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Желѣзнодорожное Дѣло

We reproduce an article first published in 1910 that describes in detail engineering projects, that were not only being developed but widely discussed. Those projects were dedicated to development of rapid, and particularly high-speed transportation in Berlin.

The developments of that time reflected broad engineering views. It seems to be an attempt to integrate into a single project all the promising ideas regarding technical advancements as well as optimal transport modelling, routing schemes, traffic organisation, urban spatial planning. The discussion touched upon radial and ring traffic system, integration of the urban transportation system into national and even global one, splitting of passenger and freight traffic and infrastructure, and engineering decisions have reminded about contemporary monorail, elevated railways, light metro, and even personal rapid transit systems... The article attracted attention in Germany, as well as in other countries, and was reproduced in Zheleznodorozhnoe Delo [Railway Business] journal. Probably, many described aspects besides historical ones might be of interest today as well.

Keywords: *history of transport and transportation, passenger transportation, urban rail transport, urban transportation system, A. Scherl, overpass, elevated railway, monorail.*

For the original Russian text of the article please see p. 211.

The editorial board expresses gratitude to the staff of the library of Russian University of Transport for the kind assistance in preparing the publication.

NEW HIGH-SPEED RAIL SYSTEM PROPOSED BY AUGUST SCHERL

(PASSENGER TRAFFIC IMPROVEMENT PROJECT)

PART 1

Last year, Berlin newspaper Tag published a summary of a recently published note by the newspaper's publisher A. Scherl on a rapid passenger traffic system proposed by him. From the numerous letters received by the editors from subscribers of the newspaper, it became clear that the issue of improving passenger traffic in Berlin is of great interest to the inhabitants of this city and, therefore, meeting the wishes of its subscribers, the editors gave in a special supplement to the newspaper a more detailed description of this system, illustrated with pictures and drawings.

In no other city, to the same extent as in Berlin, is there an urgent need for an especially fast passenger service both within the city and for moving from it to other points, provided that it is hygienic and the convenience of communication meets modern requirements; this need is conditioned, on the one hand, by rapid growth of the city's population and the ever-increasing traffic, and on the other hand, by the special propensity for movement of the inhabitants themselves. Thus, the Stadtbahn first appeared, which undoubtedly contributed to rapid development of Berlin; then Hochbahn was built, which, at first, was thought with horror, and would completely disfigure the city's streets, while in fact it laid the foundation for a number of new passenger traffic projects. They racked their brains for a long time over streamlining of mass movement in Potsdamer Platz and at other points and, as a result, limited themselves to only a few amendments; there was endless debate about whether to build a through underground road, or an elevated one, with its connection to street electric roads.

The implementation of August Scherl's idea of a high-speed single-rail railway with its central station and lines diverging in the form of rays – a road that will pass neither underground, nor above the streets, but above the houses of Berlin – will finally solve all the needs of communication in this world city. Perhaps they will object that this project belongs to a person who is not well versed, but such an objection would be completely unfounded. First of all, it should be noted that his project was subjected to serious consideration by specialist technicians; then it should not be overlooked that it is often the simple, but true instinct of just such non-technicians who often owes success in the field of civilization of measures; finally, in this project, it is important that the author is a person with such a versatile education as August Scherl.

All the above considerations prompted the editorial staff of Tag newspaper to fully satisfy the interest of Berlin population in Scherl's project and to give a more detailed description of organization of the new high-speed transportation and its original organization, to which we now proceed.

Crisis in the current state of the railway business

«The hallmark of 19th century is the worldwide development of communications». These words of Emperor William were related to the current state of affairs, but they rather outline the tasks ahead than correspond to reality.

But in comparison with railways of other countries, in terms of both passenger and freight traffic, German roads have certain advantages that anyone who has had to, in one way or another, become better acquainted with international traffic, can appreciate.

However, such undeniable advantages should be countered with significant disadvantages. Without touching on the question of the possibility of any improvements, nevertheless, it must be admitted that passenger trains have too low speed. We will only mention in passing the torment that one has to experience when spending whole hours in a cramped, overcrowded compartment of a carriage; meanwhile, the main drawback due to which trains are jam-packed is that there are too few of them in circulation.

Thus, passenger traffic suffers from an insufficient number of trains.

For example, only three or four high-speed trains circulating between Berlin and Hamburg – passenger trains, of course, do not count in this case – all passengers who need to hastily move from one city to another gather. Thus, all distant communication is concentrated only in a few hours, and the rest of the day for such a communication is completely lost.

But weaknesses of modern movement even more make themselves felt in communication between any two provincial points. It may happen here that such two points, located not only in the same Prussian province, but even in the same district, turn out to be more distant from each other in terms of travel time than Berlin from Vienna or Amsterdam.

And this is not so much due to insufficient speed as from the unsatisfactory nature of the system itself. If by continuity we mean the consistency of all individual movements with each other, then we can say that organization of modern passenger traffic does not correspond to the condition of continuity of communication. Undoubtedly, on our roads more time is spent waiting for trains than the crossing itself.

In most cases, this is explained in history of development of the railway business. Before introduction of railways, all traffic was driven by a tug on ordinary roads, and the engine was a horse. Post carriages were used to transport passengers, and carts were used to transport goods. For both types of communications, they used the same road. With railway traffic, in this respect, everything remained the same: a new road with a rail track was built, and trains, both passenger and freight, began to move along it. This circumstance was the reason for unsatisfactory railway traffic. If the same road served for the post carriage and carts, then it does not at all follow that the same would be the case for railway traffic. However, this is in fact, and from here comes the overload of the line, which is the source of all evil. If the railway administration does not satisfy the request for introduction of a new train into circulation, then there may be two reasons for this.

Firstly, this happens because, in the opinion of management, the new train will not recoup the costs associated with its appointment; for the most part such an opinion turns out to be short-sighted, since can be considered as a natural law that a new means of communication creates new passengers. But more often, especially for main lines with busy traffic, in an explicit or hidden form, the reason for refusal is the already overloaded lines. At present, passenger traffic is directly suppressed by carriage of goods and is completely deprived of any opportunity to develop depending on modern traffic conditions.

Therefore, there is nothing surprising in the fact that passenger traffic does not at all satisfy all the requirements of modern life and can only serve them within the limits of available means. And yet, despite the fact that no measures have been taken in this regard, passenger traffic has recently been increasing annually, by approximately 5,5 %; if this continues in the future, then in 10–12 years it will double against the present, and then the existing organization of railway traffic will be completely untenable. Therefore, the main requirement for a new system should be the following:

Separation of passenger traffic from goods traffic and special organization of passenger transportation.

And the technical side of the modern railway business suffers from significant shortcomings, so there is an urgent need for fundamental reforms both in arrangement of rolling stock and in construction of roads.

The steam locomotive is one of the most uneconomical steam engines at our disposal. As a motor, it can be very lightly loaded. If it has to show twice the normal pulling force for a short time, then it reaches the limit of its power. Finally, speed of the locomotive is limited by strict limits. If we want to achieve a higher speed, it is necessary to increase the number of revolutions accordingly. But then additional efforts appear, due to acceleration and deceleration of the masses moving back and forth, and blows and vibrations they cause so significant that movement becomes uneconomical and dangerous. Even the advocates and supporters of steam locomotives consider speed of 100 versts to be the limit for the economical use of their power. For further development of passenger traffic, if necessary, the use of electric traction is required, the conditions of which are completely different, and, moreover, much more favorable. Due to skillfully applied constructive techniques and expedient organization of experiments, a special society, which set itself the task of studying the issue of high-speed roads, managed, even with modern means of technology, to design a carriage that was completely reliable for movement on short lines at a speed of 200 versts per hour.

Although at first glance, the transition to a system of high-speed railways seems to be technically resolved in the most brilliant way, nevertheless, after getting acquainted with the case, we have to conclude, unfortunately, that even from the technical point of view, only very small part of the task; it turns out that rolling stock, which was considered until now to play the most important and complex role in the present issue, must be opposed by another factor, to which very little attention has been paid so far, but which, however, could reduce to utopia all dreams of high speed road, if it remained unchanged in its present form; this is the problem of the track superstructure, the solution of which, although it seems, at first glance, easy, but turns out to be the most important and necessary condition for implementation of a high-speed road.

With modern arrangement of the track superstructure, a high speed road is not feasible

The reasons why this happens can be divided into two main groups. One consists in construction of the lines itself, namely in laying the rail track, as a support for rolling stock, while the others arise from the circumstances that accompany deviation of the track from a straight line when the train passes along curves.

Already on a straight track at a speed of 200 versts per hour, oscillations that increase in proportion to the square of speed make maintenance of the track superstructure so expensive that it would seem that profitable operation is out of the question. On the curves, this is joined by barely surmountable technical difficulties, which have not yet been resolved quite satisfactorily.

The limit of achievable speed of movement is determined not by the type of rolling stock and driving force, as one would most likely expect, but by the features of the track consisting of a pair of rails. The question of speed is currently reduced to the question of a rational arrangement of the track, which still awaits its resolution.

In order to implement a high speed road, the old system must be completely abandoned. While the study of traffic on current railways implies the above first condition for a new organization of passenger traffic, from consideration of the technical side of the existing system, the following inevitable second basic condition is obtained:

Replacement of the existing double-rail track for high speed road with a special track system.

It is necessary to find a track arrangement that would ensure passage of trains both along straight sections and along curves, at a speed of 200 versts per hour.

Executing a new system

A perfect communication system is required to move with the least amount of time and motive power. To achieve this goal, in addition to high speed of movement of individual trains, it is necessary to satisfy two other conditions that represent the concept of continuity of movement.

Uniform circulation of trains often following one after another on separate sections and bringing into mutual communication along one common system of separate movements in different sections.

The new system should be based on the principle of continuity, in which various individual movements are in a rational organic inter-dependence with each other and serve their regions quite satisfactorily. A living organism can serve as a model for a new organization of communication, and just as the whole body is penetrated by strong beating veins, radial arteries and the finest veins, such communication must be organized rationally and purposefully. As the blood circulating in the body with a special force pulsates between the main more important organs, but at the same time fresh blood, flowing constantly through the networks of the second and third order, reaches the most distant parts of the body, so that nowhere there is a break in the mutual connection established between them and the inflow of vital juices to them stops, in the same way the correct currents should be established in the new system of communication and constantly maintained. Thus, the first position for the new system is obtained:

Railway network with sparse loops for fast long-distance connections between major centers.

Such a network of long-distance communications, through which trains circulate at a speed of 200 versts per hour, forming part of the new organization, satisfies the need for communication between the main settlements, but this is still not enough for communication in the future. The continuity of movement requires that for the spaces enclosed within the loops of this network there is an exit to it, so that from these spaces passengers constantly flow to the main arteries of the network and back from these arteries to the places located inside the loops of the network. From this requirement follows the second provision for new organization of communication:

The system of access networks must supply long-distance roads.

Loops of weaker movement should be adjacent to the main arteries of traffic, i.e. the main network, at a speed of 200 versts per hour, will be adjoined by a network of the second order, from secondary roads, with a speed of 120 to 150 versts per hour, and, in turn, an even more frequent and ramified network of access railways will join it roads, at a speed of 50 to 60 versts per hour, and, finally, the last branches will approach it, which can be likened to the roots feeding a tree, namely, bus lines covering all villages and settlements, and taking each passenger almost from his own house.

Buses deliver passengers on third-order lines, along which there is a continuous flow of passengers collected in this way to the nodal points of the second-order network and, finally, traffic along it is even more intensive to the main arteries, i.e. lines of the original, main network.

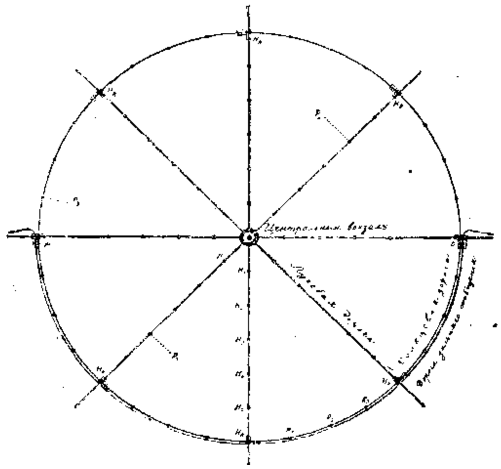
Thus, a systematic delivery of passengers will be established, the essence of which is that each train, upon its very arrival at the station, corresponds to another, for immediate further departure of passengers.

Traffic on this kind of hub-and-spoke network offers great benefits. With a reasonable arrangement of nodes, all stations in the second-order network will be served in much the same way as stations in the main network, and, in any case, much better than with current organization of traffic.

When organizing a new communication system, special attention should be paid to large cities. In view of the fact that railways approach them with a speed of 200 versts hour, all communication devices in large cities should be considered as means for transporting the world traffic to the network, delivering passengers to it from every street and even from every house. But regardless of this, there remains an independent movement within a densely populated city, and technology has to solve the important task of organizing a very intensive urban traffic.

Something has already been done in this direction. In many cities with a population of millions, there are two completely separate networks: a network of street roads, for communication between groups of streets, and a network of elevated or underground roads, for quick communication between city blocks. But here the communication arrangement, both in its organization and in respect of technical methods, has reached an extreme limit, and every railway technician will be horrified, imagining what the street traffic will reach in Berlin by 1920, if it continues to develop in the same way, like so far. That it is necessary to get out of this situation, the city administration is fully aware, and the fact that they do not stop before the multimillion projects.

The new system should give several networks of different meanings, but at the same time, such networks must be so frequent and so conveniently located that they really fulfill their purpose, and this is far from the case in Berlin. True, here street roads have, indeed, developed into a frequent network of secondary roads, but the main rapid city traffic network leaves much to be desired. Few of the lines cut through the four square miles that occupy the main city, and these lines are so difficult for most residents to get to that they prefer to travel all the way in carriages on street roads that should, however, only serve as access roads. Here it is necessary to change the whole organization, namely: to introduce a rational system in which the periphery are connected by radii with the centers. To provide a known area by means of communication, two systems can be proposed: with intersection of lines at right angles and radial. An example of the first system is the elevated roads in New York. There, a whole system of parallel lines runs along the oblong Manhattan Island, on which New York is located,



Pic. 1. New radial-peripheral system of railway traffic in a big city.

and another row of roads goes across, so that the railway lines, crossing each other, form fairly regular quadrangles. Such a system in special cases, as is the case in New York, may be quite suitable, but still, in general, one should strongly prefer a system with lines located along the radii and circumference.

In this case, a circle-shaped line will pass around the entire given space – a peripheral or ring road, and from the central point of this space they are drawn to the road circumference in the directions of the radii. In principle, such a system does not represent anything new, and in the history of Berlin railways one can find successful attempts in this direction, but, as often happens, further development was hampered by all sorts of side considerations, and the initial projects were subsequently completely distorted.

With correct system of movement, transfer of trains from radii to the ring and vice versa should not be allowed, so that movement along the ring should be completely independent, moreover, the radii leaving the city center by which the ring is divided into equal arc lengths, crossing it, pass either over, or under it, and movement, according to local needs, can be different at different radii.

Thus, roads leave the city center in all directions in the form of rays, and at a distance of 7–10 km they meet a ring road. At two diametrically opposite stations of the ring road, there should be stations for long-distance roads, and at one of them all trains arrive from north and west, and to the other from south and east. Both long-distance stations, of course, must also be connected with each other by a special half-ring. Both on radial roads and on the ring, stations should be arranged at a distance of 1 km from one another. In large cities, as they develop, suburban concentric rings with the first can be built, and the ray roads will need to be lengthened accordingly. Suburban ring roads should be built on embankments.

According to the attached drawing (Pic. 1), it is possible to visually trace the passenger's path along the «radial-peripheral» road of a large city. It gets, for example, as shown by the dotted line, from point P_1 to the station of the ray road, travels along this radius to the middle of the city, from there goes along a different radius and arrives at the desired point P_2. If a passenger needs to get to point P_3, then it is better for him to go along his radius to the ring, along which he will reach the corresponding station, from where he will arrive at point P_3. With such an arrangement, it is easy to get to long-distance roads from each point of the urban area between both long-distance railway stations, and thus, due to the radial-peripheral system of urban roads, the entire city territory becomes, as it were, one huge long-distance railway station.

When moving from any point in Germany *A* to another point *B*, with the organization described above, you can take for long trips on main lines, an average speed of about 140 km per hour, and then from Berlin it will be possible to reach the most remote places by the border of Germany in no more than 6 hours. Thus, even in relatively rare and unfavorable cases, the entire business trip – with travel back and forth – will take only one day. For most cases, travel time will be further reduced. On average, it is necessary to count 4–5 hours for such trips, which now take a whole day. This significant reduction in travel times, achieved with a new, strictly logical organization, represents a very important improvement in communications and makes travel extremely easy.

But the history of communications clearly proves to us that every improvement in communications entails development of movement. Thus, the benefits of the new organization will increase intensity and density of movement. Therefore, the following very likely result of this development of communications can be foreseen: the new organization will reduce growth of communication within the country to simple local communication.

(Zheleznodorozhnoe Delo [Railway Business], 1910, No. 11–12, pp. 51–55) ●

NEW HIGH-SPEED RAIL SYSTEM PROPOSED BY AUGUST SCHERL
(PASSENGER TRAFFIC IMPROVEMENT PROJECT)

PART 2

Trains of the new system

To implement the new system with its very fast train movement, it is necessary to have such a rolling stock, at which it is not only possible to develop the required speed of 200 km per hour, but also to achieve even greater safety and convenience of movement than on existing railways. This requirement makes it absolutely necessary to change the existing structure of railways and in the transition to a simpler type of railway track.

Instead of a two-rail track, a single-rail track should be used for a high-speed road.

The advantages of the single-rail track were known before they found a way to reach the desired goal, but before reaching it, a number of attempts were made, sometimes unsuccessful. From the numerous projects of single-rail roads, which in fact are two-, three- or even five-rail and could never supplant the exclusively dominant now double-rail road, a real single-rail road differs in a significant way, in which the disturbed equilibrium is immediately automatically restored, and the resultant of all the forces applied to the carriage at each moment passes through the rail*. With a real single-rail road, no special guiding devices are required for this, and equilibrium is ensured by a device placed in the rolling stock itself; at the same time, the car is a completely independent whole and does not need, except for a single rail, any supports and guiding devices (Pic. 1).

The automatically operating apparatus for imparting stability to rolling stock mainly consists of a rapidly rotating top of a special device, the gyrostatic moment of which is applied so that at every moment it destroys the forces tending to overturn the car.

The ability of the top to guide and impart stability to the car has long been known in technology, and already about thirty years ago, attempts were made to give stability to a body in unstable equilibrium with the help of a rapidly rotating top. In recent years, a number of designs have appeared, which, however, have not achieved practical results. In 1907, the Englishman Brennan** managed to build the first model of a single-rail car.

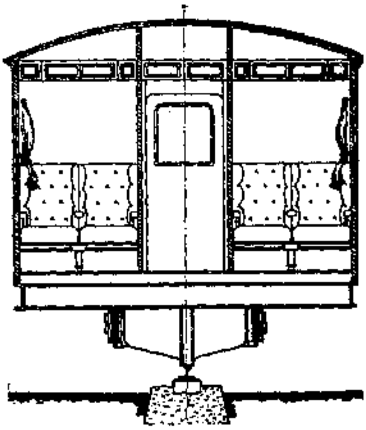
German technicians are well aware that many in Germany are also working on solving this problem.

At the present time, a detailed study of bringing rolling stock to a stable position using a gyrostatic device has been organized there in special experimental workshops. Certain results have already been achieved, and further experiments will be carried out in the form of a special technical enterprise on widely stated financial grounds and on a broader scale. Although their technical results cannot be known until the end of experiments, nevertheless, now it can be positively asserted that a real single-rail rolling stock already exists in reality, and thus there is already a means to successfully implement a new organization of communications. The transportation means of the new system is a single-rail car, which is brought to a stable position by a gyrostatic device.

With such a rolling stock, the advantages of a single-rail track are combined with the benefits of electric traction, and not only slowness of current communications is eliminated, but also

* About single-rail roads of other systems and types see «Zheleznodorozhnoe delo»: 1885, p. 272; 1886, p. 9; 1887, p. 33; 1890, p. 112; 1891, p. 491; 1893, p. 298; 1896, p. 135; 1897, p. 499; 1900, p. 12; 1901, p. 119, 148, 492; 1902, p. 31; 1909, 81d, 141d and 213d. – *ed. note*.

** See «Zheleznodorozhnoe delo» 1909, p. 81d: «Single-rail hydroscopic railway of Louis Brennan». Report of P. A. Yushchenko. – *ed. note*.



Pic. 1. Cross-section of a car of a single-rail railway.

their inconvenience for passengers. In addition to the fact that the use of a single-rail road ensures a completely quiet train ride and the absence of car vibrations, passengers do not get tired due to knocking and shaking, and, moreover, they are not at all shy in their movements and actions. Instead of wasting several hours during which transfer takes place, the passenger can be in a separate compartment, furnished with the usual comfort, and with complete convenience to go about their business.

Under normal conditions, due to simplicity of arrangement, which gives the car stability, its operation cannot be terminated. And if for some reason electric current is interrupted, then the top, due to the acquired «live» force, will continue to rotate long enough to slow down the train. When speed of rotation of the top is reduced to a certain limit, special wheels that support the car on both sides are automatically lowered. Most of the load is, of course, transferred from main wheels to the rail, while side wheels only serve to compensate for the eccentric load. No matter how many and what separate components the train of the new system consisted of, the following principle is always observed:

Each train is an independent separate unit.

The carriages of the new system should have the character of a hotel, and during the trip, the passenger is not forced to abandon his usual lifestyle, and he should be given full opportunity to use this time for his studies. Particular attention should be paid to the food part and the necessary facilities for writing and reading. In the central part of the middle car of the train there is a common hall, the technical purpose of which will be discussed below. While the train is moving, it gives to passengers a kind of hotel lobby; in the middle there is a special bureau in which the railway agent is located. If we compare a moving train with a small, completely isolated city, then we can call this bureau, as it were, a center in which all social life is concentrated. The agent located in the bureau, like a porter at the hotel, issues all the necessary information about the upcoming junction stations, about time of arrival of the train at one or another station, etc. He has at his disposal short schedules of trains in circulation on the sections in front, and, here, as in other places of the train, a visible from a distance, and if necessary, a well-lit station name appears when a train approaches it at a certain distance; here you can also get the latest newspapers and magazines along the route. If the line for railway traffic is equipped with a wireless telegraph, then it will also be possible to send and receive telegrams here. While the train is parked, the agent no longer bears these responsibilities, but disposes of reception and release of passengers from the train in the manner that will be specified later.

Track of the new system

A fully expedient track arrangement must also correspond to the improved rolling stock. At the same time, other conditions arising from the features of the new system are added to general requirements for any railway and detailed at the beginning of this article. When implementing the new system in full throughout the country, it is necessary to sharply delimit it from all other aspects of public life. There is no need to dwell on the fact that the new road, with its tremendous speed of 200 km per hour, can in no way be located among other means of communication. Its track should be completely separated from everything around it, it will be possible to get on it only at stations and other stopping points, and therefore crossing at the same level with any other tracks, crossings and transitions should not be allowed. A passer-by will not have time to read to the end the posted notice warning of the danger, as a strong jet of air from a fast-moving train will carry it away or throw it aside. Thus, both unwary people and intruders should be cut off from any opportunity to get on the track. Therefore, of course, the following requirement must be met:

New high-speed railway should be laid at the ground level.

In most cases, it will be necessary to build it in the form of an elevated railway passing over all other roads, construction of which under the railway bed will not present any difficulties for modern technology.

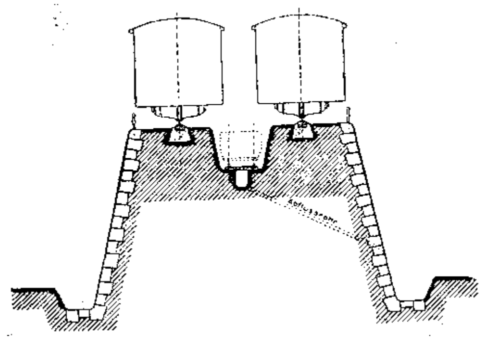
The technical side of foundation of the road and in particular the choice of building materials may vary depending on local conditions. In all cities, and in more populated areas, for example, in industrial centers, in places where coal is mined, in general, everywhere where the cost of land is very high, when constructing a railway bed, you will have to give preference to iron structures.

In general, this issue of arrangement of the lower structure of the road is a purely financial problem, and there will hardly be any difficulties in resolving it from the technical side. This or that decision in each individual case must only satisfy the conditions that have been detailed above. The substructure must be reliable enough to take on the load from rolling stock, and present such an arrangement so that movement on the new road at high speed is better than the current barriers and fences from access to the track of people and animals.

The transverse profile of the superstructure is also important. When constructing it, attention should be paid to all the needs of operation, and in particular to inspection and correction of the track, and it is necessary to be able to go around and inspect the track without stopping movement along it. It goes without saying that the currently existing method of inspecting the track along which railway agents pass on railway cars cannot take place; on the other hand, there is nothing to say about how much the most careful inspection of the track will be necessary here. And now broken rails, loose bolts and crutches and other shortcomings are sometimes the cause of accidents on railways, and at very high speeds on future roads, they can lead to even more terrible disasters. With the new system, complete traffic safety is absolutely necessary, and the technology has all the means necessary to achieve this goal.

In view of these requirements, the cross-section of a high-speed railway should be significantly different in appearance from the currently used types.

In order to protect agents inspecting or correcting the track from a strong jet of air during the passage of the train, the profile should be given a special shape. It doesn't matter whether it is an iron structure, or an earthen embankment, in the middle of the railway bed, it is necessary to make a depression about 2,5 meters wide and 1,5 meters deep, and in it lay an auxiliary track, movement along which will be carried out with the help of

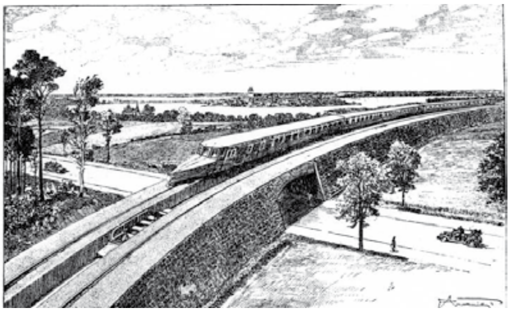


Pic. 2. Cross-section of the embankment at the haul between stations.

batteries or gas engines. This device with a single-rail track can be made without increasing track width, since the distance between both rails of main tracks should be slightly larger than the carwidth, i.e. about 4,5 meters. The auxiliary track should be equipped with cars with jacks, tools, etc. The same auxiliary car must have a room for 6–8 people.

Due to traction with the help of batteries, these cars are completely independent of delivery of driving force from the outside, and therefore, when the current stops, due to a short circuit somewhere in wires or in case of suspension of work at the central station, in terms of passenger safety, auxiliary cars still retain full ability to move along the service track. In any case, damage to the track will be able to quickly deliver the required number of workers, tools and materials to the site and make repairs with complete safety, even without stopping movement. In addition to the auxiliary cars, cars for agents who must constantly carefully monitor the condition of tracks move along this service track. These agents can comfortably sit in a slow moving carriage and inspect the right and left tracks using mirrors located on the service car and appropriately protected from the effects of weather.

To meet the above considerations and requirements, it is necessary to give the roadbed the appearance shown in Pic. 2 and 3. Pic. 2 shows a cross-section of an earthen embankment with stone retaining walls. In Pic. 3 the same embankment is shown in perspective. In both pictures, you can see a channel-shaped notch in the embankment with almost vertical walls, as well as a service car. So that rain and snow do not hinder movement in this recess, a drain pipe is arranged in its lower part, from which rainwater and from melting snow are diverted into a channel located next to the embankment by transverse



Pic. 3. General view of a single-rail road at the haul between stations.

pipes. In Pic. 2, you can clearly see both the drain and the side outlets. However, the rails of the auxiliary track in this groove must be located at such a distance from its bottom that snow can cover them only in very rare cases. On the city's elevated air roads, the observation channel may not be arranged.

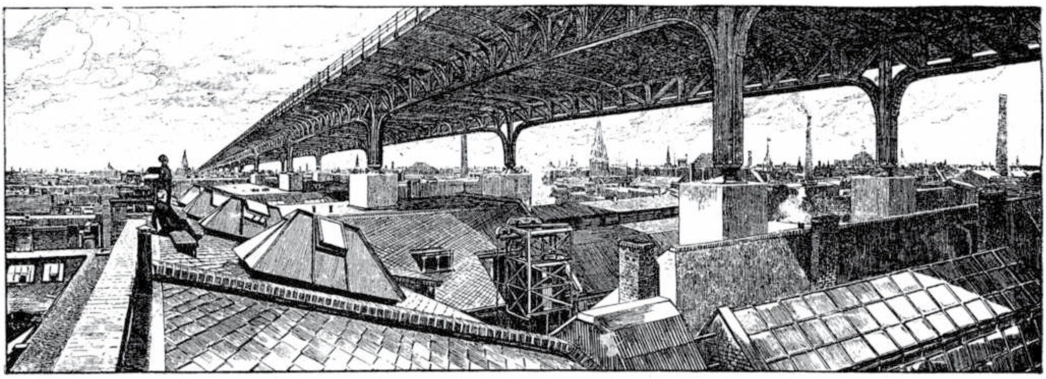
On the roads of the new system, there must be special devices to ensure traffic safety. At a very high speed, the track signals should be transmitted to the person driving the train, or, even better, signals of both kinds should be combined with each other, i.e. track signals with train signals. Then traffic safety should be increased by organizing responses to the received signals, by means of which the driver, immediately upon receiving the signal, must transmit it back to where it received it. This principle is now already applied in cases where movement is associated with special responsibility, for example, when transmitting orders on sea vessels; each driver, before executing the order received in the engine room, is obliged to telegraph it back to the captain's bridge in order to certify that he correctly understood the order received. This return of the order guarantees complete safety, since the current supplying the motors will be immediately interrupted if the driver does not return the received signal.

It is also necessary to say here about a special type of a track, namely about its arrangement in cities, in areas built up with houses. Currently, three types of roads are used for rapid communication in cities: elevated, located directly below the level of the pavement and underground. From an economic point of view, of these three types, the first is the best, as it is used in Berlin, Paris and New York, but it has significant disadvantages, namely: this type of railway obscures the streets over which it passes and besides, it very much disturbs the inhabitants with its noise. Indeed, now elevated roads are allowed only on particularly wide streets, with a boulevard in the middle, and therefore their use is very limited. In those parts of the city where this type cannot be applied, on the European continent they resort to railways located below the surface of the pavement. With this type, the appearance of the streets does not suffer, but the construction of such roads is very expensive, namely: with special technical difficulties in their construction in Berlin, a running kilometer of these roads costs about 10 million marks, while the cost of a kilometer of an ordinary elevated road is only 1,5 million marks. It would be possible to reduce to some extent the disadvantages of such roads by running them in suburban areas along wider streets, in trenches open from above, i.e., removing the upper part of the tunnel, fencing these trenches with gratings, but this would create new technical difficulties and the appearance of the streets will suffer. Moreover, even if one does not attach importance to the latter circumstance, nevertheless, roads of this type will still have a fundamental drawback, which is also characteristic of elevated roads and consists in the fact that they must follow the direction of the streets, which is why the location of the railway in the plan is very embarrassing.

The latter inconvenience can be avoided only when using an underground railway, but here construction costs are even more significant, not justified by subsequent operation; for example, it must be assumed that the cost of building underground roads in London will never pay off.

The new system makes it possible to build such a road for rapid urban traffic, which, in technical, economic and aesthetic terms, must be recognized as directly ideal.

The railway lines of the new system in cities will run high above the houses. Since movement of trains will take place almost without shocks, and, consequently, will not produce noise, it turns out that something that could not be achieved with the systems existing until now: it will no longer be necessary to hide the road deep underground; at the same time, there is no need for the railway to run in the direction of streets and, with its more or less massive iron structures, deprive the streets of some of air and light. Quite apart from the often very winding



Pic. 4. Aerial elevated road in a big city (bottom view). It will go in a straight direction over the houses. The track laid on the viaduct will be at such a height that the beauty of the city will not suffer at all. Trains will rush over the city with terrible speed, without making any noise and without causing shaking in buildings, since the viaduct is a completely independent structure and the columns supporting it, have their own foundation, are completely separated from the masonry of the surrounding buildings. The usual conditions of life and activity in cities and suburbs will not be in the least disturbed by construction of this road, along which, barely perceptible for sight and hearing, trains will run quickly. The road will go so high above the houses that it will not block the light at all and interfere with the flow of clean air. Thus, the elevated aerial road will most successfully resolve the issue of eliminating all the shortcomings of the modern train movement system.

street shapes that the current elevated roads must follow, the lines of the new city road – the elevated aerial road – will run over the rooftops along the shortest overhead line. The method of building such lines can be judged from Pic. 4 and 5.

Slender reinforced concrete columns will pass through the houses, being completely separated from the walls of the buildings and resting on special foundations deeply buried in the ground, and these columns will support the viaducts; Pic. 6 shows a sectional view of a residential building with a column of elevated aerial road.

The space occupied by a reinforced concrete pillar is already not large, but in addition, as you can see in the picture, you can make the pillar empty inside, with an elevator device and a spiral staircase around it. And now, at every step, you can find various combinations of railway lines with residential buildings. There is no need to turn to American railways for examples, since similar cases can be pointed out on Berlin Highway and Underground Railways. So, for example, Pic. 7 represents the underground road under the F rstenhof hotel, and Pic. 8 shows a railroad-cut house on Dennewitz Strasse.

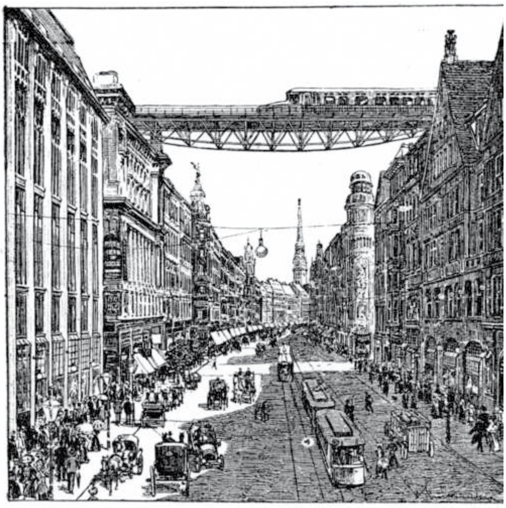
Railway stations of the new system

On railways of the new system, with new rolling stock moving along a new track arrangement, of course, the stations should also differ in appearance from the existing ones on the current roads.

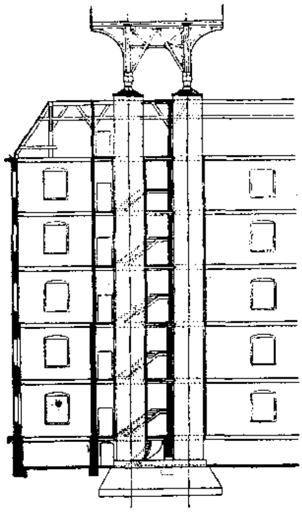
An ordinary station of a modern railway is a building in which, in addition to office, baggage and other premises, there are also halls for passengers waiting for the train, with buffets. Platforms adjoin the passenger building, which are covered with special sheds to protect passengers from weather.

But everyone is well aware that such canopies do not reach their goal far, and passengers, while waiting for a train, being in more or less open rooms, suffer from cold and through wind, and at small stations there are no canopies at all, so passengers are completely unprotected and from the rain.

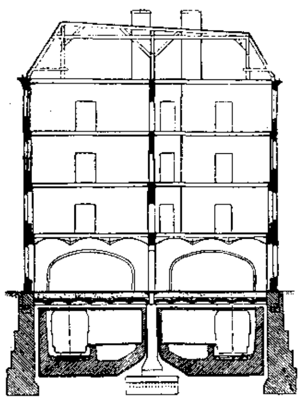
The stations on the railway of the new system are supposed to be arranged so that it will be possible to avoid both the above and various other



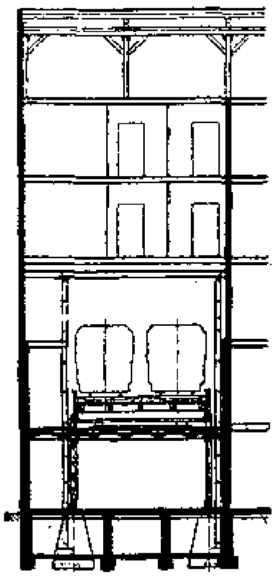
Pic. 5. Crossing the street of a big city with an elevated aerial road.



Pic. 6. Aerial elevated railway in a big city.



Pic. 7. Berlin underground railway under the hotel Fürstenhof at Leipziger Platz.



Pic. 8. Bering elevated railway at Dennewitz Strasse.

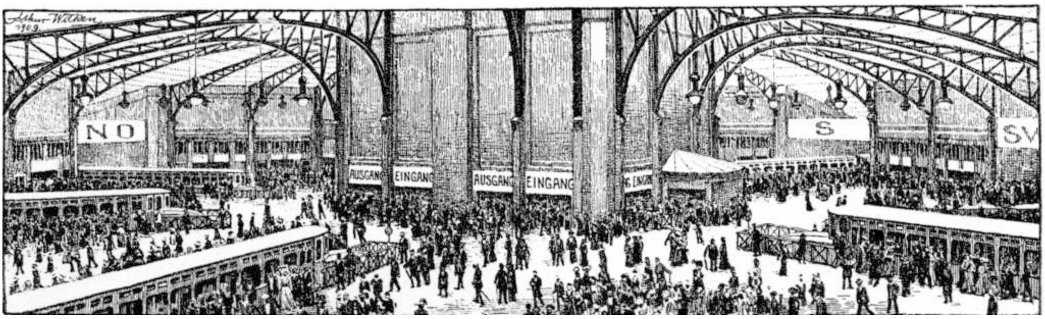
inconveniences. At the now existing railway stations, the passenger, after purchasing a ticket, has to find the train with which he should travel. Upon arrival of the train at the station, passengers immediately leave many doors, which is especially noticeable during mass movement between Berlin and its suburban areas on Sundays. There is a real dump on the platform; some rush to the exit, others are looking for a train to which they must change.

In the end, it is true, the necessary and desirable currents of passengers are established, but at the beginning, everyone scurries back and forth and collides with each other. Getting off the train and getting into the carriage for each passenger separately is not only difficult, but sometimes even fraught with danger. A radical reconstruction of passenger buildings is positively necessary.

Thanks to the new organization, a significant simplification of arrangement of stations will be achieved. The introduction of a strictly continuous movement will entail a reduction to a minimum of time that has to be spent waiting for the train; due to this, it will be possible to give significantly smaller dimensions to passenger halls and pantries. There will be almost no need for passengers themselves in these rooms, since they will not have to wait for a train for long, and, moreover, on the way they will be able to receive good food for an inexpensive price. Such premises are more likely to serve for persons accompanying passengers than for passengers themselves, and, therefore, in their size they will be much smaller than now. Therefore, at the stations of the new system, mainly only such devices will remain, which are necessary for movement itself.

This is followed by one of the most important principles, which is that all the flows of passengers, which now, as has just been said, intersect with each other, should be brought into a systematic form and organized in such a way as to completely eliminate all kinds of collisions and wasting time and friction energy. Most likely, this can be achieved by limiting independent movement of individual passengers as much as possible. Instead of arbitrary movement of individual passengers, mechanical movement of them in whole groups is established.

At the same time, on the one hand, the desired general movement of all passengers is achieved, and on the other hand, mechanical movement with the help of elevators, movable platforms and other similar devices, and conservation of power,



Pic. 9. Platform of a central railway station in a big city.

since then the need for running, walking on stairs completely disappears, etc.

The implementation of these theoretical considerations in practice necessitates introduction of a constructive element for the stations of the new system, for the definition of which you can use the word «cabin».

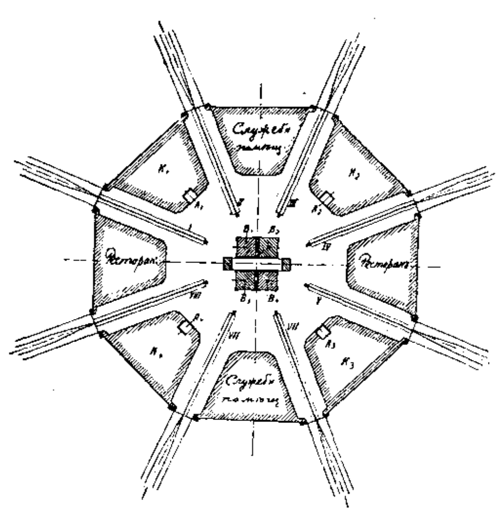
The «cabin» is an improved and modified elevator that transfers passengers from the entrance to the station directly to the train and in the same way from the train to the exit from the station. It must have all the necessary devices in order not only to serve as an elevator in the vertical direction, with movement up and down, but also to be suitable for horizontal longitudinal movement.

The entrances and exits of it, correspond to the exit and entrance doors of the middle carriage in the train, are arranged so that both flows of passengers, namely, both those leaving the cabin to the train and those moving from the train to the cabin, do not collide or interfere with each other in any way. This requirement for a strict separation of passenger flows then determines the size of the cabin. Its main purpose, consisting in mechanical supply of passengers directly to any train, will further lead to the fact that the platforms will be completely free of the public, and they will be used exclusively by railway agents. Such a device provides the public with complete safety from all kinds of accidents during arrival and departure of trains. Further, for the station of the new traffic system, an even more important and much more valuable advantage is obtained: there will be no need to cover platforms with canopies. Passengers in a cabin closed on all sides will be completely and much better than under the current, still half open canopies, protected from wind and bad weather, and since the cabin with its doors tightly adheres to the doors of the carriage, this protection is continuous.

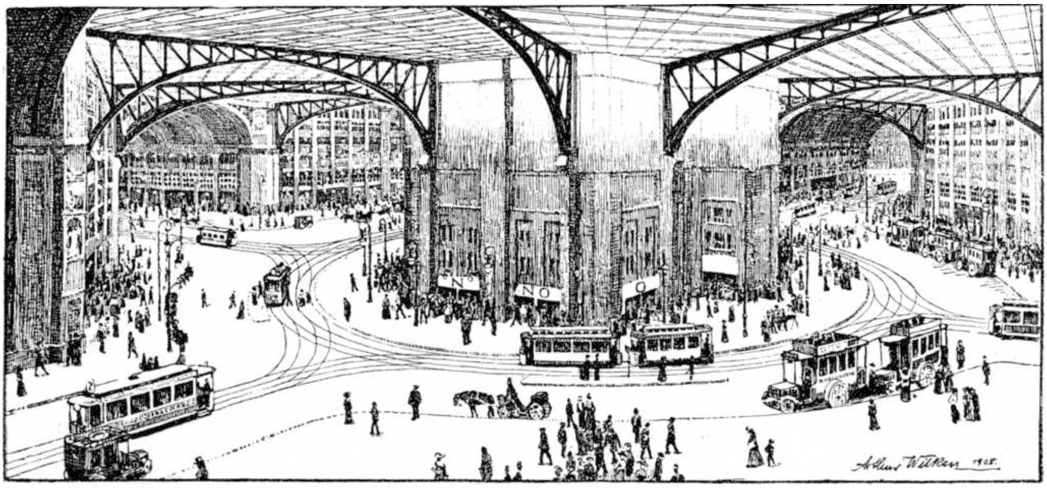
The cabin is like a car body, about 30 m long and 3 to 4 m wide, which can be moved in any direction with the help of well-known technical devices. In the middle of it, as in the middle car of each train, there is one sliding door in each longitudinal wall, 3 meters wide. Likewise, at each end of the cab there are two doors, 1,5 meters wide.

The movement should be organized in such a way that it would be known in a timely manner: on the train, about the approach to the station – by appearance or illumination of an inscription with the name of this station, together with bell signals in all train cars, and in the station cabin – about the approach of a train. Passengers who must get off at this station gather in the central train room described above so that they are ready to get off the train when the train arrives at the station.

Then the cabin begins to function, and it should be taken as a rule that a wide car door always serves to exit from it, and the same cabin



Pic. 10. Location of a platform in the plan.



Pic. 11. Access square of a central railway in a big city.

door is used to enter it, and a narrow cabin door is used to exit

First, the cabin is located on the ground floor of the station and receives passengers there who wish to travel with the next train. A few seconds before the train arrives at the station, the car is set in motion and lifted until it is installed directly next to the arriving train, and on the platform the car and the train must be positioned so that the doors are opposite the doors. Then the sliding doors open, and in a few seconds, an exchange of passengers takes place; then the train can go on, and the cabin at this time goes down again, releases its passengers and is again ready to receive new ones. The expedient combination of movement of cabins and trains leads to a special arrangement of stations of the new system.

The easiest way to set up a station is if the line runs along the embankment outside the city; the service rooms are then located in the embankment, like casemates.

The city station presents a completely different view. In this case, the road is not located on an embankment, but passes over the houses along bold reinforced concrete structures. Accordingly, the stations are located at the height of the sixth or seventh floor, and station buildings can be of a very diverse type.

The central city station is of particular interest. Its circular building rises majestically, occupying an entire block, into which four main streets flow. Omnibuses, trams and carriages serving for movement on the streets go to the square located inside the station, from where passengers directly change to elevators and go further. Thus, in a constant, continuous flow, all city traffic passes through the central point of all communication routes. Beam-shaped tracks approach the platforms of the central station from all sides. Numerous lifts bring the public to platform level, as close to the trains as possible. Already in each elevator, in order to better navigate in its position, there is a plan in the form of a panorama. On the platforms themselves, large signage indicating individual lines is placed, making it easier for passengers to understand their routes. Platforms should be large enough to accommodate passengers in the busiest traffic. Using Pics. 9 and 11, one can judge the excitement that reigns in such a center of urban traffic.

Until now, only the main components of the road of the new system have been discussed, namely, the location of the network and its equipment, but it must also be said about its upcoming operation.

It must meet the conditions of not only modern, but also future movement. Quite unexpectedly, it may turn out that new traffic conditions will cause new needs, and the new road system will capture new areas and even thanks to it, new settlements will arise. If we confine ourselves to only the first part of the task, then there would be no need at all for too many new devices, and the matter would be reduced only to some development of the existing operation.

New traffic conditions create new communication

Just as a far-sighted merchant does not confine himself to the old beaten path and existing sales markets, but creates new needs and conquers new markets, so railway leaders should strive to further develop communications. The history of railway technology at every step confirms the correctness of this position.

Now let us turn to the measures by which the new mode of movement can satisfy the requirements developed above. In this case, the following principle should take place:

Uniformity of movement on each separate line, complete harmony in movement on the whole line connected into one whole.

The rhythm of movement on any single line can be easily achieved by placing stops at equal distances and sending trains at regular intervals. With this method of movement, trains of a given line arrive at the stations at the same moment and simultaneously depart from them. The benefits of such a rule are recognized by all and where only local conditions allow, it is now always followed. On strategic railways, the location of the station is strictly maintained at equal distances. In exactly the same way, for example, one can see a certain rhythm on many suburban tracks to Berlin for opposite directions of movement, where trains cross at most of the stations. Here, trains from both sides arrive at the station at the same time, and then simultaneously depart to arrive at the neighboring stations at regular intervals to cross with other trains. The uniformity that exists here on an insignificant scale must be strictly consistently carried out in the new system of motion.

For this purpose, stopping points on the lines of the main network should be distributed as evenly as possible, namely, so that they are spaced from one another at a distance of about 20 kilometers. It will almost always be possible to set up stations at more important points on the line. In this case, it will be possible to take the main settlements on the line and proceed from here to subdivision of the line, since the distance between the stations should in no way be determined by all means 20 kilometers long, but according to local conditions, distances from 18 to 30 kilometers can be allowed in different sections.

On the contrary, it is necessary to emphasize once again what was already observed in drafting of various lines, namely: the task of roads intended for rapid movement over long distances does not at all include direct service of settlements of secondary importance, townships, villages, etc. more important cities on the main network, all other stopping points and places of adjoining to it of the secondary network must be adapted exclusively to the conditions of technical traffic.

In this respect, one can see something similar already in the current state of the railway business. We will confine ourselves to indicating only that the numerous junctions on British railways, which represent the intersection of the most important lines, are, generally speaking, relatively sparsely populated points. For passengers, these stations are as little known as, for example, in Germany – Corbeta, Bebra, Kreienzen, B rssum, etc., which do not have any meaning as settlements, but meanwhile are the most important nodes of the railway network.

For the same reason, the stations on the lines of the new system, representing the points of intersection of the main and secondary networks, should be appointed completely regardless of their importance as settlements.

The stations of the future fast track should be located at equal distances

To establish a rhythmic movement, it was also indicated that the second condition is necessary:

Trains on fast track lines must follow at regular intervals.

In this case, according to the value of the line, the schedule should be drawn up with time intervals of 10, 15, 20, 30 minutes. The time interval between two successive trains should be set so that it is contained an integral number of times without a remainder in one hour. This presents the advantage that the schedules are very simple and clear and, moreover, are easy to remember. This advantage will remain even when the required elasticity of movement is fully satisfied. If we take a half-hour interval of time for some line as the norm, then at a certain time of the day or year (in the latter case, we are talking about a certain period of movement), when the need arises, it can be replaced by intervals of a quarter of an hour, or even at 7,5 minutes.

With such a division of the hour, the principle of not only equal intervals of time, but also the clarity of the schedule, will be preserved.

As for some of the other principles detailed above, so for this last principle, to some extent, a start has already been made. On various Berlin suburban lines, for example, a half-hour period has been introduced. At certain hours of the day and at certain times of the year, the movement is denser to a 15-minute period, and at other times it is diluted to an hourly interval. But that which is still in the embryo here and, moreover, represents isolated cases, must be accepted as a rule for the new system of movement. The same simplicity, according to continuity of movement and due to its rhythm, will also differ in the train timetable books of the new system. At present, one can thoroughly get used to the timetable book only after a special rather tedious study of it, while the timetable book of the new movement system will represent a simple image of a simple movement.

The system of movement developed here in all details does not contain anything that is not sufficiently substantiated. Everything that in its totality was considered as a «new system» represents the development of existing communication in the direction of «least resistance», both technically and economically.

After the first note about the new traffic system appeared, inquiries about its profitability began to arrive from all sides. To this it can be answered that the main purpose of the published articles was to prove the technical feasibility of the project outlined in them, the financial side of the case should serve as a subject for further research. The success story of the technician shows that the question of profitability has never occupied the first place in a series of questions that have arisen in solving various problems. If Zeppelin at the very beginning of his work had immediately put the economic side of the matter in the foreground, he would hardly have achieved successful implementation of his discovery.

But if we consider the issue from a different point of view, then it turns out to be quite solid here that this note is not included in calculation of profitability of the enterprise. Under any circumstances of organic life, there is such an interaction between them that various kinds of devices that are necessary for one another feed each other and develop together.

One of the great people of recent times, who owes his successes to this everywhere manifested mutual connection, Werner von Siemens frankly spoke about this as follows:

«*My friends sometimes reproached me for the fact that with my inventions that pursue generally useful goals, I especially emphasized the benefits that they bring to all mankind, and yet, as a result, I myself derived enormous benefits from them. But it would be unfair to build on this objection. Such devices, which serve the whole society, responding to real needs and modern conditions, and whose satisfaction is long overdue, at the same time should always bring benefits to the inventor, are always carried out in the form of a profitable enterprise*».

What the oldest German electrical engineer says specifically about his work applies exactly the same to every other invention and, in general, to every success in technology. The urgent need for a radical improvement in traffic conditions, even without any detailed calculations, makes it possible, according to the considerations just given, to conclude with confidence about profitability of the above traffic improvement. It must be assumed that new means of communication will increase the welfare of the population; this alone indicates the important economic significance of the new system. Since its implementation, in contrast to gradual development of modern railways, is assumed according to one general grandiose plan, then mass production of monotonous iron parts required for the construction should take on such dimensions that one can expect a significant reduction in the cost of production and at the same time reduction in costs for road construction.

And the urgent need for new roads will come sooner than people usually think. When August Scherl, 25 years ago, on his return from a trip to England, said that Berlin should follow the example of London to build underground roads, they objected that due to the high cost (a running meter of the underground railway cost about 6500 marks) in Germany it could never come true. However, now underground roads run through Berlin along and across.

The project of August Scherl may seem utopian, but with rapid successes that technology has been making recently, it cannot be recognized as impracticable, even if not on such a wide scale as the author of the project believes. Its implementation is associated with a radical breakdown of existing railways, the technical conditions for construction and operation of which have been firmly established, and huge sums of money have been spent on their construction. In addition, such a reorganization of railway communications will require such large capital that because of this alone it will be necessary to put up with all the shortcomings of the existing means of communication for a long time. In any case, this project deserves full attention also because, by covering these shortcomings, it also outlines ways to eliminate them.

Engineer K. Tikhomirov
(Zheleznodorozhnoe Delo [Railway Business], 1910, No. 13–14, pp. 77–85) ●