(a)

The minimum value of A is –32. The maximum value of A is 31. A minimum of 6 bits are needed to represent this signed number.

The minimum value of |A| is 0. The maximum value of |A| is 32. A minimum of 6 bits are needed to represent this unsigned number.

The minimum value of C – A is: (–32) – (31) = –63. The maximum value of C – A is: (31) – (–32) = 63. A minimum of 7 bits are needed to represent this signed number.

The minimum value of |C – A| is 0. The maximum value of |C – A| is 63. A minimum of 6 bits are needed to represent this unsigned number.

The minimum value of M is 0 + 0 = 0. The maximum value of M is 63 + 63 = 126. A minimum of 7 bits are needed to represent this unsigned number.

(b)

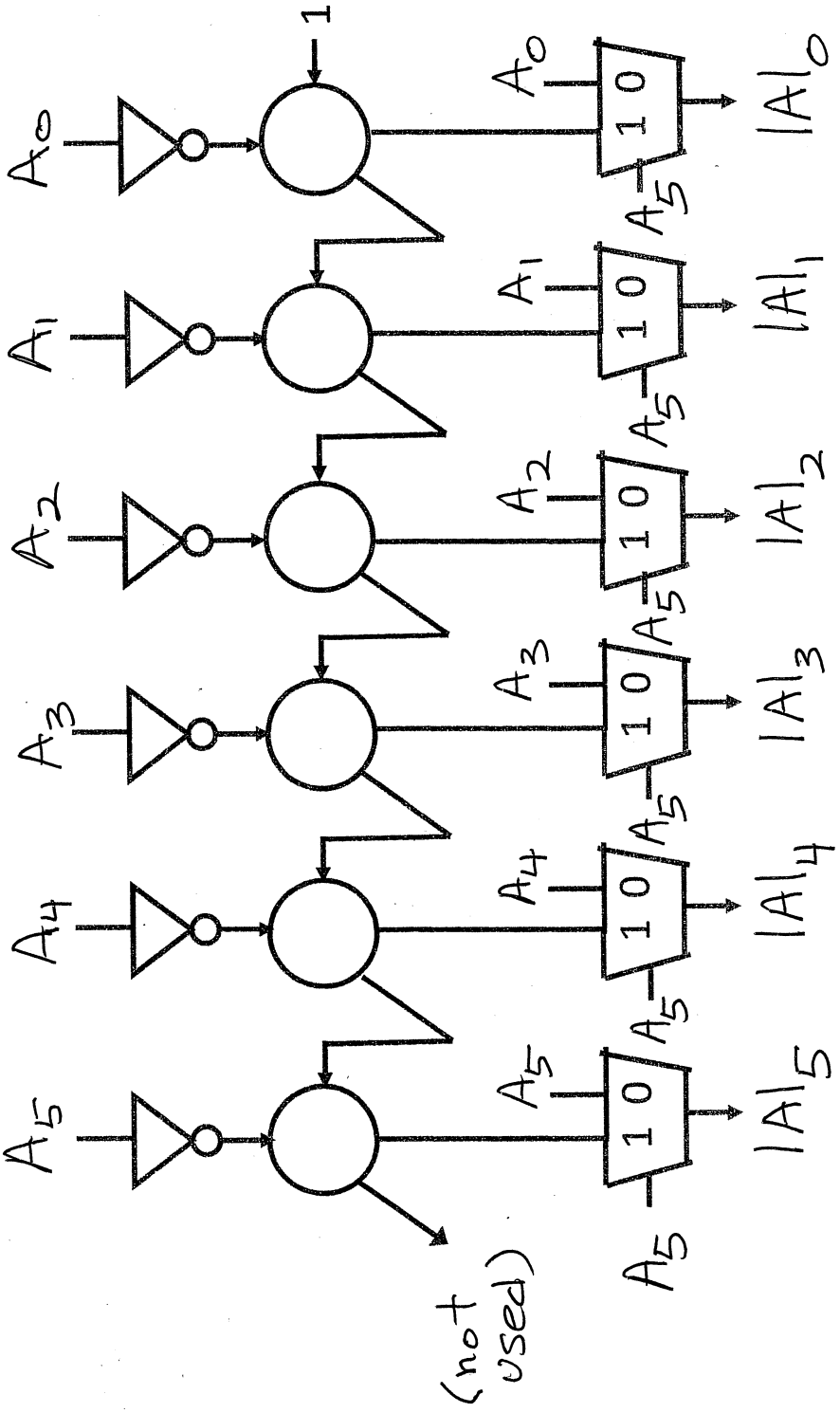
If $A \geq 0$, then |A| = A and the signed representation of A is the same as the unsigned representation of |A|.

If A < 0, then the absolute value of A is the two's complement of A, which is obtained as the one's complement plus 1.

Thus, use 2:1 MUXs with the select signal equal to A_5 to select either A or the two's complement of A. See the circuit diagram on the following page.

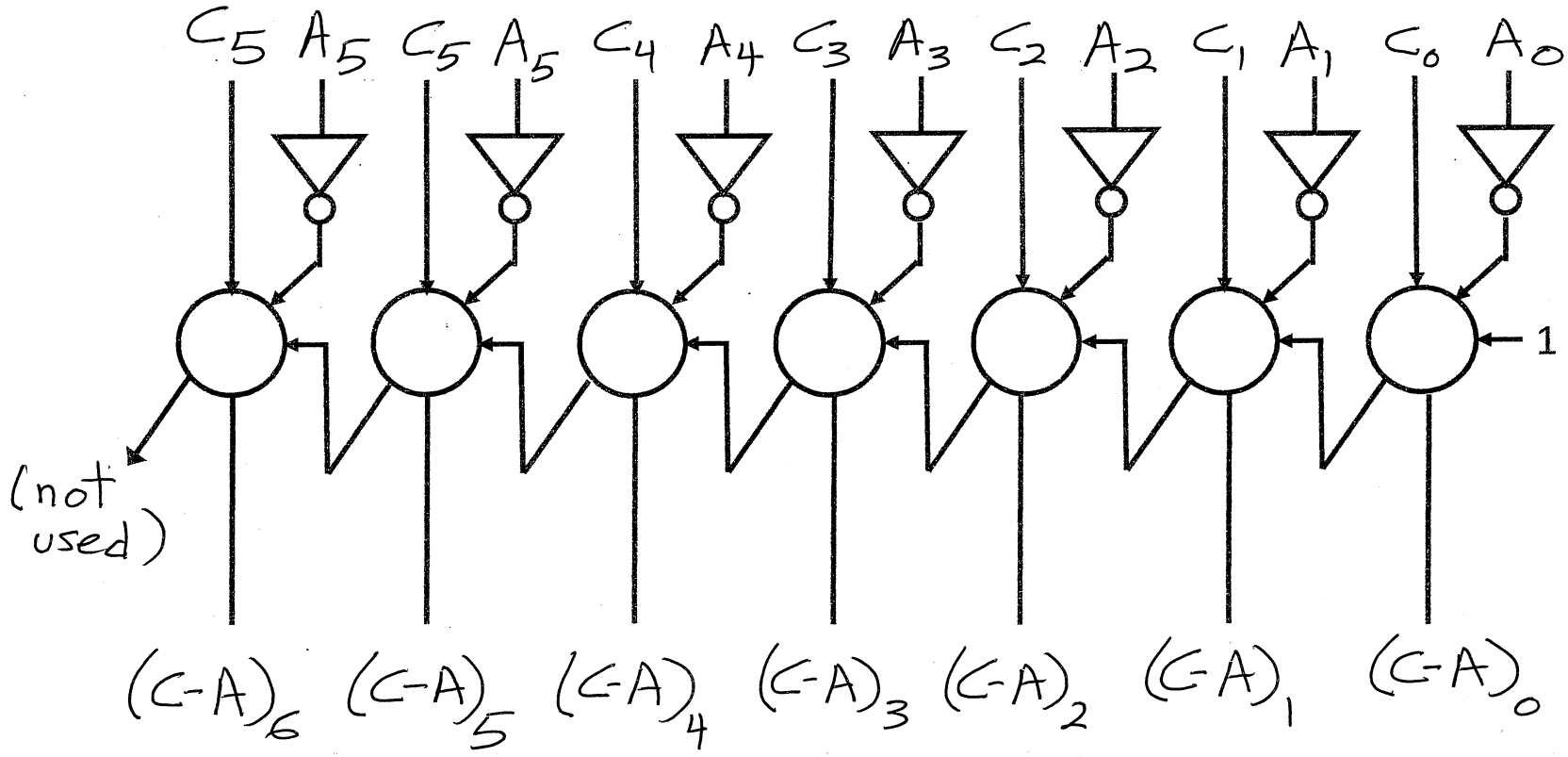
(In the diagrams on the following pages, a circle with two inputs represents a half adder for which the vertical output is the sum and the diagonal output is the carry out. A circle with three inputs represents a full adder for which the vertical output is the sum and the diagonal output is the carry out.)

(b) - cont.:



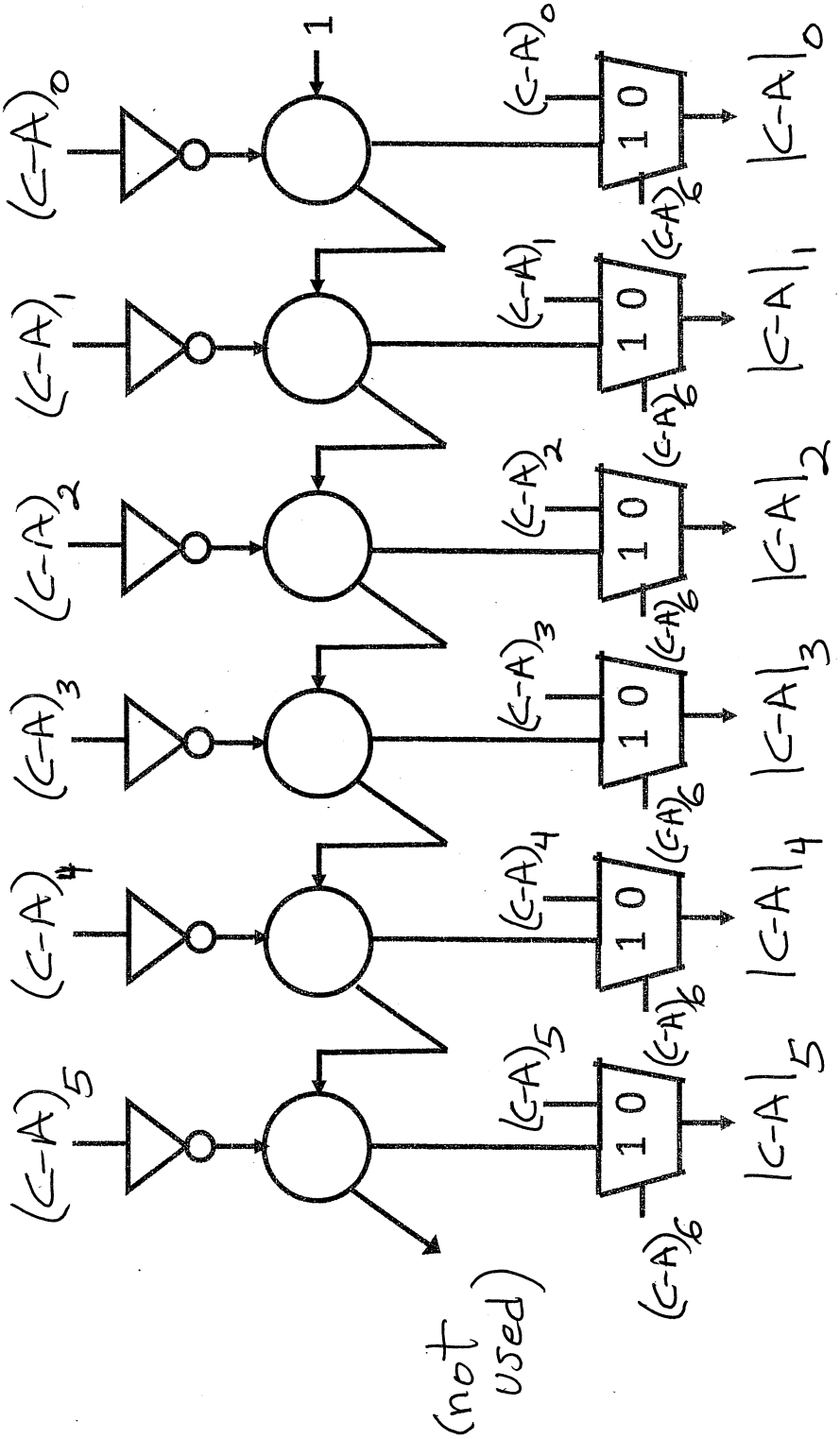
(c) $C - A = C +$ (two's complement of A)

Since $C - A$ needs 7 bits, sign-extend C and A to 7 bits before subtracting.

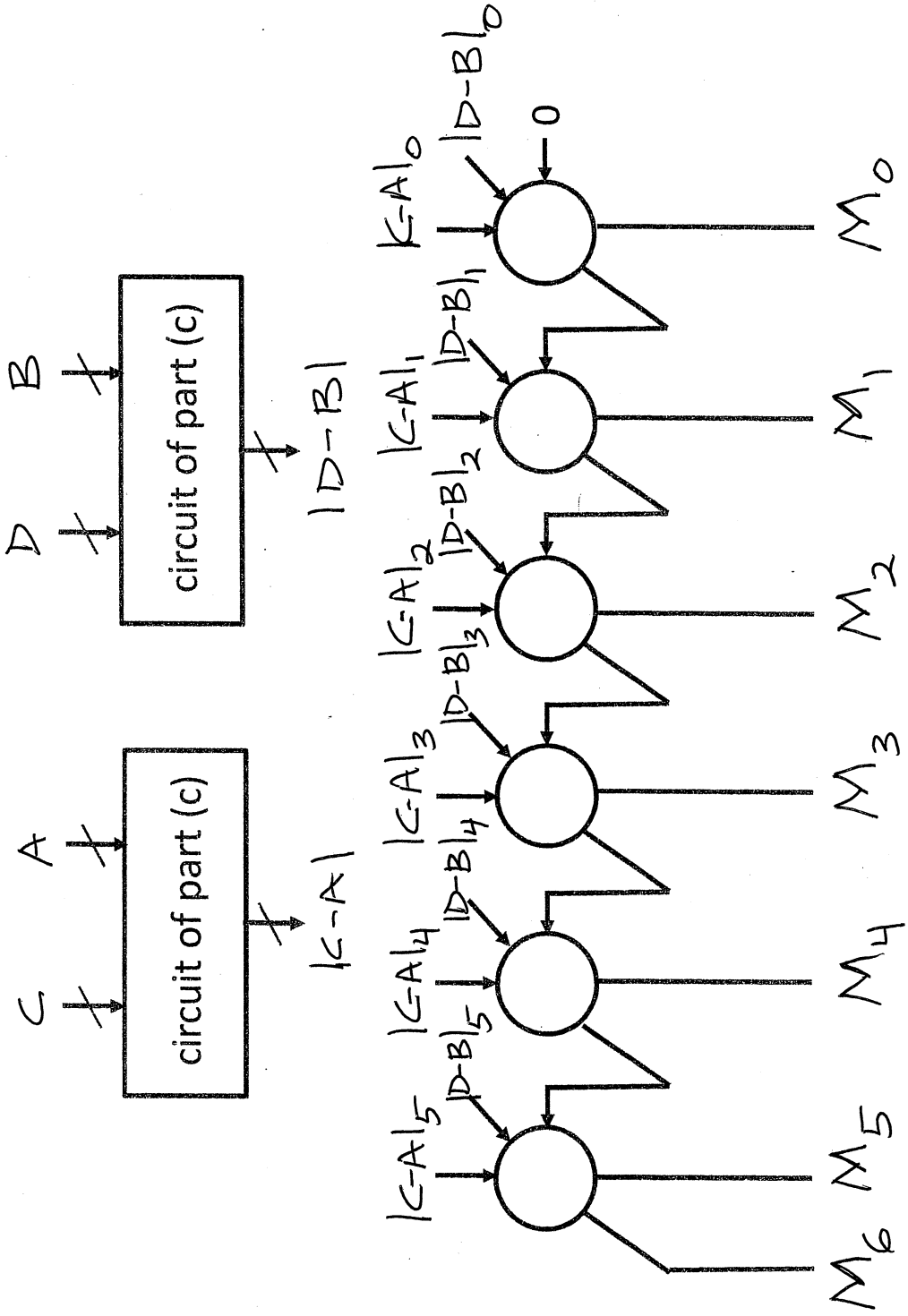


(continued on next page)

(c) - cont.

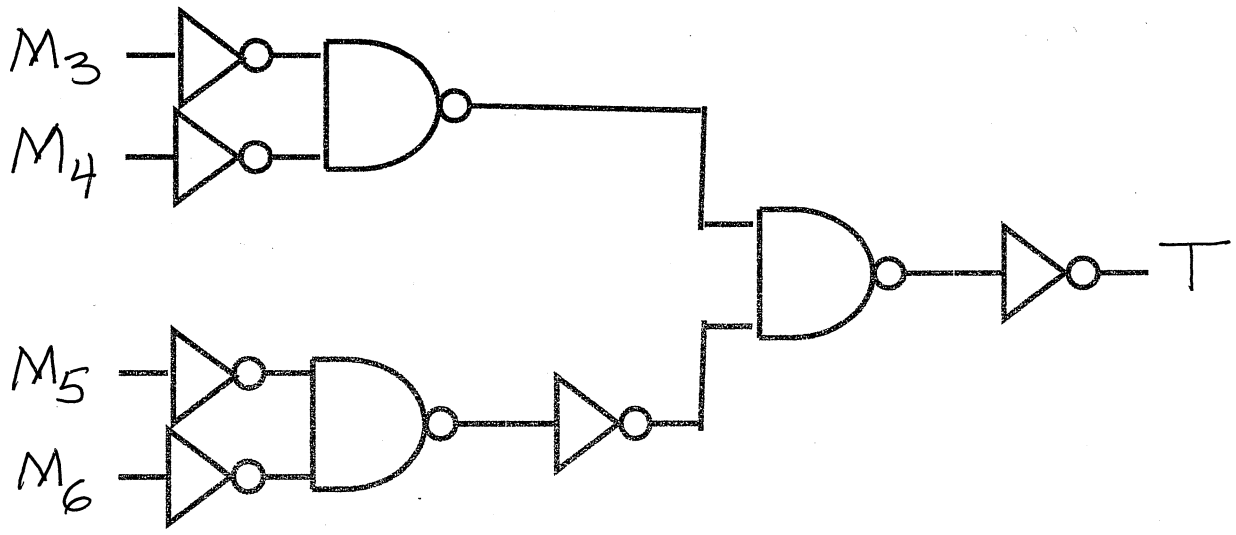


(d)


C
A
circuit of part (c)
|C-A|
D
B
circuit of part (c)
|D-B|
|C-A|0
|D-B|0
0
M0
|C-A|1
|D-B|1
M1
|C-A|2
|D-B|2
M2
|C-A|3
|D-B|3
M3
|C-A|4
|D-B|4
M4
|C-A|5
|D-B|5
M5
M6

(e) For M < 32, bits M_5 and M_6 must both be 0. For M > 7, with M_5 and M_6 both 0, need at least one of the bits M_3, M_4 to be 1.

Thus:



$$T = \begin{cases} 1 & for\ 7 < M < 32 \\ 0 & otherwise \end{cases}$$