Rewiring Reading Company NW2 103: 
*Rebuilding The Reverser*
The MP&RE Department of the RCT&HS is now producing an update newsletter of its own. The purpose of *MP&RE Shop Talk* is to inform and educate the membership as well as public about the work done by the dedicated and talented members of the MP&RE crew. The MP&RE decided to go with an e-newsletter as a means of a committee report because we wanted to provide a more in-depth description and showcase the countless hours of hard work that our volunteers dedicate to restoration and maintenance of the RCT&HS collection. *Shop Talk* will not be published on any set timeframe and will be largely web-based. Though we do not wish to exclude any members from receiving updates, it would be cost-prohibitive to print and mail this publication. *Shop Talk* will be a learning experience for us all. We realize that we’re likely to overlook a few things. Please know that it’s not our intention to exclude anyone and we will gladly do what we can to work with members so that they can share the same experience if they do not have access to the internet.

For this first issue of *Shop Talk* we decided to showcase part of a project we’ve been working on for some time. We’ve been rewiring our NW2 RDG 103 and have found many things throughout the project that were in need of attention. In late 2009, the 103 began to show signs of electrical issues. Rather than patch the ailments, it was decided to take the locomotive out of service and rewire the entire low-voltage control system. This conclusion was reached partly because the 103 had never seen any major maintenance overhauls electrically since it was built in 1947. Most of the insulation literally began to disintegrate once we started removing the sections of wire that had to be replaced. After it was decided to replace the electrical control system, we began looking for schematics and wire running lists for the 103. Our efforts were fruitless so we opted to draw up our own. This proved to be a very time-consuming task but has been invaluable as we continue to rewire the locomotive.

For this issue we’re going to look at a recent project that is part of the rewiring work being done on the 103. The reverser has been removed from the locomotive to be rebuilt, and we’re going to take a detailed look at the work that went into the job. First, a little background on what the reverser is and how it works. The NW2 has DC traction motors. These motors have four wires going into them, two for the armature and the other two for the motor field. The direction of the motor can be changed by reversing the field. Even though it’s shown off to the side in the drawing on the next page, the field is part of the motor and is wrapped around the motor armature within the motor’s housing. The field is what provides the magnetism to create the rotation in the armature of the motor. Changing the direction of the field changes the armature’s direction of rotation. This is done with a large, pneumatically-operated “drum switch.” The switch rotates 90 degrees when actuated by electro-pneumatic solenoids that are controlled by the reverser handle in the control stand.
The drawing below shows the motor going first in one direction and then the other. In one direction the electricity flows from the generator through the motor, to the AA contact on the reverser, then to the FF contact which is one side of the motor field, and then through the field to F contact and back out of the reverser on the P contact. The other drawing shows the power going through the motor to the AA contact on the reverser, then to the F contact and on through the field of the motor to the FF contact and finally back out to P. When the state of F and FF are swapped, it alters the flow of electromotive force to change the direction the motor rotates. The three blocks stacked on top of each other in the drawing are the contact fingers of the reverser which ride on the drum. They'll be seen in more detail later in this article.
The picture to the right shows what the 103’s electrical cabinet would have looked like in 1947. The reverser can be seen as item number “10” toward the lower left. A quick rundown of everything in the photo:

1. Wheel Slip Resistors
2. Current Limiting Relay
3. Transition Relay
4. Ground Relay Cut Out
5. Wheel Slip Relay
6. Ground Relay
7. Power Contactors
8. Motor Cut Out Switches
9. Shunt Field Contactor

To the left is a photo showing what the reverser drum looked like in the 103 when we began work on the project. Many years of dirt had accumulated, making it hard to get the reverser thoroughly clean. Clean components are important to maintain a locomotive’s reliability.
(Above) Our initial work began with a thorough cleaning of the reverser. We removed the solenoids, dismantling and repainting them with insulating varnish. They were also labeled FOR and REV and new wires were run to them. (Below Left) Before: This is what the FOR solenoid looked like. (Below Right) After: The freshly rebuilt FOR solenoid. When either the FOR or REV are energized, they allow control air to operate the corresponding pistons on the reverser drum which changes the field connections of the motors.
As we continued our rewiring we found that a conduit containing wires for the charging system was directly behind the reverser. There was only 3” of clearance between the reverser and the conduit. It was decided to remove the reverser altogether so that we could renew the wires in the conduit. Here we see volunteer Paul Payne disconnecting the wires and preparing the reverser for removal.

The reverser weighs approximately 200 lbs., so rather than try and muscle it out of the electrical cabinet we decided to mount our MP&RE-engineered and custom-built multi-purpose crane designed to be mounted to locomotive handrails, work benches, and so on. After a few brackets were fabricated, the crane had another application, which was reverser removal in the 103’s cab.
(Left Top) The reverser being removed from the electrical cabinet.

(Center Right) The MP&RE multi-purpose crane effortlessly lifts the 200-lb. reverser safely from the 103’s electrical cabinet.

(Left Bottom) The MP&RE multi-purpose crane is designed to swivel, which proved to be invaluable when we removed the reverser. Not only could the reverser be safely lifted out of the cabinet, it could also safely be swung over to the cab floor. After this the reverser was lowered to the ground and moved to the workshop to be cleaned and painted.
(Above) Once the reverser was moved into the workshop, we lifted it up on to the work bench and began to lay out all the mounting dimensions for the stationary contact supports as well as the movable contact supports.

(Below) Once everything was documented, disassembly began.
(Above) Starting to get stripped down and beginning to clean up components.

(Below) Stripped down all the way and prepped for paint.
(Above) Freshly painted, cleaned, and starting to be reassembled.

(Below) Back together again and ready to be reinstalled in the engine. Take note of the four new stationary contact leads to the far lower left of the reverser.
(Above) A big part of the job is to disassemble and clean all of the individual parts that make the reverser work. Here a volunteer disassembles one of the stationary contact supports.

(Below) In this view all the pieces that make up the stationary contact support can be seen.
(Above) Cleaning up some of the parts on the wire wheel.

(Below) After all the parts are cleaned and painted, the stationary contact housing is reassembled.
In this close-up view of the stationary contact housing you can see the three contact fingers mentioned earlier on page 2 of this issue that ride on the drum cam of the reverser. The entire housing is bronze and the traction motor cables terminate directly on this contact housing. There are eight of these housings in the reverser; They mount on an insulated shaft inside of the reverser. They also have insulated brackets to keep them apart from the other stationary contacts mounted in the reverser. The following page will show some before and after comparisons of the work done to the stationary contact housings. After all the steel parts were cleaned they were painted with insulating varnish. This is the red coating seen on the fasteners as well as the insulating barriers that mount between the stationary contact blocks.
(Above) Here is a photo showing the before and after of the movable contact.

(Below) During our rebuilding process we found that some of the flexible leads that connect the stationary contacts to the stationary contact support housing had deteriorated. Had this issue been ignored the reverser could have suffered a significant failure, likely melting most of the components from severe arcing that would have occurred from these leads not being able to conduct an ample amount of current to the stationary contacts. This would have been a very costly failure.
The before photo was taken before we started working on the rewiring project. Up to this point the reverser had be regularly lubricated and vacuumed once a year when we did our spring inspections.

The after shows the reverser completely reassembled, aside from the solenoids not being reinstalled. This was done so as to not accidentally damage them while we reinstall the reverser back in the 103’s electrical cabinet. The rebuilding of the reverser took our volunteers 128 hours to complete, and we feel every moment was worth the end result. Having gone over the adjustment of each contact and having inspected all of the components, we are confident the reverser will serve the 103 for another 65 years of service.
By comparing the two photos on this page, you can see how the movable contacts’ configuration changes to allow the field wires in the traction motors to be reversed and change the locomotive’s direction.
This issue’s MP&RE Volunteer Spotlight takes a look at Mark Cain. Mark has been a member of the RCT&HS since 2006 and was very active with the restoration work on Project 3640. After attending college, Mark hired out with Norfolk Southern as an electrician. He’s been an enormous help with our work on the 103 and has logged many volunteer hours to ensure that the 103 will run for many years to come.
(Above) Here 103 is seen with wreck crane 90901 (also preserved by the RCT&HS) on Jan 2, 1974. The location is unknown, if you think you know this location or have any other vintage photos of 103, please contact us at mpre.rcth@att.net.

To date, our volunteers have spent over 500 hours working on the 103 in 2012 (as of early July). 128 hours have been spent on the reverser project, showcased in this issue of Shop Talk. If the MP&RE had decided to send out the reverser to be serviced by an outside contractor, it would have cost the RCT&HS around $2,500. Our crews completely rebuilt the reverser in-house for the expense of $138.86. This was to replace the four flexible leads on the stationary contacts that were found to be in unsatisfactory condition. A project like rewiring the 103 would cost approximately $20,000 if we were to hire a contractor to come in and do the work. So far the MP&RE has spent about 1/10th that sum. We’re also adding a pre-lube system for the prime mover as well as engine protective alarms, an onboard battery charging system, and a few other systems. These would all be extras on top of that $20,000 expense of using a contractor.
Other Projects

In addition to rewiring the entire low-voltage control system in NW2 #103, the MP&RE is continuing work on re-gasketing the 16 power assemblies in our GP7 #621. In order to achieve this we first needed to remove the cylinder heads and then the cylinder liners. All the components have to be cleaned and qualified, the engine block itself needs to be cleaned and qualified, and the liners and heads need to be re-installed.

Work is continuing on GP35 #3640. We recently removed a section of the radiators so we could repair them. This is the last mechanical repair we need to complete on the 3640. While they’re out we’ll prep and paint the radiator housing and then once our repairs are made we’ll reinstall the radiators. Once they are reinstalled the main fan housing can be prepped, painted, and reinstalled, and then the cooling fans themselves can be prepped, painted, and reinstalled.

Work is scheduled to start on reinstalling the sub floor in the last caboose built by the Reading Company, #94074. Once the sub floor is in place the installation of the windows can be finished and then the finished floor can be installed. After that the interior can start being reassembled.

Our fire train tender #90691 is progressing nicely and the tank should be prepped for finish painting within a month or so. Once the finish paint sets we plan to letter the car and finish prepping and painting the undercarriage. The first coat of black has already been applied to the top of the tender.

Another more casual project we’ve been working at is sealing up the cab of RDG RS3 #485 with new window glass. This will prevent the weather from getting into the cab and stop any further deterioration of it and the carbody. Basic body work is being looked into as well as the possibility of giving the engine a paint job. We’re still researching paint and vendors so efforts have been focused on cleaning up and painting the running gear.

General preventative maintenance continues on the rest of the collection, but our main focus will continue to be the equipment mentioned above until the projects are finished. Once the 90691 is finished we plan to finish lettering the two hopper cars, offset hopper #63921 and fishbelly hopper #66418. We are currently looking at creating stencils to aid in lettering our freight cars. It is our expectation that this will speed up the process significantly.
Come join us as we re-gasket the engine block in our GP7 #621. We’ll likely only scratch the surface of the work that went into the project with the next issue. Our crews have put in countless hours on many tasks, from cleaning up caked-on oil to fabricating custom tooling to remove, clean, and qualify all the cylinder heads and liners. This project has come a long way since we started and we’re happy to finally be able to share with you some of the hard work our volunteers have put into the project.
The MP&RE Committee would like to thank the following volunteers for all of their time and hard work preserving and maintaining the RCT&HS equipment collection.

Rick Bates
Chris Bost
Mark Cain
Don Crabtree
Steve Gilbert
Ryan Lamm
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The MP&RE Department would like to thank the following corporations and vendors for their ongoing support.

Anthracite Railroads Historical Society, Inc.
Clark Filter
Derek Slifer Design
East Penn Railroad, LLC
Edenburg Welding
Genesee Valley Transportation
Norfolk Southern Foundation
Philadelphia Chapter, NRHS, Inc.
Print Lion
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Reading Blue Mountain and Northern Railroad Company
RMDI
Southeastern Pennsylvania Transportation Authority
Steamtown National Historic Site
Strasburg Rail Road Company
Taylor Pneumatic Tool Company
Wabtec Corporation
HELP US PRESERVE THE PAST FOR THE FUTURE

The MP&RE Dept. couldn’t continue its important work of preserving the RCT&HS’s collection of historic Reading Company motive power and rolling equipment without your support. That support can come in many different forms – it’s not always just about money. We utilize a variety of resources when working on our projects and we urge you to think about how you can contribute to our restoration efforts. Our work wouldn’t be possible without:

- **Blueprints and schematics** - Used to understand how equipment was built or wired during every step of the restoration process.
- **Manuals** - Used to obtain part numbers for replacement parts, to understand how components are constructed, and for technical specifications.
- **Vintage photos of Reading equipment** - Used extensively to ensure that our restoration work is as historically accurate as possible. Some projects, like the 3640 MU drop step, were fabricated solely using photos taken from a variety of angles. (Photos don’t have to be of RCT&HS equipment. Sister models are just as helpful.)
- **Tools, spare parts, and material** – Tools are a critical part of our work, and spare parts are vital to replace worn-out or compromised components.
- **Volunteers of all skill levels** – Volunteers are the most important resource we have, and we welcome enthusiastic individuals from all backgrounds and with all skill levels. Part of our goal is to educate our volunteer crews about the equipment we’re restoring and to learn from one another, so even those with no background or prior experience can contribute.
- **Financial contributions** – MP&RE volunteers make the most of every dollar donated to the Equipment Preservation Fund. We’ve saved the RCT&HS tens of thousands of dollars by doing technical repairs and rebuilds in-house and avoiding costly outside contractors.

If you have any questions about the MP&RE Dept., our work, or how you can get involved, please contact us at mpre.rcths@att.net. We also invite you to visit our Facebook page at https://www.facebook.com/pages/MPRE-Dept-Reading-Co-Technical-Historical-Society/279477532069983.

[] YES, I’d like to support the important work of the MP&RE Dept. and help preserve the equipment of the RCT&HS. Enclosed is my check, made payable to Reading Company Technical & Historical Society. Please designate my donation towards the following MP&RE priority project(s):

- Equipment Preservation Fund ______  
- RDG 103 ______  
- RDG 621 ______  
- RDG 3640 ______  
- RDG 90691 Tender ______  
- RDG 94074 Caboose ______  
- Other (Specify equipment no.) ____________________________________________________

[] YES, I am interested in supporting the work of the MP&RE Dept. beyond a financial contribution. Please contact me via □ Phone or □ E-Mail.

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