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BIG BOY

Extra 2019

BACK IN STEAM

SPECIAL COLLECTOR'S EDITION

4014's triumphant return p. 52

Cheyenne miracle restoration details p. 24

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BIG BOY
BACK IN STEAM

TRAINS MAGAZINE SPECIAL EDITION NO. 26-2019

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ON THE COVER: No. 4014 departs Evanston, Wyo., May 13, 2019. Leo de Groot
ABOVE: At East Granger, Wyo., on May 6, 2019. Mike Danneman

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BRINGING BACK THE BIG BOY

WE ARE LIVING A DREAM. America has long been about the biggest or best. In the area of railway preservation, Union Pacific has bestowed an amazing gift in the form of an operating Big Boy in May 2019. The restored locomotive is a gift of great magnitude to the 150th anniversary of the first transcontinental railroad. Best of all, this is only the start of the next chapter in the history of the world's largest operating steam locomotive, 4-8-8-4 No. 4014. We'll see this giant roaming the land for years. Those of us who have spent a lifetime admiring steam locomotives are grateful to Union Pacific and especially to the UP steam crew for its heroic restoration of this King of the Rails. Those who will be drawn to the railroad because of Big Boy will learn and know about steam power. It has been 60 years since a UP Big Boy last operated under its own power.

This special issue from TRAINS magazine will tell you the story of this amazing restoration and initial operations on the Big Boy's original operating territory inWyoming and Utah. We've been fortunate to follow this saga from the beginning in 2012 to its completion, and we're honored to bring you this special issue about Big Boy.

As Big Boy continues its journey in 2019 and beyond, join us in our pages and at TrainsMag.com to learn the latest news and information. When Big Boy runs, you don't want to miss the spectacle!

Jim Wrinn

editor@trainsmag.com

On its inaugural run, Union Pacific Big Boy No. 4014 steams away from the yard at Rawlins, Wyo., May 5, 2019. Leo de Groot

NOW THAT THE BIG BOY IS RUNNING, LET'S GET THE LITTLE BOY RUNNING!

Who would believe after 60 years the Union Pacific's Big Boy would once again operate! At the Nevada Northern Railway Museum, a Nevada non-profit corporation, our goal is to get our "Little Boy" steam locomotive operating once again after 60 years too. We are midway through our restoration! Wheels, axles and rods are done! Now we need to put her back together!

Below is Locomotive 81 as of May 10, 2019; our goal is to have her steaming in a year. Everything that needed to come off, is off! We are midway through our restoration! Tubes are out, the boiler has been tested, It's ready for tubes! Wheels, axles and rods are done, waiting for reassembly!

"Our Little Boy is less than half the size of the Big Boy, but just like the Big Boy, we are determined to restore Locomotive 81 to operation. We don't have the financial resources of the Union Pacific, that's why we're counting on the fans of steam locomotives and American history to help fund returning Locomotive 81 to operation by May 2020."

— Mark Bassett, President
Nevada Northern Railway Museum

Tubes and Flues, Total Cost: $68,001.36

The photo below shows Locomotive 81's front flue sheet. It supports the 168 two-inch tubes and 25 four-inch super-heater flues. 102 two-inch tubes are still needed, a donation of $214.28 purchases a tube, installing it costs $190.48. To purchase and install a tube requires a donation of $404.77.

102 TUBES STILL NEEDED!

MAKE A DONATION WITH A DIFFERENCE, BUY A PART FOR LOCOMOTIVE 81! IT'S EASY! GIVE US A CALL: (775) 289-2085, MAIL: POB 150040, ELY NV 89315, ONLINE: WWW.NNRY.COM

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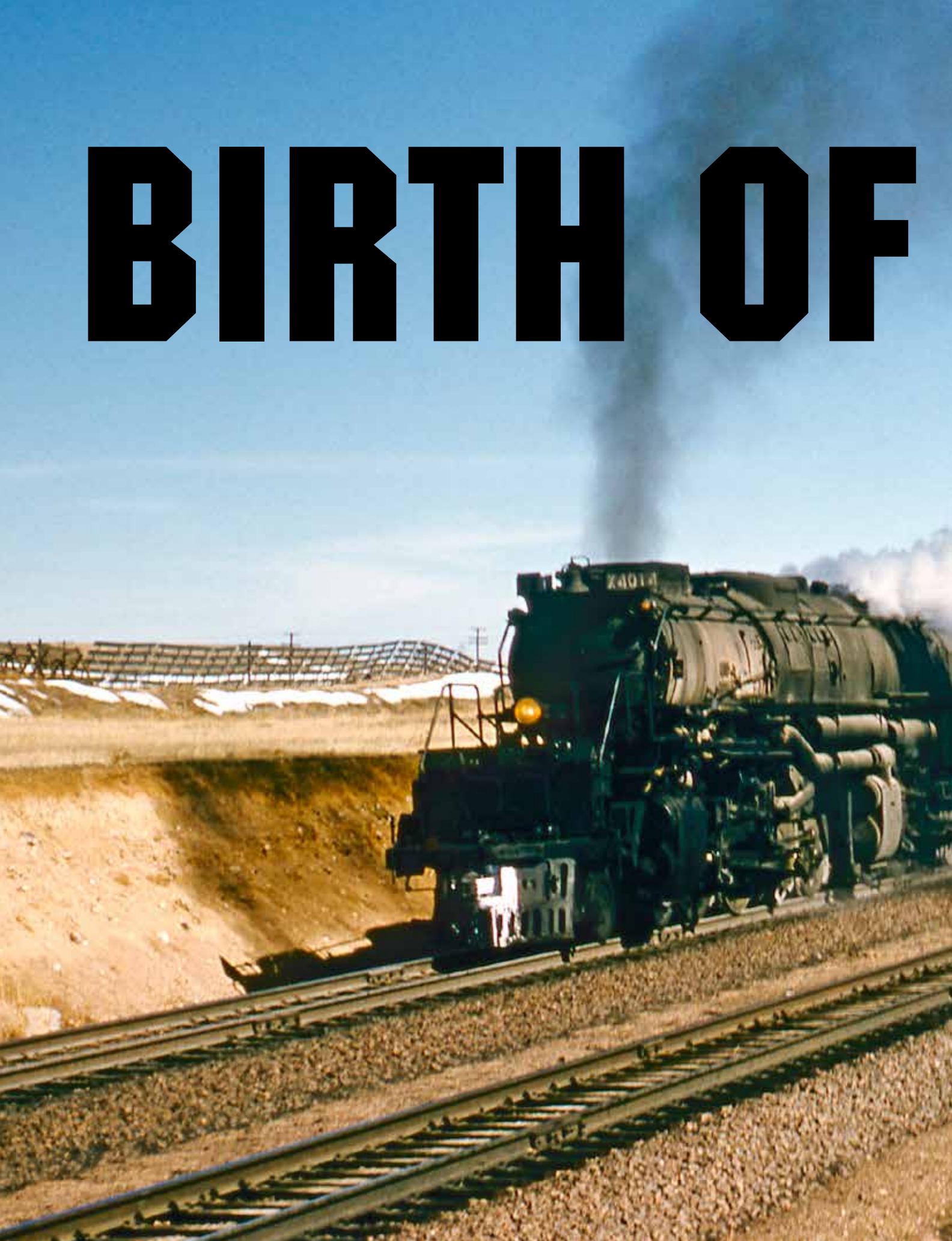
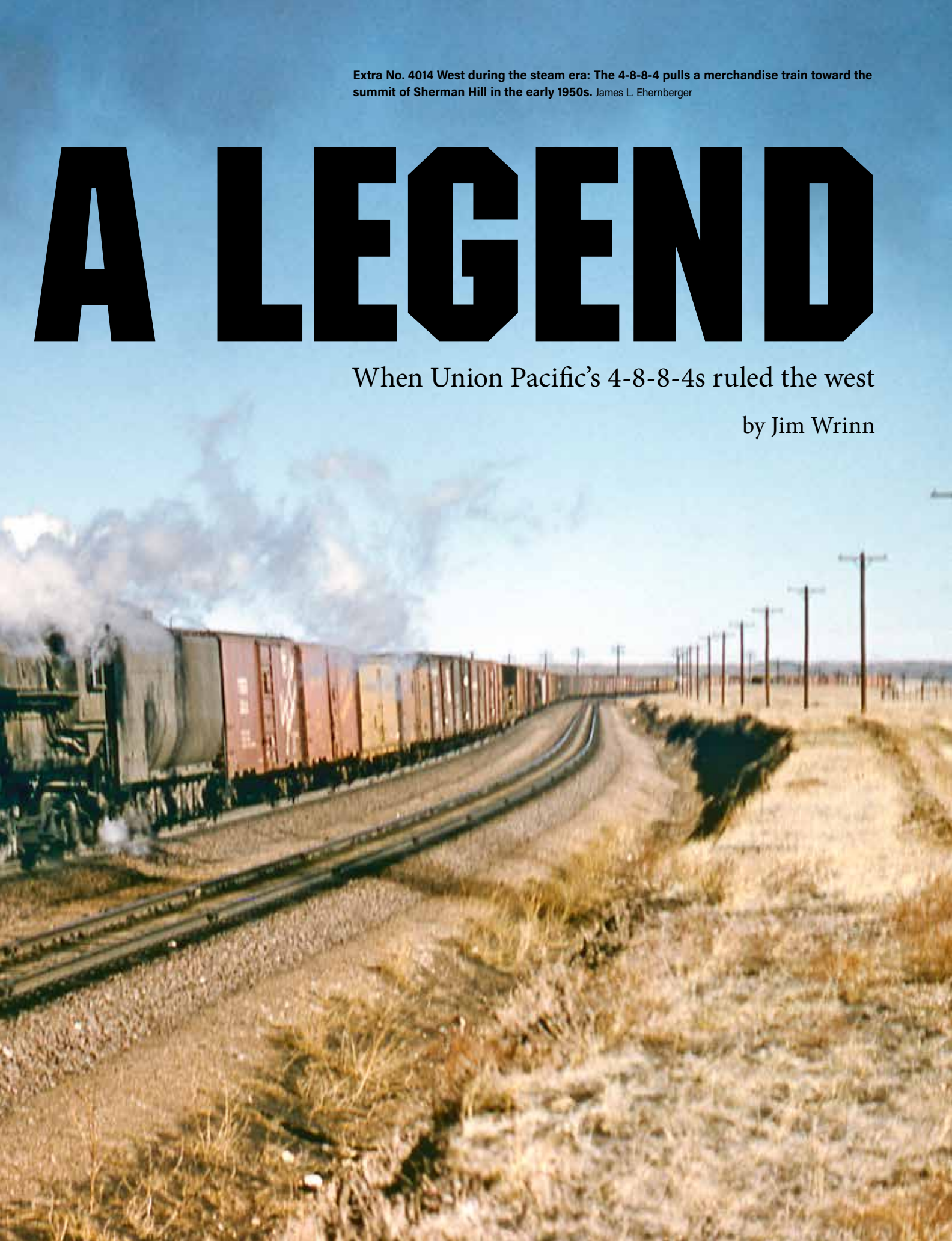




Extra No. 4014 West during the steam era: The 4-8-8-4 pulls a merchandise train toward the summit of Sherman Hill in the early 1950s. James L. Ehernberger

A LEGEND

When Union Pacific's 4-8-8-4s ruled the west

by Jim Wrinn

Long before it became a star, Big Boy No. 4014 was just the 15th engine of an initial order for 20 Union Pacific 4-8-8-4s completed in fall 1941 at Alco's plant in Schenectady, N.Y. On the eve of World War II, the engines were pressed into service. Emil Albrecht photo, James L. Ehernberger collection

NOW THAT UNION PACIFIC'S restoration of Big Boy No. 4014 is complete and the 4-8-8-4 is active again, admirers of this huge machine would do well to remember two names: Otto Jabelmann and William Jeffers. You could consider them the fathers of this amazing, unique locomotive that was one of the most successful articulated steam locomotives in North America.

The story of the Big Boy locomotive is a tale of human ingenuity and innovation, rapidly changing technology, and the eternal enchantment with overwhelming power.

Jeffers, as Union Pacific's president in 1940, instructed Jabelmann's Research and Mechanical Standards Department to design and build larger motive power to conquer the grades of the Wasatch Mountain range east of Ogden, Utah. Jabelmann was the perfect man for the task, as he had been instrumental in the creation of the company's high speed passenger 4-8-4s and its highly successful multipurpose 4-6-6-4 Challengers.

While the majority of Union Pacific's Overland Route from Omaha, Neb., to the Southern Pacific interchange in Ogden was populated with relatively easy grades, the Wasatch posed a significant barrier: The eastbound run of 65 miles from Ogden to the summit at Wahsatch, Utah, was beset by grades of 1.14 percent. Since the opening of the transcontinental railroad in 1869, UP had designed larger and larger steam power to conquer the Wasatch range. The Big Boy was the culmination of those designs.

According to the seminal 1963 book "Big Boy" by the late William W. Kratville, the Research and Mechanical Standards Department was established in 1936 under Vice President Jabelmann. Jeffers' order to Jabelmann in 1940 was to develop a locomotive capable of pulling 3,600 tons over the Wasatch unassisted. To do so, Kratville recounts, the locomotive would need 135,000 pounds of tractive effort and an adhesion factor of four. Mechanical engineers concluded that to meet Jeffers' demands would require an articulated with two sets of eight driving wheels, four guide wheels, and a four-wheel trailing truck to support the enormous furnace necessary to supply steam. Thus the 4-8-8-4 wheel arrangement was born.

Within three months, a design team had formed. UP had long been associated with the American Locomotive Co., and the railroad and the builder collaborated in the creation of the Big Boy. Because UP had accumulated significant research data, the entire project took only about a year to complete: six months to design, fabricate, and acquire parts, and another six months to construct the first locomotive.

Union Pacific's confidence in the initial design was evident with its order for 20 Big Boys from Alco at a cost of $265,174 each, or about $4.2 million in today's dollars.

The design was nothing short of an operating man's dream come true: built to run at speeds of up to 80 mph, take a maximum curvature of 20 degrees, and produce maximum power at 30-40 mph. In reality, they rarely got to run fast, but the overdesign meant the engines could put on a spectacular performance, day in and day out.

While the new engines were being built, Union Pacific worked to prepare the railroad's infrastructure for the arrival of these colossal machines, which weighed 600 tons in operating order and spanned nearly 133 feet in length with a wheelbase of 117 feet, 7 inches. The railroad rebuilt bridges, realigned curves, and laid heavier 130-pound

THE BIG BOY STORY

1940

UP President William Jeffers asks his research and mechanical standards department for bigger power to tackle grades and tonnage in the Wasatch Mountains.

1941

SUMMER

Railroad eases curves, installs heavy rail to accommodate the new power.

SEPTEMBER

- American Locomotive Co. completes Big Boy No. 4000, the first of 20 such locomotives.
- The locomotives generate more than 500 news stories while en route via Delaware & Hudson, New York Central, and Chicago & North Western.

James L. Ehernberger collection

rail between Ogden and the summit at Wahsatch. Because of the great overall length of Big Boy and the swing of both boiler and cab, the UP determined that sections of double track were placed too close for a 4000 to clear passing trains. Where curves could not be eased, the railroad instituted passing and meet restrictions to preclude damage to the locomotives or wide loads. Track work began as the railroad identified problem curves and adjusted track centers to provide more clearance.

One of the most critical concerns was turning the giant locomotives at endpoints. To do this, UP installed 135-foot turntables at the key servicing points of Ogden; Green River, Wyo.; and Laramie, Wyo., in late 1941. Cheyenne, being more space constrained, received a 126-foot table. Denver had a suitable wye track that would allow turns. A 126-foot turntable, installed at Caliente, Nev., in 1941, was moved to North Platte, Neb., in 1950 to allow easier turning of the big articulateds.

While the initial Big Boy haunt was between Ogden and Green River, as World War II progressed, the Big Boys' official operational territory extended east to Rawlins, Laramie, and Cheyenne. From time to time, they also visited the giant yard in North Platte. They were cleared to operate between Salt Lake City and Pocatello, Idaho, and between Salt Lake City and Los Angeles, although it has not been documented that they ever reached those far-flung locations.

NAMING THE BIG BOY

The name "Big Boy" came about by accident. An unknown Alco employee in Schenectady, N.Y., chalked the name "Big Boy" on No. 4000's smokebox while that first 4-8-8-4 was under construction. The name, appropriate and catchy, stuck, although it was rumored that UP had considered naming the class "Wasatch." (Trains, incidentally, disdained the Big Boy name at the time, suggesting in 1943 that if UP's 4-6-6-4 high-speed articulateds were known as Challengers, then it would only be right to call the larger 4-8-8-4 class Champ, short for champion, "for champ it is, in horsepower and size.")

The first Big Boy, No. 4000, makes its first trip from Ogden, Utah, to Green River, Wyo., in 1941, flying white flags and with a car tucked in behind the tender to allow the mechanical department to monitor the 4-8-8-4's performance. E.C. Schmidt

No. 4000 was shipped dead via the Delaware & Hudson, New York Central, and Chicago & North Western to Council Bluffs, Iowa. A UP switch engine towed the Big Boy across the Missouri River to Omaha Shops where it was officially accepted on Sept. 5, 1941. No. 4000 was steamed up, and then put on display at Omaha Union Station. A few days later, it traveled light to Council Bluffs for servicing, then back to Omaha to pick up a train of 100 empty Pacific Fruit Express reefers. The locomotive made several stops as it traveled west across Nebraska for water, fuel, and crews. It left Cheyenne going west on Sept. 8.

The Big Boy class arrived on the eve of World War II, and the ensuing crush of traffic meant the locomotives were extremely busy in their first years of service.

The first assignments for the 4000s were on the Wasatch grade in Utah, and the locomotives immediately improved operations. Working between Ogden and Green River, the 4000s allowed Union Pacific to reassign Challengers east of Green River where their increased tractive effort was badly needed to handle wartime traffic. East of Green River, the early Challengers (Nos. 3900-3939) could handle the same tonnage as the Big Boys on the Wasatch. As a result, UP could begin to operate priority green fruit blocks with minimal switching moves and reduced terminal delay.

BIG IMPACT ON OPERATIONS

Delivery of the 4000s affected operations elsewhere on the UP system. As Big Boys were assigned to the Wasatch, they dramatically reduced the use of helper engines. Wyoming Division's 9000-class 4-12-2s moved east to the Nebraska Division, displacing 5000-class 2-10-2s. The latter went where they were most needed, some as helpers and others displacing Mikados, and so on down the ladder.

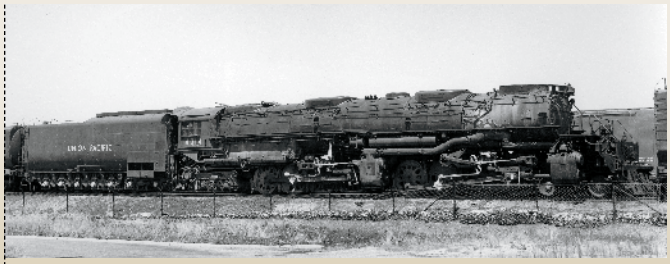
But it was not long before the Big Boys were put to the test to determine their own fate. No. 4014 was among three engines selected for this experiment.

Along with Nos. 4004 and 4016, No. 4014 was involved in a test against a

1940s

NOVEMBER

Alco finishes No. 4014.



DECEMBER

No. 4014 arrives on UP property.

Big Boys muscle wartime traffic across the U.S., averaging 7,000 miles per month.

Trains collection

Its initial career is just two years from its conclusion — and its revival by Union Pacific is still more than six decades in the future — as Big Boy No. 4014 heads west across Sherman Hill at Emkay, Wyo., in summer 1957. James L. Ehernberger

three-unit diesel in April 1943 between Ogden and Evanston. According to Kratville's book, on April 2, 1943, No. 4014 took 65 cars totaling 3,479 tons out of Ogden. All the way upgrade, the throttle was open less than full, and yet 4014 accelerated at points on the grade from 1.8 to 4.5 mph per minute. A top speed of 42 mph was recorded on level track, while the minimum speed was 13 mph on a 3-degree curve on a 1.14 percent grade. Following tests with the other two Big Boys and the diesels, the internal combustion power proved to do no better than the steam engines, and the railroad concluded that steam would remain on the route.

Sadly, Jabelmann never saw this magnificent three from his greatest creation put to the ultimate test: He died Jan. 6, 1943, while in England on a special mission connected to Lend-Lease distribution, the program under which the U.S. government provided American industrial goods for the defense of allied nations.

Big Boy had won a big fight, but the motive power competition of the 20th century — steam vs. diesel — raged on, and in fact, was just beginning.

As World War II continued in 1944, trains of cargo and troops crisscrossed the country, and the first set of Big Boys was due for heavy shopping. Union Pacific received authority from the War Production Board to build five more Big Boys, Nos. 4020-4024, at a cost of $319,600 each. They were identical to the first set except for the use of heavier metals in the boilers and rods. The arrival of the second set meant the Boy Boy's territory was extended from Green River to Cheyenne.

EARLIER DESIGNS BENEFIT THE BIG BOY

As UP's largest steam power, the Big Boys benefited from years of improvement, and testing with the road's smaller power contributed to the success of the locomotive. As a result, the 4000s shared design features with UP's other modern steam locomotives.

Cast-steel frames with integral cylinders had first been used on Union Pacific in 1930 with the final order of 4-12-2s, and they proved superior to the earlier built-up frames. However, when the Challengers

1943

Big Boys No. 4004, 4014, and 4016 are tested against a three-unit set of diesel locomotives.

1944

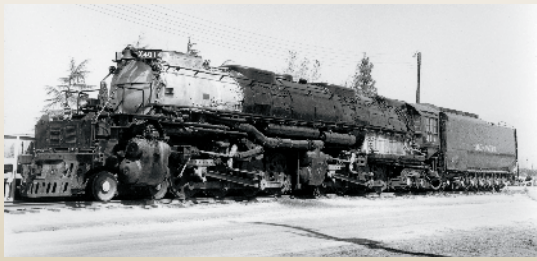
Alco builds five additional Big Boys, Nos. 4020-4024.

1959

JULY 20 & 21, 1959

- No. 4014 completes its final revenue freight run from Laramie, Wyo., to Cheyenne, Wyo., a trip of 3 hours and 35 minutes, beginning at 10:15 p.m. on July 20 and completed at 1:50 a.m. the next day.

- No. 4015 makes the final run of a Big Boy, arriving in Cheyenne at 7:55 p.m.



TRAINS collection

Like many railroads, UP affixed all of the basics of each steam locomotive in a code spelled out under the road number on the cab sides. TRAINS: Jim Wrinn

DECODING THE CAB-SIDE DATA

4-8-8-4 is the Whyte classification wheel arrangement: A four-wheel pilot truck, followed by eight driving wheels, followed by another eight driving wheels, and a four-wheel trailing truck.

1 following the wheel arrangement indicates the first subclass of that wheel arrangement.

68 is the outside diameter in inches of new driving wheel tires, excluding the flange.

23¾ 23¾ above the fraction bar indicates the inside diameter of the front and rear cylinders; 32 below the bar is their piston stroke length, all in inches.

540 is the total weight on drivers in thousands of pounds (540,000 pounds)

MB identifies the stoker as a modified type B.
— Gordon McCulloh, UP steam historian

Twin pillars of smoke mark the double smokestacks that were adopted as standard for freight power. Hidden are the many changes inside the elongated smokebox that over the years were modified to improve drafting and reduce the chance for lineside fires. TRAINS collection

were ordered in 1936, the railroad went back to built-up frames to save on their initial cost. By the time the 4-8-4s were ordered in 1937, the company had decided that cast-steel frames were superior to the built-up type, and the cast-steel strategy was adopted as standard, along with roller bearings on all axles. Sixteen General Steel Castings Corp. Boxpok (pronounced "box spoke") disc driving wheels would assure a smooth ride at any speed for the 4-8-8-4s.

The Big Boys' nickel-steel articulating side rods had mating tongue and jaw ends that rode on bronze-lined mild steel bushings, which in turn pivoted on the driver crank pins. These were designed for and first used on the 4-8-4s, after which they were designated standard for new power. By eliminating knuckle joints, rod mass was significantly reduced, thus greatly simplifying the balancing process. The Big Boys used four Nathan DV-7 lubricators for their moving parts. The original lever operation of the front two lubricators was converted to a chain-drive arrangement by 1952.

The Standard Stoker Co.'s Modified Type B (or MB) stoker was specified standard for freight power with the 4000s because of its ability to reliably deliver more coal than even a Big Boy might consume. Jabelmann-patented Labyrinth front ends were adopted as standard for new power in 1939, being used on the second batch of 4-8-4s and the Big Boys. About 1943, UP modified the front ends, but this was replaced by an Improved Master Mechanic's design by 1946 to reduce the number of trackside fires caused by sparks emitted from the twin stacks.

The double exhaust stacks were adopted as standard for freight power with Big Boy as new perspectives were emerging to improve the drafting and efficiency of large power. Cast-steel pilots first seen on 4-8-4s were upgraded with a swing coupler, being much easier to operate than the drop-coupler version. Pilot-mounted air cooling radiators on the first 4000s, the maze of coils on either side of the headlight, were put behind the air pump shields by 1951.

Another strategy introduced in 1941 was to mount the turbogenerator close to the roadbed. These were placed on the right front of the trailer truck on Big Boy. However, because of excessive contamination, they were moved to the boiler top starting in 1946, greatly improving their reliability.

Use of a single lateral cushioning, or lateral motion device, was first seen on large four- and five-axle locomotives. Two were used with the Union Pacific's 4-12-2s, with one at each end of the driver set.

On UP's 4-8-4s, with a driver wheelbase of 21 feet, 6 inches, and a need to operate at up to 100 mph, the mechanical department decided to employ lateral motion devices on axles 1 and 3 to ease curving. That strategy worked well. Thus as the second batch of

1961

OCT. 18, 1961

Railway & Locomotive Historical Society's Southern California Chapter sends letter requesting donation of a Big Boy steam locomotive to UP President Arthur Stoddard.

James L. Ehernberger

DEC. 7, 1961

UP replies that it will donate No. 4014.

DEC. 20, 1961

Chapter sends acceptance telegram to UP via Western Union.

DEC. 29, 1961

After winter storms clear, No. 4014 is painted and prepared for the journey to Southern California and departs Cheyenne in tow at speeds up to 25 mph.

4-8-4s evolved, to further ease their huge drivers at high speeds, another lateral motion device was added, so that all except the last driving boxes were allowed lateral movement. As the Big Boys' design moved forward, this principle became standard for new power, thus this engine would, like the 4-8-4, have no rigid wheelbase. Later power was similarly configured.

A TENDER STORY

The Big Boy also adopted the seven-axle Centipede tender introduced with Union Pacific's second batch of 4-8-4s. The Centipede design allowed mechanical engineers to limit the tender's length to barely more than 47 feet, while in time allowing some increase in their capacity for both fuel and water. All UP Centipede tenders were the same length, being just 15 inches longer than the 20,000-gallon, six-axle types the first batch of 4-8-4s sported. Cast-steel water bottom frames had been the UP standard for new tenders since the first of the big 18,000-gallon cylindrical tenders arrived with the 4-12-2s in 1928.

The first 20 Big Boys were ordered with 24,000-gallon Centipede tenders that held 28 tons of coal. As the first group of late Challengers was ordered in 1942, their tenders were similar to the Big Boys' tenders, but by altering their fuel space the designers increased water capacity to 25,000 gallons.

Tender trading on Union Pacific had been common for decades (as it was on many roads, large and small). It occured many times across classes as capacity requirements changed over time, or for convenience if a suitable tank was available while its locomotive was undergoing heavy maintenance. In the case of the 4000s, company records suggest they stayed within the class, but it did not take long for late tanks to be found with early 4000s and vice versa.

No. 4014's tender, with the engine since the late 1950s, carries the number plate 25-C-116, indicating that it was the tender delivered with No. 4015. To make the switch, all that needed to be done at the shop was to change the last digit of the locomotive number painted on the rear of the tank.

The Big Boy's seven-axle Centipede tenders held 24,000 gallons of water and 28 tons of coal. The tender with No. 4014, shown as it is taken to Pomona, Calif., for display, was originally delivered with locomotive No. 4015. Stan Kistler

BIG BOY EXPERIMENTS

Overall, the design of the Big Boys proved successful, but that did not stop Union Pacific from conducting experiments with the locomotives. In the mid-1940s, a number of trials were begun but no permanent changes were made to the 4000s. In late 1945, the 4019 was fitted with smoke wind wings similar to those applied to Challengers that were assigned to passenger pools on the Los Angeles & Salt Lake and Oregon-Washington Railroad & Navigation lines. Always looking for improvements, Union Pacific tried exhaust stack experiments, with No. 4007 fitted with a single stack about 1947. Unfortunately, the records did not survive to tell the full story, but the 4000s retained their double stacks.

Perhaps the most controversial experiments were oil-firing trials conducted with No. 4005 in late 1946. The long-held presumption that the oil firing with No. 4005 was somehow a failure should be put aside. The dismaying aspect of a Big Boy using oil fuel was the huge quantities it consumed and the logistics of having heated bunker C oil accessible in all the

1962

JAN. 3, 1962

Train transporting No. 4014 arrives in Las Vegas, Nev.

JAN. 5, 1962

No. 4014's train moves from Las Vegas to Yermo, Calif.

Near San Bernardino, Calif., on Jan. 6, 1962. Stan Kistler

Union Pacific continued to look for ways to improve the Big Boys throughout the locomotives' lifespan. No. 4019, leaving Ogden on Jan. 19, 1946, sports "wind wings," or smoke deflectors. Emil Albrecht, James L. Ehernberger collection

places an engine might need it. Logistically, once the trials showed just how much oil was being consumed, it was far simpler to continue to burn company coal from Hanna, Wyo., or Rock Springs, Wyo. The situation with passenger power was far different. Engines in that service did not consume nearly so much oil and were able to easily run between terminals without refueling stops. Anecdotal evidence suggests that No. 4005 fired well on bunker C, using steam heat in the oil tank to keep its approximately 6,000 gallons of oil viscous. Unfortunately, as with the stack experiments, company records of those trials apparently disappeared more than five decades ago.

Throughout 1946, changes were applied to the 4000s' reverse gear and valve motion. Their 12-inch type H power reverse was replaced by the 24-inch type M. Additionally, needle bearings were applied to all jaws in the valve gear, and the eccentric cranks were fitted with roller bearings.

POSTWAR OPERATIONS

Once World War II traffic began to decline, the 4000s spent more time on the eastern end of their territory. The postwar years saw Big Boys moving long troop trains across Wyoming. One occasion saw a 4000 with 49 sleeping cars headed east from Rawlins.

By 1948, Big Boys were making fewer trips to Ogden and were operating regularly east of Green River to Laramie and Cheyenne, and soon could be seen going south to Denver. As the mid-1950s approached, gas turbines and huge numbers of GP9s were taking over in western Wyoming, and the 4000s kept to the east end of their range. Some 4000s were used with snow removal equipment after a 1949 blizzard, and although not common, by 1950 they were also seen working eastward

1985

Stan Kistler

JAN. 6, 1962

No. 4014 leaves Yermo, moves to Southern Pacific at Colton, Calif., and arrives at Bassett.

JAN. 8, 1962

Pacific Electric moves Big Boy No. 4014 to its new home at the Los Angeles County Fairgrounds in Pomona, Calif.

1985

RailGiants Museum moves within the Los Angeles County Fairgrounds.

No. 4021, one of five locomotives from UP's 1944 order of a second group of Big Boys, prepares to lead a westbound extra out of Cheyenne toward Sherman Hill on June 24, 1956. Use of heavier metals meant these Big Boys weighed 19,000 pounds more than the originals. Al Chione collection

to North Platte.

The Big Boys continued to put on an amazing performance, wrestling 4,450 tons on the ruling 1.14 percent (and about 5,900 tons with a Mikado helper). On the 1.55-percent Sherman Hill ruling grade through Buford, their rating solo was 3,250 tons. After the 1953 completion of the low-grade third main track on Sherman Hill, to the south of the original route, their westbound tonnage rating increased to 6,000 tons. In busy times, both routes were kept full with traffic, and it was common to see doubleheaded Big Boys westbound, sometimes just to transfer power west. But it was not to last.

The increasing number of diesels on the UP system throughout the 1950s meant less work for steam power. According to Lloyd E. Stagner's book "American Steam Finale, 1954-1970," steam freight ton-miles decreased from 56.5 percent in 1953 to 31.2 percent in the first quarter of 1954.

The arrival of 100 GP9s on Union Pacific in 1957 sidelined steam across the system, and No. 4005 made the last steam trip for the year across Sherman Hill on Nov. 5. The next year saw 10 Big Boys in service between Cheyenne and Laramie, starting Aug. 22. In 1959, UP decided to shop six Big Boys for service. They entered Cheyenne-Laramie service on July 6, but a steel workers strike on July 15 and weak California fruit harvests meant UP steam's last gasp was strikingly brief.

At 10:15 p.m. on July 20, 1959, UP engineer Bruckert eased No. 4014 out of Laramie for its last revenue trip over Sherman Hill. It arrived in Cheyenne at 1:50 a.m. on July 21, 1959. A few hours later, No. 4015 made the final trip of a Big Boy, tying up in Cheyenne at 7:55 p.m. Challenger No. 3713 arrived on July 23, and that was the end for regular service UP steam.

The locomotives remained on the roster

2012

DECEMBER

Union Pacific publicly indicates its interest in acquiring and restoring a Big Boy.

2013

JUNE

Southern California Chapter of Railway & Locomotive Historical Society votes 8-2 to transfer No. 4014 to Union Pacific in exchange for a diesel and caboose to be displayed at Rail-Giants Museum, paving the way for the Big Boy's restoration.

AUGUST

UP steam crew arrives at museum to begin preparations for move.

NOVEMBER

Process of inching No. 4014 out of the fairgrounds begins.

TRAINS: Jim Wrinn

With a clear stack and an exhaust arching nicely in the Wyoming sky, and a tender full of coal, No. 4014 departs Cheyenne going westbound in the 1950s. Emil Albrecht photo, James L. Ehernberger collection

yet languished in storage in Wyoming for another two years before they were officially retired and sent to scrap starting in 1961 and 1962. Fortunately, Union Pacific officials, employees, and railroad and locomotive enthusiasts prevailed to save some of the railroad's steam power for museums, in parks, and as community shrines.

SAVING THE BIG BOYS

Thanks to their popularity, eight of the 25 Big Boys were saved, landing in places ranging from the appropriate — a park a few blocks from the Cheyenne shop — to the almost inconceivable — a private steam museum in far-away Vermont.

About the same time, Union Pacific began running its last new steam passenger locomotive, 4-8-4 No. 844, on special excursions, thus keeping the company's rich heritage alive for future generations.

Why No. 4014 was saved, and not some other member of the class, is unknown. What we do know is that the Southern California Chapter of the Railway & Locomotive Historical Society was one of the organizations that asked to save a Big Boy. The club wrote to the Union Pacific to request the donation of a Big Boy, and UP

The end is at hand for the original Big Boy, as the shield number plate is gone and workers remove No. 4000's bell at Cheyenne in 1961 ahead of the locomotive's scrapping. Eight of the 25 Big Boys were saved from the scrapper's torch and survive today. Leon Callaway

2014

NOV. 15-DEC. 26

Moving process continues, bringing No. 4014 closer to Metrolink tracks it will use to leave fairgrounds.

JAN. 26

UP's Southern Pacific heritage unit, No. 1996, pulls No. 4014 out of the fairgrounds.

Thomas Bunce

FEB. 1-2, 8-9

No. 4014 is put on public display at UP's West Colton yard.

No. 4014 heads west out of Cheyenne on Jan. 2, 1956. The locomotive would make its final revenue trip, from Laramie, Wyo., to Cheyenne, on July 20-21, 1959, just two days before Union Pacific ended all regular use of steam power. James L. Ehernberger

agreed, preparing No. 4014 in Cheyenne and shipping it to California in late 1961 and early 1962 in a regular freight train.

A train order documenting the move was recorded to say:

"Santa Fe - JAN 6 1962 - TRAIN ORDER NO. 30 - To Conductors & Engineers EXTRA UP 165 WEST - At BARSTOW - SPEED LIMIT 20 MPH WHILE HANDLING UP STEAM ENG 4014 IN YOUR TRAIN - A K J [A.K. Johnston, Superintendent]- Complete 805 AM - Myers Opr."

Extra 165 West left Barstow, Calif., with six Geeps on the point, and No. 4014 31 cars back, straddled by three gondolas ahead and three behind for braking. As was done when 4014 was delivered in 1941, all side rods were in place, but the pistons and piston rods were transported in the tender so as to prevent lubrication issues.

The freight cars ahead of No. 4014 and her braking cars were set out at UP's yard in Colton on the way to La Puente, Calif., where it was turned over to Southern Pacific for the short move to Bassett, Calif.

On Monday morning, Jan. 8, 1962, Pacific Electric moved No. 4014 to the Los Angeles County Fairgrounds at Pomona, where it joined another unique Union Pacific steam locomotive, the only surviving 4-12-2, No. 9000, placed there in 1956.

Over the next few years, the surviving eight Big Boys stood proud but quiet in their geographically spread-out locations, their years of toil in the Utah mountains and Wyoming's high plains a fading memory to those who had maintained, operated, or were simply fascinated by them.

No. 4014 itself moved only once more, being pushed and pulled across the parking lot in 1989 when the RailGiants museum was relocated within the fairgrounds. It and other pieces of rolling stock in the collection were moved on panel track, and at one point, those in charge of the move

Continued on page 18

2014

APRIL 28-MAY 8

With 11 days of moves and public displays, the Big Boy is taken from California to Cheyenne, Wyo., for restoration at UP's steam shop.

TRAINS: Jim Wrinn

URBAN LEGENDS OF THE WASATCH

THE BIG BOYS WERE denizens of some of the most remote places in America, but they still generated their share of urban legends. One such story involves Adolph Hitler, whose spies are said to have told him of huge locomotives, capable of handling heavy trains through the Rocky Mountains at high speed. It's undeniably intriguing to think that history's greatest villain might have obsessed over this symbol of American industrial might, but it doesn't seem to be true.

Steve Lee, former head of Union Pacific's steam program, heard stories about German prisoners of war passing through Cheyenne, allegedly awed and dispirited at the sight of doubleheaded 4000s charging forth to do battle with Sherman Hill. One of the captives was heard to mutter that, "any nation that could build something like that cannot be defeated," according to the story. But as Lee points out, the 4000s didn't operate out of Cheyenne during World War II; they ran on the Wasatch grade between Ogden, Utah, and Green River, Wyo. Nor could this be a case of mistaken geography: The Big Boys didn't run as doubleheaders between Ogden and Green River, owing to the tunnels.

Additional circumstantial evidence comes from the wartime files of the FBI. Eight Nazi saboteurs were sent to wreak havoc on America's war-making capability in 1942 [see CLASSIC TRAINS, Winter 2001]. The agents were captured before they could carry out their mission, but we know from their confessions that their rail objectives included Horseshoe Curve; Penn Station in Newark, N.J.; Hell Gate Bridge; unspecified targets on the Chesapeake & Ohio; and Great Northern's Cascade Tunnel. The sabotage operation was personally conceived by Hitler, which suggests that the targets would have included Union Pacific if the Führer had been interested in the Big Boys.

Another persistent legend holds that No. 4005 was sold to Argentina. In one book, the locomotive is even said to have been "partially dismantled" in preparation for the move. The 4005 did earn distinction as the guinea pig for various modifications (up to now, it remains the only Big Boy converted to burn oil, for example), but there was never anything to the Argentina rumor. The 4005 has spent its retirement years at Denver's Forney Museum of Transportation, one of eight Big Boys donated to various parks and museums. The other 17 were destroyed — but intentionally so, not as the result of sabotage. — *Peter A. Hansen, author and editor of the Railway & Locomotive Historical Society's publication, Railroad History*

No. 4014 rolls under semaphores at Echo, Utah, with a merchandise train, above. Below, No. 4014 traverses the Harriman Cutoff, also known as Track 3, the preferred westbound line across Sherman Hill after 1953. Above, UP; below, James L. Ehernberger

2016

AUGUST

After concluding work on 4-8-4 No. 844, restoration work begins in earnest on No. 4014.

2019

FEB. 6

No. 4014 passes its hydrostatic test.

MAY 2

With restoration work complete, No. 4014 debuts with a test run from Cheyenne to Nunn, Colo.

MAY 9

No. 4014 joins No. 844 as part of a celebration of the 150th anniversary of the Golden Spike in Ogden, Utah.

TRAINS: Jim Wrinn

Continued from page 16
accidentally let the engine roll free, and it pushed a Santa Fe Hudson off the end of the rails. Seeing this, and in retrieving the Hudson, some noted how freely the 4-8-8-4 rolled, and those who favored No. 4014 said it was a sign that the old locomotive wanted to go once more.

But as the years went by, even the most optimistic of steam locomotive fans around the world agreed that a Big Boy would never run again. Restoring a Big Boy was the stuff of wild imaginations. It would cost a fortune to rebuild, take years to accomplish, and then, where could such a massive beast run? No, a UP 4000 had turned its last wheel under steam in 1959, they concluded, and that was the end of the Big Boy story. Or so they thought.

Union Pacific had other ideas.

In 2012, it approached the Southern California group about reclaiming No. 4014. When the club agreed, UP painstakingly began inching the Big Boy out of its Pomona home in late 2013, and in April and May 2014, carefully moved the locomotive to Cheyenne for restoration. That process was completed just in time for the Golden Spike's 150th anniversary.

And so the legend, born in 1941, is reborn in 2019.

Portions of this story were adapted from Gordon McCulloh's writings on the history of the Big Boy locomotives that appeared in the Fall 2013 issue of the Union Pacific Historical Society's publication, The Streamliner.

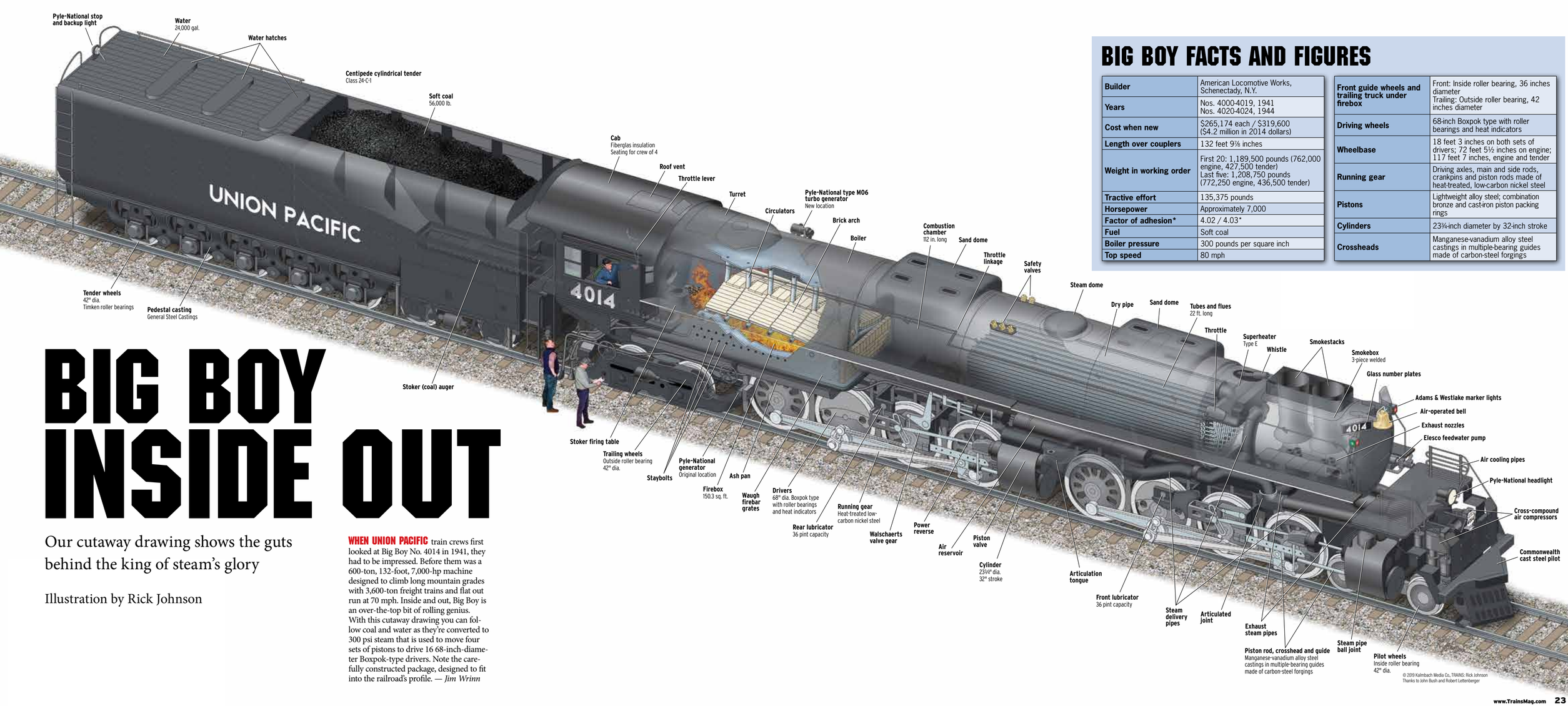
It's late in the steam era, June 28, 1956, to be exact, and No. 4014 is doubleheading with three diesels (two Geeps sandwiching an F unit) eastbound at Dale, Wyo. A portion of the Dale Creek fill is visible to the left of the locomotive. James L. Ehernberger

BIG BOY INSIDE OUT

Our cutaway drawing shows the guts behind the king of steam's glory

Illustration by Rick Johnson

WHEN UNION PACIFIC train crews first looked at Big Boy No. 4014 in 1941, they had to be impressed. Before them was a 600-ton, 132-foot, 7,000-hp machine designed to climb long mountain grades with 3,600-ton freight trains and flat out run at 70 mph. Inside and out, Big Boy is an over-the-top bit of rolling genius. With this cutaway drawing you can follow coal and water as they're converted to 300 psi steam that is used to move four sets of pistons to drive 16 68-inch-diameter Boxpok-type drivers. Note the carefully constructed package, designed to fit into the railroad's profile. — *Jim Wrinn*

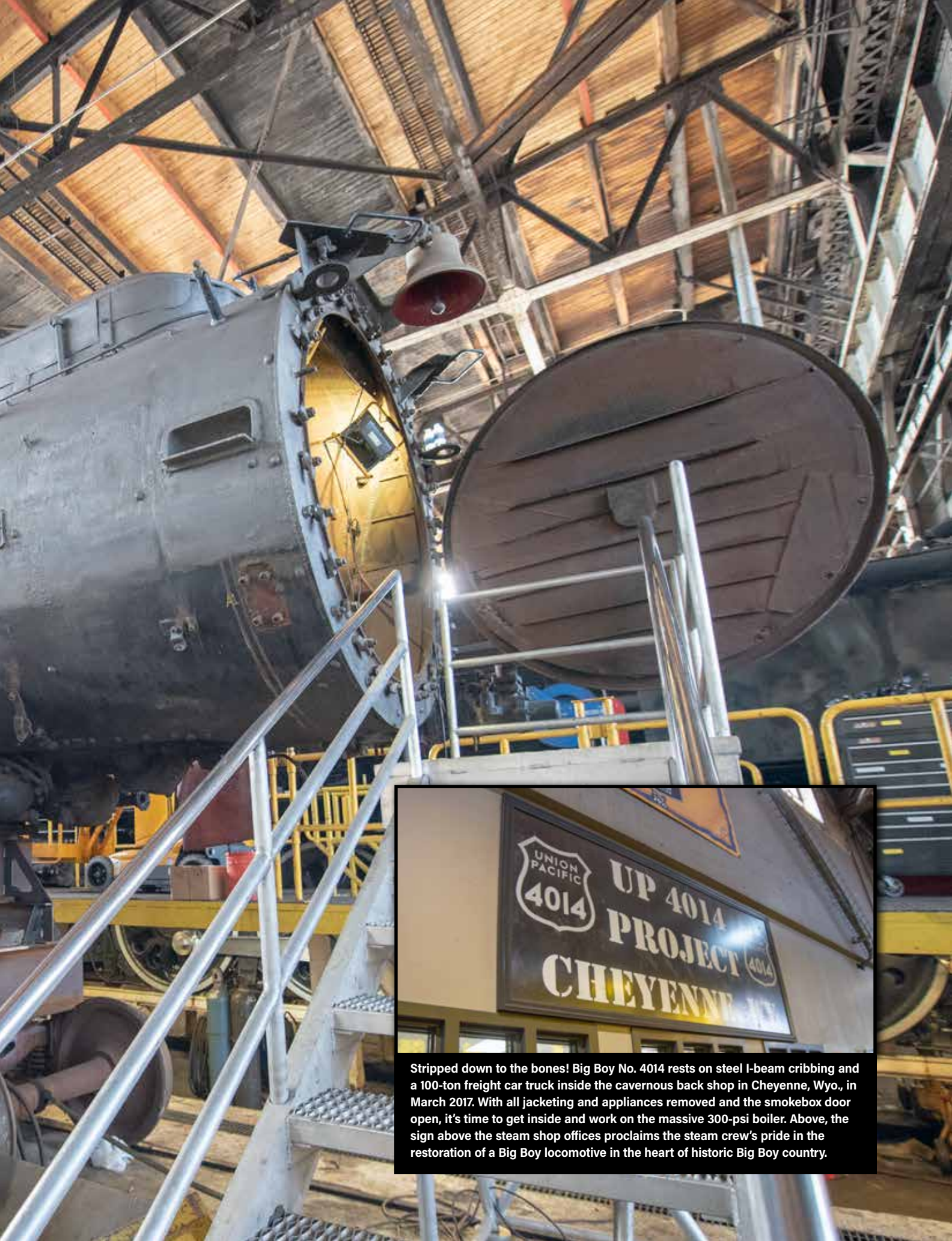


BIG BOY FACTS AND FIGURES

Builder	American Locomotive Works, Schenectady, N.Y.
Years	Nos. 4000-4019, 1941 Nos. 4020-4024, 1944
Cost when new	$265,174 each / $319,600 ($4.2 million in 2014 dollars)
Length over couplers	132 feet 9⅞ inches
Weight in working order	First 20: 1,189,500 pounds (762,000 engine, 427,500 tender) Last five: 1,208,750 pounds (772,250 engine, 436,500 tender)
Tractive effort	135,375 pounds
Horsepower	Approximately 7,000
Factor of adhesion*	4.02 / 4.03*
Fuel	Soft coal
Boiler pressure	300 pounds per square inch
Top speed	80 mph

Front guide wheels and trailing truck under firebox	Front: Inside roller bearing, 36 inches diameter Trailing: Outside roller bearing, 42 inches diameter
Driving wheels	68-inch Boxpok type with roller bearings and heat indicators
Wheelbase	18 feet 3 inches on both sets of drivers; 72 feet 5½ inches on engine; 117 feet 7 inches, engine and tender
Running gear	Driving axles, main and side rods, crankpins and piston rods made of heat-treated, low-carbon nickel steel
Pistons	Lightweight alloy steel; combination bronze and cast-iron piston packing rings
Cylinders	23¼-inch diameter by 32-inch stroke
Crossheads	Manganese-vanadium alloy steel castings in multiple-bearing guides made of carbon-steel forgings

YES, THEY COULD HANDLE IT



Stripped down to the bones! Big Boy No. 4014 rests on steel I-beam cribbing and a 100-ton freight car truck inside the cavernous back shop in Cheyenne, Wyo., in March 2017. With all jacketing and appliances removed and the smokebox door open, it's time to get inside and work on the massive 300-psi boiler. Above, the sign above the steam shop offices proclaims the steam crew's pride in the restoration of a Big Boy locomotive in the heart of historic Big Boy country.

How UP went after an isolated Big Boy in California, towed it almost 1,300 miles, and rebuilt it

Story and photos by Jim Wrinn

Spray-painted plywood signs speak of a sense of humor as well as a recognition of the challenges the UP steam team faced in 2013 when extracting Big Boy No. 4014 from its California home since 1962.

For years, conventional wisdom was that a Union Pacific Big Boy locomotive either could not, should not, or would not be restored to steam. It was too big. Too expensive. No need for it. There was no place to turn it. It would crush the very roadbed upon which it trod. Its consumption of fuel and water would be animalistic, at best. The list was long and ranged from the probable to the absurd.

But then a strange thing happened. Someone in a position of responsibility took a fresh look at the idea. Instead of accepting conventional wisdom — from know-it-all fans to grizzled railroaders — that an operating Big Boy would be a bad thing, that person gave the prospect an opportunity. And what that person recognized and decided has supercharged UP's steam locomotive public relations with the return of Big Boy No. 4014.

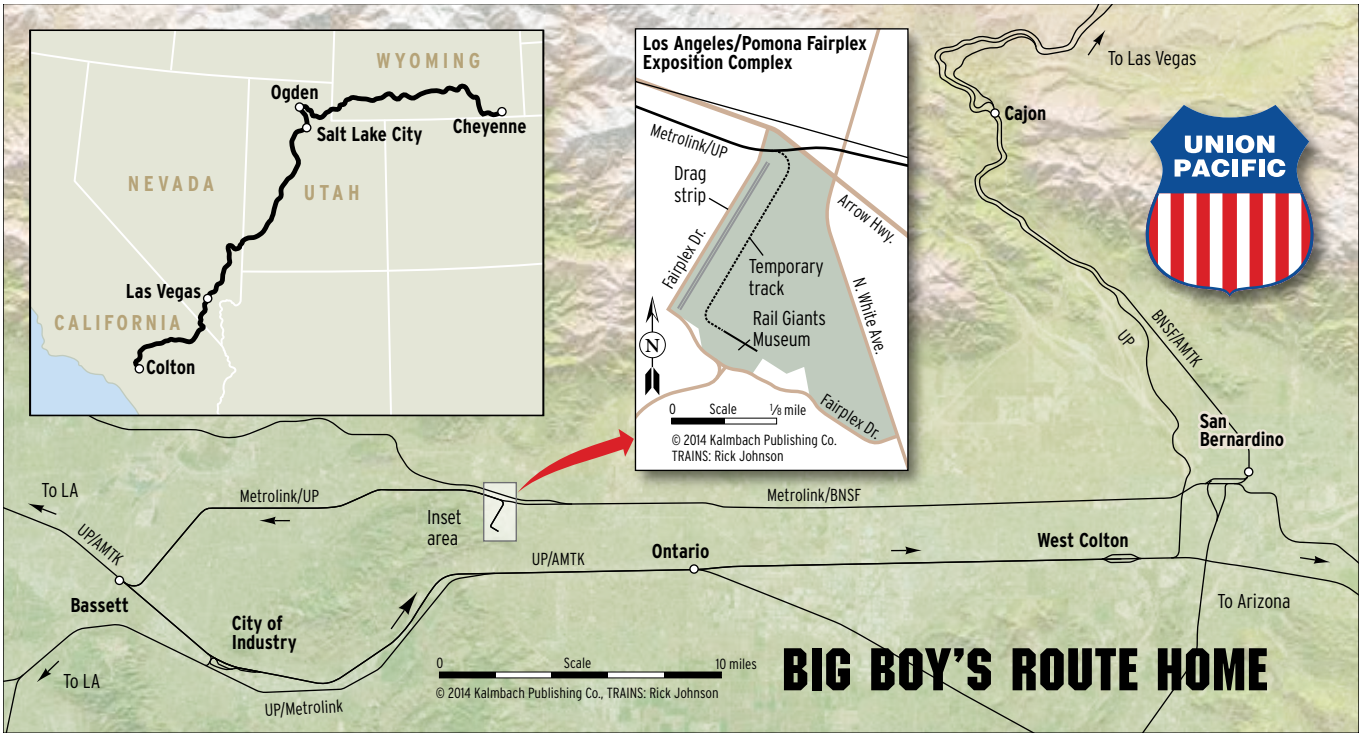
More on that later, but first, we should start with the most basic question of all: How did this happen?

The answer is that about 2011, a West Coast businessman, with a knowledge of and a background in railroading, approached the UP about restoring one of eight surviving Big Boy locomotives. He even offered to pay for the restoration that would obviously run into the millions. Given who it came from, it wasn't a bluff, and the idea caught the interest of executives at UP's headquarters in Omaha, Neb. They put the question to Ed Dickens, who had just taken over command of the company's steam locomotives — its Heritage Fleet, as UP calls its steam public-relations effort.

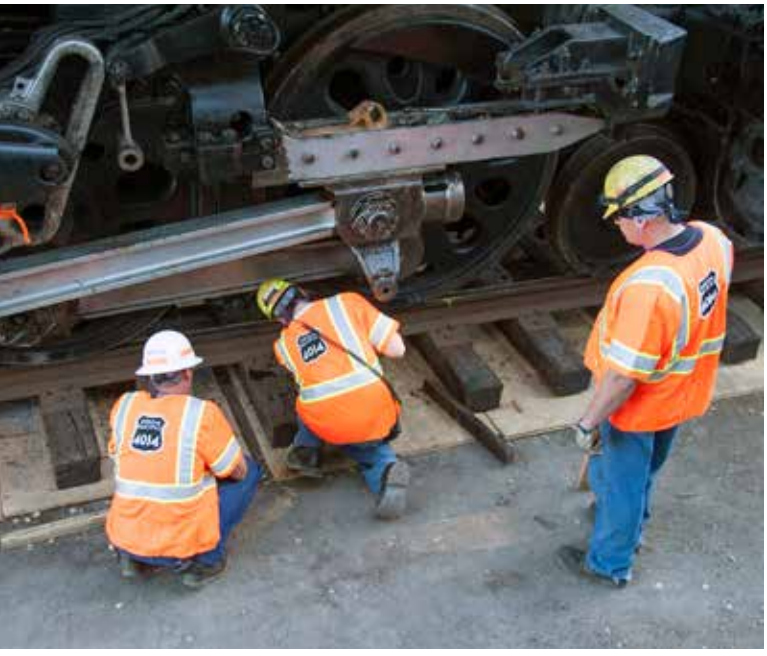
"I was approached as to whether this was feasible, and from that conversation, we began our search for a candidate," says Dickens, senior manager of Heritage Operations. He was asked if the steam crew was interested in adding such an engine and if it would be feasible to operate the locomotive in the same service that UP operates its two other steam locomotives. "Knowing the infrastructure of the UP, I felt this was something that could be done," he added in a 2013 interview. "The opportunity is right."

The more he looked into the idea, the more he liked it. Having just changed managers, it would give the program a new and exciting direction. It also would take the company's use of its steam bravado to new heights.

The railroad had run 4-8-4 No. 844 since 1962 and 4-6-6-4 No. 3985 since 1981 as public relations and goodwill ambassadors for its far-flung system across the Western U.S. But the prospect of a legendary Big Boy as part of the program was now a possibility. With this much lead time, there was also the possibility of completing the restoration in time for the 150th anniversary of the first transcontinental railroad in May 2019. Now the questions began to shift. They were not if the railroad should do this but how. Of the eight survivors, scattered from Pennsylvania to Wisconsin and to Texas (see page 94), which one should the railroad go after? Which was mechanically in the best condition? Which politically and practically would be available? Would any organization possessing one of these last giants be willing to relinquish it?



Nov. 13, 2013, will always be known as the day when No. 4014 started down the road to restoration. A front-end loader tied to the tender coupler gently tugs the dead locomotive backward from its display site at the Los Angeles County Fairgrounds and the Rail Giants Museum.



The steam crew checks the position of the No. 1 driver wheel on temporary track as it inches out of its museum berth. Plywood under the ties was installed to keep level on undulating parking lot surface.

Building track in the parking lot of the Los Angeles County Fairgrounds, the UP steam crew fashions a curve for Big Boy No. 4014 to traverse as it makes its way out of the Rail Giants Museum in Pomona, Calif.

Near Etna, Nev., just south of Caliente, Nev., the No. 4014 deadhead train rolls northbound after leaving Las Vegas. Behind the second diesel are tool cars, crew cars, and flatcars for additional braking power. Next stop, Milford, Utah, on the famous route to Salt Lake City.

The search quickly led to No. 4014, which had been owned by the Southern California Chapter of the Railway & Locomotive Historical Society since 1961 and on display at the Los Angeles County Fairgrounds in Pomona since 1962. Its home, appropriately, was called the Rail Giants Museum. It was the star of the show in an exhibit that included UP 4-12-2 No. 9000, a Santa Fe 4-6-4, and many other smaller locomotives assembled over decades. Two volunteers, Paul Guercio and Rick Brown, had been especially taken in by the Big Boy, and they did more to keep it lubricated, cleaned, and ready, as if one day, someone might come looking for it. Their actions were nothing short of prophetic.

Dickens says he looked at other survivors but No. 4014 immediately became the front-runner because its boiler barrel — the beating heart of a steam locomotive — was in excellent condition. The relatively dry desert climate of Southern California had turned out to be an excellent place to lay up a locomotive. "There's some pitting, but overall it is in extremely good shape," he said of No. 4014 in 2013. "The interior of the boiler is like a time capsule. I could see writing on the steel and as I worked my way inside it during an inspection, I could see a fuseable plug that looked like it had been removed yesterday, but it hadn't been."

The 300-psi pressure vessel that constitutes the Big Boy boiler is critical, and its display in a relatively dry climate meant the locomotive had suffered little damage from rust and condensation over the years. "On a lot of museum or display locomotives, you see moss or grass growing out of the jacket," he said. "That's not the case here." The engine was also largely intact, down to nozzles for the injectors. It had not been robbed of parts to keep other engines running or in cosmetic condition. Much of the air-brake system was complete, a good thing considering the engine had to travel dead-in-tow more than 1,200 miles from Southern California to the UP steam shop in Cheyenne, Wyo.

Some members of the chapter's board of directors agonized over losing their biggest locomotive. On the UP, Dickens kept his team excited about their potential new addition to the steam fleet. As they would ride in No. 844's cab, where the roar made conversation impossible, Dickens would hand gesture *four, zero, one, four* using his fingers to remind them of what was ahead.

After weeks of negotiations, UP in 2013 struck a deal with the historical society chapter to trade the Big Boy for an operating 1970s diesel locomotive — SD40-2 No. 3105 — a steel caboose, and proceeds from a future excursion with the restored No. 4014

Moapa, Nev., some 50 miles northeast of Las Vegas, is a strange place for people to show up next to the Union Pacific main line. But in spring 2014, they did just that to see dead No. 4014 on its way home.

UP diesel No. 4014 backs steam locomotive No. 4014 into the steam shop at Cheyenne on May 8, 2014. For the first time in 55 years, No. 4014 had come home, preparing to begin its next career.

UP steam manager Ed Dickens, right, finishes up paperwork in the moments after No. 4014 was parked inside the steam shop for the first time. At right is No. 844, in the middle of boiler work.

With the cab removed and the backhead exposed, work progresses on No. 4014's boiler in March 2017. Compare this image to the photos on page 42 showing the cab being installed in this area.

Looking down the barrel of the long boiler from the smokebox end, and with both front and rear tube sheets removed, boilermaker Jimmy Thompson uses a cutting torch to remove a staybolt.

We're far from Cheyenne, Wyo., in the heart of Pennsylvania Amish Country, in Strasburg, Pa., where the famed Strasburg Rail Road shop was working on No. 4014 wheel centers and axles in May 2017.

Above, in a scene unimaginable only a few years ago, No. 4014's boiler and front engine share space inside the Cheyenne backshop. New lubrication lines (light colored strands) have already been run on the engine.

to be run out of the Los Angeles area.

That bargain solved one problem and created another. A big one, in fact. UP's new prize member of its steam stable was trapped behind several other locomotives at the Rail Giants museum. It was almost a mile across a parking lot at the fairgrounds to the nearest railhead on a Metrolink commuter line. In short, it was marooned at the farthest point away from active rails.

To extract the engine, UP took on a herculean effort. The steam crew mounted a compressor on the tender and reactivated the air-brake system to give the engine stopping power. The crew installed panel track across the parking lot and used a giant earthmover to drag No. 4014 ever so slowly backward over a period of weeks to a point where crews could stage the engine for a daring nighttime dash on Los Angeles' Metrolink commuter railroad. The effort began in November 2013, and the midnight dash took place the following January.

Over the next few months, UP prepared to tow its repatriated Big Boy to Cheyenne. That journey took place over a two-week period in April and May 2014. A pair of hand-picked, modern freight diesels, SD70ACes Nos. 4014 and 4884 (like Big Boy's wheel arrangement) moved the engine from Los Angeles to Ogden, then across original Big Boy territory to Cheyenne. Everywhere the

Left, the steam shop crew pauses during work on No. 4014. From left, Troy Plagge, Ed Dickens, Austin Barker, Kirt Clark, Jimmy Thompson, Bruce Kirk, Ted Schulte, and Garland Baker pose with No. 4014 drivers in June 2018.


CAPY
250 TONS
CAPY
40 TONS
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locomotive and its diesel accompaniment went, people turned out. In Salt Lake City and Ogden, thousands came out, some from hundreds of miles away, just to see the dead engine. The engine returned to the places where it had become famous: Wasatch Grade, Peru Hill, Sherman Hill. The journey concluded on a rainy afternoon in Cheyenne when diesel No. 4014 tucked steam No. 4014 inside the UP steam shop next to Living Legend No. 844.

With step one, acquisition of a Big Boy locomotive, complete, it was time to turn to the hard work of restoration. Progress, however, didn't begin right away. No. 844 was lame and had to have a full boiler rebuild. While that went on, Big Boy sat. Two years went by with little direct work, but significant efforts to upgrade the shop and install an overhead crane. When the crew made parts for No. 844, they also made a set for No. 4014. When they ordered equipment for No. 844, they ordered for No. 4014 as well.

Looking from inside the firebox at work literally in the belly of the beast. Our perspective here is looking back toward the backhead. The opening is the firedoor. On the floor is ultrasonic testing gear.

Big Boy parts on a workbench: At left, mechanical lubricator; at right, a brake cylinder housing. Both were being rebuilt to prepare No. 4014 for a long service life.

Left, boilermaker Jimmy Thompson creates a burst of light with his welding gear. The boiler contains numerous rigid and flexible staybolts, depending on the area where they are used.


R4
R4
R8

Left, we are looking across three sets of drivers in June 2018 that have just returned from quartering and installation of new tires at Pennsylvania's Strasburg Rail Road. In rear is the boiler backhead.

The rear trailing truck, sans wheels and resting perpendicular, fills the foreground of this view of No. 4014's massive boiler in the steam shop in March 2018. Boilermaker Jimmy Thompson rides a lift on the side.

Immediately after No. 844's return to operation in July 2016, the steam crew wasted no time in getting to work on its next project. They used the 4-8-4 to take No. 4014 to the turntable at the steam shop. They gave the new addition a spin so that No. 4014 faced west. They separated the Big Boy from its tender, and backed the engine into the cavernous steam backshop.

Finally, it was game on. The task ahead was monumental. Even though No. 4014 had been pronounced sound, it was still a locomotive that had more than a million miles on it, shuttling between Ogden and Cheyenne for almost 20 years with heavy tonnage trains on the punishing grades of Wasatch and Sherman Hill. It also had sat outside, exposed to the elements, for almost six decades.

The first thing in any major steam restoration is to disassemble the engine and begin a thorough boiler inspection. That means removing the tubes, flues, and superheaters, testing all of the bolts and rivets, checking the metallurgy, inspecting the seams of the boiler courses, and performing an ultrasonic test to determine the thicknesses of the boiler shell and the firebox walls. With plans to convert No. 4014 to burn oil, the crew removed the ashpan and coal-burning grates that would no longer be needed. Some grates were returned to the Rail Giants museum for display, and others were donated to the Milwaukee Road 4-8-4 No. 261 in Minneapolis for use in another Alco-built steam locomotive still running.

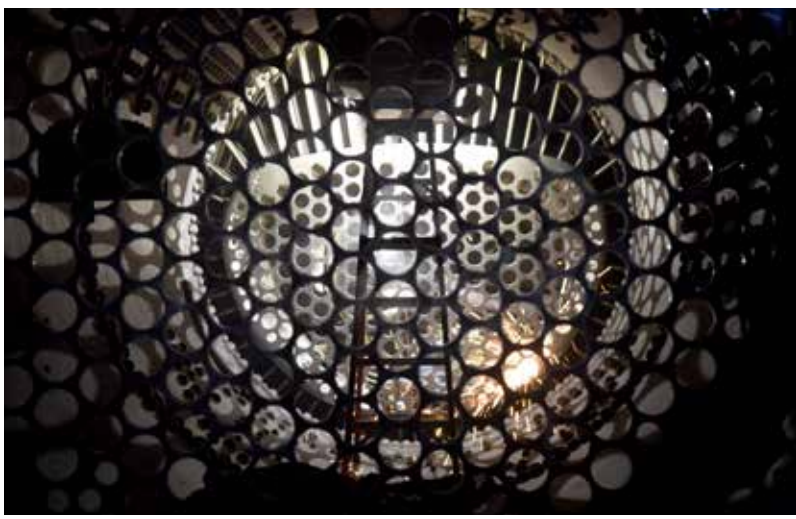
December 2016 brought visible and significant progress. In that month the steam crew contracted with a derailment-cleanup company to bring two heavy-duty cranes to the shop and hoist the 95-inch-diameter boiler into the air, enabling the front engine and the forward part of the articulated frame to be separated from the rest of the locomotive. The front portion of the boiler was set onto a specially constructed dolly.

This step was required, says Dickens, because the 4000-class design makes many areas inaccessible without taking the locomotive apart. An almost rivet-for-rivet disassembly is the only way to properly analyze and repair many components.

It had been the late 1950s since a Big Boy locomotive had been torn apart for rebuilding, and the heritage team marked every step of the way. "It might sound corny, but we've had a lot of firsts," Dickens says. "Taking the 4014 apart, being the first to walk underneath the boiler — some of these things haven't been done in 60 years. You can go and look at a Big Boy in a park, but that's very different than actually disassembling one of them."

The bulk of the work would be done in house by the UP steam

The Big Boy firebox, from the engineer's side looking forward toward the smokebox, shows multiple circulator tubes coming off the crown and sidesheets, staybolts, combustion chamber, and rear tube sheet.



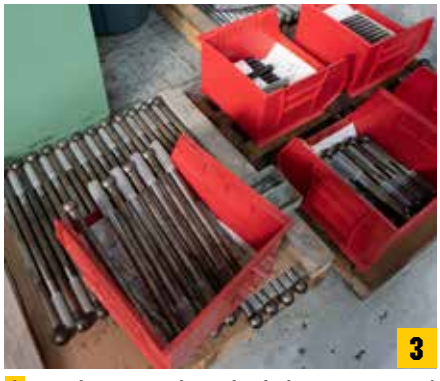
We are at the smokebox end of No. 4014 in March 2017 looking back through the boiler. Front and rear tube sheets create a pattern while a worker removes a defective staybolt in the firebox.

crew. Few components were sent to contractors. The eight driving-wheel sets, which weigh 16,000 pounds each, were sent to the Strasburg Rail Road backshop in Pennsylvania for crank pin and axle work and installation of new tires. The two cross-compound air pumps went to Colorado's Back Shop Enterprises, run by Bernie Watts, for rebuilding.

Cheyenne, Wyo., is known for several things. It's the state capital. It's also just east of the Rockies and in the spring it is a wind-whipped place. That's what we found in March 2017 when TRAINS visited the steam shop. Outside, gusts of up to 60 mph made it difficult to stand; inside, the steam crew was quietly assessing No. 4014's condition and machining replacement parts.

With the locomotive partially disassembled, the crew made progress on repairing pistons and cylinders, running gear, wheels, and other parts. Returning these components to pristine condition requires "thousands of man-hours," in Dickens' words, but overall he was surprised by how little work the locomotive will require.

As of March 2018, the time of our next visit to the shop, No. 4014 was about as disassembled as you can get and still be counted as a locomotive. The wheels were out from underneath it — all 24 of them — and 100-ton freight car trucks support the frame. It held the title of the world's largest 0-0-0-0. The boiler was as empty as it has been since Alco built the 4-8-8-4 in 1941. The cab was in another part of the shop and resting near No. 844. The tender, as yet un-rebuilt, was sitting in the yard. But there are signs of progress everywhere at the new Alamo of Steam. The Alamo of



1 March 2018, and much of Big Boy No. 4014's front engine frame has been completed. Lubrication lines, inaccessible once the boiler is reattached, are wrapped in light-brown insulating covers. The boiler sits one track over to allow workers to make progress on both portions at the same time. The grid on the boiler is made in soapstone so that each section can be tested for integrity. Mechanical lubricators have green tops. The perspective is from near the second set of cylinders looking forward. **2** The restored backhead of the locomotive shows firedoor, studs for appliances, numerous staybolts. The backhead is jacketed and insulated before controls, water glasses, and other items are installed. **3** Staybolts by the box are placed in containers for transfer from the machine shop to the shop floor. **4** Garland Baker with the computer-controlled machine that cuts staybolt threads. The massive Big Boy may be a 1941 product that was state of the art for its time, but some of its parts were made with the most modern of machines.

Steam was a term that TRAINS Editor David P. Morgan coined to describe Roanoke, Va., headquarters of the steam-committed Norfolk & Western in the 1950s, and one that I appropriated and modified with the word "new" in 1995 to describe the UP steam shop. I wrote this in March 2017: "They are the kind of signs that give confidence to the crew that is laboring so hard to see this done, the railroad that wants to see this behemoth completed as a goodwill ambassador, and the fans who have long dreamed of a Big Boy back in steam.

"The crew is working hard on multiple tasks to get the job done. They're sequestered in a 'clean room' machine shop, where computerized machine tools of today are bringing back the past. They're huddled around the gigantic trailing truck frame (estimated weight, 17,000 pounds, and the size of a small car) that's been removed. They're perched in a lift on the side of the boiler. Respectively, they're making bolts, inspecting the casting, and welding. They're also deep inside the firebox, where the task of renewing metal is ongoing. It is relentless, exhausting, and exhilarating work all at one time. But you can sense that this is a crew that is proud of getting the 4-8-4 back on the road in 2016 and that is on the verge of something big, something that was always believed to be too big to ever happen, too far out of reach, or just a silly dream. But dream no more. Throughout the shop, confidence is high that we'll see No. 4014 done in time to celebrate the 150th anniversary of the Transcontinental Railroad in May 2019. That will be 60 years since a Big Boy last pulled revenue freight in regular service.

With a new crane overhead, No. 4014's boiler sits inside the cavernous Cheyenne, Wyo., backshop in June 2018. This place once housed Big Boy overhauls in the 1940s and 1950s and the steam shop for years.

Steam shop worker Bruce Kirk checks a rigid staybolt on the engineer's side of the firebox. Such bolts allow the firebox to expand when hot. The other staybolt type is flexible and is often found on the roof.

It will be a cause of celebration among those who love steam the likes of which we've never seen before."

During that visit, Dickens said the work was about 50 percent done. The focus was on the 300-psi boiler that is the heart of this 7,000-hp giant of the rails. He estimated that 85-to-90 percent of the parts needed to restore the locomotive are on hand. Boxes of new staybolts of varying lengths were awaiting installation.

I reported further: "The steam exhaust water pump sets ready on a workbench. A Nathan lubricator shines in fresh gloss black, having been overhauled. The much celebrated burner for oil firing is in the building. The crossheads are nearly done with machining. The brake stand has been rebuilt. The list is a long and tedious one, but such is the way of steam locomotive restoration for the main line on a stage that only Union Pacific could provide. Only one highly visible part of the old No. 4014 — the ashpans from the locomotive's coal burning days — will go away with the conversion to oil firing. The time for taking parts off Big Boy has passed, and the time for putting new or refurbished parts back on has arrived.

"That is extremely evident one track over from the Big Boy, where the front engine awaits wheels and a boiler: The front pilot has been renewed. Rebuilt cross-compound air pumps are installed

Which tender would you pick to operate behind No. 4014 in 2019: The one that had been behind Challenger 4-6-6-4 No. 3985, on left, or the one that came with No. 4014 from California, on the right? Both were photographed in the yard at Cheyenne in June 2018.

TENDERS: SWIPE RIGHT OR SWIPE LEFT

WHEN BIG BOY 4014 rolls this year, it will not use the tender it brought with it from California. In the interest of time and expediency, the UP steam crew decided to prepare the tender tank from the Heritage Fleet's Challenger 4-6-6-4 No. 3985 to go behind the Big Boy for its inaugural season back in steam. The reasoning is simple: No. 4014's tender is outfitted with a coal bunker and auger to feed its cavernous firebox. No. 3985's tender was converted to carry fuel oil when the locomotive's fuel was switched in the late 1980s. The two tenders are essentially the same with minor differences other than the type of fuel they carry. No. 3985 is safe inside the Cheyenne roundhouse, having been out of service since 2010. No. 4014's tender would have required the construction of a fuel oil tank and piping modifications. No. 3985's tank is also in good shape with paint and body work, while No. 4014's tender needs some sprucing up.

To prepare No. 3985's tender, the steam crew cleaned out hundreds of pounds of rust that had accumulated inside the water portion over the years. Centipede tenders are common to not only Challengers but also UP 4-8-4s like No. 844. They're of the 4-10-0 wheel arrangement with 42-inch-diameter wheels. They carry 28 tons of coal or 6,000 gallons of fuel oil, and 24,000 gallons of water (the last five Big Boys had tanks of 25,000 gallons of water). The centipede tender, more so than the long-legged locomotive, is one of the limiting factors of the engines on tight curves.

Interestingly, both tenders have sat on a siding just outside the steam shop at either end of a cut of cars.

Eventually the tanks will be returned to their respective locomotives. But for now, a bit of the much beloved Challenger, a popular member of the steam fleet since its introduction in 1981, will share the stage.

And if you're still concerned about the appropriateness of the swap, consider this: No. 4014 has carried the tender from sister Big Boy No. 4015 for years since the steam era. The tender that came with it from California carries number plate 25-C-116, which is the one from No. 4015.

When Big Boys were being shopped in the 1940s and 1950s, if a locomotive were ready to go and its tender was not, shop forces would grab a tender that was ready, quickly scratch out the old numerals and paint in the new one, and put the engine back on the road. They were needed to move freight, and nobody cared which fuel and water source accompanied these 7,000-hp power producers.

So now, you know what's behind No. 4014 this year and what will be behind it in years to come: A tender from No. 3985 this year, and a tender from a close sister sometime in the future. — *Jim Wrinn*

on the platform. Lubrication lines, soon to be covered up by the boiler, snake across the top of the frame in all directions.

"Soon, the drivers with new tires and crank pins will return from rebuilding at the Strasburg Rail Road. Workers will load the tubes and flues into the boiler. Reassembly will begin with thousands of parts ready to breathe new life into this old friend."

In June 2018, we visited once more. My report that time focused on the work that had been accomplished in three months and the work that was ahead: "With six of the eight wheel sets back from renovation and application of new tires, boiler work at the company's steam shop in Cheyenne, Wyo., has continued at a rapid pace. Rigid staybolts, flexible stays, rigid crown bolts. Rivets. Appliance studs. The gritty, tedious work continues on the 300-psi pressure vessel. In late June, the nine-member steam crew was installing the last rigid staybolts in the firebox. The rear truck that supports the firebox and cab was ready, and attention turned to the cab, which is getting significant amounts of new metal. Ahead is rewheeling of the locomotive, installation of tubes and flues, and a hydrostatic test of the boiler to ensure its integrity."

Soon the crew was boring the cylinders and replacing the bottom of the cab where rust had taken its toll.

The smokebox interior shows fabricated design, smokestack, and live steam tubes running from the superheater header. Plastic buckets sit on a covering where the exhaust nozzles are normally found.

Above, UP steam shop manager Ed Dickens shows a rebuilt crosshead guide on a work bench. Note the many machines placed throughout the shop for easy access. Right: The biggest change in No. 4014 from its regular service career to restoration is the conversion from coal to oil firing. This is the burner for the oil firing apparatus. Fuel oil enters at right and is sprayed into the firebox as a mist that ignites in the air.

By December 2018, No. 4014's restoration was moving forward at a rapid clip. The engine was moved outside to be reunited with its rebuilt front and rear engines. The almost-completed boiler was only missing the steam dome cover and smokebox inspection hatches. The backhead neared completion with valves, piping, water glasses, and other controls. But the real drama was down at track level. Side-boom cranes lifted the boiler while the front engine was pushed into place. A wedge was clamped onto the track to keep the No. 4 driver in place while the boiler was lifted at an angle that allowed the articulation tongue and hinge to go back together. At the same time, the crew managed to get the steam exhaust pipes and the front boiler wear plate into position. It was a coordination of all of these aspects that got the Big Boy back into one piece and looking like a locomotive once more.

Meanwhile, a notice published in the federal register in December 2018 showed that UP had asked the Federal Railroad Administration for waivers on Positive Train Control compliance for steam locomotives Nos. 844, 4014, and Challenger 4-6-6-4 No. 3985, which is stored out of service in Cheyenne.

Says the filing: "UP states these units are specifically designated and utilized on an extremely limited number of excursion trips annually. Excursions utilizing this equipment historically and continually involve the highest level of preparation in planning and operational safety during operation, giving special designation to each move. No less than two operators are present at any given time ensuring continual functional safety awareness during operational moves. UP explains they have been operating steam-powered excursions without PTC-initiated application and have found no adverse mechanical effect on operational safety." The FRA decided that the locomotives do not need a waiver as UP is still on track to implement PTC by the end of 2020.

Big Boy work continued through the winter with the installation of tubes, flues, and superheaters — the guts of the impressive boiler. Cut to precise lengths, the tubes and flues are installed, rolled, and then welded into place. Set the superheaters — coils of piping in which steam runs to get a final boost before being released to the cylinders — in place and you've got yourself a boiler that is on the verge of completion. All it needs is a final squeeze test to make sure it is sound.

On Feb. 6, 2019, UP reported a break through: That final squeeze — a successful hydrostatic test of the Big Boy boiler, the heart of the locomotive. A hydrostatic test is required by Federal Railroad Administration rules to confirm the integrity of a steam locomotive's boiler. It confirms that the boiler will be able to handle the heat and pressure of steam. Such a test requires the boiler to be filled with warm water and the pressure to be raised 25

It's June 2018 and UP 4-8-4 No. 844, the only steam locomotive on a Class I American railroad that has never been retired, rests. At the right is No. 4014's cab, in the midst of getting new steel.

percent above the maximum allowable working pressure. In Big Boy's case that is 375 psi. A typical rule of thumb in steam restorations is that it takes about six months of work after a hydrostatic test to complete all of the other work necessary to start operating. That meant UP had a tight window in which to complete the locomotive before the May 10 celebration of the Golden Spike's 150th anniversary. While the hydrostatic test took place, other crew members were busy running air and steam lines and piping up the No. 8 ET brake system in the cab. One of the good things about Big Boy's immense size is that you can spread out a restoration crew so they don't get into each other's way.

A few weeks later, UP announced steam testing had begun inside the shop. On April 9, the railroad said that the restoration had reached a significant milestone: The engine had been fired up for the first time in 60 years. Given that No. 4014 had not burned oil before, the crew took its time to adjust the burner so that it evenly heats the firebox sheets.

It was now coming down to the deadline UP had set for Big Boy. A May 4 trip to Ogden for the sesquicentennial of the Golden Spike had been set. There was plenty to do. Big Boy hadn't even moved under its own power yet. A planned trip by No. 844 to Ogden the week of April 27-28 was cancelled so the steam crew could focus on completing No. 4014's restoration.

The clock was ticking — and ticking louder by the minute.

Years of hard work paid off on April 27 when the crew hitched a tug to No. 4014 and pulled it out of the shop and into the sun. That afternoon, they worked steam on the locomotive, testing the safety valves, blowing out the valves and cylinders of dirt and debris, and ultimately testing the whistle. The pops blew in the windy Wyoming air. The sudden rush of steam flowing from the four cylinders and valves created a horizontal steam cloud. And a little after 5 p.m., General Foreman Austin Barker and Rail Giants museum's Paul Guercio sounded the giant's throaty voice for the first time in six decades. The Hancock three-chime, long-bell whistle announced to everyone standing on a nearby bridge and to all within earshot of downtown Cheyenne that Big Boy was back.

With the countdown on, there was no time to waste. Valves, pistons, and valve gear all had to be installed, and the valves precisely set for proper travel to ensure the accurate admission of steam to the pistons. A thousand and one time-consuming details go into the restoration of a steam locomotive, and Big Boy was no different than any other of its kind.

The following week was deadline week, and the crew spent the

1 **Cab installation. With boiler work completed, the boiler and frame reattached, the crew cab is placed on the finished backhead.** **2** **A new shop crane eases the rebuilt and painted cab into place in February 2019. The blue flag indicates presence of shop workers on or under the engine. The circular pattern of rivets reinforces areas for air to be admitted to the firebox to aid in combustion.** **3** **Once more, Big Boy looks more like its old self. Note the rebuilt trailing truck that is pictured on page 35. Light-colored piping carries lubrication lines. The UP steam shop crew praises the new overhead crane installed to aid in the Big Boy and all future projects.** Four photos, Union Pacific

To reach the backhead to place the cab, the Big Boy was pushed out the west end of the Cheyenne backshop for the first time in February 2019. The completed locomotive begins to take shape.

time inside the shop while an early spring snow and wind whirled outside. For days, there was no visible sign of activity to observers, just a few cars in the parking lot late at night.

Every moment counted at this point. "We were still bolting items on and loading the tool car," Dickens says of the last few hours of the work. "We knew we'd get it done.

The final reassembly included the lagging and jacketing, a tedious and painstaking job on any steam locomotive. True to form for a do-it-yourself team, the crew made the bands, brackets, and clips for the sheet metal that would provide No. 4014 with its silky-smooth exterior.

Then they set the valves that time the admission of steam to the cylinders. The job is a tad easier given that Big Boy is a simple and not a compound locomotive. "Its basically two engines under one boiler," Dickens says. "That makes it slightly easier to set the valves."

Little has changed on the Big Boy from its regular service era. Gone are the stoker and the ashpan; both are unnecessary on a coal burner converted to oil firing. Another casualty of the change is the hydrostatic lubricator that was in the cab. It is gone — it only serviced the stoker motor, which, of course, has been removed. The superheater header to appliances is blanked off – they will perform just fine without a direct steam supply from the boiler's hottest steam. Otherwise, save for a few electronics such as cab signals and a radio, Big Boy is today about what it was in 1941.

The boiler, the heart of the locomotive is amazingly original. Some 800 of 4,300 staybolts were replaced, including many crown stays. A few firebox patches were installed — especially in the combustion chamber just forward of the firebox, where cinder erosion takes its toll. Both the front and back tube sheets were replaced. "When we started, I told management that I wanted to have confidence in the pressure vessel, and they supported that," Dickens says.

Timken went through all of the roller bearing assemblies on the locomotive. The shop crew installed 7,800 pounds of firebrick in the firebox. The most dazzling improvement may be in the cab floor, where a UP shield medallion 4014 is embedded in the waffle plate; it covers the drawbar pin and is removable for inspection purposes.

For its inaugural run, No. 4014's mechanical restoration took precedence over its cosmetic features. The guard over the chain

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1 It's a snowy February 2019 day, and we see Big Boy's face once more after three years inside the backshop. The restoration included work to renovate the pilot and retractable front coupler door, new air pump shields and radiator housing (the flat sheet metal on pilot), and rebuilt cross compound air pumps. 2 Still to come are the pistons and piston valves, fireman's side handrails, headlight, and UP shield emblem/front number plate that is one of the most visible portions of the engine. Overall, the Big Boy, even in the midst of completion, presents a pleasing face to all observers. The backshop once housed Big Boy work in the steam era. Two photos, Union Pacific

drive to the lubricators and the replica builder's plates were still to be installed. Dickens says he still wants to nickel plate the throttle and the reverser. But for now, at least, the crew has produced a machine worthy of the main line. On deadline, they've completed the impossible. They've brought No. 4014 back to life.

How much did Big Boy's restoration cost? We don't know. The railroad will not say. But given the immensity of the project and the size of the locomotive it is not hard to estimate. Other locomotives the size of No. 844 that are under top-to-bottom restoration are coming in at in the range of about $2 million to $3 million. It would be easy to estimate that No. 4014 would come in at least twice that cost. For a locomotive that cost about $263,000 when new, it is not out of the question to think that its restoration cost in the $5 million to $7 million range. To anyone who appreciates American history, the cost is worth it. And to the UP, the price is well within reach for the goodwill and favorable community relations that No. 4014 will earn over 2019 and in the future.

With this massive overhaul completed, No. 4014 should be on the road as a UP goodwill ambassador for the next 45 years. With that, it is entirely possible that the engine will be in operation for its centennial in 2041. But we're about to get ahead of ourselves. Once the restoration work was done in April 2019, it was time to take Big Boy out for test runs, to break in a newly rebuilt engine. Such has been traditional on American railroads for as long as steam locomotives have been rebuilt, and UP has always followed that path as well. Those tests traditionally start in the yard, and move to the main line, where the locomotives can run, no gallop, like the horses to which they've been compared.

In No. 4014's case, she has been reborn to roam on the same route that she plied so many times between Ogden and Cheyenne. She has become special among 25 locomotives that were considered special from the day the first one was completed in 1941. She has become the last of its kind to run once more, a Big Boy back in steam!

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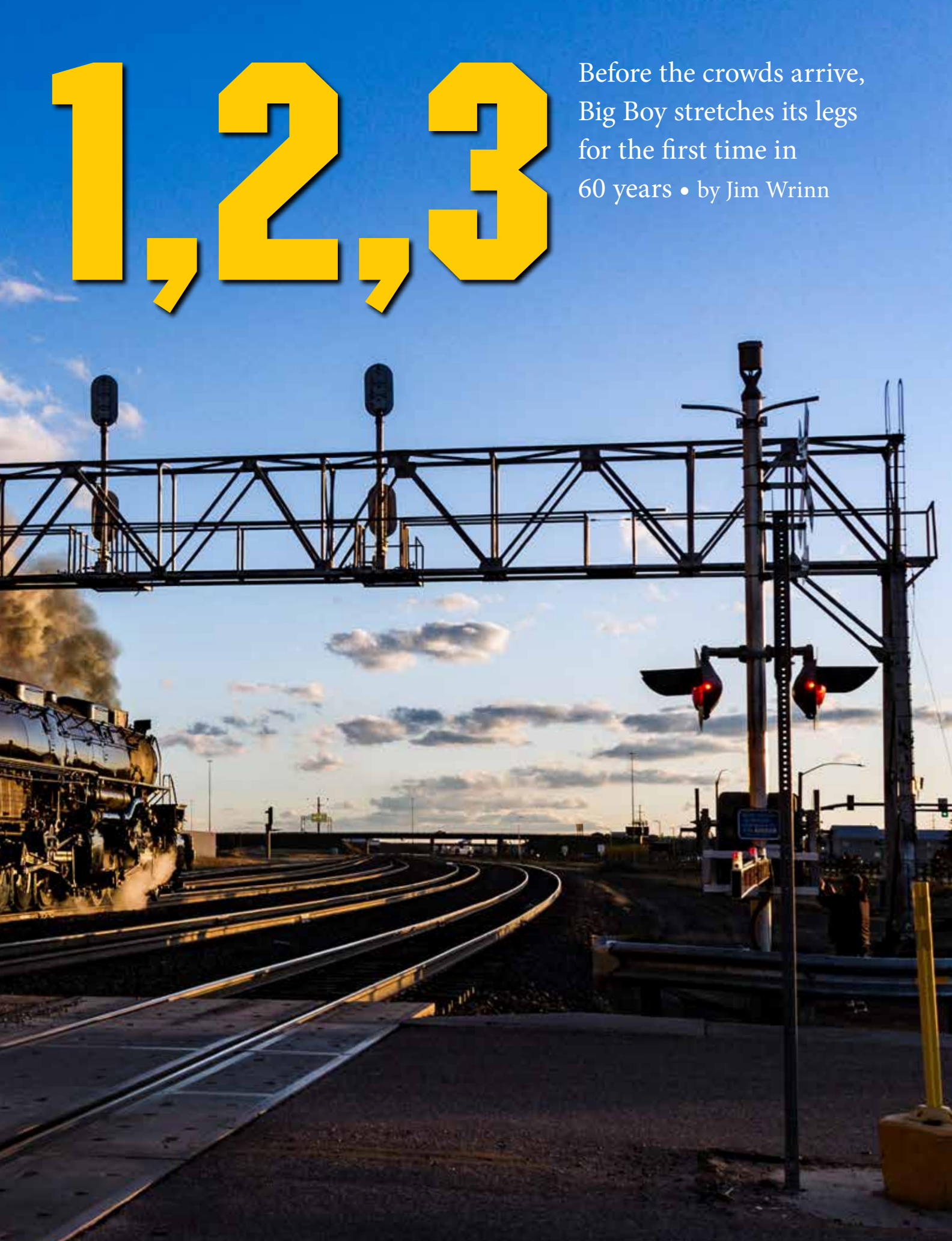
TESTING

The sun dips below the horizon as No. 4014 steams westbound out of Cheyenne, Wyo., for the first time in 60 years, on May 2, 2019. The location was the site of Tower A. John Crisanti

1,2,3

Before the crowds arrive, Big Boy stretches its legs for the first time in 60 years • by Jim Wrinn



TEST TRIPS AND BREAK-IN RUNS are vital to the success of a machine that will be in the spotlight. Some chief mechanical officers want so many miles on their engine before they debut it for the public. Others want it to be in operation for so many hours. The end result is the same: a reliable locomotive.

In the case of Big Boy No. 4014, the railway preservation community watched and wondered when such a trip would occur as the calendar counted down to the May 4 inaugural run. With a giant machine to prepare, the work went down to the wire, and the crew buttoned up the engine, fired it up, and prepared it for a May 2 journey.

Originally, the test trip was to be a Cheyenne-to-Greeley, Colo., turn, on the main line to Denver. That would put about 120 miles on the engine. On the morning of May 2, the locomotive coupled up to a canteen, two tool cars, and a diesel on the trailing end to provide backup power and also to simulate a load. The train was prepared to go south, but owing to the steady pulse of traffic on the Overland Route main line and healthy business on the Denver line, the engine had a time getting out of the yard.

The assemblage finally left after 6 p.m., making the slow climb to the junction of Sherman Hill Track 3 and the Denver line in the fading twilight. The train stopped often so the crew could inspect, and it finally made it to Speer, Wyo., as darkness fell. The train got to Nunn, Colo., before stopping and returning. The crew knew the engine was good to go West.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1 Cylinder packing gets adjustments on May 3 after the test run. TRAINS: Jim Wrinn

2 The people who made it happen: UP's steam crew poses for a portrait on the front of 4014 in Cheyenne the day prior to departure for Ogden. Seven photos, Steve Glischinski

3 Work continued on 4014 almost up to departure. A contractor works to attach banding to 4014's boiler jacket on May 3.

4 UP 4-8-4 No. 844 is fired up in the Cheyenne Steam Shop on May 3.

5 No. 844 gets a last minute bath as the crew puts a fire in the engine on the eve of the westbound journey.

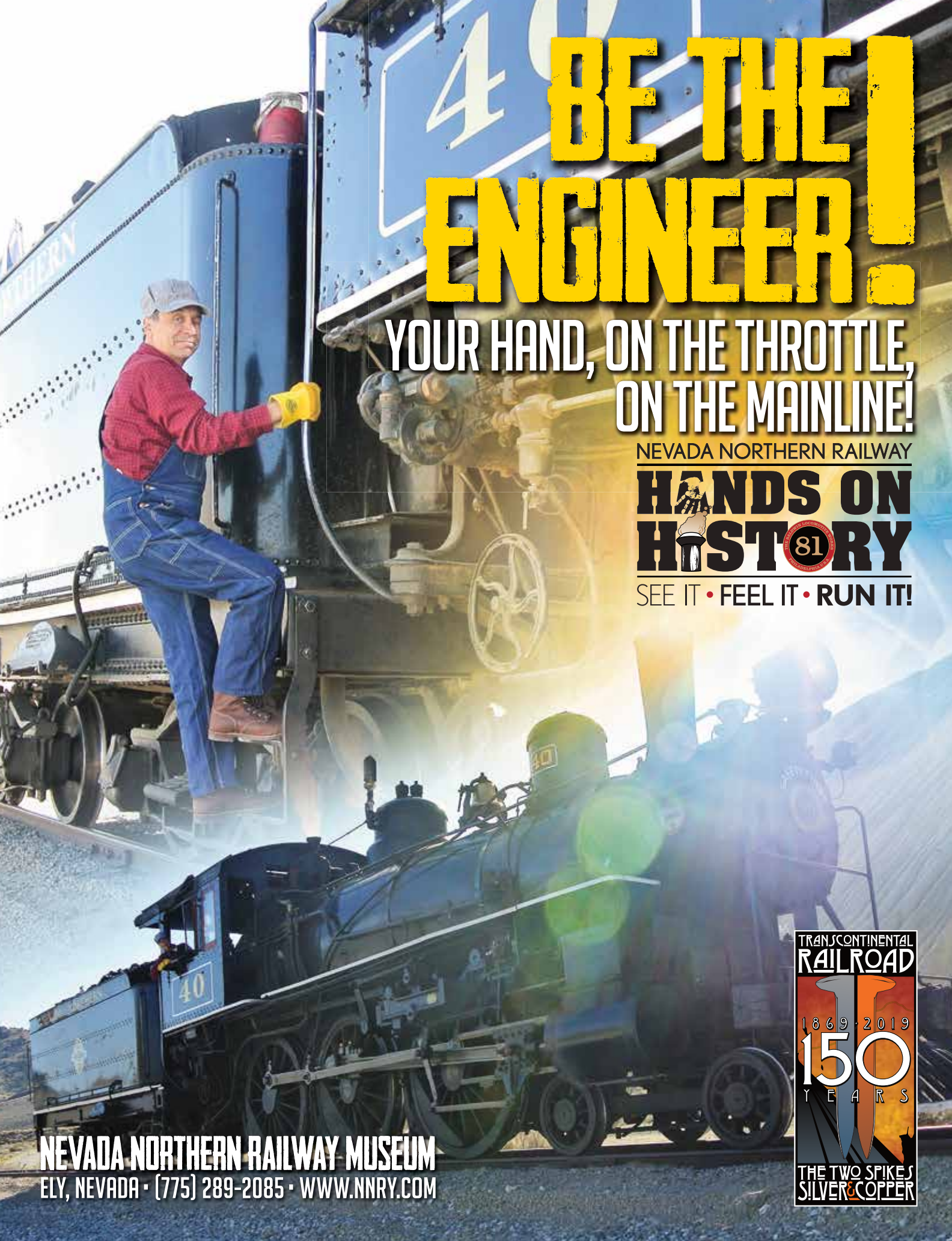
6 "Last of the Giants" was the title of UP's Big Boy promotional film from the 1950s, and UP's last two operating giants share the floor of the steam shop the day before departure for Ogden.

7 Inside the Cheyenne steam shop, workers ready UP 4014 for its big debut.

8 Big Boy 4014 shows off its long boiler inside the confines of the steam shop on May 3.

1 **Big Boy test run: It's after 6 p.m., on May 2, when Big Boy slips under the Colorado & Southern (now BNSF) bridge on the west side of the Cheyenne yard. In the 1950s, this was a classic location for photographing Big Boy locomotives as they headed west out of Cheyenne.** TRAINS: Jim Wrinn

2 **Well after sunset, No. 4014 stops at Speer Junction just south of Cheyenne, Wyo., on May 2, 2019. Illuminating the scene is a waiting manifest about to enter the Greeley Sub for the run south into Colorado.** John Crisanti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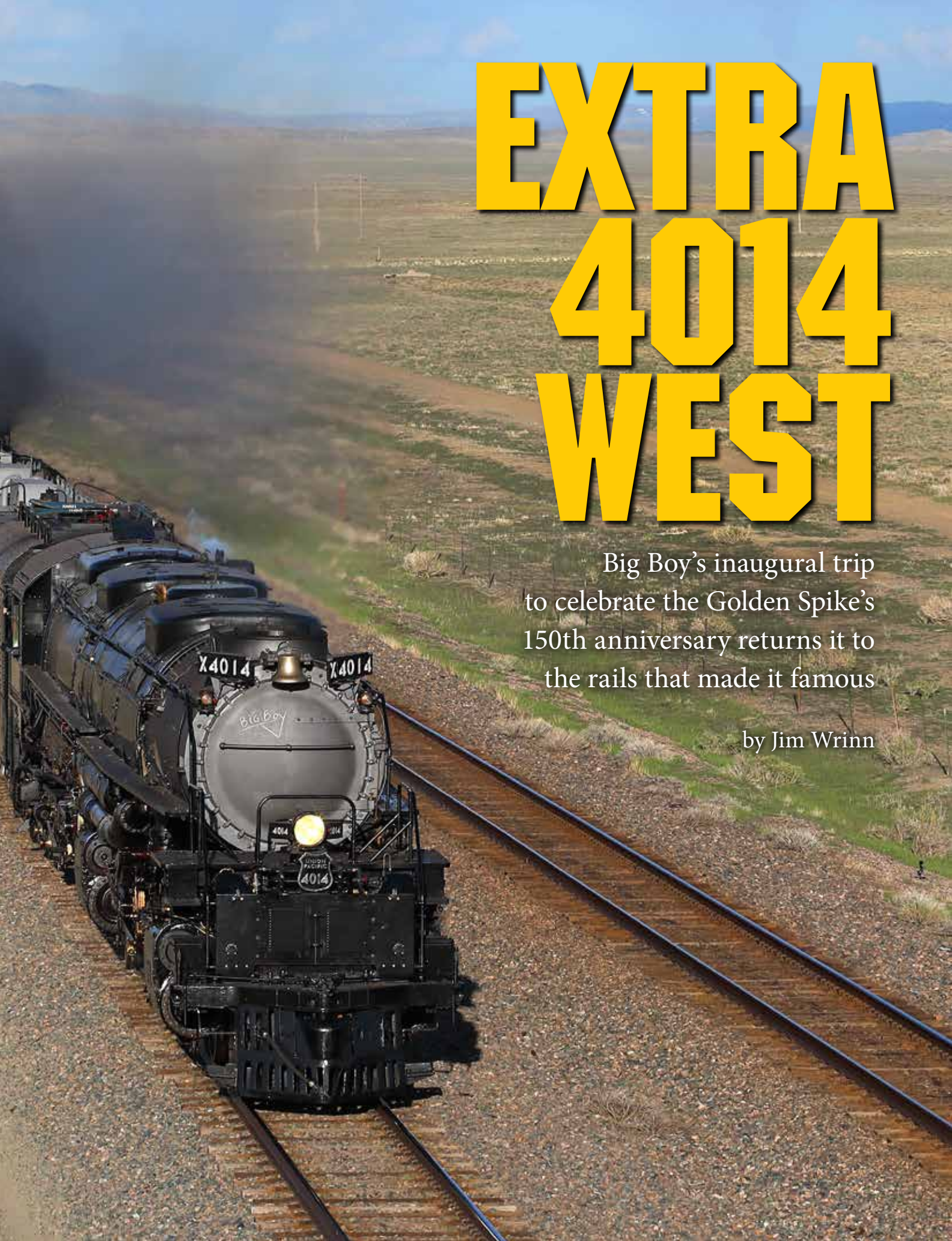
Nos. 4014 and 844 lead their special train headed to the Golden Spike 150 Celebration in Ogden at Sinclair, Wyo., on May 4, 2019.
Mike Danneman

EXTRA 4014 WEST

Big Boy's inaugural trip to celebrate the Golden Spike's 150th anniversary returns it to the rails that made it famous

by Jim Wrinn



"EVERYTHING IS POSSIBLE, EVEN THE IMPOSSIBLE" is a quote from the 2019 Disney remake of "Mary Poppins." It is a line that was appropriate in Wyoming and Utah May 4-9 as Big Boy No. 4014 made its inaugural run from Cheyenne, Wyo., to Ogden, Utah, in celebration of the 150th anniversary of the Golden Spike.

With work on Big Boy at a frenzied pace leading up to the trip, 4-8-4 No. 844 did not make a planned solo run to Ogden the week before and instead doubleheaded with the newcomer. Their duet made for an amazing sight as the Big Boy and the Living Legend thrilled spectators.

Thousands of onlookers from across the country and around the world crowded roads and populated every vacant spot along the UP main line following a christening ceremony headlined by UP Chairman, President, and CEO Lance Fritz; Wyoming Gov. Mark Gordon; and Cheyenne Mayor Marian Orr. Fritz's wife Julie smashed a bottle of champagne on the pilot of the locomotive before a crowd of several hundred who paid to see the event at the Cheyenne depot.

Then it was off to climb Sherman Hill via Track 3, the locomotive returning to Big Boy territory for the first time since July 1959. The train overnighted in three towns along the way — Rawlins, Rock Springs, and Evanston — before a triumphant return to Wasatch grade. The two left Rock Springs early on the morning of May 6 to get ahead of track work, and they continuously dodged freights on the UP's busy Overland Route.

In Ogden, Nos. 4014 and 844 participated in a special ceremony in which they appeared nose-to-nose in the same fashion as the Central Pacific 4-4-0 *Jupiter* and Union Pacific 4-4-0 No. 119 in 1869. With a call on the radio from UP's Fritz as part of a Thursday morning ceremony, Big Boy No. 4014 eased into the scene with No. 844 in front of a banner that read "#Done." Fritz, Utah Gov. Gary Herbert, U.S. Rep. Bob Bishop, and descendants of UP construction boss Grenville Dodge and Chinese laborers used hammers to tap an oversized golden spike, celebrating the 150th anniversary of the first transcontinental railroad in 1869. Big Boy had fulfilled its aim of being the biggest gift to the transcontinental railroad's 150th anniversary. BB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ACROSS SHERMAN HILL FOR THE FIRST TIME IN 60 YEARS: MAY 4

1 **Dignitaries crowd the platform at the Cheyenne depot on May 4 as Nos. 4014 and 844 hold the westbound main line. In a few minutes, No. 4014 will become the first Big Boy in steam on its original route in 60 years.** Two photos, TRAINS: Jim Wrinn

2 **UP President Lance Fritz and his wife Julie break a bottle of champagne to christen the engine on May 4, 2019. After the speeches were over, the two locomotives eased ahead to pick up passengers and head across Sherman Hill to Laramie and eventually Rawlins.**

3 **Engineer Ed Dickens talks to admirers from the gangway of Union Pacific Big Boy No. 4014 at Rawlins, Wyo., on May 4, 2019. The script on the side of the cab has changed: The fractions are gone from the cylinder dimensions, as are two letters that once described the stoker type when the engine burned coal. In their place are "DB" for Dickens-Barker, the two steam shop crew members who installed the oil burner. See page 11 for the full breakdown.** Mike Danneman


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4014
4-8-8-4-1-68 24 24 540 DB
U.P.

ACROSS SHERMAN HILL FOR THE FIRST TIME IN 60 YEARS: MAY 4

1 Nos. 4014 and 844 roll westbound near Harriman, Wyo., on Track 3, a Sherman Hill alignment that only saw Big Boys from 1953 to 1959. Two photos, Steve Glischinski

2 Hundreds of photographers depart the Highway 30 overpass west of Medicine Bow, Wyo., after the passing of No. 4014 on May 4, 2019. Note the special T-shirt that Tennessee Big Boy fans are wearing. Mike Danneman

3 UP 4014 pounds up Sherman Hill Track 3 east of Harriman, Wyo.

4 The duo join tracks 1 and 2 at Dale Junction, Wyo., as a westbound freight waits for them to pass before following the special through the Hermosa Tunnels. TRAINS: Jim Wrinn

INTO THE HIGH DESERT: MAY 5

1 People swarm around No. 4014 at Rock Springs, Wyo., on May 5, 2019. Members of the TRAINS staff are present in high-visibility vests sponsored by Railfan Depot and Nevada Northern Railway Museum. Two photos, Mike Danneman

2 Steam crew members lube No. 4014 at Rock Springs, Wyo.

3 Big Boy and No. 844 make a spirited departure from Point of Rocks, Wyo., after a servicing stop. Robert S. McGonigal

4 No. 4014 highballs at some 35 mph between Rawlins and Wamsutter, Wyo. The medallion on the floor covers a drawbar pin inspection opening. TRAINS: Jim Wrinn


4
SAFETY FIRST
UNION PACIFIC
4014

ACROSS WYOMING: MAY 6

With an early morning departure from Rock Springs, Wyo., confounding many photographers, some chose to chase the sun. Those who were at the junction town of Granger, Wyo., were richly rewarded with a dazzling sunrise and doubleheaded UP steam locomotives in their stride. Chase Gunnoe

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BACK TO ECHO CANYON: MAY 8

1 Nos. 4104 and 844 pop out of the tunnel at Curvo, Utah, on the 1869 line. Below at this famous spot is the 1916 second track for eastbound trains. Two photos, TRAINS: Jim Wrinn

2 No. 4014 steams through Castle Rock, Utah, on a cold, rainy morning. Mike Danneman

3 No. 4014's westbound passenger car special, symboled PENOG1-08, rides the Evanston Subdivision at milepost 935. It's descending Echo Canyon at Castle Rock, Utah. The train is on the original 1869 grade. On the hillside above is the 1916 second track. James Belmont

4 Nos. 4014 and 844 sprint on the last lap at Henefer, Utah, before reaching Ogden and their objective. Following along on parallel I-84 is a motorcade that by most observers' perspectives reached 12 miles in length.

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CELEBRATING THE GOLDEN SPIKE IN OGDEN, UTAH: MAY 9

1 Nos. 4014 and 844 stand in for the *Jupiter* and No. 119 in a remake of the classic East-meets-West Golden Spike pose. The two engines were positioned to face each other at Ogden, Utah, to celebrate the 150th anniversary of the Golden Spike. Two photos, TRAINS: Jim Wrinn

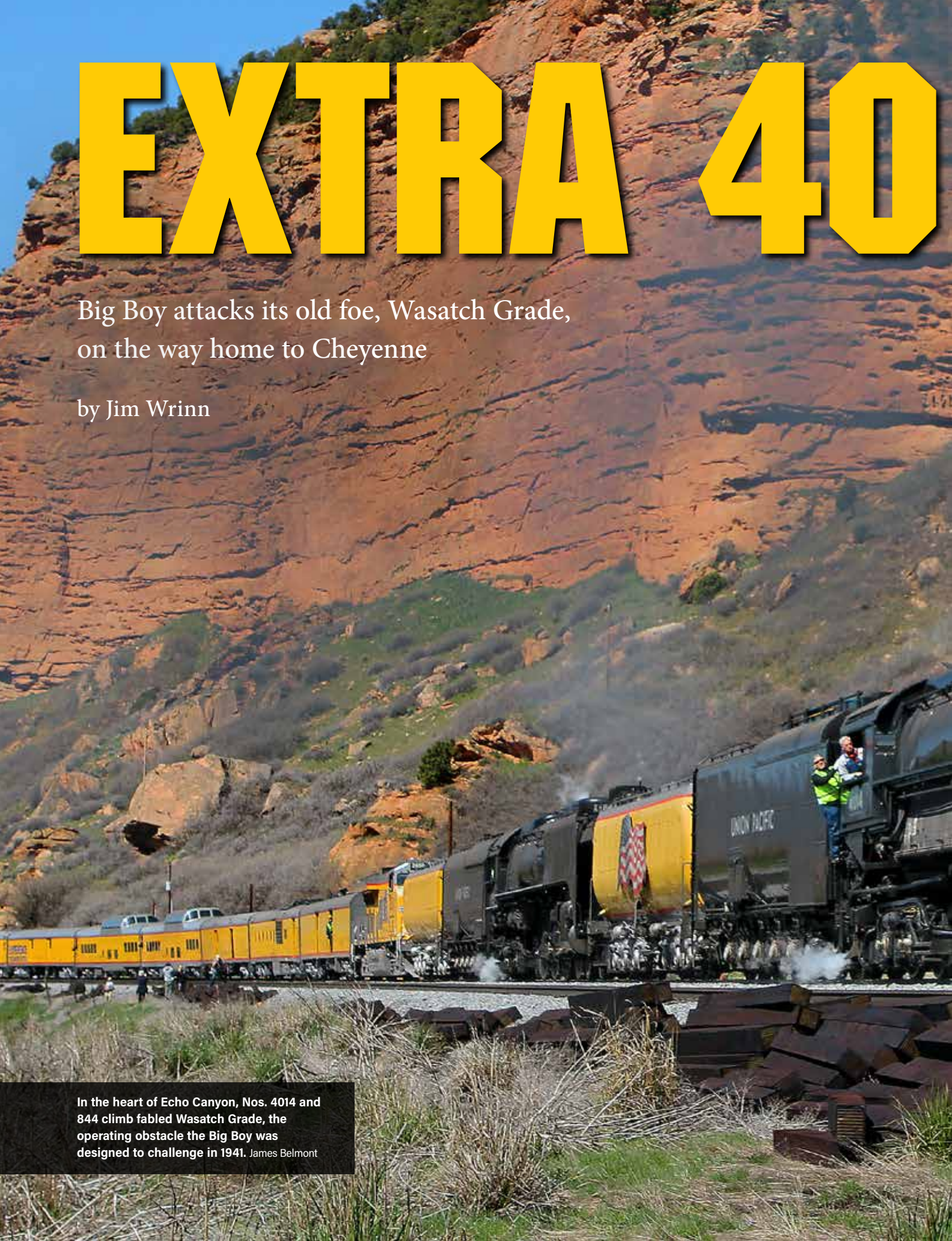
2 As Nos. 4014 and 844 look on, UP officials and guests reach for hammers to ceremonially tap a giant Golden Spike, marking the completion of the first transcontinental railroad on May 10, 1869.

2

EXTRA 40

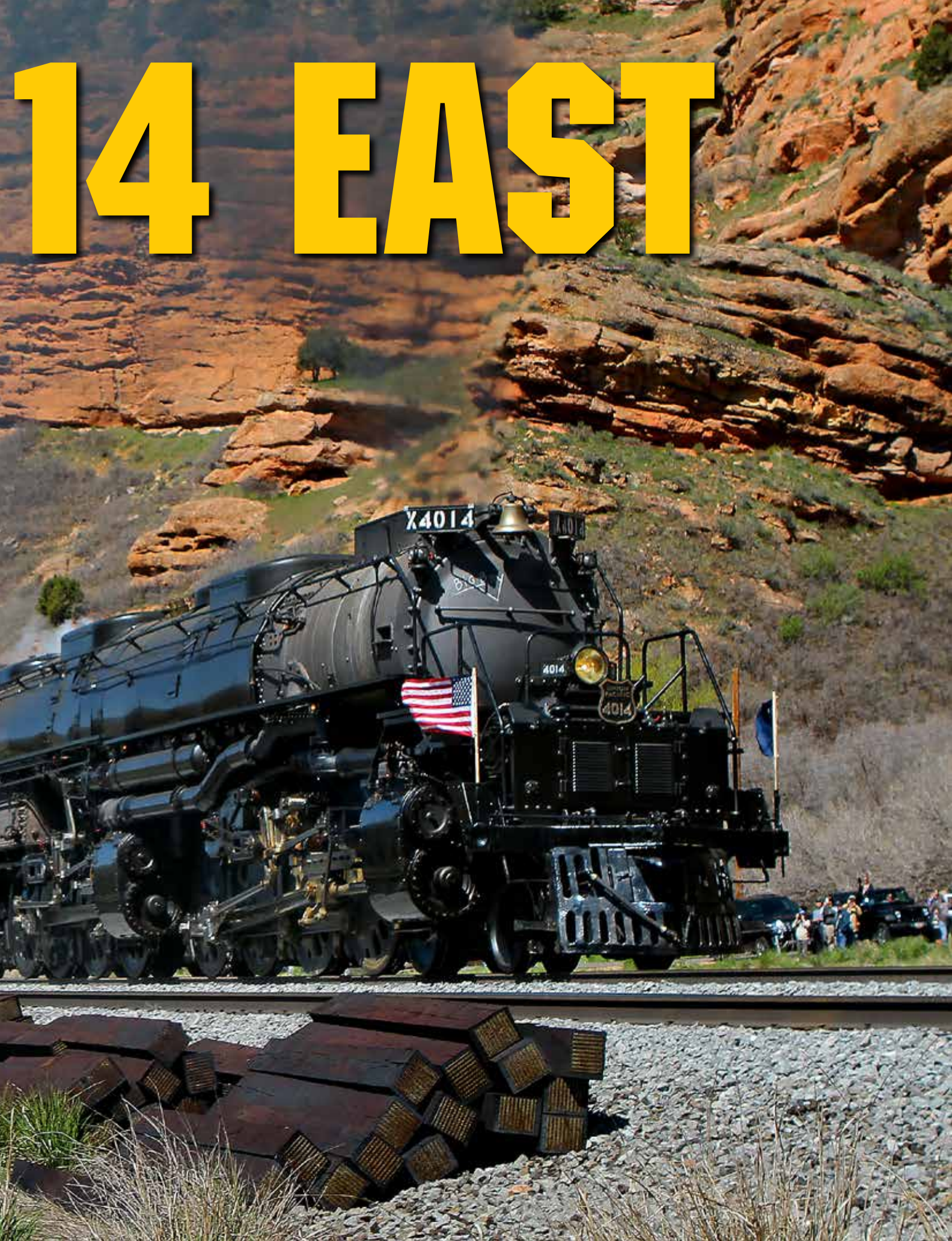
Big Boy attacks its old foe, Wasatch Grade, on the way home to Cheyenne

by Jim Wrinn



In the heart of Echo Canyon, Nos. 4014 and 844 climb fabled Wasatch Grade, the operating obstacle the Big Boy was designed to challenge in 1941. James Belmont

14 EAST



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AFTER THE BIG PARTY in Ogden, it was time for Nos. 4014 and 844 to return home to Cheyenne, retracing their 500-mile route. The first challenge: the 65-mile-long Wasatch grade for which the Big Boy locomotive was designed. The grade starts in Ogden and ends at Wahsatch, Utah, just east of Evanston, Wyo. While No. 4014's May 12 passenger special was nowhere near the tonnage it once pulled in the freight era, it was no less impressive in scenic Weber and Echo canyons.

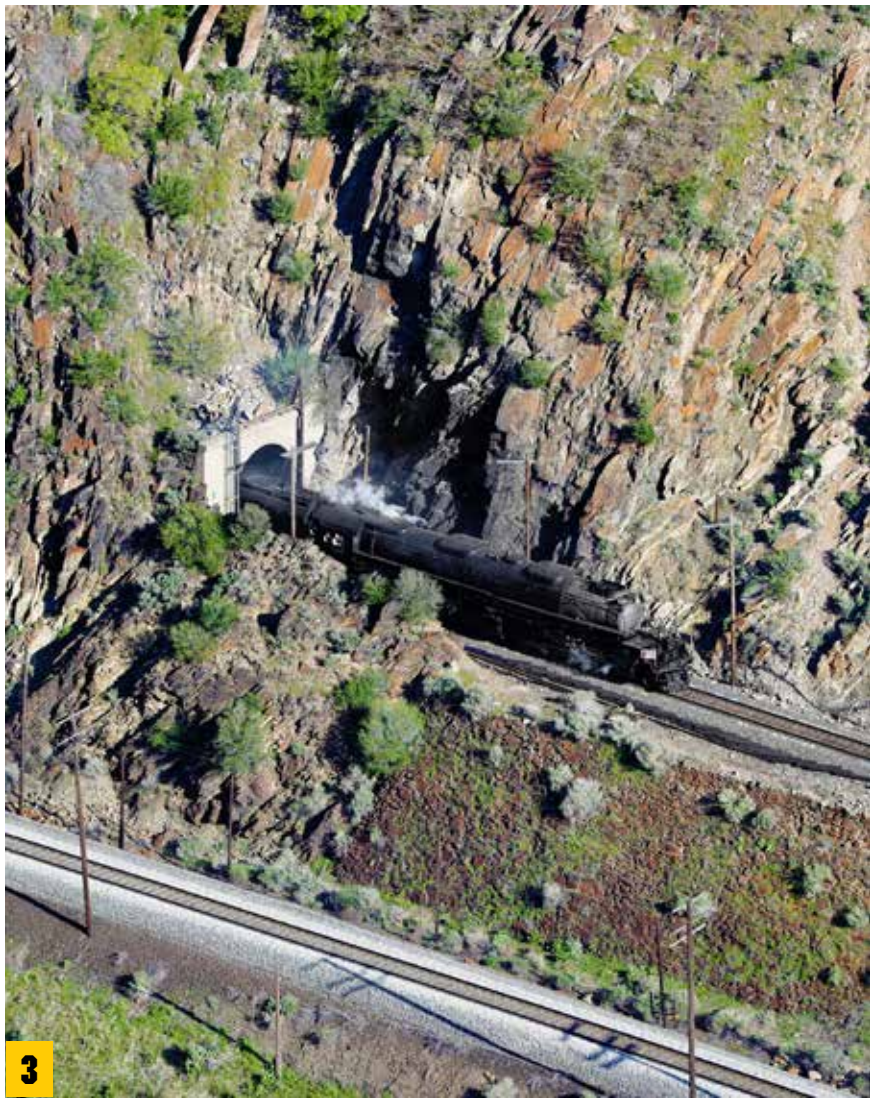
The train overnighted in Evanston and paused in Rock Springs for two days to rest the crew and provide visitors the chance to inspect the engine more closely.

2

On May 16, the special ran to Rawlins on an uneventful trip until entering the yard, where axles 2 and 3 of No. 4014's second engine dropped between the gauge. Fortunately the train was running slowly and the crew was attentive and stopped the engine quickly. With the help of wood blocking and a local track crew, the engine was rerailed and on its way in 3 hours.

The following day, No. 4014 worked its way through heavy freight traffic and a tie gang near Walcott, Wyo., and ended up in Laramie for another day of rest.

The grand finale was the eastbound trip across legendary Sherman Hill. The engine pierced the Hermosa Tunnels and dropped downhill on tracks 1 and 2 for the first time. At Cheyenne, the two steam locomotives cut off from their train and headed to the shop for a well-deserved rest with more than 1,000 miles, a tremendous amount of hard work, and millions of smiles and memories, behind them.



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CLIMBING THE LEGENDARY WASATCH GRADE: MAY 12

1 **With a long motorcade hot in pursuit on parallel Interstate 84, Nos. 4014 and 844 thread a bridge over Weber Creek near Morgan, Utah.** Sol Tucker

2 **The two locomotives drew huge crowds as they made their way out of Ogden and through the confines of Weber Canyon.** Justin Franz

3 **No. 4014 darts out of a tunnel in Weber Canyon.** Sol Tucker

4 **With the abandoned summit tunnel to the left, the doubleheader reaches the summit at Wahsatch, Utah, on the 1916 line. The original 1869 grade is on the top of the embankment over the locomotives. The sound here: like that of a jet airliner taking off.** TRAINS: Jim Wrinn

4

DOUBLEHEADING ACROSS THE DESERT: MAY 13

Wyoming is cowboy and cowgirl country, and that was evident in the send-off Nos. 4014 and 844 received on the morning of May 13 as they departed Evanston, Wyo. Leo de Groot

DEEP IN BIG BOY COUNTRY: MAY 16

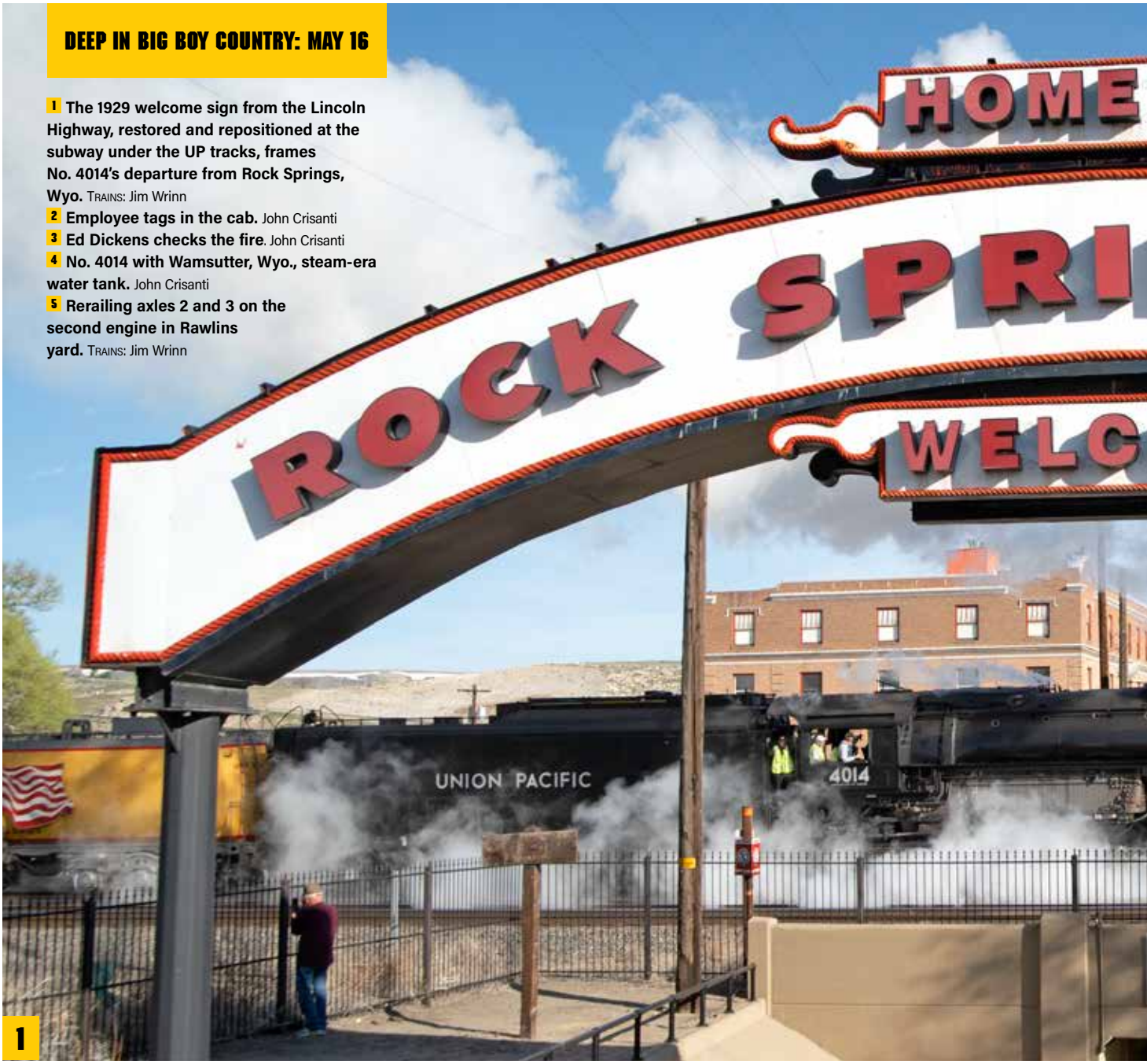
1 **The 1929 welcome sign from the Lincoln Highway, restored and repositioned at the subway under the UP tracks, frames No. 4014's departure from Rock Springs, Wyo.** TRAINS: Jim Wrinn

2 **Employee tags in the cab.** John Crisanti

3 **Ed Dickens checks the fire.** John Crisanti

4 **No. 4014 with Wamsutter, Wyo., steam-era water tank.** John Crisanti

5 **Rerailing axles 2 and 3 on the second engine in Rawlins yard.** TRAINS: Jim Wrinn



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RETURN TO LARAMIE: MAY 17

1 Rain showers move in as Nos. 4014 and 844 put on a show as they depart Rawlins, Wyo. John Crisanti

2 The famous rock formation east of Rock River, Wyo., where the main line climbs a ridge, has been a favorite of photographers on the UP since the steam era. It was no less so on this day as No. 4014 made its first eastbound trek under steam. TRAINS: Jim Wrinn

BACK HOME TO CHEYENNE: MAY 19

1 **No. 4014 pops out of Hermosa Tunnel on Sherman Hill.** James Hickey

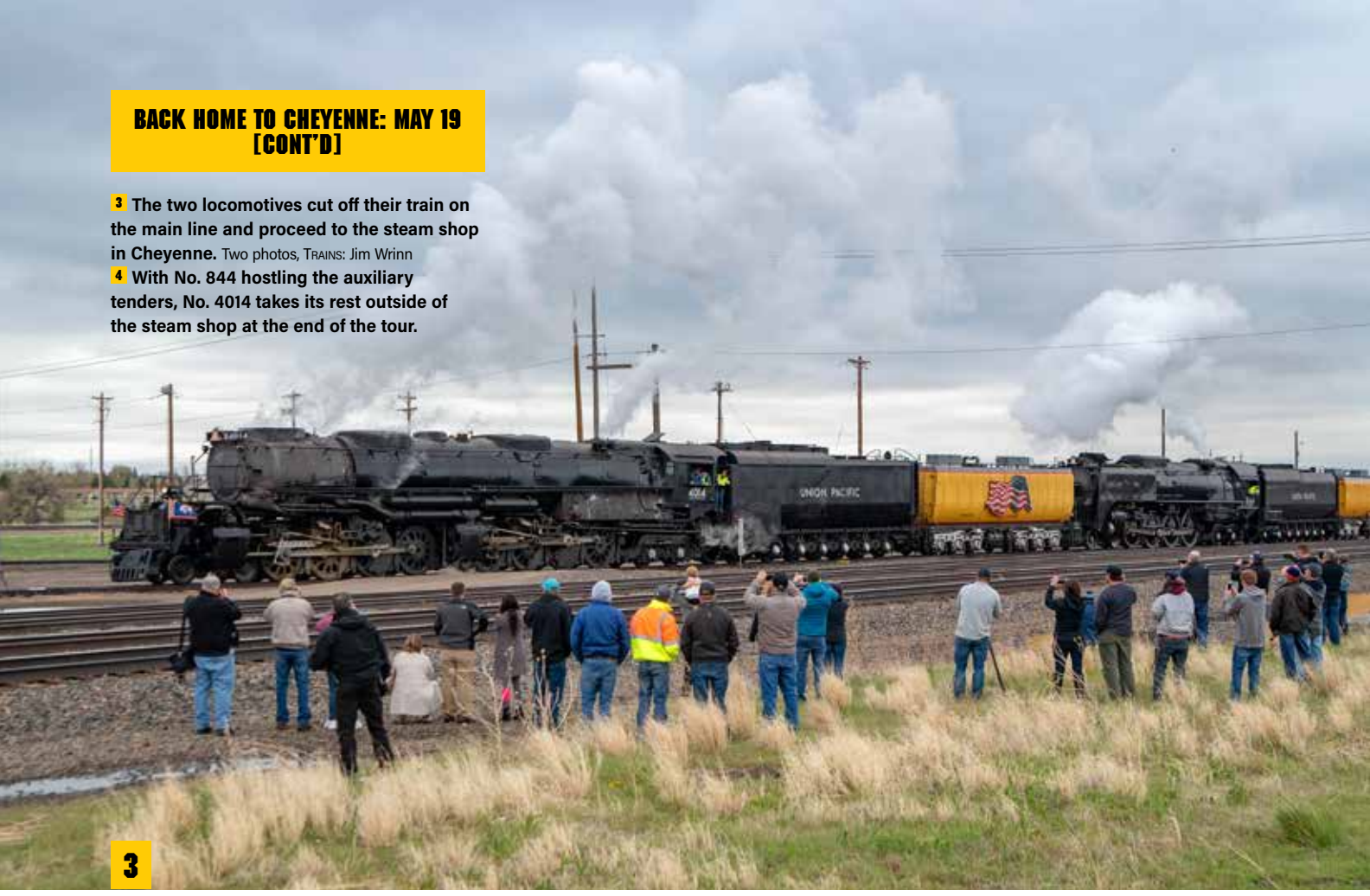
2 **The 12-car special, with office car *St. Louis* bringing up the tail, rolls downgrade at Granite, on the last few minutes into Cheyenne.** TRAINS: Jim Wrinn

1

2

BACK HOME TO CHEYENNE: MAY 19 [CONT'D]

3 The two locomotives cut off their train on the main line and proceed to the steam shop in Cheyenne. Two photos, TRAINS: Jim Wrinn
4 With No. 844 hostling the auxiliary tenders, No. 4014 takes its rest outside of the steam shop at the end of the tour.



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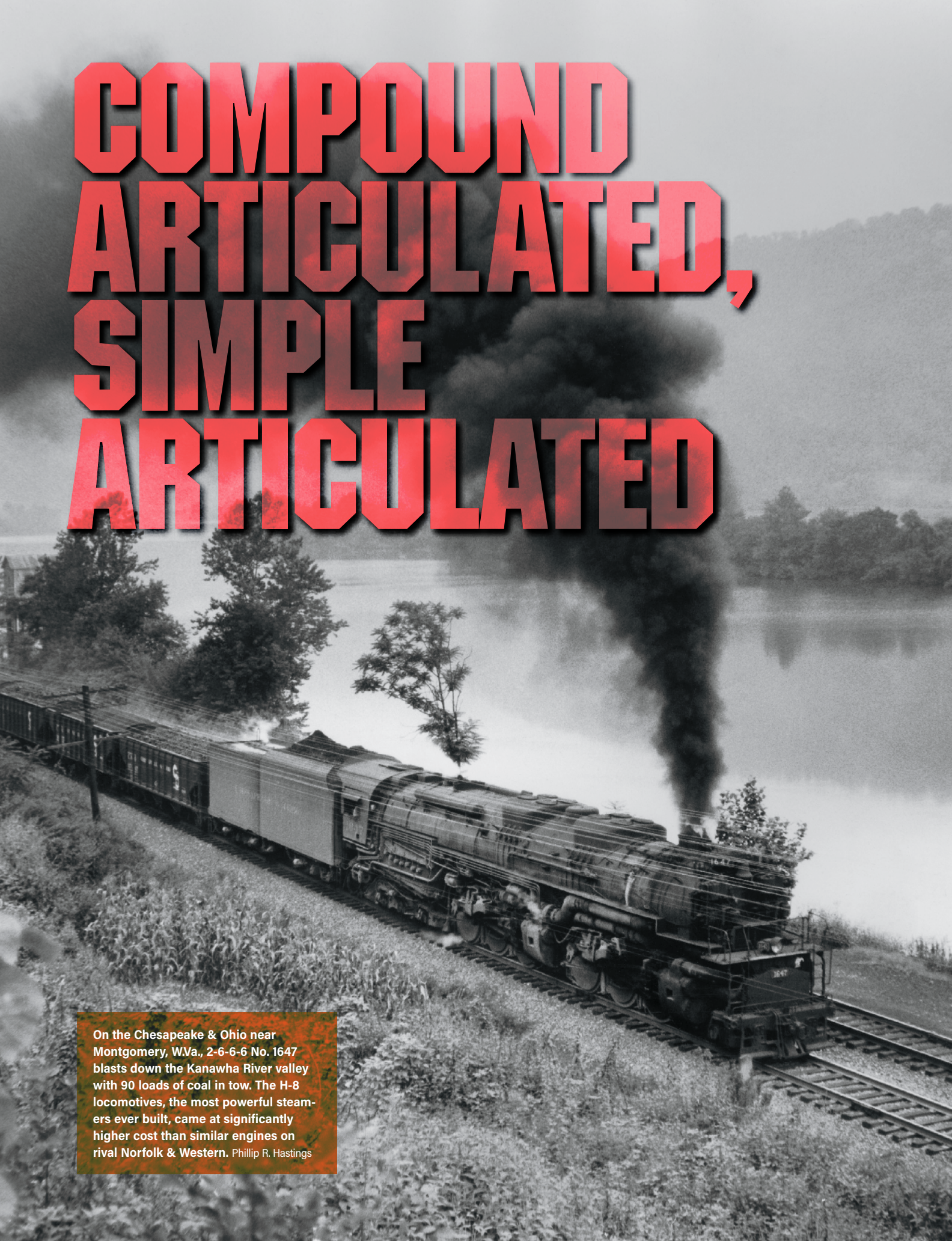
COMPOUND ARTICULATED, SIMPLE ARTICULATED



On the Chesapeake & Ohio near Montgomery, W.Va., 2-6-6-6 No. 1647 blasts down the Kanawha River valley with 90 loads of coal in tow. The H-8 locomotives, the most powerful steamers ever built, came at significantly higher cost than similar engines on rival Norfolk & Western. Phillip R. Hastings

America's first Mallet, Baltimore & Ohio 0-6-6-0 No. 2400, rolls past the reviewing stand at the Fair of the Iron Horse near Baltimore in 1927 to celebrate the railroad's centennial. The locomotive, built in 1904, saw years of service on Pennsylvania's Sand Patch grade. Baltimore & Ohio

Railroads had their reasons for choosing one or the other

by Ed King

AS ONE ABSORBS THE WRITINGS about the history of the steam locomotive in America, a couple of things stand out. First, no commercial locomotive builder ever sold a locomotive that wasn't the most efficient and profitable engine that could be had, given the buyer's limitations of loading gauges and budgets. Second, nobody charged with obtaining power for a railroad was ever motivated by thoughts of buying a locomotive that wasn't absolutely the greatest thing that could be had. In other words, it's almost impossible to find a lemon — no one ever designed a lemon, no one ever built a lemon, and no one ever bought a lemon. Well, almost no one.

There are, however, some lemons that stand out in the literature if one looks hard, and both belonged to the Norfolk & Western. In 1910-1911, it bought or built 61 heavy 4-8-0 locomotives when just about everyone else was obtaining Mikados. The 2-8-2s were forward-looking designs and the 4-8-0 was a dead end; there wasn't room for an adequate firebox over those rear drivers, and the Mikado with its trailer truck had sufficient room. An N&W official would later say that the M2-class engines were too light for heavy work and too heavy for light work.

Another lemon was the Class K3 4-8-2, built in 1926 as an answer to Lima Locomotive Works' pioneering A-1 2-8-4 of 1925. Like the A-1, the K3 used 63-inch driving wheels. Because of a long, heavy main rod connected to the third driver, they were hopelessly under-counterbalanced, leaving the engines unable to attain the speeds suggested by their excellent boilers and fireboxes. N&W got rid of all 10 of the K3s during World War II [see "N&W's Nomad Mountains," February 1979].

From Alco's production in 1904 of America's first Mallet, Baltimore & Ohio No. 2400, a monstrous 0-6-6-0 for its time, up to the advent of Norfolk & Western 2-8-8-2 No. 2200 in 1952, authors have dictated the accepted and acceptable thought on the subject. The Mallet was a compound, expanding steam from the throttle into the two high-pressure cylinders to the rear; the steam was then exhausted into a receiver where it was channeled into the two low-pressure cylinders at the front. The steam expanded again in the low-pressure cylinders, and it was then exhausted through the nozzle and smokestack like a conventional locomotive. The piston area of the two low-pressure cylinders was larger than the high-pressure cylinders by a ratio of about 2.5-to-1 in order to compensate for the steam having been expanded once.

COMPOUNDS AND CLEARANCES

Norfolk & Western had a problem: clearances. It obtained two classes of Mallets in 1910: five Class X1 0-8-8-0s from Alco and five Y1 2-8-8-2s from Baldwin. Both classes had 24.5-inch-diameter high-pressure cylinders and 39-inch-diameter low-pressure cylinders — the latter a limiting factor for all N&W steam. The X1s and Y1s used a 30-inch piston stroke and the 200-pound boiler pressure common for the day, and both classes rode on 56-inch driving wheels.

Such clearance problems didn't restrict cylinder size on other roads; N&W's neighbor Virginian Railway obtained some Class AD 2-8-8-2s in 1912 that had 28-inch high-pressure cylinders and 44-inch low-pressure ones. The Virginian would go on to obtain 10 enormous 2-10-10-2s in 1918 with low-pressure cylinders of 48-inch diameter — the largest cylinders ever applied to a steam locomotive.

N&W's first Mallet fleet, begun in 1912, consisted of 190 fine 2-6-6-2s Alco built in 1910 with a design that incorporated

Virginian's 10 Alco-built 2-10-10-2s of 1918 featured 48-inch-diameter low-pressure cylinders, the largest cylinders ever applied to a steam locomotive. The well-dressed men provide the modern viewer a sense of scale. Two photos, TRAINS collection

Norfolk & Western A Class 2-6-6-4 No. 1232 speeds a freight along the Portsmouth-Columbus, Ohio, main line in 1957. The road had main lines to both Columbus and Cincinnati. Robert Hale

superheaters and mechanical stokers. These Class Z engines got the N&W through World War I, but the railroad knew it was going to need something bigger for the future.

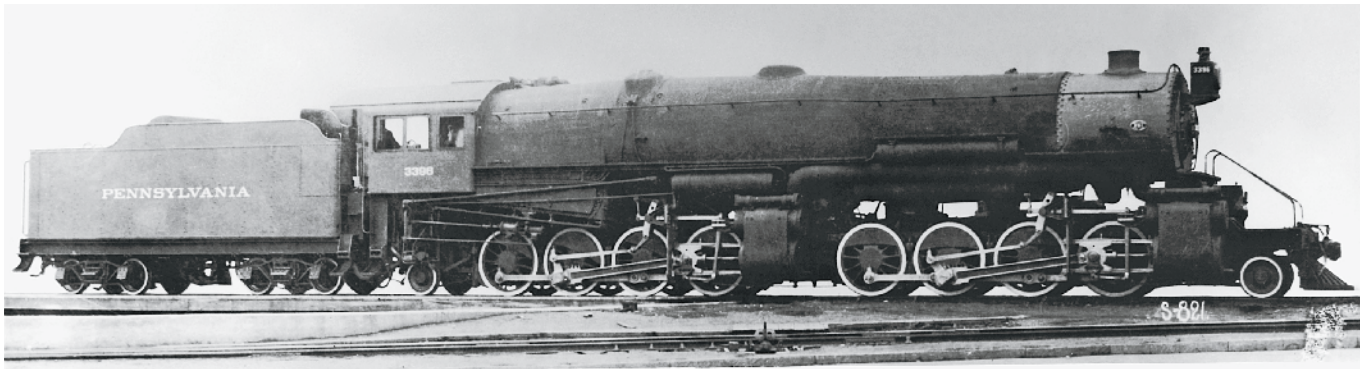
In 1918, N&W's Roanoke, Va., shop produced the Y2-class 2-8-8-2, which used the same cylinder dimensions and 56-inch drivers of the Y1 engines, but incorporated a longer piston stroke of 32 inches and a boiler pressure of 230 pounds. The Y2's power was thus equivalent to the Virginian's AD-class engines, and the Y2s were faster. The Y2 class eventually numbered 31 locomotives.

The United States Railroad Administration was created to help the railroads cope with the traffic glut caused by shipments of war materiel to eastern ports for shipment overseas during World War I. USRA decided to produce standard locomotives to replace war-worn power on the nation's railroads. Twelve standard locomotive designs were developed by the USRA design team, and all three of the big commercial builders (Alco, Baldwin, and Lima) began manufacturing them in 1918. One of N&W's mechanical engineers joined the USRA designers and obviously had a hand in USRA's standard 2-8-8-2. The USRA Mallet used a boiler pressure of 240 pounds and high-pressure cylinders of 25-inch diameter to go with low-pressure cylinders of 39 inches. It's interesting that the USRA Mallet was designed to fit N&W's clearances.

N&W obtained 50 of the USRA Mallets, designating them as Class Y3, and dynamometer car tests found them to be superior to the Y2 engines. In response, the Y2s were modified with 25-inch high-pressure cylinders and had their boiler pressure raised to 240 pounds, after which they were equal to the Y3 USRA engines. The altered Y2s became N&W's Y2a class.

In the late 1910s, N&W had devised a large exhaust nozzle to be used in connection with a large-diameter smokestack in order to move the most exhaust gasses with the least back pressure on the cylinders. Called the waffle-iron nozzle, it incorporated a central outlet and six annular ports to

THE SIMPLE ARTICULATED — A LOCOMOTIVE BUILT ON THE MALLET PATTERN BUT



The Pennsylvania's sole HH1s class 2-8-8-2 was the first simple articulated to ride the rails when it debuted in 1911. The "s" in the designation indicates a superheater-equipped locomotive, which was not able to make up for its paltry 160-pound boiler pressure.

spread the exhaust to fill, or seal, the larger stack. This exhaust system would become standard on N&W's locomotives.

NOT SO SIMPLE TO SIMPLE

The simple articulated — a locomotive built on the Mallet pattern but using live steam from the throttle in all four cylinders of equal size — first hit the rails in 1911 when the Pennsylvania Railroad built its sole HH1s-class 2-8-8-2. (In PRR nomenclature, the lower-case "s" signifies a superheater-equipped locomotive.) It was not successful, but its problems were not related to the simple-articulated concept. It was designed in a period when it was thought that superheaters allowed the use of lower boiler pressures because of the increased heat content of the steam, but that theory was found to be in error. Unlike the Mallet compound, on which the boiler fed only two high-pressure cylinders, the simple articulated needed a large and potent boiler to supply steam to all four cylinders, so the 160-pound boiler pressure of the HH1s severely limited the machine.

PRR tried the simple-articulated concept again with the HC1s of 1919 (another class of one), using PRR's standard 205-pound boiler pressure. It was condemned as too powerful. It had a feature called limited cutoff. Following the example of PRR's I1s 2-10-0 of 1915, the HC1s had a limited cutoff of 50 percent. This meant that the locomotive could get into a rod position where one side of the engine was on dead center and the other was at the point of cutoff, so no power could be produced. So-called starting ports had to be incorporated into the cylinders of the I1s engines to move them out of this rod position, but PRR designers evidently figured that it was unlikely that both engines of a simple articulated would be so affected. Engineers starting trains with the HC1s often had to jockey the reverse lever back and forth and, when the engine's valves did admit steam, the engine could lurch ahead violently enough to break coupler knuckles. The HC1s wound up in pusher service on the mountain out of Altoona, Pa. The HH1s and HC1s undoubtedly helped sour the Pennsy's attitude toward articulated locomotives in general.

The simple articulated concept lay dormant until 1924 when American Locomotive Co. built a group of 2-8-8-2s for the Chesapeake & Ohio. These were fearsome-looking engines whose actual capabilities were not any greater than the USRA-designed 2-8-8-2 Mallets. But the C&O engines, classed H-7, were publicized as being successful, and the railroad obtained 45 of them.

SPEED SELLS SIMPLES

The simple articulated grew up, and designers and pundits touted them as being superior to the Mallet compound because they were faster; speed was always an easy sell for the steam locomotive salesman. The economics of compounding inherent in the Mallet went by the board as the builders decided that the simple articulated was better for them in two ways: First, simple articulateds had to have larger boilers to supply the steam, which meant that they would be more profitable for the builders to manufacture; and second, the builders didn't have to go to the trouble to identify the factors that kept the Mallet from being faster, and then do something about them.

Lots of simple articulated locomotives hit the road in the late 1920s and 1930s. Among these were the immense 2-8-8-4 Yellowstone-class for the Northern Pacific, which were the largest locomotives in the world at the time.

Several railroads, motivated by that search for speed, converted Mallet compounds into simple engines. The Baltimore & Ohio, Great Northern, Southern Pacific, and Southern Railway all replaced those large, low-pressure cylinders with cylinders the same size as the high-pressure ones, arranging the steam and exhaust piping appropriately, and then they bragged about how much faster and more efficient these locomotives were. On the B&O, these engines were used on heavy grades, both as road engines and as helpers. But how much extra speed was going to be useful in these applications? Tonnage limited speed going up and curvature limited speed going down, where the engines were drifting anyway. But still, the railroads implicitly insisted, nobody ever built or converted a lemon.

Another interesting facet of these rebuilds is that no USRA 2-8-8-2 on any railroad was ever converted to a simple engine. Evidently the USRA engines were fast enough that any extra speed wasn't worth sacrificing the economy of compounding.

Norfolk & Western, though, believed that there was speed potential in the USRA 2-8-8-2 that it could obtain without sacrificing the economy of the compound. As the rest of the world was accumulating rosters of the faster simple engines, N&W put its dynamometer car to work with its Y2a, Y3, and Y3a engines — 30 of which were obtained in 1923 — to identify areas where they could be modified to run faster. Boosts in boiler pressure were seen as beneficial; all the locomotives had their working pressure raised in increments to 270 pounds, a 12-percent increase. This made them both faster and more efficient.

The low-pressure cylinders of the Mallet caused problems. Steam came into the back of the low-pressure cylinder castings from the receiver in the middle of the low-pressure engine frame, and had to pass down beneath the frame and then up to the top of the casting to the valves. The exhaust-steam passages had to share a fairly limited space to go down beneath the frame and up to the top center of the cylinder castings, from where it was piped through swiveling connections to the exhaust stand and the nozzle in the smokebox. N&W redesigned these low-pressure cylinders, making the steam passages as generous as possible, and ordered another 10 2-8-8-2s from Alco's Richmond Works in 1927. These Y4 engines were, indeed, found to be faster than the earlier models, but the railroad was still not satisfied. In 1929, Y3 No. 2049 was taken into Roanoke shop and emerged with a totally new concept for a low-pressure

An eastbound Northern Pacific freight assaults Montana's Bozeman Pass in July 1948 with Z-5 class 2-8-8-4 Yellowstone No. 5003 shoving behind wood caboose No. 1321. Duluth, Missabe & Iron Range also carried 18 of the wheel arrangement on its roster beginning in 1941. Bob Milner

Seaboard Air Line 2-6-6-4 No. 2502 leads a freight at Raleigh, N.C., in 1941. Seaboard's 10 such locomotives predate Norfolk & Western's arguably more famous entries by a year. They operated in fast freight and passenger service north of Hamlet, N.C. TRAINS collection

exhaust system. The exhaust was taken out of the top of the cylinder casting and the two sides were merged by what was termed a bridgepipe: From the bottom center of the bridgepipe an exhaust pipe in the shape of a shallow "u" connected it with the exhaust stand in the smokebox. No longer did the steam from the receiver have to share space in the cylinder casting with the exhaust passages. Dynamometer testing with the 2049 was gratifying, and it convinced the railroad that every Mallet it would obtain thereafter should have the bridgepipe.

As the 1930s began, Baltimore & Ohio bought from Baldwin the first high-wheeled simple articulateds — two 70-inch-drivered 2-6-6-2s, one with an Emerson water-tube firebox and the other conventional. The engine showed front-end stability problems at the speeds promised by the high drivers. Alco, also interested in getting into the high-speed articulated locomotive market, noted these problems and decided to combat them by providing a four-wheel leading truck to smooth out operation.

STUMP PULLERS

N&W, having an expanding need for a brawny "stump puller," opened the 1930s by building 20 more 2-8-8-2s that incorporated all that the railroad had learned thus far. The new engines would have big nozzles,

SIGNIFICANT ARTICULATED LOCOMOTIVES

Road	Type	Class	Nos.	Qty.	Builder	Date	Retired	Notes
AT&SF	2-6-6-2	1157	1157	1	Santa Fe	1910	1924	Jointed boiler
AT&SF	4-4-6-2	1398	1398-1399	2	Baldwin	1909	1915	Largest drivers on an articulated
AT&SF	2-10-10-2	3000	3000-3009	10	Baldwin/Santa Fe	1911	1915-1918	Rebuilt from and to 2-10-2s
B&O	0-6-6-0	DD-1	2400	1	Schenectady	1904	1938	America's first Mallet
B&O	2-6-6-2	KK-1	7400	1	Baldwin	1930	1953	
C&O	2-6-6-6	H-8	1600-1659	60	Lima	1941		Most powerful steam locomotive built
C&O	2-8-8-2	H-7	1540-1564	25	Alco	1923-1924	1952	First successful simple articulated
DM&IR	2-8-8-4	M-3	220-237	18	Baldwin	1941, 1943	1958-1963	
ERIE	2-8-8-8-2	P-1	5014-5016	3	Baldwin	1914, 1916	1929-1933	
N&W	0-8-8-0	X1	990-994	5	Schenectady	1910	1934	
N&W	2-6-6-2	Z1, Z1a	1300-1489	190	Alco	1910	1958	
N&W	2-6-6-4	A	1200-1242	43	Norfolk & Western	1936-1950	1958-1961	Built in four batches
N&W	2-8-8-2	Y1	995-999	5	Baldwin	1910	1924	
N&W	2-8-8-2	Y3	2000-2049	50	Alco and Baldwin	1919	1957-1958	USRA design
N&W	2-8-8-2	Y6	2120-2154	35	Norfolk & Western	1936-1940	1958-1960	
NP	2-8-8-4	Z-5	5000-5011	12	Alco and Baldwin	1928-1930		Largest steam locomotives at the time
PRR	2-8-8-2	HH1s	3396	1	Alco	1911	1928	First simple articulated
PRR	2-8-8-0	HC1s	3700	1	Pennsylvania	1919	1929	
SAL	2-6-6-4	R-1, R-2	2500-2509	10	Baldwin	1935-1937	1947	Sold to B&O
UP	4-6-6-4	CSA, 4664	3900-3999	105*	Schenectady	1936-1943	1962	*CSA class renumbered to 3800 series
UP	4-8-8-4	4884	4000-4024	25	Schenectady	1941, 1944	1962	"Big Boy"
VGN	2-6-6-6	AG	900-907	8	Lima	1945	1960	C&O H-8 copies
VGN	2-8-8-2	AD	601-606	6	Alco	1912	1934	
VGN	2-10-10-2	AE	800-809	10	Alco	1918	1948-1958	
VGN	2-8-8-8-2	XA	700	1	Baldwin	1916	1920	

AT&SF: Atchison, Topeka & Santa Fe; B&O: Baltimore & Ohio; C&O: Chesapeake & Ohio; DM&IR: Duluth, Missabe & Iron Range; ERIE: Erie; N&W: Norfolk & Western; NP: Northern Pacific; PRR: Pennsylvania; SAL: Seaboard Air Line; UP: Union Pacific; VGN: Virginian. Source: Guide to North American Steam Locomotives, Revised Edition

bridgepipes, and a boiler pressure of 280 pounds, later raised to 300. The Y5-class proved not only to be strong (a starting tractive effort of 152,206 pounds in simple, 126,838 in compound), it was a runner, too. But the Y5s had been built without two innovations in steam locomotive hardware — cast-bed frames and roller bearings — and as the 1930s wore on they were plagued with broken frames and hot driver journals.

The mid-1930s saw Baldwin build five 2-6-6-4 engines for the Seaboard Air Line with 69-inch drivers for fast freight and passenger service between Richmond, Va., and Hamlet, N.C. Baldwin had evidently learned some things about front-end stability since the B&O engines of 1930. The Seaboard engines were regularly operated without incident at speeds of 60 mph and more. Built with a 55,000-pound axle loading, lighter than many 4-8-4s, they handled the tonnage of two modified USRA light 2-8-2s, which were excellent engines, and they did it faster. Their success encouraged Norfolk & Western to design its own 2-6-6-4, also a successful locomotive, and first built in May 1936.

The 2-6-6-4 relieved the N&W from having to build a super-fast stump puller, but the railroad decided to build five new 2-8-8-2s later in 1936 that would incorporate bed castings and roller bearings. The one-piece bed casting allowed the low-pressure cylinders, now part of the frame, to have ultra-generous steam passages from the receiver — itself an integral part of the low-pressure engine frame — to the valves at the top of the cylinder casting. Since the bridgepipe took the exhaust steam out of the top, steam flow through the low-pressure engine was as free as could possibly be imagined. The new engines, classed Y6, forecast the ultimate compound.

We have enumerated the methods used by Norfolk & Western to make the Mallet compound faster. These are not steps that any mechanical engineer couldn't have devised, properly motivated. Those working for the commercial locomotive builders were motivated by a need to help their firms maximize profits, mainly by producing designs that could be sold easily. They created a competitive environment based on a need for speed. In the 1920s, this necessity was due to competition from motor trucks, which had the advantage of being able to provide door-to-door service no matter where the shipper and receiver were located. The Super-Power concept took hold, and it sold well. Super-Power freight locomotives — principally 2-8-4s and 2-10-4s with 100-square-foot grates under deep fireboxes and riding on 69-inch drivers — made mile-a-minute freight trains a reality, and as noted above, speed was always an easy sell, and the motor truck made it an even easier sell.

There were a couple of examples that demonstrated just how far railroads, and locomotive designers, were willing to go to avoid the use of an articulated locomotive of either kind — Mallet compounds or simple articulateds. For the Erie, Baldwin diagrammed a 2-10-4 in 1929 with 77-inch drivers, 31-inch cylinder bore and 32-inch stroke, and a boiler pressure of 260 pounds. Those 2-10-4s were never built: Erie's highly competent fleet of 105 2-8-4s and the stock market crash put an end to the idea.

The Santa Fe had dabbled unsuccessfully with Mallets between 1909 and 1911: The experiments included 2-6-6-2s with jointed boilers, passenger 4-4-6-2s with 73-inch drivers (the highest drivers ever on an articulated), and 2-10-10-2s made from conventional 2-10-2s. The Santa Fe was thus receptive to the idea that it might obtain articulated performance from a two-cylinder locomotive. The result was a class of enormous 2-10-4s. The 5001-class had cylinders with a 30-inch bore and 34-inch stroke, a boiler pressure of 310 pounds, riding on 74-inch drivers. With their 4-6-6-4-sized boilers, the engines weighed 545,000 pounds. It would be heresy not to

consider these engines among the greats, but their tractive effort of 93,000 pounds was eclipsed by most 4-6-6-4s, and those immense drivers can't have been an asset on heavy grades. Looking at the 5001-class engines, and considering the weight of the main and side rods necessary to transmit that power, a question arises. Did the engines have 74-inch drivers because they were expected to operate in the 75-80 mph range of the similarly equipped 4-8-4s, or were the large wheels necessary to provide room for proper counterbalancing for those massive rods?

N&W's locomotive designers weren't motivated by the necessity to sell locomotives. They were, however, motivated by the need to have their employer make as much money as possible. The normal parameters of gross ton-miles per train-hour and gross income carried over to net were N&W's yardsticks, but the railroad was handicapped by hauling a low-revenue commodity, coal, over a mountainous profile with heavy curvature. Its mountain freight power had to be compact, potent, and as economical to operate as possible. This is why the concept of compounding, using steam twice, had such great appeal.

MAKING THE PHYSICS WORK

The steam locomotive was beset by physical drawbacks. One of them was that the locomotive needed wheels ahead of the drivers to make it stable as it moved ahead; another was the need for wheels behind the drivers to bear the weight of a large firebox. Out of a total of seven engine axles, a 4-6-4 Hudson-type only had three that produced power. (Some had trailing-truck boosters, but they weren't effective at running speeds.) On a 4-8-4 Northern-type, half the wheels were for guiding or carrying, and not for producing power at speed.

As far as articulated locomotives were concerned, the two most likely to be considered as the ultimate were the Union Pacific 4-8-8-4 Big Boys and the Chesapeake & Ohio and Virginian 2-6-6-6 Allegheny types. Big Boy carried 71.6 percent of its weight on its 16 drivers. The 2-6-6-6, the first of which outweighed the 4-8-8-4 by 3 tons, only had 65.2 percent of its weight on its 12 drivers. It had more weight on its three-axle trailer than the total weight of many good-sized Consolidations.

But if one considers the four Baldwin-built Triplexes (the three Erie 2-8-8-8-2s built in 1914 and 1916, and Virginian's monumentally unsuccessful 2-8-8-8-4 of 1916) you get more productivity per pound of total engine weight — 93 percent in the case of the Virginian engine. Among more successful locomotives, Alco's 2-10-10-2s of 1918 for the Virginian had 90.2 percent of their engine weight available for adhesion.

N&W's Y5, Y6, Y6a, and Y6b-class Mallets carried 89.7 percent of their weight on their 58-inch driving wheels. But all this came to naught before the onslaught of Dick Dilworth's EMD FT-model diesel No. 103, which carried 100 percent of its weight on its driving wheels. And, when ballasted to the axle-loading parameters of 55,000 pounds used in light USRA engines, it could produce at 25 percent adhesion that much tractive effort per unit, or 220,000 pounds for the four-unit consist. Dilworth

NORFOLK & WESTERN'S LOCOMOTIVE DESIGNERS WEREN'T

N&W's three most famous steam locomotive types: left to right, Class J 4-8-4 No. 604, Class Y6 2-8-8-2 No. 2147, and Class A 2-6-6-4 No. 1212. Sister engines Nos. 611 and 1218 would rise to fame in the 1980s in successor Norfolk Southern's steam program. Norfolk & Western

didn't even have to produce a six-motor locomotive to out-lug steam's best at low speed — on the mountains, for instance.

Did Norfolk & Western get any payoff by sticking with compounding for its stump puller? Its operating and financial statistics from the 1950s say yes. In spite of its topography, N&W consistently ranked among the top railroads in gross ton-miles per train-hour. Its ratio of gross income carried over to net was also the envy of other roads.

But how did the 2100-series 2-8-8-2s actually do? Let's take, for instance, coal trains between Bluefield and Roanoke, Va. The standard train was about 130 cars, or 10,300 tons. These trains dropped down the mountain out of Bluefield and came out in the New River valley at Glen Lyn, Va. From Glen Lyn they came up New River against a 0.2-percent grade and constant curvature to Walton, Va., where they got another 2100-series pusher for the 1-percent grade for 7 miles to Christiansburg, Va., where the pusher cut off on the fly.

There's a mountain of anecdotal evidence that tells that the 2100-class engines came up New River at speeds between 30 and 32 mph. This topography and train consists have been run through the train-resistance formula, which indicates that 5,500 hp was required on the drawbar of the tender. How the 2100s did it was by getting far more work out of the low-pressure engine at speed than any other Mallet ever dreamed of; instead of being a liability at speed, the big low-pressure cylinders were doing their share of the pulling.

Were there other steam locomotives that could pull such a train up New River this fast? Certainly UP's Big Boy; Lima's Allegheny-types for C&O and Virginian; probably the Duluth, Missabe & Iron Range 2-8-8-4 Yellowstone-types; and Great Northern's simple 2-8-8-2 could have done it. But where the N&W's 2100 aced them all was in doing it with a boiler comparable to a good-sized 4-8-4. All the rest had humongous boilers with appetites to match. The efficient use of steam twice is what did the trick. And it's likely that it would have taken more than two of the others to get the train up Alleghany Mountain to Christiansburg.

WHAT ABOUT THOSE LEMONS?

The world of articulated locomotives also has its lemons. First was the "centipede" tender, which was one answer to getting seven axles under a high-capacity tender. Centipedes were impressive, but the five-axle rigid wheelbase didn't lend itself to reverse moves on sharp curves. The Clinchfield, which spun its locomotives on wye tracks at several locations instead of turntables, found that its six UP/Alco-design 4-6-6-4 Challengers wanted to straighten out wye tracks.

Lima then was faced with the need to put seven axles under the tenders for the H-8 class 2-6-6-6s it was building for the Chesapeake & Ohio. Ultimately, Lima put a three-axle truck forward under the coal space and a four-axle truck behind under the water end — not as impressive as the

MOTIVATED BY THE NECESSITY TO SELL LOCOMOTIVES.

Duluth, Missabe & Iron Range M-3 class 2-8-8-4 No. 228 departs Proctor, Minn., westbound with 200 empty ore cars in August 1959 under a column of exhaust. William D. Middleton

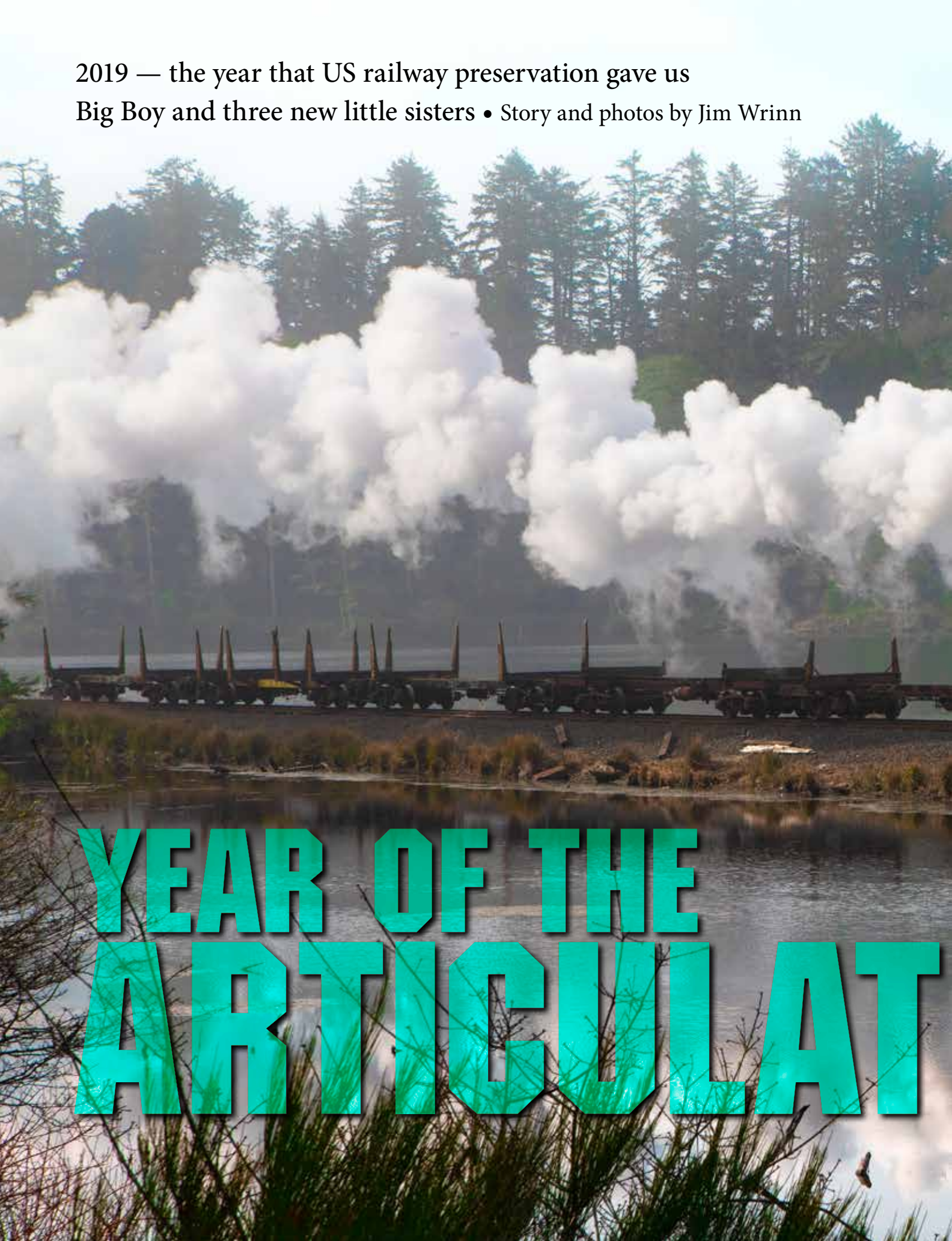
centipedes but more practical.

Another articulated lemon was the aforementioned C&O 2-6-6-6. It was not designed to be an efficient source of power for C&O, but rather to develop the most drawbar horsepower of any steam locomotive. This it did, in spectacular fashion, but at tremendous cost. The engines cost an average of $100,000 per engine more than N&W's 2-6-6-4, and outweighed the N&W engine by a full hundred tons. The C&O had a 160-car limit on coal trains between Russell, Ky., and Toledo, Ohio. Its T-1 2-10-4s could handle such a train, but we have been told by all that we must believe that the Allegheny was one of the all-time greats. Perhaps, on the C&O at least, less was more.

ED KING *is retired from a long career in railroading, including stints with Norfolk & Western, Rock Island, Soo Line, and others. He has more than 30* Trains *bylines and is a former columnist for the magazine.*

A Norfolk & Western coal train eases over the long bridge west of Cooper Tunnel near Bluefield, W.Va. The author contends that the railroad's use of compound locomotives was a great benefit to its operations in difficult mountain topography. O. Winston Link

2019 — the year that US railway preservation gave us Big Boy and three new little sisters • Story and photos by Jim Wrinn



YEAR OF THE ARTICULAT

The Lazarus locomotive, *Skookum,* pulls log cars at Smith's Lake, Ore., on March 14, 2019. This marked the locomotive's return to operation after 64 years.

EDS

Frothing in steam from four cylinders, 2-4-4-2 No. 7 *Skookum* eases away from a stop to check a tender axle journal box at Rockaway Beach, Ore., on March 18, 2019. The early articulated had just been restored and was on a TRAINS magazine-sponsored photo charter.

Rare is the year when multiple examples of one type of steam locomotive return to action after overhaul. For that reason, 2019 is an unusually good year for articulated steam locomotives — steam engines with multiple sets of cylinders, pistons, and drivers and the means to bend or articulate all under one boiler.

In addition to Big Boy No. 4014, two other articulateds are in the spotlight: Privately owned 2-4-4-2 No. 7 *Skookum,* which is in residence this summer at California's Niles Canyon Railway, and Western Maryland Scenic Railroad's former Chesapeake & Ohio 2-6-6-2 No. 1309. Add in tourist railroads in California and South Dakota with logging-type 2-6-6-2Ts, and you've got an unprecedented show of articulated power.

Not since the early 1990s, when UP operated 4-6-6-4 Challenger No. 3985 and Norfolk Southern operated Norfolk & Western A Class 2-6-6-4 No. 1218 on excursions, have there been this many articulateds running in North America at once.

Let's take a closer look at each of these amazing machines.

THE LAZARUS LOCOMOTIVE

The Lazarus locomotive is an apt description of Chris Baldo's *Skookum.* Rebuilt by Scott Wickert at the Oregon Coast Scenic Railroad over several years, it has risen from the dead after 64 years. Built for an east Tennessee logger in 1909, *Skookum* was rejected as too heavy. The manufacturer, Baldwin, resold its first logging Mallet — an engine that uses its steam twice, once in a set of high-pressure cylinders and again in a set of low-pressure cylinders — to a Washington state logger. It boomed around the Pacific Northwest until 1955

Skookum **shows off its smaller high-pressure cylinders and its larger low-pressure cylinders at Garibaldi, Ore., in March 2019.**

Two-coupled 48-inch diameter drivers of *Skookum*'s rear engine roll by in a blur. Only six models of the 2-4-4-2 type were made worldwide.

Western Maryland Scenic No. 1309 test steams in September 2018. This was the first day the locomotive was under steam since 1956. The site is at the railroad's shop in Ridgeley, W.Va. Chase Gunnoe

when it derailed in the forest and was left for dead. Enterprising enthusiasts rescued *Skookum,* carrying away parts as best they could. The engine changed hands three times, and the restoration was prolonged as the carcass was relocated twice, and significant pieces were lost. The combination of Baldo, Wickert, and Martin Hansen finally resulted in a successful restoration. TRAINS sponsored a photo event with the engine in March to mark its return to steam and its departure from the Pacific Northwest for Niles Canyon Railway, where it will run with another articulated, Clover Valley 2-6-6-2T No. 4.

NO. 1309: BEAST OF THE EAST

Nearing completion is No. 1309 at Western Maryland Scenic. The 1949 locomotive was the last steam locomotive Baldwin built for domestic use. Chesapeake & Ohio used the locomotive to pull coal trains until 1956, when diesels took over. Long displayed at the B&O Railroad Museum in Baltimore, it was acquired in 2014 by Western Maryland Scenic. Beset by funding issues and the theft of critical parts, the project has been delayed several times. The current projected budget is $2.7 million. But railroad officials and contractor Diversified Rail Services see completion on the horizon. If all goes well, the engine will be back in operation this summer. Look for it on the twisting, mountainous 17-mile run on the former Western Maryland main line between Cumberland, Md., and Frostburg, Md.

BLACK HILLS POWER PLAY

Tucked deep into the Black Hills near Mount Rushmore is one of the nation's oldest and most celebrated tourist railroads, the Black Hills Central. Since 2001, the railroad has put on show of force with 1928-built logging Mallet No. 110, a 2-6-6-2T. On a 4-percent grade with a 200-ton load, the engine literally shakes the ground. But if one Mallet is good, two is better, right? Later this year, Black Hills Central will debut No. 108, a sister locomotive of the same wheel arrangement. With that, the Black Hills Central will become a center of articulated Mallet-type steam power in regular operation. And yet another of these amazing articulateds will return to steam.

With *Skookum* representing the earliest articulated locomotives, the Black Hills sisters and Clover Valley No. 4 showing off Western logging style of the 1920s, and No. 1309 demonstrating the late refinement of an earlier style of articulated, plus UP's Big Boy, we have a remarkable Alpha to Omega look at 20th-century U.S. articulateds. It's rather difficult to contemplate so many of these engines at once, but if you want to see the breadth of American articulation, it's out there in 2019.

Days before the steam test, the crew buttoned up the massive engine in preparation for the test.

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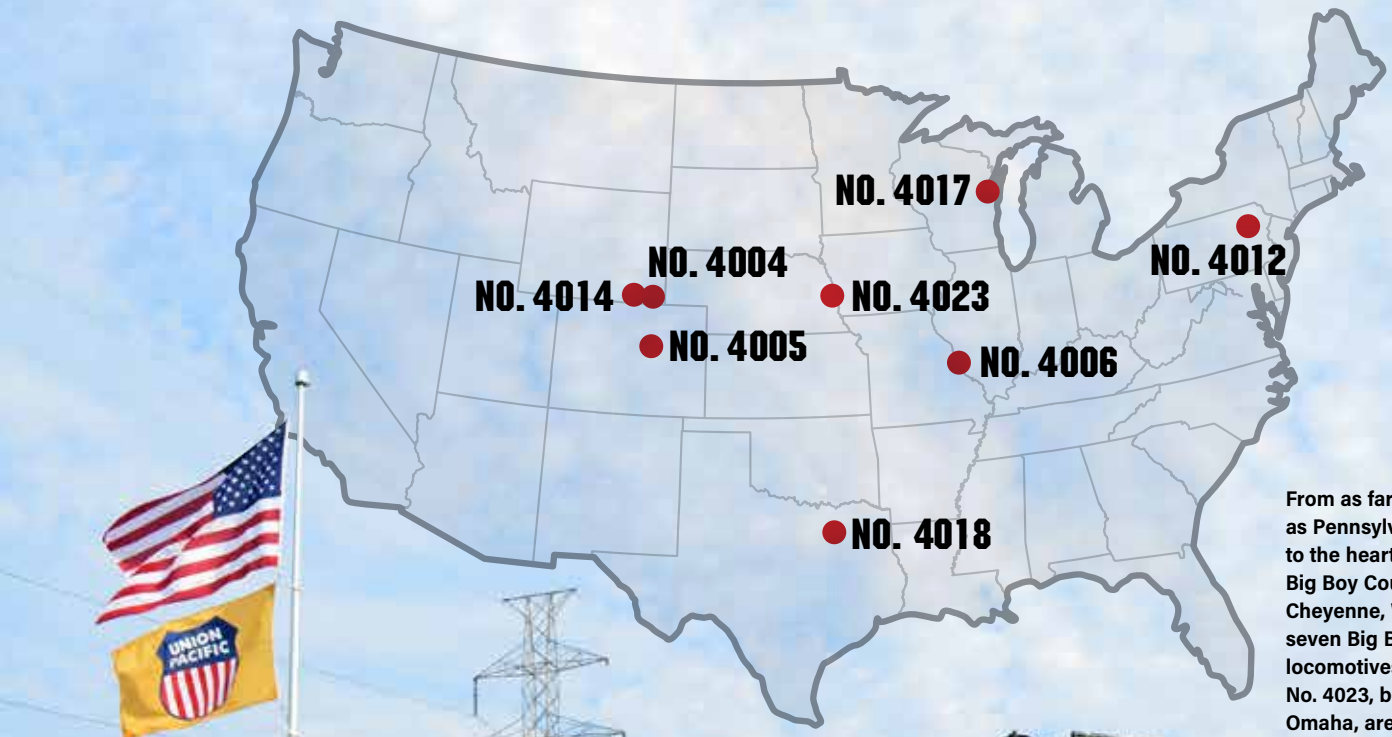
Where to find seven UP Big Boy locomotives that survive in museums and on display • by Jim Wrinn

THE OTHER BOYS



From as far east as Pennsylvania to the heart of Big Boy Country in Cheyenne, Wyo., seven Big Boy locomotives, like No. 4023, below at Omaha, are still with us. Cate Kratville-Wrinn

The most difficult to photograph Big Boy, No. 4005 at Denver's Forney Museum, is also one of the best for getting up close to of these 600-ton monsters. The locomotive is inside with other rolling stock nearby.

IF BIG BOY WERE A SUPERSTAR, and the locomotive definitely is all that and more, it would be Elvis. The King. Larger than life, capable of mesmerizing to all who behold. That's pretty close to the truth. People travel across the continent and from around the world to study, inspect, and climb on board some of the largest of surviving steam locomotives in North America. Besides No. 4014, we have seven of them, scattered from the Northeast to the Southwest and back to the heart of Big Boy Country in Cheyenne. If you've seen No. 4014 and you're ready to go look for the rest of the fleet, here's where to find them:

• No. 4004, Cheyenne, Wyo., Holliday Park. Fresh from a sorely needed 2018 cosmetic restoration, this Big Boy has been on display outside since 1963. It has been a parts donor to UP's operating steam fleet for years. Now it's been returned to its original 1941 appearance.

• No. 4005, Forney Museum of Transportation, Denver, Colo. This Big Boy has quite the story to tell. It was the only one of the 25 coal-burning engines to be converted to burn fuel oil as an experiment from 1946 to 1948. It also was the only one involved in a major wreck. The tender still bears scars from its April 1953 derailment at Red Desert, Wyo., that resulted in two fatalities among the crew.

• No. 4006, National Museum of Transportation, St. Louis, Mo. This locomotive racked up 1.06 million miles in its career — the most of any Big Boy. This Big Boy was cosmetically restored in 2014.

Two of America's most iconic locomotives, Big Boy No. 4017 and a Pennsylvania Railroad GG1 electric, are center stage at Wisconsin's National Railroad Museum in Green Bay.

• No. 4012, Steamtown National Historic Site, Scranton, Pa. Formerly part of F. Nelson Blount's private collection in Vermont. It is the largest locomotive at the site and the only Big Boy on display in the East.

• No. 4017, National Railroad Museum, Green Bay, Wis. Kept inside, this Big Boy has a cab that is accessible by steps. It carries No. 4023's tender — the only surviving tender from the final group of five Big Boys built in 1944.

• No. 4018, Museum of the American Railroad, Frisco, Texas. In 1998 the museum was approached with plans to restore No. 4018 to operation for a movie. This never materialized. But it has not lessened this giant's presence in a place way outside of normal UP Big Boy operating territory.

• No. 4023, Lauritzen Gardens, Omaha, Neb. After the steam era ended, this Big Boy was kept inside the roundhouse at

The easternmost Big Boy, No. 4012, is on display at the National Park Service site Steamtown, in the former Lackawanna shops in Scranton, Pa. Three photos, TRAINS: Jim Wrinn

St. Louis' Big Boy, No. 4006, received a cosmetic overhaul in 2014 that has it looking fresh once more. Mark Mautner

Cheyenne, Wyo., (with Challenger No. 3985) until the mid-1970s when it was relocated to Omaha, Neb., and placed adjacent to the UP shops there. A steam exhaust line was fashioned so that it appeared that smoke and steam were coming from the twin stacks. After the shops closed, the engine was relocated to the Durham Western History Museum in downtown Omaha and repositioned in 2004 to its current location at Kenefick Park in Lauritzen Gardens. This move required a trip over city streets in a special cradle designed to spread the weight of the locomotive. Today, anyone driving west on I-80 will see this locomotive, along with 1969-built Centennial-type DDA40X diesel No. 6900, perched high on a hillside overlooking the mighty Missouri River. For more dramatic effect, drive this at night when both locomotives are illuminated.

When you visit No. 4023, here's an intriguing thought: It is the only one of the last five Big Boy locomotives built in 1944 to survive. For that reason, it has the lowest mileage of any surviving Big Boy, about 829,000 miles. All others traveled more than 1 million miles. Some observers have said that for that reason, No. 4023 would have been the best candidate to restore to operation — but its location far from a railhead and in the middle of a park would make it among the most difficult and expensive of the eight survivors to retrieve. BB

No. 4018 was relocated from the state fairgrounds in Dallas to suburban Frisco, Texas. It is the largest steam locomotive in the collection at the Museum of the American Railroad. TRAINS: Jim Wrinn

OTHER PRESERVED UNION PACIFIC LOCOMOTIVES

0-6-0 Six survivors	
4420	Evanston, Wyo.
4436	Ogden Union Station, Ogden, Utah
4439	Griffith Park, Los Angeles, Calif.
4442	Clark County Heritage Museum, Henderson, Nev.
4455	Colorado Railroad Museum, Golden, Colo.
4466	California State Railroad Museum, Sacramento, Calif.
2-8-0 21 survivors	
407	Legion Park, Sidney, Neb.
421	City Park, Fairbury, Neb.
423	Carl Gray Park, Gering, Neb.
428	Illinois Railway Museum, Union, Ill. (under restoration)
437	Stuhr Museum of the Prairie Pioneer, Grand Island, Neb.
440	Painted as Chicago & North Western, Antigo, Wis.
460	Pony Express Museum, Marysville, Kan.
477	Kenwood Park, Salina, Kan.
480	Memorial Park, North Platte, Neb.
481	7th & 11th streets, Kearney, Neb.
485	Dawson County Museum, Lexington, Neb.
529	Northwest Railway Museum, Snoqualmie, Wash.
561	Pawnee Park, Columbus, Neb.
616	Lakeside Park, Nampa, Idaho
618	Heber Valley Railroad, Heber City, Utah (under restoration)
6051	Fairmont Park, Riverside, Calif.
6072	Wyman Park, Fort Riley, Kan.
6237	Hastings Museum, Hastings, Neb.
6264	Nevada State Railroad Museum, Boulder City, Nev.
6533	Elm Street, Rawlins, Wyo.
6535	Railroad Heritage Park, Laramie, Wyo.
2-8-2 Four survivors	
2005	Ross Park, Pocatello, Idaho
2295	Boise depot, Boise, Idaho
2537	Jefferson Park, Walla Walla, Wash.
2564	Orange Empire Railway Museum, Perris, Calif.
2-10-2	
5511	UP historical collection, Cheyenne, Wyo.
4-4-0	
737	The Double-T Western Village, Stevinson, Calif.
4-6-0 Two survivors	
1242	Lions Park, Cheyenne, Wyo.
1243	Durham Western Heritage Museum, Omaha, Neb.
4-6-2 Two survivors	
3203	Portland, Ore. (under restoration)
3206	Spokane County Fairgrounds, Spokane, Wash.
4-8-4 Three survivors besides No. 844	
814	Rock Island Depot, Council Bluffs, Iowa
833	Utah State Railroad Museum, Ogden Union Station
838	UP historical collection, Cheyenne, Wyo.
4-6-6-4 One survivor in addition to No. 3985	
3977	Cody Park, North Platte, Neb.
4-12-2	
9000	Los Angeles County Fairplex, Pomona, Calif.

The Steam Dream has come true!

Big Boy No. 4014 Photo by Cate Kratville-Wrinn. Use by permission.

5 Locomotive Photos by Shelley Hunter.

Members of The Railway and Locomotive Historical Society, Southern California Chapter, honor Big Boy No. 4014's restoration.
We greatly appreciate Union Pacific's steam crew, and countless RailGiants' volunteers who cared for No. 4014 beginning in 1962 knowing in their hearts it would again run on steam.

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