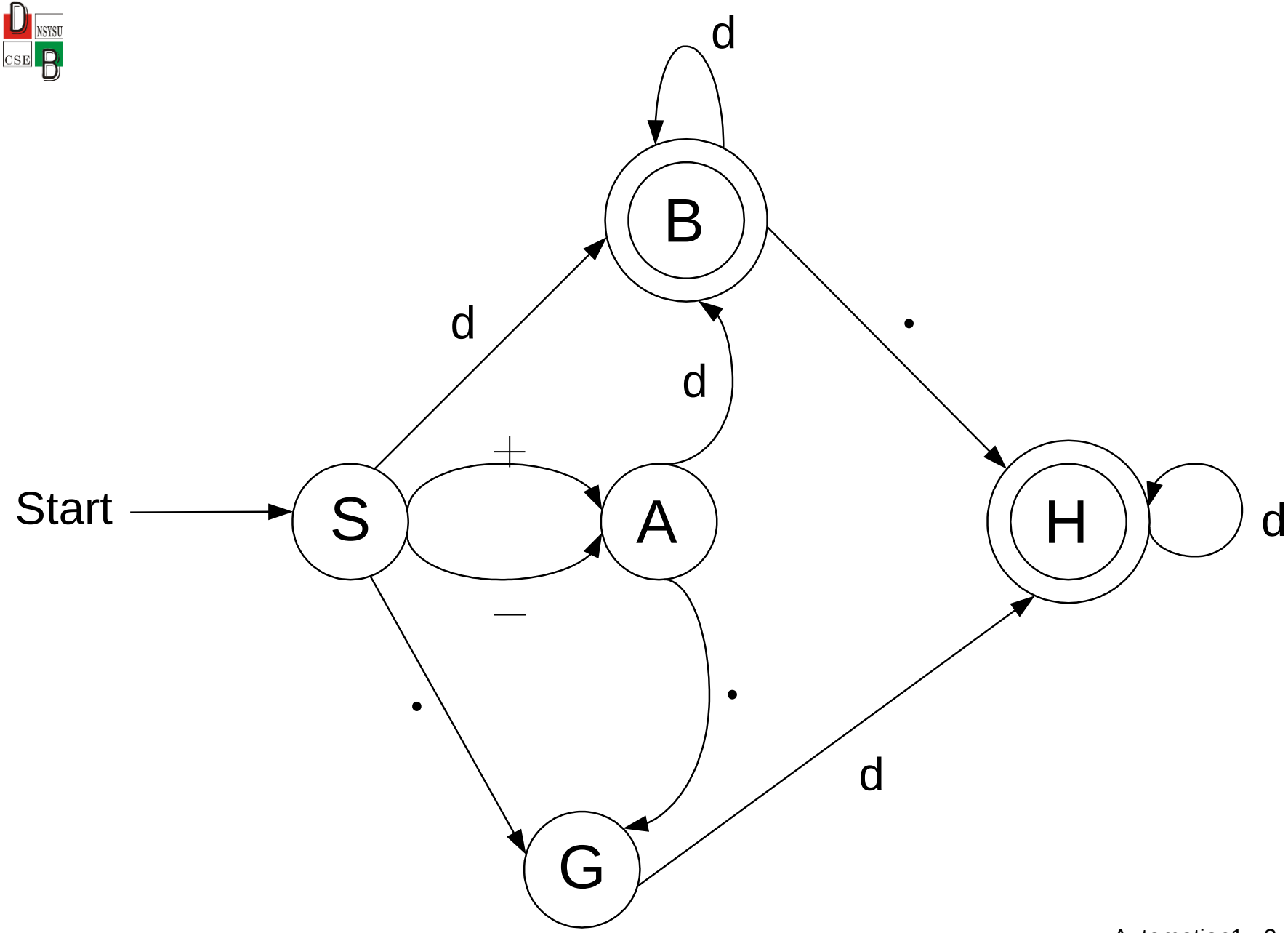
Automation


d
B
d
d
.
Start
S
+
A
H
d
—
.
.
d
G

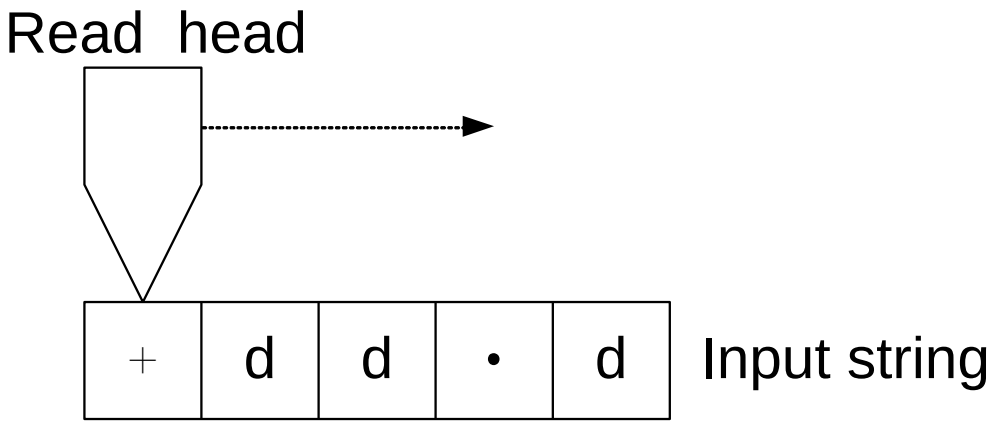


Figure 3.1. A finite-state automaton.

- From NFA → DFA:
  - (1) the case with the empty string.
  - (2) the case without the empty string.
  - (3) remove the empty string, and then …

Input token

States	δ	+	−	•	d
	S	A	A	G	B
	A			G	B
	(B)			H	B
	G				H
	(H)				H

Figure 3.2. Finite-state automaton of figure 3.1 as a table, expressing the transition function δ.

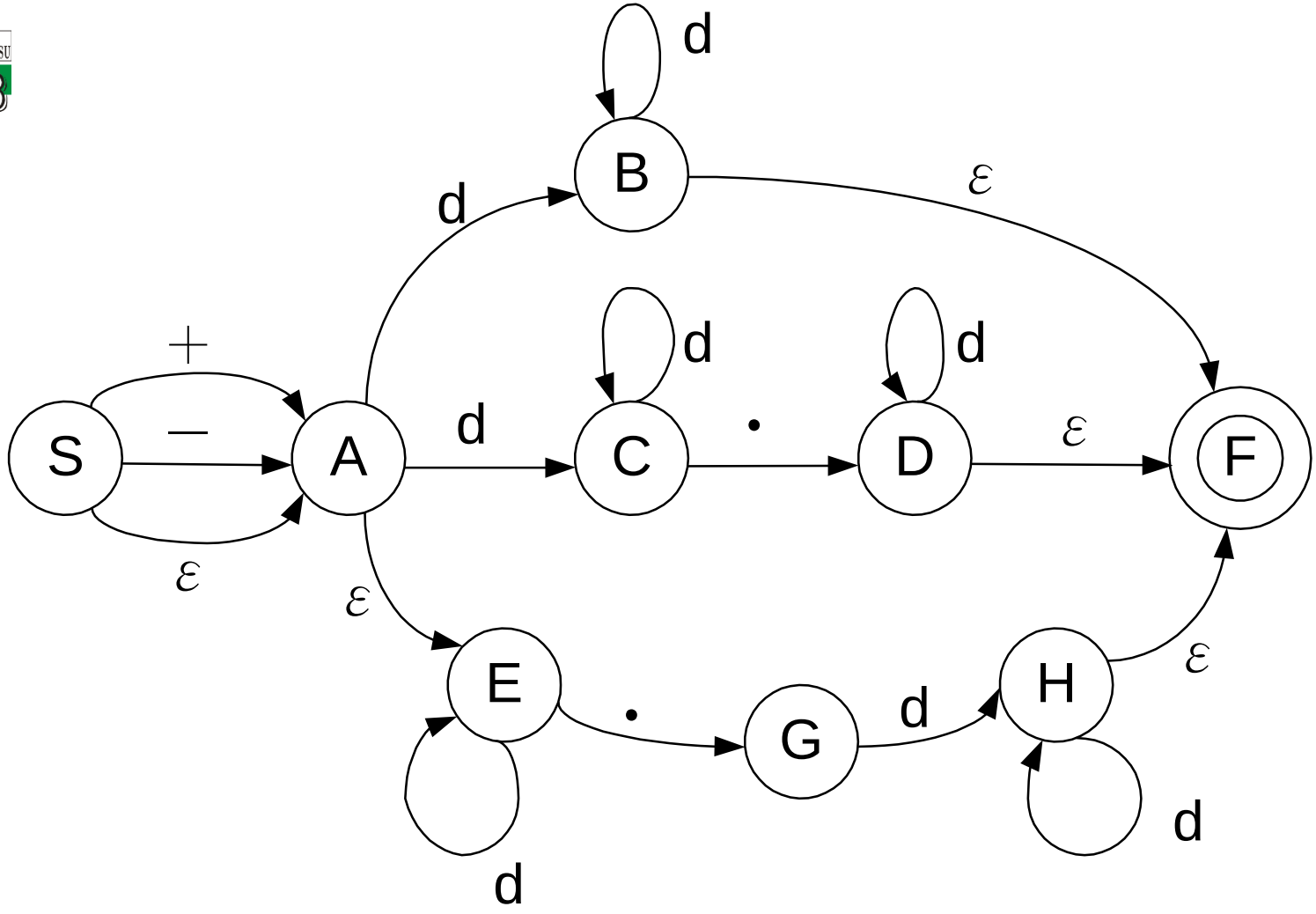


Figure 3.3. A non-deterministic machine equivalent to the machine in figure 3.1.

(+|-|ε) (d+|d+.d*|d*.d+) ➔ signed real number

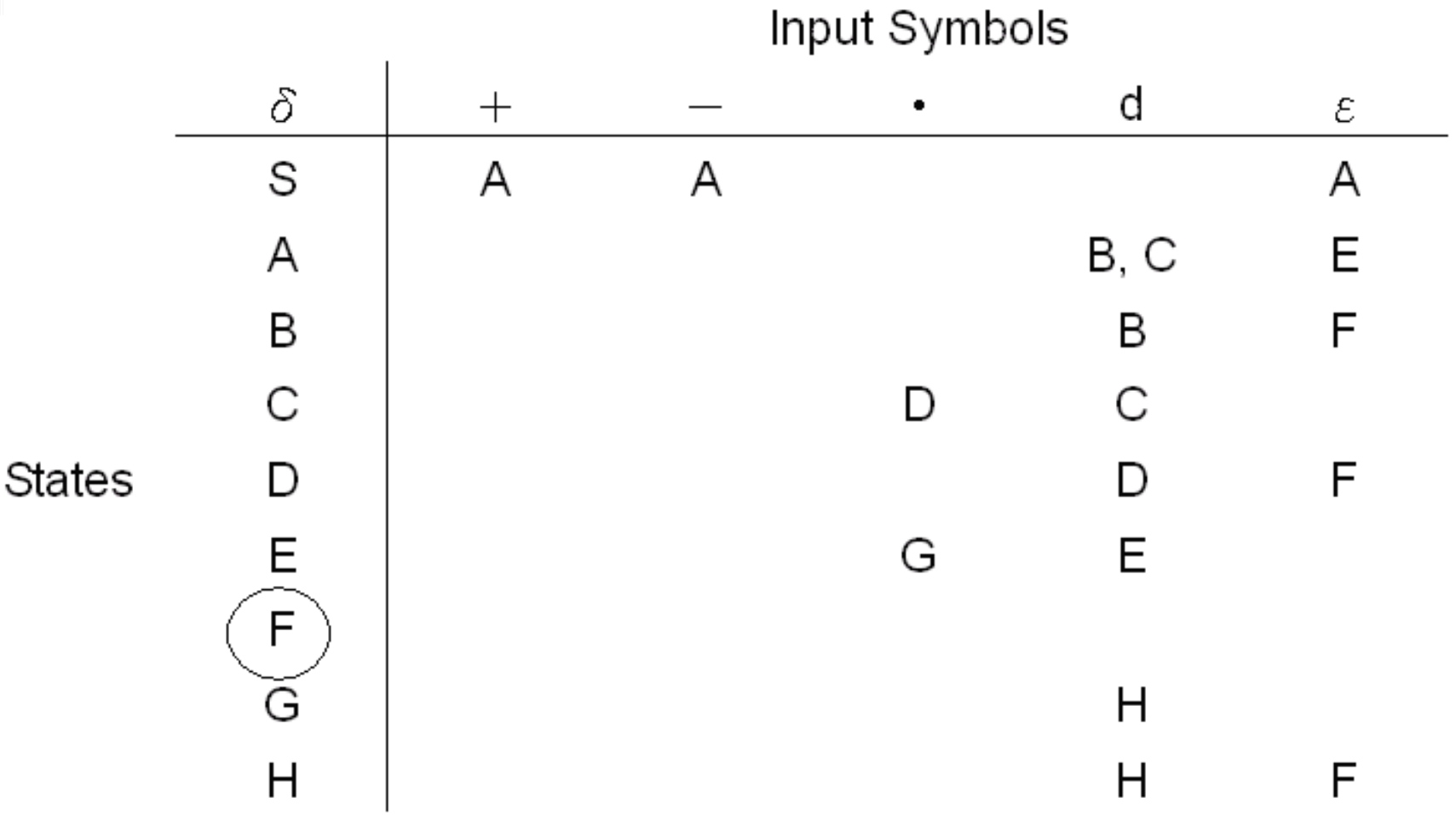
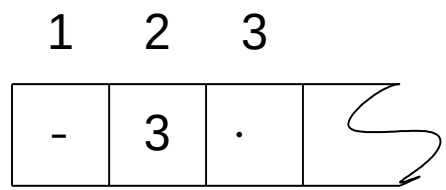


Figure 3.4. Tabular form of the non-deterministic finite automaton of figure 3.3.



Input list
Current symbol: ·
Current state: B

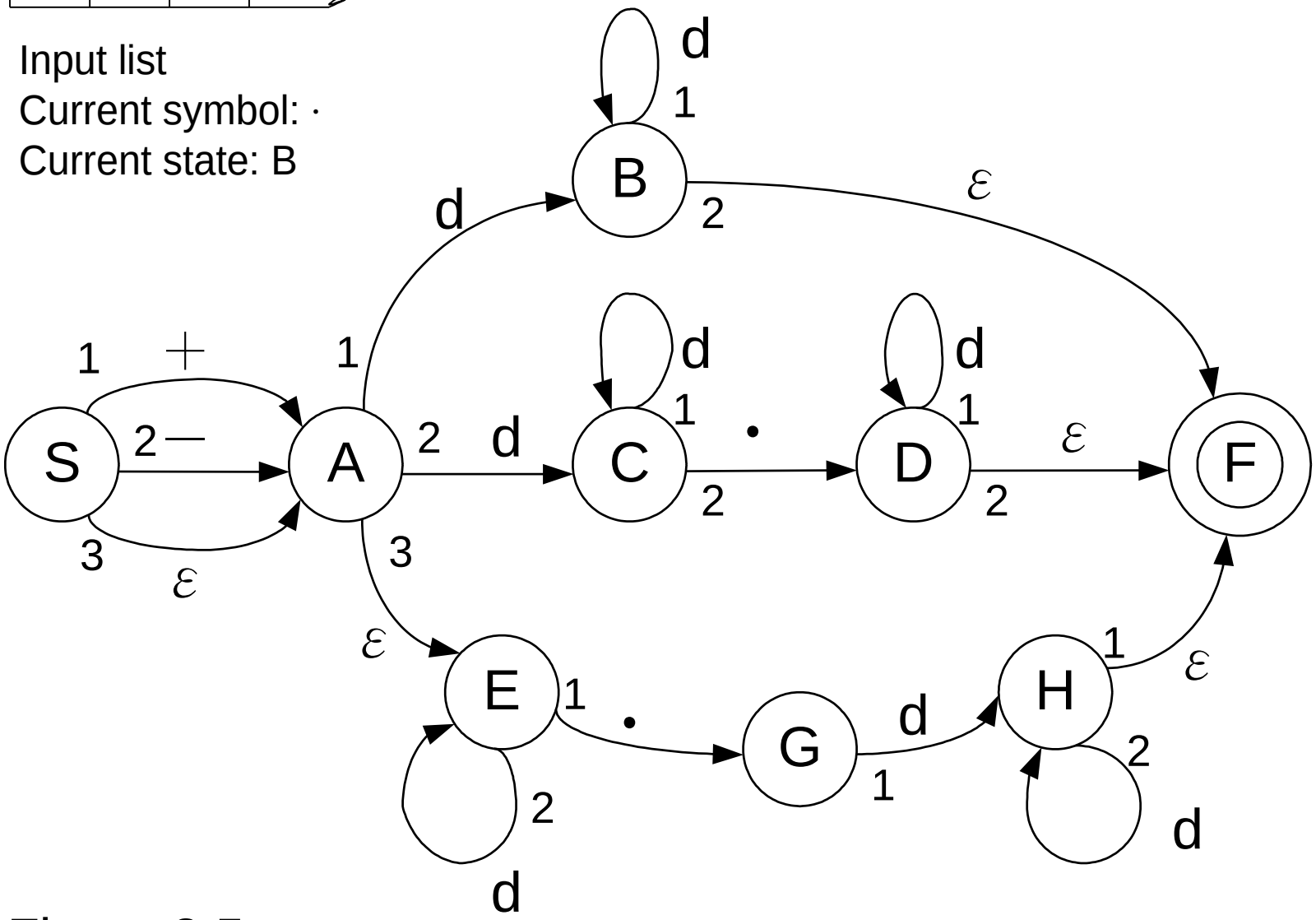


Figure 3.5.

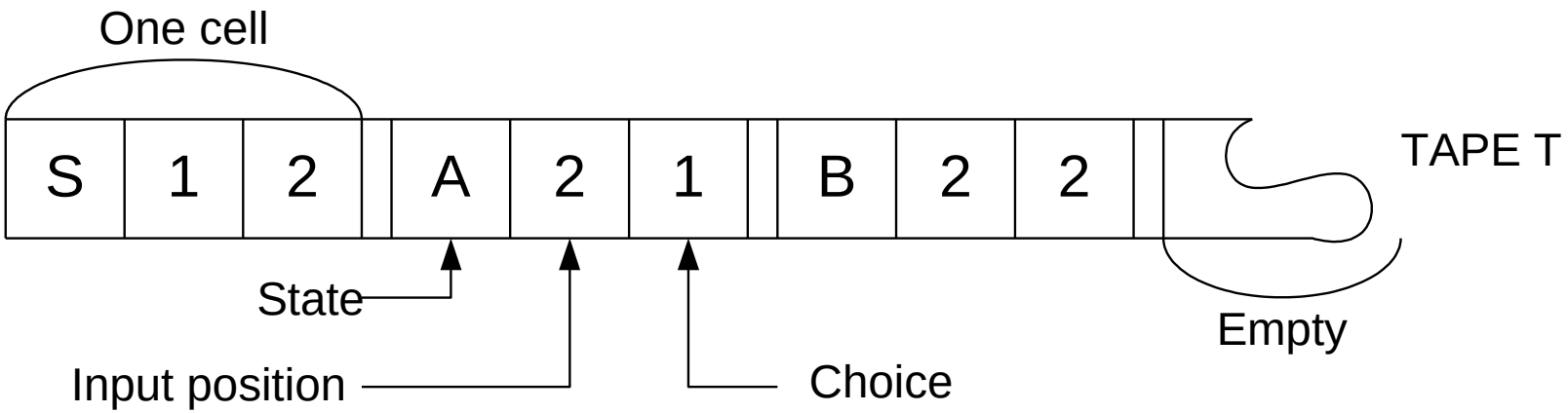


Figure 3.5. Backtracking machine M and its tape T, shown in one configuration. Input string: "-3."

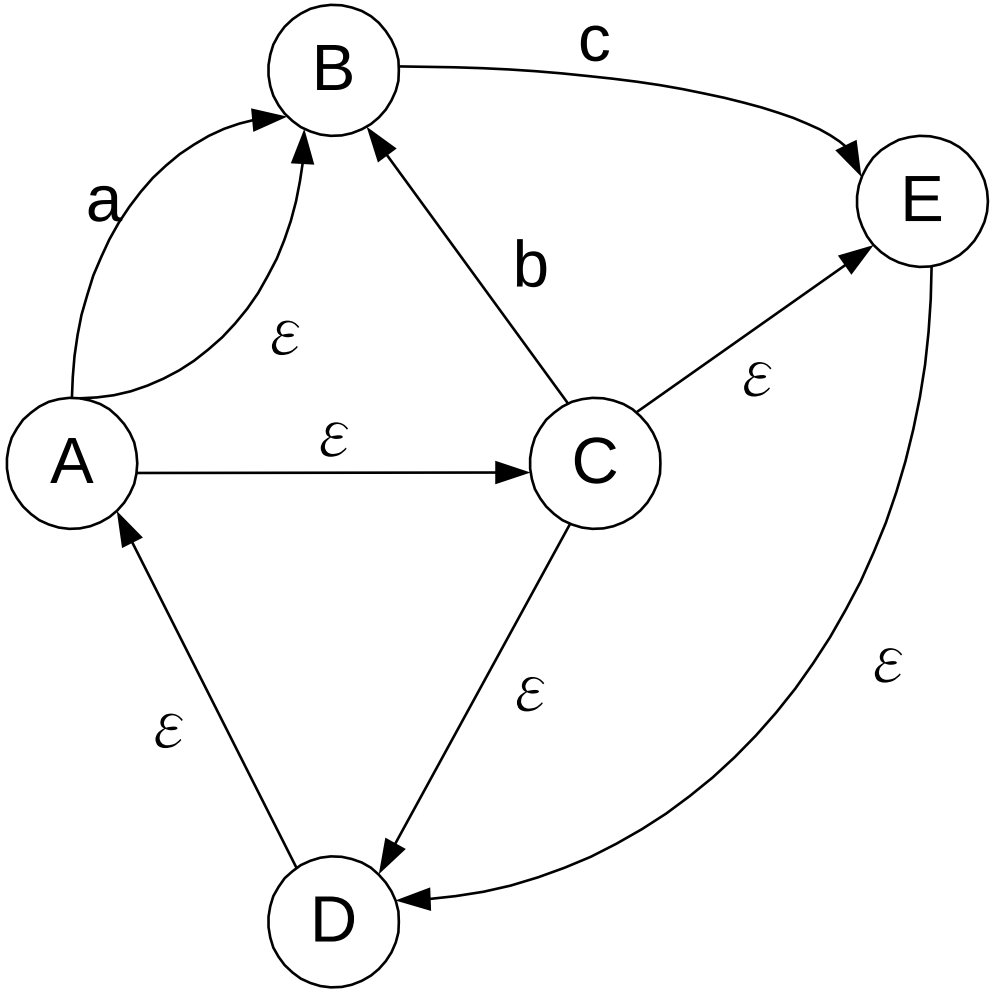


Figure 3.6. A finite-state automaton with several empty cycles.

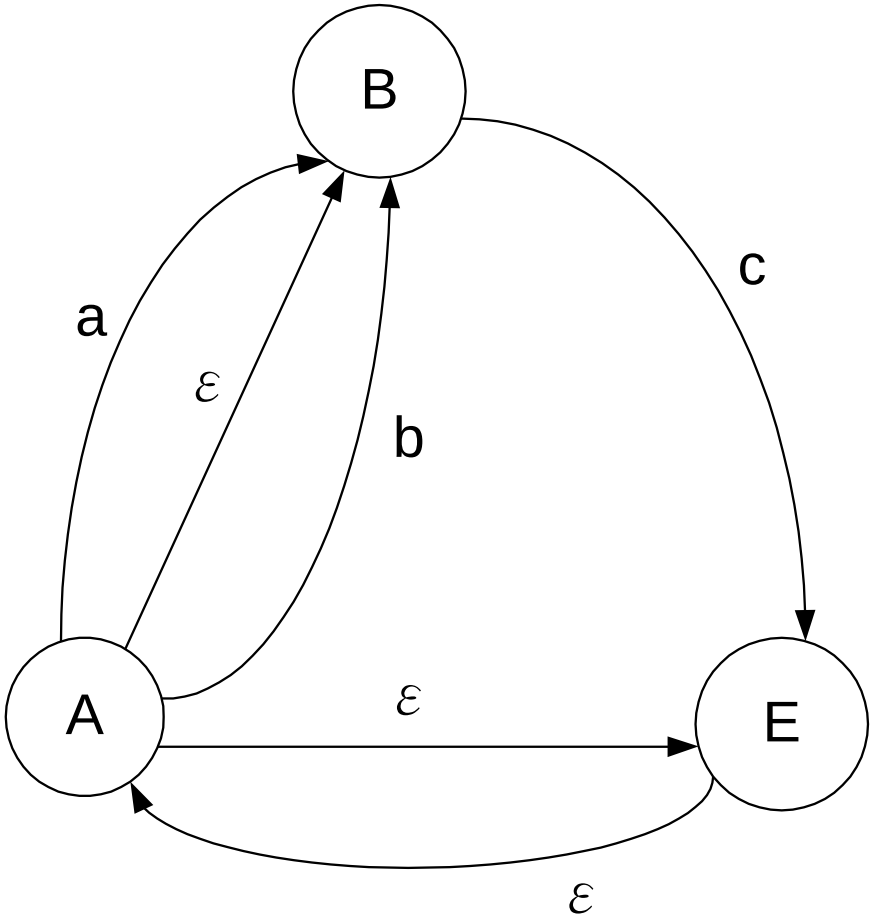


Figure 3.7. The finite-state automaton of figure 3.6 with the ACD empty cycle removed by merging states A, C, and D.

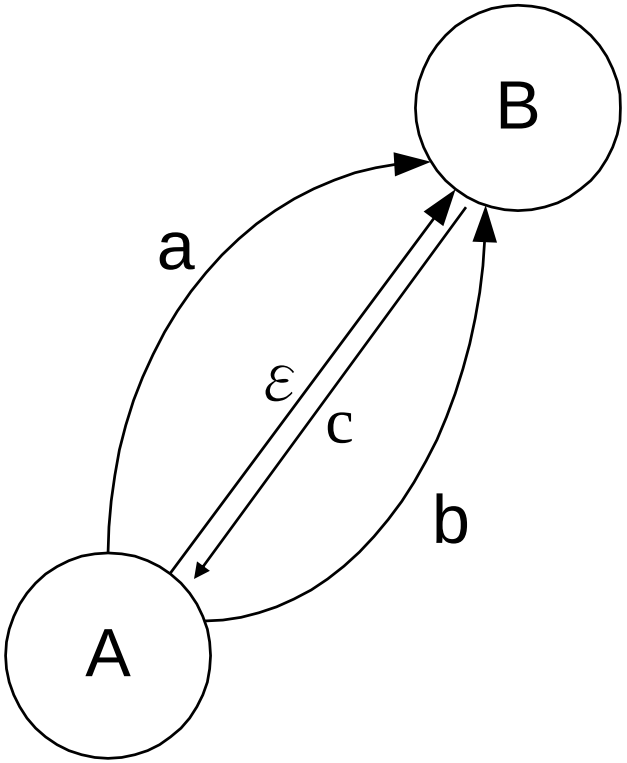


Figure 3.8. The finite-state automaton of figure 3.7 with all empty cycles removed by merging states.

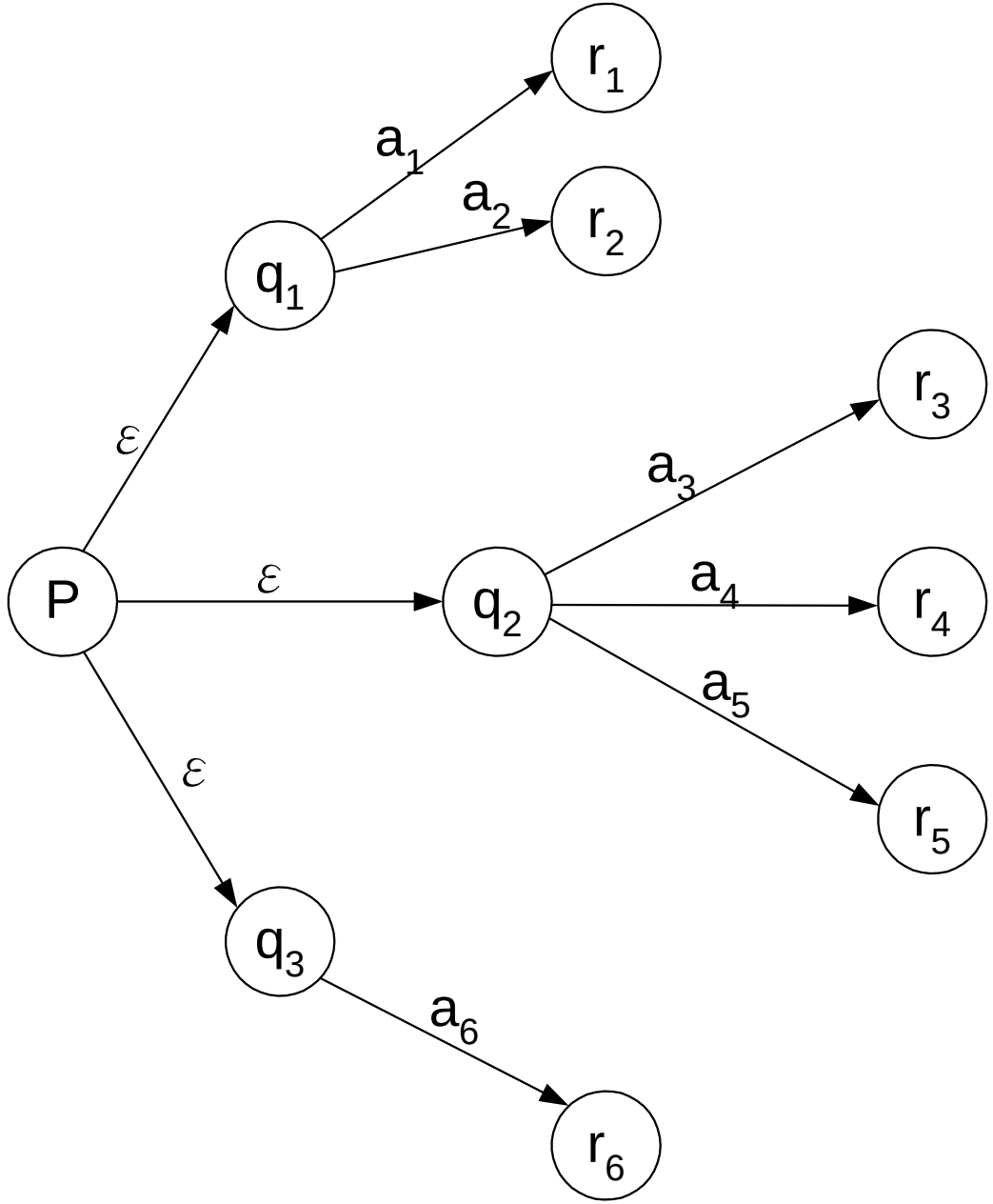


Figure 3.9. A state p with empty moves to state q_1, q_2, ...

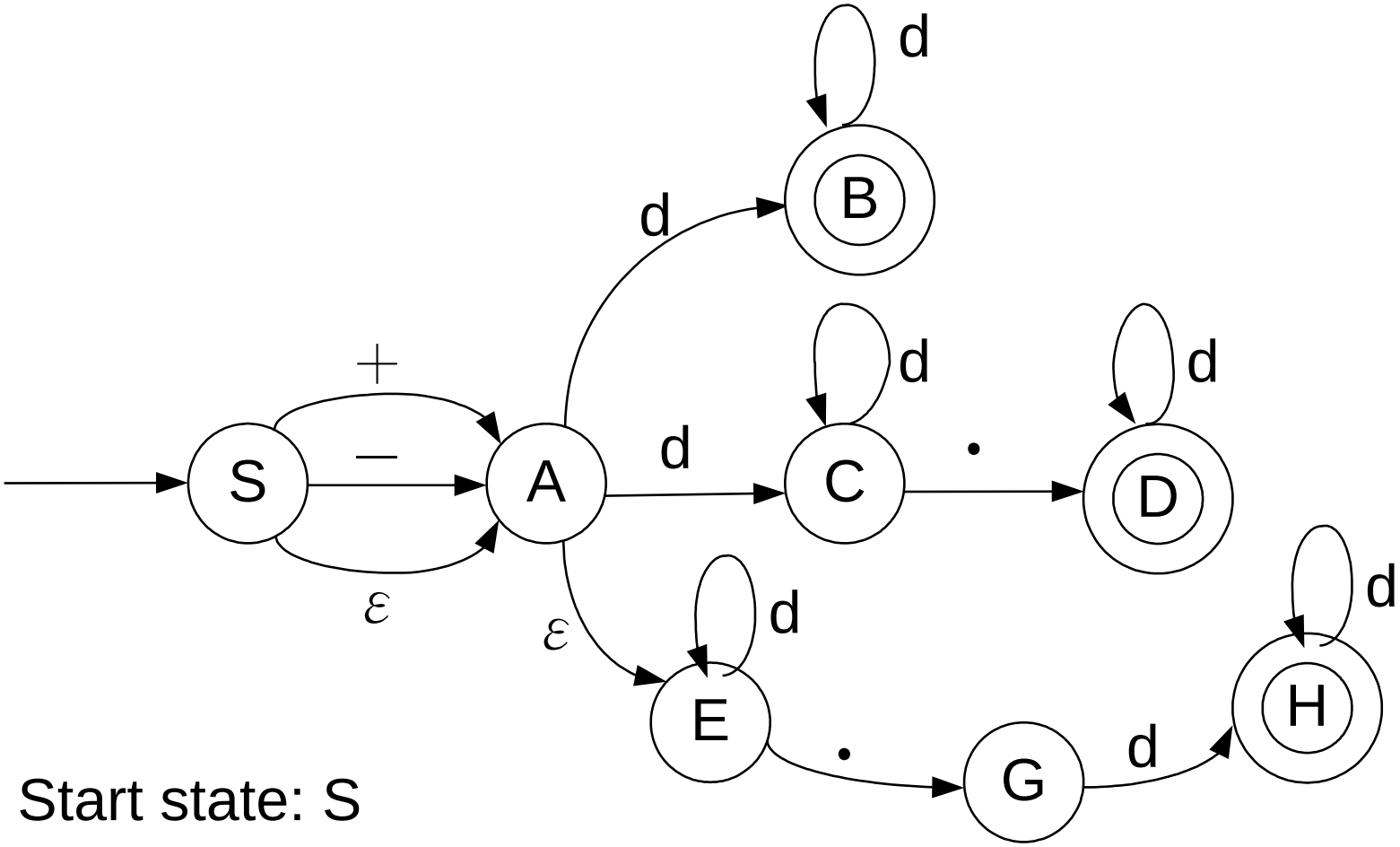


Figure 3.10. The finite-state automaton of figure 3.3 with empty moves to F removed.

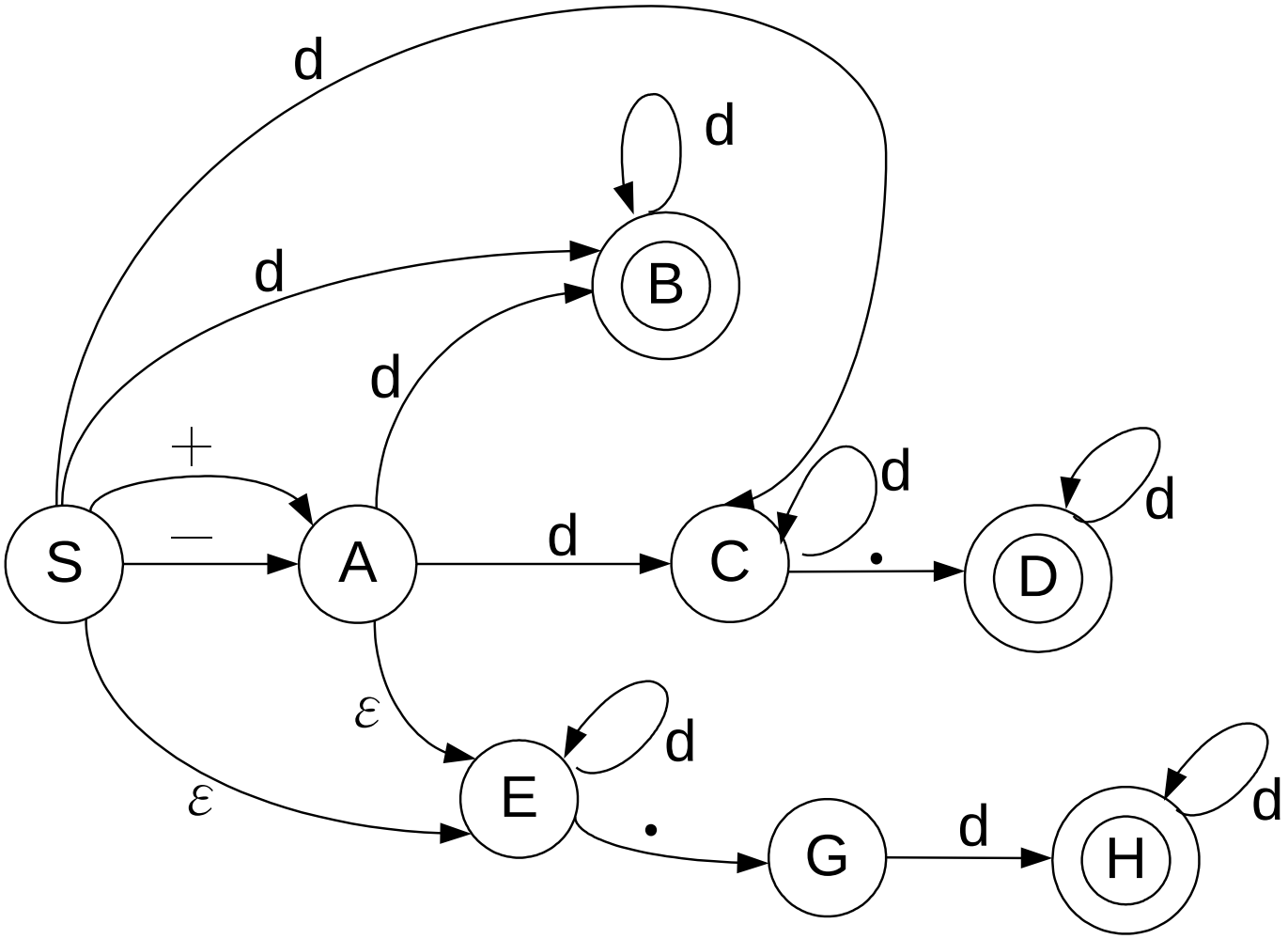


Figure 3.11. The finite-state automaton of figure 3.10 with the S to A empty moves removed.

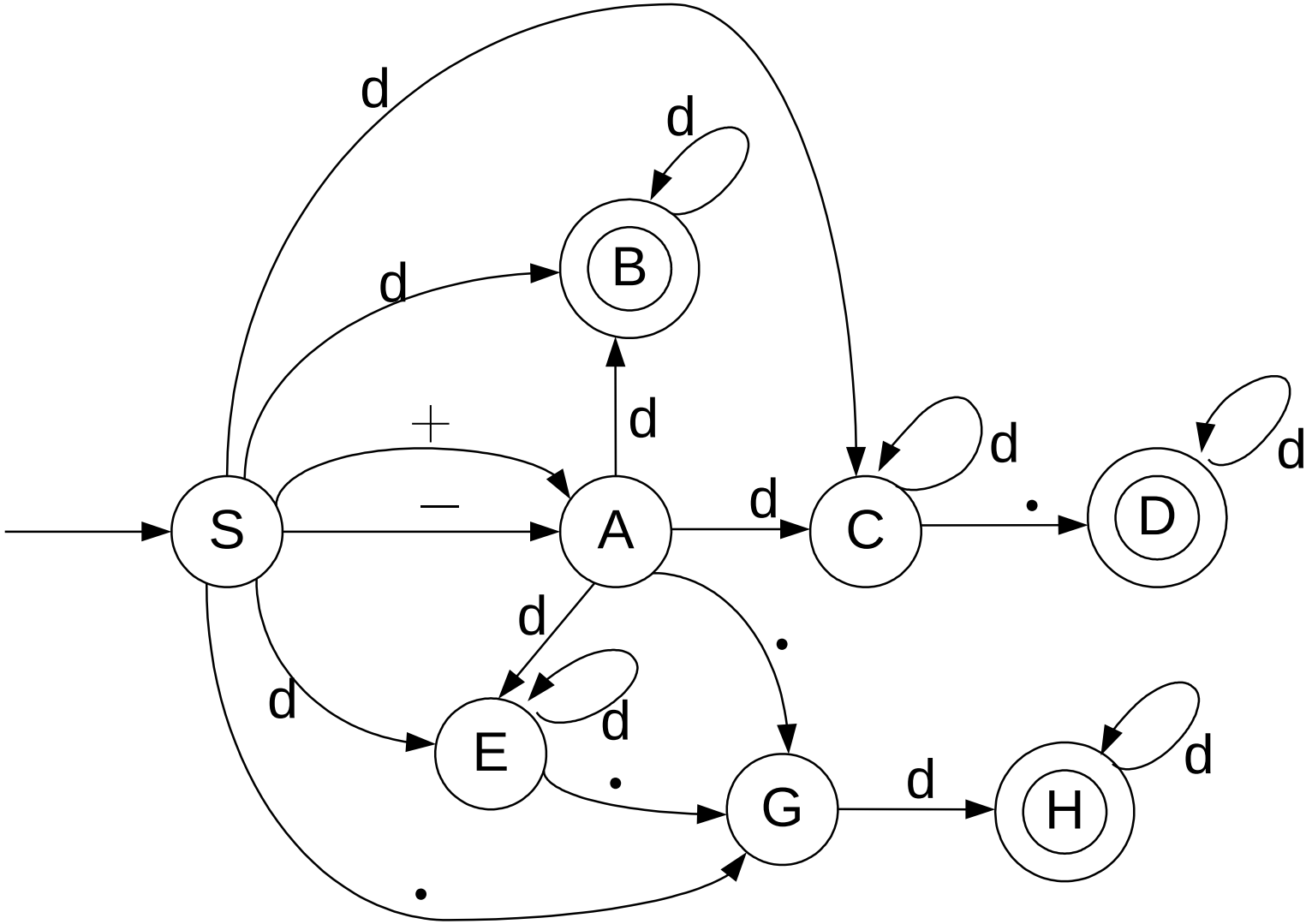


Figure 3.12. The finite-state automaton of figure 3.11 with all empty moves removed.

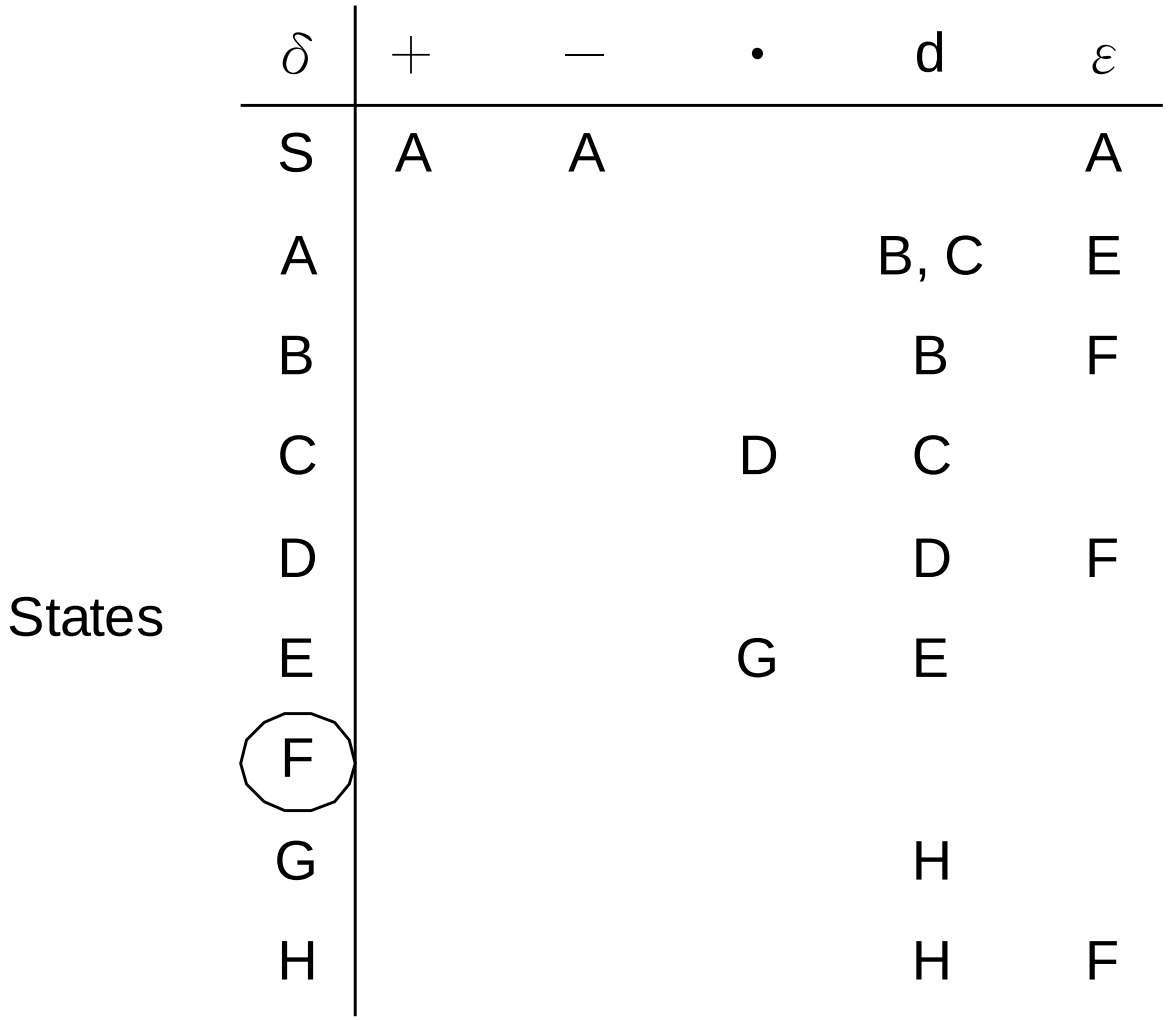


Figure 3.13. Tabular form of the non-deterministic finite-state automaton of figure 3.5, with the halt states marked.

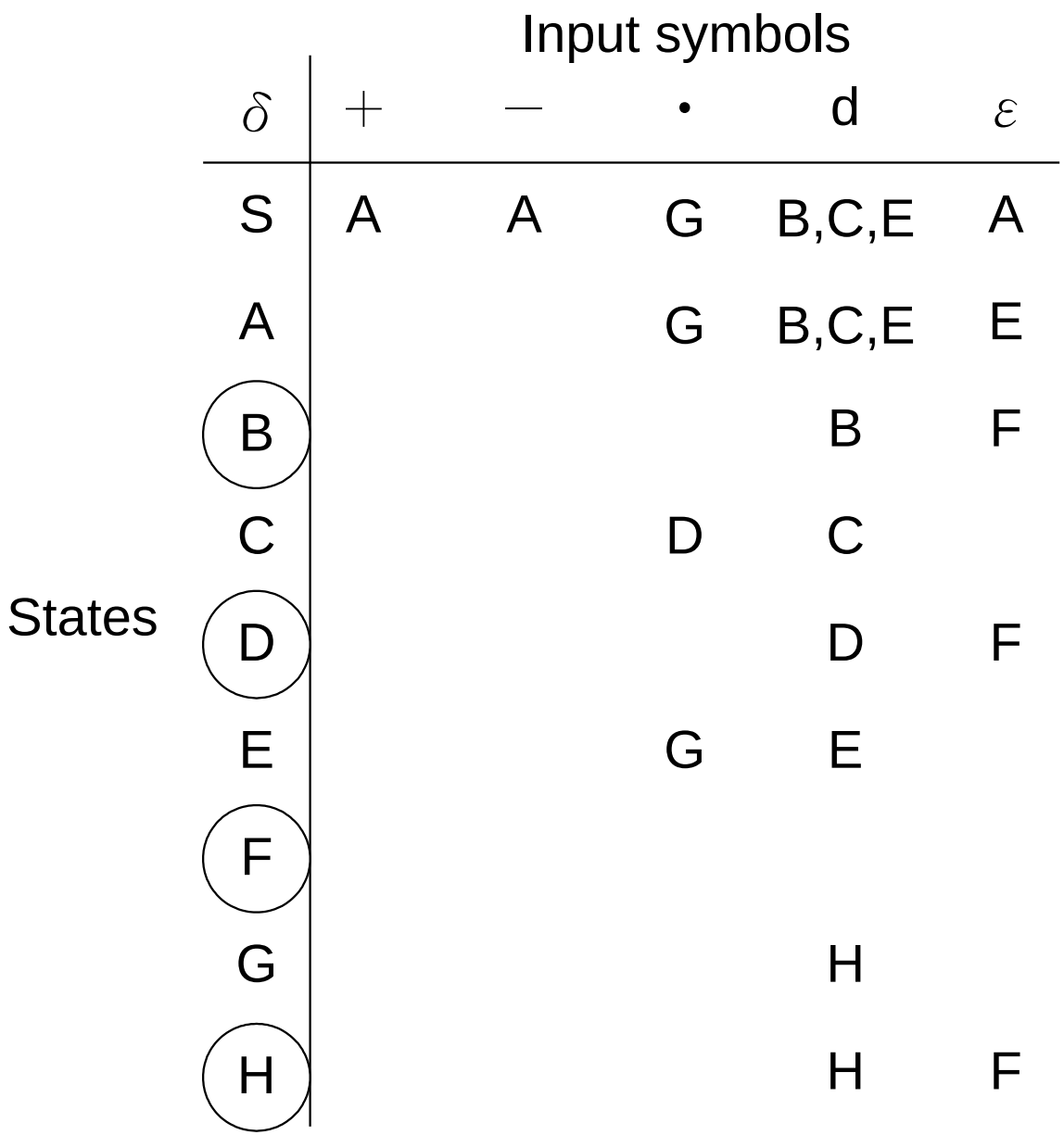


Figure 3.14. Empty move removal. Theε column may be deleted.

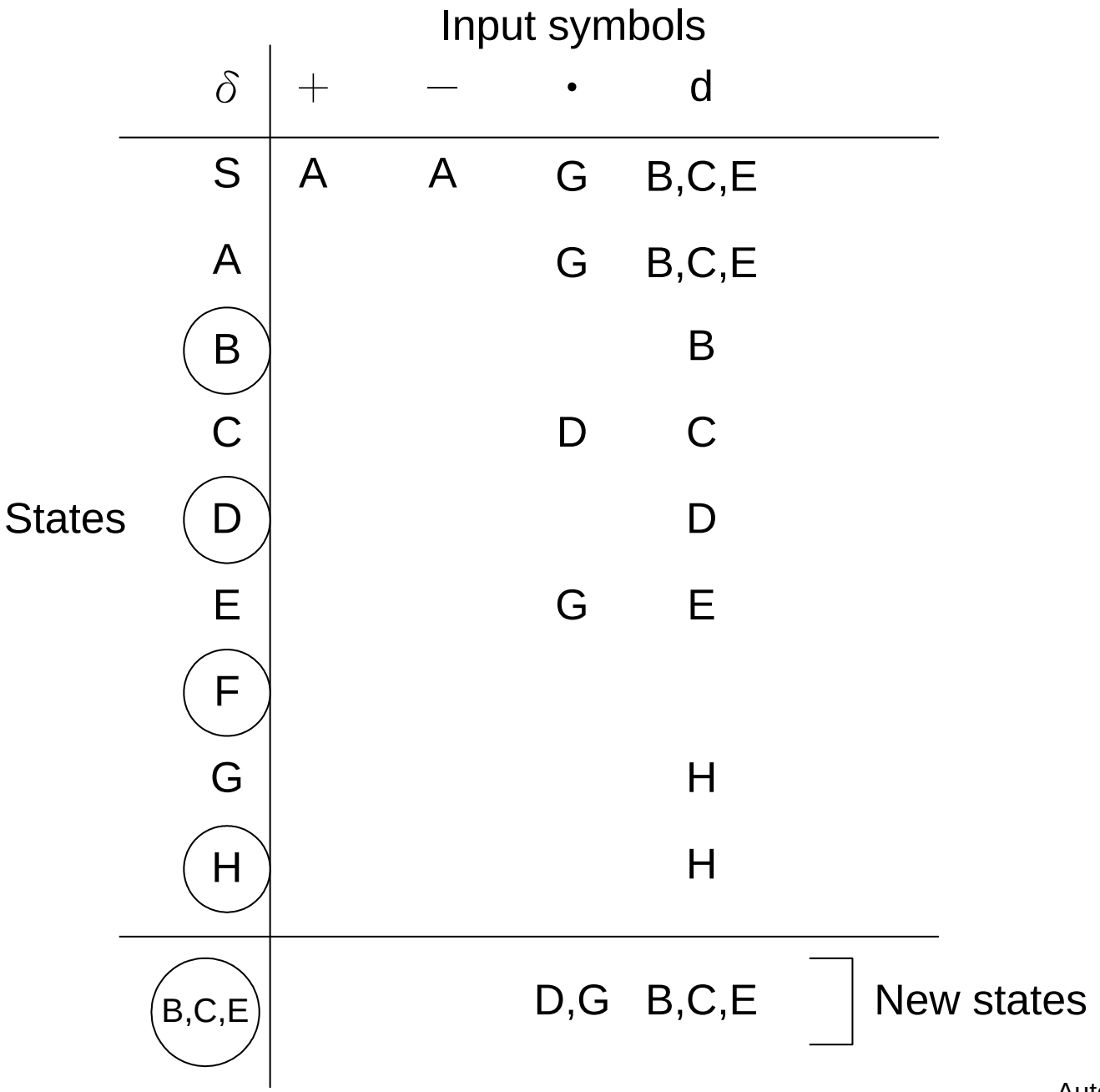
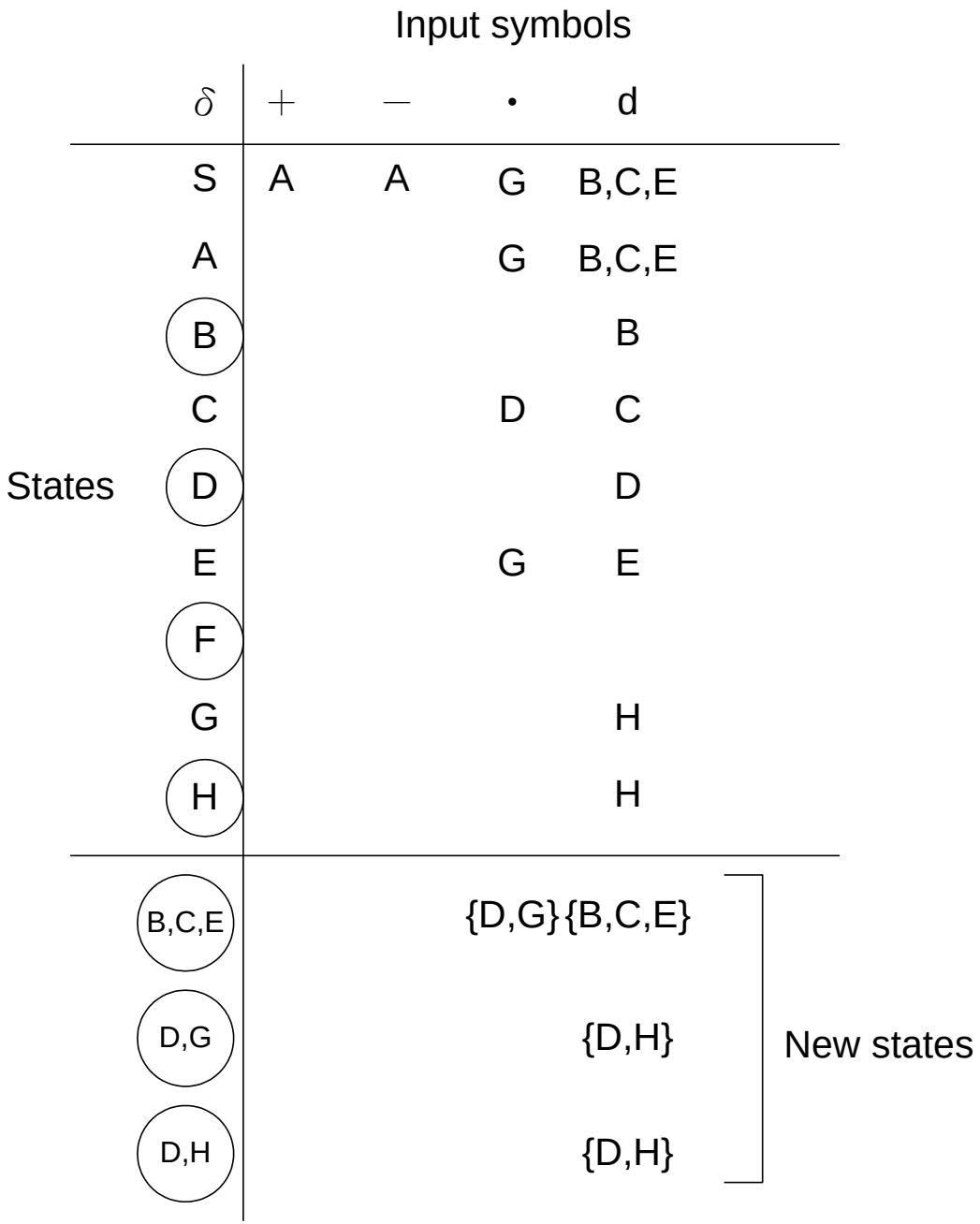


Figure 3.15. New composite state {B, C, E} created.



{B}{C}{D}{E}{F} are inaccessible.

Figure 3.16. Completion of new state creation.

Input symbols

States δ	+	−	•	d
S	A	A	G	B,C,E
A			G	B,C,E
G				H
H				H
B,C,E			D,G	B,C,E
D,G				D,H
D,H				D,H

{H}{D,G}{D,H} are merged

Figure 3.17. Inaccessible states removed.

δ	0	1	a
A	B	C	
B	E	D	C
C	E	D	B
D	F		
(E)		D	
(F)			

{B}{C} are merged

Figure 3.18. A machine to be reduced.

δ	0	1	a
A	B	B	
B	E	D	B
D	F		
(E)		D	
(F)			

{B} {C} are merged.

Figure 3.19. Machine of figure 3.18 reduced.

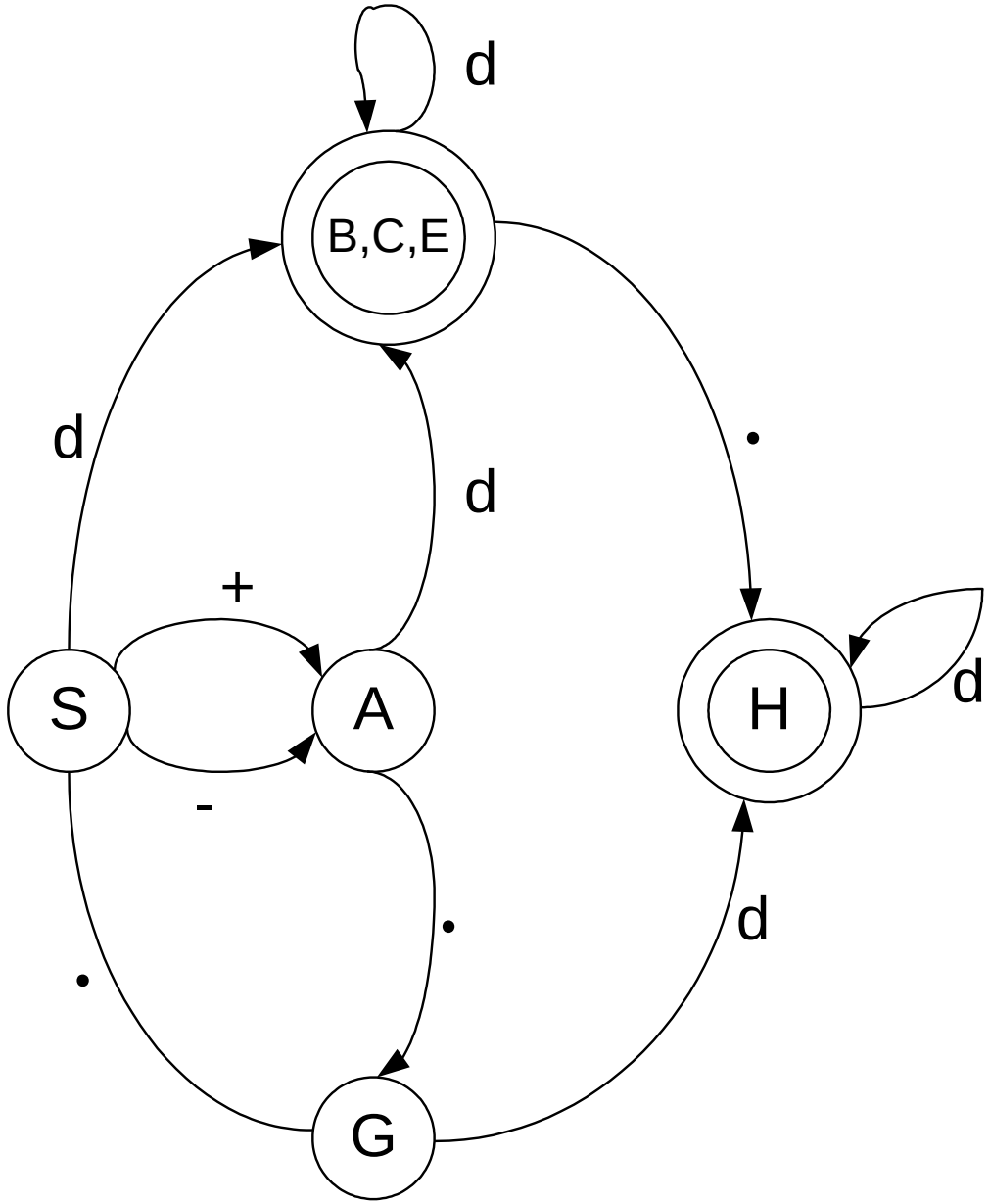


Figure 3.20. The machine of figure 3.12 made deterministic and reduced.

States	δ	Input a	b	c
	1	2	5	
	2	3	4	1
	3	5	2	
	4	3	2	1
	5	1	4	1
	6	1		1
	7	3	6	3

{1,2,3,5,6,7,}{4}

{2,5}{1,3,6,7}{4}

{1,3}{6,7}{2,5}{4}

{6,7}{1,3}{2,5}{4}

{6}{7}{1,3}{2,5}{4}

Figure 3.21. Another machine to be reduced.

(a) Unmarked

	Input a	b	c
	(1,3)	(2,5)	(2,5)
Feasible	(2,5)	(1,3)	(4,4)	(1,1)
state	(2,7)	(3,3)	(4,6)	(1,3)
pairs	(5,7)	(1,3)	(4,6)	(1,3)

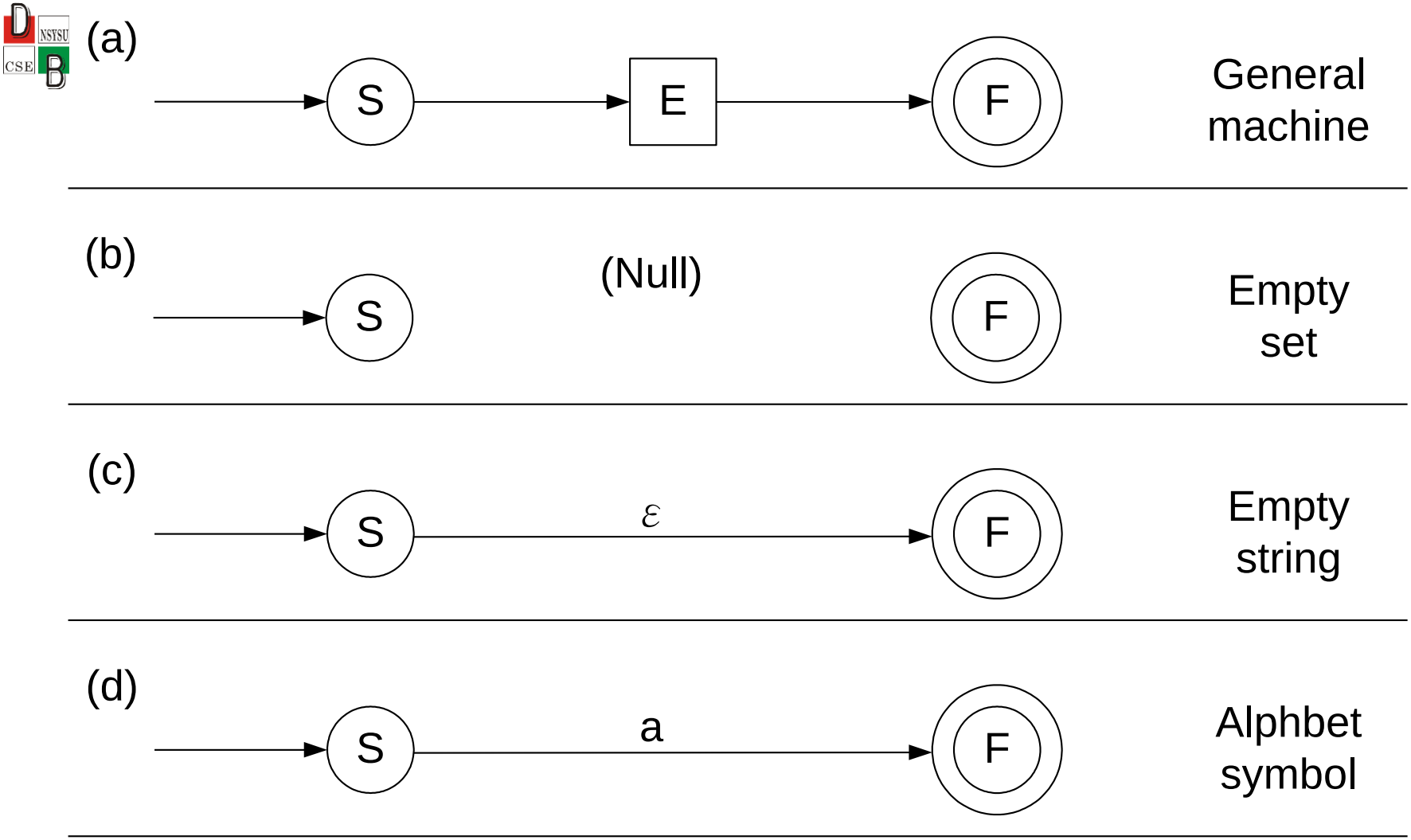
(b) Marked

	Input a	b	c
	(1,3)	(2,5)	(2,5)
Feasible	(2,5)	(1,3)	(4,4)	(1,1)
state	(2,7)	✓(3,3)	(4,6)	(1,3)
pairs	(5,7)	✓(1,3)	(4,6)	(1,3)

{2,7}. {5,7} are not mergeable.

{4}{123567}=> {13}{2567} => {257}{6}

Try {13}{25}{27}{57}


(a)
S
E
F
General machine
(b)
S
(Null)
F
Empty set
(c)
S
ε
F
Empty string
(d)
S
a
F
Alphbet symbol

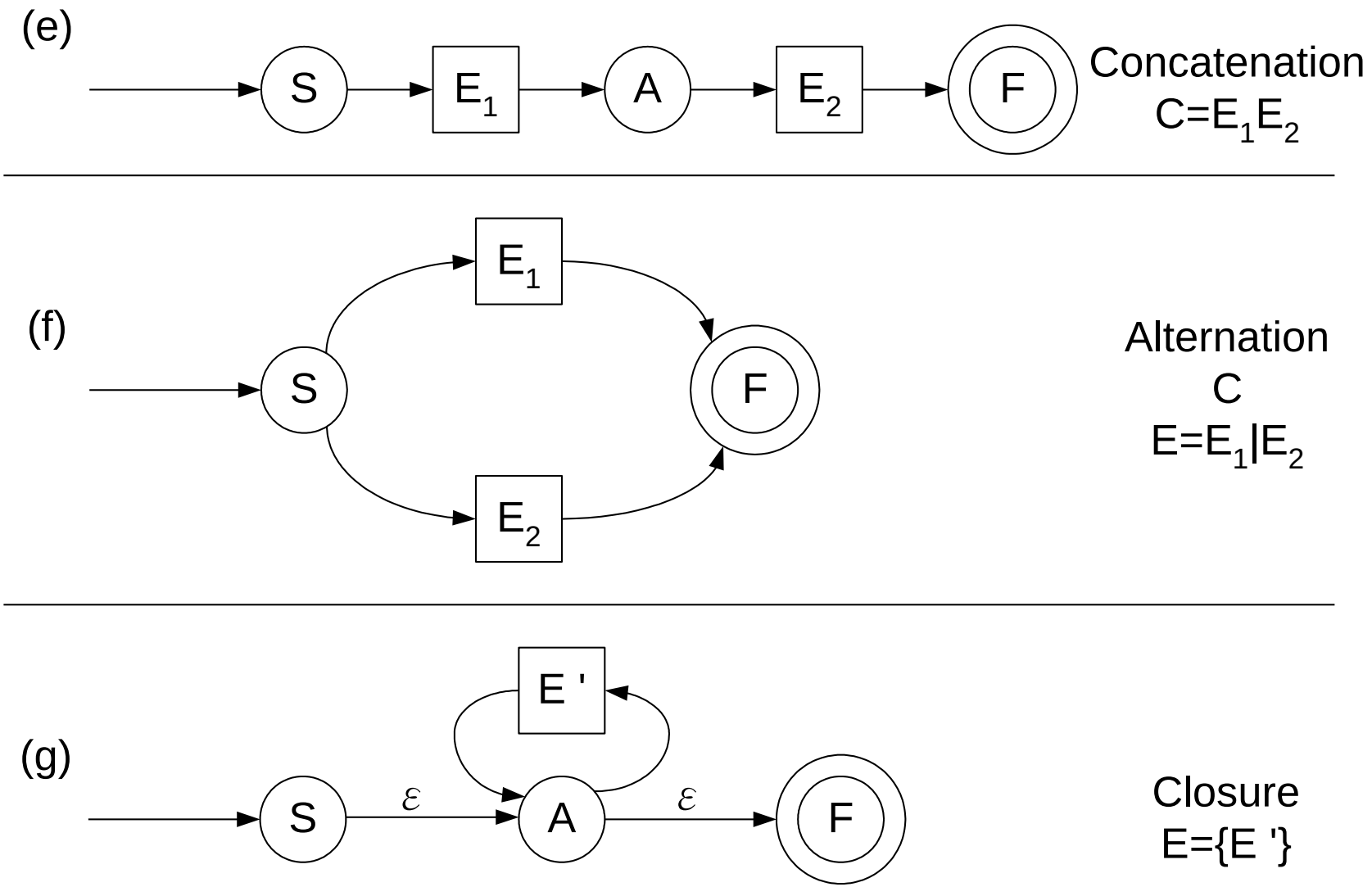


Figure 3.23. Generation of a non-deterministic finite-state automaton from components of a regular expression.

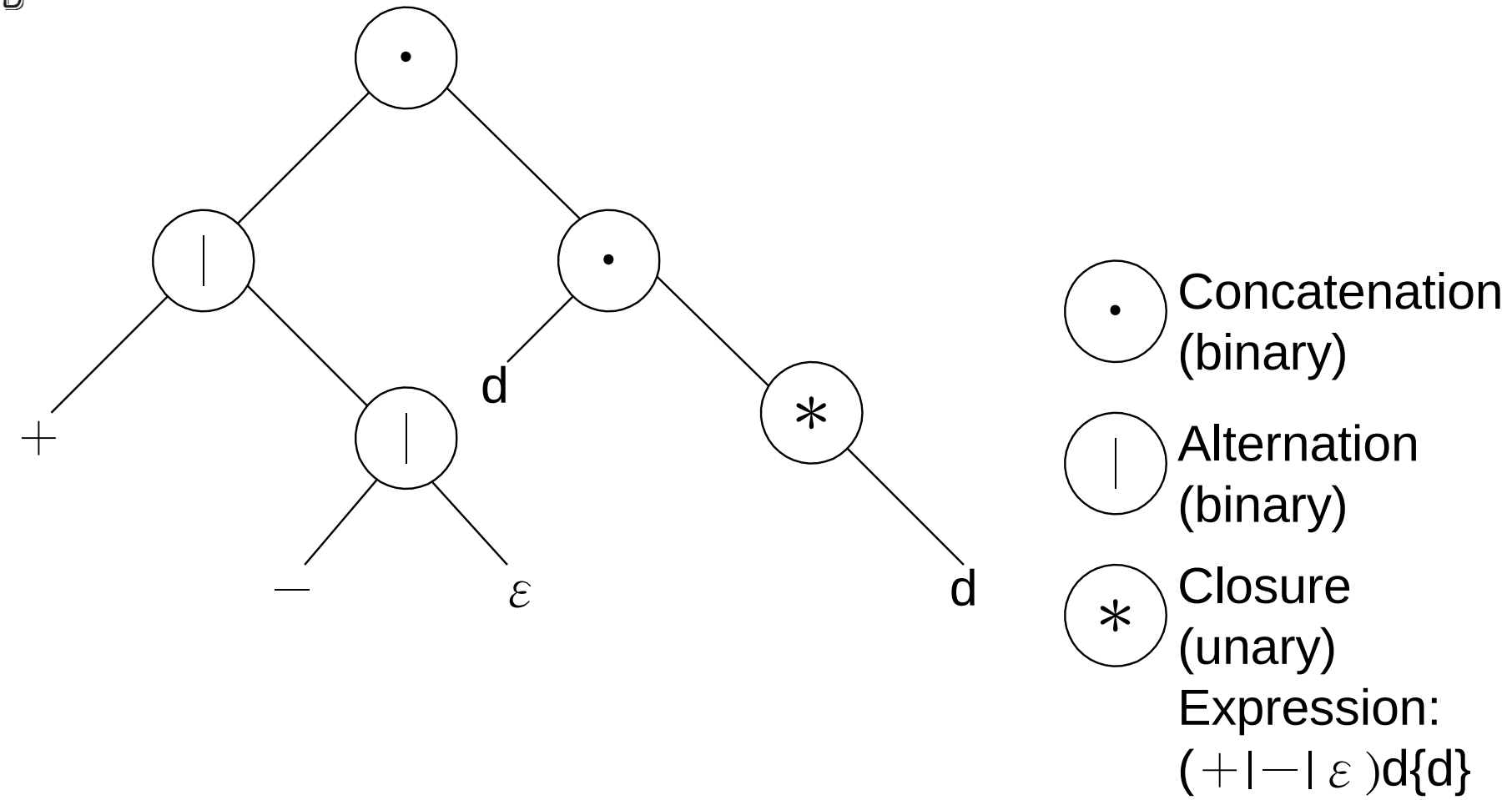


Figure 3.24. The regular expression "(+|−| ε)d{d}" as a tree.

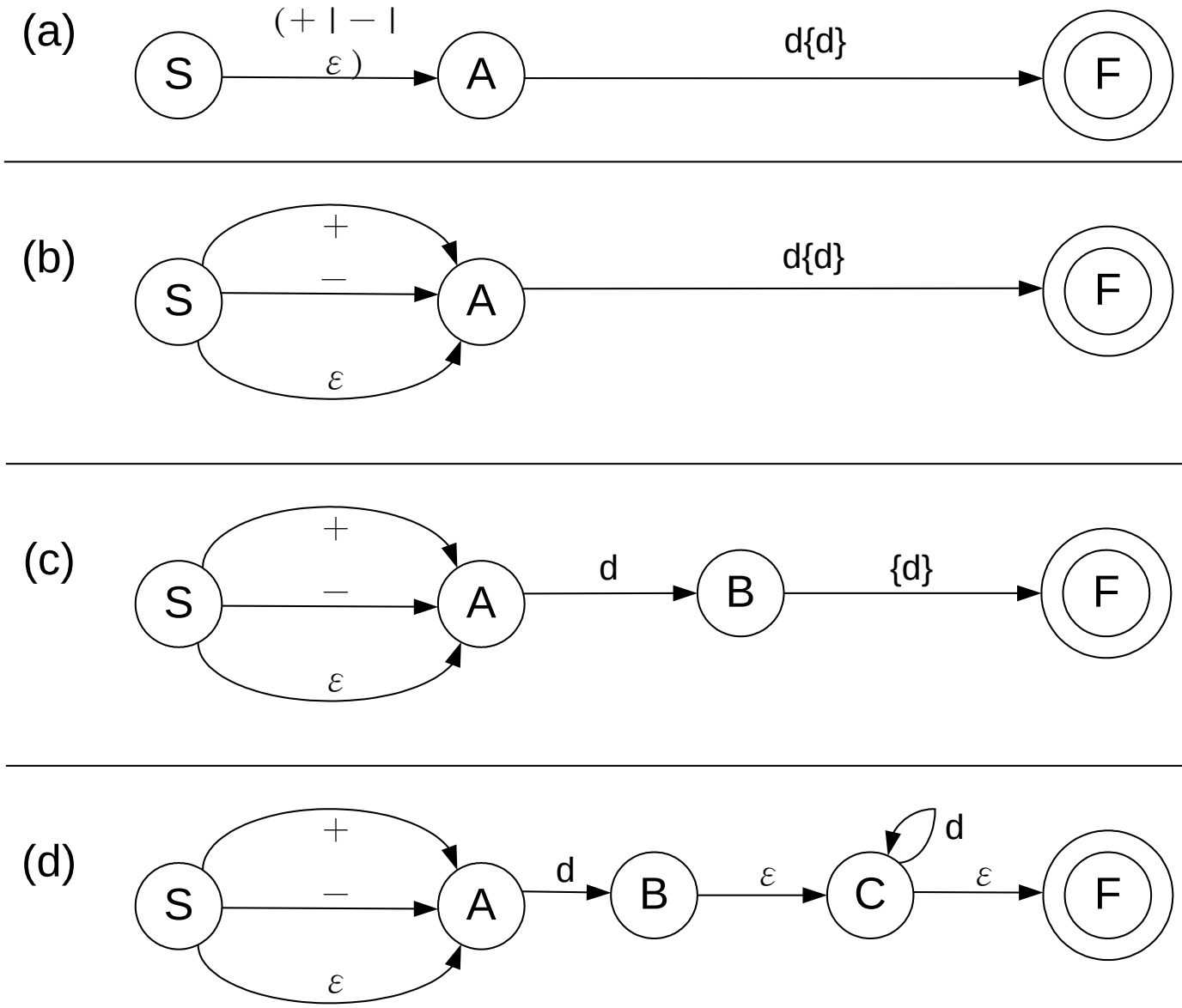


Figure 3.25. Development of a finite-state automaton from the regular expression "(+|−| ε)d{d}".

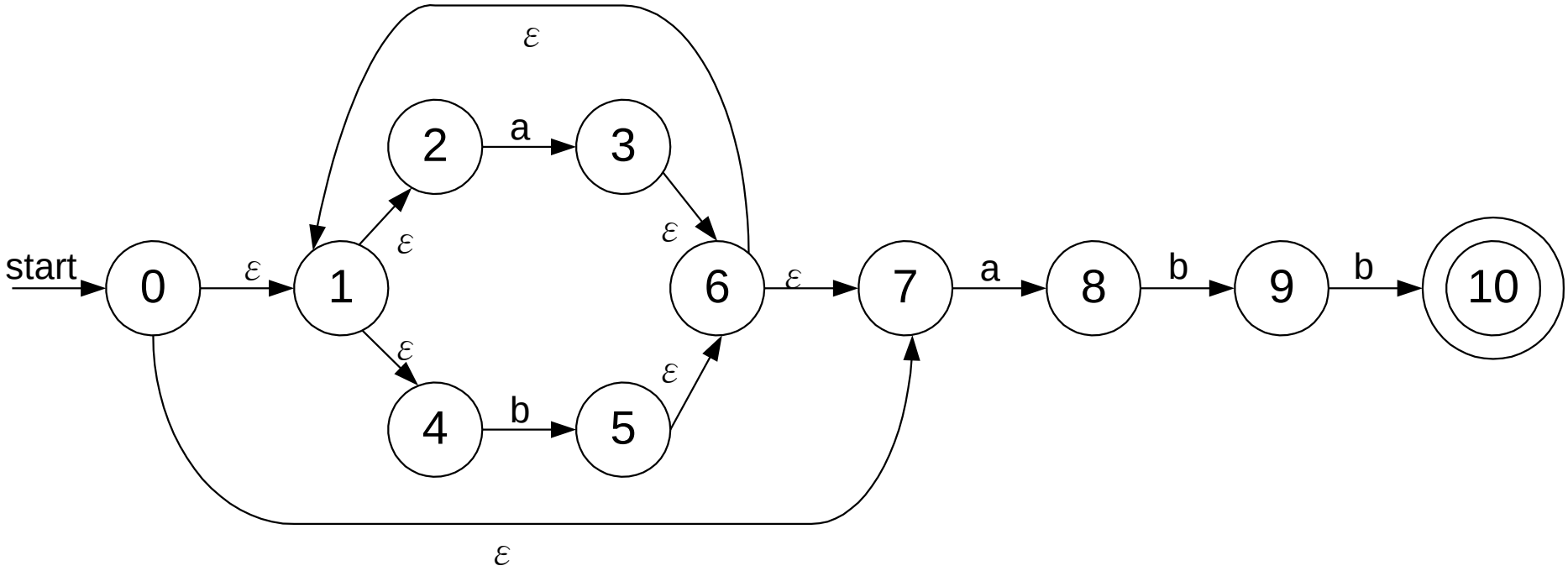


Fig.3.27. NFA for (a|b)*abb.

STATE	INPUT SYMBOL	
	a	b
A	B	C
B	B	D
C	B	C
D	B	E
(E)	B	C

(a|b)*abb

Fig. 3.28. Transition table for DFA.

(a|b)*abb

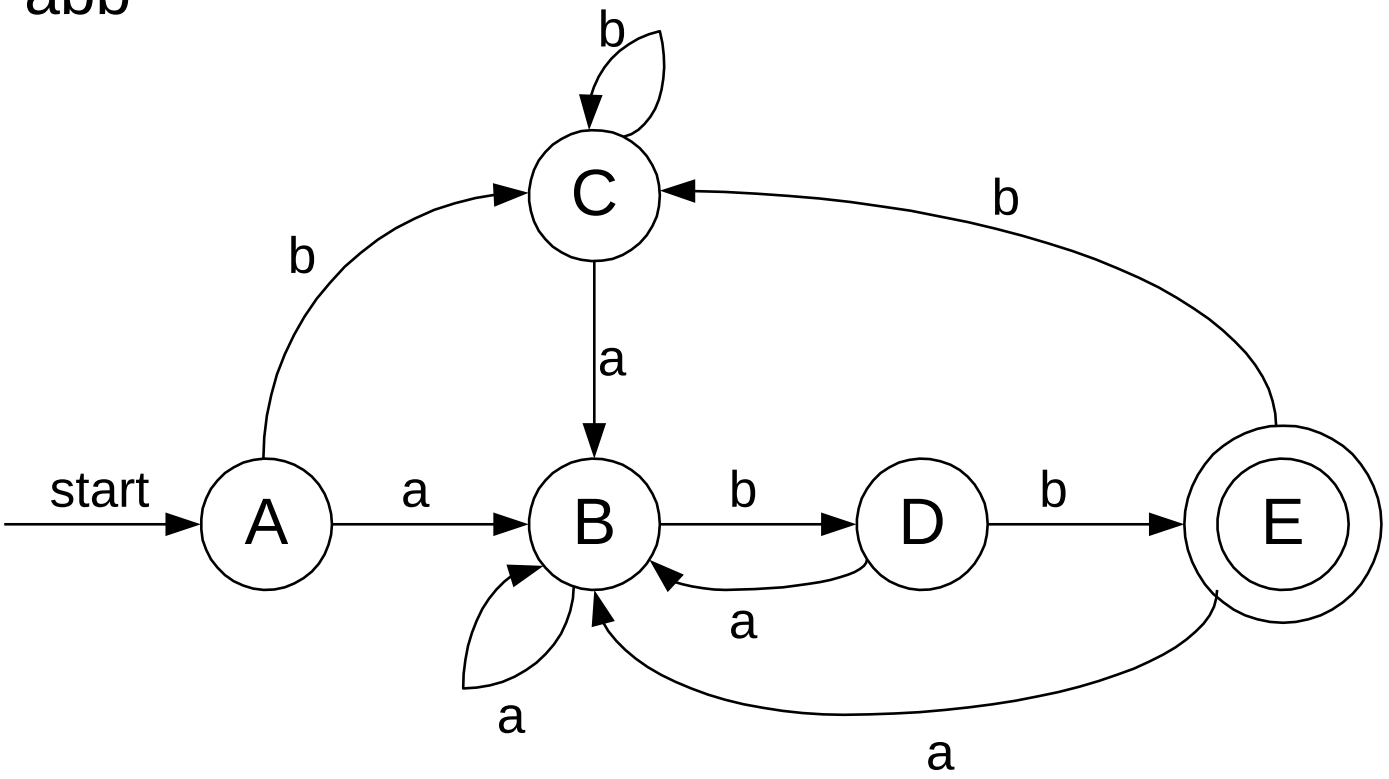


Fig.3.29. Result of applying the subset construction to Fig. 3.27.

STATE	INPUT SYMBOL	
	a	b
A	B	A
B	B	D
D	B	E
(E)	B	A

Fig. 3.46. Transition table of reduced DFA.