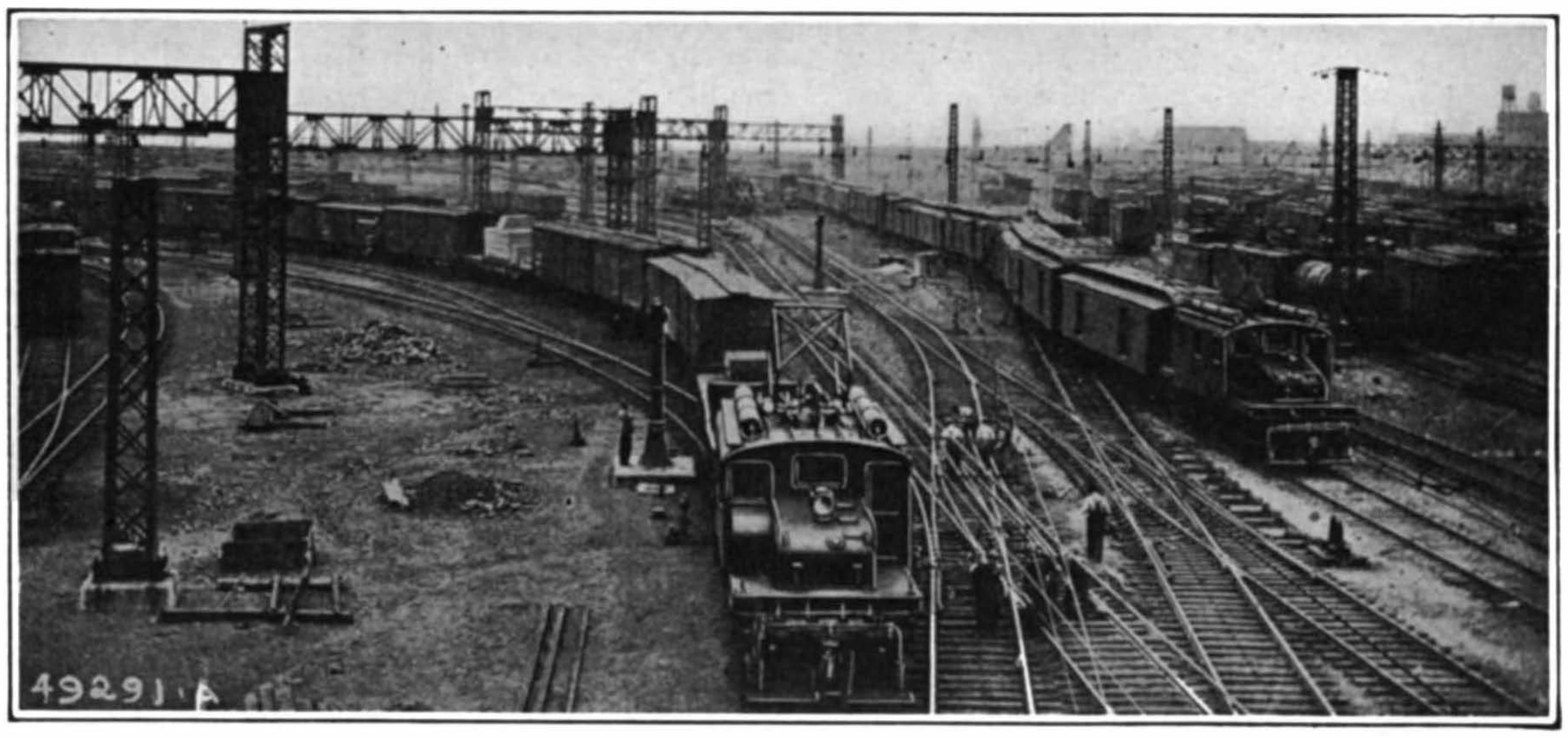
The Problems of Electrification

The Struggle Toward a Standard, and What Is Likely to Come of It

By Robert G. Skerrett



The electric locomotive demonstrating its greater economy and efficiency in terminal yards

To tell the average American that we have outgrown steam traction will probably shock him as he casually judges the apparent efficiency of the speeding express, or comes upon an occasional freight train in the course of his daily habit of life. Yet the fact remains that such is the status of our land transportation system when the aggregate movement of cars and tonnage is considered. Our national well-being is contingent upon an improvement in this matter; and it appears that improvement is possible only through the substitution of electricity for steam as a motive power. Mr. Skerrett tells us in this article something of the manner in which this substitution must be effected.—THE EDITOR.

ACCORDING to the latest official figures, we have upon our 230,000 miles of steam lines a matter of substantially 2,500,000 freight cars and quite 30,000 freight locomotives, not to mention 15,000 engines at terminals for switching service. Offhand, this array of rolling stock might seem ample for our needs, but an analysis of what it has been doing recently will make it clear that there is something radically faulty in performance, especially in view of the many million tons of goods of all sorts that are cluttering stations and warehouses awaiting much-delayed distribution. To be specific: the final report of the United States Railroad Administration reveals that the average miles per freight car per day were about 22; that each loaded car carried as a rule something less than 30 tons; and that fully one-third of the car miles was run without lading. Finally, we find that each freight engine made an average of approximately but 60 miles every twenty-four hours.

One does not have to be versed in higher mathematics to realize that there is a tremendous lack of service or wastage under existing conditions. Why is this the case? What is the logical relief? It is not necessary to reiterate in detail the multiple operative shortcomings of the steam locomotive, but let us sum up a few of them. It seems that one-quarter of the coal mined annually in this country and six per cent of our fuel oil is consumed by the steam engines of our railways, and a good third of those combustibles is sacrificed in what are termed "stand-by losses." Aside from that, the fuel is inefficiently utilized when the locomotives are actually doing work. Further, the distribution of coal for our trunk lines requires a tonnage movement amounting to approximately 20 per cent of the total freight-ton miles that should yield revenue. This is not hard to understand if we recall the fact that there is first the transportation of the fuel from the mine to the coaling station, then its wanderings on the engine tender, and next the trip of the empty coal car back to the colliery. It is authoritatively declared that the tenders of our steam locomotives of all kinds add about 11 per cent to the ton mileage of our roads without bringing in a return.

Plainly, to just the extent in which we may find a way to reduce the ton mileage of railway coal or oil we shall be able to utilize the cars so freed for the carriage of other essential freight. In 1918, our steam lines burned 163,000,000 tons of coal and 45,700,000 barrels of oil. According to Government data, counting an average load of 30 tons, 5,677,000 car trips were needed to deliver the fuel during that year. This arraignment of the steam locomotive would be incomplete if we failed to take into account the handicaps imposed by seasonal and atmospheric conditions as well as the steam tractor's inadequacy when it comes both to mounting and to descending steep grades with heavy trailing loads.

Anyone with a moderate knowledge of the physical geography of the United States must be alive to the fact that the mountainous nature of many sections interferes greatly with rapid movement on the part of both passenger and freight service, but much more so in the case of freight trains. Because of numerous heavy gradients, engineering difficulties, and the expense entailed, the mountain routes are frequently single-track lines and seldom more than double track. Thus, the tide of traffic is slowed down and passed through constricted channels. This would not be so bad if the steam engine could maintain a higher speed when climbing and descending these slopes, but unfortunately the steam locomotive cannot do this. It must materially reduce its load when going up hill in order to pull the train along and, because of its deficient grip upon the rails it often cannot hold safely back the same number of laden cars when sweeping down the opposite incline.

Therefore, we have a reversal of the very action upon which we normally count when we seek to shift from one reservoir to another a given fluid volume by means of a relatively small connecting conduit. That is to say, just where increased velocity is essential on our railways we cannot have it. Every now and then some of our steam roads—and these frequently among our most important trunk lines—have to contend with this bottle-necking, and it is at these points or along these sections that the freight movement is throttled.

The apparent solution of the problem, which is becoming more and more acute from year to year, is the substitution of electric traction. Out west one transcontinental road is pulling trains of 4,000 tons up and down steep mountain slopes and exercising perfect control the while. It is doing this at speeds hitherto unattained under like circumstances, and the schedule is being maintained with remarkable regularity. Not only that, but the oper-

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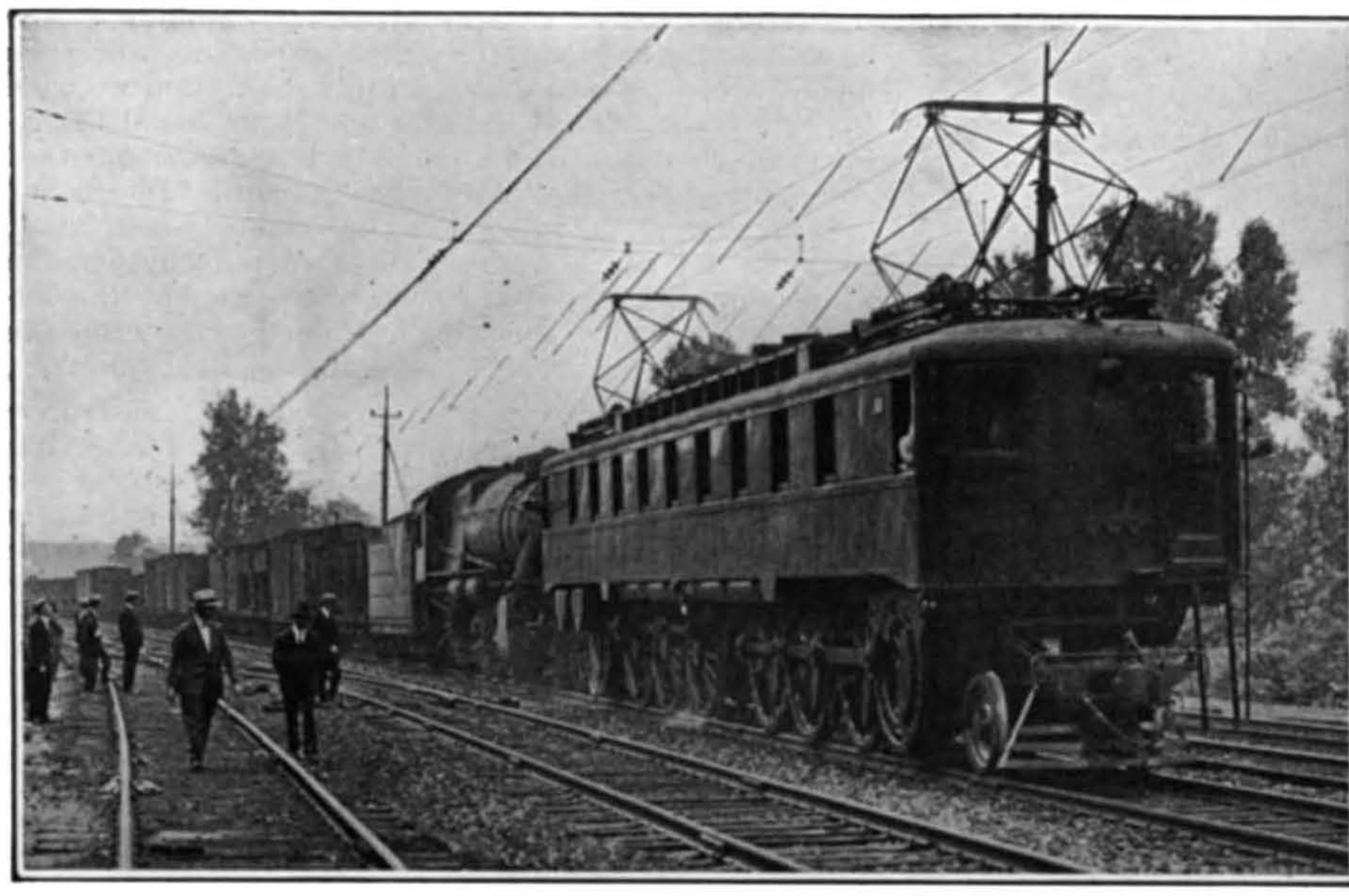

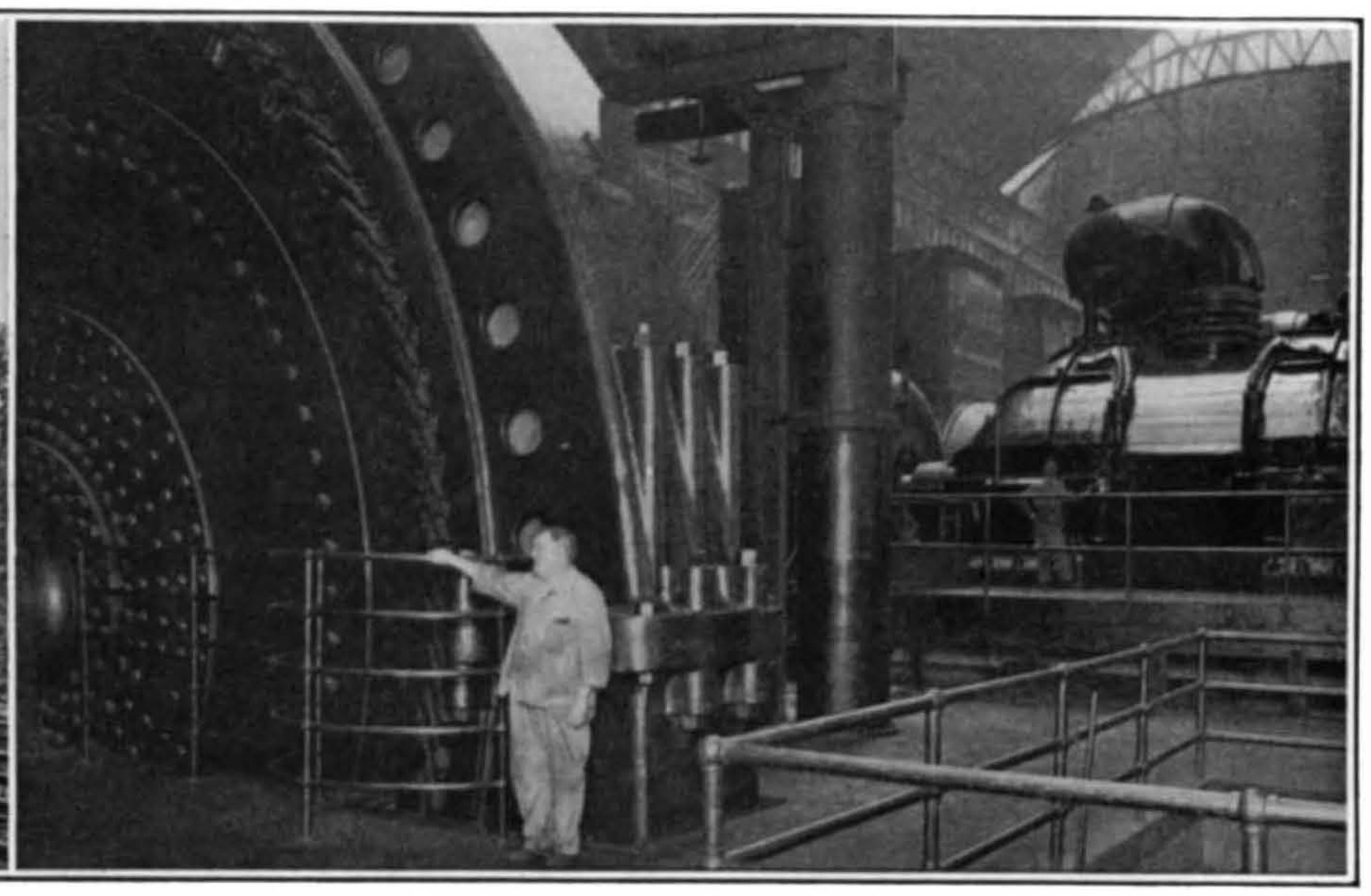

Left: A powerful electric locomotive of special design that has saved the day in speeding up freight traffic on one trunk line. *Right:* In the foreground a big dynamo driven by reciprocating engine; in the middle distance a steam turbo-generator set of like power, much higher efficiency, and far less bulk. Where fuel must be employed for the generation of current, it is units of the latter type that will be relied on in large railroad central stations

Typical units that are making electrification of our railroads a success

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The Problems of Electrification

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ative costs show great economies. Another electrified western line is handling trains of 4,600 tons at a speed 20 per cent higher than was possible with steam traction and a limiting load of 3,500 tons.

Here in the East, down in a mountainous part of West Virginia where there is an extensive movement of coal from local mines, a railway formerly operated entirely by steam, now handles double the capacity on a certain section with 12 electric locomotives where it used to employ 33 great Mallet engines. The grades are extremely heavy, and yet, on the stiffest of these, trains of 3,500 tons are dealt with without trouble, and are moved about 100 per cent faster than when steam locomotives did the work. In fact, in numerous instances throughout the country, it is no uncommon thing to maintain electrified freight speeds of 15 miles or more an hour where formerly steam traction was limited to 6 and 8 miles. Thus we see how entirely feasible it is not only to reduce the bottle-necking condition but, at the same time to increase the loads which can be hauled by a single engine.

As is pretty generally known, several different systems of railroad electrification have been developed, each with its own particular claims to consideration. For the most part the lines so operated are not interrelated, and each typifies a more or less distinct step forward in the art; and as may be imagined each has its advocates. At present three lines focusing in the City of New York are using direct current of 600 volts, distributed by third rail. In effect this is an expansion of trolley practice to the main-line field—the third rail providing a conductor of sufficient volume to handle the heavy low-voltage current. Aside from complicating yard lay-outs and inviting numerous troubles, this arrangement is not suitable for long distances.

For trunk-line work, where the runs are of considerable length, we have naturally had recourse to trolley wires and high-voltage current in the distributive systems, and we have resorted to both direct current as well as single-phase alternating current on the roads concerned. The direct-current service has successively jumped from 1,500 volts to 2,400 volts, and then to 3,000 volts on the greatest electrified stretch in the country. But in order to obtain efficient primary distribution of energy from the power stations, alternating current of 100,000 volts is depended upon. This feeds to seven or more sub-stations along the route, where the alternating current is transformed to direct current of 3,000 volts by means of motor-generator sets installed at these points. As may be imagined, these sub-stations are necessarily complicated and extensive in their equipment.

Single-phase alternating current systems are in service in connection with a number of important roads in the East, where they are handling the varying demands of express and local passenger traffic and dealing efficiently with fast and slow freight on both fairly level and mountainous runs. Instead of motor-generator sets, as in the case of direct-current sub-stations, the transforming work is done by static transformers with no moving parts.

Similarly, where the overhead wires carry a much higher voltage than is needed for the operative motors of the electric locomotive or the multiple-unit train, small static transformers on either the locomotive or the cars meet every requirement. Structurally, they are of extreme simplicity, and besides are automatic in their functioning. High-voltage alternating current can be distributed farther, more efficiently, and by smaller conductors than is practicable in the case of direct current.

For multiple-unit operation, which must inevitably be counted upon to handle local passenger traffic in and out of populous centers, alternating current is preëminently suited; for it makes it feasible to equip every car with its own drive. The multiple-unit train, where every car or every other car is self-impelled, exerts a much augmented tractive effort, so that it can reach full speed in a brief while after a stop. Where high-voltage, direct current is used, on the other hand, the locomotive is relied upon generally to do all of the pulling, and only its driving wheels are tractors. Accordingly, it takes longer to acquire or to resume maximum headway, and the condition of the tracks may interfere with this to such an extent as to impose the hauling of fewer cars.

On mountain sections, where high-voltage alternating-current distribution is provided, and the locomotives are driven by induction motors, the problem of handling heavy freight trains is radically modified for the better because of the uniform pace and good speed which these tractors can maintain both up and down grade. Further, this type of tractor places a minimum burden on the brake installation.

In densely settled areas, railway electrification has occasioned two reflex vexations. Alternating-current systems give rise to a phenomenon known as inductive interference, which is apt to upset the operation of nearby telegraph and telephone lines. This annoyance has been pretty effectually reduced by the proper bonding of the rails so that the return circuit is taken care of in a way to obviate the disturbance of neighboring systems of communication. Inductive interference, like a mischievous boy, promptly betrays its activities in an audible manner. Direct current, however, promotes the electrolysis of underground conduits, etc.; and the extent of its silent, insidious and destructive work is very frequently not detectable until collapse of the pipes, structure, etc., takes place. Then the damage may be of a very costly nature.

It is probable that no one system will be accepted to the exclusion of all others, but when a system is selected for a given railroad the decision should be made only after careful consideration not alone of the problems of that particular line but also of those of its neighbors—in this way achieving as complete a measure of unification as is economically possible.

California's Seaweed Industry

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The process of manufacture is ingenious and interesting in view of the fact that they designed all the machinery and equipment for a purpose entirely new. The whole takes seventy-two hours but operation necessarily is continuous. The leaves and stems of the algæ are used. One of the most clever conceptions in the factory is a battery of four "mortars" or bowls twenty-two inches in diameter and fourteen deep in a solid block of concrete, with corresponding quadruple wooden "pestles"—an adaptation on a modern mechanical scale of the primitive method of grinding. Into these mortars the raw material or dry weed is first placed and in a few minutes it is stamped into a fine mass. The object is to free it of the millions of tiny shells, bits of sand, alkaline deposits and other foreign matter. Then it goes through various tanks and vats, one containing a secret solution for bleaching and the others plain water for washing, after which it is run through a wringer and spread on racks to dry in the California sun. It looks like white moss.

Next it is boiled three to four hours, filtered, distributed in galvanized iron trays four feet long, two wide and three inches deep, and five hours later it comes out jelled, like a large sheet of rubber. In this form it comes to the sharp knives of another wonderful machine, which cuts it into pieces a foot long and two inches square, each intact but sliced lengthwise as are noodles. Having now undergone extreme heat a siege of the opposite character is provided, for it is placed on wooden trays and carried into a great refrigerating room and for ten hours kept at ten degrees below zero. The sticks come out solid ice. They are slowly melted, the water drained off, then put through a forcing machine which flattens each "noodle" into a thin, transparent sheet. Again the California sun is invoked to dry them. Finally they are tied in three-pound sheaves of silvery sheen, and thus they first go into the market.

The factory is also making a superior vegetable isinglass as an experiment and the owner believes he can approach in quality, at low cost, the Russian mineral isinglass now selling for $11.50 a pound. An adhesive plaster, photographic films and other products are included in his plans, which thus far have in nowise been disappointing. Potash, iodine and other by-products of the algæ will be conserved, appliances for that purpose being in course of installation.

Edison's Views on Life and Death

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lions upon millions of entities, and that our body and our mind represent the vote or the voice, whichever you wish to call it, of our entities.

"Now let's see why we must be composed of life entities. Supposing you take a finger print of your thumb, in the conventional manner of the police records. Then burn your thumb sufficiently to destroy the skin. Do you know that after the new skin has formed the finger print of your recovered thumb will be precisely the same as the first one? Yes, absolutely the same, even down to the last line and irregularity. I tried it to make sure. Here is a mystery which has remained unanswered until now.

"Of course, you say it is nature. But what is nature? That seems to me to be such an evasive reply. It means nothing. It is just a subterfuge—a convenient way of shutting off further questioning by merely giving an empty word for an answer. I have never been satisfied with that word 'nature.' Now my answer is that the skin didn't happen to grow that way again by accident. Someone had to plan the new growth and to supervise it to make certain that it would conform in every way with the old skin. You do not know just what that pattern is, and so your brain plays no part in the operation.

"Here is where our life entities come into action. I firmly believe that the life entities rebuild that thumb with consummate care, drawing upon their remarkable memory for all the details.

"Let us consider an analogy, for the sake of making my point more clear to you. Supposing that a man from Mars came to this earth, and his eyes were so much coarser than ours that the smallest thing he could see was the Brooklyn Bridge. He could not see us. Naturally, he might take Brooklyn Bridge for some natural growth, just as we consider grass, sand, minerals and other things as matters of natural development. Supposing that same man from Mars were to destroy the Brooklyn Bridge, and several years later he happened to find a new bridge in precisely the same place and of precisely the same design. Would it seem logical for that man to assume that the bridge simply grew again in the same manner and in the same place? Don't you suppose that the Martian would be compelled to assume that some intelligence and guided effort were behind the rebuilding of the structure he had destroyed?

"That is precisely the stand we should take regarding the life entities. Obviously, the entire matter is one of conjecture. Perhaps the entities in our bodies are ninety-five per cent workers and five per cent directors. At any rate, it is the ensemble of all these entities which gives us our physical form, mental properties, personality, and so on.

"The entities are life, I again repeat.