Automated Flashlight Assembly Project

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Loading the Machine

1. Be sure to check that power to the machine is off.

2. Check machine for visible signs of loose hardware or damaged components. If any components are loose or damaged do not load the machine without repairing them first.

3. Load batteries into battery chute with positive (+) terminal facing downwards. Do not allow batteries to hang outside end of chute once loaded.

4. Load flashlight body with closed surface facing upwards in flashlight body chute. Do not allow flashlight bodies to hang outside of chute once loaded.

5. Load flashlight head units with threaded area facing upwards into flashlight head chute.

6. Load flashlight lenses with flat surface facing downwards in flashlight lens chute.

7. Load O-rings in O-ring tray.

8. Load heat sinks with battery contact facing upwards in heat sink chute.

9. Load threaded ring flat into ring tray. Do not stack or overlap threaded rings.

10. Check each station to be sure components have not shifted during the loading process. If components are properly aligned the machine can be turned on and assembly started.

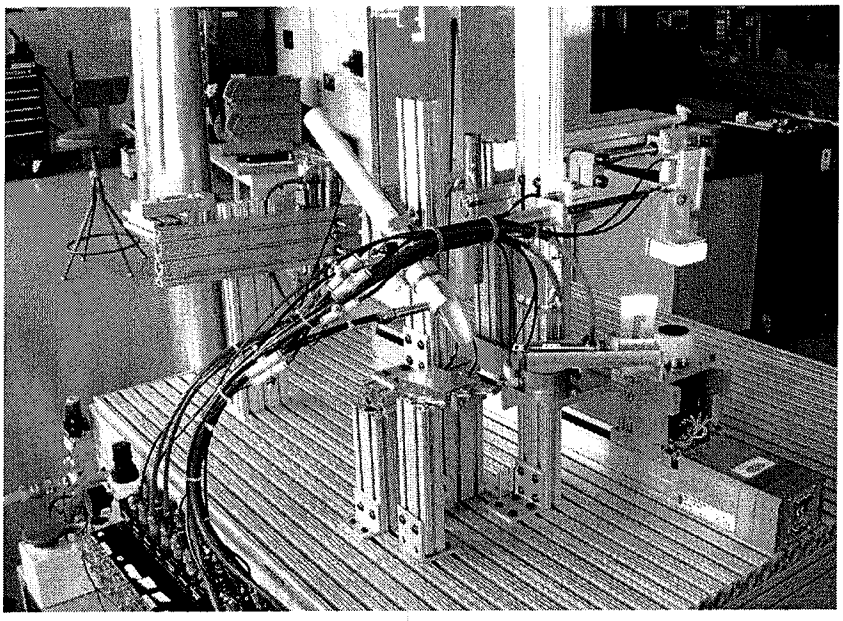

Figure 1 (View of Assembly System *(facing west)*)

How to Start and Run the Machine

Step 1: Turn on the power by plugging the machine in. In the case of our machine this consists of connecting two orange extension cords.

Step 2: Turn on the air pressure by twisting the large red knob at the controls of the machine clockwise (as indicated by the arrow) and lift upward. When you do this you will see and hear all the pneumatic components of the machine assume their default "off" position.

Step 3: Check to make sure all the components are indeed in their default positions. Facing the machine from the east side of the table (the side which all the components are nearest to, around the corner from the controls), the two-axis slider near the motor should be in the lower right position. In other words, the small plunger is down, and the large left/right slider is fully extended. The rotating arm that holds the housing and battery should be all the way to the left just above a small magnet on a fully extended plunger. The cylinder with the clamp mechanism inside the rotating arm should be fully retracted.

Step 4: Put a flashlight nose front-down into the motor-mounted rubber-lined nose grip. If you are actually assembling a full flashlight you should have all the other necessary parts (O-ring, lens, and heat sink/LED assembly) into it in the proper order.

Step 5: Make sure the PLC is on and running- if not, find a way to turn it on.

Step 6: You will use the following PLC switches to operate the machine, and they give the PLC the following commands:

Switch Label	Command
X100	"READY"
X101	"PART PLACED"
X102	"OK"

Initially, turn all these switches off if they are not already. When the tube of batteries is loaded, and everything looks good to you, switch on the "ok" switch (x102).

Step 7: Flip on the "ready" switch (x100). Now the machine should begin to run, and each motion is delayed by a timer. If something goes wrong at any point, turn off the "ok" switch and the program will stop running.

Step 8: Once the battery is dropped onto the rotating arm, it should stand upright. If not, stop the program. Once it is standing upright the user must quickly drop a body housing over the battery (you should have about 5 seconds to do this).

Step 9: Once the battery and housing are lowered onto the nose cone, again it is up to the user to do the threading since the program does not go this far.

Step 10: Once the two halves of the flashlight body are threaded together, flip the "part placed" switch on the PLC. The machine should then raise up and return to its original position.

Step 11: Remove the flashlight, then flip off the "part placed" switch.

Step 12: The machine is not yet to the "idle" stage. Flip off the "ready" switch and then flip it back on. When you flip it back on the program should begin anew and repeat steps 7-12 as many times as desired.

Step 13: When you are done, turn off the air by pressing down on the large red knob. Now unplug the machine. You are done!

Clearing Jams

The only cause for jams would involve misalignment of components or the malfunction of an air cylinder timing mechanism. If a battery is jammed in the battery feeder, it can be cleared by manually operating the cylinder involved—holding the activation button until the battery clears. If the rotary transport tray arm catches on the magnet slide plate, the problem can be fixed by either cycling the magnet slide or adjusting the arm for better clearance. If the final step of threading the two assemblies together jams, the part will need to be removed and realigned. If that does not solve the problem, inspect threads for defects. (Editor's Note: *If Rhy's stuff jams, go find Rhy and have him fix it, because I don't know what he was planning to do.*)

State Diagram

For the state diagram on the following page, **outputs are bold,** and inputs are not. This program has been written not in its ideal state were the machine completed, but such that it could run the part of the machine that we have set up (moving the battery and housing to the nose piece and lowering it for threading), without any sensors, since at the end of the quarter we did not have functional sensors in place. The operation is described in the section "How to start and run the machine."

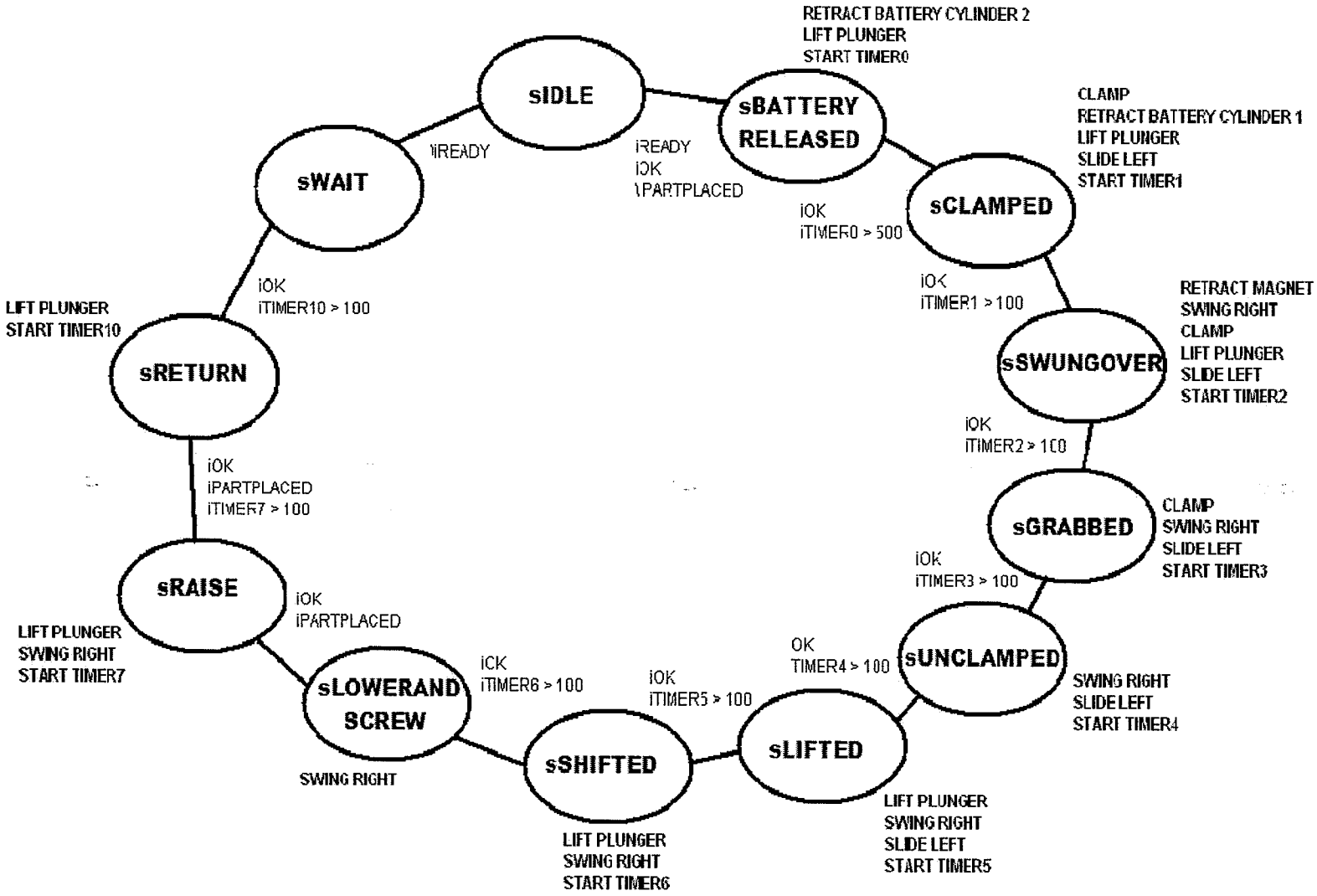

Figure 2 (State Diagram)

Individual Machine Operations

Flashlight Head Singulator and Loader

The flashlight heads are moved into position for loading by a piston. The loader then rotates up from the bottom, picks up a head and loads it into the flashlight head holder through a 180 degree rotation. After the head is placed the arm returns and a piston moves the next head from the feeding tube into the loading area and the process repeats.

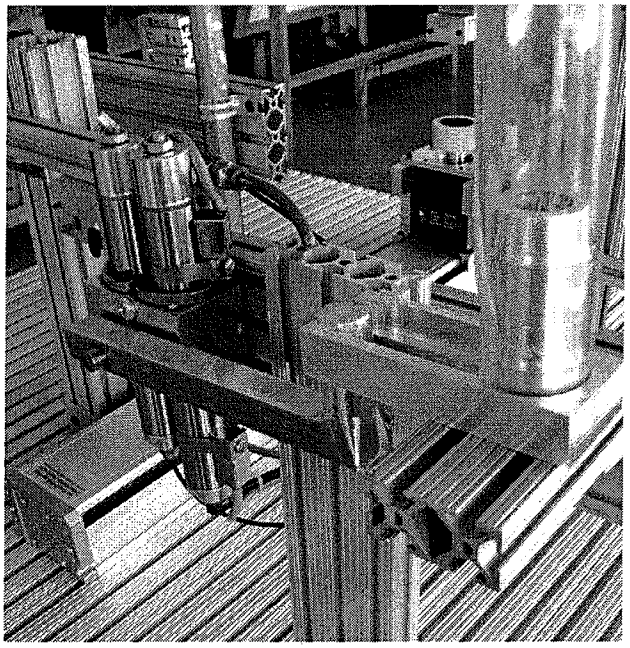

Figure 3 (Head Singulator and Loader)

Head Holder

The head holder is a cup with a slip resistant lining that holds the head in place throughout the assembly process. It is mounted on the shaft of a Smart Motor so that it can be rotated at the last stage when threading subassemblies.

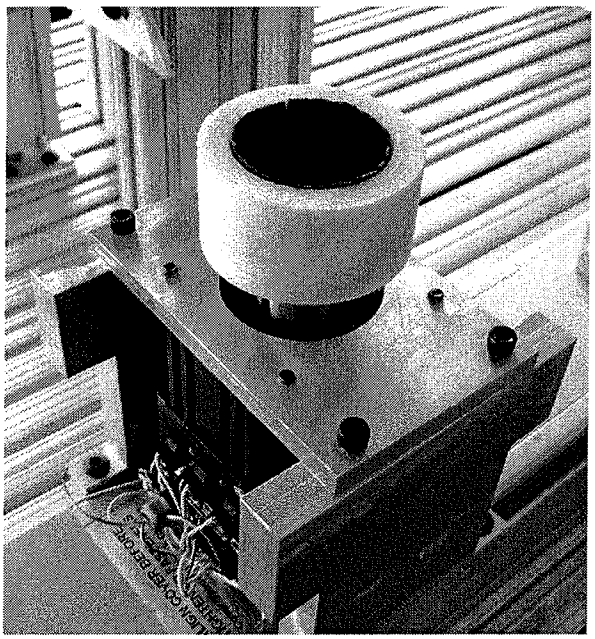

Figure 4 (Head Holder Mounted on Smart Motor)

O-Ring Plucker

The O-ring plucker selects an O-ring from the feed line (not constructed) as it rotates around and then lets it fall into the head of the flashlight as it rotates to the vertical position, and repeats. (Editor's Note: *This device is basically a solid cylinder with conical shaped ends that rotates about an axis through its center.*)

Lens Dispenser

As the dispenser alternates between its positions it will let a lens drop into the flashlight head while holding the other lenses back and then it will let the lenses advance so that the next one will be ready to be placed. (Editor's Note: *I don't know exactly what this is supposed to looks like or how it's supposed to work.*)

Heat Sink Feeder

The heat sink is dropped into the head from a vertical tube once the holder advances to that stage. (Editor's Note: *This was not finished, but it only needs some way of singulating the parts to be complete.*)

Battery Feeder

Batteries are singulated by using two air cylinders mounted in the side of the feeder chute. One holds the backed-up batteries while the other cylinder is activated to release one battery onto the transport tray. Upon closing the lower cylinder, the upper one is then activated to drop the batteries into position and is then closed again to hold the remaining batteries.

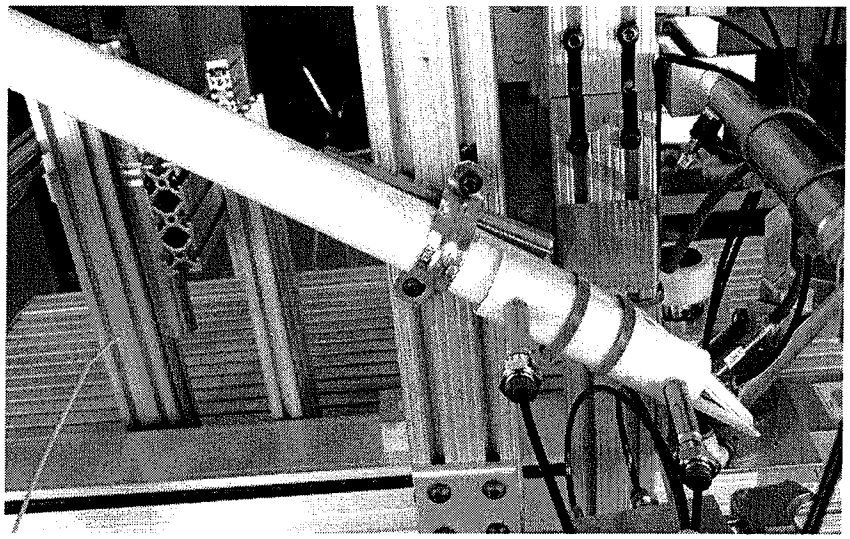

Figure 5 (Battery Feeder)

Body Feeder

We did not make a functioning body feeder, but it should be mounted above the transport tray so that when a battery is in place, the body can be dropped down over the battery.

Magnet Slide Plate

To hold the battery in position for mounting the flashlight body, a strong magnet is mounted under the rotary transport tray to hold the battery rigid and vertical. Once the body and battery are assembled together, the magnet is then pulled away from the tray slightly using a pneumatic slide. The transport tray arm is then free to move with less resistance.

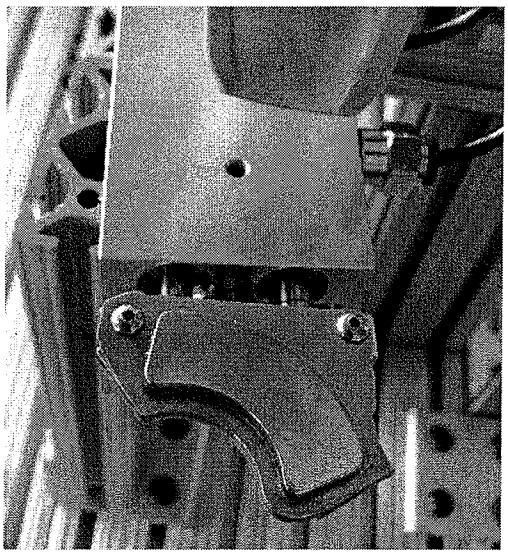

Figure 6 (Magnet Slide Plate)

Stabilization Actuator

The pneumatic stabilization actuator is activated once the flashlight body is placed over the battery in the transport tray. Once the body is registered in place by the optical sensor the stabilization plunger extends and pushes the battery to the end of the transport tray where it is held firmly in place.

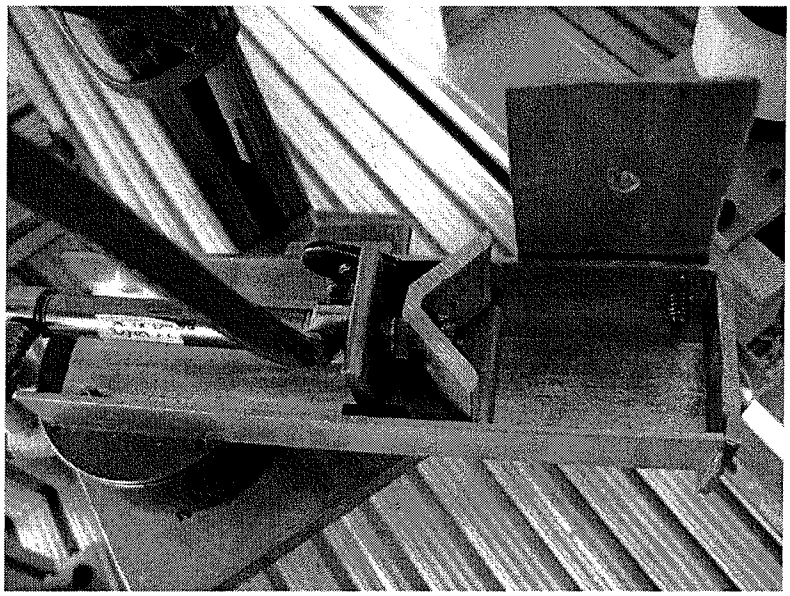

Figure 7 (Battery/Body Assembly Transport Tray with Stabilization Actuator)

Rotating Battery/Body Assembly Transport Tray

The mechanism that transports the assembled battery and flashlight body combination is a transport tray attached to a pneumatic swivel with approximately 170 degrees of rotation. This mechanism transports the assembled battery and flashlight body approximately 170 degrees away from the initial battery loading position. Once the transport tray has come to the fully rotated position, opposite the battery loading chute, an optical sensor is triggered signaling the PLC to move to the next assembly process.

Flashlight Battery/Body Transport

Following the sensor trigger by the rotating assembly transport, a linear slide controlled by a pneumatic actuator is drawn into position directly above the battery/body assembly through the retraction of the pneumatic actuator. Once the transport assembly is directly above the battery/body assembly an optical sensor is triggered for the next step of assembly to begin.

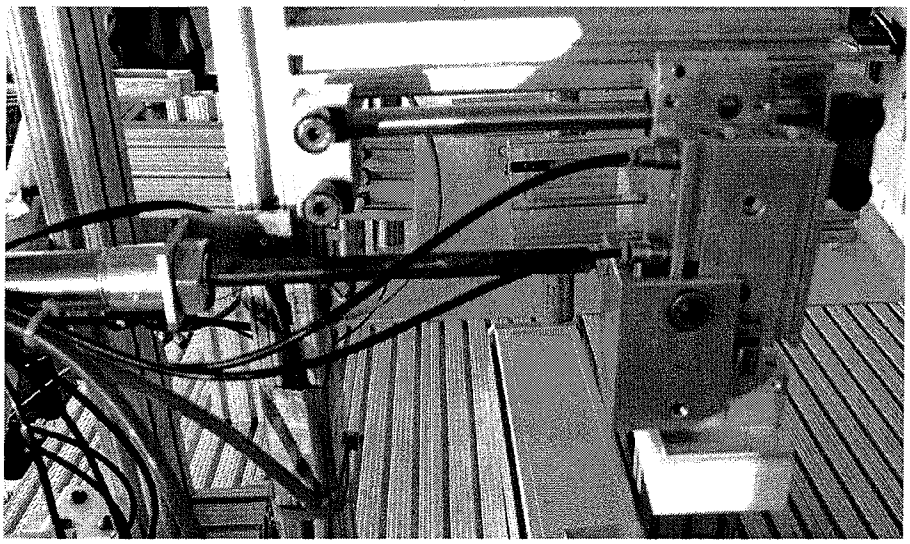

Figure 8 (Battery/Body Transport Slide)

Flashlight Battery/Body Assembly Pickup

Attached to the flashlight battery/body transport and positioned directly above the battery/body assembly, the battery/body assembly pickup is extended. The pickup consists of a magnet countersunk into a centering block which draws the body/battery assembly into itself through the magnetic attraction of the battery located inside the flashlight body. Once the pickup has fully extended it is retracted along with the battery/body assembly that is now magnetically bound to the centering block. At this point the previously mentioned flashlight battery/body transport is returned to its starting position by the extension of the attached pneumatic actuator. Once the

transport has returned to the fully extended position, an optical sensor is trigged by the now present battery/body assembly to induce the extension of the assembly pickup.

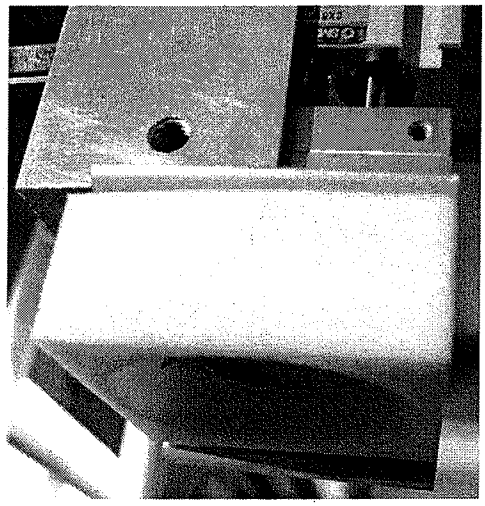

Figure 9 (Battery/Body Assembly Magnetic Pickup)

Flashlight Head Assembly Threading

With the arrival of the battery/body assembly via the assembly pickup and transport, the waiting flashlight head is now located directly underneath the assembly pickup. As the assembly pickup is extended the flashlight head positioning cup is rotated by a smart motor. The light pressure from the extending assembly pickup along with the rotation of the flashlight head is all that is needed to smoothly thread the flashlight head assembly onto the body due to the precision machining of the flashlight surfaces by its designer, Dr. Ralph Stirling.

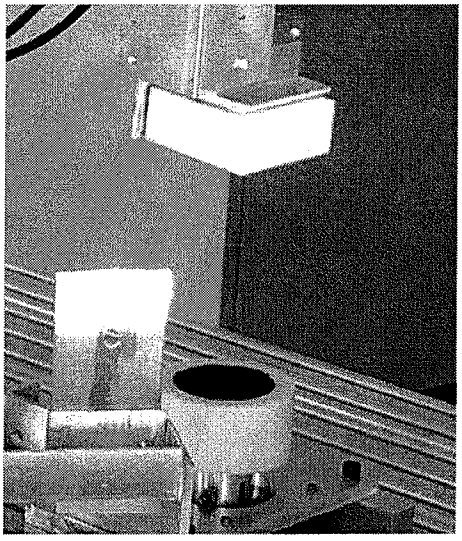

Figure 10 (Final Position for Threading)

Final Product Remover

After the subassemblies are threaded together, the battery/body assembly pickup is raised and the completed flashlight can be removed. (Editor's Note: *We were planning to mount an arm on the rotary battery/body assembly transport tray that would tip the final product out of the holder and into a box.*)

PLC Ladder Logic

See following pages.

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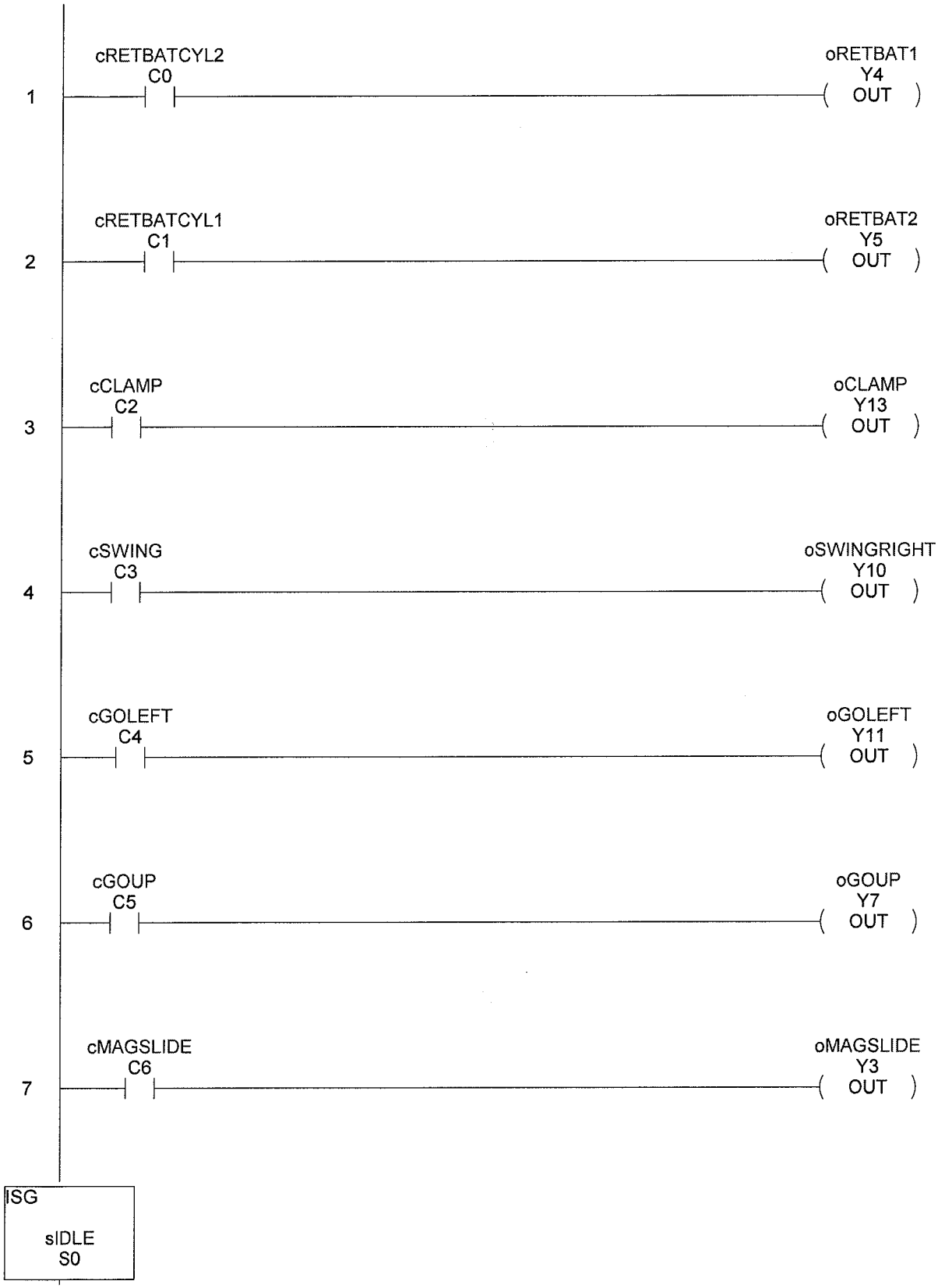
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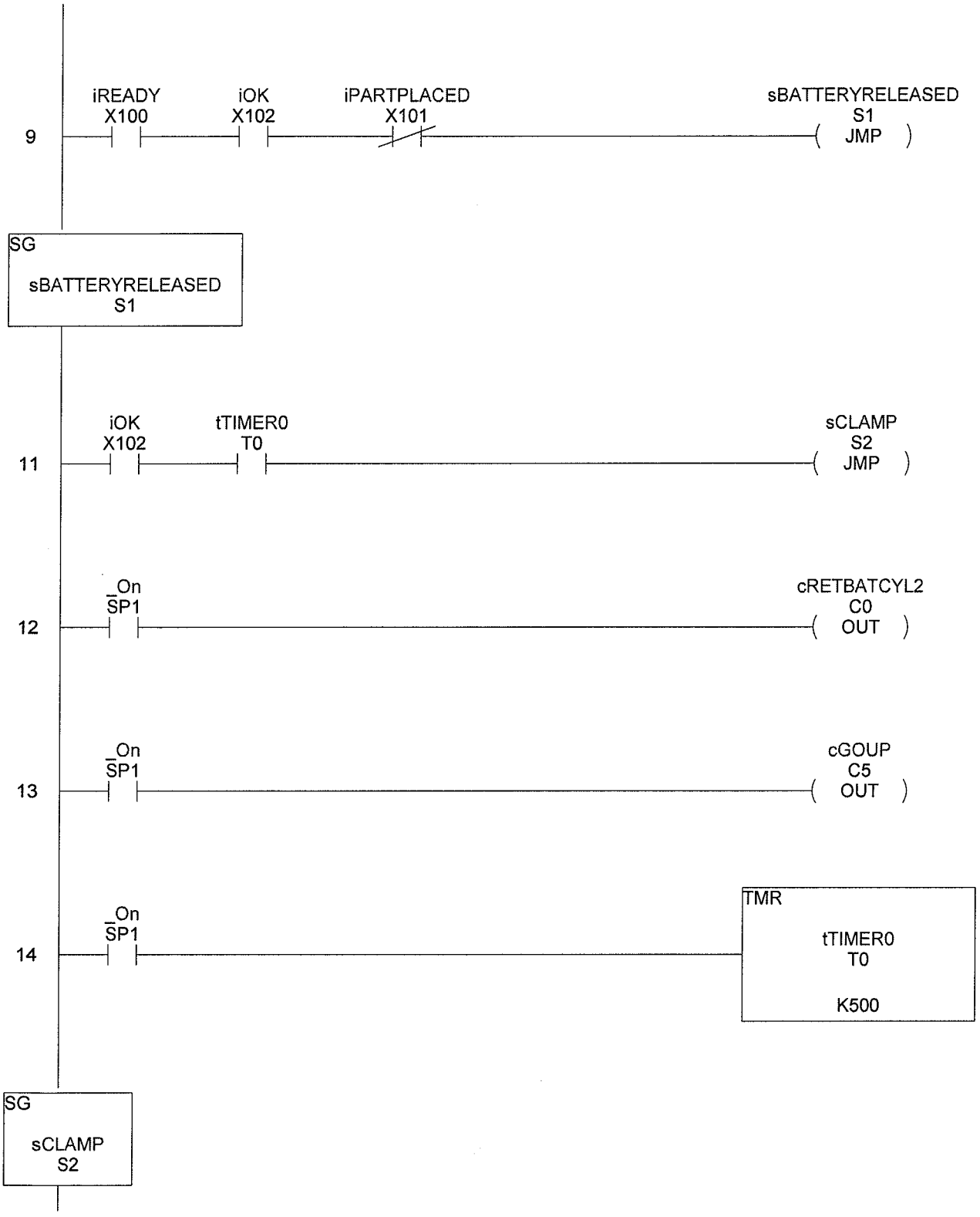
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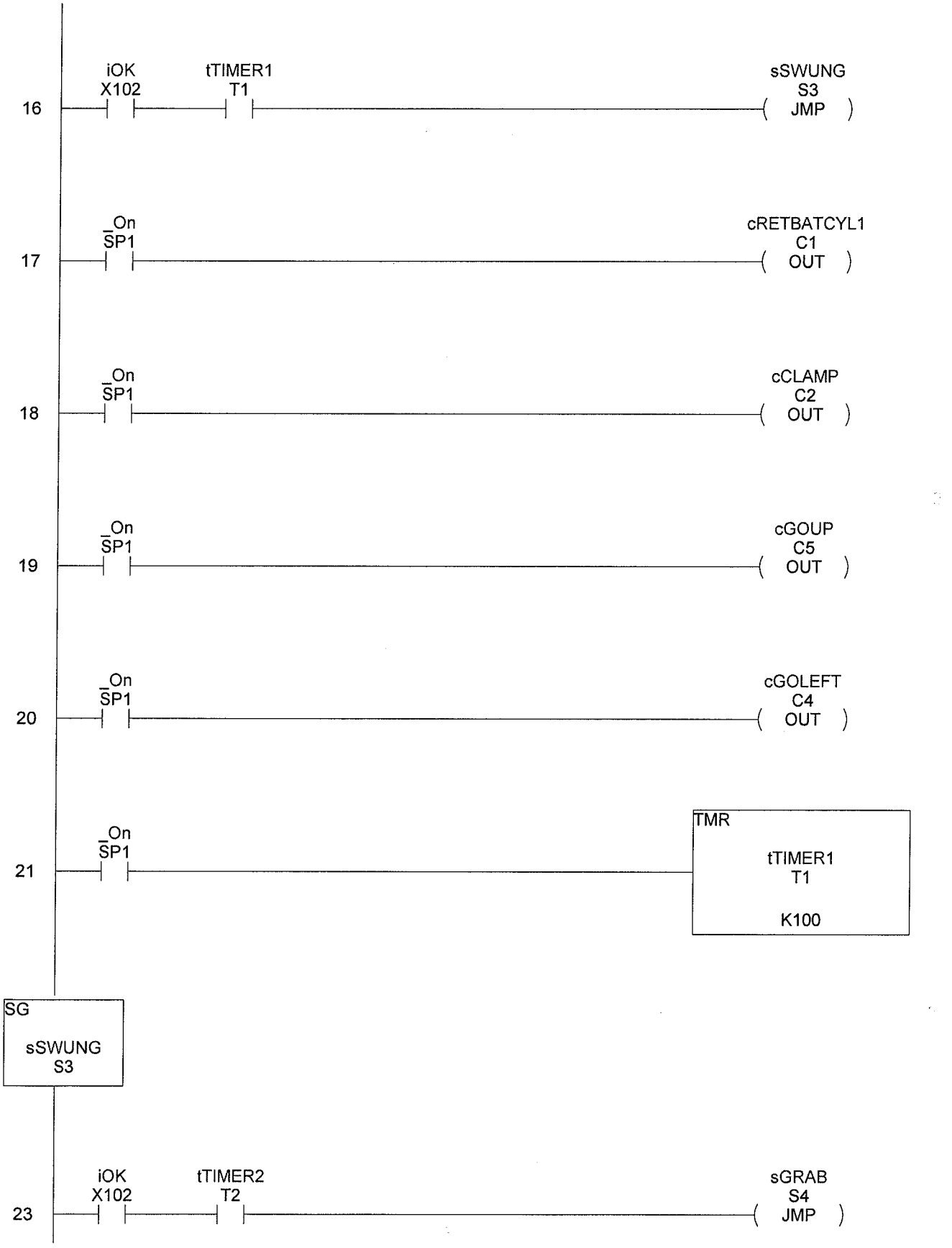
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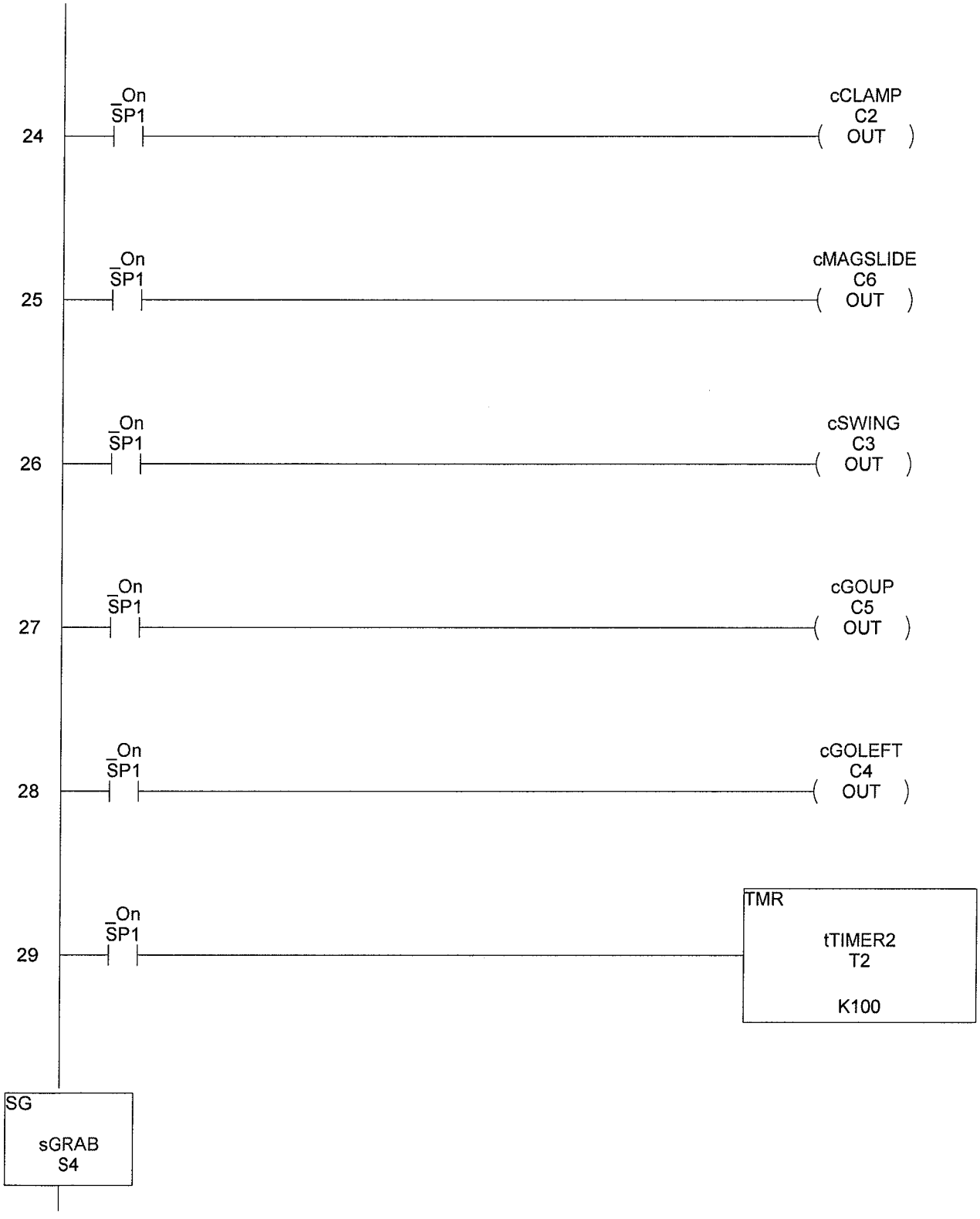
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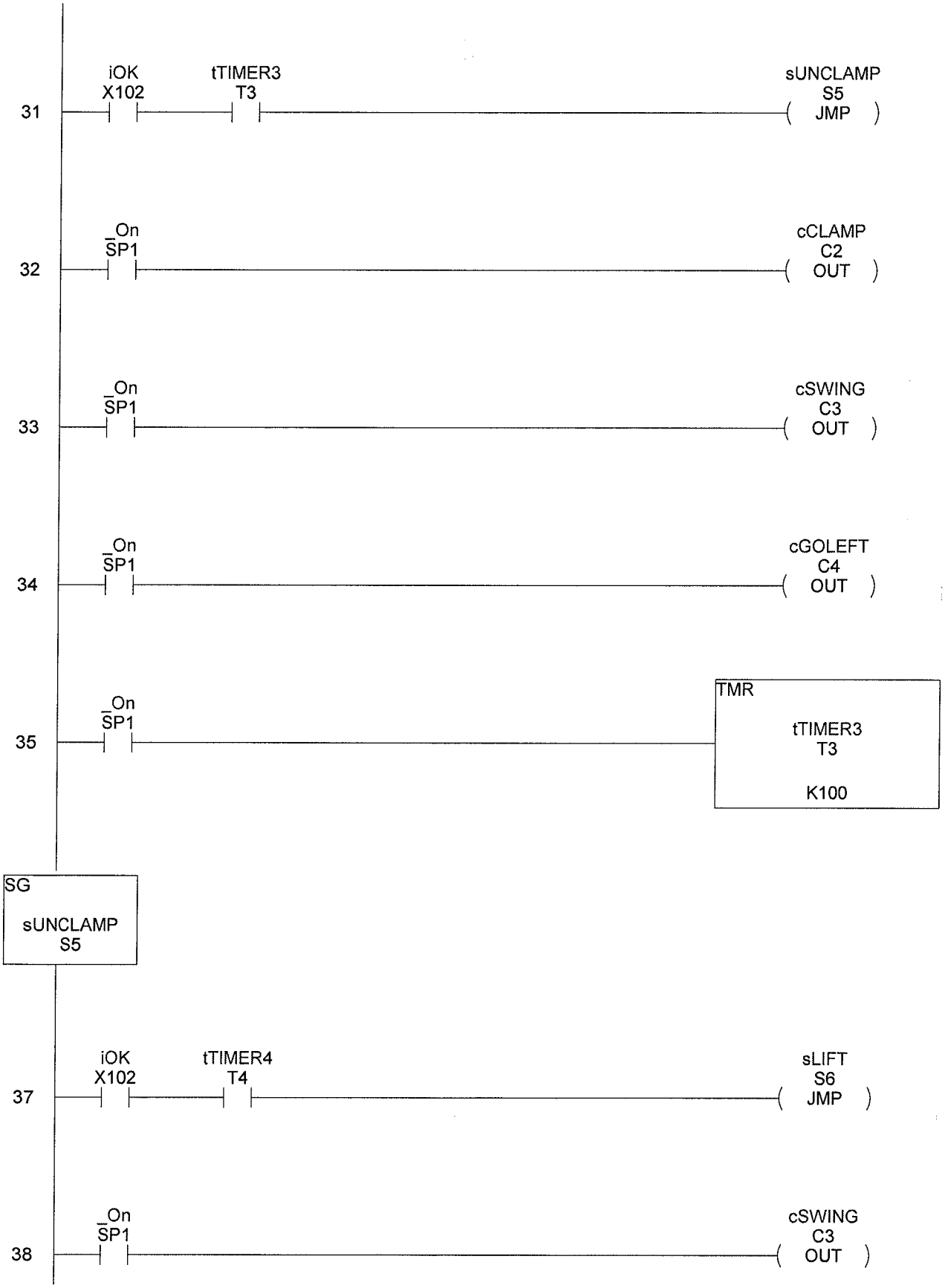
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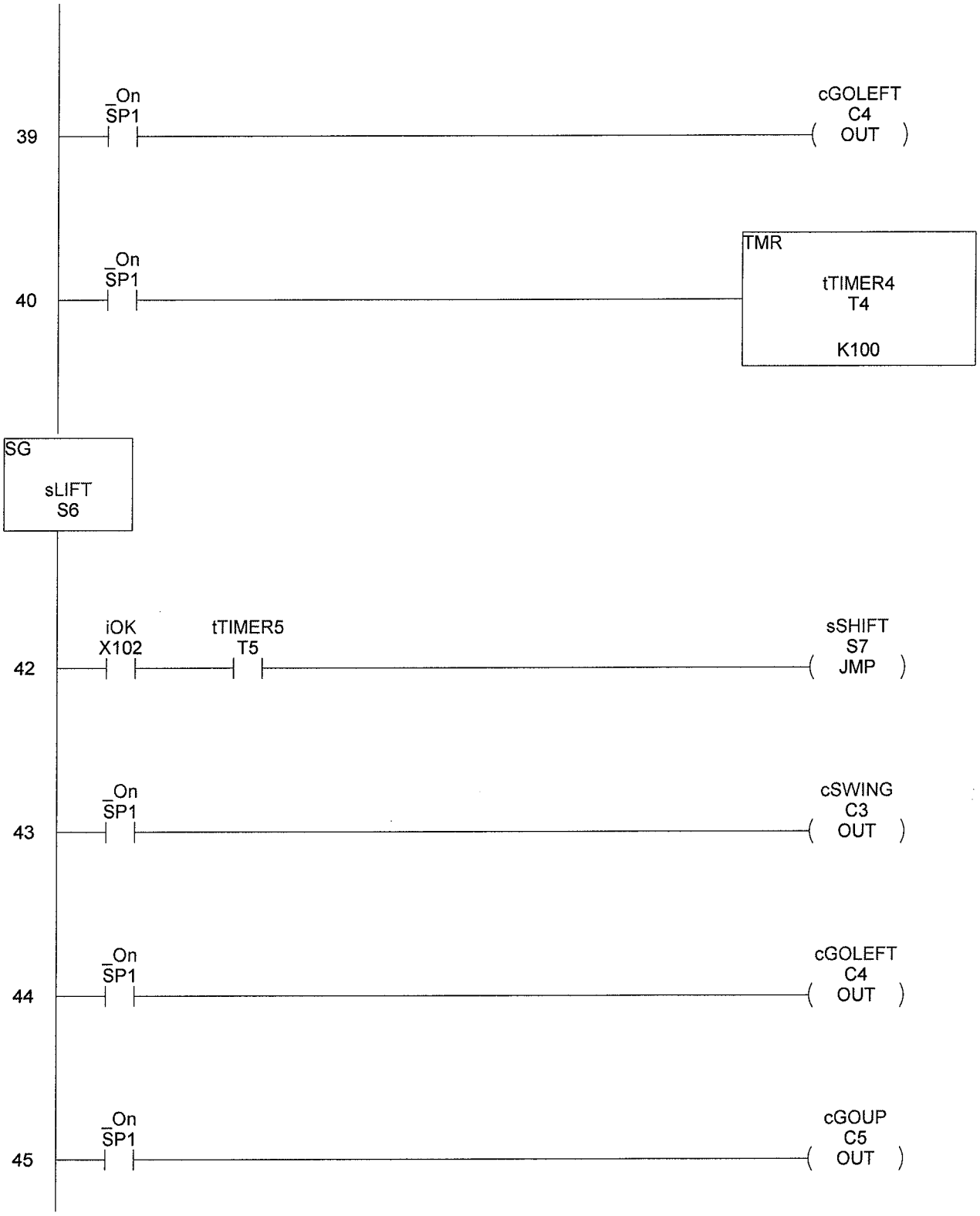
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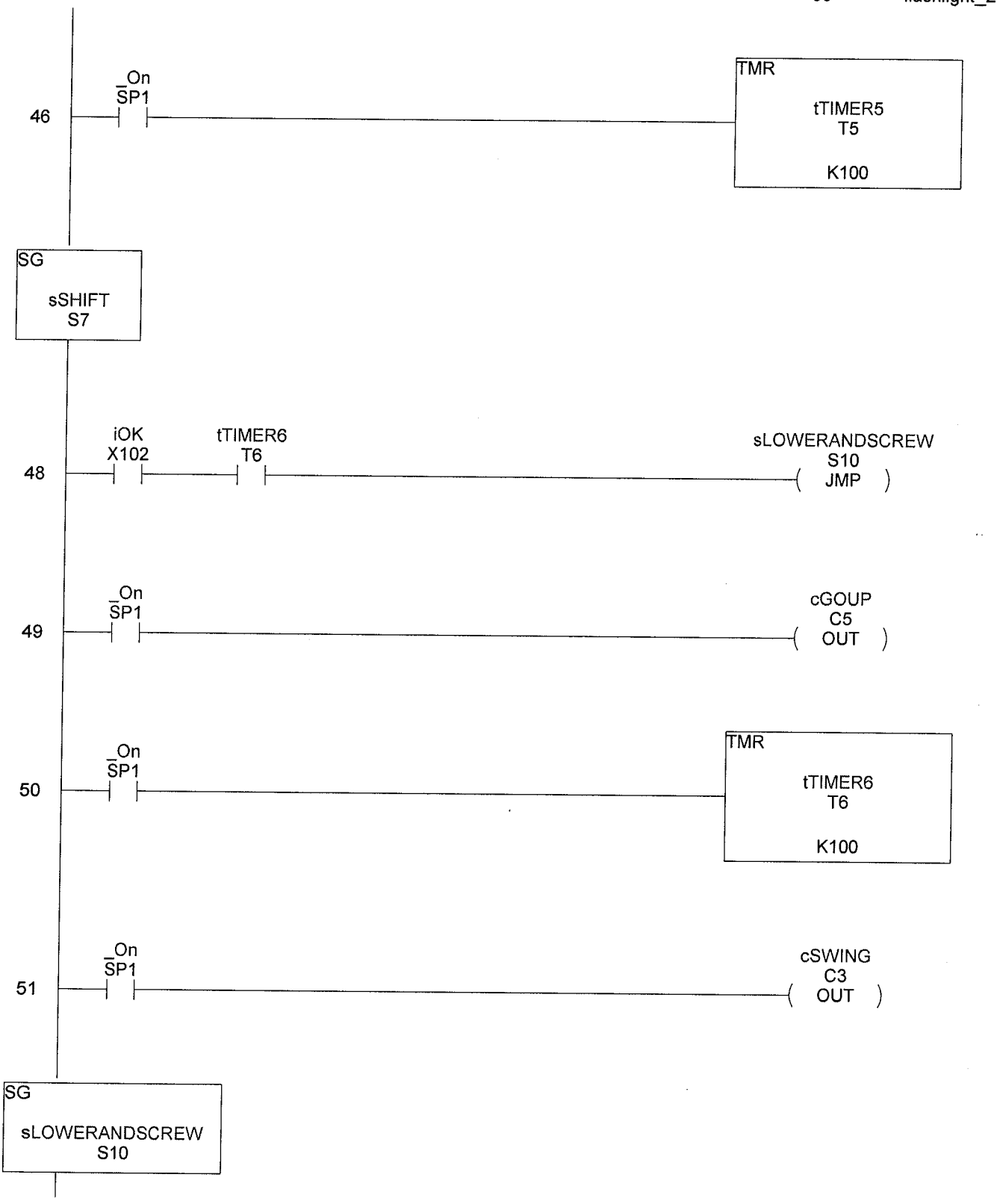
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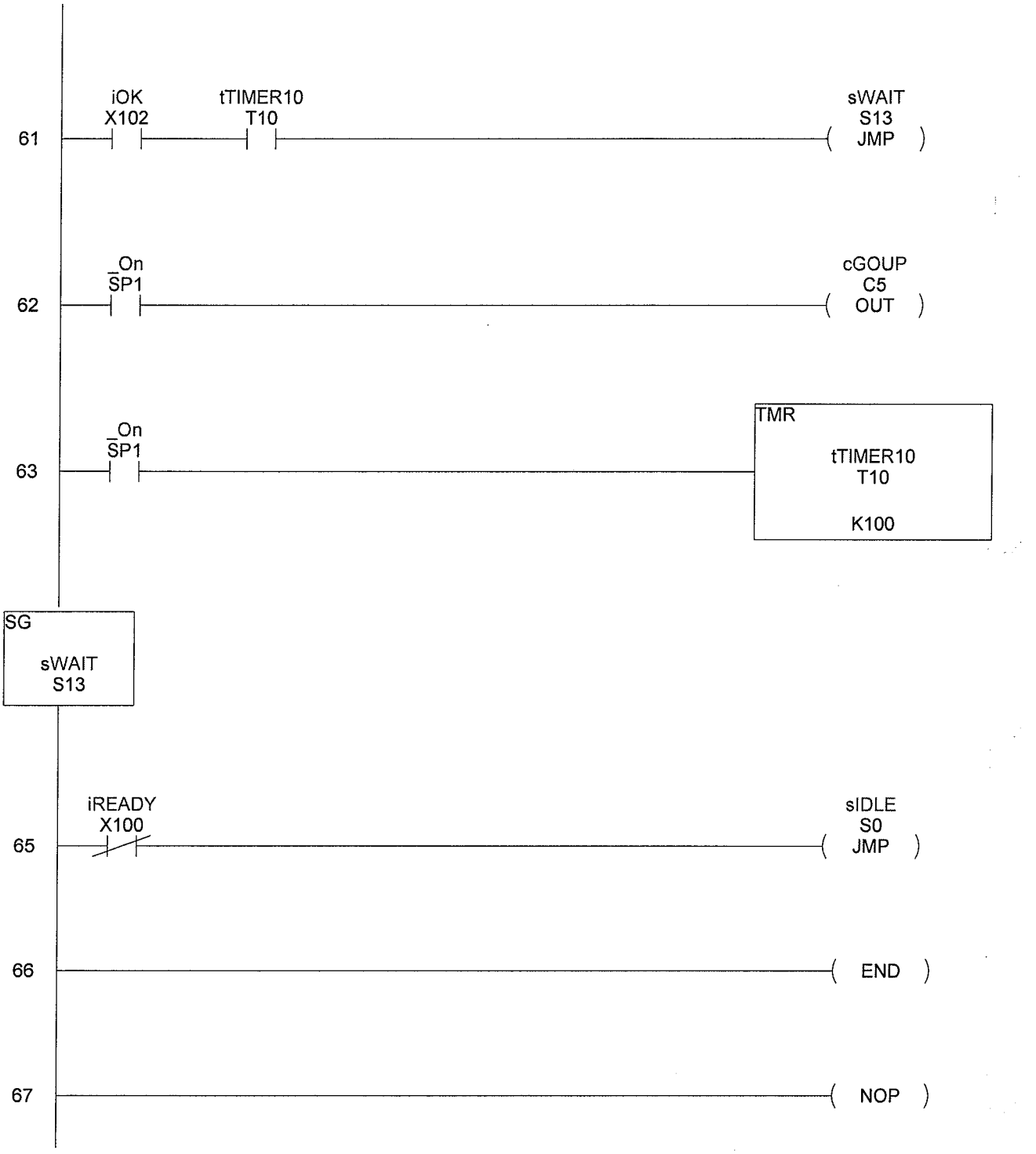
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