

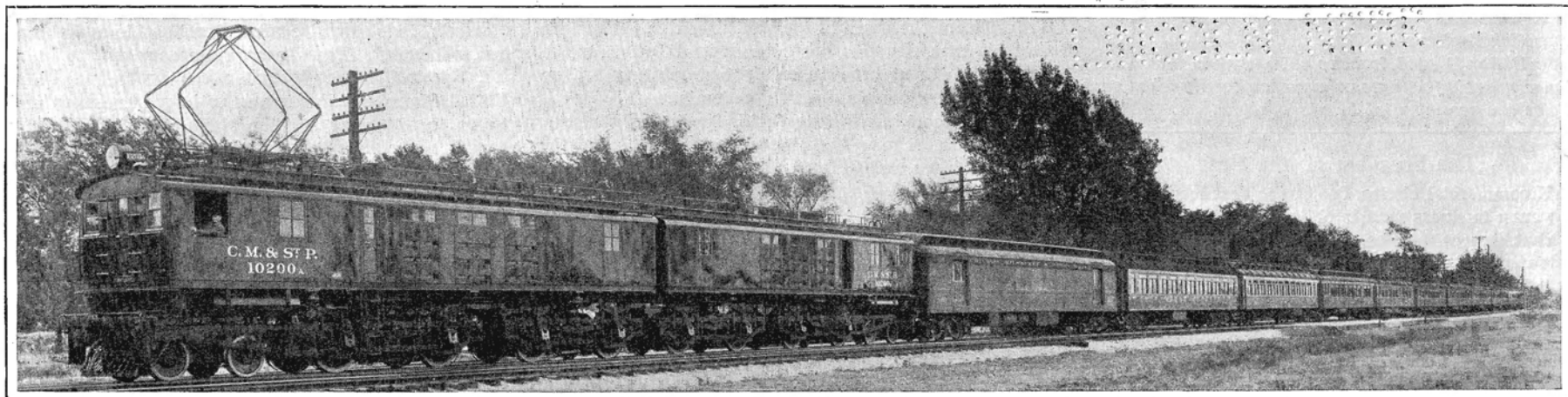
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One of the electric passenger locomotives of the Chicago, Milwaukee & St. Paul Railway, capable of hauling an 800-ton train at 60 miles per hour

Three Thousand-Volt Direct-Current Electric Locomotives

REPRESENTING the last word in the electrification of steam railroad lines, the undertaking of the Chicago, Milwaukee & St. Paul Railway in electrifying 440 miles of its transcontinental system between Harlowton, Montana, and Avery, Idaho, in connection with its through service between Chicago, Milwaukee, St. Paul, Minneapolis and the Pacific north coast, discloses many interesting features. Harlowton is 4,163 feet above sea level, while Avery is at an elevation of 2,494 feet. Two mountain ranges of 6,300 and 5,700 feet, respectively, are crossed by this section of the railroad.

Although the railway placed its initial order for the necessary equipment only in September, 1914, it is announced that the electric locomotives will enter active work some time this month. The overhead construction, which will include 650 miles of single track, has been completed for a distance of more than 200 miles. The 100,000-volt transmission line which is being erected to parallel the electrified tracks has been completed for an equal distance, while the tie-in lines from the 100,000-volt system of the Montana Power Company are ready for service. The trackage now available for train operation includes extensive yards and sidings at

Three Forks, Deer Lodge and Piedmont, and passing tracks at other points. The rail bonding crews have followed the overhead construction gangs, completing the ground circuits.

While the electric locomotives are undoubtedly the most interesting feature of the electrification, nevertheless a few facts concerning the trolley construction and transmission lines are worthy of note.

Wooden poles are used throughout the system, both for cross span and bracket construction. The twin No. 0000 trolley wires are suspended individually and separately from the same steel catenary, and the hangers of one trolley wire are located at points mid span on the other. In the switching yards only one trolley wire is used.

The current for operating the locomotives on the opening stretch of the electrified railroad is derived from Montana water power. This current is sent over the transmission line at a potential of 100,000 volts to the seven substations designed to supply power to the first half of the 440 miles of route. The substations transform the 100,000-volt three-phase alternating current into 3,000-volt direct current through the agency of step-down transformers and rotary converters.

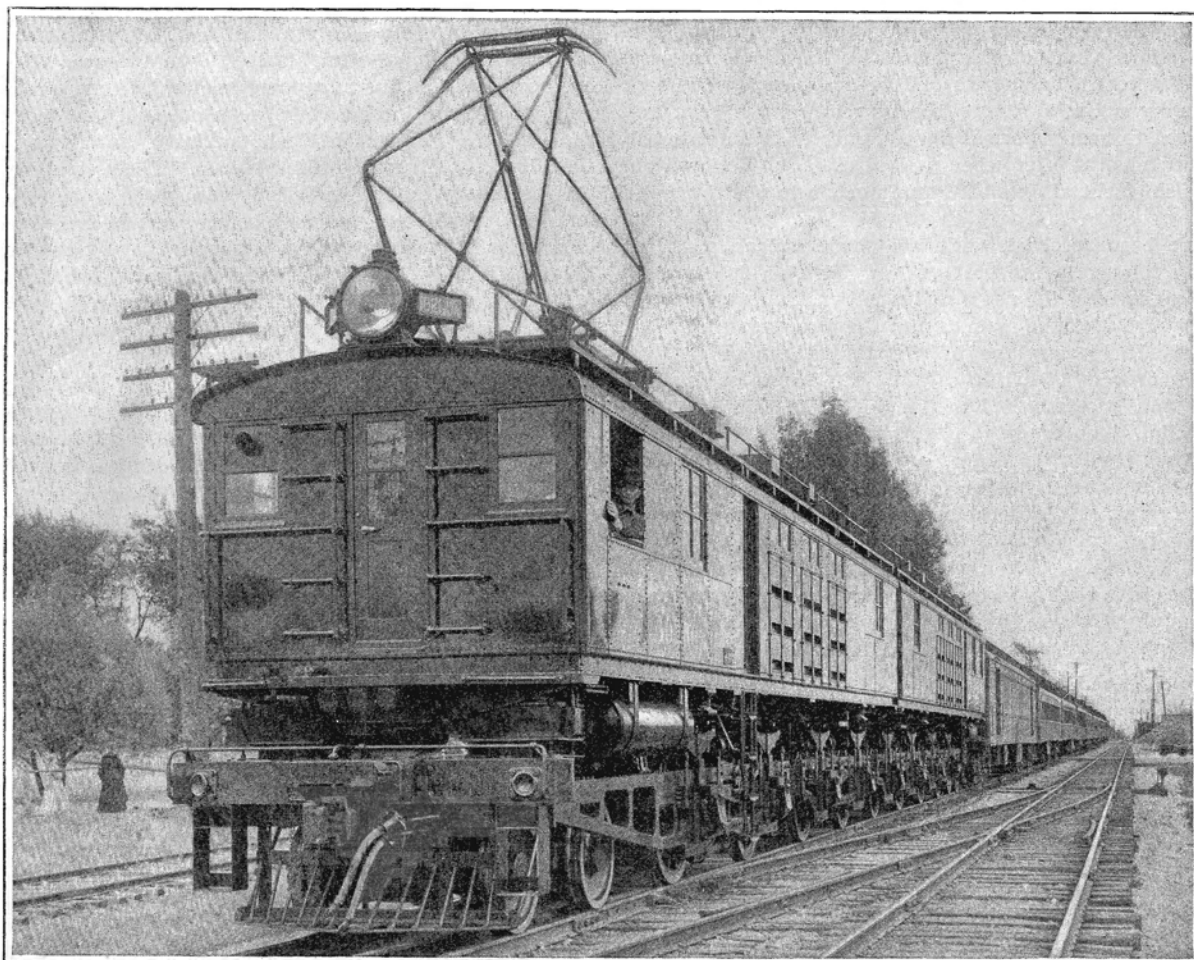
The initial number of electric locomotives for the

railroad will be forty-two, of which twelve will be geared for passenger service and thirty for freight. The locomotives are said to be the most powerful ever built and have a continuous capacity greater than that of any steam or electric locomotive in existence. Although each locomotive weighs but 94 per cent as much as a combined Mallet steam engine and tender, which it is replacing, it has a tonnage rating of 23.5 per cent greater and a speed with drag tonnage of approximately 57.5 to 96.8 per cent greater than the latter.

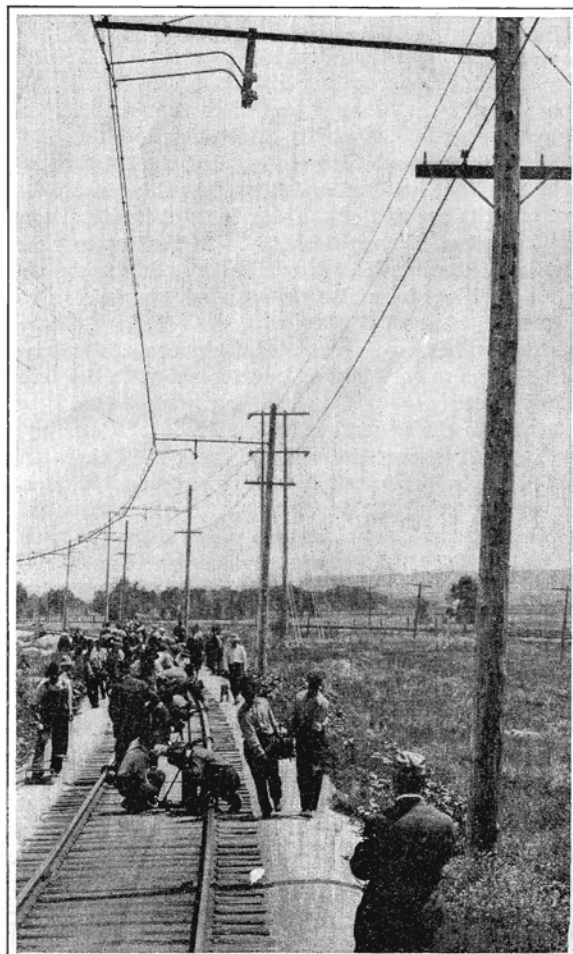
The electric locomotives are each 112 feet 8 inches long, and in reality comprise two distinct machines permanently coupled together and used as a single unit. The capacity of one locomotive is rated at 3,440 horse-power; the entire tractive effort being brought to bear on eight drive wheels, each 52 inches in diameter. In order to save the track from wear and tear by minimizing the vertical and horizontal blows, the drive wheels are fitted with separate motors, individually twin-gearred to each of eight pairs of drivers.

Perhaps the most important feature of the new locomotives is that they are the first direct-current engines to operate on a potential as high as 3,000 volts. Furthermore, on down grades the locomotive

(Concluded on page 411.)



End view of one of the most powerful electric locomotives ever built. It is designed to operate on 3,000 volts direct current



Section of the single-track electrified railway, showing simple overhead construction, and bonding crews at work

...or for an occasional day on the rifle range, and against the local mandate of many trade unions that are antagonistic to the Guard, because the organization is subject to strike duty, or in the face of that most serious obstacle of all, the more or less scornful attitude assumed by many of our so-called good citizens.

As a company commander, I have had to contend with each of these obstacles, and know that they exist not only as isolated cases, but are prevalent to a large extent throughout the whole country, and their harmful influence cannot be overestimated.

It is manifestly impossible for a company commander of the National Guard to maintain the high standard of discipline obtained in the regular army, when he has to persuade men to join his company in the face of the difficulties imposed by such conditions. In addition to these difficulties, the niggardly appropriations made by most states make it necessary for these officers personally to defray the many little items of expense, incident to maintaining a reasonably efficient organization.

Inasmuch as no encouragement is received by the recruit from his employer or his fellow citizens, and he receives no drill pay for his service, some inducement must be made to induce him to enlist, in addition to the patriotic impulse that most of our young men normally possess. In some states, in the large cities, adequate armories with club and athletic features are provided; but in most cities these features are lacking and it devolves upon the company commanders to provide them.

No matter what legislation is passed by Congress, whether it be a reorganization of the present Guard or a wholly new scheme, we shall never succeed in creating an adequate volunteer citizen soldiery until we have first created a condition that will make service in that body popular. When the average young American learns to feel toward the Guard as he does toward his Alma Mater, and toward his fellow Guardsmen as he does the fellow members of his "Frat," we will have a citizen soldiery that will not only be efficient, but one of which we may justly feel proud.

I once asked a young Englishman if he had had any military training. With visible pride he replied—"Yes, in the King's Own." When we establish and maintain a Navy reasonable in size and properly balanced and efficient as our Navy men know how to make it; when we have created a modest but well equipped Regular Army, with a Reserve into which to graduate our trained men, and when we have created a mental attitude toward service in our Citizen soldiery that will enable our young men to say with pride that they have served in "Uncle Sam's Own," we will have solved the problem of National Defense.

These United States do not belong to the present generation; they did not belong to the last, nor will they belong to the next. Our country and all it stands for constitute a sacred trust, with each succeeding generation as trustees. We are obligated by the highest sense of duty to safeguard those institutions against every possible danger.

...staff of the army and the General staff of the Navy, there can be no question that an adequate National Guard is of vital importance to a comprehensive plan of defense. This cannot be obtained without more cooperation on the part of the employers of the men who enlist in that organization. As a means of bringing this about, the National Security League has not only placed the matter before the large National corporations, as referred to in General Logan's letter, but has appealed to over fifteen thousand firms throughout the country, asking them also to do their part in this cause.

Three Thousand-Volt Direct-Current Electric Locomotive

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controls the train by reversing the current, which changes the motors into generators and sends back into the line about 30 per cent of the energy used in hauling a train up grade. This results in a uniform speed on all down grades and makes it unnecessary to resort to the air brakes except in cases of emergency. Not only is the train more uniformly controlled by this method, but all danger from worn brake-shoes or overheated wheels is eliminated, not to mention the direct economy effected.

The electric locomotives operate at their best efficiency in the coldest weather—quite the opposite to steam locomotives, with which trouble is experienced in maintaining the steam under like conditions. They require inspection only once in every 2,000 miles of travel, whereas the steam locomotives must be overhauled at the end of each division, or after every run of 100 or 125 miles. Another advantage in favor of the electric locomotive over its steam competitor is that the latter consumes 80 per cent of the fuel used in actual service while standing at division points, while the electric locomotive consumes power only when in motion.

The passenger locomotives on the new electrified line are geared to haul 800 tons at 60 miles an hour, while the freight locomotives will haul 2,500 tons on a one per cent grade at a speed of 16 miles per hour. When two locomotives are used to haul a train, about the same speeds can be maintained on a two per cent grade.

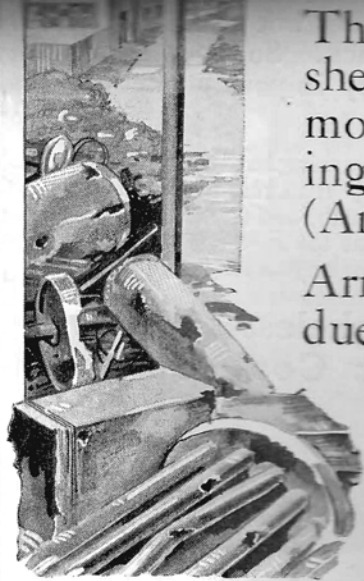
Owing to the greater speed of the electric locomotives over the huge Mallet steam engines which they are replacing, it is believed by the railroad company that the same results will be achieved as though the line had been double tracked over the mountain division. Present plans of operation call for the general use of an electric locomotive at each end of a train on up grades approximately 35 miles long over the electrified section of the road, while on down grades only the head engine will do the regenerative braking.

Penetration of Bullets

(Continued from page 404)

inch thickness, but toughened by the addition of vanadium, etc., and heat treated into the bargain. There is a huge difference in the ability of steels to resist bullet penetration.

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This shows results of lap weld

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