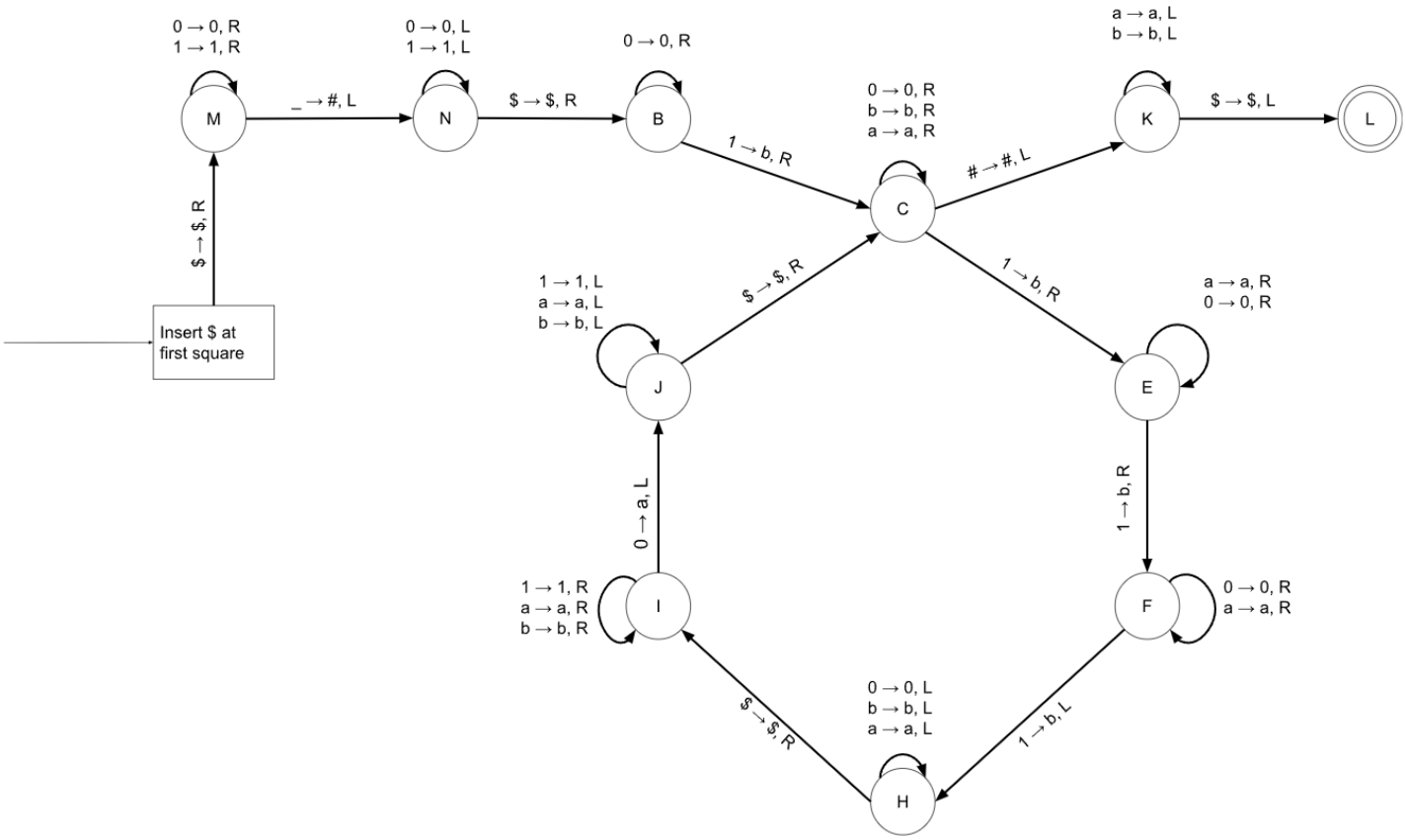
a



Explaination:

1. First we used the machine from lecture 37 to inser the $ at the left most square, after shifting all symbols to right. After using that machine our tape head was pointing at the leftmost square, So we read $ and move the tapehead one step left, And we transition to state **M**.
2. Where we keep moving the tapehead to right on seeing symbol 1 and 0 without replacing the symbol. Once we saw an empty tape symbol, **_**, we replaced it with **#** marking the end of our given string 1 step left of this symbol. While moving the tapehead one step left at the sametime we move to state **N**.
3. At state **N** we keep moving the tapehead left each time we see 0 or 1 until we see $ without replacing any symbol, on seeing $ symbol we move tapehead to right and move to state **B**.
4. From state **B** we keep moving the tapehead one step right each time we see a 0 without replacing the symbol, On seeing a 1 we replace it with b and move the tapehead to right and move to state **C**.
5. From **C** we keep moving the tapehead right each time we see 0, a or b without replacing any symbol.
    1. On seeing a 1 at state **C**:

    1. we replace it with b and move the tapehead to right also move to state **E**.
    2. From state **E** we keep moving the tapehead right each time we see 0 or a without replacing any symbol. On seeing a 1 we replace it with b and move the tapehead to right also move to state **F**.
    3. From state **F** we keep moving the tapehead right each time we see 0 or a without replacing any symbol. On seeing a 1 we replace it with b and move the tapehead to left also move to state **H**.
    4. At state **H** we keep moving the tapehead left each time we see 0, a or b until we see $ without replacing any symbol, on seeing $ symbol we move tapehead to right and move to state **I**.
    5. At state **I** we keep moving the tapehead right each time we see 1, a or b until we see 0 without replacing any symbol, on seeing 0 we replace it with symbol a and we move tapehead to left and move to state **J**.
    6. At state **J** we keep moving the tapehead left each time we see 1, a or b until we see $ without replacing any symbol, on seeing $ symbol we move tapehead to right and move to state **C**.
6. On seeing a # at state **C**:
    1. We move the tapehead 1 step left with replacing the symbol. and move to state **K**.
    2. Once at **K** we keep moving the tapehead left each time we see a or b until we see $ without replacing any symbol, on seeing $ symbol we move tapehead to left and move to final state **L**.

Simplified:

1. We first prep the tape my putting a $ at the left most square and # of the string.
2. Once, that is done, we mark the first 1 with b and move to state C. From there We go through C → E → F → H →I → J and C again. In this cycle we mark 1 0 by a for each 3 1's marked b.
3. After marking all symbols if we see a # at C we move to K and then check of we have any unmaked symbol in the string, if not we move to L and thus reaching the final state.