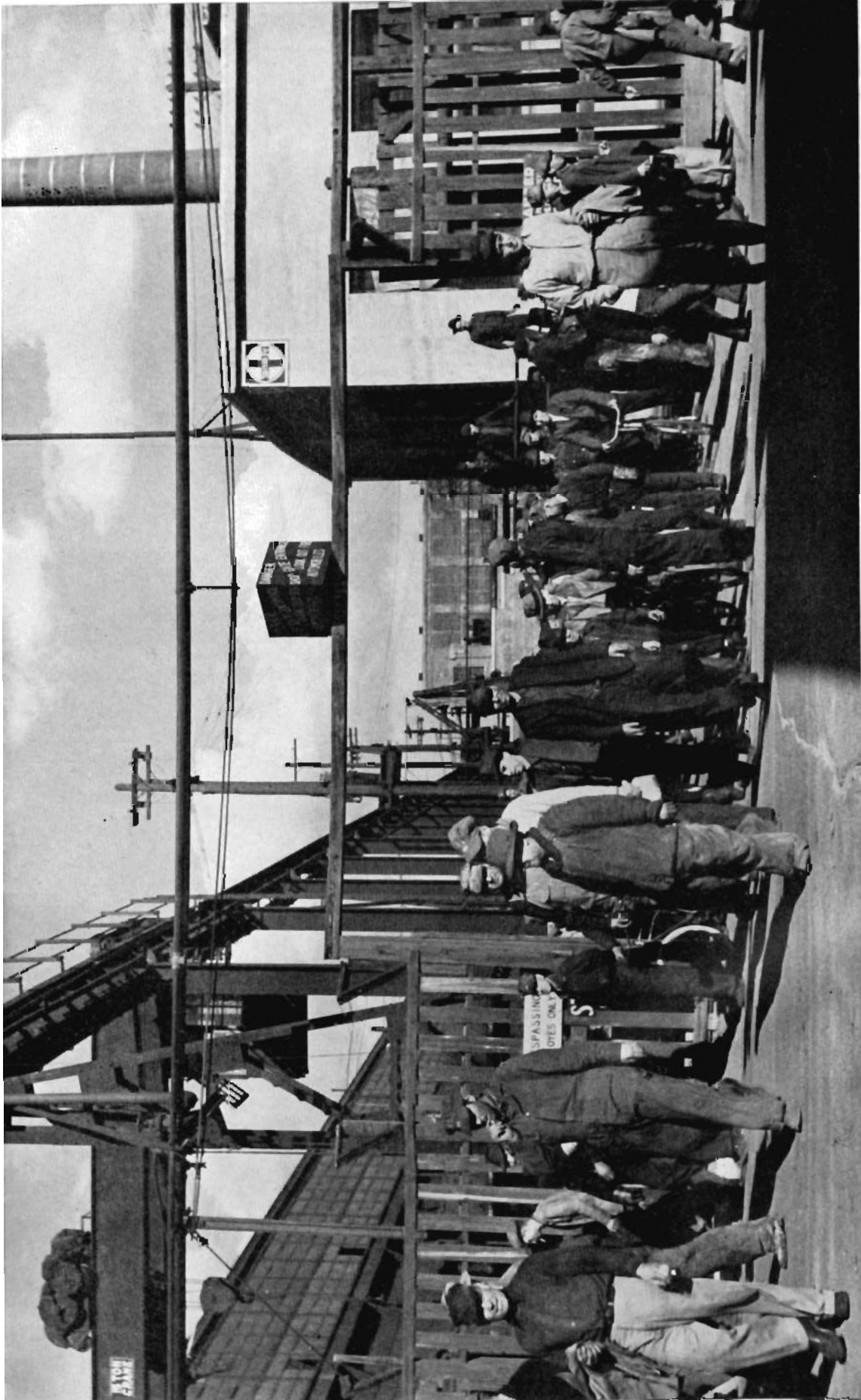


*Wheels keep 'em Rolling!*





Part of our forces at Albuquerque, N. M., bound for their homes after a hard day's work in the shops

# Locomotive and Equipment Maintenance

## Unsung Heroes in Shops and Roundhouses Keep 'em Rolling on the Santa Fe

By J. R. HUBBARD

**J**UST as most of us accept good health, Americans scarcely were aware of the vitalness of their railroads until war seriously crippled rubber and water borne commerce. While realization of railway importance is dawning on American consciousness, many persons do not fully appreciate the fundamental soundness of railroad transportation.

One phase of railway fundamentals will be discussed in this article—mechanical equipment and its maintenance. The Santa Fe Railway, serving the Pacific Coast, the Gulf of Mexico and the vast inland empire between those points and Chicago, has performed its wartime functions in such a manner as to make an excellent example of sound, safe and efficient transportation in a period of extreme stress.

Over its 13,000-mile network of steel, the Santa Fe handled more than 30 billion ton-miles of freight in 1942. At the same time it carried our armed forces, civilian government personnel, war workers and other travelers to the tune of more than three billion passenger miles.

Performance of this feat is made more remarkable by the fact that it was carried out in a period of equipment and material scarcity due to abnormal war demands. While the traffic load doubled, replacement equipment was unavailable even to meet a normal year's requirements. Old and worn equipment was repaired or rebuilt and made to serve.

How the job was done is a long story. It goes back a good many years. Combining practical experience with scientific experi-

mentation, the Santa Fe mechanical department built up a set of standards for each item of equipment and every procedure of shop practice. Today's mechanical equipment is the result of more than fifty years of progressive experience.

To qualify under Santa Fe standards, equipment must be more than good—it must be the best. It is designed and built for vigorous service. Safety—a prime factor in every Santa Fe operation—is carefully considered in design and construction. Durability and repairability go hand in hand across the draftsman's table as Santa Fe motive power and rolling stock are born.

Rugged dependability of equipment plus a well organized and systematically carried out re-conditioning program has enabled the Santa Fe to handle its staggering war load without faltering. Under this program, equipment is regularly inspected for wear and defects. Worn or defective parts are replaced before they reach a substandard condition. In this manner many replaced parts themselves can be reconditioned for further service.

To appreciate the size and scope of this job let us consider one steam locomotive

for a moment. In a list prepared a few years ago, 15,299 parts of a locomotive were itemized which could contribute to an engine failure. While this number may vary somewhat from the newer and larger present locomotives, it will result in nearly twenty-three million parts for the 1,500 steam locomotives now in service.

Generally speaking Santa Fe steam locomotives in freight service run 120,000

### OUR COVER PAGE

No one needs to tell Tony Fioretti of the Albuquerque shops that "Victory rides on wheels." He and his 16,000 fellow-employees in our mechanical department fully realize how necessary wheels are to transportation, especially in wartime when so many men and so much material must be moved quickly and safely to destination. That's why these men of the Santa Fe are working night and day in our shops and roundhouses repairing locomotive power and equipment. It's their job to "keep 'em rolling" on our busy railroad.

miles between general overhauls; passenger locomotives 200,000 miles. Roller bearing equipped engines run 350,000 to 400,000 miles. However, in each case engines are given a thorough external inspection at the end of each trip or at the end of each day's work. Along with this inspection, the engine gets a complete lubrication and its stores are replenished. At the end of each thirty days, the engine is taken to its roundhouse for a thorough internal as well as external inspection.

Replacements or adjustments, termed running repairs, are made from time to time following these inspections as the need indicates. At the end of 40,000 miles, freight engines are given a Class Five re-conditioning job. This includes any light repair necessary to firebox, boiler and flues are tested. Driving wheel tires are re-conditioned or renewed, all driving wheels are "dropped," driving boxes are refitted and a general overhaul is made on side and main rods, valve gear, spring and brake rigging, guides, pistons trucks and trailers. Passenger engines receive this treatment at from 60,000 to 75,000 miles.

Another Class Five job is done before the engine is ready for a general re-conditioning. This general repair work is done at the great shops in Shopton, Topeka, Cleburne, Albuquerque, San Bernardino and La Junta. Roundhouses for running repairs are conveniently situated at the following points: Richmond, Los Angeles, Barstow, Bakersfield, Fresno, San Bernardino, Needles, Phoenix, Winslow, Las Vegas, Raton, Clovis, Belen, El Paso, Slaton, Temple, Fort Worth, Galveston, Purcell, Arkansas City, Waynoka, Wellington, Amarillo, Newton, Dodge City, Emporia, Chanute, Argentine, Marceline, Chillicothe, Chicago, and Shopton.

### Safety the Watchword

Safety is the Santa Fe watchword, pass-word and persistent theme. Nowhere on the property is more emphasis placed on safety than in the mechanical department. Safety for the public, the passenger and the shippers' goods are inherent in the planning and construction of equipment. So it is natural that the same care should extend to planning and supervision of work in the shops.

Long experience in working with power machinery, sharp tools and heavy metal equipment has developed a set of shop practice rules that if carefully followed will prevent injury to workmen. Among the first instructions a shop apprentice re-

ceives are those directed at safe working practices. He is required to learn and observe these rules. His foreman, his shop safety committee and the department safety supervisor are constantly on the alert to improve the observance of safety practices.

Much safety equipment has been developed to protect the shop workmen. Safety shoes which protect the feet from falling objects; shatter-proof goggles to protect the eyes and screens to shield the unwary from fast moving machinery and belts have contributed materially to safer working conditions.

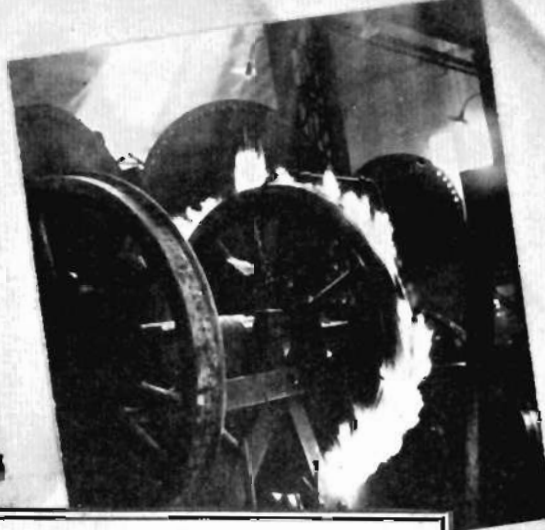
However, the most important factor is the man, himself. Safety reminders are posted at many points around the shops in an effort to keep safety constantly before the worker. But more important are safety meetings at which the supervisors and men get together to discuss shop conditions and rules interpretations. These meetings are conducted regularly even though the men are perfectly familiar with the rules, principally to keep safety questions alive in the workers' thoughts and their minds alert to danger.

### An Engine of War Is Reborn

Under a heavy coat of travel grime—worn-out grease, grit and desert dust—a locomotive arrives at the general repair shop for a 200,000 mile overhaul. The tender is uncoupled and the engine is sent to the erecting floor of the shop for dismantling.

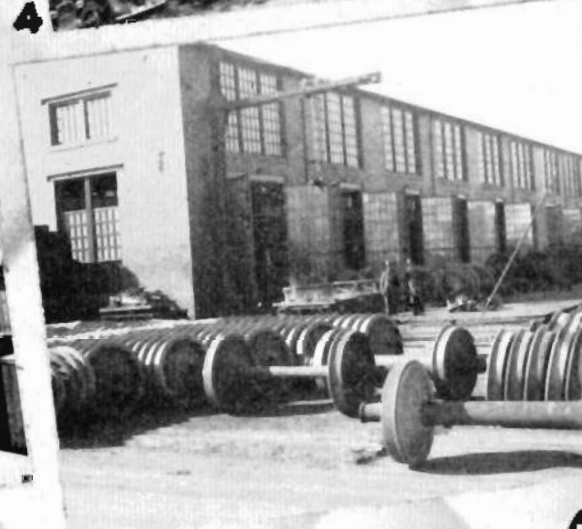
First, the wheels and running gear are loosened. Then the engine is "unwheeled" and placed on a series of heavy wooden blocks. There it is completely stripped and parts cleaned in a lye vat. Pipes, pumps, cab, cylinders, domes and insulating lagging are removed, leaving the bare boiler and fire-box resting on the frame. The boiler and frame are sand blasted and the frame is then removed, if defective, and sent to the blacksmith shop where breaks may be welded. As this stripping is done, each part removed is marked with the engine's number and sent to the machine shop for inspection, repair or rejection.

Flues are cut loose from the boiler with an acetylene torch, removed and placed in a tumbling machine. This machine rolls the flues over and over rattling them together until all of the water scale is knocked off. After inspection, most of these flues are found to be in serviceable condition, their damaged ends are cut



## MAJOR REPAIR SHOPS ON THE SANTA FE

1. Oldest general repair shop on the Santa Fe system is at Topeka, Kan.
2. Re-tiring a locomotive driver wheel at Shopton, Ia.
3. General view of the Albuquerque shops.
4. Partial view of Cleburne shops.
5. Boiler and machine shop at San Bernardino, Cal.
6. Locomotive repair shop at La Junta, Colo.

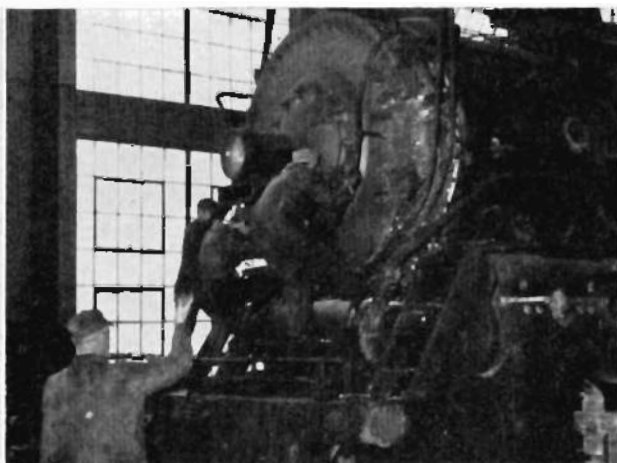




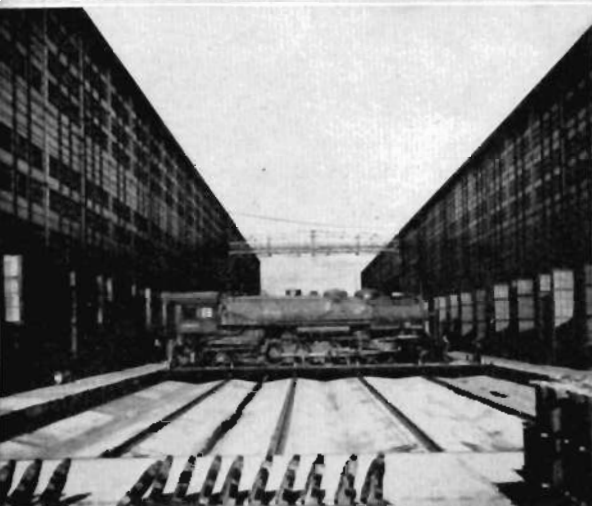
## *An Engine Of*



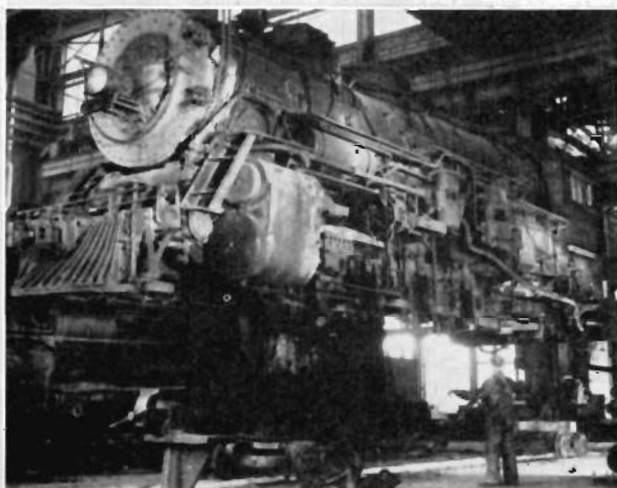
**TRAVEL-WORN** after thousands of miles of service, this big Santa Fe locomotive is pushed to the shops for general overhauling.



**CRANE CABLE** is placed around locomotive boiler so that engine may be lifted from its wheels and moved to overhaul shop.

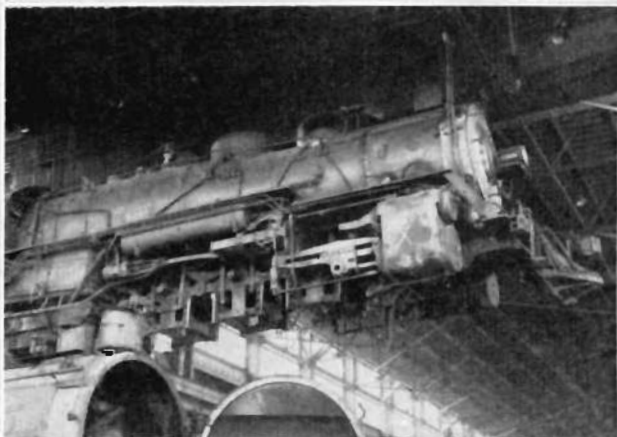


**MINUS ITS TENDER**, locomotive is placed on transfer table to be moved into shop for stripping.



**AFTER DRIVE RODS AND WHEELS** have been disengaged, 250-ton crane picks up engine.

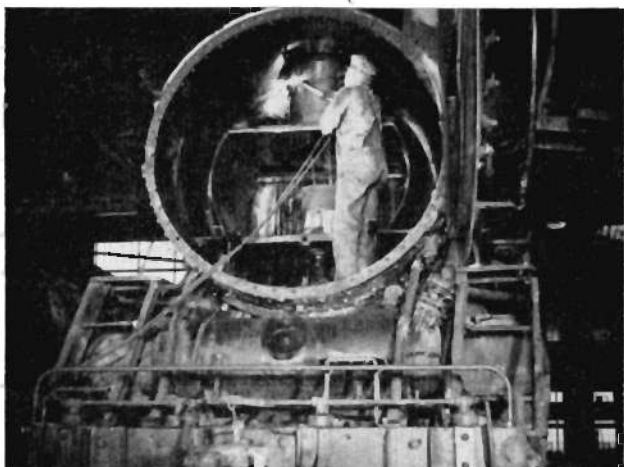
**INSIDE THE SHOP** ready for dismantling.



**CRANE MOVES LOCOMOTIVE** through shop to point where it will be dismantled.

# War Is Reborn

(continued)



**DISMANTLING BEGINS** as worker burns off bolts on petticoat pipe (inner stack), preparatory to its removal.

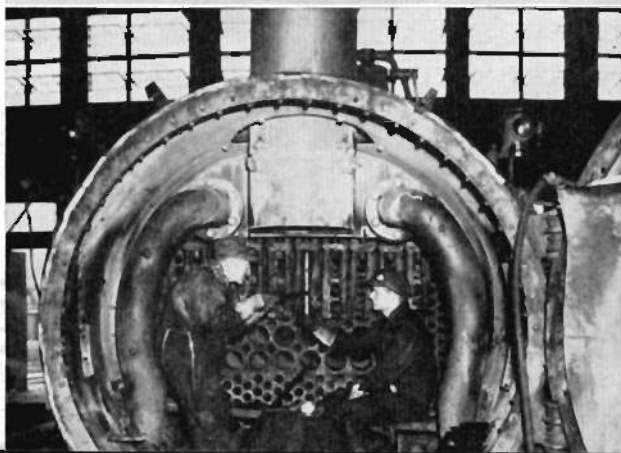


**WATER HEATER** bundle is taken out of its jacket.



**SPARK ARRESTOR** is pulled out.

**REMOVING** superheater tubes.



**LOCOMOTIVE CAB** is stripped of boiler mounting instruments by pipefitters.

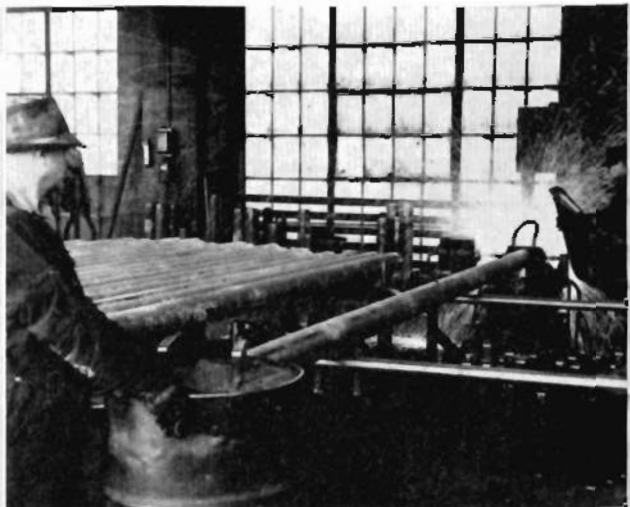
**ASBESTOS LAGGING** covering boiler is removed.



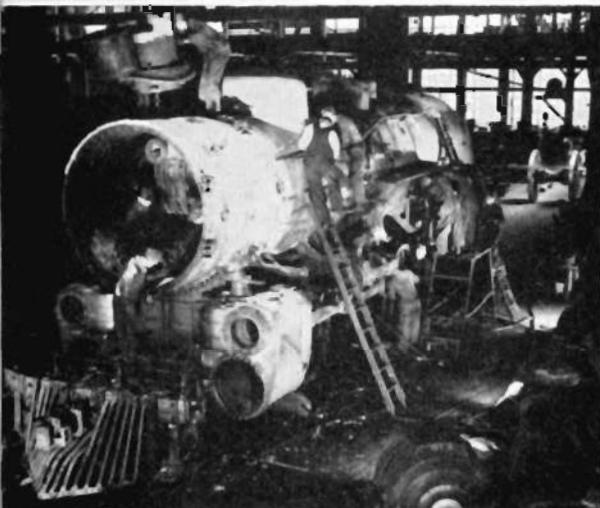
## *An Engine Of*



**OVERHEAD CRANE** removes locomotive cab.



**WELDING NEW**, safe ends on boiler flues.

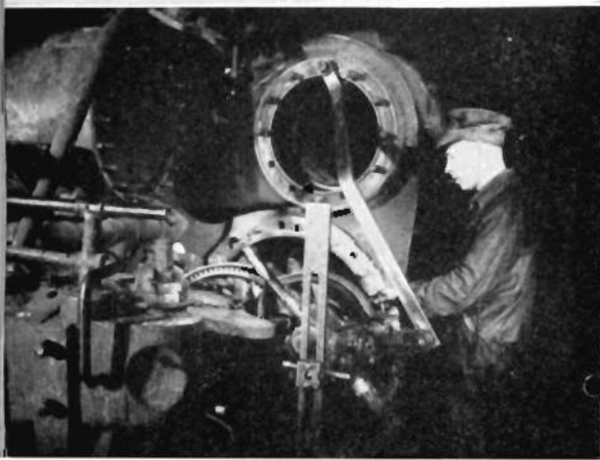


**LOCOMOTIVE NOW LOOKS** like skeleton with mechanics on ladders and moveable platforms having stripped the iron horse of its outer raiment.

**HORIZONTAL GRINDING MACHINE** puts mirror-like finish on piston rods.



**MECHANIC REBORES** locomotive cylinder.



**WHEEL IS PRESSED** off axle by 600-ton hydraulic press.





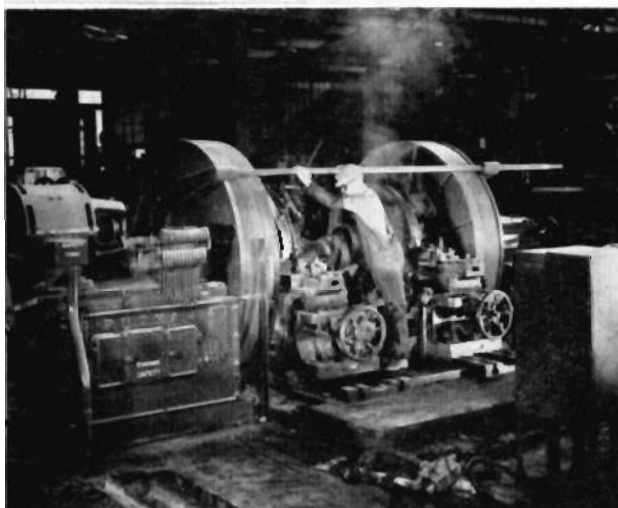
# War Is Reborn

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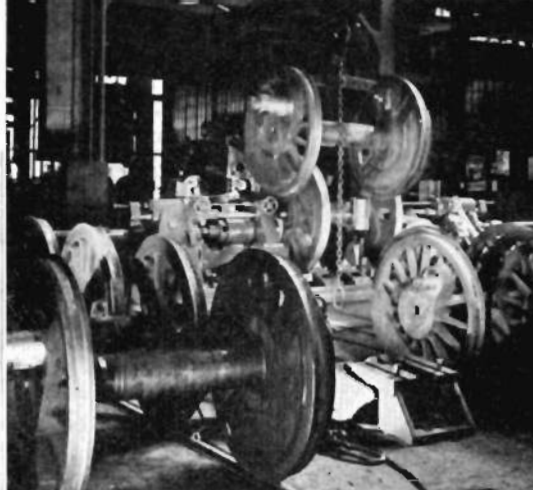
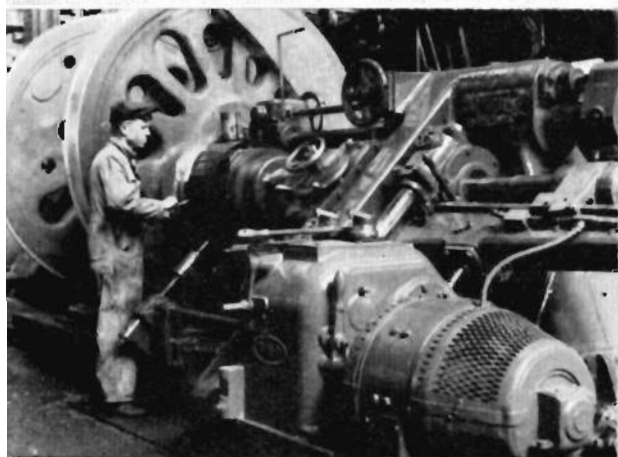


**DRIVING TIRE** is re-bored.

**INTRICATE MACHINE** turns tread on driver tires.

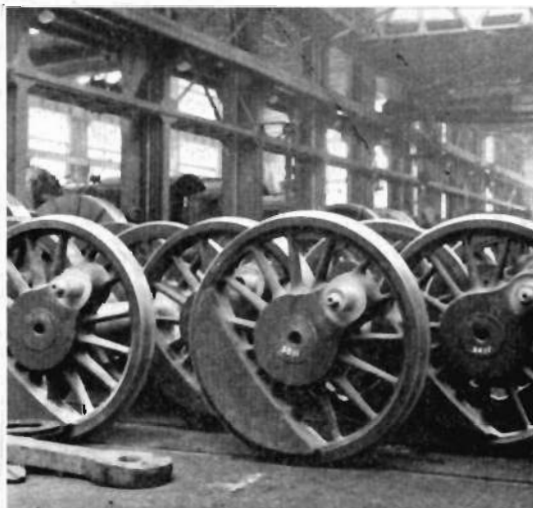


**QUARTERING MACHINE** grinds driver pin.

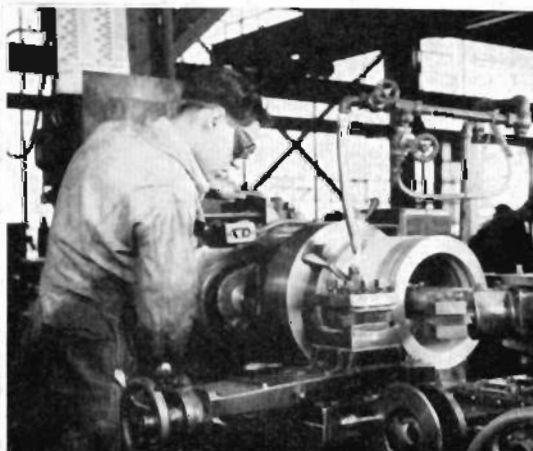


**WHEELS ARE SHIFTED** to different parts of shop with small crane.

**RECONDITIONED WHEELS** ready for service.



**MULTIPLE OPERATION** turret lathe making brass bush for a main rod.



## *An Engine Of*

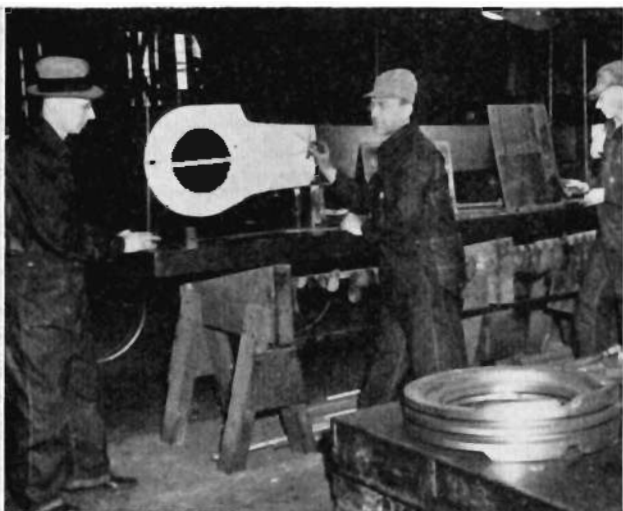


**MACHINING A GUIDE** on a draw-cut shaper.

**APPRENTICES** are instructed on machining engine parts on horizontal lathe.



**CALIPERING NEW CYLINDER BUSHING** during turning operation.

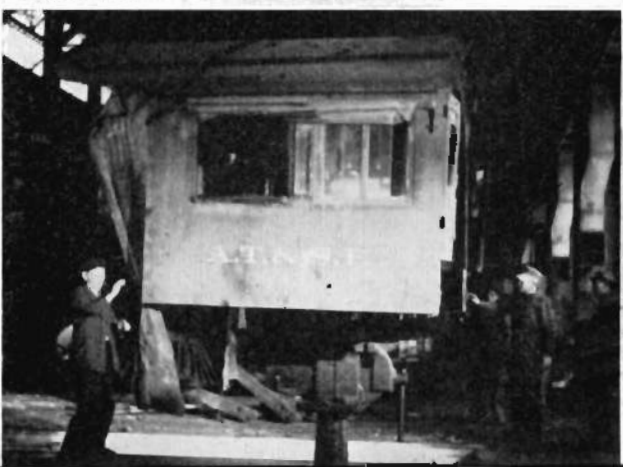


**LAYING OUT** a main rod.

**FORGING A DISCARDED AXLE** with aid of steam hammer to make other parts.



**REASSEMBLING BEGINS.** Cab is ready to be put back on locomotive.



# War Is Reborn

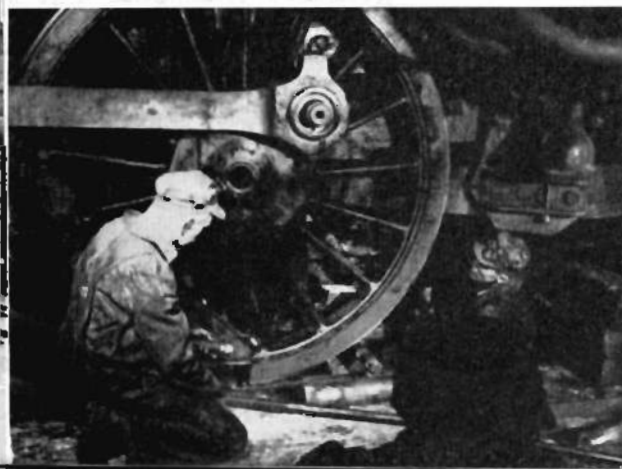


**MECHANICS REPLACE AIR-PUMP.**

**REPAIRED LOCOMOTIVE is lowered into place over wheels.**

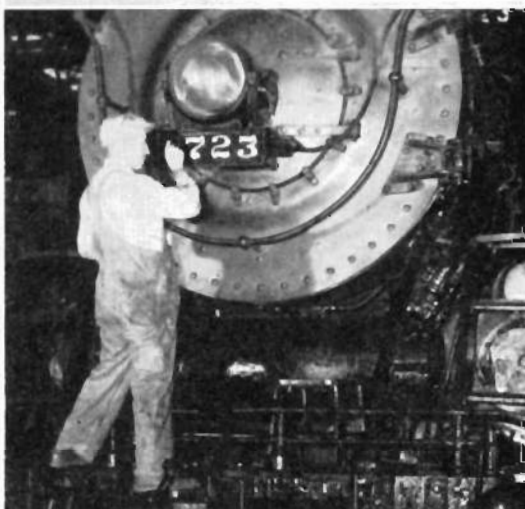


**AFTER ENGINE has been set on wheels, pedestal binders are replaced.**

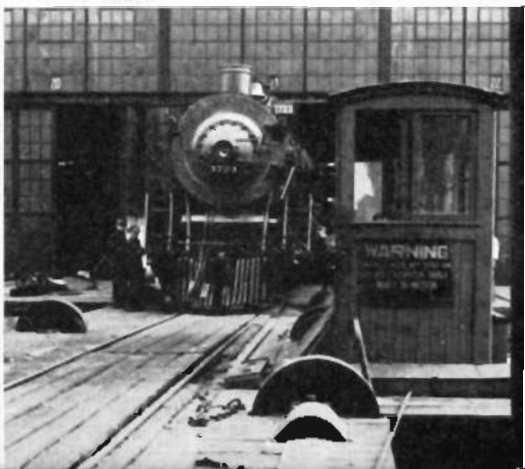


**TRAILER TRUCK is guided into place.**

**RENEWED AND GLISTENING, the rejuvenated locomotive gets its old number back.**



**READY FOR THE ROAD AGAIN and many more in service.**





**SAFETY IS OF PARAMOUNT IMPORTANCE, ALWAYS**

This group of mechanical and store department forces at Richmond, California, was called together at noon for a safety meeting and the opening of the third War Bond drive. Their happy expressions were caused by the news just received, broadcast over the loud speaker system, that Italy had capitulated to unconditional surrender terms and requested an armistice. On the platform, standing, is A. J. Dietrich, assistant master mechanic, speaker. Seated, left to right—L. J. Brooder, chief clerk; E. O. Cook, division storekeeper; W. E. Johnson, general car foreman; D. R. Cook, general locomotive foreman. Of this group, more than 90 per cent are signed up for Bond purchases under the pay roll deduction plan.



off, new safe ends welded on and shaped for re-insertion into the boiler. Then they are filled with water under pressures greater than those of working conditions to test for leaks and weaknesses.

If necessary stay-bolts and radials will be removed from the firebox and a new firebox shaped from  $\frac{3}{8}$  inch steel sections. This box will be drilled for staybolts, shaped under huge rollers and riveted into one piece. The boiler has been thoroughly checked and new courses of heavy plate steel fitted in replacement of defective sections.

A block buster could hardly scatter a locomotive wider than parts of the dismantled engine now are spread through the machine shops. At one end of the great plant, the oil tank is thoroughly steamed out to remove fuel oil fumes before repairs are started. The cistern and tank are taken off the trucks which are completely overhauled. The fuel tank is removed and checked for leaks and the big water reservoir carefully inspected.

On the erecting floor, the driving wheels have been rolled over to big wheel lathes where the tires are trued up—each tire in the set of six or eight being turned to the exact size of the others. On the quartering machine adjacent to the wheel lathes, crank pins for the driving rods are turned down in exact adjustment, and counter balances are checked.

Across the erecting floor on the machine side, main and side rods are being magnafluxed for invisible fractures or faults. This magnaflux process uses an electromagnet and a sensitized powder. This powder is dusted lightly over a part under inspection. Then the magnetic current is passed through the metal. Any cracks or fissures will cause the powder to gather



GENERAL VIEW OF THE LOCOMOTIVE SHOPS  
San Bernardino, California

over the spot where a fissure occurs. All working parts of the locomotive are given this inspection and those having defects are scrapped.

After the rods have passed the magnaflux inspection, the inspector checks the eyes for out-of-round or taper. When this evidence of wear is found, the rods go to the micro-grinder or milling machine and the eye is machined to a new size and fitted with a new brass bushing. Crank pins on the wheels are trued up and new brasses fitted so that when they are assembled they are sound and sturdy as new ones.

Out-of-round or worn cylinders are machined to a new size and fitted with new pistons and rings.

New brass liners are applied on worn crossheads and then machined down to a predetermined size with exact precision. Driving wheel axles are placed in a big lathe and trued up. A new set of driving boxes will be bored to fit the axles.

Parts for the valve motion undergo a careful inspection for wear and adjustment. Worn link blocks are built up with brass welding. The valve link is ground

to new size and the block machined down to fit within three-thousandths of an inch. Worn parts on the automatic stoker are built up by welding and fitted into new assemblies.

In another section of the machine bay, the intricate parts of air-pumps, valves, gauges and the myriad assembly from the locomotive cab undergo a beauty treatment. All of this gear is cleaned and restored to A-1 condition before going back to the erecting floor and return to the engine.

To a layman making his first trip through the repair shops, one of the most impressive things noticed is the rebuilding of used parts. Many of these parts originally were designed with extra weight or extra size so that they could be machined down for subsequent fittings. Very few parts are scrapped entirely. Even parts that are discarded for one purpose may be utilized for another. Defective axles are used in forgings; drawbars made from scrapped staybolts. Bolts and nuts are re-threaded; broken asbestos insulating blocks are ground up and processed for re-use. Even dirty journal packing is cleaned with both oil and packing salvaged. Defective flues go into locomotive pilots. Diesel crankcase oil goes through a reclaiming plant where 75 per cent of the oil is saved. The list is almost endless.

The engine frame comes back from the blacksmith shop looking like new. Flues and super-heater tubes are back from the flue shop and we are ready to start assembling our new engine.

Overhead, great electric traveling cranes lift and shift huge engine parts about the shop with effortless ease. Now one of them hovers over our boiler assembly and lifts the firebox wrapper high in the air. Another crane takes the new firebox and lowers it gently into the upraised opening. After this is lowered on the new frame, boilermakers swarm into and around the firebox applying staybolts and radial stays. At the front end of the boiler, other workers start installing the flues. The boiler now is given a hydrostatic test under 25 per cent greater than working pressure.

At the other end of the shop, the wheels are being lined up with driving boxes and rods. Soon we will be ready to "wheel" the new engine and start installing the auxiliary machinery. The big boiler, and various assemblies will weigh upwards of 300,000 pounds when it is set back on the wheels. This is a ticklish job for the erecting foreman, crane operator and "wheeling" crew. Any slip could send tons of steel crashing into the workmen.

Men selected for this work are trained as a team and drilled in their duties. Every possible safeguard is taken to prevent accidents. Especial care is used at all times to inspect the cranes and their rigging of cables and hitches. Expert tool men check all of the tools used in the shops at frequent intervals to avoid the use of faulty equipment. Workmen are cautioned at all times to work safe and to never take chances.

Inspectors keep close tab on the job of assembling the hundreds of working parts as they are refitted to the engine. All of these parts must meet the critical set of standards that have made Santa Fe a leader in the transportation field.

When the locomotive is all assembled, it is filled with fuel, water and stores. Then it is fired up and tested under steam. When these tests are passed the engine goes on the road for a trial trip or to the slip-track.

The trial trip serves two purposes. One is to observe its performance under working conditions and the other is to give the newly fitted bearings a chance to "break-in" slowly. Usually the trial trip is made in local freight service where the schedule is slow and the veteran engineer who is staging the trial has an opportunity to observe the engine's performance. The slip-track is a greased track near the shops where the engine can be put through her paces with wheels slipping on the track. After passing the trial trip satisfactorily, the engine is assigned to a regular turn in service.

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### The Apprentice School

One of the highly important factors con-



SERVICING ENGINE AT NEWTON

On this and the following three pages are reproduced representative scenes of roundhouses and other running repair facilities at various locations on the Santa Fe.



Barstow, Cal., roundhouse.



35-stall roundhouse at Bakersfield, Cal.



Roundhouse and turntable at Needles, Cal.



Bird's-eye view of Richmond, Cal., roundhouse.



Car sheds at Waynoka, Okla.



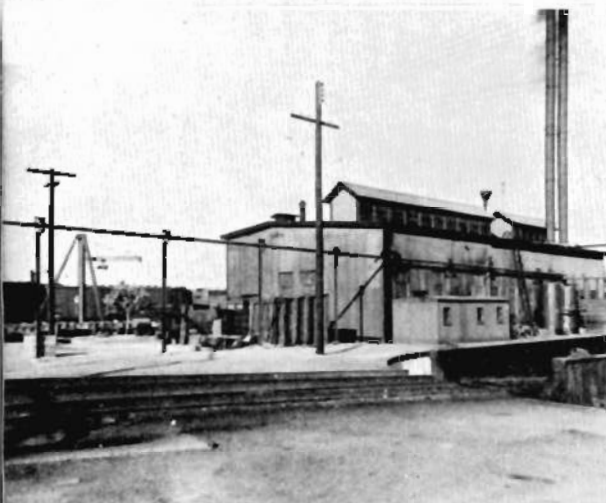
Turntable and yards at Winslow, Ariz.



Roundhouse and shops, Wellington, Kan.



General view of yards and facilities at Amarillo, Tex.



Machine shops, El Paso, Tex.



Car shops at West Wichita, Kan.



Repair track and shed, Slaton, Tex.

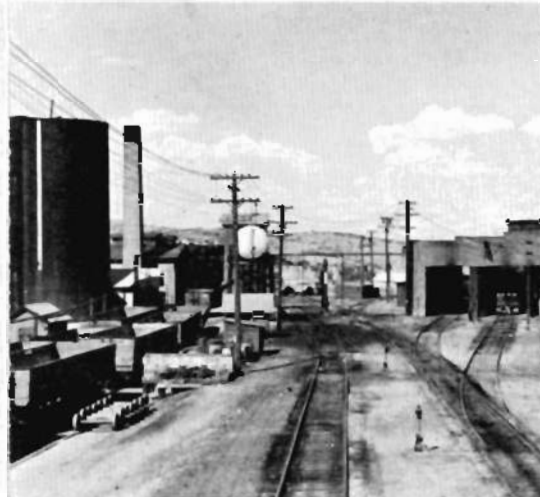


Emporia, Kan., shops.





**Shops and roundhouse at Newton, Kan.**



**Mechanical facilities at Prescott, Ariz.**



**Diesel repair shop, Chicago, Ill.**



**Partial view of facilities at Argentine, Kan.**



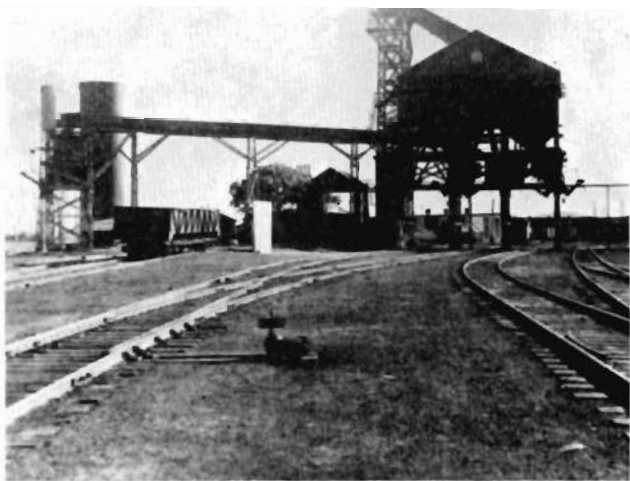
**Corwith, Ill., roundhouse.**



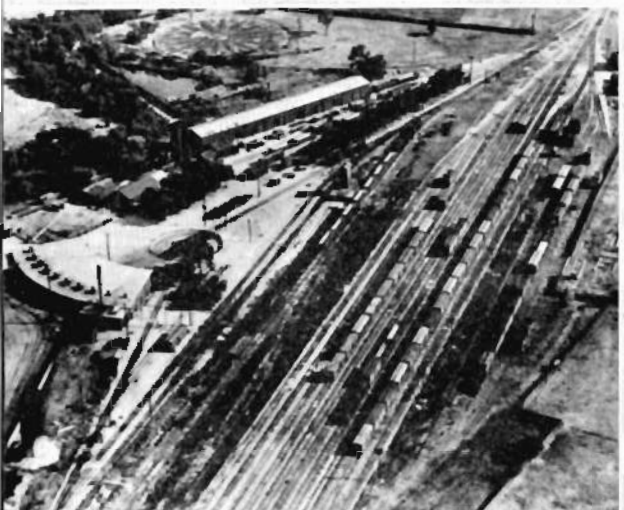
**Chanute, Kan., shops and roundhouse.**



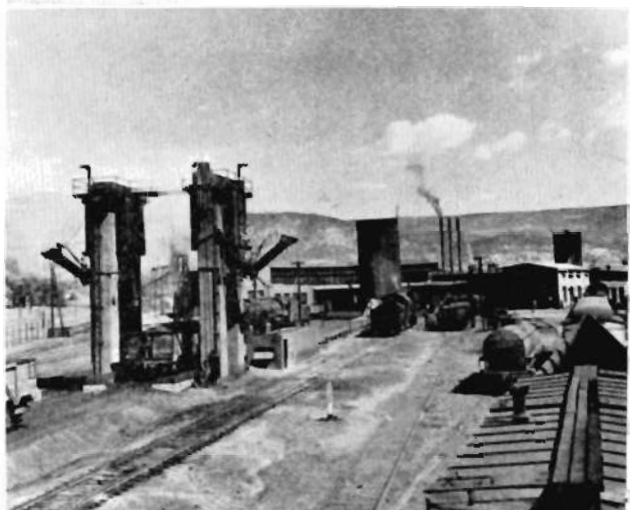
**Santa Fe shops at Galveston, Tex.**



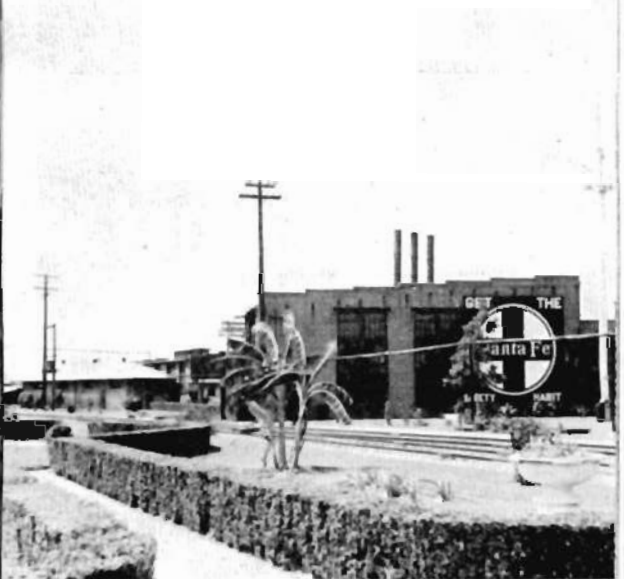
**Coal chute and roundhouse (background), Las Vegas, New Mexico.**



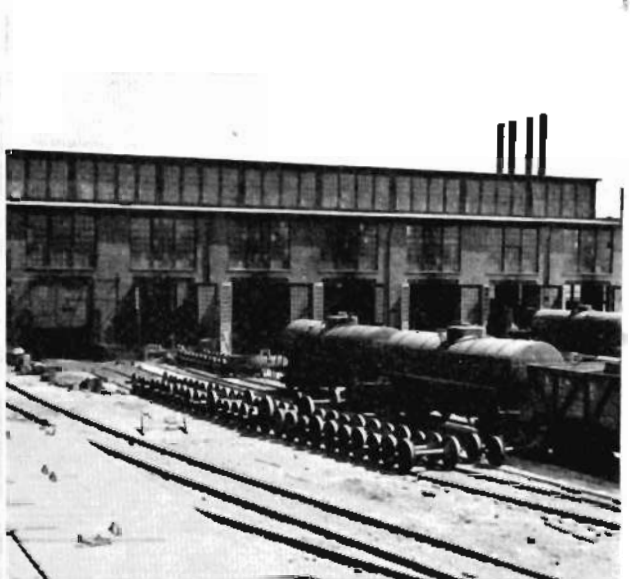
**Aerial view of facilities at Gainesville, Tex.**



**Roundhouse facilities at Raton, N. M.**



**Mechanical department facilities at Temple, Tex.**



**Back shop at Clovis, N. M.**

tributing to the Santa Fe's mechanical excellence is the apprentice school and system for training mechanics. Under this system an apprentice has an opportunity to learn mechanics in both theory and practice. He attends schoolroom classes two hours twice a week and works his regular shift under the eyes of competent instructors in the shops.

The average apprentice of today has a high school education or better. He more often than not comes from a Santa Fe family and has the Santa Fe traditions for a background. He may start his apprenticeship in any of a dozen crafts, but will be released from service if he shows no aptitude for the work after six months at his chosen trade. By showing aptitude and energy, an apprentice may become a full-fledged mechanic in four years.

The success of the system is borne out by the fact that many of the mechanical department executives are graduates from the apprentice school. Nearly all of the supervisors either had apprentice training or were graduated from the school.

### The Important Freight Car

Nearly eight billion pounds of carrying capacity are provided in the more than 80,000 freight cars belonging to the Santa Fe System. These are cars of all types and sizes, but the box type car probably outnumbers the others since it is used for

a wide variety of loads. Other cars largely are built for special purposes such as transportation of livestock, oil, perishable foods and coal, sand or gravel.

The average freight car has a capacity of 100,000 pounds although this varies from 80,000 to 150,000 pounds in some cases. The 80,000-pound capacity type usually is an older car and probably would be slated for re-building or scrapping now if building materials were available. However, many of these old wooden sided cars are serving Uncle Sam well during the war emergency. They require a great deal of repair and are frequent visitors in the car shops.

Body repairs probably run highest of any type of shop work in these older cars. Travel strains loosen their roofs and damage doors. Much body repair work is done with non-critical wooden material for the duration.

Various other disorders will send a freight car to the "rip" track for repair. These include flat or cracked wheels, damaged trucks and faulty brake rigging. Draft gear damage is reported with some frequency due to the heavy strains that are put on this equipment. However, much of this repair work is done outside the shops at the nearest point where light repairs can be made.

Constant inspections are made of freight



A GROUP OF SHOP EMPLOYEES AT THE LOS ANGELES, CALIFORNIA, ROUNDHOUSE.

car equipment at each division point. As soon as a freight train arrives in the division yards, blue signals are attached at each end of train, inspectors and oilers set to work on it. No small part of the Santa Fe's successful operations are responsible to the efficient and loyal work of these carmen who work around the clock in bad weather and good. Neglected or overlooked equipment failures are the cause of many damaging wrecks.

As the car inspector checks a train, he tags "bad order" cars. These must be switched out of the train before it can proceed. Some of these bad order cars can be repaired locally, others must be sent into general repair shops.

When heavy repair is indicated, if the car is laden, the load will be transferred to another car and the bad order forwarded to the rip track at some shop. There it is switched to its designated track and a blue flagged derail locked in place. This blue flag prevents engines moving in on the track and disturbing the car while it is under repair thus protecting the men who are at work on the repair job. Blue flags also are used on the trains while they are being inspected. It is a dischargeable offense for an engineer or trainman to move a train while it is under the protection of the blue flag. This permits the inspectors or car repairmen to move in and about the train without danger.

On the rip track, a car is jacked up off its trucks and tripods placed under car for safety. The trucks are run out and sent to the truck repair shop while the carmen go over the frame and body doing whatever work is indicated. Brake rigging also is checked over for needed work. Meanwhile the trucks are dismantled, the wheels going to the wheel shop for turning or replacement as required.

Freight car wheels are of two types, iron and steel. The trend in recent years with heavier cars and greater speed has been toward the steel wheels. In repairing the flat or worn wheel surfaces, it is the usual practice to turn them to a new size in a grinder. This grinder cuts a pair of wheels on the same axle to the same size. Different sized wheels may be used in the same set of trucks, but each wheel in a pair must be exactly the same.

With newly turned or replaced wheels, the trucks are re-assembled. New or rebuilt parts replace those showing excess wear. Meanwhile any frame welding or re-inforcing that is necessary has been

done. Car flooring, sheeting and roof have been checked over and renewed and the car is ready for its trucks and return to duty.

Large wood working shops are a part of car repairing facilities. Modern power machinery, saws, planes and bores the various wooden parts to numbered specifications. This eliminates much hand work on the job and expedites the car's return to service. All through the car shops, similar labor saving practices are followed. Paint is applied with a power sprayer, mechanical hoists save much heavy lifting, air hammers and other power tools daily save much manual labor.

The car shops in Wichita are home port for a huge fleet of Santa Fe refrigerator cars. These brilliant orange colored cars are built to carry perishable foods across blazing heat of the deserts and frigid mountain passes in winter. Inside the steel body of modern refrigerator cars are seven layers of insulating material to preserve an even interior temperature. The cars are fitted with various types of equipment for transportation of meats, fruits and vegetables.

The Wichita shops build these cars from the ground up and do running repair work necessary to keep the fleet in fit condition. Wartime material shortages halted construction of new cars, but the full shop crew is kept on the job for maintaining the fleet and rebuilding other types of cars.

### Eternal Search for Improvement

Searching constantly for improved steels, alloys, lubricants and fuels, the Santa Fe maintains a modern test department with laboratory engineers and chemists. Many improvements in train speeds and performance have resulted over the years from the development in water treatment, lubricants and fuels.

All water used by the Santa Fe except that obtained from municipalities is tested regularly. Treatments are prescribed for various types of water used in steam locomotives in an effort to obtain as high a degree of suitability and uniformity as possible. In the early days of the Santa Fe, engines could be used only short distances because of water trouble encountered in the boilers. Now locomotives are assigned to regular runs from Los Angeles and Galveston to Kansas City. Others are assigned from Chicago to La Junta.

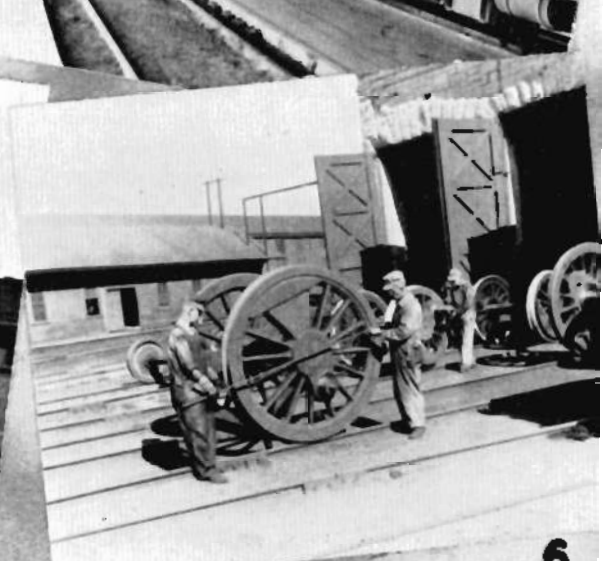
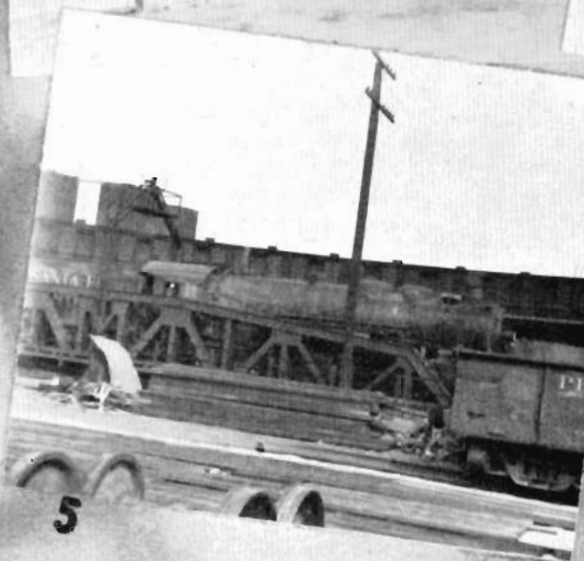
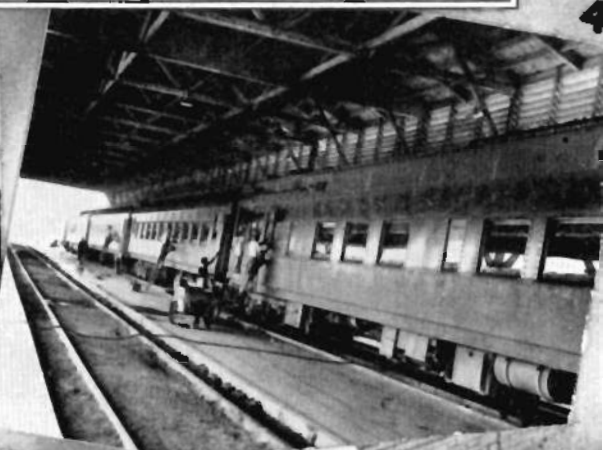
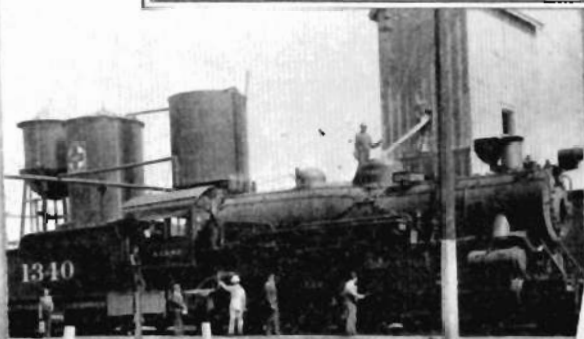
Analysis is made of steel, iron, ballast, engine sand, cross ties, fire-brick for fire-





### OTHER SERVICE CENTERS FOR MOTIVE POWER AND EQUIPMENT

1. Shops and roundhouse at Fort Worth, Tex.
2. Walter Hester, hostler helper, cleans No. 1352 at Brownwood, Tex.
3. Servicing an engine at the Calwa, Cal., roundhouse.
4. Passenger cleaning and repair force at work in car sheds at Phoenix, Ariz.
5. Turning an engine in front of roundhouse at Belen, N. M.
6. Bru Baker and P. S. Hartley in foreground caliper a driving wheel while Charles Williams, background, performs the same operation on a main pin at Arkansas City, Kan.





boxes and nearly every material used by the railway. Physical examinations also are made on many kinds of equipment to test durability and efficiency. The test department is in charge of rail detector cars that are used to discover concealed defects in track rails. The department also operates a dynamometer car which records data for determining efficiency of locomotives. An oil reclaiming plant for processing used Diesel crankcase oil also is under the supervision of the test department.

This department plays an important part in development of substitute materials whose use is dictated by wartime needs.

### The Busy Store Department

While not actually a part of the mechanical department, the store department works in closest co-operation with the shop activities. Some 80,000 items, 60 per cent of which are used by the mechanical department, are carried in storehouses located at strategic points all over the Santa Fe system.

Usually the storehouse is located adjacent to the shops and roundhouses. The thousands of items from cotter keys to huge driving wheels and cast steel cylinders are kept in readiness for sending to the shops on a moment's notice.

Working in conjunction with the store department is the shop order department in the Topeka shops. Many standard car and locomotive parts are manufactured and delivered to the store department for distribution. This type of material includes new engine rods, pistons, pins, metal window frames, angle irons, bolts and studs.

Passenger, dining and baggage cars come from all parts of the Santa Fe System to the Topeka coach shop for re-conditioning. This shop is capable of rebuilding a complete car from trucks to upholstery. Some of the finest cabinet work is done on the interiors of dining and lounge cars. Nearly every line of skilled craftsmanship is represented in the coach shops. Each passenger car carries its own air conditioning unit, electric generator and a set of storage batteries for standby service.

Both cars and locomotives on passenger trains receive careful inspection and servicing at regular intervals along their runs. Cars are supplied with ice and water



### BUSY RAILROADERS

Top—C. H. Curnutt, painter, sprays interior of box car with mineral slag in the Wichita shops. Center—Santa Fe's familiar map is stenciled on side of box car at the Wichita shops by Ansel J. McClead, painter, and his helper, A. O. Clubb. Bottom—H. E. Whitaker, left, and W. J. Cochran, oilers, lubricate cars at Wellington, under the supervision of Fred Helzer, center, head car inspector.

while their electric equipment, air-conditioning systems and running gear are being serviced. While the train is stopped, the locomotive tender is filled with water and fuel and grease cups on working parts are filled by high pressure grease guns. These servicing crews are carefully trained and work with speedy efficiency to send the trains safely on their ways.

### Diesel Motive Power

Since 1936 the Santa Fe has built up one of the world's largest fleets of Diesel-electric motive power. One hundred and fifteen of these locomotives now are in service and 69 more are on order. Probably the most impressive members of the fleet are the 28 freight locomotives assigned to the mountainous territory between Winslow and Needles. These 5,400 horsepower locomotives handle 2,900 to 4,800 ton trains on grades of 1.4 to 1.8 per cent, rapidly and efficiently.

The Santa Fe's 14 passenger Diesels ranging from 1,800 to 4,000 horsepower handle the speedy streamlined trains. These engines take transcontinental trains from Chicago to Los Angeles, approximately 2,200 miles, with stops only long enough to add fuel and water.

Seventy-three Diesel switch engines are in daily service at Santa Fe terminals. These engines operate in almost continuous service, requiring little time off the job for inspection and service. In most terminals, these locomotives ranging from 380 to 1,000 horsepower are assigned to three eight-hour tricks daily.

During the seven years the Santa Fe has operated Diesel-electric motive power, the locomotives' performance has been so outstanding that repair classifications similar to those used for steam locomotives have not been set up. Diesel locomotive 1-A which has been in passenger service since 1936 was remodeled several years ago and has run 1,466,421 miles since that time without a general overhaul.

One reason for this remarkable record is the fact that maintenance is kept up currently. Many repairs are made even while the locomotive is on the road. Expert Diesel maintainers ride the locomotives on their road trips, keeping careful watch of the performance of the Diesel engines, electric generators, traction motors and the steam unit that provides heat and air-conditioned power for passenger trains.

In addition to the constant inspection, maintainers repair worn or defective parts frequently while the train is speeding along. This class of repair work includes replacement of pistons, cylinder liners and bearing shells. The fact that the power is generated in two or four engine units permits any one of them to be cut out of service temporarily for repair work. Even various cylinders can be cut out of service with the remainder of the engine continuing.

The big freight locomotives are powered by four 1,350 horsepower 16-cylinder Diesels. Passenger power has two different sizes of engines used either in one, two or three unit combinations. All passenger Diesel motors are 12 cylindered. The type is of 900 horsepower and the other 1,000 horsepower. Diesel motors in the same classification are interchangeable and extra motors are maintained for replacement when one must be removed from the power car for heavy repair. When a motor is taken out for this purpose it is completely rebuilt and made ready for the next replacement need.

In the Chicago shops where most general repairs are made on the passenger Diesels, a modern shop designed especially for the work has been erected. Freight Diesels are repaired at a special section of the roundhouse at Winslow.

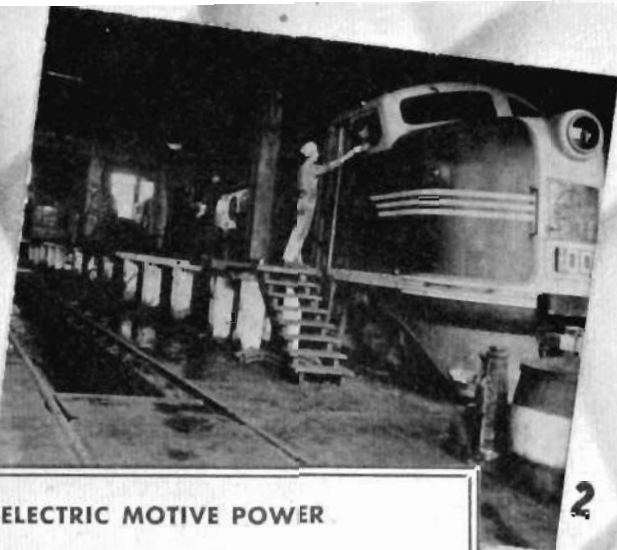
Diesel passenger locomotives average around 20,000 miles per month or more than 600 miles daily. The freight Diesels run about 10,000 miles per month. Durability of this type of power is reflected in the fact that general inspection of engine bearings and electric motor windings are required only every 200,000 miles. Crankshaft bearings usually run 500,000 miles and one set lasted for more than 700,000 miles.

Probably the greatest wear on a Diesel locomotive is on the wheels. These wheels are removed from the trucks and trued up on lathes and grinding machines after running from 25,000 to 100,000 miles. Power axle gear and pinions usually are set up for re-conditioning after 250,000 miles. Axles on the power wheels are renewed at 400,000 miles. Generators seem to run indefinitely, some of them have been in service since 1936.

Lubricating oil in the crankcases is run for 30,000 miles in passenger service. This usually is after six round trips between Los Angeles and Chicago. In freight service the crankcase oil is changed more fre-



1



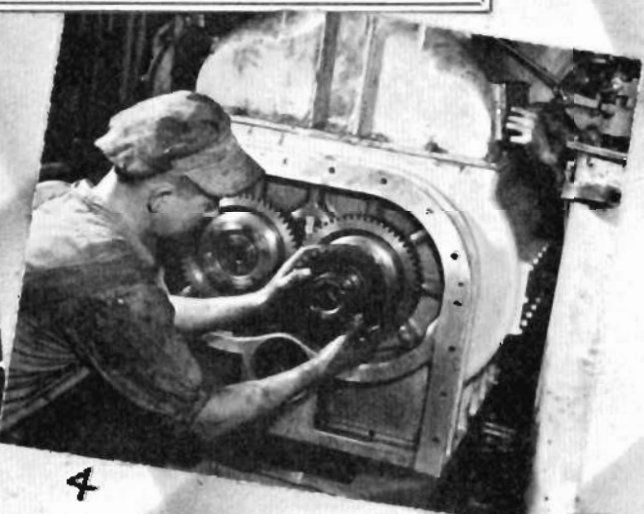
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# MAINTENANCE OF DIESEL-ELECTRIC MOTIVE POWER

1. El Capitan's 4000 horsepower Diesel-electric locomotive gets a bath at Chicago.
2. Servicing No. 100, the giant freight Diesel at Winslow, Ariz.
3. Major Diesel repairs are made at Chicago in the above shop.
4. Repairing air blower which provides oxygen for burning fuel oil in the Diesel engines.
5. Mechanics adjust high pressure fuel pump control on a 12-cylinder, 900 horsepower Diesel engine.
6. Turning one of the big Santa Fe Diesel locomotives.



3



4



5



6



quently since the freight locomotives are geared to slower speeds.

Holding heavy freight trains in check on long down grades of the mountains by the use of air brakes has resulted in heavy wear to car wheels and brake shoes. By the use of a dynamic braking system on Diesel freight locomotives, this wear has been reduced materially. Reversing the function of traction motors and generating electricity on the down grades, dynamic braking has greatly reduced the amount of air brake application. Electricity generated by the traction motors is dissipated through a system of grids installed on the locomotive roof.

Santa Fe executives believe that Diesel power has passed through its experimental stage and now occupies a definite place in the transportation field. The almost constant availability of this type of power has been a great factor in speeding the war work of the United States.

Man power for maintenance of Santa Fe power in the face of steadily increasing demands has been a critical problem to meet. Big general repair shops such as those at San Bernardino, Topeka, Albuquerque and Cleburne have increased their working hours from eight to nine hours and added night shifts so that production now is on an 18-hour basis daily. Running

repair shops are operating on the largest overtime basis in their histories so that the greatest production possible is being turned out with a minimum number of men.

Since it has been impossible to replace all of the men called into military service, women have taken over a number of jobs in the mechanical department. More than 600 of the department's 16,187 employees now are women.

Personnel of the Santa Fe mechanical department demonstrates daily its loyalty and patriotism. Despite handicaps, time required for overhauling a locomotive has been reduced from 60 days in pre-war times to 34 days now. The percentage of power out of service now is the lowest in the history of the railroad.

Besides its daily wartime job, the department has furnished 2,800 men for the armed forces and is among the leaders of the entire Santa Fe System in the purchase of War Bonds through pay roll deductions. Among the first to sign 100 per cent on the Bond program, various units of the department have consistently maintained their 100 per cent standing. The entire department stands near the head of the Santa Fe roster now with 95 per cent participation in the Bond program.

### PRAISE FOR RAILROAD OPERATION

"They (the railroads) have surpassed all expectations in the face of very heavy odds. They are carrying a load which has risen to a peak towering above all prior peaks, and they are doing this with facilities which are less in sum total than when the war began. This is because we have lost the use for the time being of most of our ocean and considerable of our Great Lakes shipping, because of the inroads which the loss of most of our sources of natural rubber has made on our highway automotive transportation, and because in the drive to carry war production to the utmost possible heights, the supply of new equipment and facilities for our domestic carriers has been held down to levels which have not, in general, been sufficient to take care of normal replacements."

"It has been a case of making the most of what we have, or making little do much. \* \* \* The job has been done, and it is not yet possible to point to any situation where the war effort has suffered seriously because of any default on the part of transportation. \* \* \* I take my hat off to the carriers for their performance."

"I have paid tribute many times to what the railroads have done in this war, and they deserve all that praise and more. The Nation joins in it."

—Joseph B. Eastman, Director, Office of Defense Transportation.

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