

September 10, 2019

Excerpts of the report by fluidfreeride engineer in relation to caliper malfunctioning of Mercane WideWheel electric scooter

Problem:

Several users have reported brake failures centered around the brake caliper. The typical symptoms are: 1) the brakes reportedly suddenly stop working, 2) there is a snapping motion and sound from the caliper when the caliper arm approaches the cable adjuster, 3) the lever arm sticks in the forward position and it can be returned to the rearward (resting) position by hand.

Materials reviewed:

Reviewed several customer videos that show a problem with the disc brake caliper on the Wide Wheel electric scooters. Reviewed descriptions of the problem written by customers, and descriptions of issue supplied by the manufacturer. Examined the brake caliper on a used, in-tact Wide Wheel scooter. Examined two new “good” calipers and one used “defective” caliper.

Terminology:

In order to better communicate what is occurring, below four pictures of a new caliper along with annotations that show key parts along with common terminology. See figures 1, 2, 3 and 4.

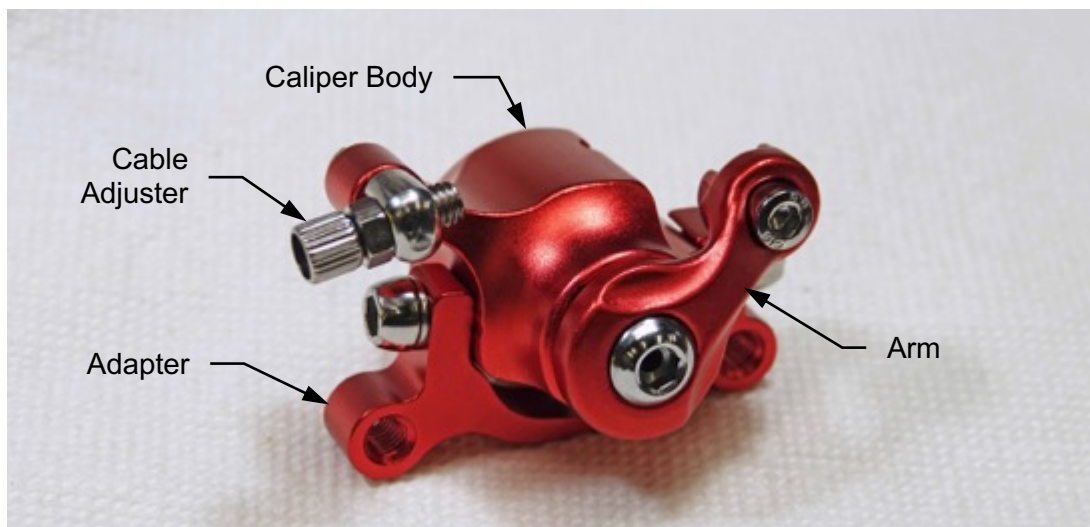


Figure 1 Caliper.

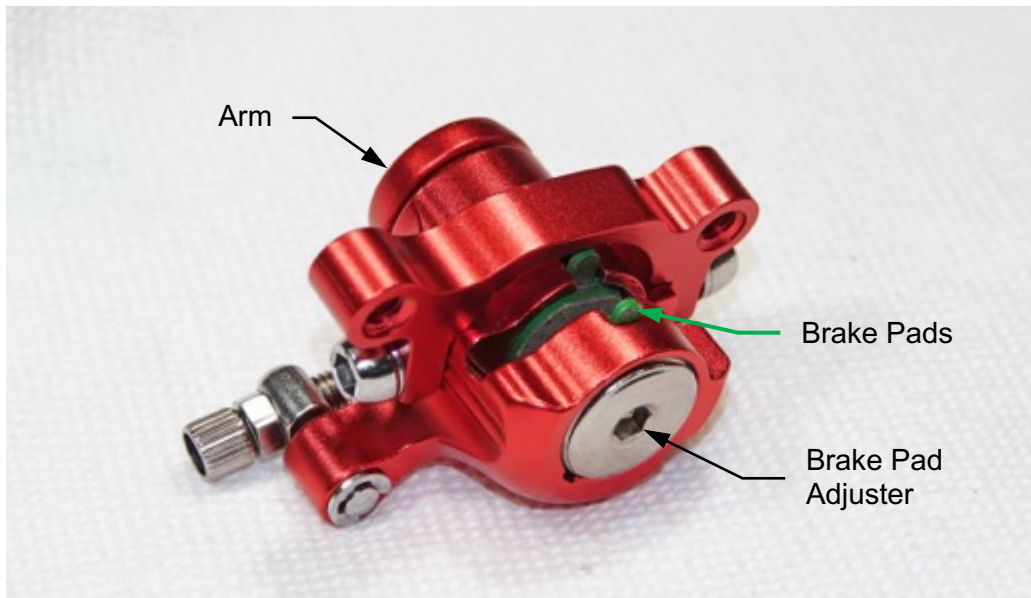


Figure 2 A Caliper, viewed from the inboard, underside.

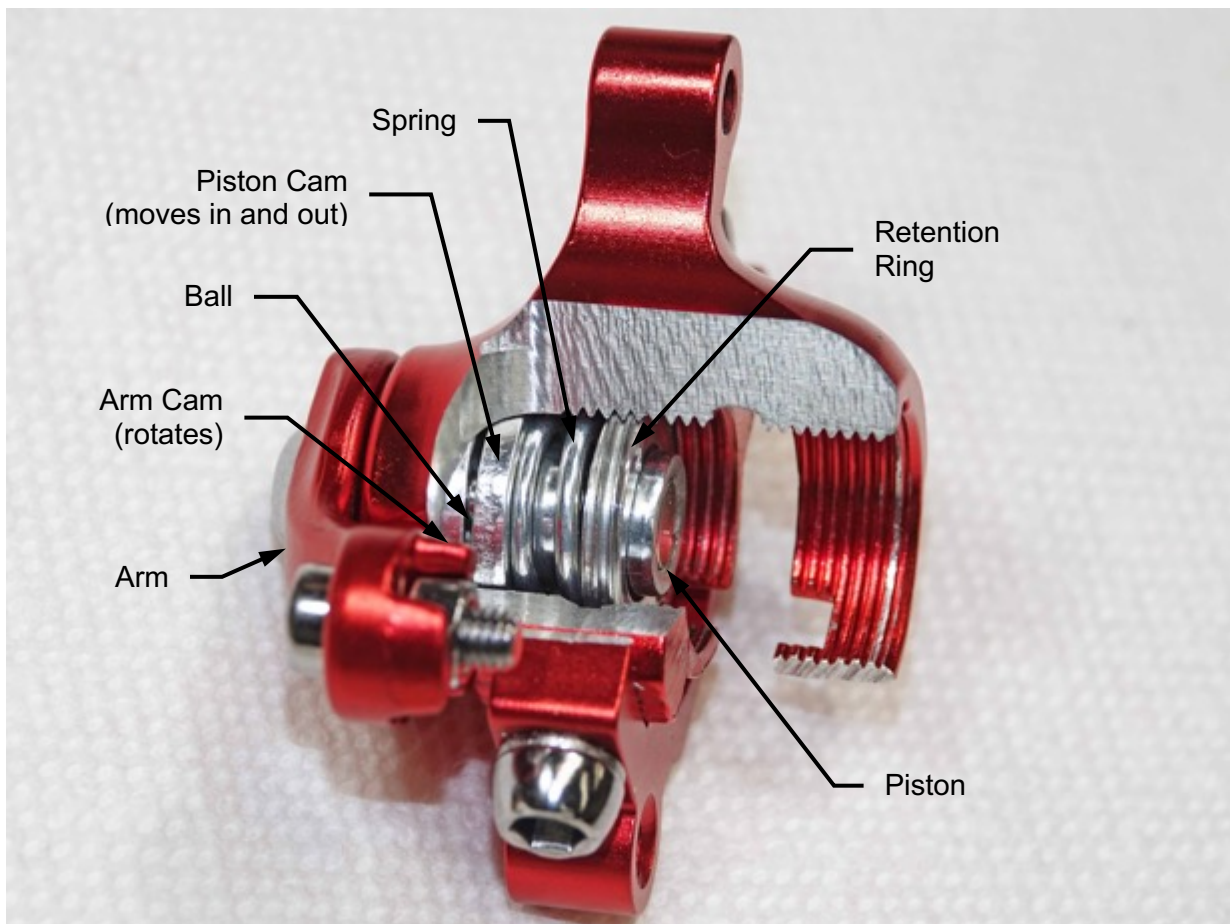


Figure 3 A sectioned caliper.

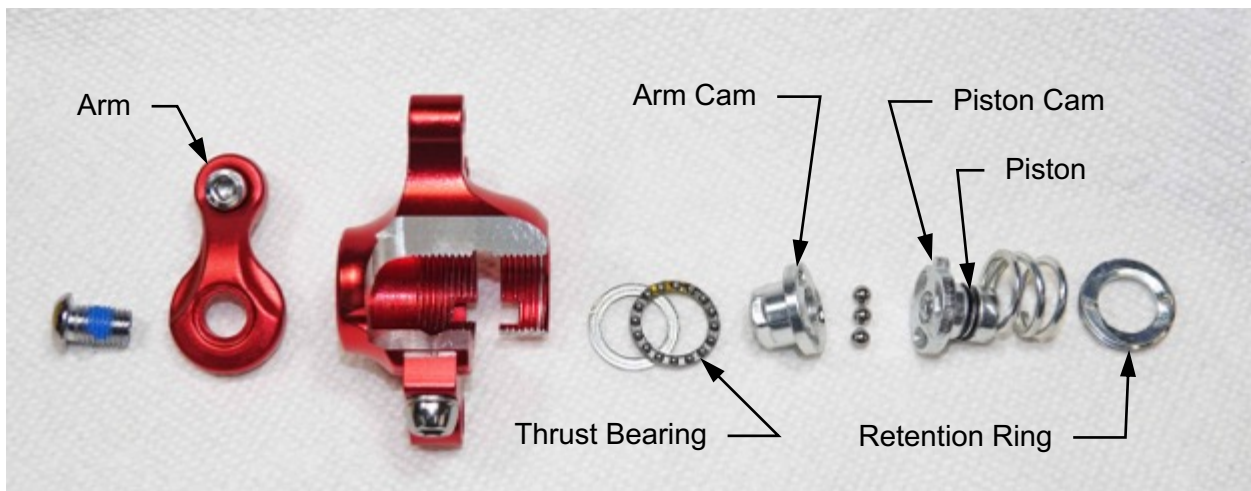
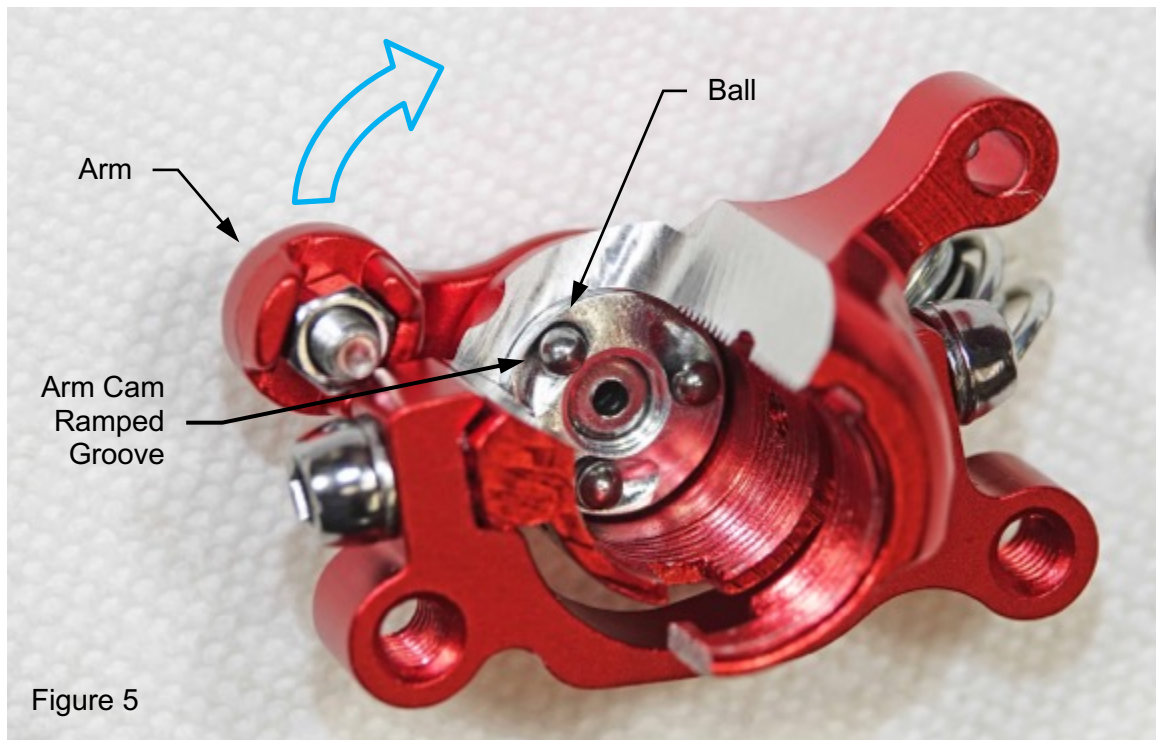


Figure 4 A disassembled caliper.

Operation:

1. The Arm is directly attached to the Arm Cam. Pulling on the Arm causes the Arm Cam to rotate.
2. The Piston Cam is guided so that it cannot rotate but it is free to move axially (in and out).
3. The Arm Cam and Piston Cam have faces with ramped grooves. See figure 5. Three ball bearings fit into the grooves. As the Arm and Arm Cam are rotated, the balls ride up the ramped grooves causing the piston to move towards the rotor (disc).



4.

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5. The spring keeps the Arm Cam, balls, and Piston Cam in contact with each other and encourages the piston to remain in the retracted position. This mechanism also encourages the Arm to return to its resting position.
 6. The Retention Ring keeps the spring, Piston Cam, Arm Cam and thrust bearing retained inside of the caliper housing.
 7. Most importantly, the axial position (or tightness) of the Retention Ring determines how far the Piston and the attached Piston Cam can move. See figures 6 and 7 below. The limit is reached when the spring binds, or is fully compressed against the Retention Ring.
 8. If the Piston Cam is allowed to move too far towards the Rotor (disc), the balls can ride up out of the ramped grooves, causing the snapping, sticking, and the inability to increase the braking force.
 9. When the Retention Ring is installed too loosely, the Arm correspondingly can be observed to move excessively forward, closer to the cable adjuster.

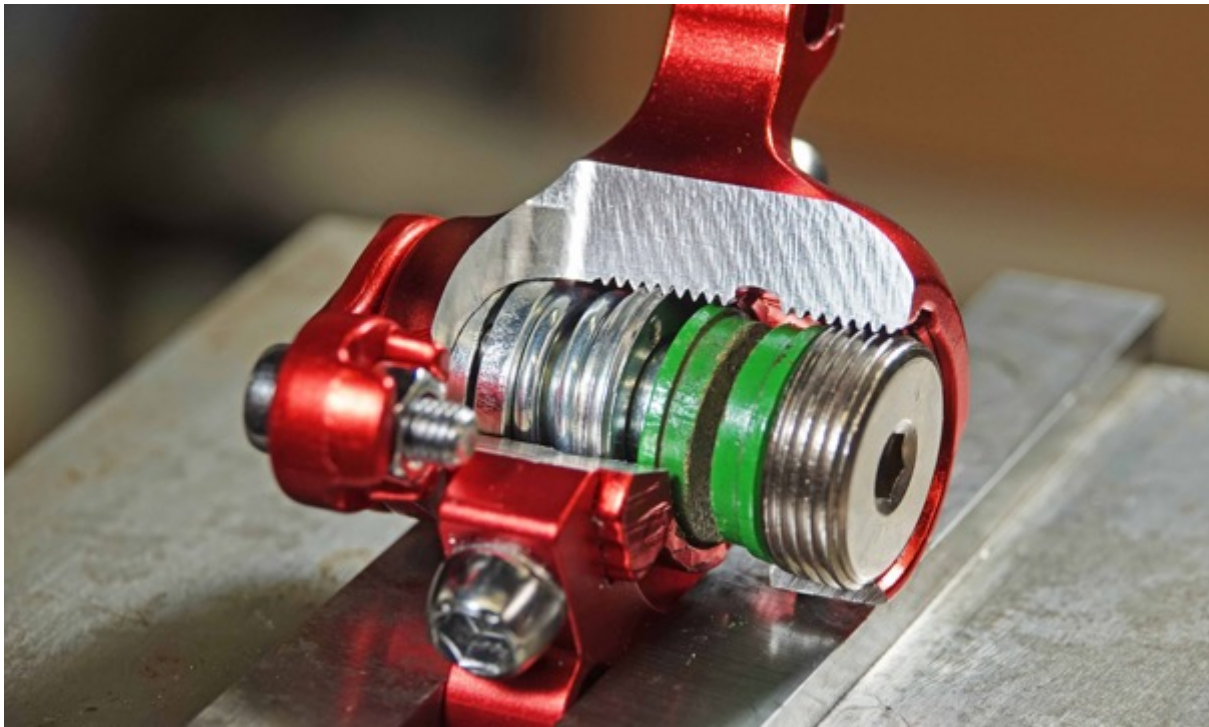


Figure 6 Arm in the relaxed position.

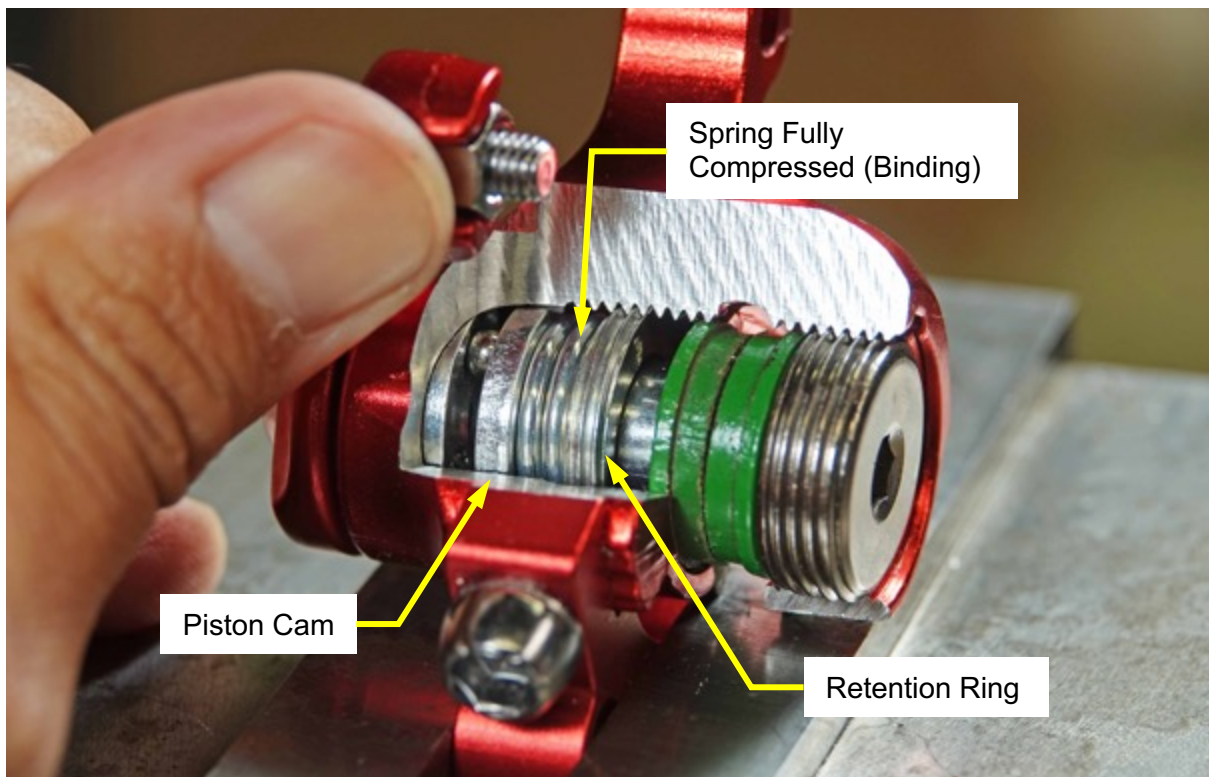


Figure 7 Arm in the fully actuated position.

Findings:

The problem is caused by improper installation of the retention ring during assembly of the caliper at the factory.

When the Retention Ring is backed out too much during assembly, the Piston is allowed to move inward (towards the rotor) more than the design is intended for which results in the three ball bearings riding up and out of the ramped grooves in the faces of the Arm Cam and the Piston Cam. Figure 8 shows the face of the Piston Cam on a defective caliper. Note the grease tracks which indicate that the balls had ridden up and out of the ramped grooves and onto the relatively flat face of the cam.

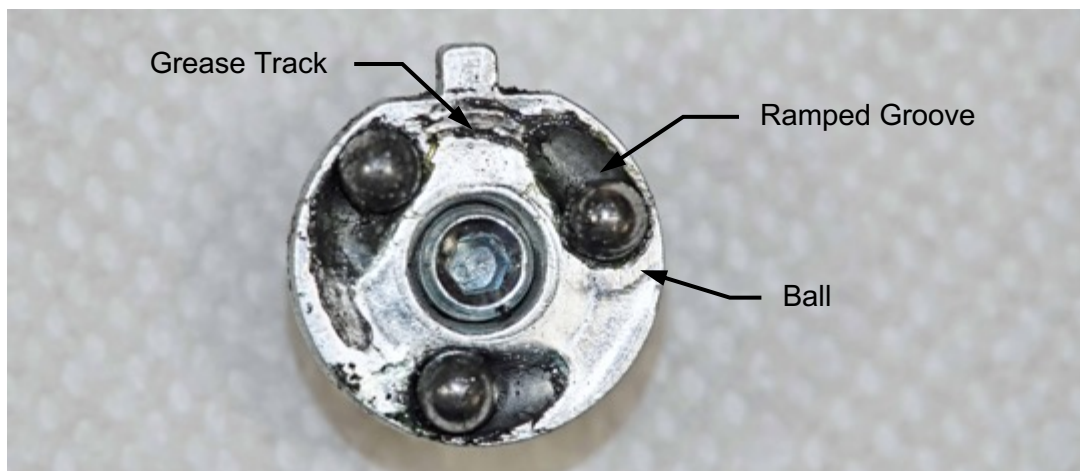


Figure 8 The face of the Piston Cam from a defective caliper.

The snapping sound occurs when the balls ride up out of the ramped grooves and onto the relatively flat cam face.

The relatively flat cam face also explains why the mechanism sticks. In conjunction with the spring, the ramped grooves provide for the return action of the Piston and Arm. When the balls are on the flat portion, the return mechanism does not work. The Arm can be rotated manually and returned to the resting position, which re-seats the balls.

The loss of braking, or the inability to increase braking force occurs when the balls are up on top of the flat portion of the cam faces. The axial (in and out) motion of the Piston depends on the angle of the ramped grooves. Without the ramped surfaces, further rotation of the Arm does not result in additional movement of the Piston.

The key solution here is to limit the axial movement of the Piston Cam so that the balls are never allowed to ride up out of the ramped grooves. This can be achieved by properly installing the Retainer Ring during assembly.