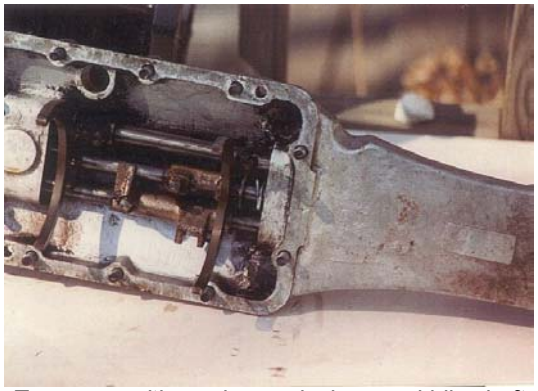
The Box of Mossy Gears

by: Rob Reilly (of Engine List Fame!)

Well, I had to go back to some very old files to find this. The reason it wasn't in the jag-lovers archives is that it happened back in '93/94 when we were on the old British cars list before jag-lovers was formed. I also wrote this up for the Classic Jaguar Association with a couple of drawings showing the gears in neutral with the stop pin and stuck in first without the pin, and it was published in the CJA bulletin for Sept/Oct 1996.

MEMO XK120 Moss Gearbox Problem
Date: August 31, 1993

My XK120 FHC (679187) got its first test drive with the original JH-type Moss gearbox on that day. Seemed a little difficult to get it into first and second, tendency to pop out of second. After about half a mile of driving around my neighborhood, it got stuck in first gear! Arrgh! Drove home a quarter mile in first and into the garage, and pulled the top cover off. The first gear was all the way back and the second gear synchro sleeve was all the way forward, allowing the six spring-loaded balls and one plunger/ball to come partially out and prevent the gears from returning to where they are supposed to be. I got lucky in that none of the balls fell out. With a hammer and prybar I got the gears back to neutral position without breaking anything.



Top cover with washer and wire on middle shaft added by DPO

On investigating further I discovered a spacer/washer on the 1st/2nd fork actuator rod that isn't in the parts list. It has the effect of reducing the rearward travel of the fork into 1st. Also, the locking wire on the setscrew for the 1st/2nd fork was a different color than all the other locking wires. Aha! Some Previous Owner has been messing with the fork, maybe to fix the same problem. Now to figure out what he did, he must have added the washer, maybe he replaced some parts with newer parts? I sought help from other Jaguar owners on the Internet.

A friend on the Internet suggested this diagnosis: "Take the top off the box and roll the car forward in 2nd gear...rotating into view you should see a soft metal pin/rivet/stop which is the over-engagement stop. This is likely to be considerably worn. The in-situ repair is to dob a blob of arc-welding on it and re-shape it to the original dimensions. Obviously you have to be very careful about gunk dropping into the gear-box during this procedure."

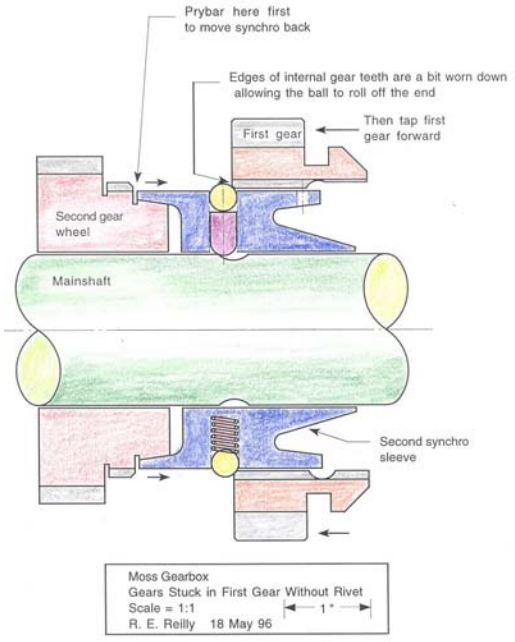
What I found was there is no stop pin/rivet at all, nor never was there in my gearbox.

Another friend suggested this remedy: "There seems to be a propensity for those Moss boxes to stick in first gear. You'll need a spacer (washer) at the back of the case to keep first gear from moving along the mainshaft too far. It's crude but effective. A friend has done it to the Moss box in his 1951 Morgan. No more trouble. Of course it requires removing and dismantling the box to install the spacer, whose thickness will have to be determined. I think it was in the .100" range."

Another friend wrote to me: "My '64 E-type shares the same (flawed) gearbox design as your 120 and has the same "stuck in first" problem as yours. My best guess is that the "stuck in first" problem is due to wear in the interlock mechanism, which should prevent the synchronizing sleeve from moving forward when first gear is engaged. I believe what happens is that when first gear is moved forward (disengage), the syncro

sleeve moves forward too-- just a bit-- which wedges the interlocking ball and plunger between the main shaft and first gear. Additional force on first gear now gets transferred through the interlock ball and plunger to the sleeve, which adds even more wedging pressure to the ball and plunger. Now the whole mess is locked up solid and no amount of reasonable force is going to make first gear budge.

My workabout solution in the E-type is to shove the gear selector all the way back in first and rattle it back and forth (with a little more force on the "back") until it suddenly is able to go to neutral as if nothing had happened at all. From the amount of force that results in no action, you'd be surprised at how light a shaking unsticks things. When first gear is fully engaged, the six spring loaded balls and the one interlock ball should protrude a bit from the syncro sleeve. You can measure what Jaguar designed in, and it's a frighteningly large percentage that hangs out! As long as the ball's point of contact is inside the syncro sleeve, I believe you're okay.



Pry first gear forward while pushing the syncro sleeve backwards."

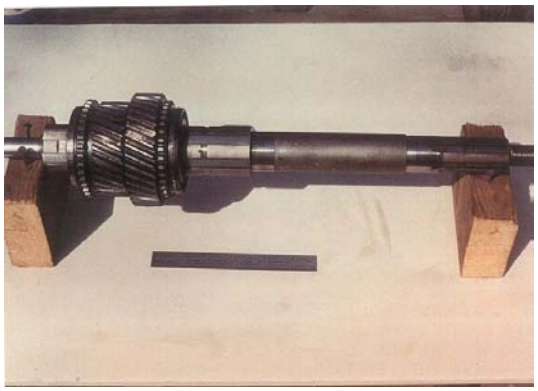
"You may wish to confirm also that the syncro sleeve can't move all the way forward when first is engaged. Take careful measurements between the syncro sleeve and second gear both in first, and while pressing the syncro sleeve forward (in neutral). Only in the later case should the sleeve be all the way forward. I too was told that this is a common problem and that the easy solution was to install a spacer on the 1st/2nd striking rod to limit rearward travel. I got this "fix" from the owner of a shop that exclusively worked on British cars, so you can probably guess lots of shops were willing to do this."

"Second gear. First make sure the problem isn't caused by the dreaded Previous Owner trying to solve the first gear problem. Has the striking rod plunger spring been cut short? Plunger okay? Fork bent by excessive force to get out of first? You may be able to check this out by shoving first gear forward, shifting the gearbox top assembly to second, and then fitting the top to the gearbox and noting alignment problems. Otherwise, it could be worn engagement splines on second gear, or worn roller bearings. I would bet your second gear problem is a bent fork from some gorilla trying to force it out of first."

Well, the E-type box is similar to the XK120, but not exactly-exactly the same. There are little differences/improvements as you go newer.

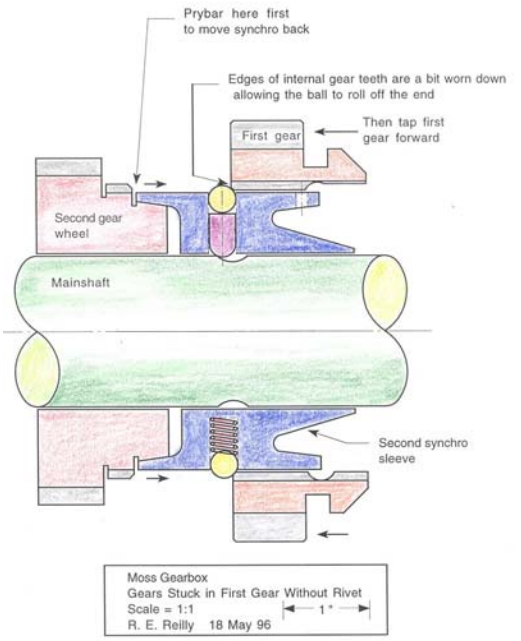
I borrowed a top cover from a 140 box with an OS number, slightly different forks, tried it, no difference in operation, still pops out of second, didn't dare try first. Then I took the top cover off my Mark 5, a JH box exactly the same as the 120. The same in second, and then I got stuck in first again. So I concluded there was a problem internally, maybe the plunger/ball combination was too short, allowing the second synchro sleeve to move forward when first was moving backward. That plunger came in three lengths, indicating that it's length is critical to the operation. It is a cylinder 5/16" in diameter, about 1/2" long and spherical on one end.

Next I pulled the gearbox out of the car. It comes out rather easily after removing the seats, floorboards and tunnel. I should mention a curiosity about the Moss box. It is one of the few places on a 120 where you need Whitworth wrenches.



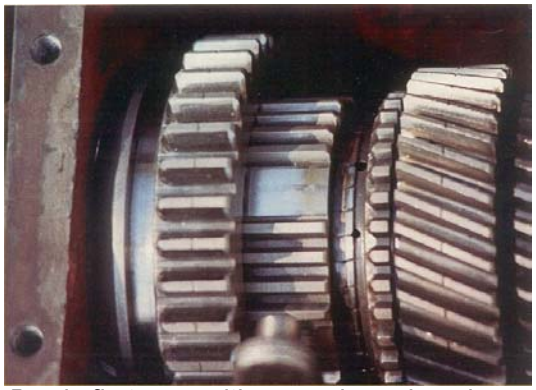
Mainshaft with damage forward of dimple caused by hammering on first gear

I took the gearbox apart and found that on the internal teeth of the first speed wheel with the relieved tooth, the unrelieved part of this tooth had been deformed into a furrow shape by the ball/plunger riding against it. There was a corresponding dimple on the mainshaft caused by the other end of the plunger. Thus I at least knew why it took a blunt nose chisel and a big hammer to get it out of first gear, and I now knew why the thing was popping out of second gear. That tooth was thus wider than it should be, and it was too wide to engage properly with the external teeth on the rear of the second gear wheel, thus preventing the first speed wheel from moving all the way forward into second gear engaged position. That wide tooth I filed off back to normal width, so it would go into second and not pop out anymore.

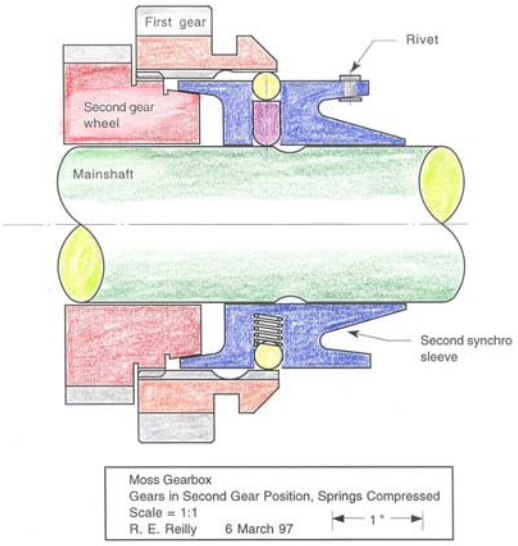


I now see it would have been better if I had tried to prybar the second speed synchro sleeve back to the rear, instead of beating the first gear wheel forward. The furrowed tooth and dimpled mainshaft appear to be due to my hammering. I thought these gears were supposed to be harder than a woodpecker's lips, but apparently not.

I decided to machine a relief in the tooth exactly opposite to the one relieved tooth, thus making the second tooth the same as the first tooth originally was. Then I could install the first speed wheel on the second speed synchroniser sleeve 180 degrees from where it was. These can go on the mainshaft any of six ways, so it would be necessary to assemble them in one of five ways so the ball/plunger will not pass over the damaged dimple on the mainshaft.



Box in first gear with second synchro sleeve pulled back by the stop pin, second gear wheel synchro cone visible



The internal cone of the second speed synchro sleeve and the external cone of the second gear wheel were burned and some metal has been abraded. This is likely due to the two trying to synchronise together while the thing was stuck in first gear, which they couldn't do because they were moving at different speeds. So now I regret having driven home that quarter mile stuck in first.

In studying my box of Mossy gears, I think I am faced with a combination of normal wear and a basic design flaw. They were working together to allow the second synchro sleeve to move forward when the first gear was too far back.

I also read through a stack of old EJAG News and Jaguar Driver magazines looking for anything on Moss boxes. I found a couple of gems:

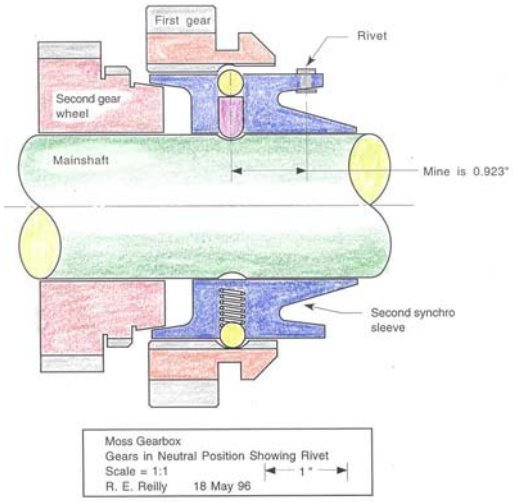
In Sept '87 EJAG, former Jaguar North America service rep Roland Pike said "The stop pin on 1st/2nd synchro is to prevent the sliding gear overrunning its position, allowing the balls to fly out. Heavy-handed gear shifting sometimes sheared off this pin, with the usual symptom being sticking in first gear. The condition could be alleviated by fitting washers on the selector rod in the top cover.

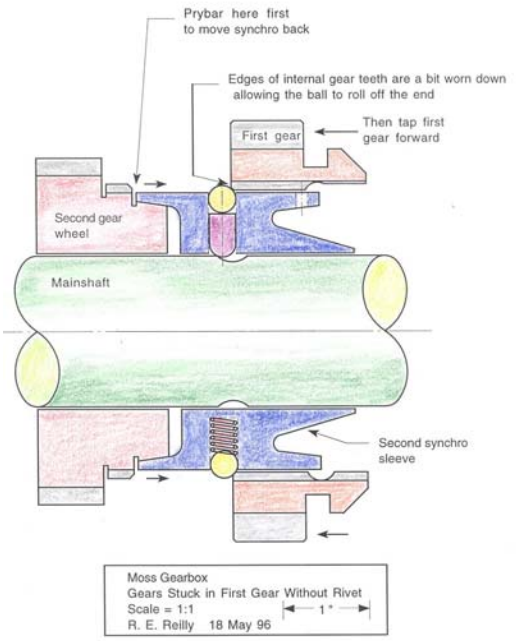
The interlock plungers are to disengage the synchro cone clutches, which tend to ride up in use and would otherwise break free with a clunk".

In Oct. '87 EJAG reported that in later SL and JL boxes there was a new 2nd synchro sleeve identical to the previous one, but with a stop pin added, and the new parts were to be used whenever repairing an earlier SH, SL, JH (my 120), or JL box.

Other than that, there seems to be virtually nothing written about these boxes which is why I decided to summarize my findings into one or two pages and publish it.

First to be explored was the possibility of a worn ball/plunger. The balls are all .3125" diameter. The plunger is .3122" dia. and .4895" long, with one spherical end and one flat straight-cut end. Adding the ball and plunger together = .802" The mainshaft is 1.645" dia. at the dimples.





The ID of the first gear at the peaks of the internal teeth is 3.250". That leaves a space between of .8025", so the problem is not a worn plunger.

Three alternative repair schemes were suggested:

1. A washer/spacer on the shifter fork actuator rod to limit fork travel

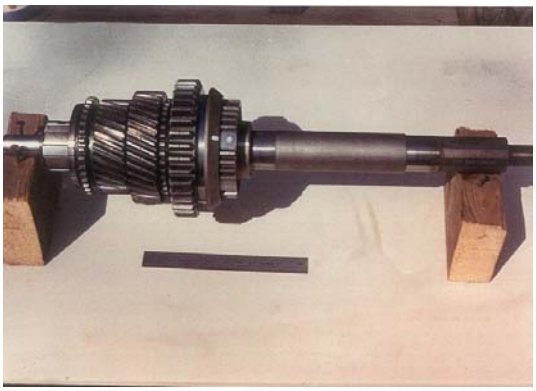
2. A washer/spacer on the mainshaft to limit first gear travel

3. A stop pin such as was incorporated in later boxes

A dilemma: I didn't want to reduce the amount of tooth engagement between the first mainshaft gear and the first idler gear on the countershaft (layshaft). Alternatives 1 & 2 would reduce tooth engagement. As it was now, from neutral the first gear must move .300" to the rear before it begins to engage the idler,

but if it moves back more than .900" in relation to the second synchro sleeve, the plunger ball pops partway out, allowing the sleeve to move forward, allowing the ball to pop out some more, allowing the sleeve to move some more, and we're stuck in first. Subtracting for the roundedness of the teeth, we have only around 1/2" of tooth face contact as is. Alternative No. 3 begins to look better.

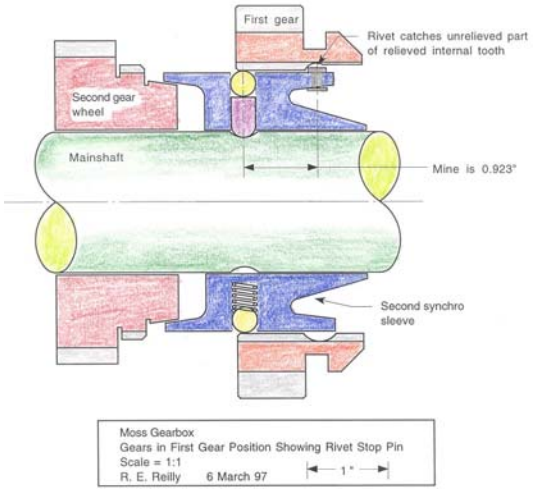
I examined a partially disassembled box from a Jaguar Mark 1 at a shop near me called JK Restorations, an E-type specialist.



Mainshaft with stop pin visible between paint marks in the second synchro sleeve

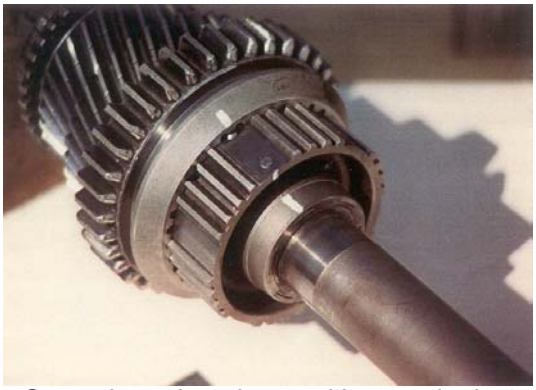
The stop pin is nothing more than an ordinary rivet, short enough to allow the relieved part of the one special internal tooth in the first gear to pass, but long enough to stop the unrelieved part of this tooth. This rivet has about a 1/8" diameter solid shank. It is stuck through a drilled hole in the outer "rim" of the second synchro sleeve, centered 3/16" from the rear of the rim, in line with the plunger hole, and hammered down a bit to keep it from falling out.

My plan was to try to drill a hole in my second synchro sleeve and put in a rivet, but first I had to double check the location was right for it to stop my first gear. Can't assume the Mark 1 is exactly-exactly the same.



The idea is to stop the first gear just short of where the ball plunger would roll off the forward end of the internal tooth. But that forward end is now a bit worn off from engaging second gear.

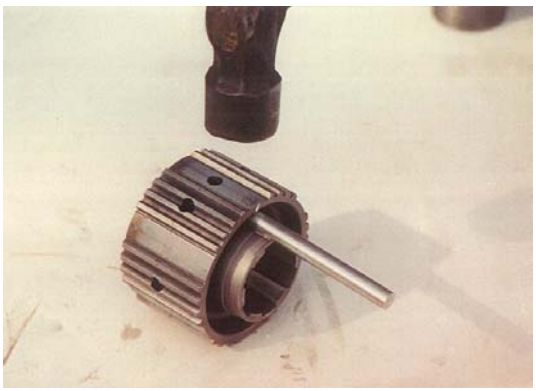
Anyway, I went to work on my Mossy gears.



Second synchro sleeve with stop pin rivet added between paint marks. This was added to all gearboxes from Dec 1952 to prevent overtravel when shifting into first; reference Service Bulletin No. 116

I determined that the hole for the stop pin rivet should be centered at 0.923" from the center of the plunger hole. This is based on my rivet being 0.141" stock diameter and being mashed down to 0.180" diameter.

Did I say something was harder than woodpecker lips? It's the second synchro sleeve. I could just barely scratch centerlines with my scribe, and the center punch just flattened its point when I tried to centerpunch for the hole. Ordinary high-speed drill bits didn't make a dent. I set up the sleeve in a Bridgeport mill, then used a letter O drill bit (0.316") to find the plunger hole center and set it to zero, then moved the table over 0.923". I used a carbide centering drill to start the rivet hole, then a carbide end mill to finish the hole.



Hammer and backing tool for flattening out the stop pin rivet in the second synchro sleeve

I installed the rivet by using a piece of steel ground into the shape of a wedge that would fit between the rivet head and the neck of the sleeve, then hammering out the shank to 0.180" diameter, then filing it down so the first gear wheel would just clear over it. I tapered the front edge slightly so it wouldn't stick. Feels right, and looks right.

Now to turn my attention to the problem of poor synchromesh in second gear. The second synchro sleeve and the second gear wheel synchro cones were worn, and some metal was built up in the grooves in the second gear wheel cone. I chipped this out, then tried them together. There is supposed to be a gap between the front face of the sleeve and the rear face of the wheel, but there was none. This meant the sleeve internal cone was worn so bad that it was not rubbing effectively on the wheel external cone, instead the vertical faces were rubbing. I put the sleeve in a lathe and turned off .025" off the front face. Now it seems about right. Then I lapped the cones together using valve grinding paste, rubbing them together until they seemed to "get a good bite" in the words of the manual.

I also looked at the front and rear shaft seals for the first time and discovered they are made of LEATHER!! They are marked "ANGUS", as in Aberdeen Angus. How quaint. I wonder, was there some connection with Skinners Union (SU Carburetters) or Chicago Rawhide (CR Industries, rubber seals)? I replaced them with new rubber seals.

The Mossbox went together, but not without incident. I nearly got bitten by a serious flaw in the official factory shop manual for XK120-Mark7, in the section on gearboxes. My 3rd/4th synchro sleeve has two plungers and two relieved teeth, one forward and one to the rear, and the 2 notches in the mainshaft are offset; thus it can go on the mainshaft six different ways but only one way is right. The manual says nothing about this little fact. It just says to assemble the sleeve to the mainshaft. Apparently the paragraph on assembling the 3rd/4th synchro only applies to the earliest SH type box, or maybe the whole paragraph was simply cut and pasted (not on a Macintosh, I mean literally by some office girl with scissors) from an earlier manual like the Mark 4 or SS100. If I hadn't noticed this I would have got the gearbox together and then not been able to shift into 3rd and 4th. In "Complete Official Jaguar E", I see they have added a couple of paragraphs and pictures explaining this in detail.

Another discovery I made was that you have to tighten the tailshaft nut all the way, thus pulling the mainshaft bearings to their proper places in the tailcase, and then back off on the nut just a bit to relieve the preload on the bearings. If you don't do this the mainshaft will be too far forward and the 2nd and 3rd gears will be out of alignment with the countershaft gears. Once again the manual says nothing about that.

Speaking of which, I have yet to see a well written manual for the Jaguar. I don't think the publishers of most common manuals get much feedback. They should open a support forum for their manuals.

A few questions I never got answers for:

1. Why is the gearbox called a "Moss" box? Who or what is/was Moss?

2. The trademark "G.G.Co." is stamped on just about all the gears and shafts in this thing. Is this the trademark of some gear company in the UK?

3. Did Jaguar assemble the boxes or did they buy them already pre-assembled?

4. Is there anyone selling new gears for these gearboxes?

I did find a reference that Moss gearboxes were used by Aston-Martin, Bristol, AC and Triumph.

I have confirmed from two sources that there WAS a Moss Gear Company, but I could find no other information on it. It's odd that the literature mentions so many other suppliers like Lucas, SU, ENV, Salisbury, Bluemel, Burman, Lockheed, Girling, Hardy-Spicer and Tecalemit, but nothing about Moss.

I can't help wondering if the stop pin is the whole story. After all, Jaguar was delivering cars without the pin for many years--presumably they did not manifest the "stuck in first problem" upon leaving the showroom floor.

MEMO XK120 Moss Gearbox-Final
Update Date: May 4, 1994

The Mossbox is back in, and I drove the car in to work today. It shifts perfect, just like new (well, new for 1951 anyway). No doubts about what gear I'm in, no chirping as I put it in 2nd, no popping out of 2nd, and no worries about getting stuck in first. Fantastic!!!

Rob Reilly