WALLA WALLA UNIVERSITY

Manufacturing Lab Project

Automated Flashlight Assembly Manual

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Introduction

This report is list of instructions, descriptions, codes and vital documentation needed to operate and understand how to manage and work the turret to automate the assembly of flashlights.

Starting Machine

These are the necessary steps in order to start the assembly machine in a safe and efficient manner.

1. Remove any and all obstructions that you may see that can harm the equipment on the machine or may harm you. Check to see that all parts are free to move without hindrance.
2. Load each station with the appropriate parts in order to automate assembly.
3. Once steps one and two have been performed turn on power and check that all PLC's are set to "stop" to prevent unwanted movement.
4. Turn the E-Stop knob clockwise to begin flow of air into cylinders.
5. Set PLC's to run to load programs
6. To start flip switch X100 on the PLC. To run one cycle, flip switch on and then off. To run machine continuously, flip switch X100 on and leave it on.

In order to stop the machine in case of an emergency or to simply stop automation press the E-stop button. Once having performed this if you require to start the machine again follow the instructions above if not make sure the PLC's are set to stop and disconnect the power to the machine.

Description of Operations

Clearing Machine

Note that if any machine jams immediately press the E-stop button. Then verify that each part in that station has not been damaged, if so then remove it from the assembly line at once and replace it with another one. Be sure to inspect each air and any sensor that may be functioning in that station. If any sensor or air cylinder has been damaged replace at once and recalibrate machine before continuing automation process. Failure to do so will result into possible jams of the system as automation continues. Only once having verified that each sensor and mechanism is working properly you may once again begin the process of automation of the indexing table.

Station #1 – Flashlight Nose Dispensing

Function

The purpose of this station is to provide one flashlight nose part into one of the eight rotating flashlight holders on the indexing table. In order for this to take place the station requires a feeding tube with multiple air cylinders to control flow of parts. While one cylinder allows a part to drop another prevents a secondary part from dropping. Also a sliding system is installed to place the nose of the flashlight comfortably into one of the holders on the indexing table.

Loading

Drop one or more nose cones of the flashlight down the plastic cylinder face down. This type of feeding can be done by hand to pre load the machine for automation.

Design

The station starts in the up position with both air cylinders extended. The indexing turret moves into position below the station and the station moves down so that the bottom of the cylinder is close to the turret. The top cylinder retracts, releasing the flashlight nose cones which are caught by the bottom cylinder. The top cylinder extends to hold the remaining nose cones in place, and then the bottom cylinder retracts to release the nose cone into the indexing turret. The station returns to the up position so the nose cone will not hit the cylinder when the turret rotates.

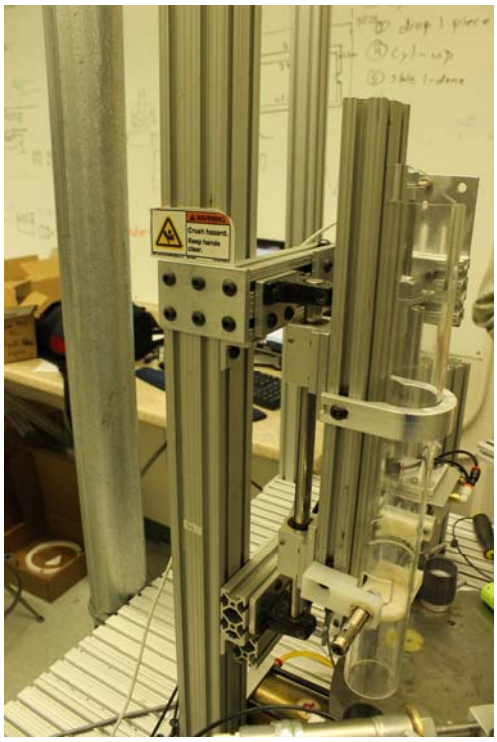


Figure 1 Nose Cone Station

Station #2 – Inner O-ring and Circuit Dispensing

Function

The purpose of this station is to supply the nose of the flashlight with an inner o-ring and the circuit that controls the flashlight. The o-rings are placed in a slot ramp with two pistons mounted on to its side. Each piston moves independently to the each other to insure that only one o-ring is supplied to the nose of the flashlight. After the o-ring is dropped into the flashlight nose the circuit is then pressed in to it. The circuit (heat sink) is stacked in a tube where once again air cylinders regulate how many drop into a singular flashlight nose at a time. Sensor's are placed around the tube to notify that the circuit is in position and can be installed.

Loading

Slide several o-rings in to the narrow slit of the o-ring dispenser and place the circuits (heat sinks) into the plastic clear cylinder stacked each on top of each other.

Design

The indexing turret with the nose cone moves into place and a cylinder underneath the turret activates and pushes a cone up in the center of the flashlight nose cone. The O ring is released, falls into the flashlight nose cone and is guided into position by the turret cone which is then retracted. Heat sinks for the flashlight have been loaded into the plastic cylinder with both air cylinders extended. The top cylinder retracts and lets the heat sinks fall onto the bottom cylinder and then extends to hold the top heat sinks in place. The bottom air cylinder retracts and the heat sinks falls into the flashlight nose cone. The bottom air cylinder extends and the indexing turret is ready to move to the next station.

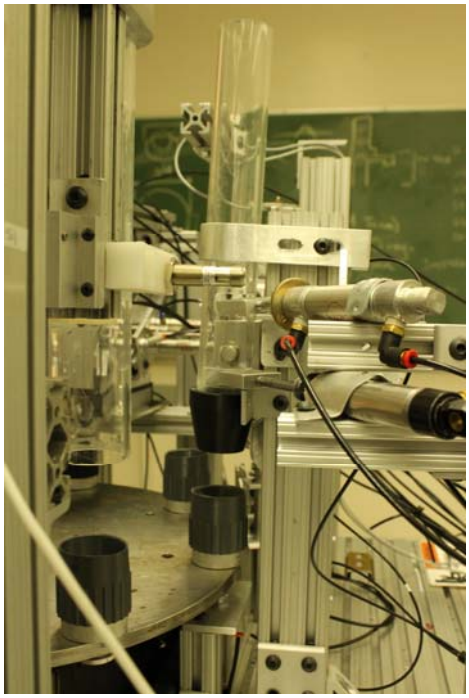


Figure 2 Heat Sink and O-Ring

Station #3 – Fiber Glass Washer

Function

This station is used to install a fiber glass washer to hold the circuit in place inside of the flashlight nose. Otherwise without this washer if the nose piece was to flip over or tilt the circuit may unaligned or fall off.

Loading

Stack several washers on the spring loaded circular plate in station three.

Design

The indexing turret moves into position with the nose cone and heat sink inside of it. The fiber glass washer is picked up by a vacuum mounted to an air cylinder. The air cylinder starts in the up position and when the indexing turret moves into place it extends down and the vacuum is activated to pick up the washer. Another air cylinder pivots the vacuum over top of the flashlight nose cone on the indexer and the air cylinder is extended placing the washer and vacuum on top of the heat sink. The vacuum turns off leaving the washer on top of the heat sink and the station returns to its starting position.

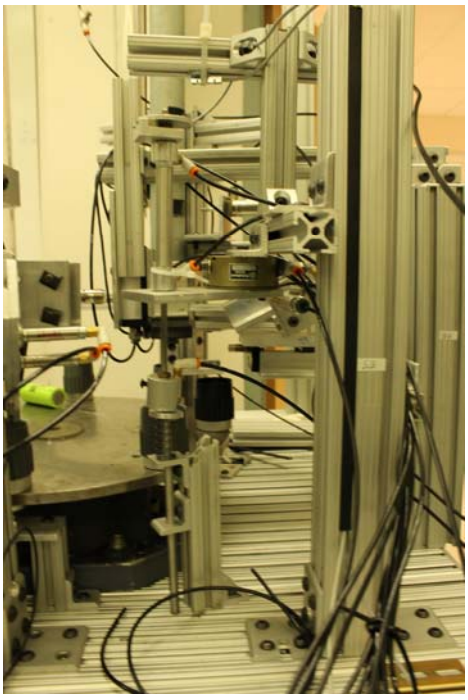


Figure 3 Fiber Glass Washer

Station #4 – Magnetic Ring

Function

This station is used to drop a magnetic ring into place above the nose of the flashlight. The station uses two air cylinders that actuate independently to supply only one ring to a sliding pneumatic that drops the ring down into place using a specialized made gripper.

Loading

To load this station slide the magnetic rings down the aluminum chute. Each ring is symmetrical so orientation of ring placement isn't important.

Design

Metal rings for the flashlight are loaded onto an inclined ramp which has two air cylinders near the bottom for catching the rings. Both cylinders start in the extended position. The gripper starts in the up position with the grippers open. When the indexer turret moves to the station the top air cylinder retracts allowing the metal rings to slide forward. The first metal rings is stopped by the lower air cylinder and the top air cylinder extends pushing the other rings back up the ramp. A horizontal guide is extended below the bottom of the ramp and the lower air cylinder is released. The metal ring slides onto the horizontal guide and the gripper closes. The guide retracts and the gripper lowers, placing the metal ring on the flashlight nose cone. The gripper opens and returns to the up position and the lower air cylinder extends. The indexing turret is ready for to move to the final station.

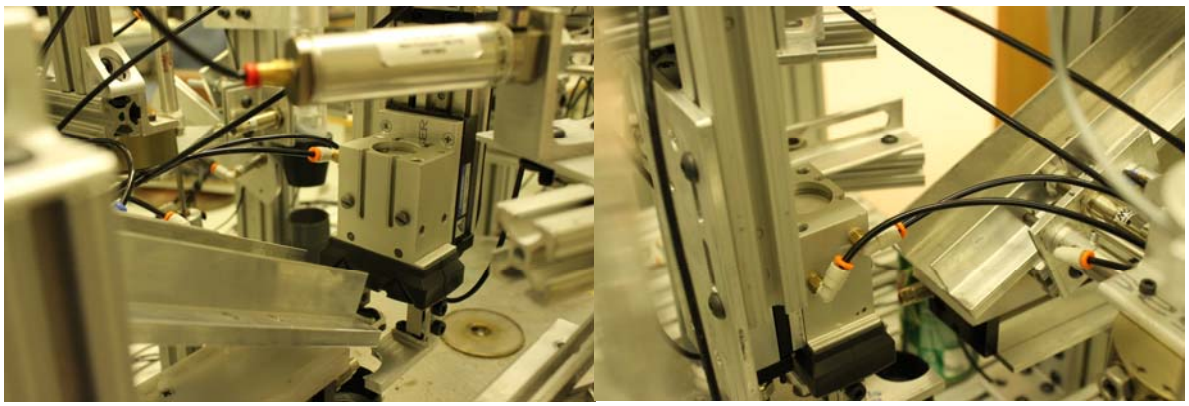


Figure 4 Magnetic Ring

Station #5 – Battery and Housing with O-Ring

Function

The purpose of this station is to drop the housing and battery on top of the pre assembled nose piece of the flashlight. Air cylinders drop down a battery from a plastic cylinder into place for another cylinder to pushy the battery into a metal tube. Once the battery is pushed into this secondary position a third cylinder then actuates and drops the housing of the flashlight on top of the battery. Once having completed the alignment of the housing and battery, they are dropped on top of the nose piece of the flashlight.

Loading

Load the batteries one at a time for now down the plastic clear cylinder. Then load the housings of the flashlight with the internal ring already inside of it down the aluminum pipe one on top of each other.

Design

The station starts with all air cylinders except the top air cylinder of the metal guide cylinder retracted. The indexing turret moves into position beneath the metal guide cylinder. The metal cylinder holds the battery housing with O-rings pre inserted in them. The battery is dropped into the plastic guide cylinder and the air cylinder extends, moving the battery to the bottom level of the metal guide cylinder. The bottom air cylinder of the metal guide extends and the battery guide cylinder extends, pushing the battery onto into the metal guide. The battery guide retracts, and then the plastic guide air cylinder retracts. The top air cylinder of the metal guide retracts allowing the battery casing to fall on top of the battery. The bottom air cylinder of the metal guide retracts and the battery and casing fall on top of the flashlight nose cone. The flashlight is removed at the next station and the nose cone threading is hand tightened.

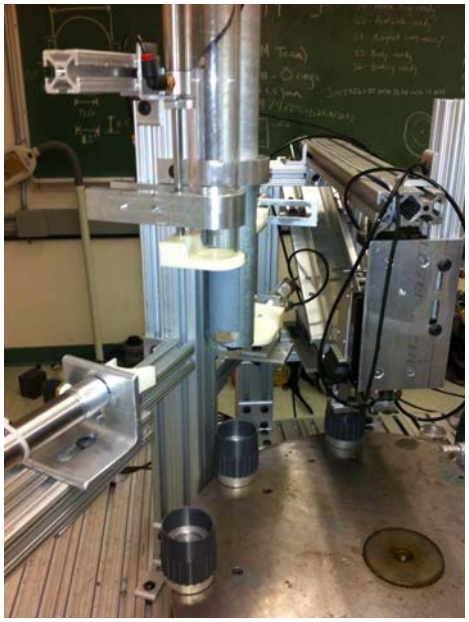


Figure 6. Battery and Housing with O-Ring

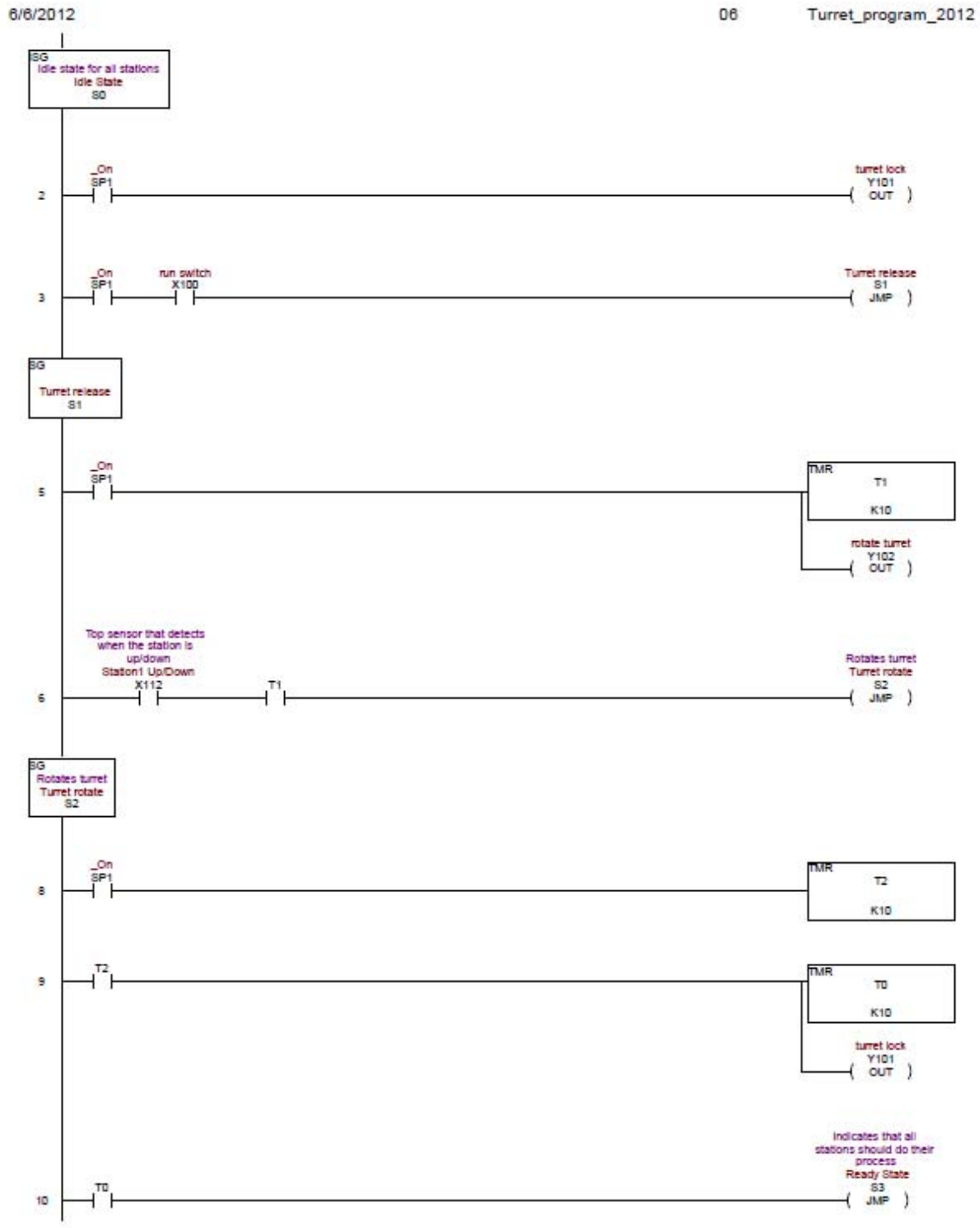
Suggestions

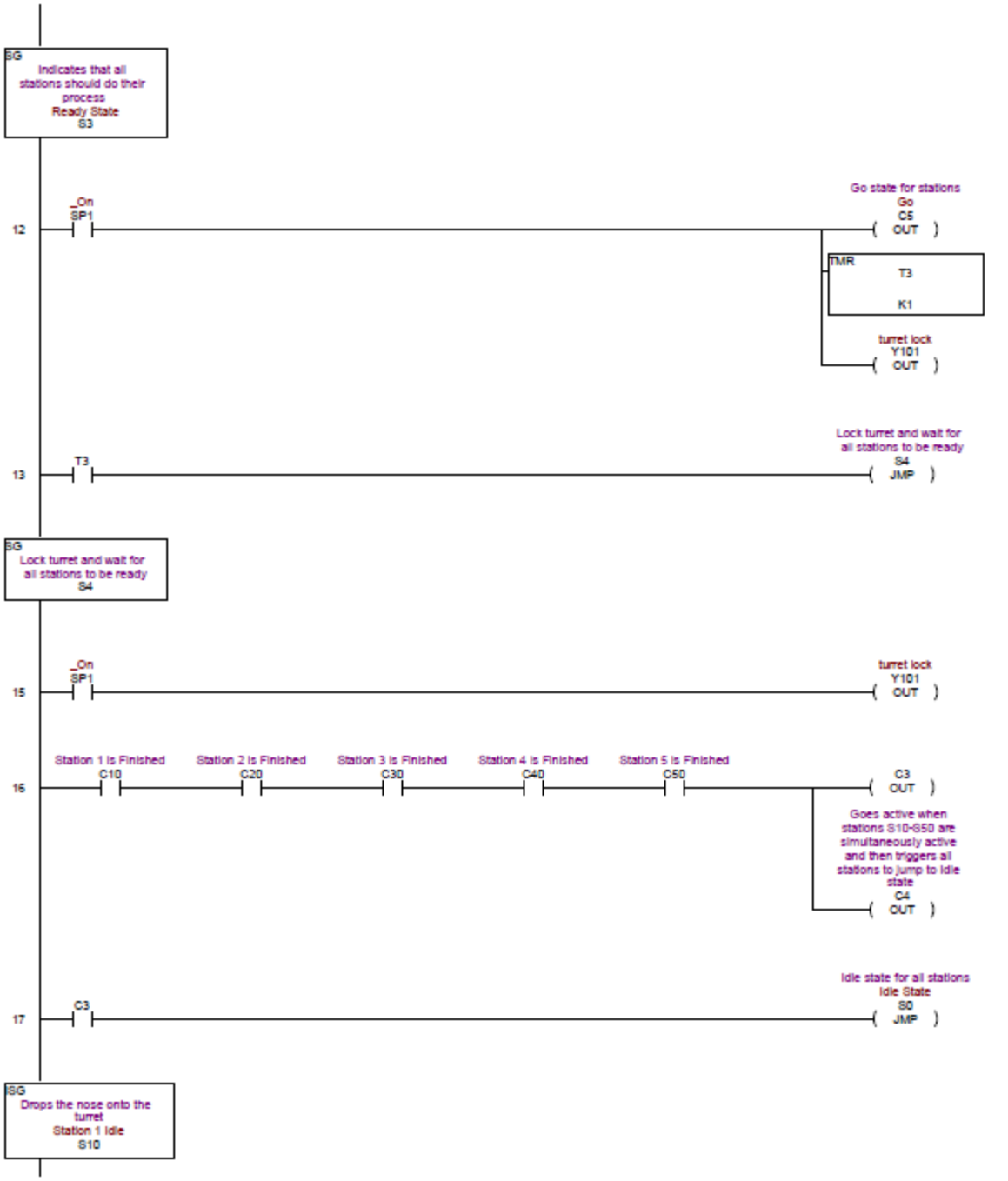
The nose cone holders for the indexing turret need to be redesigned. They are barely larger than the nose cone and many are oval shaped which causes the nose cone to not fall into the turret completely when it is dropped at the first station. A wider nose cone holder would be a better design since it would allow more uniform loading of the nose cone into the indexing turret.

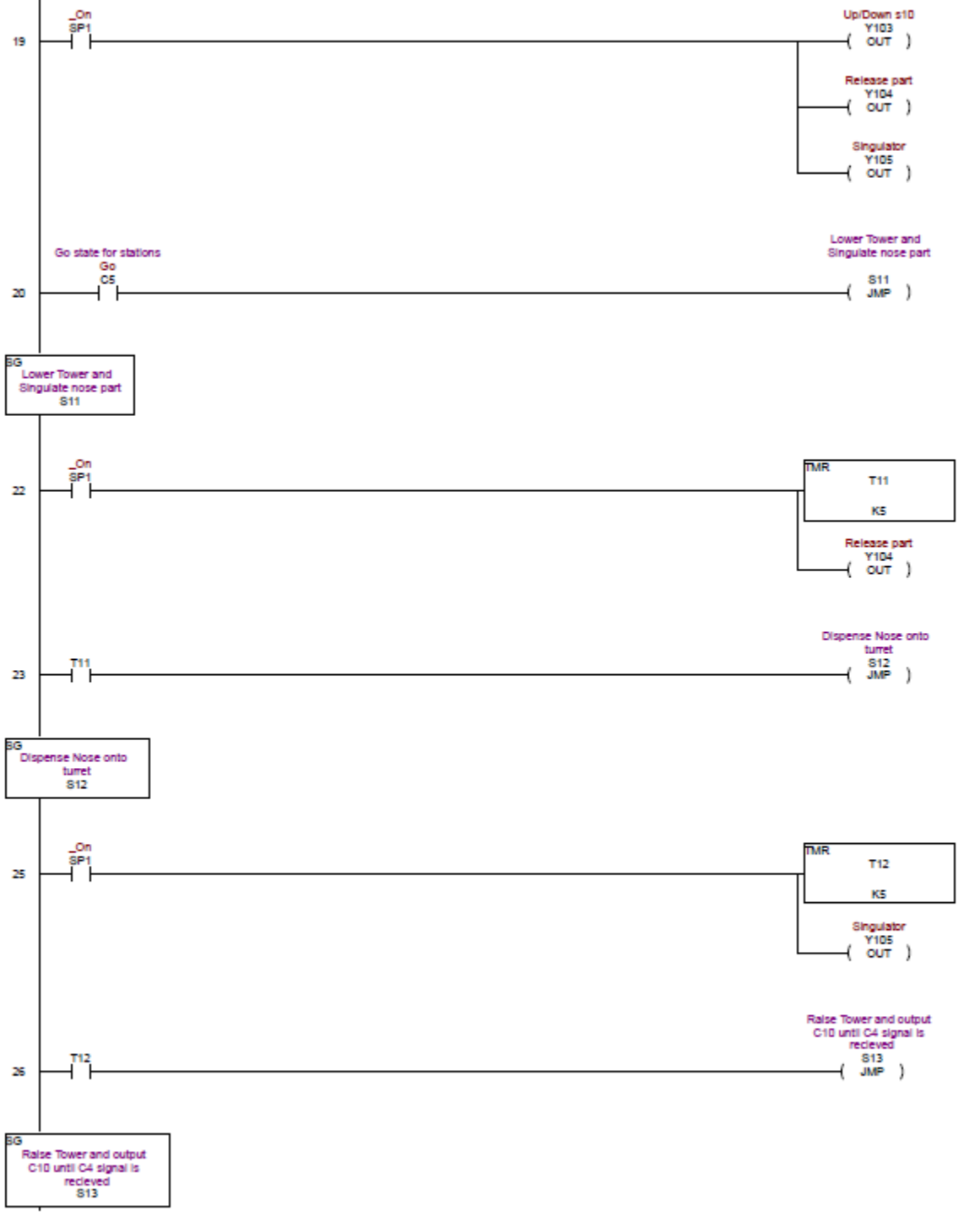
The tightening mechanism to screw the flashlight together does not work. It uses a wheel to spin the nose cone holder while pressure is applied to the battery cover to screw the nose cone and battery cover together. There is not enough friction between the wheel and turret to spin the nose cone so the tightening does not work. The station needs to be redesigned.

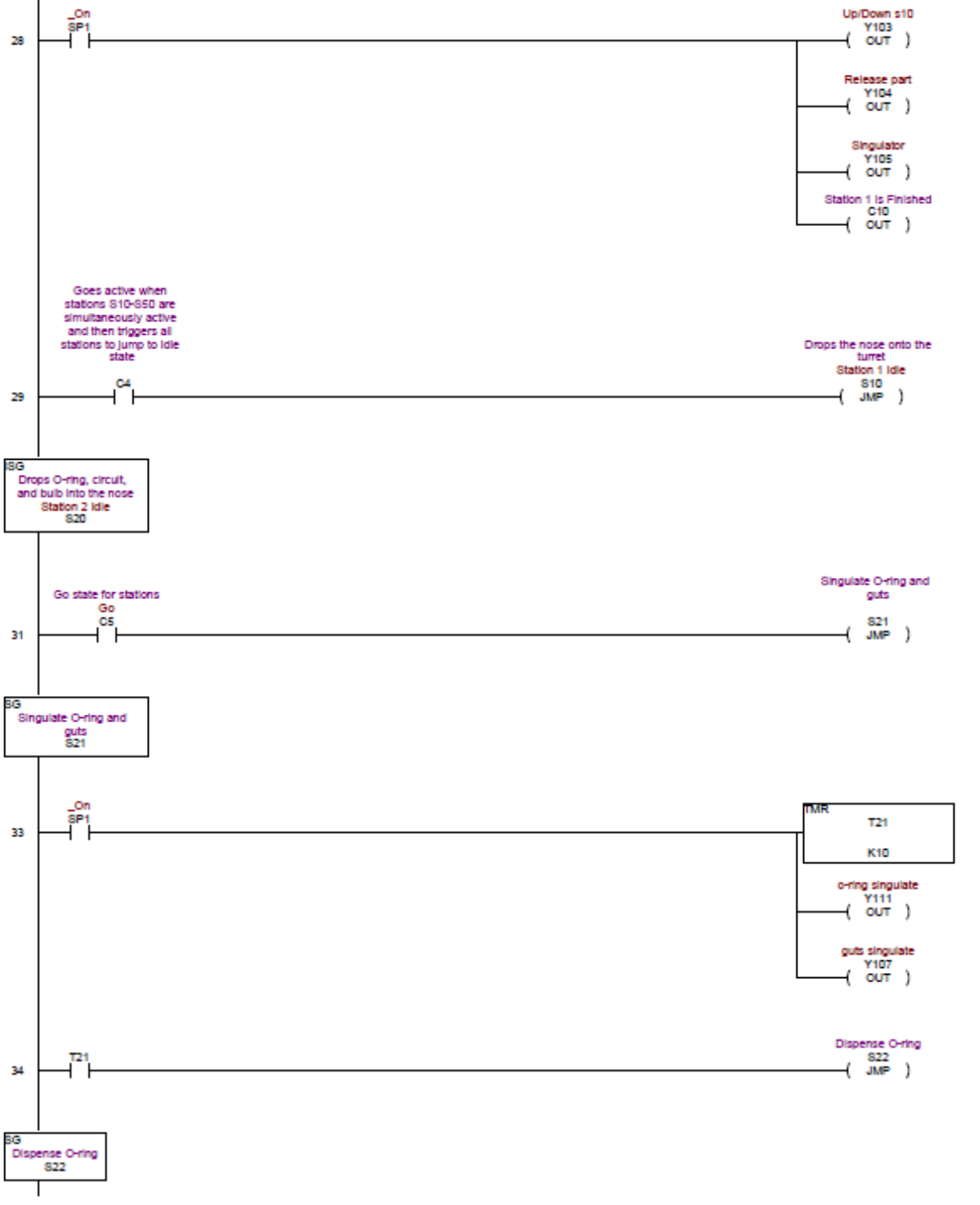
Appendix

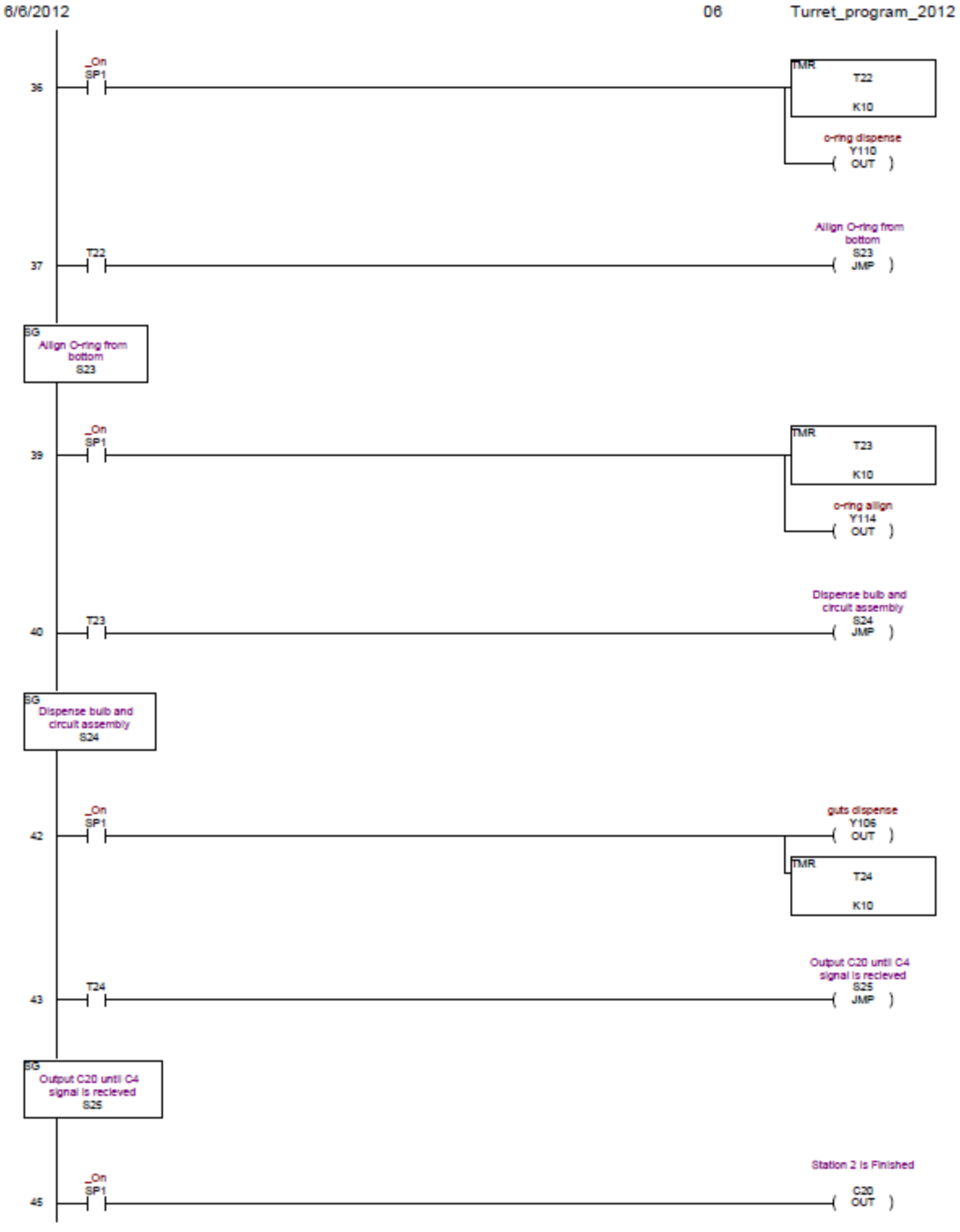
PLC Ladder Diagram:

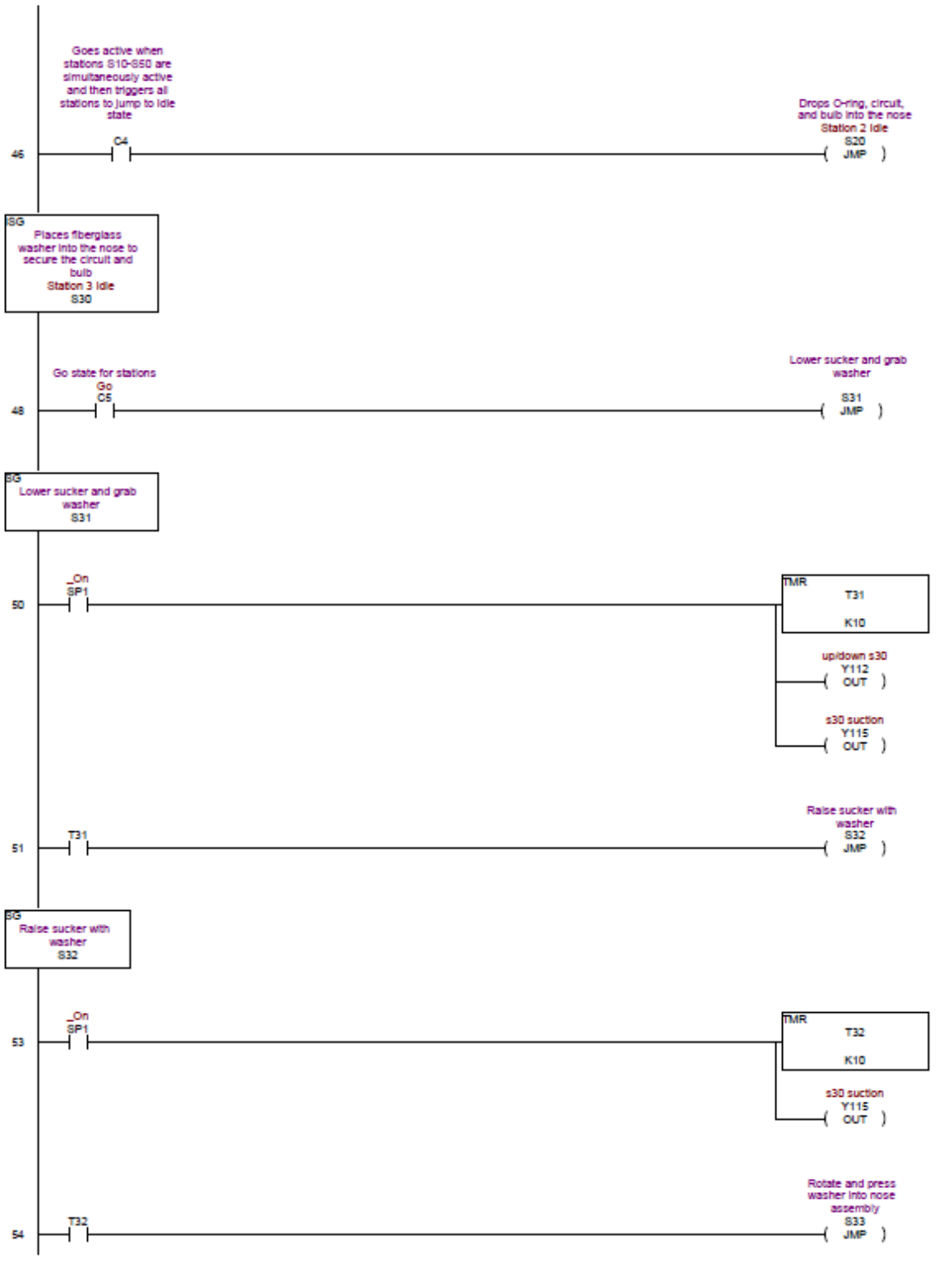


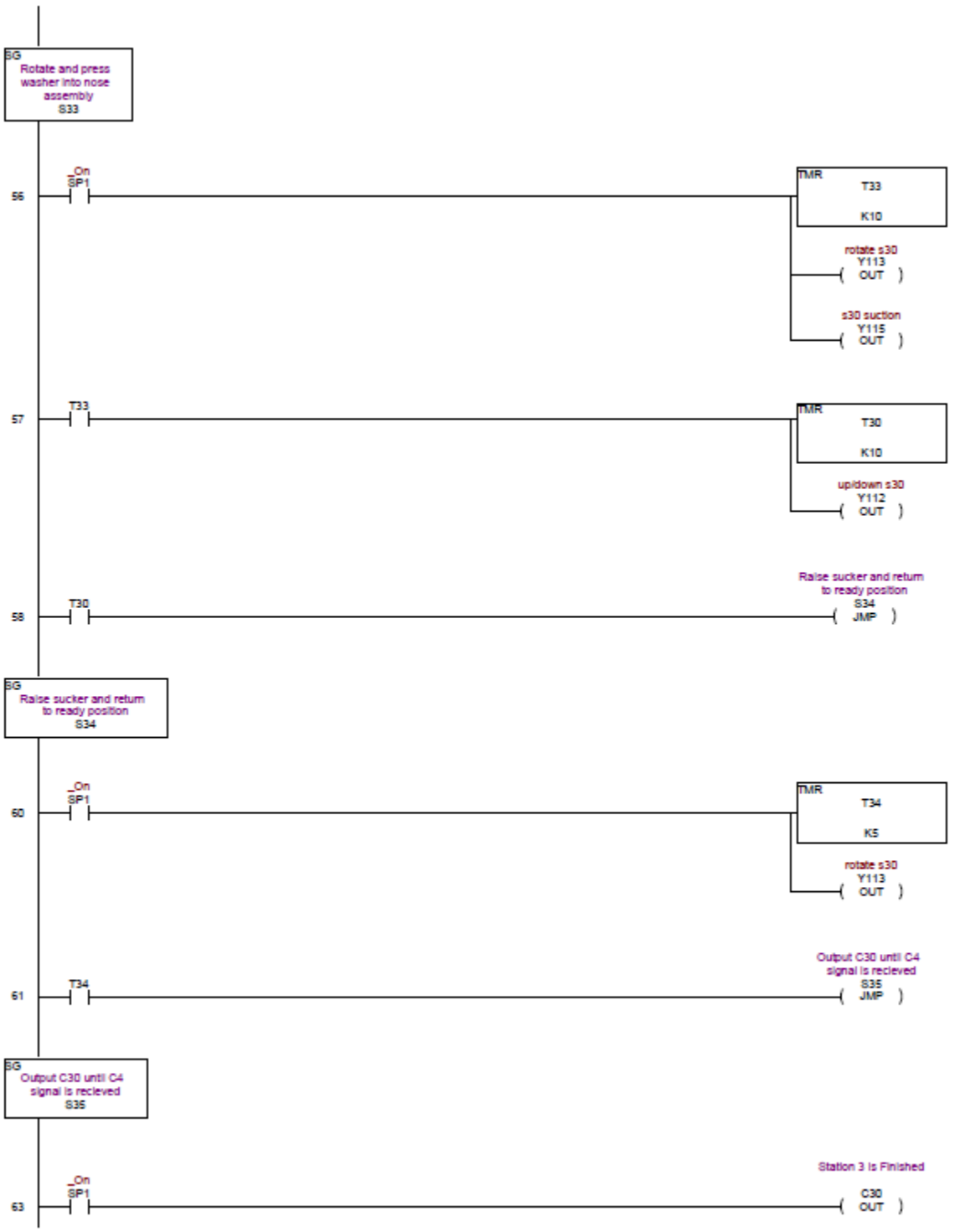

SG
Indicates that all stations should do their process
Ready State
S3
12
_On
SP1
Go state for stations
Go
C5
OUT
TMR
T3
K1
turret lock
Y101
OUT
13
T3
Lock turret and wait for all stations to be ready
S4
JMP
SG
Lock turret and wait for all stations to be ready
S4
15
_On
SP1
turret lock
Y101
OUT
16
Station 1 is Finished
C10
Station 2 is Finished
C20
Station 3 is Finished
C30
Station 4 is Finished
C40
Station 5 is Finished
C50
C3
OUT
Goes active when stations S10-S50 are simultaneously active and then triggers all stations to jump to Idle state
C4
OUT
17
C3
Idle state for all stations
Idle State
S0
JMP
SG
Drops the nose onto the turret
Station 1 Idle
S10

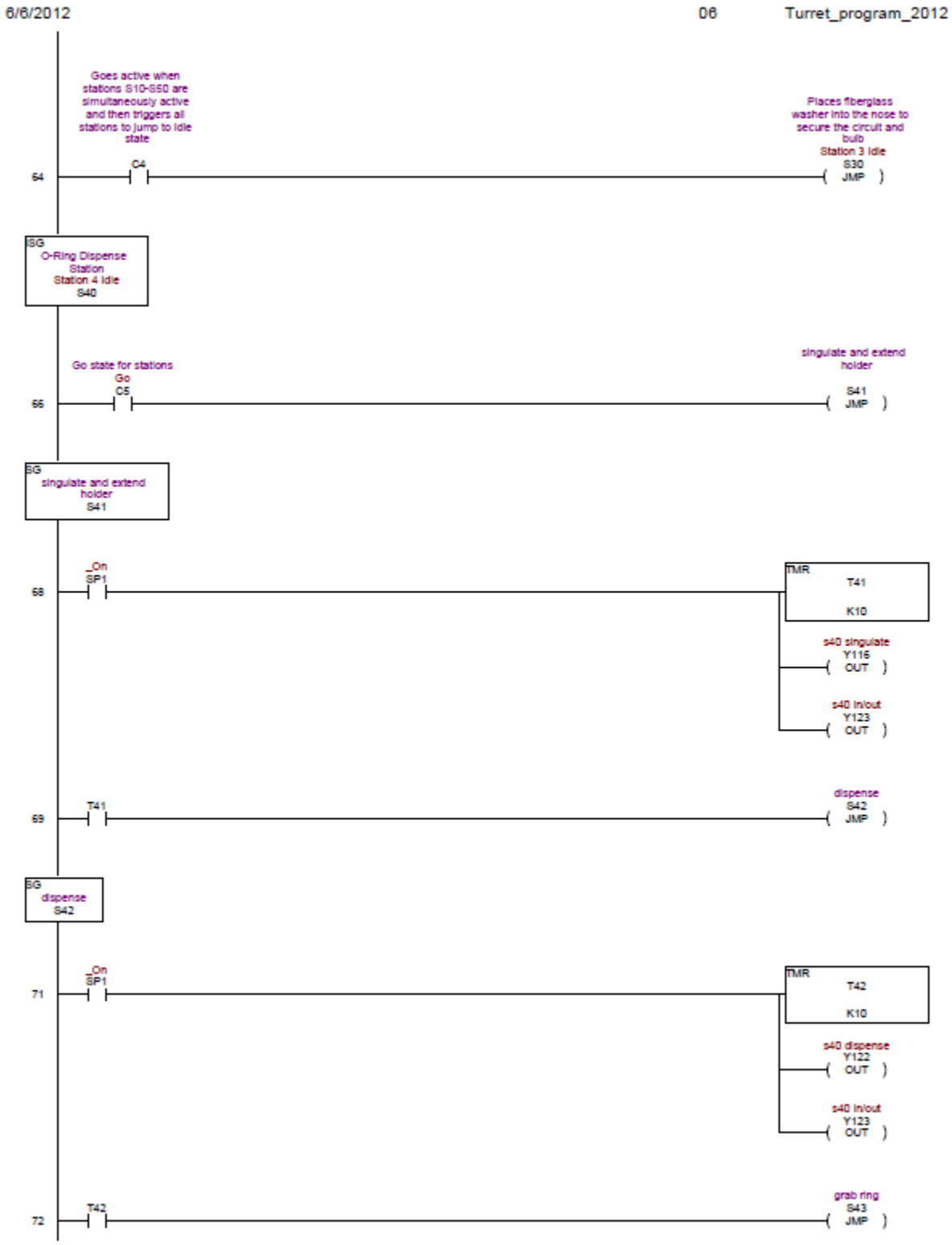

19
_On
SP1
Up/Down ±10
Y103
OUT
Release part
Y104
OUT
Singulator
Y105
OUT
Go state for stations
Go
C5
20
Lower Tower and
Singulate nose part
S11
JMP
SG
Lower Tower and
Singulate nose part
S11
22
_On
SP1
TMR
T11
K5
Release part
Y104
OUT
23
T11
Dispense Nose onto
turret
S12
JMP
SG
Dispense Nose onto
turret
S12
25
_On
SP1
TMR
T12
K5
Singulator
Y105
OUT
26
T12
Raise Tower and output
C10 until C4 signal is
recieved
S13
JMP
SG
Raise Tower and output
C10 until C4 signal is
recieved
S13

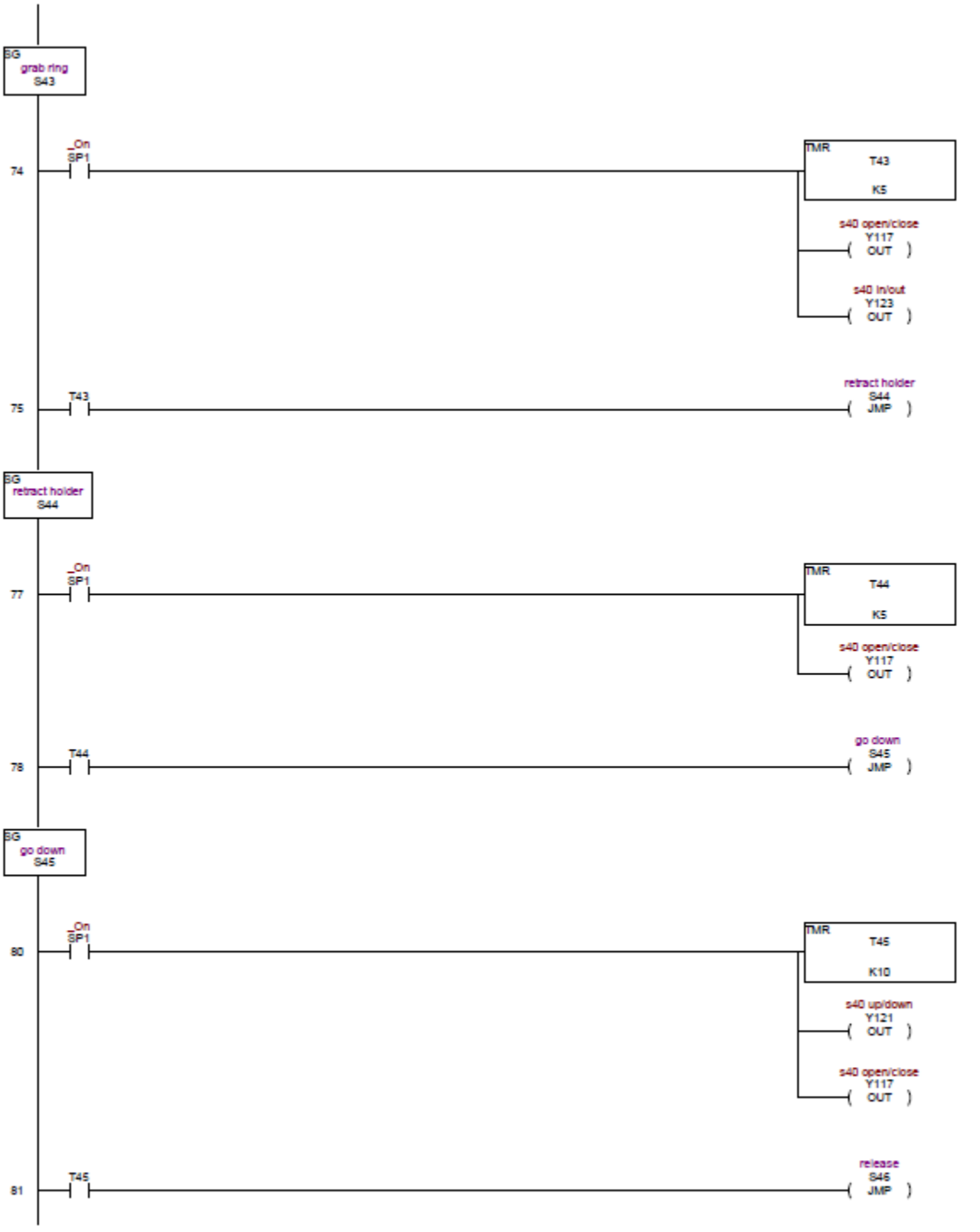

28
_On
SP1
Up/Down s10
Y103
OUT
Release part
Y104
OUT
Singulator
Y105
OUT
Station 1 Is Finished
C10
OUT
29
Goes active when stations S10-S50 are simultaneously active and then triggers all stations to jump to idle state
C4
Drops the nose onto the turret
Station 1 Idle
S10
JMP
SG
Drops O-ring, circuit, and bulb into the nose
Station 2 Idle
S20
31
Go state for stations
Go
C5
Singulate O-ring and guts
S21
JMP
SG
Singulate O-ring and guts
S21
33
_On
SP1
TMR
T21
K10
o-ring singulate
Y111
OUT
guts singulate
Y107
OUT
34
T21
Dispense O-ring
S22
JMP
SG
Dispense O-ring
S22

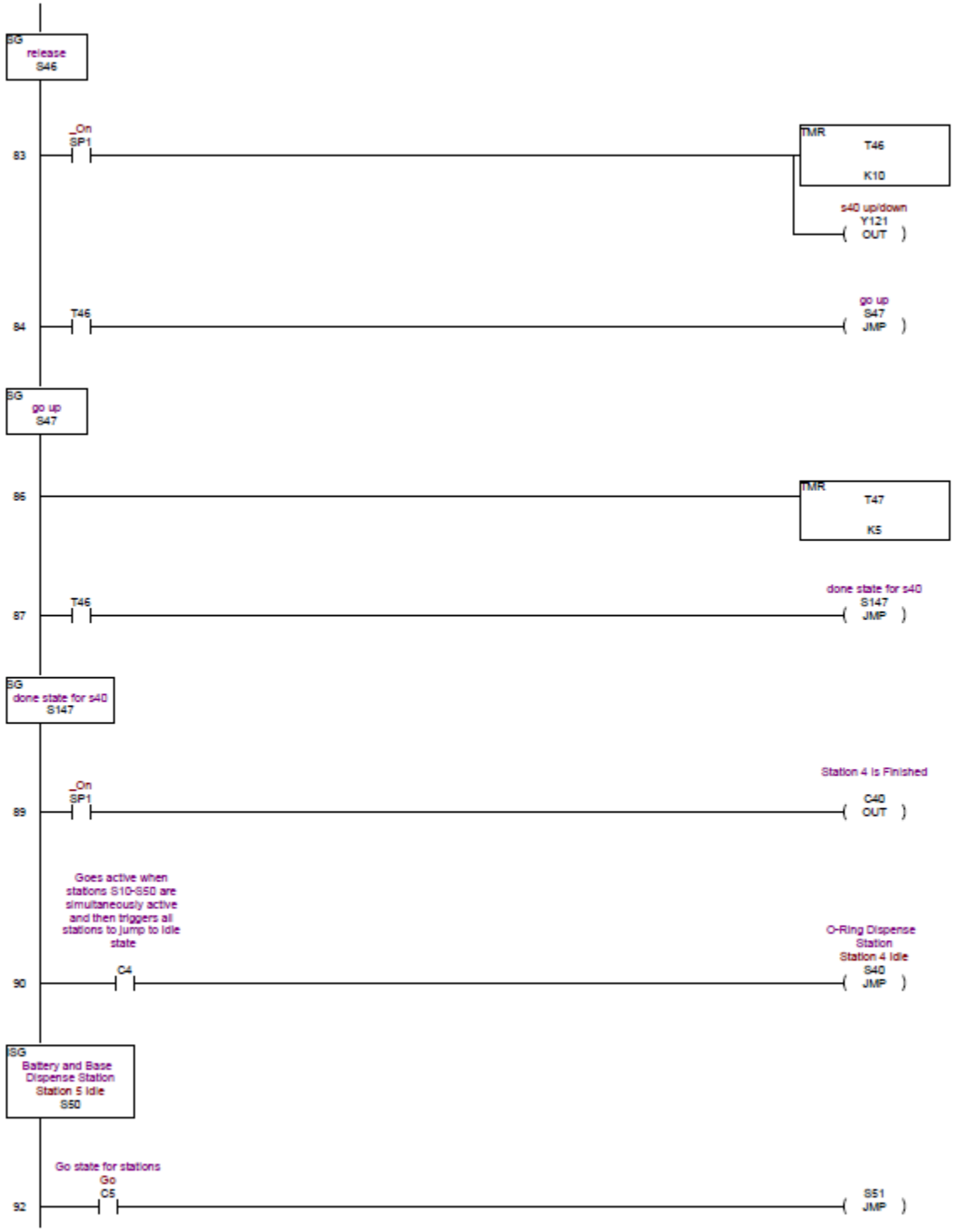

6/6/2012
06
Turret_program_2012
36
_On
SP1
TMR
T22
K10
o-ring dispense
Y110
OUT
37
T22
Allign O-ring from bottom
S23
JMP
SG
Allign O-ring from bottom
S23
39
_On
SP1
TMR
T23
K10
o-ring allign
Y114
OUT
40
T23
Dispense bulb and circuit assembly
S24
JMP
SG
Dispense bulb and circuit assembly
S24
42
_On
SP1
guts dispense
Y106
OUT
TMR
T24
K10
43
T24
Output C20 until C4 signal is recieved
S25
JMP
SG
Output C20 until C4 signal is recieved
S25
45
_On
SP1
Station 2 is Finished
C20
OUT

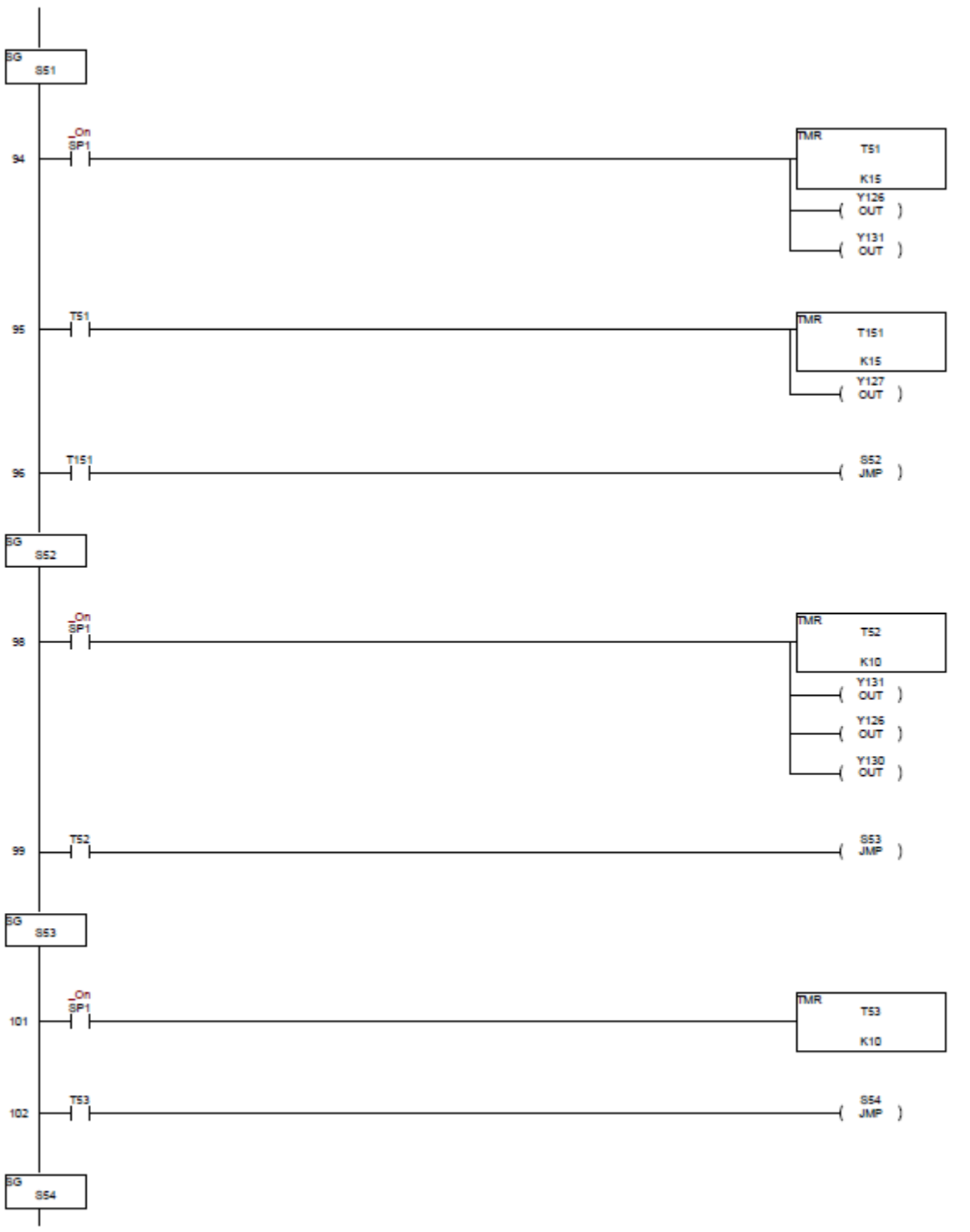

Goes active when stations S10-S50 are simultaneously active and then triggers all stations to jump to Idle state
C4
46
Drops O-ring, circuit, and bulb into the nose Station 2 Idle
S20
JMP
SG
Places fiberglass washer into the nose to secure the circuit and bulb
Station 3 Idle
S30
Go state for stations
Go
C5
48
Lower sucker and grab washer
S31
JMP
SG
Lower sucker and grab washer
S31
_On
SP1
50
TMR
T31
K10
up/down s30
Y112
OUT
s30 suction
Y115
OUT
T31
51
Raise sucker with washer
S32
JMP
SG
Raise sucker with washer
S32
_On
SP1
53
TMR
T32
K10
s30 suction
Y115
OUT
T32
54
Rotate and press washer into nose assembly
S33
JMP

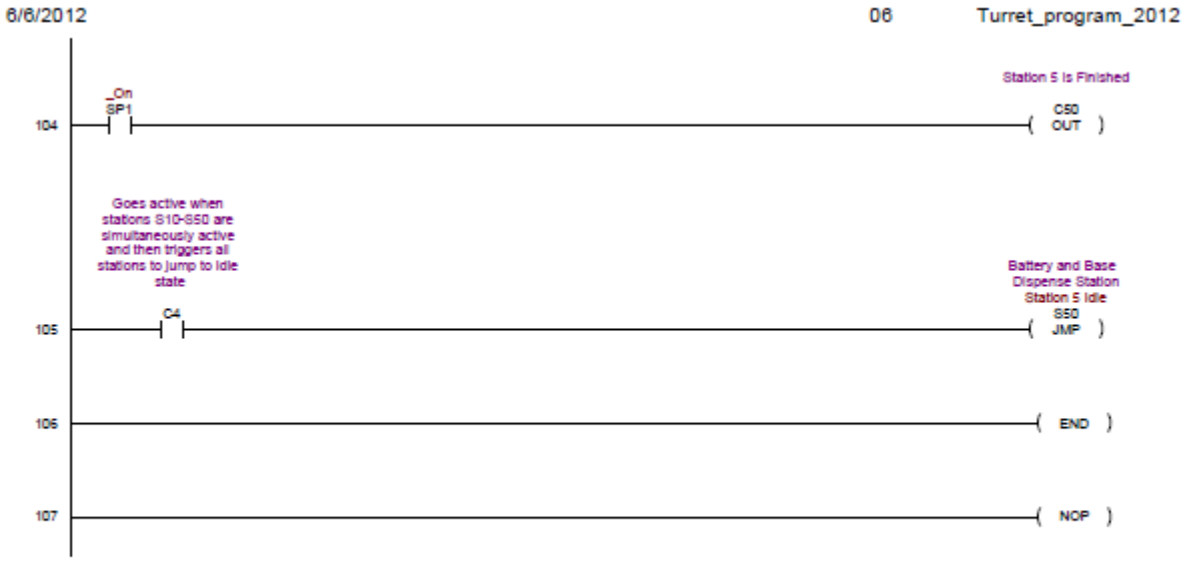

SG
Rotate and press washer into nose assembly
S33
56
_On
SP1
TMR
T33
K10
rotate s30
Y113
OUT
s30 suction
Y115
OUT
57
T33
TMR
T30
K10
upldown s30
Y112
OUT
58
T30
Raise sucker and return to ready position
S34
JMP
SG
Raise sucker and return to ready position
S34
60
_On
SP1
TMR
T34
K5
rotate s30
Y113
OUT
61
T34
Output C30 until C4 signal is recieved
S35
JMP
SG
Output C30 until C4 signal is recieved
S35
63
_On
SP1
Station 3 is Finished
C30
OUT


6/6/2012
06
Turret_program_2012
Goes active when stations S10-S50 are simultaneously active and then triggers all stations to jump to idle state
C4
64
Places fiberglass washer into the nose to secure the circuit and bulb
Station 3 Idle
S30
JMP
SG
O-Ring Dispense Station
Station 4 Idle
S40
Go state for stations
Go
C5
66
singulate and extend holder
S41
JMP
SG
singulate and extend holder
S41
_On
SP1
68
TMR
T41
K10
s40 singulate
Y116
OUT
s40 in/out
Y123
OUT
T41
69
dispense
S42
JMP
SG
dispense
S42
_On
SP1
71
TMR
T42
K10
s40 dispense
Y122
OUT
s40 in/out
Y123
OUT
T42
72
grab ring
S43
JMP


SG
grab ring
S43
74
_On
SP1
TMR
T43
K5
s40 open/close
Y117
OUT
s40 in/out
Y123
OUT
75
T43
retract holder
S44
JMP
SG
retract holder
S44
77
_On
SP1
TMR
T44
K5
s40 open/close
Y117
OUT
78
T44
go down
S45
JMP
SG
go down
S45
80
_On
SP1
TMR
T45
K10
s40 up/down
Y121
OUT
s40 open/close
Y117
OUT
81
T45
release
S46
JMP


SG
release
S46
83
_On
SP1
TMR
T46
K10
s40 up/down
Y121
OUT
84
T46
go up
S47
JMP
SG
go up
S47
86
TMR
T47
K5
87
T46
done state for s40
S147
JMP
SG
done state for s40
S147
89
_On
SP1
Station 4 is Finished
C40
OUT
Goes active when stations S10-S50 are simultaneously active and then triggers all stations to jump to Idle state
90
C4
O-Ring Dispense Station
Station 4 Idle
S40
JMP
SG
Battery and Base Dispense Station
Station 5 Idle
S50
Go state for stations
Go
C5
92
S51
JMP


SG
S51
94
_On
SP1
TMR
T51
K15
Y126
OUT
Y131
OUT
95
T51
TMR
T151
K15
Y127
OUT
96
T151
S52
JMP
SG
S52
98
_On
SP1
TMR
T52
K10
Y131
OUT
Y126
OUT
Y130
OUT
99
T52
S53
JMP
SG
S53
101
_On
SP1
TMR
T53
K10
102
T53
S54
JMP
SG
S54


6/6/2012
06
Turret_program_2012
Station 5 is Finished
_On
SP1
C50
OUT
104
Goes active when stations S10-S50 are simultaneously active and then triggers all stations to jump to idle state
Battery and Base Dispense Station Station 5 Idle
C4
S50
JMP
105
END
106
NOP
107