Rolling on Rollers

The Norfolk and Western Railway Has Pioneered in the Use of Floating Driving-Axle Type Roller Bearings on Its Mallet Locomotives

By **G. T. WISBEY,** ***Assistant Foreman,*** **Roanoke Shops**

FOUR years ago, the Norfolk and Western, as it has done time and again, pioneered in the use of a new mechanical contrivance to provide more efficient service to its patrons. The new device is what is called the "floating driving-axle type roller bearing"—an arrangement of roller bearings in the locomotive driving wheels so that the principal weight of the engine is carried through roller bearings direct to the drivers instead of through the axles. With the new bearings the axles serve only to hold the wheels together and to transmit the force exerted by the connecting rod of one side of the engine to the other.

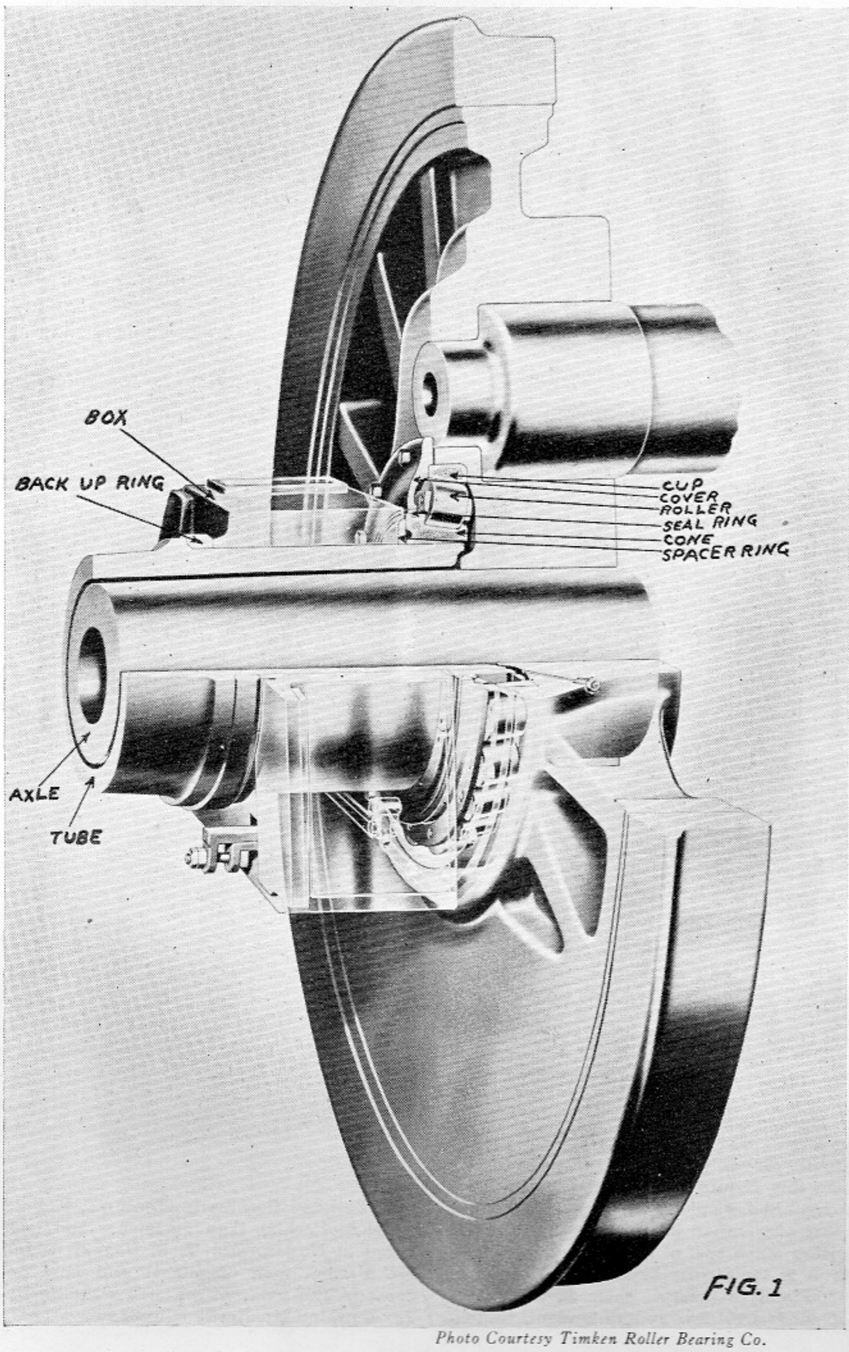


Photo Courtesy Timken Roller Bearing Co.

Our railroad has found that using roller bearings on its locomotives has brought three major benefits: (1) a decrease in oil consumption, (2) greater availability of the engines due to less time required for lubrication, and (3) decreased locomotive maintenance costs. "Greater availability" of locomotives means simply this: that they are ready for service in quicker time after they reach the roundhouse than they would ordinarily be ready. Hence no delay to freight cars ready to be moved. Hence the best possible quality of transportation service.

It is often difficult for a person who has never seen a locomotive driving wheel equipped with roller bearings to understand how the load is carried to the wheels, direct, the axles carrying no dead weight whatever. Secret of the "floating axle" arrangement may best be seen by referring to Fig. 1 nearby, which shows the various parts of the roller bearing assembly, the locomotive driving wheel and the locomotive axle. It may be noted from this picture that the axle revolves inside of a tube carrying driving "boxes" upon which the locomotive is carried. The weight of the locomotive on these boxes is then transmitted through the tube direct to the roller bearings upon which the tube rests. The tube and boxes are stationary, and are so fitted into the wheel that the roller bearings revolve between the tube and a cup in the inner recess of the wheel. As the wheel revolves, the entire load carried by the drivers is concentrated usually upon not more than five rollers at a time.

People who doubt that the railroads ever learn anything new should visit Roanoke Shops sometime and watch N. & W. workers on the job as they expertly apply these roller bearings.

A "phantom" drawing of a locomotive driving wheel and axle, showing the tube, driving box and roller bearing assembly

It's a job quite as interesting to watch as the assembling of an automobile or the building of a skyscraper . . . and every bit as complex and precise as either of the two. Talk about "Precision Transportation"—one may see visible evidence of it here as men deal in clearances of thousandths of an inch. And yet the folks who put the wheels on the axles and apply the bearings do their work as matter-of-factly and quite as easily as a bricklayer or a carpenter.

Putting wheels, axles, tubes and bearings together is a "ticklish job," though, as is demonstrated by the pictures nearby and the following description of how it's done:

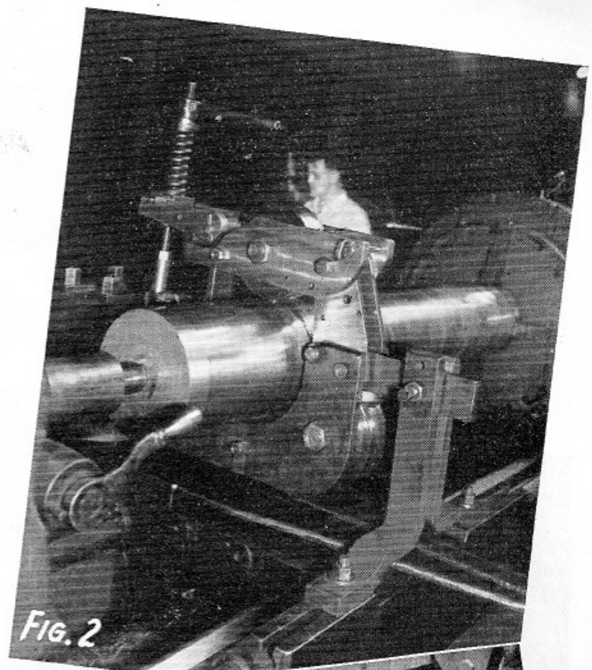
Step No. 1 is called "finishing," or processing, the axles. The purpose of this operation is to machine the axles to somewhere near the proper diameter. When delivered to the railroad, locomotive axles are rough-finished bars of steel somewhat larger in diameter than needed. They are first turned, then ground, leaving the diameter .025″ to .045″ larger than the bore of the wheel. The two end sections of the axle which are inserted in the wheels are then rolled with large rollers, as shown in Fig. 2, with the pressure exerted by each roller mounting from zero up to 25,000 pounds. (The rolling increases the density and strength of the axles.) At this stage of the operations, the two ends of the axle are rolled smooth but still slightly larger than the bore of the wheel. The purpose of this slight difference in diameter (which may be detected only by a micrometer) is to make the axle fit very tightly in the wheel bore when pressed in at a pressure varying from 175 to 200 tons.

Step No. 2 in the process is called "finishing" the driving wheels. This operation includes the cutting of a recess inside the hub of the driving wheel to receive the roller bearing assembly. This recess, at first, is 1/16″ smaller in diameter than it is later when finished. Then the wheels are bored to a pre-determined micrometered diameter to receive the axle. But before the axle is inserted a test is made for a very important purpose. The shop workers must now know very accurately what the finished diameter of the axle must be in order to press it in with sufficient pressure to make it secure. And so a test is made. A plug, varying from .025″ to .030″ larger in diameter than the wheel bore, is pressed through the wheel bore, as shown in Fig. 3. A record is kept of the tonnage required to press the plug through the wheel. If the tonnage is too small it means either that the wheel bore is too large or that the density of the composition of the steel in the wheel is too low. Either of the two possibilities are soon discovered, however, by the insertion of a larger plug. If the pressure required is again too small it means that the wheel bore is continuing to enlarge without the ability to resist the passage of the plug. In that case the wheel is scrapped. But if the bore resists the second time, by requiring more pressure to insert the plug, it is then known that an axle larger than the first must be used.

Finally, when the plug is withdrawn, the men get to work with their micrometers and take accurate readings inside of the wheel bore to see what happened. These measurements, together with the record of the pressure required to insert the plug, now govern the size of the finished axle. The men know, now, that an axle which in diameter is slightly larger than the inside dimensions of the wheel bore can be inserted with sufficient pressure.

Step No. 3 in the procedure of putting axles, wheel, bearings and tube together is to prepare the tube for insertion in the wheel. This operation is illustrated in Figs. 4 and 5, the first of which shows the ends of the tube being ground so that when finished they will be approximately .005″ larger than the inner diameter of the "cone" containing the roller bearings.

This slight difference in measurement again assures a tight fit when the bearing assembly is forced out to the ends of the tube. But notice that word *out.* It has a very significant meaning.



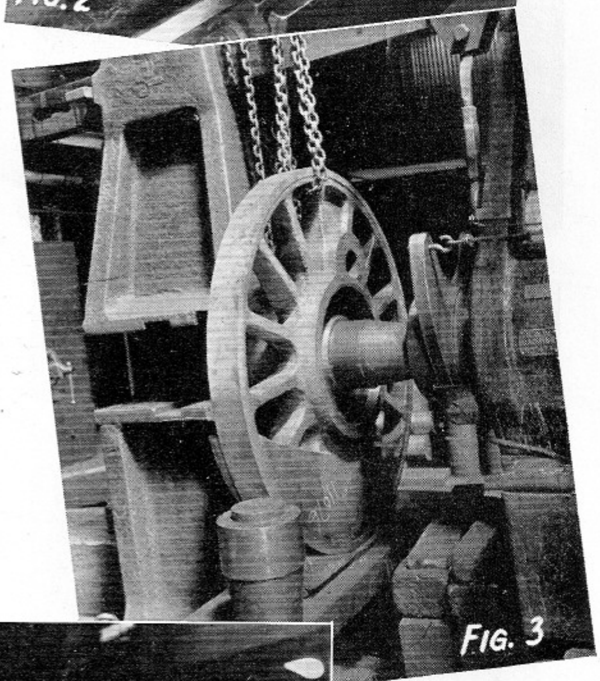


Fig. 2. Rolling the driving axle. Fig. 3. Pressing the plug through the wheel bore to test the diameter. Fig. 4. Grinding the end of the roller bearing tube

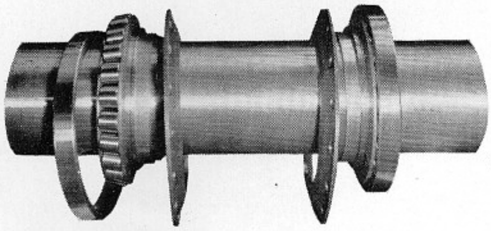


FIG. 5

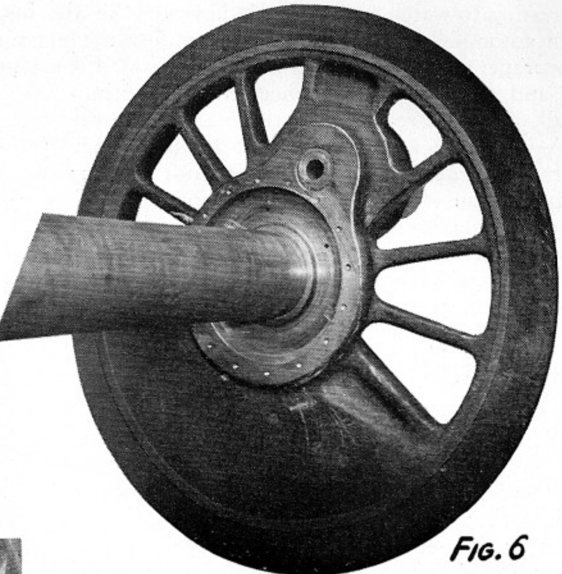


FIG. 6

Fig. 5. The tube, carrying, from left to right, the outer race, the roller bearing "cone" and cover and similar parts for other end of tube. Fig. 6. The axle mounted in the driving wheel. Fig. 7. This device enables the bearings to be forced into the driving wheel by 25-ton jacks. Fig. 8. The jacking device shown lifted from the tube. Fig. 9. To determine whether the tube is centralized with the roller bearing races and each wheel, a fixture and gauges are used

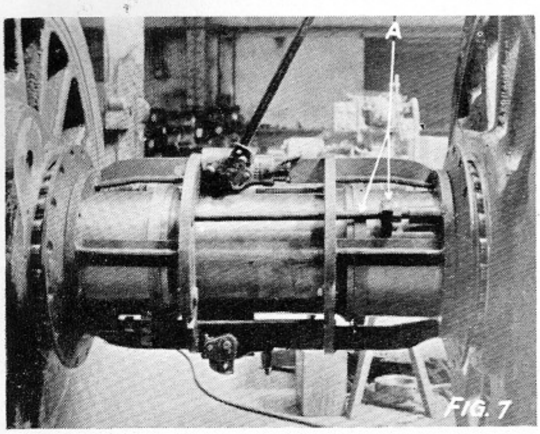


FIG. 7

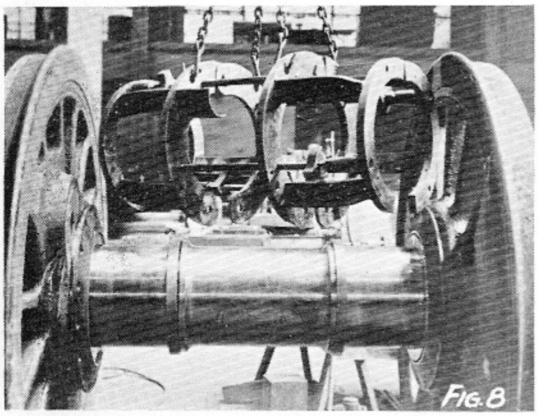


FIG. 8

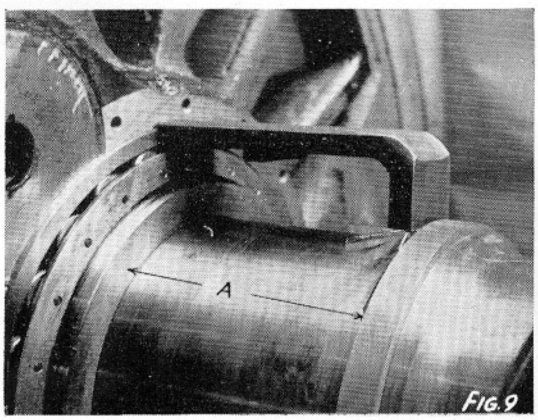


FIG. 9

It means that the bearings, instead of being applied to the tube by force, at first, are *slipped* on in some other manner, permitting a later operation by the use of pressure. This "other manner" is the expanding of the bearing assembly in boiling water. When so expanded the assembly can be easily slipped on the tube and moved back out of the way toward the back-up rings. When the assembly cools it is forced out and over the ends of the tube with such pressure and with such a tight fit that they are permanently solid with the tube.

The tube and bearing assemblies are now about ready to be inserted in the wheel but before this is done, one of the driving wheels is pressed on the axle, as explained previously, at a pressure varying from 175 to 200 tons and as shown in Fig. 6. Then the free end of the axle (not yet fitted with a wheel) is slipped into the tube containing the roller bearing assemblies. Now the second wheel is mounted, the tires are applied and the wheels are "quartered" so that the bores for the crank pins are opposite to each other on the two wheels at an angle of exactly 90 degrees. The crank pins are then fitted and applied and the wheels are placed in a lathe so that the "cup seat" or recess to receive the outer race of the roller bearing assembly will be not more than .004″ and not less than .003″ smaller than the outer race diameter. This insures a tight fit when the race is forced into the recess of the wheel.

Step No. 4 in the procedure is the actual insertion of the roller bearings into the wheel. This is done as follows: First, the "cup" or outer race on which the roller bearings roll is driven into the wheel with a soft hand hammer. As this hammering proceeds a man checks the operation periodically with a gauge to see that the cup is seated uniformly in the wheel. When this operation is completed, the bearing "cone" (containing an inner race and the rollers proper) is driven between the outer circumference of the tube and the inner circumference of the outer bearing race which has already been driven into the wheel. But the bearings are not forced all the way in. The remainder of the job is left to a pair of 25-ton jacks which force the bearings into the wheel until all are in contact with the inner and outer races, as shown in Figs. 7 and 8. (It is very important that the bearing cone be equally spaced and kept parallel with the two "back-up" rings which encircle the tube. This is checked frequently during the jacking operation and adjustments are made by moving the rods and lugs shown at "A," Fig. 7.)

After the bearings have been forced into the wheel, the final step, *No. 5*, begins. This step is providing exactly the proper clearance—.006″—between the rollers and the two races in which they revolve. This delicate operation is conducted as follows: First, a micrometer reading is taken, as illustrated in Fig. 9, to arrive at the distance between the inner race of the wheel and the back-up ring. Then the boxes as illustrated in Figs. 10 and 11 which support the locomotive are micrometered to ascertain their width and then are applied to the tube. Now there must be a clearance of .006″ between the rollers and the races and so the width of the box plus .006″ is subtracted from the micrometered distance between the inner race and the back-up ring. The remainder of this distance is then consumed by a spacer ring which is ground exactly to the thickness required.

At this point there is no clearance between the rollers and the races. But there *is* a clearance of exactly .006″ between the spacer ring and the inner race. To transfer this clearance to the bearing assembly, one end of the tube is now pushed further into the recess of the wheel so that the box and spacer ring fit snugly between the backup ring and the inner race. This operation withdraws the tube and bearings a distance of .006″ from the opposite wheel and provides the proper clearance there. Then the tube is pushed further into the recess of the cleared, or opposite, wheel until all parts are snug, providing the proper clearance between the bearings and races in the first wheel. The total clearance is now .012″ or .006″ in each of the two wheels.

After the clearance has been carefully checked with a dial indicator the wheels are ready for service under the locomotive.

MOULDING MEN . . .

THE Norfolk and Western Family wishes a warm "Happy Birthday" to the Boy Scouts, world-wide organization which celebrates its 30th American anniversary this month.

Aims and accomplishments of Scouting in America are readily proven by the fact that more than 8,700,000 persons in the United States today are or have been identified with the Scout movement. Among N. & W. employees alone there are more than 100 men actively working to promote good citizenship among the Boy Scouts, "the youth of tomorrow."

It was on February 8, 1910, that the organization was incorporated under the laws of the District of Columbia, with President Taft as first honorary president. By the end of 1911 Scout membership totaled 61,495. Since then it has shown consistent growth under the leadership of James E. West, national executive officer, with the cooperation of volunteer leaders.

Boy Scouts all over the world have given youngsters the opportunity to live life to the fullest. They are taught by men they respect to become courteous, useful citizens in every walk of life on the streets of every nation.

The Scout Motto, "Be Prepared," is an eloquent description of Scouting's teachings. There is much for older citizens in the Scout Oath: "On my honor, I will do my best: to do my duty to God and my country and to obey the Scout Law; to help other people at all times; to keep myself physically strong, mentally awake, and morally straight."

$20,000,000 FOR IMPROVEMENTS . . .

MEMBERS of the Norfolk and Western Family will be interested to know that the N. & W. will spend $20,000,000 in 1940 for new equipment, car-rebuilding and many other additions and betterments to railroad facilities in an extensive program of improvements to maintain our road's position as one of the best equipped carriers of the nation.

Construction of ten new Y-6 heavy freight locomotives and modernization of ten Y-5 locomotives as well as rebuilding and repairing freight cars will keep mechanical employees in Roanoke busy throughout 1940. The new locomotives are part of a construction program announced two months ago, including 3,500 all-steel 55-ton hopper cars, 2,752 of which have already been delivered.

Work that will require five months to complete has already begun on a $500,000 classification and storage yard of 1,100 car capacity and a 200-car capacity repair yard at Lambert Point.

Twenty-five thousand tons of 131-pound steel rails to be used in annual replacements have been ordered. New siding construction and extension of siding all over the line have been planned. The signal interlocking plant at Lynchburg will be modernized and new equipment installed. A 36-mile stretch between Forest and Evergreen (near Lynchburg) will get new signal facilities.

A steady increase in traffic the last half of 1939 has resulted in the recalling of 2,000 furloughed N. & W. employees during the year from all over the system.

Additions and extensions to passing sidings will be made at 15 different points along the line during 1940. Total mileage of these improvements is 8.7, an aggregate of more than 46,000 feet. Yard track construction at Lambert Point, Bluefield and Kinney will total 15.2 miles, or 80,300 feet of rail. Shop tracks at these three points will amount to 5.3 miles, or 28,030 feet.

The purpose of the 1940 improvement program is to continue the Norfolk and Western policy (proven successful by many years of experience) of keeping the railroad fully prepared to adequately handle any increases in traffic which may occur now or in the future.

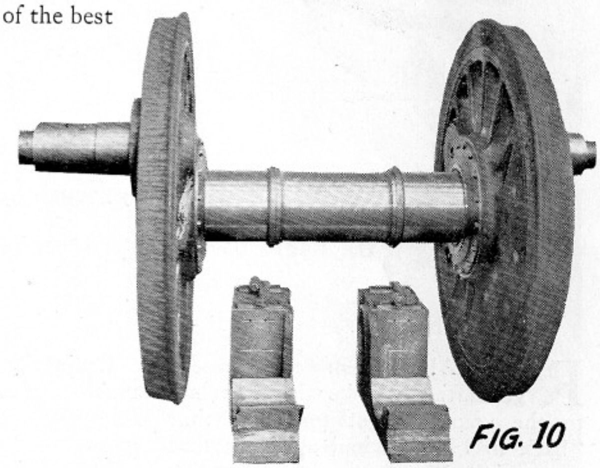


FIG. 10

The driving wheels, complete with tube and roller bearings, but before the application of the driving boxes and the determination of the proper clearance

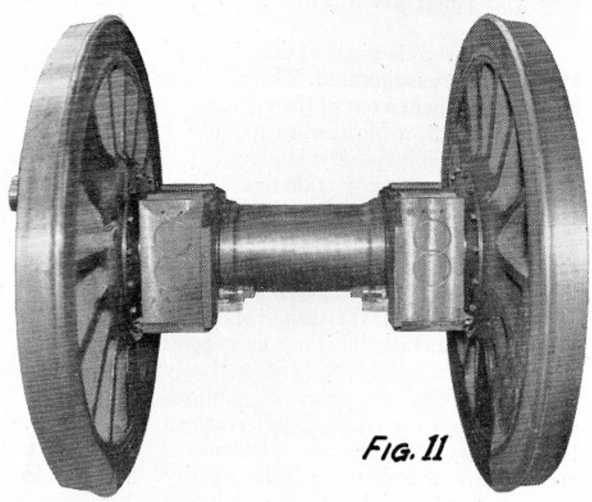


FIG. 11

The driving wheels completely assembled