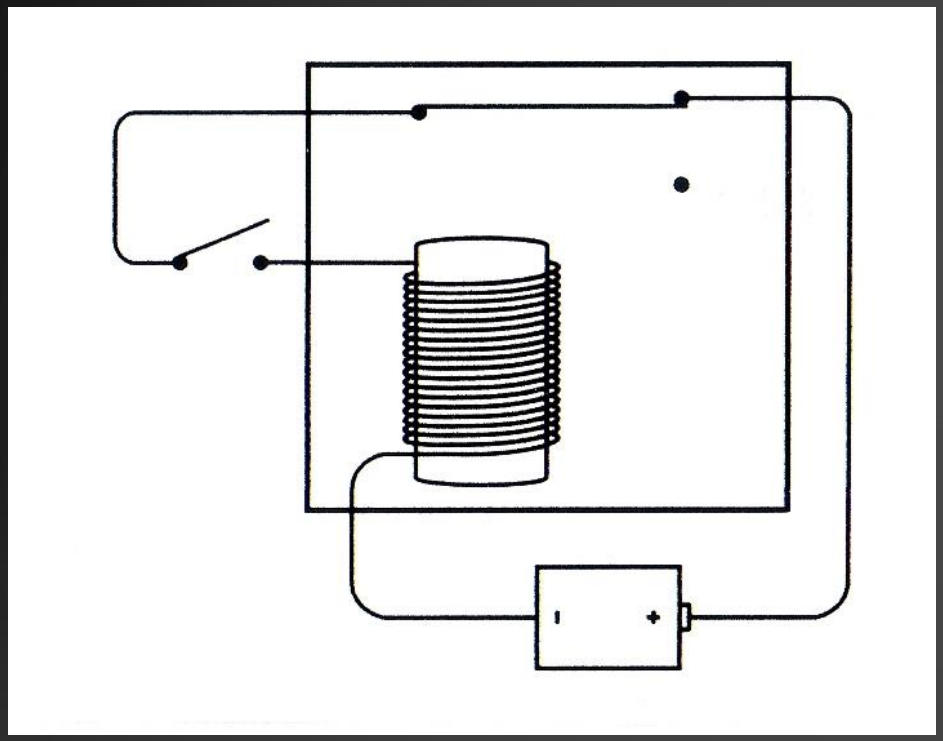
SEQUENTIAL CIRCUITS
THE RELAY CIRCUIT

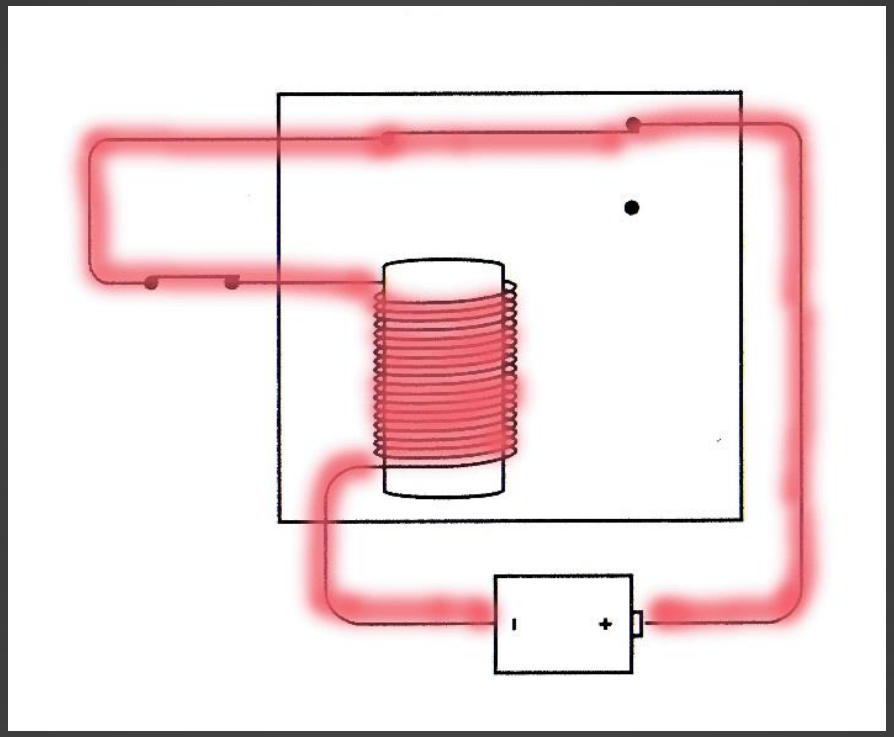


This circuit is one big *circle*.

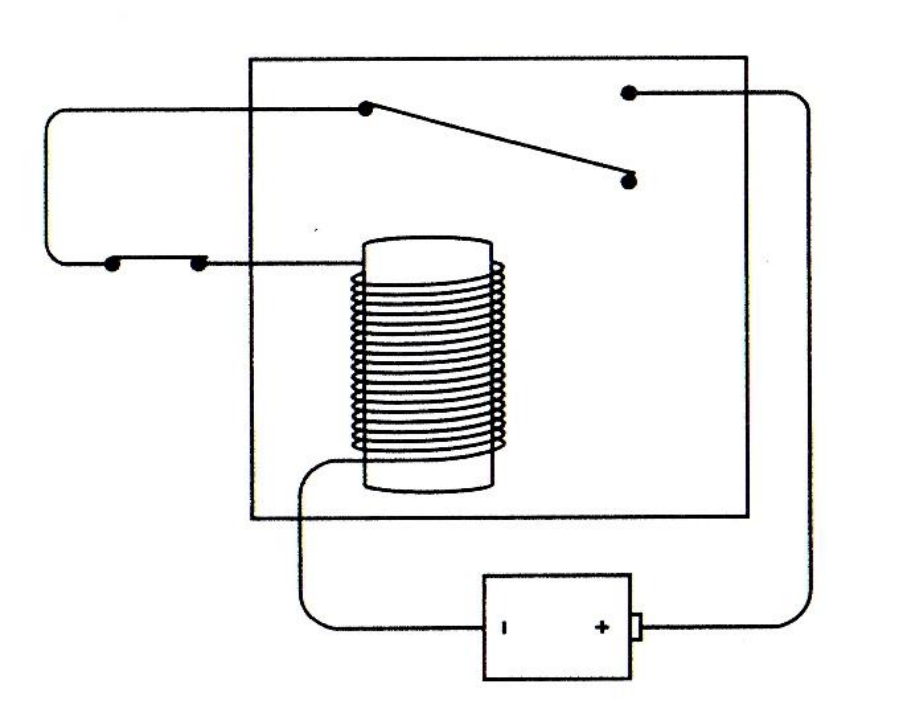
The main switch is *open* and the *flexible contact* is closed.

Note: A closed *inverter* (NOT gate) circuit performs the same function.

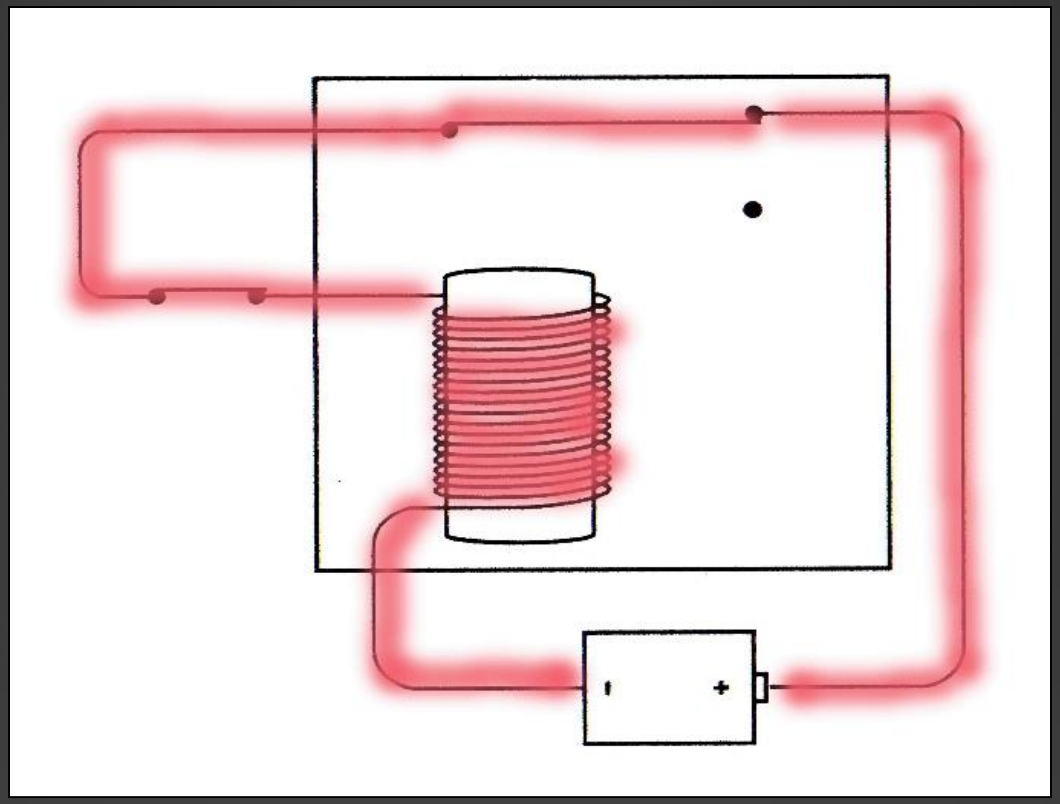
THE MAIN SWITCH IS *CLOSED* AND THE CIRCUIT IS COMPLETED.



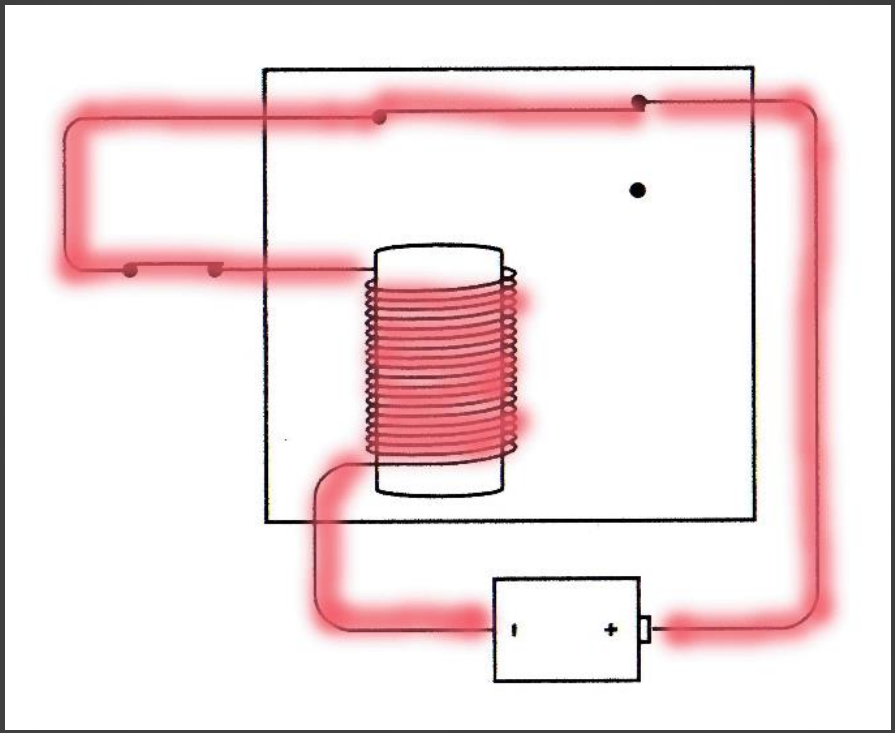
THE COMPLETED CIRCUIT ACTIVATES THE *ELECTROMAGNET* WHICH PULLS DOWN THE FLEXIBLE CONTACT.



BUT WHEN THE CONTACT CHANGES POSITION, THE CIRCUIT IS NO LONGER COMPLETE;
NOW THE ELECTROMAGNET IS *DEACTIVATED* AND THE FLEXIBLE CONTACT FLIPS BACK UP TO THE CLOSED POSITION TO COMPLETE THE CIRCUIT.

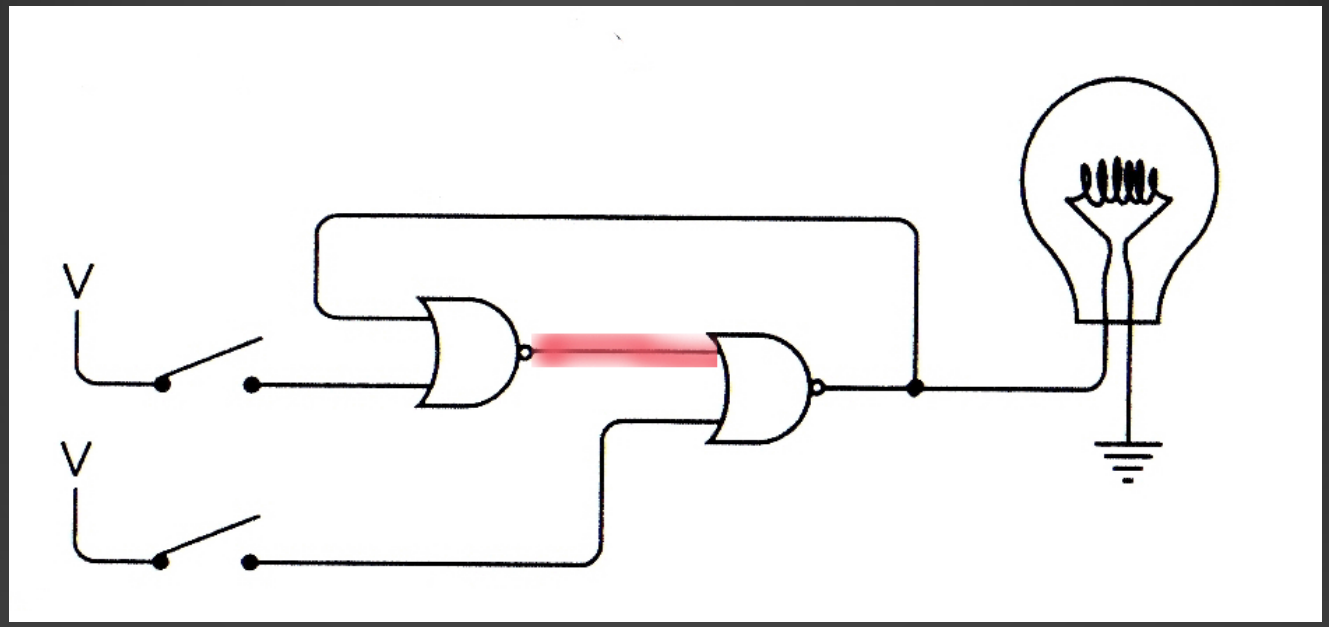


WHILE THE SWITCH IS CLOSED, THE FLEXIBLE CONTACT OPENS AND CLOSES REPEATEDLY THE COMMON BUZZER OR A BELL USES SUCH A CIRCUIT OR AN EXAMPLE OF A DIGITAL APPLICATION IS AN *OSCILLATOR* OR A *CLOCK*.

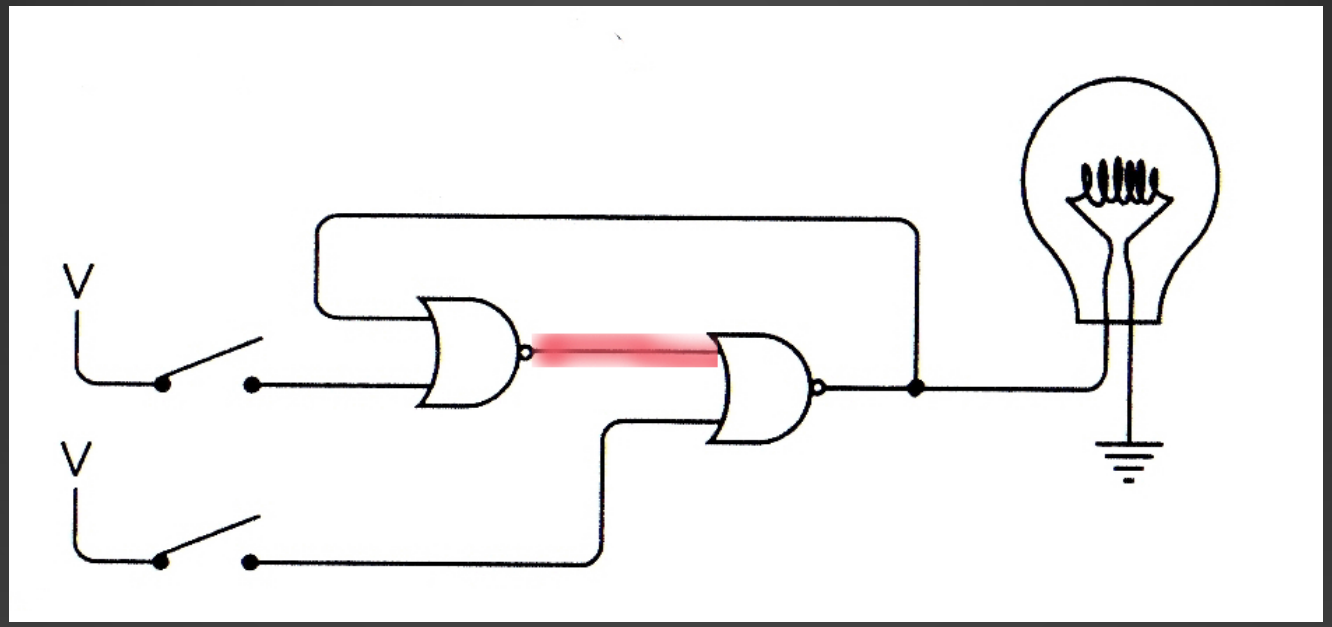


DIGITAL CIRCUITS AS MEMORY

HOW ARE BITS STORED?
CONSIDER THIS EXAMPLE OF A *FEEDBACK CIRCUIT*.

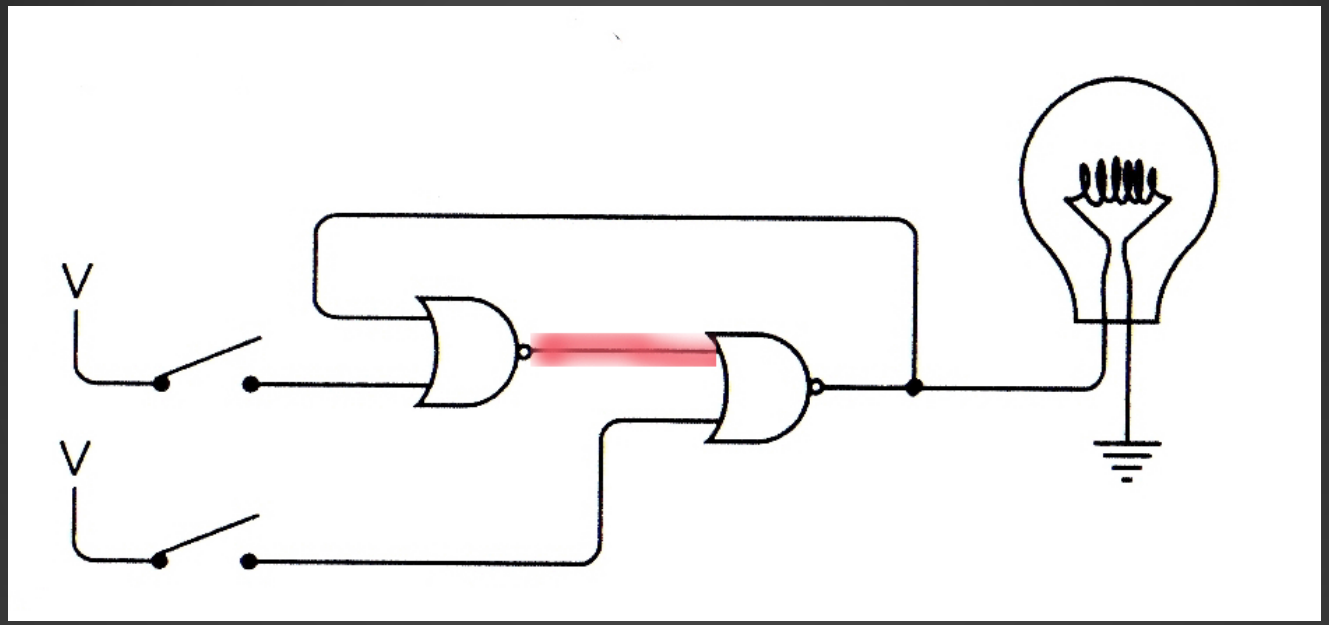


IN THIS CIRCUIT, THE OUTPUT OF THE LEFT NOR GATE IS THE INPUT TO THE RIGHT NOR GATE AND THE OUTPUT OF THE RIGHT NOR GATE IS IN TURN INPUT TO THE LEFT NOR GATE.

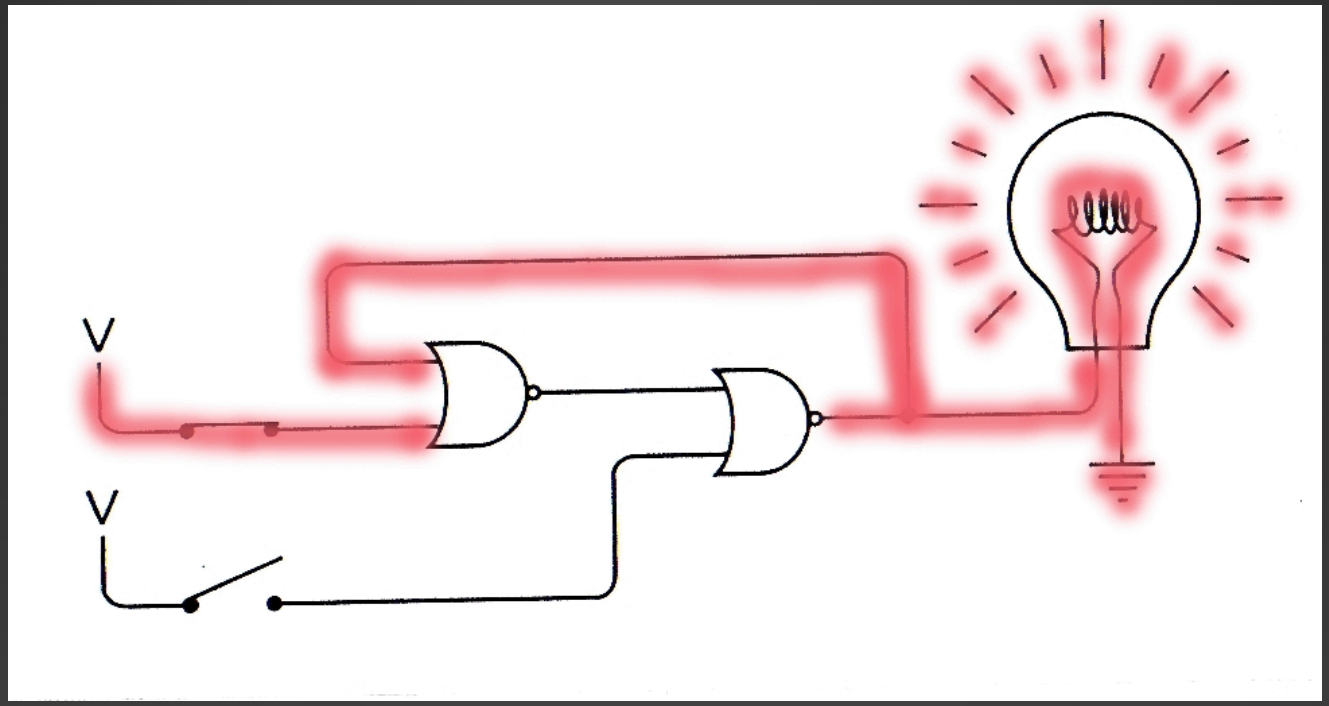


AT THE OUTSET, BOTH SWITCHES ARE OPEN, I.E., BOTH INPUTS ARE 0.

SO, THE ONLY CURRENT FLOWING IN THIS CIRCUIT IS FROM THE LEFT NOR GATE OUTPUT TO THE RIGHT NOR GATE.

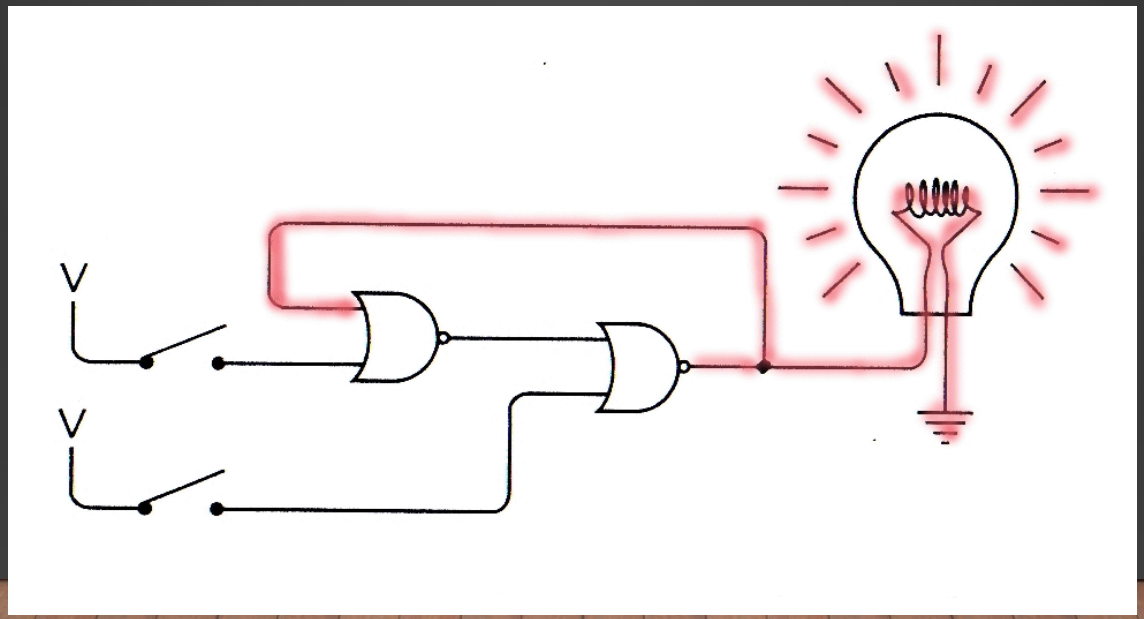


THE UPPER SWITCH IS NOW CLOSED.
THE OUTPUT FROM THE LEFT NOR GATE BECOMES 0, WHICH CAUSES THE OUTPUT FROM THE RIGHT NOR GATE TO BECOME 1 AND THE LIGHT BULB IS TURNED ON.



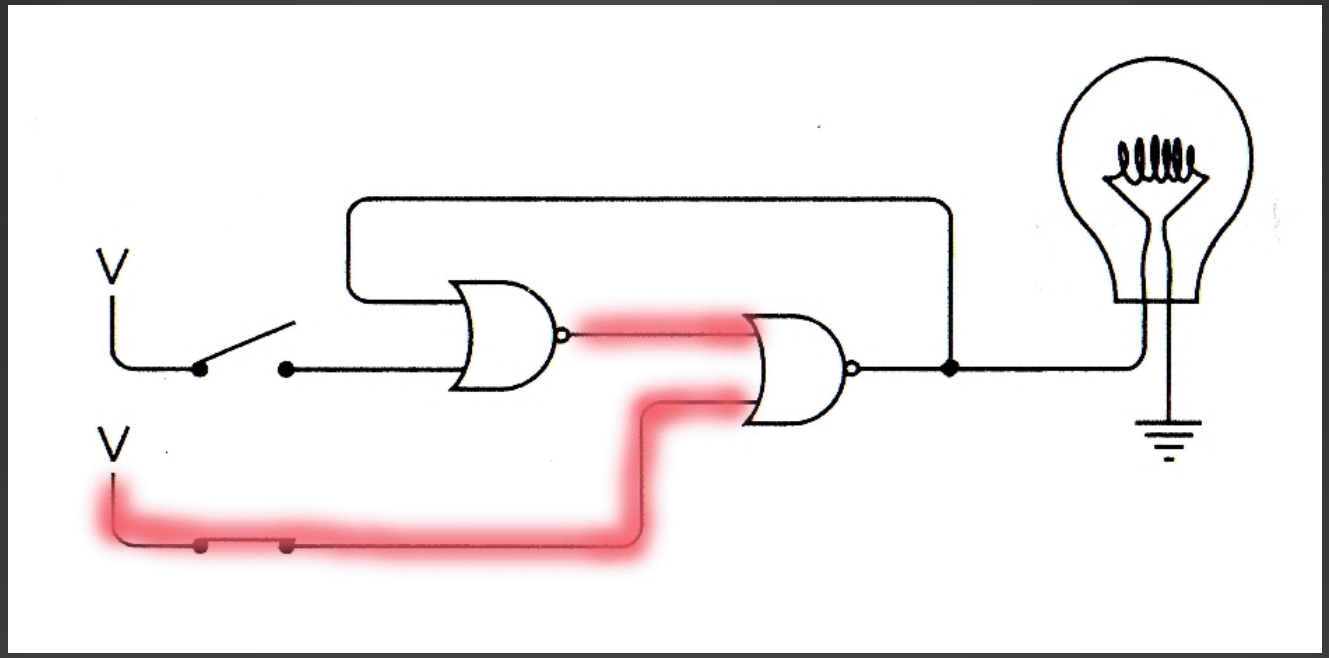
NOW IF WE OPEN THE UPPER SWITCH (BACK TO ITS PREVIOUS POSITION,) AS IF BY MAGIC THE LIGHT REMAINS ON.
THIS IS BECAUSE THE OUTPUT OF A NOR GATE IS 0 IF EITHER INPUT IS 1 AND THE OUTPUT OF THE LEFT NOR GATE REMAINS THE SAME (0).

AT THIS POINT, THE UPPER SWITCH LOSES ITS EFFECT ON THE CIRCUIT BECAUSE THE OUTPUT OF THE LEFT NOR GATE REMAINS 0
THE TOP SWITCH MAY BE OPENED OR CLOSED WITHOUT AFFECTING THE OUTPUT TO THE LIGHT BULB.



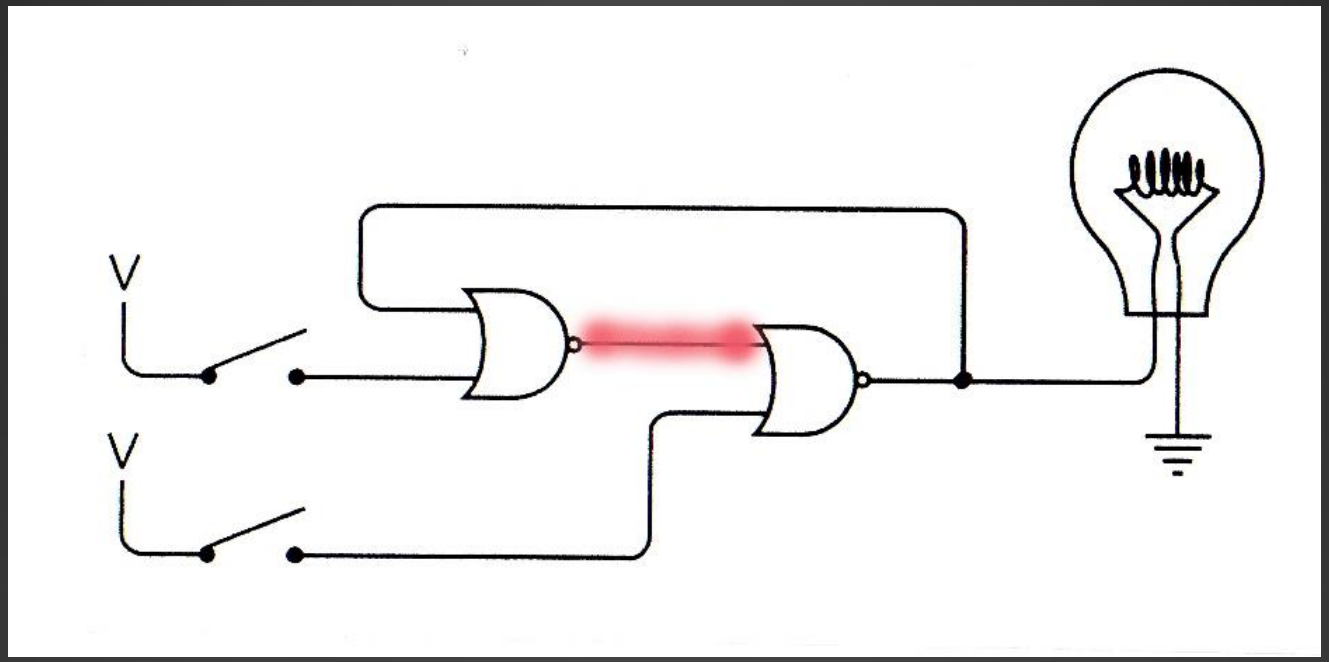
WHEN THE LOWER SWITCH IS CLOSED, ONE OF THE INPUTS TO THE RIGHT NOR GATE BECOMES 1 AND ITS OUTPUT BECOMES 0, WHICH TURNS OFF THE LIGHT BULB.

THE OUTPUT OF THE LEFT NOR GATE BECOMES 1.



NOW, WE CAN OPEN THE LOWER SWITCH AND THE LIGHT BULB REMAINS TURNED OFF.

THIS IS WHERE WE STARTED.



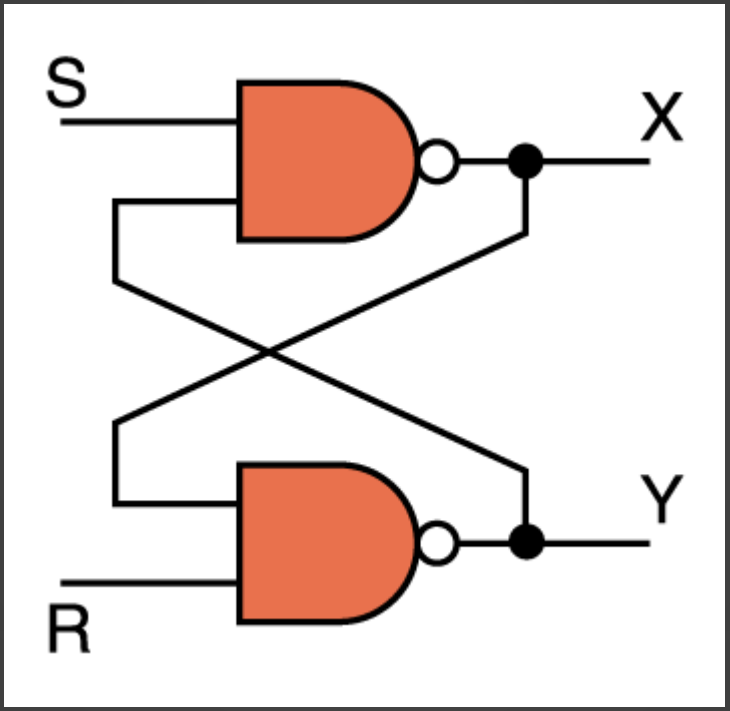
SUMMARY

- **Closing the top switch causes the light bulb to turn on, and stays on when the top switch is opened.**
- **Closing the bottom switch causes the light bulb to go off, and it stays off when the bottom switch is opened.**
- **It is possible for both switches to be open and the light bulb can be either *on* or *off*.**
- **This type circuit is said to have two *stable states* other wise known as a *flip-flop* or S-R (set-reset) circuit.**

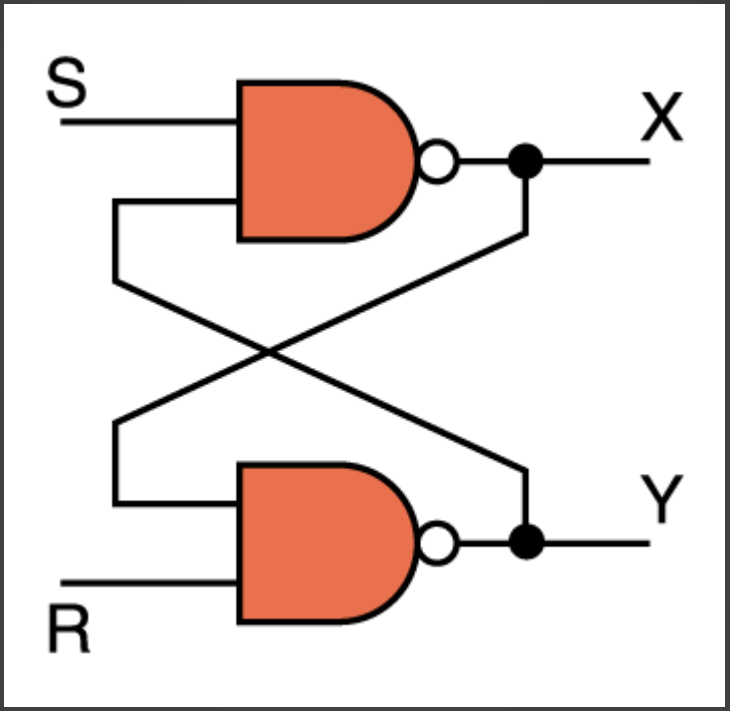
SUMMARY (CONT'D)

- **This type of circuit "remembers" which switch was most recently closed, e.g. if the light is on, surmise that the upper switch was most recently closed; if the light is off, the lower switch was most recently closed – in this way, the circuit *retains information.***
- ***Flip-Flops*** or ***S-R latches*** **add memory to a circuit by "remembering" what happened earlier which can further be applied to a circuit that can *count* or any circuit that relies on historical information of itself.**

S-R LATCH CIRCUIT DIAGRAM

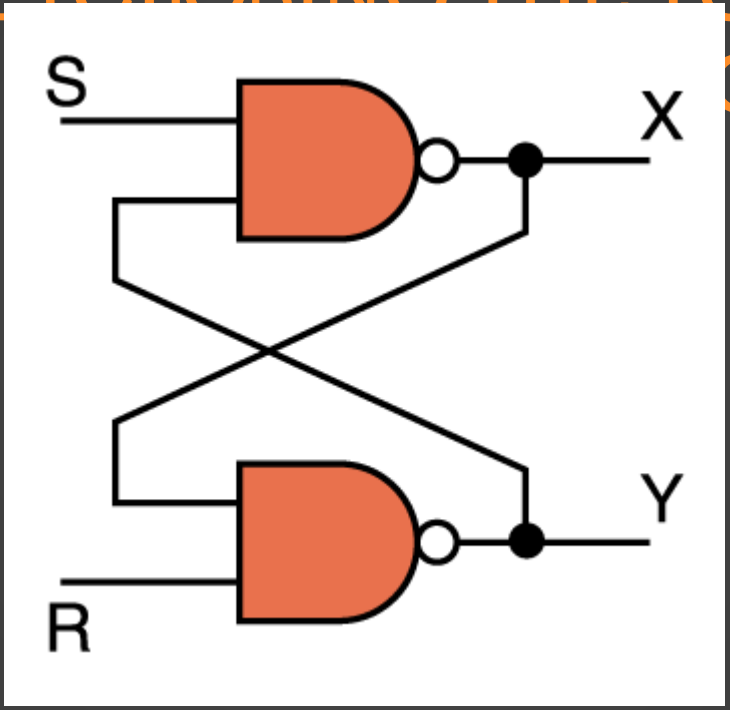


OUR *LIGHT BULB* IN THIS CONTEXT IS X; Y IS THE OPPOSITE OF X IF X IS 0, THEN Y IS 1 AND VICE VERSA.

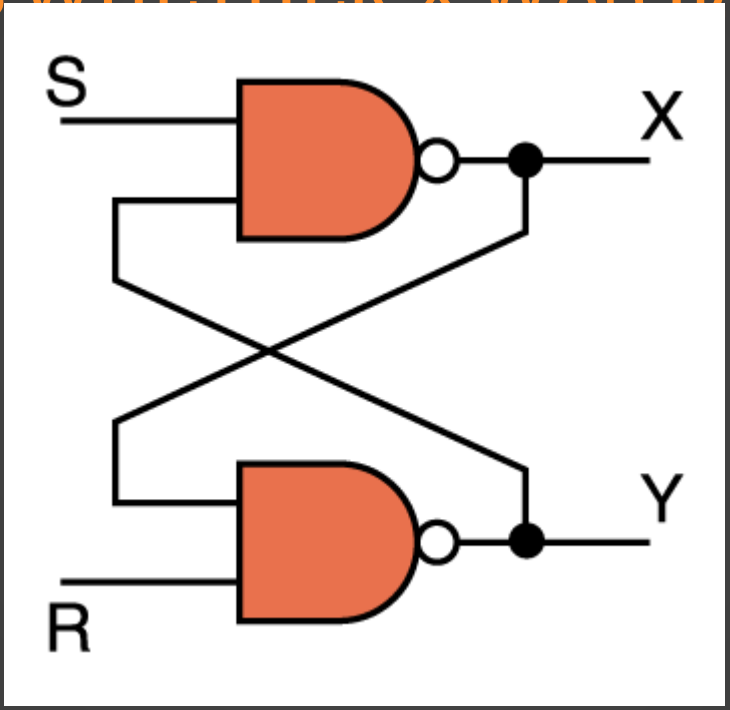


INPUT S IS FOR *SET* AS IN "SET X TO 1" AND INPUT R IS FOR *RESET* AS IN "RESET X TO 0".

WHEN S IS 1 (CLOSING THE TOP SWITCH) X BECO OMES 0.



WHEN R IS 1 (CLOSING THE BOTTOM SWITCH) X BECOMES 0 AND Y BECOMES 1. WHEN BOTH INPUTS ARE 0, THE OUTPUT INDICATES WHETHER X WAS LAST *SET* OR



S-R / FLIP-FLOP LOGIC TABLE

Inputs		Outputs	
S	R	X	Y
1	0	1	0
0	1	0	1
0	0	X	Y
1	1	Disallowed	Disallowed