Europa S2 Alternate Master Cylinder - The Ford Courier MC

With new OEM Girling master cylinders no longer available, all Europa owners will eventually have to make the decision between re-sleeving and replacing the stock master cylinder when it comes time to rebuild the master cylinder. Rather than playing Russian roulette with re-sleeving, I chose to go with replacement. My first choice was the well documented Datsun/Nissan F10 MC. With the Datsun/NissanF10 master cylinders becoming nearly impossible to find in stock, I stumbled across the master cylinder used in the 70s vintage Ford Courier and Mazda B1600 P/U trucks in a posting by Doug Shepard on the Europa mail list as a possible candidate.

These master cylinders are still readily available from various brake component manufacturers. The one that I purchased was a Cardone 13-1777 dual circuit; 0.75" bore MC with integral reservoir. The outlet ports on the same side as the stock Girling and has a north/south orientation for the mounting flange.



Preparation

The master cylinder linkage extension box needs to be removed for this modification. Although the linkage box can be removed from the front with the closing plate attached, it is highly recommended that the closing plate be removed to aid in re-installation of the linkage box. Disconnect the brake lines from the MC and remove the stock Girling MC at this point if desired, although the MC can be removed after the linkage box is removed, on the bench. Remove the four 5/16-24 bolts attaching the linkage box to the backing plate (located inside the front chassis) with a $\frac{1}{2}$ " socket and wobbly extension. As a note, the top right bolt is impossible to get a socket on from the front due to clearance issues with the steering rack. I had to reach in from the wheel well and slip the socket on by hand then attach the extension from the front. After ensuring that the clevis pin has been removed from the brake pedal, pull the entire linkage box assembly out from the front the linkage box assembly and pull the linkage assembly from the linkage box.



Modification

The first issue encountered is the spacing of the mounting holes. The OEM spacing of the mounting bolts is 2.25"; the Cardone is approximately 2.3". I used a die grinder with a carbide rotary burr bit to elongate the inside of each hole. It does not take much grinding to make the mounting holes fit. No other modification is necessary; The Cardone fits perfectly onto the stock S2 brake linkage box once the holes are elongated.

The second and most critical issue is the Girling OEM pushrod arrangement. As is, the OEM pushrod arrangement will physically fit into the bore and work with the Cardone but the primary piston of the Cardone does not have the matching hemispherical recess to accept the head of the Girling pushrod. This will cause the piston to be pushed in a few millimeters when the Girling pushrod is locked into position with the circlip into the Cardone. In effect, all pedal free play is lost and in my case, brakes started locking up within 2 miles of a test drive.



The solution is to change out the OEM pushrod for an adjustable threaded pushrod and clevis assembly. Clevises are available from Pegasus and McMaster-Carr. Threaded pushrods are available from Pegasus.

The pushrods need to be modified by grinding the heads down to the same diameter as the bolt. The modified pushrod will then fit into the 1" long cavity of the primary piston.



The third issue is providing a mechanical stop for the brake pedal. With the OEM Girling MC, the pushrod captured by the washer and snap ring in the MC bore. With the Cardone, nothing restrains the pushrod from being pulled out of the MC. My solution is to secure a $1-\frac{1}{2}$ " fender washer to the brake operating rod. The washer provides the mechanical stop for the brake system and allows free play adjustment using washers behind the fender washer. Installing a mechanical stop is essential for this modification.



The Ford Courier service manual recommends 0.12"-0.34" free play at the pedal.

The fourth issue is the need to run new brake lines from the Cardone MC to the stock three way junction due to the Cardone MC having non banjo type metric fittings. The Cardone uses M10x1.25 fittings with double flare, the stock end at the three ways junction uses 3/8-24 with bubble flares.

Road test

My short 12 mile road test with several hard braking stops from 55 mph was very positive. The brakes were a little spongy due to some air still left in the lines from insufficient bleeding but had no problems stopping the car from 55 mph. I could detect no binding of the pushrod with the MC; brake operation was smooth and positive. I will update this section with a long term report after several thousand more miles on the car,

Random thoughts and helpful hints

For those without access to a mini lathe, a bench grinder in conjunction with a portable drill works well in grinding the pushrod to a uniform tip. Secure the pushrod in a portable drill and grind the head with the drill running in the opposite direction as the grinder. Polish the head in a bench drill press and Emory cloth till the head is smooth. As a note, threaded pushrods from Pegasus cost \$15, grade 5, 4" long 5/16-24 hex head bolts from a hardware store cost \$1.20. Either one can be used.

The Ford brake system on the Courier was designed to use a long single rod from the brake pedal to the master cylinder. On the Europa, the arc that the pushrod makes from rest to full travel within the bore of the master cylinder is a major concern due to the possibility of the rod binding inside the bore of the primary piston. Without changing the stock pivot point, I believe that keeping the pushrod fairly short will minimize any chance of the rod binding with the primary piston. The second concern is achieving full pushrod travel during brake actuation without the clevis hitting the back of the MC bore. I'm using approximately 4" from the tip of the pushrod to the centerline of the pivot. This length provides a smooth operation and full length rod travel on the bench. Full travel of both primary and secondary pistons in the MC is only necessary to achieve full bench bleeding of the MC. Verify pushrod travel by bolting on the MC to the linkage box with proper torque and observing the pushrod from the rear of the linkage box as the brake operating rod that is connected to the brake pedal is pushed in. If travel length is satisfactory, remove the MC, mark the position of the pushrod in the clevis, apply thread lock to the pushrod, and then screw in to its permanent position.



Although one Europa owner has used the Girling pushrod with the Cardone with no evidence of brake lockup (so far), I highly recommend not doing so. From my understanding of master cylinder operation, the seals maintaining hydraulic pressure are just scant fractions of an inch away from the return ports connecting the bore to the reservoir. Even if the return ports are just partially blocked, this may eventually cause brake lockup over time.

A side benefit of the Cardone is that the reservoir cap has the same threads as the Girling; result the Sovy device will fit the Cardone. I do not plan on using the Sovy canister on my S2 so can't verify that the threads will provide a leak proof fitting.

In purchasing the M10x1.25 fittings for the Cardone, get the shortest fittings that you can find. The longer fittings that I fitted reduced the clearance between the brake line loop and spare tire.

Toyo Kogyo (Mazda) manufactured the Courier for Ford. Mazda also concurrently marketed their mini P/U truck, the B1600. Not verified, but I'm assuming that the master cylinder from the Mazda B1600 will also work with this modification.



Disclaimer

I am neither an automotive engineer nor a professional auto tech. My procedure modifies the braking system from the stock system designed by young and bright Lotus engineers. Take all that I have written with great skepticism and a large grain of salt. There may be issues in my modification that I'm not aware of and which may cause great bodily injury or death. Use this modification at your own risk as no long term testing has been done and please good mechanical common sense.