KILLER BEES 33

2014

DESIGN BINDER

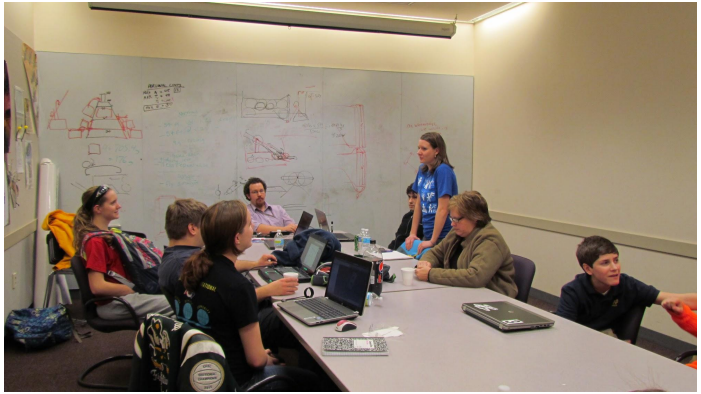
BUZZ XIX

INITIAL DESIGN PROCESS

After Kickoff, we immediately began the design process by reviewing the game rules with the entire team. During this step, we also looked over the field specifications. We continued development by determining primary functional objectives for the machine. These were determined by analyzing cost and benefits of game tasks relative to point value. Simulated matches, with team members as the robots, provided valuable insight into timing and potential gameplay. Some of the primary functional objectives that were derived from these discussions included:

- Throw into high goal
- Catch the ball
- Shoot at multiple spots
- Pass to other teams
- Collect from the floor
- Throw over the truss
- Robust
- Drive fast
- Quick processing
- Score in the low point goal
- Spit the ball out
- Play good defense
- Quick shot turnover
- Reliable Shot
- Low center of gravity
- Be agile
- Score extra balls quickly
- Score extra balls quickly
- Simple
- Multiple auton programs
- Align to the wall for shooting
- Collect ball while driving full speed
- Shoot while moving
- Catch own throw

DEVELOPMENT OF DESIGN



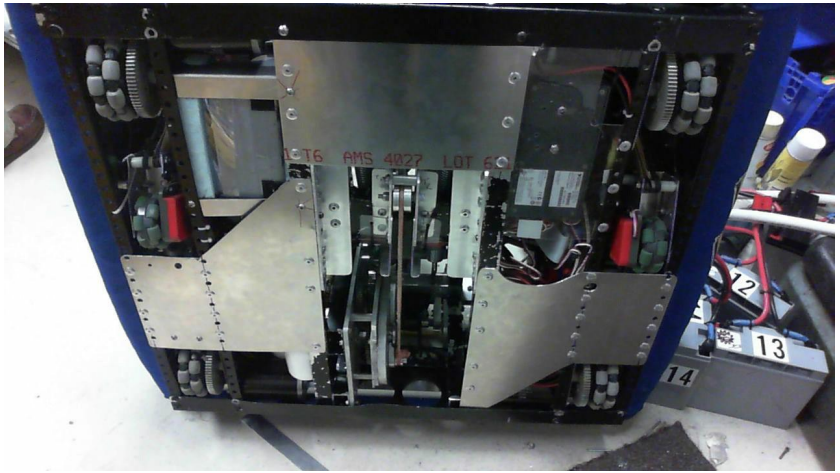
During week one, we were able to hold brainstorming sessions in Chrysler's Innovation Space. Widespread availability of projectors and whiteboard allowed students and mentors to convey design concepts and ideas to the entire team. At this time, a list of functional objectives was compiled for the machine. The CAD process also began in this space, which allowed for younger students and mentors to easily collaborate on the design process. Mentors and students began the prototyping process in various sections, such as the catapult, catapult release, collector, catching mechanisms, and chassis.

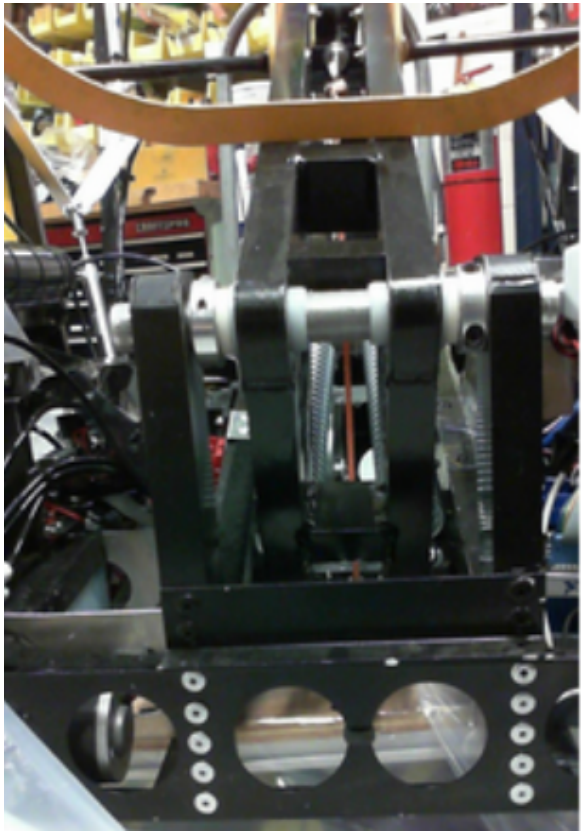
CHASSIS DEVELOPMENT

The chassis is a key part of the design of our robot. Our chassis is designed for optimal acceleration and quick field maneuverability. We chose a 4 wheel omnidirectional drive train, inspired by FRC Team 148 (2013) and Build Blitz's Team JVN. The omnidrive is lighter, more efficient, has little turning scrub, is difficult to play defense on and requires less torsional stiffness.

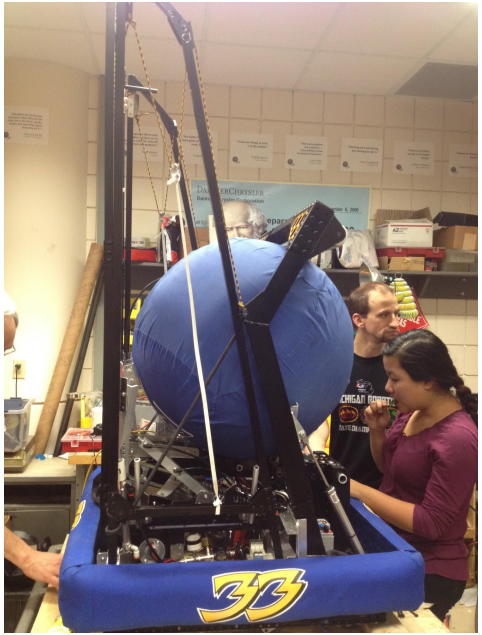
CHASSIS SPECS

- 28” x 28” chassis frame
- x4 direct drive CIMs
- x4 VEXpro 4’’ omni wheels
- Gear Ratio: 11:70
- Speed: 14 ft/sec





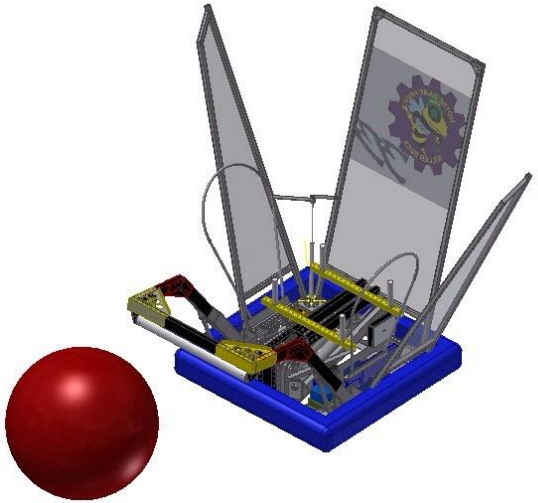
CATCHING DEVELOPMENT

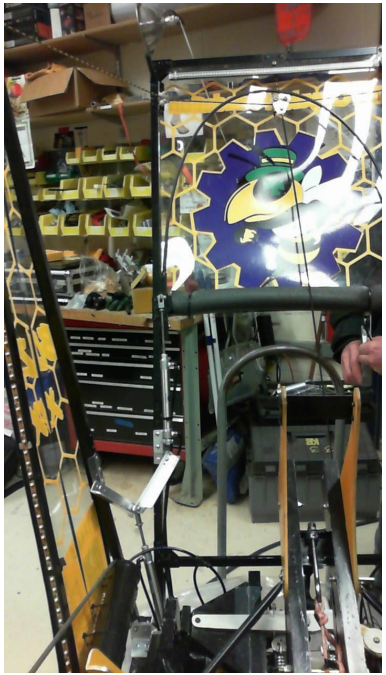


In order to develop an effective catching mechanism, we built a kit bot chassis with a large catcher that funnelled the ball into a spot as low on the robot as possible. We came to the conclusion that in order to catch the ball more accurately and securely, we would need pivoting “wings”. In addition, we recognized the need to stabilize the ball as it sat in the catapult cradle, especially when the collector was down. A hoop of fiberglass rod, activated by two pistons, clamps the ball and secures it in the cradle.

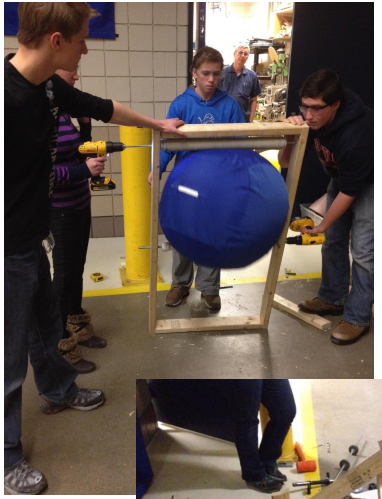
CATCHER SPECS

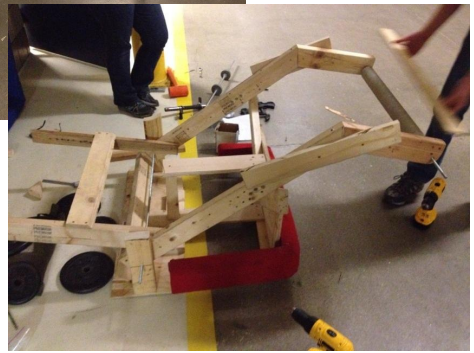
- Height: 59”
- Deploys quickly to catch balls and minimize bounce-outs
- String pulley system slaves the side and back panels together
  - 550 paracord
- x4 4” pistons open/close wings
- Bungee attached to the collector assists pneumatics.
- x2 5/8 fiberglass rods help contain the ball before it settles.





COLLECTOR DEVELOPMENT

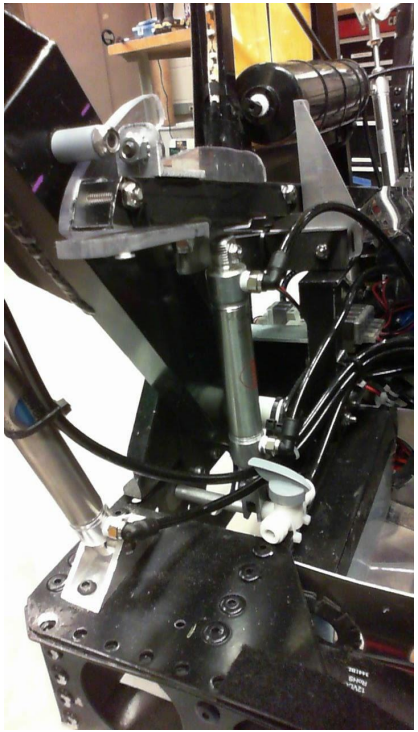




Functional objectives for the collector included the ability to collect while moving, gently “pass” the ball to another robot, collect balls that approach the robot at angles, and serve as part of our catching apparatus. Initial prototypes experimented with both straight and bent-arm models. The bent-arm model proved to be most effective for collecting balls approaching from the sides. The team worked to find the optimal roller height for collecting from both sides and front of the robot and the optimal angle for the bend in the arm. In addition to arm structure, prototypes tested various roller and wheel surfaces. Both 4” and 2” wheels had difficulty collecting balls from the side. A continuous PVC roller with anti-abrasion gum rubber covering was most effective.

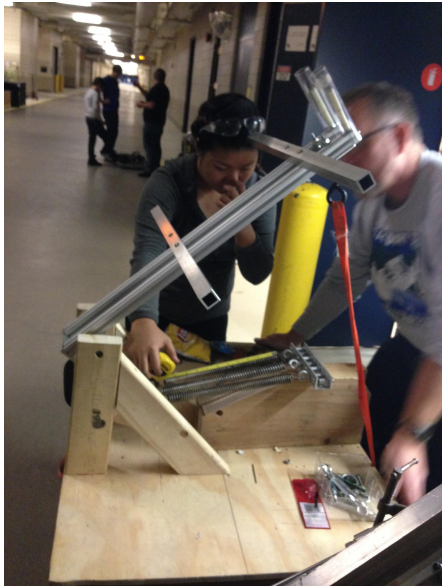
SHORT SHOT MECHANISM

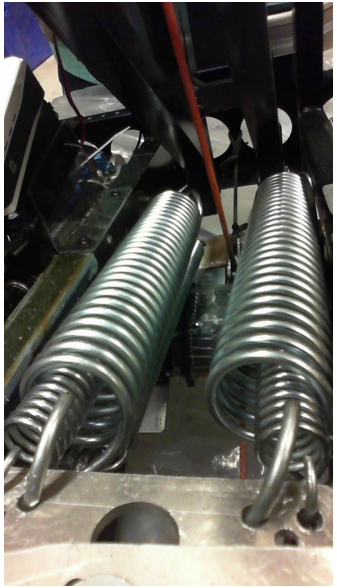
Being able to make a short shot is imperative to the game play and robot versatility. In order to accomplish the task, we brainstormed ideas such as adjusting the shot angle with the upstop and adjusting spring tension. However, we concluded that we can do a “pop shot” by deflecting the ball off of the collector. After making sure our collector could withstand the force of the ball, we tested different heights of the collector to see which would produce the optimal deflection. In addition, striking the collector adds topsin to ball, allowing it to more easily score if it contacts the goal in any way.



- Specs:
  - x2 2” pistons
  - custom hooks to lock collector into place

CATAPULT DEVELOPMENT

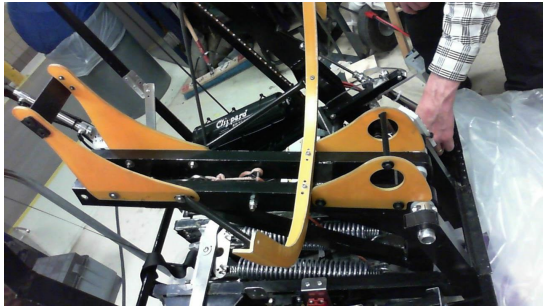


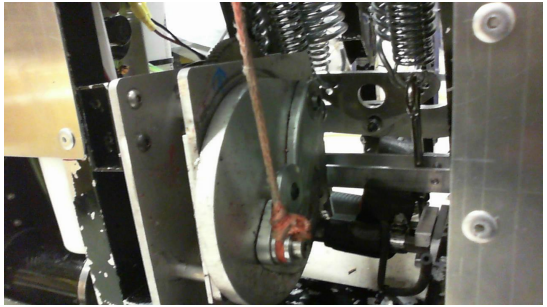


At the beginning of the season, we established multiple objectives for the catapult, such as being able to make a short shot and a full court pass. Throughout the prototyping process, it became apparent that we needed more spring force than we had immediately available. In order to achieve the spring forces we needed, we used extension springs, surgical tubing, and even a large compression spring. We discovered that cradling the ball to its circumference provided the most consistent flight path. We also found that a seatbelt would not stretch over time and would be a reliable upstop.

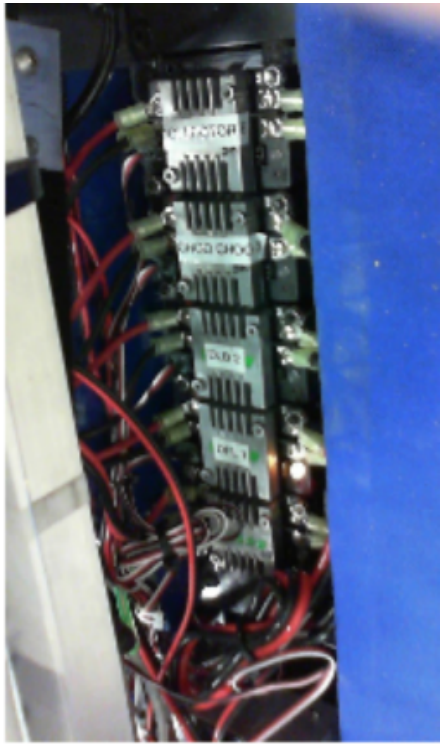
CATAPULT SPECS

- Spring tensioner: CIM with VEXpro Versa Planetary Gearbox
  - Gear Ratio: 60:1
- x6 springs, total of approx. 900 lbs of spring force
  - x2 18 lbs/in large springs
  - x4 9 lbs/in medium springs
- Rollover “choo-choo” cam w/ interlocking flail/hub design
  - final drive: 160:1 ratio
  - CIM with Dewalt transmission: bi-directional roller clutch prevents backdriving
  - Custom bearing from flail to crank, maximizes torsional rigidity
  - Optimization of thrust faces (gearbox face for crank, crank for flail)
- Dyneema cord: 8000 lb load





ELECTRONICS AND PNEUMATICS

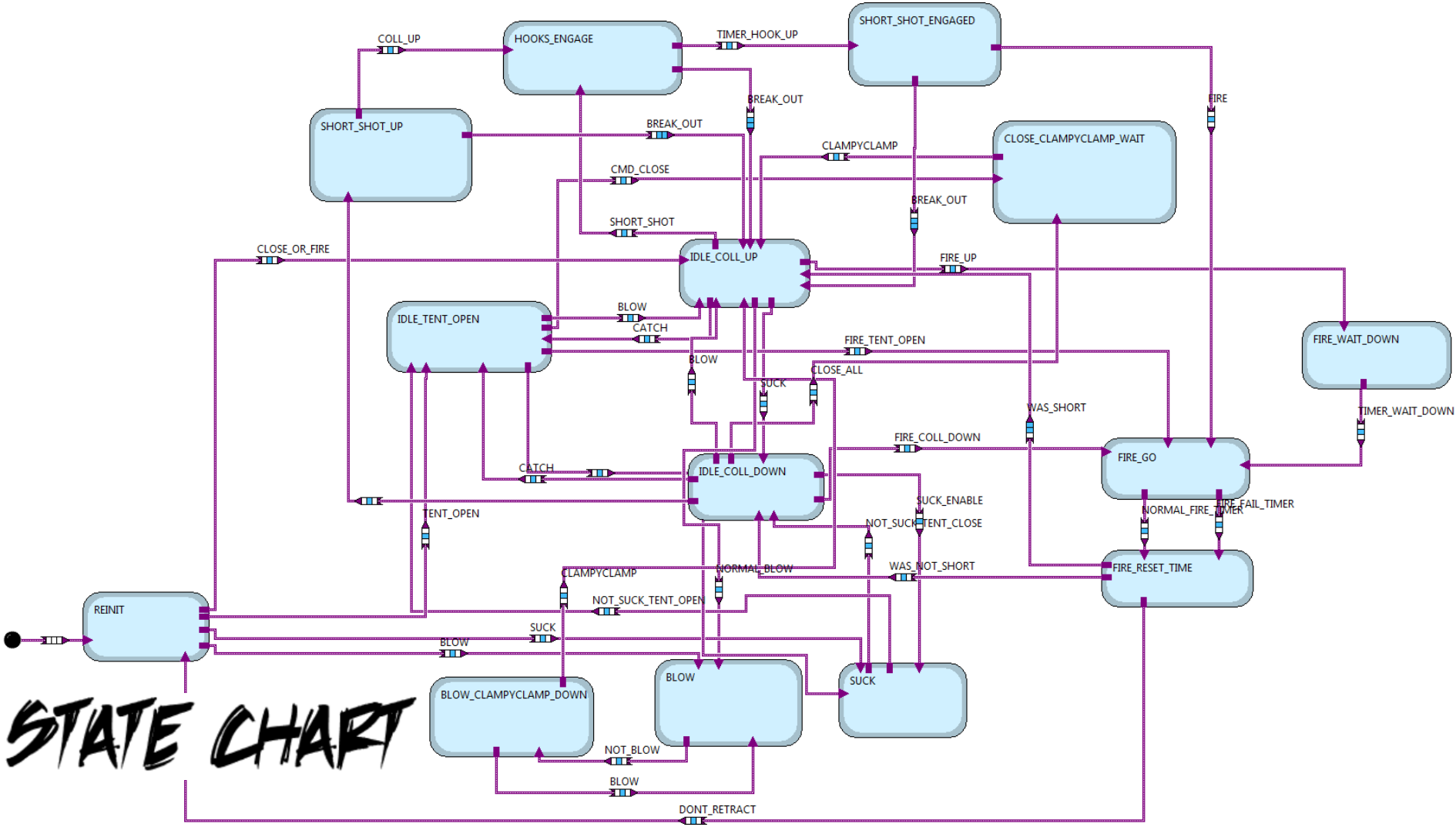


- Placement of cRIO, PD board, and Talons was rendered in CAD prior to assembly.
  - x8 Talons
    - x1 release motor, x1 tensioner motor, x4 drivetrain motors, x2 collector motors
  - x1 Spike (On-board compressor)
- Pneumatics are integral to our design. They are optimized for all mechanisms on the robot to provide quick actuation for catching, collecting, and shot selection.
    - x2 5” Pistons (Collector)
    - x4 4” Pistons (Ball clamp, catching)
    - x2 2” Pistons (Short shot mechanism)

PROGRAMMING AND LOGIC

- Absolute encoder used to detect angular position of rollover cam (choo choo)
- Optical sensor mounted on the front of the catapult z-frame used for ball detection
- Spring potentiometer used to calibrate spring tension
- Limit switch to detect collector state
- x2 VEX Optical Shaft Encoders mounted on 2” VEX omni wheels used as follower wheels for encoders

The state machine manages all robot operations, aside from the drive train. This allows for complex interactions between the various subsystems to be easily coordinated within the programming.


HOOKS_ENGAGE
SHORT_SHOT_ENGAGED
SHORT_SHOT_UP
CLOSE_CLAMPYCLAMP_WAIT
IDLE_COLL_UP
IDLE_TENT_OPEN
FIRE_WAIT_DOWN
FIRE_GO
IDLE_COLL_DOWN
FIRE_RESET_TIME
REINIT
BLOW_CLAMPYCLAMP_DOWN
BLOW
SUCK
COLL_UP
TIMER_HOOK_UP
BREAK_OUT
FIRE
CLAMPYCLAMP
CMD_CLOSE
SHORT_SHOT
CLOSE_OR_FIRE
FIRE_UP
CATCH
FIRE_TENT_OPEN
CLOSE_ALL
WAS_SHORT
TIMER_WAIT_DOWN
FIRE_COLL_DOWN
TENT_OPEN
SUCK_ENABLE
NORMAL_FIRE_TIMER
FIRE_FAIL_TIMER
NOT_SUCK_TENT_CLOSE
WAS_NOT_SHORT
NORMAL_BLOW
NOT_SUCK_TENT_OPEN
NOT_BLOW
DONT_RETRACT
STATE CHART