Trolley Canal Boats (Excerpt)

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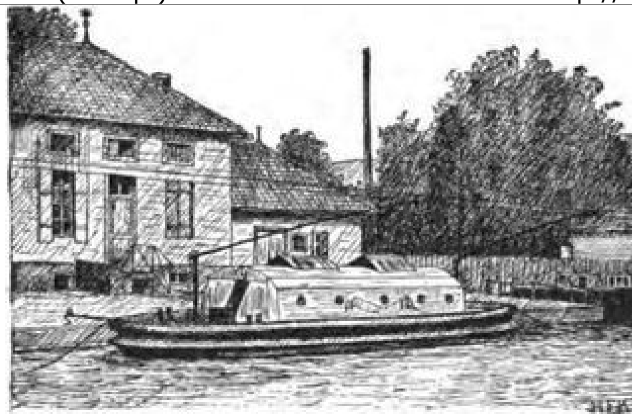
This is a guest post by Kris De Decker. Readers will remember that Kris was the author of the Oil Drum post Wind Powered Factories. A longer version of this post on trolley canal boats was published in low tech magazine.

For many centuries, canal boats were propelled by men, horses or mules on the towpath beside the water. Before diesel power took over, engineers developed several interesting methods powered by electricity: trolleyboats, floating funiculars and electric mules. Many of these ecological solutions could be applied today instead of diesel engines. Because of the very low energy requirements, they could easily be powered by renewable energy, generated on the spot by water turbines located at sluices. One trolleyboat line is still in use.

Most of these systems are at least four times more efficient than diesel powered barges.

As described in a previous article, trolleybuses and trolleytrucks would make a lot of sense these days because they could deliver electric transport for a bargain, using simple and existing technology.



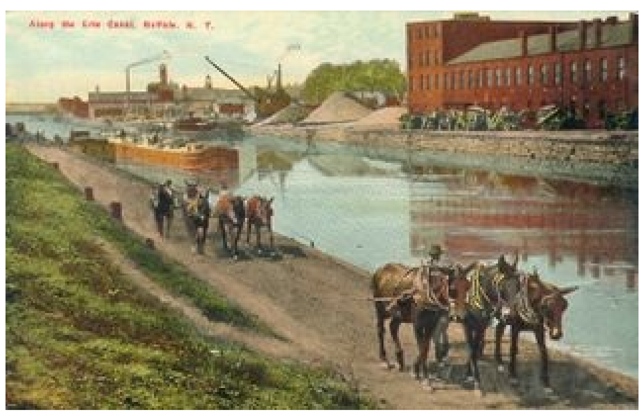
The same method was once applied to boats, too. Not for sea travel, of course, but for canal transport. Some canal boats were also propelled by systems that resemble those of cable trains, and yet another method combined common railway technology with canal barges.

All this happened at the turn of the twentieth century, mainly in France and to a lesser extent in Germany, in Belgium and (only experimentally) in the United States.

Up until the second half of the nineteenth century, canal barges were the main means of transporting goods over longer distances through regions where no good natural waterways existed. In all of Europe by the end of the 1800s, there were between 19,300 and 24,000 kilometres (12,000 and 15,000 miles) of canals. In the US in 1880, the total length of canals was around 7,200 kilometres (4,500 miles).

Mules and horses

From the 1840s onwards the rapid progress of railways threatened to make these canal networks obsolete. In 1880, already 3,200 km (2,000 miles) of canals in the US had fallen into disuse because of the rise of the railroads.



Canal boats, which had a capacity of up to 240 tons in the second half of the 19th century, were towed by horses or mules on the tow path (sails were not an option on most canals). This method was very efficient compared to non-motorised land-based transport; a horse could carry 10 times more cargo in this way than was possible when hauling a cart on the road. Compared to the new railways, however, the cargo capacity of animal powered barges was limited and the speed was low.

In most countries, animal traction remained the only method in use on the canals, until it was superseded by diesel engines in the 1930s or later, or until the canals fell into disrepair altogether (like in the United Kingdom). But, faced with the decline in traffic at the end of the 1800s, some governments and canal companies attracted engineers to look for more modern and efficient ways of boat propulsion to compete with the railways.

Steam barges

The obvious solution to canal barge transport was the steam engine - the same technology that kept trains going. Some canal barges were indeed converted to independent steam powered vehicles or towboats, but it soon became clear that this could not work when applied to large numbers of boats.

The reason was the state of the canals. In those times, canals were simply a large ditch without reinforced banks. If all barges would be equipped with steam engines onboard, or towed by steam boats, then the wash of the screws (or paddlewheels) would have destroyed the banks of the canals in no time.

Another obstacle was the limited depth of most canals, not exceeding 2 to 2.5 metres (6.5 to 8.5 feet) and this only in the middle of the canal. This made higher speeds problematic, because the stern of a propeller powered boat comes to lay deeper in the water as speed goes up.

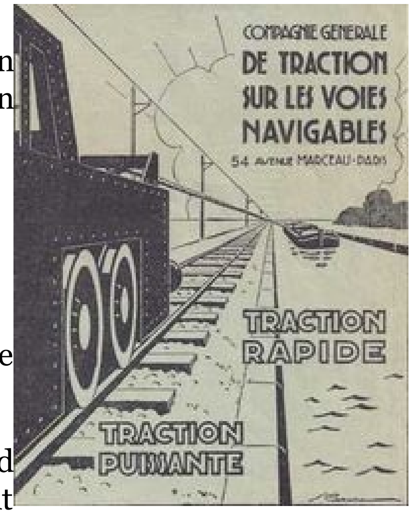
A third problem of steam power was that the bulky engine took away cargo space, thereby lowering the efficiency of the transport system. This made that, even though steam boats already existed since the end of the 1700s, and many of them were in use on rivers and lakes, only 84 of them were operated on American canals in 1906.

Batteries

Because of these challenges, another obvious method - electric boats powered by batteries - was no solution either. At the end of the 19th century, thousands of electric automobiles were in use on the streets.

The first "automobile" or independent boat carrying its own battery was already demonstrated in 1838, and at the end of the 1870s one even made a trip across the English Channel. But, these boats were not suited for canal transportation. The propeller or paddlewheel would create the same wash as a steamboat, destroying the delicate canal banks. The batteries would take up almost all the cargo space.

Overview of electrical methods



Ultimately, engineers found the solution in electric propulsion without the use of batteries. Roughly, all methods can be divided in five classes:

1. Trolley propeller towing - engine on the boat.
2. Trolley submerged chain towing - engine on the boat.
3. Funiculars - engine on the banks.
4. Manned electric mules - engine on the banks.
5. Unmanned electric mules - engine on the banks or over the water.

Most of these systems were initially powered by steam engines, and later adapted to electricity, which made them much more efficient and practical. Some systems were afterwards converted to diesel engines. With the exception of funicular boats, all electrical systems were fed by a trolley line.

Apart from some regional success stories, none of these technologies found widespread use, in spite of the many successful tests. Peak oil and global warming were no concerns in those times. Most countries chose to further deepen out and reinforce their canals in order to allow self-propelled steam and, a bit later, diesel boats.

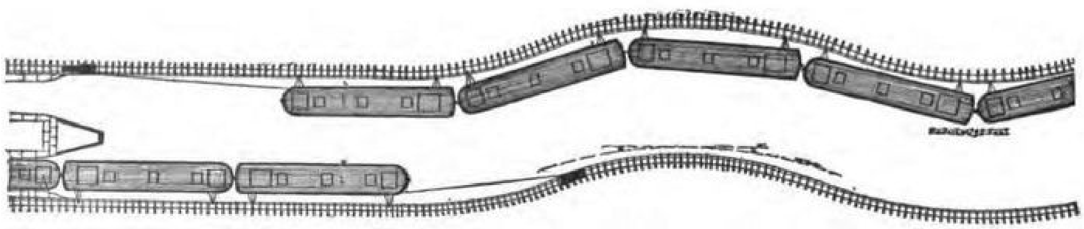
At the end of the article I will explain why it is time to ditch these and finally give the trolley systems the attention they deserve; they are our best chance to develop a completely oil independent, land-based cargo transport network with a large capacity.

The original article discusses all of these five methods. Here, we are providing only a bit of information about the method that found widespread use on a regional scale.

4. Motor locomotive haulage (electric mules)

The only method that found a widespread use, at least on a regional scale, adhered to the old and primitive method of haulage or towing by mules on the path next to the canal. But, for the slow and uneconomical animal, a more efficient mechanical mule was substituted, hooked up to a trolleyline. The machines were either run upon a track on the banks of the canal - this method being practically a railway along the banks, the boats being trailers connected by a 50 metre (165 feet) long tow line to the motor cars (illustration below) - or either run upon the towpath itself - this method somewhat resembling a land-based trolleytruck convoy (picture above).

As with the animal powered systems, two persons were needed to operate the convoy: one on the banks (driving the locomotive or truck) and one on the boat (steering). Using this method none of the boats were equipped with a motor, which resulted in the same advantages as with the funicular [cable towing] system: any boat previously towed by mules or horses could be hauled in this way without any adaptations or the need for a specially designed towboat, and no wash was created, leaving the delicate canal banks untouched and eliminating the need for deeper waterways.



Electric mules on rails turned out to be much more reliable on the towpath than trolleytrucks, being operational every day and both day and night. The trolleytruck system only worked during daylight (at night too many drivers would end up in the water) and it could not be operated in winter conditions. The use and maintenance of the track system was two times cheaper than the trolleytruck system, but because of the higher capital costs a trolleytruck system remained a better choice on sections where traffic was low.

Bring back the trolleyboats!

All the above is more than a gallery of obsolete technology. Canal transport is already one of the most energy-efficient ways to transport goods. For every litre of fuel burned, a barge can carry a tonne of cargo for 127 kilometres (79 miles), compared to 97 km (60 miles) for a train and 50 km (31 miles) for a truck (source). Electrifying canals could boost this efficiency even further, bringing the possibility of a zero-emission transport system within reach.

These days many canals have reinforced banks, so trolley systems with a propeller would no longer pose a problem. However, especially interesting are those systems in which traction happens on land instead of in the water (all systems excluding a propeller), because they are extremely energy-efficient.

To move a barge of a certain tonnage at low speeds, an electric mule (or any of the other systems described) needs an engine at least 4 times less powerful than when this engine would be placed on the boat itself, propelling a screw (source). Wheels are more efficient than propellers. This means that for every litre of fuel, a barge towed by a machine on the banks or via a chain on the bottom of the canal could carry a tonne of cargo for 500 kilometres (310 miles) - ten times more efficient than a truck or lorry.

Zero-emissions transport system

Because many canals have locks and thus artificial height differences between water surfaces, renewable energy could be generated on the spot. The required electricity to power the barges could also be generated by wind turbines or solar panels, which would make a zero-emissions transport system also possible in flat countries. Because of the very low energy requirements, the investment in renewable energy would be relatively small (contrary to, for instance, the plans to charge electric cars using solar panels). And as always, obsolete systems can be substantially improved with today's technology and materials.

Low-tech canals

Of course, canal barges are much slower than trucks or trains. But, if they could haul cargo for almost nothing, it would still be an economical choice for many goods. This advantage would grow if oil prices would rise. Many abandoned canals could be put in use again, and even new ones could be built.

Almost all methods above were designed for use on very shallow, trapezoidal "low-tech" canals, which were only 2 metres (6.5 feet) deep at the centre, and much less on the sides (see picture below). These are not public works like the Panama Canal which would take decades and require thousands of workers (or energy-guzzling machines) to build. This is something that might even be done on a community level.

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