Fig. 1

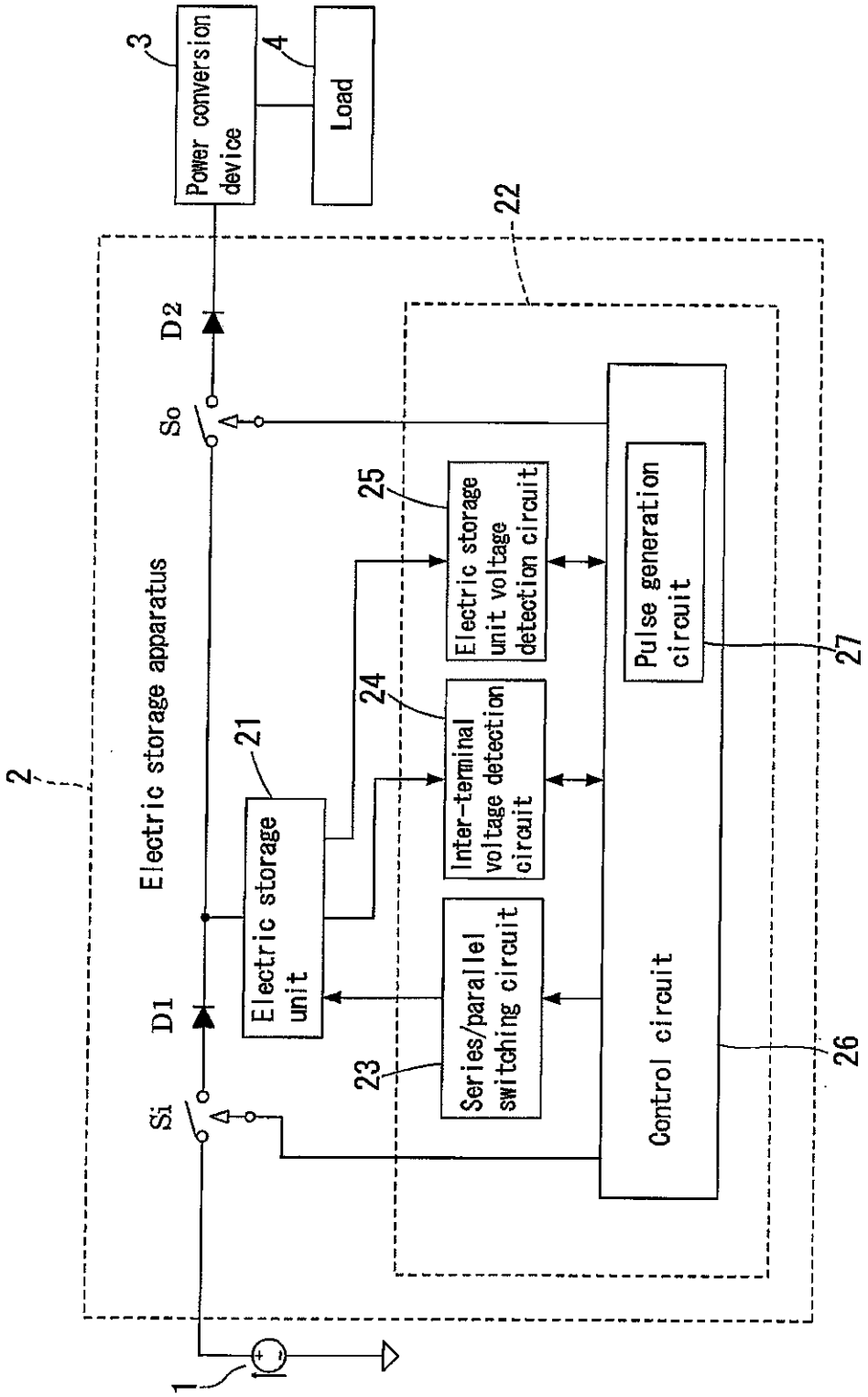

Power conversion device
Load
3
4
22
Electric storage apparatus
2
D2
So
D1
Si
21
Electric storage unit
24
Inter-terminal voltage detection circuit
25
Electric storage unit voltage detection circuit
23
Series/parallel switching circuit
Control circuit
Pulse generation circuit
26
27
1

Fig. 2

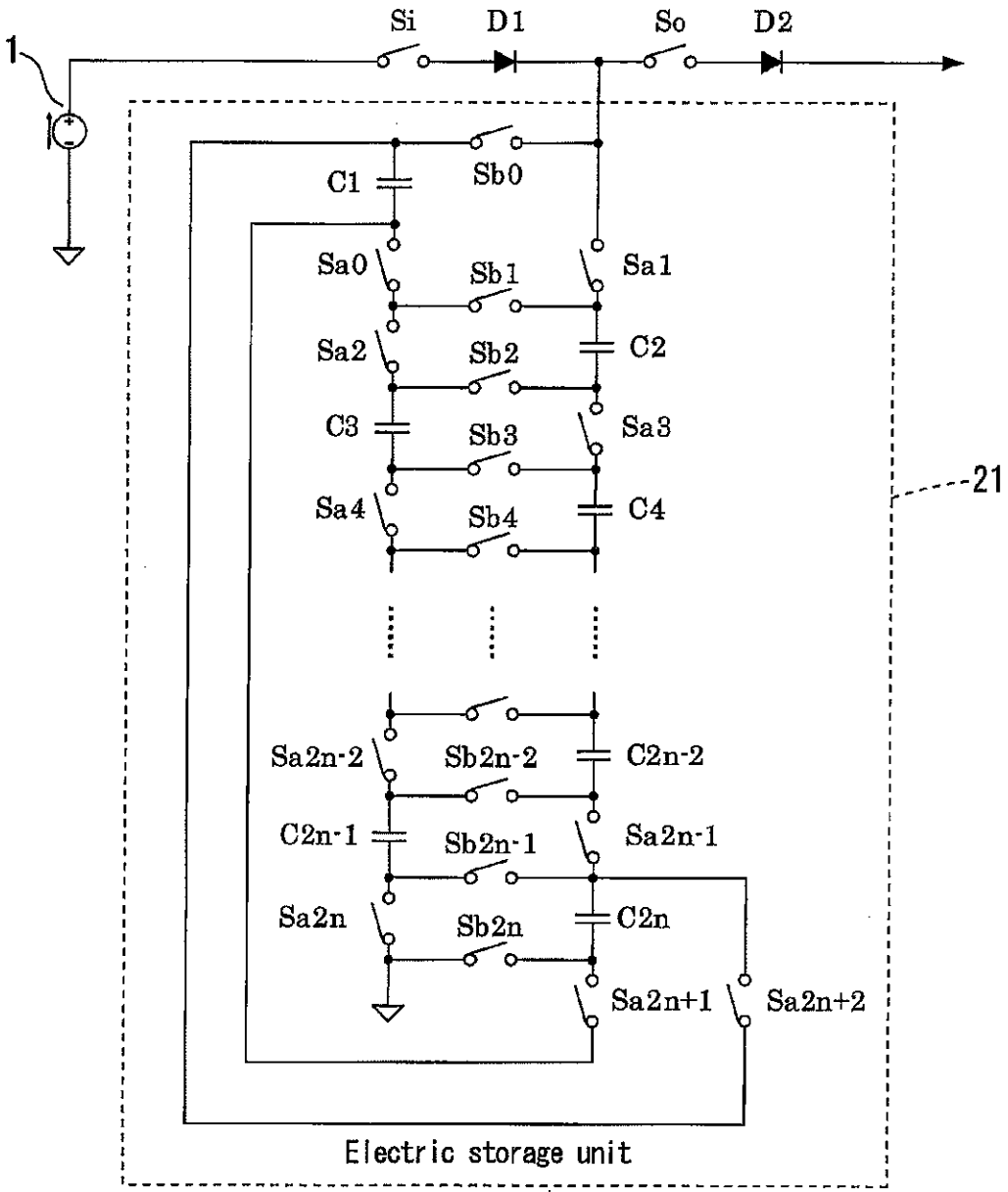

1
Si
D1
So
D2
C1
Sb0
Sa0
Sb1
Sa1
Sa2
Sb2
C2
C3
Sb3
Sa3
Sa4
Sb4
C4
21
Sa2n-2
Sb2n-2
C2n-2
C2n-1
Sb2n-1
Sa2n-1
Sa2n
Sb2n
C2n
Sa2n+1
Sa2n+2
Electric storage unit

Fig. 3(a)

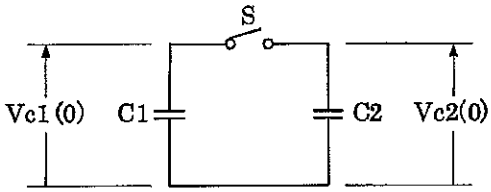


Fig. 3(b)

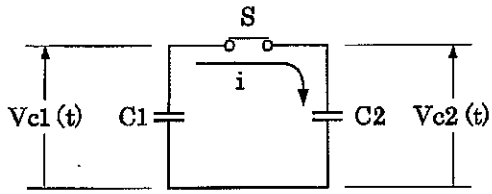
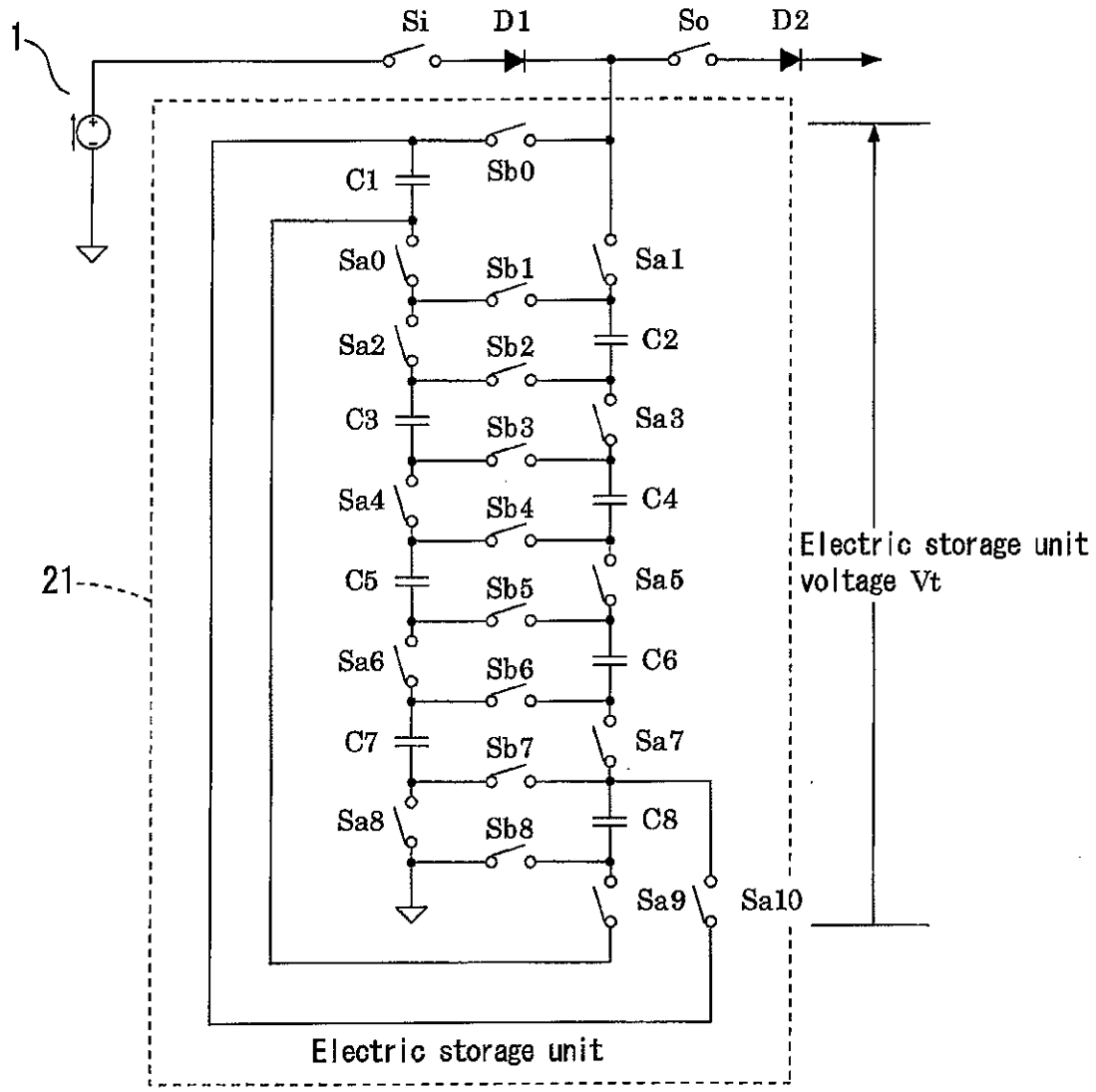


Fig. 4



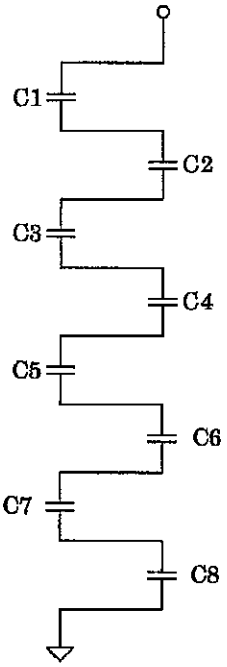


Fig. 5(a)

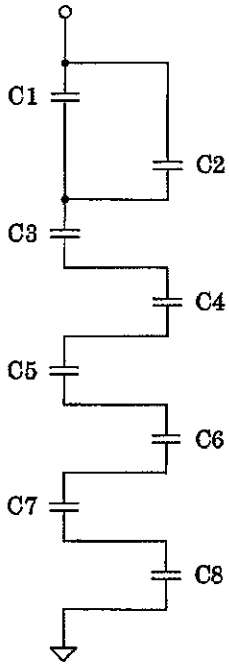


Fig. 5(b)

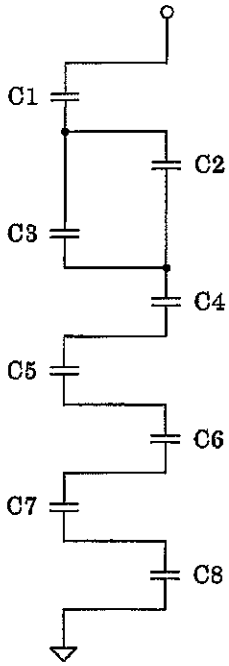


Fig. 5(c)

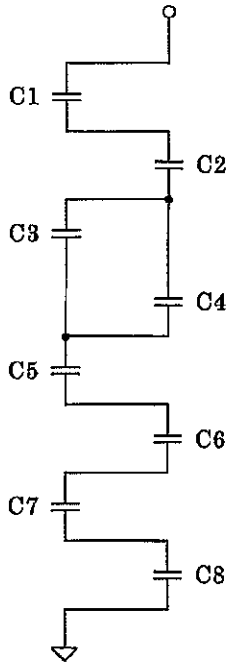


Fig. 5(d)

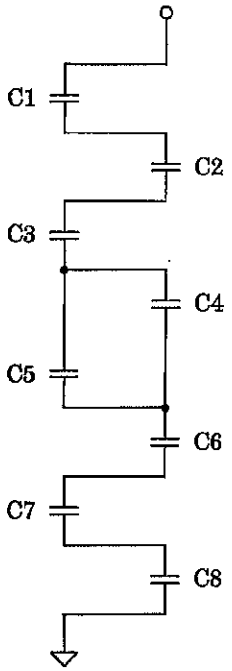


Fig. 5(e)

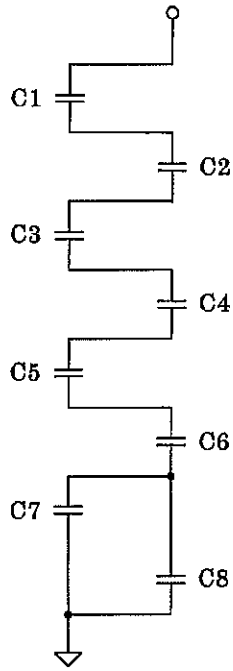


Fig. 5(f)

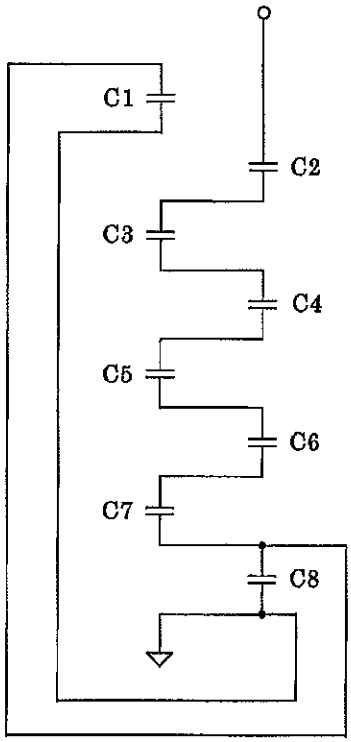


Fig. 5(g)

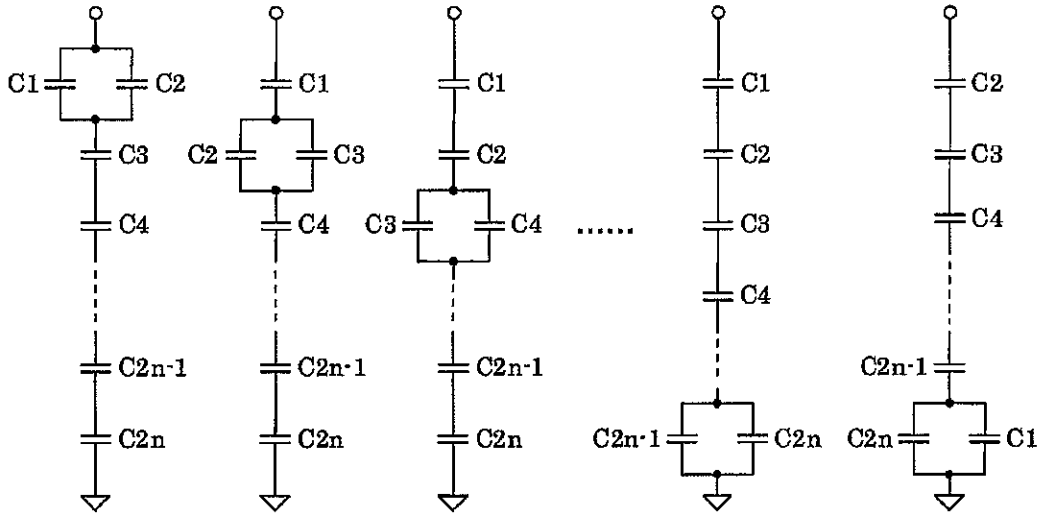


Fig. 6(a) Fig. 6(b) Fig. 6(c) Fig. 6(d) Fig. 6(e)

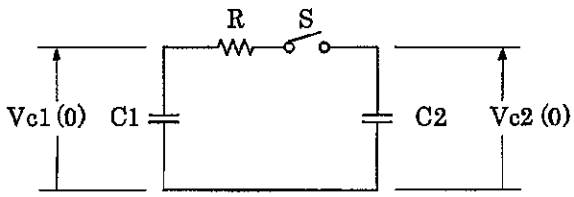


Fig. 7(a)

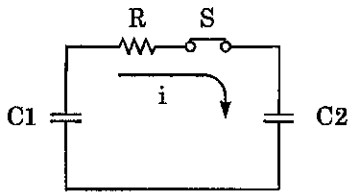


Fig. 7(b)

Fig. 8

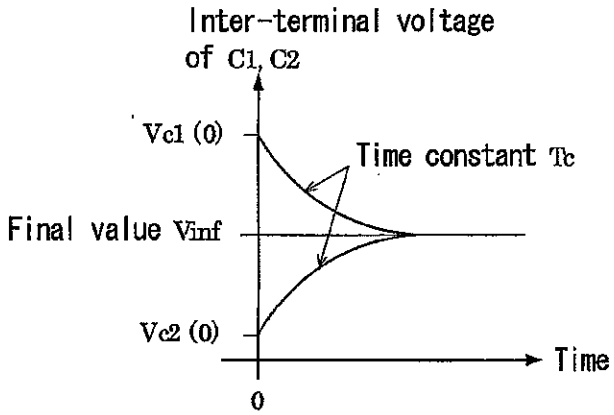


Fig. 9

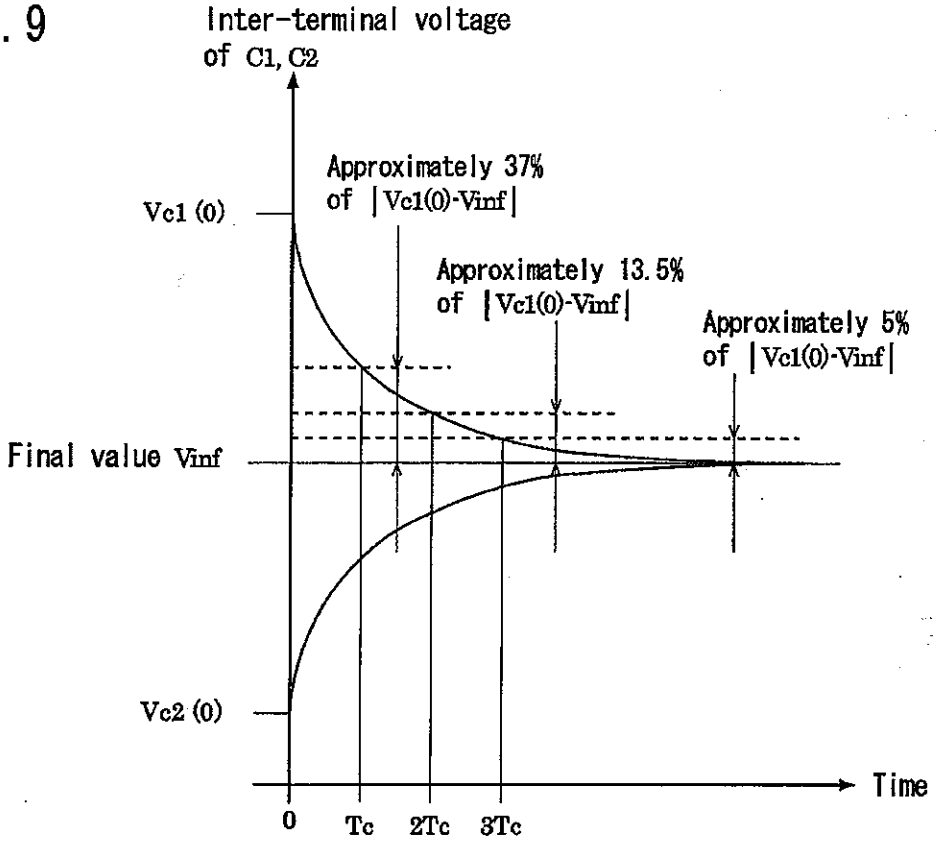

Inter-terminal voltage
of C1, C2
Approximately 37%
of |Vc1(0)-Vinf|
Approximately 13.5%
of |Vc1(0)-Vinf|
Approximately 5%
of |Vc1(0)-Vinf|
Vc1 (0)
Final value Vinf
Vc2 (0)
Time
0
Tc
2Tc
3Tc

Fig. 10

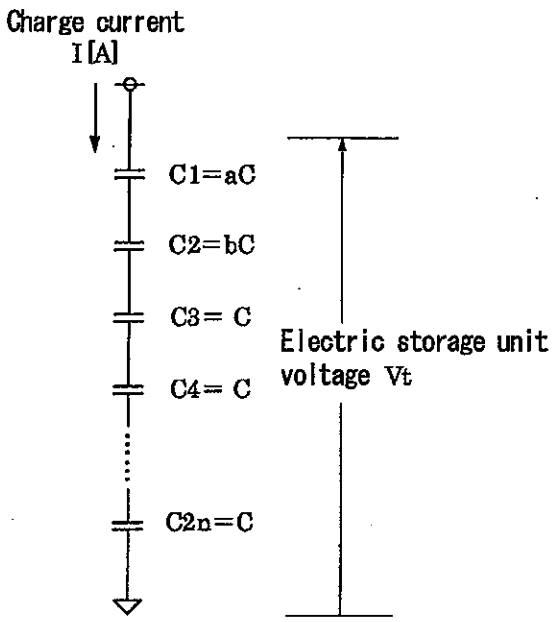

Charge current
I[A]
C1=aC
C2=bC
C3= C
C4= C
C2n=C
Electric storage unit
voltage Vt

Fig. 11

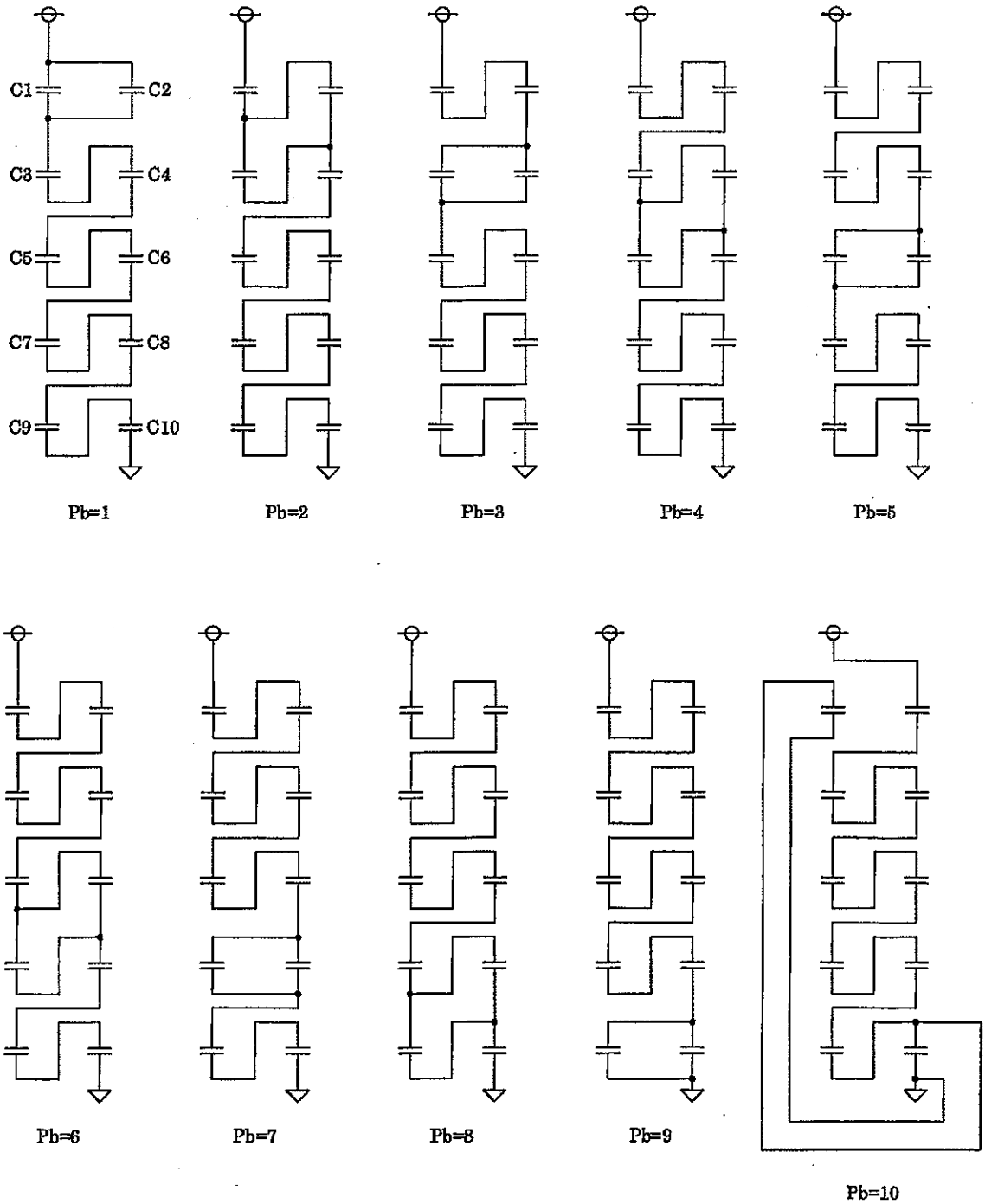

C1
C2
C3
C4
C5
C6
C7
C8
C9
C10
Pb=1
Pb=2
Pb=3
Pb=4
Pb=5
Pb=6
Pb=7
Pb=8
Pb=9
Pb=10

Fig. 12

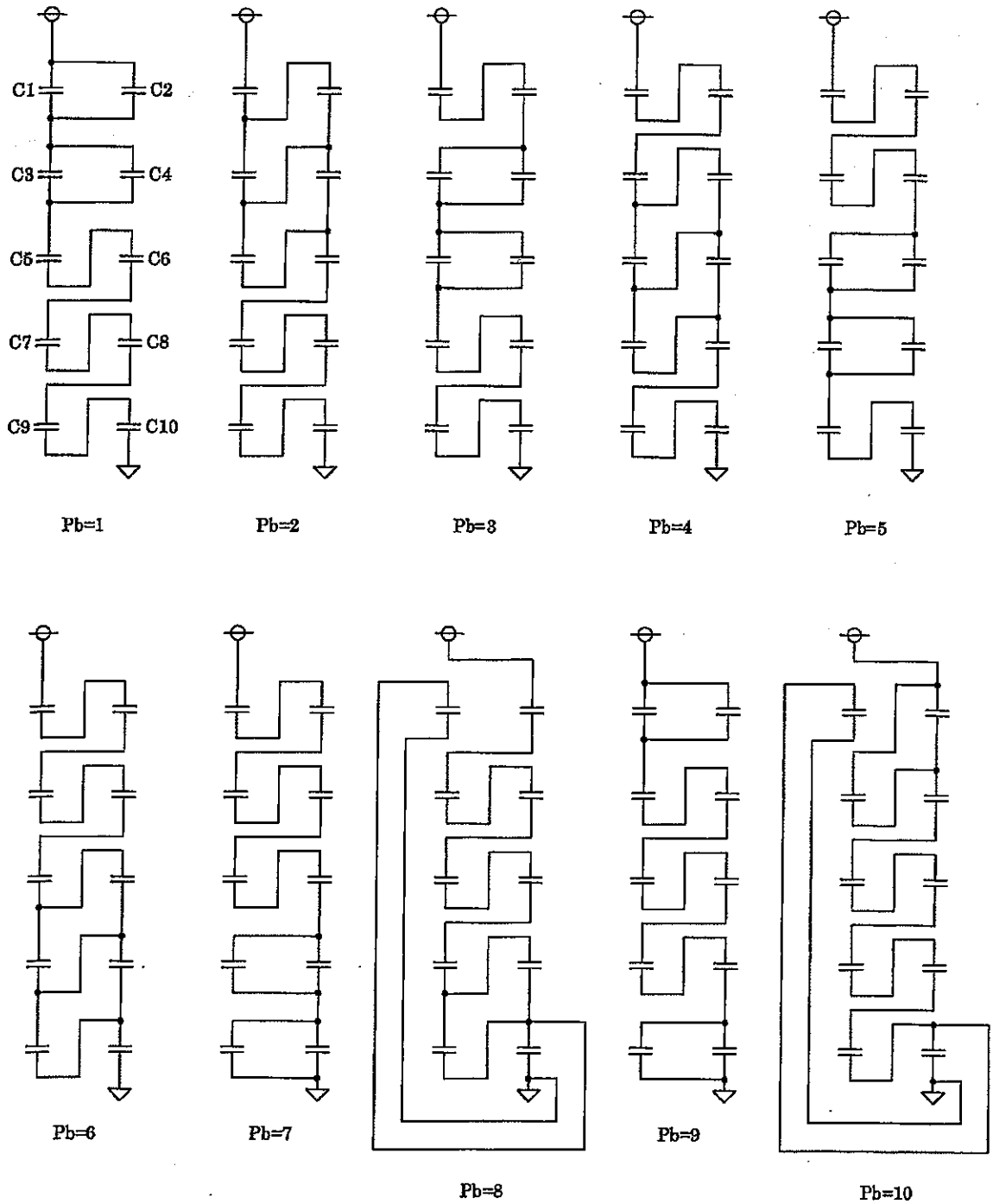

C1
C2
C3
C4
C5
C6
C7
C8
C9
C10
Pb=1
Pb=2
Pb=3
Pb=4
Pb=5
Pb=6
Pb=7
Pb=8
Pb=9
Pb=10

Fig. 13

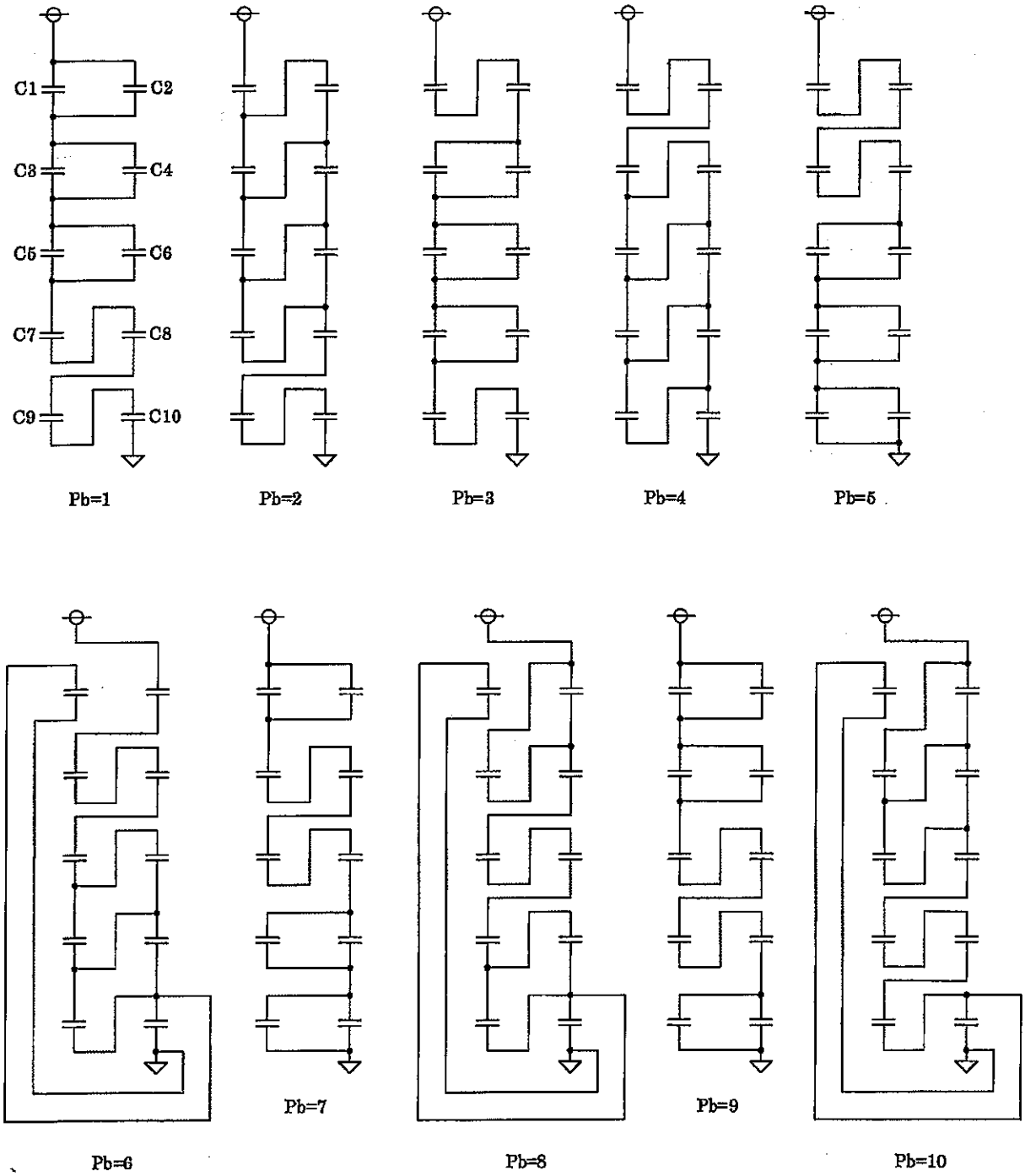

C1
C2
C3
C4
C5
C6
C7
C8
C9
C10
Pb=1
Pb=2
Pb=3
Pb=4
Pb=5
Pb=6
Pb=7
Pb=8
Pb=9
Pb=10

Fig. 14

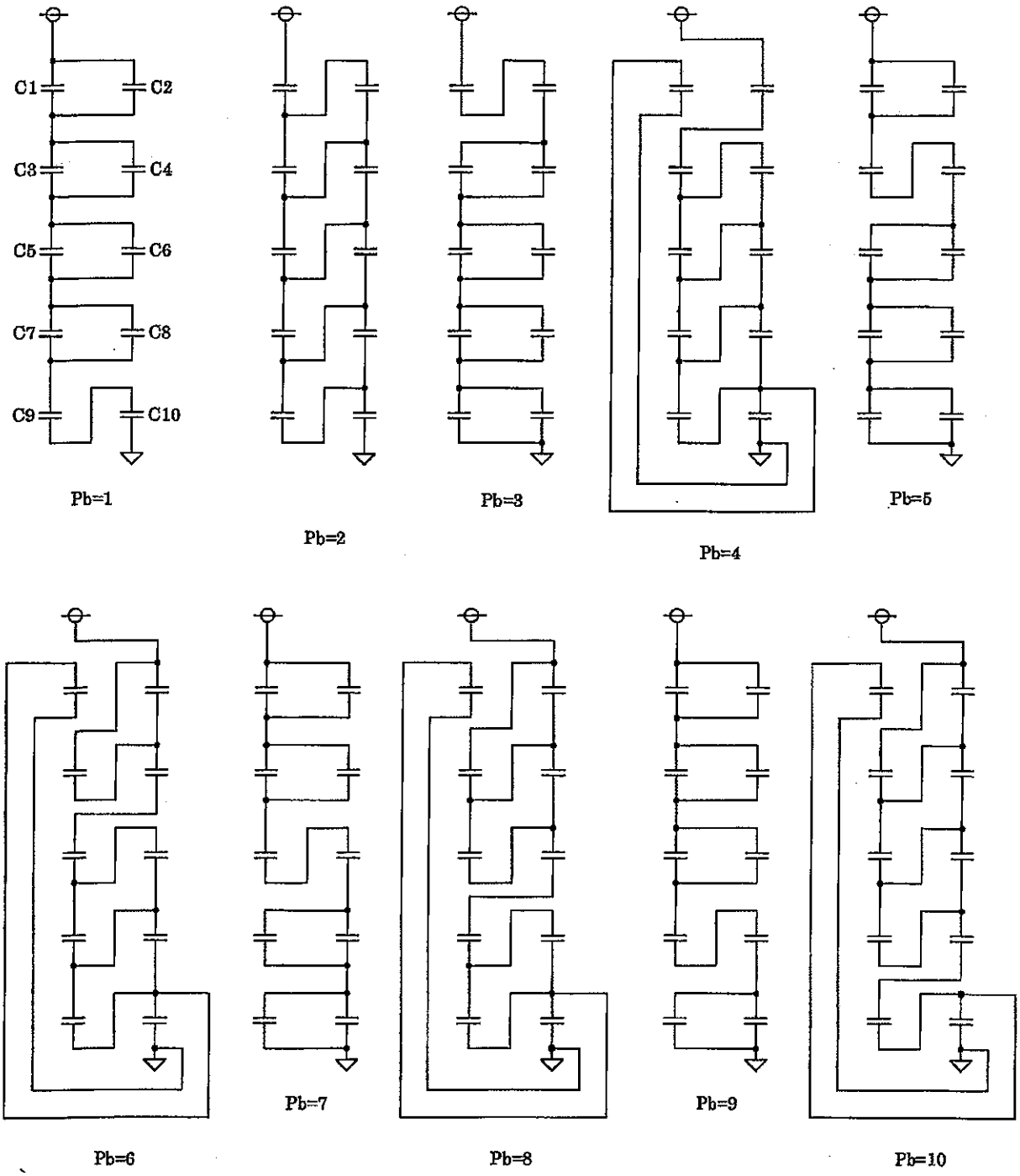

C1
C2
C3
C4
C5
C6
C7
C8
C9
C10
Pb=1
Pb=2
Pb=3
Pb=4
Pb=5
Pb=6
Pb=7
Pb=8
Pb=9
Pb=10

Fig. 15

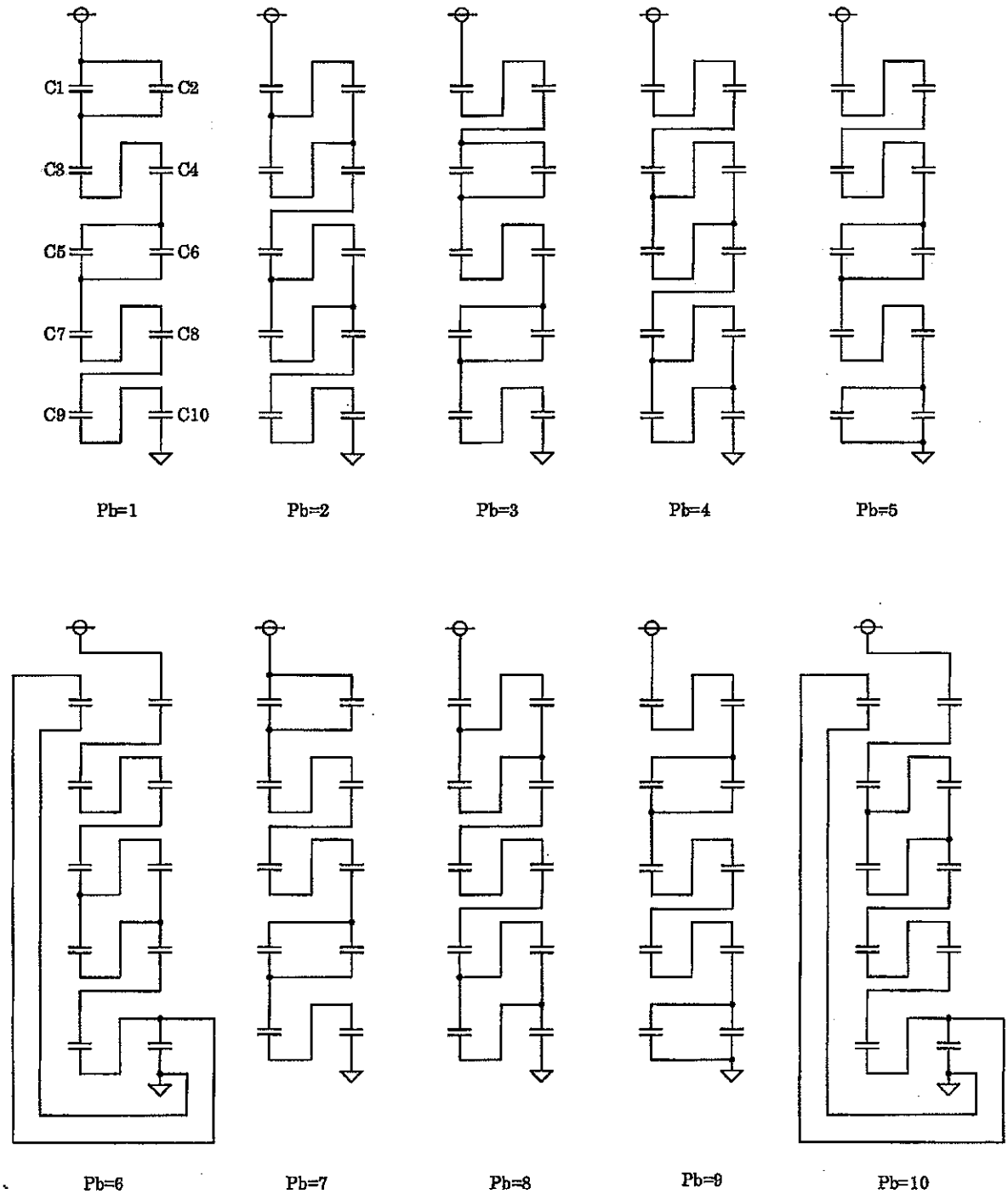
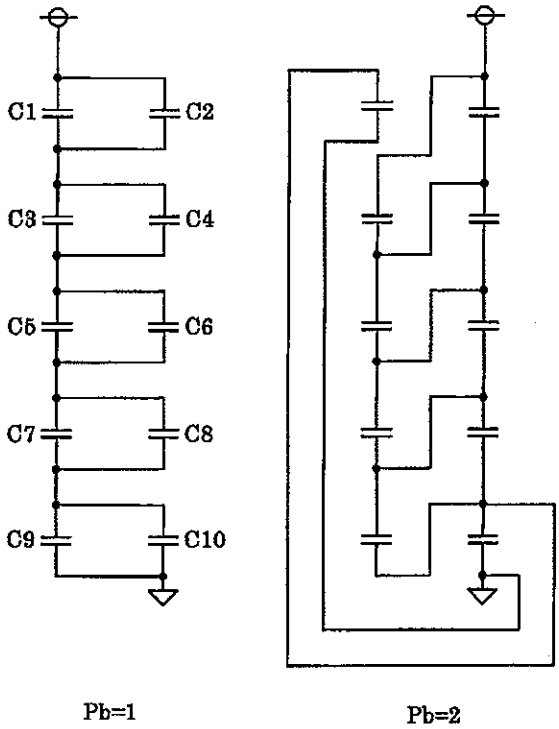

C1
C2
C3
C4
C5
C6
C7
C8
C9
C10
Pb=1
Pb=2
Pb=3
Pb=4
Pb=5
Pb=6
Pb=7
Pb=8
Pb=9
Pb=10

Fig. 16



Pb=1 Pb=2

Fig. 17

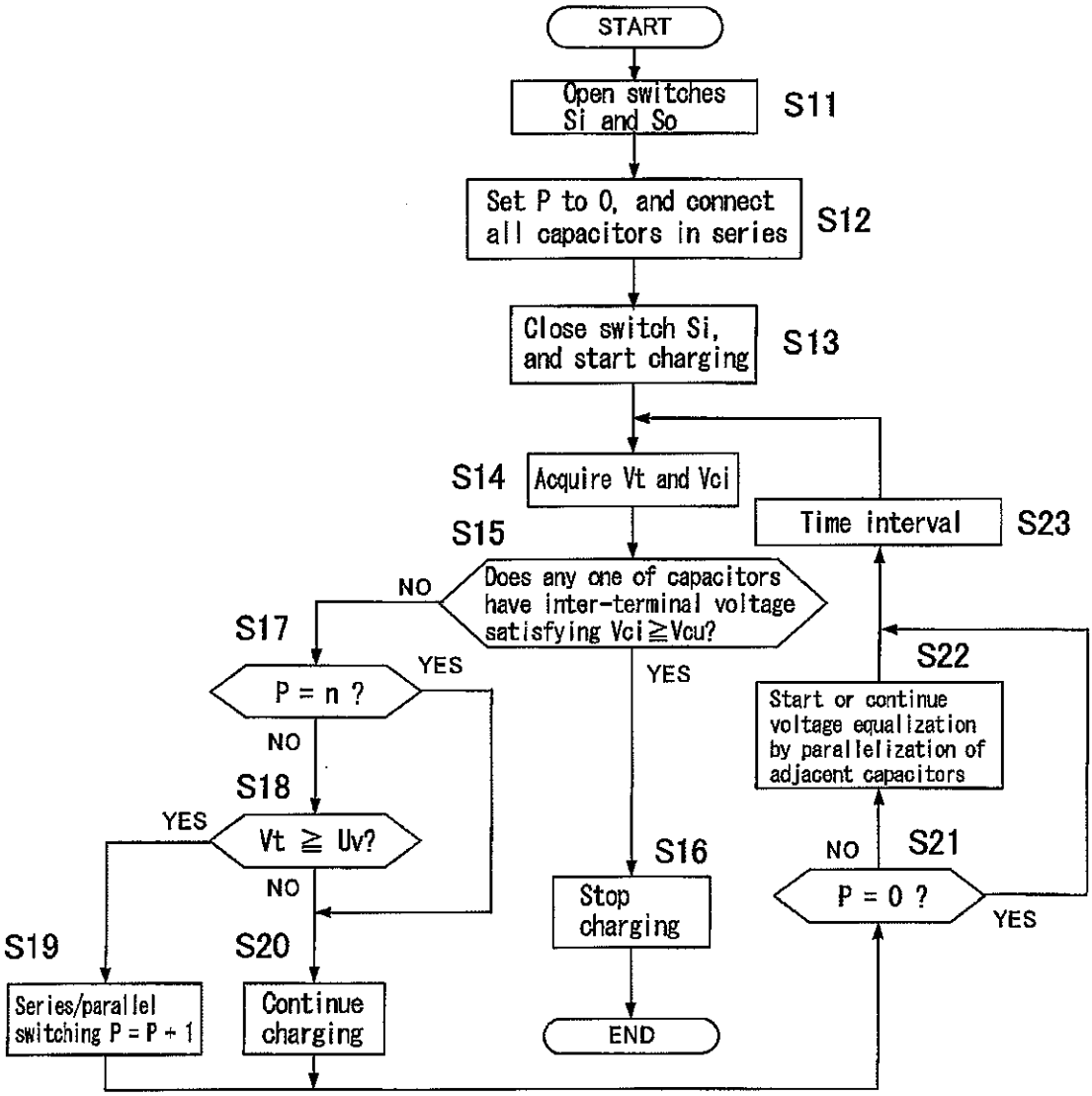

START
Open switches Si and So
S11
Set P to 0, and connect all capacitors in series
S12
Close switch Si, and start charging
S13
S14
Acquire Vt and Vci
S15
Does any one of capacitors have inter-terminal voltage satisfying Vci≧Vcu?
NO
YES
S17
P = n ?
YES
NO
S18
Vt ≧ Uv?
YES
NO
S19
Series/parallel switching P = P + 1
S20
Continue charging
S16
Stop charging
END
Time interval
S23
S22
Start or continue voltage equalization by parallelization of adjacent capacitors
NO
S21
P = 0 ?
YES

Fig. 18

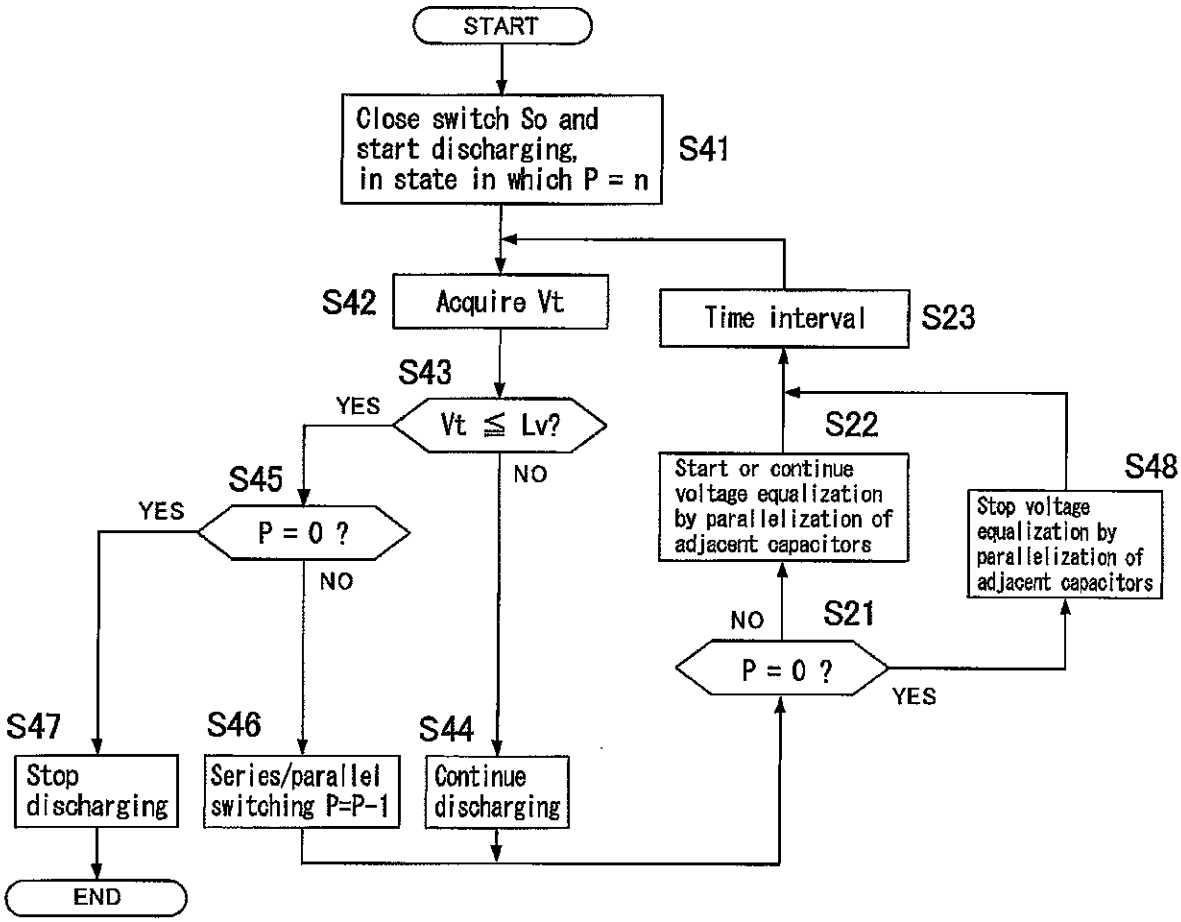

START
Close switch So and start discharging, in state in which P = n
S41
S42
Acquire Vt
S43
YES
Vt ≦ Lv?
NO
S45
YES
P = 0 ?
NO
S47
Stop discharging
S46
Series/parallel switching P=P-1
S44
Continue discharging
END
Time interval
S23
S22
Start or continue voltage equalization by parallelization of adjacent capacitors
S48
Stop voltage equalization by parallelization of adjacent capacitors
NO
S21
P = 0 ?
YES

Fig. 19

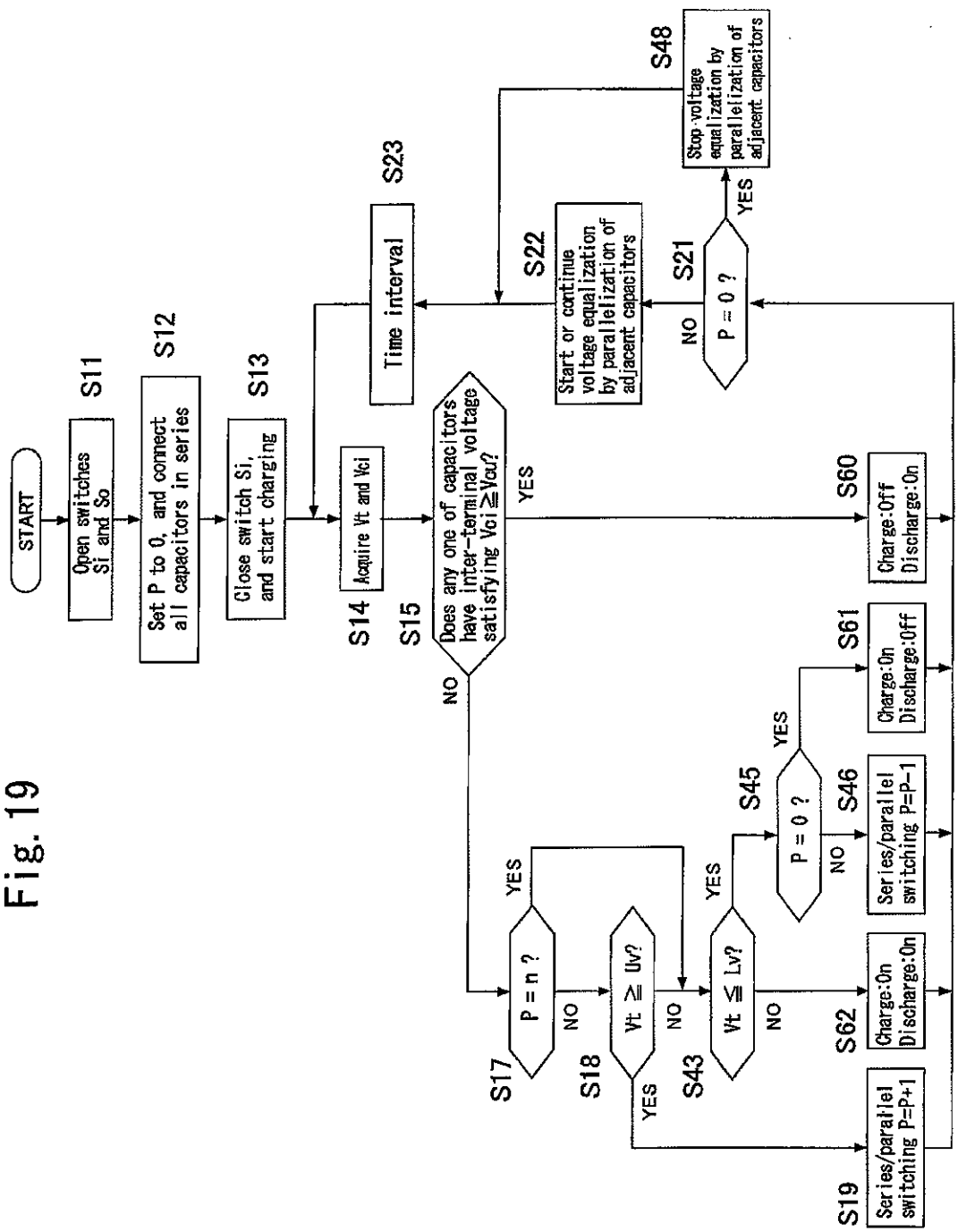
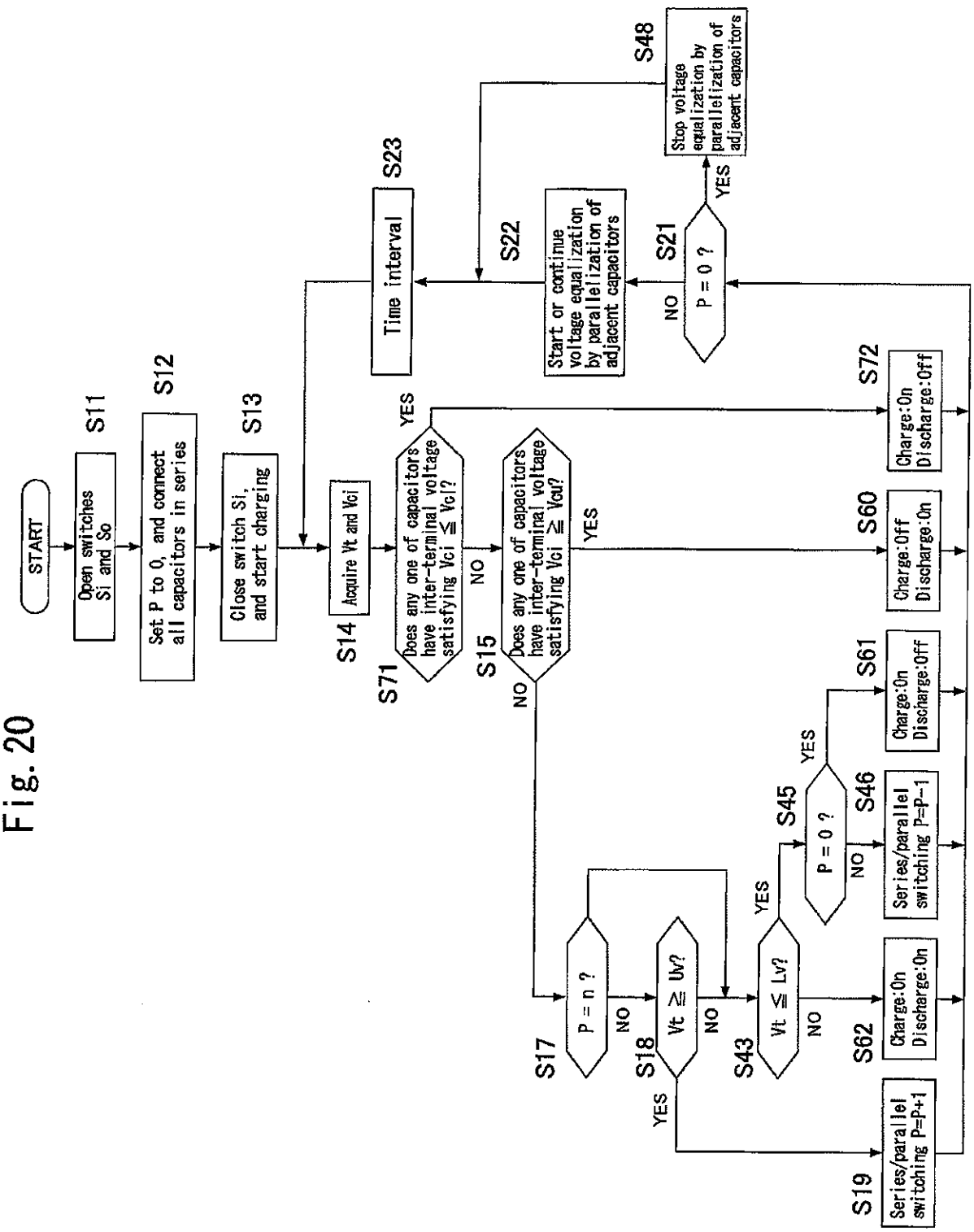

START
Open switches Si and So
S11
Set P to 0, and connect all capacitors in series
S12
Close switch Si, and start charging
S13
Time interval
S23
Acquire Vt and Voi
S14
Does any one of capacitors have inter-terminal voltage satisfying Voi≧Vou?
S15
YES
NO
Start or continue voltage equalization by parallelization of adjacent capacitors
S22
Stop voltage equalization by parallelization of adjacent capacitors
S48
P = 0 ?
S21
YES
NO
Charge:Off Discharge:On
S60
P = n ?
S17
YES
NO
Vt ≧ Uv?
S18
YES
NO
Vt ≦ Lv?
S43
YES
NO
P = 0 ?
S45
YES
NO
Charge:On Discharge:Off
S61
Series/parallel switching P=P-1
S46
Charge:On Discharge:On
S62
Series/parallel switching P=P+1
S19

Fig. 20


START
Open switches Si and So
S11
Set P to 0, and connect all capacitors in series
S12
Close switch Si, and start charging
S13
Acquire Vt and Vci
S14
Does any one of capacitors have inter-terminal voltage satisfying Vci ≦ Vcl?
S71
YES
NO
Does any one of capacitors have inter-terminal voltage satisfying Vci ≧ Vcu?
S15
YES
NO
Charge:On Discharge:Off
S72
Charge:Off Discharge:On
S60
Charge:On Discharge:Off
S61
P = n ?
S17
NO
YES
Vt ≧ Uv?
S18
NO
YES
Vt ≦ Lv?
S43
NO
YES
P = 0 ?
S45
NO
YES
Series/parallel switching P=P-1
S46
Charge:On Discharge:On
S62
Series/parallel switching P=P+1
S19
Time interval
S23
Start or continue voltage equalization by parallelization of adjacent capacitors
S22
P = 0 ?
S21
NO
YES
Stop voltage equalization by parallelization of adjacent capacitors
S48

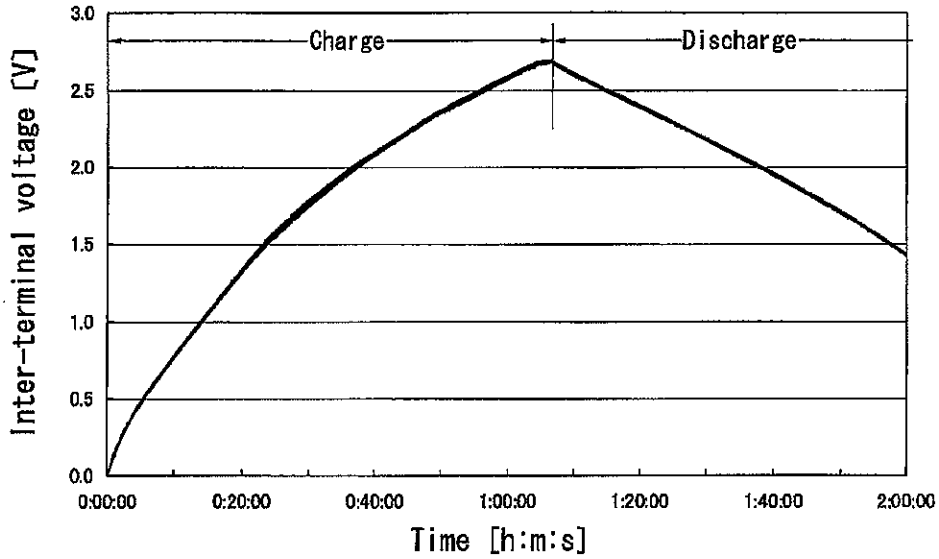


Fig. 21 (a)

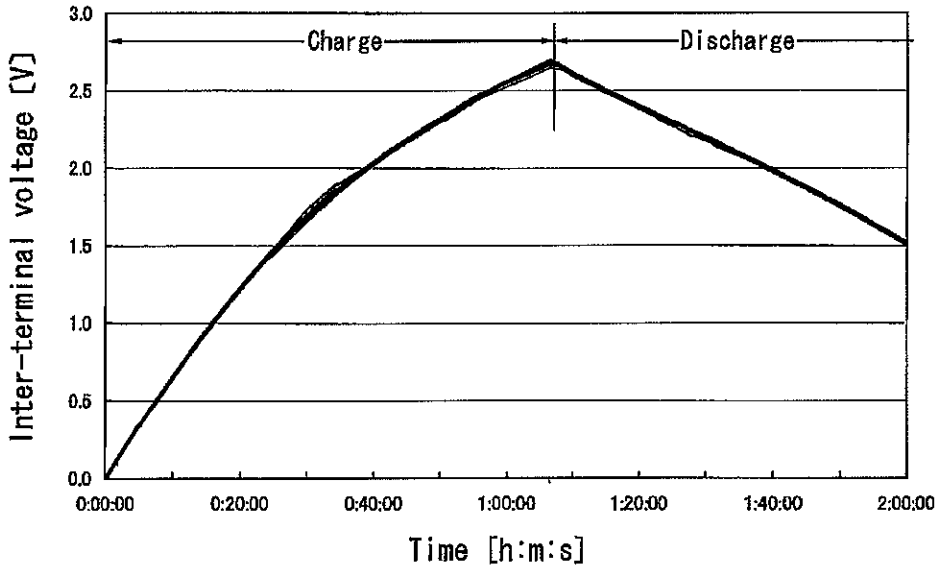


Fig. 21 (b)

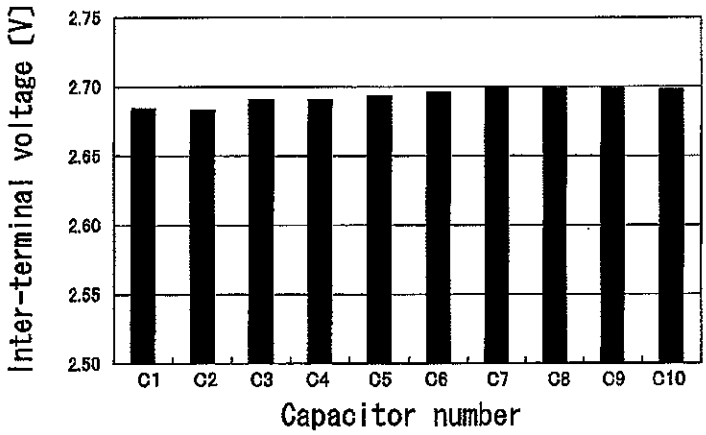


Fig. 22(a)

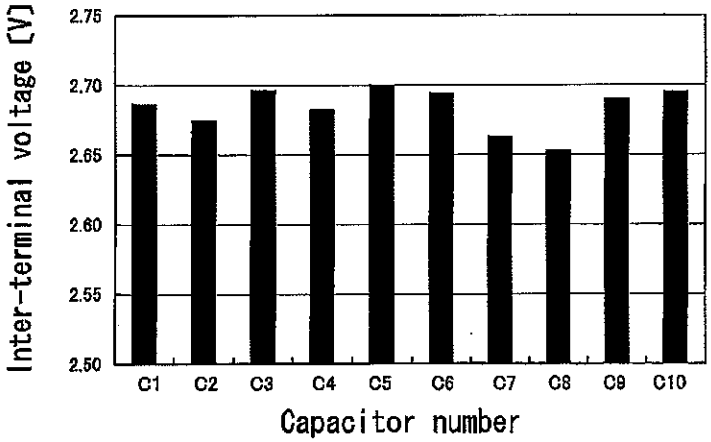


Fig. 22(b)

Fig. 23

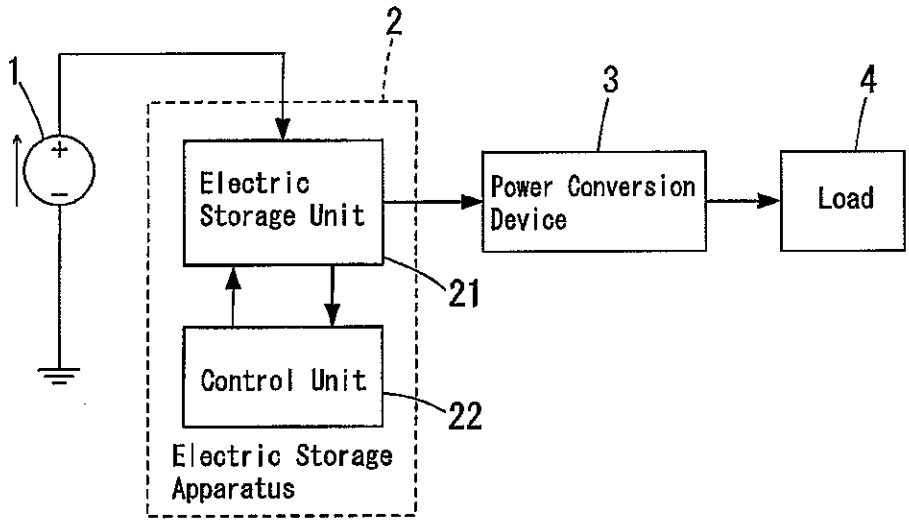

1
2
3
4
Electric Storage Unit
Power Conversion Device
Load
21
Control Unit
22
Electric Storage Apparatus

Fig. 24

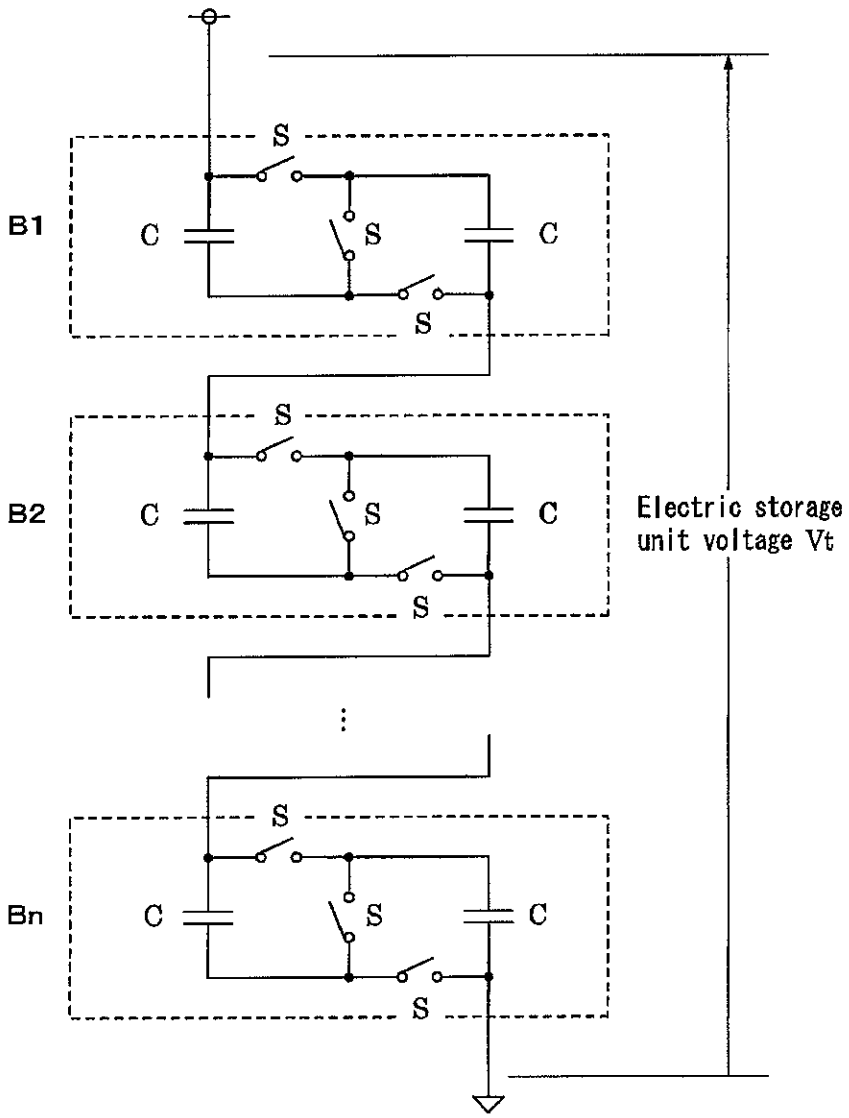
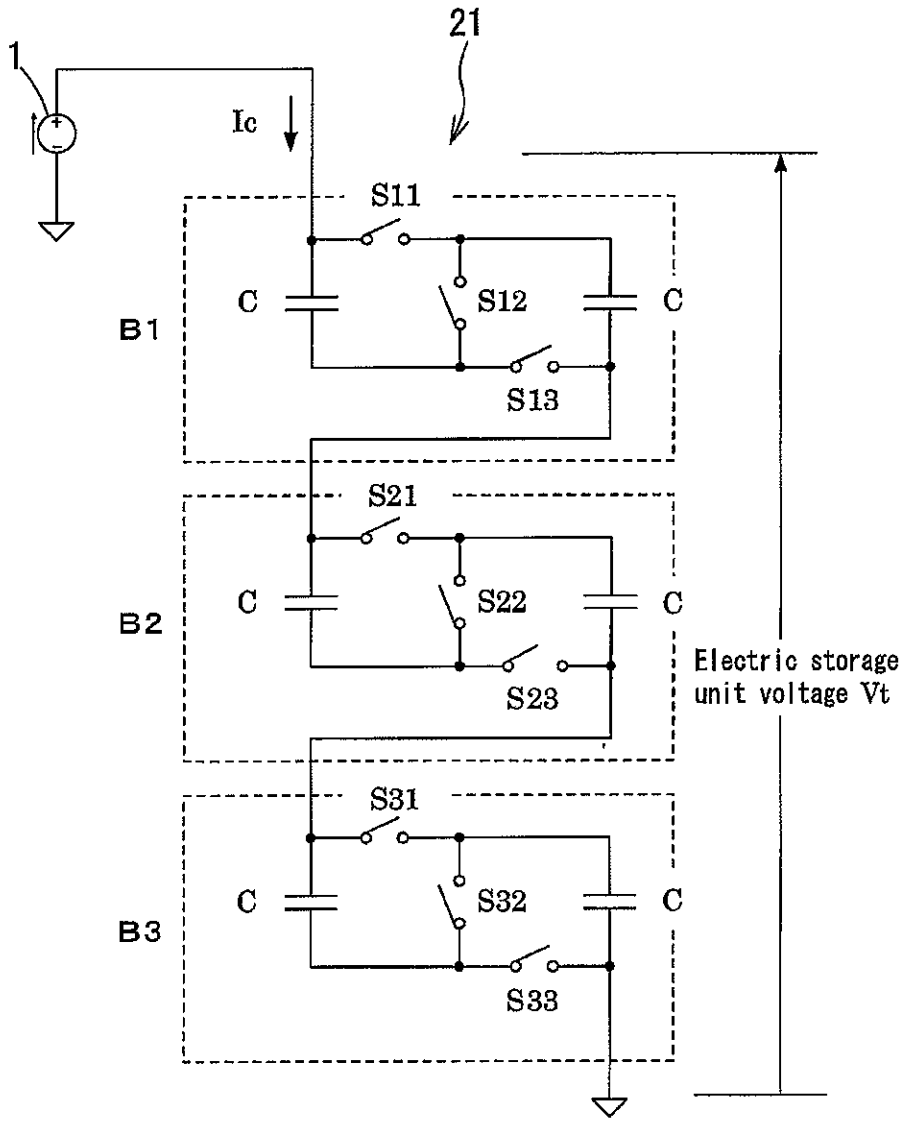

B1
B2
Bn
S
C
Electric storage unit voltage Vt

Fig. 25


1
21
Ic
S11
C
S12
C
B1
S13
S21
C
S22
C
B2
S23
Electric storage unit voltage Vt
S31
C
S32
C
B3
S33

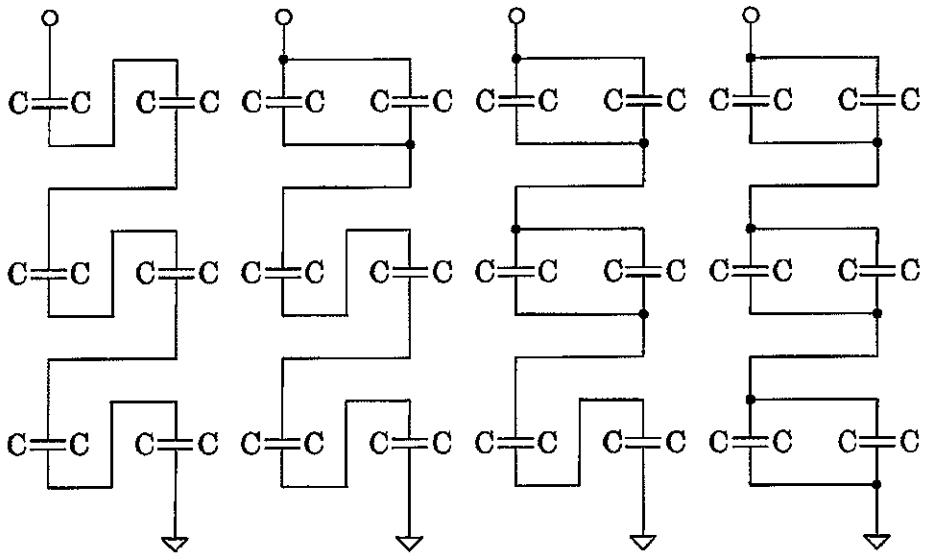
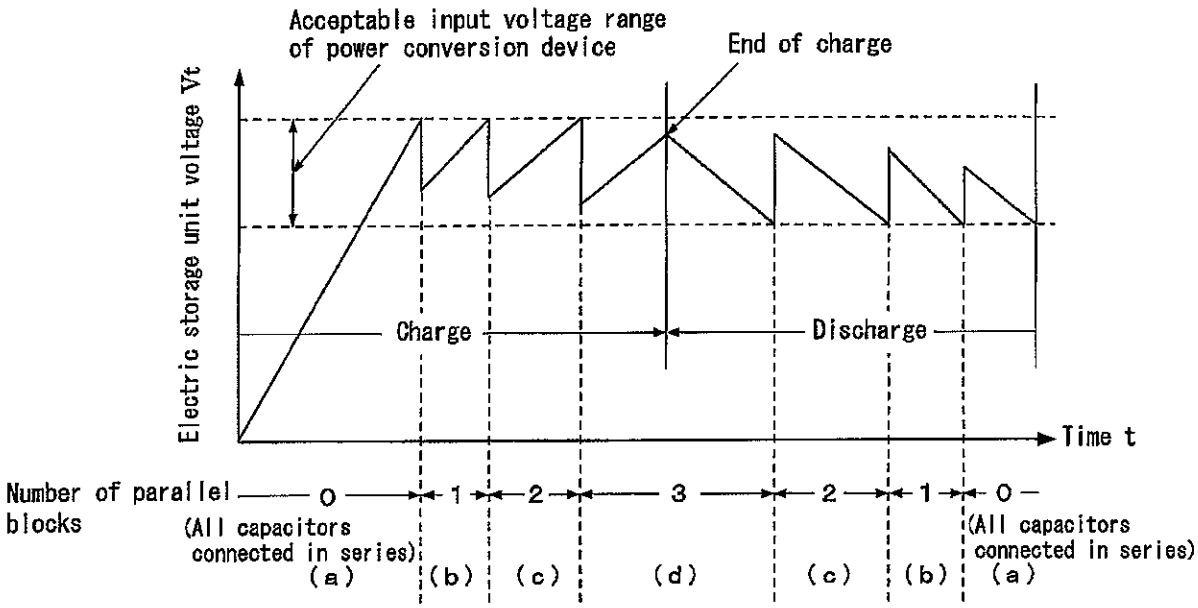


Fig. 26(a) Fig. 26(b) Fig. 26(c) Fig. 26(d)

Fig. 27



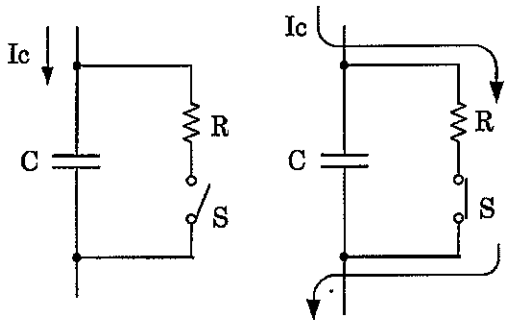
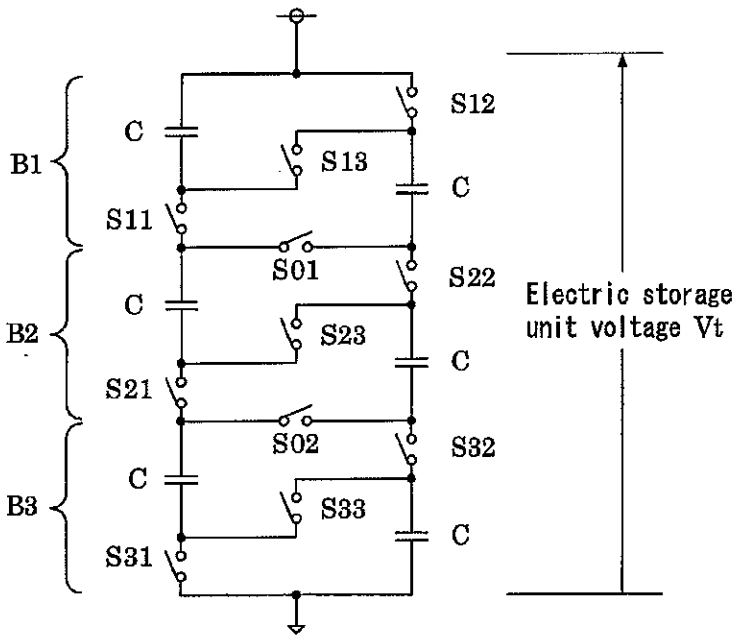


Fig. 28(a) Fig. 28(b)

Fig. 29



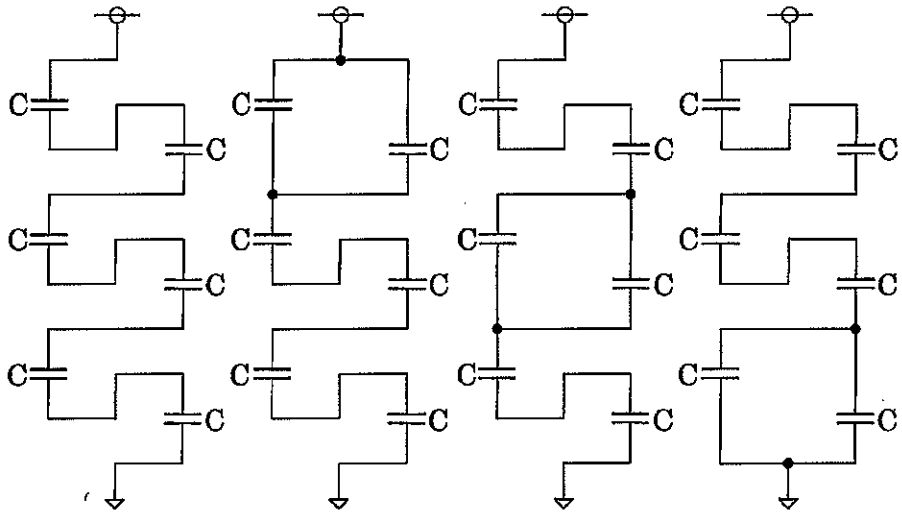


Fig. 30(a) Fig. 30(b) Fig. 30(c) Fig. 30(d)

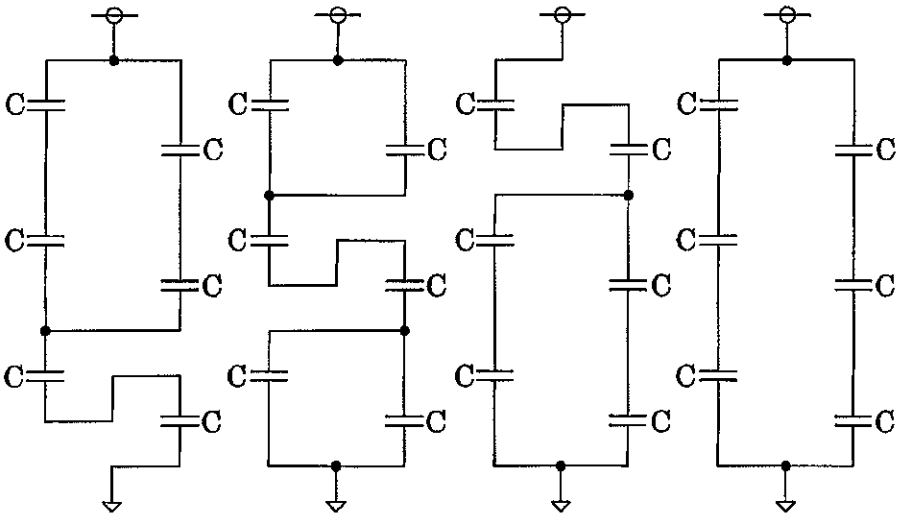


Fig. 30(e) Fig. 30(f) Fig. 30(g) Fig. 30(h)