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Electrical Traction: publication of 1912


Желѣзнодорожное Дѣло

Press Archives
The Journal presents a selection of two articles each of them first appeared in the journal «Railway Business» in 1912.
They demonstrate the interest that was paid more than a century ago towards electrified railways considering technical (choice of electric power supply system, traction current) and economic advantages compared to steam locomotive traction.
The material in some ways echoes the content of the article published in the issue on the development of transport science and the chronology of industrial revolutions.
When reproducing the publication, the style, punctuation, and vocabulary of that time are preserved as much as possible.

A Note on the Comparative Cost of Operation for Electric and Steam Traction

Recently, the question of electrification of railways in general and, in particular, of sections of railways with the most complicated profiles has been raised more and more often. In solving this issue, the main role is played by the cost of operation for steam and electric traction. There are no such experiments on our railway network, and therefore the following article by *Wernekke* from No. 24 of the journal *Zeitung des Vereins Deutscher Eisenbahnverwaltungen* of 1910 is of some interest in this regard.

The railway, connecting by tunnel, under the bottom of the River Mersey, Liverpool with Birkenhead, has existed since 1886 and was served by steam traction. Since 1903 it has been rebuilt for electric traction. The railroad has recently published comparative data on the cost of operation for steam and electric traction.

Trains are in motion daily for 19 hours, and only for 4 hours does traffic stop. Formerly, in the case of steam traction, in certain morning and evening hours, when the traffic increased considerably, as it is the case on all suburban and urban roads, it was necessary to increase the number of trains, but with electric traction, it was sufficient to increase only the composition of trains to meet this increased traffic; when doing this, the previous two, and sometimes three separate trains are assembled into one.

Due to this, during the period of heavy traffic, it became possible to remain with the usual number of trains, which facilitates operation. With steam traction, it was impossible to increase the composition of trains, since steam locomotives would not be able to develop an appropriate traction force; with electric traction, the development of the traction force required for the movement of enlarged trains is not difficult, since the number of engines also increases.

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The text of the archived publication in Russian is published in the first part of the issue.
Текст архивной публикации на русском языке публикуется в первой части данного выпуска.

From the data for the last three years, it is seen that for the movement with electric traction of one ton of cargo over a distance of 8,12 km, with an average speed of 35,8 km/h, it is necessary to spend 1 kg of coal, costing 8,93 marks per ton. With steam traction, having spent 1 kg of coal, costing moreover 16,32 marks per ton, it was possible to develop a force sufficient to move one ton of cargo over a distance of 7,85 km, with an average speed of 28,6 km/h. At the same time, the cost of maintaining this line, as a ratio to t•km, has now decreased from 0,11 to 0,5 pfennig, i.e., by 0.06 pfennig.

Previously, the rails had to be replaced after 32,000,000 tons of cargo had been transported on them, and now they can withstand the passage of up to 47,500,000 tons of cargo.

With the use of electric energy, the cost of 1 t•km significantly decreased, namely: operating costs for maintenance, operation and repair decreased from 1,25 to 0,80 pfennig or by 0,45 pfennig. The total operating costs, except for the interest on the increasing cost with the transition to electric traction, decreased from 1,82 to 1,27 pfennig, i.e., by 0,55 pfennig. If counted together with interest on fixed capital expended and increased as a result of the introduction of electric traction, we get a decrease in total operating costs, which, as indicated above, reached a decrease per t•km from 1,82 pfennig to 0,27 pfennig, so that the total cost per train-kilometre decreased to 1,55 pfennig. The last two figures are of particular importance when compared with each other, since they indicate that, although with the introduction of electric traction on the existing steam railway, fixed capital is greatly increased, and interest costs naturally increase, operating costs are reduced, and in the end electric traction is more profitable than steam one. In favour of the latter is also the fact that it was possible to increase the average speed of trains from 25 to 32 km/h. Previously, traffic on this road was not very active, but with the introduction of electric traction, the number of completed transportations rose from 69 to 108 million tons • km.

Perhaps the increase in traffic had an impact on reducing the costs attributed to the unit of cargo.

Engineer V. A. Sokovich
(*Zheleznodorozhnoe Delo [Rail Business]*, 1912, pp. 55–56).

The current Situation of Electric Traction in Large States
From Journal des Transports, 1911, No. 12

The decision of the Swiss government to start work on the electrification of all lines of the Swiss federal railways, the report of the Norwegian government commission recommending a study of the method of switching most of the lines of the Norwegian network to electric traction – all this marks a new stage in the spread of electric traction to large railway lines.

The aforesaid progress in the electrification of the great European states would have proceeded still more rapidly had it not been for the difficulty in choosing the current system, and as the wait-and-see attitude of some countries does not entail a delay for them in comparison with other countries in the same state of waiting, the large railway companies prefer to expect more precise instructions, which will not fail to be ascertained from the latest experience before investing the huge capital necessary for the transition to electric traction.

Although the three-phase system has produced the best results in most cases of its application, especially in Switzerland and Northern Italy, the single-phase system and the medium or high voltage DC system are now preferred, depending on the circumstances.

In recent years, there have been lengthy and interesting disputes between representatives of the above-mentioned three systems, and the partisans of the single-phase system are mainly engineers who are in business relations with large interested firms.

Adopting one system for all cases seems impossible; on a case-by-case basis, local conditions should be examined. Thus, the introduction of a third rail in most suburban roads has not yet proved the profitability of its use for lines with weak traffic, as the use of single-phase current in Prussia has not yet shown its suitability for suburban lines. The unification of electrification systems in Prussia was introduced only for strategic reasons.

However, single-phase current has been applied on one commuter line near London and on one near New York, while high-voltage direct current transmitted through trolls has been installed on numerous commuter lines in America and even in Germany. Currently, the latter system is spreading faster than all others, to the detriment of the single-phase system, which it has supplanted on many American commuter lines.

The New World, apparently, leaves gradually single-phase currents.

Improvements in the transmission of direct current by means of a trolley gave him, in competition with a single-phase current, an advantage at such distances at which the direct current transmitted by the third rail could not compete. It must be thought that if the Prussian government were to make its decision at the present time, it would prefer direct current with a trolley to its single-phase current.

But the Prussian government then had in mind the general picture of all electric railway devices, and not just the direct current commuter lines in England and the United States.

To establish a homogeneous type of material equipment for all electric railways in Germany, the main German designers, of course, prefer to supply the same items to both their own and foreign customers than to prepare new ones for direct currents. The tenacity with which they campaigned in favour of single-phase current cannot surprise those who are familiar with the vigorous activity of German industry.

The efforts of German firms to introduce their material electrical part in European and other countries had been promoted a few years ago by Westinghouse by vigorous propaganda in favour of a single-phase railway traction system.

However, there is no system that is equally applicable to all kinds of conditions. Electric traction has not yet reached such a degree of development that it is possible to wish for the generalisation of one and the same system. In the interests of the development of the cause itself, it is only to be regretted that the Prussian Government, for strategic or other reasons, made it practically impossible to make widespread use of any new electric traction system within the German Empire.

Although the influence of Germany was strongly reflected in the principal states of Europe, nevertheless the experience of the United States, where the question of the use of various electric propulsion systems was most studied, seeks to change, if not completely reject, European undertakings.

In America, the two systems – based on single-phase and direct current – are most common by various designers; hundreds of miles of track have been operated on both systems for many years. So here you can learn more than in Germany, where the freedom of electrification is closed. The systems of electrical devices in America are very different from those used in Europe, and, nevertheless, their experience is still insufficient to solve the problem of electric traction on large lines. Even in America itself, it is impossible to combine systems, since there are various cases in which single-phase traction is used more conveniently than a high or low voltage DC system. Fortunately, American engineers willingly acquaint themselves with the results of their research and even their mistakes. For example, Mr. Murray, an engineer of the New Haven Railroad Company, owner of the main single-phase line, and at the same time an ardent supporter of the single-phase system, published the results of his experiments, and at the same time reported the annoyance he felt during the debate in the Society of American Electrical Engineers.

Mr Murray said: «I will give you the most detailed explanation of the operating conditions of the New York, New Haven, and Hartford lines. In the first project, it was about four tracks of 60 miles. Regarding the second project it was discussed that it might be continued to Boston, in total, for 220 miles. With regard to the single-phase system, I have a firm belief in its applicability on large lines. On the contrary, I do not think that it is suitable for long-distance connections; an exception here may be some small separate line or lines, albeit long-distance, but included in the service area of large central lines. But I believe that the single-phase system is the only one in which the director of the railway company can count on savings when transiting from steam to electric traction.

Since the electrification of large railway lines is a matter of the distant future, at present this question has little to do with England.

The introduction of a more expensive and less advantageous system for local lines is of little importance, if we take into account that this does not prevent the use of alternating currents on long lines, at least some of these lines turned into suburban lines or ran in parallel with the latter served by direct currents. In any case, at the border of the suburban network, it will be easier to replace a DC electric locomotive with an AC electric locomotive than to do what has to be done now, when an electric locomotive is replaced by a steam locomotive, while the main arteries are still served by steam traction.

While traction by the direct current transmitted by the trolley is applied almost everywhere for local propulsion, it is possible to find several long runs with weak motion, served partially or even entirely by a single-phase current. This type is represented by the Indianapolis–Cincinnati line, where a current of 3,300 volts and 25 periods operates over a length of 104 miles. In the intercity section of this line, a speed of 50 miles per hour was reached, with a wagon weight of 55 tons, and the work was of satisfactory benefit, although electrification was not cheap, as it is generally the case with single-phase machines, especially because of the high cost of motors. In other states, you can find similar examples when using currents both alternating in 25 periods and constant currents from 800 to 1700 volts. Lines of this kind, even with increased traffic, make up the majority of completed projects.

Local networks in Chicago, New York, London, Boston, Paris use almost all direct currents. However, there are exceptions, such as the line from New Haven to New York. In Berlin, regardless of strategic considerations, underground lines are powered by direct current. It should be noted that there have been cases when the single-phase method of operation was replaced by another, but there has never been anything like this with direct current. A striking example is the railroad from Washington and Baltimore to Annapolis, where significant savings were obtained.

A significant advantage of a single-phase system lies in the cheaper equipment of the line when transmitting high-voltage energy: the savings are sufficient to compensate for both the weak return of alternating current, and the significant cost of repairs and equipment in general with single-phase current. All this is now much more expensive than repair and equipment with direct current. It follows that with increased traffic, direct current is more profitable, and on a long line with weak movement, a high voltage current should be used.

In large cities, with a central electric station for trams, direct current is preferred.

Usually, generators are arranged three-phase, high voltage, even if the current has to be transformed into a direct, low voltage. Three-phase current can be taken in 25 or 60 periods, but now more single-phase is used, in Europe in 15 periods, and in America – in 25. A current with such a small number of periods is not suitable for electric lighting, neither for plants and factories, three-phase and direct currents are preferable to single-phase currents.

Thus, for a central power plant that supplies currents of all kinds (and this is the ideal of an economical organisation), a three-phase system is the most beneficial. It can give both direct alternating current, and transform it into direct current, and serve for electric lighting and even for powering small single-phase motors. Hence there is a clear need for special projects of detailed estimates for electrical devices, according to local conditions and the purpose of currents.

(*Zheleznodorozhnoe Delo [Rail Business]*, 1912, pp. 83–84) ●