# Electromagnetic Actuation for Rail and Road Vehicles

W. Sobolewski,
Trimodale Verkehrs-Werke GmbH
Hörnumstraße 12, 22047 Hamburg, Deutschland
Tel.: 040 / 66 41 35, E-Mail: usomichi@freenet.de

ABSTRACT: This article introduces an innovative electromagnetic drive. The construction is based on magnetic levitation in connection with a modified railway to wing rail. Actuation can be used in route-bound traffic for rail and road vehicles. This pioneering electromagnetic actuation can be applied in long-distance, regional and local traffic concepts.

## 1. INTRODUCTION

The new development of an electromagnetic actuation presented in this article is a pioneering innovation for rail and road traffic, and provides a solution to the global challenge caused by traffic problems worldwide.

The new development presented here, consisting of an electromagnetic actuation and a modified railway, renders possible three to five-fold increase in traffic efficiency. This increase in efficiency can only be achieved in rail traffic, because higher speeds can be reached on rail.

An electronic traffic flow control and the electromagnetic actuation enable optimum speed adjustment which leads to an increase in capacity on rail. On account of the electromagnetic actuation, there are no abrasion particles (fines) from brakes, rails and railway wheels. Each railway wheel, for example, loses 64 kg of iron fines during its period of abrasion, which is extremely detrimental to health.

The traffic congestion we are familiar with on the roads, and the train delays, are clear evidence that the expansion of traffic routes can not keep pace with the growth in traffic volume, and that such expansion is also limited.

In order to meet this challenge, an increase in efficiency of the existing traffic systems is essential. The new development presented here provides the opportunity for sufficient increase in efficiency.

Compared to present-day traffic systems, electromagnetic actuation is by far more efficient. When including the factor of time gain, an added value of 30 % can be assumed.

Lower energy consumption, lower maintenance costs and lower staff requirements hen using electromagnetic motion are factors which make a considerable economic difference.

The construction of a magnetic levitation route costs less than the construction of a conventional rail route with a bottom of ballast with railway ties, or the construction of a solid roadway of concrete.

Successive modernisation of our means of transport is more urgent than ever:

- to counteract the threat of traffic infarct;
- and to relieve us of the noisy, odorous, time-consuming, health-damaging and expensive traffic, there is now technology available in the form of the no-contact electromagnetic actuation.

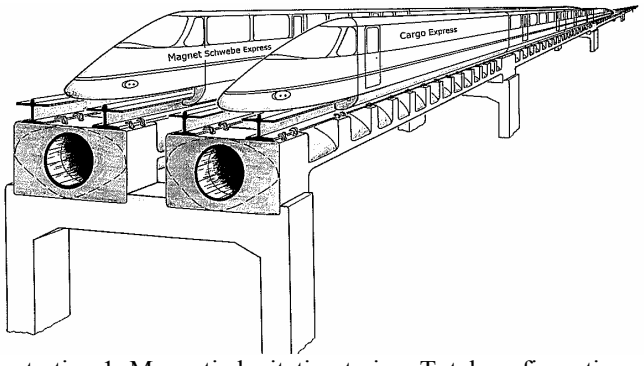


Illustration 1: Magnetic levitation train – Total configuration

## 2. TECHNICAL DESCRIPTION, FEATURES AND ASPECTS OF THE TRI-MODAL TRAFFIC SYSTEM

### *2.1 Advantages of electromagnetic actuation*

A new basic technology has been generated based on magnetic levitation which leads to a multiple increase in efficiency in rail and road traffic. Magnetic levitation is the fastest technology of motion of all ground means of transport.

The reduction of travel and freight times amounts to more than 50%. Non-contact motion technology ensures a pleasant, smooth, comfortable and safe train journey.

The embracing of the track by electromagnetic actuation provides travel safety unknown up to now, because the train can not derail.

Magnetic levitation provides the greatest possible care for the environment and resources by means of the non-contact, electromagnetic actuation, because there is no need for combustion engines such as diesel locomotives and railway wheel wheels with their axles and bogies. There is also no need for power supply overhead lines and their countless power pylons and their line carriers. The overhead line system costs amount to 40 % of the route costs. Also, overhead lines are often the cause of operational failures.

A magnetic levitation train can handle hilly landscapes in the same way a car can, since its hill climbing ability amounts to 10 %. In contrast, a wheel/railway has a hill climbing ability of 4 %. This means there is no need for the construction of tunnels or bridges.

Magnetic levitation provides a five-fold faster acceleration and a shorter breaking distance. This means that intermediate distances are shorter, and more vehicles can use the route.

### *2.2 The magnetic Levitation System and Energy Supply*

- Actuation is generated from a stator-linear motor which is located in the vehicle. Actuation and braking of the vehicle is made electromagnetically via the rail wings and rail frame.
- The vehicle is carried and maintained in levitation by the carrier magnets integrated in the drive. The carrying power per m train is 4 t.
- The magnetic levitation vehicles are guided via control magnets which effect sideways on the frame of the wing rails

The functions required for traffic, namely
- carrying
- guiding
- actuating

are fulfilled via the combination of wing rails and electromagnetic actuation.

By means of the rail geometry, magnetic levitation is divided into four equal, functional units which increase the level of safety, i.e. each vehicle has

- four drive motors
- four varying magnets
- four control magnets.

Energy can be supplied via all known technologies,

- pantograph as for the ICE
- conductor rail as for city railway
- induction as for the Transrapid

or via the hydrogen motor located in the vehicle.

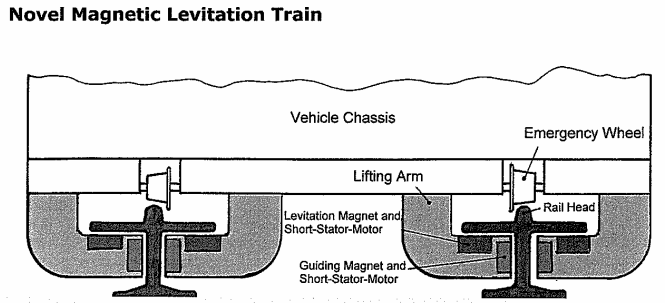


Illustration 2: Electromagnetic Actuation

### *2.3 Vehicle with electromagnetic actuation*

Electromagnetic actuation for vehicles can be used in route-bound traffic on the wing rail. The drive is located beneath the vehicle. Telescopic carriers, equipped with the actuation, carrying and control technology, are bracketed beneath the rail wings.

A new type of rim formed as a wheel flange can guide a vehicle from the street over rails to the wing rails, and the journey can be continued electromagnetically.

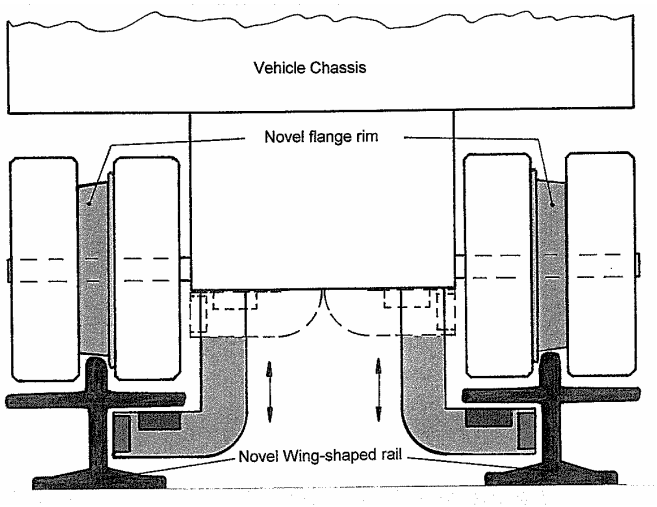


Illustration 3: Vehicle with electromagnetic actuation

*2.4 Wing rails for electromagnetic actuation, and the use of the wheel/rail system*

The foundation of the new wing rail can be bottom ballast with railway ties, a ground road of reinforced concrete, or an elevated, tubular route. The wing rail can also be used in suspended mode.

The new wing rail of the 'tri-modal traffic system' is a further development of the conventional rail with a higher frame and additional wings. The dimensions of the rail head are the same as for conventional rails. However, the new wing rails have far greater lifetime on account of the non-contact motion.

These new rail wings can be used by

- conventional railway vehicles
- maglev vehicles and
- road vehicles with rubber tyres, or with wheel flanges or with magnetic levitation.

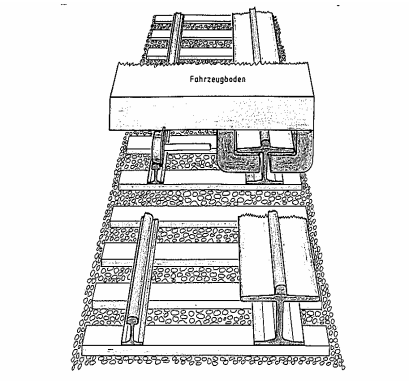


Illustration 4: Wing rails for Multiple Use

*2.5 Route for Multiple Use*

The new tubular route can be built at ground level or elevated. The route consists of industrial, prefabricated components, preferably of reinforced concrete produced in centrifugal moulding.

From an engineering standpoint, the prestressed or fiber concrete centrifugal moulding process provides four times as much solidity compared to fully concrete bearers. The dead weight in the case of equal solidity is approx. 30 % lower, which leads to a considerable reduction in costs.

The upper side of the track or road way, which forms the travel surface, is convex curved to ensure that storm water and easily drain off. Dents have been formed on the rounded surface of the concrete moulds by section and with swells to enable the fastening of railways or special rails for magnetic levitation.

The advantage of elevated track or road ways lies in the secure anchorage in foundation soil, which saves material, and does not require any additional sand and rubble ballast.

The elevated track or road way provides the advantage of bridging streets and rivers, and enables continued use of areas by man and animals, and a lower exploitation of land. Travels services are barely affected by snow-drifts or flooding.

For functional and construction reasons a symmetrically placed tube has been placed through the concrete moulds. This tube is also a pipeline, through which oil or other resources can be transported.

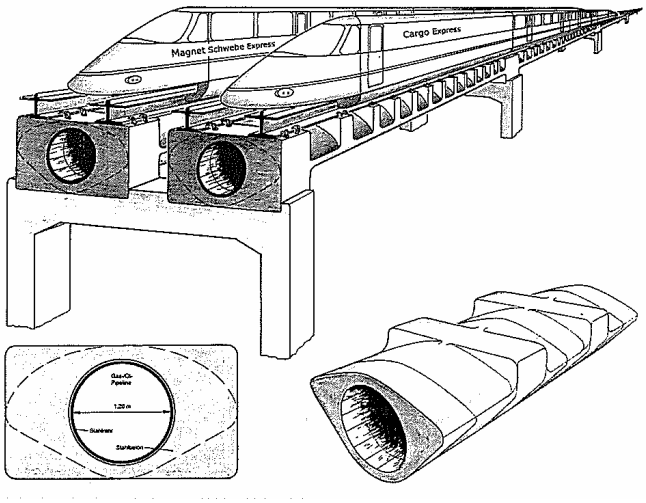


Illustration 5: Tubular Track or Road way for Multiple Use

## 3. ASPECTS FROM THE STANDPOINT OF THE TRI-MODAL TRAFFIC SYSTEM

*3.1 Preconditions for the Application of the Tri-modal Traffic System*

The increase in mobility across the world, especially as a result of globalization, forces us to increase our efficiency with regard to traffic performance. The traffic volume developing can no longer be handled sufficiently by present-day traffic systems.

Land connections between eg. Europe and Asia, are still very poor and inadequately developed. However, Europeans and Asians strive for improved land connections. At some country borders, the wheel housings have to be changed because of different track widths on the rail tracks. This means loss in time and money.

Present means of transport, whether road or rail vehicles, are subject to continuous material abrasion. All material abrasion contains highly toxic particles for man and animal. Especially those metal fines which oxidize in the lung. Every year, 65,000 people die of poisonous air in Germany, and 310,000 across Europe. In addition to this, all drive

systems leave traces of residual combustion which not only damage our health, but also generate considerable $CO^2$ emissions.

Our means of transport and traffic systems are no longer up to date, because thy can no longer keep up with the constantly growing demands of traffic and life expectation.

From the standpoint of future-oriented traffic technology, such as g. the 'Tri-modal Traffic System' with electromagnetic actuation, we are now living with an obsolete traffic system.

In Europe, every year this old traffic system costs us

- 750 billion EUR for 7,500 km congestion,
- 650 billion EUR for external costs such as: accidents, noise, air pollution, health damage etc.
- 42,000 traffic deaths
- 210,00 deaths from air pollution,

and billions more for the over 50 % lost travel and freight times.

These burdens and costs amounting to billions of Euros have to be paid by Europeans, since they have no means of defending themselves against the transport industry and transport politicians. This industry is not interested in essential improvements to present-day transport technology, because it fears financial losses from modernization. Therefore, it is not surprising that the Traffic Advisory Board of the European Commission, which is made up of thirty Board members of the transport industry, has made unfavourable proposals for traffic improvements to the European Commission.

The Advisory Board proposed that an improvement of the disastrous traffic situation in Europe could be achieved by doubling the traffic systems for the old traffic technology, although all members involved are familiar with the advantages of electromagnetic actuation, and know that it protects the environment and resources, and would halve costs. It would also make the 500 billion costs for new roadways unnecessary, since electromagnetic actuation used on the existing traffic network can achieve a three to five times increase in efficiency of traffic performance.

### *3.2 Possibilities for the Application of the `Tri-modal Traffic System` with electromagnetic actuation*

All ground means of transport, whether underground, city railway, regional railway or long-distance railway and freight traffic can be equipped with electromagnetic actuation. The vehicles can run on existing lines, whether train or motorway, on applying the new, modified rails.

The system is technically designed to ensure that passenger and freight wagons can run at the same speed, which means that the wagons can be mixed. The travel speed for passenger and freight traffic should be approx. 400 km/h.

Compared to ship freights from Europe to Asia, where freights travel for approx. 4 weeks, by land the freight would travel a maximum of one week via electromagnetic actuation.

There is nothing to stop the worldwide application of electromagnetic actuation technology, provided society can convince politicians and the industry of the sense and significance of this future-oriented technology.

### *3.3 Results to be expected from the `Tri-modal Traffic System*

Electromagnetic actuation will relieve us of harmful combustion motors such as diesel locomotives. There will be no need for railway wheels and brakes, which cause so much damage and such high costs. The railway lines will have an expected five-fold increase in lifetime on account of the non-contact motion. Expensive overhead masts will no longer be required. Travel and freight times will be reduced by more than 50 %. The `Tri-modal Traffic System` will be more efficient, and provide additional value compared to existing traffic systems of approx. 30 %.

## 4. REFERENCES


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