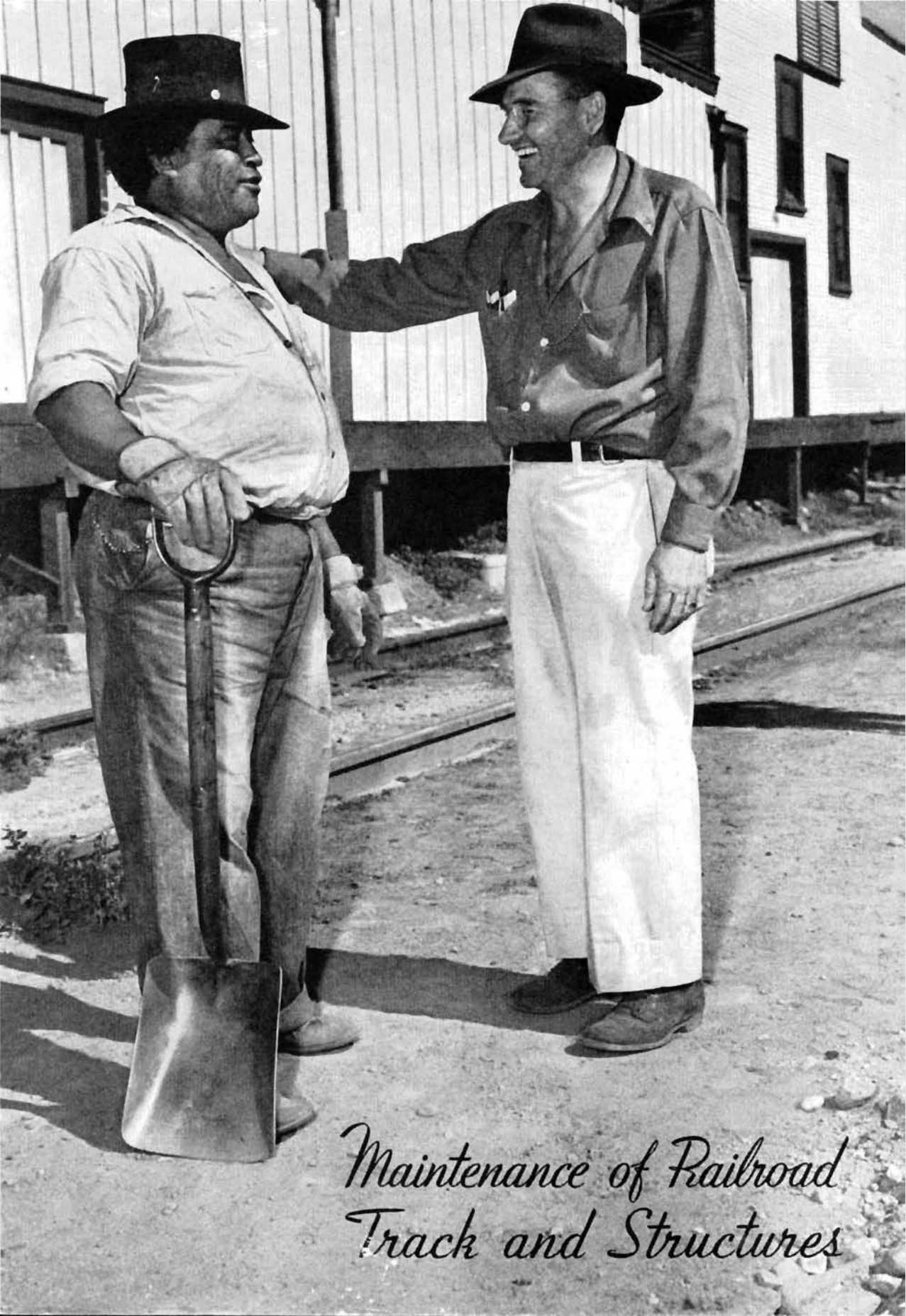


Maintenance of Railroad Track and Structures

FREIGHT TRAIN MOVES CAUTIOUSLY OVER NEW RAIL NEAR SCHOLLE, N. M.

This track laying gang on the Santa Fe's main line near Scholle, N. M., quickly removed its equipment from the rails to permit an approaching freight train to pass. New track was installed on this section of the railroad with little delay to important war traffic.

Maintenance of Track and Structures Important and Costly Feature of Railway Operation

By CHARLES W. LANE

MOST folks, when thinking of railroads, no doubt let their minds dwell only on locomotives and cars—in other words, trains—without considering even for a moment the fundamentals of railroading; briefly, the things that make or permit a train to move.

So for a few minutes let us go into the background and take a look at the bits of steel, the sticks of wood, and the chips of stone that form the nucleus of a modern railroad plant, expertly prepared and manipulated by a vast army of employees—engineers, steel gangs, section men, bridge builders, carpenters, tiemakers and other workmen—before a wheel can turn.

As trains must have a roadway to support and guide them, track is the prerequisite of a railroad. Without it, trains could not budge an inch, could get nowhere, and only with good track can they move safely and on time. It is an old adage that a railroad is only as good as its track, and in this the Santa Fe is supreme among American railroads.

Bridges, trestles, viaducts and tunnels are track links of the same materials—steel, wood and stone—but represent more complicated construction since they are designed to give trains direct and easy passage over streams, canyons, streets and highways, and through hills and mountains. Buildings, too, are examples of how men of brawn and intelligence can mold these products into structures necessary for successful railroad operation.

There is no disposition here to delve into the complexities of what may be the most important elements or phases of railroading. The point is that track is the skeleton or backbone of a railroad, like the framework of a building, and as a matter of sequence is entitled to first consideration. This treatise is so confined.

It is history that railroads, to a great extent, superseded the trails and paths established as trade routes before the coming of the Iron Horse. In the case of the Santa Fe, its founders dreamed of converting the Santa Fe Trail into a ribbon of steel, to take over the flow of commerce between Old Santa Fe and the Missouri River, and being successful in that, spread their web to other portions of the Southwest. And that is the vast Santa Fe System of today, a chain of some 2,500 thriving, bustling communities, tied together with rail, ties and rock ballast.

Like the early trade routes themselves, it was quite natural that the railroads should follow the flat valley levels to avoid hills and other barriers. They built around such obstacles instead of cutting across, as is the tendency nowadays. This probably increased the mileage, but engineers were forced to wrestle with the problem of gravity which affected mule, horse, oxen and steam power alike; besides, the time element in those days wasn't so very important.

While the railroads will always seek such common advantages, modern demands for speed have brought about extensive realignment of track and other time-saving improvements. This program, particularly applicable to the Santa Fe's transcontinental main line, has increased the problem of constructing bridges, fills, grades, tunnels

THIS MONTH'S COVER

Victor M. Marrequez, who has been a Santa Fe section hand as long as he can remember, is one of our best men, according to W. C. Cagle, right, roadmaster on the Los Angeles Division. Vic just radiates good humor and in this picture is evidently enjoying a good joke as told by Roadmaster Cagle, who speaks Spanish like a native. He is the son of a Santa Fe roadmaster and learned the tricks of the trade from his dad.

and track, for in almost total disregard of costs distance must be reduced to expedite service.

Perhaps the traveler does not realize the engineering, construction and maintenance part of the railroad picture as he zips from Chicago to Los Angeles on the Super Chief within the brief space of forty-one hours or less, but let him glance at a map and he will find himself passing from Lake Michigan and the Mississippi valley across the rising plains country and through the Rocky Mountains, to top four lofty ranges, each more than a mile high, before again dropping down to almost sea level.

Traversing this distance of more than 2,200 miles, the passenger crosses the Illinois, Mississippi, Missouri, Arkansas, Rio Grande and Colorado rivers by means of mammoth bridges, also the one that spans Canyon Diablo, a gash 225 feet deep and 550 feet wide, which slits a high mesa in northern Arizona. And he can stay comfortably in his berth and on a short side trip climb 7,000 feet and gaze into the awesome depths of the Grand Canyon.

PAUSE THAT REFRESHES

Rail laying is hard work, especially under a hot summer's sun, and the familiar cry of the water boy, "Ah-gwah!" (water), is a welcome sound to thirsty track workers.

Not the least of the traveler's experiences is that of being carried through Raton tunnel, altitude 7,621 feet, and the highest point on the Santa Fe System Lines, to avoid going over or around a mountain top that is still higher. To accommodate double tracks, there are two of these tunnels, the first one being 2,041 feet long and the other 2,678 feet long. They constitute one of the greatest railroad engineering feats in the world. Before the tunnels were built the mountain summit was surmounted by a "switchback," or a system of zigzag tracks.

Millions of such passengers and thousands of carloads of freight move over the Santa Fe each year, transported quickly and efficiently because good track and high maintenance standards are a Santa Fe tradition. There is no finer, smoother, safer railroad track in the world, thanks to engineering knowledge and the efforts of thousands of faithful employees who know their jobs and do them well at all times.

Track and Rail

After experimenting with probably twenty different track measurements ranging from three to six feet wide, which made interchange of cars almost impossible, the railroads shortly after 1870 got together and adopted a standard gauge of 4 feet, 8½ inches. This is the distance inside the heads of the two parallel rails, the gauge line being five-eighths of an inch below the top of each rail.

There are several versions of how this decision was reached. Most plausible, perhaps, is that 4 feet, 8½ inches was uppermost in the minds of early engineers who possibly saw a link with other modes of transportation, this being the distance between wagon wheels and other highway vehicles, as handed down from the days of the ancient Roman chariots and later adopted by the English tramways. Automobiles have the same gauge; in fact, any motor car equipped with flange wheels can travel on railroad track.

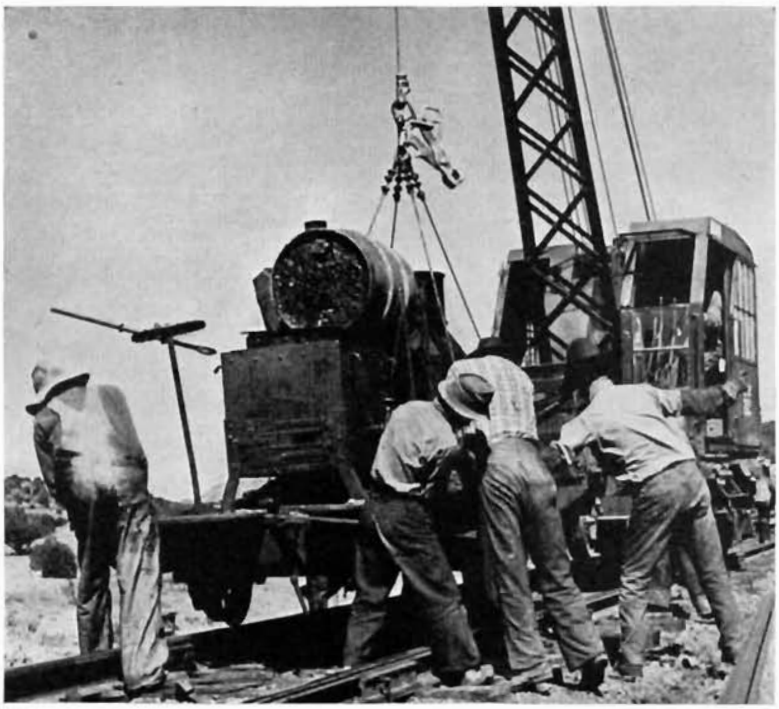
While the width of railroad track thus became standard and has not changed in seventy-five years—except that some narrow gauge is still in use in mountainous and industrial areas—size and weight of rail have increased to keep pace with the density of traffic and the weight of locomotives and cars. Although they are longer and heavier than the early day product, the size of ties has varied somewhat less.

A cross section of Santa Fe rail reveals sizes and weight ranging from fifty-two pounds to the yard, used in very early construction, to the massive 131-pound rail, recently adopted by the Santa Fe for all high speed transcontinental main line. In between are weights of 60, 75, 90, 110 and the popular 112-pound steel, standard for many years, and still in use on an extensive part of the Santa Fe System Lines. Rail

of 150 pounds is considered the next step.

Even though some of the first rail on the Santa Fe was iron, having been manufactured in England and shipped to this country before the Civil War, only solid steel has been used for many years. Each rail is thirty-nine feet long, thus the larger size of 131 pounds to the yard weighs 1,703 pounds, or nearly a ton. This length was agreed upon to retain even yardage as a means of computing weight, and it is the maximum that a forty-foot flat car will accommodate in shipping.

Supporting the rails are wooden ties, spaced to average from 3,250 to 3,520 to a mile; somewhat less in substandard track where spacing may be farther apart. For many years the standard tie was eight feet long. Now for transcontinental main line the standard is nine feet long, nine inches wide, and seven inches thick, the extra length having been decreed as necessary to spread the ever increasing weight of trains.



TRAINS MUST MOVE WITHOUT DELAY

In order that traffic may move without undue delay, rail laying gangs must continually be on the alert for approaching trains. Track workers on the Santa Fe's main line near Scholle, N. M., are shown above placing their equipment back on the track after allowing a freight train to pass.

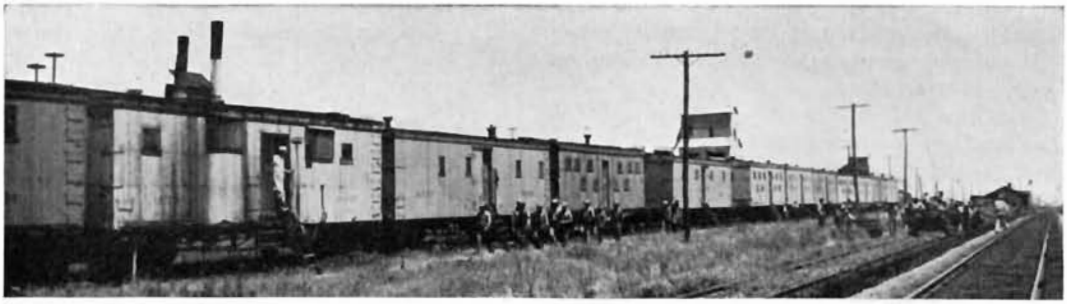
Rails do not rest immediately on the ties but are cushioned by steel plates, through which spikes are driven to hold the rails in place. There are twice as many plates as ties, and four times more spikes than plates. There are 271 rail joints in each mile of track, staggered so that those on one side will be opposite the center of the other rail. All joints are bonded—wired to conduct electricity—in signal territory.

The top part of a rail which comes in contact with the wheels of a train is known as the head, and the bottom spread resting on the tie plates is called the base. The long neck between the two which gives height to the rail is the web. It is through the web that rail ends are bolted together with plates known as angle bars. As two are required for each joint, there are 542 of these angle bars in each mile of track.

Rail is good for a period of from fifteen to twenty years, depending upon the density of traffic; in other words, the extent to which it is used, governed by the number, length, speed and weight of trains. Life of steel tie plates is considerably longer. Aside from wear and tear, which is unusually severe during the present period of heavy military traffic, flaws occasionally develop in rail and replacements are necessary.

In the process of manufacture, each rail is lettered, dated and given a heat or serial number which designates the five to seven rails that come from a single ingot. The Santa Fe keeps records showing when and where all rail is installed in the track, and if a flaw is discovered each rail of the same series is carefully checked. Should a transverse fissure be found, all member rails are discarded, so far as main line use is concerned.

While open flaws are visible to track supervisors who cover an assigned territory daily, rail detector cars are used to reveal fissure and other interior flaws which have not reached the surface, and hence cannot be seen with the naked eye. All main track is inspected by these supervisors who travel by motor car at slow speed. These men



A TYPICAL SANTA FE WORK CAMP

Good food and comfortable living quarters for the men who work on the line are essential to successful railroad maintenance. The scenes on this page, showing a camp near Marland, Okla., are similar to those of other camps on the Santa Fe.

Top: General view of camp showing kitchen car, two dining cars, one each for colored and white members of the crew, and living quarters on far end.

Center: A piece of rail serves as the dinner gong for Chef William L. Coleman and the noise he makes with the claw hammer is his way of saying "Come and get it."

Lower left: Hats are left outside as the men clamber up a short ladder to the dining room.

Lower right: What the small boy once told his mother about not caring much what the food was "as long as there was plenty of it," is the first rule with the men in a railroad construction camp. They demand an abundance of bread, meat, potatoes, beans and coffee, the latter strong and black.

were known as track walkers when they hiked over a section—usually six to eight miles—daily.

Track and Ties

In early days the ordinary life of a railroad tie was six to seven years, somewhat longer in dry or desert territory where the timbers were subject to less moisture. Now that all ties are treated with creosote, they are good for an average of thirty years, regardless of location or weather conditions. Use of larger and heavier tie plates also prevents rail from cutting into the ties under the heavy impact of trains. This prolongs the life of a tie; however, the period of a tie's usefulness is determined largely by the strain of pressure and wear.

Santa Fe ties are produced in Texas, Louisiana, eastern Oklahoma, New Mexico and Arizona, while some of those used in California originate in the Pacific Northwest. They are for the most part Southern pine, Western pine, Douglas fir, oak and gum. While the pine varieties outnumber the hardwoods, oak and gum are used exclusively on the sharper curves. Redwood is used to some extent where the supply is convenient.

Since water is the greatest natural enemy of the railroads, ties which were once placed flat on the ground presented a serious maintenance problem before the Santa Fe began pioneering in wood preserving back in 1885. Deterioration was so rapid that the company at one time decided to grow hardwood trees for the purpose of perpetuating its tie supply and initiated several groves in California.

Any such plan was abandoned, however, with the perfection of what is known as standard creosote mixture, consisting of fifty per cent creosote and fifty per cent petroleum residuum or fuel oil. This treatment first doubled, then tripled and later quadrupled the life of ties and other timbers, with an estimated saving to the Santa Fe of approximately five million dollars a year. All poles, crossing plank, bridge and foundation timbers are similarly treated, the idea being to prevent decay, and wood that is thoroughly saturated with chemical is not subject to damage by termites.

HE WARNS STEEL GANG OF APPROACHING TRAIN

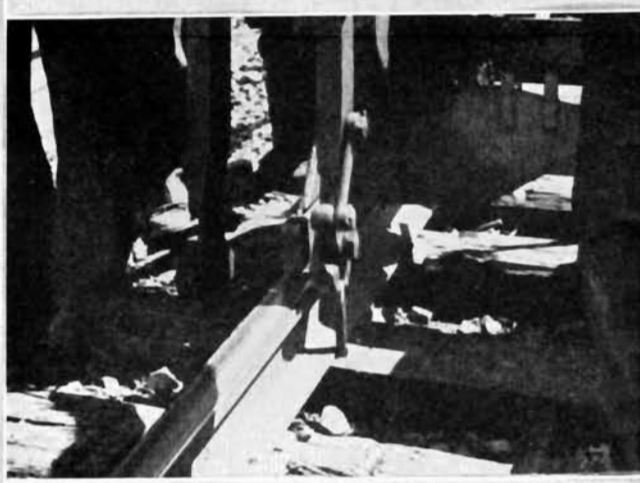
Using portable telephone, Henry H. Lewis, operator, keeps in touch with the dispatcher, obtaining train information for this steel gang on the Northern Division near Ardmore, Okla., and informs dispatcher when track is open or closed in order to minimize delay to approaching trains and workmen.

The Santa Fe, one of the largest railroads in the United States, has 13,137 miles of main line track. It operates an additional 1,910 miles of second, third and fourth main track, and 5,806 miles of yard tracks and sidings, a total of 20,853 miles. In this gigantic network, extending from Chicago to the Pacific Ocean and south to the Gulf of Mexico, with lines radiating to all parts of the Southwest, there are more than 60,000,000 ties, with a turnover of 2,500,000 annually—500,000 for new construction and 2,000,000 for maintenance.

Santa Fe ties are cut green by private operators under contract. Inspected and found to meet the company's requirements, they are rushed by logger train to the nearest treating plant as quickly as possible and piled in long rows for air seasoning. Largest of these plants is located at Som-

Rail Laying Operations

WORKMEN UNLOAD TOOLS to begin laying new 131-pound steel on the Santa Fe's main line near Scholle, New Mexico.



CLOSE-UP VIEW of spike puller. Machines operate in pairs, one on each side of rail.

WORK IS UNDER WAY with men pulling spikes, removing rail, adzing ties and performing other operations preliminary to laying the new rail.

WITH A HEAVE and a ho, old rail is removed to make way for the new.

AUTOMATIC SPIKE PULLERS, powered by a gasoline engine, easily keep ahead of the steel gang as they remove old track spikes.

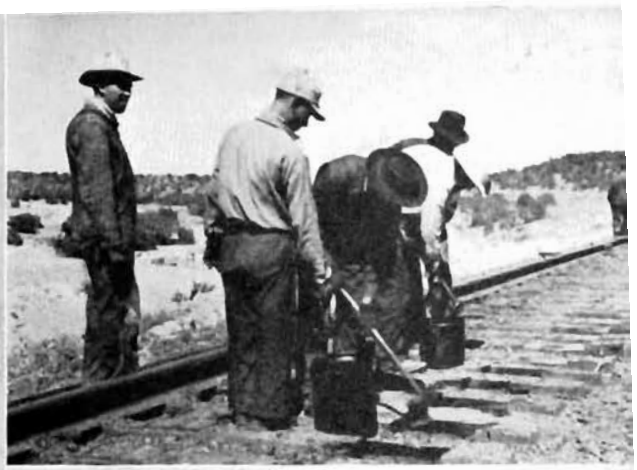
OLD SPIKE HOLES are sealed with creosoted plugs to keep water from seeping in and rotting ties. Note workman with bundle of plugs.

On the Western Lines

POWER ADZERS cut new seats in the old ties for the tie plates on which the new rail will rest.

CLOSE-UP of power adzer head. Screen on top and flaps on sides prevent wood chips from flying up and injuring operator.

NEWLY ADZED TIES are swept clean before applying hot creosote.



WORKMEN SWAB TIE SEATS with creosote to preserve wood. Seats have been cut the same width as the tie plate.

TIE PLATES are placed in position on the ties. Note how snuggly they fit into the adzed tie seats.

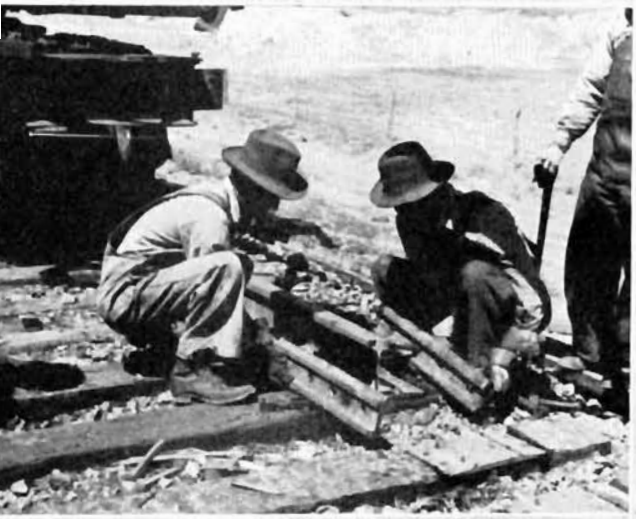
GRINDER ON RIGHT sharpens the tie adzer bits which are being placed in adzer head by fellow-worker on left.

Rail Laying Operations

WORKMAN DRAWS hot creosote from heater. The use of this preservative lengthens the life of a tie to 25 or 30 years.

ANGLE BARS are spread so rail may slip into place. Grippers used by workers prevent mashed fingers and other injuries.

ANGLE BARS must be placed into position before a new section of rail is laid.



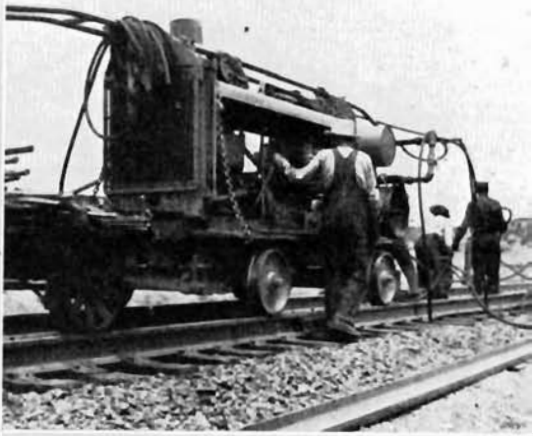
TRACK WORKERS push bolts through rail joint bars and "start" nuts which will be tightened later with power wrenches.

A NEW SECTION of 131-pound rail, 39 feet long and weighing approximately 1,700 pounds, is moved over track by rail laying crane and guided into place by workmen.

WITH THE AID of lining bars, the new rail is set to gauge. Gauge is 4 feet, 8½ inches, the standard on most American railroads.

On the Western Lines

SKELETON SPIKING the rail to hold it in place after it has been set to gauge. Note gauging bars across track.



THIS MOBILE AIR COMPRESSOR furnishes power fo air hammers, which are shown in the backgroun ing the spikes which previously were set by hand

CLOSE-UP OF A SPIKING MACHINE (air hammer) fits over the head of spike and drives it firm the tie.

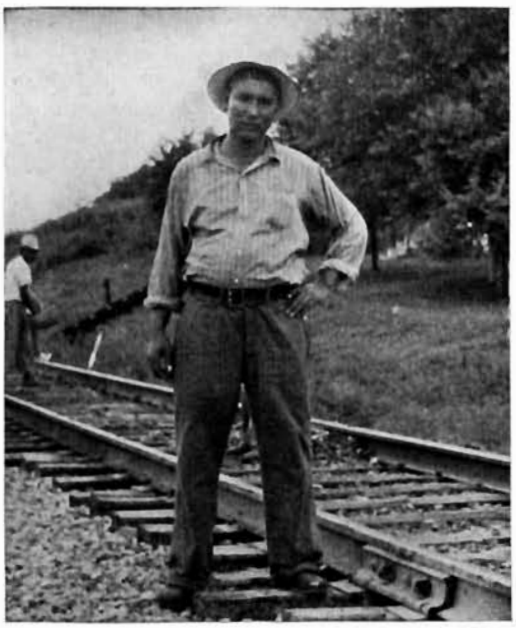
WORKMEN DISTRIBUTE track spikes along the new rail.

ALTHOUGH COMPRESSED AIR HAMMERS are used to drive track spikes, they first must be set by hand as this group is doing.

WORKMEN TIGHTEN NUTS holding angle bars an with power wrench. This is one of the final oper in laying the new rail.

erville, Texas; others at Wellington, Kansas; Albuquerque, New Mexico, and National City, California.

After the ties are thoroughly dry—the seasoning process lasting from five to eighteen months—the ties are shunted into the treating plant where the creosote mixture is applied under tremendous pressure. The ties remain enclosed in a vessel from five to twelve hours, depending on the kind and density of the wood, every effort being made to reach the heart of each timber. Even so, complete penetration is not always possible.



AN IMPORTANT COG

Many of our Mexican section men are unable to speak English and that's where Jose A. Contreras comes in. He's the official interpreter of a section gang on the Missouri Division and transmits the boss's orders to his fellow-workers.

Although they are ready as soon as treated, ties are generally stored at least sixty days before they are distributed and put to use. Before being treated they are dressed for tie plates and bored for spikes. These holes are small and are intended largely as guides to show where the spikes should be placed. Whenever it is necessary to cut treated ties, or bore additional holes in them, the disturbed portion must be treated with a hot preservative and the former holes sealed. Marks at one end indicate the type of wood, length of the tie, and the weight of rail for which the tie is bored. On the opposite end are shown the location of the treating plant, and the class and year of treatment. When ties are inserted in the track, a dating nail is driven into each of them. This shows how long the ties have been in use.

While the new standard of high speed main line track calls for ties nine feet long, nine inches wide and seven inches thick, a larger number of eight-foot ties are in use and still in wide demand for secondary main line and other track. These former standard ties are eight to nine inches wide and six to seven inches thick, depending largely on whether they are hewn or sawn, the hewn ties running to slightly more bulk. Switch ties are considerably longer than those used in regular track, varying in length according to the need.

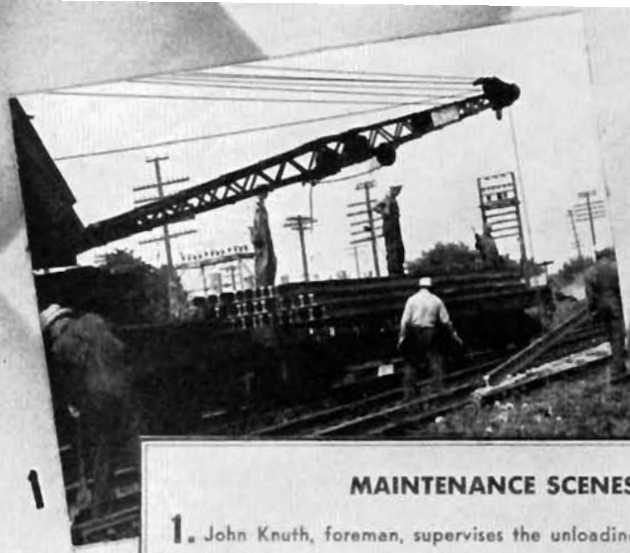
Since ties, aside from labor, represent the largest maintenance expense of a railroad, the Santa Fe has always been a leader in wood preserving methods, and its four treating plants are conducted on the highest scientific basis known to the chemical engineering world. Maintained in connection with this activity are 450 miles of test track where ties are carefully inspected every year. Results of this study have an important bearing on treating operations.

Track and Ballast

All main line track and many of the important branches are ballasted, the kind of ballast depending largely upon the source of supply. While among the materials commonly used are cinders, chats, oyster shell, gravel, volcanic ash and iron slag, crushed rock — the chips of stone—is considered superior, and, therefore, is used wherever possible.

In standard practice, ballast is deposited six to ten inches under the bottom of the ties, even twelve inches in places where the ground is soft or poorly drained. Purpose is to protect the ties by facilitating drainage, hold them more firmly in place, and to add to the stability of the roadbed. Ballast is also used in decking a certain type of bridge.

In ordinary repair work, ballast is tamped into position with shovels, but in the case of new track it is spread over the entire surface and allowed to settle as the track is lifted from the ground, and the tamping completed with air guns. Any type of ballast has a tendency to pulverize under the heavy pounding of trains and must be replaced at intervals. Ballast also is affected by weather conditions, particularly moisture, and in times of floods or high water some is washed away, although every effort is made to prevent waste.



MAINTENANCE SCENES ON EASTERN LINES

1. John Knuth, foreman, supervises the unloading of rail at Toluca, Ill.

2. Unloading rail fastenings and tie plates.

3. Middle Division section gang working on track near Ellinor, Kan.

4. Method of applying rail anchors on the Illinois Division.

5. Surfacing gang trowels ballast under ties. The trowel consists of a hopper with a long thin trough which feeds ballast under the raised track.

6. General Foreman M. C. Woodward supervises rebuilding of freight house at Great Bend, Kan., recently destroyed by fire.

Because dust and dirt hold moisture and encourage the growth of grass and weeds, it is often necessary to clean ballast and put it back to use. This is carried on either with ballast forks or a mechanical device, usually during dry weather when it is easy to remove all foreign substances. The supplying and handling of ballast is an expensive part of railroad construction and maintenance. Fortunately for the Santa Fe, much of the desirable material is available in its own territory.

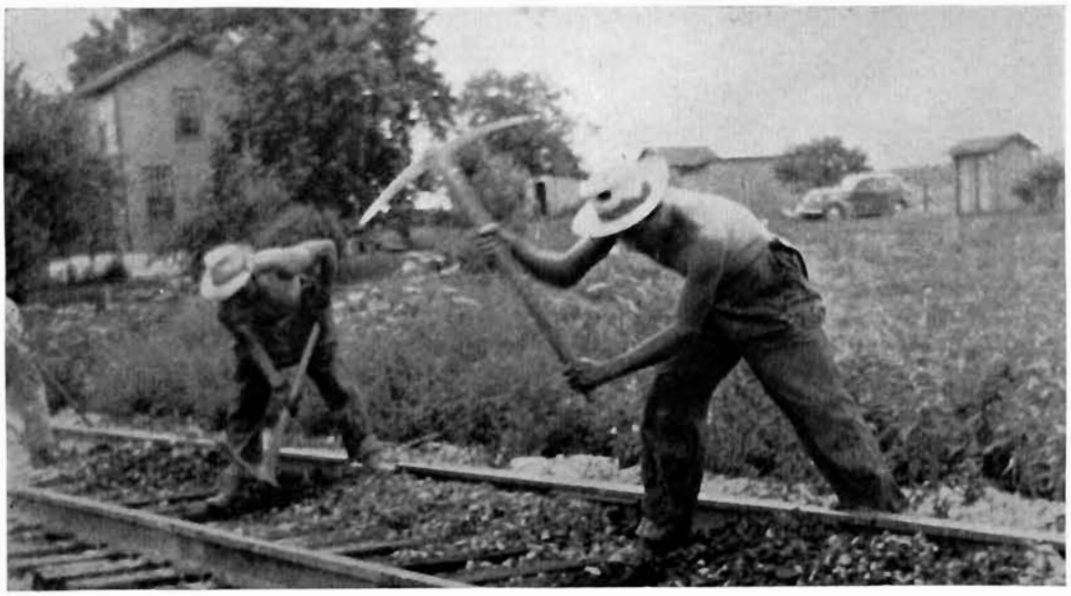
New Track Construction

After surveys have been made by the engineering department, the first step in building new track is to prepare the subgrade and construct cuts and fills of standard width. This work was formerly done well in advance to allow the roadbed to settle; now sheep-foot rollers are used to tamp the fills in layers as constructed, and also to consolidate the base of cuts. Rails, ties, plates, spikes, bolts and other fastenings are then distributed. Since virtually all construction in the present era consists of extensions or additional double trackage, existing facilities permit much of this work to be accomplished with work trains. In case of new or original line, work trains deliver the material as construction proceeds but more manual labor is involved in handling it.

Distribution of material per mile calls for an average of 271 39-foot rails, 3,250 to 3,520 ties, 6,500 to 7,040 tie plates, 542 angle bars, 1,084 bolts, and from 13,000 to 14,080 spikes. Spikes are handled and delivered in wood kegs at the rate of approximately fifty-seven kegs to the mile. This refers to what are known as line spikes, or those that are driven square and snug against the rail, usually four to a tie in ordinary track; more in high speed main line. Anchor spikes double the total; however, these are used only on heavy duty main line, curves, switch turnouts and at other crucial points.

Rails are unloaded from flat or coal cars by derrick, and must be dropped, both ends simultaneously, on an even surface to prevent damage. Ties are piled on the ground by hand, care being used not to splinter or otherwise mar the wood fiber. When extra ties are stored on the right of way, they are neatly piled and covered with several inches of dirt as a precaution against fire or excessive checking. Ties must not be placed where they will come in contact with water or obstruct drainage, and the piles should be at least fifty feet apart. Handling of rail and ties is much the same, whether intended for a new project or renewal purposes.

After fastenings have been distributed along the right of way, the construction of track is taken over by a large crew of men known as a steel gang. Ties are placed on the roadbed, 10¾ inches apart, averaging

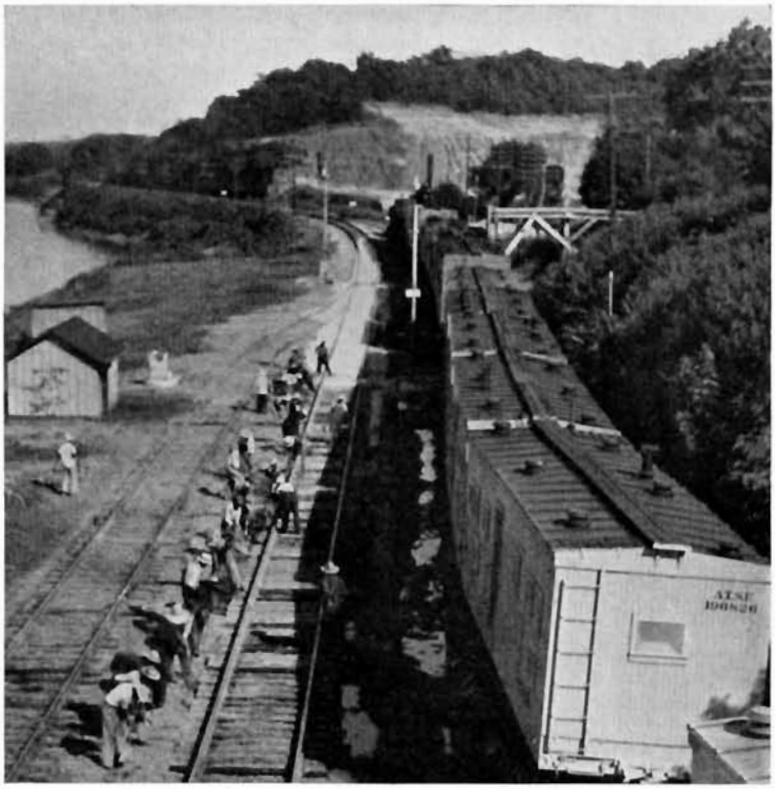


EVERYTHING IS SHIPSHAPE ON THE MISSOURI DIVISION

Keeping the Santa Fe's tracks in proper repair is one continuous job and goes on day after day. These employees are working on our track on the Missouri Division. The cozy home and outbuildings in the background are occupied by the foreman of this section gang.

twenty inches from center to center, requiring 24, 25 or 26 ties to each 39-foot rail, depending on the size of the ties. Then come the tie plates which are attached to the ties by outside line spikes. These spikes are inserted in holes bored for that purpose and serve as a guide for the first rail. After the gauge of 4 feet, 8½ inches has been established, line spikes are driven on the outside of the other rail.

Both rails are now in place, having been swung into position by a power crane, and full spiking proceeds with the aid of air guns. While the number of spikes varies according to type of construction, modern high speed track calls for six to eight line spikes and four anchor spikes per tie. This requires eight-hole plates to permit staggering of the spikes, while in ordinary track, four-hole plates are used. Rail joints are bolted together with angle bars, proper allowance for expansion being made as determined by the temperature of the rail. No rail is laid when the temperature is below zero.



BIRD'S-EYE VIEW OF MEN AT WORK
Here's an entire surfacing gang near Lecompton, Kan., with a string of camp cars shown on the siding

With all rail and tie work completed, the new track is ready for its first consignment of ballast, which is delivered by dump cars and spread to the top of the rails. The track is then lifted five inches with power jacks, and the ballast shovel-tamped under the ties. This operation is repeated, and where necessary a third application of ballast is made. The track is then permitted to carry traffic for a period of thirty to sixty days, with trains traveling at slow speed, after which the ballast is air-tamped and the track given a final surfacing and dressing. Where eight-foot ties are used, the ballast must be thoroughly tamped from the end to fifteen inches inside of the rail base; nineteen inches where nine-foot ties are used. After the final dressing, the track is ready for regular service but speed of trains is usually restricted for some time.

Track Maintenance

Division engineers are responsible for the maintenance of way and structures on their respective divisions. Directly under them are roadmasters and general bridge and building foremen. Roadmasters are in charge of section crews, directed by a foreman, who look after all phases of track repair and maintenance. General bridge and building foremen have jurisdiction over bridge, carpenter, paint and water service gangs. In most instances he bears the title of general bridge, building and water service foreman; in others, where operations make the work unusually heavy, a separate water service division is maintained, but within the same department.

Roadmasters make frequent trips over their districts and all track is inspected daily by section men and their supervisors, also at certain intervals by higher officials. When the need for ordinary repairs is reported, the foreman of that particular section and his men usually take care of the matter the following day, or as soon as pos-

sible. In cases of emergency, however, section crews spring quickly into action and every effort is made to protect traffic until repairs can be made. These men are especially alert to danger during stormy or inclement weather.

Section men, through their roadmaster and foreman, are responsible for the safety

NICE FOOTWORK!
Track maintenance not only demands a strong back but it requires "know how," too. These workers on the Terminal Division in California demonstrate the proper method of shovel-tamping ballast under the ties.

and maintenance of the track and roadbed in territory assigned to them. Whenever the track is obstructed or damaged, it is their duty to see to it that it is cleared and opened with the shortest possible delay. They must constantly keep a sharp lookout for possible defects, and in making repairs must be on guard for the protection of trains as well as themselves, safety being of first importance at all times. In addition to the track, section men must maintain cattle guards, crossings, roadway signs, right of way fences, as well as drainage of the roadbed.

An important duty of section crews during the summer time is the destruction of weeds by the use of mowing machines, heat, steam or chemical. Spraying with chemical is the most commonly used method at present. There is a scarcity of distillate for burners which sear the weeds with a hot flame, and the practice of scalding with steam, which calls for a boiler, virtually has been abandoned. This work is carried on with mechanical devices which are operated like small motor cars, and all vegetable growth is eliminated a distance of from eighteen to twenty-four inches on either side of the track. Regular mowing machines are used on the remainder of the right of way.

Weeds, grass and brush are destroyed, not only because they are an obstruction but because they create shade and dampness which foul ballast, corrode metal and cause ties to rot. Section men must see that bridges, trestles and other structures are kept free of weeds, trash and any other accumulation of material that creates a fire hazard. Overhanging trees, rock or earth that may slide call for immediate attention; buildings, station grounds and other premises must be kept neat, tidy and in sanitary condition. Not the least of a section man's job is driving livestock from the right of way and closing gates.

Because of the disastrous effects of water, section crews make every effort to keep the track and roadbed properly drained. Ditches are provided to divert water from the roadbed, and it is often necessary to install tile drainage systems in cuts where moisture seeps in from the sides. These channels must be kept open at all times, especially following sudden rains; also during quick thaws after a heavy snow storm, so that the water can make a hasty retreat towards a natural passageway.

Section men formerly used old-fashioned pump handle cars to transport them over their districts. This meant manual labor in getting to and from work, besides these cars were small and would not accommodate more than six men, four of whom were required to do the pumping. Now they use motor cars which are considerably larger. Crews are provided with tools which must be accounted for by the foreman. The latter holds frequent conferences with his men to outline work to be done and to see that all instructions are understood, with emphasis on safety. New employees are carefully trained in this manner.

Bridges and Buildings

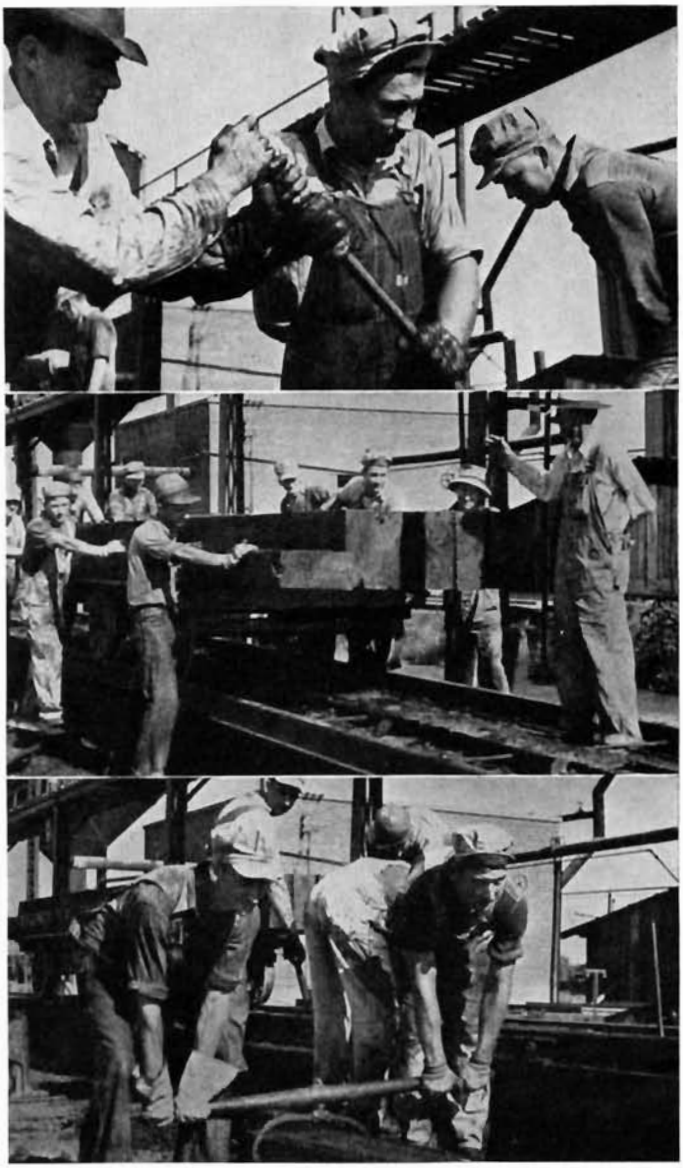
The general foreman of bridge, building and water service has direct charge of maintaining all bridges, trestles, viaducts, culverts and tunnels, also all buildings, including standard depots, freight depots, platforms and loading docks, shops, roundhouses, turntables, car sheds, switch and bridge shanties, yard offices, stockyards, agents' cottages, section houses, bunk houses for laborers, section fences, coal chutes and water and oil facilities. Under him are bridge and building foremen, paint foremen, bridge inspectors, water service foremen and fuel foremen each with crews of men necessary to maintain all bridges and building facilities. The general foreman must see that his foremen are provided

with tools and materials and that new employees are properly instructed in both practical and safety rules before they are assigned to their respective tasks.

While all steel bridges are constructed by a system steel bridge gang, such bridges, except in the case of heavy or unusual repairs, are maintained by the bridge and building service department of each division, which has supervision over all other bridge structures, including trestles, viaducts, culverts, tunnels, and necessary piers and abutments. Before any bridge is built, engineers scan previous weather records, check high water marks and survey the water shed for the purpose of determining the size of the outlet, as well as the acreage likely to be affected in the event the flow of water is impeded.

With this information, engineers decide upon the size, height and type of bridge required, ranging from metal, concrete, and wood structures, to culverts, trestles and open steel spans supported by masonry piers and abutments. Aside from the larger steel bridges, all main line bridges are ballast decked as a precaution against fire. Most of these bridges are supported with timbers which have been treated with creosote the same as ties. Known as pile bridges, they are cheaper than steel or concrete and are almost as durable. Trestles are constructed in a similar manner, heavy hammers—some weighing as much as 3,000 pounds—being used to drive the piling far into the ground. When the constant deposit of silt causes the bed of a stream to rise, it is necessary to raise bridges accordingly. Steel jetties are used to protect bridges and to prevent streams from changing their course.

Probably no other feature is more important to safe railroad operation than the construction and maintenance of bridges and buildings. Like other portions of the track, bridges are inspected almost daily, either by the bridge foreman or his inspectors, and the larger bridges are carefully guarded, especially during the present emergency. The general foreman also frequently examines all structures that he may have full knowledge of their condition. When damage or defects of any kind are discovered, repairs are made quickly and in such a manner as to avoid delay of trains. Here, as in many other phases of main-



EASTERN DIVISION B. AND B. GANG

Left to right, top—Lewis Jones, Marvin Branson and Lee Welch renew supports for rails in oil unloading rack in the Emporia yards. Center—Albert Shaw, foreman, supervises repair work on oil loading rack. Bottom—Carrol Cozad, left, and Edward Hellman show how easy it is to move one of the supports with the aid of a lifting bar.

TRACK MAINTENANCE ON COAST LINES IS

1. Extra gang surfaces road bed near Ballico, Cal.

2. J. H. Bell, roadmaster, decides an old tie must be replaced and explains reason why to workman.

3. Spikes are pulled and ballast cleaned out preparatory to removing old tie.

4. Using a special tool, track worker takes out old tie.

5. New eight-foot creosoted tie, good for 25 to 30 years' service, is slid under rails.

6. Jacking up rail in order to tamp new ballast under ties and hold them in place.

REPRESENTATIVE OF WORK ON ENTIRE SYSTEM

7. Ballast is tamped between ties with air hammers.

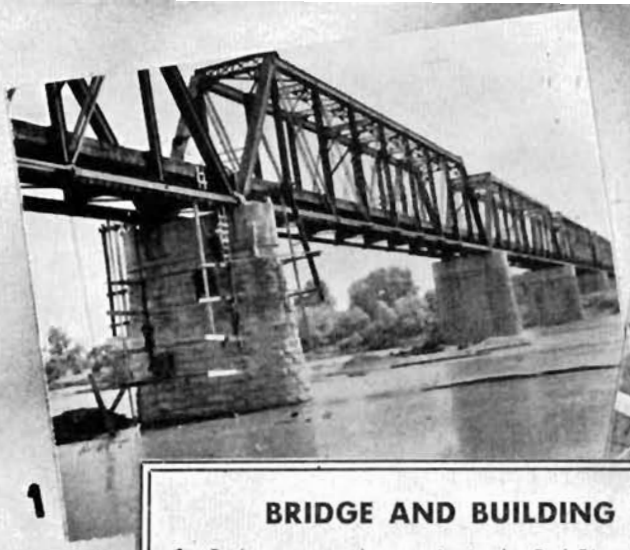
8. Oxy-acetalene tanks, used by track welders, are placed at convenient points along right of way.

9. After track ends are welded, grinding crew finishes off weld, smoothing it down to a tolerance of 1/100 of an inch.

10. Following welding and grinding operations, a new slot is cut between rails to allow for expansion and contraction.

11. Roadmaster Bell checks accuracy of weld and grind job.

12. A cleaning up gang shovels ballast at crossing.



BRIDGE AND BUILDING WORK ON GULF LINES

1. Bridge gang makes repairs to the Red River bridge connecting Texas and Oklahoma on the main line near Gainesville, Tex.

2. Cap rock is stabilized and steel tied preparatory to pouring 15-inch concrete encasement on Pier No. 1 of the Red River bridge.

3. Constructing cofferdam to be used in holding back water, enabling workmen to repair that part of bridge pier which normally is below the water level.

4. On another section of the Gulf Lines, near Bangs, Tex., a bridge is raised with hydraulic jacks, in connection with application of an eight-inch rock ballast section to the track.

5. Bridge and building gang install a triple 3x4x38-foot creosote drain box at bridge 31-A between Alvin and Rosenberg, Tex.

6. Grade over bridge near Ardmore, Okla., is lowered by surfacing gang.

tenance, the duties of bridge and section men overlap, as inspections include all parts of the railroad and all such employees are charged with the single responsibility of keeping the line open and traffic moving safely at all times. All property is inspected at regular intervals by superintendents, accompanied by division engineers and other officials. Such inspections are not only for the purpose of ascertaining general conditions but to consider improvements and betterments.

Standard depots and other buildings are constructed and maintained by carpenters and other workmen under the direction of the general bridge and building foreman. These crews, usually in groups of from six to ten men each, also maintain platforms and loading docks, turntables, car sheds, stockyards, whistling signs for stations and highways, bridge number boards, mile post markers, curve markers, wing fences and road planking at all public highways, water and fuel facilities. Turntables are inspected and greased an average of once a year. Paint crews contribute their part of the maintenance program by operating, so far as possible, on the outside during the summer; inside during the winter.

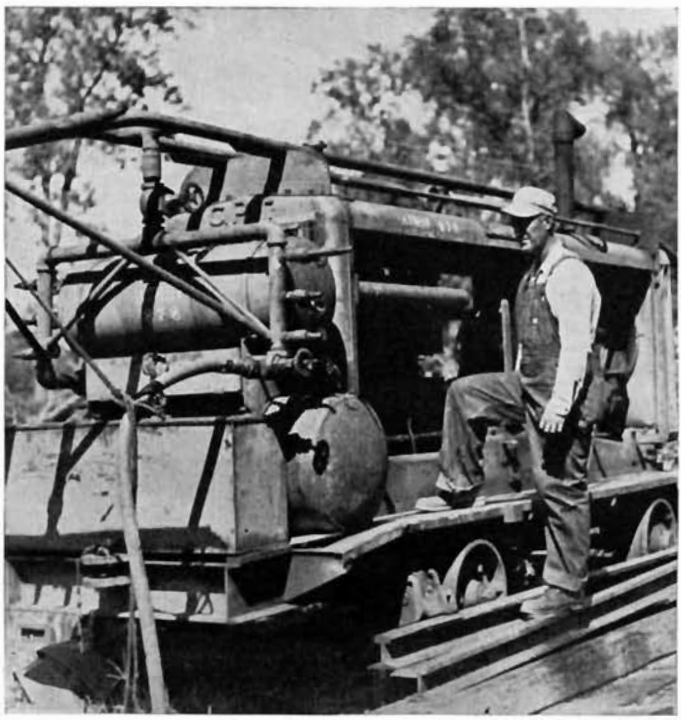
Water service foremen, who are also members of the general bridge and building foreman's staff, have immediate jurisdiction over water and oil pumping and treating plants, including wells, reservoirs, artificial lakes, tanks, boilers, motors, pumps, water and oil cranes, pipe lines and everything incidental to the supply of water and oil for locomotitve use. Water cranes are constantly being enlarged to save time, many locomotives now having a water carrying capacity of 15,000 to 20,000 gallons. The water service foreman is responsible for the maintenance of heating plants, also the water supply in buildings and yards. He has the assistance of pumpers at well and treating plants, and that of a fuel foreman who is in charge of coal chutes and the supply of coal and oil.

Safety the First Rule

Since a large number of the reportable personal injuries, as well as a dominant share of the fatalities, among Santa Fe employees are contributed by the maintenance of way and bridge and building departments, safety is of prime importance in all phases of construction and maintenance; in fact, it is the first rule in the book. The Santa Fe has approximately 55,000 employees, 21 per cent of whom, roughly speaking, make up these forces. In 1942, 29.7 per cent of the fatalities in the Santa Fe family occurred in these departments, and they also were charged with 27 per cent of all reportable personal injuries.

Because of this and past experiences, the company is constantly preaching the gospel of safety to these workers. Its educational campaign is built around four safety meetings annually on each division. These meetings are in charge of competent supervisors and are held at various points in order to promote the greatest possible attendance. In addition, there are a similar number of maintenance of way meetings at which the matter of safety always is a chief topic of discussion. Carefully prepared literature is used effectively in this work.

Employees are carefully trained and educated in the proper handling of material, such as ties and rails, to avoid crushed hands and fingers; also in the correct use



SUPERLATIVE AIR POWER

John Allen, machine operator on extra gang No. 8, tends the big compressor which supplies power for the air ballast tampers on surfacing work at Lecompton, Kan.

of spike claw bars and other tools to prevent similar injuries. As track jacks are large enough to cause a derailment, these tools must be used at the side of the track to eliminate any chance of their being left between the rails. These jacks have a capacity lift of fifteen tons, and it is important that the working mechanism be kept free of dirt particles and in proper condition, otherwise a jack may trip unexpectedly under heavy load and injure the operator. Power drive track tools, such as adzers, spike drivers, tampers and power picks, call for special training and supervision by the foreman in charge. Adzers, which are used to trim ties for tie plates, revolve in a circular manner and are too sharp and dangerous to be handled by amateurs. Operators of these tools usually wear shin guards as protection against flying objects. For the same reason, men cutting rails with chisels, wear goggles to protect their eyes.

RE-SURFACING GANG, WHITE EAGLE

Top — Using pneumatic tampers, track workers re-surface and renew ballast at White Eagle, Okla., where double track lines merge. Center—Special forks screen and clean ballast before it is tamped between ties. Bottom—Machines at left are "crawler" type compressors which supply power for pneumatic tampers.

Members of track gangs are divided into groups or spaced apart to avoid being struck with their own tools. Safe scaffolds are a matter of first consideration in bridge and building work.

The great majority of Santa Fe employees complete each year's work without loss of time due to personal injury, a feat accomplished through general observance of safety rules and the exercise of ordinary care and caution. While great credit is due to the company's educational program and to the men themselves, much of the responsibility rests with the foreman of each job in issuing instructions as to safe methods and seeing to it personally that they are carried out. His first duty, in line with the company's general policy, is to make sure that his men are given a safe place in which to work, and provide them with standard tools that are in good condition. Defective tools are quickly discarded. Next, the foreman should see that all employees are conversant with the rules of safety, taking time to discuss them with his gang for the purpose of eliminating any unsafe practices. Whether an injury is slight or serious, an accident is notice that something was wrong and the foreman's investigation and treatment must fit the case.

One of the greatest contributions to the accident column comes through the use and operation of work trains. Foremen must give close supervision to the handling of such trains and the manipulation of cars carrying rail, ties, ballast and other material. It is important that the foreman instruct work train employees in affording proper flag protection against other trains, also that they understand how to light fusees, place torpedoes and that they proceed away from such obstructions a safe distance.

Each foreman is provided with a book of rules, current time-tables, and a standard watch in order that he may protect his out-

fit from passing trains, and must be on the alert at all times regardless of schedules and previous orders. Notice of approaching trains must be given sufficiently in advance to permit workmen to clear the track and remain a safe distance away to avoid accident. Men are especially instructed not to attempt to get on or off moving equipment. Motor cars can come within the same category as work trains, and there is the additional hazard of removing and putting them back on the track. Largely because of the grade crossing danger, the speed of motor cars is restricted to a maximum of twenty-five miles an hour.

In addition to instruction in safety matters, all employees in construction work receive a certain amount of training in physical education better to fit them for their various tasks. For instance, in the lifting of heavy objects they are taught to use the natural laws of power and gravity and to adopt the power stance to avoid unnecessary strain to their backs and muscles. They also are encouraged to consume an additional amount of salt, both in their food and drinking water, to replace the salt lost through excessive perspiration during the summer months. It has been found that a deficiency in the supply of salt in the body has a tendency to leave a man in a weakened condition, destroy his mental alertness and make him more prone to accidents and human failure.

Extra track and bridge gangs travel and live in specially built cars—bunk cars, dining and kitchen cars, tool and material cars, and in many cases they are provided with a recreation car and shower bath equipment. These cars, as well as the work camp, are closely supervised and maintained in the best possible sanitary condition.

A Great Drama of Life

As guardians of the tracks, bridges and buildings they have built, these men of the construction and maintenance forces are engaged in one of the greatest dramas in our everyday life, and rise to heroic roles when the safety of the railroad is imperiled in time of storm, war or other emergency. Joining them on the alert in the present crisis, which demands that the vital supply lines of the nation must be kept open for the movement of men, food and war material, are members of the special service department, who guard every important bridge, building and other facility on the Santa Fe System Lines.

Any abnormal weather conditions call for rigid inspection of the track and bridges, and in case of severe wind, rain or snow, all members of the maintenance forces go on patrol duty to protect traffic. Bridges, trestles, culverts and other points subject to floods are closely watched, and high water in streams must be reported to the roadmaster and the general foreman of bridges and buildings. Cuts as well as crossings and switches must be kept free of ice and snow. When danger becomes apparent, trains are protected with temporary slow signs or are brought to a standstill until the safety of the track is no longer questionable. When slow signs are used, resume speed signs are placed on the opposite side of the danger point to save further delay.

Thus the men who have converted the bits of steel, the sticks of wood and the chips of stone into a great railroad, preserve and protect it zealously under any and all conditions that passengers and freight may be transported swiftly, safely and on time. It is their contribution to an industry all important to the welfare of the nation.

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