



MINDSTORMS™

EXPLORATION MARS™

CONSTRUCTION KIT PRESENTS

9736

Introduction

The Space Academy has been formed by the nations of Earth. It's mission is to train a new generation of explorers. As the newest member of the Academy, you will use this Constructopedia™ as a training manual. It will help you meet the challenges of space.

In this Constructopedia, you will learn how to build machines for Martian Missions. The included software will then help you use and control these machines.

Exploration Mars™ is an expansion set of the LEGO® MINDSTORMS™ Robotics Invention System™. The RCX is from the Robotics Invention System.

Einführung

Eine Space Academy/Weltraumakademie wurde von den Nationen der Welt gegründet. Sie hat den Auftrag, eine neue Generation von Forschern auszubilden. Diese Constructopedia™ dient dir als jüngstem Mitglied der Akademie als Schulungshandbuch. Es hilft dir, dich den Herausforderungen im Weltraum zu stellen.

In dieser Constructopedia lernst du, Modelle für Marsmissionen zu bauen. Die zugehörige Software unterstützt dich anschließend bei der Verwendung und Steuerung dieser Maschinen.

Exploration Mars™ ist ein Erweiterungssatz für das LEGO® MINDSTORMS™ Robotics Invention System™. Kombiniere Elemente beider Bausätze, um die Marsmodelle zu bauen.

CONTENTS / INHALT

Introduction Einführung	<i>page 2</i> <i>Seite 2</i>
Project Ideas Ideen für projekte	<i>page 4</i> <i>Seite 4</i>
Building Instructions Bauanleitungen	
Mars Lander Mars Lander	<i>page 6</i> <i>Seite 6</i>
Rover 1 Rover 1	<i>page 16</i> <i>Seite 16</i>
Rover 2 Rover 2	<i>page 22</i> <i>Seite 22</i>
Turntable Drehscheibe	<i>page 28</i> <i>Seite 28</i>
Robotic Arm Robotic Arm	<i>page 32</i> <i>Seite 32</i>
Additional ideas Weitere ideen	<i>page 40</i> <i>Seite 40</i>
Special Features Besondere Funktionen	<i>page 41</i> <i>Seite 41</i>
Tips & Tricks Tipps & Tricks	<i>page 44</i> <i>Seite 44</i>
Camera Attachment Anhang: Kamera	<i>page 46</i> <i>Seite 46</i>
Parts ID Teile-ID	<i>page 47</i> <i>Seite 47</i>

PROJECT IDEAS / IDEEN FÜR PROJEKTE

- US** These are the models used to solve the Martian Missions on the CD-ROM. You can also design your own inventions for the Missions.
- D** Dies sind die Modelle, mit deren Hilfe die Marsmissionen auf der CD-ROM ausgeführt werden. Du kannst für die Missionen auch eigene Ideen realisieren.

Rover 1

Basic Mars vehicle which can explore your Mars Yard.
(page 16)

Einfaches Mars-Fahrzeug, das deinen Mars Yard erkunden kann.
(Seite 16)



Rover 2

Rover with RCX standing upright. Much faster than Rover 1.
(page 22)

Rover mit aufrecht stehendem RCX: viel schneller als Rover 1.
(Seite 22)



Robotic Arm

Lifts objects from your Mars Yard.
To make it turn, attach to the Turntable.
(page 32)

Hebt Gegenstände im Mars Yard.
Verbinde ihn mit der Drehscheibe, damit
er sich drehen kann.
(Seite 32)



Mars Lander

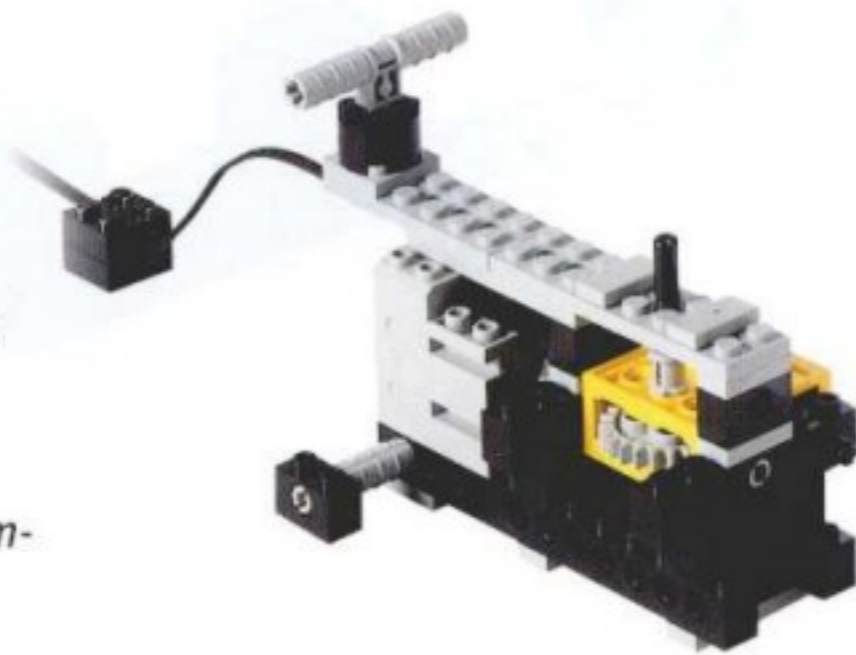
The home base for all of your Missions. Build
it first so you can use it with the other models.
(page 6)

Die Ausgangsbasis für alle deine Missionen.
Baue sie zuerst, damit du sie zusammen mit
den anderen Modellen verwenden kannst.
(Seite 6)

Turntable

Adds motion to the Robotic Arm
or PC video camera (not included).
(page 28)

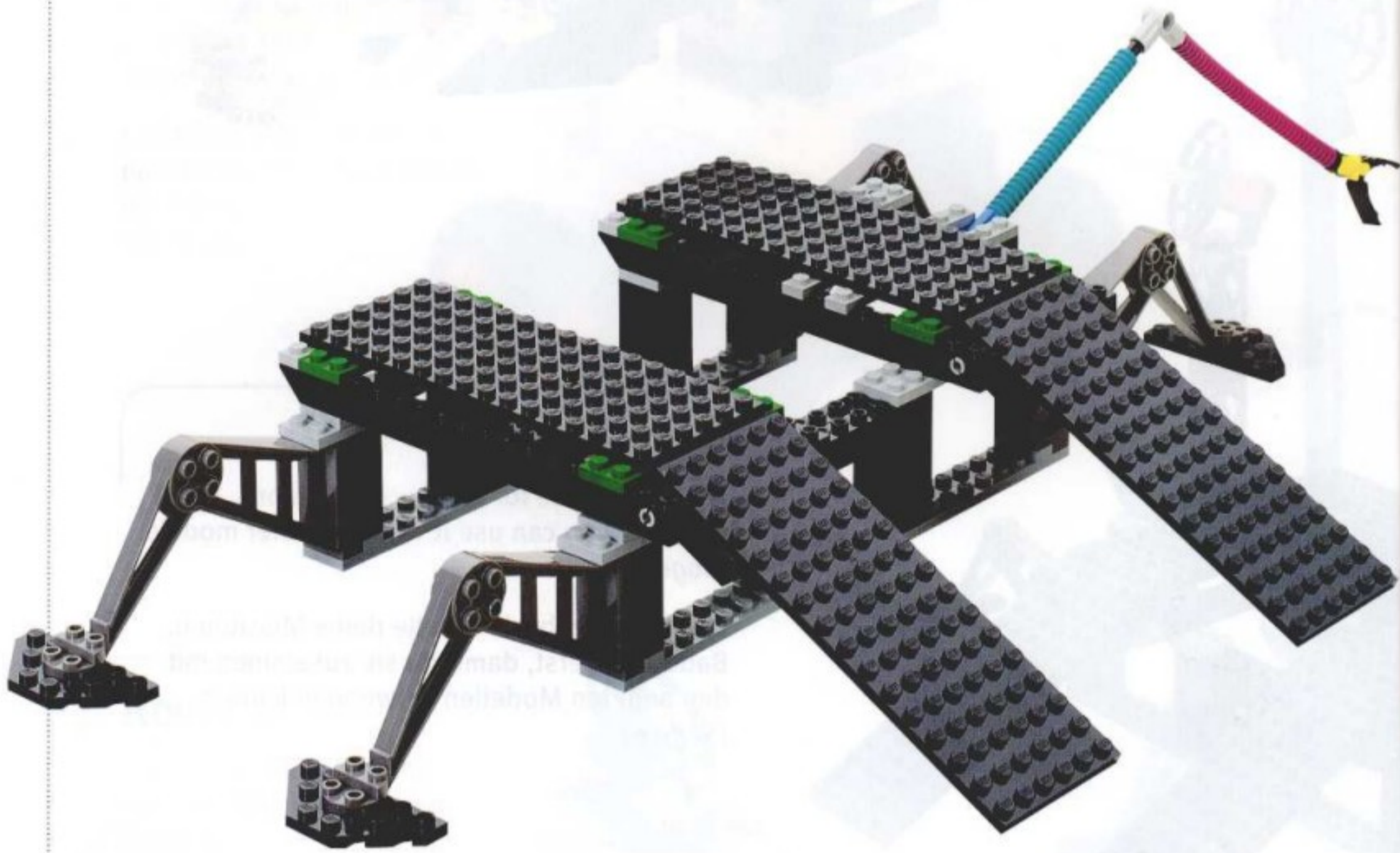
Macht den Robotic Arm oder die
PC video Kamera (nicht im Lieferum-
fang enthalten) beweglich.
(Seite 28)





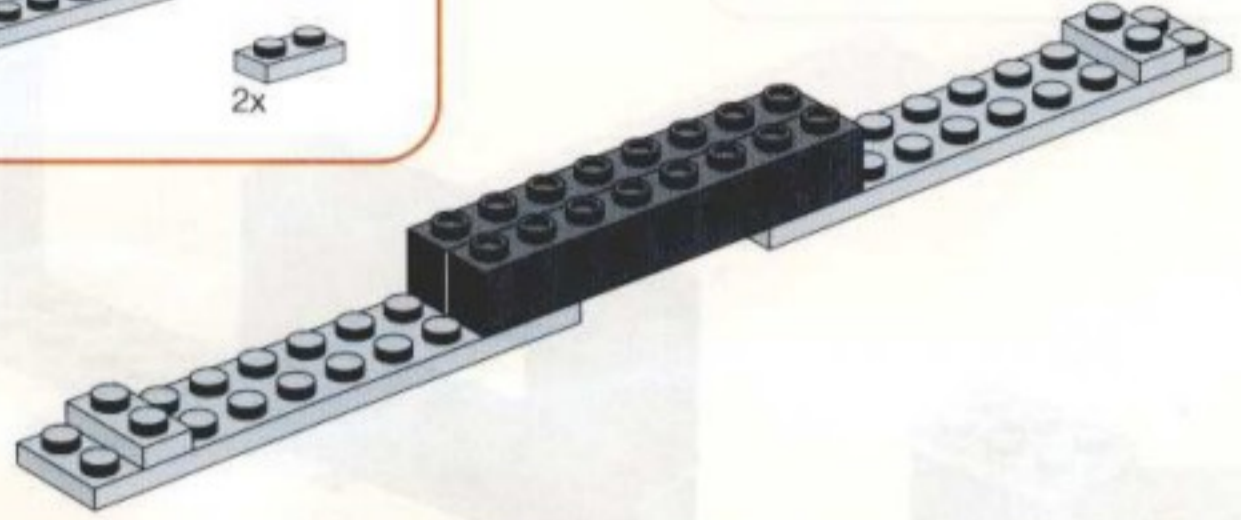
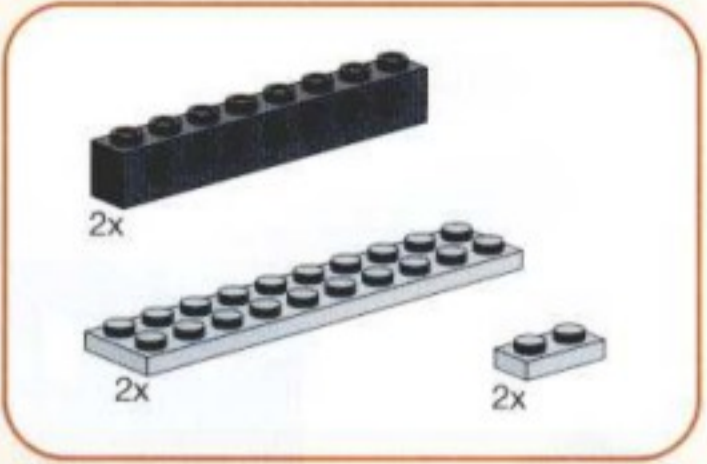
MARS LANDER

- US** The following pages show you how to build the Mars Lander.
- D** Auf den folgenden Seiten erfährst du, wie der Mars Lander gebaut wird.

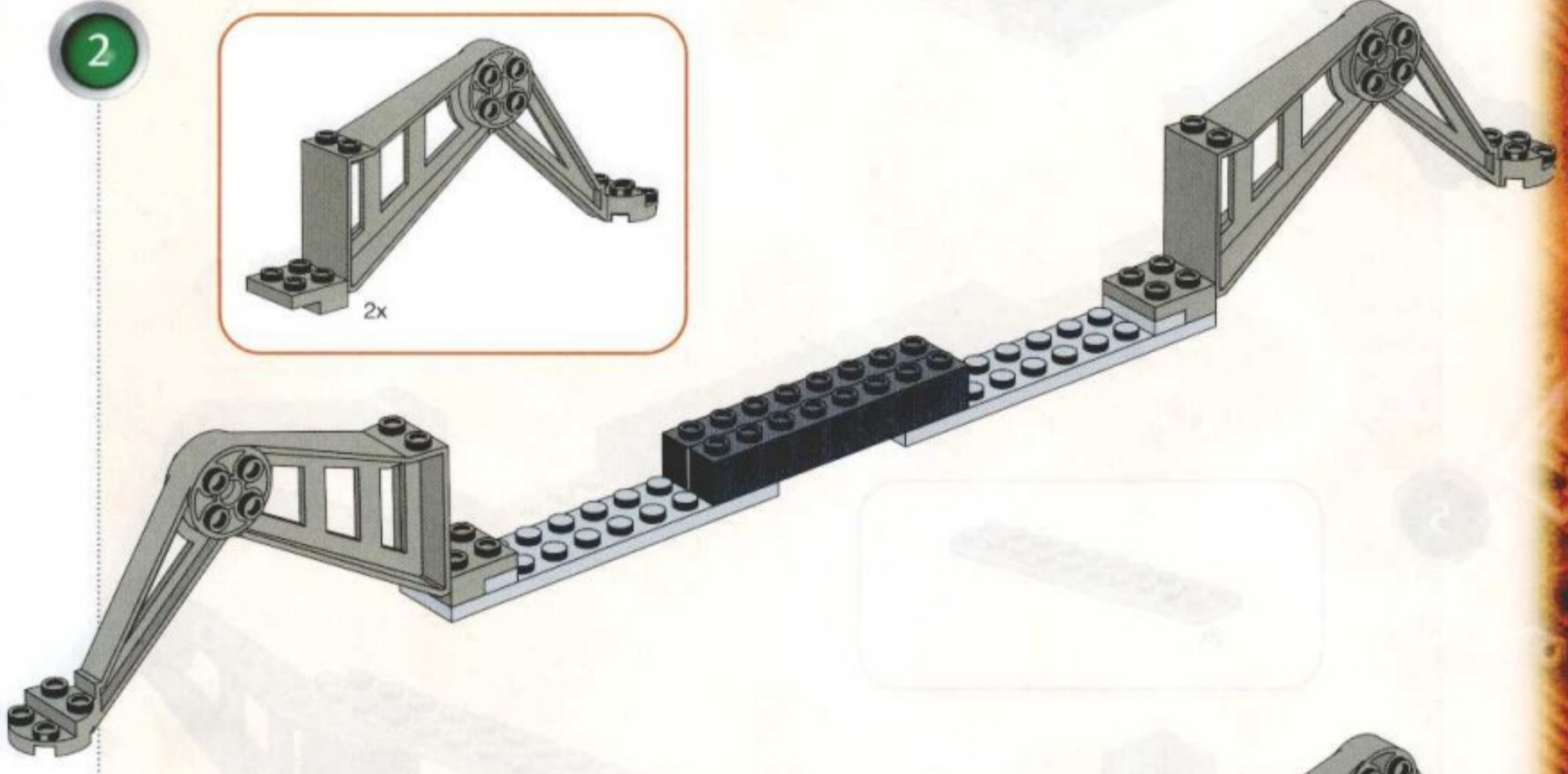
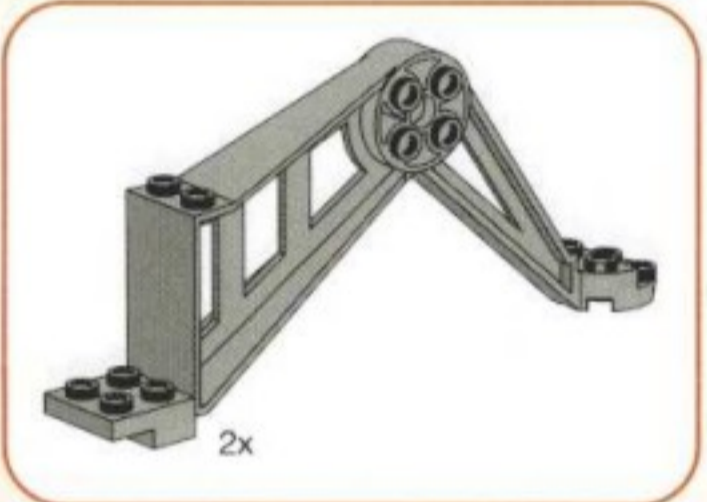




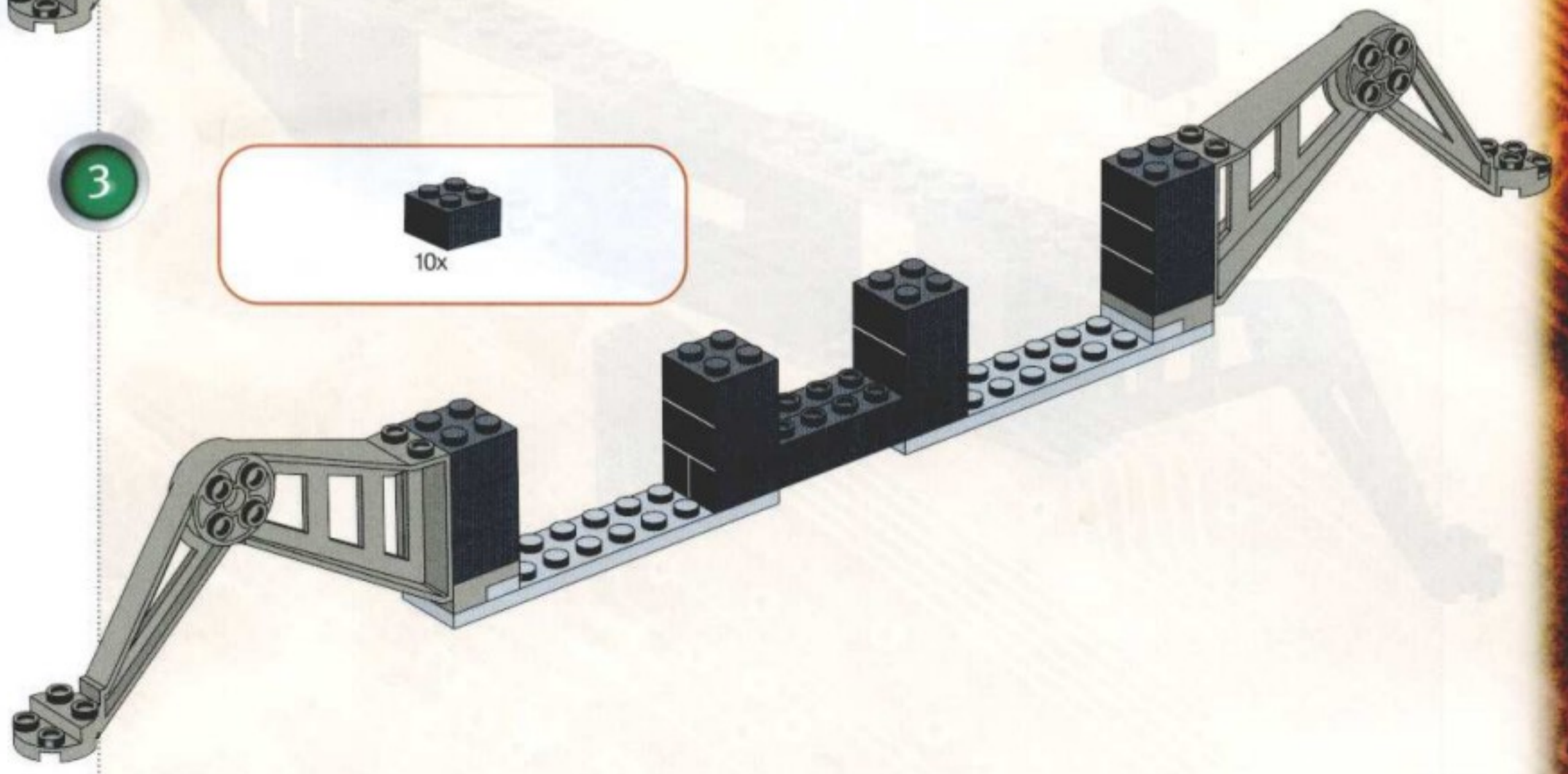
1



2



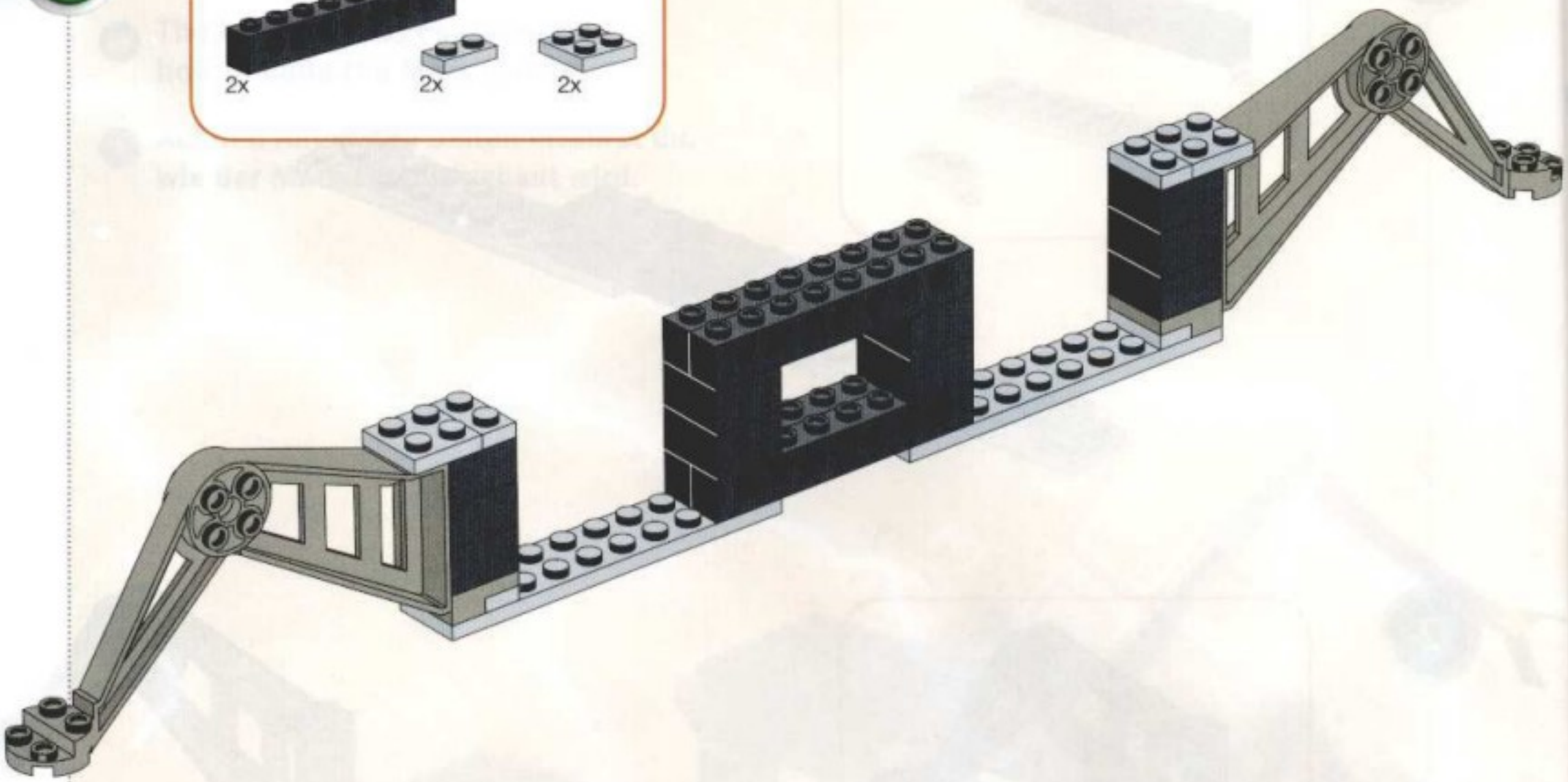
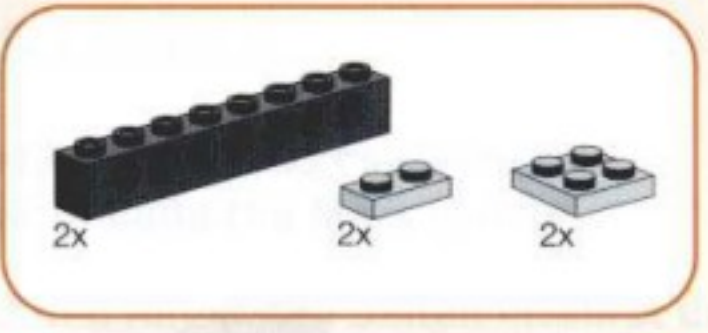
3



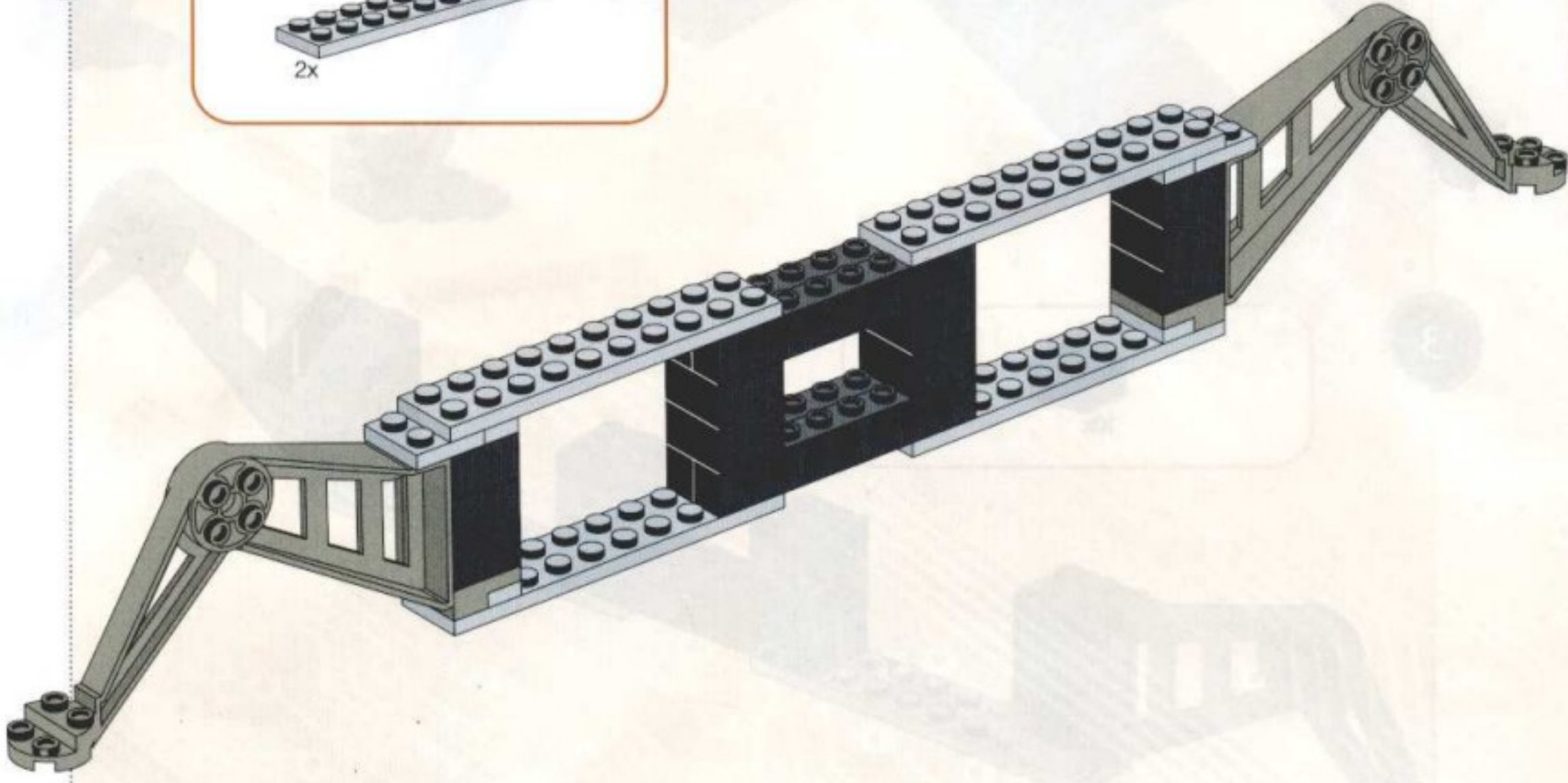
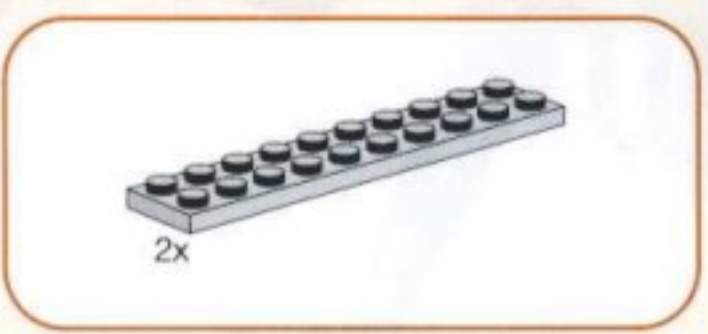
BAUANLEITUNGEN
BUILDING INSTRUCTIONS
TIPS & TRICKS
SONDERFUNKTIONEN



4

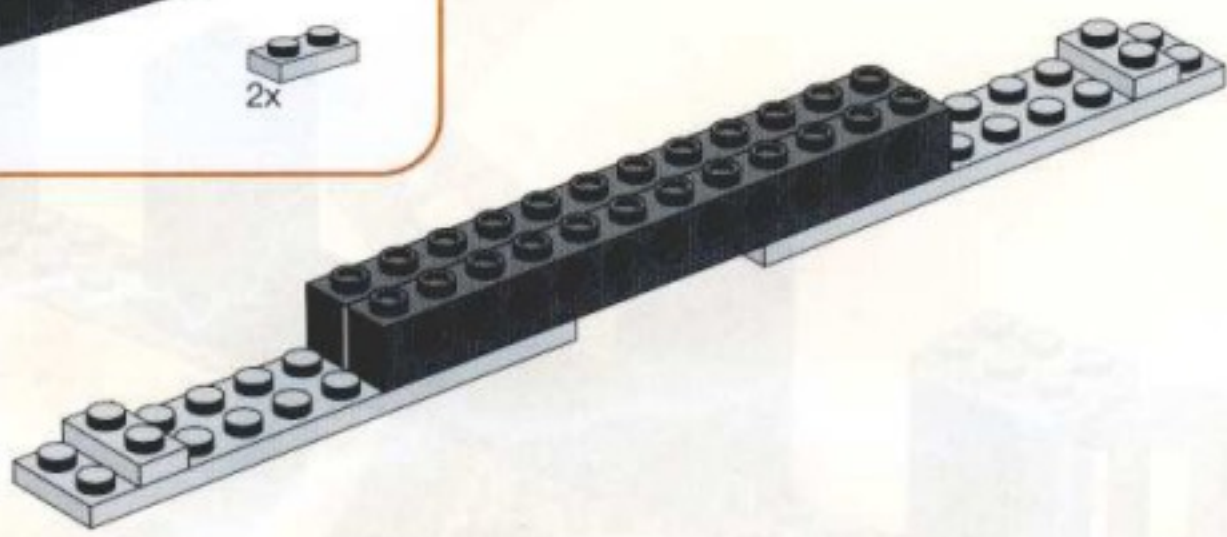
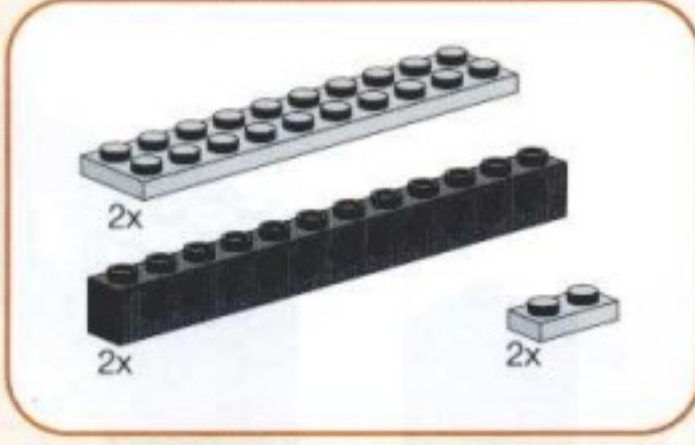


5

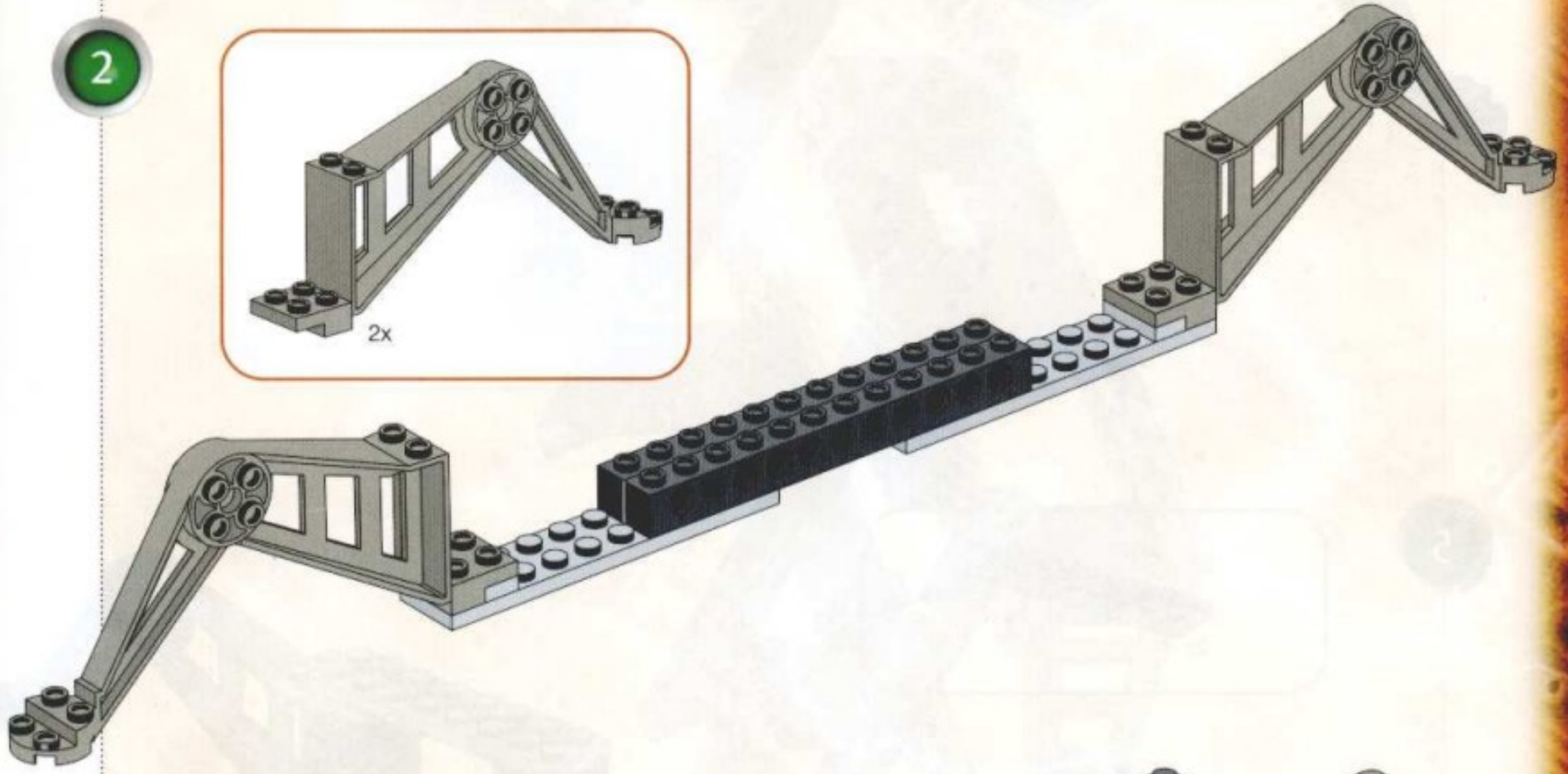
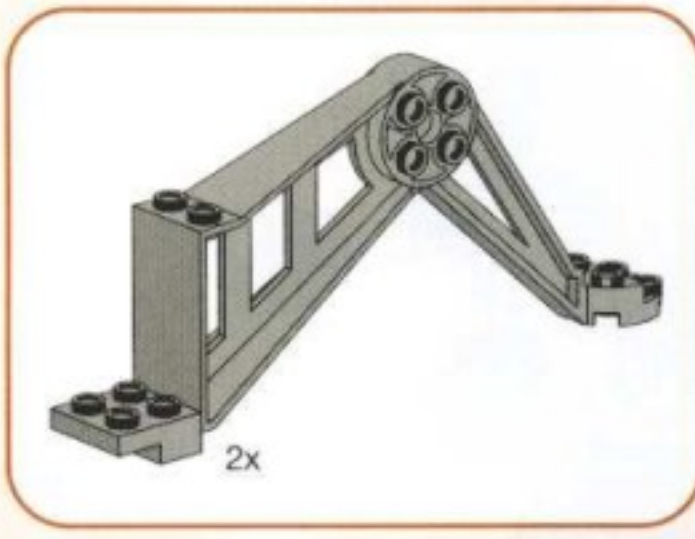




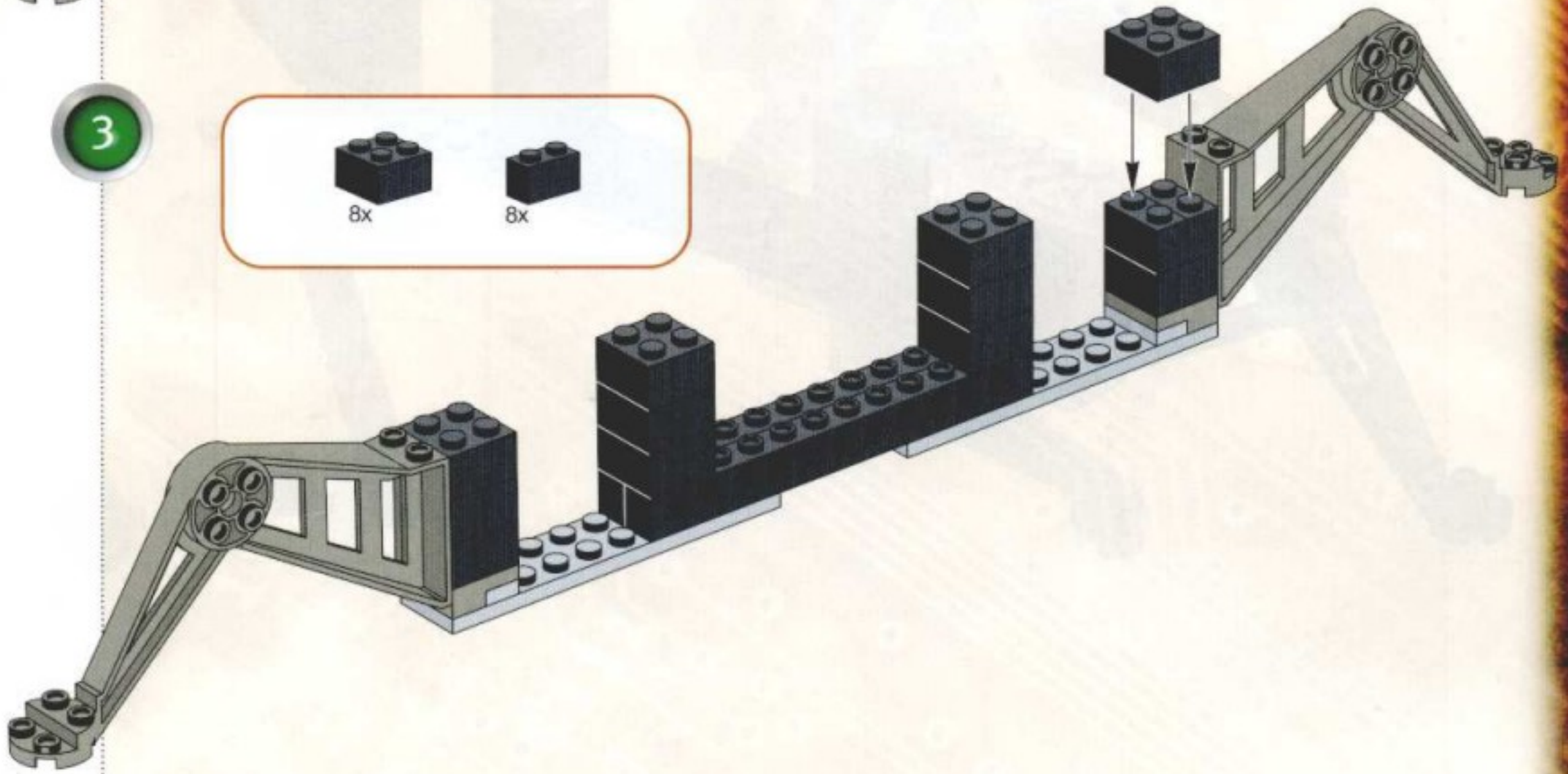
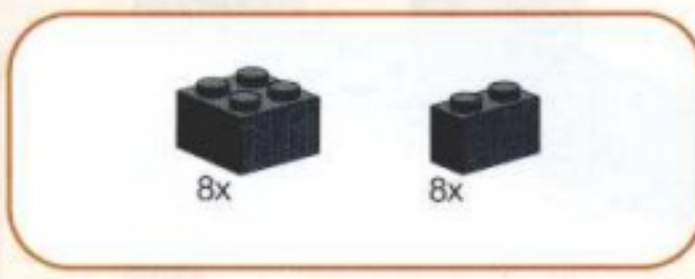
1



2

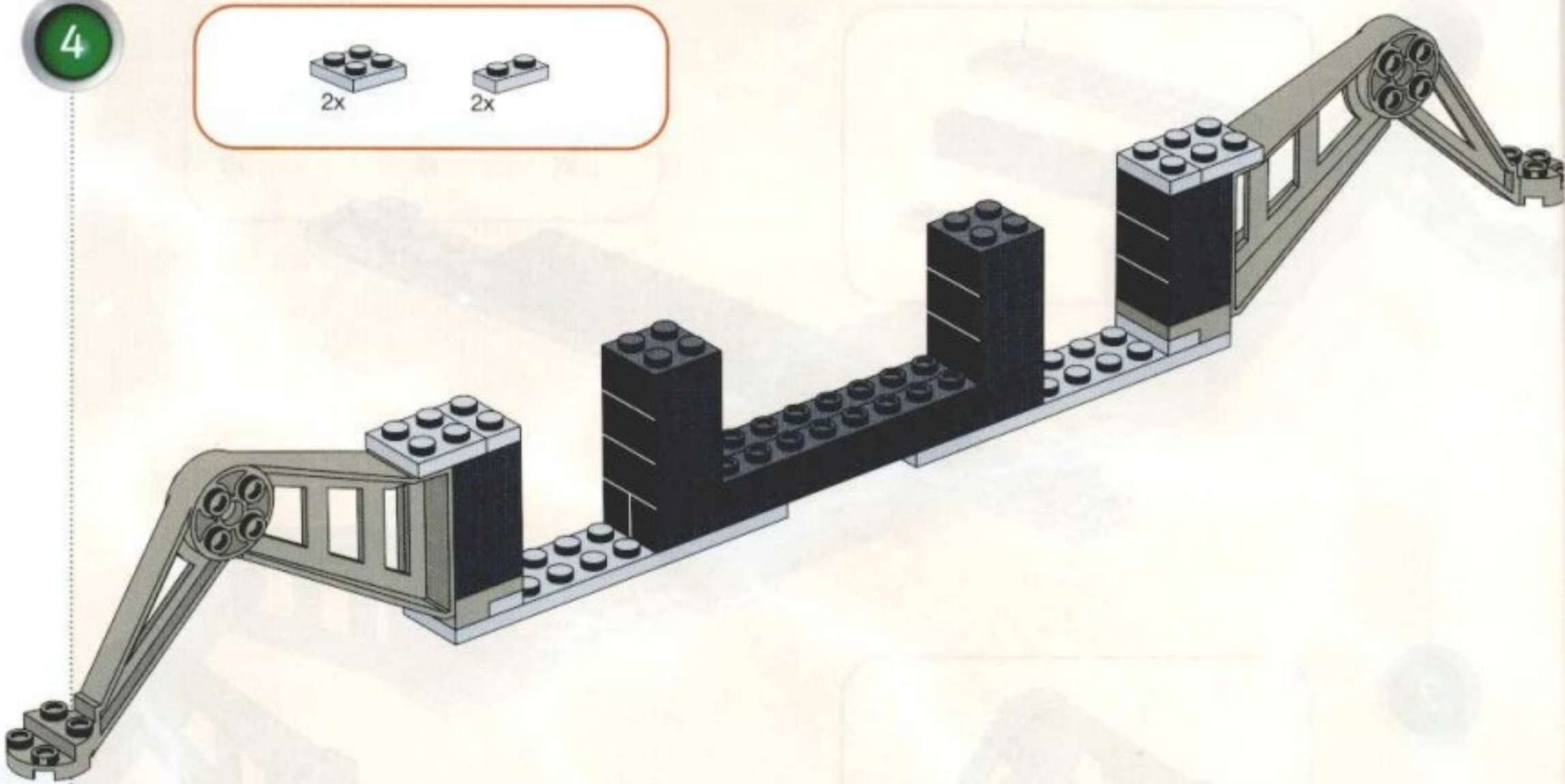


3

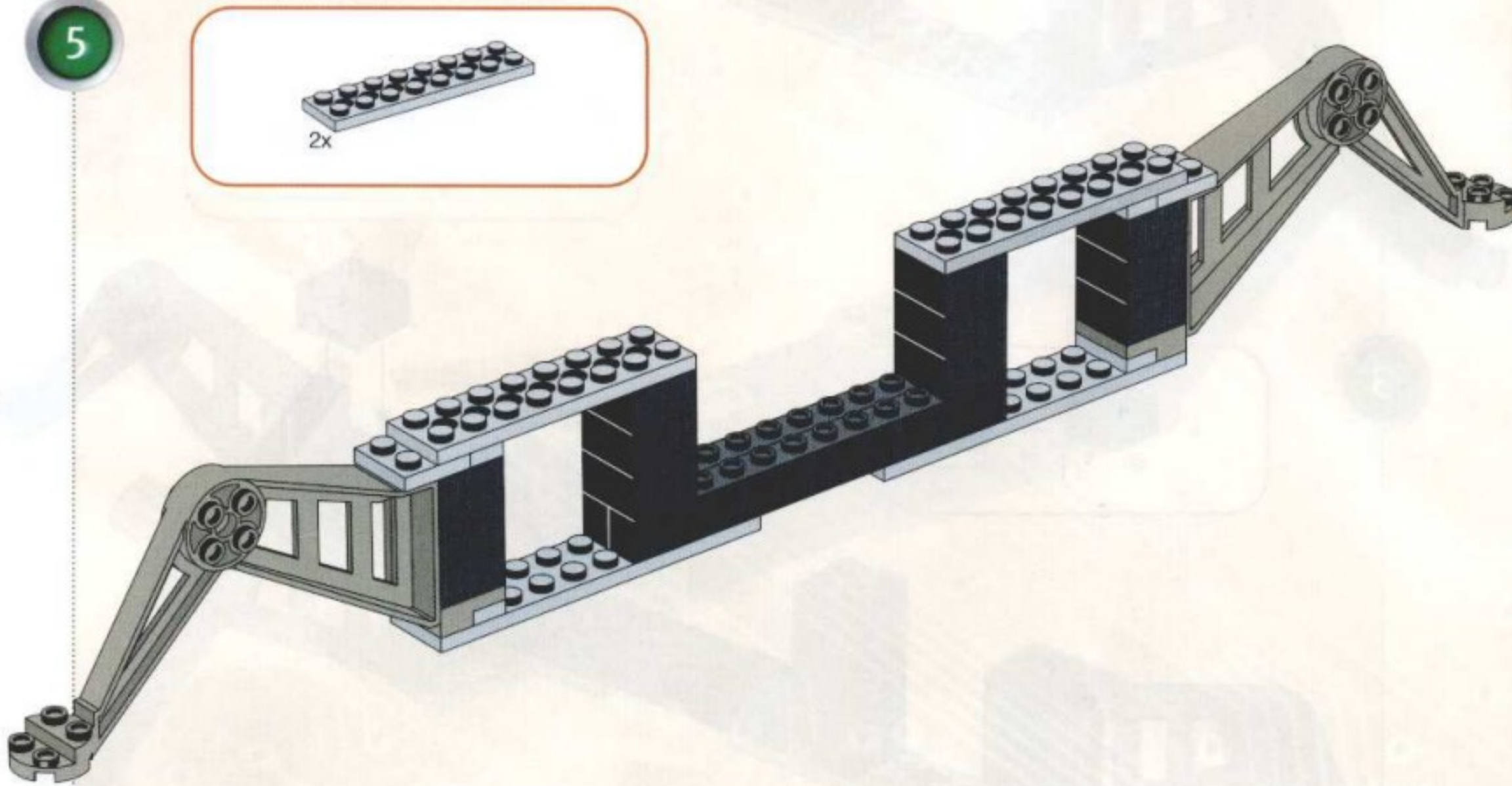
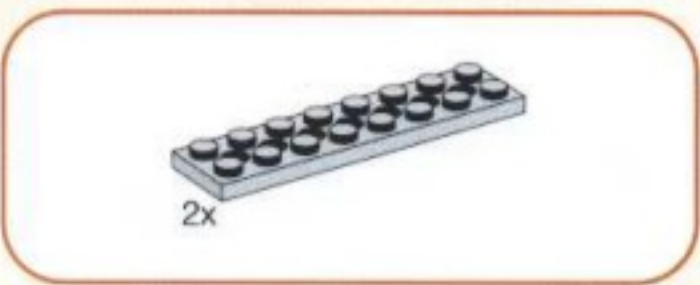


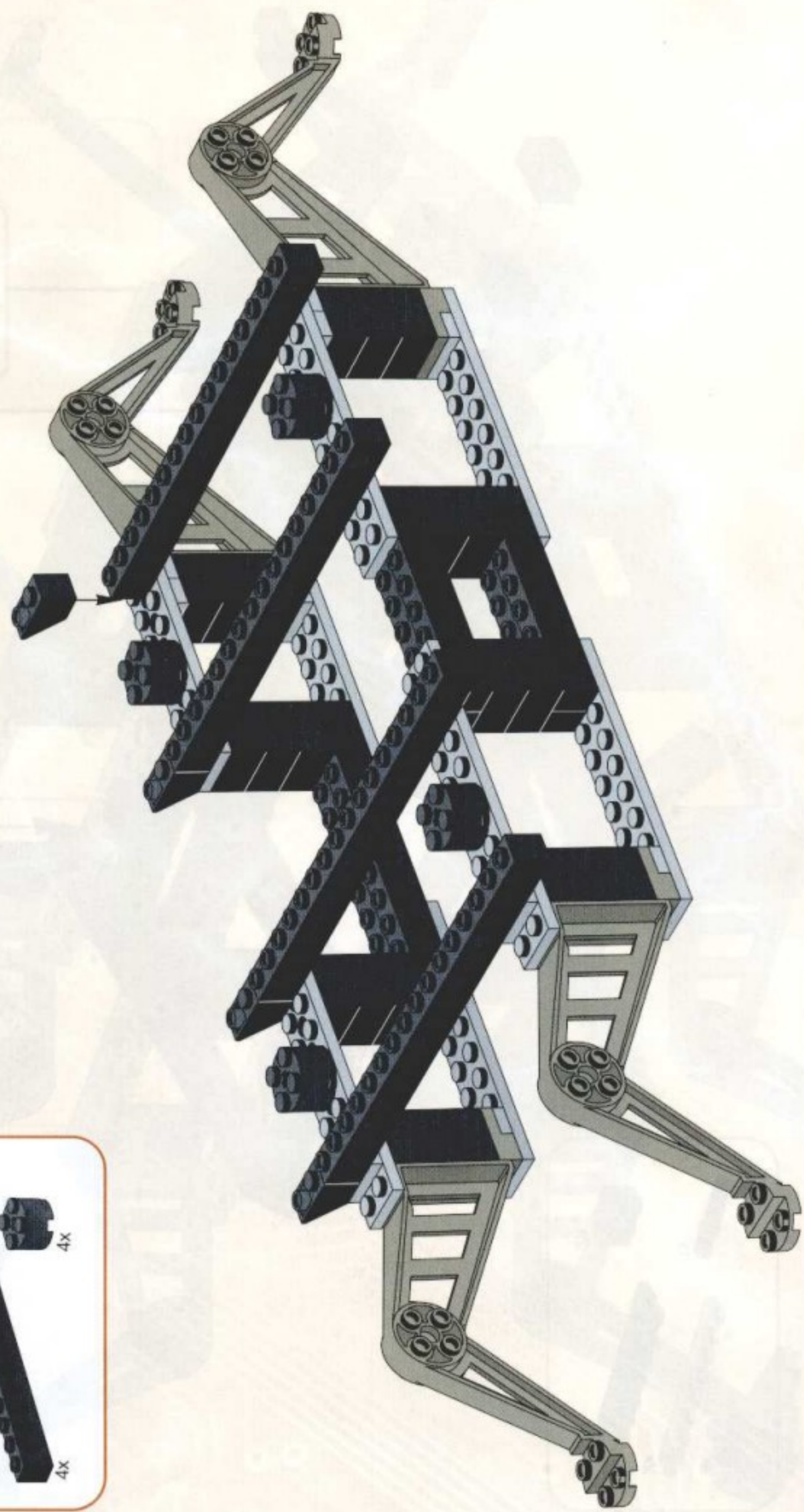


4

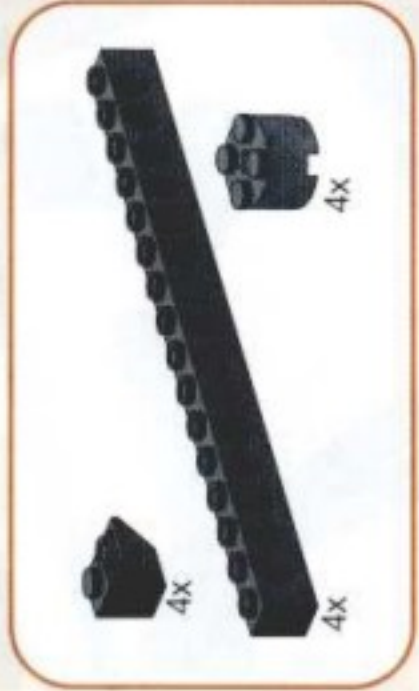


5

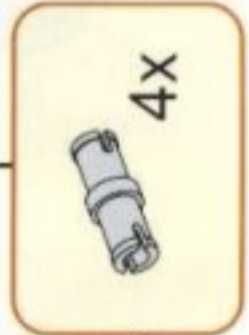
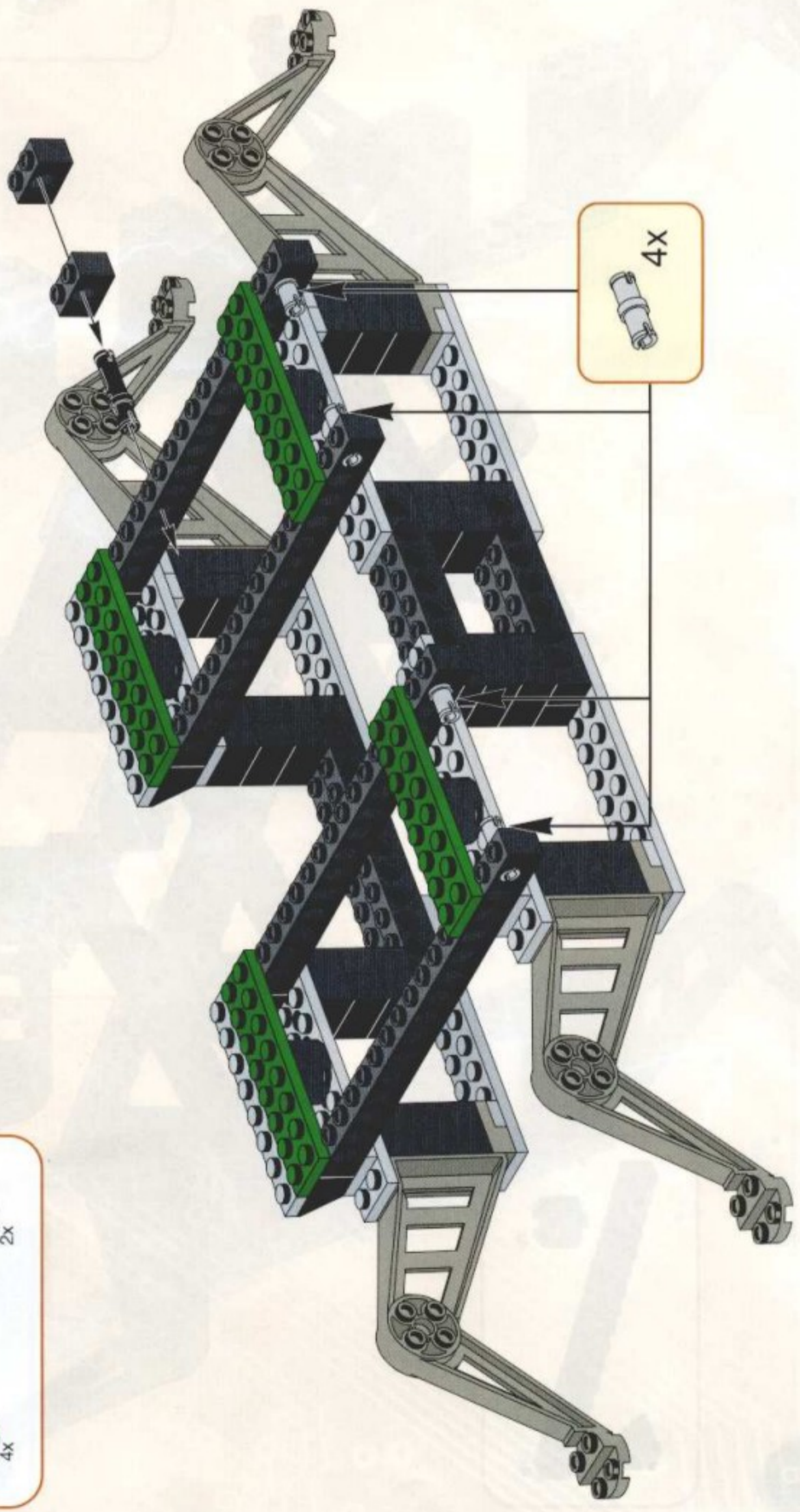


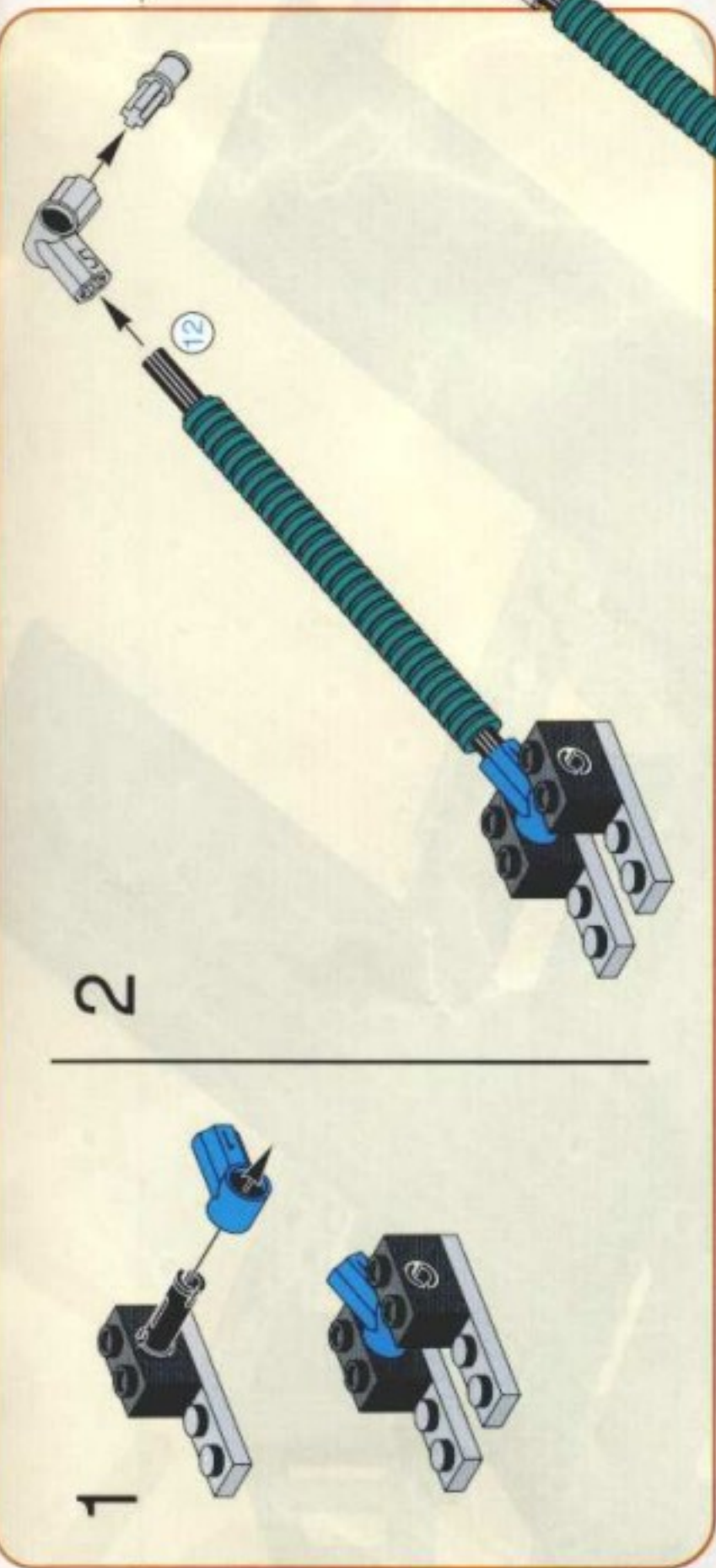
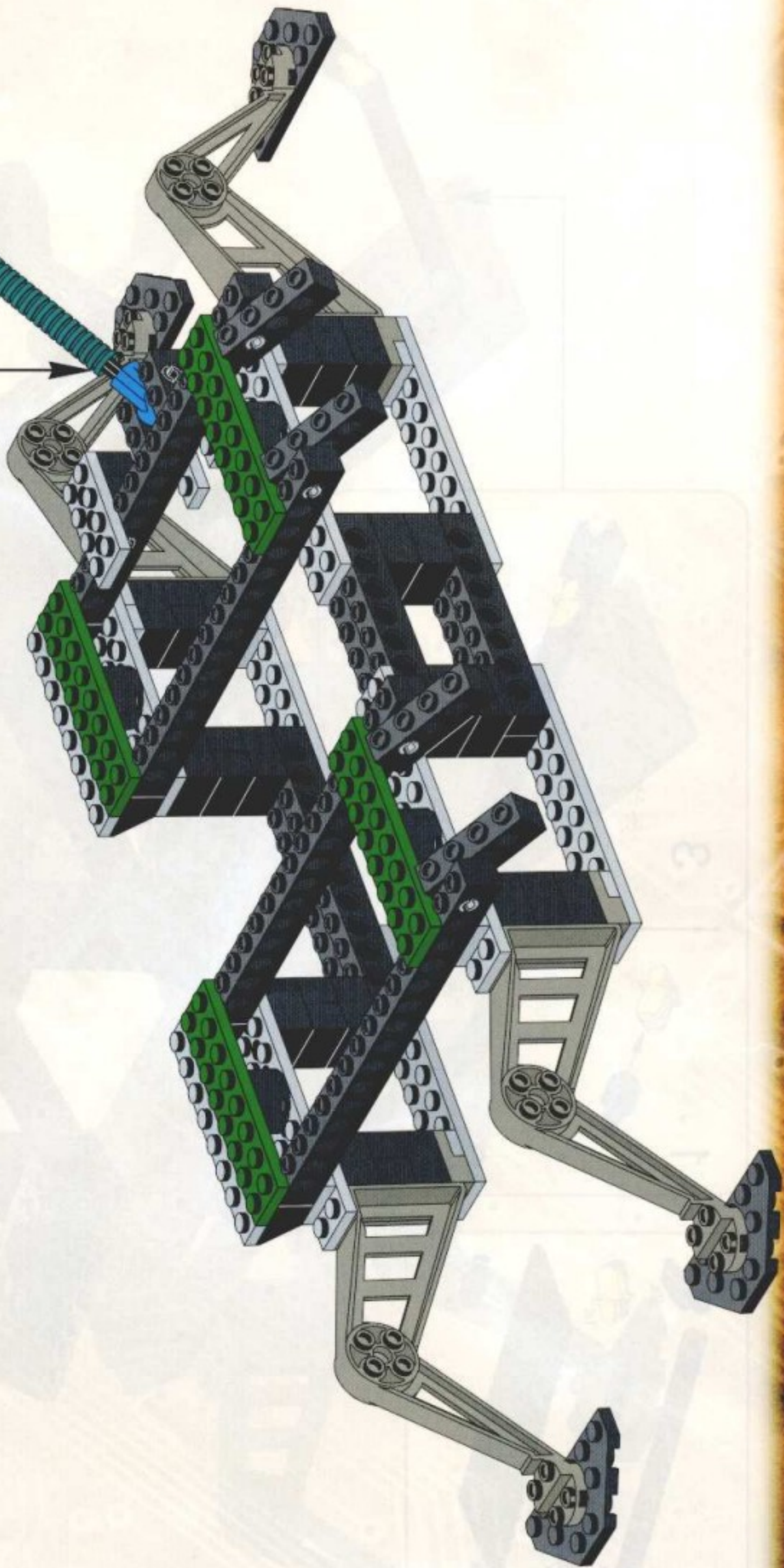


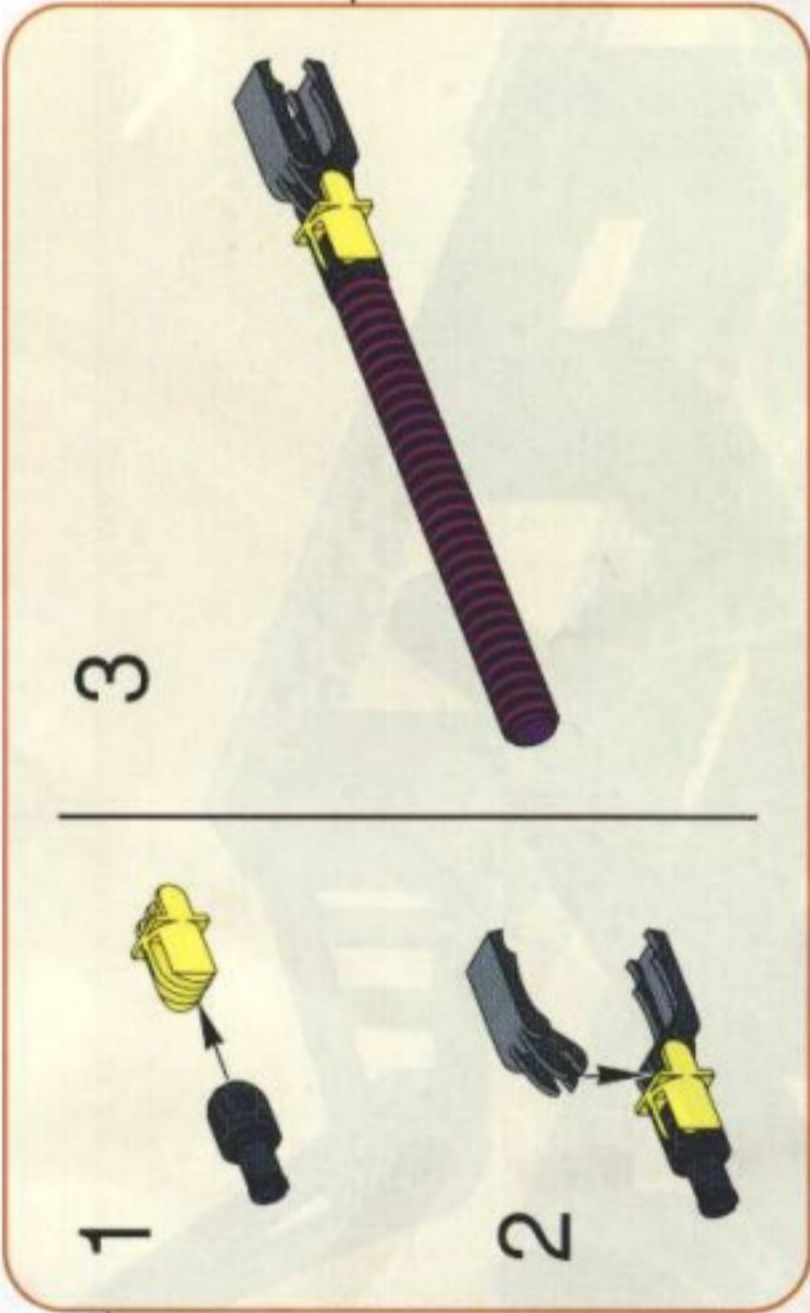
4x



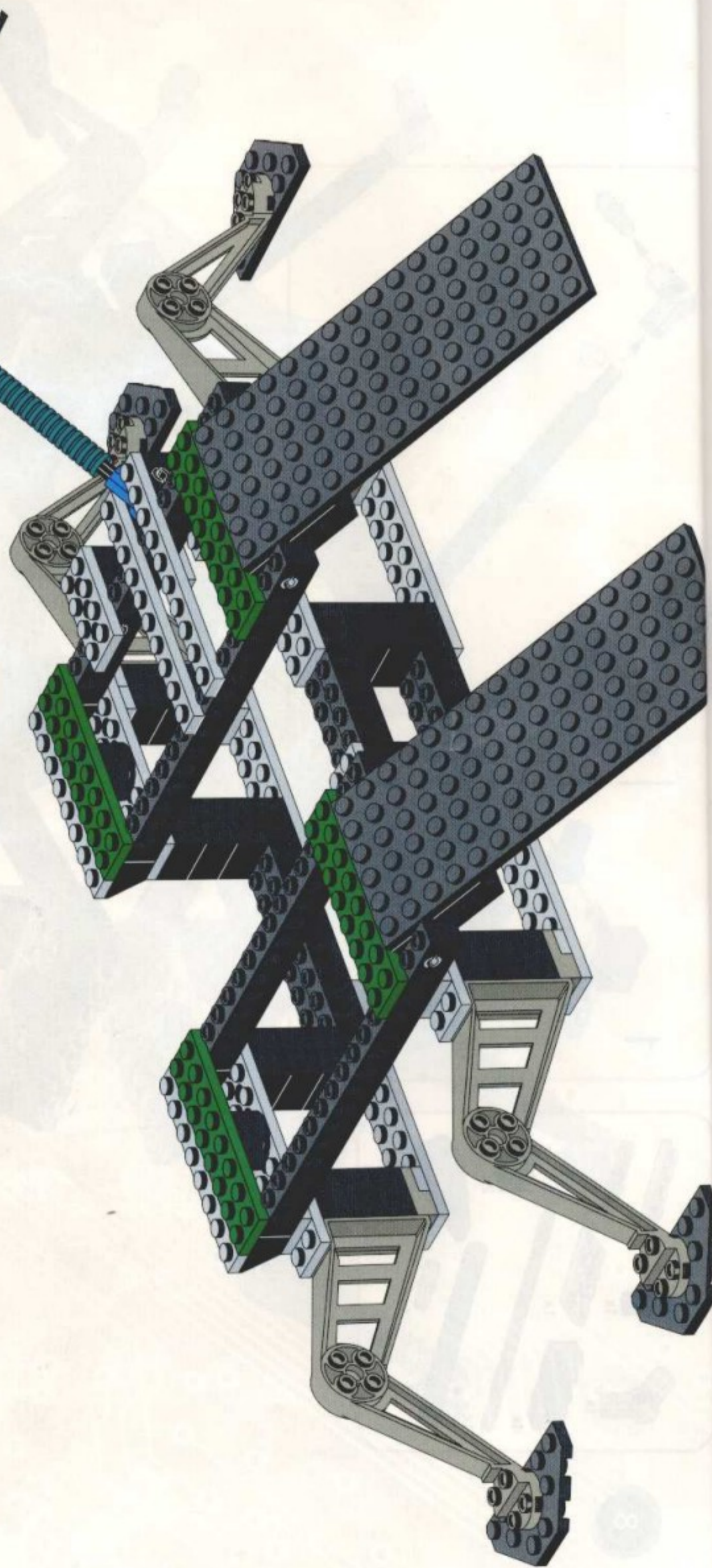
7







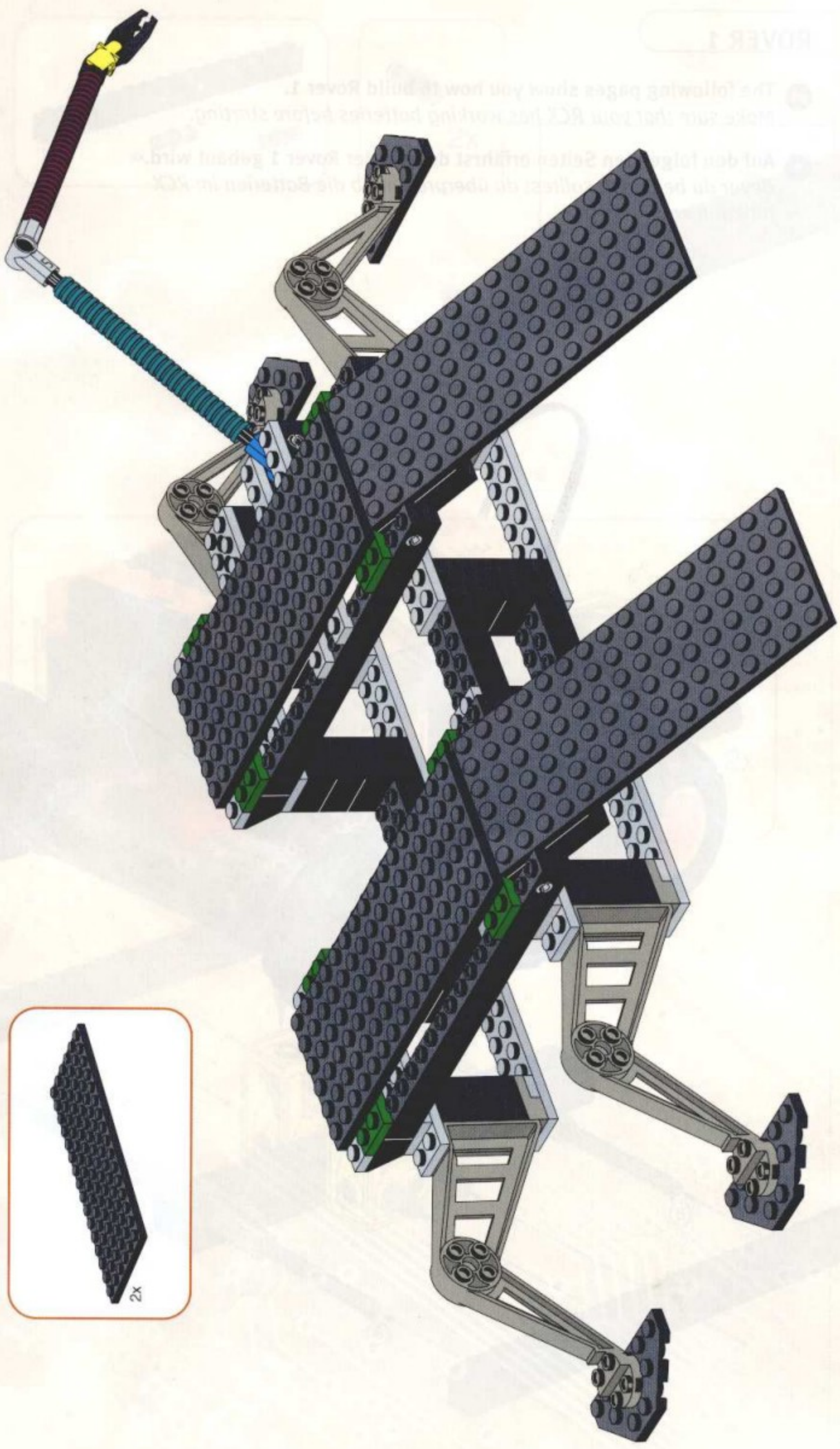
9



8

ROVER 1

The following pages show you how to build Rover 1.
Make sure that your RCX has working batteries before starting.
Auf den folgenden Seiten erfährst du, wie du Rover 1 baust.
Stelle sicher, dass die Batterien im RCX funktionieren.



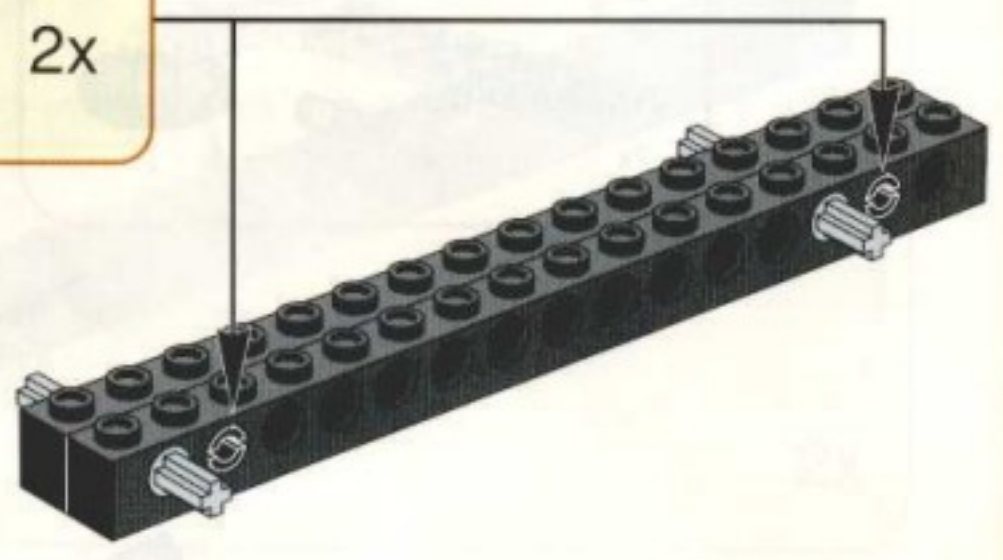
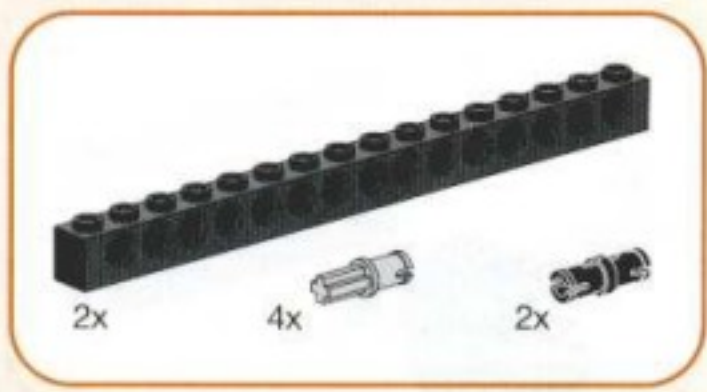
ROVER 1

- US** The following pages show you how to build Rover 1.
Make sure that your RCX has working batteries before starting.
- D** Auf den folgenden Seiten erfährst du, wie der Rover 1 gebaut wird.
Bevor du beginnst, solltest du überprüfen, ob die Batterien im RCX funktionieren.

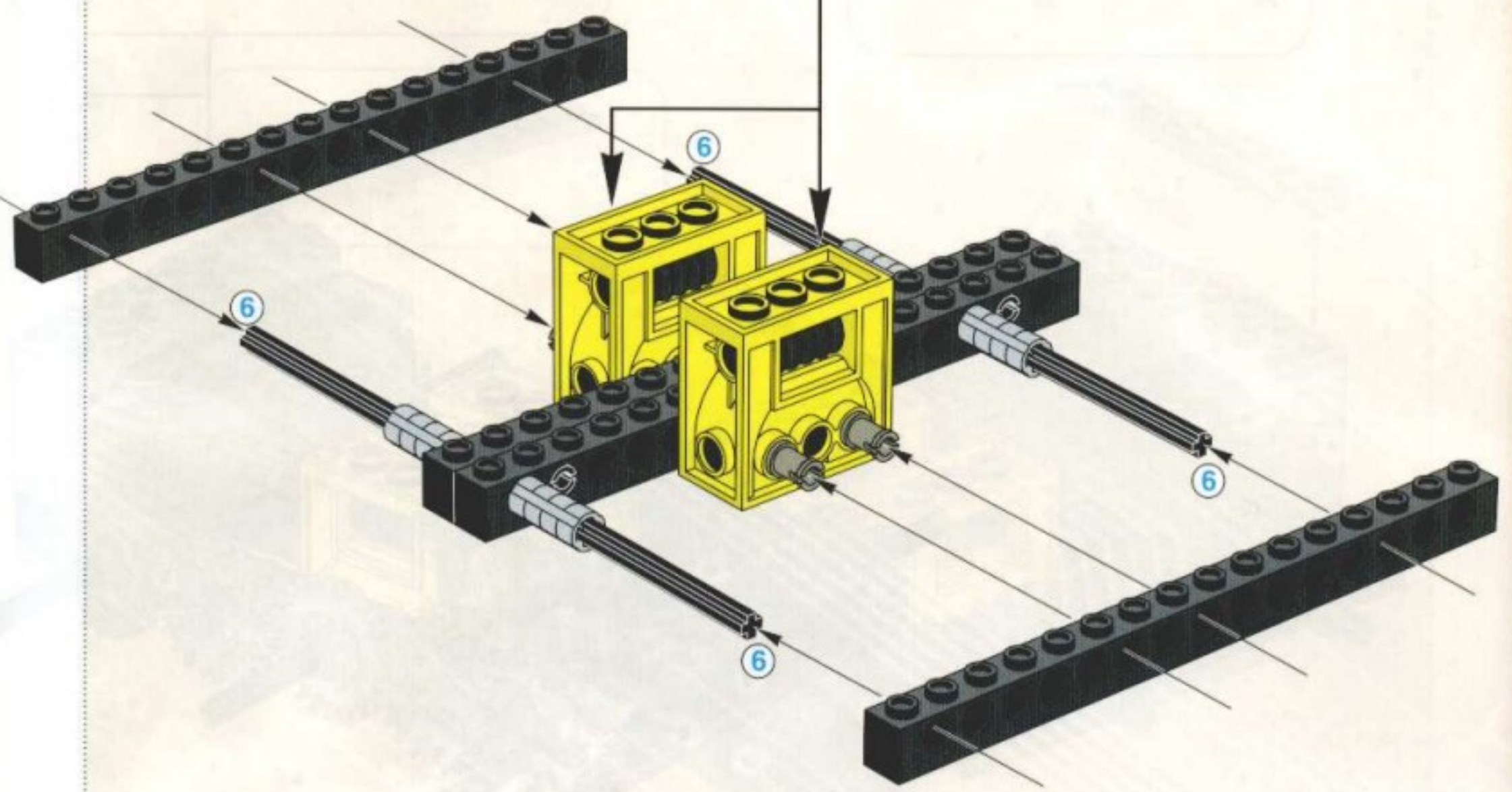
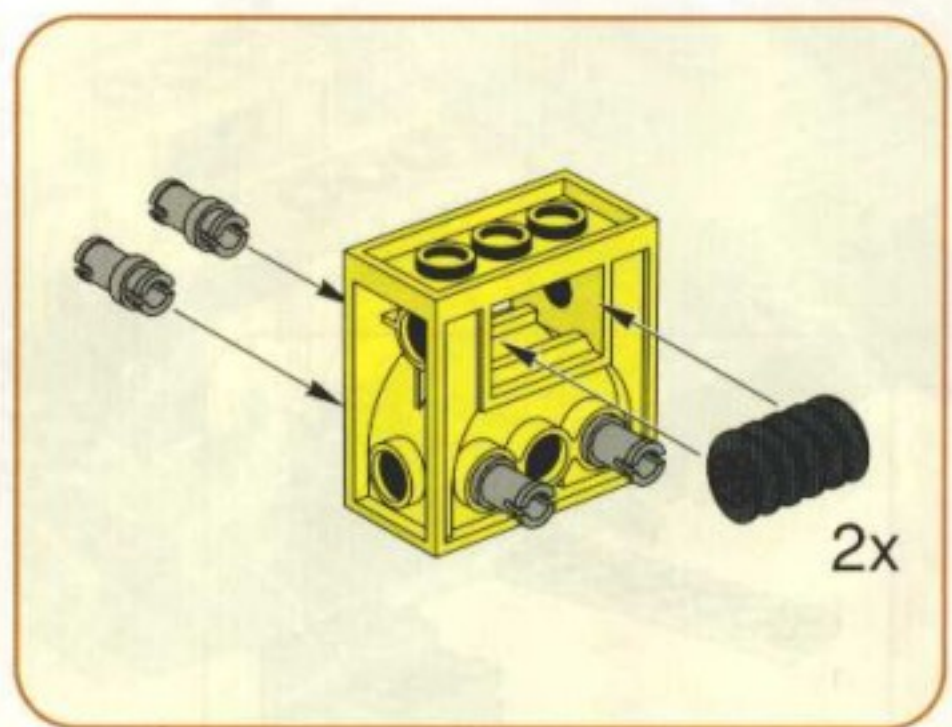




1

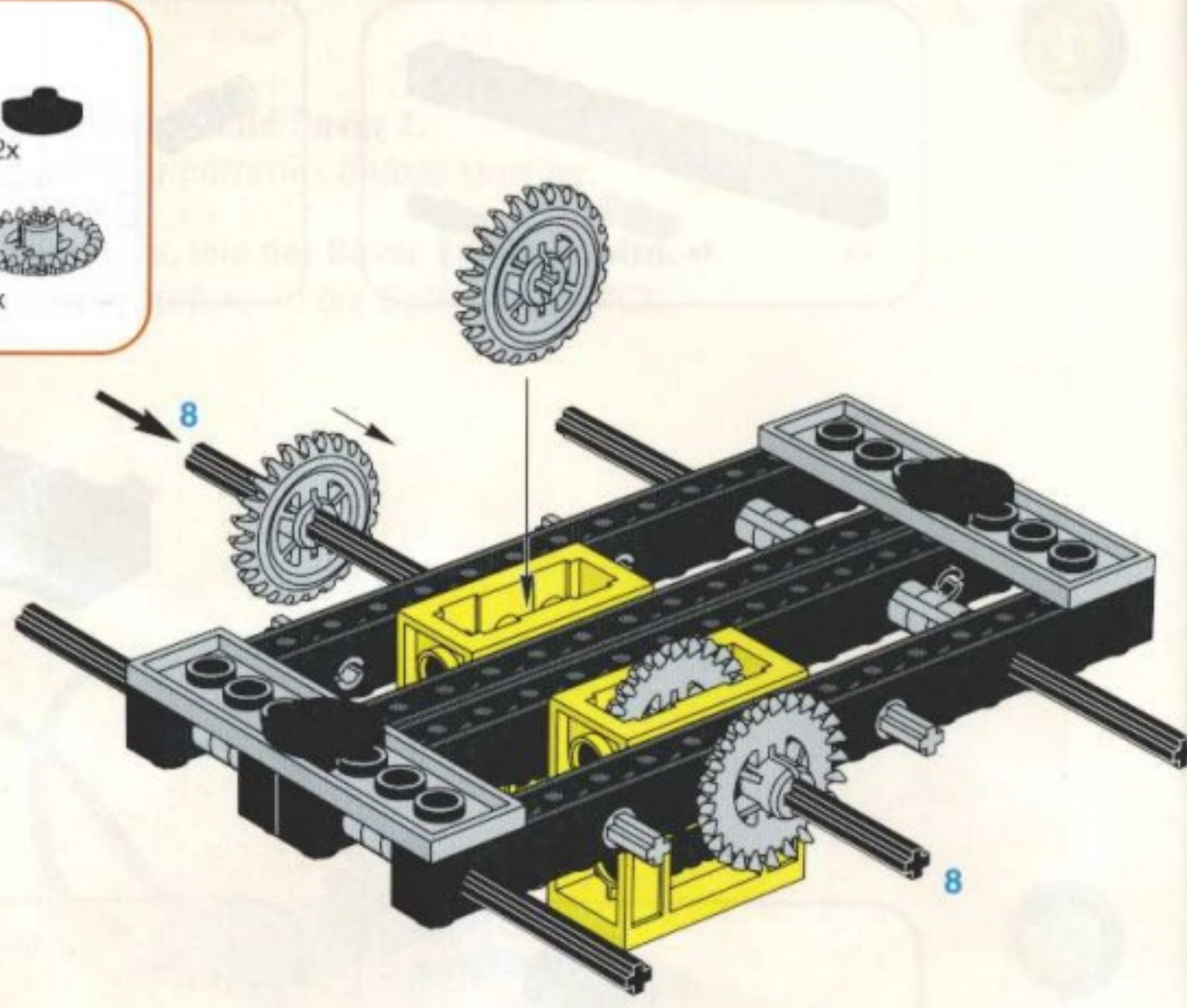


2

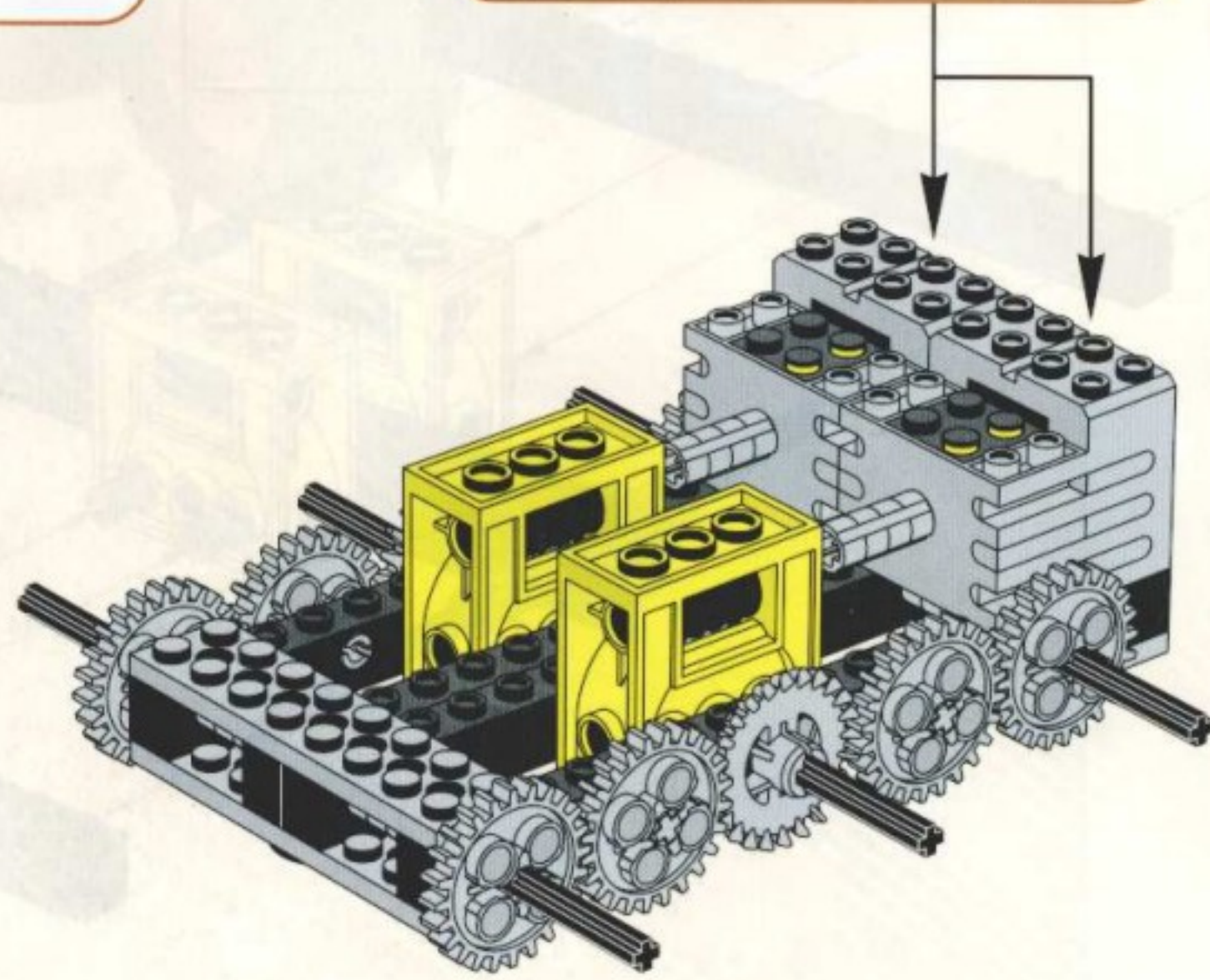
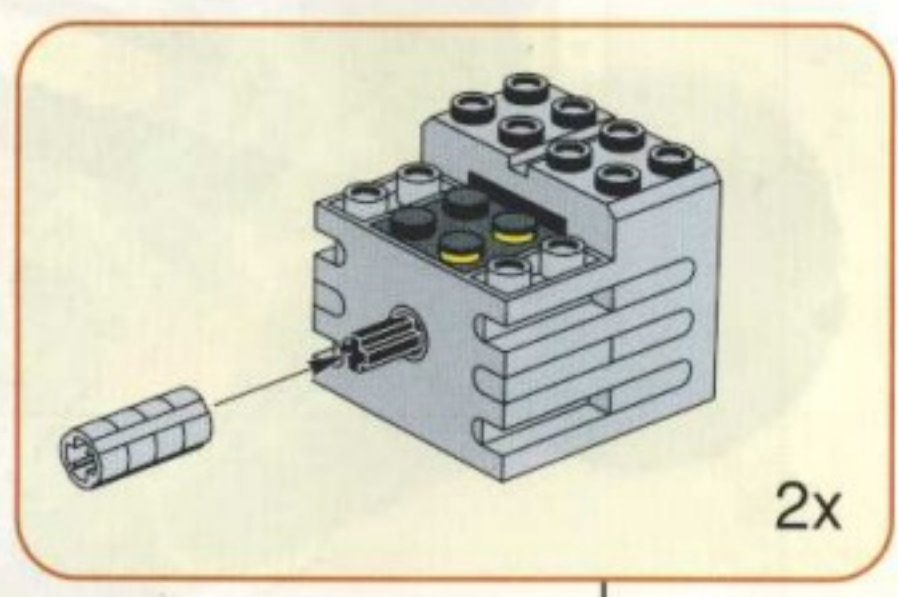
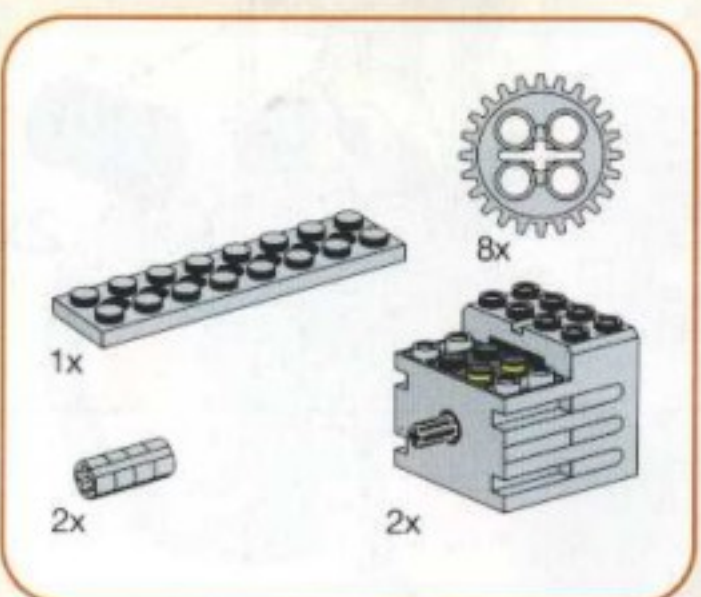




3

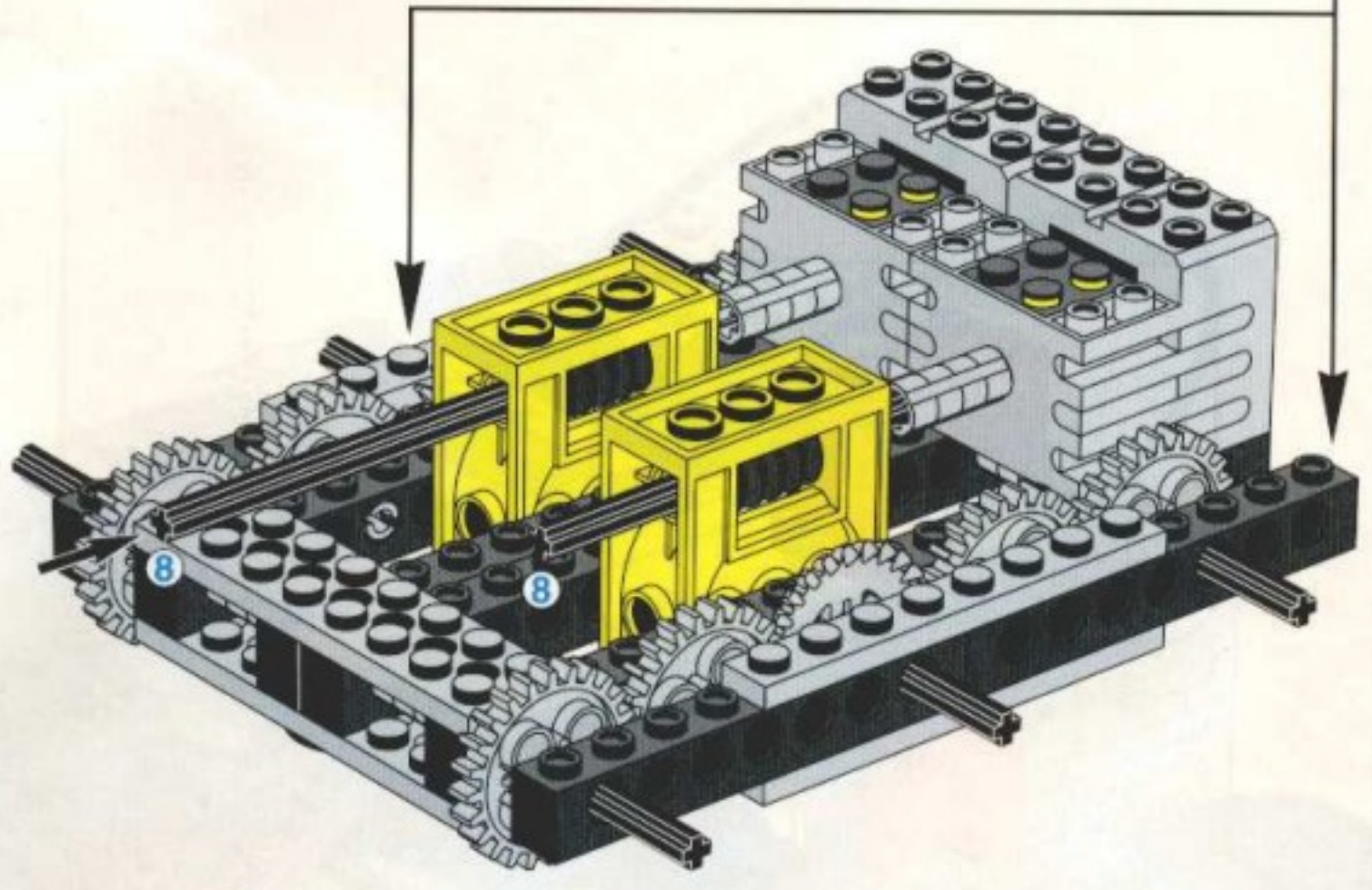
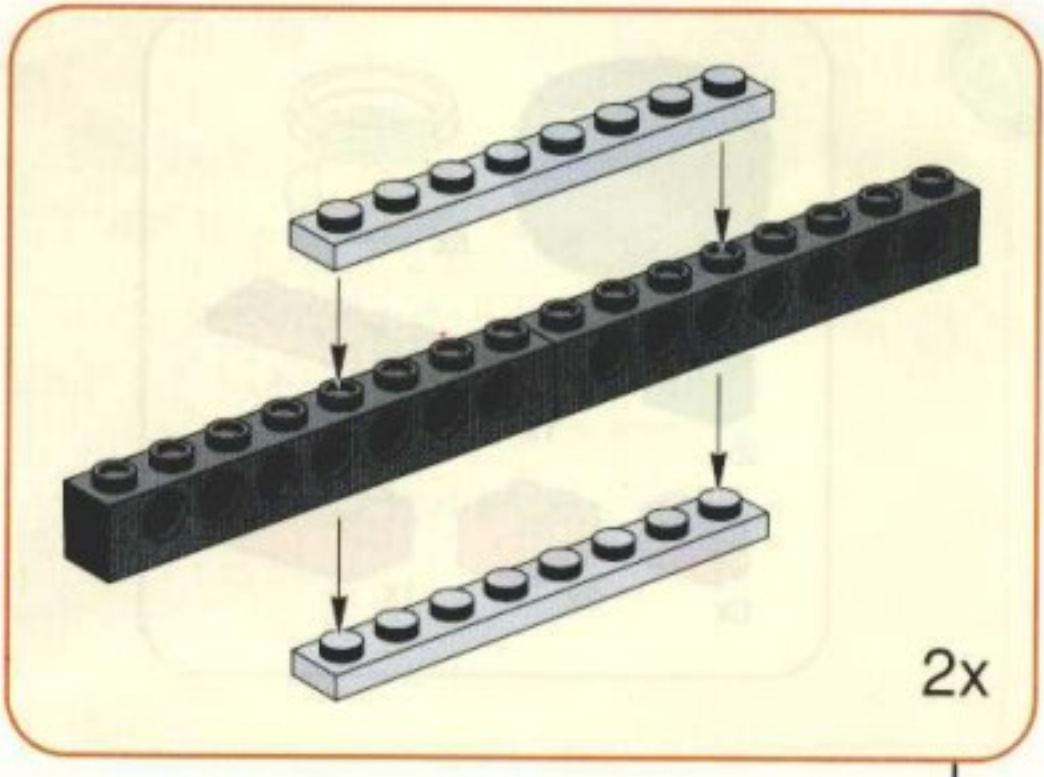
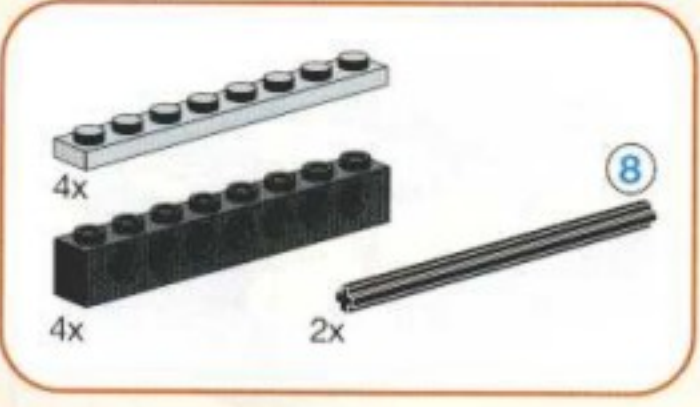


4

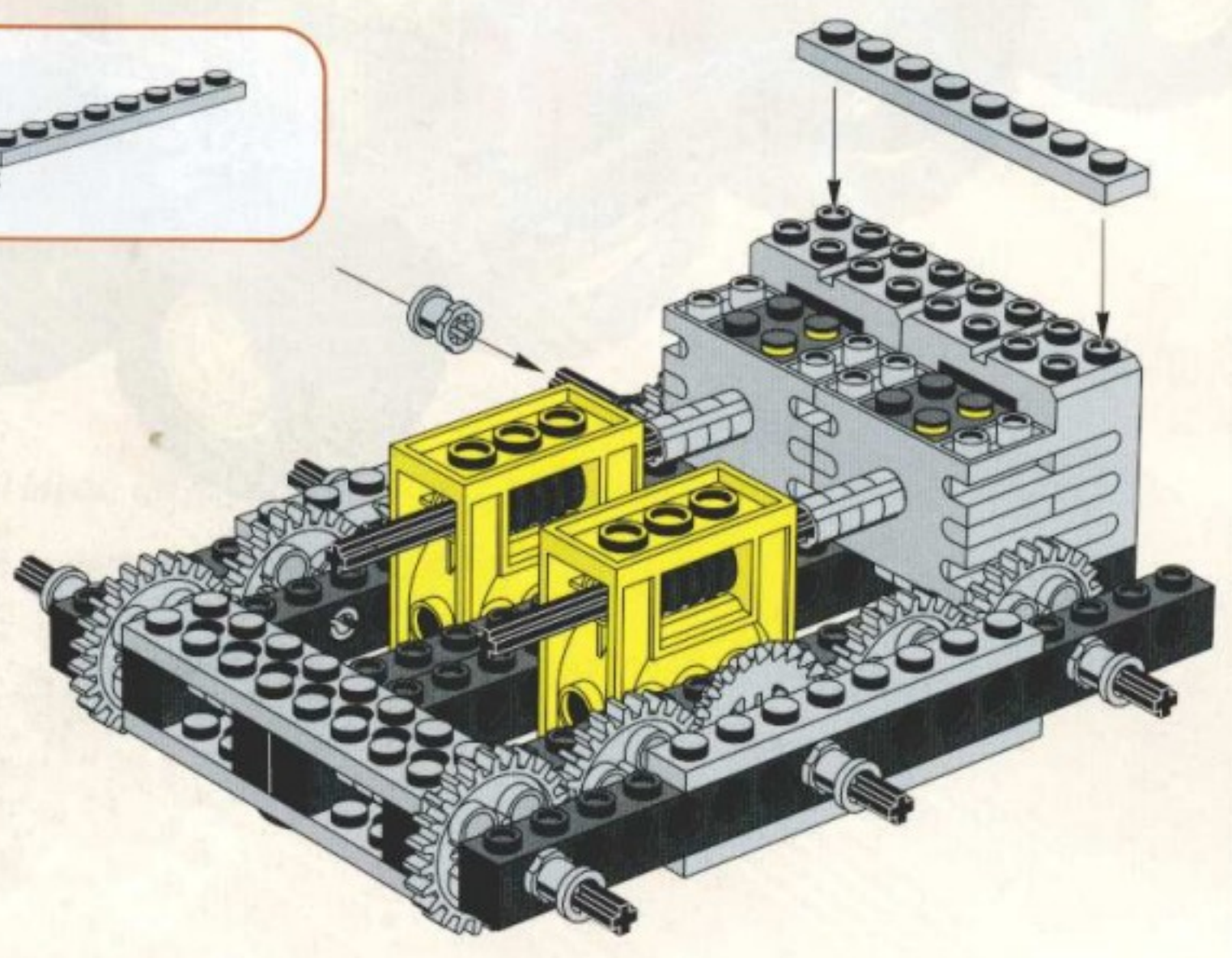
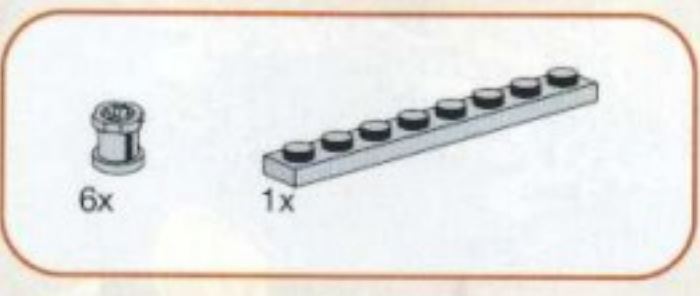




5

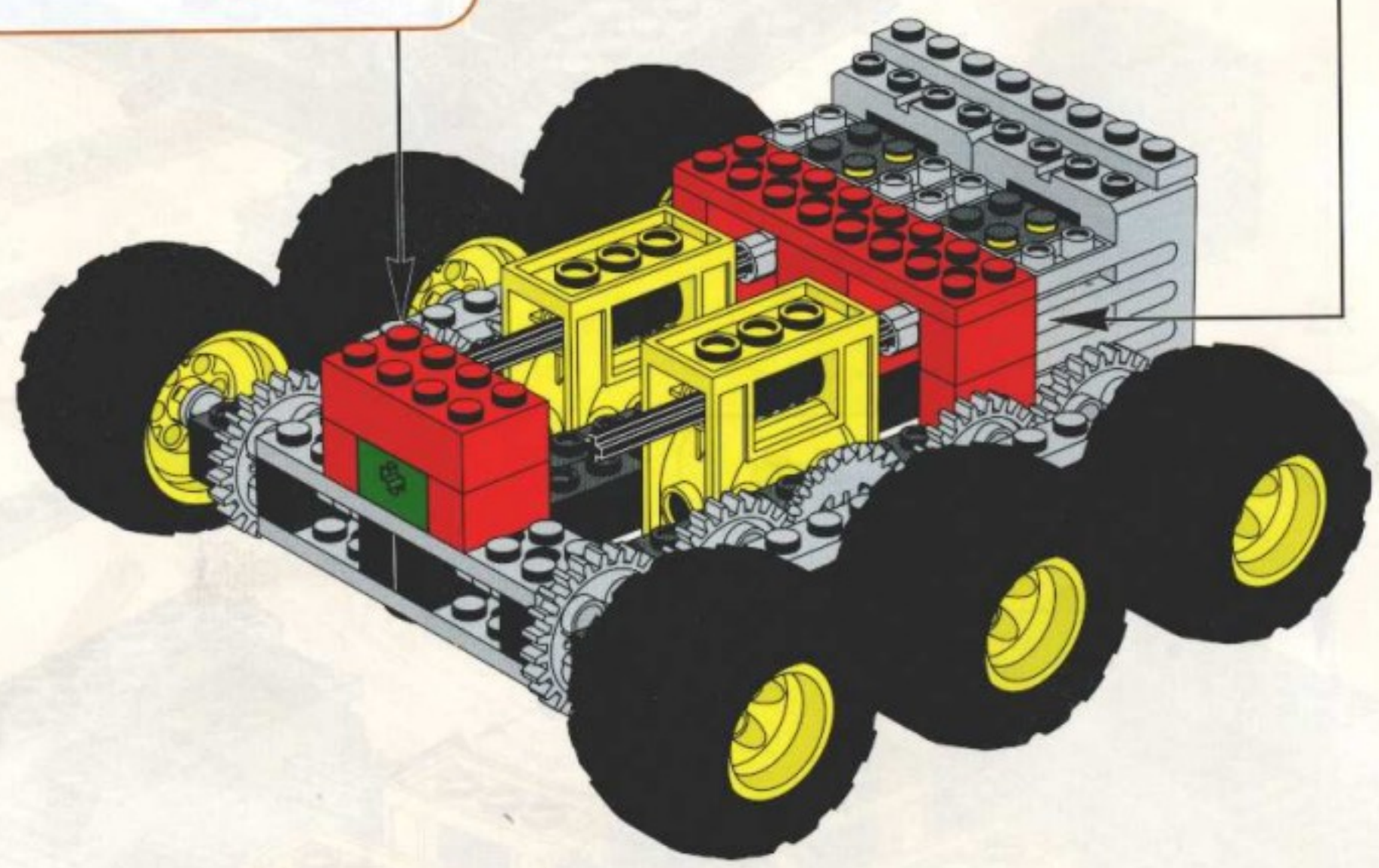
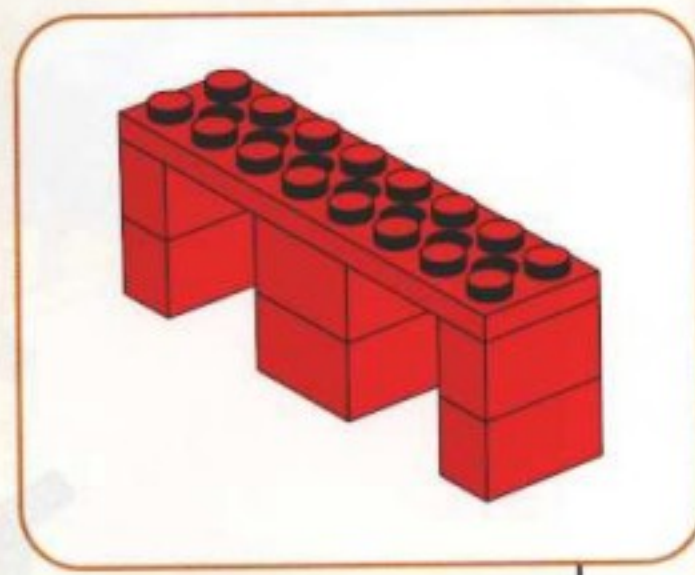
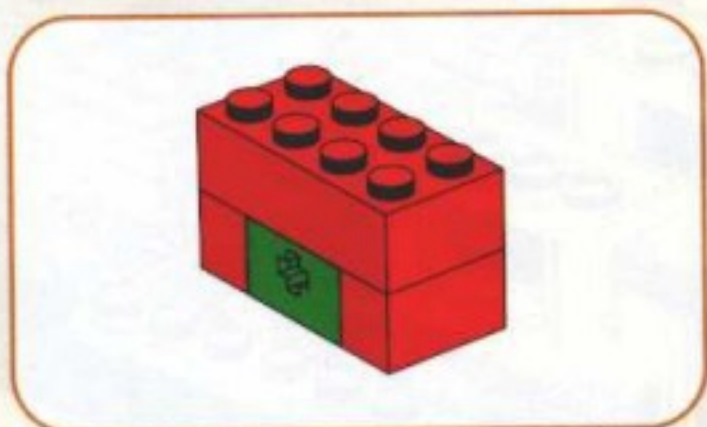
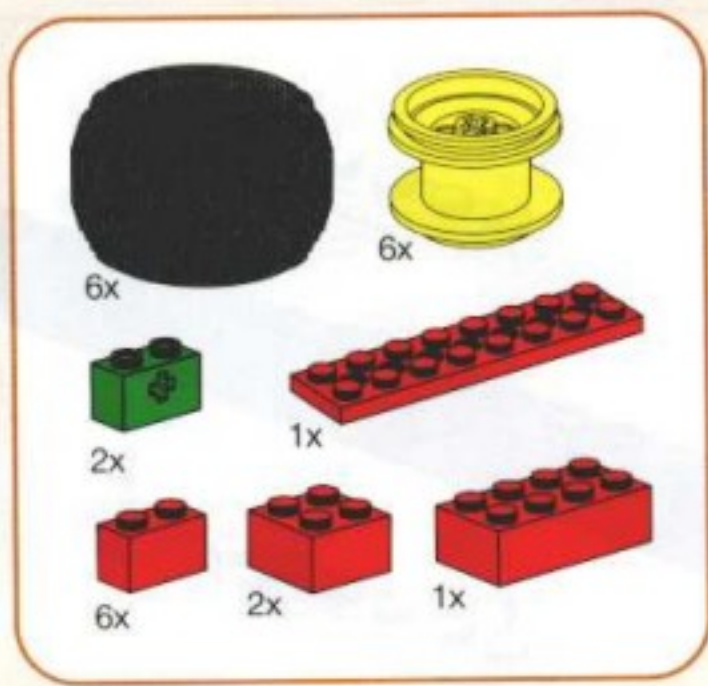


6





7



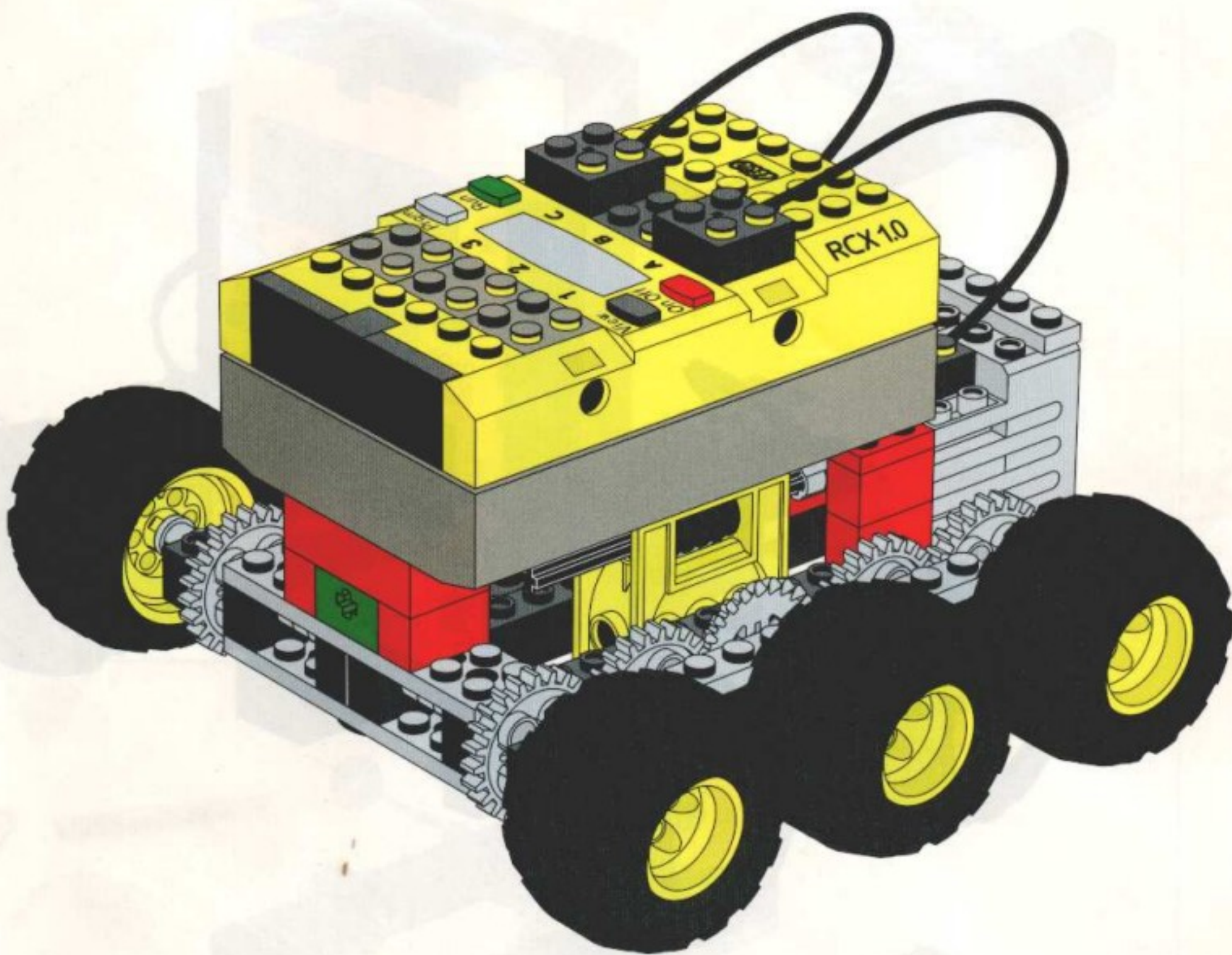


8



ROVER 2

The following pages show you how to build Rover 2. Make sure that your RCX 1.0 is working before you start. On the following pages, we will show you how to build the rover. When you begin, you will see the following steps:



For additional ideas, go to page 40.

Weitere Ideen findest du auf Seite 40.

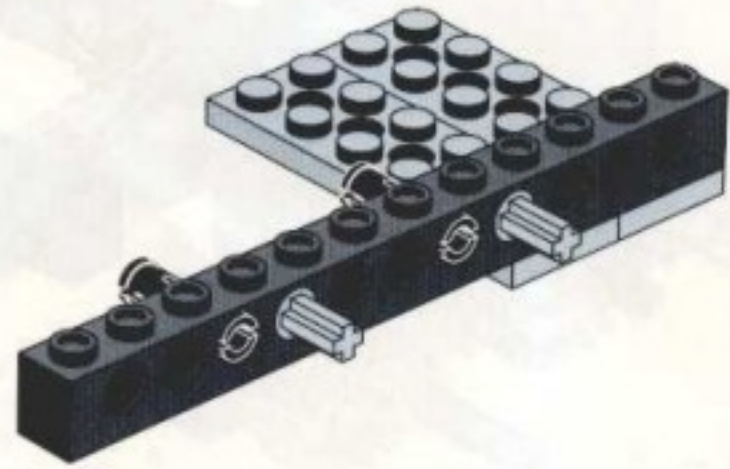
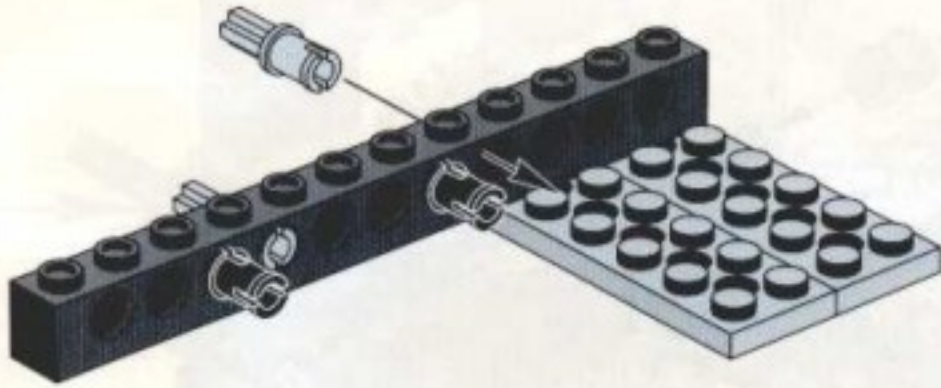
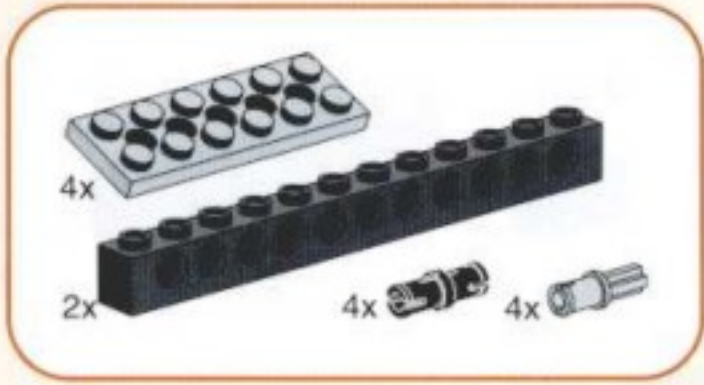
ROVER 2

- US** The following pages show you how to build Rover 2.
Make sure that your RCX has working batteries before starting.
- D** Auf den folgenden Seiten erfährst du, wie der Rover 2 gebaut wird.
Bevor du beginnst, solltest du überprüfen, ob die Batterien im RCX funktionieren.

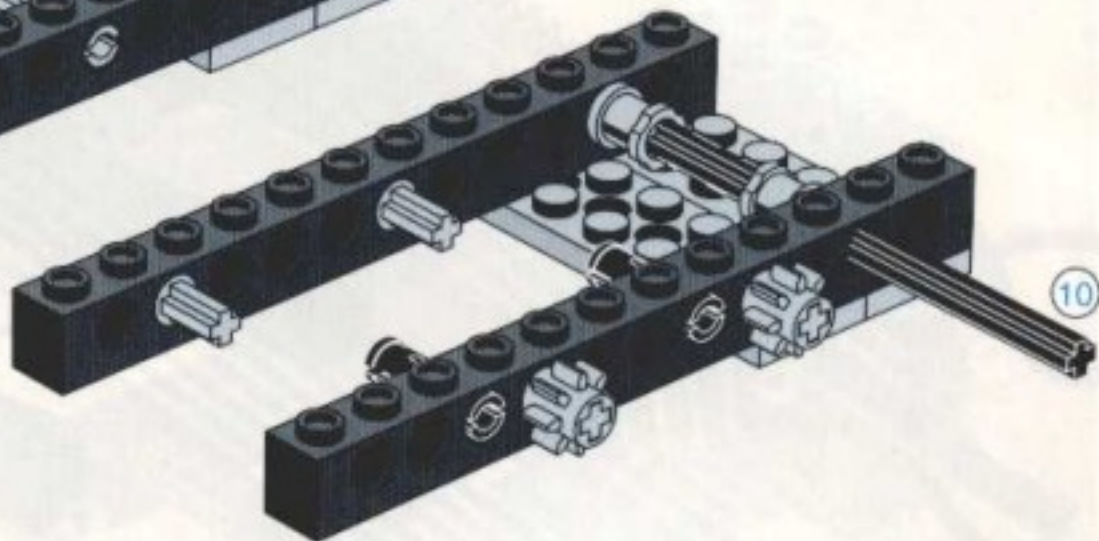
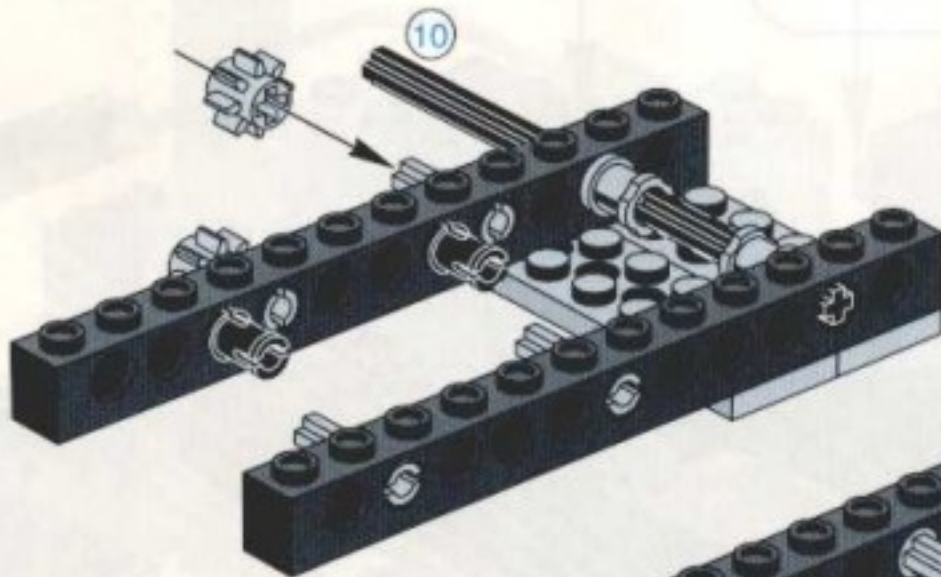
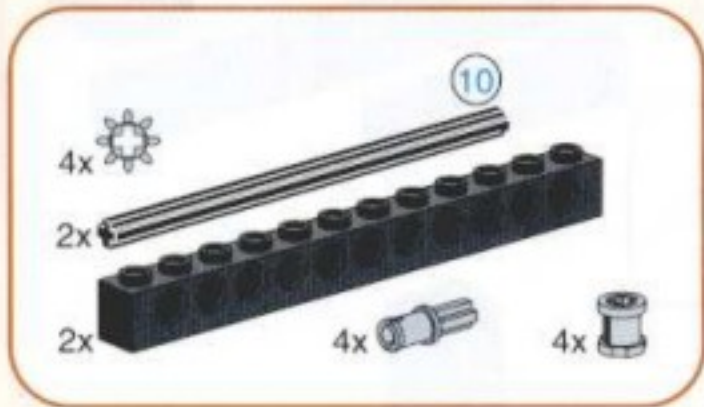




1

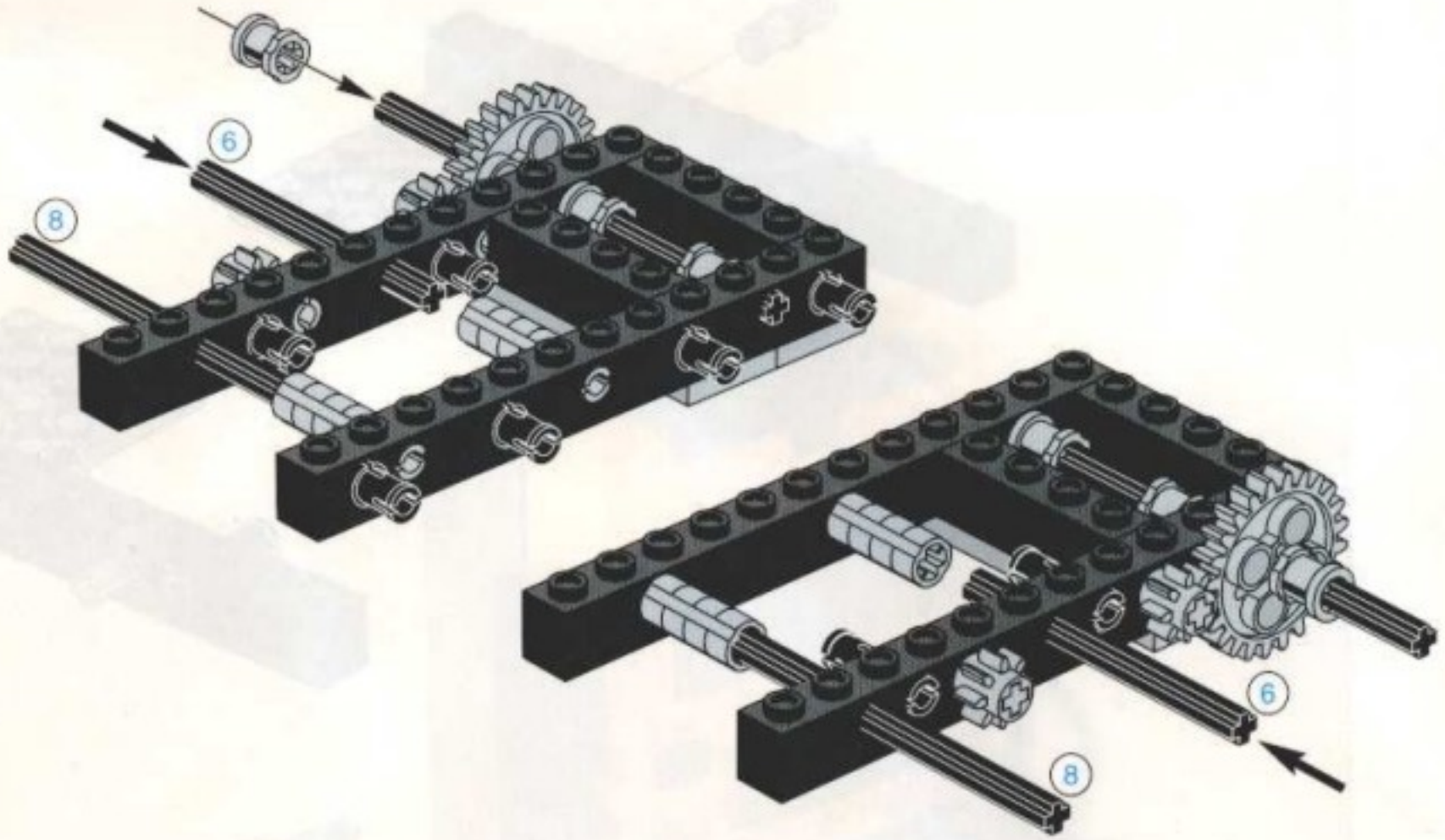
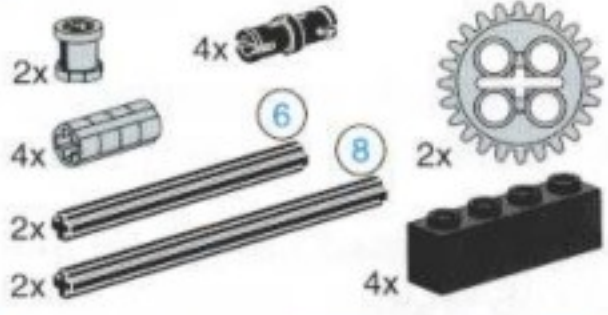


2

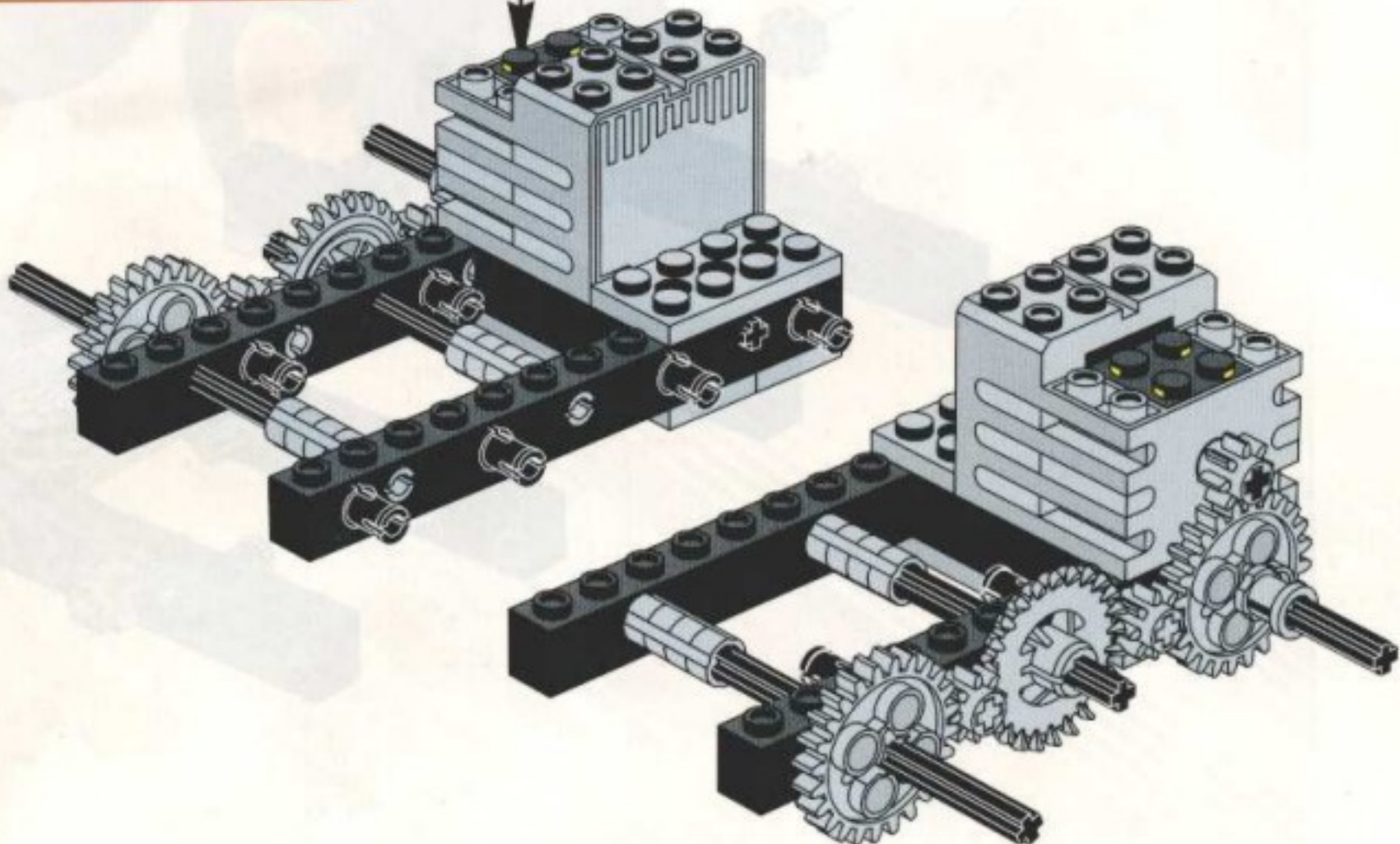
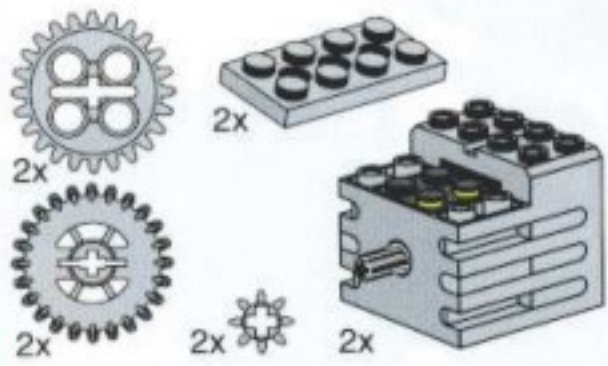




3

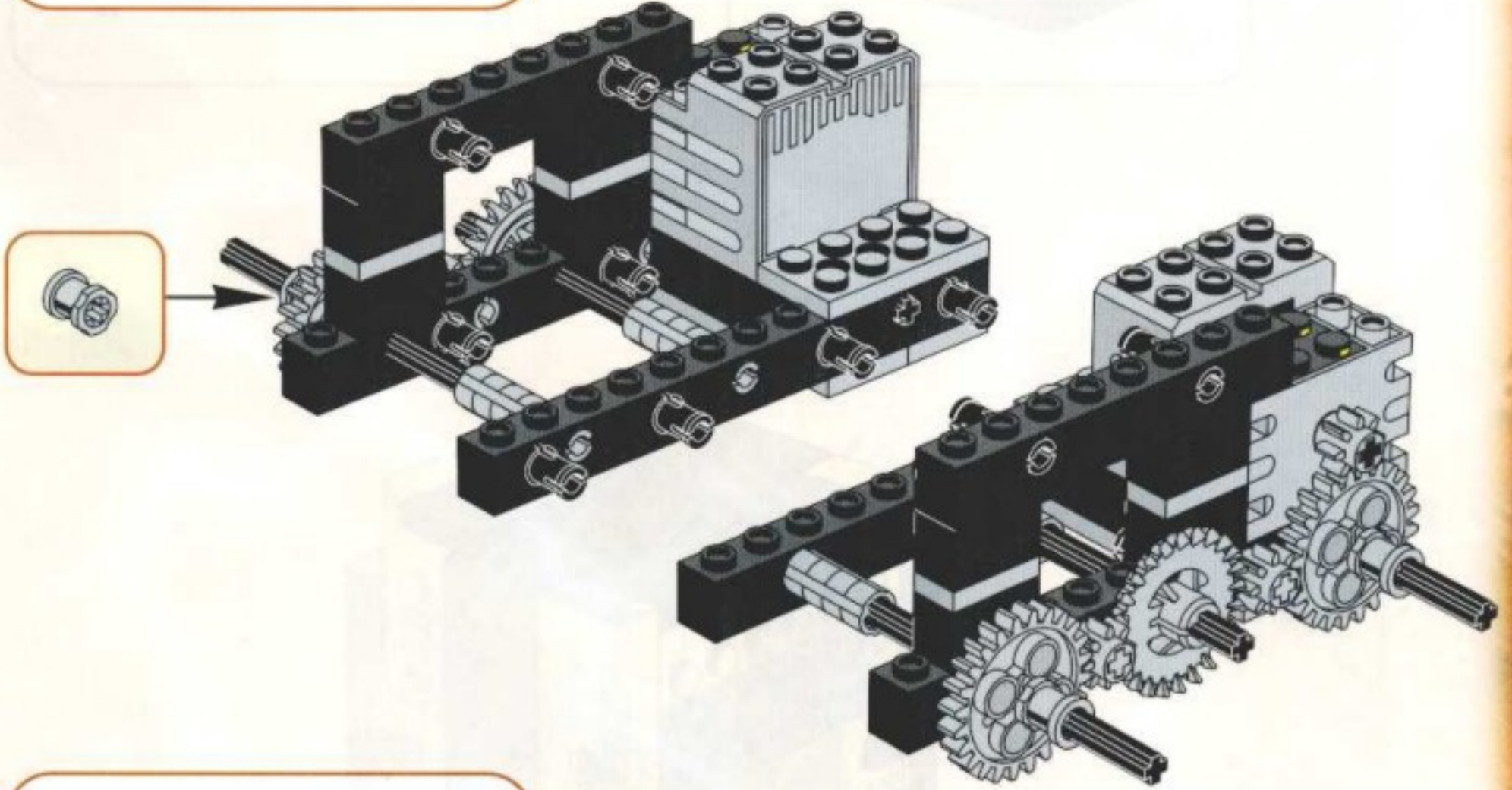
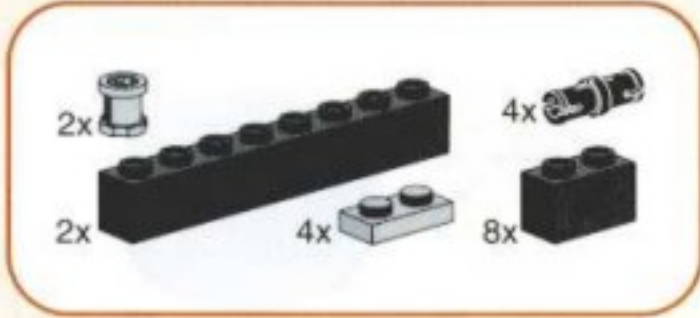


4

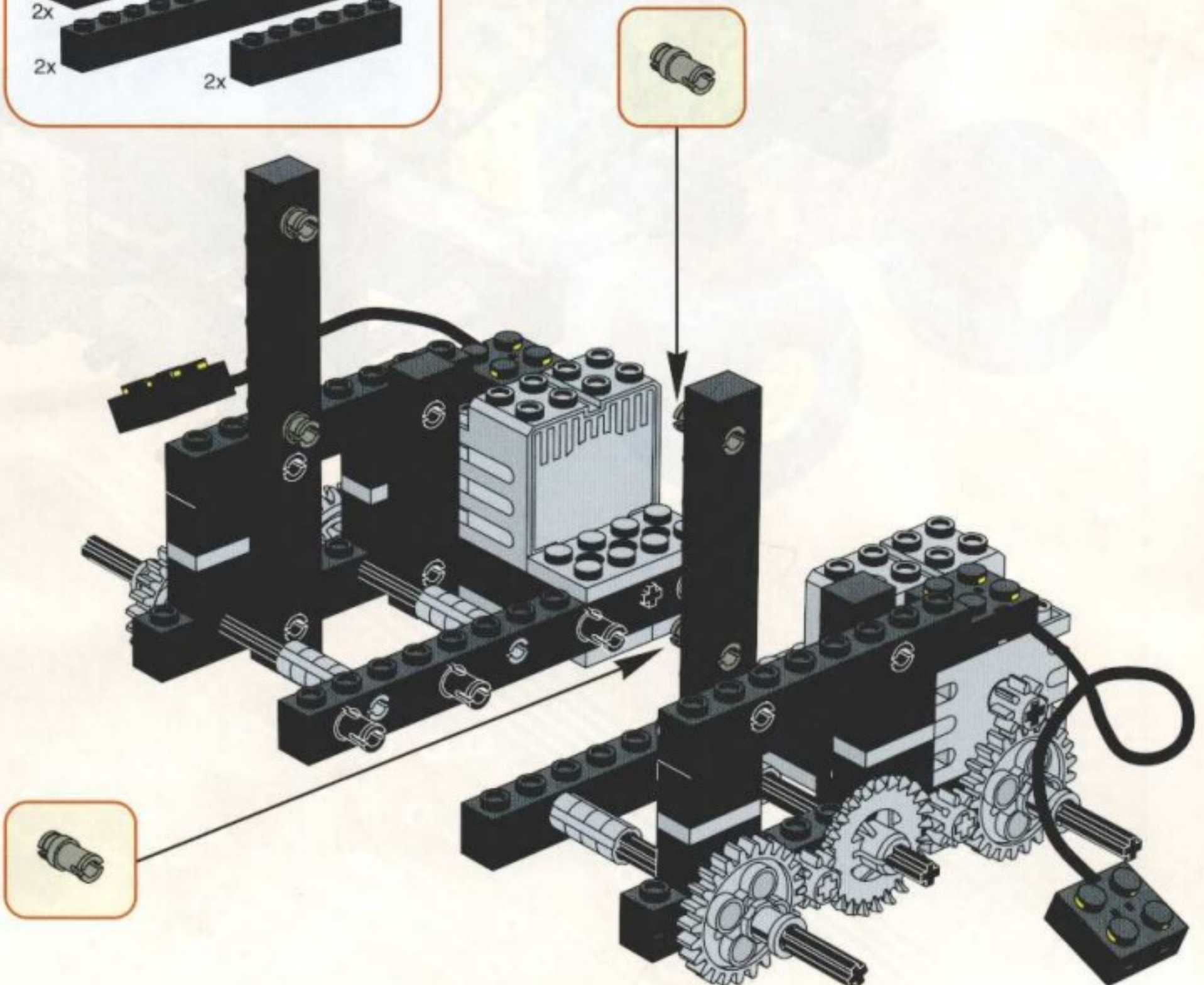
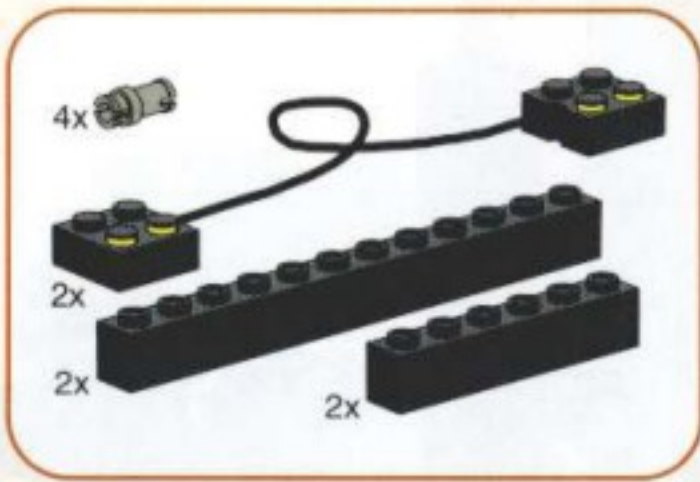




5

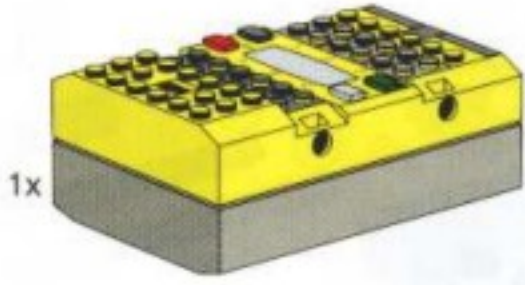


6

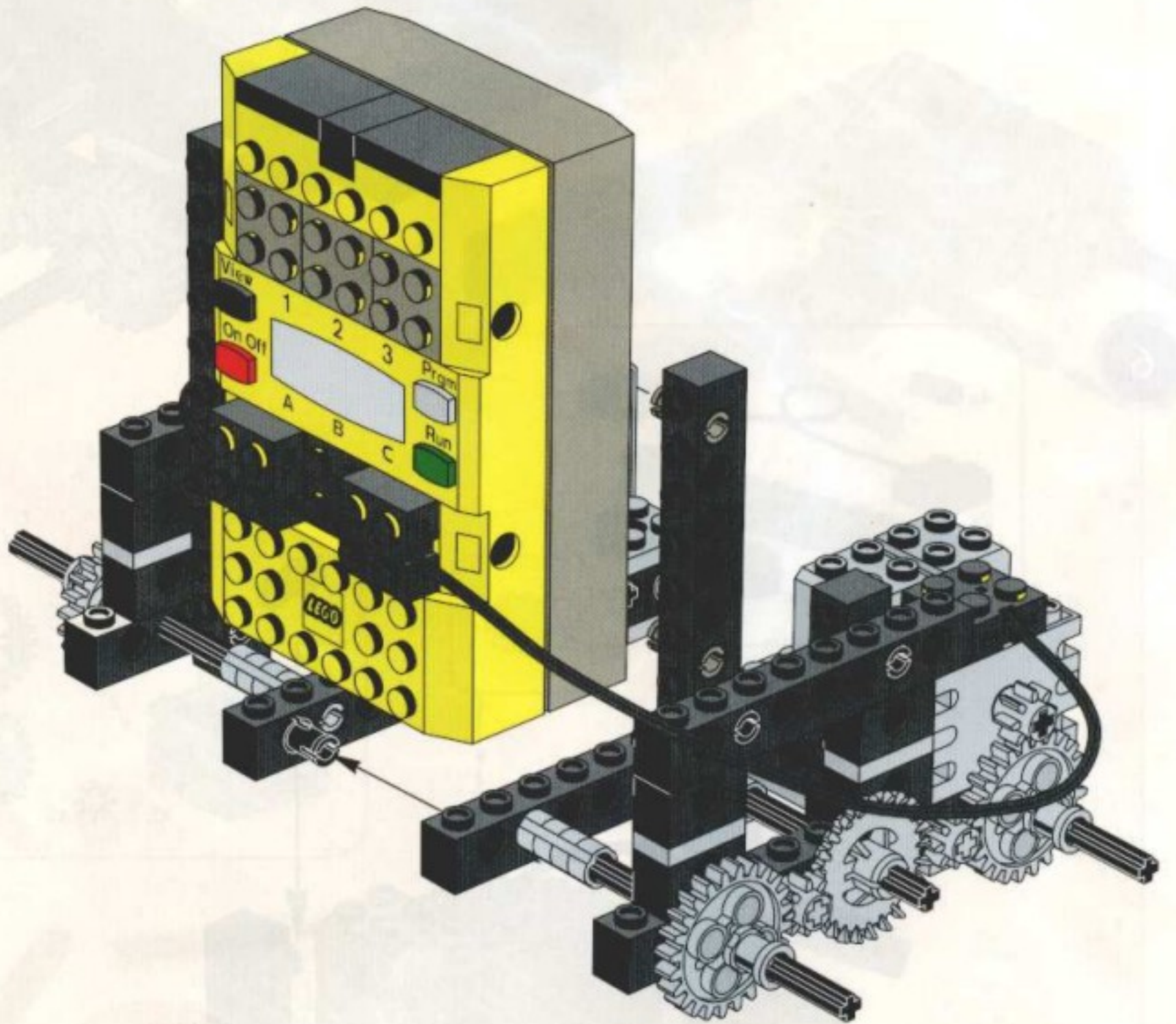




7



1x



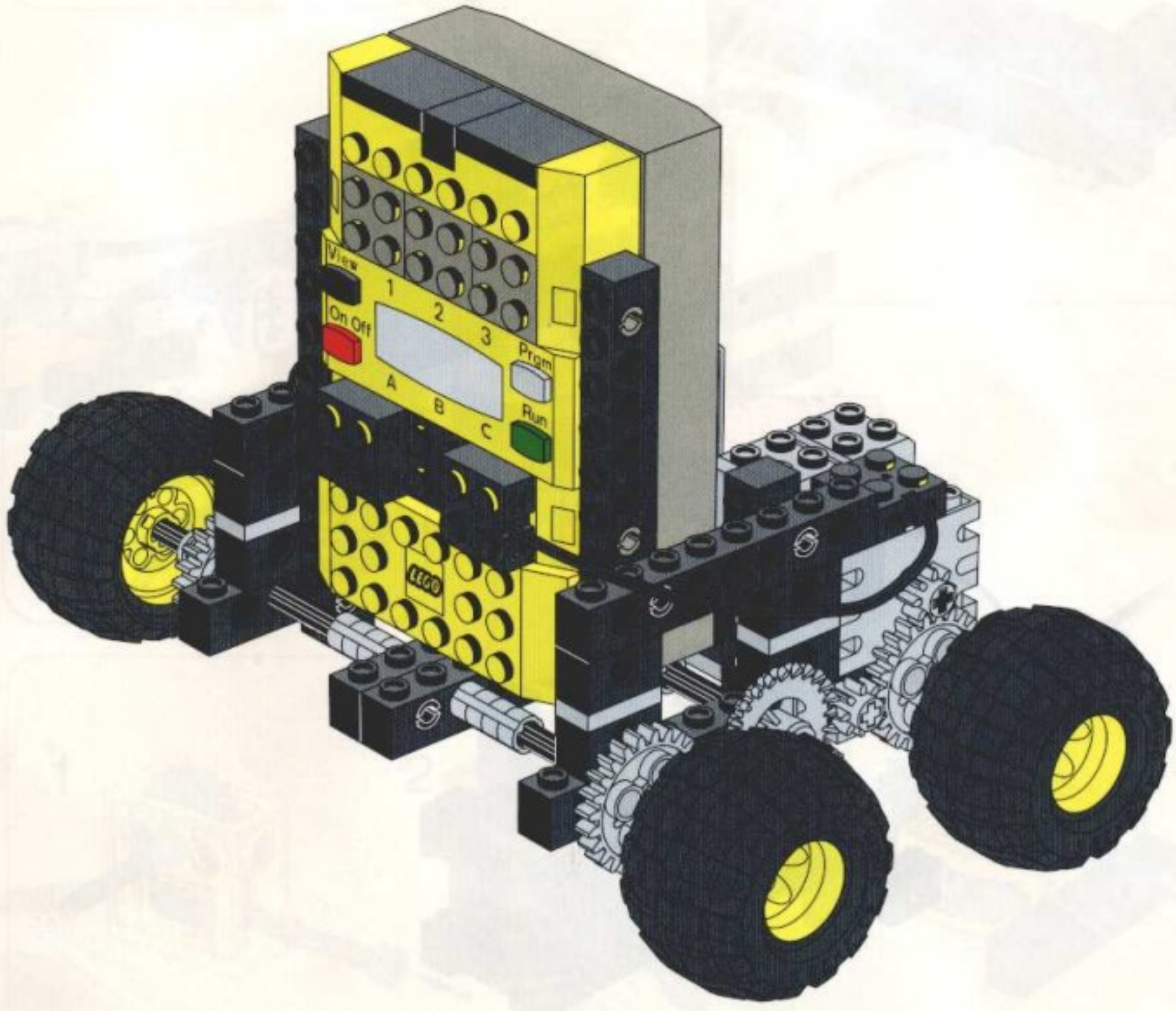


8



TURNTABLE / DREHSCHLEIBE

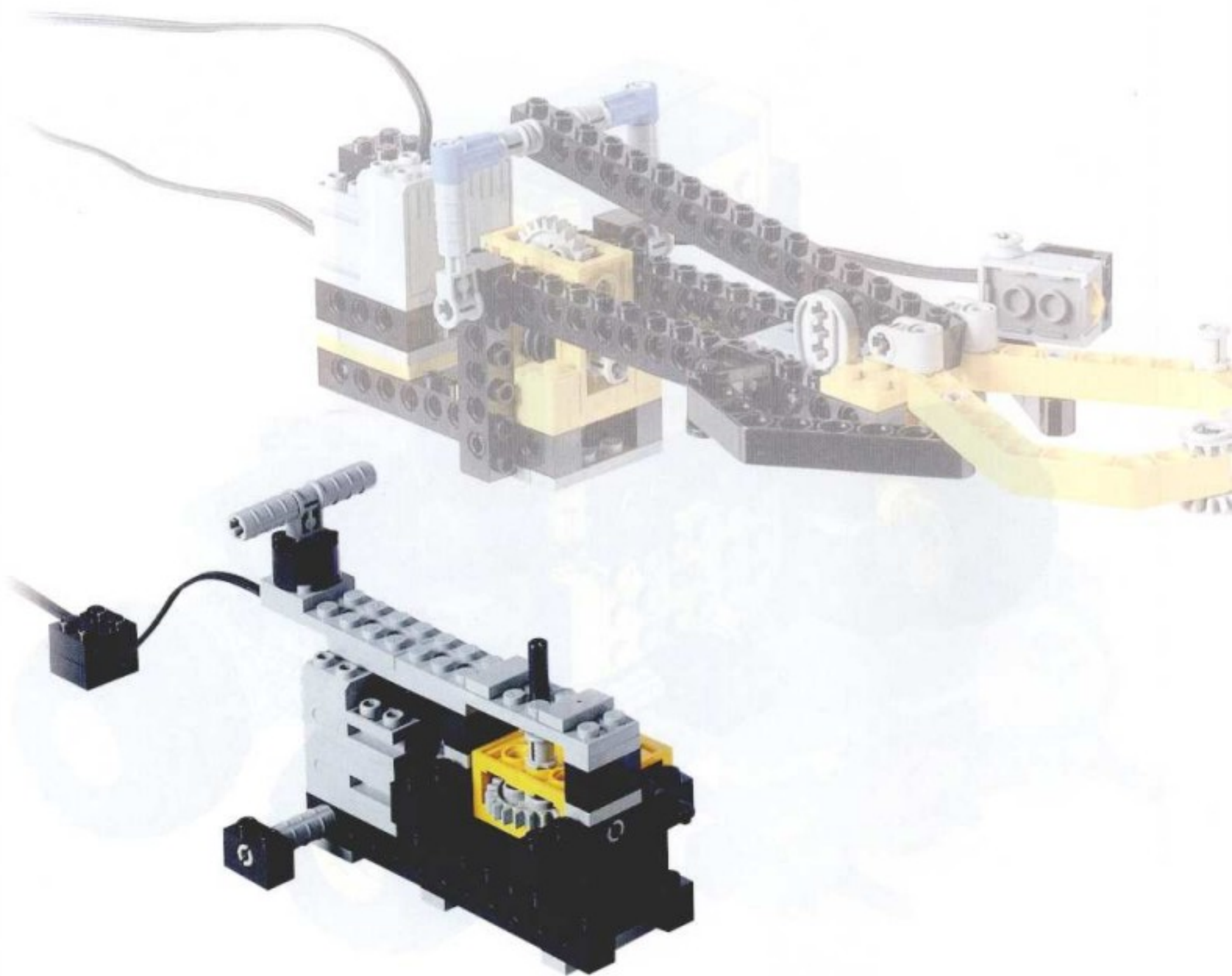
The following steps show you how to build the turntable. The following steps show you how to build the turntable. The following steps show you how to build the turntable.





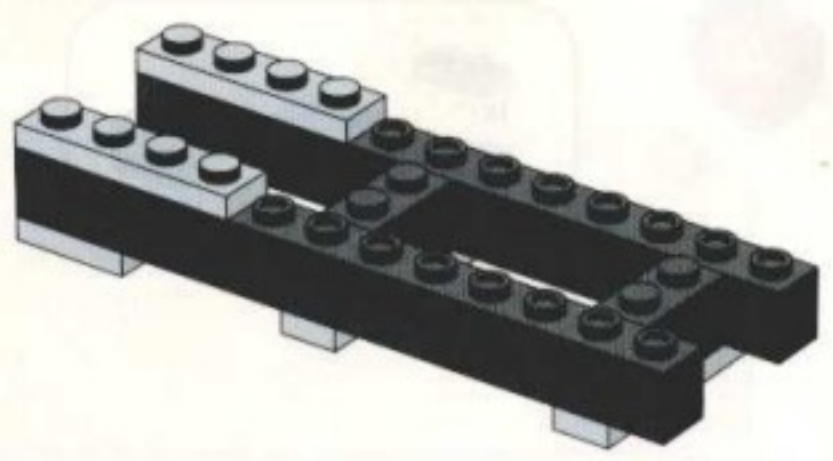
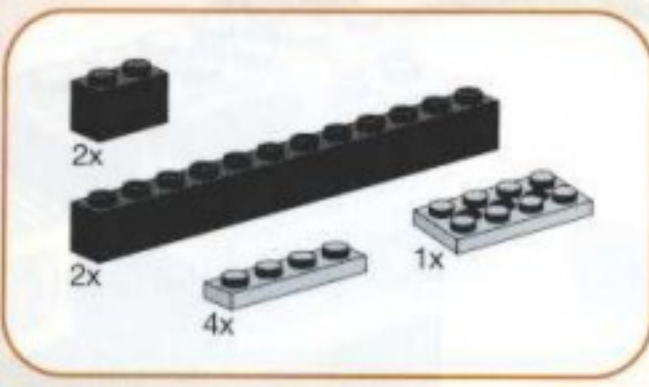
TURNTABLE / DREHSCHEIBE

- US** The following pages show you how to build the Turntable.
- D** Auf den folgenden Seiten erfährst du, wie eine Drehscheibe gebaut wird.

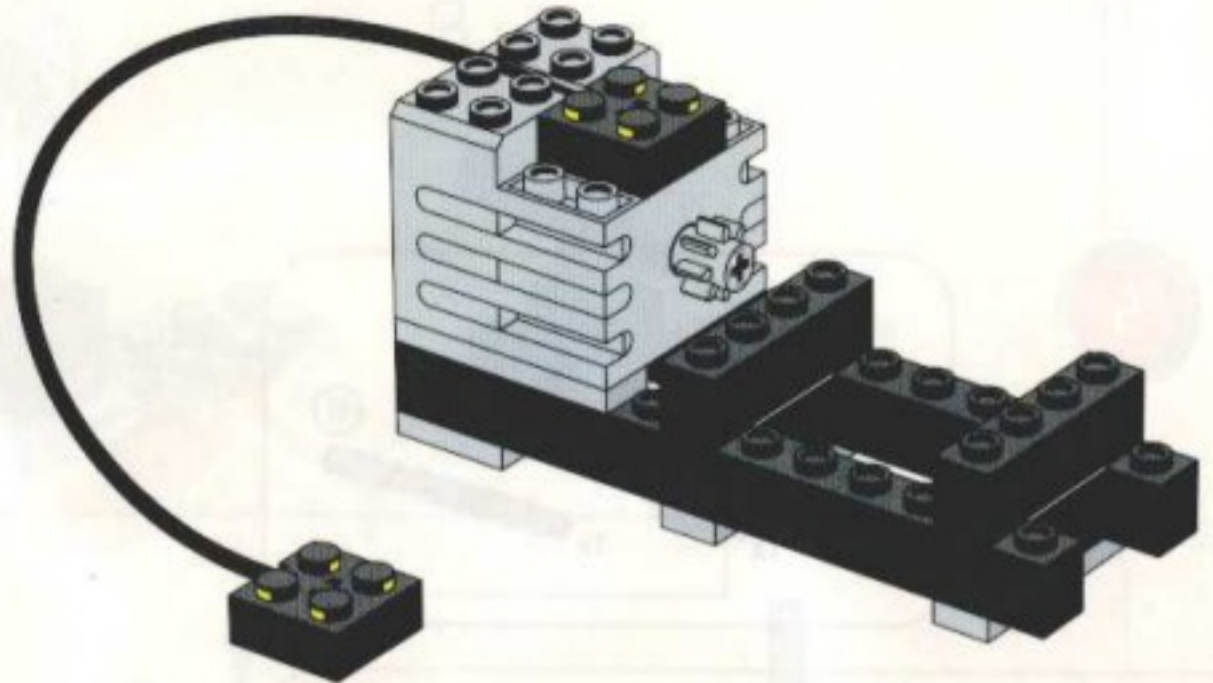
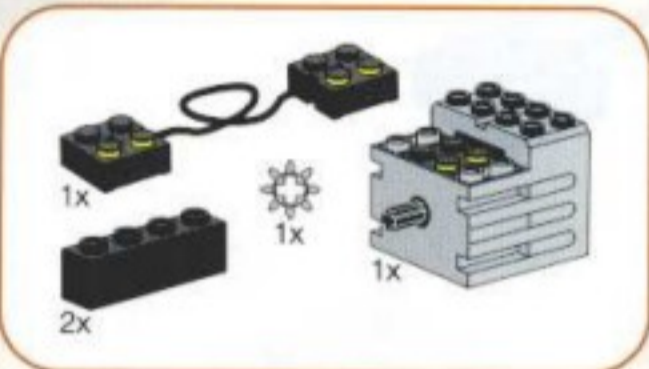




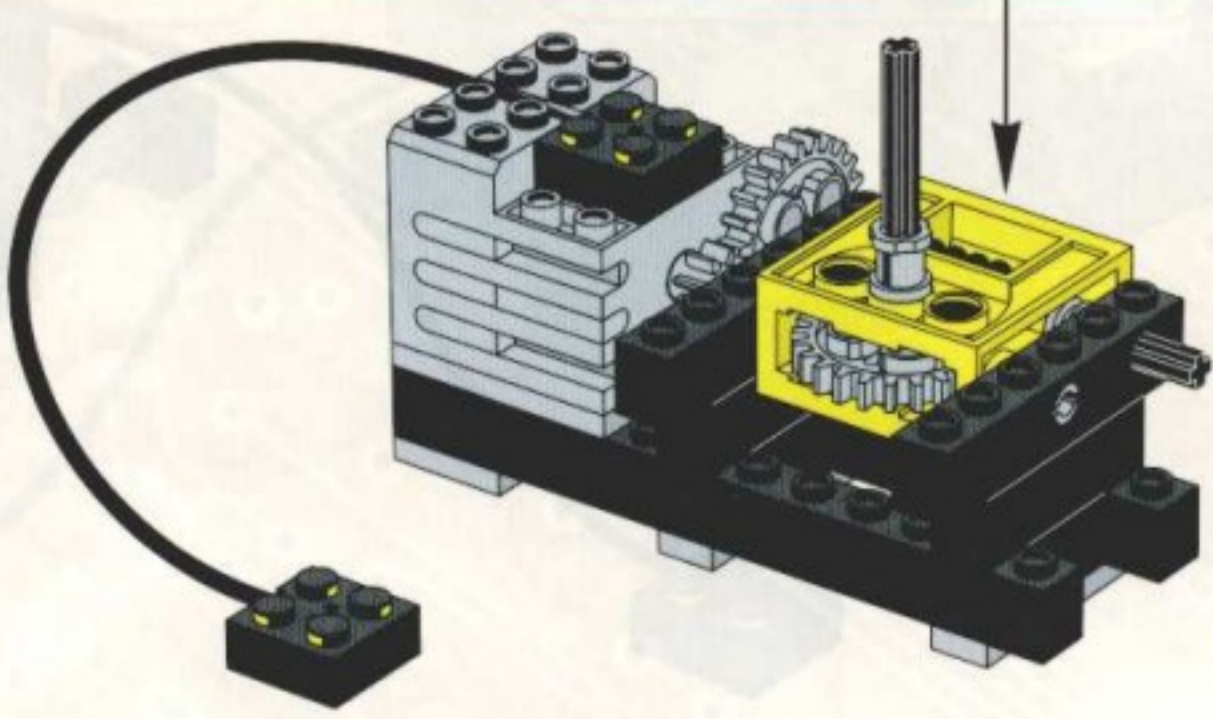
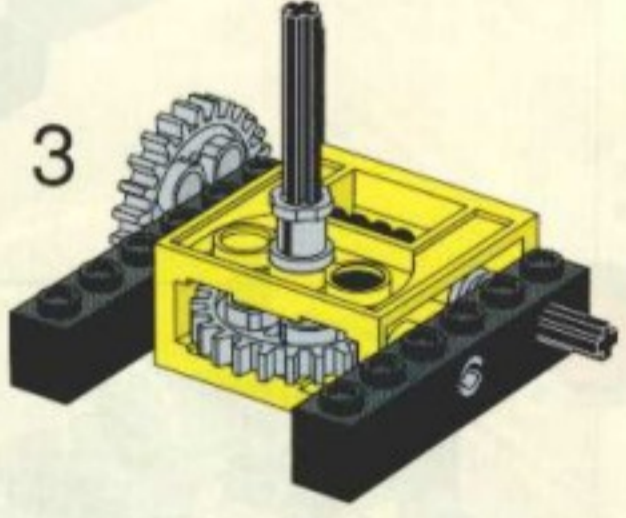
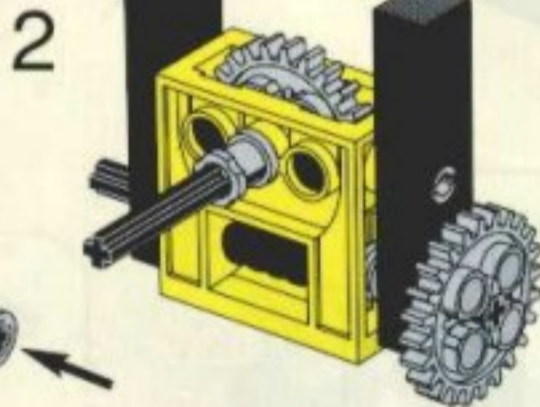
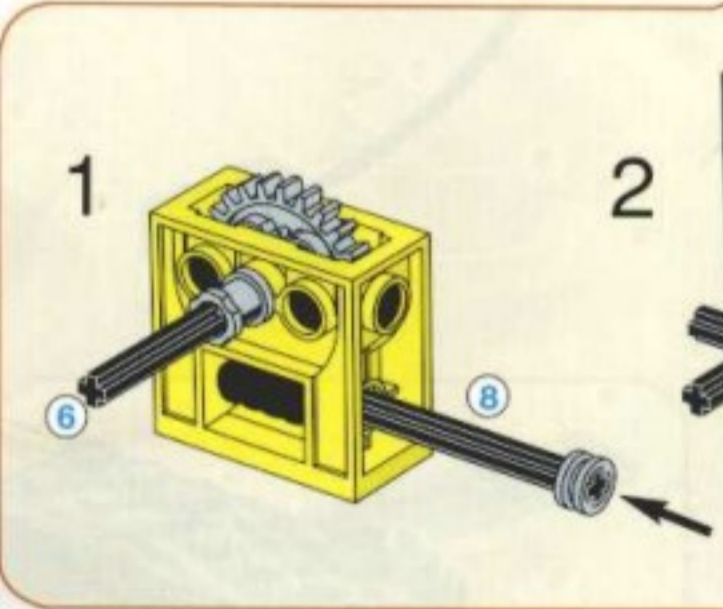
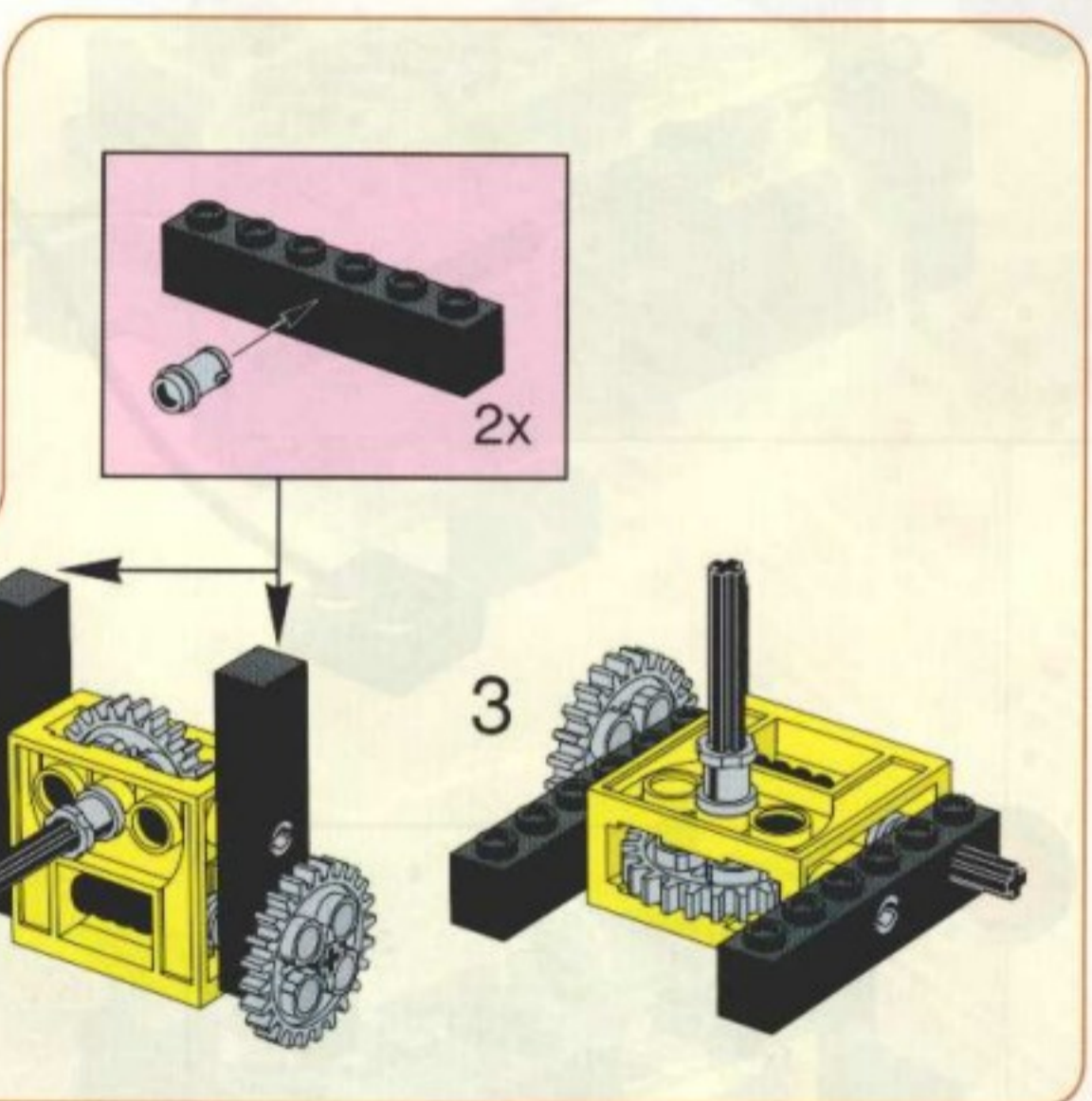
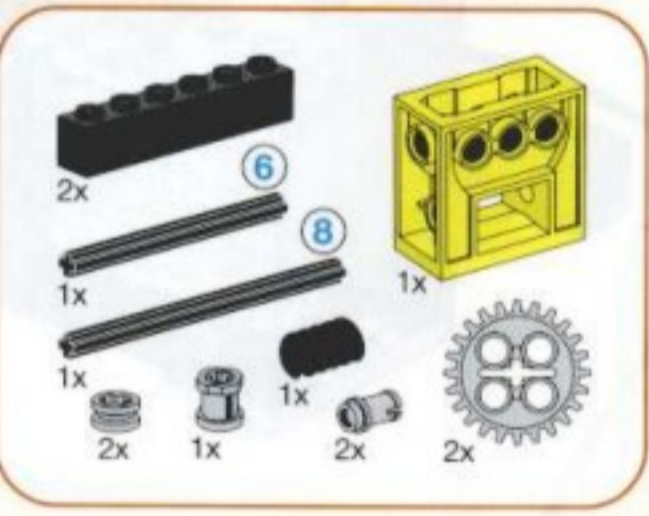
1



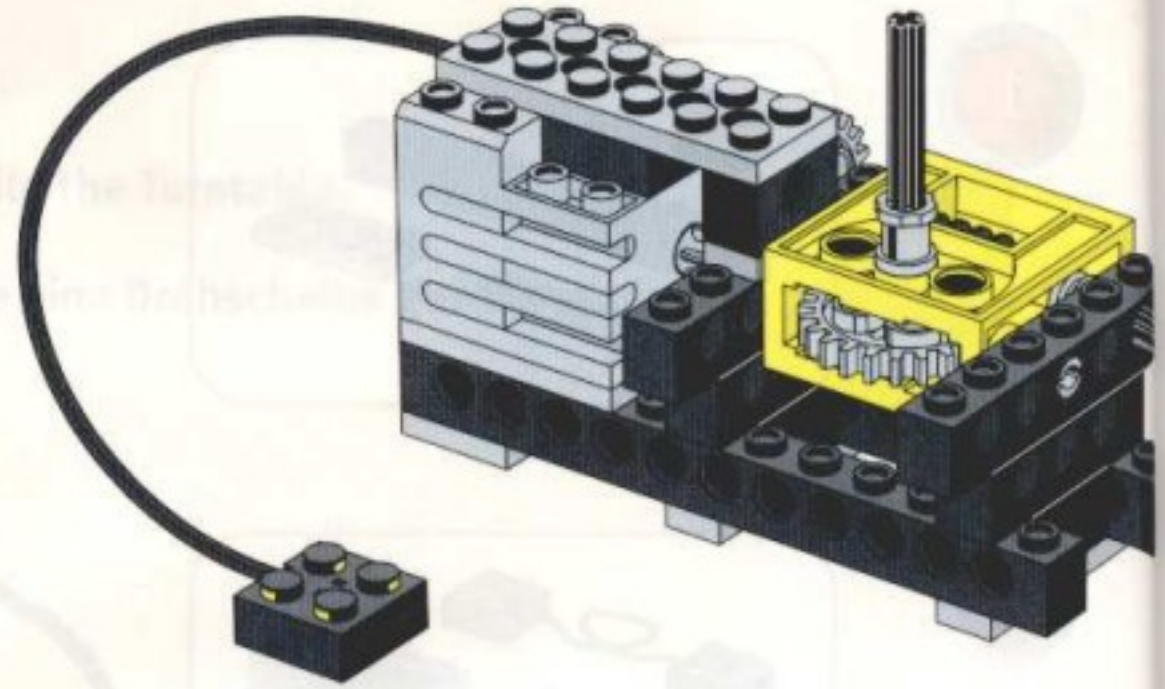
2



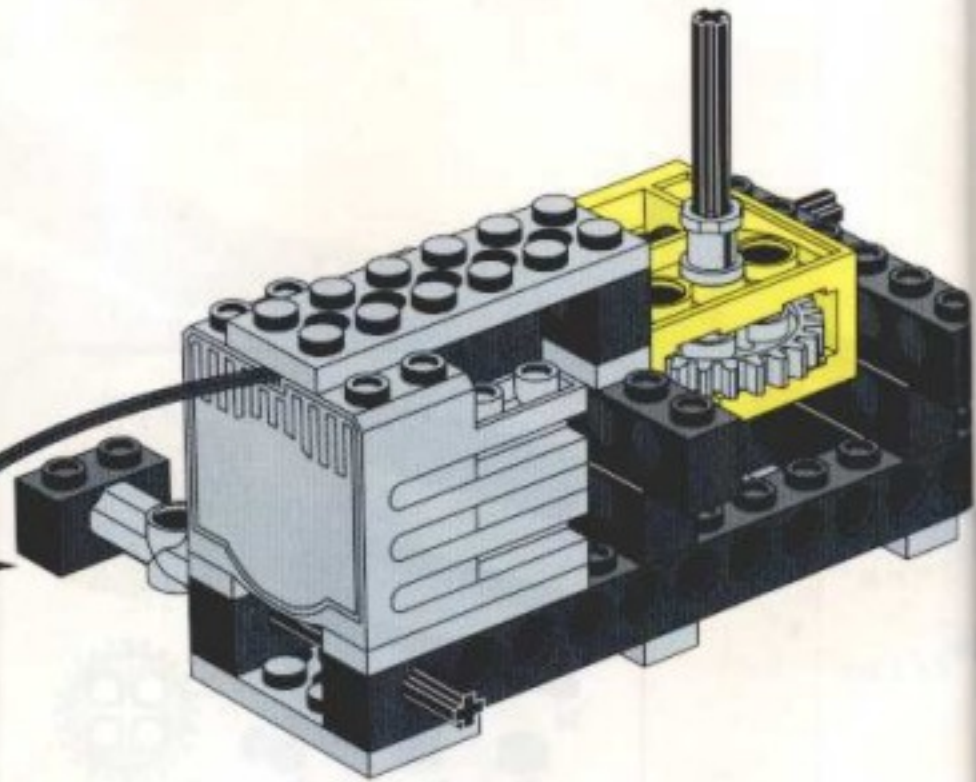
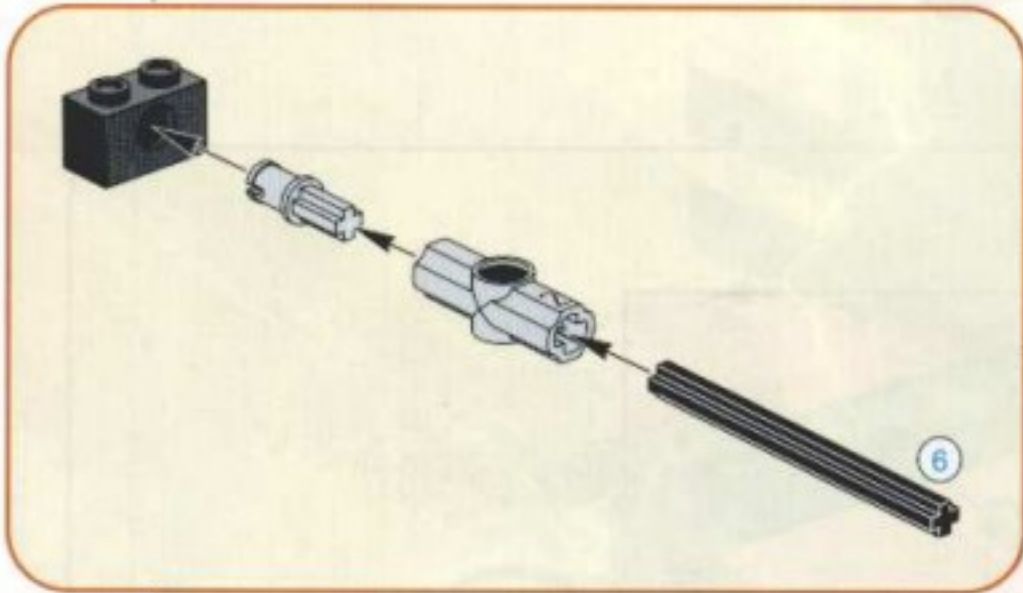
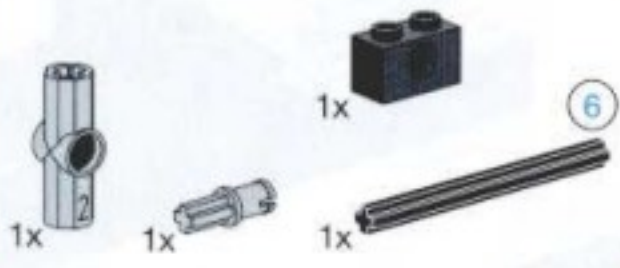
3



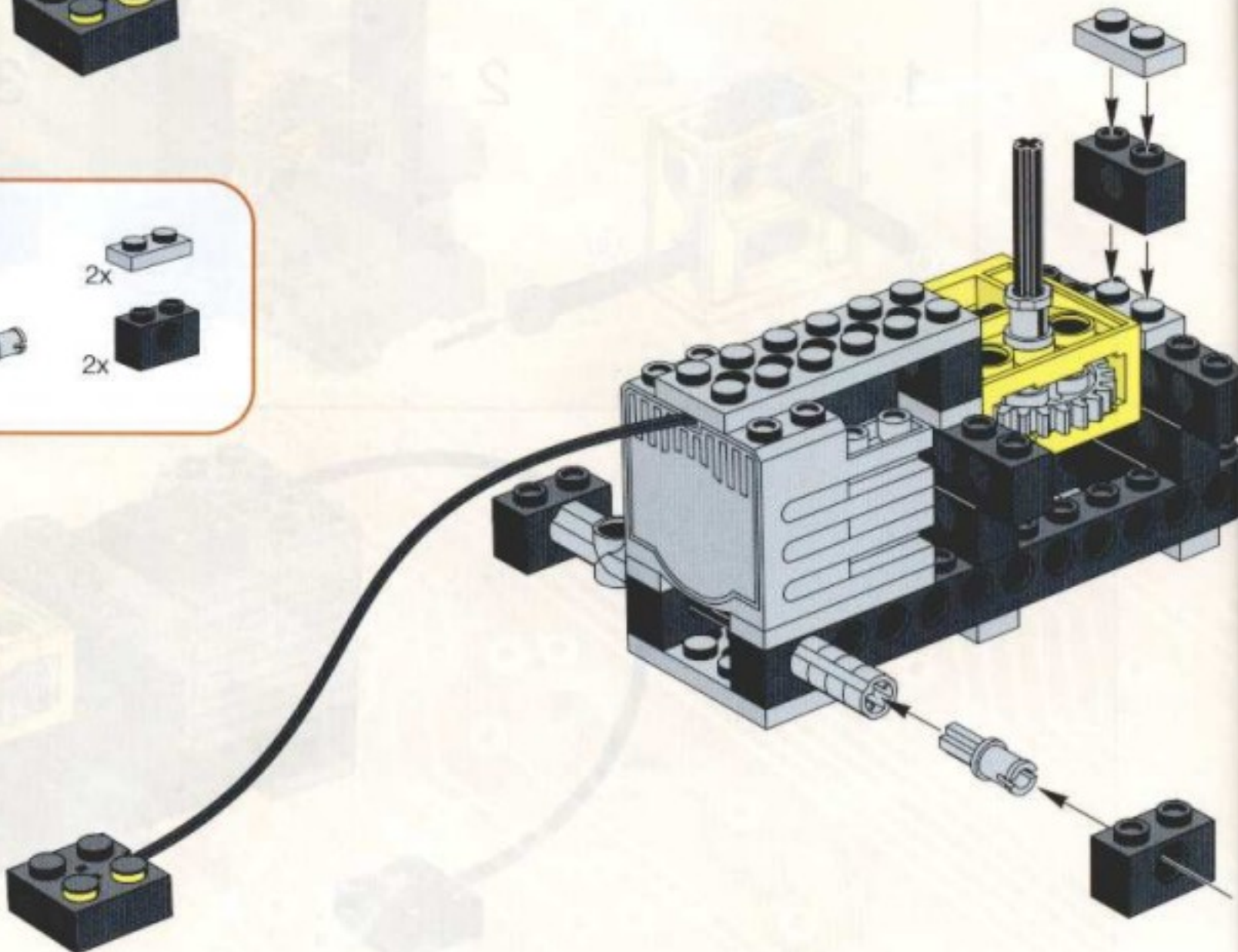
4



5

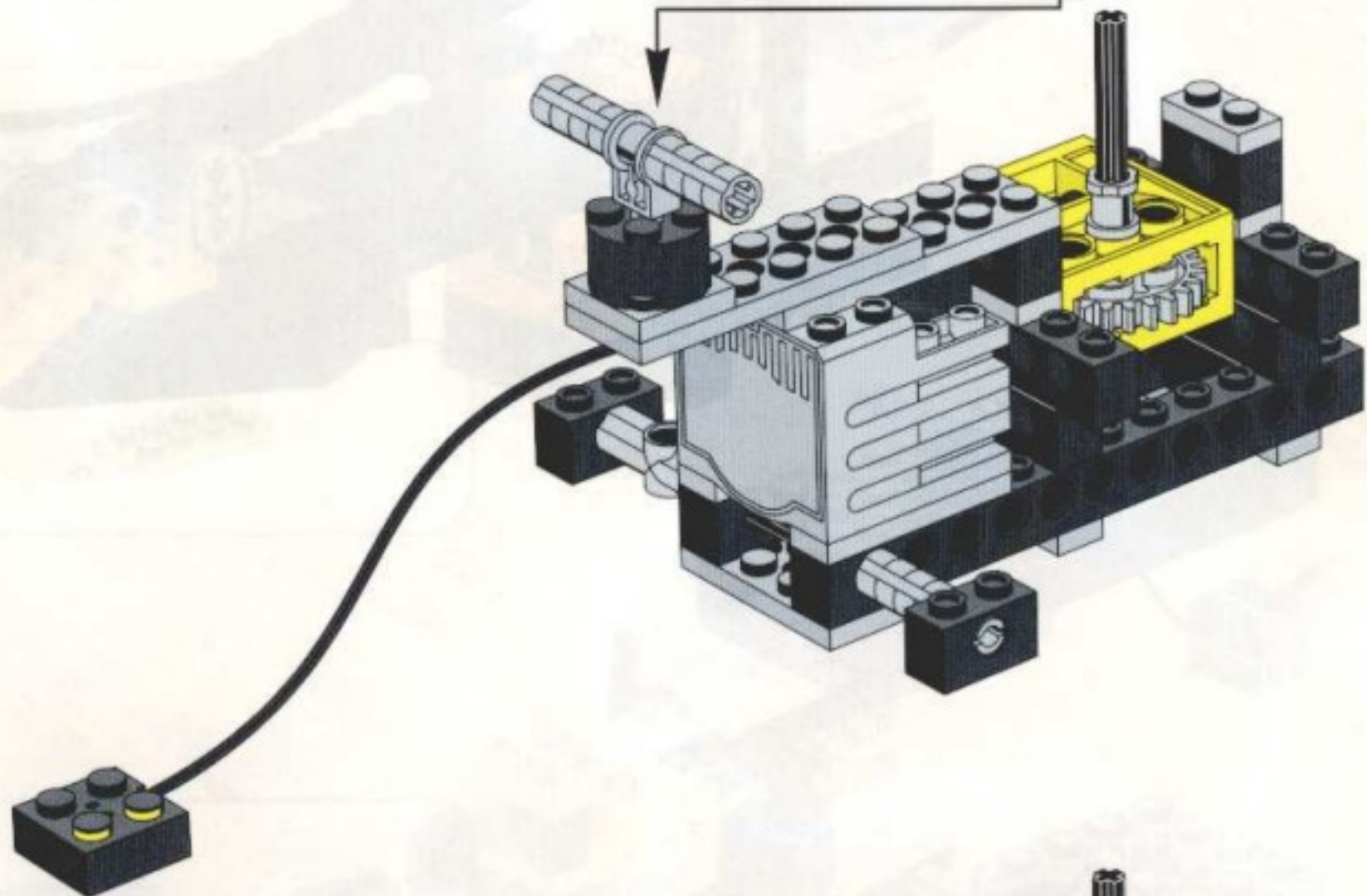
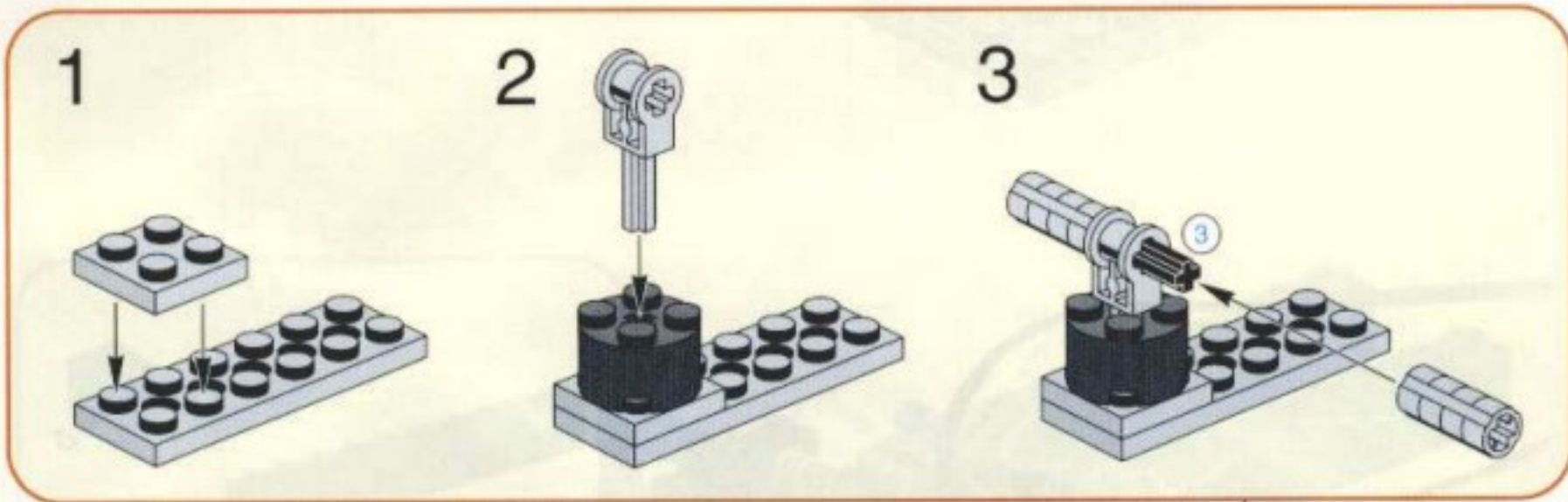
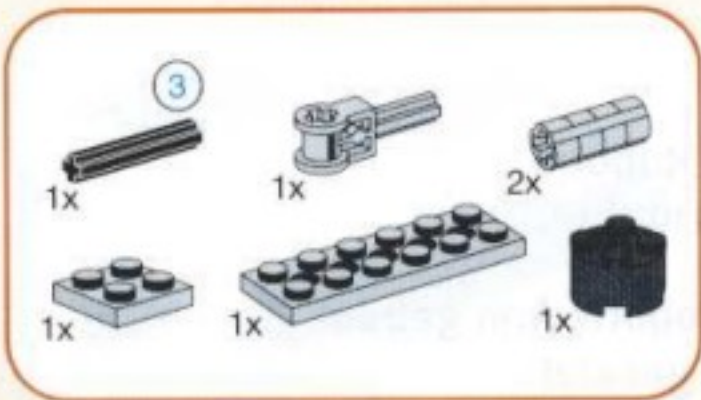


6

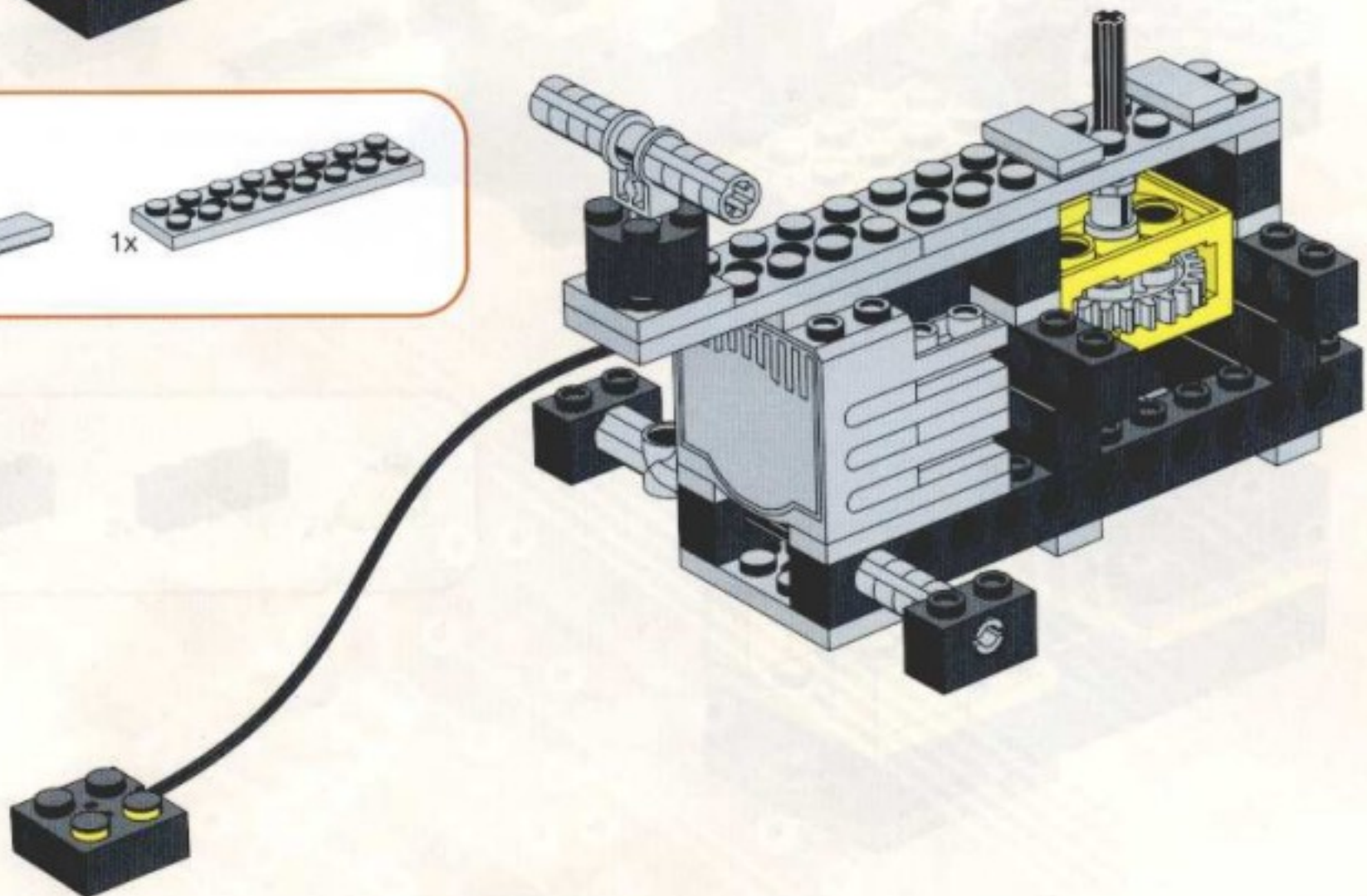
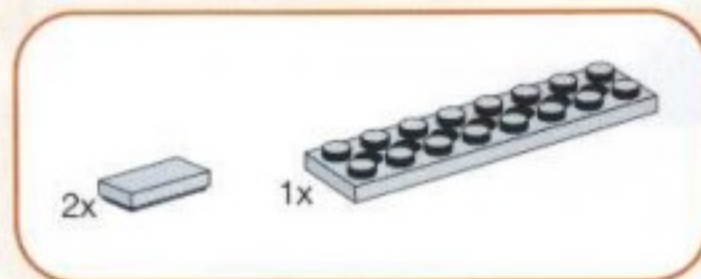




7



8



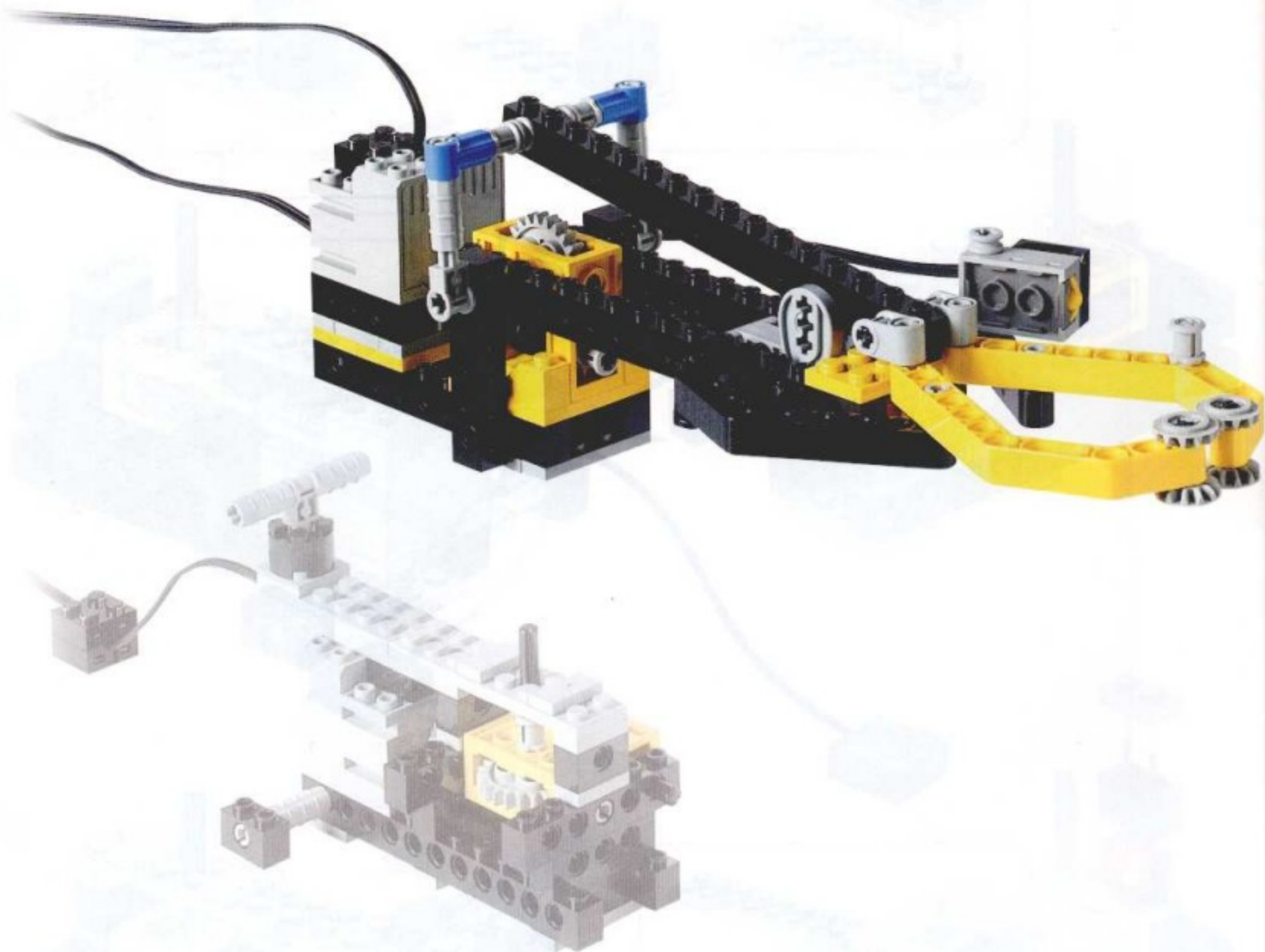
ROBOTIC ARM

The following pages show you how to build the arm. The Robot Arm is placed on top of the Robot. Auf den folgenden Seiten erfährst du, wie der Arm der Roboter Arm wird auf die Oberseite des Roboters.



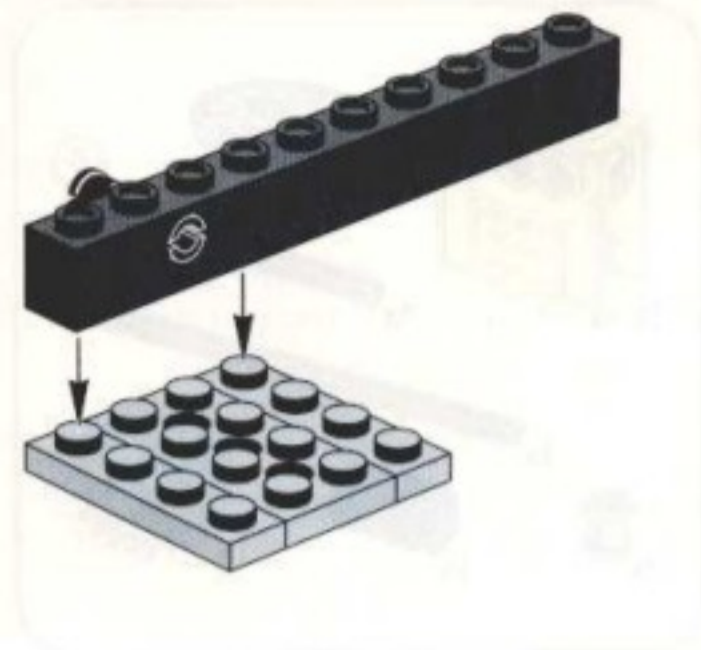
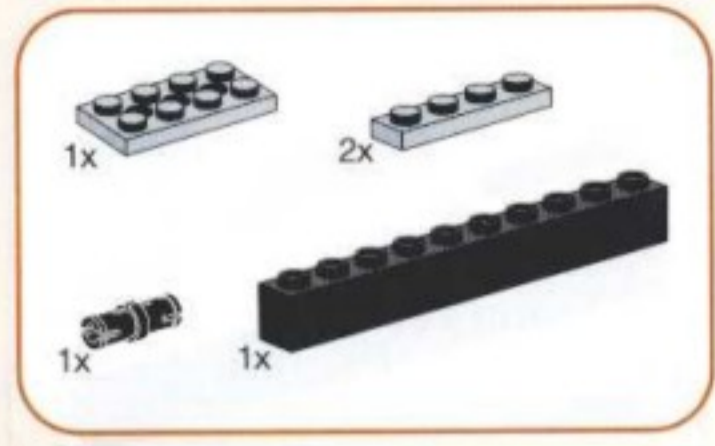
ROBOTIC ARM

- US** The following pages show you how to build the Robotic Arm. The Robotic Arm is placed on top of the Turntable.
- D** Auf den folgenden Seiten erfährst du, wie der Robotic Arm gebaut wird. Der Robotic Arm wird auf die Drehscheibe gesetzt.

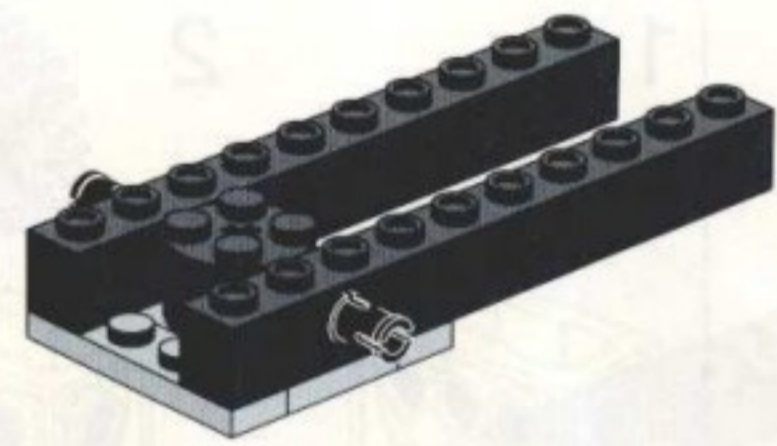
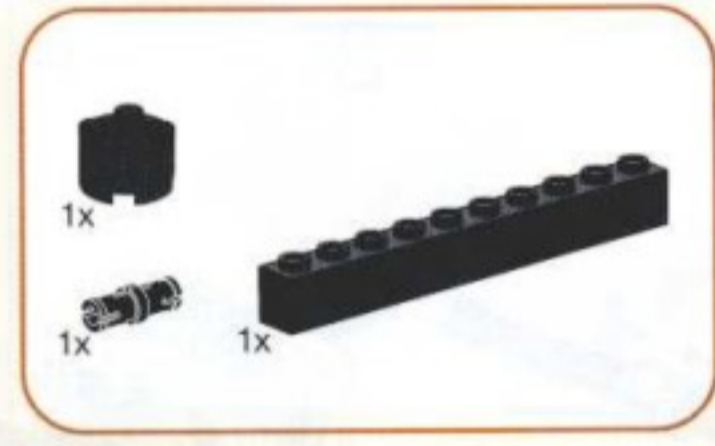




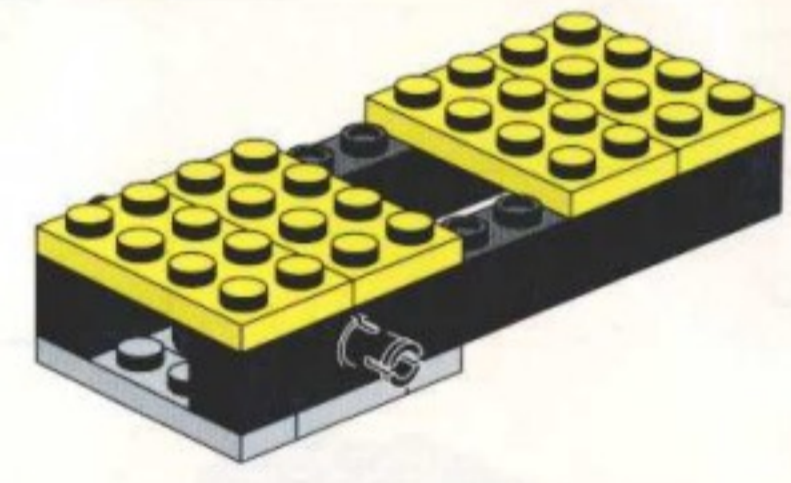
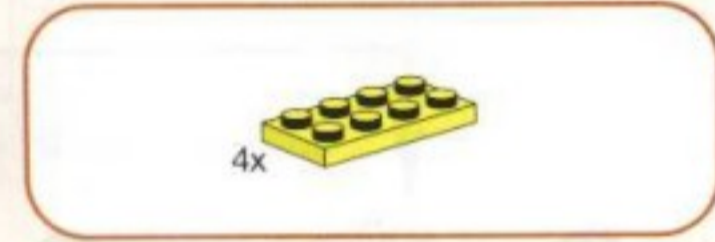
1



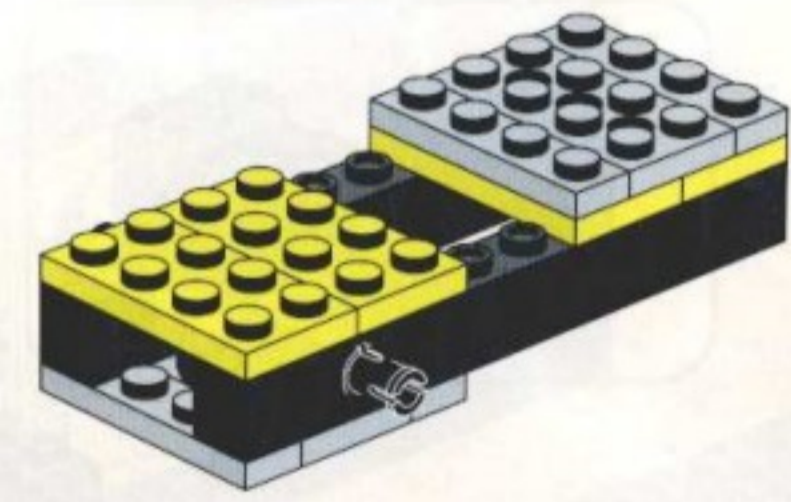
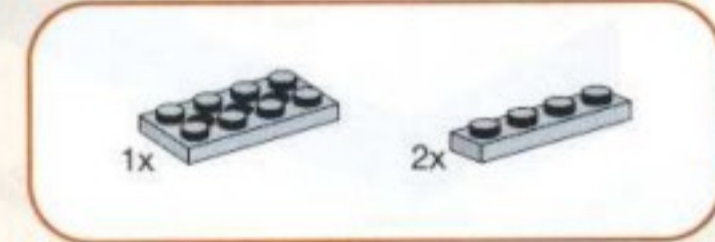
2



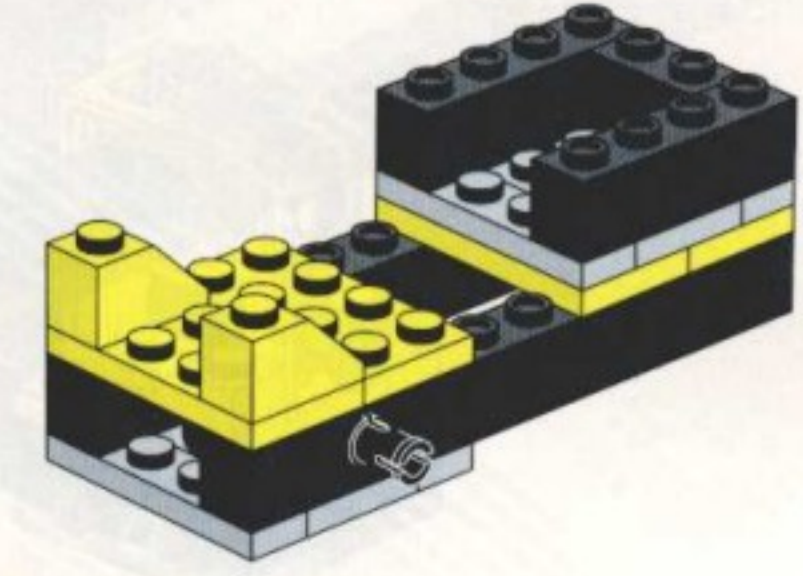
3



4

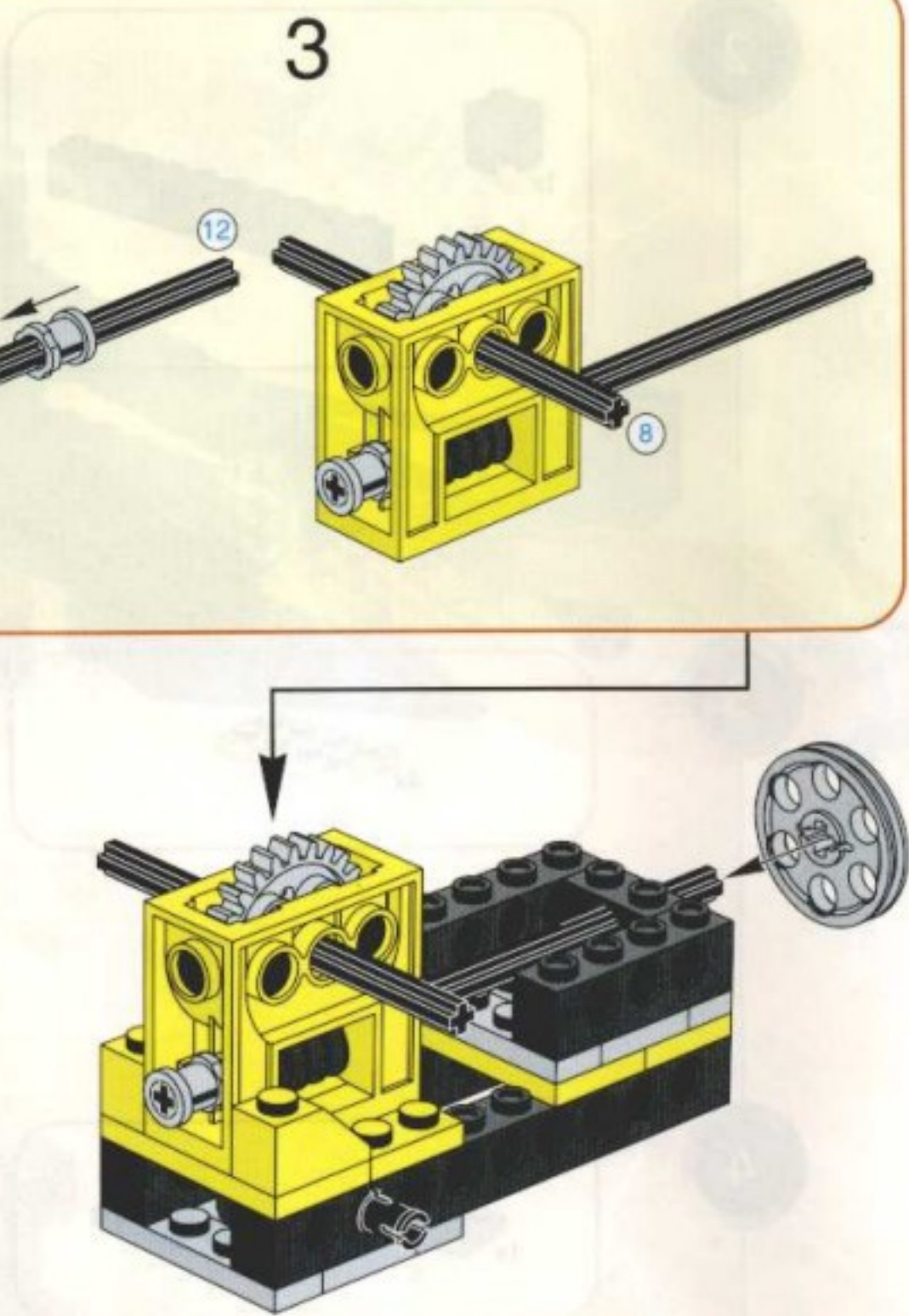
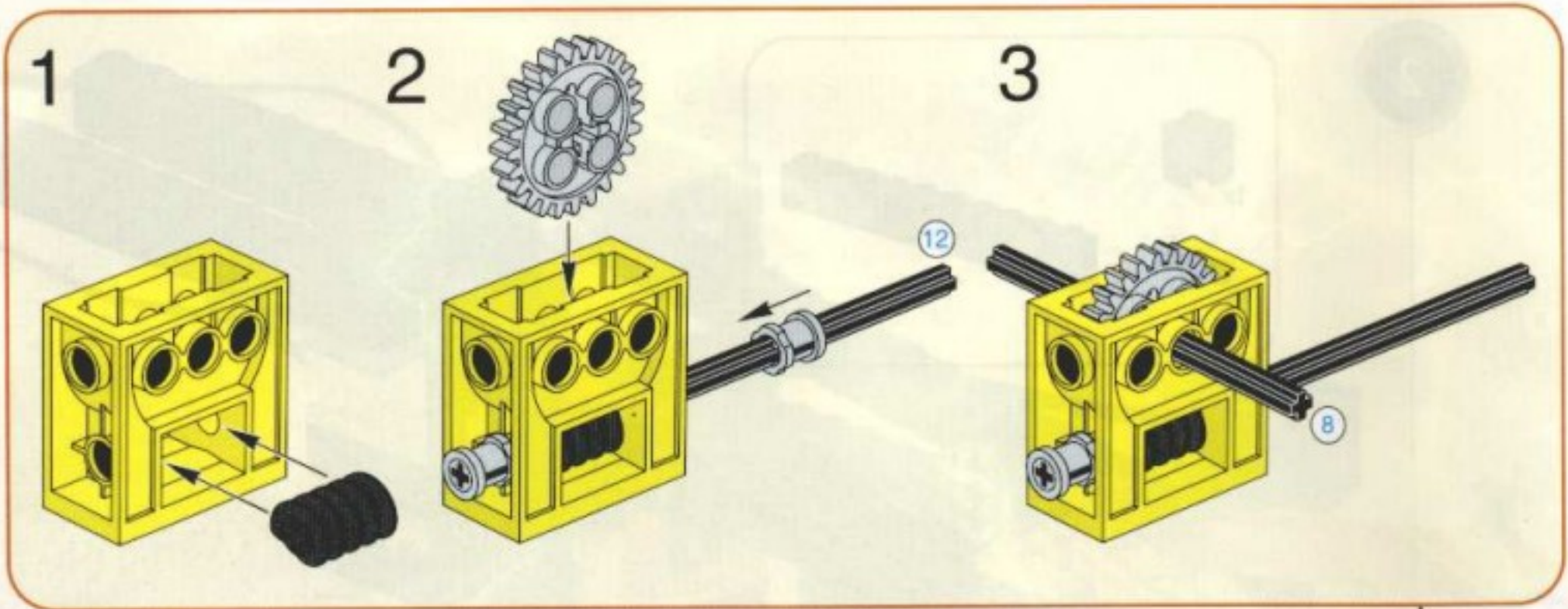


5

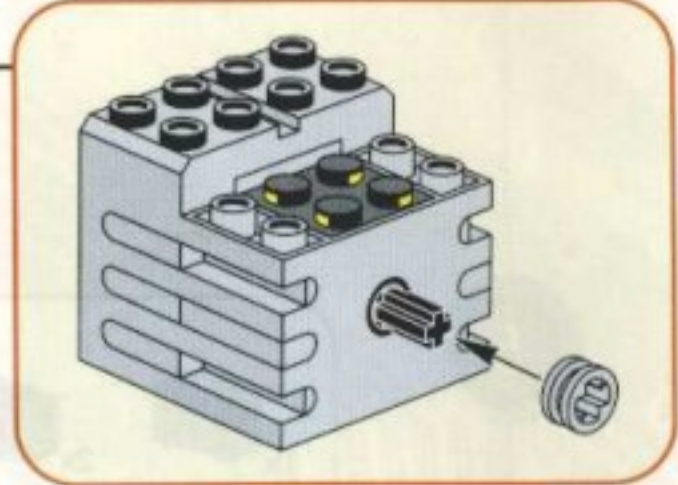
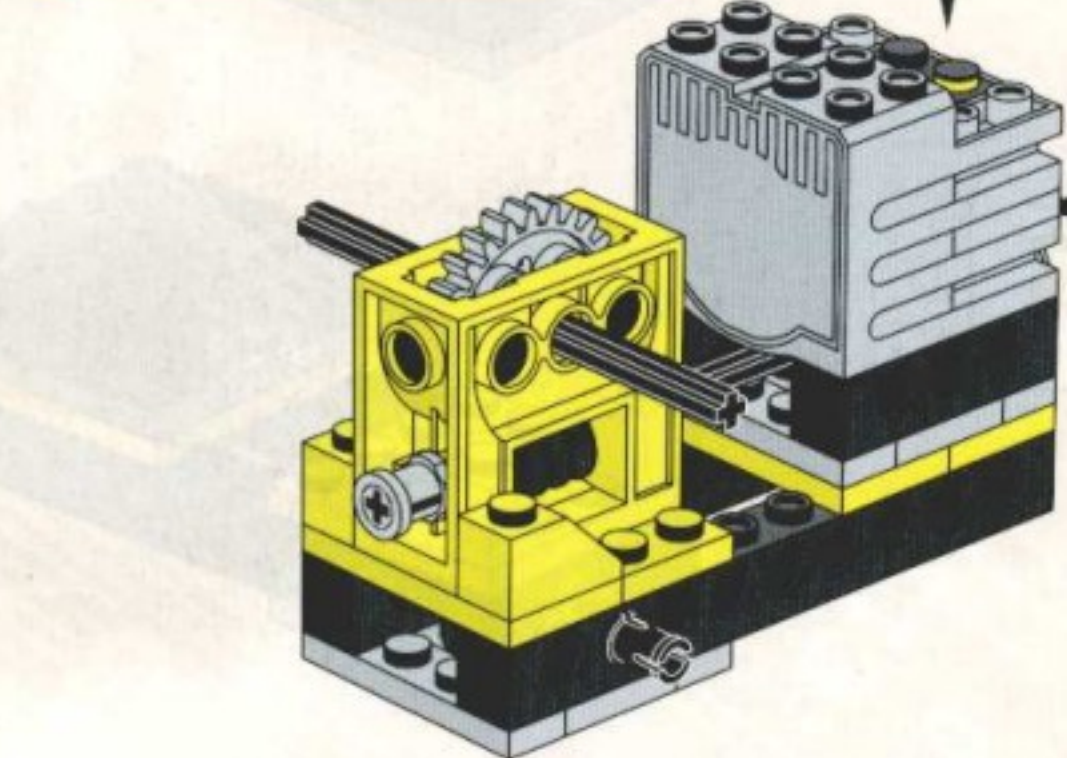
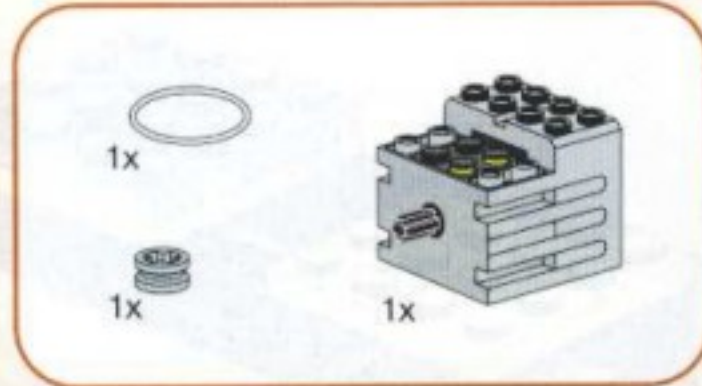




6

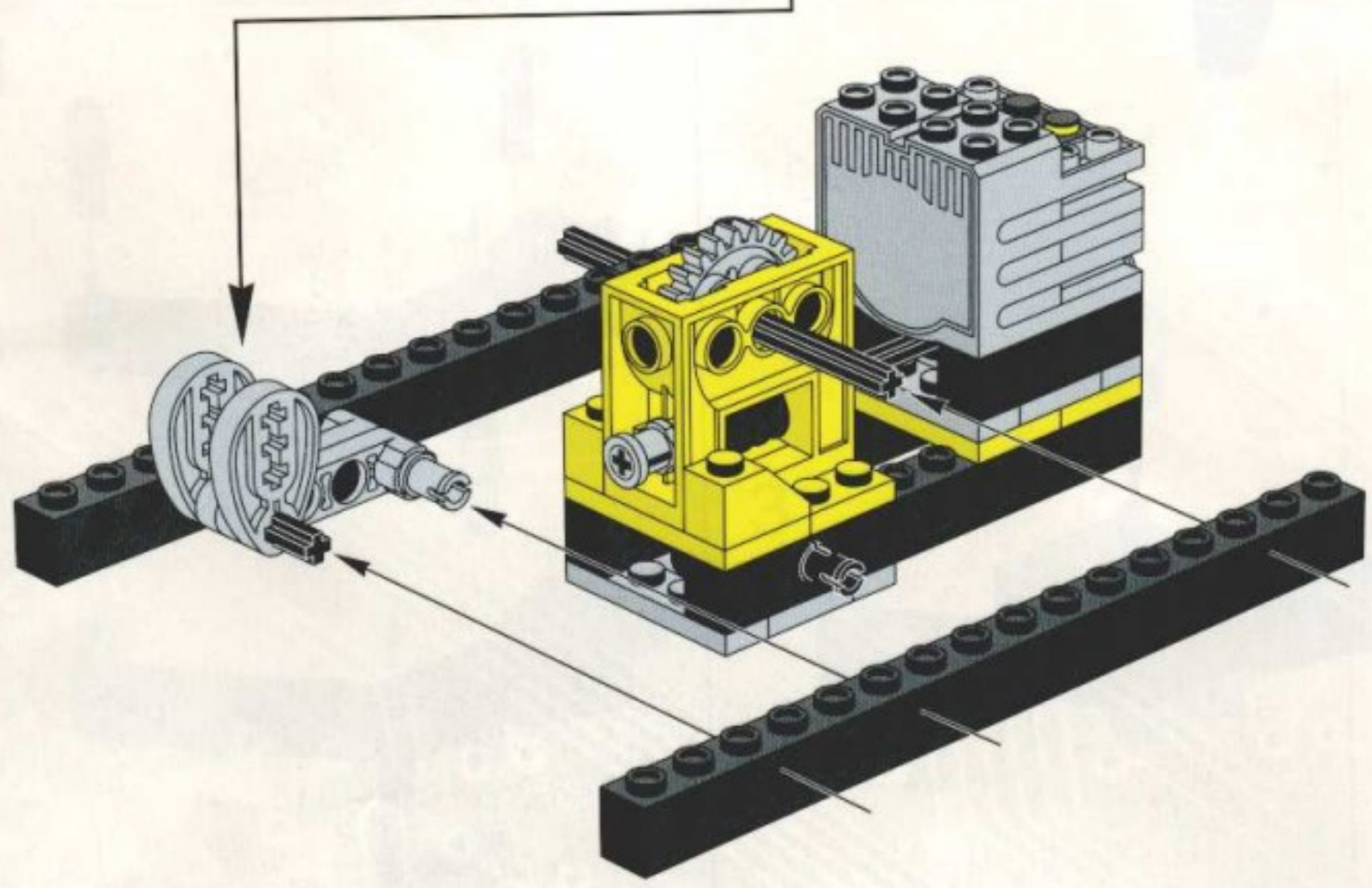
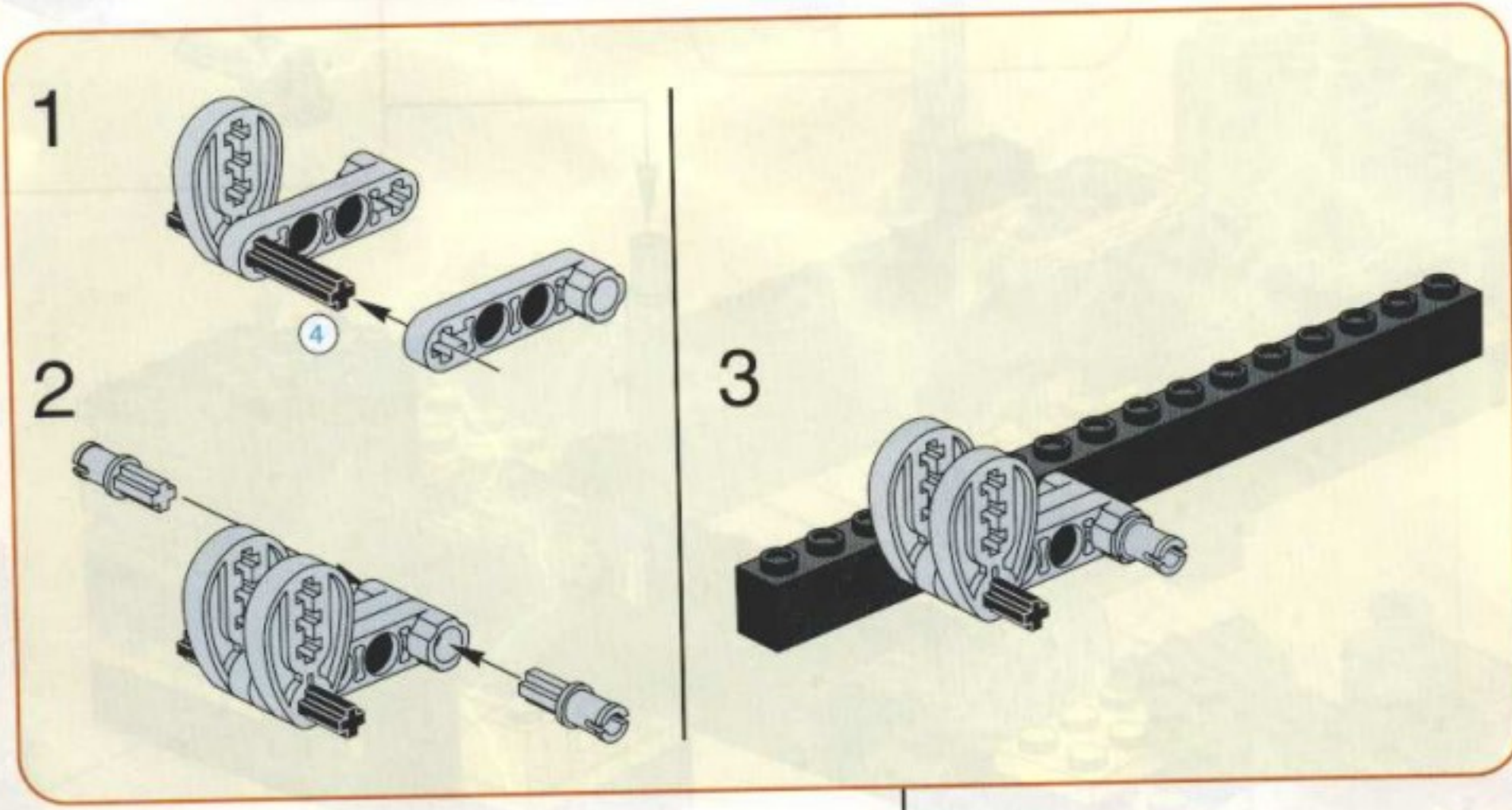
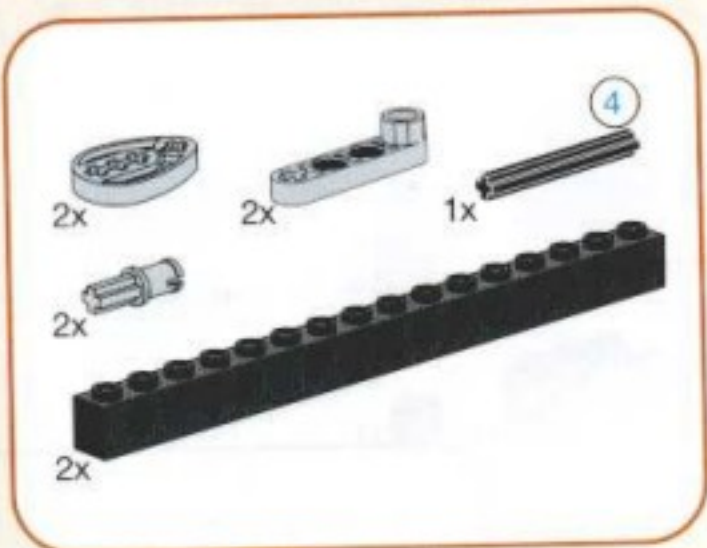


7



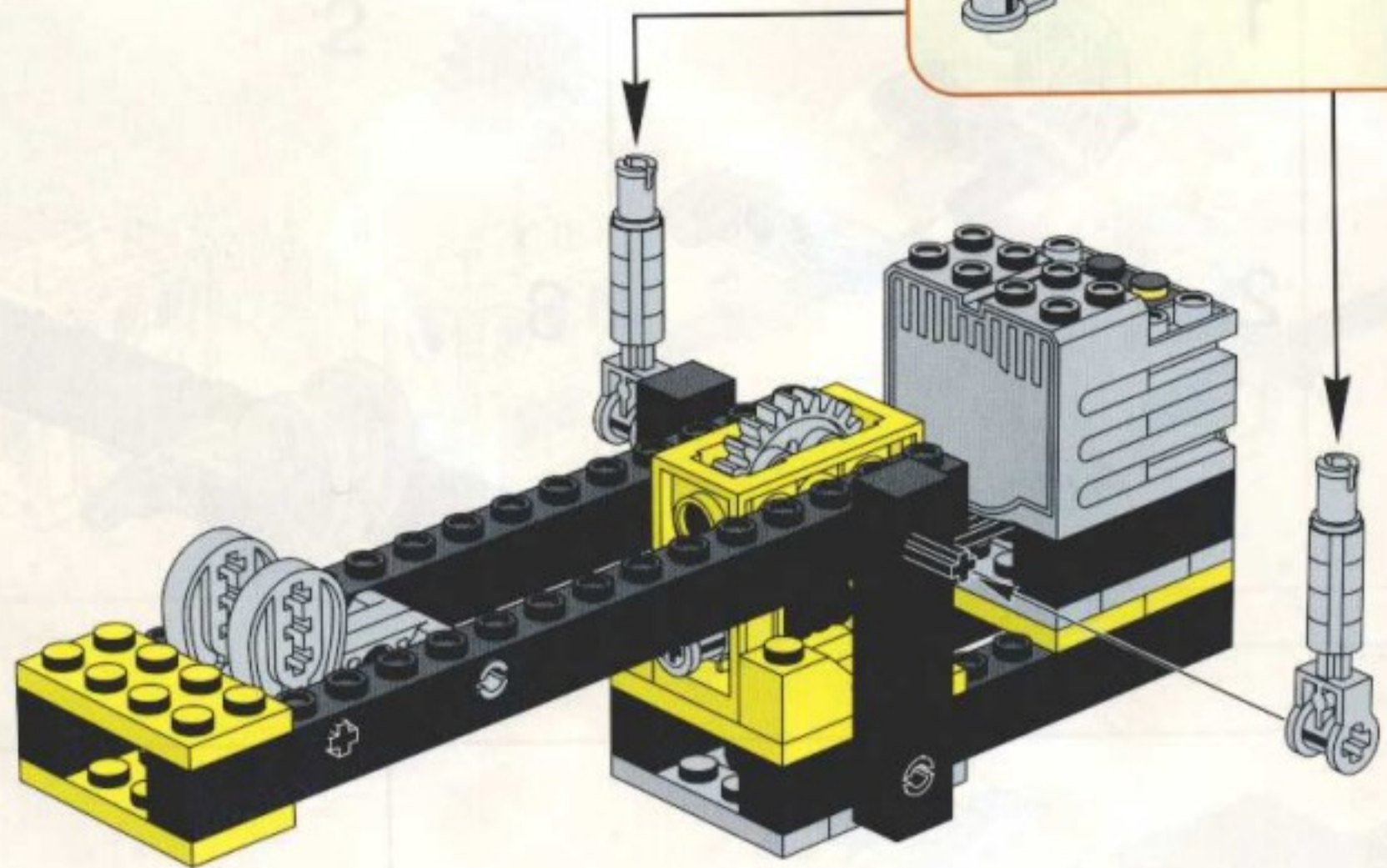
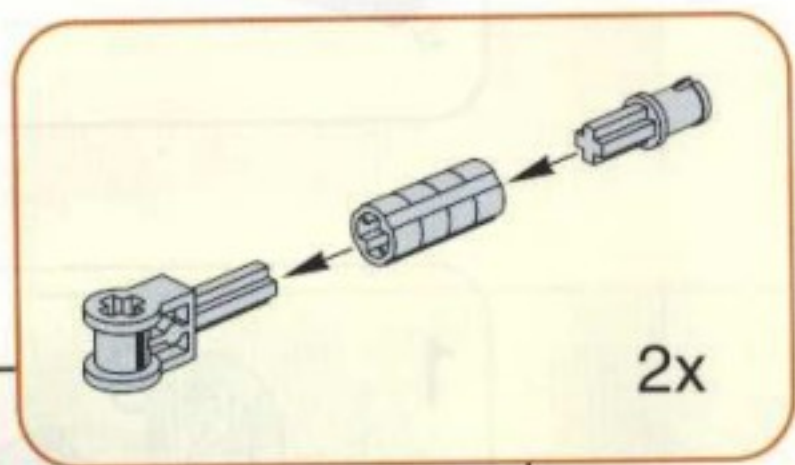
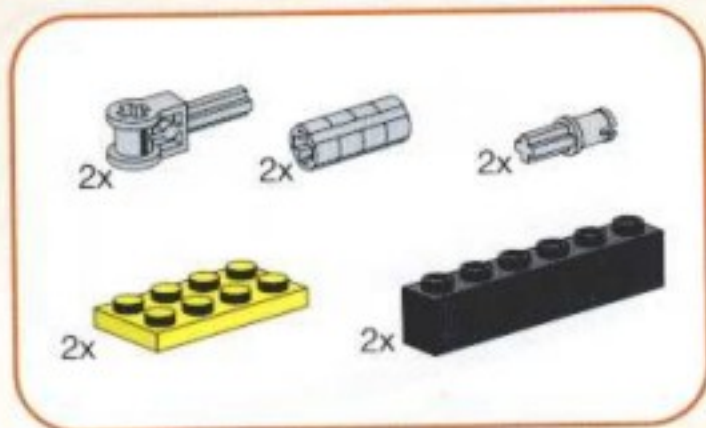
27

8



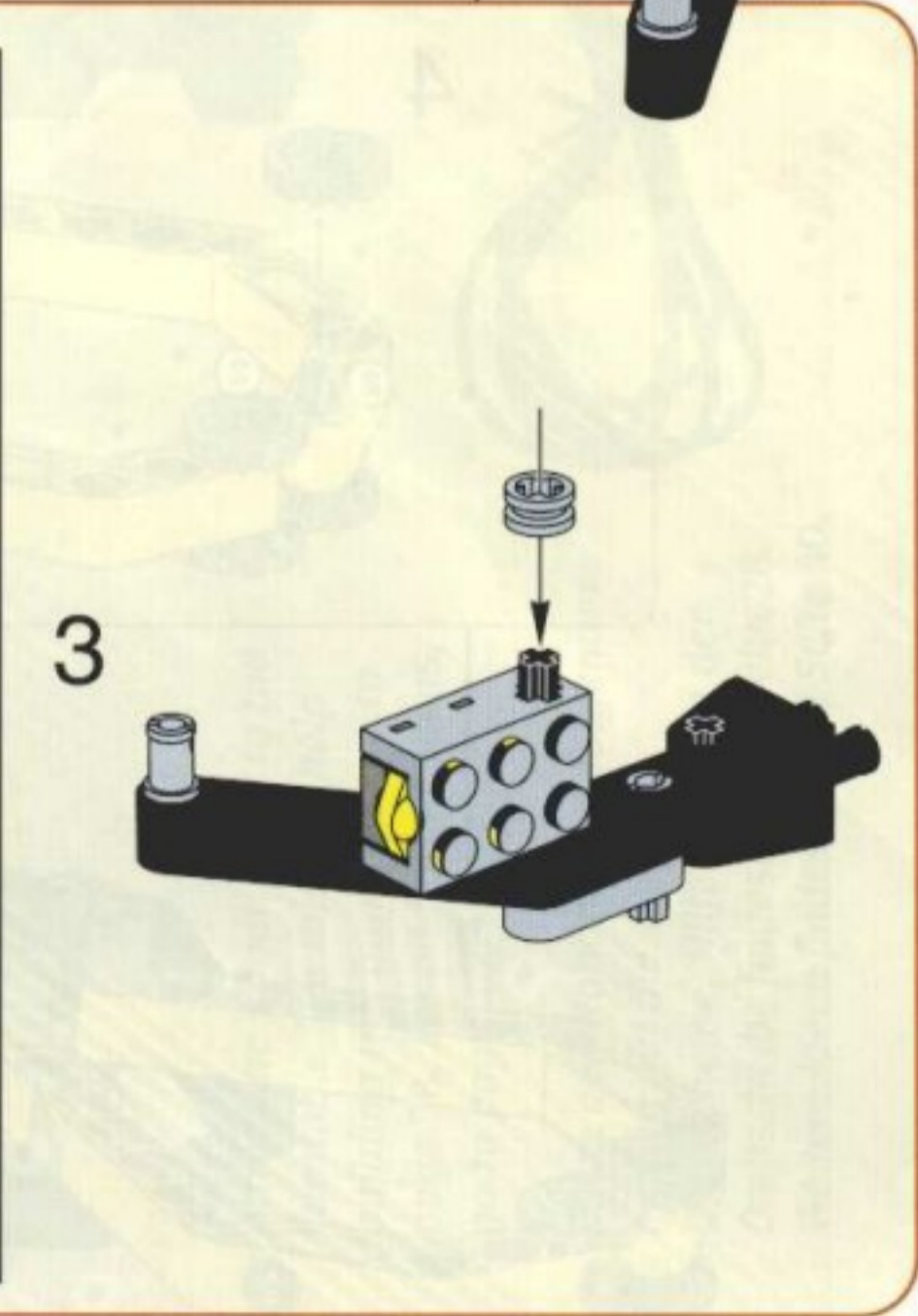
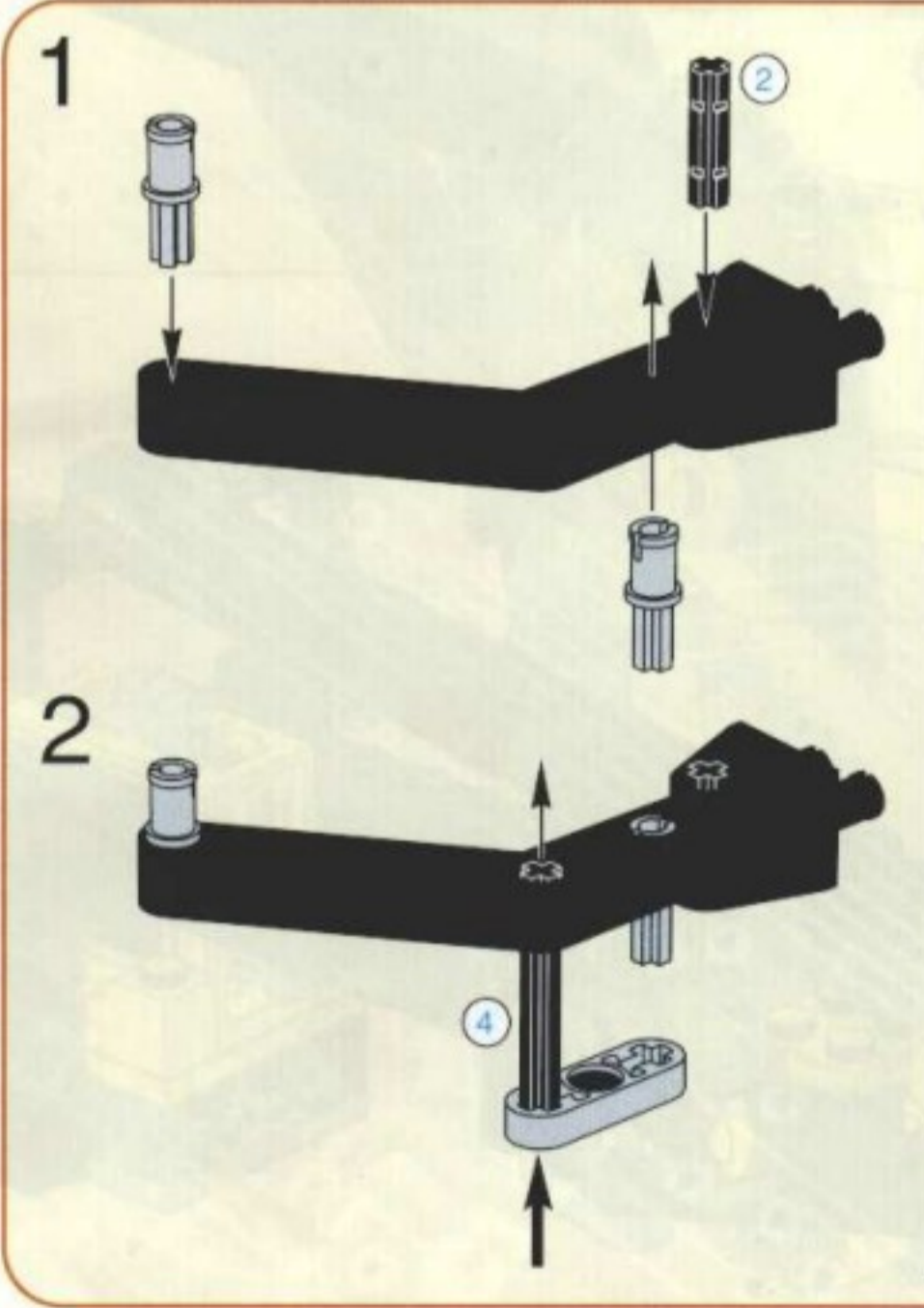
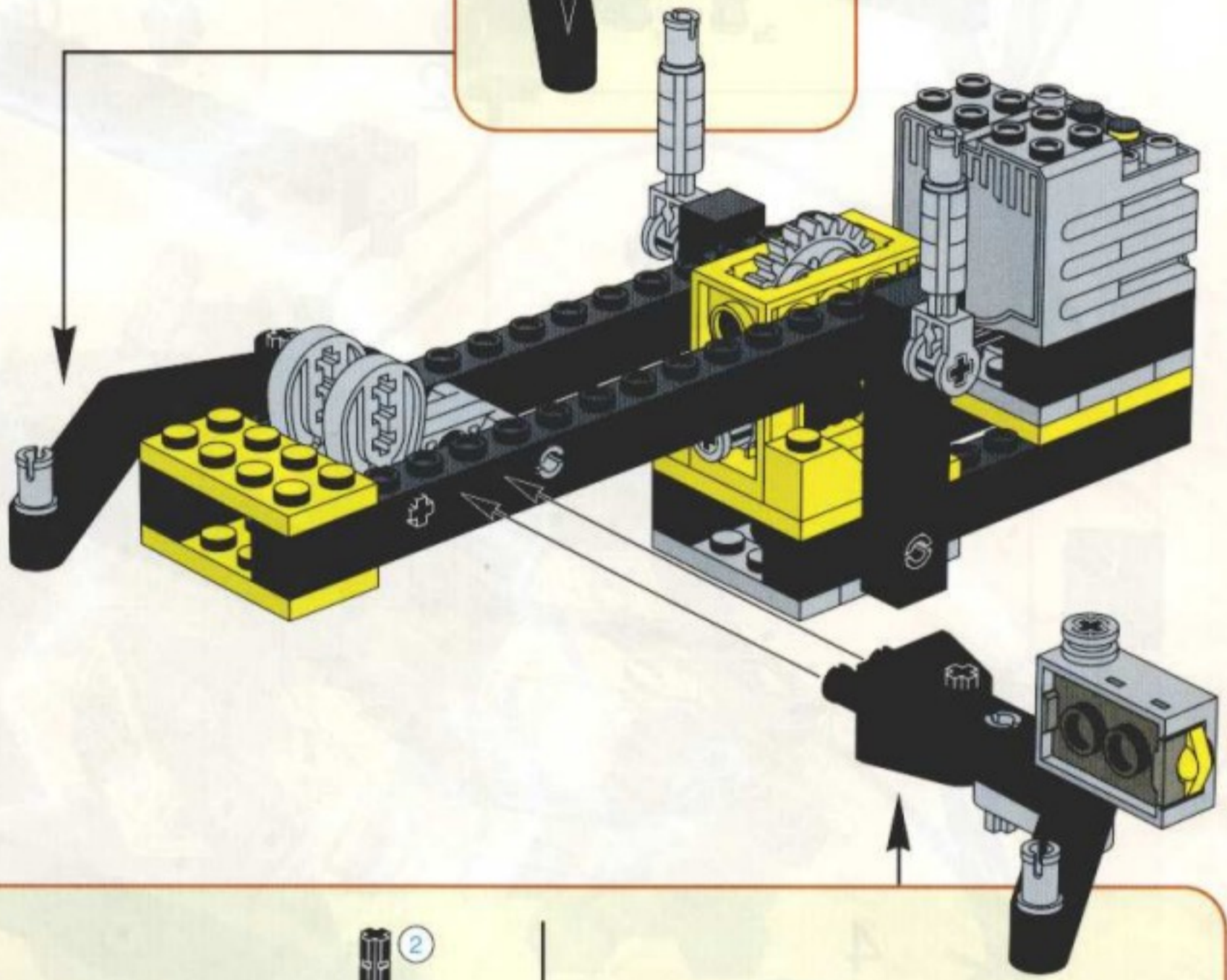
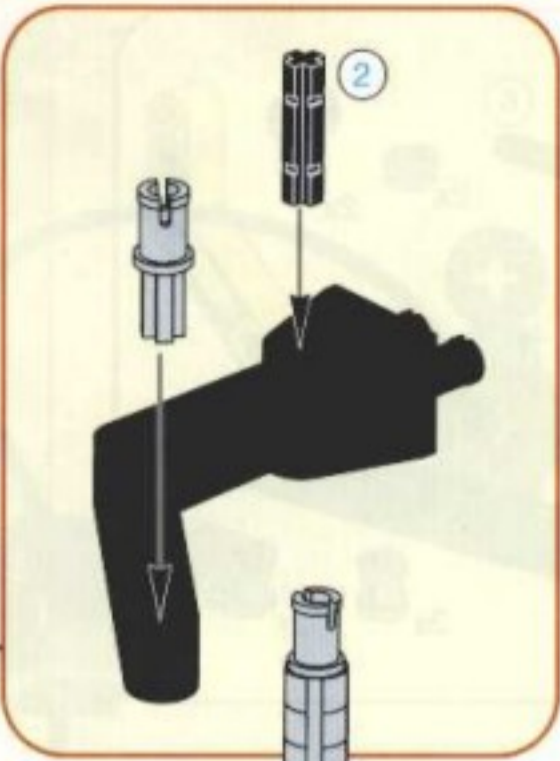
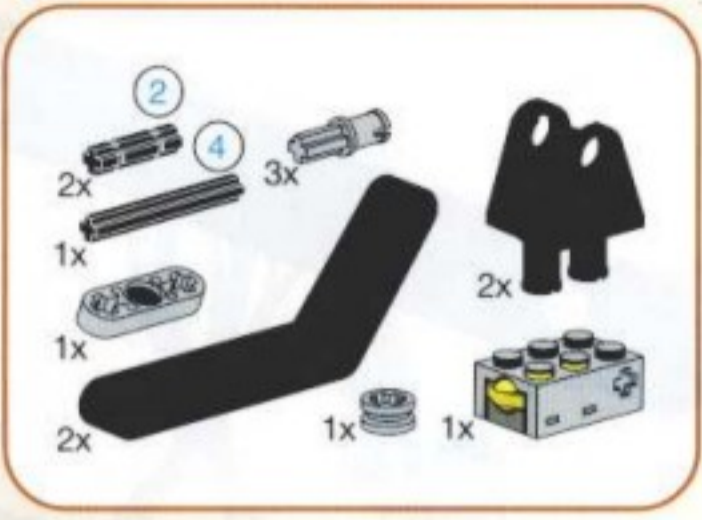


9





10



11

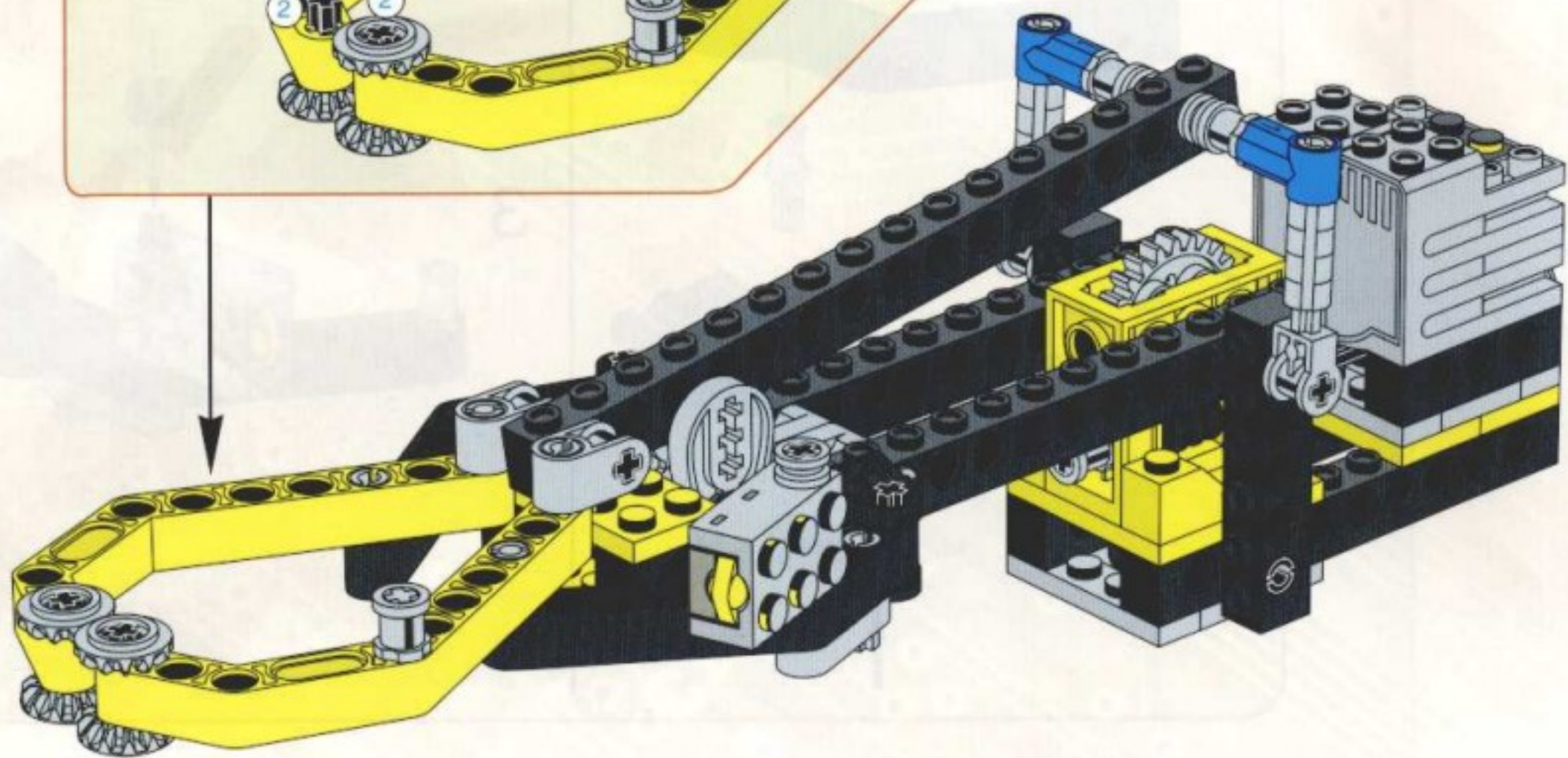


1

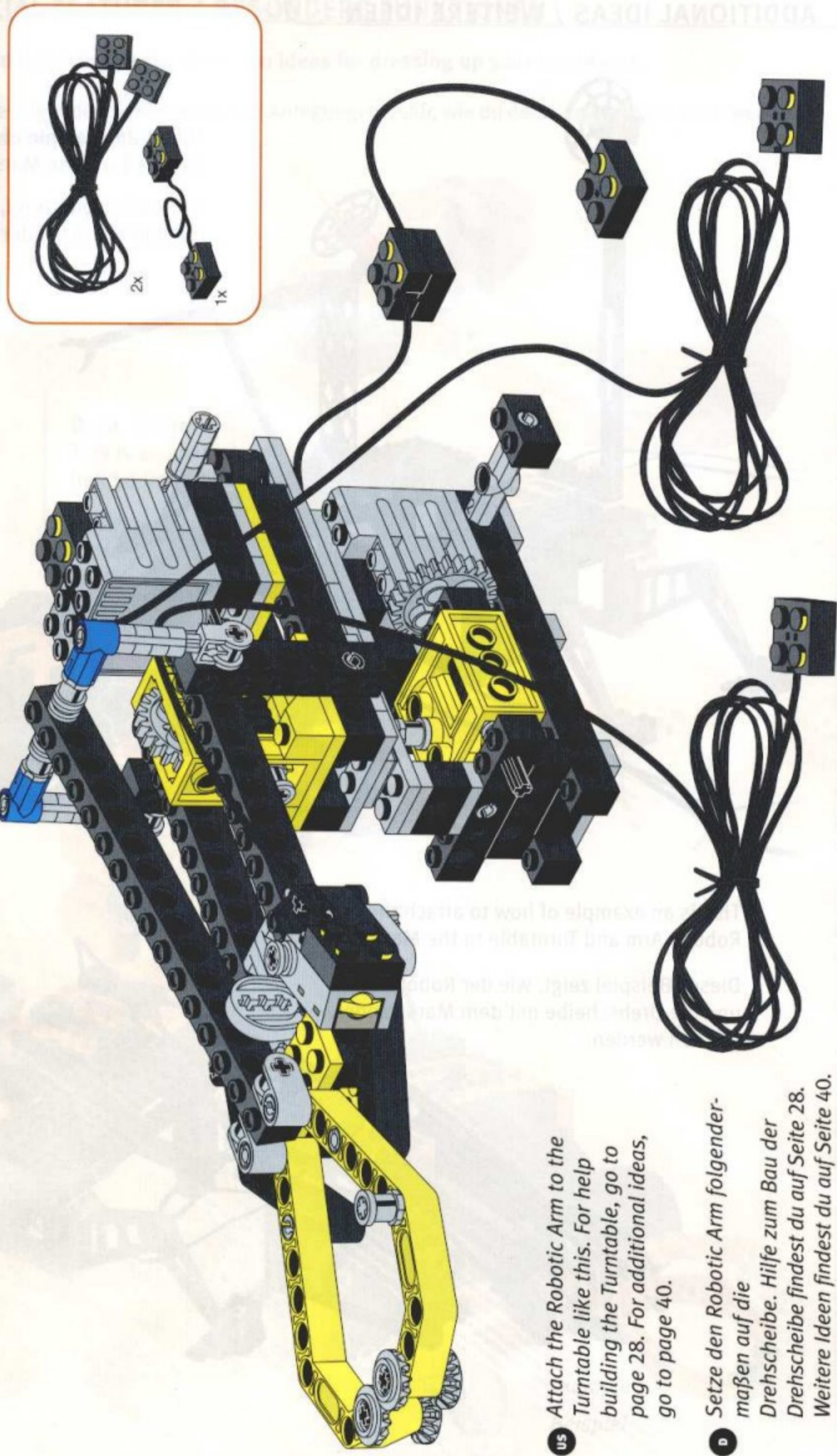
2

3

4



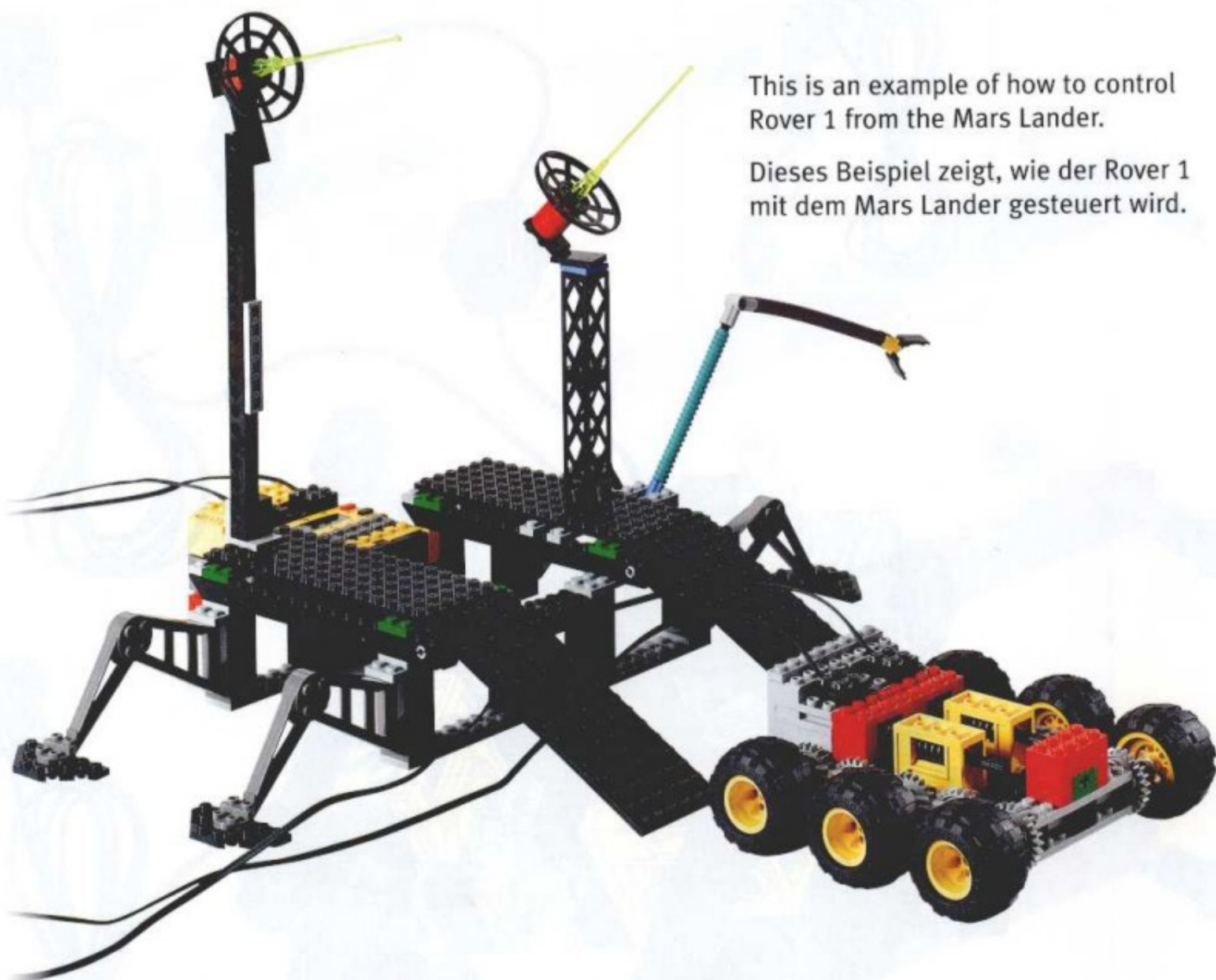
12



us Attach the Robotic Arm to the Turntable like this. For help building the Turntable, go to page 28. For additional ideas, go to page 40.

D Setze den Robotic Arm folgendermaßen auf die Drehscheibe. Hilfe zum Bau der Drehscheibe findest du auf Seite 28. Weitere Ideen findest du auf Seite 40.

ADDITIONAL IDEAS / WEITERE IDEEN



This is an example of how to control Rover 1 from the Mars Lander.

Dieses Beispiel zeigt, wie der Rover 1 mit dem Mars Lander gesteuert wird.

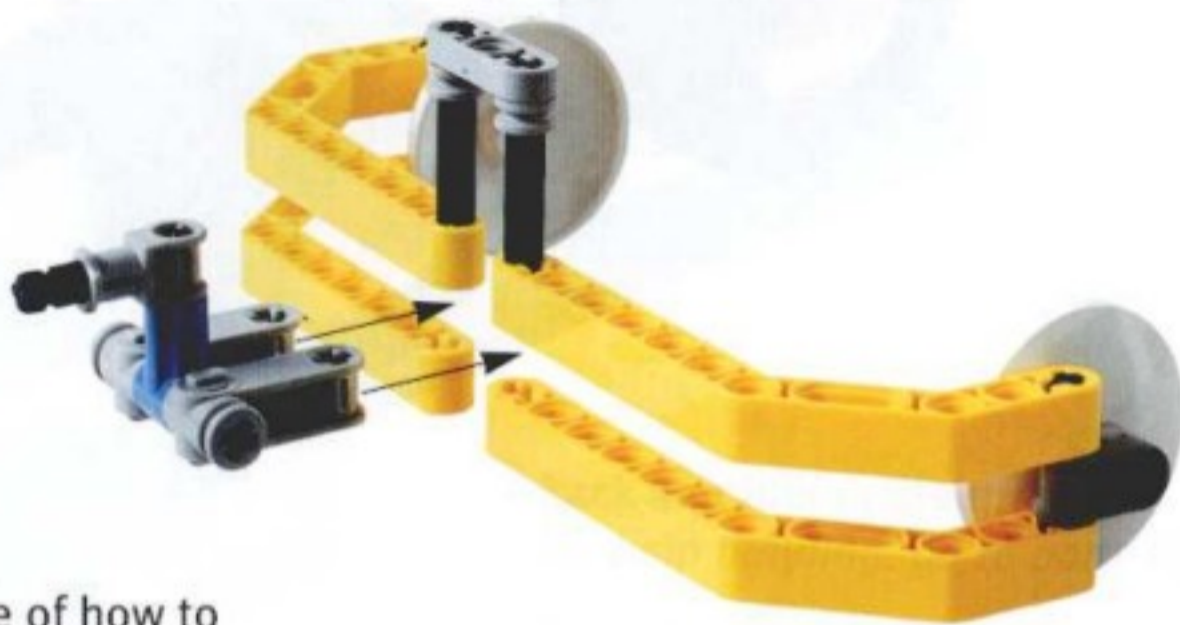
This is an example of how to attach the Robotic Arm and Turntable to the Mars Lander.

Dieses Beispiel zeigt, wie der Robotic Arm und die Drehscheibe mit dem Mars Lander verbunden werden.



SPECIAL FEATURES / BESONDERE FUNKTIONEN

- US The following pages show you ideas for dressing up your inventions.
- D Die folgenden Seiten enthalten Anregungen dafür, wie du deine Erfindungen noch weiter ausbauen kannst.

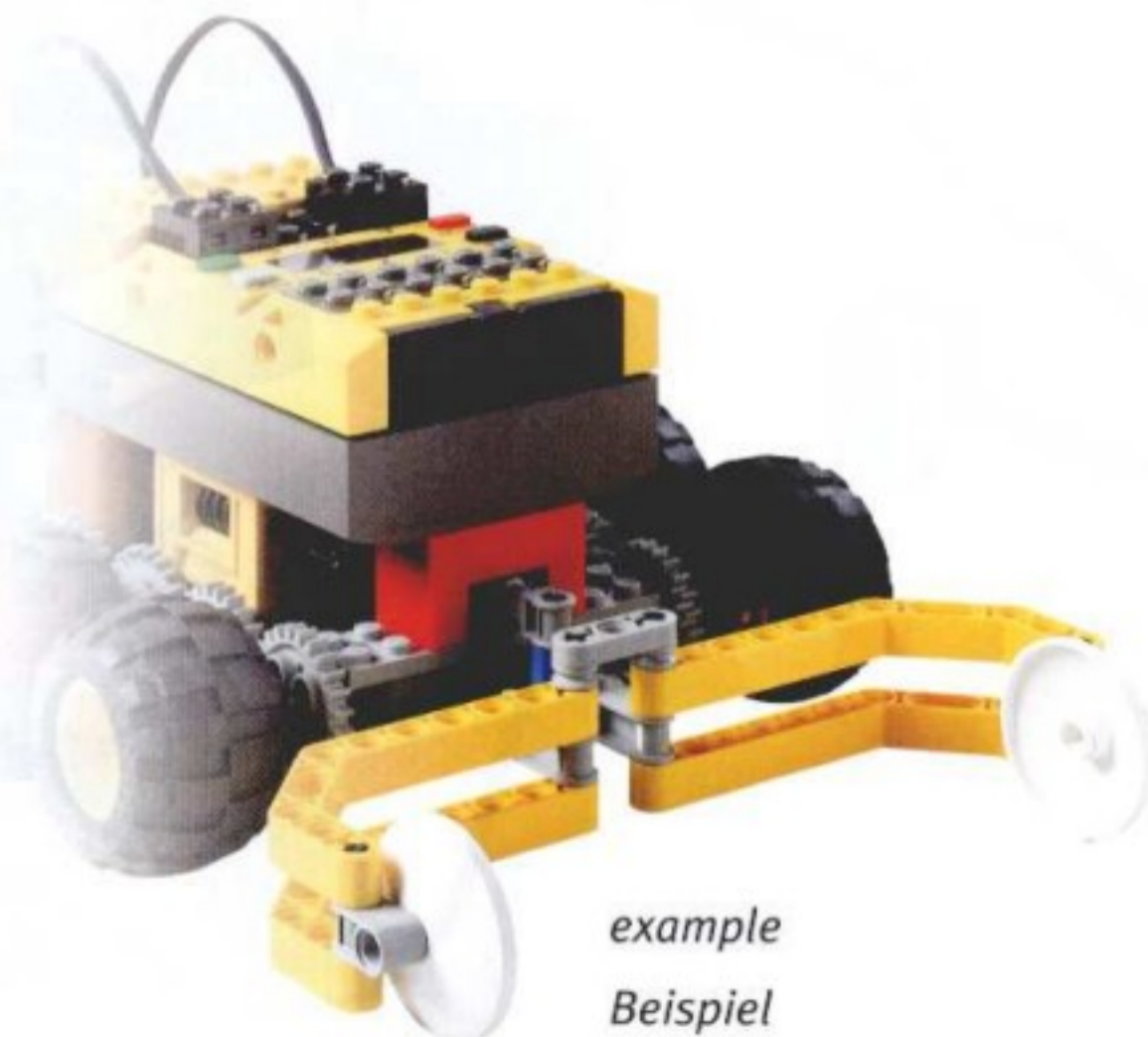


Dozer Blade

This is an example of how to build a Dozer Blade.

Planierschild

Dieses Beispiel zeigt, wie du einen Dozer Blade/Planierschild bauen kannst.



example
Beispiel



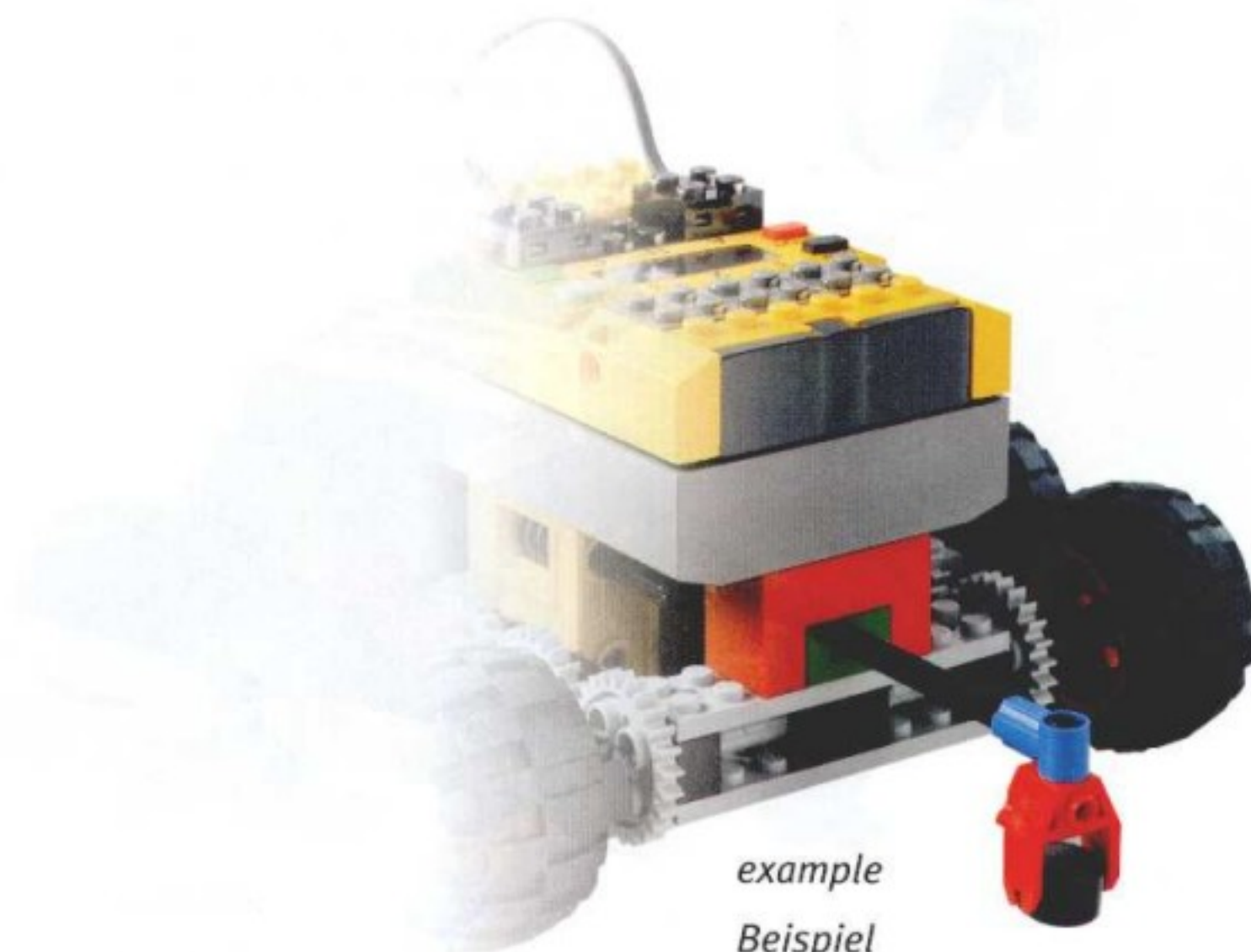
Off-Track Wheels

Nicht schienengebundene
Räder



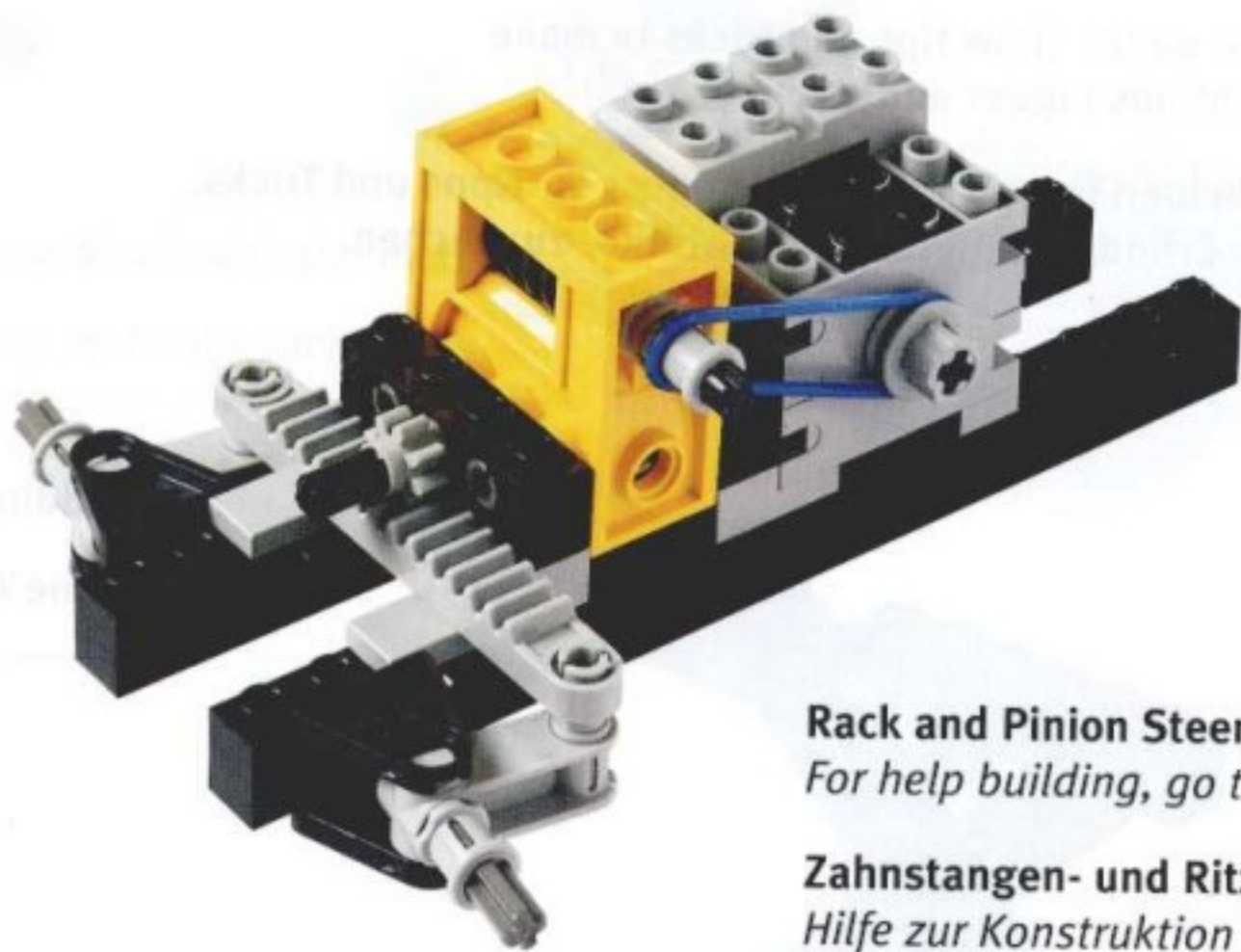
Magnetic Arm

Magnetarm



example

Beispiel



Rack and Pinion Steering
For help building, go to page 45.

Zahnstangen- und Ritzellenkung
Hilfe zur Konstruktion findest du auf Seite 45.



Touch Sensor Steering
Lenkung durch Berührungssensoren



TIPS & TRICKS / TIPPS & TRICKS

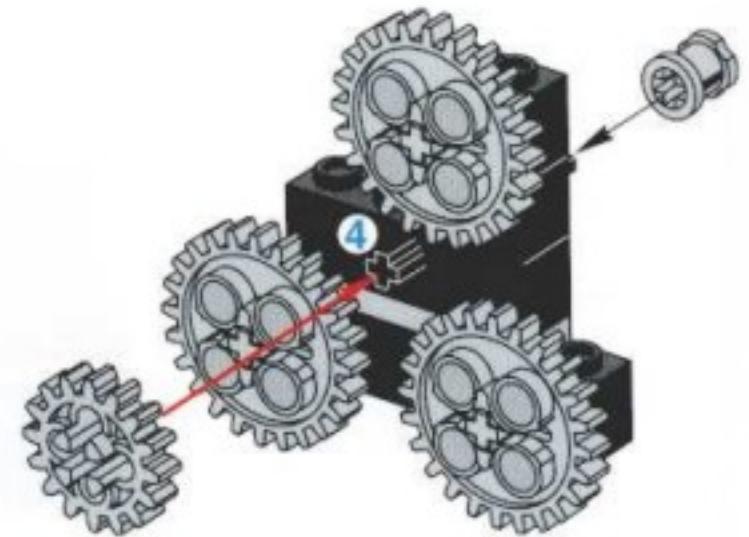
- US** These two pages show tips and tricks to make your inventions bigger and stronger.
- D** Auf den beiden folgenden Seiten findest du Tipps und Tricks, um deine Erfindungen größer und stärker zu machen.



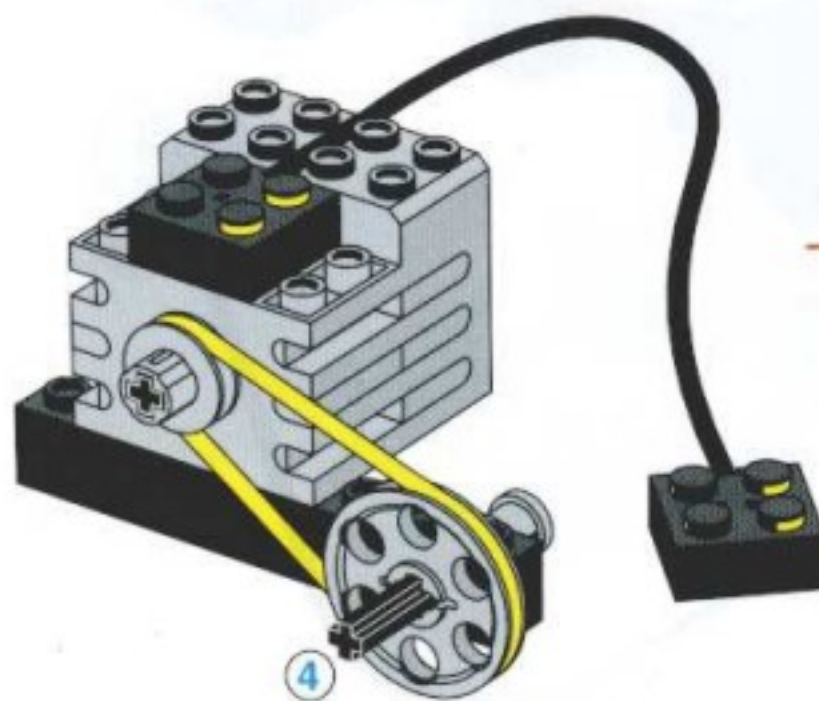
Adding an axle
Eine Achse hinzufügen



Making a lander leg
Ein Landebein bauen

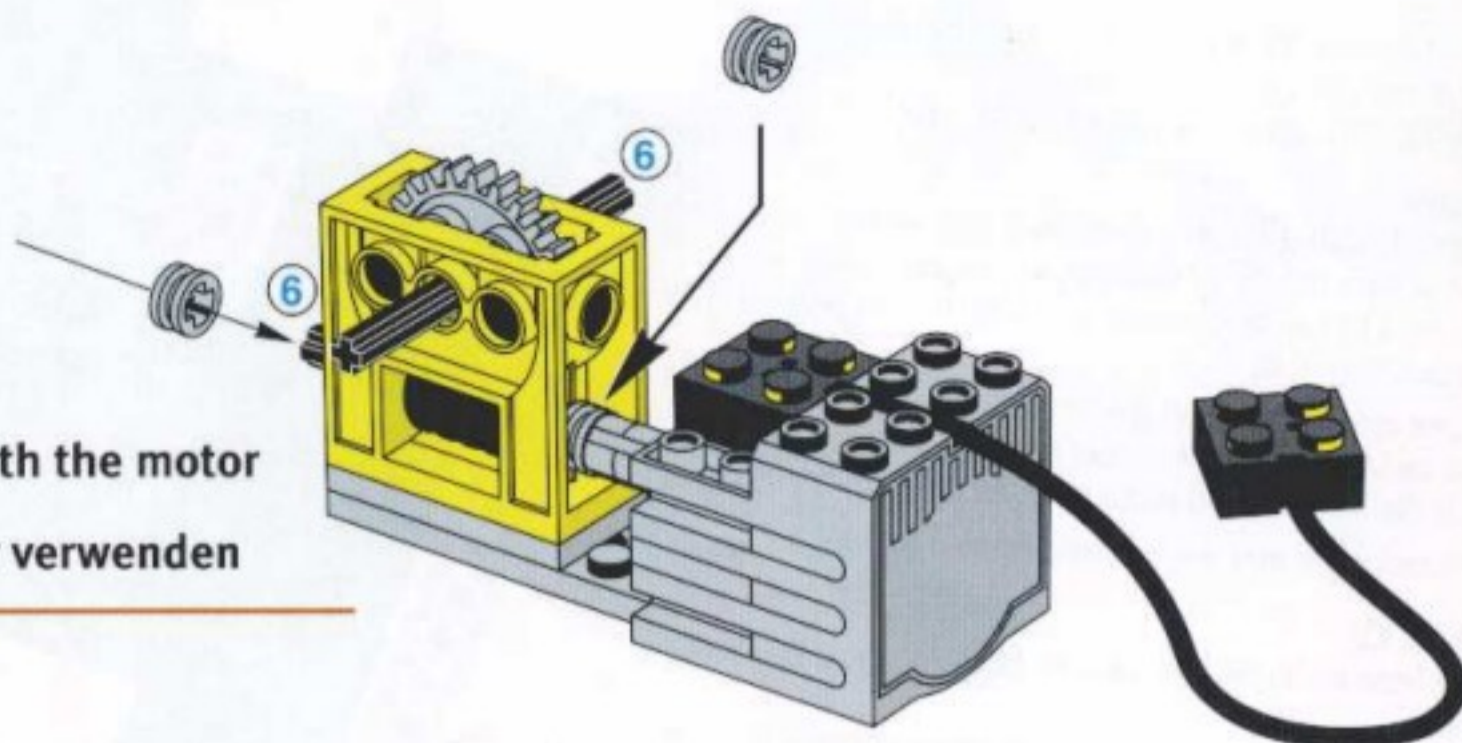


Linking gears
Zahnräder miteinander verbinden



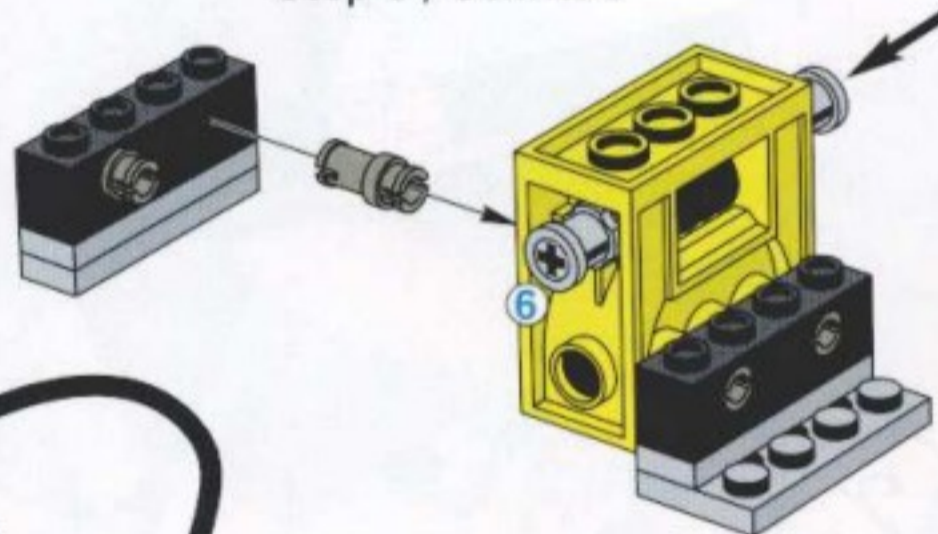
Using pulley wheels
Rillenräder verwenden

Using the gear block with the motor
 Getriebeblock im Motor verwenden

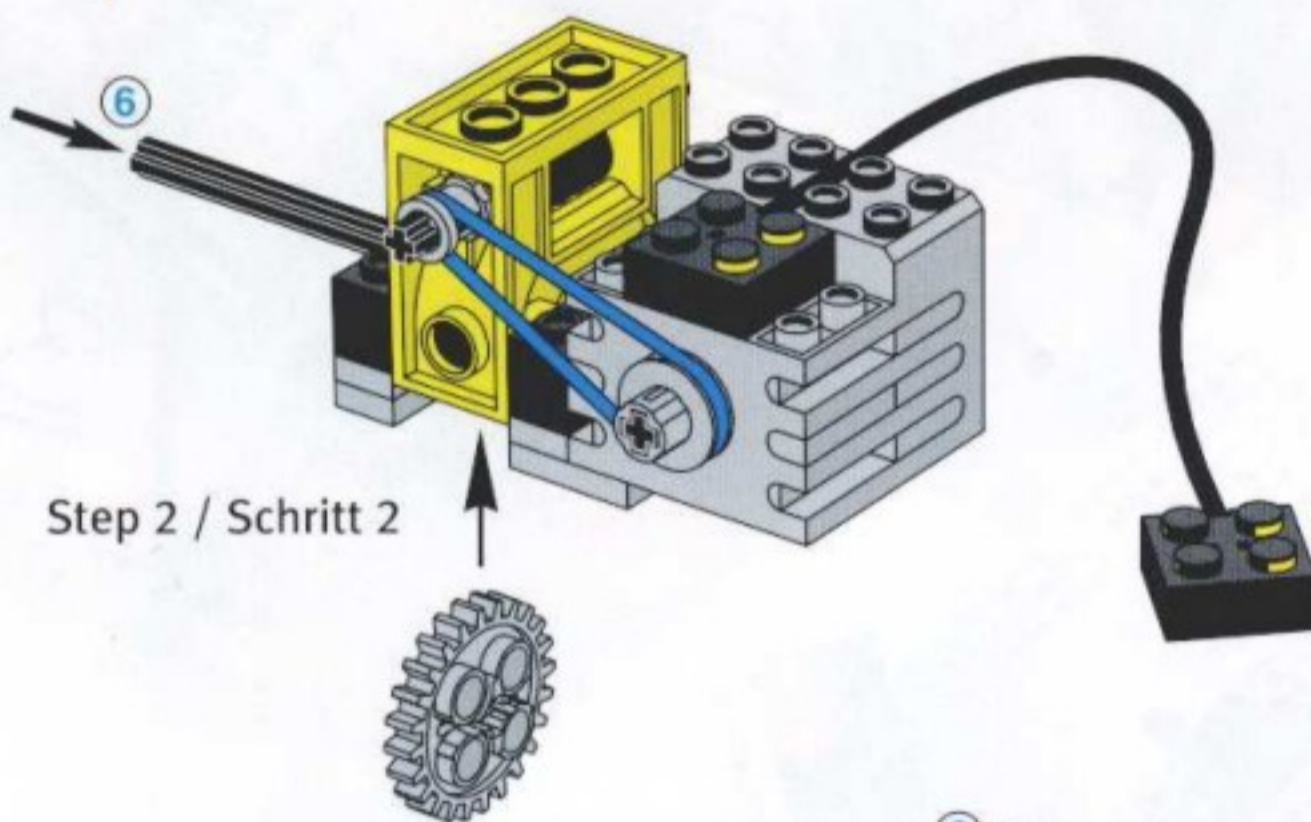


Strong but slow gearing
 Starkes, aber langsames
 Getriebe

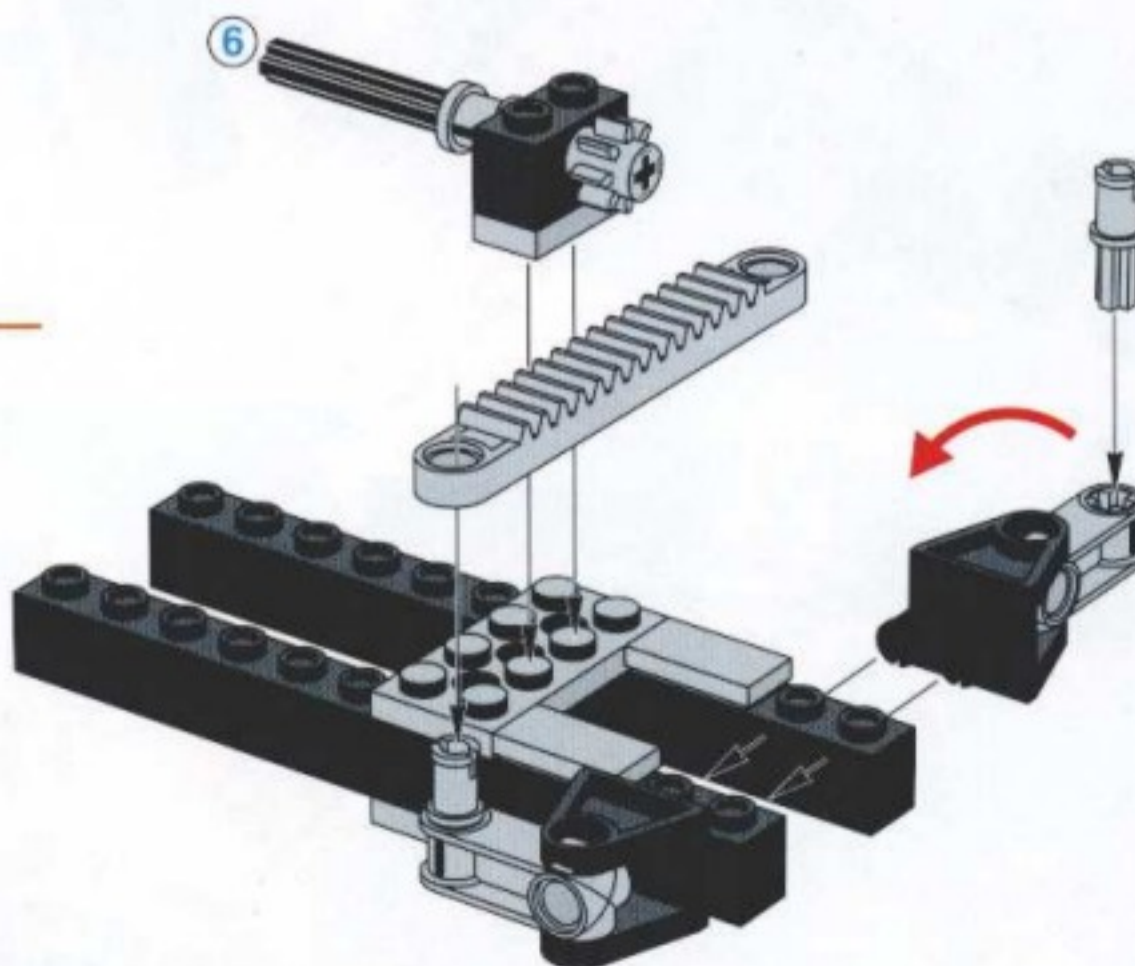
Step 1 / Schritt 1



Step 2 / Schritt 2



Steering construction
 Lenkungsstruktur



TOP SECRET

CODE: NU-ML9736 DEP.: MINDSTORMS
REF: Mass Launcher on Mars
FAO: MB, SC, BHN, PM, MD, SL, ICU

MB, SC, BHN

We are at the final stage of testing for the Mass Launcher (ML) prototype on Mars. With the ML prototype, we have successfully sent materials into a LO (Low Orbit) and will aim for PIO (Phobos Insertion Orbit) when we build the real ML.

The program used to drive the ML is in RCX Code. Touch Sensors are used to control the LA1 (Loading Arm) and LA2 (Launching Arm). The LA1 loads mass onto the LA2 and the LA2 shoots the object into orbit.

The ML is designed to work in a low gravity environment.

PM, MD, SL, ICU

Die letzte Testphase für den Mass Launcher (ML)-Prototyp auf dem Mars hat begonnen.

Mit dem ML-Prototyp konnten wir Materialien erfolgreich in eine NU (niedrige Umlaufbahn) bringen. Wenn wir den richtigen ML bauen, ist unser Ziel die PU (Phobos-Umlaufbahn).

Das Programm zur Steuerung des ML ist im RCX-Code geschrieben. Der LA1 (Ladearm) und LA2 (Wurfarm) werden über Berührungssensoren gesteuert. Der LA1 lädt Masse auf den LA2, der das Objekt in die Umlaufbahn schießt. Der ML ist für den Einsatz in einer Umgebung mit geringer Schwerkraft konzipiert.

1
BASE



2
A



3
MOTOR



242/100
Escape
E
E=0
ve = 1/2 v_{op}
1/2 m v_{op}
v_{op} = v_l
R

2
B





1165

7

8 LOADER

H6R
 $mv^2 = ve$

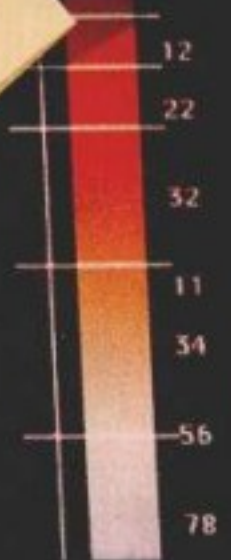
calculate for Mars

$$\frac{1}{2}mv^2 = \frac{GMm}{r}$$

$$\frac{1}{2}mv^2$$

6

MARS topographical chart
2000-04-23/legorelaysatellite1



... friction on ML at Equator and ... to be calculated...

...ape velocity for Mars is set to 5 ...

PROPOSAL for transport of raw materials ... be drafted soon.

Please consider Mindstorms unit for transport to MHO (Mars High Orbit) or PIO (Phobos Insertion Orbit). It will prove essential to further exploitation of Mars resources to have a number of Mass Launchers on the Equator by the end of Year 5 (Earth year 2005).

...sted number of ML: 10 pcs. by Year 3 and 20 by Year 5.

KN: Can we venture into search for H2O and CO2? Benefit = propulsion for ships

SAC: What about collection of electrons for propulsion, that is: Mars LO?

MG: Insertion of mirrors for terraforming - release of H2O in atmosphere

...ote to above (HM): What is time frame on this??

YR: The search for H2O and CO2 has high priority with GP and GS.

MEMBER: The ML project has TOP SECRET status until 2000
News releases on mindstorms.com has been coordinated.

IA BR



3 MOTOR

1105

8 LOADER

MASS LAUNCHER

$E = -\frac{GMm}{R}$ velocity = v_e

$E = 0$

$v_e = \sqrt{\frac{2GM}{R}}$

calculate for Mars

$\frac{1}{2}mv^2 = \frac{GMm}{R}$

$v_{op}^2 = v^2 + \frac{2GM}{R}$

4

6



... friction on ML at Equator and ... to be calculated...

... escape velocity for Mars is set to ...

PROPOSAL for transport of raw material ... can be drafted soon.

Please consider Mindstorms unit for transport to MHO (Mars High Orbit) or PIO (Phobos Insertion Orbit). It will prove essential to further exploitation of Mars resources to have a number of Mass Launchers on the Equator by the end of year 5 (Earth year 2005).

Suggested number of ML: 10 pcs. by Year 3 and 20 by Year 5.

NKN: Can we venture into search for H2O and CO2? Benefit = propulsion for ...

SAC: What about collection of electrons for propulsion, that is: Mars LO?

TMG: Insertion of mirrors for terraforming - release of H2O in atmosphere. Note to above (HM): What is time frame on this??

YR: The search for H2O and CO2 has high priority with GP and GS.

REMEMBER: The ML project has TOP SECRET status until 2000. News releases on mindstorms.com has been coordinated.

MARS topographical chart 2000-04-23/legorelaysatellite1





7



6

MARRS
TERRAFORM

for rocket launch
 $(m-dm)(v+dv) + (-dm)dv$
 $m dv + c dm = 0$
 $dv = -c \frac{dm}{m} = -c d(\ln m)$
 $v = -\int_{m_0}^{m} c d(\ln m)$
velocity

Calculus
wheel



CAMERA REFERENCE / ANHANG: KAMERA

US *This page is for those of you who have a PC video camera connected to your computer.*
These two models are examples of how to connect a camera to your robotic inventions. They can be used with the Ranger and Surveyor Missions on the the CD-ROM.

D *Diese Seite ist für diejenigen von euch, die eine mit eurem Computer verbundene PC video Kamera haben.*

Die beiden folgenden Modelle sind Beispiele dafür, wie eine Kamera mit deinen Robotererfindungen verbunden werden kann. Sie können bei den Ranger- und Surveyor-Missionen auf der CD-ROM verwendet werden.



The Exploration Mars software works with most PC video cameras. If you already have a PC video camera, please refer to those instructions for help on connecting it to your computer. If you have any problems with your camera, please contact the manufacturer.

Mit Windows™ 98 kompatible PC video Kamera müssten sich bei Exploration Mars einsetzen lassen. Wenn du bereits eine PC video Kamera oder eine Webkamera hast, findest du in diesen Anweisungen Hinweise zum Anschluss der Kamera an deinen Computer. Wenn du Probleme mit deiner Kamera hast, wende dich bitte an deren Hersteller.



LEGO MINDSTORMS™

www.legomindstorms.com