

MARTIN SODOMKA



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HOW TO BUILD A RAILWAY

A technical tale about the age of steam

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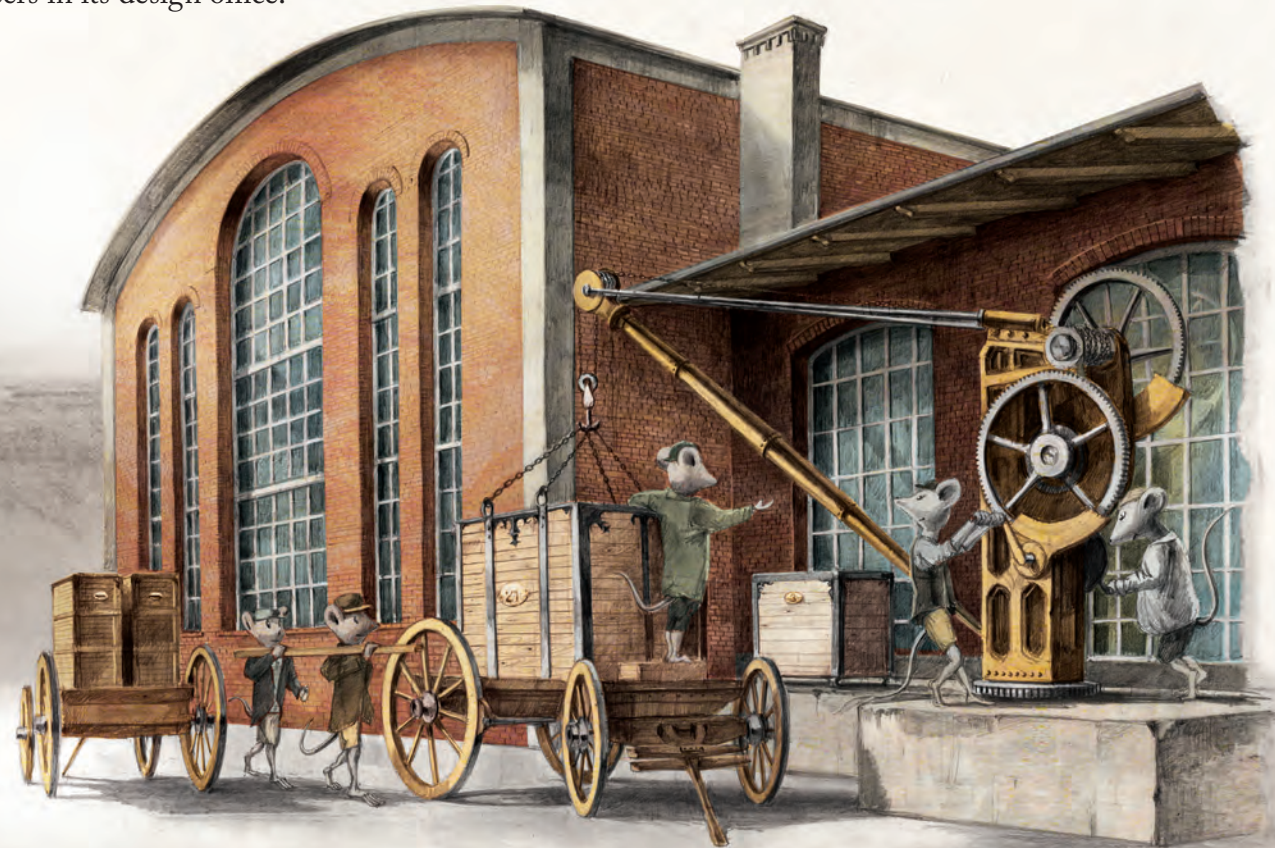


Let us now return to the Royal City and to the Ministry of Economic Affairs, where officials had – unusually for them – been working at great speed. In the few days since the session of the government, an order for three locomotives had been placed with Stephenson Ltd., a world-famous manufacturer in the Island Empire. It was the Ministry's plan that the three domestic firms invited to enter the competition would be given one locomotive each. It would be the task of these firms' engineers to study the design of the locomotive, then assemble and launch one of their own. Although the purchased machines were dismantled to make them easier to transport, many weeks passed before they arrived in the Monarchy.

Although the KAEW company produced steam engines only, locomotives were nothing new for the engineers in its design office.

One of them, Mr Trojan, had been involved in their development in the Island Empire, no less. By the time the heavy crates and their mysterious load appeared in the yard in front of the assembly shop, construction work on KAEW's own locomotive was in full swing.

Max was now assistant to Schwach the foreman, who was slowly beginning to appreciate his industriousness and aptitude. Their relationship was benefiting, too, from Max's decision to keep his smart comments to himself, a decision he mostly abided by. Max should have been moved to another shop long before, and he had stayed with Schwach at his own request. A few days from now, they would start assembly work on the legendary Island locomotive, and he wanted to be there when they did.



INDUSTRIAL ESPIONAGE



INDUSTRIAL PATENT

Every new invention costs its creator a lot of work and often a great deal of money. So it is only fair that their efforts should be properly rewarded. In the first instance, they must record their invention at the patent office, which registers it under its protection for a certain period, usually twenty years. The inventor then becomes the owner of the patent. This means that they have the exclusive right to put their invention into production, although if they choose, they can allow it to be produced by another under licence for an agreed fee.

"Praise the Lord, Max, is your light still on?" called Arnold, who was returning in high spirits from a Sunday visit to the theatre. "Do you spend your money on anything but paraffin?"

"Good evening, Arnold," replied Max, looking up from the desk. "How was the theatre? Did they marry in the end? Did it make you tearful?"

"You're a barbarian," replied Arnold. "What are you studying?"

"The latest number of the Imperial Engineers' Gazette," said Max, as he continued to thumb through the thick journal. "The Islanders are thinking of producing a locomotive powered by three wheelsets."

"I have to admit, Max, that I don't really know how locomotives work," said Arnold. "Of course, as

a civil engineer, I don't need to. But as I'm building a railway, it would be good to know more about them. How about giving me a short lecture? But in really simple terms, so that I understand. You might like to imagine that I'm Miller from Midway's daughter."

"My imagination doesn't stretch that far, Arnold. Surely you noticed the fervour with which that young miss admired the railway? There's no way that I'd ever explain to her how a locomotive works."

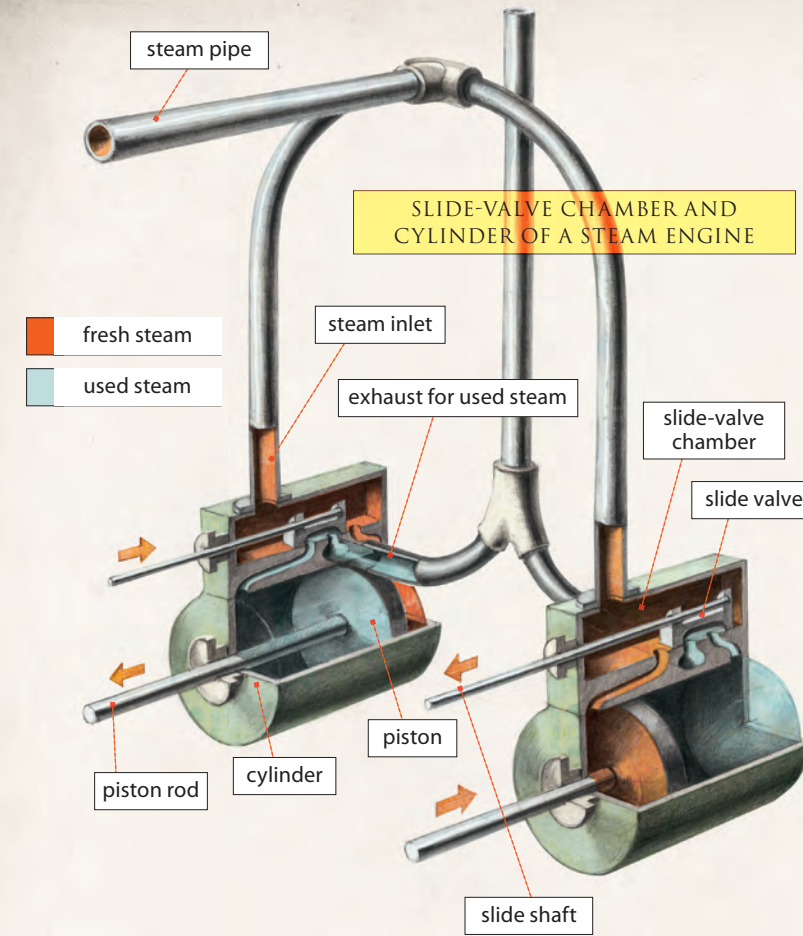
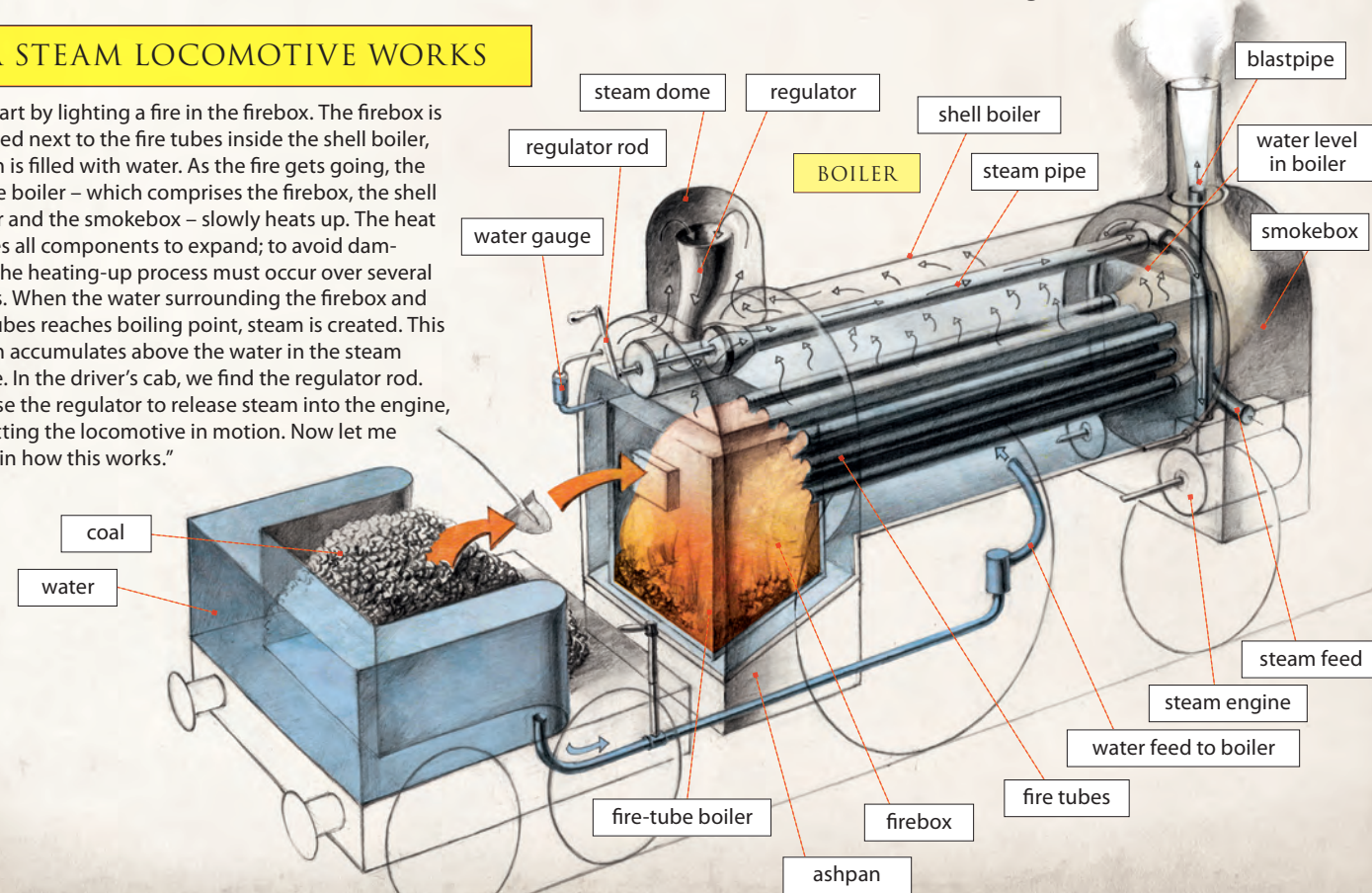
"All right, let's forget the girl," said Arnold, waving the thought away.

"You started it!" Max protested.

"I beg your pardon," said Arnold. "Anyway, what have I got? Coal, water, and a shiny new track ahead of me which I want to move along. So how do I do it?"

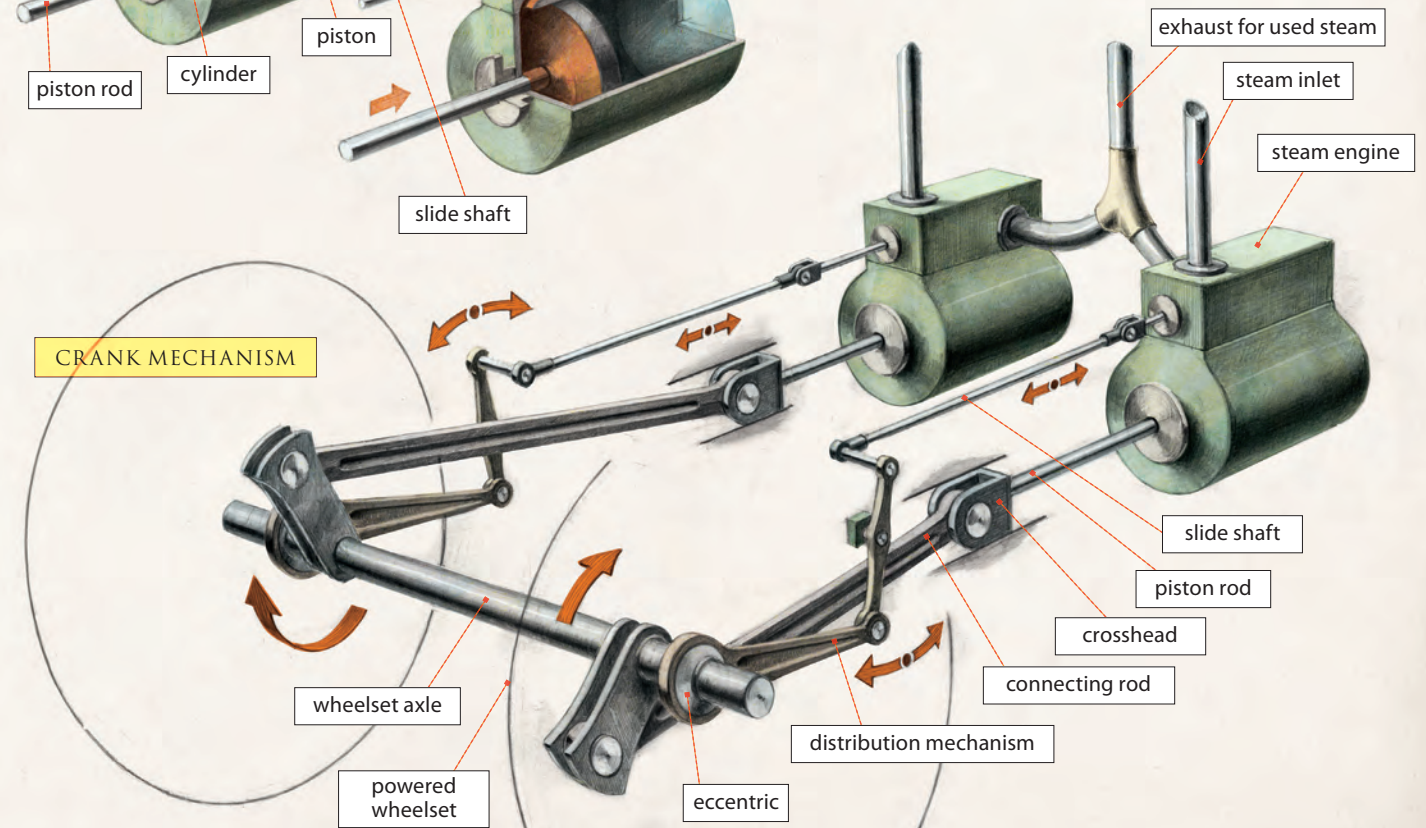
HOW A STEAM LOCOMOTIVE WORKS

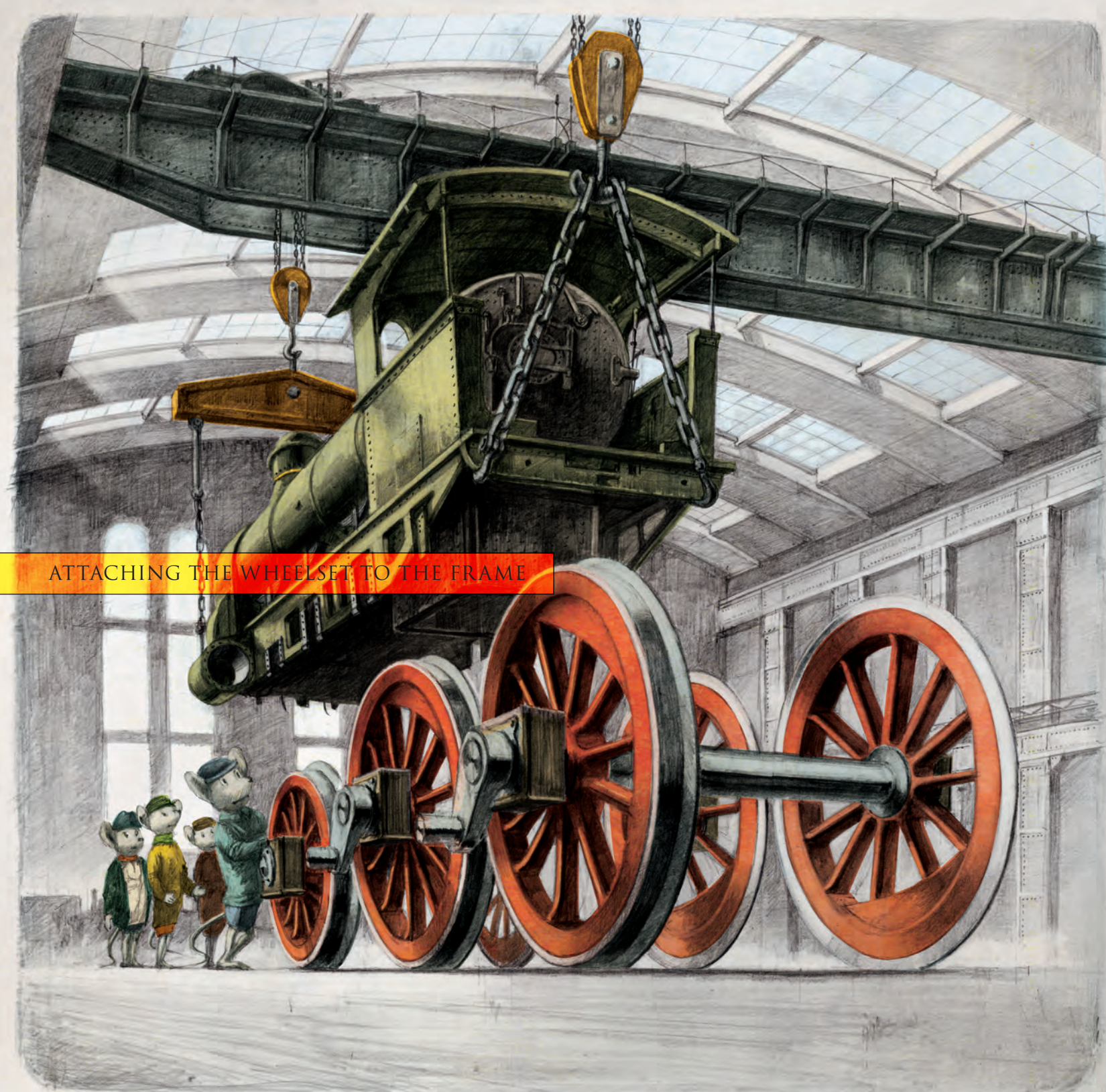
"We start by lighting a fire in the firebox. The firebox is situated next to the fire tubes inside the shell boiler, which is filled with water. As the fire gets going, the whole boiler – which comprises the firebox, the shell boiler and the smokebox – slowly heats up. The heat causes all components to expand; to avoid damage, the heating-up process must occur over several hours. When the water surrounding the firebox and fire tubes reaches boiling point, steam is created. This steam accumulates above the water in the steam dome. In the driver's cab, we find the regulator rod. We use the regulator to release steam into the engine, so setting the locomotive in motion. Now let me explain how this works."



"A steam engine comprises a slide-valve chamber and a cylinder. A locomotive has two steam engines – one on each side. Steam rushes into the slide-valve chamber, where it is distributed by the slide valve to the cylinder, alternately in front of and behind the piston. The steam causes the piston and piston rod to make a sliding motion, which then, by means of a crank mechanism, converts to the rotational movement of the locomotive's wheel. Having done its work, the steam exits by one side of the cylinder through the channel of the slide valve, simultaneously freeing up space for fresh steam to enter from the other side. Used steam doesn't exit to no effect – by means of the so-called blastpipe, it is diverted to the chimney, where its flow increases the boiler's thrust."

"The crank mechanism includes a valve gear, which is a set of pull-rods that control the movement of the slide valve. The engineer can operate the valve-gear mechanism, so deciding whether the locomotive will move backwards or forwards, from his cab. But I'll explain all that to you some other time, Arnold. It's getting late. I hope at least some of that made sense to you. Arnold? Arnold, you've fallen asleep!"





ATTACHING THE WHEELSET TO THE FRAME

“Well, friends, a week from now I reckon we’ll be starting a fire under the boiler and letting our beauty show us how strong and fast she is,” Kowalski told his colleagues, all of whom had gathered that morning in the assembly shop to supervise the setting of the crank mechanism.

“I hear that the Baron is planning to hold a banquet, said one of the designers. “He’ll light his pipe and then use the same match on the wood chips in the locomotive’s firebox.”

“I hope the flame doesn’t let him down,” volunteered another. “That would be a bad sign.”

“Let’s not go in for idle debate, gentlemen,” said Kowalski. “What have we decided on for lubrication? Will we go with that new mineral lubricant from crude oil?”

“I’m in favour,” said Senior Engineer Trojan. “Not only is whale blubber terribly expensive, I can’t imagine whales would like it much. Besides, it’s about time we started using oil for something other than paraffin distillation. It creates so much waste – no one knows what to do with the petrol it leaves behind.”

“Let’s return to the task at hand,” Kowalski went on. “So we’ve decided on the test drive route Manadam– Skinflats–Small Hills, where the track is ready. We have the Chief Inspector’s permission. We’ll perform the test shortly after sunrise, but even so we need to be prepared for an army of onlookers.”

“This will be a different kind of test drive to the one we did on the Island. That was carried out on our factory’s tiny polygon.”

“Is it known how we’ll get the locomotive to the Royal City?” someone asked. “With the competition being held before the opening of the Raudnitz Tunnel?”

“By riverboat,” said Kowalski. “The railway siding to the port of Manadam is ready, and they’re finishing off the railway dock in the Royal City.”

“Do we have a crane for it?” asked someone else.

“We did consider using a crane, but then Mr Trojan came up with the idea of moving the locomotive by specially modified tugboat. We calculated the cost and learned that this would be cheaper than building a crane.”

“What hard work it was!” remarked Trojan. “Now I’ll be really disappointed if we don’t win the competition.”

MOUNTING THE CRANK MECHANISM



Arnold was wrong to think that what had come to Max in the Raudnitz Tunnel was an attack of madness. It was an idea. For the rest of the holiday he made a poor companion. He filled page after page of his notebook with crazy sketches, and he couldn't wait to get back to the office.

"Please come and take a look, Mr Kowalski," said Max, as soon as he was back at his drawing board. "Until now, the steam has gone directly to the steam engine to do its work. Here, before it enters the engine, the steam passes through superheating pipes built into the boiler's fire tubes."

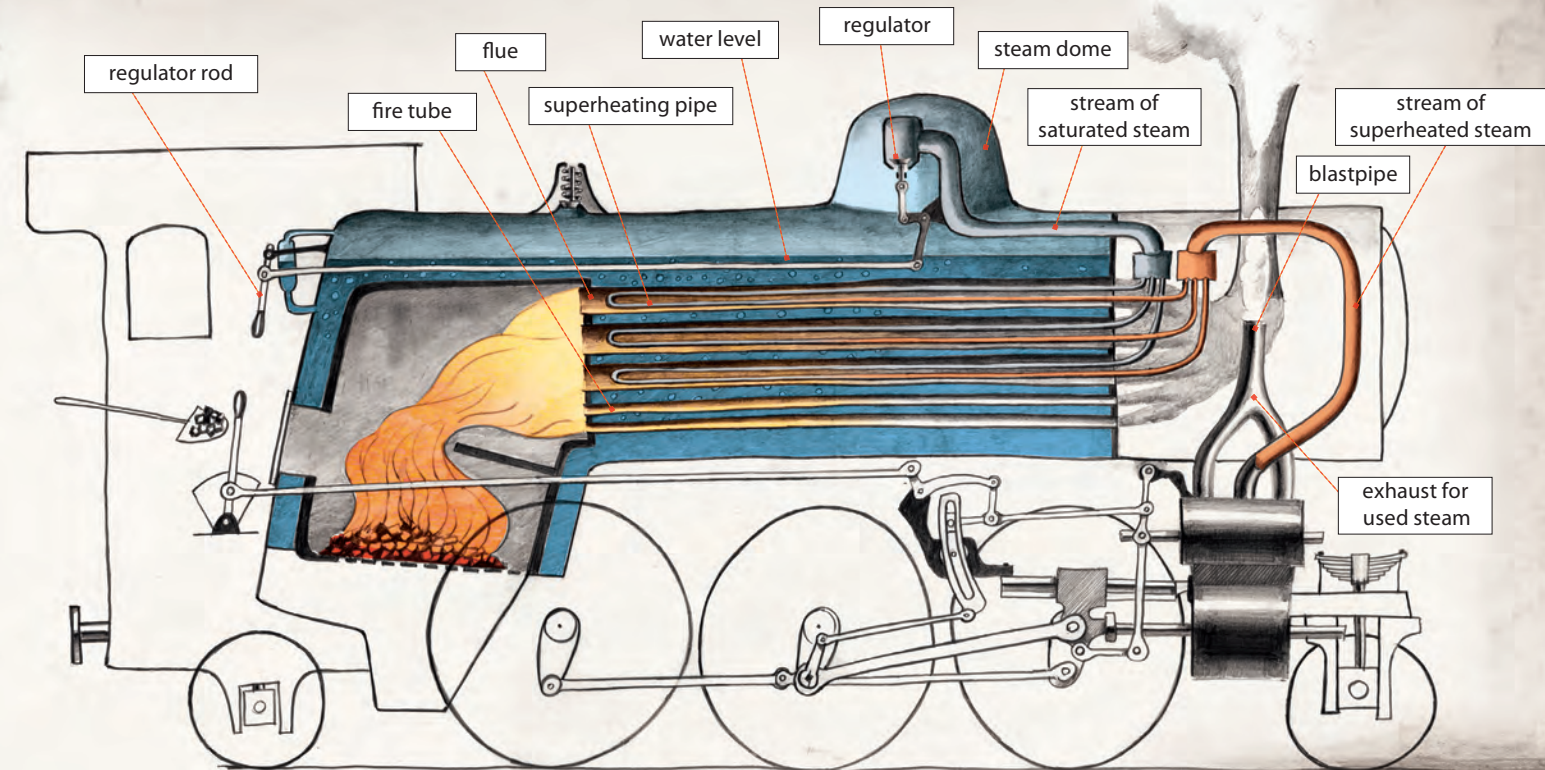
"I see," said Kowalski, thinking hard. "But the diameter of the fire tubes will need to be increased ..."

"Yes, I know," Max went on eagerly, "their di-

ameter is greater. To avoid confusion, I've taken to calling them flues. The steam passes through the superheating pipes, so increasing the pressure and the temperature significantly – I reckon up to 400°C. In addition, in this way the steam is so well dried that all drops of water are removed, meaning that there's no condensation in the steam engine; this will increase efficiency still further."

"I must admit, Max, that your idea isn't at all bad," Kowalski declared. "What I like about it most is that the superheater uses heat from hot combustion products that would otherwise be lost to no effect. Congratulations! You will have this fantastic invention patented, I suppose."

"Do you think I could ...?"



"Certainly I do!" said Kowalski. Then he added sadly and a little hesitantly, "I only regret that it will

SUPERHEATING THE STEAM

be impossible for us at KAEW to try out your idea on a locomotive. I would understand, of course, if you wished to move to our competitor First Royal. A talent like yours would surely find a use in Professor's Braun's team."

Max was astonished. "But Mr Kowalski, you took me into the design office and put your trust in me. Surely you can't think ... I've no intention ..."

"Thank you, Max," said Kowalski with relief. "I appreciate your attitude very much, and I won't

forget it. By the by, as you know, the celebratory ride from the Royal City to Manadam will take place next Saturday. On the way back, a train will be added to the parade, pulled by the Island locomotive we put together here."

"I don't understand why our Lizzie can't do it," said Max, seeing red. "She's a much better machine! The Island's locomotives are already museum pieces."

"Don't let it upset you. You haven't heard the best news yet," said Kowalski. "Our office has been given three tickets for the ride, and I trust your pride won't stop you from coming along. This first, historic train ride to the Royal City shouldn't be missed, you know."

The celebratory ride from the Royal City to Manadam was a long-anticipated, indeed historic event. The two trains set out, the first pulled by the Island's locomotive, the second by Professor Braun's. The King and his ministers, Chief Inspector Perner and a number of guests travelled in a special saloon carriage, which was attached to the end of the second train. Stops were made in almost every town, to be greeted by a band and a speech by the local mayor. The trains had just puffed up the eastern edge of the Dragon Mountains when the King invited Professor Braun to take coffee with him in his saloon car.

LAW OF ENERGY CONSERVATION

"Is it truly the case, Professor, that our journey is powered by boiled water?" said the King, as his opening remark.

"I wouldn't put quite it that way, Your Majesty. The heat inside the locomotive is generated by burning coal, so creating kinetic energy. The water is simply the medium."

"Your explanation is too complicated, Professor," grumbled the King.

"It works the other way around, too," said the Professor, glad of the opportunity to make things clear. "Kinetic energy can be converted to heat – when the train brakes, the brake blocks heat up. Imagine a comet crashing into Earth: its tremendous speed is converted instantly into kinetic energy, so creating a devastating explosion."

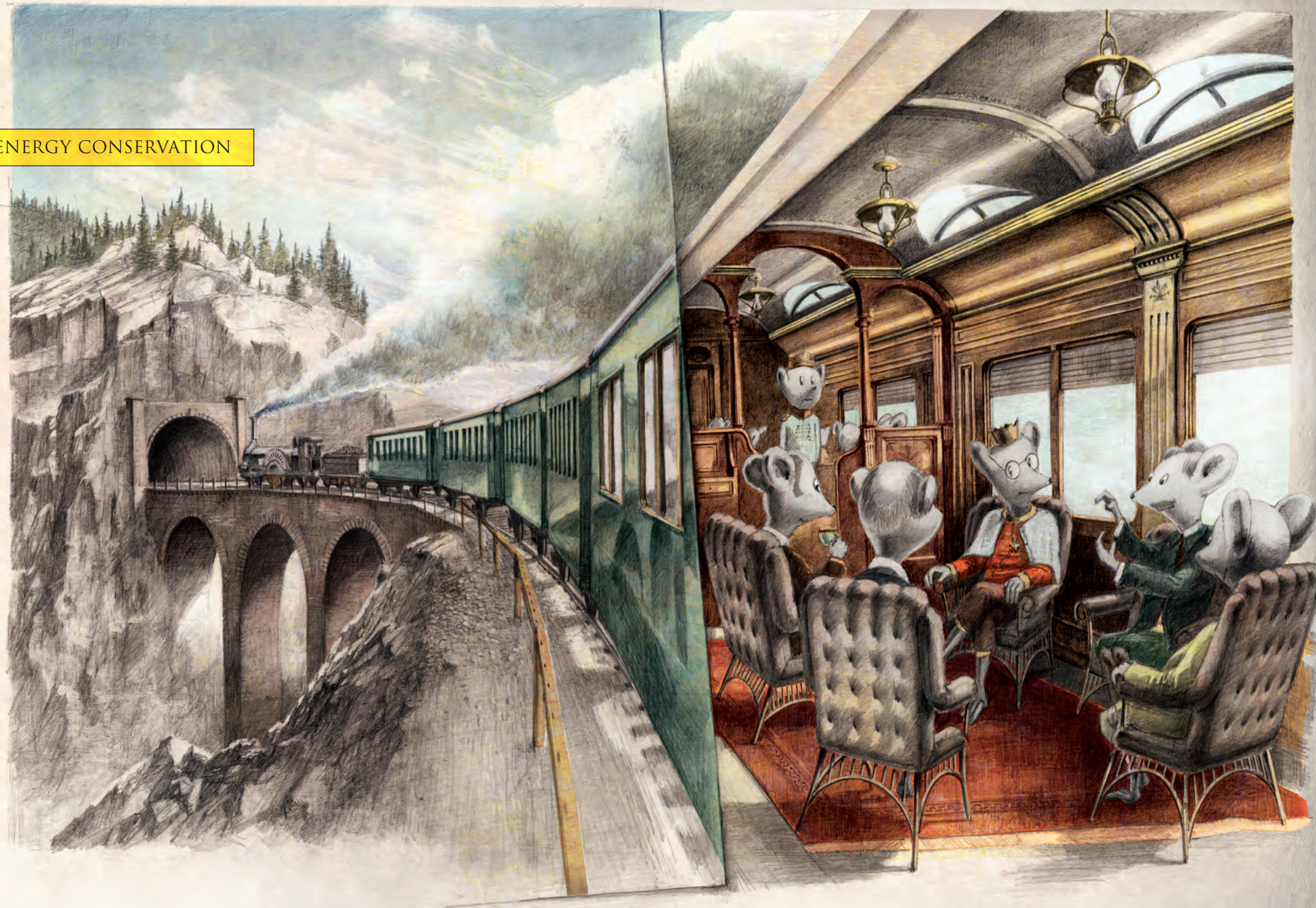
"And now you are frightening us," one of the ministers chipped in obsequiously.

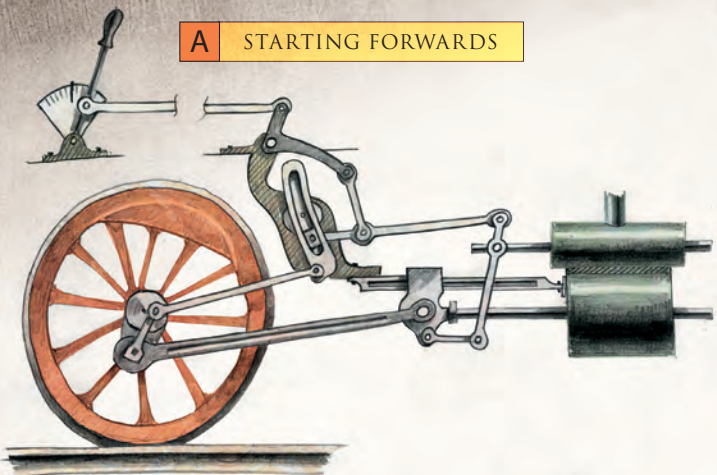
"That is not my intention, gentlemen," continued the Professor, by now in a world of his own. "No energy can be extinguished, but nor can it arise out of nothing. It is conserved always, in every circumstance: that is law."

"If only such physical laws had applied when we set our budget!" said the King, giving his finance minister a meaningful look.

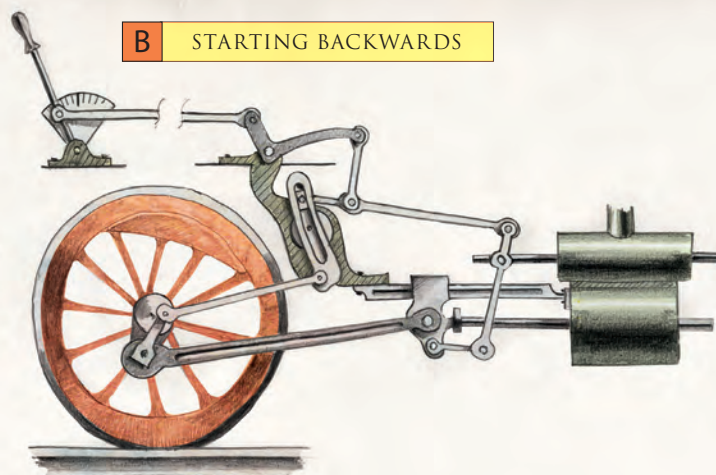
A few years after the time in which our story is set, an extremely bright lad called Albert was born. Albert was forever scribbling things on paper; it didn't take him long to work out that matter could be converted directly into energy. One kilogram of matter (be it of gold, potato peelings or whatever else) would give us 90,000,000,000,000 kilojoules of energy. Before the morning shift, and before the locomotive set out on its journey, the stoker would put a kilogram's worth of fuel in his satchel, so allowing him and the engineer to disconnect the (unnecessary) tender. A force of 100 kilonewtons would take their locomotive a surprisingly long way; in fact, it could take it all the way around the globe – 22,500 times! The problem is, nobody knows how to put this into practice. For that, we must wait for another brainbox like Albert to come along.

$$E = m \cdot c^2$$



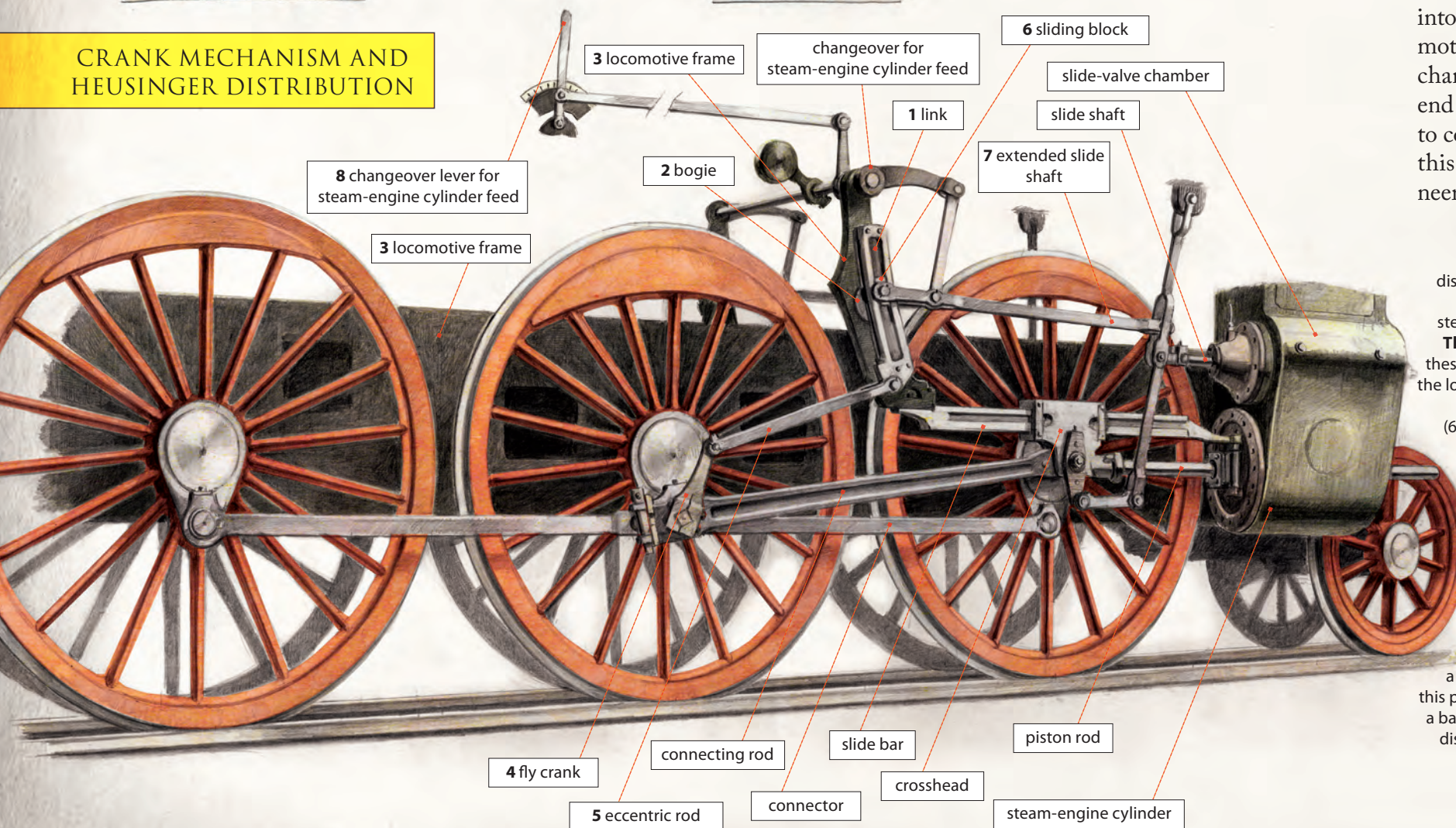


A STARTING FORWARDS



B STARTING BACKWARDS

CRANK MECHANISM AND HEUSINGER DISTRIBUTION



Outdoors the first snowflakes were falling, but the design office was nice and warm thanks to its cast-iron stove. The air smelled of coffee and sharpened pencils. Through the small panes of the large windows light fell on the boards and a large desk covered with drawings. It was at this desk that Mr Trojan was standing as he addressed the others.

“Heusinger’s distribution system is based on the latest research, which has proven that a smooth ride can be achieved without the need for a steam flow into the cylinder for the whole time the piston is in motion. This makes it possible to close the filling channel much earlier, before the piston comes to the end of its path. The pressure of the steam allows it to continue to expand and so do its work. Thanks to this solution, known as partial charging, the engineer can drive the locomotive by adjusting the link

on the crank mechanism. When starting, he sets the charge at high; once the ride is smooth, he can reduce it by half. Now he can save whole clouds of steam, and his stoker won’t have to keep stoking, so stretching his arms like a monkey’s.”

“Please express yourself more moderately, Mr Trojan,” said Kowalski. “We wouldn’t wish to offend other animal species.”

“But I’m right, aren’t I?” said Trojan. “Have you ever seen a monkey?”

“With our big ears and long tails, we’re no oil paintings ourselves,” replied Kowalski.

“We look normal,” Trojan protested. “Holy cow! We’re back to discussing nonsense,” sighed Kowalski.

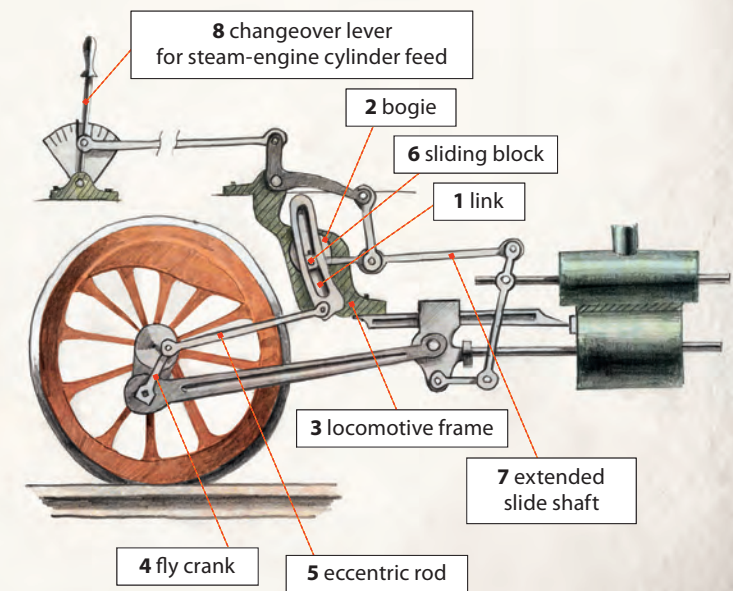
“Be careful, boss,” Max chipped in. “We wouldn’t want the cows to complain at your choice of words.”

An essential part of every steam engine, a slide valve ensures the optimum supply of steam to the cylinder. Let’s take a look at the distribution mechanism which sets the slide valve in motion. As the steam locomotive evolved, various such mechanisms were tried out.

DISTRIBUTION MECHANISM

The Heusinger distribution system proved the most successful of these. It works as follows: a curved link (1) is attached by a bogie (2) to the locomotive frame (3), allowing for a swinging movement, achieved by means of a fly crank with an eccentric rod (4, 5). A sliding block (6) moves along a milled groove in the link. An extended slide shaft (7) is attached to the sliding block. The engineer controls the position of the sliding block in the link using the changeover lever (8), in so doing adjusting the charging of the cylinders and determining whether the locomotive will move forwards or backwards. To move off forwards (A), the engineer moves the sliding block downwards, so drawing a great charge into the cylinders. For a smooth forward ride, the engineer reduces the charge by shifting the sliding block to a position just below the rotational centre of the link (C). To move off backwards, the engineer shifts the sliding block into the upper half of the link (B); for a smooth backward ride, he shifts it to a position just above the rotational centre of the link. If you started this paragraph at the beginning and you’re still reading it, you deserve a bar of chocolate for your trouble. And if you’ve understood how the distribution mechanism works, take a look in the mirror. What you’ll see there is the face of a genius!

C SMOOTH RIDE FORWARDS



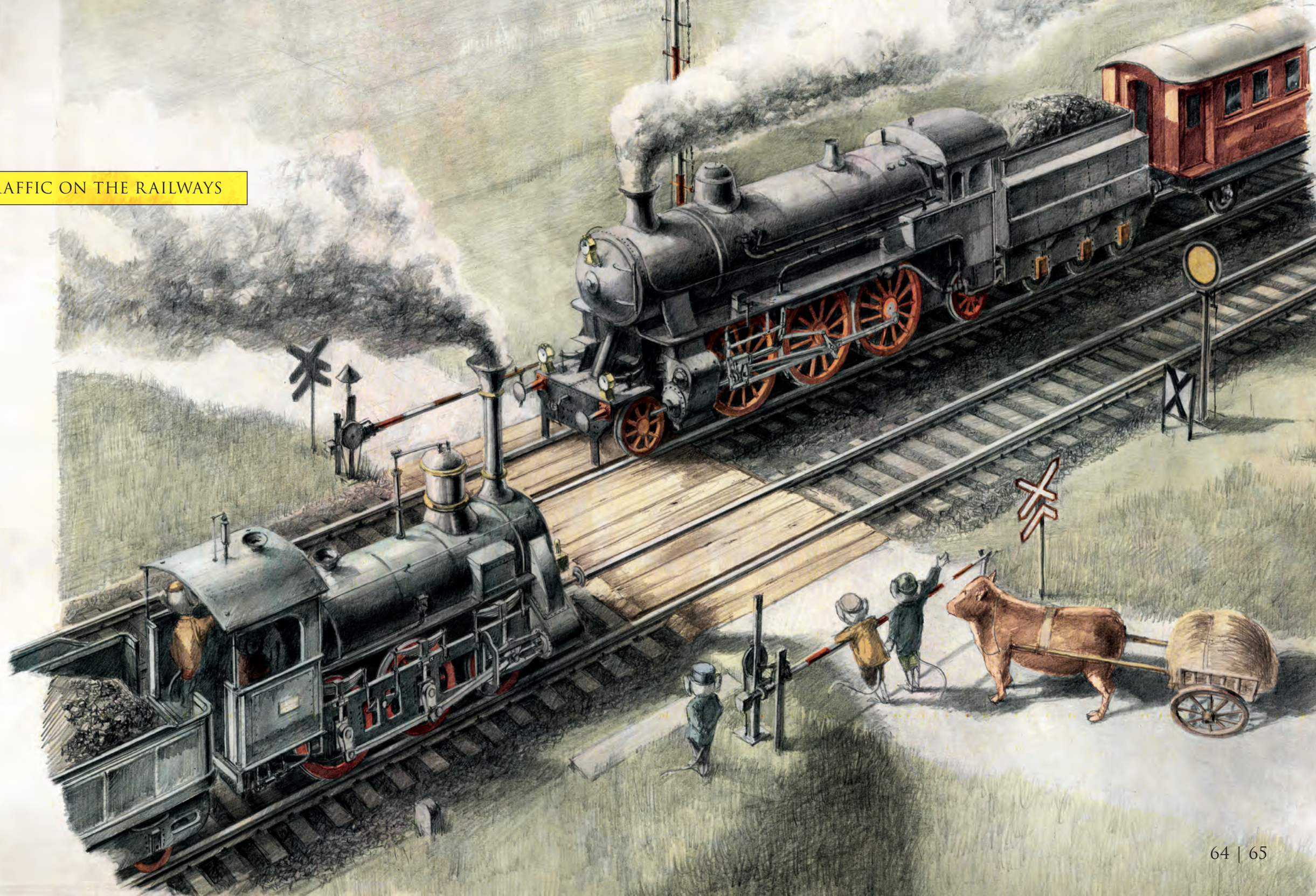
The railways had been in operation for two years now. They had altered the landscape, brought distant places closer together and provided a living for thousands of people. Gradually and according to plan, more towns were connected to the railways and the main routes

REGULAR TRAFFIC ON THE RAILWAYS

were connected to the international network. Small, sleepy villages, such as Midway and Small Hills, became new centres of trade. The building of local tracks, connecting the Monarchy's more remote places to the railway network, was ongoing. The central railway was rebuilt with two tracks, while a large goods station was completed in Manadam.

Max's first trip by rail had ended in the accident at Whitcastle, and it had taken him just a few kilometres. But he had travelled much further than he could have imagined. On his return to the city, he received a visit from his father, who confessed to having spent a sleepless, fear-filled night. The first news that reached Manadam had exaggerated the extent of the accident, and old Mr Reznar had entertained the darkest thoughts. In the process, he had recognized with a heavy heart the foolishness and pointlessness of his quarrel with his son.

Max accepted with alacrity his invitation to dine at the family home. And he did not go there alone. The young lady who accompanied him was called Rachel.





FITTING OUT AND MAINTAINING A LOCOMOTIVE

“Hello, Max. You’re a difficult chap to track down.”
 “Good to see you, Arnold. We’re testing something new. Come and see. It’s a coaling crane. New locomotives have a huge tender, so it’s impossible to stoke them with a shovel. This thing still isn’t working exactly as we want it to, though, so we’re giving it a good talking-to. Anyway, how did you find me?”

“I went to your office and your assistant told me you’d be here today.”
 “Why didn’t he come with you?” said Max with a frown.
 “There was no need. I know this heating shed: we built it last year. But I’ve come, Max, to say goodbye. I wanted to catch you now because I’m leaving early tomorrow morning.”

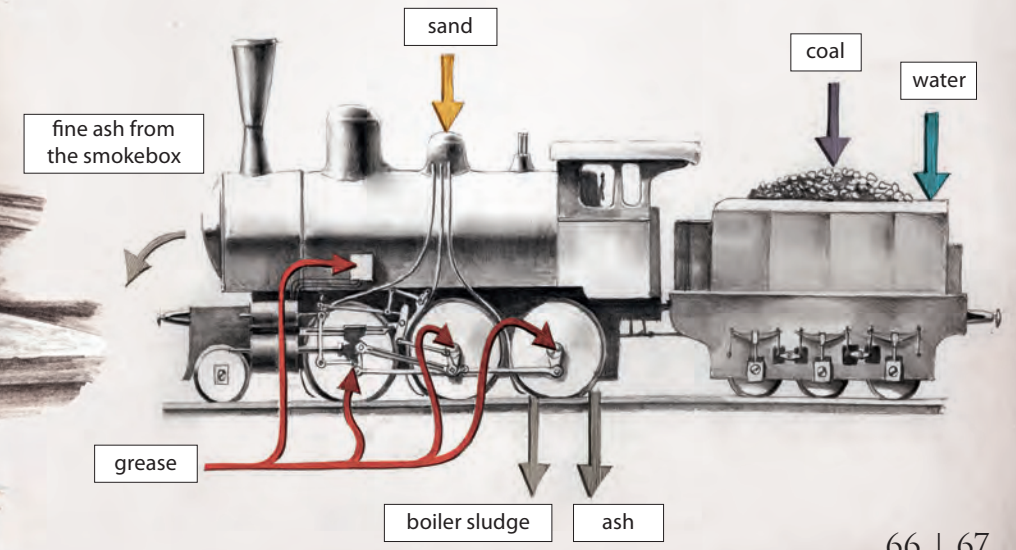
“Look after yourself, my friend. How long will you be away?”
 “A year. Maybe two. We’ll be directing the building of the railway right across the Eastern Mark.”

“I haven’t even had chance to congratulate you on getting the job of chief engineer,” said Max. “I read about it in the paper.”

“Thanks. By the way, I heard an interesting rumour. They say you’ve contracted yourselves to send ten locomotives to the Island Empire. If so, that’s quite a feat.”

Max suddenly looked sad. “I’m really sorry you won’t be at our wedding.”

With a smile, Arnold put his hand in Max’s. “Maybe I’ll make it back in time to become a godfather.”




Next time you go on a train, try to imagine what the landscape was like before the railways came along. All those bridges, tunnels and stations give the impression that they have been there forever, don't they? As you travel in your comfortable carriage, it probably never crosses your mind that the place where you're sitting might once have been impenetrable forest, rocks or marshland.

Our ancestors started building the railways more than 170 years ago, and not only did they build them well, they managed to do so without diggers, electricity and mobile telephones. The work they did has been immensely useful, and it may well serve us into the next century.

There are other olden-day inventions we still use today – the book, for instance. The book allows us to enter the mind of another person, or to travel in time. So there's nothing to stop us visiting the railway builders of the distant past!

For children aged 8+



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