$$\therefore R_2 = \frac{3\rho v^2}{1 w^2} \quad \text{—— (2)}$$

$$\frac{R_1}{R_2} = \frac{A_2}{A_1}$$

$$\frac{A_2}{A_1} = \frac{2\rho v^2}{w^2} \times \frac{1 w^2}{3\rho v^2} = \frac{2}{3}$$

$A_1 = 1$ (62): $\therefore A_2 = \frac{2}{3}$

$W_1 = 8$ A × L × den: × 2·5

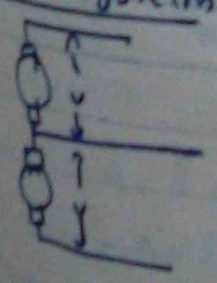
$= 2.5 \times 1 \times 4$ den : $= 2.5\,u$

$W_2 =$ A × L × den × 3·5

$= \frac{2}{3} \times u \times 3.5 = \frac{7}{3} u$

7 : 5 : 7

(35) calculate the relative weight of copper required for the distribution cable in a ~~load~~ low voltage system with (a) AC 3ϕ 4 wire system is used for lighting compare the amount of cu: required the needed for 2 wire system with the same lamp voltage Assume the same loss and balanced load the neutral wire is 1/2 these of respect outer 3ϕ 4 wire system 2 wire system



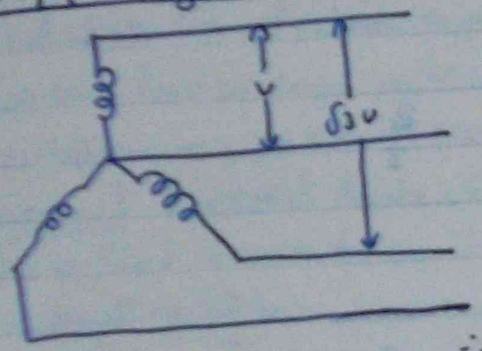
$$P = 2 I^2 R_1$$

$$I = \frac{W}{2V}$$

$$P = 2 \times \frac{W^2}{4V^2} R_1 = \frac{W^2 R_1}{2V^2}$$

$$\therefore R_1 = \frac{2\rho v^2}{w^2} \quad \text{(1)}$$

AC 3φ 4 wire system



$P = 3 I^2 R_2$

$I = \frac{W}{\sqrt{3} \times \sqrt{3} V}$

$I = \frac{W}{3V}$

$\therefore P = 3 \times \frac{W^2}{9V^2} R_2$

$\therefore R_2 = \frac{3 \rho V^2}{W^2}$ — (2)

$\frac{R_1}{R_2} = \frac{A_2}{A_1}$ $\quad \therefore \frac{A_2}{A_1} = \frac{2 \rho V^2}{W^2} \times \frac{W^2}{3 \rho V^2} = \frac{2}{3}$

$\therefore A_2 = \frac{2}{3}$ $\quad (A_1 = 1$ [illegible] $)$

$w_2 = A \times l \times$ den: $\times 2.5$

$= 1 \times n \times 2.5 = 2.5 n$

$w_{\frac{1}{2}} = A \frac{1}{2} \times$ den: $\times 3.5$

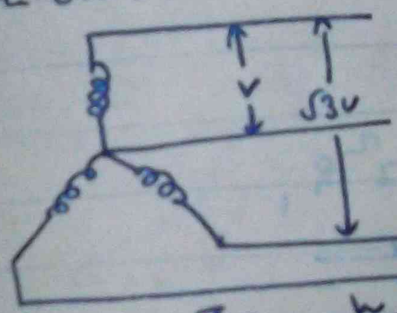
$= \frac{2}{3} \times n \times 3.5 = \frac{7}{3} n$

$\frac{w_1}{w_2} = \frac{2.5}{\frac{7}{3}} = \frac{7.5}{7}$

$\therefore w_1 : w_2 = 1 : .93$

A 3φ 4 wire system is use for lighting compare the amount of copper required that needed for a 2 wire system with the same lamp voltage Assume the same efficiency and balanced load. The neutral core is ½ the CSA of respective outer.

3φ 4 wire

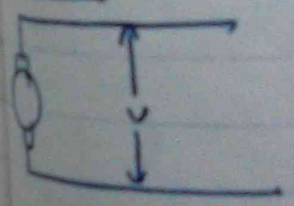


$P = 3 I^2 R_1$

$I = \frac{W}{\sqrt{3} \times \sqrt{3} V} = \frac{W}{3V}$

$P = 3 \times \frac{W^2}{9V^2} \times R_1$ $\quad \therefore R_1 = \frac{3 \rho V^2}{W^2}$ — (1)

2 wire



$I = \frac{W}{V}$

$P = 2 I^2 R_2$ $\quad \therefore R_2 = \frac{\rho V^2}{2 W^2}$ — (2)

$P = 2 \times \frac{W^2}{V^2} R_2$

$\frac{R_1}{R_2} = \frac{A_2}{A_1} = \frac{3 \rho V^2}{W^2} \times \frac{2 W^2}{\rho V^2} = 6$

$\rho = 1$ [illegible] Ω $\quad \therefore A_2 = 6$

$w_2 = A \times l \times$ den: $\times 3.5 = 3.5 n$

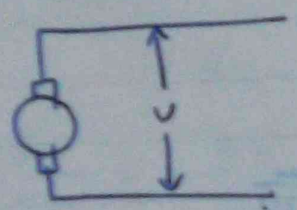
$w_1 = A \times l \times$ den: $\times 2 = 6 \times 2 n = 12 n$

$w_1 : w_2 = 1 : 3.43$

$\frac{w_1}{w_2} = \frac{3.5}{12}$

(33) Power ಸಿಸ್ಟಮ್ DC 2wire system (ಅಥವಾ) 3wire system ಕೆಳಗೆ ಕೊಟ್ಟಿರುವ consumer Terminal voltage ಇದ್ದಾಗ 200ಕೆಜಿ ತೂಕದ copper ಸಿಸ್ಟಮ್ ಅನ್ನು ಉಪಯೋಗಿಸಿ ಎಷ್ಟು ಲೋಡ್ ಅನ್ನು ಸರಬರಾಜು ಮಾಡಬಹುದು ಎಂದು ಲೆಕ್ಕ ಹಾಕಿ.

DC 2 wire

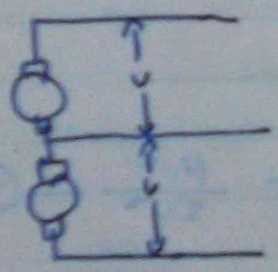


$P = 2I^2 R_1$

$I = \frac{W}{V}$

$\therefore P = 2\frac{W^2}{V^2} R_1$

$R_1 = \frac{\rho l_1}{2A_1}$ ——— (1)



$P = 2I^2 R_2$

$I = \frac{W}{2V}$

$P = 2 \times \frac{W^2}{4V^2} R_2$

$\therefore R_2 = \frac{2\rho l_2}{A_2}$ ——— (2)

$\frac{R_1}{R_2} = \frac{A_2}{A_1} = \frac{\rho l_2}{2A_1} \times \frac{A_1}{2A_2} = \frac{1}{4}$

$A_1 = 1$ ಕೆಜಿ $\therefore A_2 = \frac{1}{4}$

$W_1 = A_1 \times l_1 \times$ den $\times 2 = 2A$

$W_2 = A_2 \times l_2$ den $\times 2.5 = \frac{1}{4} A \times 2.5 = \frac{2.5}{4} A$

$\frac{W_1}{W_2} = \frac{2}{2.5/4} = \frac{8}{2.5} = 3.2 : 1$

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Balancing

If the centre of gravity of a rotating piece of machinary does not coincide with the centre of rotation, centrifugal forces are set up which causes vibration as well as putting an extra load on the bearing.

To balance an eccentric load in its own plane it can be done by the counterbalance placed diametrically opposite of such mass and radius from the centre so that it will creat a centrifugal force of equal magnitude and opposite in direction to that of the eccentric load.

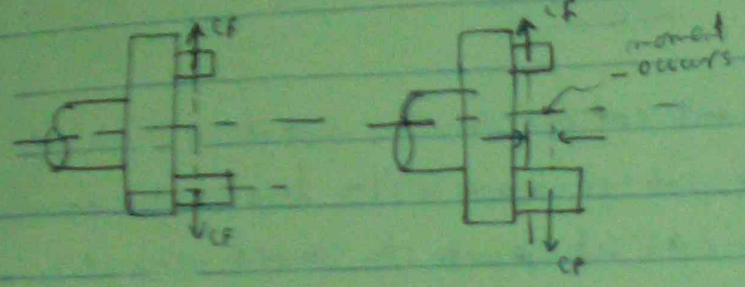
For balance, the centrifugal force of m must be equal to the centrifugal force of m_1

$$m\omega^2 r = m_1 \omega_1^2 r_1 \quad \text{but} \quad [\omega = \omega_1]$$

$$\boxed{m r = m_1 r_1}$$

The centre of gravity of the masses must lie on the same plane otherwise an unbalanced couple will be setup when the system rotates, which will cause the rocking action.

(rail forward and backward)



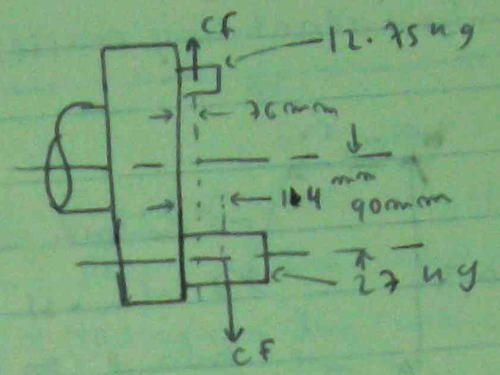
The unbalanced moment = CF × moment arm (dist. between the line of action of each CF)

(13)

Ex A valve box casting of mass 27 kg is secured to the face plate of a lathe in such a position that its centre of gravity is 90 mm radially from the centre of rotation and 114 mm axially from the surface of the face plate. Calculate the radius at which to fix a counter balance of 12.75 kg to the centre of gravity.

If the counter balance is 75 mm only from the face plate surface, Calculate the unbalanced couple when rotating at 200 rev/min.

$\omega = 2\pi n$ rad/s



{ axial - 75 : 2 mm
radial - 60 : 2 mm }

m_x g mass of bar = 27 kg r_1 = 90 mm

axial length from face plate = 114 mm

$\omega_x = \omega_c$ = 200 rev/min

m_c mass of counter balance = 12.75 kg r_2 ??

unbalanced couple = ?

To balance CF

CF of = CF of counter balance

$m_x \frac{v_x^2}{r_x} = m_c \frac{v_c^2}{r_c}$

$m_x \omega_x^2 r_x = m_c \omega_c^2 r_c$

$27 \times 90 = 12.75 \times r_c$

$r_c = 190.5$ mm.

unbalanced couple = CF × dist. bet: line of action of two CF

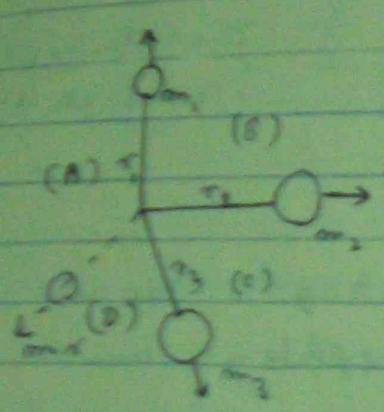
$= m_v \omega_v^2 r_v \times \frac{(114 - 75)}{1000}$

$= 27 \left(\frac{200 \times 2\pi}{60}\right)^2 \times \frac{90}{1000} \times \frac{39}{1000}$

$= 40.48$ N

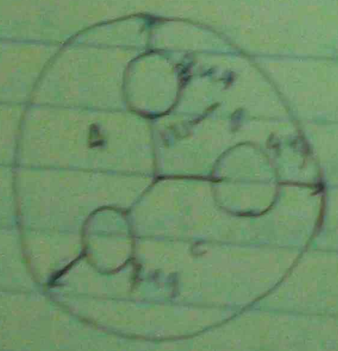
(or) $12.75 \left(\frac{200 \times 2\pi}{60}\right)^2 \times 190.5$

Balancing of number of rotating masses



Centrifugal force of mass to balance can be found by vector diagram

* Two masses are fixed at the right angle each other on a distance which is to rotate one is 3kg at a radius of the centre of rotation, and the other is 4 kg at 150 mm radius find the position to fix a balance mass of 7kg to equalise the centrifugal force



$m_1r_1 = 3 \times \frac{111}{1000} = 0.315$ kg-m

$m_2r_2 = 4 \times \frac{150}{1000} = 0.6$ kg-m

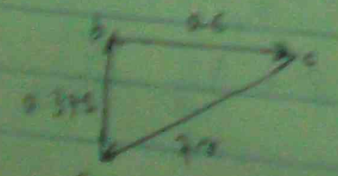
$m_3r_3 = 7 \times r = 7r$ kg-m

$ac = \sqrt{ab^2 + bc^2}$

$= \sqrt{0.315^2 + 0.6^2} = 0.703$ kg-m

$7r = 0.703$

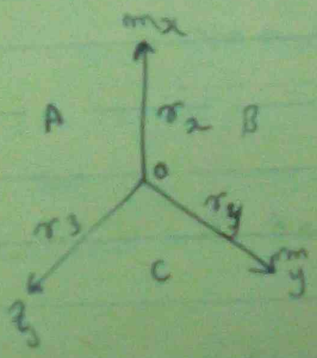
$r = 0.101$ cm //



$\tan\alpha = 0.315/0.6 \Rightarrow \alpha = 32°$

$\theta = 180 - 32 = 148°$ from (2)

** Three masses x, y, z are to rotate in the same plane at the angular velocity. Their masses and radii from the centre of rotation are respectively 9 kg at 400 mm radius, 10 kg at 350 mm, and 12 kg at 250 mm. Calculate the angles between them so that they will balance.



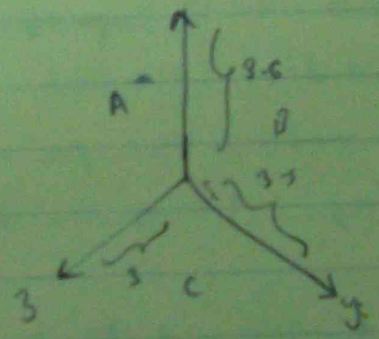
Solid $m_x r_x$, $m_y r_y$, $m_3 r_3$

$m_x r_x = 9 \times 0.4 = 3.6$ kg-m

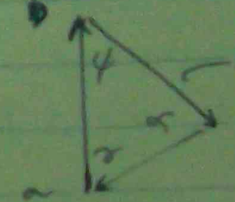
$m_y r_y = 10 \times 0.35 = 3.5$ kg-m

$m_3 r_3 = 12 \times 0.25 = 3$ kg-m

Scale = 1 kg-m = 1 cm

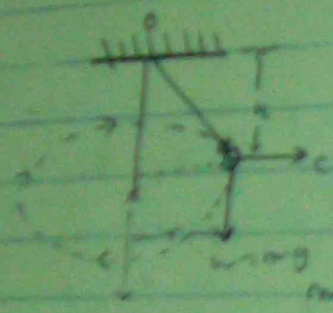


scale for space diagram



ϕ, γ, α are xy, yz, zx

conical Pendulum



angular velocity ω rad/sec

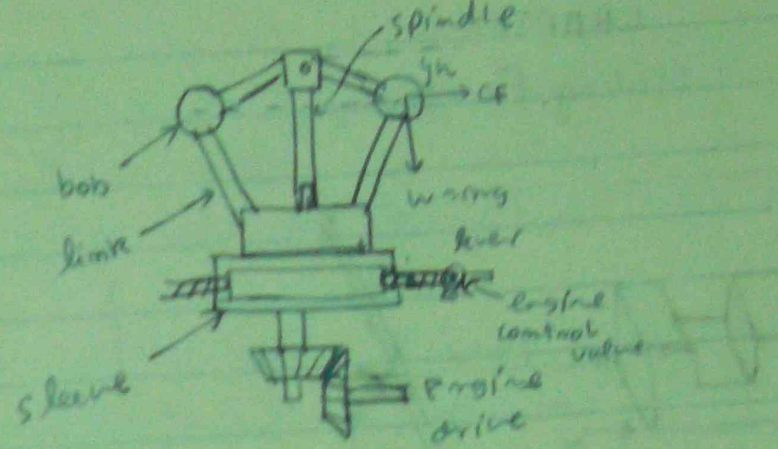
$CF \times h = mg \times r$

$m\omega^2 r \times h = mg r$

$\therefore \boxed{h = g/\omega^2}$ Proved

Simple unloaded Governor

- watt governor
- work on the principle of the conical pendulum
- consist of pair of bob mass suspended on arms from a center spindle
- These bobs are connected by pair of links to a sliding sleeve on the spindle
- The sleeve may move up to down according to the load
- It is called the height of the governor



(Ex) Find the height of the watt governor rotating at speed of 60 rev:/min and find the change in height.

at 60 rev:/min $\rightarrow h_1 = \frac{g}{\omega^2} = \frac{9.81}{(\frac{60 \times 2\pi}{60})^2}$

$= 0.248m$

at 75 rev:/min $\rightarrow h_1 = \frac{g}{\omega_1^2}$

$= \frac{9.81}{(\frac{75 \times 2\pi}{60})^2} = 0.159m$

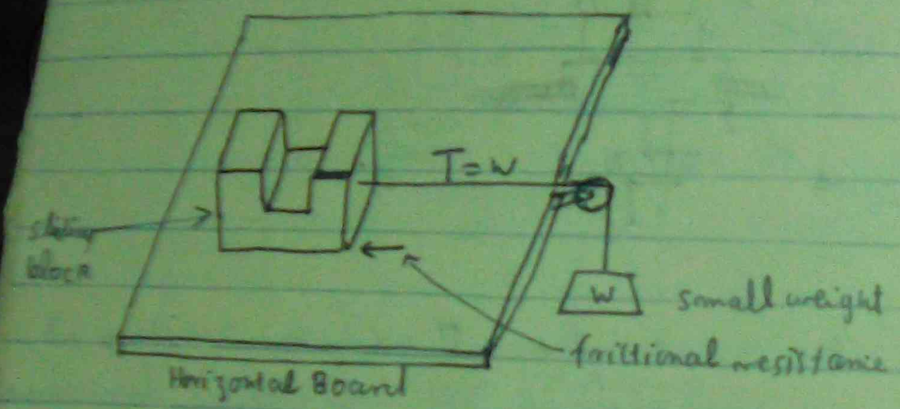
change in height $= 0.159 - 0.248$

$= 0.089$

* change in height $= h_2 - h_1$ *

CHAPTER 6

Sliding Friction



Friction force

The force required to commence the frictional resistance is called the friction force

Static friction

The friction at rest is called the static friction

Limit Sliding friction

The friction at moved is called the sliding friction.

The lower at sliding friction.

Frictional resistance is proportional to the total pressure between the surface. $F_f \propto N$

(i) It depends upon the nature and roughness of the surface.

(ii) It is independent of the area in contact.

F_f # area

(iii) It is independent of the speed of sliding at low speed F_f # speed

(iiii) It opposes motion.

coefficient of friction

coefficient of friction is the ratio of the force to overcome the frictional resistance and the normal pressure between the surfaces symbol (μ)

$$\text{coefficient of friction } \mu = \frac{\text{friction force}}{\text{Normal pressure between the surface}} = \frac{F_f}{N}$$

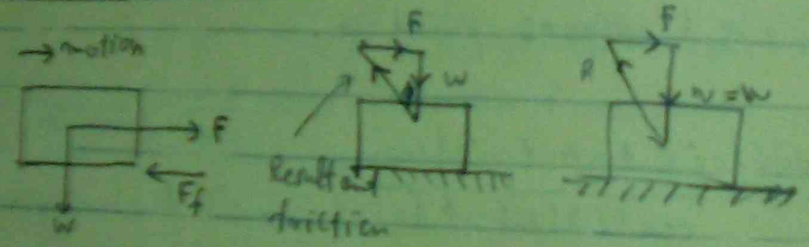
Normal pressure between surfaces = weight of the body + the load on top of the body it there are any.

* force required to just cause it slide = F_f *

Friction angle

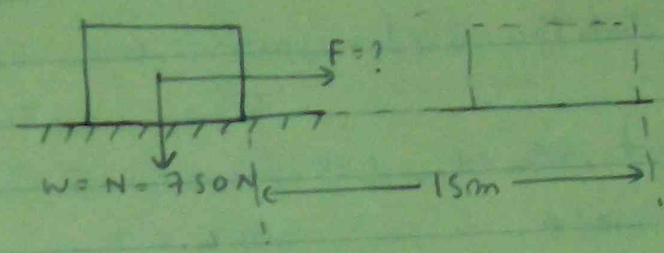
The magnitude of the angle ϕ between the reaction of the plane and normal pressure between surfaces

Force parallel to the plane



$$\tan\phi = \frac{F}{N} = \frac{F_f}{N} = \mu$$

Ex A casting weighting 750N is pulled along a horizontal workshop floor for a distance of 15m long a horizontal force. If the coefficient of friction between the casting and the floor is 0.32, calculate the force applied and the work done.



$W = N = 750N$, distance moved = 15m

$\mu = 0.32$, $WD = ?$

$WD = F \times dist$, $\mu = \frac{f}{N}$ $\quad F = \mu N = 0.32 \times 750 = 240N$

$\therefore WD = F \times dist = 240 \times 15 = 3600$ J

(2/6) A shaft ~~dis~~ runs at 50 rev/sec in bearings 100mm dia the total load on the bearing is 25.15kN and the coefficient of friction is 0.04. calculate

(1) the friction force at the skin of the shaft
(2) the work done against the shaft per revolution
(3) the work lost to friction every second
(4) the equivalent HP power loss.

Radius

Shaft speed = 50 rev/sec dia = 100mm

Normal load = 25×10^3 N $= 0.1$,

$\mu = 0.04$

$\mu = \frac{F_f}{N} \Rightarrow F_f = \mu N = 0.04 \times 25 \times 10^3 = 1000N$

(1) one rev. ⇒ dist. travelled = circumference = πD

$= \pi \times 0.1 = 0.1\pi m$

$W.D/_{rev.}$ = Force at skin of the shaft × dist = $1000 \times 0.1\pi$

$= 314.2\ J$ ✻

$W.D/_{sec} = W.D/_{rev.} \times rev./_{sec} = 314.2 \times J/_{rev.} \times 30\ rev/_{sec}$

$= 15710\ J/_{sec} = 15710\ W$

equivalent $kW = \frac{15710}{1000} = 15.71\ kW$

(2) (3/6) If a block of steel of 50kg mass requires a horizontal force of 70N to cause it to slide along a horizontal plane, what is the coefficient of friction between the block and plane.

If a horizontal force of 80N is applied, what will be the acceleration and the dist: travelled in 4 sec from rest?

Normal force (or) block mass $m = 50kg \rightarrow W = 50 \times 9.81\ N$

force read: to just cause to slide = 70N = Ff

$$\mu = \frac{Ff}{N} = \frac{70}{50 \times 9.81} = 0.1428$$

Force to cause to accelerate = applied force − Ff

accelerating force = $80 - 70 = 10N = ma$

$10 = 50 \times a$

$a = 0.2\ m/sec^2$ ✻

$$\text{acceleration} = \frac{\text{final velocity} - \text{initial velocity}}{\text{time}}$$

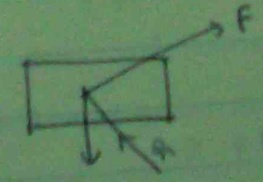
$0.2 = \frac{v - 0}{4} \Rightarrow v = 0.8\ m/sec$

dist: travelled = avg: velo: × time

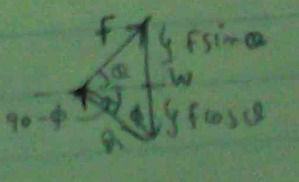
$= \frac{0.8 - 0}{2} \times 4 = 1.6m$ ✻

Force not parallel to the plane

Instead of the force applied being parallel to the horizontal plane cross which the body is sliding, let it be inclined upward at θ degree



space diag:



μ = vector diag:

$$\mu = \frac{F\cos\theta}{W - F\sin\theta}$$

Sine rule $\frac{W}{\sin(90-(\phi+\theta))} = \frac{F}{\sin\phi}$

(Ex) A body of 40 N weight is to be pulled along a horizontal plane the line of action of the applied force is inclined ~~upwards~~ upwards at 26° to the horizontal. Find the magnitude of the force to slide the body at steady speed. Find also the magnitude and direction of the least force that will moved the body.

W (Normal force) = 40 N, $\mu = 0.5$

$\theta = 26°$

$\mu = \tan\phi = 0.3 \Rightarrow \phi = 16.7°$

$\theta + (90 - \phi) = 26 + (90 - 16.7) = 99.3$

Sine rule $\Rightarrow \frac{F}{\sin 16.7} = \frac{W}{\sin 99.3}$

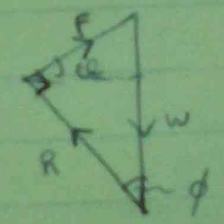
$F = \frac{40}{\sin 99.3} \times \sin 16.7 = 11.6\,SN$

Normal force to surface

ϕ = angle bet. N and R

(6/6) Least force = ? → Ex. 2 on p. 90

Least force The force to pull up or down along a plane is least under the force vector of the vector diag: is shortest i.e the force and reaction are at right



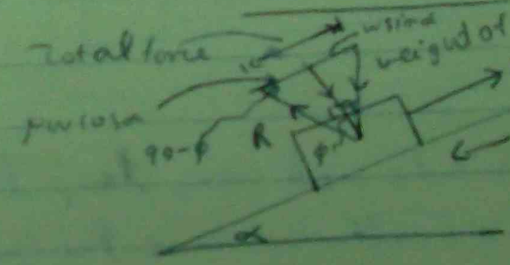
Same body, same plane ⇒ same coefficient of friction

$\therefore \mu = 0.3 \Rightarrow \phi = 16.7°$

$\therefore F = W\sin\phi = 40\sin 16.7 = 11.5\,N$ ✻

16.7° from horizontal

Inclined Plane



$\mu W\cos\alpha$ = friction force

$W\sin\alpha$ = force of gravity

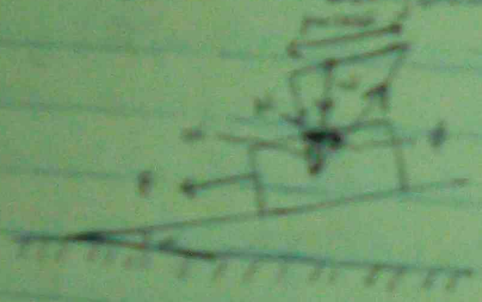
N = Normal force bet: surface

$\mu = \frac{Ff}{W} = \frac{Ff}{W\cos\alpha} \Rightarrow Ff = \mu W\cos\alpha$

Force up inclined plane

Weight $= \frac{F}{\sin(90+\alpha)} = \frac{W}{\sin 90 - \beta}$

Force to pull the body down



Force down = friction force − force of gravity

$F_{down} = \text{friction} - \text{weight}$

Force held

If the plane is not very steep the body will slide down and the force of gravity is greater than the friction force. To prevent from sliding down a force must be applied. This is called the force to hold.

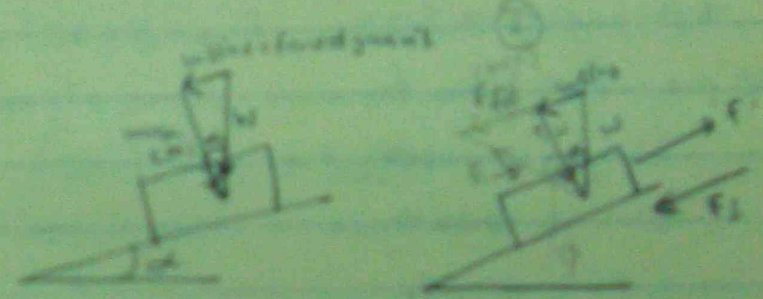
Angle of Repose

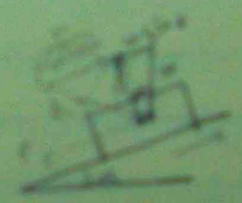
The angle at which the force of gravity is equal to the body may be just at rest or nearly sliding.

friction force = force of gravity

$\mu W \cos\alpha = W \sin\alpha$

$\mu = \tan\alpha$ or angle $= \tan^{-1}\mu$





Force to hold F to prevent from sliding

Q/c

(5) A body of 200N weight is to be pulled up a slope which is inclined at 30 degrees to the horizontal the coefficient of friction between the body and the plane being 0.2 Find the force required assuming it be approved parallel to the plane and find also the work done in pulling the body a distance of 50m up the slope

$W = 200\,N \quad \alpha = 30^\circ \quad \mu = 0.2$

Distance moved $= 50\,m \quad F_{up} = ? \quad W = ?$

F_{up} = friction force + force of gravity

$= \mu R \cos\alpha + W \sin\alpha$

$= 0.2 \times 200 \times \cos 30^\circ + 200 \sin 30^\circ$

$= 134.64\,N$ ✱

$W = F \times d$

$= 134.64\,N \times 50\,m$

$= 6732\,J$ ✱

2/0

Q/c) On a inclined plane, a body which weighs 50N requires a force of 35N to pull it up the incline. If the coefficient of friction is 0.25. Find the angle of incline.

$W = 50N \quad F_{up} = 35N \quad \mu = 0.25 \quad \alpha = ?$

F_{up} = friction force + force of gravity

$= \mu R \cos\alpha + W \sin\alpha$

$35 = 0.25 \times 50 \times \cos\alpha + 50 \times \sin\alpha$

$R = \sqrt{1 - \sin^2\alpha}\,\cos\alpha$

$$\frac{F_{up}}{\sin(\phi + \alpha)} = \frac{F_d}{\sin(90 + \phi)}$$

$$\frac{35}{\sin(142' + \alpha)} = \frac{50}{\sin(90 + 142')}$$

$$\sin(142' + \alpha) = \frac{35 \cos 142'}{50}$$

$$\sin(142' + \alpha) = 0.679$$

$142' + \alpha = \sin^{-1} 0.679 = 42'46'$

$\alpha = 42'46' - 14'2' = 28'44'$ ✱

(10) A cutting weight 1.12 kN and rest on an inclined which rises 1 in 5. If the coefficient of friction between the cutting and the plane is 0.32 find the force required to moves it (1) up the plane (2) down the plane.

W = 1.12 kN = 1120 N

Rad: 5, 1, ring

$\sin\alpha = \frac{1}{5} = 0.2$

$\alpha = 11°32'$

$\mu = 0.32$ $F_{up} = ?$, $F_{down} = ?$

University: 1, 5, 1 ring

F_{up} = Friction force + force of gravity

$= \mu W\cos\alpha + W\sin\alpha$

$= 0.32 \times 1120 \times \cos 11°32' + 1120 \sin 11°32'$

$= 575.5$ N

F_{down} = Friction Force − force of gravity

$= 0.32 \times 1120 \times \cos 11°32' - 1120 \sin 11°32'$

$= 124.2$ N

(11) A mass of 500 kg stands on a ramp inclined at 18°12' to the horizontal, the coefficient of friction between the surface of the mass and ramp being 0.27. If it is allowed to move from rest find the acclaration of the mass down the plane, the velocity after 6 sec the distance moved in this time.

mass = 500 kg $W = 500 \times 9.81 = 4905$ N

$\alpha = 18°12'$ $\mu = 0.27$ $V_i = 0$ $t = 6$ sec $a = ?$

dist = ? $V_{final} = ?$

F_{down} & F_{down} = Friction force − $W\sin\alpha$

$= \mu W\cos\alpha - W\sin\alpha$

$= 0.27 \times 4905 \times \cos 18°12' - 4905 \sin 18°12'$

$= -274$ N ✱

− ve show the plane is sufficient steep the body will slide down itself.

$F = 274$ N $= m \times a$

$a = \frac{274}{500} = 0.548$ cm/sec^2 ✱

$a = \frac{V_f - V_i}{t}$

$V_f = a \times t = 0.548 \times 6 = 3.286$ cm/sec

dist moved = avg velo × time

$= \frac{V_f + V_i}{2} \times t$

$= \frac{0 + 3.288}{2} \times 6$

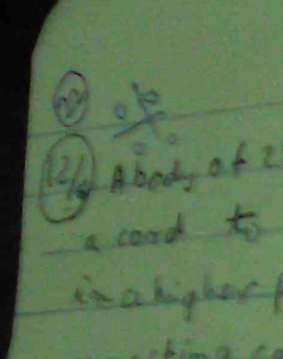
$= 9.864$ cm ✱

(12/6) A body of 25N on an inclined plane is connected by a cord to another of 50N weight what is in a higher position on the same plane and the connecting cord is parallel to the plane. The coefficient of friction between the bodies and the plane are 0.15 and 0.3 respectively If the inclination of the plane is such that the connected system is just on the verge of sliding, find the angle of the plane inclined and the tension in the cord.

W = 25N W_{large} = 50N

Small

$\mu_s = 0.15$ $\mu_L = 0.3$ $\alpha = ?$ $T = ?$



at static at repose condition.

(rest - static)

First

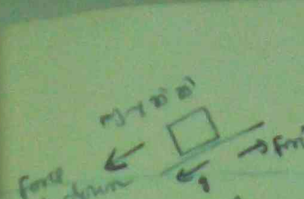
Small μ => will slide down

Second

larger μ will remain at rest

for small $F_{hold} = W\sin\alpha - \mu W\cos\alpha$

$= 25\sin\alpha - 7.5\cos\alpha$ —①



Force toup = fri + grav:

Force dom = fri − grav:

Force tohold = grav: − friction

★ For large

$F_{down} = \mu W\cos\alpha - W\sin\alpha$

$= 0.3 \times 50\cos\alpha - 50\sin\alpha$

$= 15\cos\alpha - 50\sin\alpha$ —②

$F_{down} = F_{hold}$ $25\sin\alpha - 7.5\cos\alpha = 15\cos\alpha - 50\sin\alpha$

$75\sin\alpha = 13.75\cos\alpha$

$\tan\alpha = 13.75/75 = 14°2'$

$T = F_{hold}$ (or) F_{down}

$= 15\cos\alpha - 50\sin\alpha = 50\cos 14°2' - 50\sin 14°2'$

$= 2.42N$

(13/6) The force required to pull a body up an inclined plane of 16°16' and the force to pull it down is 10 N Find the weight of the body in resting the coefficient of friction between the surface

$\alpha = 16°16'$ F. 10N down

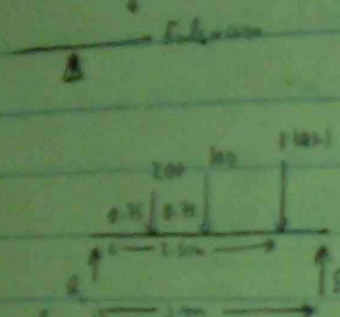
$F_{up} = \mu W\cos\alpha + W\sin\alpha$

$\begin{cases} 109 = \mu W\cos 16°16' + W\sin 16°16' & —① \\ 10 = \mu W\cos 16°16' - W\sin 16°16' & —② \end{cases}$

① − ② => $99 = 2W\sin 16°16'$

$W = \frac{99}{2\sin 16°16'} = 267.8N$

0.25, 1.5 and 2.5m respectively from the left end.



$R_1 = ?$ $R_2 = ?$

Taking moment about R_1

$\Sigma \circlearrowleft M = \Sigma \circlearrowright M$

$R_2 \times 2 = 200 \times 0.75 + 100 \times 1.5 + 120 \times 2.5$

$R_2 = \frac{150 + 150 + 300}{3}$

$= 200N$ ✱

Taking $\Sigma \uparrow F = \Sigma \downarrow F$

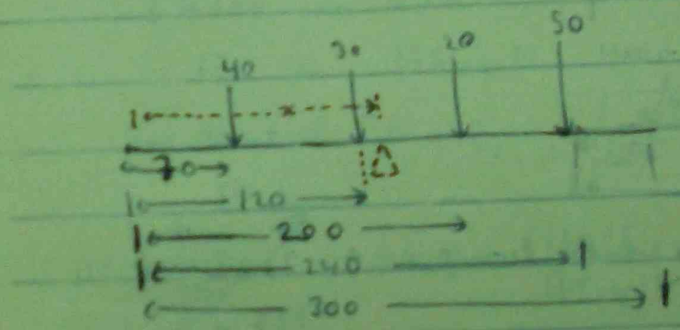
$R_1 + R_2 = 200 + 100 + 120$

$R_1 + 200 = 200 + 100 + 120$

$R_1 = 320N$ ✱

(1/7) A bar 500mm long carries loads of 40, 30, 20 and 50N at distances of 70, 170, 200 and 240mm respectively from the left end.

Neglecting the weight of the bar, calculate the position to place a single support so that the bar will balance.



assumption

the support (R) will be between the 30N and 20N for loads, x mm from left end.

In equilibrium

$\Sigma \circlearrowleft M = \Sigma \circlearrowright M$

$40(x-70) + 30x(x-170) = 20 \times (200-x) + 50x(240-x)$

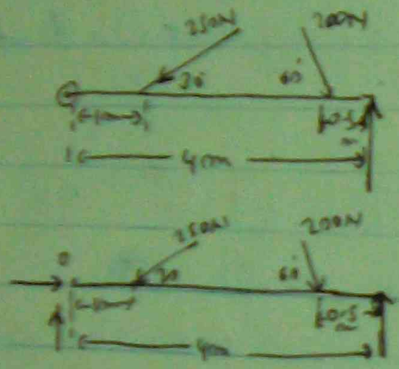
$40x - 2800 + 30x - 3600 = 4000 - 20x + 12000 - 50x$

$40x + 30x + 20x + 50x = 4000 + 12000 + 2800 + 3600$

$140x = 22400$

$x = 160mm$ ✱

Ex A horizontal beam 4m long is hinged at one end and simply supported at the other end, and carries inclined loads as shown in fig. Neglecting the weight of the beam find the resistance at each end.



250N tend → vertical component = $250\sin 30°$

$= 125\,N \downarrow$

horizontal component = $250\cos 30°$

$= 215.3\,N$

for 200N tends → vertical component = $200\sin 60°$

$= 173.2\,N$

horizontal component = $200\cos 60°$

$= 100\,N$

assumption → F is to the Right hand side moment about o, in equilibrium

$\Sigma \circlearrowleft m = \Sigma \circlearrowright m$

$R_2 \times 4 = 125 \times 1 + 173.2\,[4 - 0.5]$

$R_2 = \dfrac{125 + 606.2}{4} = 182.8\,N \uparrow$

$\Sigma \uparrow F = \Sigma \downarrow F \rightarrow R_1 + R_2 = 125 + 173.2$

$R_1 = 125 + 173.2 - 182.8$

$= 115.4\,N \uparrow$ *

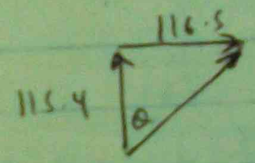
$\Sigma \overrightarrow{\text{Forces}} = \Sigma \overleftarrow{\text{forces}}$

$F + 100 = 216.5$

$F = 116.5\,N$

Resultant of F and $R_1 = \sqrt{F_0^2 + R_1^2} = \sqrt{116.5^2 + 115.4^2}$

$= 164\,N$



$\tan\theta = \dfrac{116.5}{115.4} \Rightarrow \theta = 45°15'$

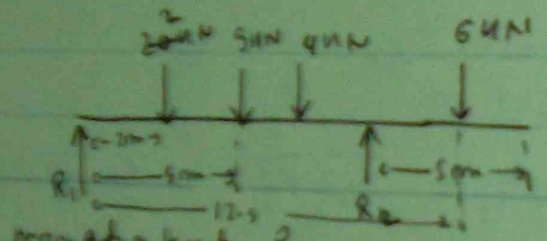
Right hand Reaction = 182.8N ↑

Reaction at hinge 164 N, 45°15' from vertical clockwise

(-) shows the opposite direction of F

* ≈ 182.8 N

(4/7) A beam of uniform section is 15m long and weighs 4 kN. It is simply supported at the left end and at 5m from the right end and carries loads of 2, 5 and 6 kN at 2, 5 and 12.5m respectively from the left end. Find the reactions.



moment about R_1,

$\Sigma \curvearrowleft M = \Sigma \curvearrowright M$

$R_2 \times 10 = 2 \times 2 - 5 \times 5 + 4 \times 7.5 + 6 \times 12.5$

$R_2 = 18.4$ kN

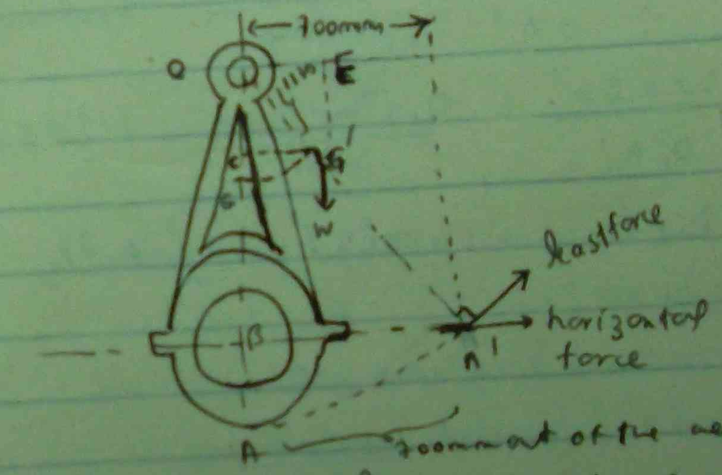
$\Sigma \uparrow F = \Sigma \downarrow F$

$R_1 + R_2 = 2 + 5 + 4 + 6$

$R_1 = 17 - 13.4$

$= 3.6$ kN

(5/7) A connecting rod is 2100mm long between its top and bottom end centres, its weight is 9.24 kN and its centre of gravity is at 1170mm from the top end. If it hangs freely from the top, find the least force required at the bottom end to pull it 7.00mm out of the vertical. Find also the force required if it is applied in a horizontal direction.



$OA = OA' =$ length of rod $= 2100$mm

$W =$ wt of rod $= 0.24$ kN

$OG = OE' = 1170$mm

The least force is when we have the maximum perpendicular distance

$\Sigma \circlearrowleft m = \Sigma \circlearrowright m$

least force $\times OA' = W \times OB$

$R \times OA' = W \times CG'$

similar triangle $\triangle CG'A$ & OBA'

$$\frac{CG'}{BA'} = \frac{OG'}{OA'}$$

$$CG' = \frac{OG' \times BA'}{OA'} = \frac{1170 \times 700}{2100} \rightarrow 390\,mm$$

$$\text{Least force} = \frac{W \times CG'}{OA'} = \frac{9.24 \times 390}{2100} \rightarrow 1.715\,kN$$

~~least force~~ when the force is applied horizontally

$\Sigma \circlearrowleft m = \Sigma \circlearrowright m$

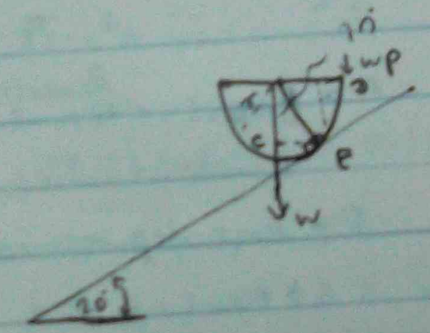
horizontal force $\times OB = W \times OE$

$$\text{horizontal force} = \frac{W \times OE}{OB}$$

$$= \frac{W \times CB'}{OB} = \frac{9.24 \times 390}{\sqrt{OA'^2 - BA'^2}}$$

$$= \frac{9.24 \times 340}{\sqrt{2100^2 - 700^2}} = 1.22\,kN$$

A solid hemisphere of mass 22.68 kg stands on its curved surface on a plane inclined at 20 degrees to the horizontal, the friction of the surfaces being sufficient to prevent sliding. Calculate the downward vertical force required to ~~so~~ apply at the periphery of its flat surface to make the hemisphere rest in a position with its flat surface horizontal.



$wp = 2$ C = Turning point

on equilibrium, moment to w must be equal moment due to wp

$\Sigma \circlearrowleft m = \Sigma \circlearrowright m$

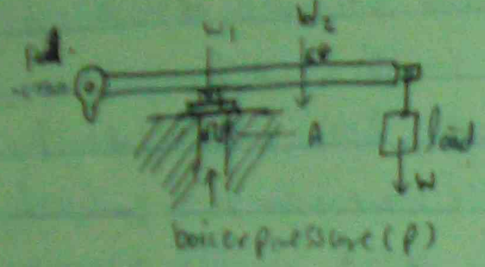
$w \times CD = wp \times DE$

$w r \sin 20 = wp [r - r \sin 20]$

$$wp = \frac{w \sin 20}{1 - \sin 20} = \frac{22.68 \times 9.81 \times \sin 20}{1 - \sin 20}$$

$= 115.6\,N$

lever safety valve



W_1 = weight of valve (N)
W_2 = weight of lever (N)
W = weight of load (N)
L = length of lever (m)
x = distance from fulcrum to valve (m)
y = " " " to cod
lever (m)
A = Cross sectional area of valve (m^2)
P = Max allowable pressure of steam (N/m^2)

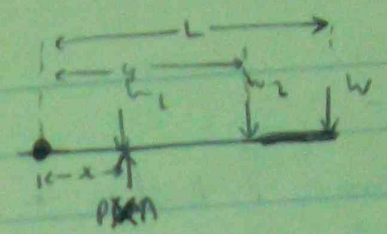
moment about fulcrum

$\Sigma M_{cw} = \Sigma M_{ac}$

$(P \times A)x = W_1 x + W_2 y + WL$

$PAx = W_1 x + W_2 y + WL$

(1) 3/3 A lever safety valve blows off at 7 bar when the load on the end is 320N and at 10 bar when the load is 480N. Distance from fulcrum and to load 625mm, To valve centre 100mm, to centre of gravity of lever 275mm and the weight of the lever is 40N.
Calculate the diameter of the valve.



given data

$W_1 = ?$, $W_2 = 40N$, $W = 320N, 480N$

$x = 100mm$, $y = 275mm$, $L = 625mm$

$P_1 = 7 bar$, $P_2 = 10 bar$

$\Sigma M_{cw} = \Sigma M_{ac}$

$PAx = W_1 x + W_2 y + WL$

(1) $7 \times 10^5 A \times 0.1 = 0.1 \times W_1 + 40 \times 0.275 + 310 \times 0.025$ — (i)

$\times 10 \rightarrow$

$10 \times 10^5 A \times 0.1 = 0.1 W_1 + 40 \times 0.275 + 480 \times 0.625$ — (ii)

(1) $y \Rightarrow$ $70,000 A = 0.1 W_1 + 211$ — (iii)

$100000 A = 0.1 W_1 + 311$ — (iv)

$30000 A = 100$

$\therefore A = \frac{100}{30000} = \frac{1}{300} m^2$

$\frac{\pi}{4} \times d^2 = \frac{1}{300} \times (10^3)^2 mm^2$

$d = 65.1mm$ #

Centers of Gravity

The center of gravity of a mass is that point through which the weight of the mass may be considered as acting. The term centroid would be used instead of center of gravity.

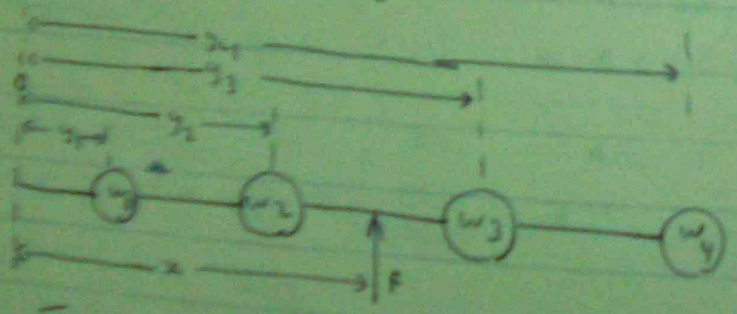
① Centroid (or) I.C of parallelogram = intersection of diagonals.

② Triangle = 1/3 × height from base.

③ Pyramid/Cone = 1/4 height from base

④ Semi circular area = $\frac{4r}{3\pi}$ from diameter

⑤ Semi plane = $2/3\,r$



The center of gravity of a system of load can be found by taking moments.

x = required position of the support from the end taking moment about end 00,

$\Sigma \downarrow m = \Sigma \downarrow m \Rightarrow F \times x = w_1 y_1 + w_2 y_2 + w_3 y_3 + w_4 y_4$

$\Sigma \uparrow F = \Sigma \downarrow$ forces

$F = w_1 + w_2 + w_3 + w_4$

$$x = \frac{w_1 y_1 + w_2 y_2 + w_3 y_3 + w_4 y_4}{F}$$

$$x = \frac{w_1 y_1 + w_2 y_2 + w_3 y_3 + w_4 y_4}{w_1 + w_2 + w_3 + w_4}$$

$$x = \frac{\Sigma \text{ of moments of weights}}{\Sigma \text{ of weight}}$$

but weight = volume × specific weight

$$\therefore x = \frac{\Sigma \text{ volume} \times \text{specific weight} \times \text{leverage}}{\Sigma \text{ volume} \times \text{specific weight}}$$

$$= \frac{\Sigma \text{ moment of volume}}{\Sigma \text{ volumes}}$$

but volume = area × thickness,

for uniform section of system we can cancel the thickness.

$$\therefore x = \frac{\Sigma \text{ area} \times \text{thickness} \times \text{leverage}}{\Sigma \text{ area} \times \text{thickness}}$$

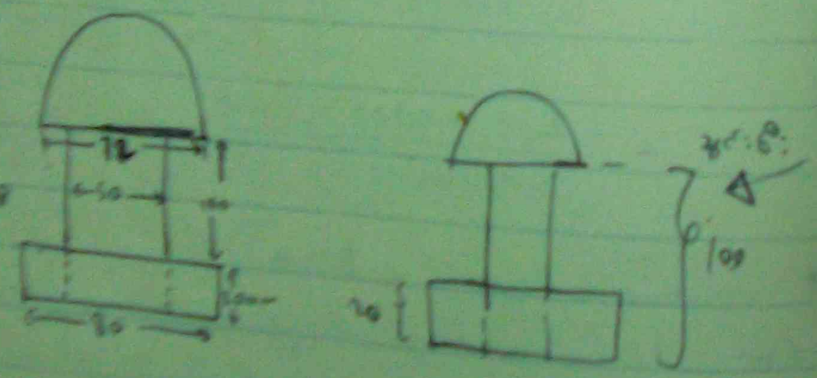
$$= \frac{\Sigma \text{ moments of area}}{\Sigma \text{ areas}}$$

1st moment of area = area × leverage

2nd " = Area × (leverage)² (r)

= moment of area × leverage

Ex The pin of a fork joint is 50mm diameter, the shank is 100mm long, and the head is a hemisphere 75mm dia. A circular ring washer 90mm diameter and 20mm thick is fitted on the shank in such a position as to leave room between head and washer. The whole is of similar material calculate the position of centre of gravity. the assembly from the end of the shank:



volume of head = $\frac{4}{3}\pi r^3 \times \frac{1}{2} = \frac{2}{3} \times \pi (75/2)^3$

$= \frac{1}{12}\pi(75)^3 = \frac{1}{2}\pi(75)^3$

$= \pi \times 211 \times 10^3 \text{ mm}^3$

c.g of head from $o_0 = 100 + \frac{3}{8} \times 36 = 113.5$ mm

volume of shank $= \frac{\pi}{4} d^2 h = \frac{\pi}{4} \times (50)^2 \times 100 = \pi \times 62.5 \times 10^3 \text{ mm}^3$

c.g of shank from $o_0 = \frac{1}{2} \times 100 = 50$ mm

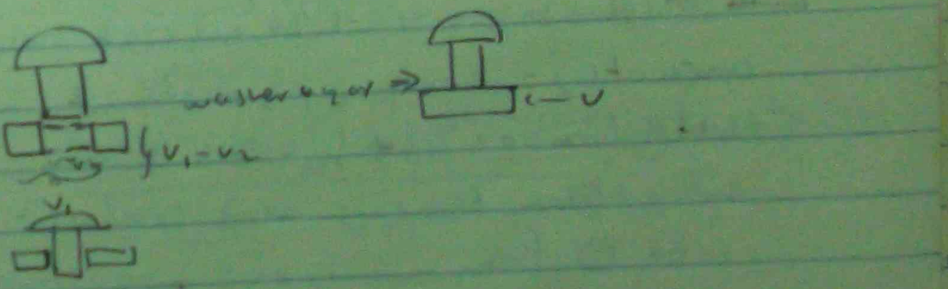
volume of washer $= \left[\frac{\pi}{4} 80^2 - \frac{\pi}{4} 50^2\right] \times 20 = \pi \times 19.5 \times 10^3 \text{ mm}^3$

c.g of washer from $o_0 = 10 + \frac{1}{2} \times 20 = 20$ mm

$$\bar{x} = \frac{\Sigma \text{moments of volumes}}{\Sigma \text{volumes}}$$

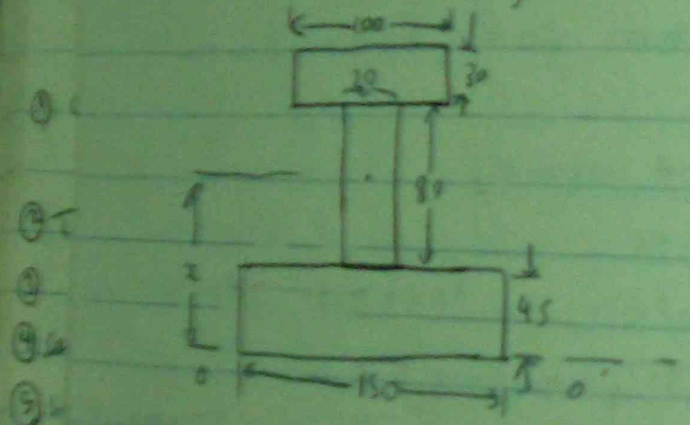
$$= \frac{\pi \times 31.4 \times 10^3 \times 113.5 + \pi \times 63.5 \times 10^3 \times 50 + \pi \times 19.5 \times 10^3 \times 20}{\pi \times 31.4 \times 10^3 + \pi \times 63.5 \times 10^3 + \pi \times 19.5 \times 10^3}$$

= 62.29 mm from o_0



(Ex) A steel plate of uniform thickness is composed of three rectangles and its dimension are given in fig. Find the position of its center of gravity from the bottom edge. So.

all dimension are given in mm x̄ = ?



area of ① = 100 * 30 = 3x10³ mm²

CG of ① from xx = 45 + 30 + ½ x 30 = 140 mm

area of ② = 80 x 20 = 1.6 x 10³ mm²

CG of ② from oo = 45 + ½ x 80 = 85 mm

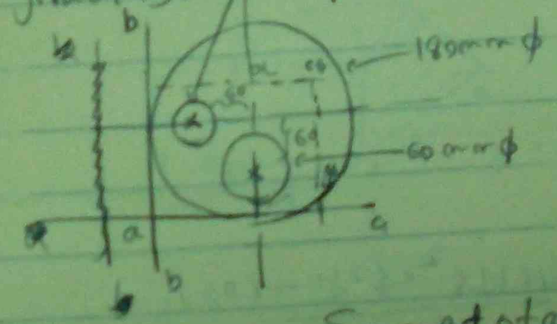
area of ③ = 150 x 45 = 7.3 x 10³ mm²

CG of ③ from oo = ½ x 45 = 22.5 mm

x̄ = Σ moment of area / Σ areas = (3x10³ * 140 + 1.6x10³ x 85 + 7.3x10³ x 22.5) / (3x10³ + 1.6x10³ + 7.3x10³)

= 60.9 mm from oo

(Ex) A circular plate of uniform thickness is 180 mm dia: has two circular holes. one hole is 60 mm dia: its centre ~~beats~~ being at 60 mm from the plate centre and the other hole is 50 mm dia: its centre being at 50 mm from the plate centre. The centre of the hole and the plate line at the corner of a right angled triangle. Find the position of the centre of gravity.



ȳ = Σ moment of area / Σ areas

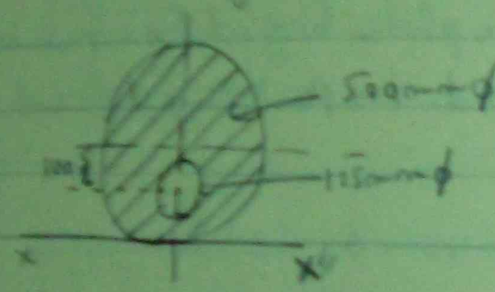
= (π/4 x 180² x 90 − (π/4 x 60² x (90 − 60) + π/4 x 30² x (90))) / (π/4 x 180² − (π/4 x 60² + π/4 x 50²))

= 46.4 mm

x̄ = (π/4 x 180² x 90 − (π/4 x 60² x 90 + π/4 x 50² x (90 − 60))) / (π/4 x 180² − (π/4 x 60² + π/4 x 50²))

= 93 mm from bb

(9) An axial shaft of uniform thickness is 500mm dia: the hole for the shaft is 125mm diameter and its centre is 100mm from the centre of the shaft. Calculate the position of centre of gravity of the shaft from its geometrical centre.



Taking moment about x x

$$\bar{x} = \frac{\pi/4 \times 500^2 \times 250 - \pi/4 \times 125^2 \times (250 - 100)}{\pi/4 \times 500^2 - \pi/4 \times 125^2}$$

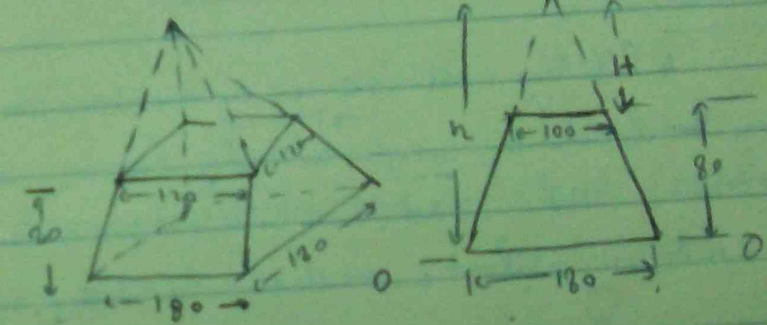
$$= \frac{500^2 \times 250 - 125^2 \times 150}{500^2 - 125^2}$$

$$= 256.66 \text{ mm from xx}$$

distance of geometrical line = 256.66 − 250

= 6.66mm

(10/7) The perpendicular height of the frustum of a square ~~pby~~ pyramid is 180mm, the sides of the base are each 180mm long, the sides of the top are 120mm long. Find the height of the centre of gravity of the frustum above the base.



Pyramid volume = $\frac{1}{3}$ × base area × height

$H/h = \frac{120}{180}$ ∴ $H = \frac{120}{120} h = \frac{120}{180}(H + 80)$

$H = 160\text{mm}$ $h = H + 80 = 160 + 80$

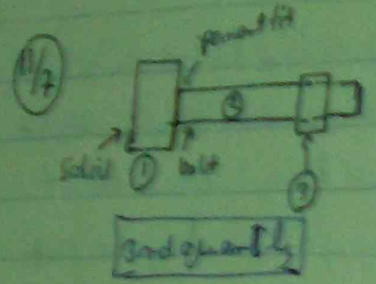
$= 240\text{mm}$

$$\bar{x} = \frac{\Sigma \text{ moments of volume}}{\Sigma \text{ of area volume}}$$

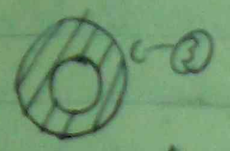
$$= \frac{\frac{1}{3} \times 120 \times 120 \times 240 \times \frac{1}{4} \times 240 - \frac{1}{3} \times 170 \times 170 \times 160 \left[80 + \frac{3}{4} \times 160\right]}{\frac{1}{3} \times 120 \times 120 \times 240 - \frac{1}{3} \times 170 \times 170 \times 160}$$

$= 34.7$ mm from base.

$\frac{1}{3} \pi r^2 H \rightarrow H/4$ CG



CO = ?



CHAPTER 8

LIFTING MACHINE

Lifting machine

A lifting machine is a mechanism designed to lift heavy loads by comparatively forces, applied to force (effort) (P), Load (W) Input work is to m/c = Input work is to m/c = lost work due to friction + useful WD

Input work done = The product of applied force and the dist moved due to this force.

useful work done = the product of load and the distance it is lifted.

- velocity ratio = $\frac{\text{dist: moved by effort}}{\text{dist: moved by load}}$ (VR)
- mechanical advantage = $\frac{\text{load lifted}}{\text{effort applied}} = \frac{W}{P}$ (MA)
- efficiency = $\frac{\text{useful WD}}{\text{work applied}} = \frac{W \times \text{dist: W moved}}{P \times \text{dist: P moved}}$.

$$= \frac{W}{P} \times \frac{1}{\frac{\text{dist: P moved}}{\text{dist: W moved}}} = \frac{W}{P} \times \frac{1}{VR} = \frac{MA}{VR}$$

load effort = is the effort at 100% efficiency

⇒ no friction.

$$\text{effcy} = 100\% \Rightarrow 1 = \frac{MA}{VR} = \frac{W/P}{VR} \Rightarrow$$

$$P = \frac{W}{VR}$$

effort to overcome friction = Actual effort − ideal effort

$$= P - \frac{W}{VR}$$

Ideal load is the load at 100% efficiency

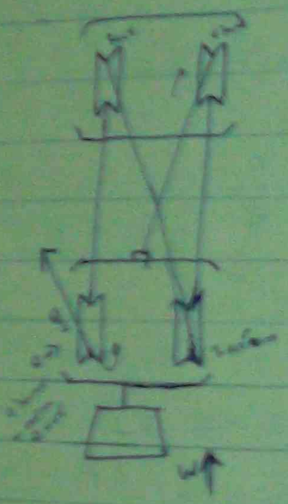
$$\Rightarrow \text{effcy} = 1 = \frac{MA}{VR} \Rightarrow 1 = \frac{W/P}{VR} \Rightarrow$$

$$W = VR \times P$$

load lost due to friction = Ideal load − actual load

$$= P \times VR - W$$

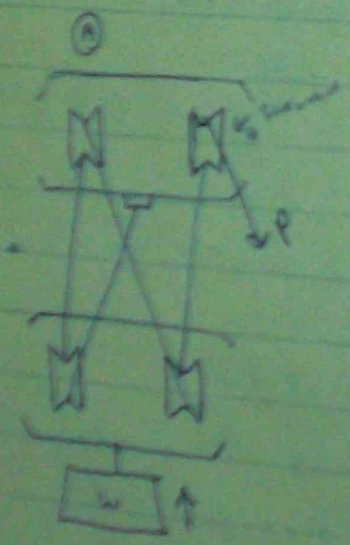
Rope pulley block



For Figure (A)

dir:- of effort & load are in same direction

∴ VR = no. of pulley in system + 1



For fig (B)

direction of effort and load are in opposite direction

VR = no. of pulley in system

eff = $\frac{MA}{VR}$

MA = $\frac{W}{P}$

VR = $\frac{\text{distance moved by effort}}{\text{distance moved by load}}$ ⇒ no. of pulleys + 1

eff = $\sqrt[n]{\text{overall eff}^{cy}}$

Efficiency of each pulley - eff:- of each pulley is not important but if it is required may find as follows.

$eff_1 \times eff_2 \times eff_3 \times etc$ = overall effcy ; here again it is assumed that every pulley has same effcy:

$$\therefore eff = \sqrt[n]{\text{overall effcy}}, \quad n = \text{no. of pulleys}$$

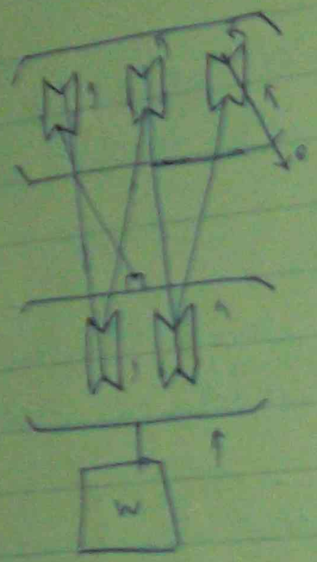
(1/8) In a set of rope pulley blocks which has 3 pulleys in the top block and 2 in the bottom an effort of 300N is required to lift a load of 1.26KN, Find the VR, MA & efficiency when lifting this load.

no. of pulley in the top = 3 P = 300N

" bottom = 2 W = 1.26KN

VR = ? MA = ? effcy = ?

$$MA = \frac{\text{load lifted}}{\text{effort}} = \frac{1.26 \times 10^3}{300} = 4.2$$

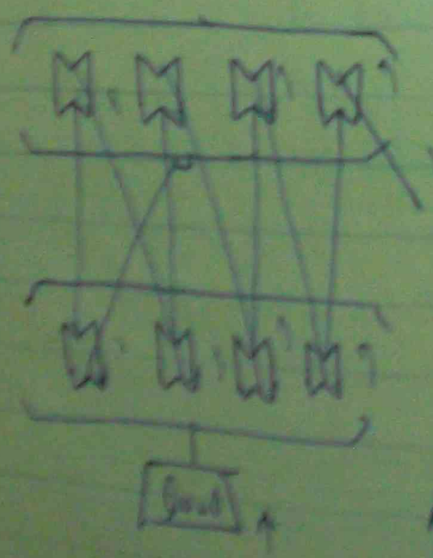


effort and load opposite direction VR = no. of pulleys

$$\text{effcy} = \frac{MA}{VR} = \frac{4.2}{5} \times 100$$

$$= 84\%$$

(2/3) Three four pulley in each block of a set of rope pulley blocks if the efficiency is 70% when lifting a load of 2.8kN, what is the effort applied? what is the efficiency of each pulley



effcy = 0.7 W = 2.8kN P=? effcy: each pulley =?

opposite direction ⇒ VR = 8

$$\therefore \text{effcy} = \frac{MA}{VR} \times 100 \longrightarrow MA = 5.6$$

overall

$$MA = \frac{W}{P}$$

$$\therefore P = \frac{W}{MA} = \frac{2.8 \times 10^3}{5.6} = 500N$$

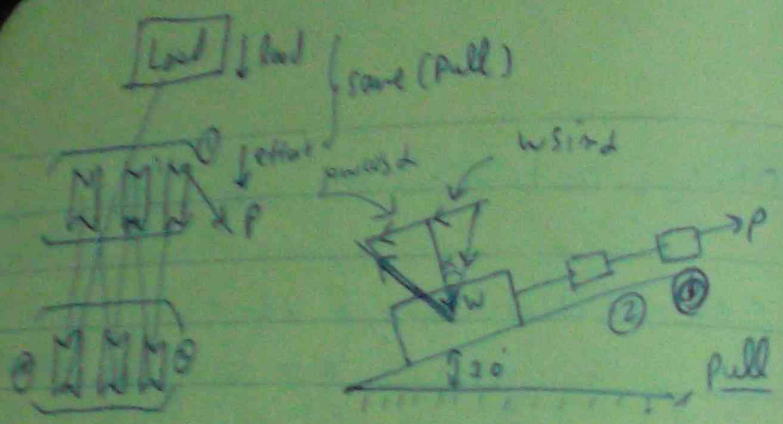
$$\text{effcy} = \sqrt[n]{\text{overall effcy}} = \sqrt[8]{0.7} = 0.96$$

$$= 96\%$$

(3/3) A set of rope pulley block with 3 pulleys in each block is used to pull a same machine up. Skids is 0.4. The at 20 degrees to the hanging the mass of the m/c and the coefficient of fraction between it and the skid is 0.9 The blocks are parallel to skid and arrange so that the pull on the force end of the rope is up the plane find the effort required assuming the effcy = of 75.

$\alpha = 20°$ $\mu = 0.4$ effcy = 0.75

wt = 1 ton = 10^3 kg = 9.81 N P = ?



Load direction VR = 6+1 = 7

effy = 0.75 = MR/VR ⇒ MA = 0.75×7

= 5.25

Load on hold → direction force to pull m/c up where

(load) W = wcosα + wsinα = 0.4×9.31×cos20 + 9.81 sin20

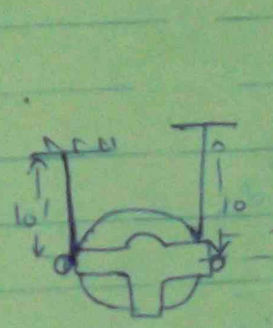
= 7.044 kN

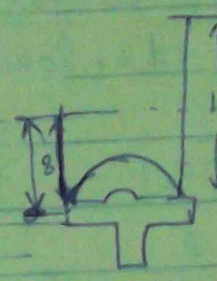
MA = W/P ⇒ 5.25 = 7.04/P kN

(same) P = 7.04/5.25 = 2.34 kN

Effect of smooth block

effect of smooth block





lifting rope moved 4m

Smooth block good

In many lifting machines the load is carried on a smooth block. A smooth block is usually single pully running freely in a frame which carries the load the rope carries down from the m/c passes around the pully & the force end to the smooth

Wheel and Differential Axle

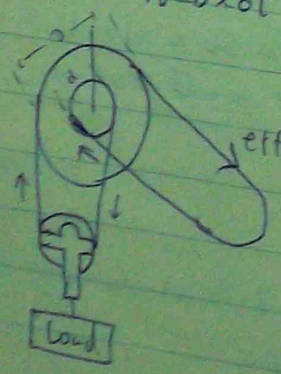
$VR = \frac{\text{Dist: moved by effort}}{\text{Dist: moved by load}}$

$= \frac{\pi D}{\frac{1}{2}(\pi d_1 - \pi d_2)} = \frac{2\pi D}{\pi d_1 - \pi d_2}$

$VR = \frac{2D}{d_1 - d_2}$ or $\frac{2R}{r_1 - r_2}$

Western differential pulley block

When the effort is applied to obtain the compound sheave, one side of the load chain is pulled upon to the large pulley the other side is lowered off the smaller pulley the movement of the load is half of this difference between lifting and lowering effects due to the chain passing around the snatch block



D = dia of large pulley in compound shave

d = " small "

dist. moved by effort = πD

load = $\frac{1}{2}(\pi D$

$VR = \frac{\pi D}{\frac{1}{2}(\pi D - \pi d)} = \frac{2D}{D-d} = \frac{2R}{R-r}$

As a chain is used instead of a rope the pulley have sprockets or teeth the pitch of the teeth is constant. Therefore the above expression can be change as follow.

$V.R = \frac{2 \times \text{no: of teeth in large pulley}}{\text{difference in no of teeth in two pulley}}$

4/8 In a wheel and differential axle type of lifting machine, a crank handle of 240 mm radius take the place of the wheel and the diameter of the differential axle are 110 mm and 80 mm respectively at the handle to lift a load of 1.12 kN find the velocity ratio mechanical Advantage and efficiency at this load.

force = 80 N

$R = 240$ mm $\quad R_1 = \frac{110}{2} = 55$ mm

$R_2 = \frac{80}{2} = 40$ mm

$W = 1.12$ kN $\quad P = ?$ $\quad VR = \frac{2R}{r_1 - r_2} = \frac{2 \times 240}{80 - 40} = 32$

$MA = \frac{W}{P} = \frac{1.12 \times 10^3}{80} = 14$

$\text{effy} = \frac{MA}{VR} = \frac{14}{32} \times 100 = 43.7\%$

$VR = \frac{\text{Distance moved by effort}}{\text{Distance moved by load}}$

$= \frac{\pi D}{\frac{1}{2}(\pi d_1 - \pi d_2)} = \frac{2\pi D}{\pi d_1 - \pi d_2}$

$VR = \frac{2D}{d_1 - d_2}$ or $\frac{2R}{r_1 - r_2}$

Weston differential pulley block

When the effort is applied to draw the chain on the unloaded side of the load chain is pulled over the large pulley the other side is taken off the smaller pulley the movement of the load is half the difference between lifting and lowering effects due to the chain passing around the movable pulley

D = Dia. of large pulley
d = Dia. of small
Load $= \frac{1}{2}(\pi D$

$VR = \frac{\pi D}{\frac{1}{2}(\pi D - \pi d)} = \frac{2D}{D-d} = \frac{2R}{R-r}$

As a chain is used instead of a rope the pulley have sprockets or teeth the pitch of the teeth is constant. Therefore the above expression can be change as follows.

VR = No. of teeth in large pulley / Difference in no of teeth in two pulleys

In a wheel and differential axle lifting machine, a crank handle of 140 mm radius take the place of the wheel and the diameter of the differential axle are 44 mm and 40 mm respectively at the handle to lift a load of 1.12 kN find the velocity ratio, mechanical advantage and efficiency at this load.

force = 50 N

$R = 140$ mm $\quad r_1 = \frac{44}{2} = 22$ mm

$r_2 = \frac{40}{2} = 20$ mm

$W = 1.12$ kN $\quad P = ?$ $\quad VR = \frac{2R}{r_1 - r_2} = \frac{2 \times 140}{44 - 40} = 70$

$M.A = \frac{W}{P} = \frac{1.12 \times 10^3}{50} = 14$

$\text{Effy} = \frac{M.A}{V.R} = \frac{14}{70} \times 100 = 20\%$

(5/8) The efficiency of a set of chain driven differential pulley block is 85%. When lifting a load of 1.89 kN. If the large and small pulleys of the compound sheave 27 and 24 teeth respectively find the effort reqd: ~~to~~ to lift this load

effy = 0.85 $W = 1.89 \times 10^3$ N No of teeth of large Pulley = 27

" Small = 24

$VR = \frac{2 \times \text{no: of teeth in large pulley}}{\text{diff: in no: of teeth in 2 pulleys.}}$

$= \frac{2 \times 27}{27-24} = 18$

$effy = \frac{MA}{VR} \Rightarrow VR = 0.85 \times 18 = 6.3$

$MA = \frac{W}{P} \Rightarrow P = \frac{W}{MA} = \frac{1.89 \times 10^3}{6.3} = 301$ N

(6/8) The dia of the small pulley of a set of differential pulley block is 130mm. When lifting a load of 560N. The effort reqd: is 50N and the efficiency is 40%. Find the dia: of the large pulley.

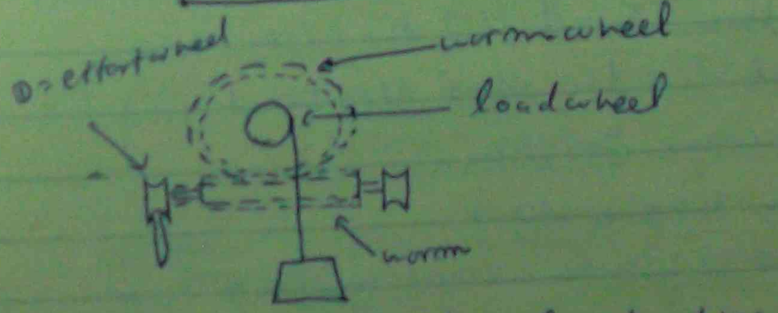
$d = 130$mm $W = 560$N $P = 50$N effy = 0.4, D = ?

$effy = \frac{MA}{VR} = \frac{\frac{W}{P}}{VR} \quad \therefore VR = \frac{W}{P \times effy} = \frac{560}{50 \times 0.4} = 28$

$VR = \frac{2D}{D-d}$

~~$D = VR\,d = 28 \times 130$~~ $D = 140$mm

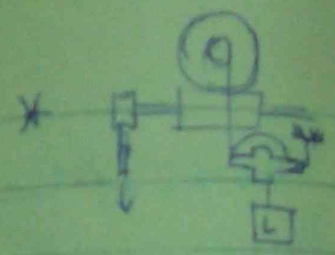
Worm and worm wheel



D = dia: of effort wheel, d = dia: of load wheel

N = no: of teeth in worm wheel

$VR = \frac{\text{dist: moved by effort}}{\text{" " " load}} = \frac{\pi D}{\frac{1}{N} \times \pi d} = \frac{DN}{d}$



If the snatch block is used.

$$VR = \frac{\pi D}{\frac{1}{2}\frac{1}{N}\pi d} = \frac{2DN}{d}$$

(9) (9/2) The effort wheel of a worm and wormwheel chain block is 200mm dia. the worm is single start and there are 40 Teeth in the wormwheel. The load wheel is 125mm dia and the load is carried by snatch block on the loop of the lifting chain from the load wheel to the framework of the machine. If the effort required to lift a load of 6720N ~~find the efficiency~~ is 150N. find (i) the effy when lifting this load (ii) the ideal effort and (iii) the effort to overcome friction.

D = 200mm single start

N = 40, d = 125mm snatch block

P = 150N, W = 6.72 KN

Efficiency? Ideal P? Overcome effort?

Worm and wormwheel ~~ratio~~ ratio ~~of~~ ~~mechanical~~ efficiency

W.H.N ~~effort~~ comp → KN (N ⇒ N effort comp ⇒ N

effort: $\eta = \frac{MA}{VR} = \frac{W/P}{\frac{2\pi N D}{d}} = \frac{6.72\times10^3/150}{2\times\frac{40\times200}{125}} = 0.35$

$= 35\%$

$\text{Ideal effy} = 1 = \frac{MA}{VR}$

$1 = \frac{W/P}{\frac{2\pi N D}{d}}$ ∴ P =

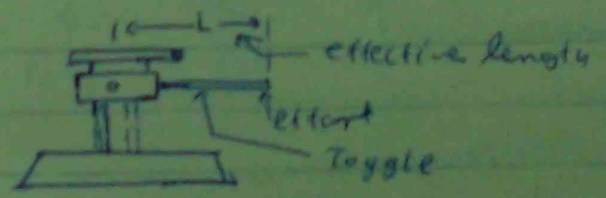
$1 = \frac{6.72\times10^3}{P\times 2\times\frac{40\times200}{125}}$

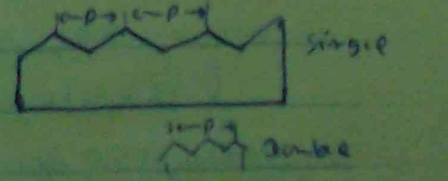
$P = 52.5\ N$

$P_{\text{overcome friction}} = P_{\text{actual}} - P_{\text{ideal}} = 150 - 52.5$

$= 97.5\ N$

Screw Jack

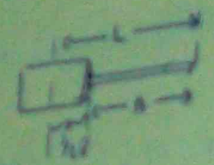




Lead = axial distance moved up (or) down when turning one revolution.

= Pitch × no. of start { 1 → for single start, 2 → for double start, 3 → for tripple start.

(Single) Lead = 1×P / Double = Lead = 2P



$L = a + 2R$

$\text{Pitch} = \frac{1}{\text{no of thread/mm}} = \frac{1}{\text{tpm}}$ — teeth/mm

$VR = \frac{\text{dist: moved by effort}}{\text{dist: moved by the load}} = \frac{2\pi L}{\text{lead}}$ ✱

(7/2) The pitch of the thread of a screw jet is 8mm and the effective length of the toggle bar is 320mm. If when lifting a load of 20kN the work lost in overcoming friction is 70%. Find the effort applied at the end of the toggle.

{ Single start: pitch × 1 = lead
Double start: pitch × 2 = lead
Triple start: pitch × 3 = lead }

Double start = Single start

Pitch = 8mm

$L = 320mm$

$W = 20kN$

loss = 70% effort = ?

$\therefore$ effcy = 30%

$= 0.3$

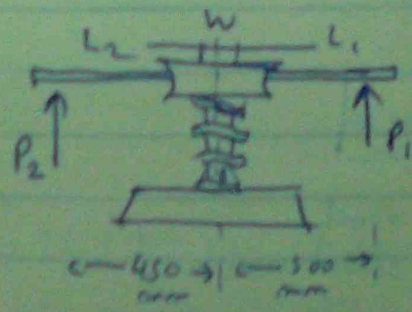
$\text{effcy} = \frac{m.a}{VR} \Rightarrow 0.3 = \frac{W/P}{\frac{2\pi L}{\text{Lead}}} \Rightarrow 0.3 = \frac{\text{work o/p}}{\text{work i/p}}$

$0.3 = \frac{W \times \text{Pitch} \times \text{no: of start}}{P \times 2\pi L}$

$\therefore 0.3 = \frac{20 \times 10^3 \times 8 \times 1}{P \times 2\pi \times 320}$

$P = \frac{20 \times 10^3 \times 8}{0.3 \times 2\pi \times 320} = 223\,N$ ✱

✱✱ (9/2) (23) Two toggles bars are used in a screw Jack to raise a carrying of 3 tonne mass. The screw thread has a pitch of 12mm. One toggle bar is 500mm long and the other toggle bar is 450mm long. Find the effort required at the end of the toggle if the efficiency is 35% when lifting the load. (The effort applied at right angles)



$W = 3\,\text{tonne} = 3 \times 10^3\,kg$

Pitch = 12mm $L_1 = 60mm$,

$L_2 = 40mm$

effcy = 0.35

$P_1 = 220N$, $P_2 = ?$

$\text{effcy} = \frac{m.a}{VR}$

$0.35 = \frac{W/P}{\frac{2\pi L_1}{\text{Lead}}} = \frac{W \times \text{Pitch} \times \text{no: of start}}{P \times 2\pi L_1}$

$$0.25 = \frac{3\times10^{3}\times 22\delta}{P\times 2\pi\times 500}$$

δ = ?

$P = 321.1\ N$

$\sum P_x L = P_1L_1 + P_2L_2$

$P_1L_1 = 220\times 512$

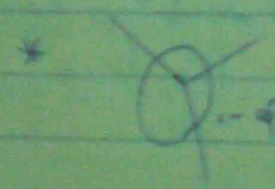
$P_2L_2 = ?$

The actual effort applied at this 200N (given data) so extra turning moment due to extra effort (321.1 − 220) is equal to turning moment due to effort applied at L_2.

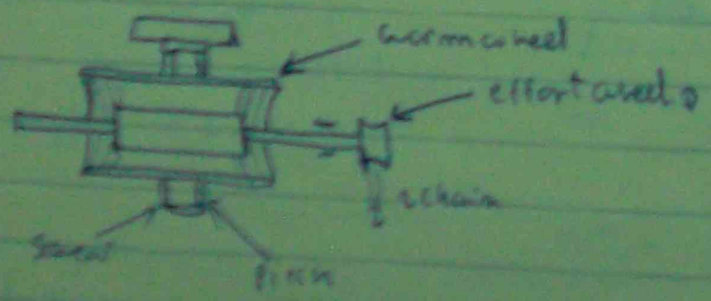
$P_2L_2 = (321 - 220)\times 500$

$P_2\times 450 = 101\times 500$

$P_2 = 112\ N$



worm lever screw jack



$V.R = \dfrac{\text{distance moved by effort}}{\text{distance moved by load}}$

$= \dfrac{\pi D N}{\text{lead}}$

N = no: of teeth in worm

D = dia: of effort wheel

Lead = pitch × no: of start (for screw)

If effort wheel rotable (turn turn) ⇒ dist: moved by effort $= \pi D$

⇒ worm 1 turn rotation.

∴ worm wheel will rotate $\frac{1}{N}$ turn

If screw rotate 1 turn → moved up lead

$\frac{1}{N}$ → $\frac{1}{N}\times$ lead

= distance moved by lead.

(14/8) Find the no: of teeth in the worm & worm wheel of a worm driven screw Jack to give a VR of 550 if the worm is single thread. The screw has pitch of 10mm and the effort wheel is 100mm diameter Assuming a effy: of 90%. find the effort reqd:

to lift a load of 50kN

N = 2 VR = 550 single start

Pitch = 16mm, D = 100mm

Effy = 0.3, Load = 50kN

$$Effy = \frac{MA}{VR}$$

$$= \frac{W/P}{\pi DN/Lead}$$

$$= \frac{W \times Pitch \times no.of\ start}{P \times \pi D N}$$

$$0.3 = \frac{50\times10^3 \times 16\times1}{P \times \pi \times 100 \times N} \quad -(1)$$

$$VR = \frac{\pi DN}{Lead} \Rightarrow 550 = \frac{\pi \times 100 \times N}{16}$$

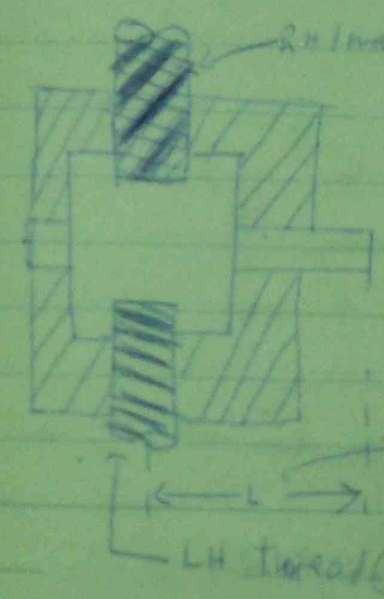
$$N = \frac{16 \times 550}{2\pi \times 100} \text{ sub (1) eqn eqn}$$

$$= 2.8$$

$$P = 3.03 kN$$

• Worm & Screw

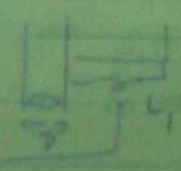
Screw both L(or) Tw buckle



$$VR = \frac{2\pi L}{Pitch_1 + Pitch_2}$$

lead = pitch × no. of start

* Duct bottle nut



$L_1 + P_2 = L$

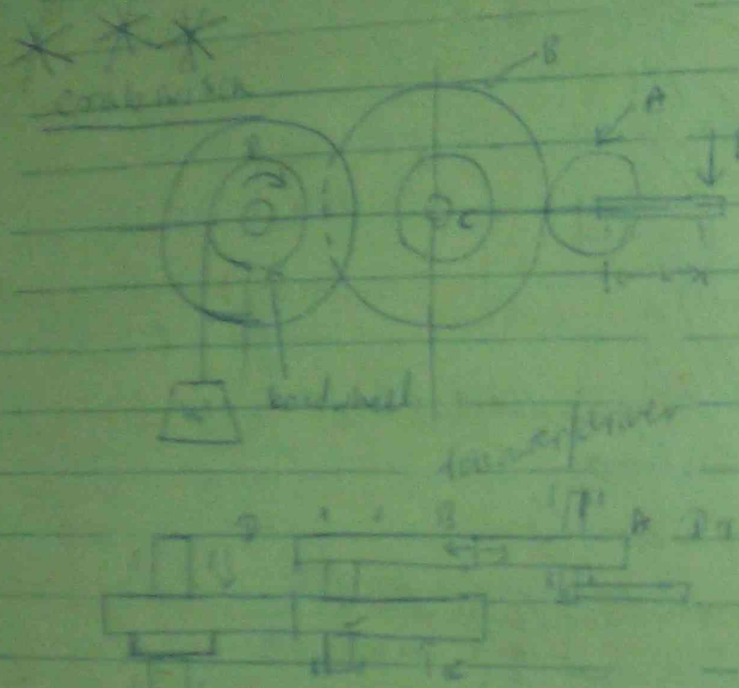
lengthen in

11/12 A worm & screw is used to tighten a gas rope. The right and left hand threads each have a pitch of 4mm and the effective length of the toggle lever is 250mm. Assuming an efficiency of 25% find the pull in the rope of rope when an effort of 40N is applied.

$P_1 = P_2 = 4mm$ Length = 250mm Effy = 0.25

Effort = 40N Load = ?

$$Effy = \frac{MA}{VR} \Rightarrow 0.25 = \frac{W/40}{\frac{2\pi \times 250}{4+4}}$$



N_A = teeth on driver (A)

N_B = " " follower (B)

N_C = " " driver (C)

N_D = " " follower (D)

Pitch of

Pitch circle radius of crank handle

Pitch circle revolution → Number of revolution

N_A = teeth on stud A → A one revolution

N_B = " → $\frac{N_A}{N_B}$ revolution of B and C

N_C = " → C one revolution

N_D = " → $\frac{N_C}{N_D}$ rev of D

If C turns one revolution Pinion turns N_C/N_D revolution.

$\therefore$ C/rev → P (N_C/N_D) rev.

C $\frac{N_A}{N_B}$ → $\frac{N_A}{N_B} \times \frac{N_C}{N_D}$ rev. of D marked on wheel

Leadscrew 1 rev: → T d moves up

" $\frac{N_A N_C}{N_B N_D}$ → T d $\frac{N_A N_C}{N_B N_D}$

$\therefore$ VR = $\frac{\text{Dist moved by P}}{\text{" " W}}$

$= \frac{2\pi L}{T d \frac{N_A N_C}{N_B N_D}}$