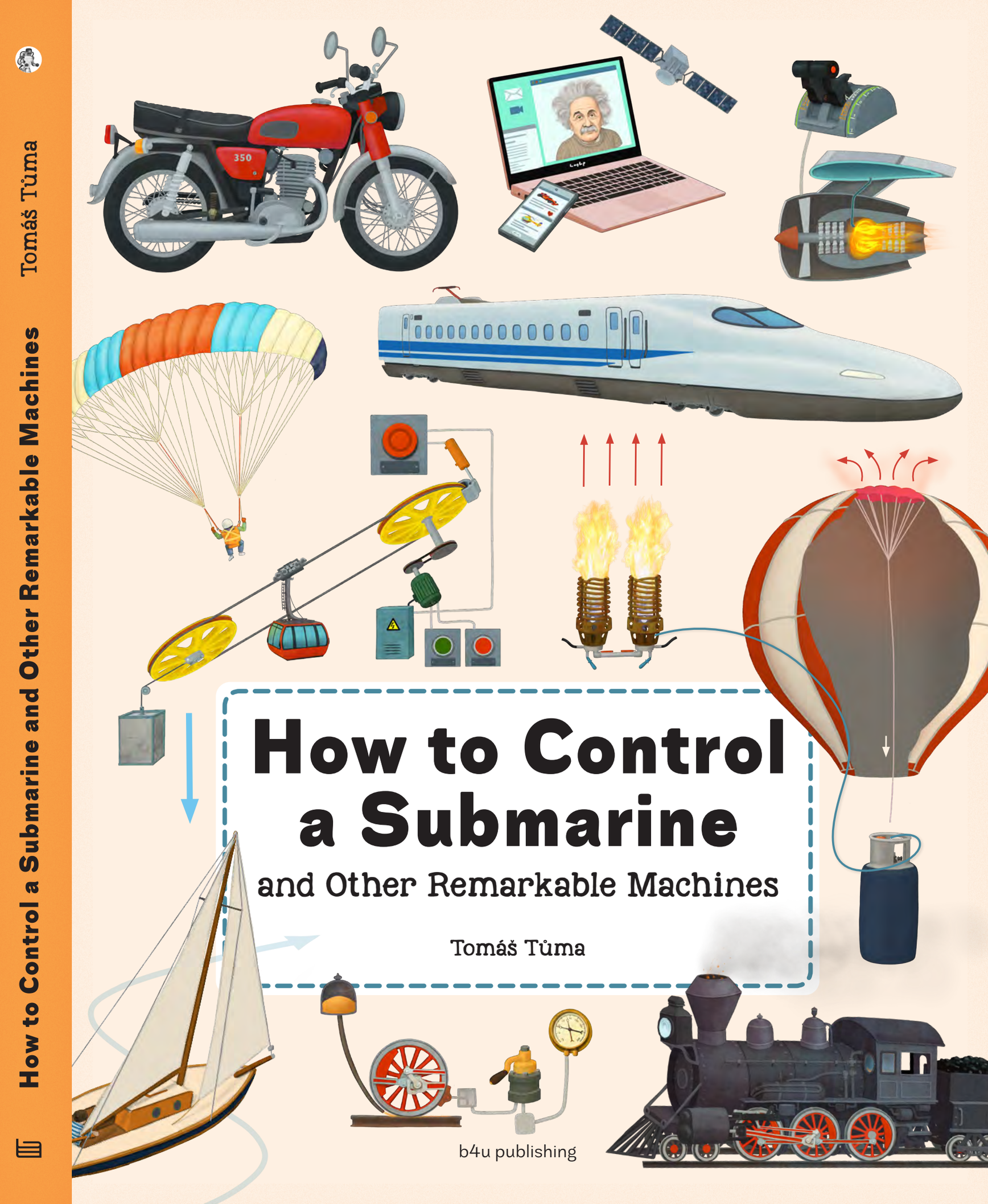
How to Control a Submarine and Other Remarkable Machines
Tomáš Tůma
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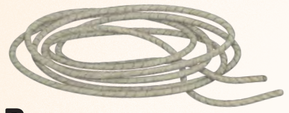
List of content

How works

a Sailboat

The adventurer's heart beats faster at the sight of vast ocean, the sound of waves breaking against a ship's bow. Just close your eyes and let your imagination wander to become a captain of a caravel voyaging around the world's unexplored regions or to be steering a frigate chasing a pirate ship laden with treasure. A small boat with a sail and rudder is more than enough for you to understand the basics of sailing.



Ropes

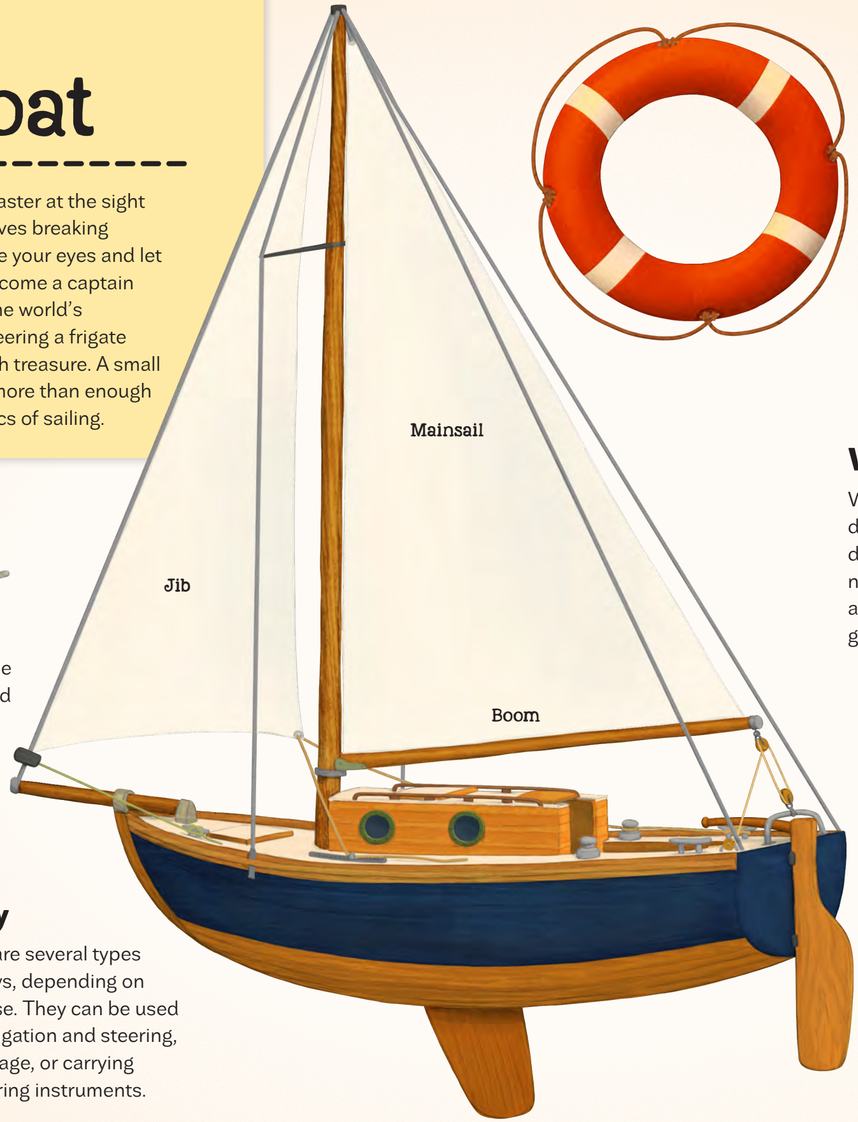
Depending on what you want to do with it you need to choose a rope of suitable thickness and characteristics. The so-called headfast, used when you need to moor a ship, must be flexible and resilient.

Buoy

There are several types of buoys, depending on their use. They can be used for navigation and steering, anchorage, or carrying measuring instruments.

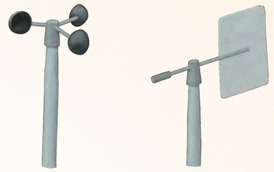
Compass

It's very easy to get lost in all that vast blue space, which is why the compass is a basic piece of equipment for any seafarer. It works even if the GPS runs out of power.



Man overboard!

Swimming in heavy seas can wear out even a good swimmer. Never undock without having a life jacket and life ring around!



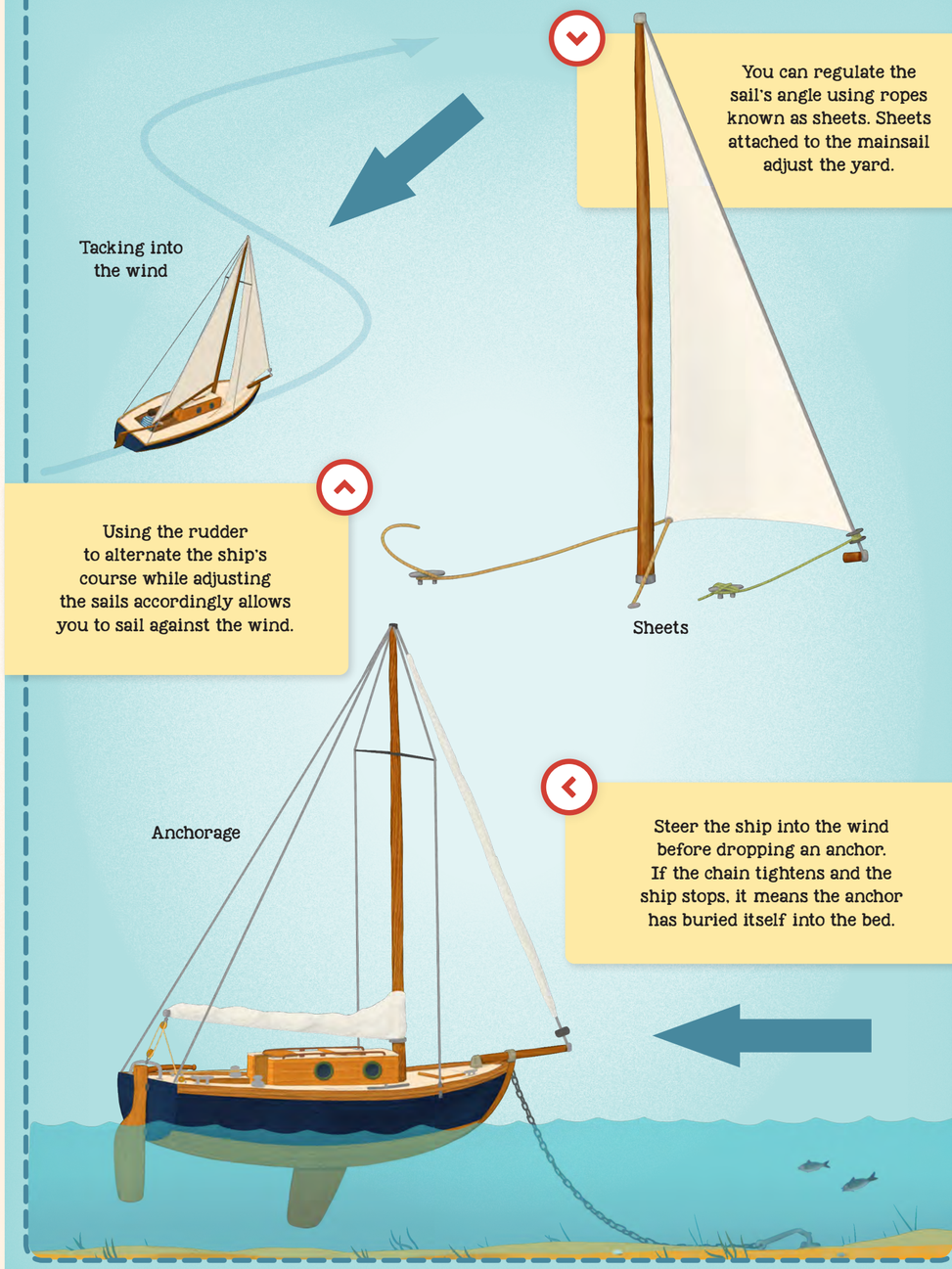
Wind

Wind direction and strength vary depending on the weather, time of the day, or the shape of the coast. Wind needs to be strong enough to make a ship sail. On the other hand, stormy gusts can destroy the sails.

Bucket comes in handy

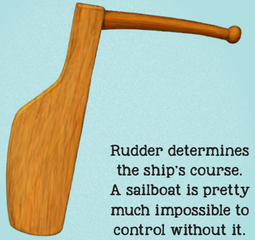
What kind of equipment is required depends on the sailboat's size. A small boat must be equipped with a paddle, a container to pour out water, or a manual pump.

Required equipment

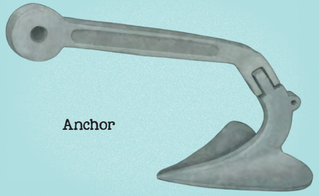


No sailor can make do without knowing their way around nots. The well-known bowline knot is easy to untie even if tightened.

A noose that secures a line to a cleat is called the cleat hitch.



Rudder determines the ship's course. A sailboat is pretty much impossible to control without it.



Anchor

How works

a Hot-air balloon

There's a certain sense of adventure and romanticism to travelling in the wicker basket of a hot-air balloon. Not even the wind whooshing is enough to spoil the perfect view of a landscape unfurling - that's because there isn't any whooshing. The balloon is actually carried by the wind. This type of aviation has one drawback, though, and that's the inability to quickly change the flight's horizontal course. Its advantages include the possibility of taking off from a meadow or field, with no runway needed.

Fuel

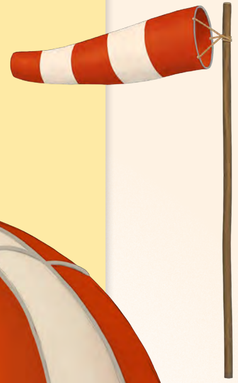
Fuel tanks contain propane or propane-butane. You'd need roughly 35 kg of propane for one-hour flight.

Ventilator

A ventilator inflates the hot-air balloon before take-off to make sure air can be heated without the burners setting the balloon aflame.

Textile envelope

Basket



Where to?

Air temperature affects fuel consumption. Wind direction usually varies depending on height, allowing the balloon to change course.

Up!

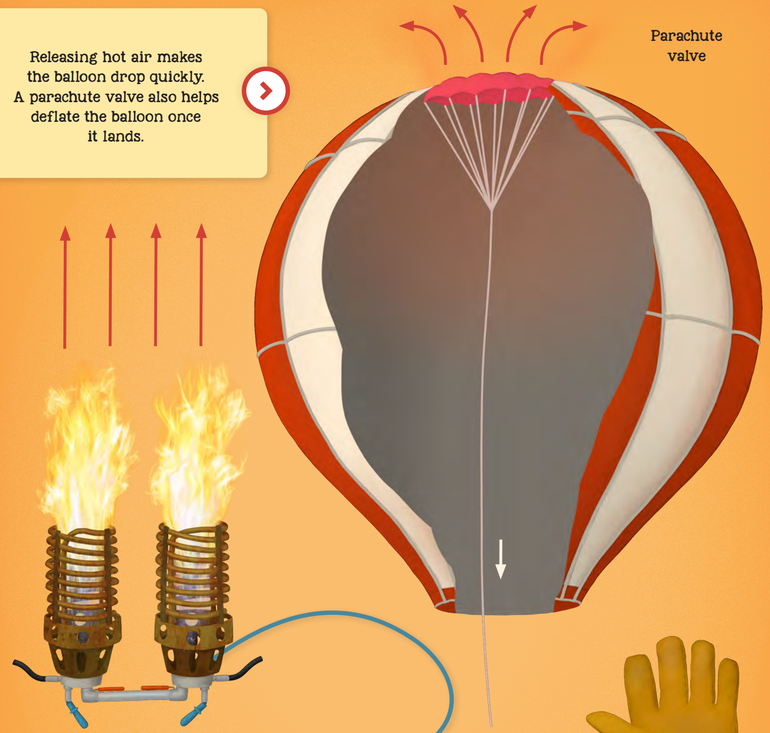
Aeronauts flying hot-air balloons control the balloon's ascent by heating the air. You can get higher by dropping sandbags when flying a balloon that runs on light gas, such as helium.

Light gas

Hot air

Releasing hot air makes the balloon drop quickly. A parachute valve also helps deflate the balloon once it lands.

Parachute valve



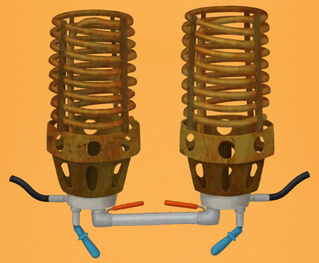
Burners

Fuel tank

Gloves protect against burns

Opening the blast valve ignites the fuel that's conveyed to the main burner's evaporator spiral. The flame of the ignition burner is responsible for the ignition.

A parachute valve cord opens the parachute valve in the top part of the balloon.



Heat is provided by a main flight burner, an ignition burner, and a whisper burner.

A basic flight instrument includes an altimeter and a variometer. The variometer shows the rate of descent or ascent.

How works

a Steam engine

Steam's pressure is enough to lift more than just a lid off a pot full of boiling water. An efficient steam engine can move a train of several thousands of tonnes. In the 20th century, construction advanced so much that engines could be made to go at 200 km/h. Nowadays even the few well-preserved steam engines left have little use, except for nostalgia-filled trips.

Working under pressure

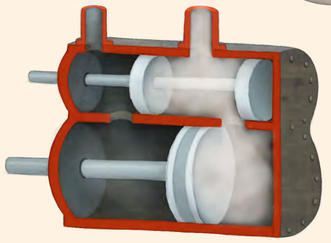
The fireman and the engine driver are a well-oiled machine. They constantly monitor steam pressure, water supply, fuel's distribution in the firebox, pressure in the brake pipes, and the rails in front of the train. A slight mistake, such as the boiler's door being open while the train's passing through a tunnel, could put the engine's crew in danger.

Start

You start the engine by striking a match. After heating the boiler up with wood you add some coal. At first you're surrounded with smoke and the water's temperature is slow to rise. It will be several hours before the wheels begin moving.

Water and coal

Apart from fuel you'll also need lots of water to drive the engine. Water cranes are used to quickly fill the water tank at the engine's side or the tender's fuel tank.

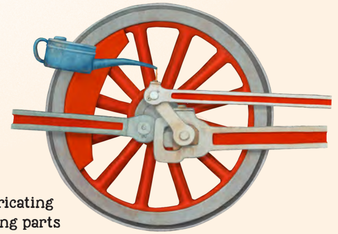


Steam power

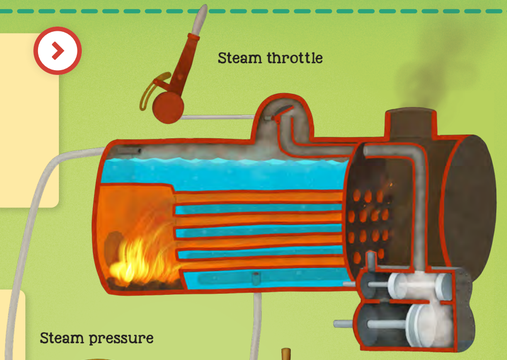
The engine's elaborate construction relies on hot steam pressure moving the piston in both directions. A valve releases the steam into the right part of the cylinder. A piston-rod and a crank transfer the piston's movement to the wheels.

Greasing the wheels

The engine's quickly moving parts would soon become red-hot and seize up without lubrication. Before driving off it's necessary to check and refill oil in the grease press and in many other places.



A regulator works sort of like gas in a car. It regulates the amount of steam released into the steam engine.



If pressure in the boiler becomes too high and the safety valve fails, a terrible explosion occurs.

Low water level can result in the firebox's top burning through, an explosion, and the crew suffering burns. A significant drop in the amount of water leads to a decreased steam production. Moreover, dispersed water droplets damage the steam engine.

Pouring the contents of a sandbox under the steam engine's wheels helps the engine pull away and ascend.

Wheels start moving once there's enough negative pressure throughout the vacuum braking system. This also ensures that the train will be able to stop even if the brakes are faulty or wagons decoupled.

Hydraulic oil temperature

Fuel gauge

Dipper and body control

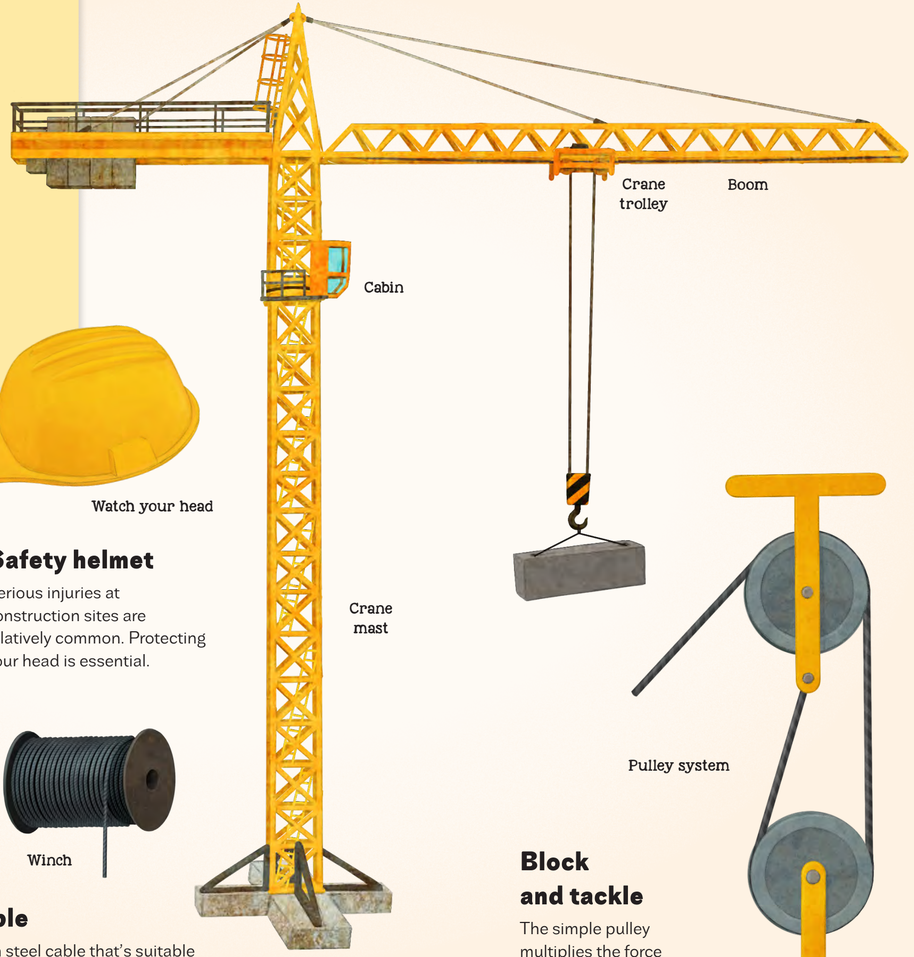
Boom and bucket control

Left and right track travel levers. By pushing the levers apart you can make the caterpillar go straight ahead.

How works

a Crane

Our team of hard workers includes a tower crane as well. It can be found at construction sites, in warehouses, or in ports. The heaviest among these giants help erect high-rise building and can lift a load of up to 60 tonnes. Lighter cranes have a chassis or tracked travel and can be assembled quickly.



Counterjib

Without a set of heavy concrete blocks to act as a counterbalance the crane would topple over when lifting a heavy load.

Counterjib

Electric motor

Electric motors power the trolley and the hoisting mechanism's winding drum and make the crane rotate.

Watch your head

Safety helmet

Serious injuries at construction sites are relatively common. Protecting your head is essential.

Winch

Cable

A firm steel cable that's suitable for cranes consists of many wires wound in many strands. It must be flexible and can't be prone to angular momentum.

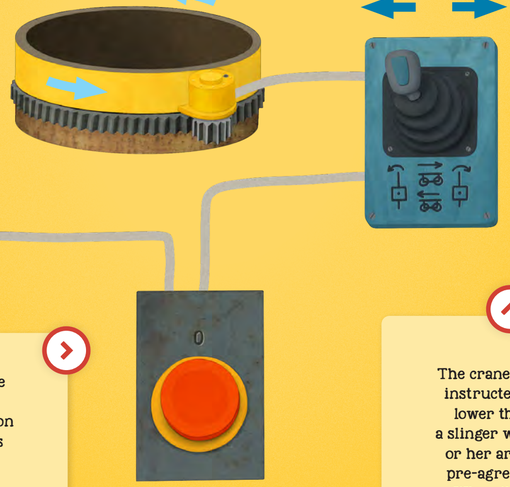
Pulley system

Block and tackle

The simple pulley multiplies the force on the steel cable and decreases the strain on the hosting mechanism's electric motor.

Lifting and lowering loads

The crane's turntable can be found at the crane's top or bottom. It's important for the operator to have a perfect view out of the cabin when rotating the crane.



In case of a failure or accident, an emergency button immediately stops the operation.

The crane operator is instructed to lift or lower the load by a slinger who uses his or her arms to give pre-agreed signals. When the slinger raises their forearm and makes a circular motion, it means "up".

Rudder angle indicator

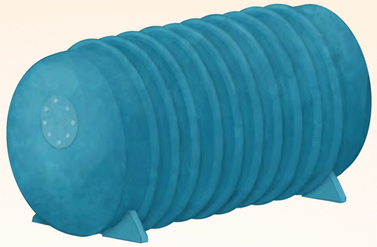
Handling the rudder requires great foresight because the heavy ship's inertia takes no prisoners.

Setting a required voyage speed

How works

a Submarine

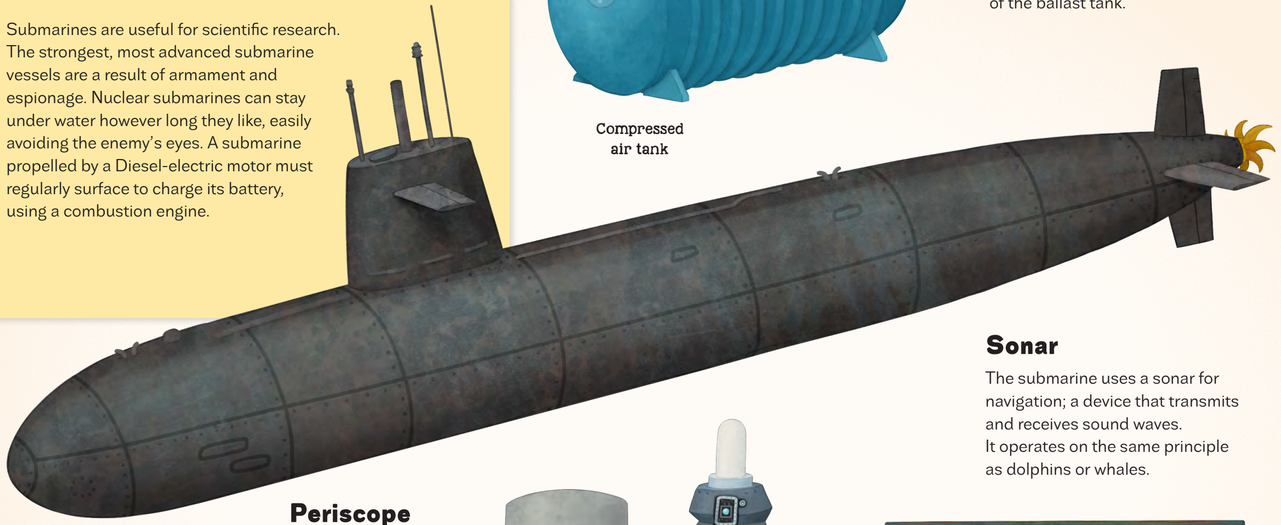
Submarines are useful for scientific research. The strongest, most advanced submarine vessels are a result of armament and espionage. Nuclear submarines can stay under water however long they like, easily avoiding the enemy's eyes. A submarine propelled by a Diesel-electric motor must regularly surface to charge its battery, using a combustion engine.



Compressed air tank

Air

Air supply is key if anyone's to survive inside a submarine. Air's also used for pushing water out of the ballast tank.



Sonar

The submarine uses a sonar for navigation; a device that transmits and receives sound waves. It operates on the same principle as dolphins or whales.

Linked accumulators

Battery

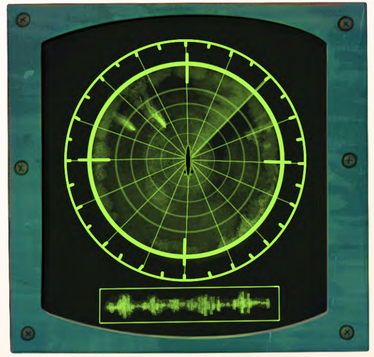
If a submarine runs on a Diesel-electric engine, the batteries are its only source of power when underwater.

Periscope

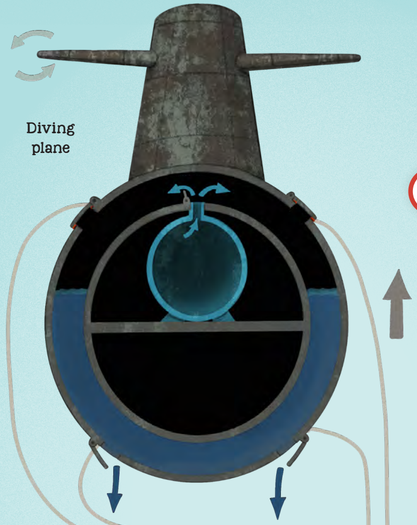
This device makes it possible for the surface to be observed safely. Modern periscopes contain a variety of sensors that allow the operator to monitor the situation at night.

Periscope

Camera and sensors



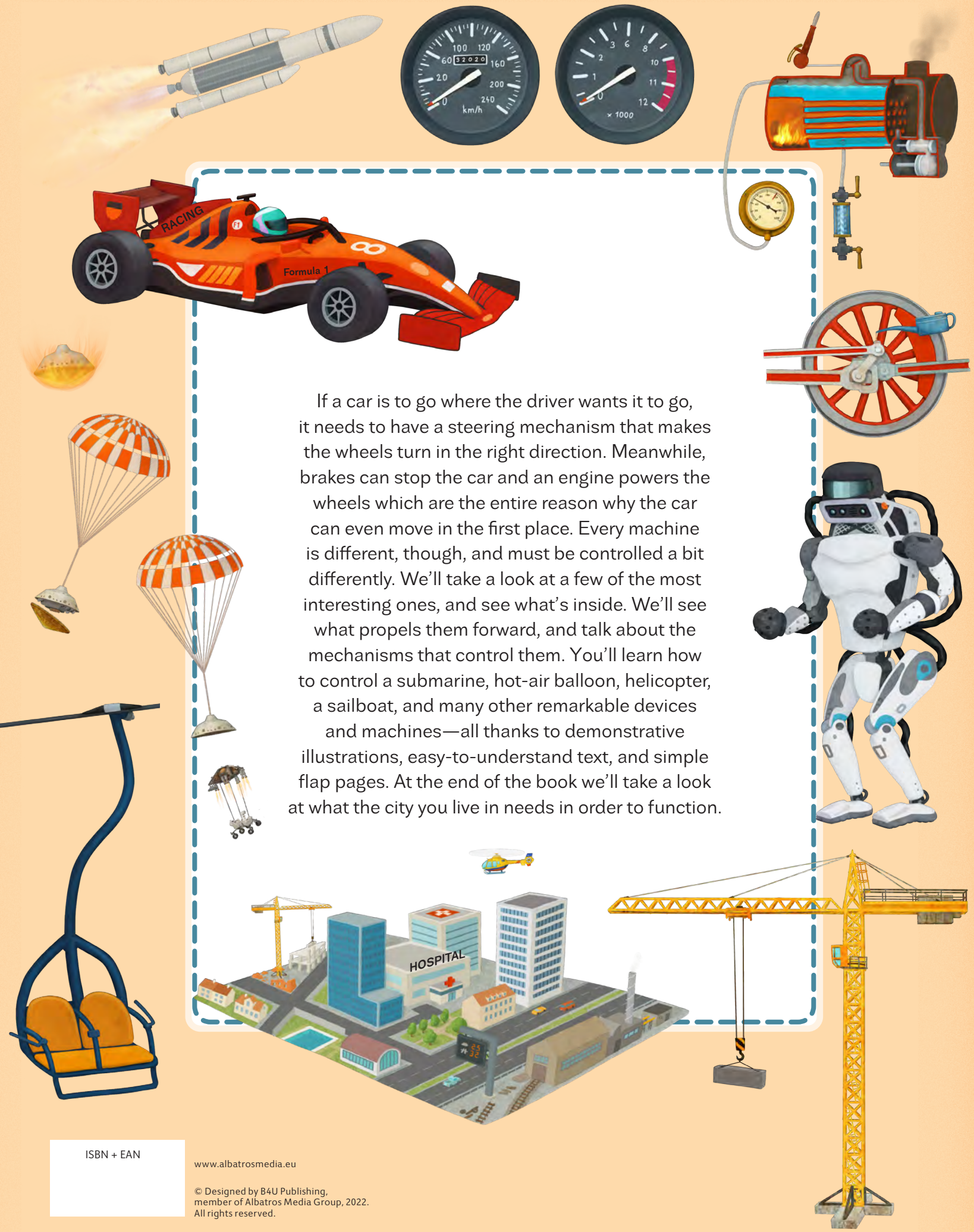
Torpedoes on the port side!



The amount of water in ballast tanks affects buoyancy. Using air pressure to empty the tanks makes the submarine surface. When the ballast tanks are flooded, only diving planes can make the submarine manoeuvre towards the bottom or surface.

If the screw propeller fails, the submarine has a big problem because it's no longer possible to use rudders.

A submarine propelled by a screw propeller can be manoeuvred simply by setting the diving planes and directional rudders.



If a car is to go where the driver wants it to go, it needs to have a steering mechanism that makes the wheels turn in the right direction. Meanwhile, brakes can stop the car and an engine powers the wheels which are the entire reason why the car can even move in the first place. Every machine is different, though, and must be controlled a bit differently. We'll take a look at a few of the most interesting ones, and see what's inside. We'll see what propels them forward, and talk about the mechanisms that control them. You'll learn how to control a submarine, hot-air balloon, helicopter, a sailboat, and many other remarkable devices and machines—all thanks to demonstrative illustrations, easy-to-understand text, and simple flap pages. At the end of the book we'll take a look at what the city you live in needs in order to function.

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