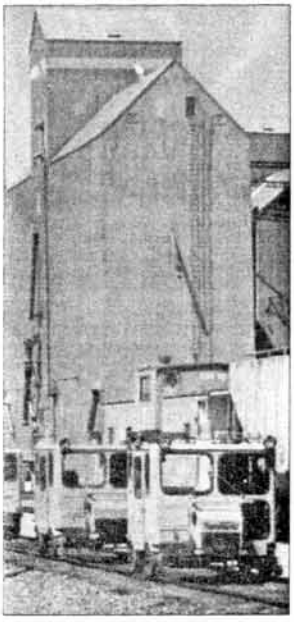
More on MT19 Axles

by Tom Norman

In my earlier article on axle failures in ***THE SETOFF*** (November/December 1999), I recommended using an axle keyway depth of 0.0625" instead of 0.125" as found on MT19-Bs. I felt the shallow keyway depth would increase axle strength, and 0.0625" was similar to the 0.049" depth of keyway in M9 and M19s. My calculations were based on my old college textbooks from the 1960s. Thanks to Rick Tinsley, I was furnished with current aerospace data on keyways and stress concentration factors. Based on his data, changing from 1/8" to 1/16" keyway depth only offers a 7% increase in shaft strength. However, a much more important factor evolved. If the bottom of the keyway is machined with a corner radius, the keyway stress is reduced. In the MT19, an axle deflection of 1/4" causes a bending stress of approximately 22,000 psi. However, because of stress concentration in the keyway, the figure must be multiplied by a stress factor (I will call it "K") based on Rick's information. His data and calculations demonstrate that a keyway with a fillet radius of 1/32" (0.03125") gives a K of 2.02, but if that radius is as small as 0.010" K increases to slightly over 3. Multiplying the unnotched axle bending stress times K gives a keyway stress of 44,000 psi for the 1/32" fillet radius, and 66,000 psi for 0.010" fillet radius.



Norman's MT19 at Geraldine, Montana, April 2000. The cars are turned and ready to return to Denton over the line of Central Montana Rail, Inc.

This keyway stress must be kept within the endurance limit of the shaft material. Fairmont used AISI 1045 steel with an endurance limit of 44,000 psi. Even with a 1/32" fillet radius the 1045 material is at the endurance limit if exposed to enough cycles of 1/4" axle deflections. Checking the AISI 1045 S–N curve (unit stress vs cycles), failure at that stress can occur in 100,000 cycles. Assuming 10,000 miles on a motorcar, that corresponds to 12,600,000 axle revolutions. If the motorcar axle was subject to the 1/4" deflection only 1% of the time, that would equal 126,000 cycles. Using a different steel such as AISI 4340 steel with a Rockwell C hardness of 38 to 40, gives an endurance limit of 72,000 psi, well above the stress calculated.

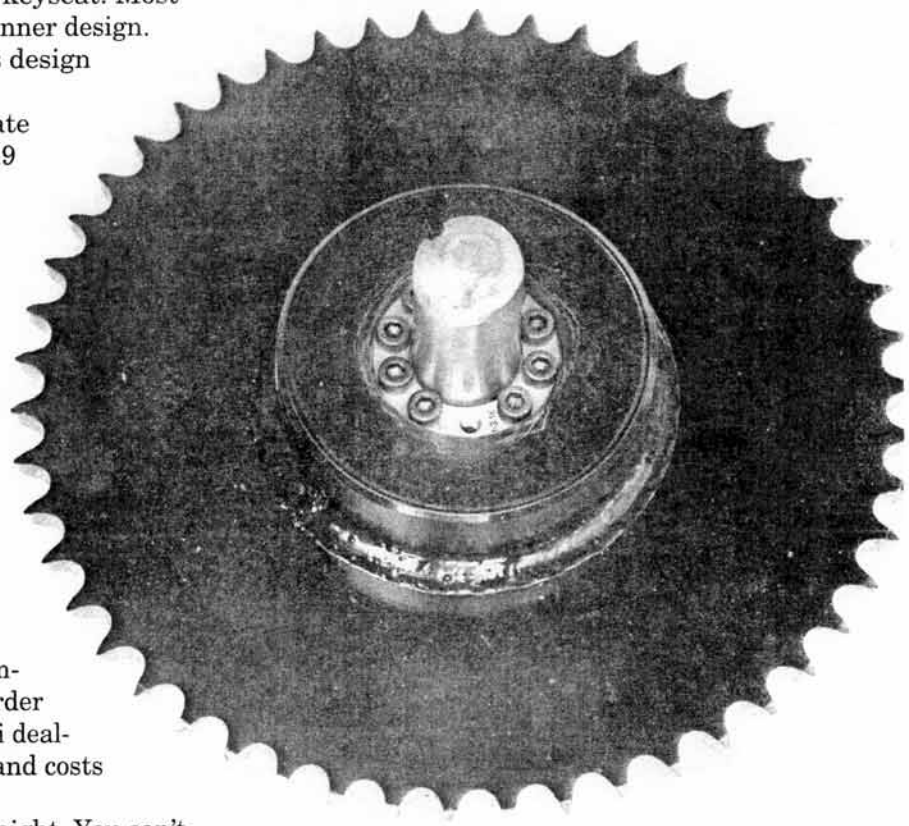
Is a 1/4" axle deflection possible? Bill Owen provided test data in the November/December 2000 issue of ***THE SETOFF***, in which he recorded deflections of up to 5/16" during engine braking in the forward direction, or acceleration in the reverse direction. Bill's test of axle deflections was made with the center bearing bracket in the original forward position. The chain, while in reverse or compression braking, causes a force on the axle with a vertical and horizontal component. The horizontal component is restrained by the center bearing casting and bracket, but the vertical component is only restricted by the spring, if left in place. In Bill's case he removed the spring. Regardless, the vertical component causes the axle to deflect upward as the center bearing pivots, but restrained at the axle ends by the wheel bearing springs, resulting in the 5/16" deflection Bill measured. Using Bill's dual idler arrangement effectively limited the axle deflection to 1/16".

I like the dual idler system, but I would suggest replacing the MT19 rear axle at the same time. The used axles have been subjected to a number of bending cycles and can be approaching the failure point. My axle broke after 12,200 miles of operation. Previously I recommended AISI 4340 steel heat treated to Rockwell C of 38 to 40. Unfor-

tunately I could only find it in an annealed condition, which required sending the material off to heat treat, straightening, then centerless grinding to the correct diameter before machining. Recently I've found that Ryerson Steel has a product called "Rychrome" that is AISI 4140 steel, turned ground and polished to the correct diameter for the rear axle. It comes already hardened to Rockwell C 27 to 34. I've ordered several pieces, and they are nice and straight. The endurance limit is 65,000 psi, compared to 72,000 psi for the 4340, or 44,000 psi for stock 1045 axles. If someone needs a new axle I would suggest using the 4140 Rychrome.

Try to have the keyway in your new axle machined with a 1/32" fillet radius. This will require the key to have a 1/32" radius in order to fit the keyway. Also the sled runner keyseat has lower stress than the end mill keyseat. Most Fairmont axles have the sled runner design. Each end of the keyway in this design curves up like a sled runner.

Another option is to eliminate the keyway entirely. On my MT19 I just recently installed a US Tsubaki Power Lock PL1-3/16 hub and 50B50 sprocket. The PL1-3/16 Power Lock (right) uses six locking bolts, two taper rings, and an inner and outer ring that expand to lock the Power Lock to the axle and sprocket hub, when the locking bolts are tightened. It will transmit 376 ft-lbs of torque with no keyway. The B48G Onan's maximum torque at the rear axle is 253 ft-lbs. US Tsubaki has assigned a special part number "MT19" so that others can order it through their local US Tsubaki dealer. It is for the 50 series chain and costs about $125.



US Tsubaki Power Lock PL1-3/16 hub and 50B50 sprocket can be ordered through your local US Tsubaki dealer. Use the specially assigned parts number "MT19"

Finally, the axle must be straight. You can't just put the dual idler in, reverse the center bearing, and put on a keyless sprocket. The center bearing still restricts axle movement in the horizontal direction. If the axle has a bend in it, it will be restrained twice each revolution, inducing stress and possibly leading to a bending fatigue failure. Remember, an MT19 with 10,000 miles has 12,600,000 axle revolutions! In conclusion, I feel that the dual idler system will significantly reduce axle bending stress. Using Rychrome 4140 steel will significantly improve endurance limit over AISI 1045 steel. Use a 1/8" deep keyway with a 1/32" fillet radius if possible, otherwise try the keyless sprocket. Hopefully we can eliminate MT19 rear axle failures. ❑