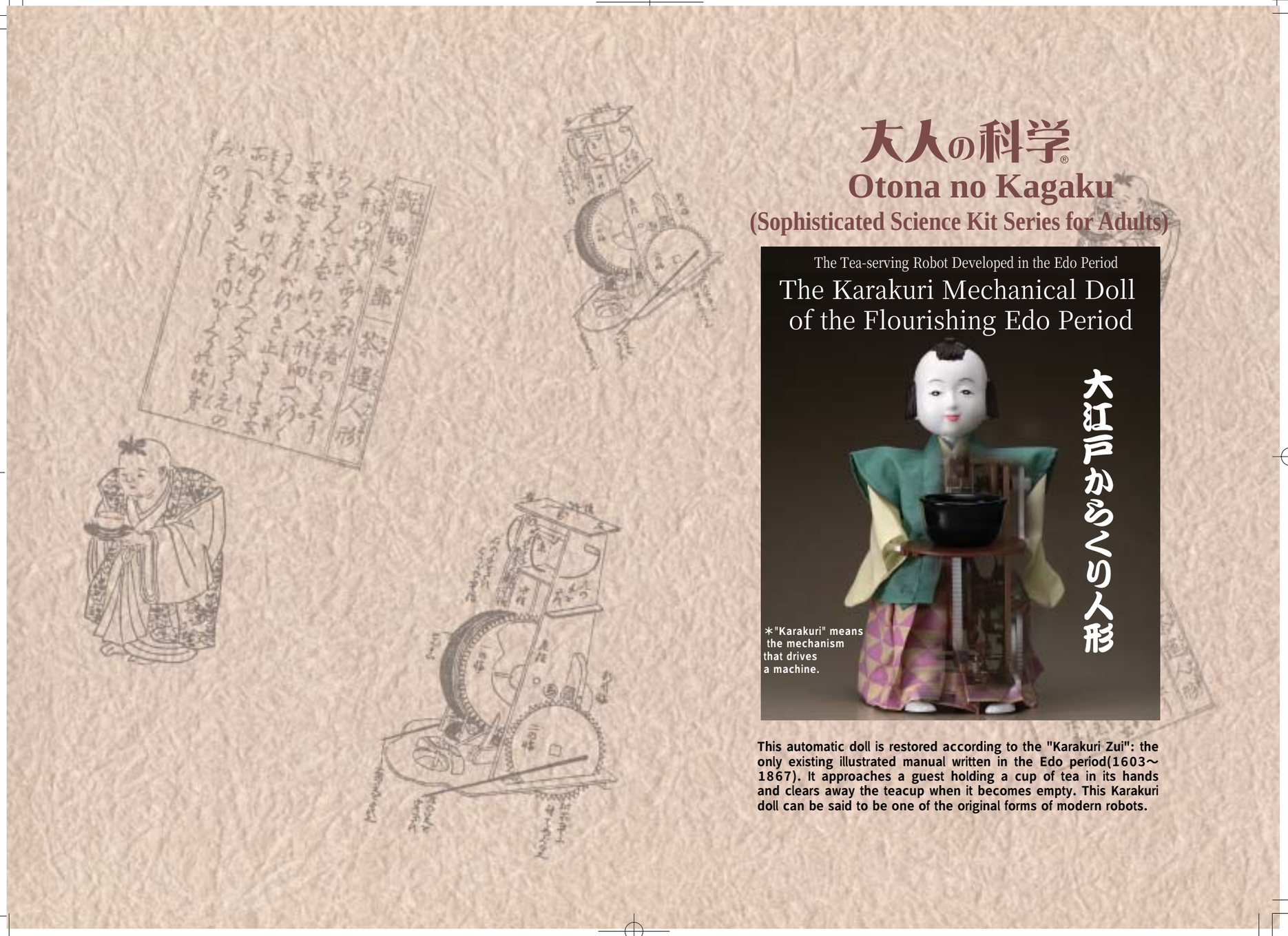


大人の科学®
Otona no Kagaku
(Sophisticated Science Kit Series for Adults)

The Tea-serving Robot Developed in the Edo Period

The Karakuri Mechanical Doll of the Flourishing Edo Period

＊"Karakuri" means the mechanism that drives a machine.

This automatic doll is restored according to the "Karakuri Zui": the only existing illustrated manual written in the Edo period(1603～1867). It approaches a guest holding a cup of tea in its hands and clears away the teacup when it becomes empty. This Karakuri doll can be said to be one of the original forms of modern robots.

CONTENTS

⚠ CAUTION! ★Please read the following instructions before using this kit.

- ● Be careful of handling thin and pointed metal bars contained in this kit. Improper use may cause injury to persons.
- ● Be careful of handling some metallic parts that are made thin and sharp functionally. Improper use may cause injury to persons.
- ● Be careful not to swallow small parts to avoid suffocation.
- ● Be careful not to point your hands and eyes with the screwdriver in this kit to avoid injury.
- ● Be careful that your fingers are not caught in a machine while operation.
- ● Do not operate the doll on a road to avoid the risk of traffic accidents.
- ● Do not break up the mainspring. An inner spring may cause injury to persons.
- ★ Please read the assembly instructions and cautions in this booklet carefully before use. Do not use the parts that are broken or deformed.
- ★ Please handle the doll with good care. The doll may be broken if it is treated roughly. For example, do not shake it with its head down.
- ★ Be careful not to be scalded when the doll serves hot drinks.
- ★ The colors may fade out of Kimonos when it is exposed to the sun. Keep the doll with care.
- ★ Do not wash the Kimonos with whites. The colors may be washed off and stain whites.

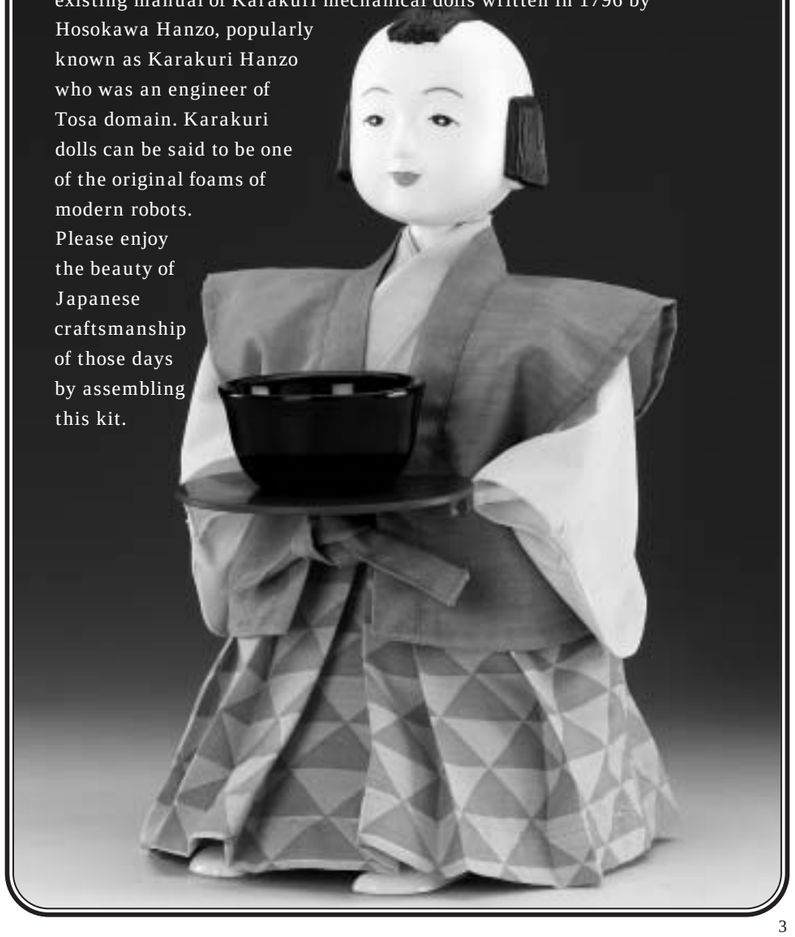
● The plastic materials used in this kit

head (white) : styrene **body, tray, tweezers and other brown parts** : styrene
arms, feet and other white parts : polyacetal
guards (transparent) : polyethylene terephthalate **handle of the screwdriver** : polystyrene
small bags (transparent) : polyethylene

∗When you dispose the kit, follow the regulations of each local government.

The World of Karakuri Mechanical Dolls

The history of Karakuri ("Karakuri" means the mechanism that drives a machine.) automatic dolls in Japan began in the early Edo period(1603~1867). The tea-serving doll is the most typical one and it appears in the book written by Ihara Saikaku, a very popular novelist in the Edo period. This Karakuri doll kit is produced according to the "Karakuri Zui", the only existing manual of Karakuri mechanical dolls written in 1796 by Hosokawa Hanzo, popularly known as Karakuri Hanzo who was an engineer of Tosa domain. Karakuri dolls can be said to be one of the original foams of modern robots. Please enjoy the beauty of Japanese craftsmanship of those days by assembling this kit.



Parts in this Kit

tension spring (small)

tension spring (middle)

tension spring (large)

∗For each size, two springs are contained in this kit. One is a spare.

looped string (small)

looped string (middle)

looped string (large)

front wheel rubber

front wheel

front wheel connector

front wheel bearing

front wheel bridge

bottom panel

driving wheel cover

auxiliary wheel

∗If the driving wheel cover is stuck in the auxiliary wheel, please separate each other.

driving wheel

driving wheel rubber

rubber band

mainspring shaft

reversal stopper A

left foot

right foot

mainspring

adiuster

rotary wheel A

reversal stopper B

rotary wheel B

rotary plate

large wheel

escape wheel

neck (right)

neck (left)

neck joint (upper)

escapement bridge

escapement

neck bridge

left arm

escapement cock

upper chest

neck joint (lower)

left body

right arm

lower chest

auto-adjustment pin

arm shaft

both sides adhesive tape

front chest

head

lower guard

upper guard

right body

hakama skirt

chanchanko vest

tray

kimono top 1

kimono top 2

winding knob

tweezers

screwdriver

teacup

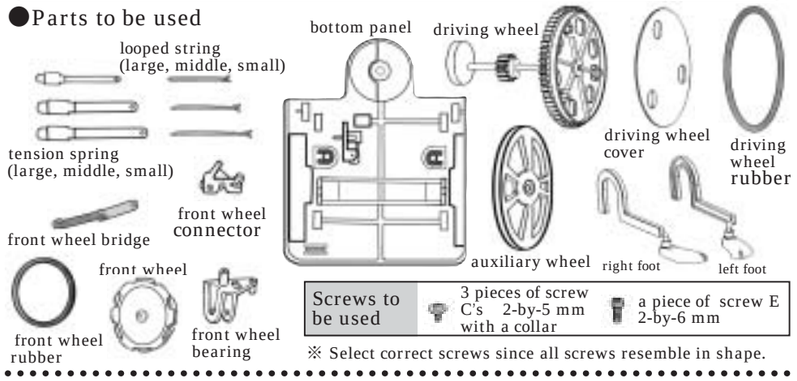
A Variety of Screws

- A: 8 pieces of 3-by-8 mm screws
- B: 3 pieces of 2.6-by-5 mm screws with a collar
- C: 5 pieces of 2-by-5 mm screws with a collar
- D: 4 pieces of 2-by-10 mm screws
- E: 8 pieces of 2-by-6 mm screws
- F: 4 pieces of 3-by-6 mm screws

∗For handy usage, put screws on small trays separately.

Let's Assemble the Cart!

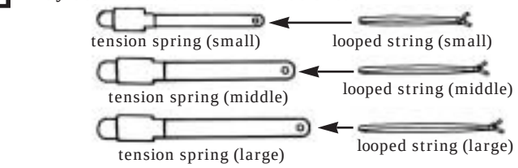
●Parts to be used



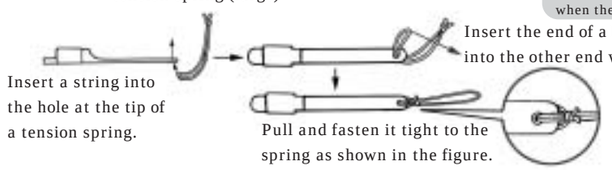
Screws to be used	3 pieces of screw C's 2-by-5 mm with a collar	a piece of screw E 2-by-6 mm

※ Select correct screws since all screws resemble in shape.

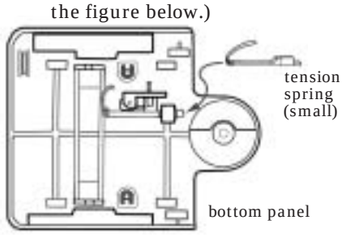
1 Insert each looped string into each tension spring. Pay attention to the combinations.



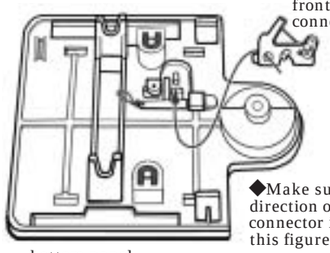
Note: In this "Let's make the cart" section, only tension spring (small) is used. At this time, however, prepare all three tension springs by inserting strings to avoid mistakes, since the three parts look alike and may be mistaken. Keep these springs back in the bags when they are ready.



2 Insert the tension spring (small) into the socket on the bottom plate.(Put it in completely like the figure below.)

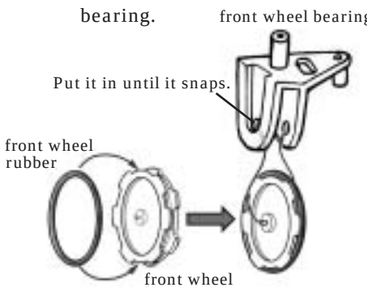


3 Fit the front wheel connector to the projection of the bottom panel.

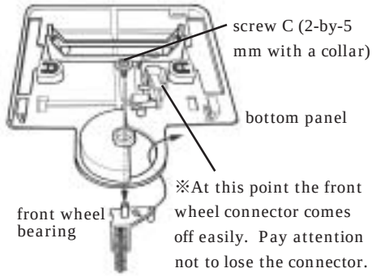


◆Make sure the direction of the connector is like this figure.

4 Fit the front wheel rubber around the front wheel. Put the wheel into the front wheel bearing.

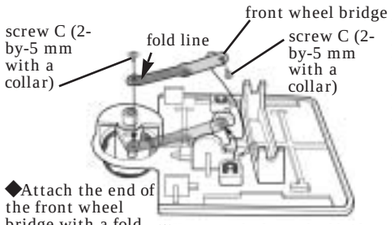


5 Fasten the front wheel bearing to the bottom panel with a screw C.



※At this point the front wheel connector comes off easily. Pay attention not to lose the connector.

6 Connect the front wheel bearing and the front wheel connector with the front wheel bridge and fasten with screw C's.

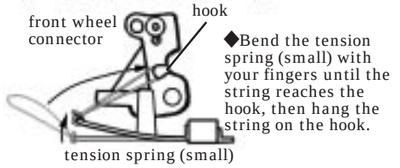


◆Attach the end of the front wheel bridge with a fold line to the front wheel bearing.

※However the front wheel bridge might twist reversely at the center, it is no problem.

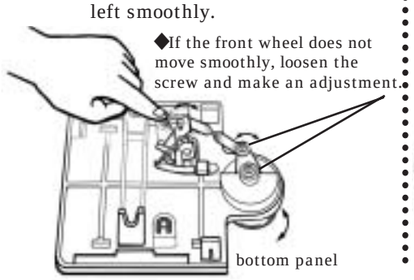
7 Hang the string attached to the tension spring (small) on the hook of the front wheel connector with tweezers.

※When you use the tweezers it may turn white at the pivot, yet it is usable.



◆Bend the tension spring (small) with your fingers until the string reaches the hook, then hang the string on the hook.

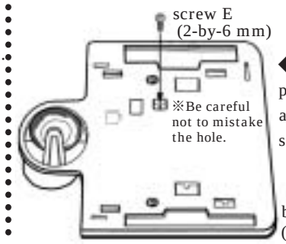
8 Move the front wheel connector back and forth and make sure the front wheel turns right and left smoothly.



◆If the front wheel does not move smoothly, loosen the screw and make an adjustment.

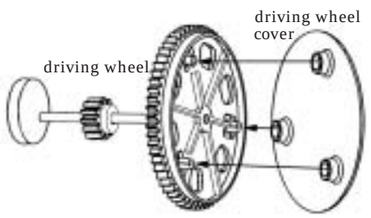
9 Place the bottom panel with its face down and turn the screw E just a few times at this point.

◆Screw E is used for adjustment afterward.



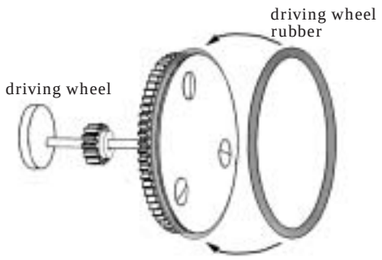
◆Please see p.22 for the adjustment of screw E.

10 Put the driving wheel cover on the driving wheel.

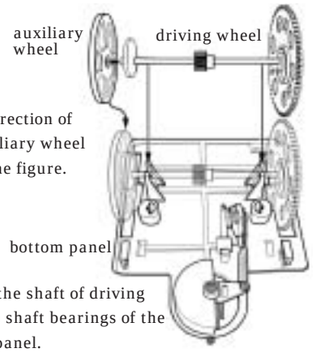


◆Fit the projection of the driving wheel to the holes of the driving wheel cover and snap in.

11 Fit the driving wheel rubber in the groove between driving wheel and driving wheel cover.



12 Attach the auxiliary wheel to the shaft of the driving wheel.

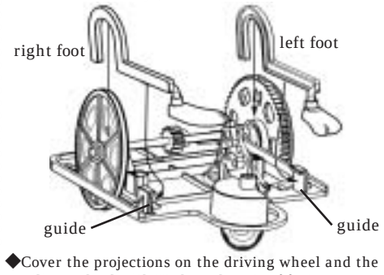


◆The direction of the auxiliary wheel is like the figure.

◆Push the shaft of driving wheel in shaft bearings of the bottom panel.

13 Install feet inside the driving wheel and auxiliary wheel.

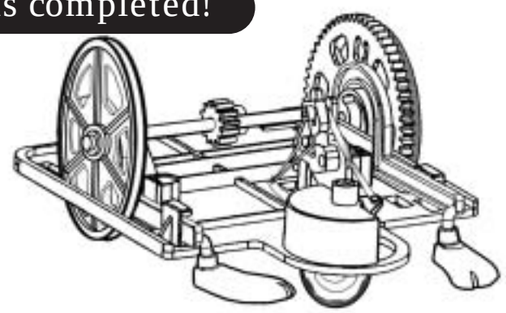
(Be careful not to install right foot and left foot inversely.)



◆Cover the projections on the driving wheel and the auxiliary wheel with U-shaped parts of feet. Fit the feet with the guides on the bottom panel.

Now the cart is completed!

You've finished the cart. Keep it as it is until you use it at p.18.



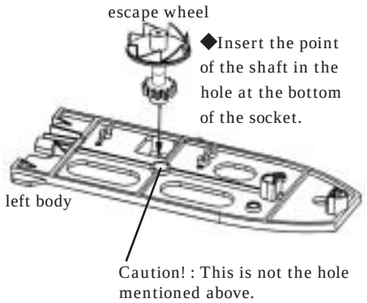
Let's Install the Escapement!

●Parts to be used

Screws to be used	3 pieces of screw E's, 2-by-6 mm	2 piece of screw C's, 2-by-5 mm with a collar	4 pieces of screw F's, 3-by-6 mm

※ Select right screws since all screws resemble in shape.

1 Set the escape wheel in the socket of the left body.

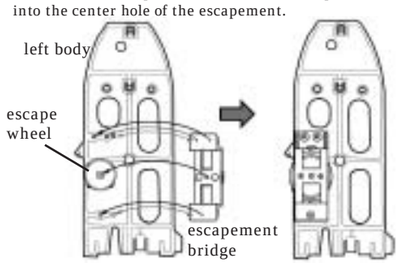


◆Insert the point of the shaft in the hole at the bottom of the socket.

Caution! : This is not the hole mentioned above.

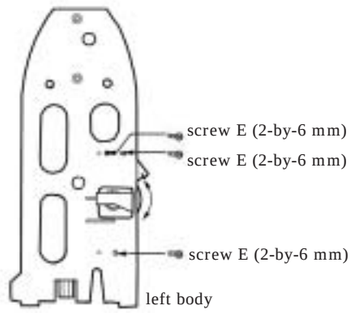
2 Push the escapement bridge into the left body.

◆Push the projections at the top and the bottom of the escapement bridge into the holes of the left body. At the same time, push the shaft of the escape wheel into the center hole of the escapement.



3 Fasten the escapement bridge to the left body with screw E's from the backside.

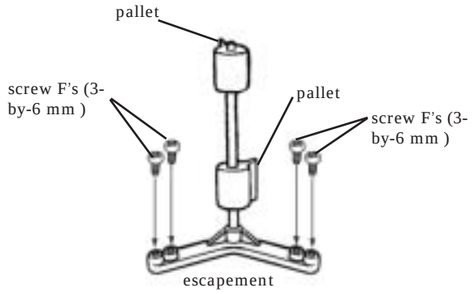
◆These three screw E's have to be fastened firmly.



4

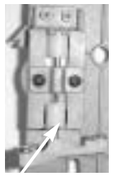
Attach four screw F's to the bottom parts of the escapement.

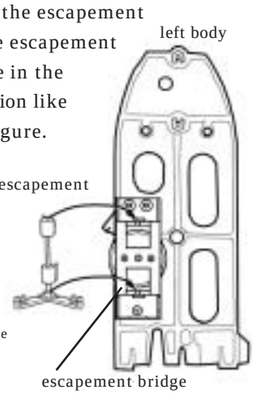
◆These four screw F's have to be fastened firmly.



5

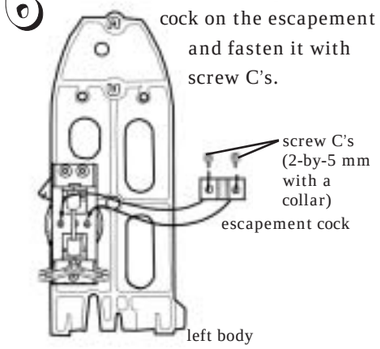
Place the escapement on the escapement bridge in the direction like this figure.


Put the pallet in the escapement.



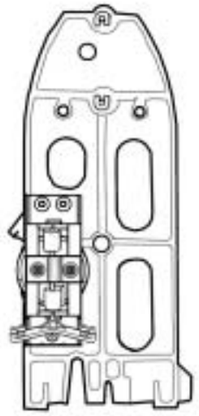
6

Put the escapement cock on the escapement and fasten it with screw C's.



Now the left body is completed!

You've finished installing the escapement to the left body. Look at the figure to make sure that the escapement is correctly attached.

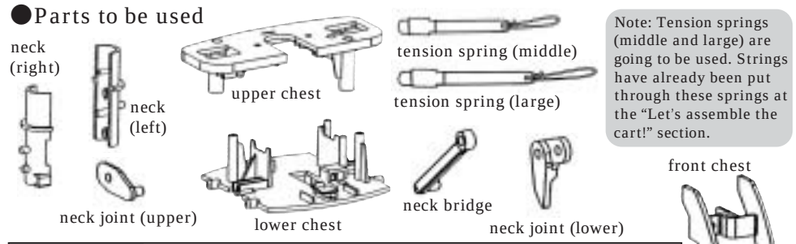


The roll of the escapement

The main components of the escapement are two cylindrical parts with pallets attached on the upper part of the shaft. The escapement controls the speed of the rotation by hanging the pallets on the wheels. The heavier are the sheet weights around the bottom parts of the shaft, the more slowly the wheel rotates, and the lighter, the faster.

Let's Assemble the Chest Unit!

●Parts to be used



Note: Tension springs (middle and large) are going to be used. Strings have already been put through these springs at the "Let's assemble the cart!" section.

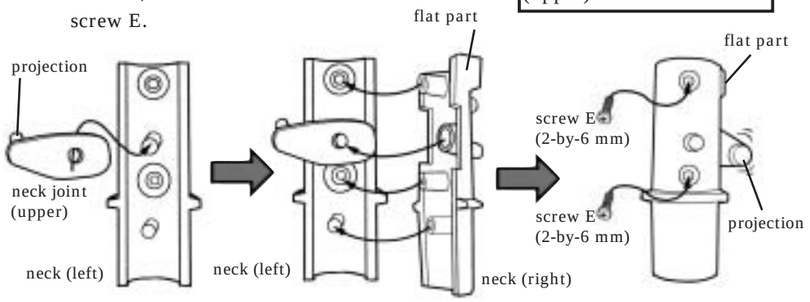
Screws to be used	2 pieces of screw B's, 2.6-by-5 mm with a collar	1 piece of screw D, 2-by-10 mm	4 pieces of screw E's, 2-by-6 mm

※ Select right screws carefully since all screws resemble in shape.

1

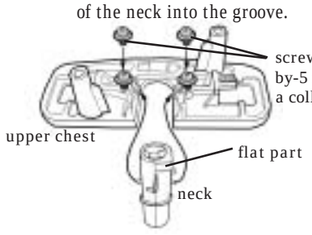
Put the neck joint (upper) between the neck parts (right and left) and fasten it with a screw E.

IMPORTANT Pay attention to the direction of the neck joint (upper).



2

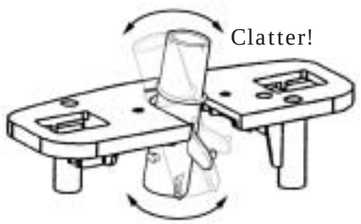
Attach screw B's on the chest (upper) as the figure shows. Turn them a couple of times and fasten them loose, so that a small space remains between collars of screws and the chest. Fit the projection of the neck into the groove.



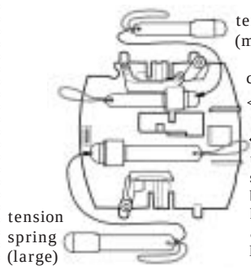
3

Hold the chest and the neck as shown in the figure, and fasten them with screw B's.

4 Check if the neck and the neck joint (upper) move back and forth smoothly.

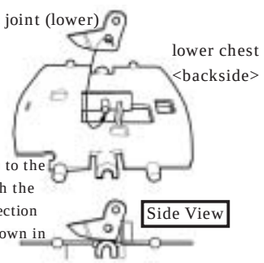


5 Put tension springs (large and middle) into frames on the chest (lower) to the end as shown in the figure.



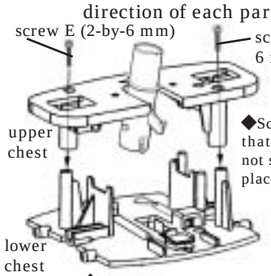
◆Be careful not to take the large sheet spring for middle, because both springs have the same width, although their lengths are different.

6 Turn over the lower chest and put the neck joint (lower) on the projection of the lower chest.



◆Pay attention to the direction. Attach the joint in this direction and angle as shown in the figure.

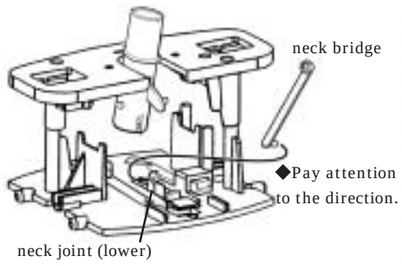
7 Fasten the upper chest and the lower chest with screw E's paying attention to the direction of each part.



◆Screw enough so that the parts will not slip out of the place.

◆Pay attention to the direction.

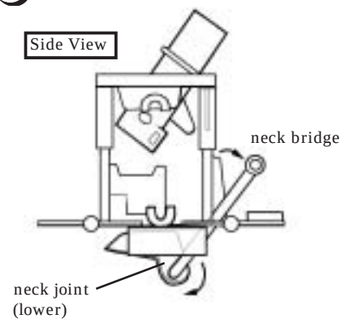
8 Put the neck bridge in the hole of the neck joint (lower).



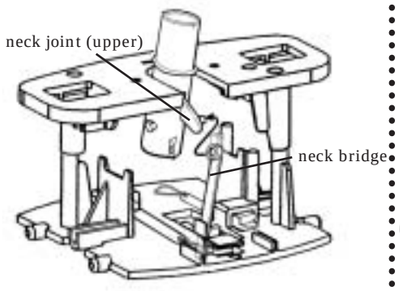
◆Pay attention to the direction.

※Hold the part from the backside with fingers so that you can see the hole.

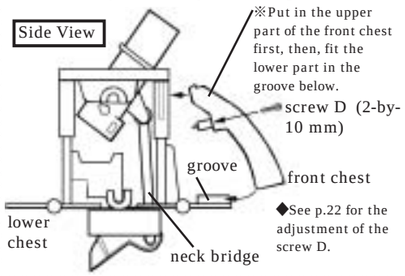
9 Keep the neck bridge down.



10 Put the hole of the neck bridge on the projection of the neck joint (upper).

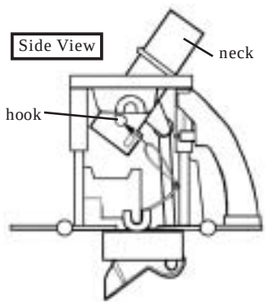


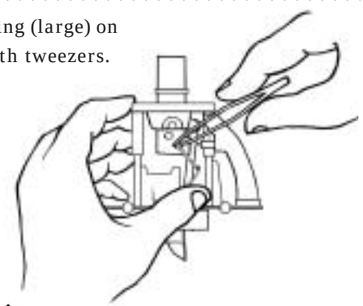
11 Hold the bridge softly and fit the front chest in the groove of the lower chest.Turn the screw D for adjustment just a couple of times.



◆See p.22 for the adjustment of the screw D.

12 Hang the string of the tension spring (large) on the hook at the side of the neck with tweezers.

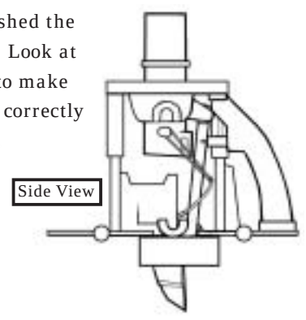


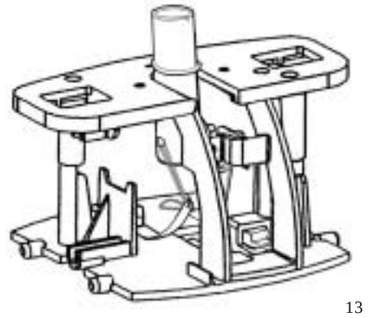


◆Bend the tension spring (large) with your fingers until the string reaches the hook, then hang the string on the hook with tweezers.

Now the Chest Unit is Completed!

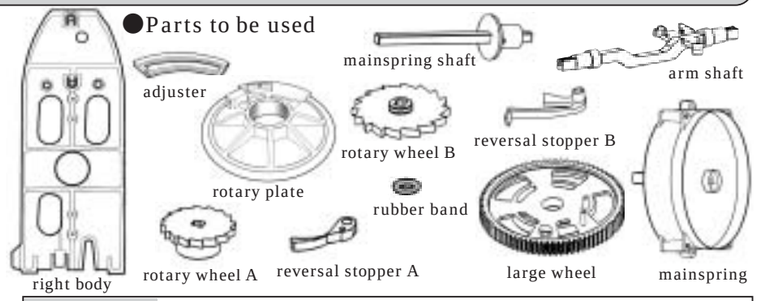
You've finished the chest unit. Look at the figure to make sure if it is correctly assembled.





Let's Assemble the Motive Power Unit!

●Parts to be used



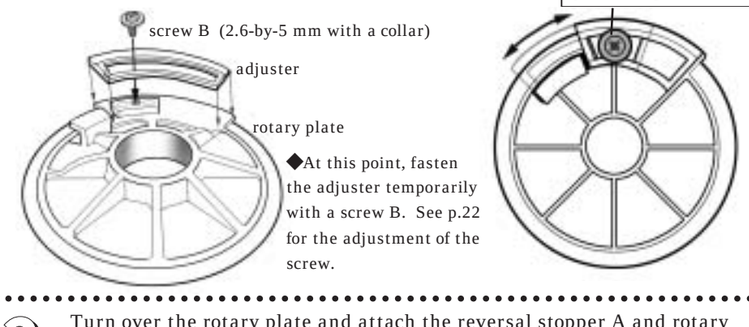
Screws to be used	8 pieces of screw A's, 3-by-8 mm	1 piece of screw B, 2.6-by-5 mm with a collar	1 piece of screw D, 2-by-10 mm

※ Select right screws since all screws resemble in shape.

1

Attach the adjuster to the rotary plate. Put the adjuster on the projection and fasten with a screw B.

The adjuster can move left and right to some extent by loosening the screw B.



◆At this point, fasten the adjuster temporarily with a screw B. See p.22 for the adjustment of the screw.

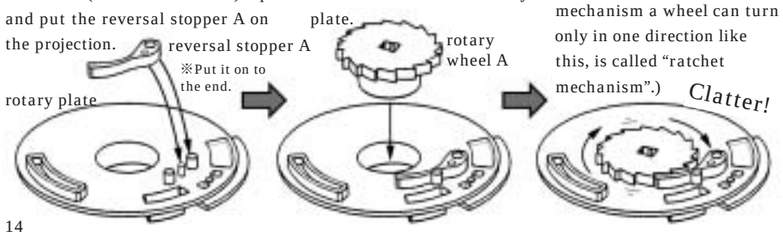
2

Turn over the rotary plate and attach the reversal stopper A and rotary wheel A in the right direction.

①Place the rotary plate with its backside (without a screw) up and put the reversal stopper A on the projection.

②Fit the rotary wheel A in the center hole of the rotary plate.

③Make sure that the rotary wheel A turns to only one direction clattering. (The mechanism a wheel can turn only in one direction like this, is called “ratchet mechanism”.)



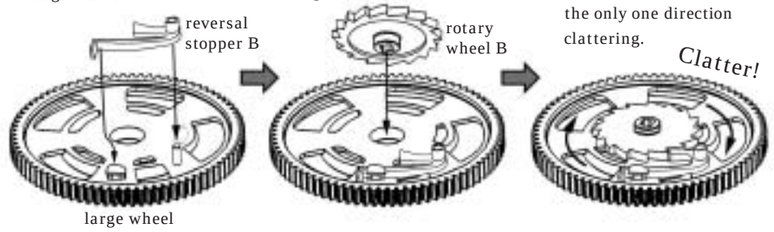
3

Attach the reversal stopper B and the rotary wheel B to the large wheel.

①Put the reversal stopper B on the projection of the large wheel.

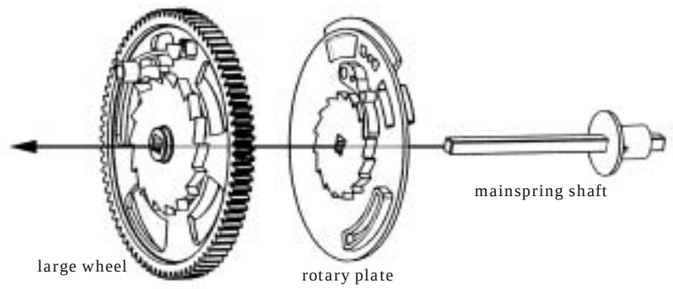
②Fit the rotary wheel B in the center hole of the large wheel.

③Make sure that the rotary wheel B turns in the only one direction clattering.



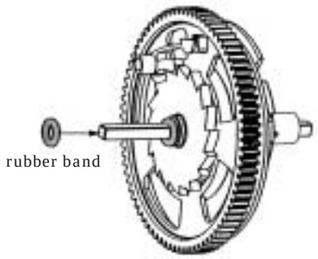
4

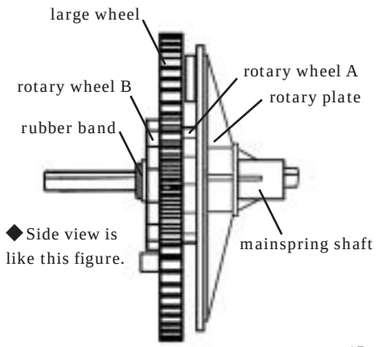
Put the mainspring shaft through the rotary plate first, then though the large wheel in the direction as shown in the figure.



5

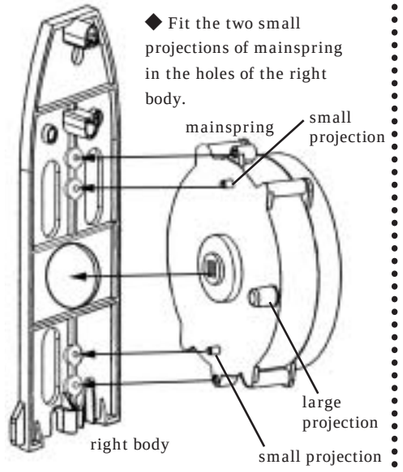
Put the rubber band into the mainspring shaft to the end so that the parts don't come apart.



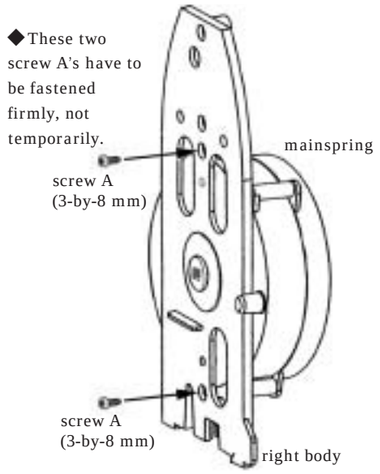


◆Side view is like this figure.

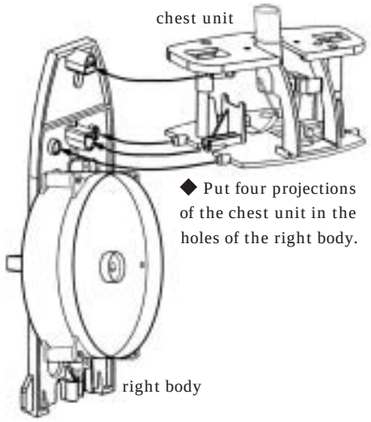
6 Attach the mainspring to the right body in the direction like the figure below.



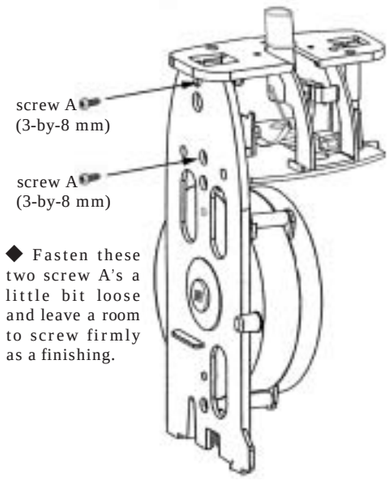
7 Fasten the mainspring to the right body with screw A's.



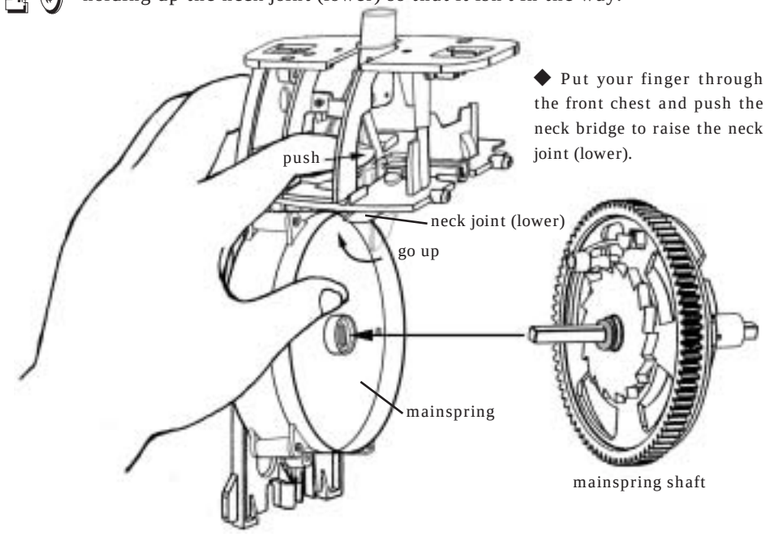
8 Attach the chest unit finished at p.13 to the right body.



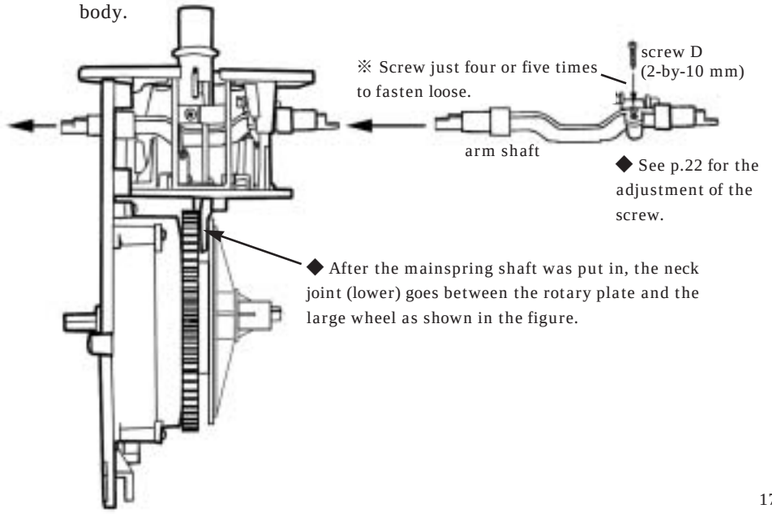
9 Fasten the chest unit to the right body with screw A's.



10 Insert the mainspring shaft into the center hole of the mainspring, while holding up the neck joint (lower) so that it isn't in the way.



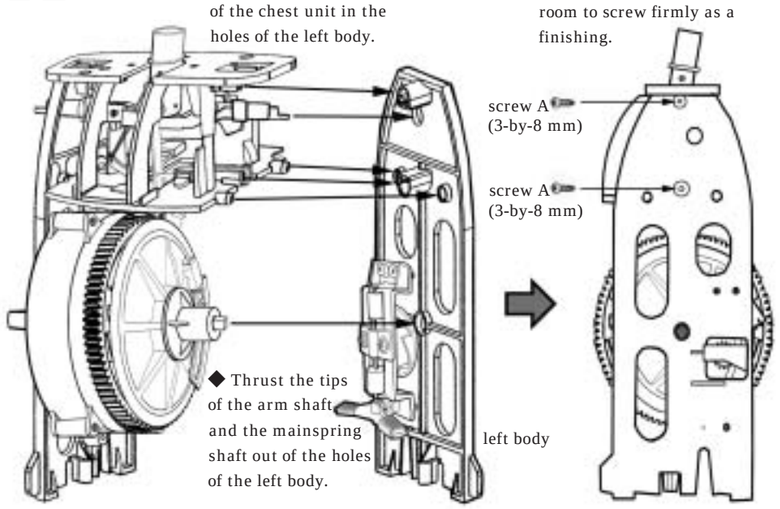
11 Fasten a screw D for adjustment to the arm shaft loose. Then, put the arm shaft through the front chest till the tip comes out from the hole of the right body.



12 Attach the left body to the chest unit.

◆ Put four projections of the chest unit in the holes of the left body.

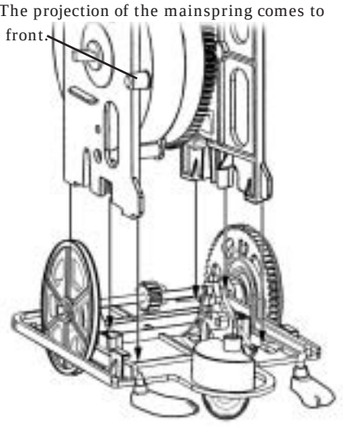
◆ Fasten these two screw A's a little bit loose and leave a room to screw firmly as a finishing.



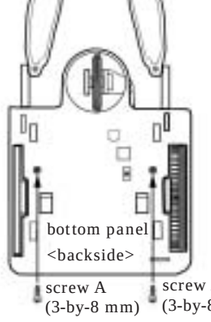
13 Place the body unit you assembled above on the cart you've finished on page 8.

◆ Put six projections of the left body and the right body in the holes of the cart firmly.

◆ The projection of the mainspring comes to the front.



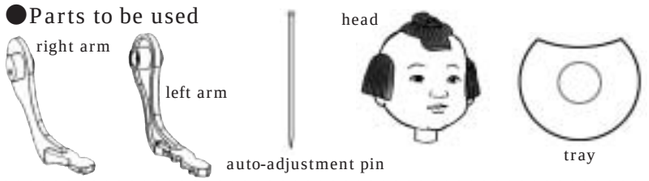
14 Fasten the right body and the left body with screw A's from the backside of the cart.



◆ Fasten these two screw A's a little bit loose at this point. Make sure that there is no distortion all over, then fasten screw A's (not only the two screw A's fastened now but also screw A's fastened loose at 9 and 12) again firmly.

Let's Install Other Parts!

●Parts to be used

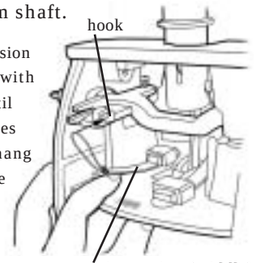


Screws to be used

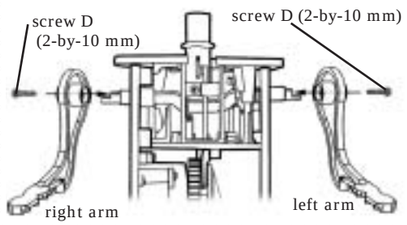
2 pieces of screw **D**'s 2-by-10 mm

1 Hang the string of the tension spring (middle) on the hook of the arm shaft.

◆ Bend the tension spring (middle) with your fingers until the string reaches the hook, then hang the string on the hook with tweezers.

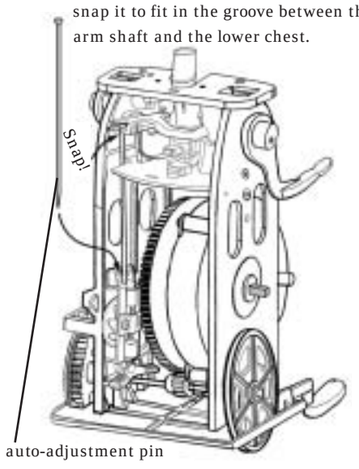


2 Attach the right and the left arms to the arm shaft and fasten with screw D's.

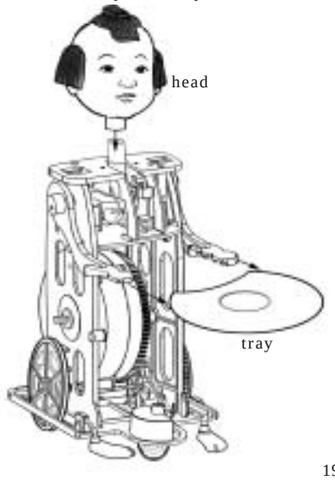


3 Install the auto-adjustment pin.

◆ Put the point of the pin in the hole of the escapement bridge first, and then snap it to fit in the groove between the arm shaft and the lower chest.

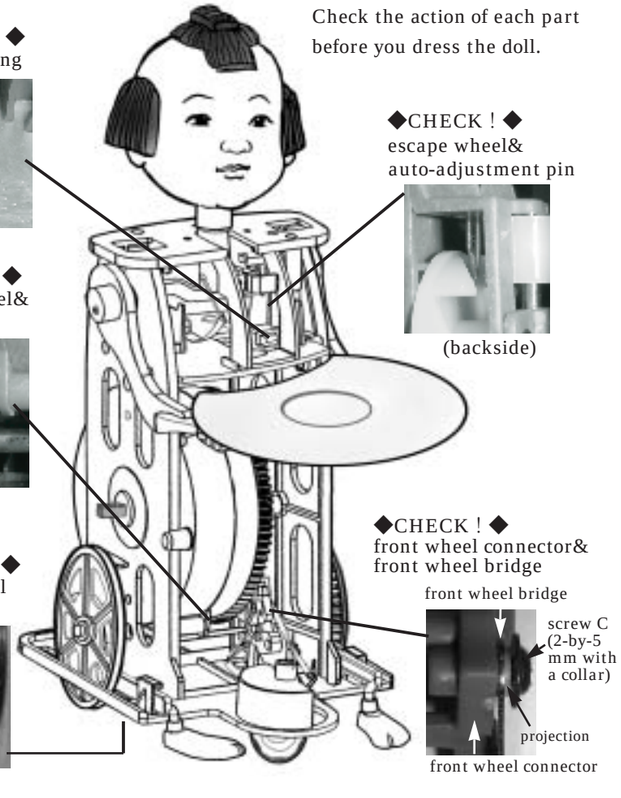


4 Insert the head into the neck and insert the both arms into the tray. Now you've done!



The Finished Mechanical Doll

Check the action of each part before you dress the doll.



✱When you don't use the doll for a long time✱

1. Be sure to take off the teacup from the tray, otherwise the tension spring might deteriorate and become useless.
2. Be sure to leave the mainspring unwound. Loosen it completely. It might become out of order, if it is left wound for a long time.

Let's Do the Test Run

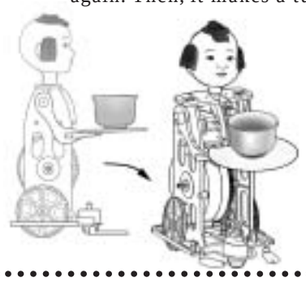
1 Set the doll on the flat place and wind up the mainspring with the winding knob.

2 When you put the teacup on the tray, the doll starts moving. First, it goes straight.

※Do not fill the cup with tea during the test so that the tea might not be spilt.

3 After the doll goes straight for a while, it makes a bow. Then, take the teacup and the doll stops.

4 Return the teacup on the tray and the doll starts moving again. Then, it makes a turn.



5 After the turn, it goes straight.

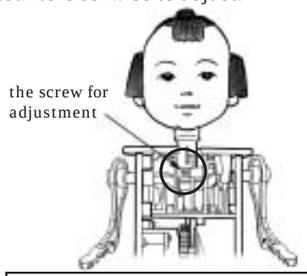
6 When the doll gets back to the starting point, take the teacup and the doll stops.

Make Fine Adjustments to each part

Before your performance in front of guests, test a couple of times and grasp how each part works, how long the doll moves and how it turns. Then make fine adjustments to each action as follows if necessary.

1. The angle of the neck→Adjust the screw at the chest.

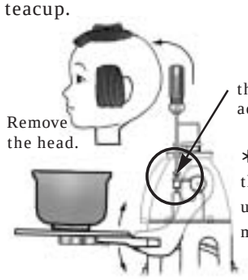
The screw at the front chest is to adjust the neck angle. Turn it clockwise or counterclockwise to adjust.



When you turn the screw clockwise,	the doll looks downward.
When you turn the screw counter-clockwise,	the doll looks upward.

2. The angle of the tray →Adjust the screw at the arm shaft.

Adjust the angle of the tray so that it becomes level when you put on the teacup.

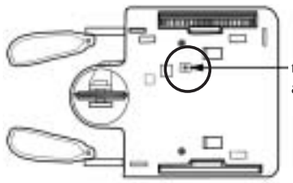


∗Before you make this adjustment, unwind the mainspring.

When you turn the screw clockwise,	the arms go up.
When you turn the screw counter-clockwise,	the arms go down.

3. Course→Adjust the screw at the bottom panel.

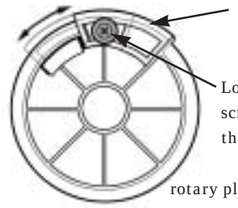
Adjust the doll so that it goes straightforward. (If you don't make this adjustment, the doll tends to go rightward.) When the doll doesn't go straight, adjust this screw.



When you turn the screw clockwise,	the doll goes rightward.
When you turn the screw counter-clockwise,	the doll goes leftward.

4. The angle of the turn→Move the adjuster at the rotary plate.

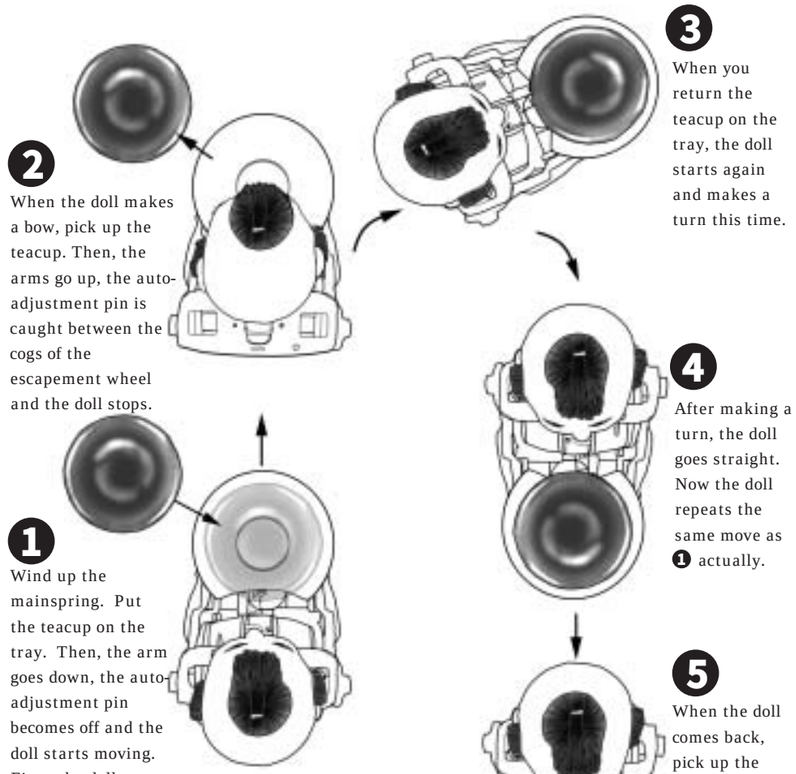
Loosen the screw before you move the adjuster. Adjust the angle of the turn. Look at the consecutive action of the doll and adjust so that it makes good turn.



When you move the adjuster rightward,	the angle of the turn becomes larger.
When you move the adjuster leftward,	the angle of the turn becomes smaller.

Check the Move of the Doll

If the doll moves as follows, you've made good adjustments. Check it now!



❶ Wind up the mainspring. Put the teacup on the tray. Then, the arm goes down, the auto-adjustment pin becomes off and the doll starts moving. First, the doll goes straightforward.

❷ When the doll makes a bow, pick up the teacup. Then, the arms go up, the auto-adjustment pin is caught between the cogs of the escapement wheel and the doll stops.

❸ When you return the teacup on the tray, the doll starts again and makes a turn this time.

❹ After making a turn, the doll goes straight. Now the doll repeats the same move as ❶ actually.

❺ When the doll comes back, pick up the teacup. Then, the doll stops. This is the end of a series of moves.

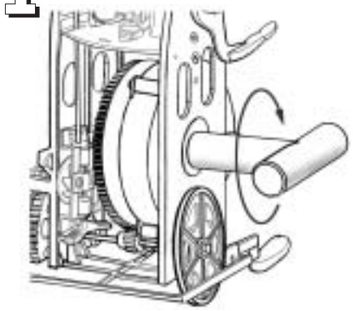
These are the three basic moves of the doll.
1. The doll starts moving when the teacup is put on the tray and stops when the teacup is taken.
2. The doll goes straight about a fixed distance (90 cm at the longest).
3. The doll turns after it makes a bow.

Make the Final Adjustment Before your Performance

When you finish the adjustments on p.22, make the final adjustment before you show the doll to your guest.(This adjustment is possible after the doll is dressed. In that case, pull the hakama up.)

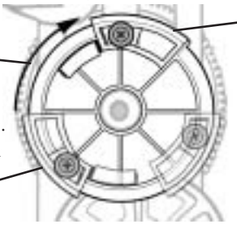
● Adjust the distance between the starting point and where the doll bows in front of your guest.

1 Wind up the mainspring.



2 When you wind up the mainspring, the adjuster at the rotary plate comes to the position shown in the figure below. Turn the rotary plate clockwise and change the position to suite the distance between you and the guest. (The more you turn, the less the distance becomes. Take a look at the figure below and adjust the distance.)

※ Be sure to turn the rotary plate always clockwise.



When the adjuster is at this position, the doll goes straight about 45 cm.

When the mainspring is wound, the adjuster comes to this position. The doll goes straight about 90 cm (the longest) if you set the doll in motion in this condition.

◆Note: Keep the screw of the adjuster as it is. (Do not loosen it and change the position of the adjuster itself.)

●If the doll doesn't move successfully after all adjustments, check the following points.●

★The doll starts right after you wind up the mainspring without putting the teacup on the tray. →The tension spring (middle) might not be working well. Knot the string twice and make the loop smaller or change the tension spring (middle) with a spare.

★The doll doesn't go straight after the turn. →The tension spring (small) might not be working well. Knot the string twice and make the loop smaller or change the tension spring (small) with a spare.

★The doll bows from the beginning. →The tension spring (large) might not be working well. Knot the string twice and make the loop smaller or change the tension spring (large) with a spare.

★The doll doesn't make a bow at all.→If the doll is dressed already and if it is too tight around the neck, the doll can't bow. In this case, loosen the Kimono a little so that the doll can move the neck.

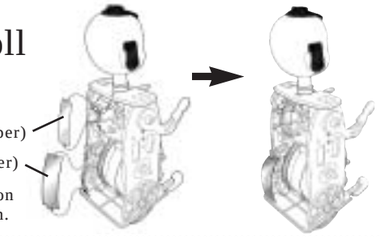
●How to Dress the Doll

★Before you start dressing ★

Put on guards (upper and lower) beforehand so that the dress is not caught in wheels.

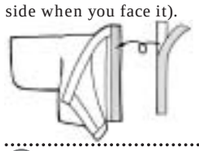
guard (upper)
guard (lower)

◆ Pay attention to the direction.



1 Dress the kimono tops.

1. Cut a both side adhesive tape into 10cm. Put it on the inside of the back margin of the kimono top 1 (the left side when you face it).



2. Put each arm through sleeves of the kimono top 1 and the 2. Peel the thin paper from the adhesive tape and paste the both sides of kimono tops together at the back.

Align the collars of both tops.

Parts to be used

2 Dress the hakama skirt.

1. Unfold the hakama skirt and put through the doll from the bottom. Bring the front laces back and tie them at the back.(Tie the laces at the height as shown in the figure below. Adjust the skirt so that the insteps come out a little bit.)

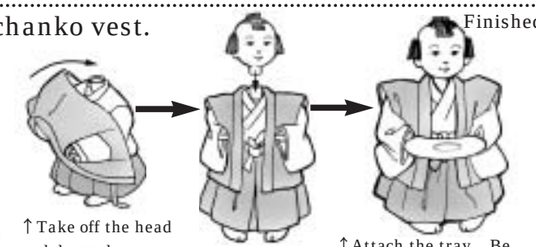
2. Bring the back laces to the front and tie them at the front. (Cover the back knot with the hakama skirt. Make the back part higher and the front part lower.)

※ Check the collar, the nape, the neckline and the position of the hakama skirt. If they are all right, cut the rest of the adhesive tape and fasten the front with it.

Note: If the front is crossed too tight, the doll can't bow. Check if the neck can move back and forth before you fasten the front with a tape.

3 Dress the chanchanko vest.

Take off the head. Turn the vest upside down and put the both arms through sleeve holes as shown in the figure. Dress the vest as it covers the neck. Tie the laces. (If the front knot comes out forward, fasten with an adhesive tape.) Put the head on again. Now you've finished!



↑Take off the head and dress the chanchanko vest.

↑Tie the front laces.

Finished!

↑Attach the tray. Be careful that the front laces do not touch the tray.

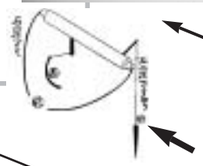
Mechanisms of the Karakuri Mechanical Doll

What mechanisms make this doll move?

This karakuri doll is basically modeled after the mechanisms described in the “Karakuri Zui”. The very best technologies of the Edo period(1603~1867) are applied to the mechanisms of the doll.

●The mechanism of a start and a stop

What takes on the switching system for a start and a stop is the auto-adjustment pin connected with the arms. (The ⓜ in the figure of the "Karakuri Zui") When you put the teacup on the tray, the arms go down and the pin goes up. This pin plays the role of the stopper for the cogwheel. When the pin goes up, the stopper becomes off and the cogwheel starts turning. When you take the teacup, the arms go up and the stopper works and the cogwheel stops.

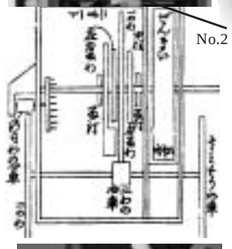


No.1 wheel

●The mechanism of going straight

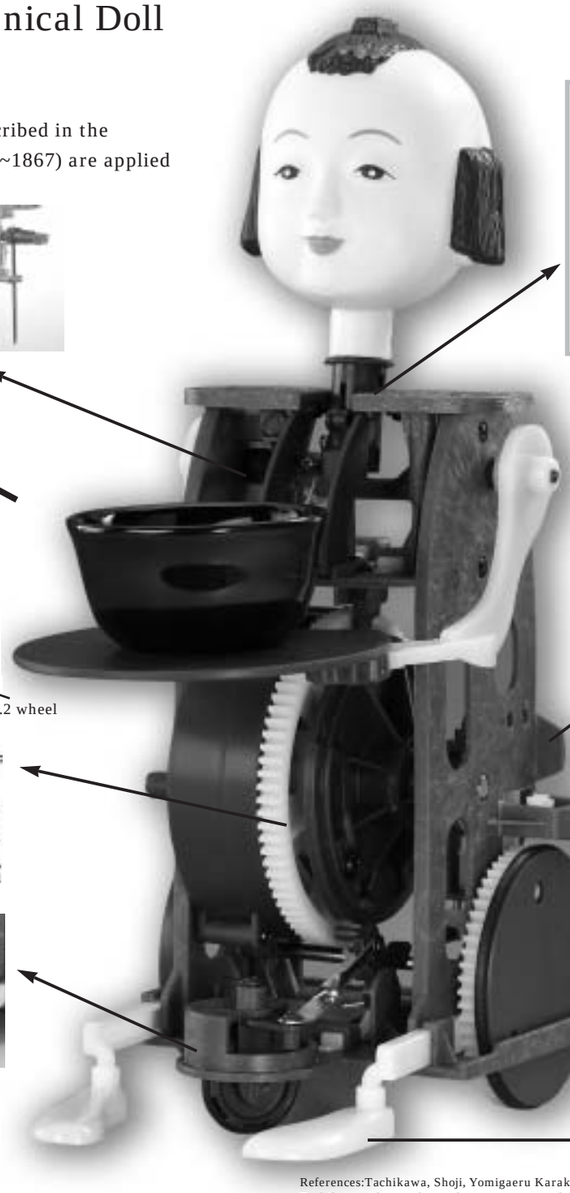
When the mainspring loosens, it generates power. This power first effects on the No.1 wheel. This wheel has 80 cogs. The power is transmitted to the No.2 wheel, and it has 12 cogs. Based on the calculation, the No.2 wheel turns about 7 times while No.1 wheel turns once. After 5 turns, however, the projection at the rotary plate begins to push the front wheel. The doll moves about 18 cm while the No.2 wheel turns once, so it goes straight about 90 cm long before the projection catches the front wheel (and the doll begins to turn). For the mainspring, the “Karakuri Zui” specifies that a whale fin should be used.

No.2 wheel



●The mechanism of a turn

What takes on a turn is the little wheel at the bottom. The angle of the wheel decides the course of the doll just like the front wheel of a tricycle determines its route. The angle of the wheel changes by being pushed by the rotary plate. The doll continues to turn right while the wheel is pushed. When the front wheel connector gets off the projection, the wheel goes back to the former position and the doll goes straight. You can control the angle of the turn by adjusting the projection.



●The mechanism of a bow

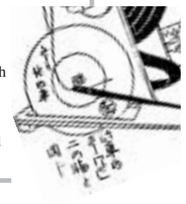
This doll makes a bow politely when it brings a cup of tea to the guest. What a charming action it is! The part that controls this action is the rotary plate. When the projection catches the part extended from the neck, the front of the neck is pulled and the head goes down. When the projection gets out of the place, the neck is released and the head goes back to the former position. Since the rotary plate also controls the front wheel, the doll always makes a bow before it makes a turn coordinately.

●The mechanism of adjusting the speed

What controls the speed is a cogwheel at the back part called “gyojirin”. (See the picture.) Being caught in the cogwheel, the two stoppers at the escapement controls the rotation. The technology used for the escapement of a Japanese clock is applied to this mechanism. The sheet weights around the speed control bar have made the finer speed control possible.

●The mechanism of the shuffle walk

While the doll is moving, its feet move back and forth. It looks as if the doll conforms to the manners of the tea ceremony and shuffles forward. This unique walk style is realized by the crank movement made by the pivots controlling the move of each foot, since their shafts are not aligned with the center of the driving wheels. The "Karakuri Zui" instructs that the left pivot should be attached forward and right pivot backward.



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