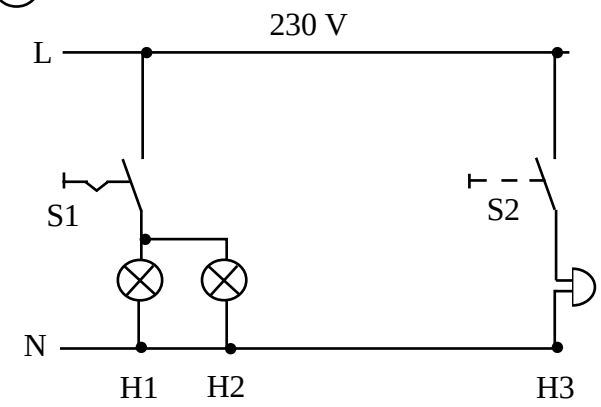
JOSÉ LUIS VALENTÍN LABARTA

INSTALACIONES ELÉCTRICAS DE INTERIOR

SOLUCIONARIO

EDITORIAL DONOSTIARRA

1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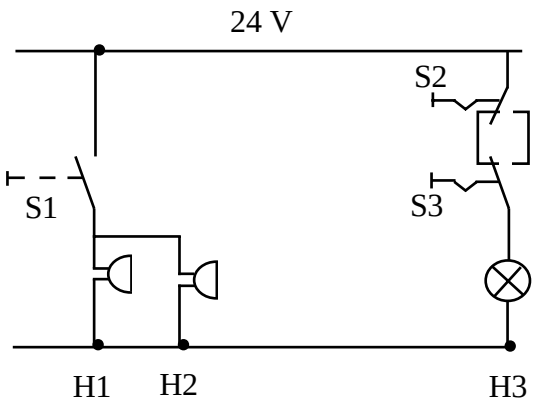
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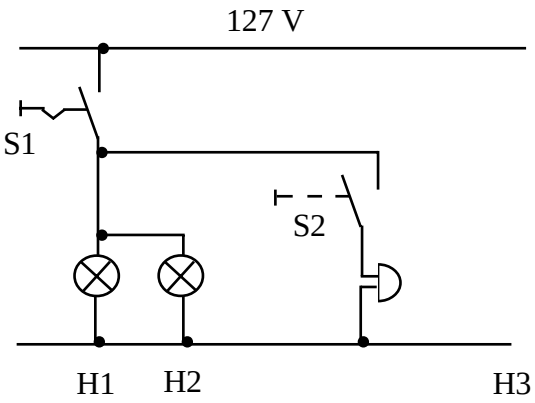
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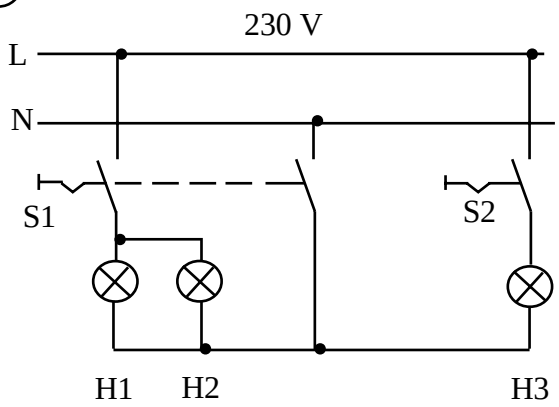
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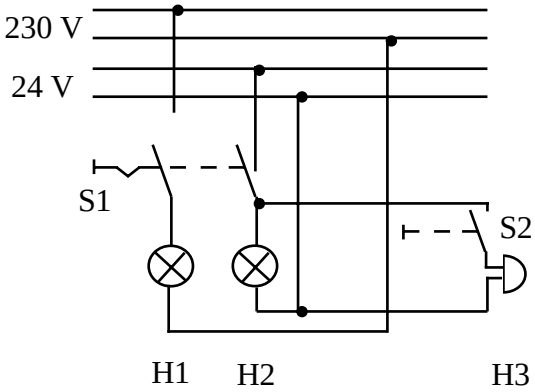
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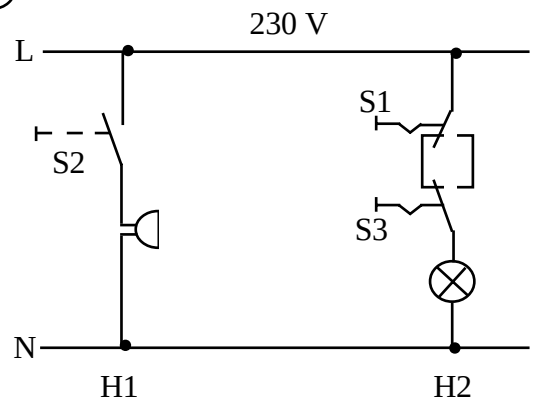
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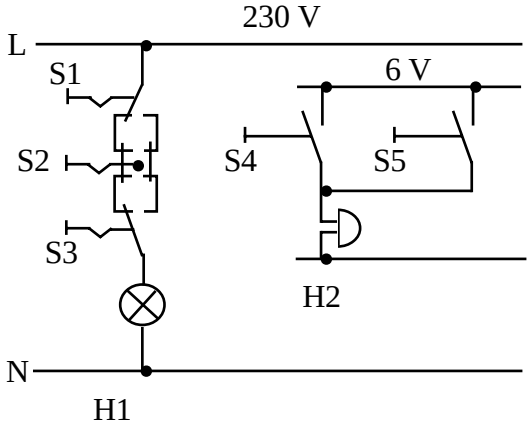
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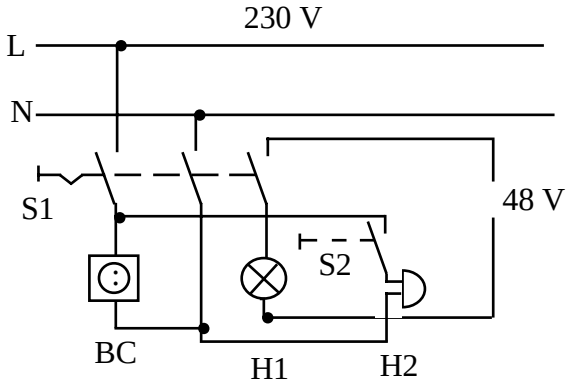
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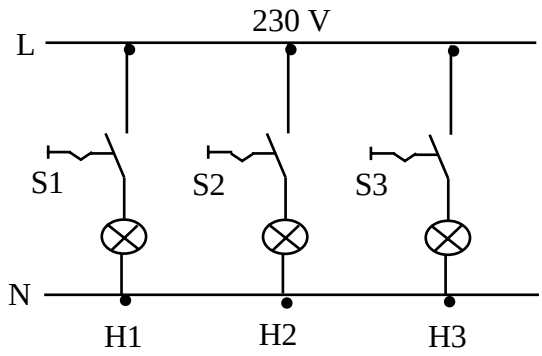
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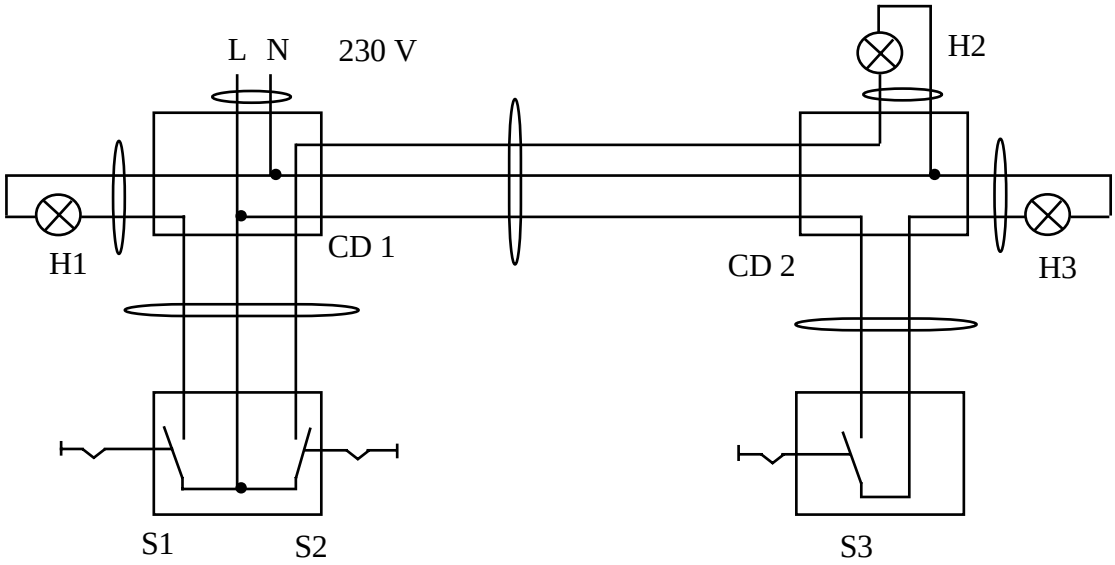
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CD 1
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S1
S2
S3

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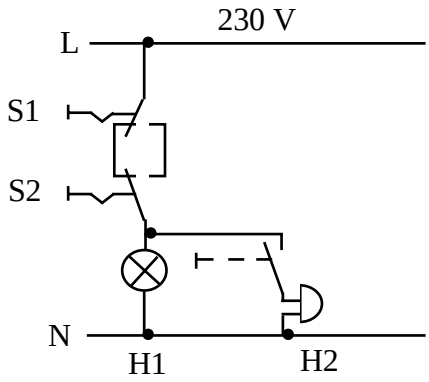
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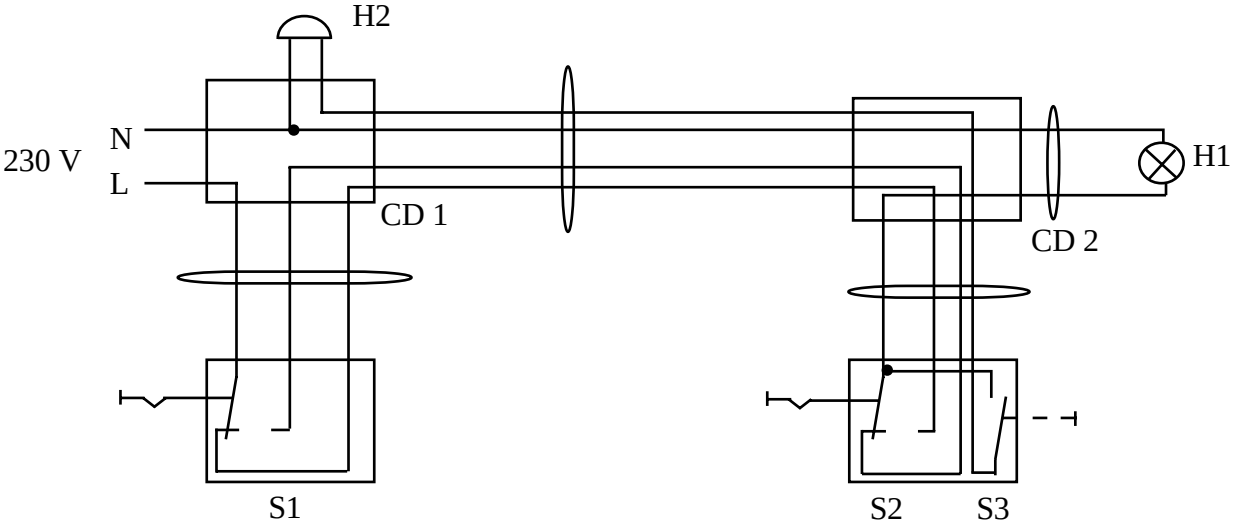
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S2
S3

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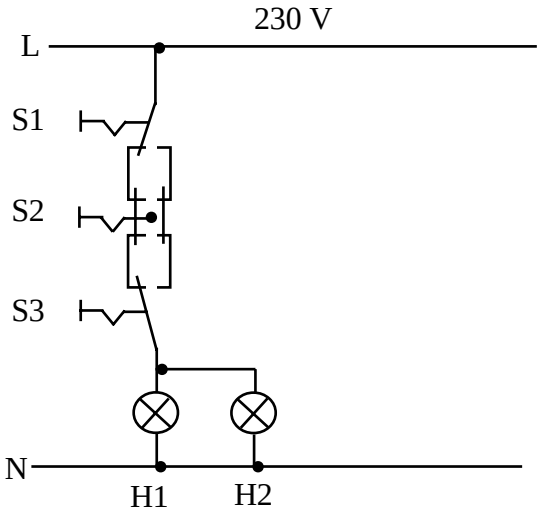

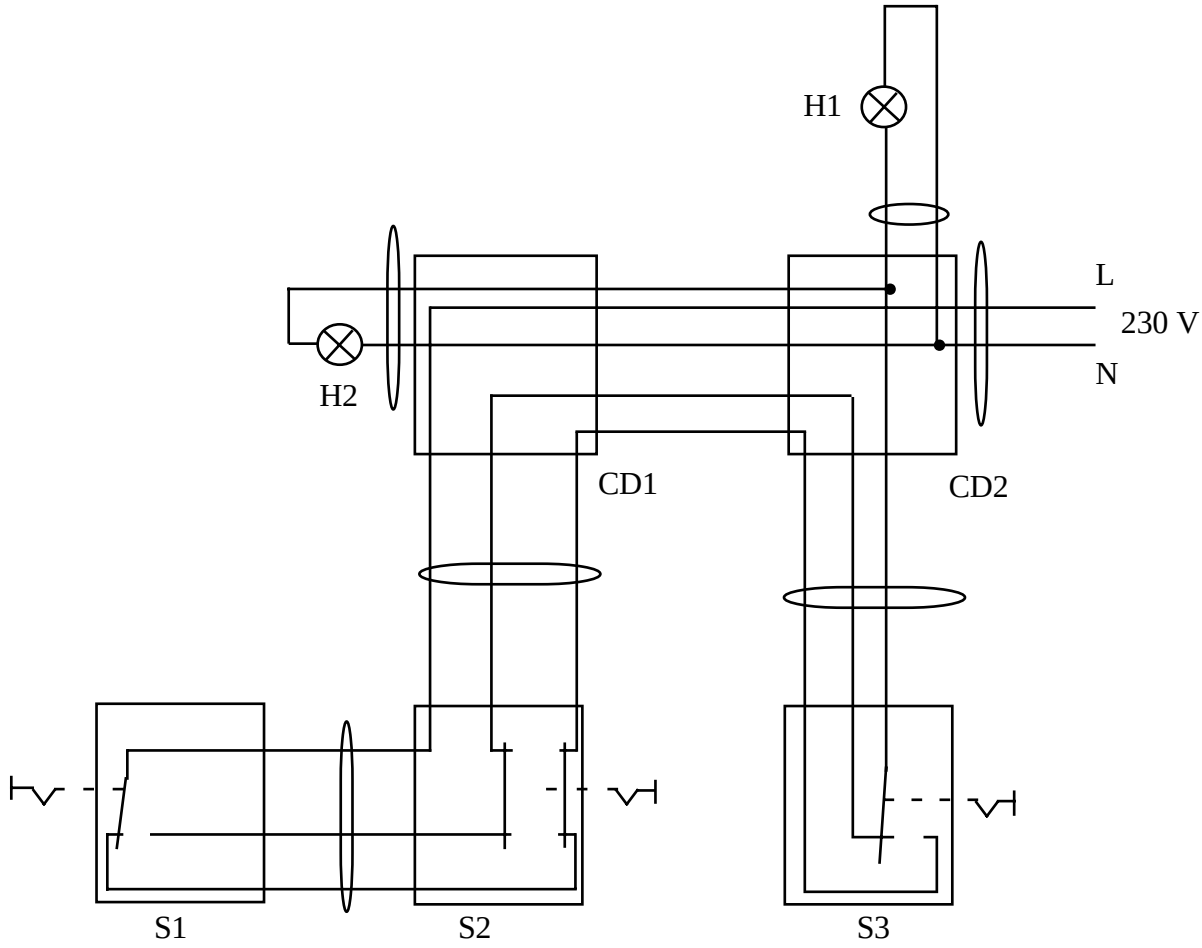

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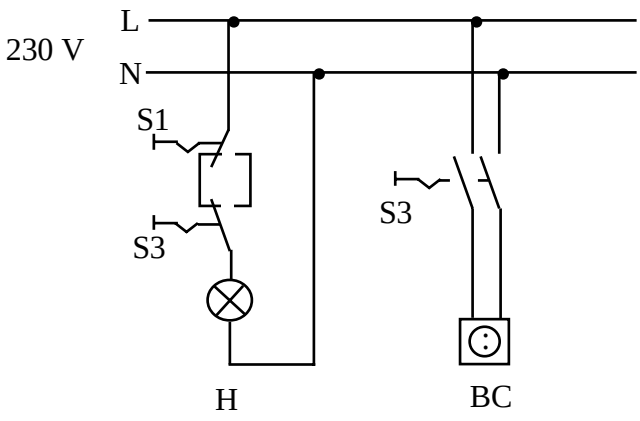

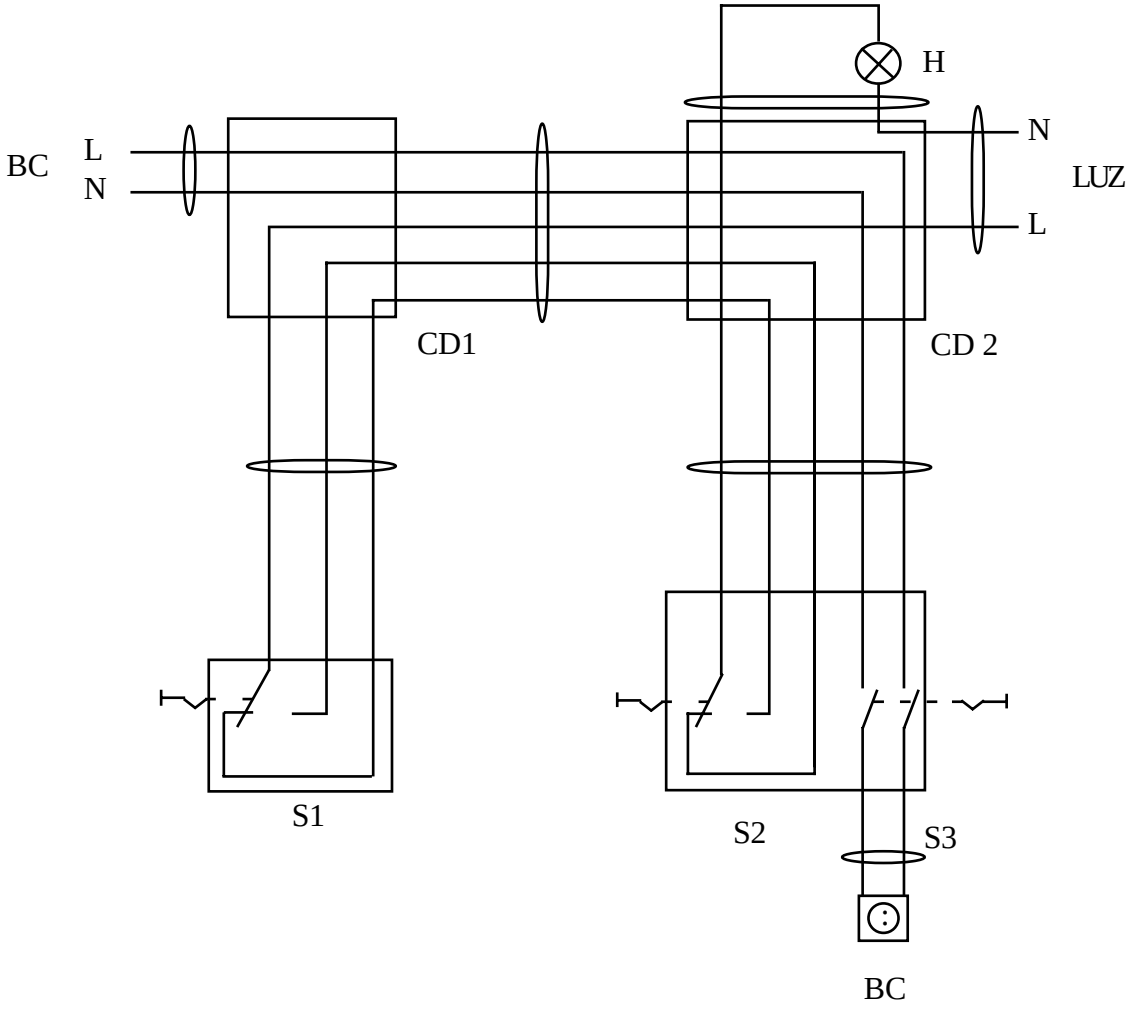

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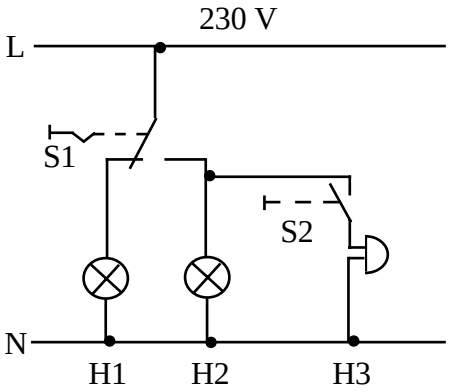

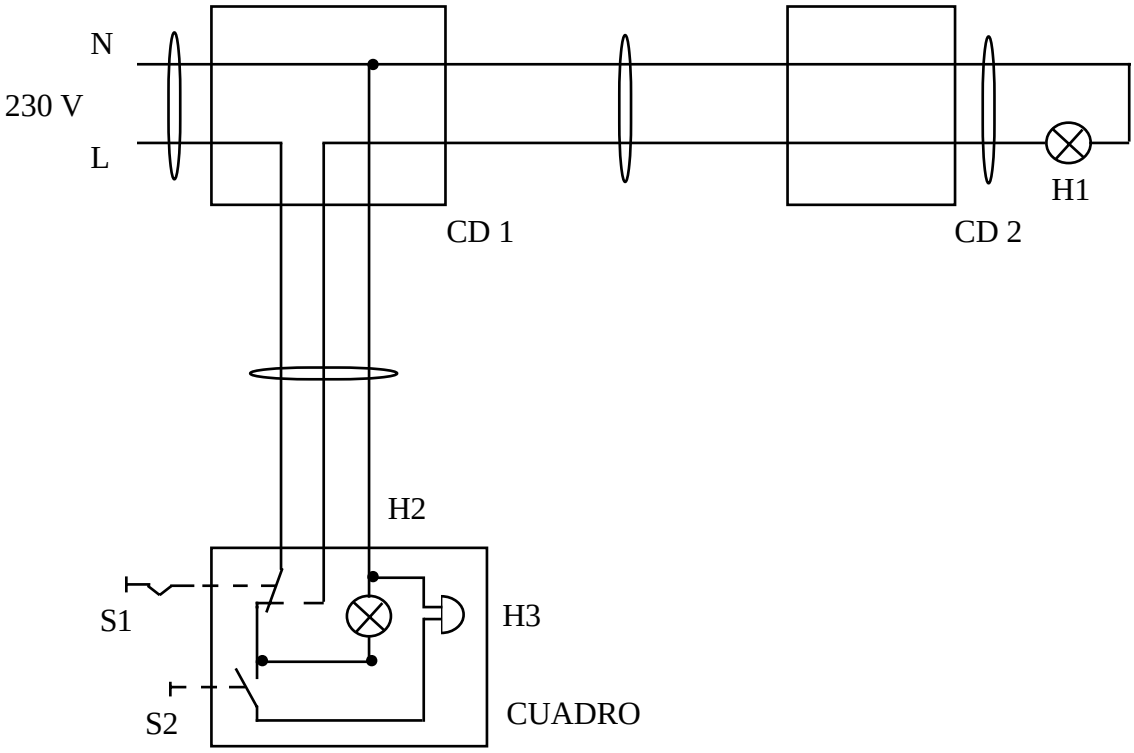

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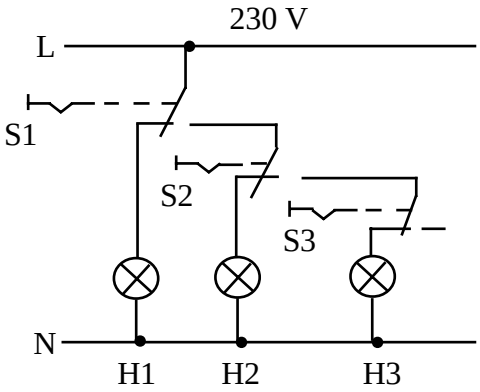

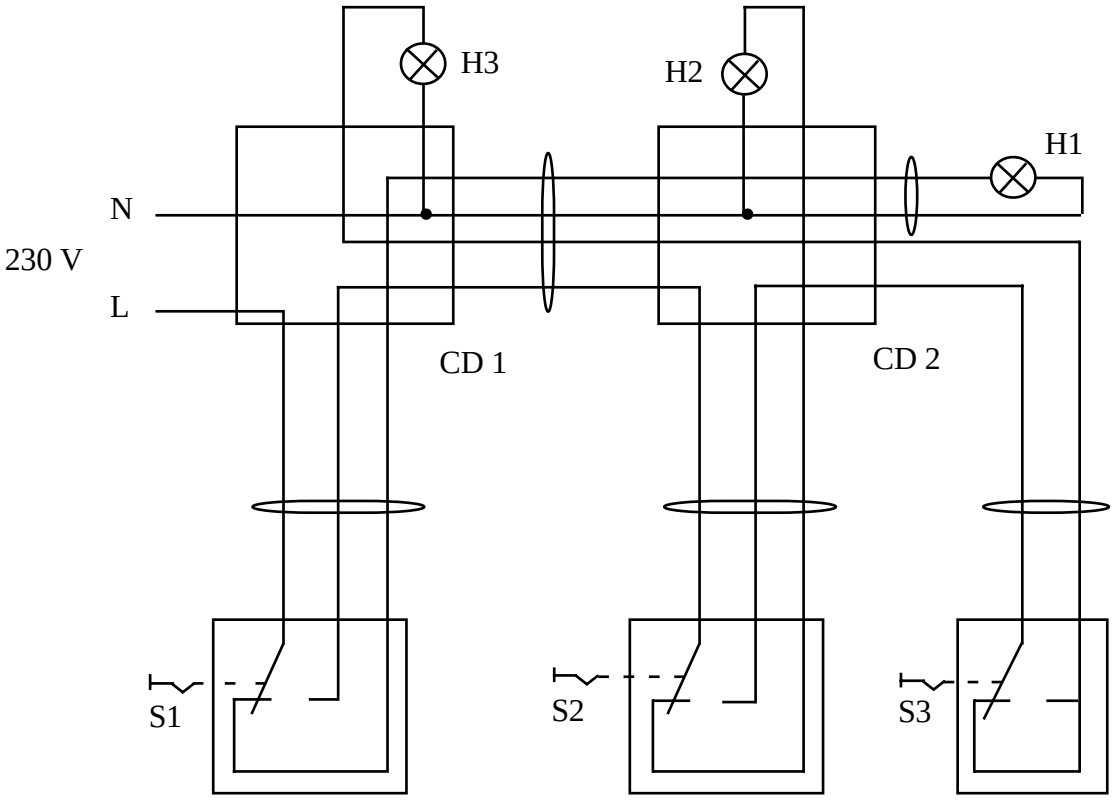

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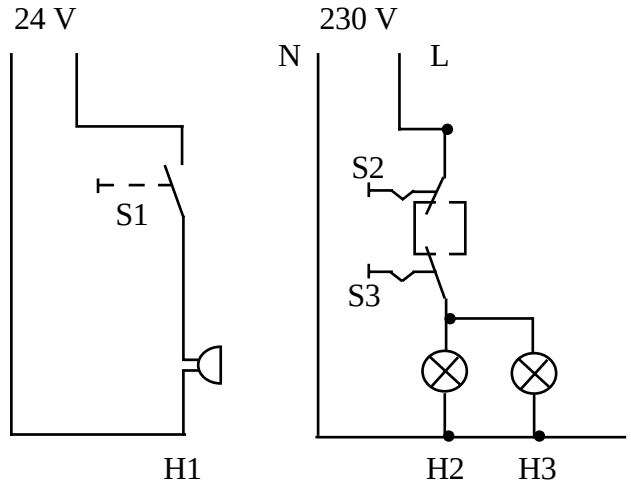

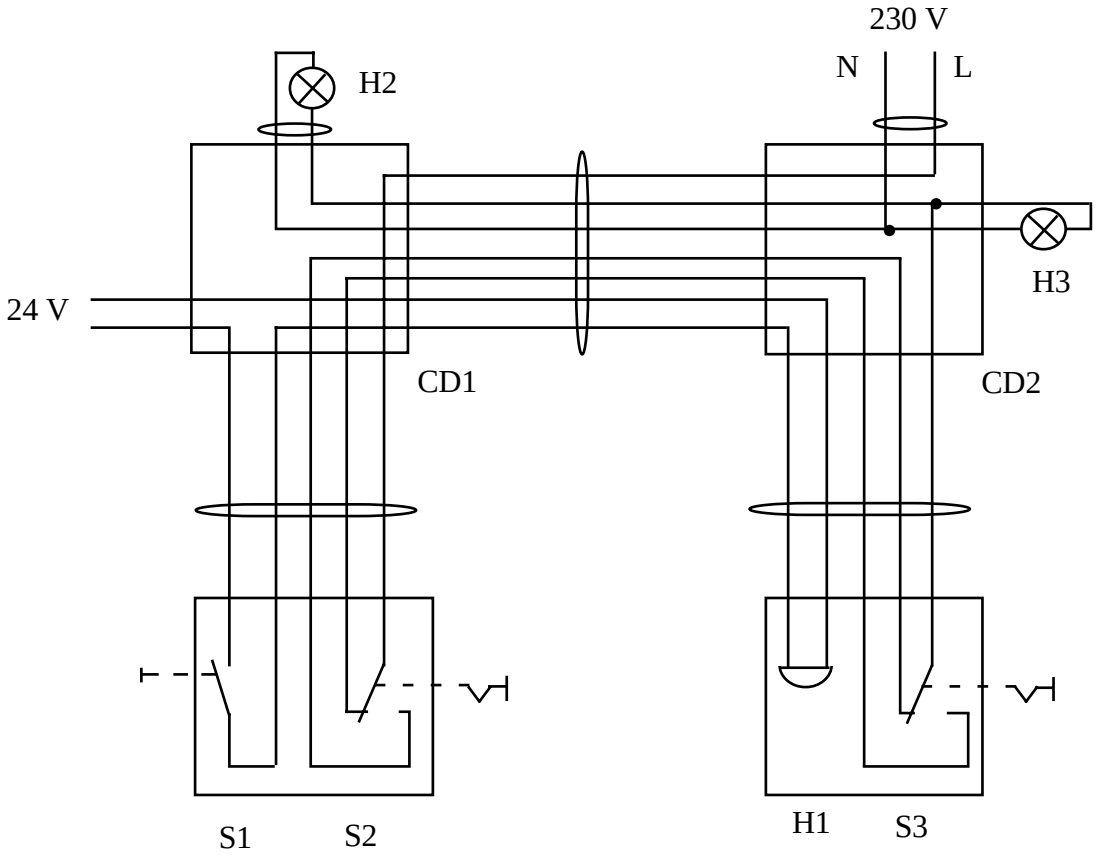

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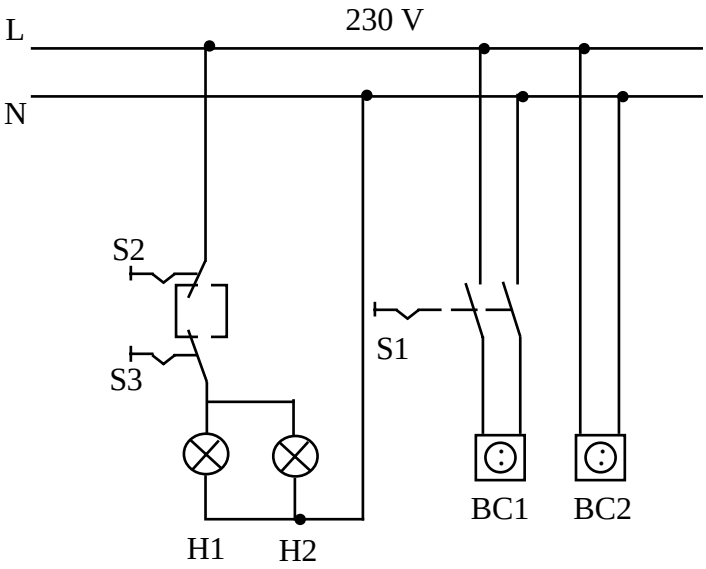
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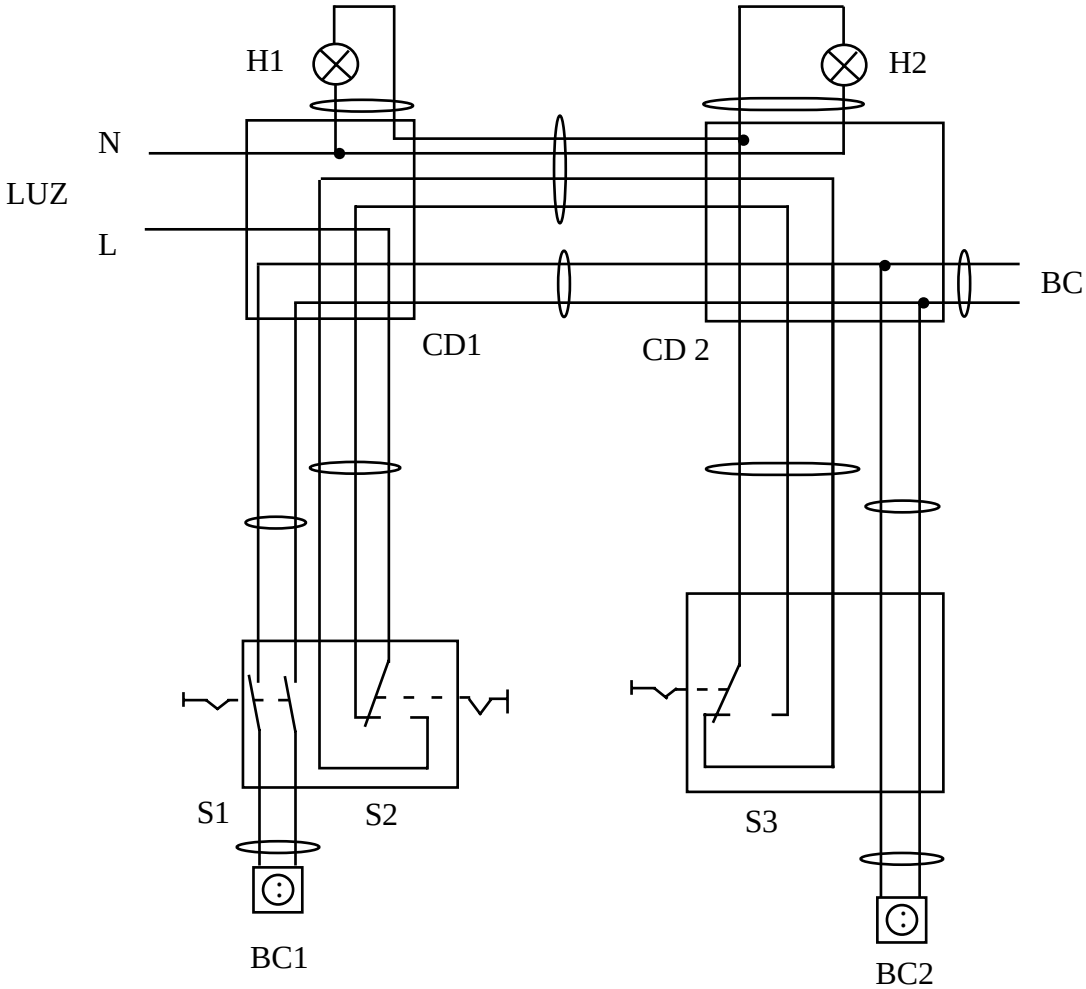
N
S2
S3
S1
BC1
BC2
H1
H2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S2
S3
BC1
BC2

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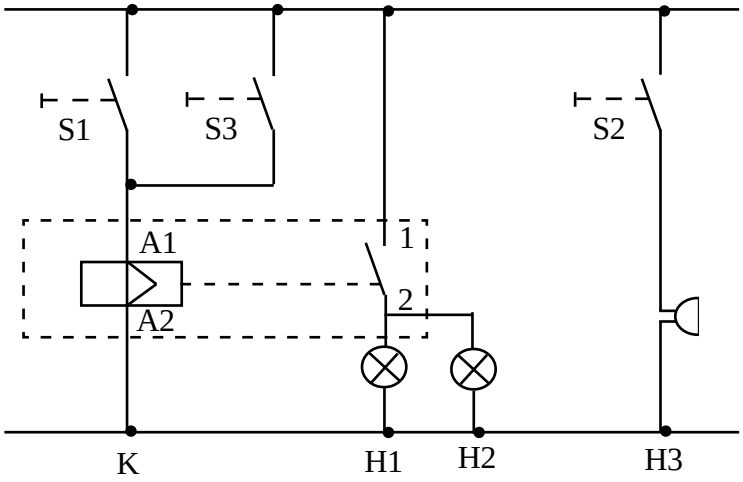

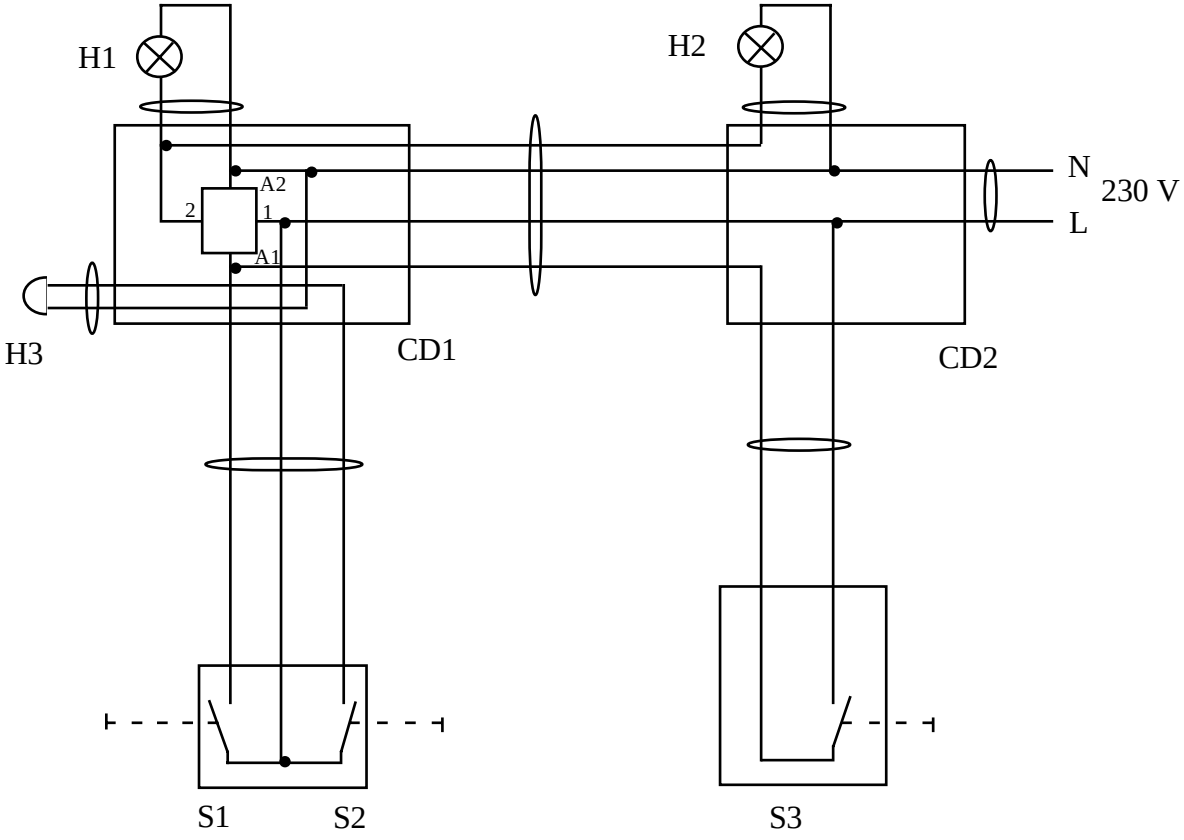

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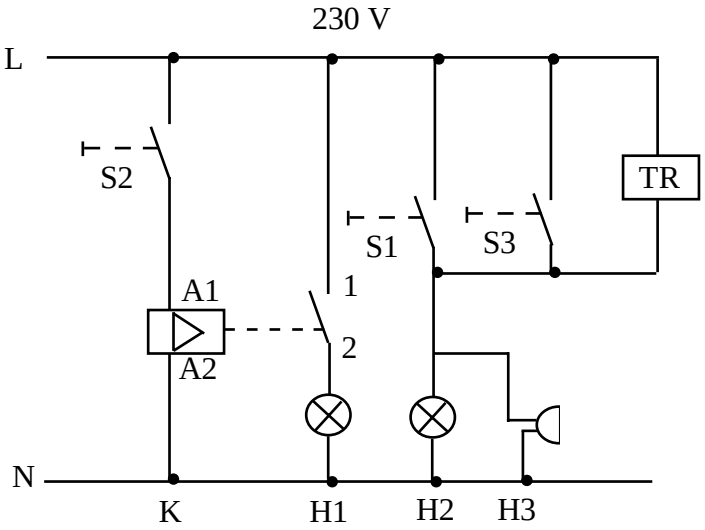
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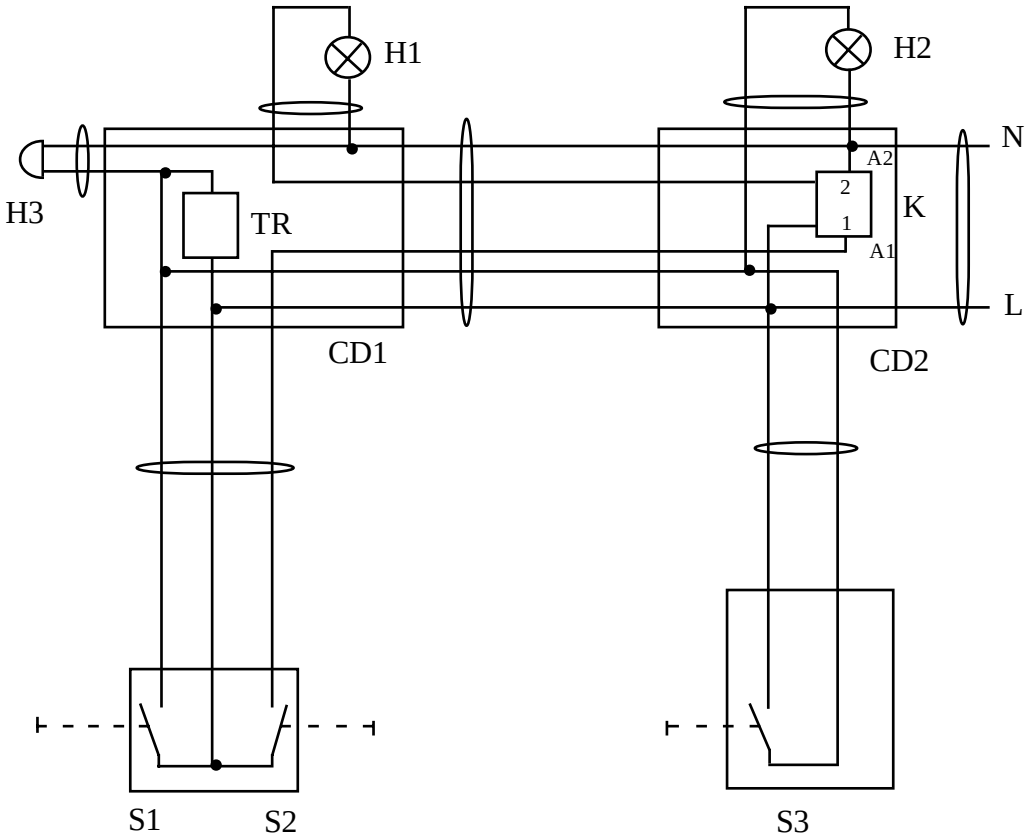
2
A2
N
K
H1
H2
H3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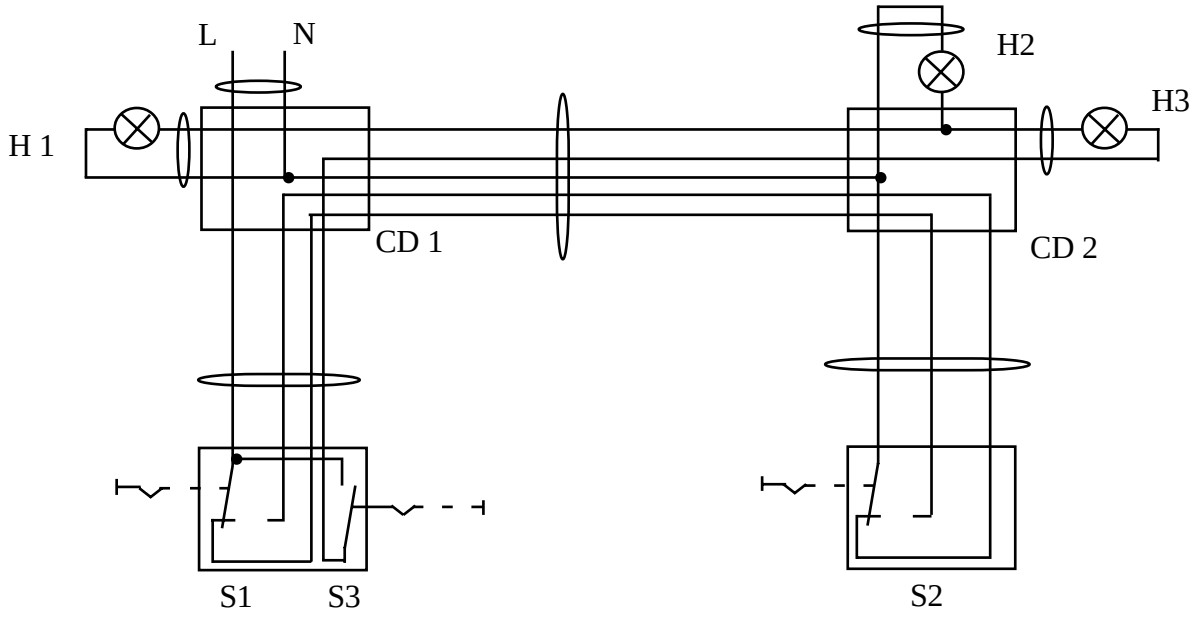
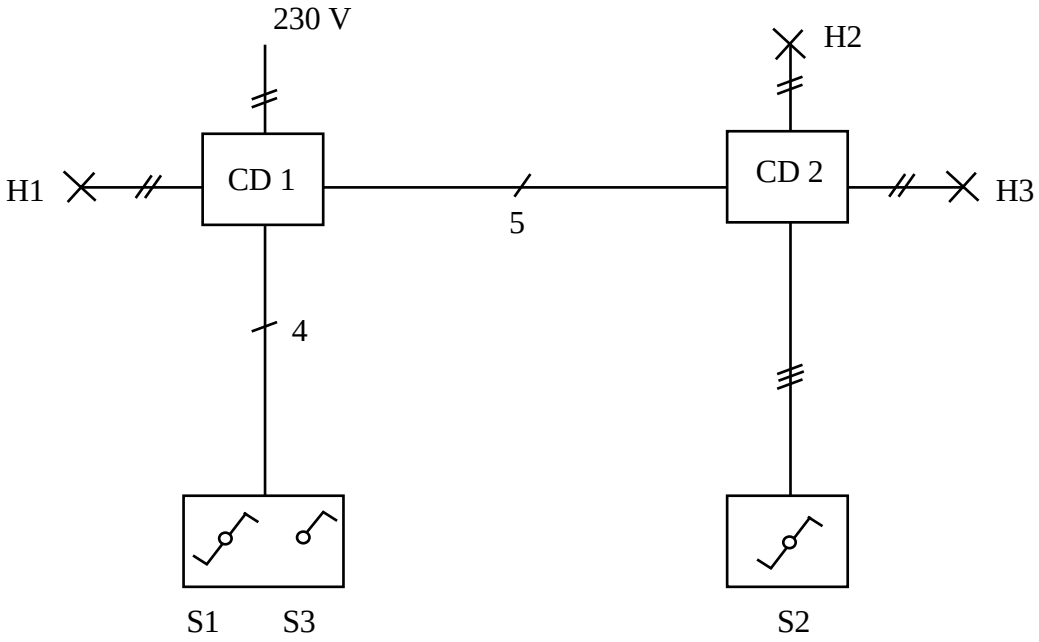
TR
L
CD1
CD2
S1
S2
S3

①





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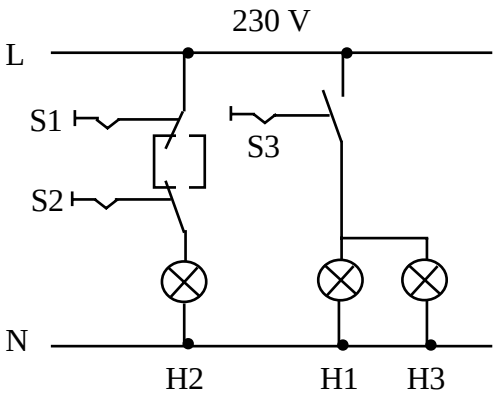
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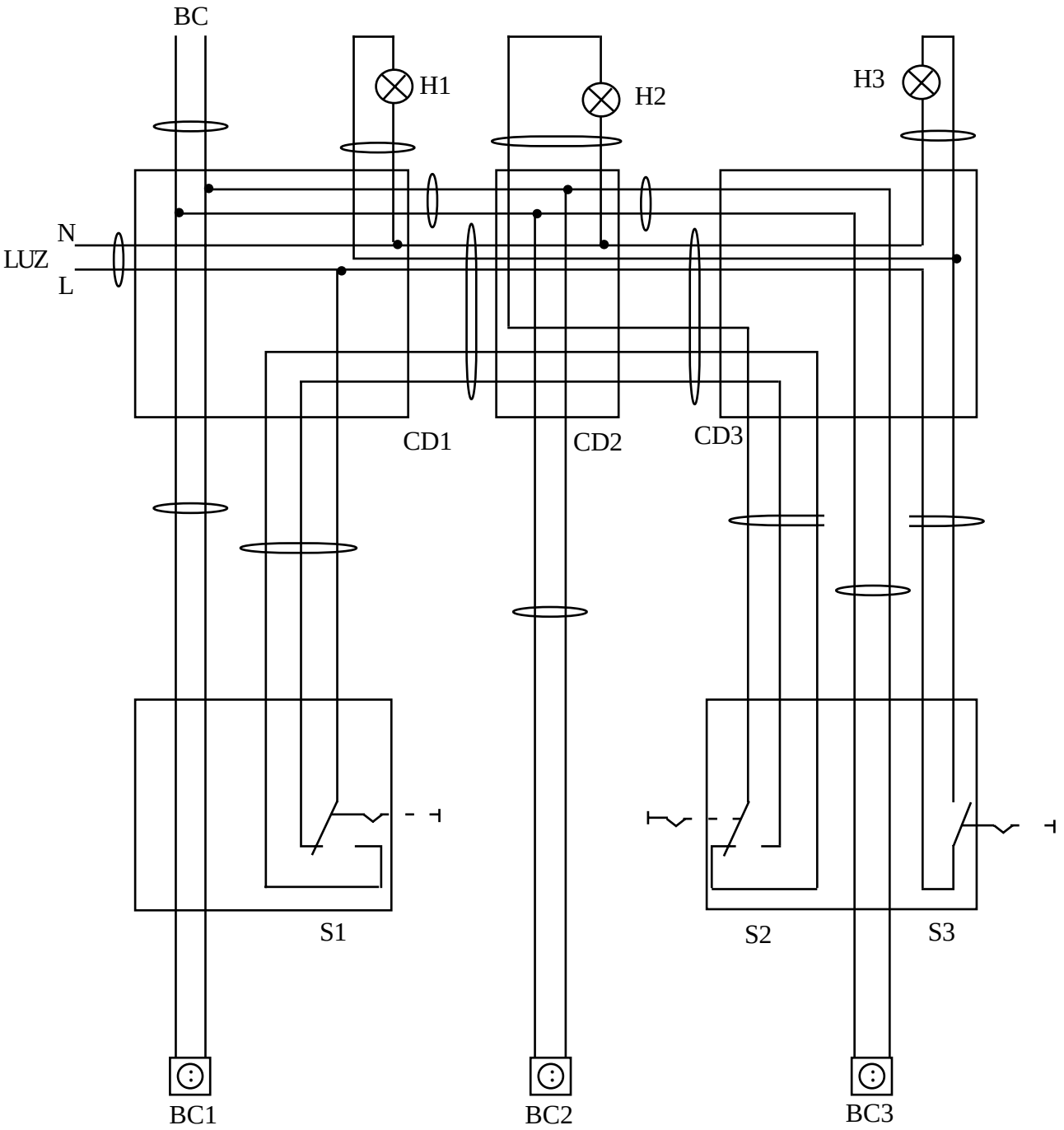
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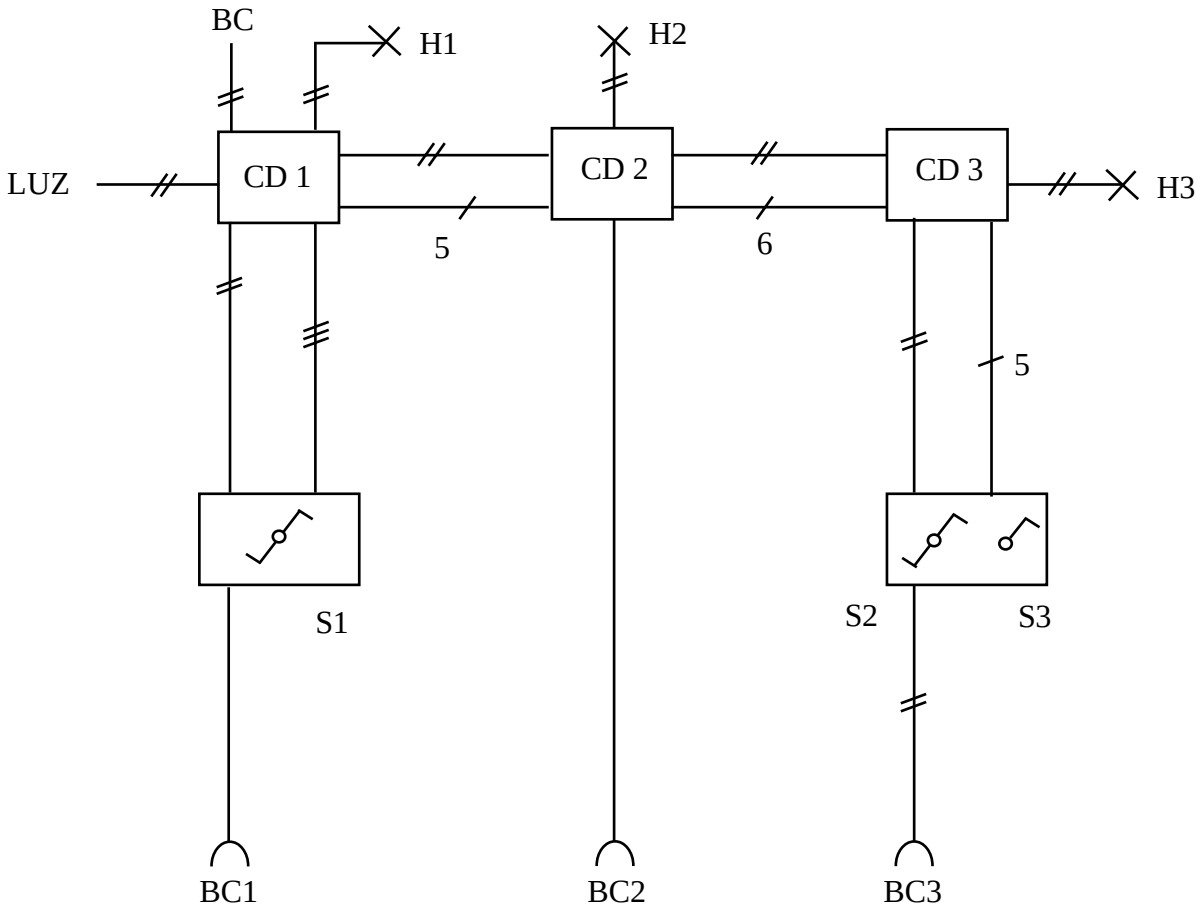
BC1
BC2
BC3

②



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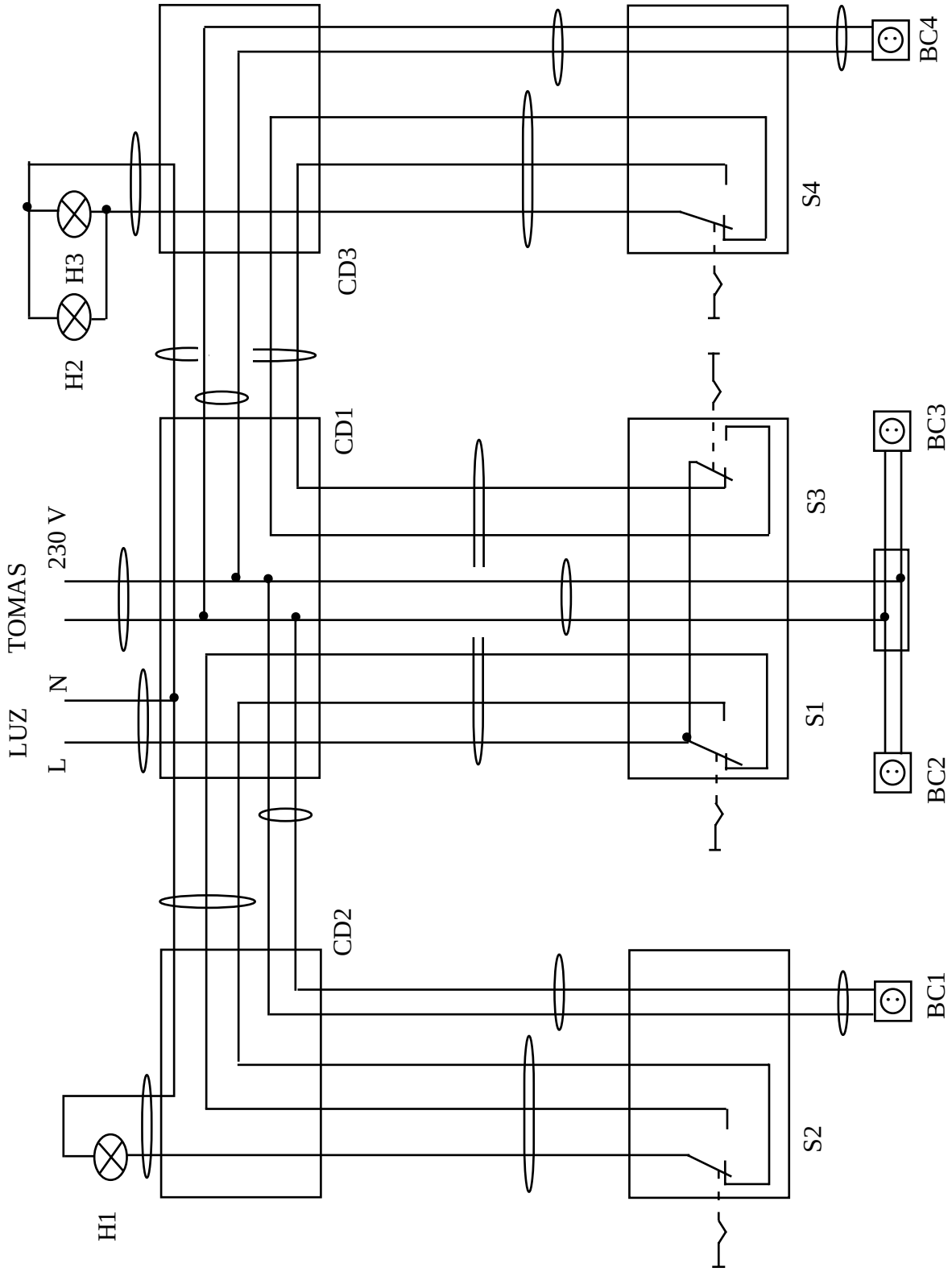

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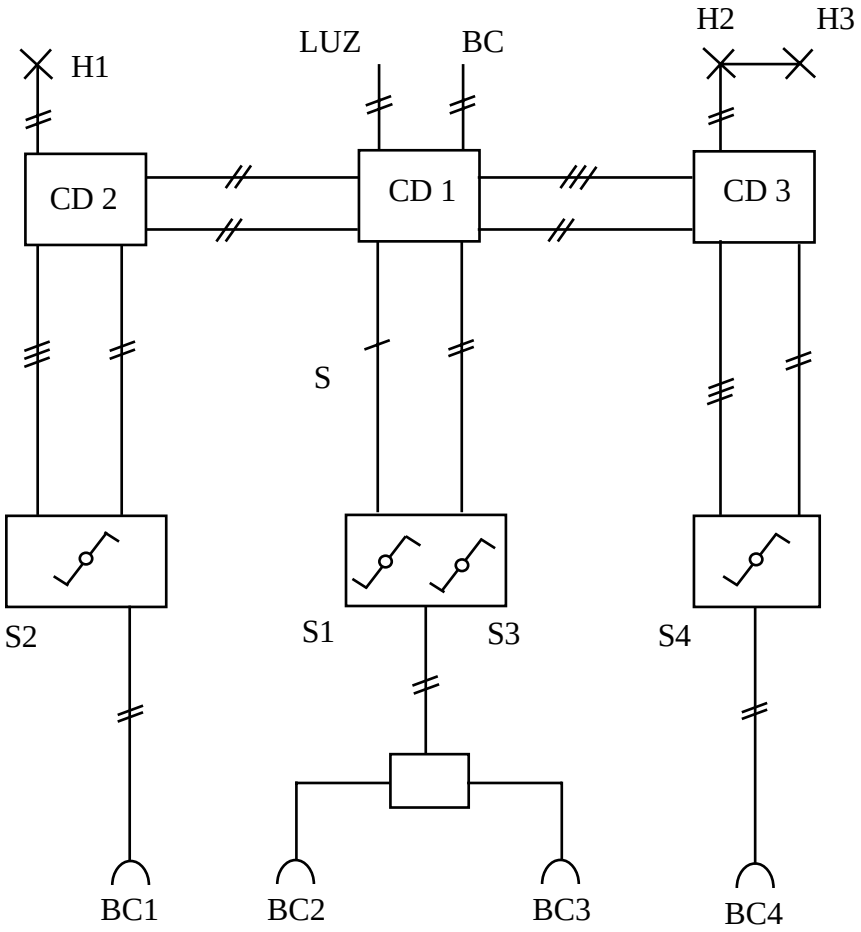
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S2
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S3
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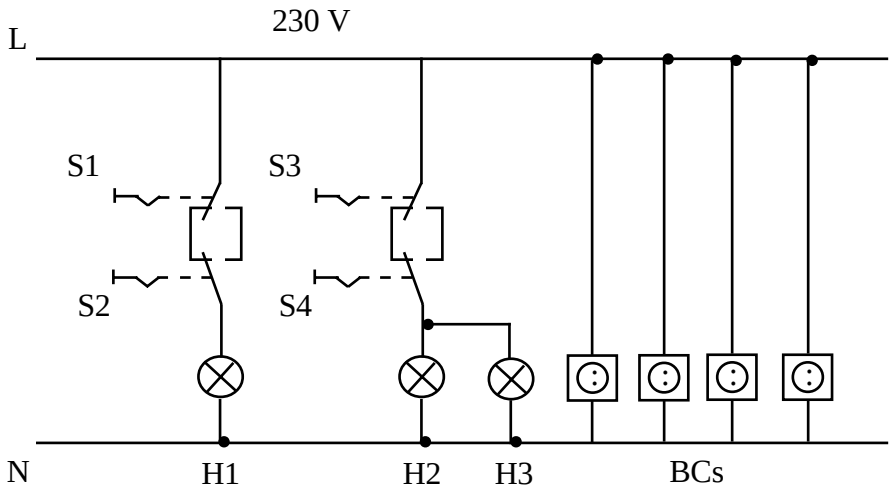
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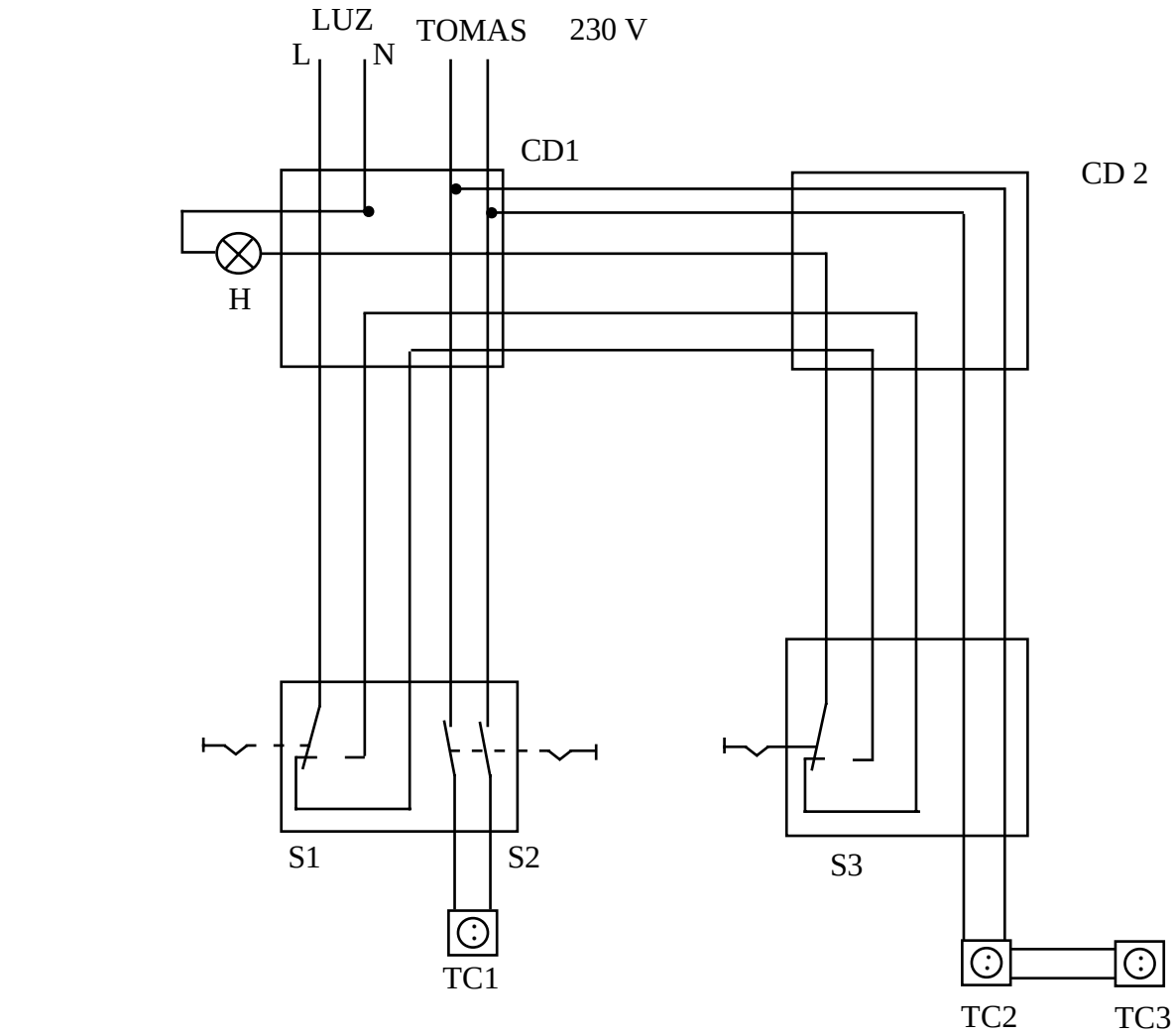
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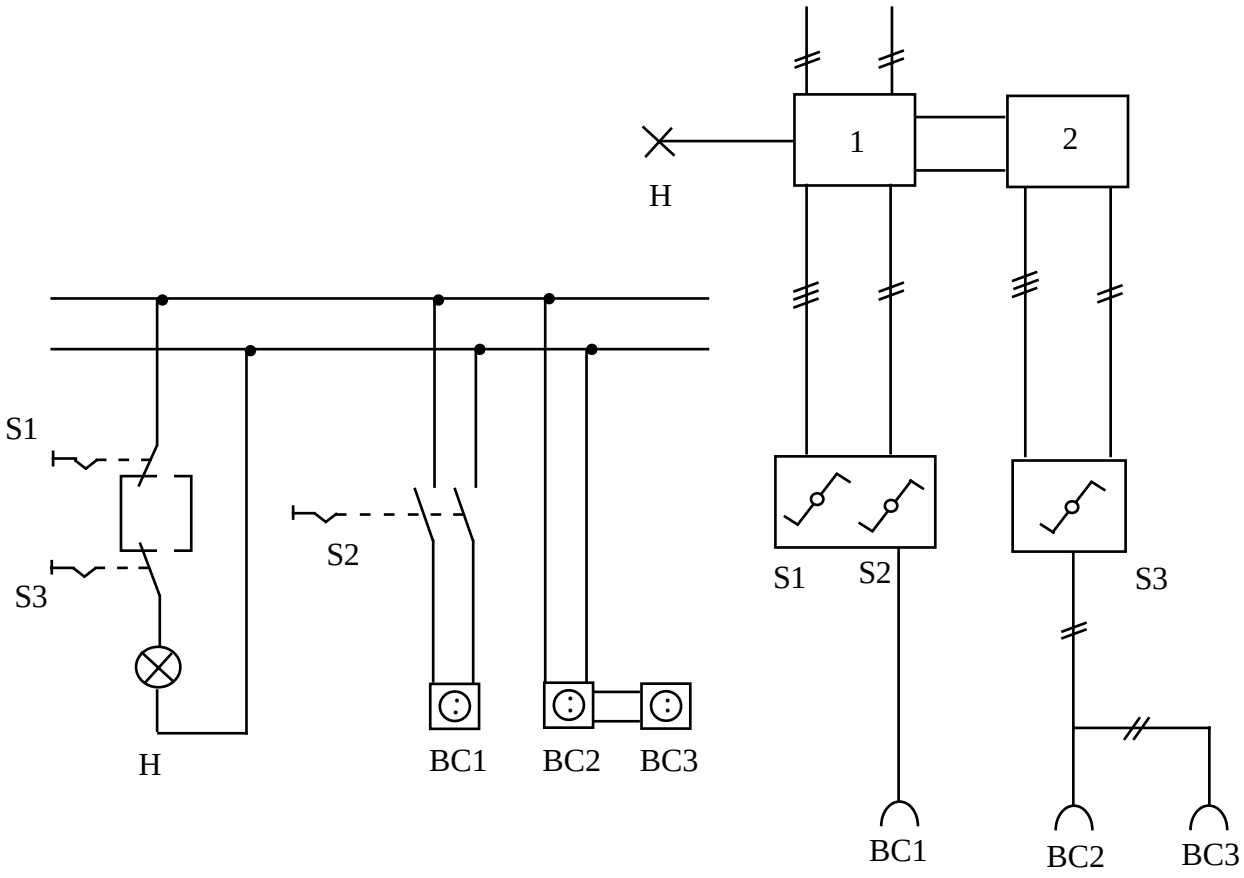
S2
S3
TC1
TC2
TC3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BC3
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BC3

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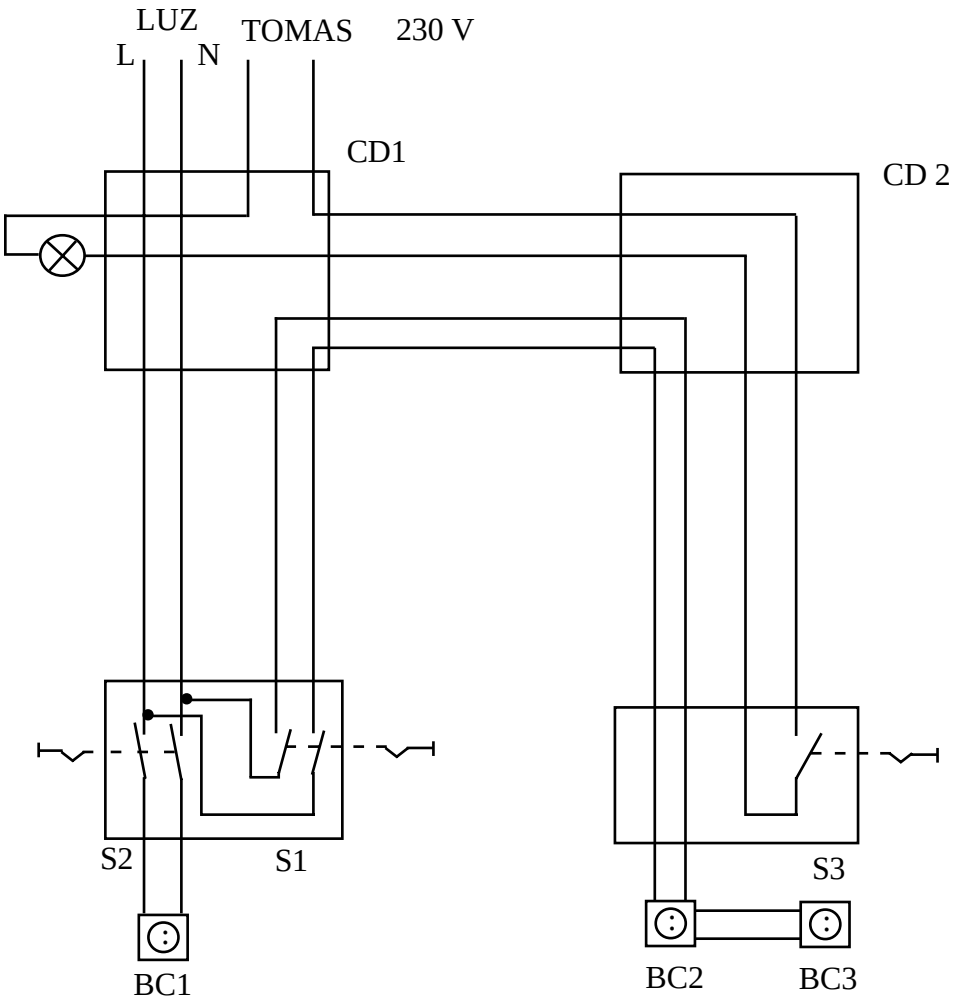
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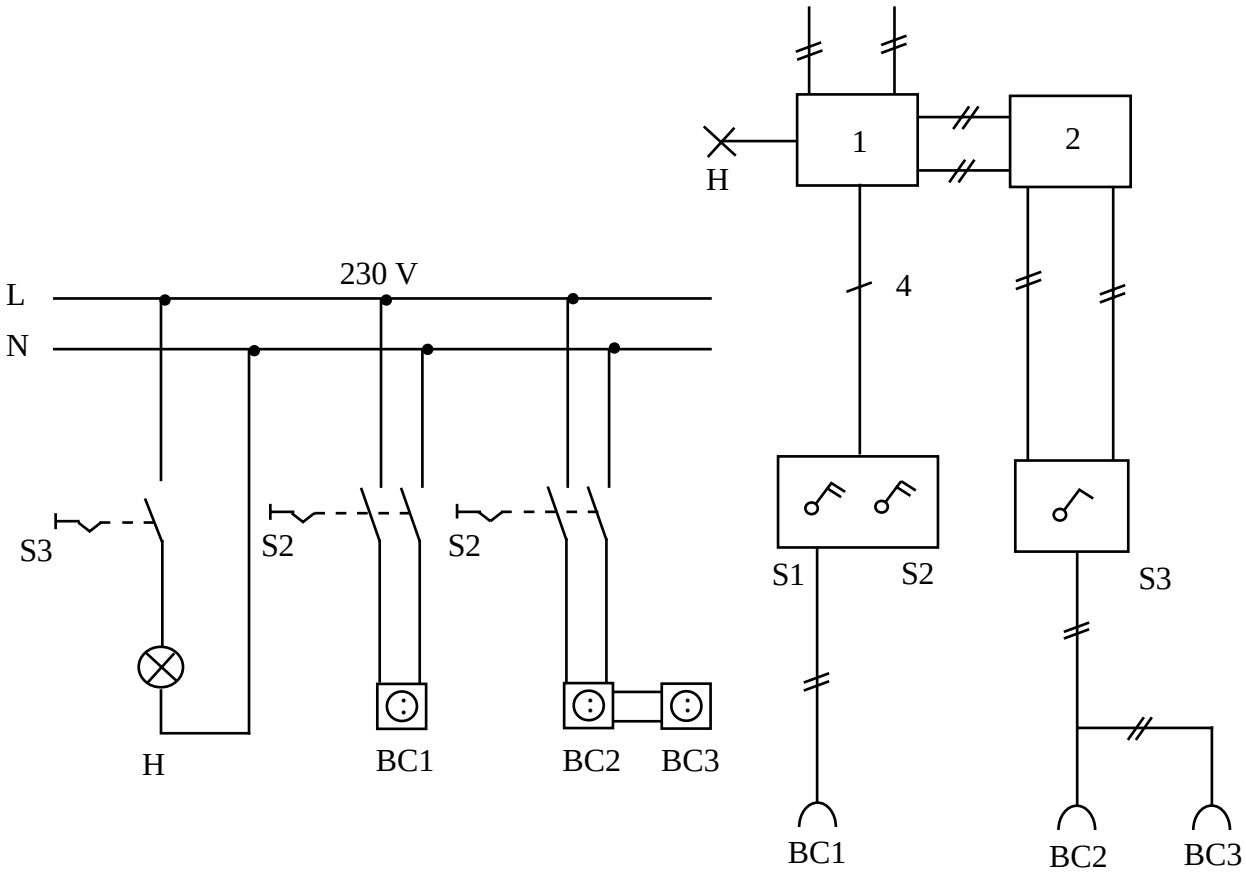
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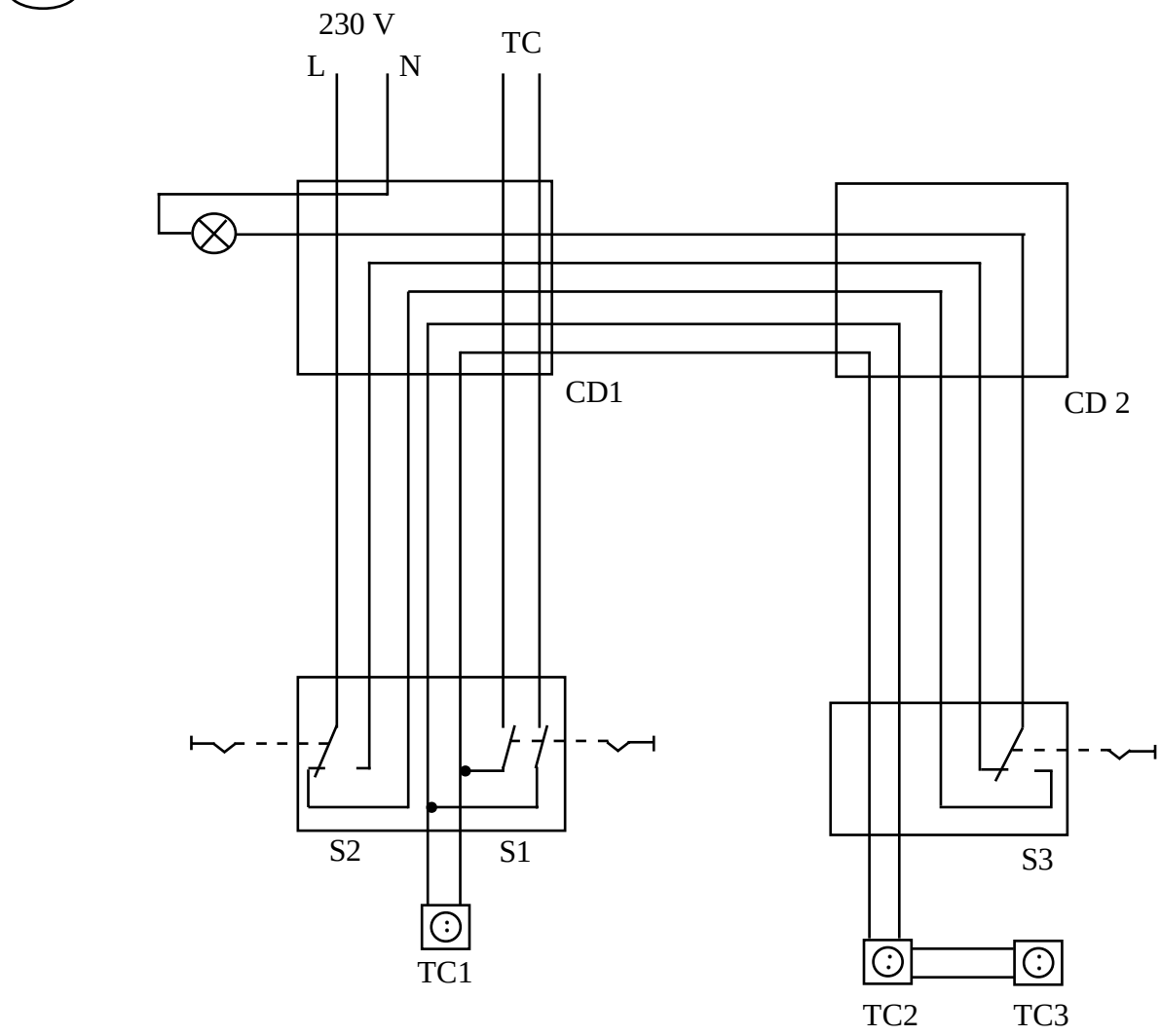
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TC1
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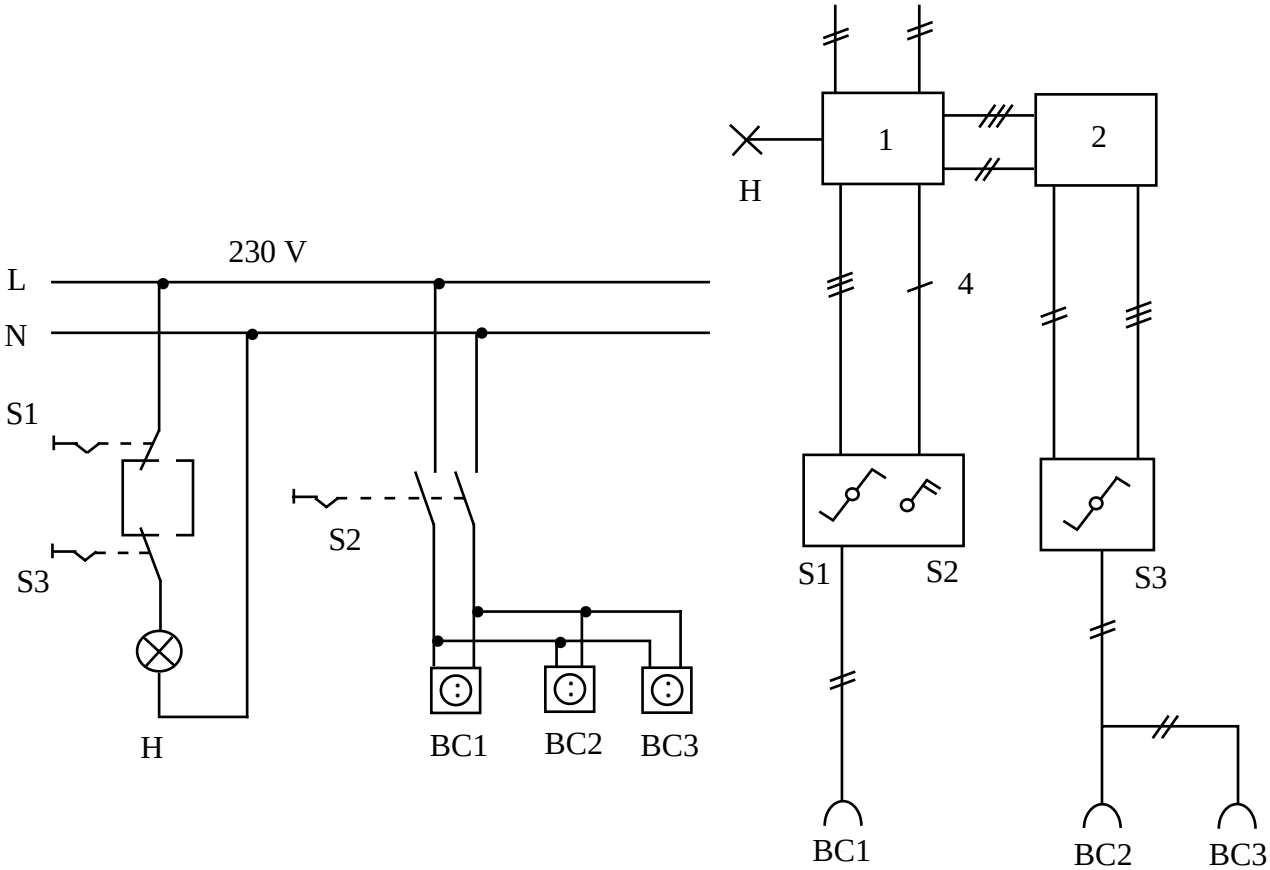
TC3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S3
S2
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BC2
BC3
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H
4
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S2
S3
BC1
BC2
BC3

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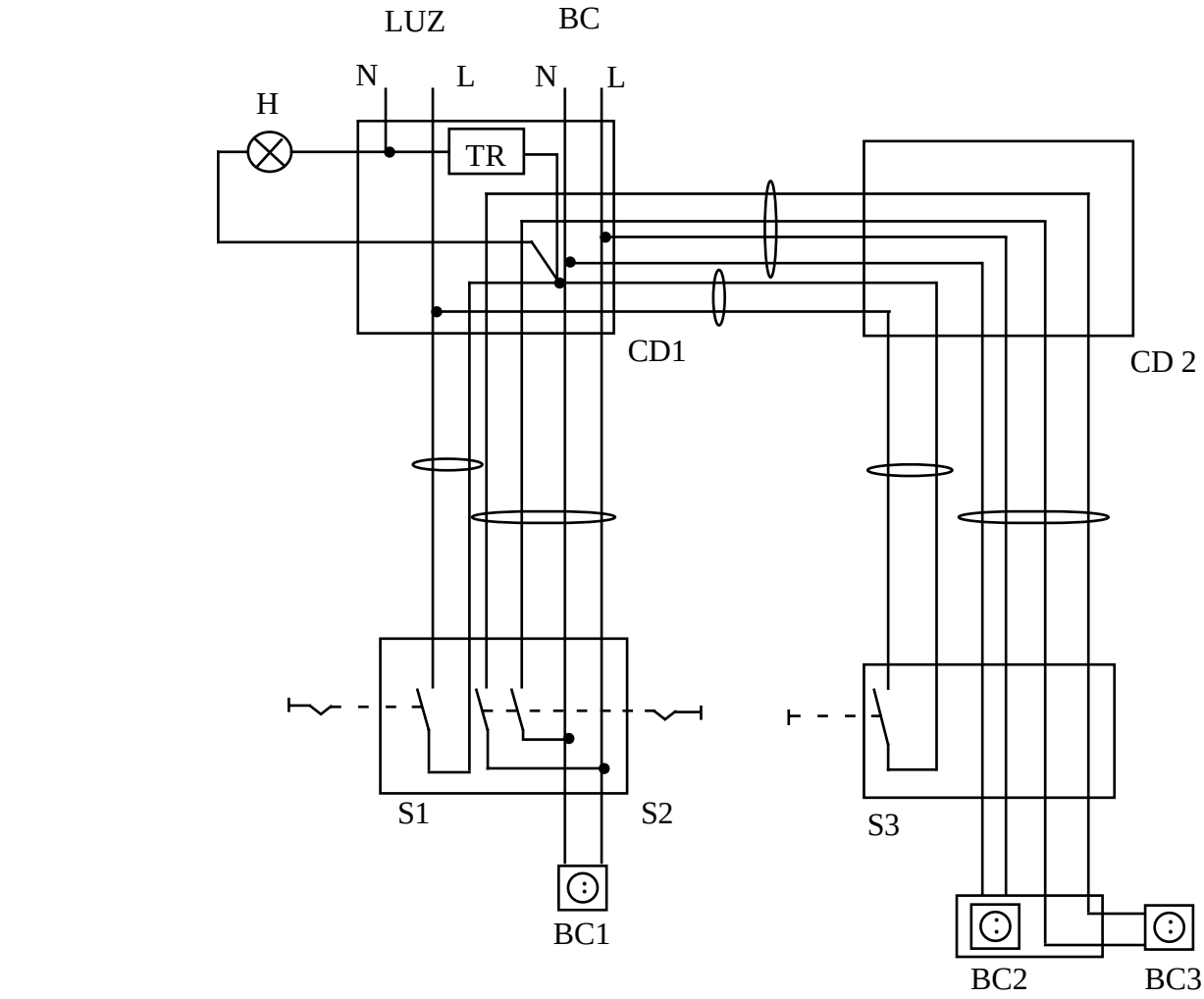
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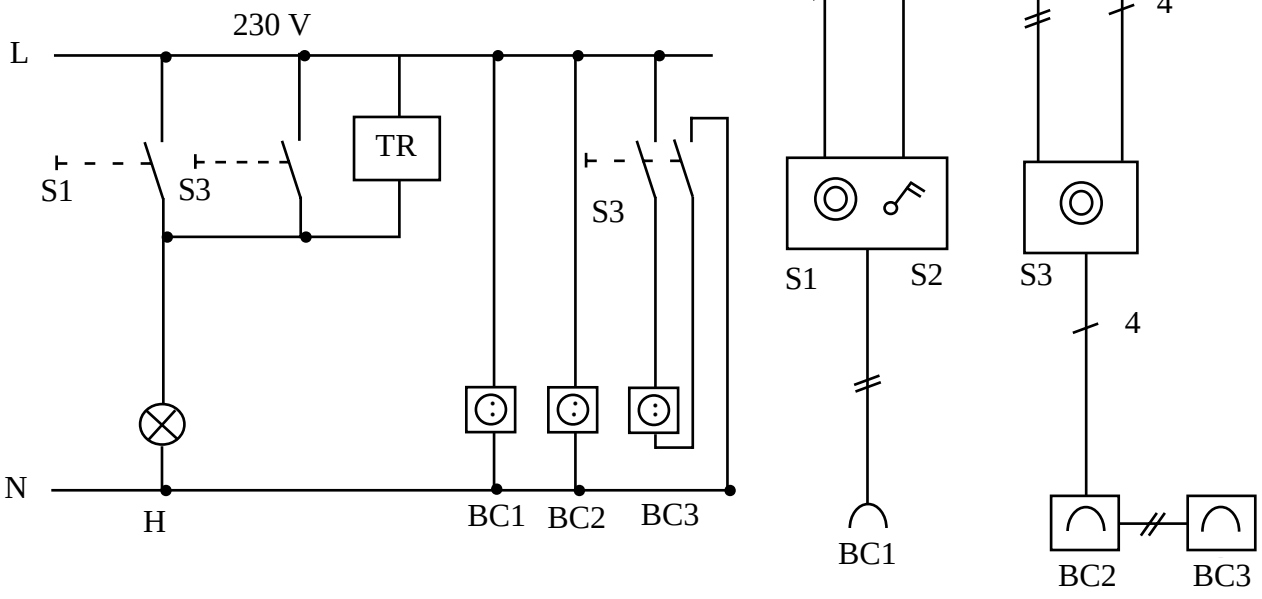
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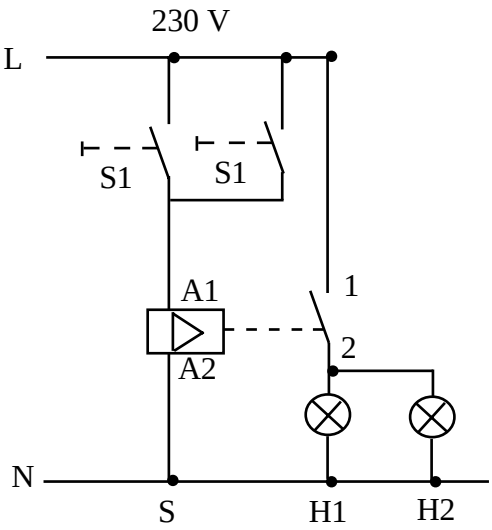

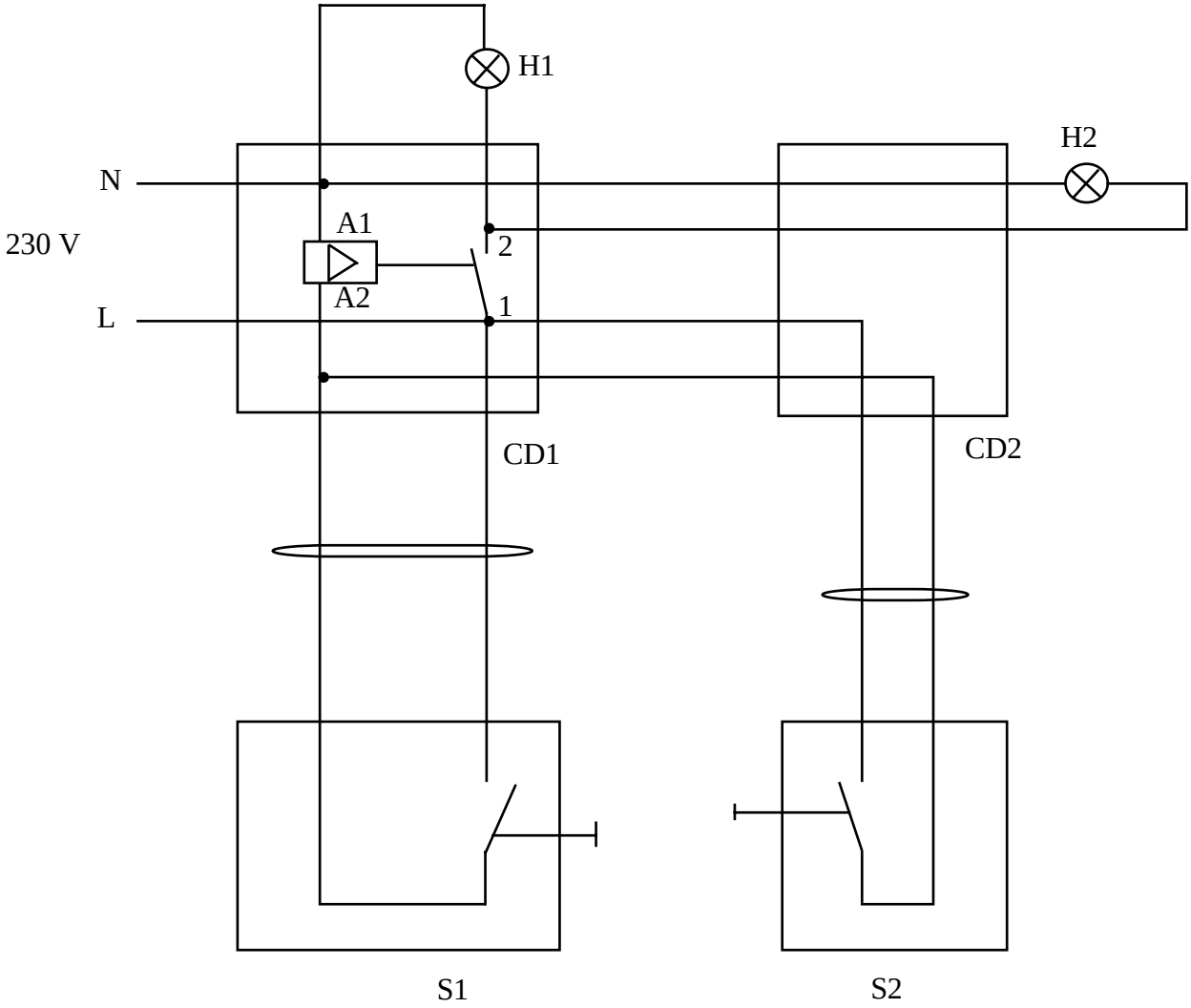

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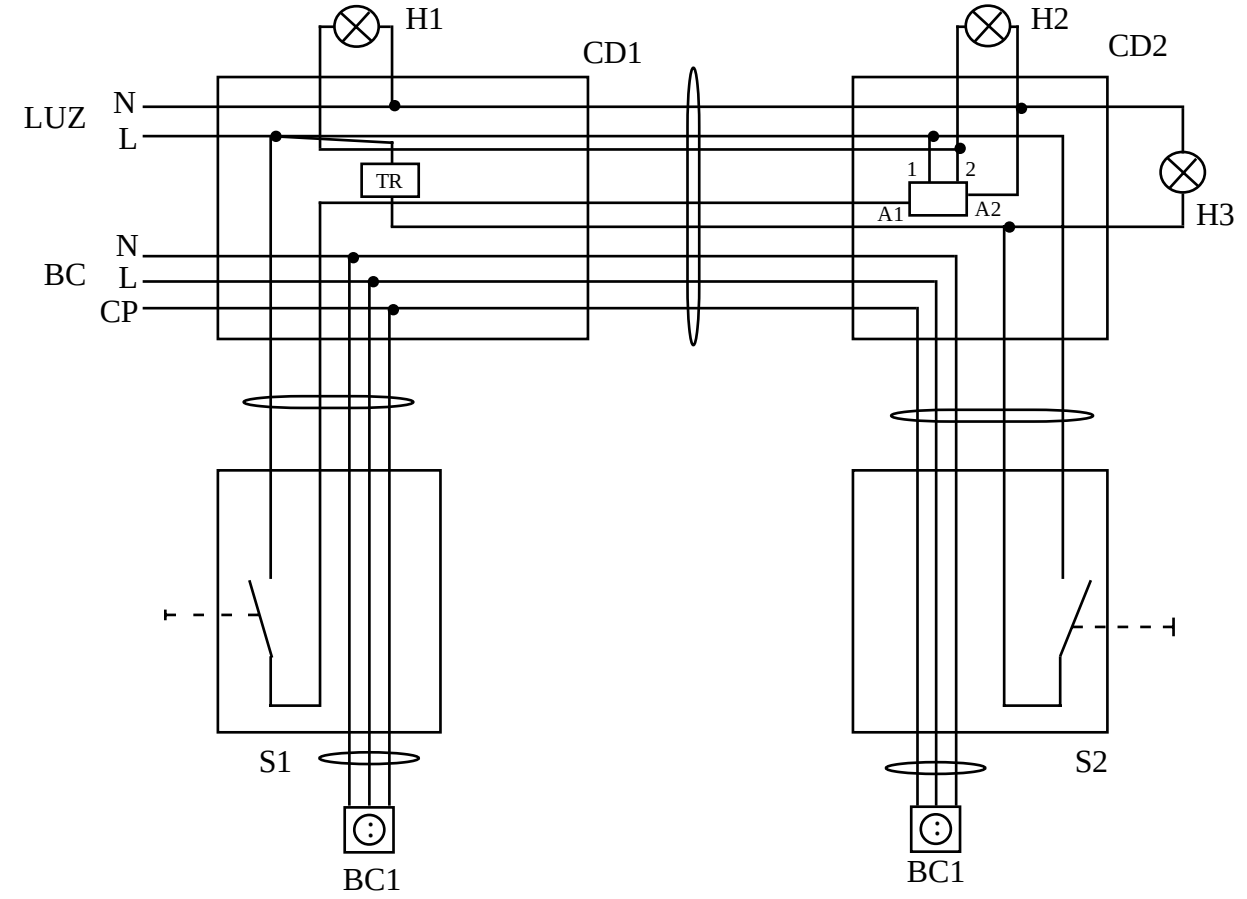
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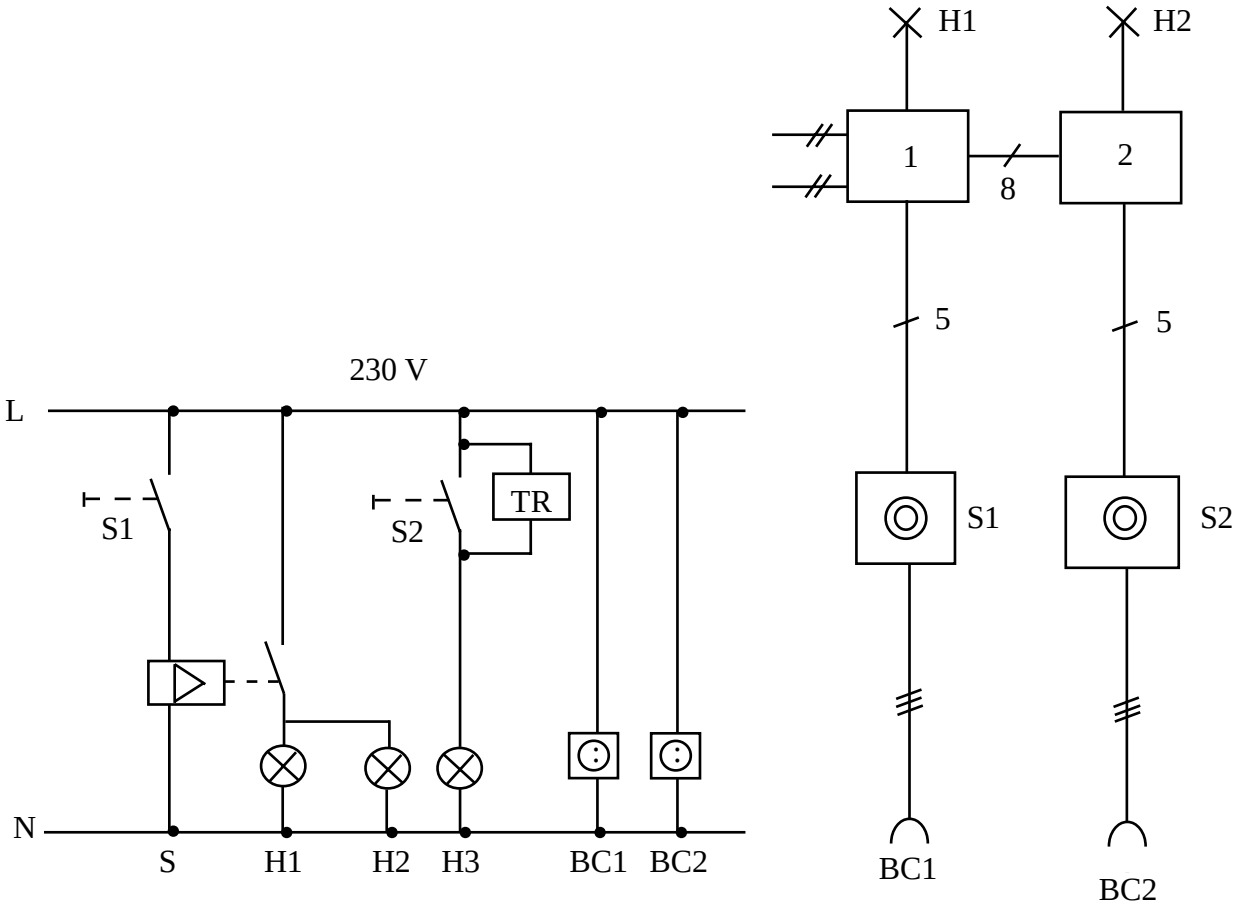
BC1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H3
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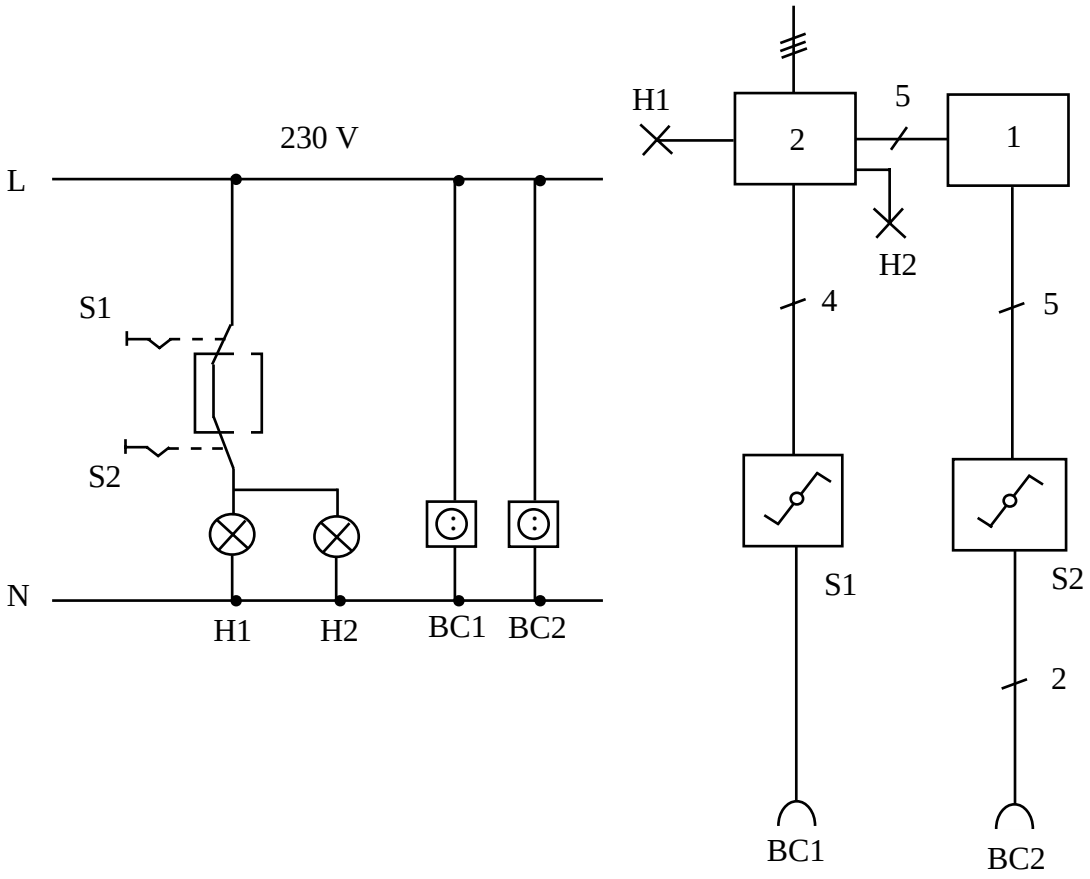
BC2

6-1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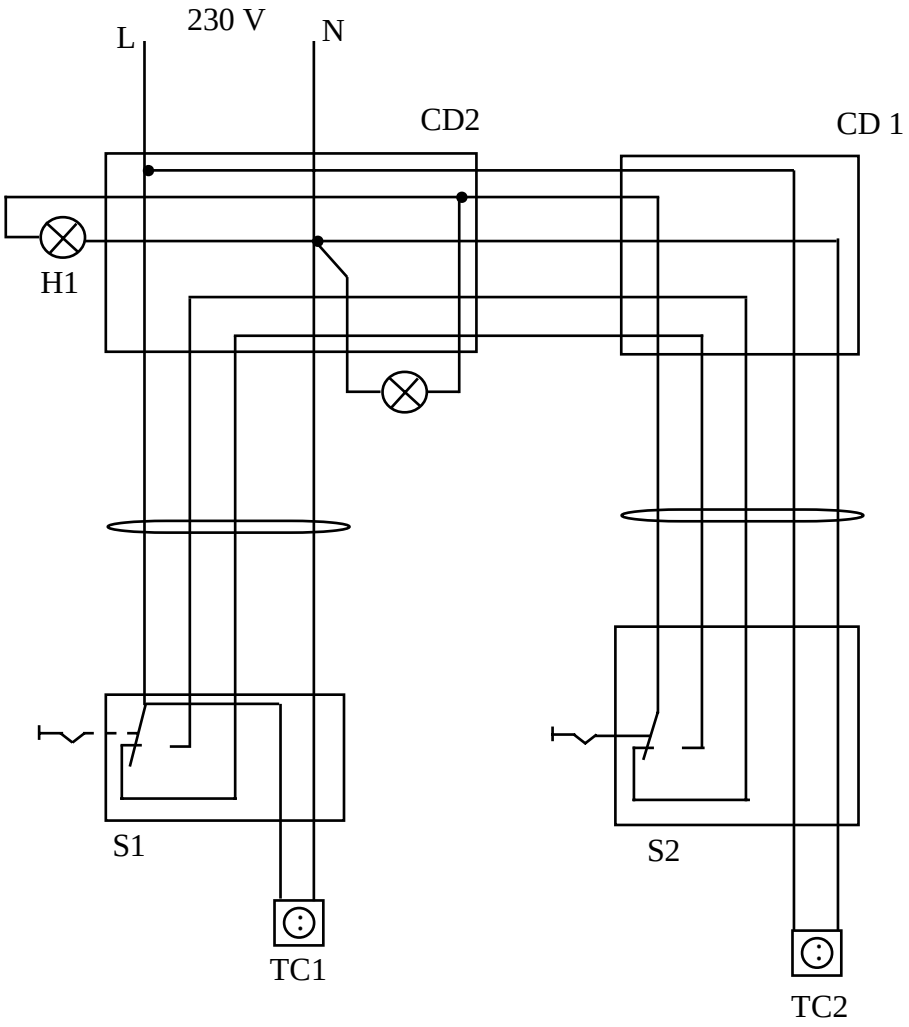
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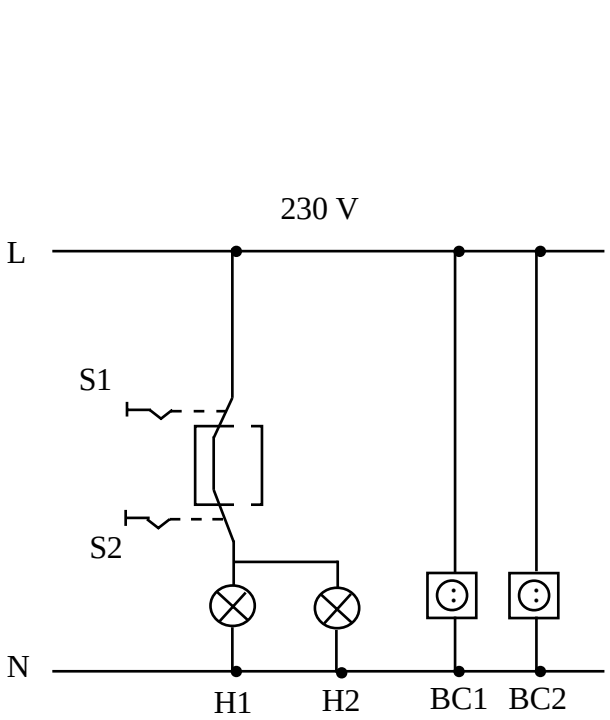
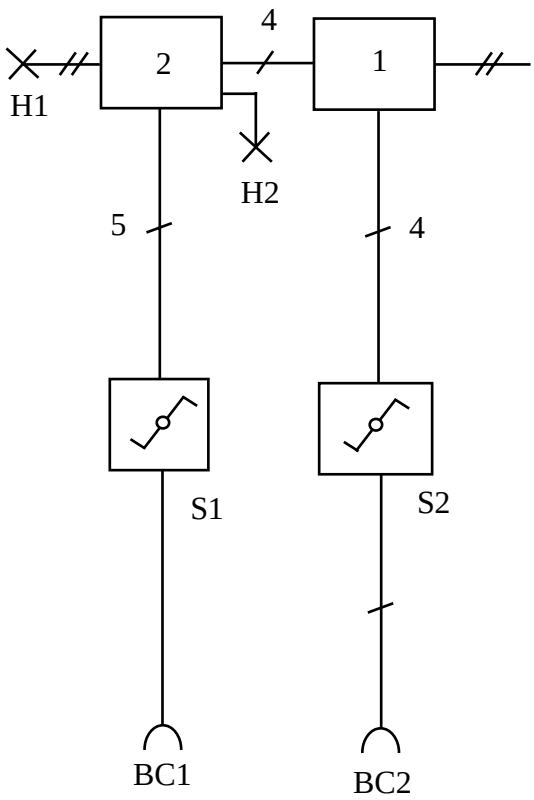
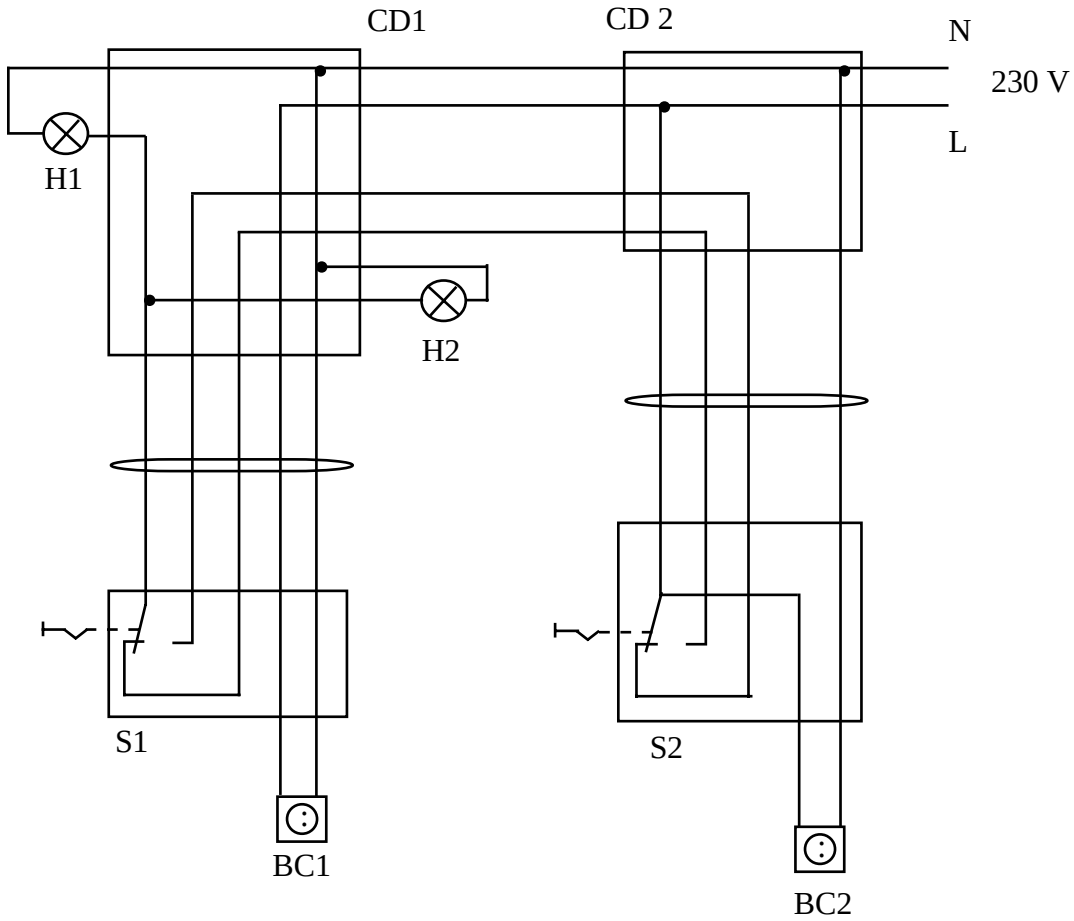
S2
TC1
TC2

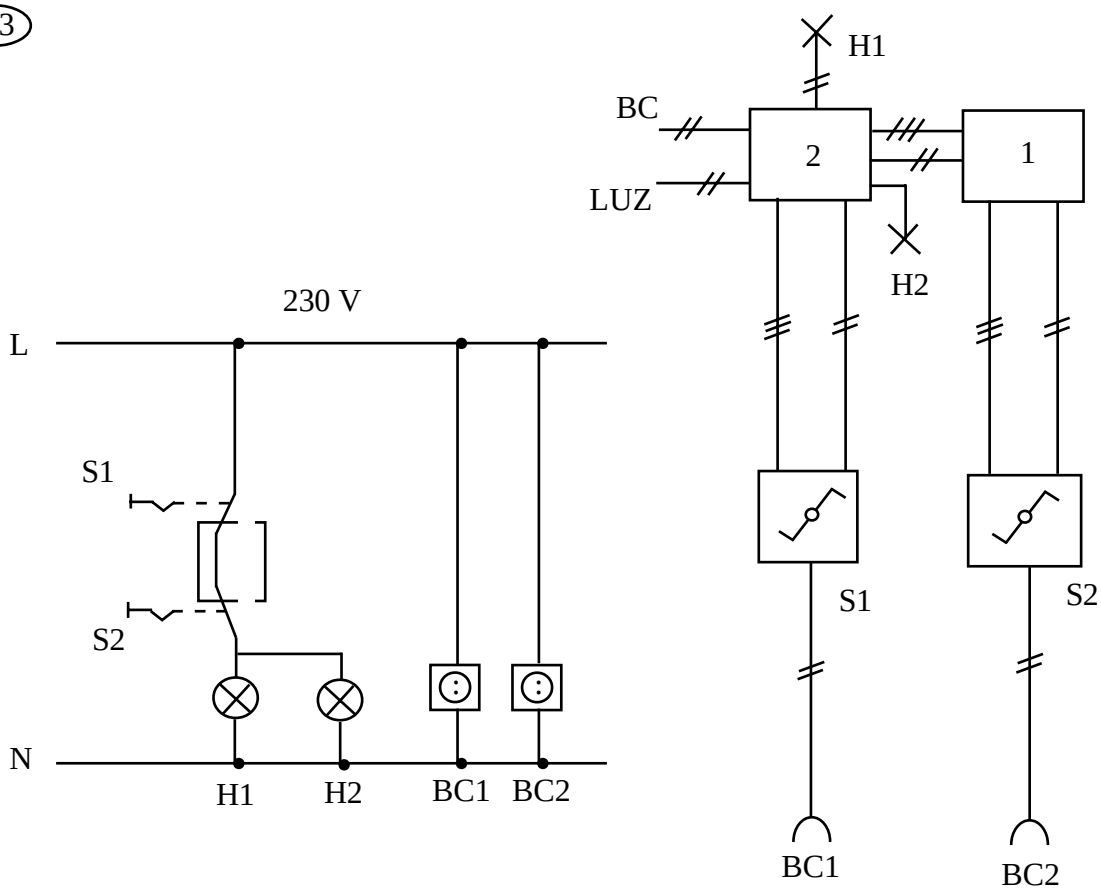
6-2

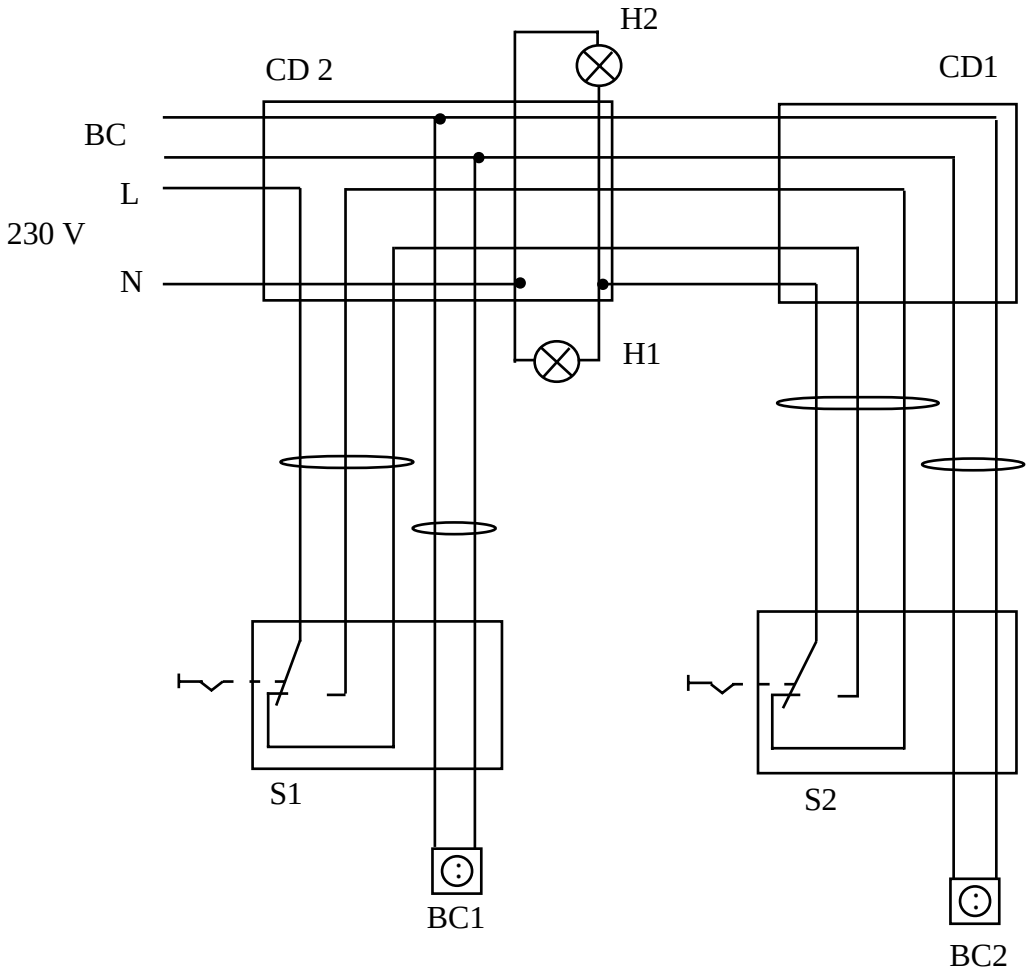

230 V
L
S1
S2
N
H1
H2
BC1
BC2


4
2
1
H1
H2
5
4
S1
S2
BC1
BC2

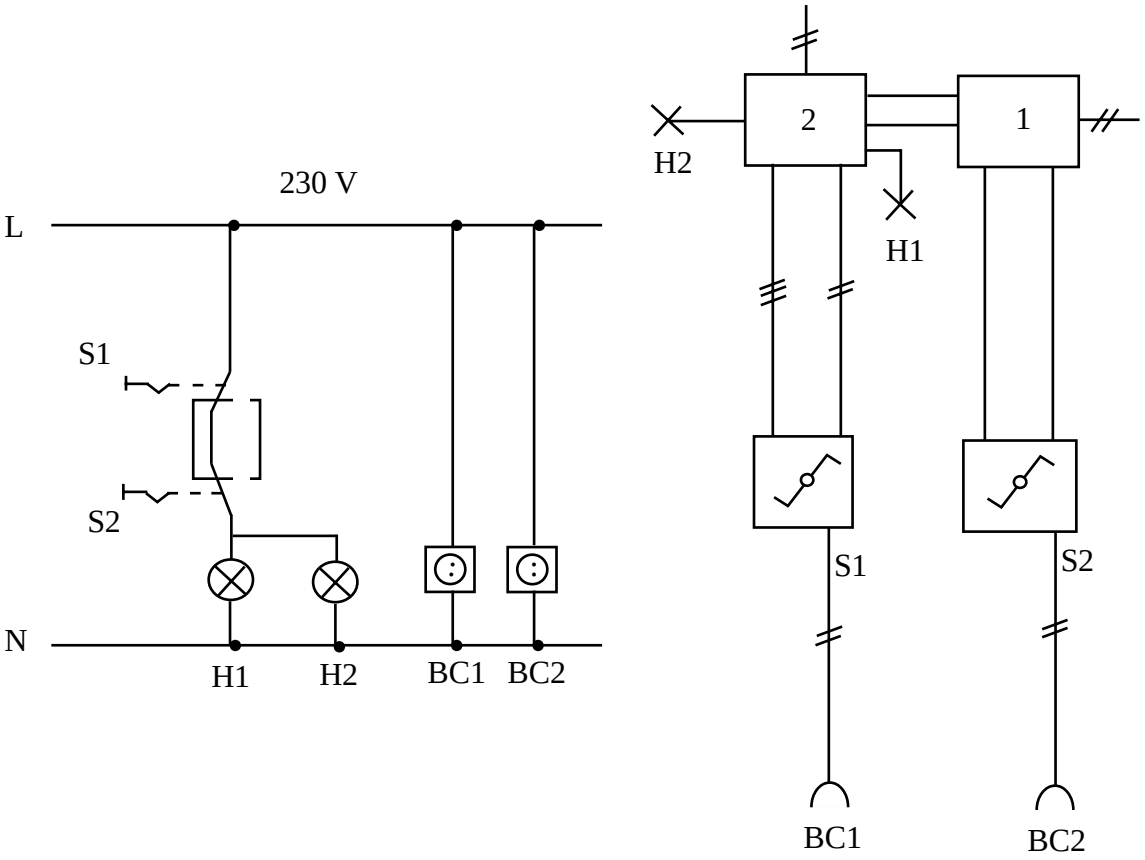

CD1
CD 2
N
230 V
L
H1
H2
S1
S2
BC1
BC2

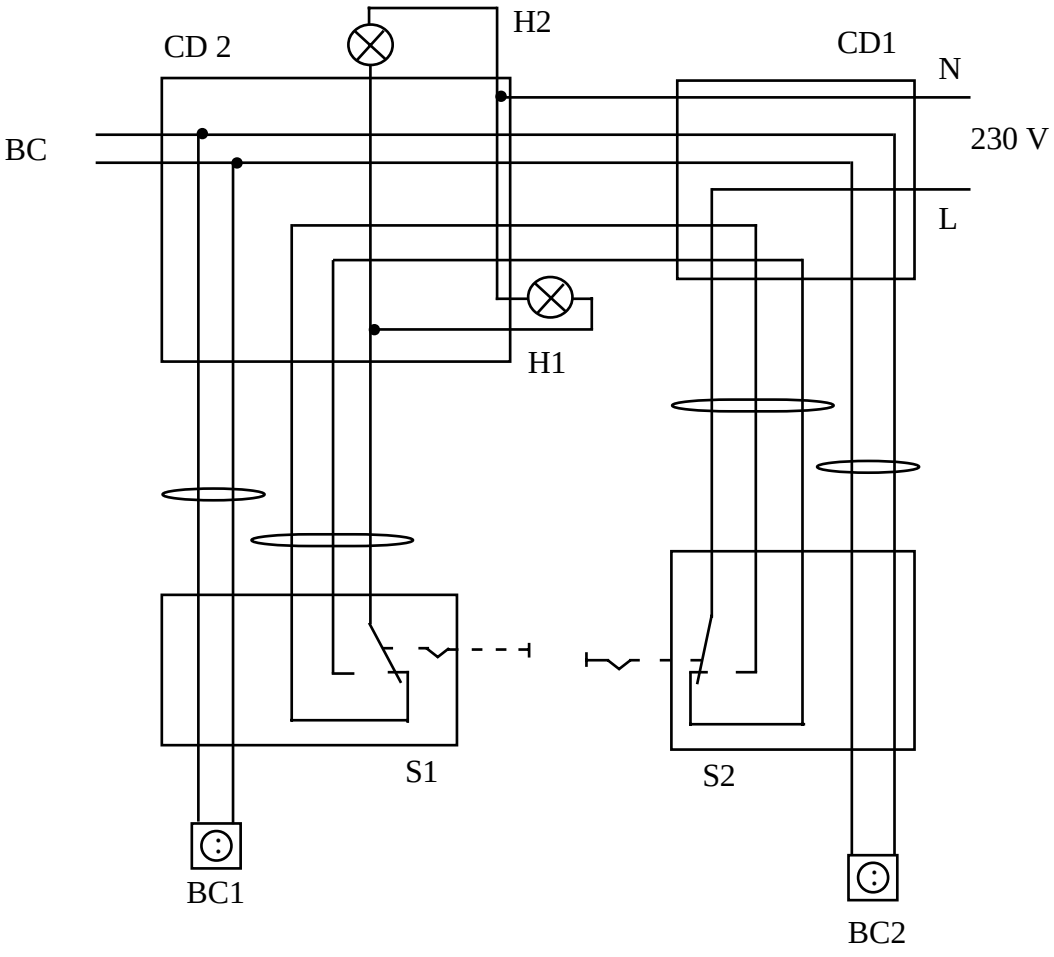
6-3


H1
BC
2
1
LUZ
H2
230 V
L
S1
S2
S1
S2
N
H1
H2
BC1
BC2
BC1
BC2

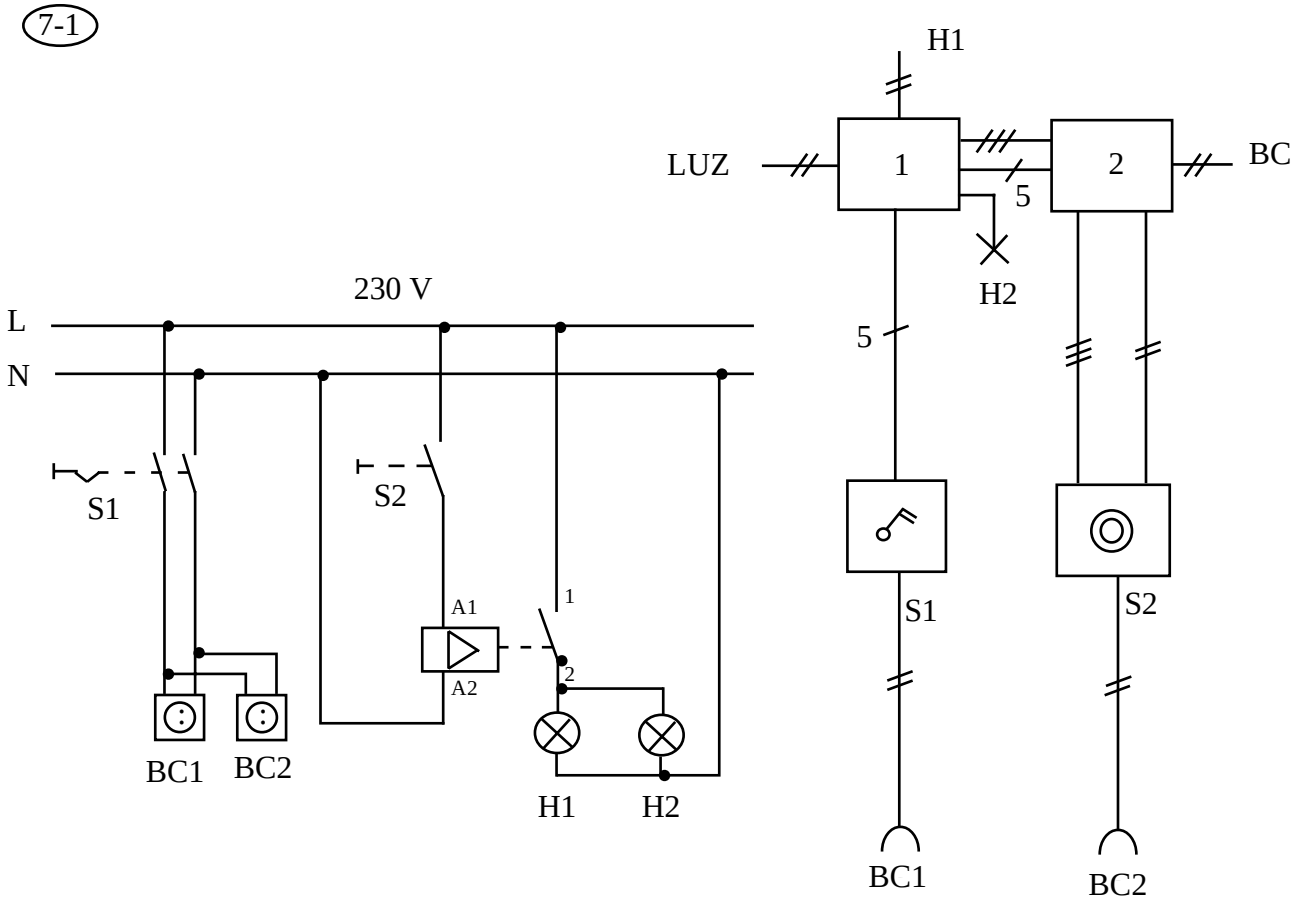

H2
CD 2
CD1
BC
L
230 V
N
H1
S1
S2
BC1
BC2

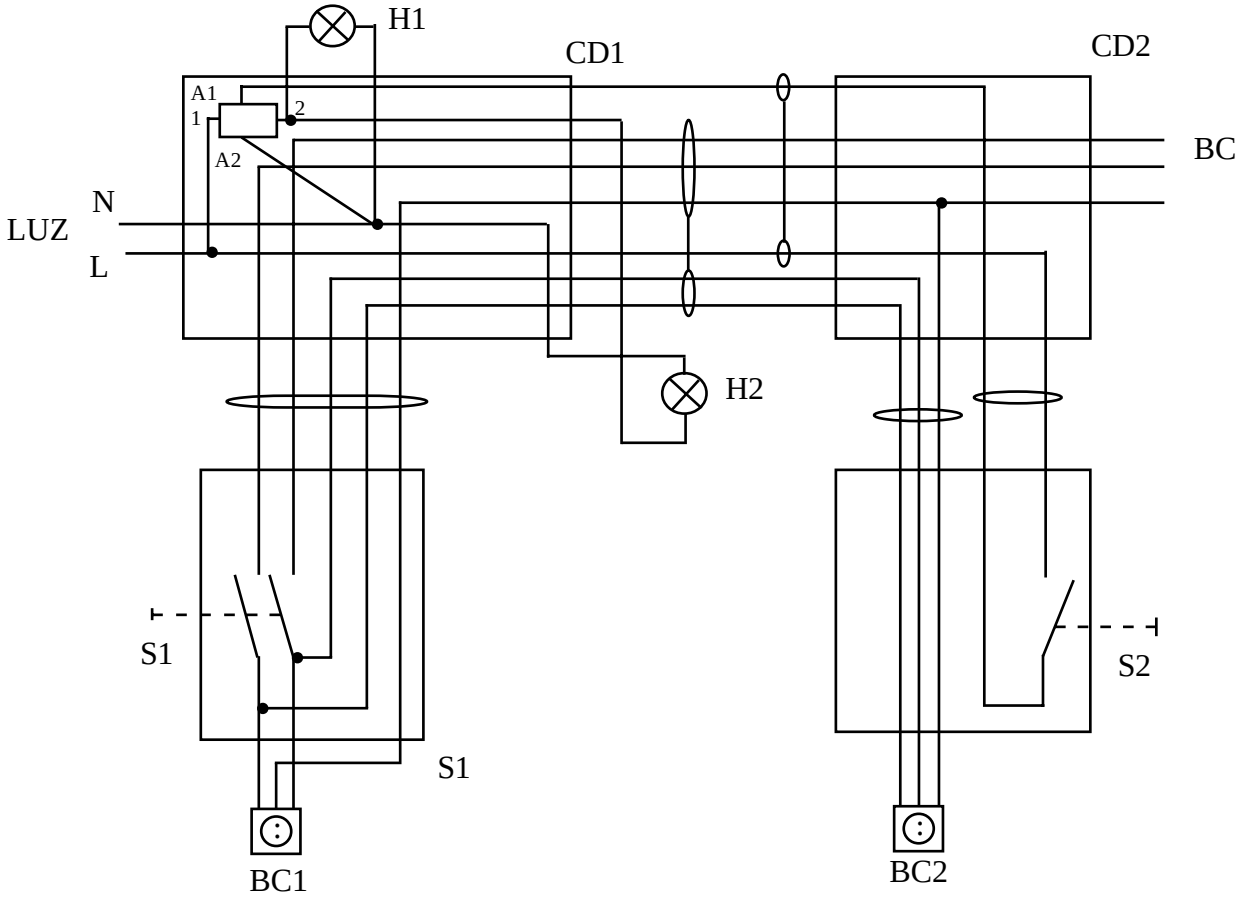
6-4


230 V
L
S1
S2
N
H1
H2
BC1
BC2
2
1
H2
H1
S1
S2
BC1
BC2

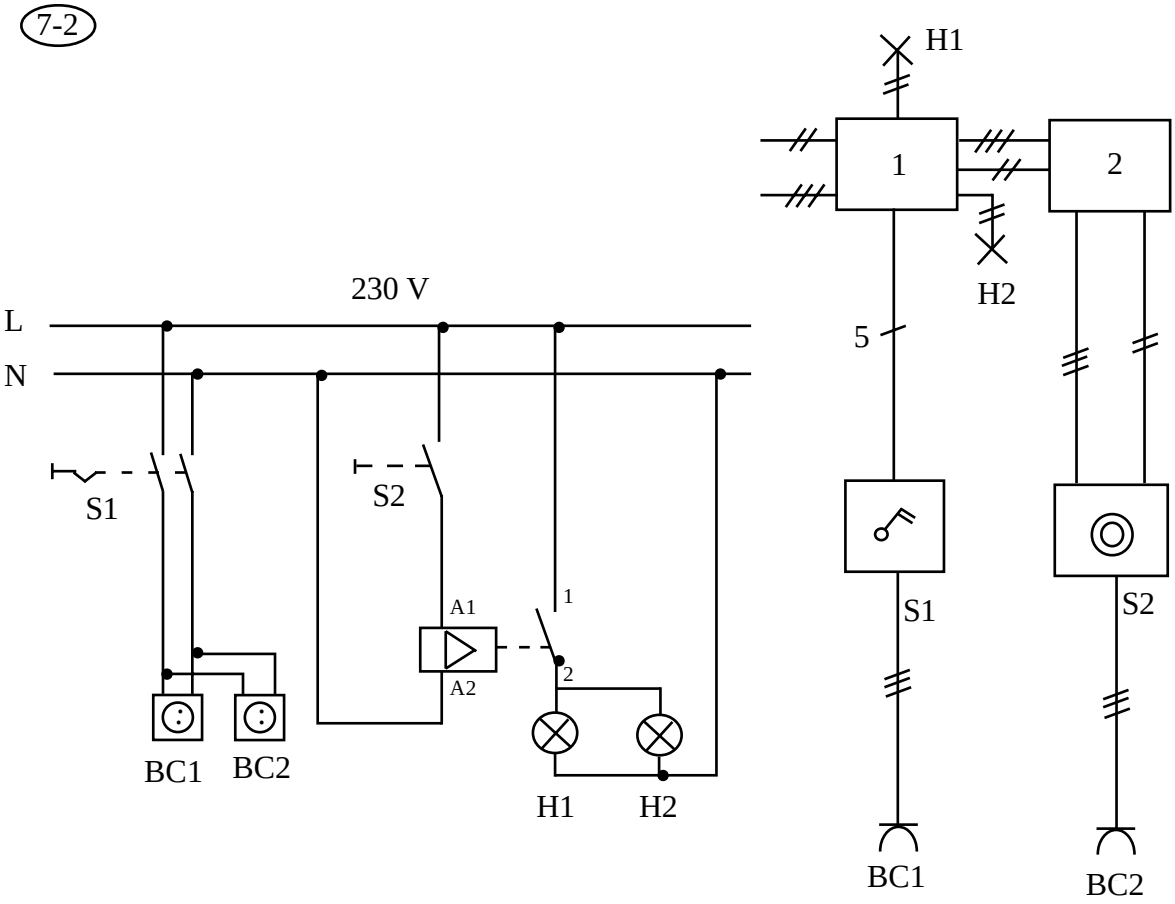

CD 2
H2
CD1
N
BC
230 V
L
H1
S1
S2
BC1
BC2

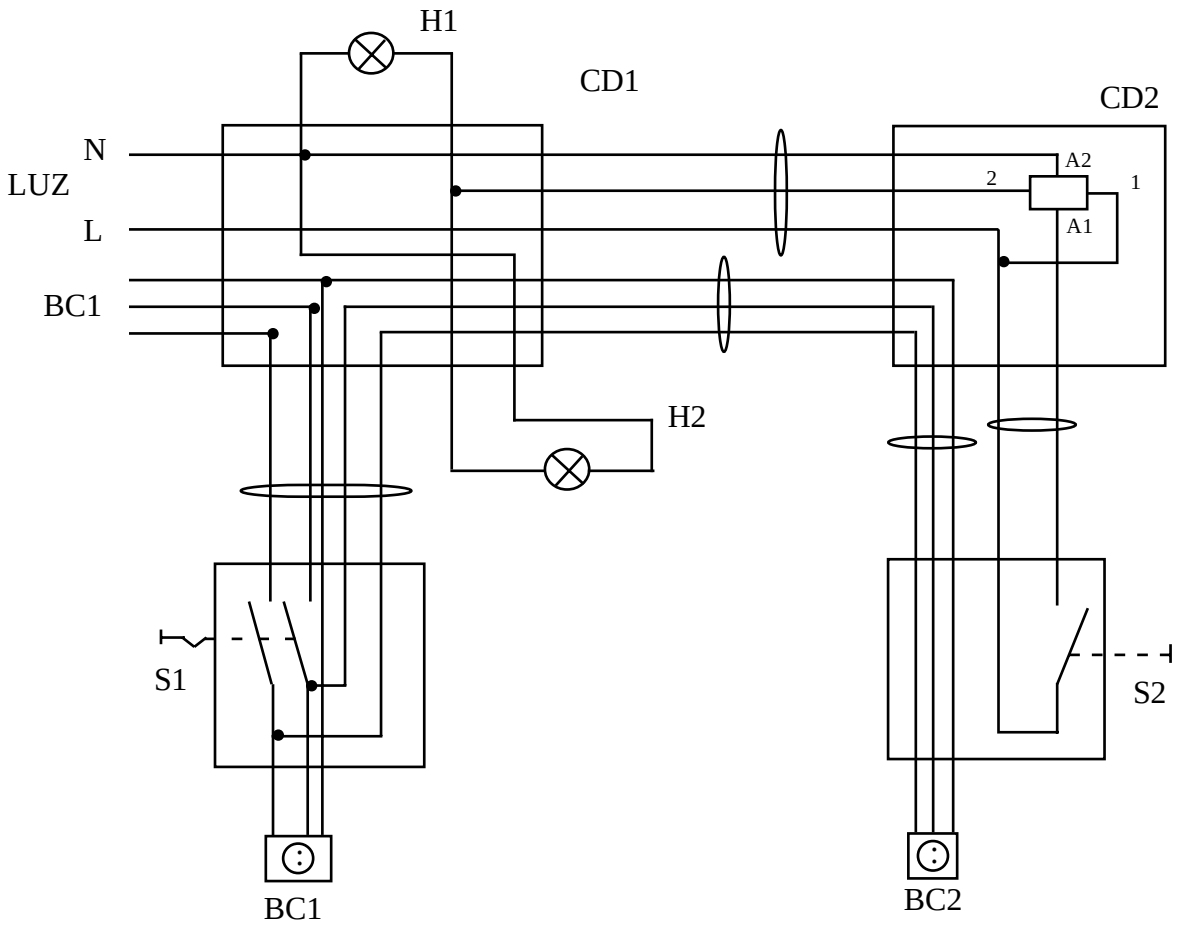
7-1


H1
LUZ
1
2
BC
5
H2
230 V
L
N
5
S1
S2
A1
1
2
A2
S1
S2
BC1
BC2
H1
H2
BC1
BC2

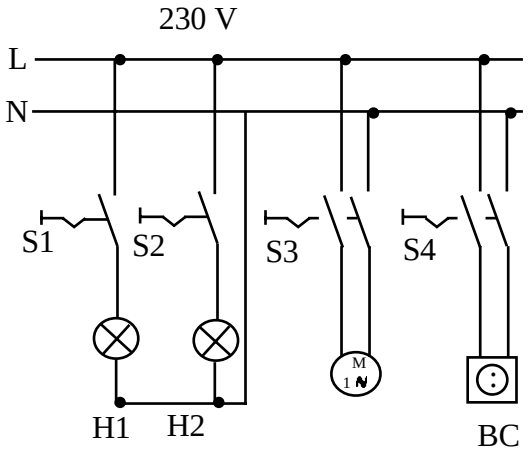

H1
CD1
CD2
A1
1
2
A2
BC
N
LUZ
L
H2
S1
S2
S1
BC1
BC2

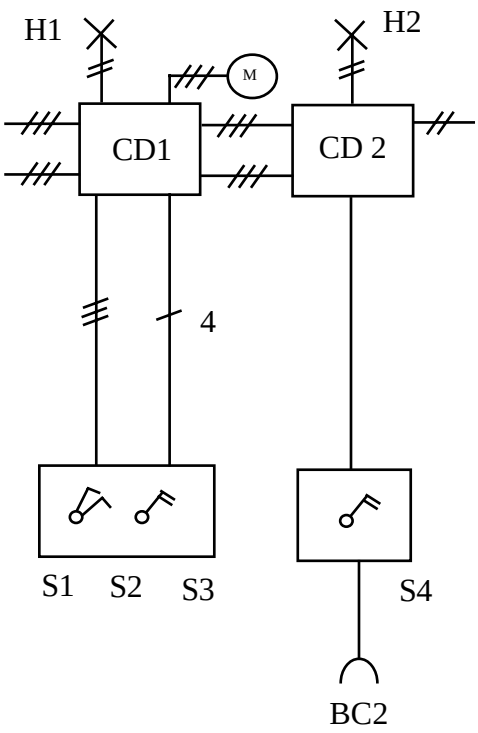
7-2

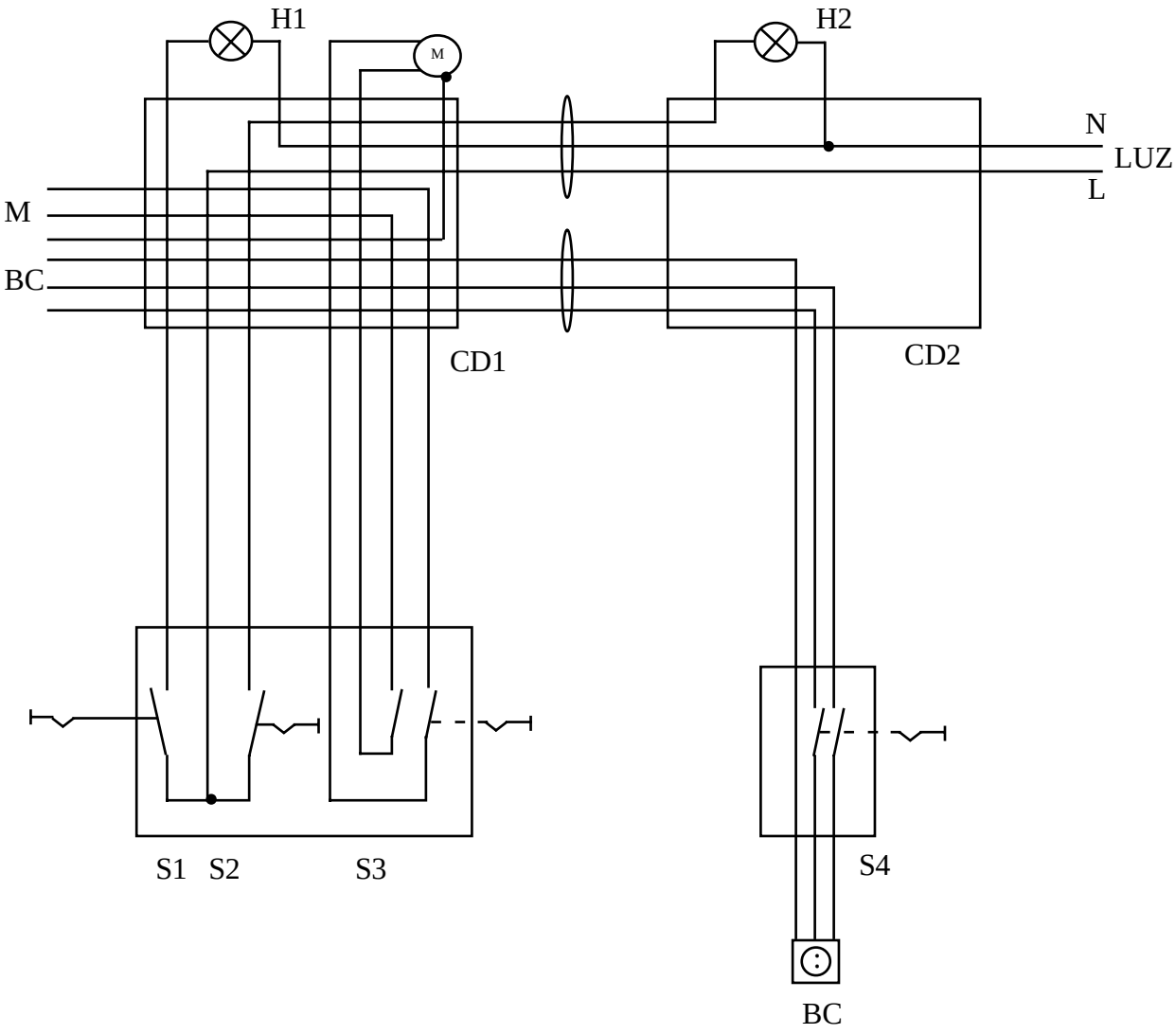

H1
1
2
H2
5
230 V
L
N
S1
S2
A1
A2
1
2
BC1
BC2
H1
H2
S1
S2
BC1
BC2


H1
CD1
CD2
N
LUZ
L
BC1
A2
2
1
A1
H2
S1
S2
BC1
BC2

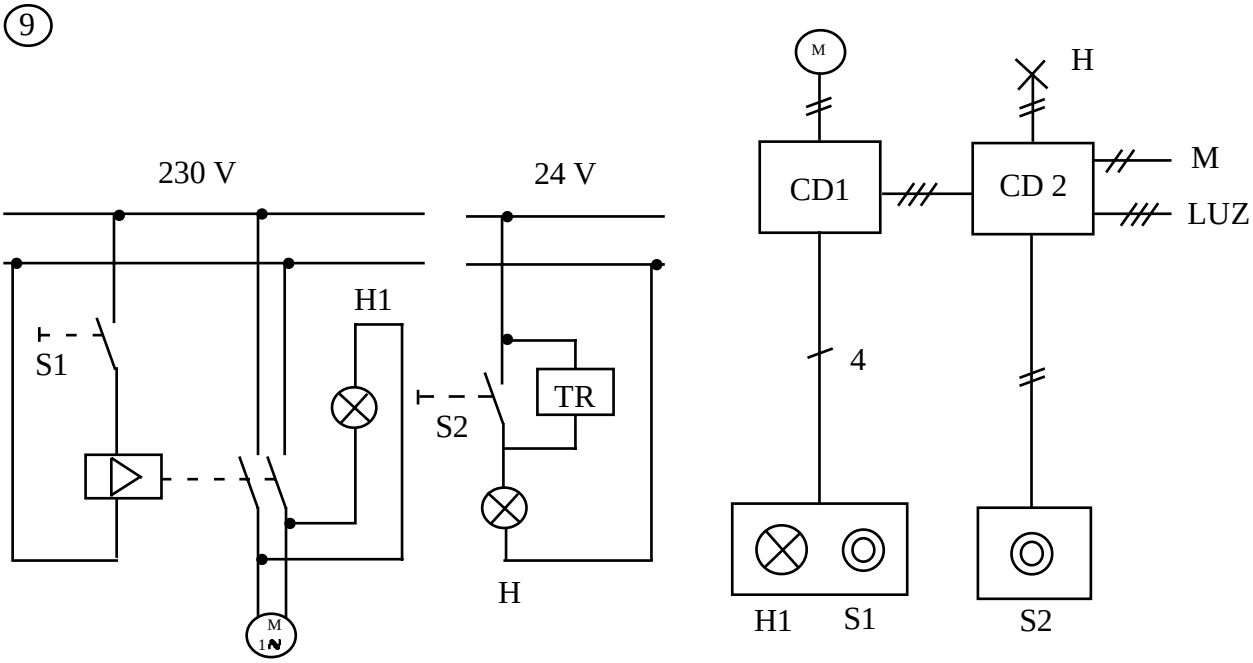
8

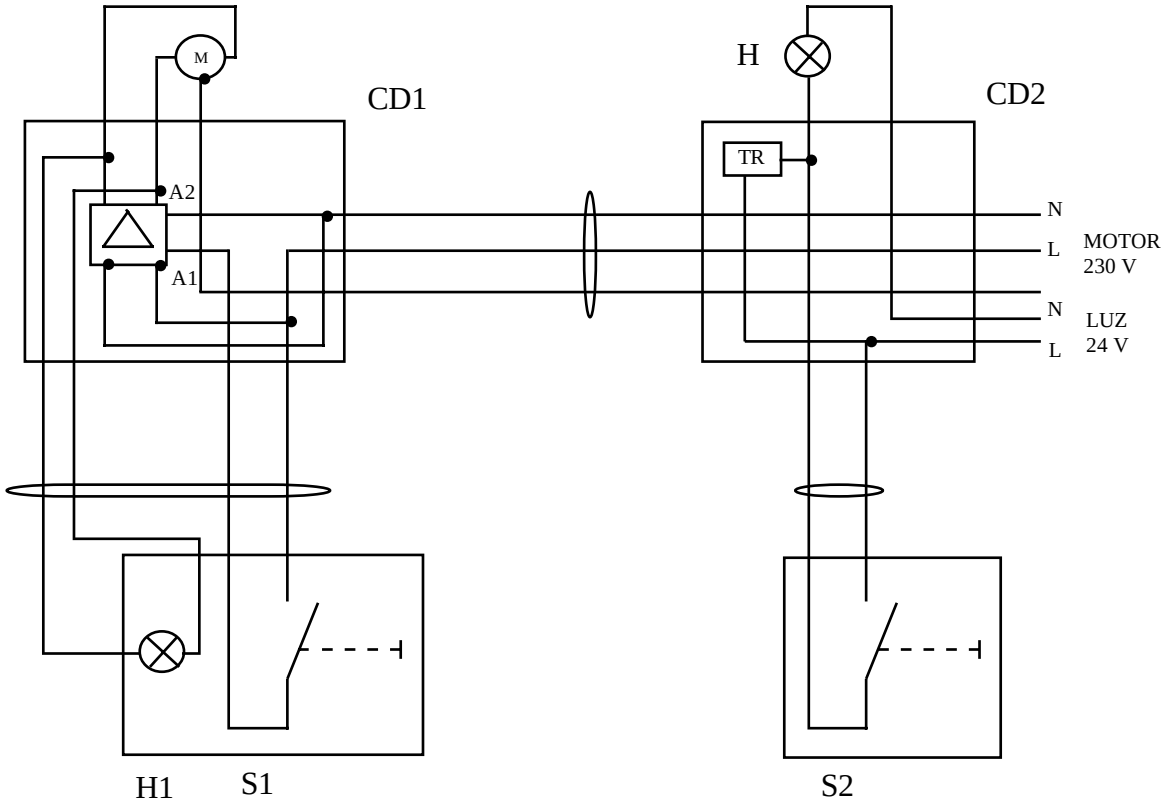

230 V
L
N
S1
S2
S3
S4
M
1 N
H1
H2
BC

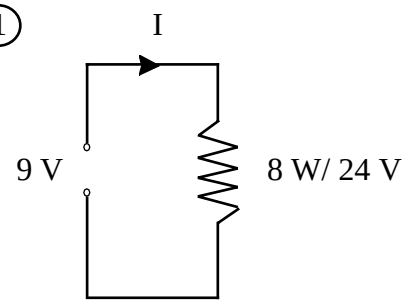

H1
H2
M
CD1
CD 2
4
S1
S2
S3
S4
BC2


H1
M
H2
N
LUZ
L
M
BC
CD1
CD2
S1
S2
S3
S4
BC

9


230 V
24 V
H1
S1
S2
TR
H
M
1~
M
H
CD1
CD 2
M
LUZ
4
H1
S1
S2


M
CD1
A2
A1
H
CD2
TR
N
L
MOTOR
230 V
N
LUZ
24 V
L
H1
S1
S2

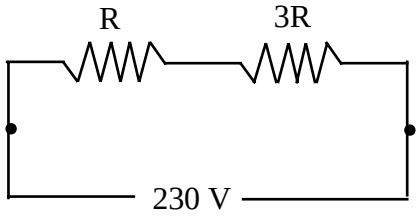
① 

$$R = \frac{U^2}{P} = \frac{24^2}{8} = 72\Omega$$

$$I = \frac{9}{72} = O{,}125\ A$$

$$P = U \times I = 9 \times 0{,}125 = 1{,}125\ W$$

---

② 

$$I = \frac{P}{U} = \frac{100}{230} = 0{,}4347\ A$$

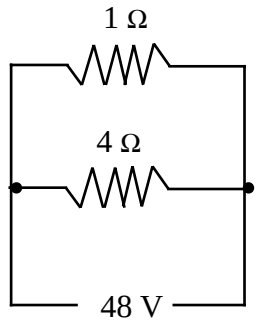
$$R_t = R + 3R = 4R$$

$$I = \frac{U}{R_t} = \frac{230}{4R} = 0{,}4347\ A$$

$$R = 132{,}27\ \Omega = R1$$

$$3 \times 132{,}27\ \Omega = 396{,}82\ \Omega = R_2$$

---

③ 

$$\frac{1}{Re} = \frac{1}{1} + \frac{1}{4} = 1{,}25$$

$$Re = 0{,}8\ \Omega$$

$$I = \frac{48}{0{,}8} = 60\ A$$

$$P = 48\ X\ 60 = 2880\ w$$

---

④

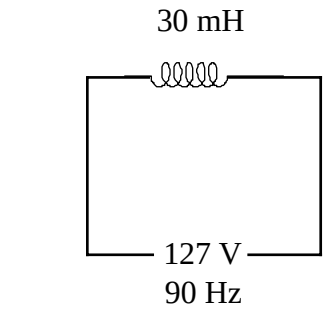
$$\frac{1}{Re} = \frac{1}{r} + \frac{1}{2r} + \frac{1}{r/2} = \frac{1}{r} + \frac{1}{2r} + \frac{2}{r} = \frac{1}{r}\left(1 + \frac{1}{2} + 2\right) = \frac{3{,}5}{r}$$

$$Re = \frac{r}{3{,}5} = 0{,}2857\ r$$

$$P = \frac{U^2}{Re} \qquad 1000 = \frac{24^2}{0{,}2857r}$$

$$r = 2{,}016\ \Omega$$
$$r_1 = 2{,}016\ \Omega$$
$$r_2 = 4{,}032\ \Omega$$
$$r_3 = 1{,}008\ \Omega$$

⑤



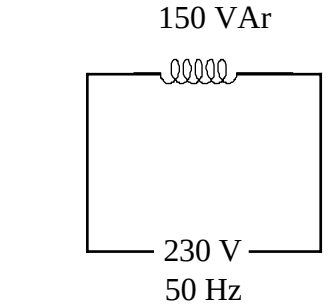
$X_L = 2\pi fL = 6{,}28 \times 60 \times 30 \times 10^{-3} = 11{,}34\ \Omega$

$I = \dfrac{127}{11{,}34} = 11{,}20\ A$

$Q = 127 \times 11{,}20 = 1442{,}3\ VAr$

---

⑥



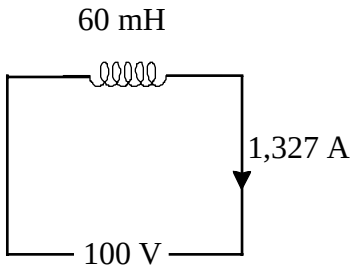
$I = \dfrac{Q}{U} = \dfrac{150}{230} = 0{,}652\ A$

$X_L = \dfrac{U}{I} = \dfrac{230}{0{,}652} = 352{,}76\ \Omega = 2\pi \times 50 \times L$

$L = 1{,}123\ H = 1123\ mH$

---

⑦



$Q = UI = 100\ X\ 1{,}327 = 132{,}7\ VAr$

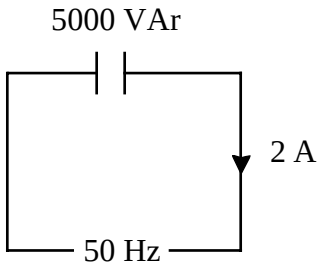
$X_L = \dfrac{U}{I} = \dfrac{100}{1{,}327} = 75{,}36\ \Omega = 2\pi \times 50 \times L$

$75{,}36 = 2\pi \times f \times 60 \times 10^{-3}$

$f = 200\ Hz$

---

⑧



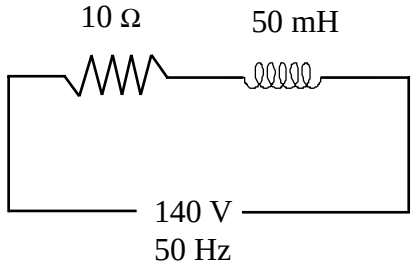
$U = \dfrac{Q}{I} = \dfrac{5000}{2} = 2500\ V$

$X_L = \dfrac{U}{I} = \dfrac{2500}{2} = 1250\ \Omega = \dfrac{1}{2\pi \times 50 \times C}$

$C = \dfrac{1}{1250 \times 2\pi \times 50} = 2{,}54\ \mu F$

---

⑨



$X_L = 2\pi \times 50 \times 50 \times 10^{-3} = 15{,}7\ \Omega$

$R = \sqrt{10^2 + 15{,}7^2} = 18{,}614\ \Omega$

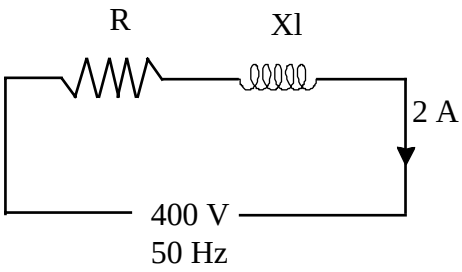
$I = \dfrac{240}{18{,}614} = 12{,}89\ A$

$P = 10 \times 12{,}89 = 1661{,}52\ W$

$Q = 15{,}7 \times 12{,}89 = 2608{,}59\ VAr$

$S = 240 \times 12{,}89 = 3093{,}60\ VA$

(10)



$R = X_L = a$

$I = \frac{U}{Z} \longrightarrow Z = UI = 400 \times 1 = 400\ \Omega$

$Z = \sqrt{R^2 + X_L^2} = \sqrt{a^2 + a^2} = a\sqrt{2} = 400\ \Omega$

$a = 282{,}84\ \Omega = R$

$L = \frac{282{,}84}{2\pi \times 50} = 0{,}9\ H = 900\ mH$

$\cos \varphi = \frac{R}{Z} = \frac{282{,}84}{400} = 0{,}706 = \text{sen}\ \varphi$

$P = 400 \times 1 \times 0{,}706 = 282{,}4\ W$

$Q = 400 \times 1 \times 0{,}706 = 282{,}4\ VAr$

$S = UI = 400 \times 1 = 400\ VA$

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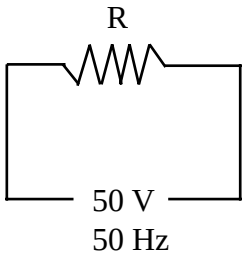
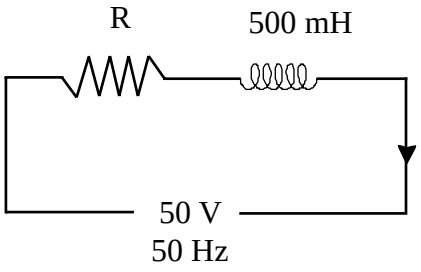
(11)





$Q = UI \qquad 7 = 50 \times I \longrightarrow I = 0{,}14\ A = \frac{50}{\sqrt{R^2 + X_L^2}}$

$X_L = 2\pi \times 50 \times 500 \times 10^{-3} = 157\ \Omega$

$0{,}14 = \frac{50}{\sqrt{R^2 + 157^2}} \longrightarrow R = 320\ \underline{\Omega}$

$(I)\ \text{Antes} = \frac{50}{320} = 0{,}156\ A$

$(P)\ \text{Antes} = 50 \times 0{,}156 = 7{,}81\ W$

$(I)\ \text{Despues} = 0{,}14\ A$

$(P)\ \text{Despues} = 320 \times 0{,}14^2 = 6{,}27\ W$

12

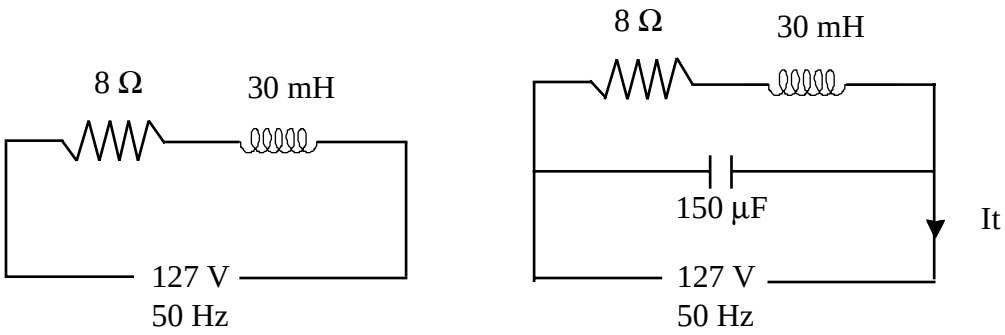
$$X_L = 2\pi \times 50 \times 30 \times 10^{-3} = 9{,}42\ \Omega$$

$$Z = \sqrt{8^2 + 9{,}42^2} = 12{,}358\ \Omega$$

$$I = \frac{127}{12{,}358} = 10{,}276\ A$$

$$P = 8 \times 10{,}276^2 = 844{,}89\ W$$

$$\cos \varphi = \frac{r}{Z} = \frac{8}{12{,}358} = 0{,}647$$



$$P_t = 844{,}49\ W$$

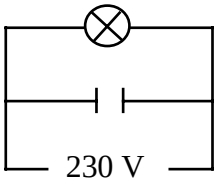
$$Q_t = Q_L - Q_C = 9{,}42 \times 10{,}276^2 - \frac{U^2}{X_C} = 994{,}71 - \frac{127^2}{\frac{10^6}{2\pi \times 50 \times 150}} = 994{,}71 - 759{,}67 = 235{,}04\ VAr$$

$$\text{tg}\ \varphi_t = \frac{235{,}04}{884{,}89} = 0{,}265 \longrightarrow \cos \varphi_t = 0{,}966$$

$$I_t = \frac{844{,}89}{127 \times 0{,}966} = 6{,}886\ A$$

$$S_t = 127 \times 6{,}886 = 874 VA$$

13



$\cos \varphi = 0{,}72 \longrightarrow \operatorname{tg} \varphi = 0{,}9638$

$Q = P \cdot \operatorname{tg} \varphi = 350 \text{ x } 0{,}9638 = 337{,}35 \text{ VAr}$

$$337{,}35 = \frac{230^2}{Xc}$$

$$Xc = 156{,}81 = \frac{1}{2\pi \text{ x } 50 \text{ x } C}$$

$C = 20{,}31 \ \mu F$

El $\cos \varphi = 1{,}00$

$$\text{Antes} \longrightarrow I = \frac{350}{230 \text{ x } 0{,}72} = 2{,}113 \text{ A}$$

$$\text{Despues} \longrightarrow I = \frac{350}{230 \text{ x } 1{,}00} = 1{,}522 \text{ A}$$

14

$$\cos \varphi = \frac{4400}{230 \text{ x } 26{,}6} = 0{,}719$$

$I` = 26{,}6 - 5{,}32 = 21{,}28 \text{ A}$

$$\cos \varphi' = \frac{4400}{230 \text{ x } 21{,}28} = 0{,}898$$

$\operatorname{tg} \varphi = 0{,}966$

$\operatorname{tg} \varphi' = 0{,}49$

$Qc = 4400 \ (0{,}966 - 0{,}49) = 2094{,}4 \text{ VAr}$

$$2094{,}4 = \frac{230^2}{Xc} \longrightarrow Xc = 25{,}26 \ \Omega = \frac{1}{2\pi \text{ x } 50 \text{ x } C}$$

$C = 126 \ \mu F$

$Q` = 4400 \text{ x } 0{,}49 = 2156 \text{ VAr}$

$S' = 230 \text{ x } 21{,}28 = 4894{,}4 \text{ VA}$

① La caída será el doble cuando la resistencia sea el doble, ó sea, cuando la resistividad sea el doble que a 20º C.

Si a 20º C es de 0,0178 Ω x mm²/m, a la temperatura indicada será de 2 x 0,0178 = 0,0356 Ω x mm²/m.

$$0{,}0356 = 0{,}0178 \, (1 + 0{,}0039 \times \Delta t)$$
$$\Delta t = 256^{\circ} C = t - 20$$
$$t = 276^{\circ} C$$

---

②

$$I = \frac{3300}{230 \times 0{,}92} = 15{,}595 \text{ A}$$

$$Ct = \frac{2 \times 3300 \times 16}{44 \times 230 \times 4} = 2{,}6 \text{ V}$$

---

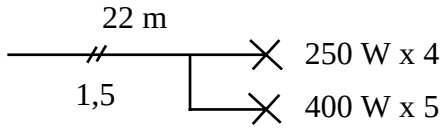
③

$$1{,}2\ \% = \frac{Ct}{230} \times 100 \longrightarrow Ct = 2{,}76 \text{ V} = \frac{2 \times 1500 \times 24}{44 \times 127 \times S}$$

$$S = 4{,}668 \text{ mm}^2 \longrightarrow 6 \text{ mm}^2$$

---

④



$$Ct = \frac{2 \times 1000 \times 22}{44 \times 230 \times 1{,}5} = 2{,}9 \text{ V}$$

$$(Ct)t = 2{,}9 \times 0{,}85 = 2{,}46 \text{ V} = \frac{2 \times 3000 \times 22}{44 \times 230 \times S} = 2{,}46 \text{ V}$$

$$S = 5{,}3 \text{ mm}^2 \longrightarrow 6 \text{ mm}^2$$

⑤ La mayor caída tiene lugar en la lámpara de 150 W.

$$Ct = \frac{2 \times 250 \times 22}{44 \times 230 \times 1,5} + \frac{2 \times 150 \times 22}{44 \times 230 \times 1,5} = 0,724 + 0,434 = 1,158 \text{ V}$$

$$Ct\ (\%) = \frac{1,158}{230} \times 100 = 0,50\ \%$$

$$I = \frac{250}{230 \times 0,85} = 1,278 \text{ A}$$

$\text{tg}\ \varphi = 0,619$ $\qquad Q = P \cdot \text{tg}\ \varphi = 250 \times 0,619 = 154,9$ VAr

---

⑥

$$Ct = \frac{2 \times 6000 \times 16}{44 \times 230 \times 10} + \frac{2 \times 9000 \times 8}{44 \times 230 \times 10} = 1,897 + 1,423 = 3,32 \text{ V}$$

$U_1 = 228,5 + 3,32 = 231,82$ V

Pt = 9000 W / $\text{tg}\ \varphi_1 = 0,593$ / 0,593 X 6000 = 3558 VAr
$\text{tg}\ \varphi_2 = 0,455$ / 0,455 X 3000 = 1366 VAr

Qt = 3558 + 1366 = 4924 VAr

$$\text{tg}\ \varphi = \frac{4924}{9000} = 0,547 \longrightarrow \cos \varphi = 0,877$$

$$I = \frac{9000}{230 \times 0,877} = 44,62 \text{ A}$$

S = 230 x 44,62 = 10263 VA

---

⑦

$$2,8 = \frac{Ct}{230} \times 100 \longrightarrow Ct = 6,44 \text{ V}$$

$$Ct = \frac{2 \times 6000 \times 12}{44 \times 230 \times 6} + \frac{2 \times 15000 \times 21}{44 \times 230 \times S} = 6,44$$

$$\frac{62,25}{S} = 6,44 - 2,37 = 4,07$$

$S = 15,29\ mm^2 \longrightarrow 16\ mm^2$

$\text{tg } \varphi_1 = 0{,}964 \longrightarrow Q_1 = 6000 \text{ x } 0{,}964 = 5784 \text{ VAr}$

$\text{tg } \varphi_2 = 0{,}54 \longrightarrow Q_2 = 9000 \text{ x } 0{,}54 = 4859 \text{ VAr}$

$Qt = 10643 \text{ VAr} \qquad \text{tg } \varphi_t = \dfrac{10643}{15000} = 0{,}709$

$\cos \varphi_t = 0{,}815$

$S = \dfrac{P}{\cos \varphi} = \dfrac{15000}{0{,}815} = 18401 \text{ VA}$

---

⑧

$P_1 = 12000 \text{ W} \qquad Q_1 = 12000 \text{ x tg } \varphi_1 = 12000 \text{ x } 0{,}54 = 6480 \text{ VAr}$

$P_2 = 8000 \text{ W} \qquad Q_2 = 0$

$P_t = 20000 \text{ W}$

$Q_t = 6480 \text{ VAr}$

$\text{tg } \varphi_t = \dfrac{6480}{20000} = 0{,}324 \longrightarrow \cos \varphi_t = 0{,}95$

$I = \dfrac{20000}{230 \text{ x } 0{,}95} = 91{,}53 \text{ A}$

Al reemplazar por alumínio ($\gamma = 28 \text{ m}/\omega\text{mm}^2$), la caída de tensión aumenta en la proporción

$\dfrac{44}{28} = 1{,}57$, es decir, el 57 %.

- Con cobre :

$Ct = \dfrac{2 \text{ x } 12000 \text{ x } 19}{44 \text{ x } 230 \text{ x } 25} + \dfrac{2 \text{ x } 20000 \text{ x } 34}{44 \text{ x } 230 \text{ x } 35} = 1{,}80 + 1{,}92 = 3{,}72 \text{ V}$

- Con Alumínio :

$Ct = 1{,}8 \text{ x } 1{,}57 + 1{,}92 = 4{,}746 \text{ V}$

La proporción es $\dfrac{4{,}746}{3{,}72} = 1{,}27$

Ha aumentado el 27 %

⑨

$$\text{- En 24 V} \longrightarrow Ct = \frac{2 \times 800 \times 7}{44 \times 24 \times 10} = 1{,}06 \text{ V}$$

$$Ct\,(\%) = \frac{1{,}06}{24} \times 100 = 4{,}41\ \%$$

$$\text{- En 230 V} \longrightarrow Ct = \frac{2 \times 4000 \times 24}{44 \times 230 \times 16} = 1{,}18 \text{ V}$$

$$Ct\,(\%) = \frac{1{,}18}{230} \times 100 = 0{,}51\ \%$$

$$(Ct)_{1\text{-}2} = 4{,}41 + 0{,}51 = 4{,}92\ \%$$

$$P = 300 + 500 + 3200 = 4000 \text{ W}$$

$$Q = 300 \times 0{,}724 + 0 + 3200 \times 0{,}48 = 219{,}2 + 1536 = 1753{,}2 \text{ VAr}$$

$$\text{tg } \varphi_t = \frac{1753{,}2}{4000} = 0{,}438 \longrightarrow \cos \varphi_t = 0{,}916$$

---

⑩

$$\text{- En 132 V} \longrightarrow Ct = \frac{2 \times 1000 \times 6}{44 \times 132 \times 10} + \frac{2 \times 3000 \times 11}{44 \times 132 \times 10} = 0{,}206 + 1{,}136 = 1{,}342 \text{ V}$$

$$Ct\,(\%) = \frac{1{,}342}{132} \times 100 = 1{,}017\ \%$$

$$\text{- En 230 V} \longrightarrow Ct = \frac{2 \times 3000 \times 9}{44 \times 230 \times 6} = 0{,}889 \text{ V}$$

$$Ct\,(\%) = \frac{0{,}889}{230} \times 100 = 0{,}386\ \%$$

$$Ct\,(\%) = 1{,}017 + 0{,}386 = 1{,}403\ \%$$

$$\text{tg } \varphi_1 = 0{,}672 \longrightarrow Q_1 = 1000 \times 0{,}672 = 672 \text{ VAr}$$
$$\text{tg } \varphi_2 = 0{,}484 \longrightarrow Q_2 = 2000 \times 0{,}484 = 968 \text{ VAr}$$

$$Qt = 1640 \text{ VAr}$$

$$\text{tg } \varphi_t = \frac{1640}{3000} = 0{,}546 \longrightarrow \cos \varphi_t = 0{,}877$$

$$I = \frac{3000}{132 \times 0{,}877} = 25{,}91 \text{ A}$$

(11)

P es la potencia de la R

$$(Ct)_{12} = 1{,}5 \times \frac{230}{100} = 3{,}45 \text{ V}$$

$$3{,}45 = \frac{2 \times 900 \times 13}{44 \times 132 \times 1{,}5} + \frac{2\,(900 + P) \times 8}{44 \times 230 \times 4}$$

$$1{,}90 = \frac{16\,(900 + P)}{40480}$$

$$P = 3907 \text{ W}$$

$$Q_1 = 900 \times 0{,}566 = 510 \text{ VAr}$$

$$\left.\begin{array}{l} P_t = 4807 \text{ W} \\ Q_t = 510 \text{ VAr} \end{array}\right] \quad \text{tg } \varphi_t = \frac{510}{4807} = 0{,}106 \longrightarrow \cos \varphi_t = 0{,}994$$

$$I_t = \frac{4807}{230 \times 0{,}994} = 21{,}02 \text{ A}$$

1

$$P_n = \frac{8000}{0{,}90} = 8889 \text{ W}$$

$$\cos \varphi_n = \frac{8889}{\sqrt{3} \text{ x } 400 \text{ x } 15} \longrightarrow = 0{,}856$$

$$\text{tg } \varphi_n = 0{,}604$$

$$Q_n = P_n \text{ x tg } \varphi_n = 8889 \text{ x } 0{,}604 = 5368 \text{ VAr}$$

$$S_n = 400 \text{ x } 15 \text{ x } \sqrt{3} = 10380 \text{ VA}$$

2

$$P = \frac{2200}{0{,}82} = 2683 \text{ W}$$

$$I = \frac{2683}{\sqrt{3} \text{ x } 400 \text{ x } 0{,}86} \longrightarrow = 4{,}51 \text{ A}$$

$$Ct = \frac{2683 \text{ x } 31}{44 \text{ x } 400 \text{ x } 4} = 1{,}18 \text{ V}$$

$$Ct\ (\%) = \frac{1{,}18}{400} \text{ x } 100 = 0{,}295 \ \%$$

$$\text{tg } \varphi_n = 0{,}593$$

$$Q_n = P_n \text{ x tg } \varphi_n = 2683 \text{ x } 0{,}593 = 1592 \text{ VAr}$$

③

$P_1 = 2000 / 0{,}84 = 2381 \text{ W} = 2{,}381 \text{ kW}$
$R_1 = 2381 \text{ x } \text{tg } \varphi = 2{,}381 \text{ tg } \varphi_1 \text{ (kVAr)}$

$P_2 = 4000 / 0{,}84 = 4{,}762 \text{ kW}$
$R_2 = 4{,}762 \text{ tg } \varphi$

$P_t = 2{,}381 + 4{,}762 = 7{,}143 \text{ kW}$
$R_t = 7{,}143 \text{ tg } \varphi$

$$I_t = \frac{S_t}{\sqrt{3} \text{ x } 400} = 12 \longrightarrow S_t = 8{,}304 \text{ kVA}$$

$$8{,}304 = \sqrt{P_t^2 + Q_t^2} = \sqrt{7{,}143^2 + 7{,}143^2 \text{ tg}^2 \varphi} = 7{,}143 \sqrt{1 + \text{tg}^2 \alpha}$$

$\text{tg } \varphi = 0{,}592 \longrightarrow \boxed{\cos \varphi = 0{,}86}$

$Q_t = 7{,}143 \text{ x } 0{,}592 = 4{,}228 \text{ kVAr}$

$$Ct = \frac{7.143 \text{ x } 7}{44 \text{ x } 400 \text{ x } 16} + \frac{4762 \text{ x } 24}{44 \text{ x } 400 \text{ x } 16} = \frac{50001 + 114288}{358400} = 0{,}458 \text{ V}$$

$= 0{,}177 + 0{,}406 = 0{,}583 \text{ V}$

$$(Ct)\ \% = \frac{0{,}583}{400} \text{ x } 100 = 0{,}146\ \%$$

---

④

- A plena carga $$I = \frac{15000 / 0{,}94}{\sqrt{3} \text{ x } 400 \text{ x } 0{,}92} = 25{,}06 \text{ A}$$

- A media carga $P'_u = 15000 / 2 = 7500 \text{ W}$

$\text{Rendin}' = 0{,}94 \text{ x } 0{,}90 = 0{,}846$

$I' = 25{,}06 \text{ x } 0{,}60 = 15{,}04 \text{ A}$

$$\cos \varphi' = \frac{7500 / 0{,}846}{\sqrt{3} \text{ x } 400 \text{ x } 15{,}04} = 0{,}852$$

$\text{tg } \varphi' = 0{,}614$

$Q' = (7500 / 0{,}846) \text{ x } 0{,}614 = 5443 \text{ VAr}$

5

$P_1 = 6000$ W
$Q_1 = 0$ VAr

$P_2 = 7500$ W
$Q_2 = 7500 \times 0{,}48 = 3600$ VAr

$P_3 = 4000$ W
$Q_3 = 4000 \times 0{,}59 = 2360$ VAr

$P_t = 17500$ W
$Q_t = 5960$ VAr

$$\text{tg } \varphi_t = \frac{5960}{17500} = 0{,}34 \longrightarrow \cos \varphi_t = 0{,}946$$

$$I_t = \frac{17500}{\sqrt{3} \times 400 \times 0{,}946} = 26{,}73 \text{ A}$$

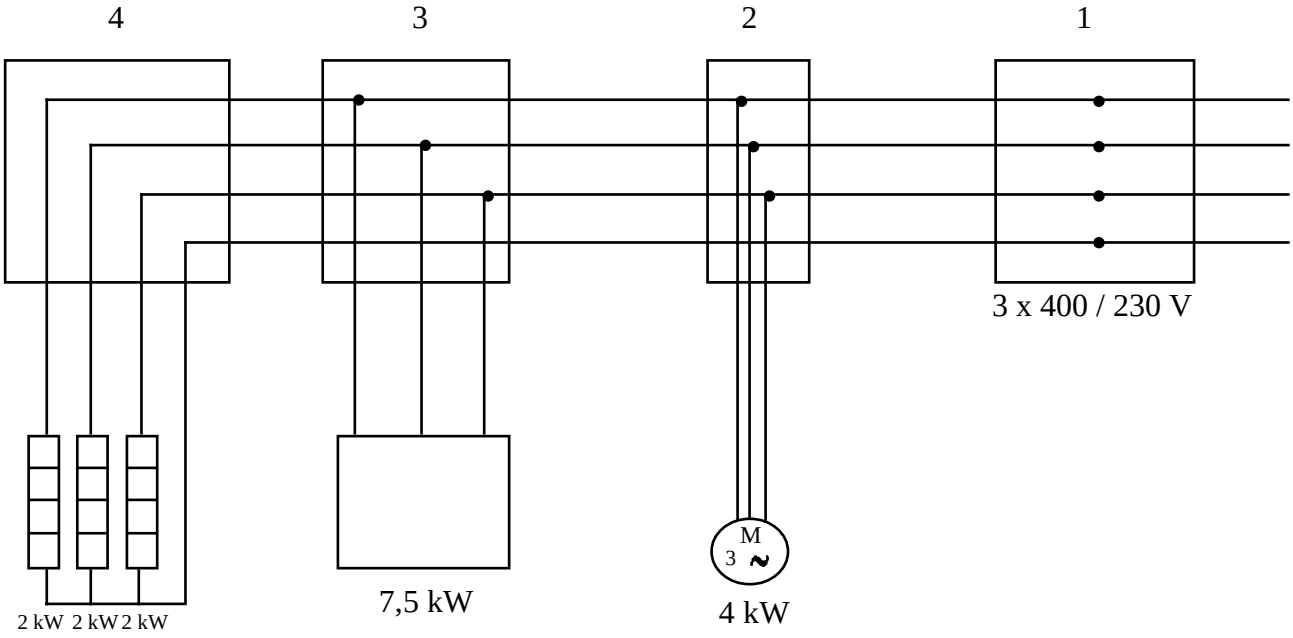
$$Ct = \frac{6000 \times 8}{44 \times 400 \times 16} + \frac{13500 \times 12}{44 \times 400 \times 16} + \frac{17500 \times 14}{44 \times 400 \times 16} = 0{,}17 + 0{,}575 + 0{,}87 = 1{,}61 \text{ V}$$

- La tensión entre fases en el punto 4 es de:

$$228 \times \sqrt{3} = 394{,}44 \text{ V}$$

- La tensión en 1 es de:

$$394{,}44 + 1{,}61 = 396{,}05 \text{ V}$$



6

$P_1 = 8000 / 0{,}92 = 8696$ W
$Q_1 = 8696 \times 0{,}646 = 5617$ VAr

$P_2 = 1000 / 0{,}92 = 10869$ W
$Q_2 = 10869 \times 0{,}698 = 7587$ VAr

$P_t = 19565$ W
$Q_t = 13204$ VAr

$$\text{tg } \varphi_t = \frac{13204}{19565} = 0{,}675 \longrightarrow \cos \varphi_t = 0{,}83$$

$$I_t = \frac{19505}{\sqrt{3} \times 230 \times 0{,}83} = 59{,}24 \text{ A}$$

$$Ct = \frac{19505 \times 18}{44 \times 400 \times 16} + \frac{19565 \times 24}{44 \times 230 \times 25} + \frac{8696 \times 8}{44 \times 230 \times 25}$$

$$(Ct)\,\% = \frac{1{,}25}{400} \times 100 + \frac{1{,}85}{230} \times 100 + \frac{0{,}77}{230} \times 100$$

$$0{,}312 + 0{,}804 + 0{,}117 = 1{,}23\,\%$$

①

1 - HO7R-A1 x 16 K
2 - H1VD-1 x 6 U
3 - HO5DV-2 x 4 H
4 - HO7RV-A3 x 10 K
5 - H1VV-2G16 R
6 - HO5EV-3 x 10 / 6F
7 - H1DV-3G25R
8 - HO7RV-3G10 / 6H

---

②

S (mm^2)	1,5	2,5	4	6	10	16	25	35	50
D ext (mm)	3	3,6	4,2	4,8	5,3	6,8	8,4	9,6	11
S ext (mm^2)	7	10,2	13,8	18	22	36	55	72	95

---

③

Rollo 1 = $\frac{1}{1,83}$ = 0,546 Km

0,546 · 115 = 62,84 Kg

Rollo 2 = $\frac{1}{1,15}$ = 0,869 Km

0,869 · 170 = 147,8 Kg

Rollo 3 = $\frac{1}{0,727}$ = 1,375 Km

1,375 · 265 = 364 Kg

Rollo 4 = $\frac{1}{0,624}$ = 1,602 Km

1,602 · 360 = 577 Kg

---

④

	De (mm)	S_{cu} (mm)	S_t (mm^2)
3 x 10 / 6	16,9	16	224,2
3 x 16 / 10	18,8	20,9	277,45
3 x 25 / 16	22,7	22,5	404,5
3 x 35 / 16	25,1	24,46	495,55
3 x 50 / 25	27,9	28,6	611,05

①

1.1 - 37 x 1,15 = 42,55 A
1.2 - 105 x 1,23 = 129,15 A
1.3 - 68 x 0,96 = 65,28 A
1.4 - 70 x 1,22 = 85,4 A
1.5 - 116 x 1,26 = 146,16 A

---

②

2.1 - 27 A
2.2 - 91 A
2.3 - 52 A
2.4 - 88 A
2.5 - 54 A
2.6 - 44 A

---

③

3.1 - El de 2,5 mm^2 - 17,5 x 0,80 = 14 A
El de 4 mm^2 - 23 x 0,80 = 18,4 A

3.2 - El de 4,0 mm^2 - 23 x 0,80 = 18,4 A
El de 10 mm^2 - 37 x 0,80 = 29,6 A

3.3 - Los de 6 mm^2 - 37 x 0,65 = 24,05 A
Los de 10 mm^2 - 50 x 0,65 = 32,5 A

3.4 - El de 4 mm^2 - 20 x 0,70 = 14 A
El de 6 mm^2 - 25 x 0,70 = 17,5 A
El de 10 mm^2 - 34 x 0,70 = 23,8 A

---

④

$$\text{PVC} \longrightarrow \text{Icc} = 115 \frac{S}{\sqrt{t}}$$

$$\text{XLPE (R)} \longrightarrow \text{Icc} = 135 \frac{S}{\sqrt{t}}$$

	1``	2``	3``	4``	5``
H07V - 1x 16	1840	1301	1063	920	823
H1R - 1x 25	3375	2306	1950	1687	1513
H07VV - 1x 50	5750	4065	3324	2875	2578

(5)

La potencia de las lámparas es de :

$P_t = 9 \times 100 + 11 \times 150 = 2550$ W
$S = 1{,}8\ P = 4590$ VA (a considerar)
$P_t = 4590 \times 0{,}80 = 3672$ W (a considerar)

$$I = \frac{4590}{230} = 19{,}95 \text{ A}$$

$P_2 = 11 \times 150 \times 1{,}8 \times 0{,}80 = 2376$ W

(S) inicial ⟶ 6 mm²

$I_{na} = 36 \times 0{,}70 = 22{,}5 \text{ A} > 19{,}95 \text{ A}$

(Van 3 circuitos de CD1 a S1/S2)

$$Ct = \frac{2 \times 3672 \times 9}{44 \times 230 \times 6} + \frac{2 \times 2376 \times 23}{44 \times 230 \times 6} = 1{,}088 + 1{,}8 = 1{,}89 \text{ V}$$

$$Ct\ (\%) = \frac{1{,}89}{230} \times 100 = 1{,}25\ \% < 1{,}3\ \%$$

(S) definitiva ⟶ 6 mm²

---

(6)

$P_t = 1400 + 1920 = 3320$ W
$S = 1{,}8 \times 3320 = 5976$ VA (a considerar)
P_2 (a considerar) $= 1920 \times 1{,}8 \times 0{,}85 = 2937{,}6$ W

$$I = \frac{5976}{230} = 26 \text{ A}$$

(S) inicial ⟶ 6 mm²

$I_{na} = 32 \text{ A} > 26 \text{ A}$

$$Ct = \frac{2 \times 5976 \times 0{,}8 \times 26}{44 \times 230 \times 6} + \frac{2 \times 2937{,}6 \times 14}{44 \times 230 \times 6} = 4{,}3 \text{ V} + 1{,}35 = 5{,}65 \text{ V}$$

$$Ct\ (\%) = \frac{5{,}65}{230} \times 100 = 2{,}46\ \% < 3\ \%$$

(S) definitiva ⟶ 6 mm²

7

$$I = \frac{7500 / 0,92}{\sqrt{3} \times 400 \times 0,87} = 13,54 \text{ A}$$

$$1,25\ I = 16,9 \text{ A}$$

(S) inicial ⟶ 1,5 mm^2

$$I_{na} = 18 \text{ A} > 16,9 \text{ A}$$

$$(Ct) = \frac{7500 / 0,92 \times 21}{44 \times 400 \times 1,5} = 6,48 \text{ V}$$

$$Ct\ (\%) = \frac{6,48}{400} \times 100 = 1,62\ \% < 5\ \%$$

(S) definitiva fases, neutro y protección ⟶ 1,5 mm^2

8

$$I_1 = \frac{7500 / 0,93}{\sqrt{3} \times 400 \times 0,85} = 20,11 \text{ A}$$

$$I_2 = \frac{8000 / 0,91}{\sqrt{3} \times 400 \times 0,85} = 14,94 \text{ A}$$

$$1,25\ I_1 + I_2 = 40 \text{ A}$$

(S) inicial ⟶ 10 mm^2

$$I_{na} = 44 \text{ A} > 40 \text{ A}$$

$$P_1 = \frac{11000}{0,93} = 11828 \text{ W}$$

$$P_2 = \frac{8000}{0,91} = 8791 \text{ W}$$

$$P_t = 20619 \text{ W}$$

$$Ct = \frac{20619 \times 13}{44 \times 400 \times 10} + \frac{11828 \times 24}{44 \times 400 \times 10} = 1,52 + 1,61 = 3,13 \text{ V}$$

$$Ct\ (\%) = \frac{3,13}{400} \times 100 = 0,78\ \% < 5\ \%$$

(S) definitiva fases, neutro y protección ⟶ 10 mm^2

⑨

$$I_1 = \frac{8000}{\sqrt{3} \text{ x } 400 \text{ x } 1{,}00} = 11{,}56 \text{ A}$$

$$I_2 = \frac{7500 / 0{,}84}{\sqrt{3} \text{ x } 400 \text{ x } 0{,}80} = 16{,}13 \text{ A}$$

$$I_3 = \frac{15000 / 0{,}94}{\sqrt{3} \text{ x } 400 \text{ x } 0{,}86} = 26{,}81 \text{ A}$$

· Circuito 2

$1{,}25 \text{ x } 16{,}13 = 20{,}16 \text{ A}$

(S) inicial ⟶ 6 mm²

$I_{ma} = 32{,}5 \text{ x } 0{,}70 = 22{,}4 \text{ A} > 20{,}16 \text{ A}$

(3 Circuitos en tubo)

· Circuito 1

11,56 A

(S) inicial ⟶ 2,5 mm²

$I_{ma} = 18{,}5 \text{ x } 0{,}70 = 12{,}95 \text{ A} > 11{,}56 \text{ A}$

· Circuito 3

$1{,}25 \text{ x } 26{,}81 = 33{,}51 \text{ A}$

(S) inicial ⟶ 16 mm²

$I_{ma} = 59 \text{ x } 0{,}70 = 41{,}3 \text{ A} > 33{,}51 \text{ A}$

Circuito común

$I_t = 1{,}25 \text{ x } 26{,}81 + 16{,}13 + 11{,}56 = 61{,}2 \text{ A}$

(S) inicial ⟶ 25 mm²

$I_{ma} = 77 \text{ A} > 61{,}2 \text{ A}$

Las caídas de tensión son relativamente pequeñas

Al motor grande:

$$Ct = \frac{1500 / 0{,}94 \text{ x } 16}{44 \text{ x } 400 \text{ x } 16} + \frac{\left(\frac{15000}{0{,}94} + \frac{7500}{0{,}84} + 8000 \right) \text{ x } 11}{44 \text{ x } 400 \text{ x } 25} = 0{,}96 + 0{,}822 = 1{,}728 \text{ V}$$

$$Ct\ (\%) = \frac{1{,}728}{400} \text{ x } 100 = 0{,}43\ \% < 5\ \%$$

A los demas, parecido.

(1)

1 - 25 mm.
2 - 20 mm.
3 - 32 mm.
4 - 63 mm.

$5 - Sc = \pi \frac{14 \cdot 6^2}{4} = 167{,}33 \text{ mm}^2$

$4Sc = 669{,}32 \text{ mm}^2 = \pi \frac{Di^2}{4}$

Di = 29,2 mm.
Dext ⟶ 32 mm

---

(2)

(2-1)

$De = \sqrt{\frac{4 \times 4}{\pi}} = 2{,}26 \text{ mm}$

De = 2,25 + 2 x 0,8 = 3,86 mm

$Sc = \pi \frac{3{,}86^2}{4} = 11{,}7 \text{ mm}^2$

$St = 6 \times 11{,}7 = 70{,}2 \text{ mm}^2$

$Stubo = 3 \times 70{,}2 = 210{,}6 \text{ mm}^2 = \pi \frac{Di^2}{4}$

Di = 16,38 mm
Dext = 16,38 + 2 x 1,5 = 19,38 mm
D ⟶ 20 mm

---

(2)

(2-2)

$De = \sqrt{\frac{4 \times 6}{\pi}} = 2{,}76 \text{ mm}$

De = 2,76 + 2 x 1,1 = 4,96 mm

$Sc = \pi \frac{4{,}96^2}{4} = 19{,}31 \text{ mm}^2$ (conductores).

$St = 9 \times 19{,}31 = 173{,}8 \text{ mm}^2$

$Stubo = 2{,}5 \times 173{,}8 = 434{,}5 \text{ mm}^2 = \pi \frac{Di^2}{4}$

Di = 23,52 mm
Dext = 23,52 + 3 = 26,52 mm
Dtubo ⟶ 32 mm

(2) (2-3)

$$Dc = \sqrt{\frac{4 \times 2,5}{\pi}} = 1,78 \text{ mm}$$

$De = 1,78 + 1,8 = 3,58$ mm

$$Se = \pi \frac{3,58^2}{4} = 10,06 \text{ mm}^2$$

$$Dc = \sqrt{\frac{4 \times 4}{\pi}} = 2,26 \text{ mm}$$

$De = 2,26 + 1,8 = 4,06$ mm

$$Se = \pi \frac{4,06^2}{4} = 12,94 \text{ mm}^2$$

$St = 3 \times 10,06 + 5 \times 12,94 = 30,18 + 64,7 = 95 \text{ mm}^2$

$$2,5 \times 95 = 238 \text{ mm}^2 = \pi \frac{Di^2}{4}$$

$Di = 17,4$ mm
$Dext = 17,4 + 3 = 20,4$ mm
Dtubo ⟶ 25 mm

---

(2) (2-4)

$$Dc = \sqrt{\frac{4 \times 4}{\pi}} = 2,257 \text{ mm}$$

$$Dc = \sqrt{\frac{4 \times 6}{\pi}} = 2,765 \text{ mm}$$

$$Dc = \sqrt{\frac{4 \times 10}{\pi}} = 3,569 \text{ mm}$$

- $Dais = 2,257 + 2,.4 = 4,657$ m

$$Sa = \pi \frac{4,657^2}{4} = 17,02 \text{ mm}^2$$

- $Dais = 2,765 + 2,.4 = 5,165$ m

$$Se = \pi \frac{5,165^2}{4} = 20,94 \text{ mm}^2$$

- $Dais = 3,659 + 2,.4 = 6,059$ m

$$Se = \pi \frac{6,059^2}{4} = 28,82 \text{ mm}^2$$

$St = 4 (17,02 + 20,94 + 28,82) = 267,12 \text{ mm}^2$

$$(Si)tubo = 4 \times 267,12 = 1068 \text{ mm}^2 = \pi \frac{Di^2}{4}$$

$Di = 36,9$ mm
$Dext = 36,9 + 3 = 39,9$ mm ⟶ 40 mm
Por tabla, si hay conductores de 10 mm^2 ⟶ De = 63 mm

③

$$P = \frac{22000}{0,93} = 23656 \text{ W}$$

$$I = \frac{23656}{\sqrt{3} \times 400 \times 0,94} = 36,37 \text{ A}$$

$1,25\ I = 45,46$ A

$(S)i \longrightarrow 16$ mm^2

$I_{na} = 59$ A $> 45,46$ A

$$Ct = \frac{23656 \times 13}{44 \times 400 \times 16} = 1,09 \text{ V}$$

$$Ct\ (\%) = \frac{1,09}{400} \times 100 = 0,27\ \% < 5\ \%$$

(S) definitiva - F, N y protección $\longrightarrow 16$ mm^2

(De)tubo $= 32$ mm

---

④

$S = 30 \times 160 + 1,8 \times 40 \times 180 = 17760$ VA

$$I = \frac{17760}{\sqrt{3} \times 400} = 25,67 \text{ A}$$

$P = 17760 \times 0,90 = 15984$ W

Pdescarga $= 11664$ W

(S)inicial $\longrightarrow 4,0$ mm^2

Ina $= 27$ A $> 25,67$ A

$$Ct = \frac{15984 \times 26}{44 \times 400 \times 4} + \frac{11664 \times 14}{44 \times 400 \times 4} = 5,90 + 2,32 = 8,22 \text{ V}$$

$$Ct\ (\%) = \frac{8,22}{400} \times 100 = 2,05\ \% < 3\ \%$$

(S) definitiva - F, N y Cp $\longrightarrow 4$ mm^2

(De)tubo $= 25$ mm

5

$$Pn = \frac{7500 \times 3}{0{,}80} = 28125\ W$$

$$Pr = 6000\ W$$

$$Im = \frac{28125}{\sqrt{3} \times 400 \times 0{,}90} = 45\ A$$

$$Ir = \frac{6000}{\sqrt{3} \times 400} = 8{,}67\ A$$

$It = 1{,}25 \times 45 + 8{,}67 = 64{,}92\ A$ $Pt = 34125W$

$(S)inicial \longrightarrow 16\ mm^2$

$Ina = 80\ A > 64{,}92\ A$

$$Ct = \frac{34125 \times 19}{44 \times 400 \times 16} = 2{,}3\ V$$

$$Ct\ (\%) = \frac{2{,}3}{400} \times 100 = 0{,}57\ \% < 5\ \%$$

(S) definitiva - F, N y Cp $\longrightarrow 16\ mm^2$
$(De)tubo = 32\ mm$

6

Circuito 1

$$P_1 = \frac{5000}{0{,}84} = 5952\ W$$

$$I_1 = \frac{5952}{\sqrt{3} \times 400 \times 0{,}86} = 10\ A$$

$$P_2 = \frac{7500}{0{,}86} = 8721\ W$$

$$I_1 = \frac{8721}{\sqrt{3} \times 400 \times 0{,}88} = 14{,}32\ A$$

$1{,}25 \times 14{,}32 + 10 = 27{,}9\ A$

$(S)inicial \longrightarrow 6\ mm^2$

$Ina = 32\ A > 27{,}9\ A$

$$Ct = \frac{(5952 + 8721) \times 23}{44 \times 400 \times 6} = 3{,}19\ V$$

$$Ct\ (\%) = \frac{3{,}19}{400} \times 100 = 0{,}80\ \% < 5\ \%$$

(S) definitiva - F, N y Cp $\longrightarrow 6\ mm^2$

⑥

Circuito 2 $P = \frac{18500}{0,88} = 21022\ W$

$I = \frac{21022}{\sqrt{3}\ x\ 400\ x\ 0,91} = 33,38\ A$

$1,25\ I = 41,73\ A$

$(S)inicial \longrightarrow 10\ mm^2$

$Ina = 44\ A > 41,73\ A$

$Ct = \frac{21022\ x\ 23}{44\ x\ 400\ x\ 10} = 2,75\ V$

$Ct\ (\%) = \frac{2,75}{400}\ x\ 100 = 0,68\ \% < 5\ \%$

(S) definitiva - F, N y Cp $\longrightarrow 10\ mm^2$

Por contener 5 de 10 mm^2, el tubo ya será como mínimo de 32 mm.

S_6

- $d = \sqrt{\frac{4\ x\ 6}{\pi}} = 2,76\ mm$
- $d + 2,8 = 5,56\ mm$
- $S = 24,30\ mm^2$

S_{10}

- $d = \sqrt{\frac{4\ x\ 10}{\pi}} = 3,57\ mm$
- $d + 2,8 = 6,37\ mm$
- $S = 31,85\ mm^2$

$St = 5\ (24,30 + 31,85) = 281\ mm^2$

$2,5\ St = 702\ mm^2 = \pi\ \frac{Di^2}{4}$

$Di = 29,9\ mm$

$Dext = 34\ mm \longrightarrow 40\ mm$

1

A

$S = 1{,}8\ P_2 + P_1 = 1{,}8 \times 2000 + 6000 = 9600\ VA$

$$I = \frac{9600}{230} = 41{,}73\ A$$

IGA ⟶ Bipolar. 50 A. 230 V
ID ⟶ Bipolar. 50 A. / 30 mA

B

$$I_1 = \frac{5000 \times 1{,}8}{230} = 39{,}13\ A \longrightarrow \text{ID 40 A / 30 mA}$$

$$I_2 = \frac{3000}{230 \times 0{,}90} = 14{,}50 \longrightarrow \text{ID 16 A / 30 mA}$$

$$I_t = \frac{1{,}8 \times 5000 + 3000}{230} = 52\ A$$

PIA ⟶ Bipolar 63 A / 230 V

2

A

$$I = \frac{7500}{230} = 32{,}6\ A$$

IGA ⟶ Bipolar 230 V / 40A

(S)inicial ⟶ 10 mm^2

Ima = 50 A > 32,6 A

1,13 x 40 = 42,5 A < 50 A

(S) definitiva - F, N y Cp ⟶ 10 mm^2

B

$$I = \frac{16000}{\sqrt{3} \times 400 \times 0{,}90} = 25{,}7\ A$$

IGA ⟶ Tetrapolar 3 x 400/230 V 32A

(S)inicial ⟶ 6 mm^2 (mínima legal)

Ima = 44 A > 25,7 A

1,13 x 32 = 36,16 A < 44 A

(S) definitiva - F, N y Cp ⟶ 6 mm^2

2

C

$$I = \frac{36000}{\sqrt{3} \times 400 \times 0{,}90} = 57{,}8 \text{ A}$$

IGA ⟶ Tretapolar 3 x 400/230 V 63A

(S)inicial ⟶ 25 mm^2

Ima = 70 A

1,13 x 63 = 71,19 A > 70 A

(S) definitiva ⟶ 35 mm^2

Ima = 86 A > 71,19 A

(S) definitiva - Fases = 35 mm^2
- N/Cp = 25 mm^2

D

$$I = \frac{45000}{\sqrt{3} \times 400 \times 0{,}90} = 72{,}25 \text{ A}$$

IGA ⟶ Tretapolar 3 x 400/230 V 80 A

(S)inicial ⟶ 25 mm^2

Ima = 106 A

1,13 x 80 = 90,4 A < 106 A

(S) definitiva - Fases = 25 mm^2
- N/Cp = 16 mm^2

3

A

$$I = \frac{3500}{230 \times 0{,}98} = 15{,}53 \text{ A}$$

PIA → Bipolar 230 V 16A

(S)inicial → 25 mm^2

Ima = 21 A

1,13 x 16 = 18,8 A < 21 A

$$Ct = \frac{2 \times 3500 \times 20}{44 \times 230 \times 2{,}5} = 5{,}53 \text{ V}$$

$$Ct\ (\%) = \frac{5{,}53}{230} \times 100 = 2{,}4\ \% < 3\ \%$$

(S) definitiva - F, N y Cp = 2,5 mm^2
Dt = 16 mm

B

$$I = \frac{8200}{230} = 35{,}62 \text{ A}$$

PIA → Bipolar 230 V 40A

(S)inicial → 10 mm^2

Ima = 52 A

1,13 x 40 = 45,2 A < 52 A

$$Ct = \frac{2 \times 8200 \times 16}{44 \times 230 \times 10} = 2{,}59 \text{ V}$$

$$Ct\ (\%) = \frac{2{,}59}{230} \times 100 = 1{,}12\ \% < 3\ \%$$

(S) definitiva - F, N y Cp = 10 mm^2
Dt = 25 mm

③

Ⓒ $I = \dfrac{1{,}8 \times 10800}{\sqrt{3} \times 400} = 28{,}09\ A$

PIA ⟶ Tetrapolar 3 x 400/230 V 32A

(S)inicial ⟶ 6 mm^2

Ima = 44 x 0,96 = 42,24 A

1,13 x 32 = 36,16 A < 42,24 A

$Ct = \dfrac{1{,}8 \times 10800 \times 0{,}87 \times 27}{44 \times 400 \times 6} = 4{,}22\ V$

$Ct\ (\%) = \dfrac{4{,}22}{400} \times 100 = 1{,}05\ \% < 3\ \%$

(S) definitiva - F, N y Cp = 6 mm^2

---

④

Ⓐ $I = \dfrac{1{,}8 \times 6000}{230} = 46{,}9\ A$

P = 1,8 x 6000 x 0,75 = 8100 W

PIA ⟶ Bipolar 230 V 50A

(S)inicial ⟶ 25 mm^2

Ima = 84 x 0,80 = 67, 2 A

1,13 x 50 = 56,5 A < 67,2 A

$Ct = \dfrac{2 \times 8100 \times 24}{44 \times 230 \times 25} = 1{,}54\ V$

$Ct\ (\%) = \dfrac{1{,}54}{230} \times 100 = 0{,}668\ \% < 2\ \%$

(S) definitiva - F, N = 25 mm^2

- Cp = 16 mm^2

$I_2 = \dfrac{5500}{230 \cdot 0{,}92} = 26\ A$

④ PIA ⟶ Bipolar 230 V 32 A

(S)inicial ⟶ 10 mm^2

Ⓐ Ima = 50 A x 0,80 = 40 A

1,13 x 32 = 36,1 A < 40 A

$$Ct = \frac{2 \times 5500 \times 24}{44 \times 230 \times 10} = 2,6 \text{ V}$$

$$Ct\ (\%) = \frac{2,6}{230} \times 100 = 1,13\ \% < 2\ \%$$

(S) definitiva - F, N y Cp = 10 mm^2

Si solo estuvieran los de 25 mm^2 ⟶ Dt = 32 mm

25 mm^2 ⟶ $d = \sqrt{\frac{4 \times 25}{\pi}} = 5,64$ mm

d + 2 = 7,64 mm

$$Sc = \pi \frac{7,64^2}{4} = 45,86 \text{ mm}^2$$

10 mm^2 ⟶ $d = \sqrt{\frac{4 \times 10}{\pi}} = 3,57$ mm

d + 2 = 5,57 mm

$$Sc = \pi \frac{5,57^2}{4} = 24,35 \text{ mm}^2$$

16 mm^2 ⟶ $d = \sqrt{\frac{4 \times 16}{\pi}} = 4,51$ mm

d + 2 = 6,51 mm

$$Sc = \pi \frac{6,51^2}{4} = 33,27 \text{ mm}^2$$

St = 2 x 45,86 + 33,27 + 3 x 24,35 = 198, 04 mm^2

Stubo = 2,5 x 198,04 = 495 mm^2

$$495 = \pi \frac{Di^2}{4}$$

Di = 25,11 mm

Dex = 25,11 + 2,8 = 27,91 m ⟶ Dt = 32 mm

ID ⟶ bipolar 230 V 80 A / 30 mA

4

B

$$I_1 = \frac{4400 / 0{,}78}{230 \times 0{,}80} = 30{,}66 \text{ A}$$

$1{,}25\ I_1 = 38{,}22$ A

PIA ⟶ Bipolar 230 V 40A

(S)inicial ⟶ 10 mm^2

Ima = 68 x 0,8 = 54,4 A

1,13 x 40 = 45,2 A < 54,4 A

$$Ct = \frac{2 \times 5641 \times 32}{44 \times 230 \times 10} = 3{,}56 \text{ V}$$

$$Ct\ (\%) = \frac{3{,}56}{230} \times 100 = 1{,}55\ \% > 1{,}25\ \%$$ (no vale).

(S) definitiva - F, N y Cp = 16 mm^2

$$I_2 = \frac{8800}{\sqrt{3} \times 400} = 12{,}71 \text{ A}$$

PIA ⟶ Tetrapolar 3 x 400 / 230 V 16 A

(S)inicial ⟶ 2,5 mm^2

Ima = 25 A x 0,8 = 20 A

1,13 x 16 = 18 A < 20 A

$$Ct = \frac{8800 \times 32}{44 \times 230 \times 2{,}5} = 6{,}4 \text{ V}$$ (1,6 % > 1,25 %) (no vale).

(S) definitiva - F, N y Cp = 4 mm^2 (Ct = 1 % < 1,25 %)

ID ⟶ Ifases = 38,23 + 12,71 = 51,03 A

ID ⟶ Tetrapolar 3 x 400 / 230 V 63 A / 300 mA

Tubo si solo estuvieran los 3 de 16 mm^2 ⟶ 32 mm

Por semenjanza con el 4 C ⟶ Dt = 32 mm

④

Ⓒ $\cdot I_1 = \dfrac{5500 / 0{,}92}{\sqrt{3} \text{ x } 400 \text{ x } 0{,}88} = 9{,}81 \text{ A}$

1,25 x 9,81 = 12,27 A

PIA ⟶ Tetrapolar 3 x 400 / 230 V 16 A

(S)inicial ⟶ 4 mm^2

Ima = 30 x 0,8 = 24 A

1,13 x 16 = 18,08 A < 24 A

$Ct = \dfrac{5978 \text{ x } 14}{44 \text{ x } 400 \text{ x } 4} = 1{,}19 \text{ V}$ (0,30 % < 2 %)

$\cdot I_2 = \dfrac{9000 / 0{,}93}{\sqrt{3} \text{ x } 400 \text{ x } 0{,}90} = 15{,}54 \text{ A}$

1,25 x 15,54 = 19,42 A

PIA ⟶ Tetrapolar 3 x 400 / 230 V 25 A

(S)inicial ⟶ 6 mm^2

Ima = 37 x 0,8 = 29,6 A

1,13 x 25 = 28,25 A < 29,6 A

$Ct = \dfrac{9977 \text{ x } 14}{44 \text{ x } 400 \text{ x } 6} = 1{,}28 \text{ V}$ (0,32 % < 2 %)

$(Dc)_4 = \sqrt{\dfrac{4 \text{ x } 4}{\pi}} = 2{,}25 \text{ mm}$

Dmc = 5,8 x 2,25 = 13,05 mm

$(St)_4 = \pi \dfrac{13{,}05^2}{4} = 170 \text{ mm}^2$

$(Dc)_6 = \sqrt{\dfrac{4 \text{ x } 6}{\pi}} = 2{,}76 \text{ mm}$

Dmc = 5,8 x 2,76 = 16 mm

$(St)_6 = \pi \dfrac{16{,}00^2}{4} = 201 \text{ mm}^2$

$St = 371 = \dfrac{\pi Di^2}{4}$ ⟶ Di = 21,73 mm / Dex = 21,73 + 2 x 1,2 = 24,13 mm

Dt = 25 mm

El diferencial lo escogemos por la suma

12,27 + 19,42 = 31,69 A

ID ⟶ Tetrapolar 3 x 400 / 230 V. 32 A / 300 mA

④

Ⓓ

· $I_1 = \dfrac{15000 / 0,92}{\sqrt{3} \text{ x } 400 \text{ x } 0,93} = 25,33$ A

$1,25\ I_1 = 31,67$ A

PIA ⟶ Tetrapolar 3 x 400 / 230 V 32 A

(S)inicial ⟶ 10 mm^2

Ima = 60 x 0,8 = 48 A

1,13 x 32 = 36,16 A < 48 A

$Ct = \dfrac{16304 \text{ x } 34}{44 \text{ x } 400 \text{ x } 10} = 3,15$ V (0,78 % < 5 %)

· $I_2 = \dfrac{22000 / 0,93}{\sqrt{3} \text{ x } 400 \text{ x } 0,94} = 36,37$ A

$1,25\ I_2 = 45,46$ A

PIA ⟶ Tetrapolar 3 x 400 / 230 V 50 A

(S)inicial ⟶ 16 mm^2

Ima = 80 x 0,8 = 64 A

1,13 x 50 = 56,5 A < 64 A

$Ct = \dfrac{23656 \text{ x } 34}{44 \text{ x } 400 \text{ x } 16} = 2,85$ V (0,71 % < 5 %)

Sdefinitiva ⟶ 3F, N y Cp ⟶ 16 mm^2

El diferencial lo escogemos por la suma

31,67 + 45,46 = 77,13 A ⟶ 80 A

ID ⟶ Tetrapolar 3 x 400 / 230 V. 80 A / 300 mA

Los 5 de 16 mm^2 (solos) ⟶ 32 mm

10

$(Dc) = \sqrt{\dfrac{4 \text{ x } 10}{\pi}} = 3,569$ mm

Dex = 3,569 + 2,8 = 6,37 mm

$(Se) = \pi \dfrac{6,37^2}{4} = 31,84\ mm^2$

16

$(Dc) = \sqrt{\dfrac{4 \text{ x } 16}{\pi}} = 4,51$ mm

Dex = 4,51 + 2,8 = 7,31 mm

$(Se) = \pi \dfrac{7,31^2}{4} = 42\ mm^2$

④

Ⓓ

$St = 5 (311,84 + 42) = 369,2 \text{ mm}^2$

$2,5\ St = 923 \text{ mm}^2 = \pi \dfrac{Di^2}{4} \longrightarrow Di = 34 \text{ mm}$

$Di + 4 = 38 \text{ mm} \longrightarrow Di = 40 \text{ mm}$

$22,56 + 27,38 = 49,54 \text{ A}$

ID ⟶ Tetrapolar 3 x 400 / 230 V.50 A / 300 mA

Línea común (12 m) ⟶ PIA 3 x 400 / 230 V.50 A

(S)inicial ⟶ 16 mm^2

Ima = 59 A > 49,54 A

1,13 x 50 = 56,5 A < 59 A

$Ct = \dfrac{(10989 + 18000) \text{ x } 12}{44 \text{ x } 400 \text{ x } 16} = 1,23 \text{ V}$

(Ct)máx = 1,23 + 1,47 = 2,7 V (0,67% < 3%)

(S) definitiva - 3F, N y Cp = 16 mm^2

Dt (tramo común) ⟶ 40 mm (tabla)

10

$(Dc) = \sqrt{\dfrac{4 \text{ x } 10}{\pi}} = 3,569 \text{ mm}$

Dais = 3,569 + 3 = 6,569 mm

$(Se) = \pi \dfrac{6,569^2}{4} = 33,87 \text{ mm}^2$

16

$(Dc) = \sqrt{\dfrac{4 \text{ x } 16}{\pi}} = 4,514 \text{ mm}$

Dais = 4,514 + 3 = 7,514 mm

$(Se) = \pi \dfrac{7,514^2}{4} = 44,33 \text{ mm}^2$

$St = 5 (33,87 + 44,33) = 391 \text{ mm}^2$

$3St = 1173 = \pi \dfrac{Di^2}{4} \longrightarrow Di = 38,65 \text{ mm}$

Dex = 38,65 + 4 = 42,65 mm ⟶ 50 mm

5

A

$$I_1 = \frac{10000 / 0{,}91}{\sqrt{3} \text{ x } 400 \text{ x } 0{,}88} = 18 \text{ A}$$

$1{,}25\ I_1 = 22{,}56$ A

PIA ⟶ Tetrapolar 3 x 400 / 230 V 25 A

(S)inicial ⟶ 10 mm^2

Ima = 44 x 0,8 = 35,2 A

1,13 x 25 = 28,25 A < 35,2 A

$$Ct = \frac{10989 \text{ x } 8}{44 \text{ x } 400 \text{ x } 10} = 0{,}5 \text{ V}$$

(S) definitiva ⟶ 3F, N y Cp ⟶ 10 mm^2

$$I_2 = \frac{18000}{\sqrt{3} \text{ x } 400 \text{ x } 0{,}95} = 27{,}38 \text{ A}$$

PIA ⟶ Tetrapolar 3 x 400 / 230 V 32 A

(S) inicial ⟶ 16 mm^2

Ima = 59 x 0,8 = 47,2 A > 27,38 A

1,13 x 32 = 36,16 A < 47,2 A

$$Ct = \frac{18000 \text{ x } 23}{44 \text{ x } 400 \text{ x } 16} = 1{,}47 \text{ V}$$

(S) definitiva ⟶ 3F, N y Cp ⟶ 16 mm^2

5

B

$$I_1 = \frac{30000 / 0{,}9}{\sqrt{3} \text{ x } 400 \text{ x } 0{,}91} = 52{,}93 \text{ A}$$

$1{,}25\ I_1 = 66{,}17$ A

PIA ⟶ Tetrapolar 3 x 400 / 230 V 80 A

(S)inicial ⟶ 35 mm^2

Ima = 131 x 0,8 = 105 A > 66,17 A

1,13 x 80 = 90,4 A < 105 A

$$Ct = \frac{33333 \text{ x } 16}{44 \text{ x } 400 \text{ x } 35} = 0{,}865 \text{ V}$$

(S) definitiva - F, N = 35 mm^2
- Cp = 16 mm^2

$$I_2 = \frac{18000}{\sqrt{3} \text{ x } 400} = 26 \text{ A}$$

PIA ⟶ Tetrapolar 3 x 400 / 230 V 32 A

(S)inicial ⟶ 10 mm^2

Ima = 60 x 0,8 = 48 A > 26 A

1,13 x 32 = 36,2 A < 48 A

$$Ct = \frac{18000 \text{ x } 26}{44 \text{ x } 400 \text{ x } 10} = 2{,}66 \text{ V}$$

ID ⟶ Tetrapolar 3 x 400 / 230 V. 100 A / 300 mA

Línea común (12 m)

PIA ⟶ Tetrapolar 3 x 400 / 230 V. 100 A

(S)inicial ⟶ 35 mm^2

Ima = 131 > 92 A

1,13 x 100 = 113 A < 131 A

$$Ct = \frac{(33333 + 18000) \text{ x } 12}{44 \text{ x } 400 \text{ x } 35} = 1 \text{ V}$$

(5)

(B)

$(Ct)_{máx} = 1 + 2{,}66 = 3{,}66$ V (0,91 % < 5 %)

(S) definitiva - 3F, N = 35 mm²
- Cp = 16 mm²

Dt (línea común) = 40 mm (tabla)

35

$$(Dc) = \sqrt{\frac{4 \times 35}{\pi}} = 6{,}677 \text{ mm}$$

Dex = 6,677 + 3 = 9,677 mm

$$(Se) = \pi \frac{9{,}677^2}{4} = 73{,}51 \text{ mm}^2$$

10

$$(Dc) = \sqrt{\frac{4 \times 10}{\pi}} = 3{,}569 \text{ mm}$$

Dex = 6,569 mm

$$(Se) = \pi \frac{6{,}569^2}{4} = 33{,}87 \text{ mm}^2$$

$St = 5 (73{,}51 + 33{,}87) = 537 \text{ mm}^2$

$3St = 1611 \text{ mm}^2 = \pi \frac{Di^2}{4} \longrightarrow Di = 45{,}3$ mm

Dex = 45,3 + 4 = 49,3 mm ⟶ 50 mm

①

$\cos \varphi = 0{,}964 \longrightarrow \operatorname{tg} \varphi = 0{,}855$

$Qc = P \cdot \operatorname{tg} \varphi = 5000 \times 0{,}855 = 4275 \text{ VAr}$

$4275 = \dfrac{230^2}{Xc} \longrightarrow Xc = 12{,}37\ \Omega = \dfrac{1}{2\pi \times 50 \times C}$

$C = 257\ \mu F$

$I_{sin\ corregir} = \dfrac{5000}{230 \times 0{,}76} = 28{,}60 \text{ A}$

$I_{corregido} = \dfrac{5000}{230 \times 1{,}00} = 21{,}74 \text{ A}$

---

②

$\cos \varphi' = \dfrac{8800}{240 \times 37{,}5} = 0{,}964 \longrightarrow \operatorname{tg} \varphi' = 0{,}218$

$\cos \varphi = \dfrac{8800}{240 \times 50} = 0{,}733 \longrightarrow \operatorname{tg} \varphi = 0{,}927$

$Qc = 8800\ (0{,}927 - 0{,}218) = 6239{,}2 \text{ VAr} = \dfrac{240^2}{Xc}$

$Xc = 9{,}23 = \dfrac{1}{2\pi \times 60 \times C} \longrightarrow C = 287{,}5\ \mu F$

---

③

$P_1 = 6000 \text{ W}$
$\operatorname{tg}\varphi_1 = 0{,}566$
$Q_1 = 6000 \cdot 0{,}566 = 3400 \text{ VAr}$

$P_2 = 4000 \text{ W}$
$\operatorname{tg}\varphi_2 = 0{,}908$
$Q_2 = 3635{,}7 \text{ VAr}$

$P = 10000 \text{ W}$
$Q = 7035{,}7 \text{ VAr}$

$\operatorname{tg} \varphi = \dfrac{Q}{P} = 0{,}70357 \longrightarrow \cos \varphi = 0{,}817$

$I_{sin\ corregir} = \dfrac{10000}{230 \times 0{,}817} = 53{,}22 \text{ A}$

$Qc = 7035{,}7 \text{ VAr} = \dfrac{230^2}{Xc}$

$Xc = 7{,}518\ \Omega = \dfrac{1}{2\pi \times 50 \times C}$

$C = 423{,}6\ \mu F$

$I_{corregido} = \dfrac{10000}{230 \times 1{,}00} = 43{,}48 \text{ A}$

④

$$\cos \varphi = \frac{8000}{\sqrt{3} \times 400 \times 16,5} = 0,70 \longrightarrow \operatorname{tg} \varphi = 1,02$$

$$\cos \varphi' = \frac{8000}{\sqrt{3} \times 400 \times 16,5 \times 0,75} = 0,93 \longrightarrow \operatorname{tg} \varphi' = 0,395$$

$$Qc = 8800 \, (1,02 - 0,395) = 5000 \text{ VAr}$$

$$C = \frac{5000}{6\pi \times 50 \times 400^2} = 33,17 \, \mu F$$

---

⑤

$$\operatorname{tg}\varphi = 0,882$$

$$Q = P \cdot \operatorname{tg}\varphi = 45 \times 100 \times 0,882 = 3969 \text{ VAr} = \frac{230^2}{Xc}$$

$$Xc = 13,33 \, \Omega = \frac{1}{2\pi \times 50 \times C}$$

$$C = 239 \, \mu F$$

A efectos de elección de conductores el conjunto equivale a una carga de :

$$S = 1,8 \times 45 \times 100 = 8100 \text{ VA} = 8100 \text{ W} \quad (\text{pues } \cos\varphi = 1)$$

$$I = \frac{8100}{230} = 35,21 \text{ A}$$

PIA ⟶ Bipolar 230 V 40 A

(S)inicial ⟶ 10 mm^2

Ima = 50 A > 35,21 A

1,13 x 40 = 45,2 A < 50 A

$$Ct = \frac{2 \times 8100 \times 25}{44 \times 230 \times 10} = 4 \text{ V} \quad (1,74 \, \% < 3 \, \%)$$

(S) definitiva - F, N y Cp = 10 mm^2

(6)

$Qc = 0,9 \times 7000 = 6300$ VAr

$$C = \frac{6300}{6\pi \times 50 \times 400^2} = 41,8\ \mu F$$

$$\cos \varphi_n = \frac{15000 / 0,9}{\sqrt{3} \times 400 \times 29} = 0,83 \longrightarrow tg\ \varphi = 0,672$$

$$Q_n = \frac{15000}{0,90} \times 0,672 = 11200 \text{ VAr}$$

$Q'_n = 11200 - 6300 = 4900$ VAr

$$tg\ \varphi'_n = \frac{4900}{\frac{15000}{0,90}} = 0,294 \longrightarrow \cos \varphi = 0,96$$

$$I'_n = \frac{15000 / 0,9}{\sqrt{3} \times 400 \times 0,96} = 25 \text{ A}$$

---

(7)

$$Pt = \frac{5500}{0,92} + \frac{11000}{0,94} = 5978 + 11702 = 17680 \text{ W}$$

$\cos \varphi_t = 0,85 \longrightarrow tg\ \varphi_t = 0,619$

$Q_n = 17680 \times 0,619 = 10944$ VAr
$Q_o = 10944 \times 0,7 = 7660$ VAr
$Q_c = 0,9 \times 7660 = 6895$ VAr

$$C = \frac{6895}{6\pi \times 50 \times 400^2} = 45,74\ \mu F$$

$Q'_n = 10994 - 6895 = 4049$ VAr

$$tg\ \varphi'_n = \frac{1049}{17680} = 0,229 \longrightarrow \cos \varphi'_n = 0,974$$

$$I'_n = \frac{17680}{\sqrt{3} \times 400 \times 0,974} = 26,23 \text{ A}$$

Para escoger los conductores :

$$I = \frac{11702}{\sqrt{3} \times 400 \times 0,974} \times 1,25 + \frac{5978}{\sqrt{3} \times 400 \times 0,974} = 21,7 + 8,87 = 30,57 \text{ A}$$

PIA $\longrightarrow$ Tetrapolar 3 x 400 / 230 V. 32 A
(S)inicial $\longrightarrow$ 10 mm^2
Ima = 40 A > 30,57 A
1,13 x 32 = 36 A < 48 A

$$Ct = \frac{17680 \times 32}{44 \times 400 \times 10} = 3,21 \text{ V} \quad (0,8\ \% < 5\ \%)$$

Sdef = 3G10 / 10

8

$$\cos \varphi = \frac{0,74}{\sqrt{0,74^2 + 0,44^2}} = 0,859$$

$$P = \frac{Wa}{20} = \frac{740}{20} = 37 \text{ kW} = 37000 \text{ W}$$

$$\text{Isin corregir} = \frac{37000}{\sqrt{3} \text{ x } 400 \text{ x } 0,859} = 62,24 \text{ A}$$

$$\text{tg } \varphi = 0,596$$

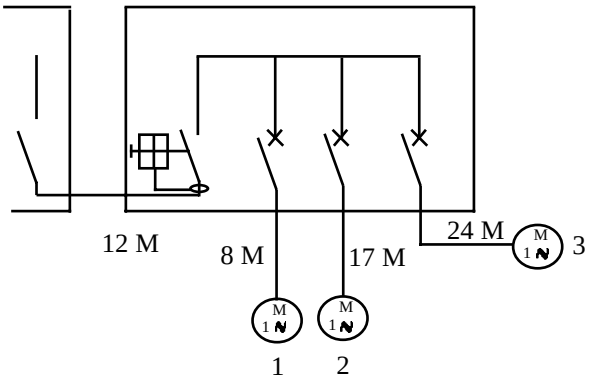
$$Q = 37000 \text{ x } 0,\ 596 = 22052 \text{ VAr}$$

$$\text{Cada grupo : } \frac{22052}{5} = 4411 \text{ VAr}$$

$$C = \frac{4411}{6\pi \text{ x } 50 \text{ x } 400^2} = 29,27 \ \mu F$$

$$\text{Icorregida} = \frac{37000}{\sqrt{3} \text{ x } 400 \text{ x } 1,00} = 53,46 \text{ A}$$

1



$$I_1 = \frac{7500 / 0{,}92}{\sqrt{3} \times 400 \times 0{,}84} = 14 \text{ A}$$

$$I_2 = \frac{11000 / 0{,}94}{\sqrt{3} \times 400 \times 0{,}90} = 18{,}8 \text{ A}$$

$$I_1 = \frac{15000 / 0{,}95}{\sqrt{3} \times 400 \times 0{,}92} = 24{,}8 \text{ A}$$

$1{,}25\ I_1 \rightarrow 17{,}5 \text{ A} \rightarrow$ PIA $\rightarrow$ 20 A $\rightarrow$ S1 $\rightarrow 4 \text{ mm}^2$

Ima = 24 A > 17,5 A

1,13 x 20 = 22,6 A < 24 A

$1{,}25\ I_2 \rightarrow 23{,}5 \text{ A} \rightarrow$ PIA $\rightarrow$ 25 A $\rightarrow$ S2 $\rightarrow 6 \text{ mm}^2$

Ima = 32 A > 23,5 A

1,13 x 25 = 28,25 A < 32 A

$1{,}25\ I_3 \rightarrow 31 \text{ A} \rightarrow$ PIA $\rightarrow$ 32 A $\rightarrow$ S3 $\rightarrow 10 \text{ mm}^2$

Ina = 40 A > 31 A

1,13 x 32 = 36 A < 40 A

Línea común :
1,25 x 24,8 + 14 + 18,8 = 63,8 A
PIA $\rightarrow$ 80 A $\rightarrow$ S = 35 mm²
Ima = 96 A > 63,8 A
1,13 x 80 = 90,4 A < 96 A

$$(\text{Ct})\text{línea} = \frac{(8152 + 11702 + 15789) \times 12}{44 \times 400 \times 35} = 0{,}69 \text{ V}$$

$$(\text{Ct})\ \text{M3} = \frac{15789 \times 24}{44 \times 400 \times 10} = 2{,}15 \text{ V}$$

Ct = 0,69 + 2,15 = 2,84 V (0,71 % < 5 %)

②

$$\frac{16000}{25000} = 0{,}64 \qquad \frac{18000}{25000} = 0{,}72 \qquad \frac{20000}{25000} = 0{,}80 \qquad \frac{22000}{25000} = 0{,}88 \qquad \frac{24000}{25000} = 0{,}96$$

$$\frac{\frac{2000}{0{,}81}}{25000} \times 100 = 9{,}87\ \% \longrightarrow 6{,}2\ A$$

$$\frac{\frac{8000}{0{,}94}}{25000} \times 100 = 34\ \% \longrightarrow 21{,}4\ A$$

$$\frac{\frac{15000}{0{,}74}}{25000} \times 100 = 81\ \% \longrightarrow 50{,}9\ A$$

③

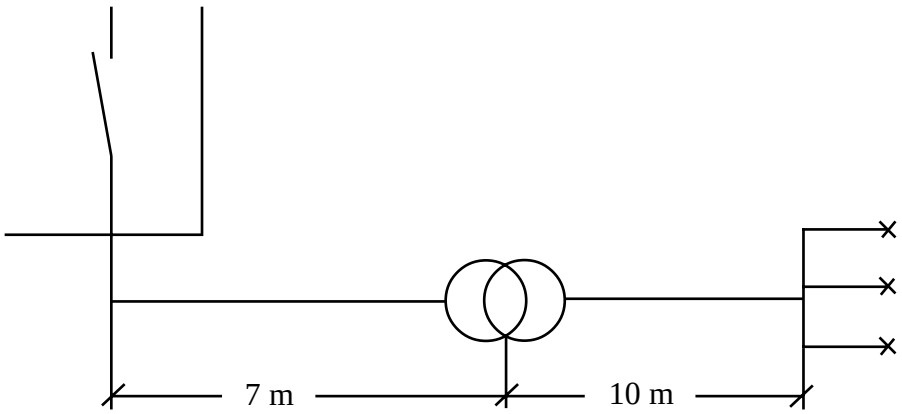
P = 2000 W

cos φ= 0,95

$$I_1 = \frac{2000}{230 \times 0{,}95} = 9{,}15\ A$$

$$I_2 = \frac{2000}{48 \times 0{,}95} = 43{,}86\ A$$

PIA ⟶ 10 A



(S)inicial ⟶ 1,5 mm²
Ima = 15 A > 9,15 A

$$Ct = \frac{2 \times 2000 \times 7}{44 \times 230 \times 1{,}5} = 1{,}84\ V \quad (0{,}8\ \%)$$

(S)inicial ⟶ 16 mm²
Ima = 66 A > 59,7 A

$$Ct = \frac{2 \times 2000 \times 10}{44 \times 48 \times 16} = 1{,}18\ V \quad (2{,}46\ \%)$$

Ct = 2,46 + 0,8 = 3,26 % > 3 %

Pasamos a 2,5 mm² el primario

$$Ct = \frac{2 \times 4000 \times 7}{44 \times 230 \times 2{,}5} = 1{,}10\ V \quad (0{,}48\ \%)$$

Ct = 0,48 + 2,46 = 2,94 % < 3 %