CHAPTER XVIII

The Movement of Toys

THE "movement of toys" does not necessarily imply the use of elaborate clockwork, steam or electrical apparatus. Many of the most popular toys of the present day depend for their action on no such means. Simple laws of nature, such as, for instance, *gravitation* (involving acceleration and retarded velocity); *inherent properties of bodies* (elasticity, expansion and contraction); and finally, chemistry, make possible the successful operation of many most ingenious contrivances.

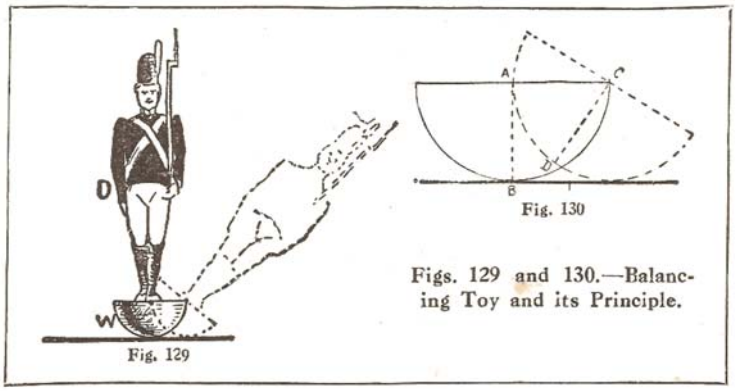


Fig. 129

Fig. 130

Figs. 129 and 130.—Balancing Toy and its Principle.

Balancing Toys – Fig. 129 comprises a figure **D**, made of the pith of the elder tree, which is extremely light and is affixed to the half of a leaden bullet **W**. On account, therefore, of the disproportion between the weight of the figure and that of the base, exclude the consideration of the former, and confine attention to the latter. The centre of gravity of the hemispherical base is, of course, in its axis, and therefore tends to approach the horizontal plane as much as possible. This can never be accomplished until the axis becomes perpendicular to the horizon. Whenever the curved surface is in any other position, the centre of gravity is not in the lowest plane to which it can descend, as may be seen from the diagram (Fig. 130). If the axis **AB** be removed to **DC** it is evident that the centre of gravity will be raised, and that, if left alone, it would immediately descend again into its original position.

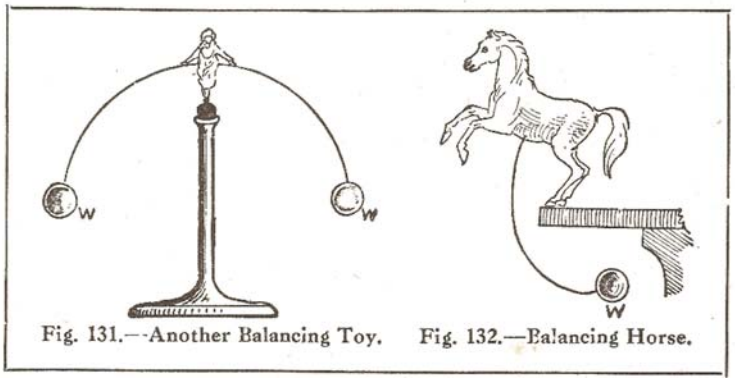


Fig. 131.—Another Balancing Toy.

Fig. 132.—Balancing Horse.

Fig. 131 serves to illustrate the subject further. It consists of a small figure supported on a stand by a ball, which is quite loose; and yet it is made to turn and balance itself in all directions, always recovering its erect position whenever the force applied to it is removed. The two weights **WW** in this case constitute the centre of gravity, considerably below the point of suspension or support; and therefore maintain the figure upright, and make it resume its perpendicular position after it has been removed from the perpendicular position.

The next example furnishes a good instance of the application of the balancing principle, a principle that is adopted in the production of a large number of interesting toys.

Thus in the case of the toy horse shown by Fig. 132, the centre of gravity of which would be somewhere about the middle of its body, it is very evident that, if we were to place its hind legs on the edge of the table, the line of motion would fall considerably beyond the base, and the horse would then fall to the ground. There is, however, a stiff wire attached to a weight **W**, which is connected to the body of the horse, and by means of this addition the animal prances with perfect security at the edge of the table; so that the figure which was incapable of supporting itself is actually prevented from falling by adding the weight to its unsupported end, although actually the centre of gravity has been altered. In order to produce the desired effect the wire must be bent so as to throw the weight far back under the table; by which contrivance, since the centre of gravity of the whole compound figure is thrown into the leaden weight, the hind legs of the horse thus become the point of suspension.

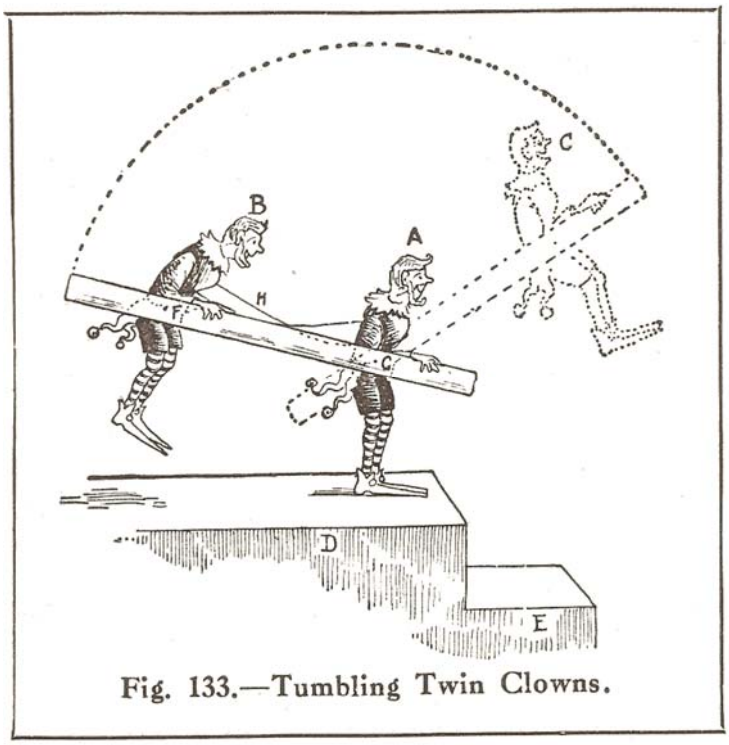


Fig. 133.—Tumbling Twin Clowns.

Tumbling Twin Clowns - This is a toy that automatically works its way down a series of successive planes. The contrivance (Fig. 133) is more complicated than the toys already mentioned. The action will be described first. As soon as the figure **A** is placed upon the step **D** in the position **AB**, quicksilver [mercury, which is a poison, must not be used these days, particularly not in children's toys] contained within the parallel tubes held by the clowns runs down the inclined tubes, swings the figure **B** round to **C**, and the centre of gravity having been thus adjusted, the whole would remain at rest but for the contrivance to be next described. Besides their connection with the poles or tubes by means of pivots **F** and **G**, the figures are connected with each other by silken strings **H**, which keep the figure **B** steadily in its position while it traverses the arc until it arrives at **C**, when the increased tension has the effect of capsizing it, and of thus producing a momentum, which, by carrying its centre of gravity beyond the line of motion, causes it to descend upon the step **E**, when the quicksilver, by again flowing to the lowest

part of the tubes, places the figures in the same position, only one step lower, as they were at the commencement of their action.

There are certain niceties in the adjustment of the minute parts of the apparatus, without which the effect could not be accomplished. The quantity of quicksilver, for instance, must bear its proper proportion to the weight and size of the figures; and in order to prevent its too rapid passage along the inclined tubes, strings are stretched across their interior to retard the flow. Again, some manipulation is necessary with regard to the silken strings in order to ensure the necessary degree of tension; and finally, the pivots at **F** and **G** need to be skilfully fitted, so that the swivelling motion of the figures is exactly at right angles in relation to the direction of the two parallel tubes employed.

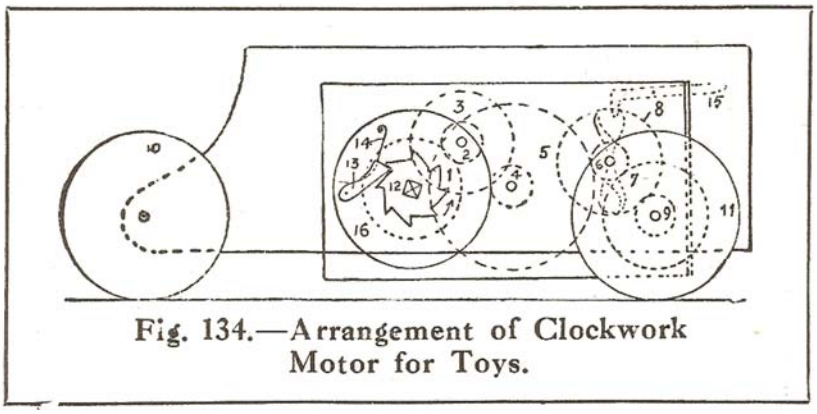


Fig. 134.—Arrangement of Clockwork Motor for Toys.

Clockwork Toys - Clockwork as utilised for the operation of mechanical toys generally consists of a train of from four to five spur wheels, the teeth of which mesh and thus engage with a suitable number of pinion wheels; a ratchet wheel, usually mounted on the spindle, to which the inner end of a flat spiral steel spring is fastened; a small spring pressing against a pivoted piece, the latter forming a catch to fall behind the teeth of the ratchet; a balance, fly-wheel or flan, to act as a control and to keep the mechanism as a whole from racing; and a stop and start lever device, arranged to drop into a niche on the edge of a disc, the latter being mounted on the same spindle as that carrying the control mechanism. The general arrangement of such a device is illustrated in Fig. 134, wherein **16** represents the circular casing containing the spiral spring, the outer end of which is fixed at some point on the inside edge of the casing, while its inner end is fastened by hooking to the spindle on which it is carried. The outer end of the spindle is furnished with a square shank to afford a grip for the winding-up key. The ratchet wheel **12** turns with the winding of the spring, and is kept from a reverse action by means of the piece **13** pressed into position by the small spring **14**. On the opposite side of the main spring casing and on the same spindle, is affixed the first driving spur-wheel **1**. This engages with a pinion wheel **2** mounted on a spindle with the second spur-wheel **3**. This, in its turn, engages with the pinion **4**, with which turns the spur-wheel *5*. The latter engages with spur-wheel **6**, on the spindle of which is also mounted the balance fly-wheel or fan, as the case may be. In the illustration a fan is indicated by the dotted lines. The pinion **6** also engages with a spur-wheel **7**; or if higher speed is needed for the vehicle wheel **11**, then **8** may take the form of a spur-wheel to engage with a pinion at **9**; **8** also represents the position, on the fly-wheel spindle, of a blank wheel niched for the reception of the stop and start lever **15**. The illustration shows the clockwork when it is locked by the lever **15**. This is the common type of clockwork, such as is employed in toy engines and other small vehicles where a progressive movement is desired; but many variations have been introduced

and additions made where secondary movements are required. Fig. 135 shows a simpler motor, being a spiral spring wound by means of a ratchet and pawl.

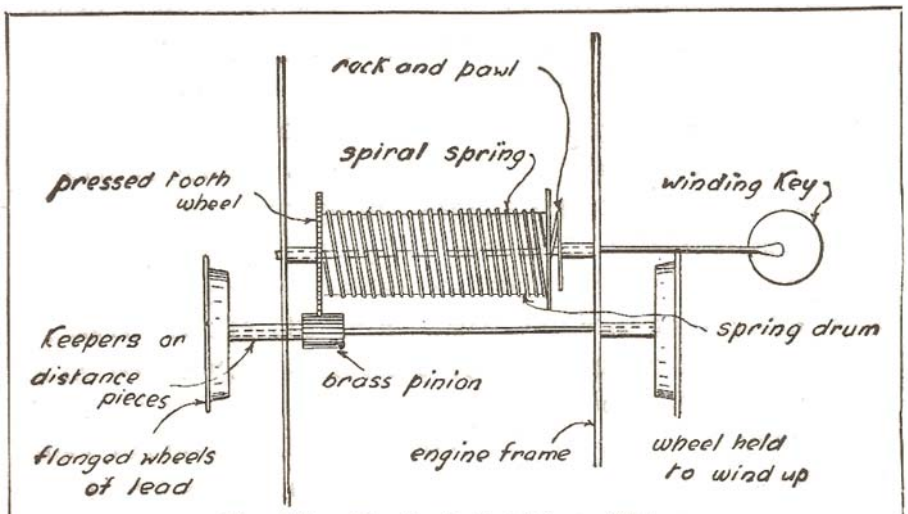


Fig. 135.—Simple Spring-driven Motor.

Toys Operated by Means of Elastic - Many clever toys have been devised dependent on elastic for their motive power; it is unfortunate, however, that this substance is not durable for any great length of time.

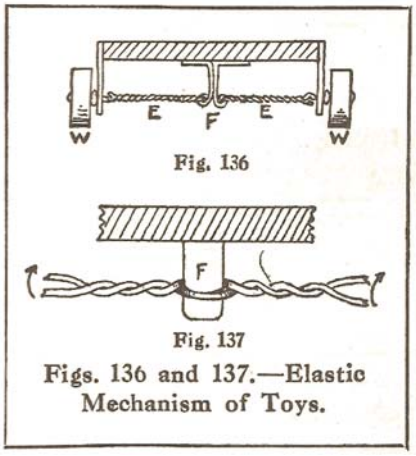


Fig. 136

Fig. 137

Figs. 136 and 137.—Elastic Mechanism of Toys.

Elastic, on account of its lightness, is eminently suited as a motive power for aeroplanes and flying devices of every kind; but it is also useful for the propulsion of screws in toy boats and in light toys, for vehicular propulsion both in a straight or circular path. Fig. 136 shows what is probably the simplest way of making a body travel in a direct line. The two front wheels **WW** of a carriage are each furnished with a small hook on the inner side of their spindles, and a double hook at **F** is fixed mid-way on a level with it. Two elastic bands **EE** are then connected and twisted up by drawing the carriage backwards along the ground or any level surface. It is evident that each band will thus be twisted in a direction opposite to its companion, so that the wheels will rotate in the same direction when pressure on the carriage is released. Motive power is thus supplied, which although lasting but a short time will be sufficient to propel the toy a considerable distance. Instead of using two bands, one will suffice, providing that means are used to make both wheels rotate in the same direction. This may be done by substituting the peg **F** for the hook (Fig. 137), and looping the band around the peg.

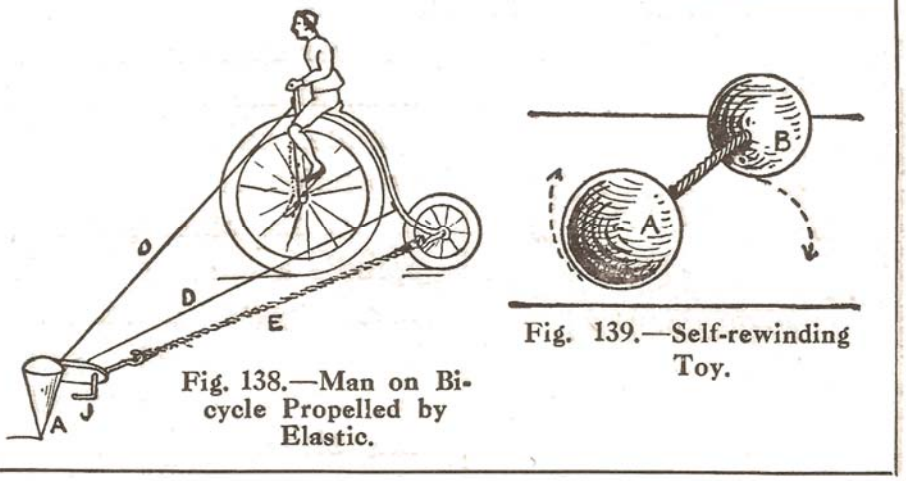


Fig. 138.—Man on Bicycle Propelled by Elastic.

Fig. 139.—Self-rewinding Toy.

The Man on a Bicycle - Fig. 138 shows how a figure representing a cyclist may be made to pedal his machine and ride it round a circular path. The frame of the machine being steadied by wire struts **DD** terminating in a weighted piece **A** situated at the radial centre, the whole contrivance preserves its balance. The small wheel of the bicycle is fixed to a spindle that turns in a fork at the back part of the machine. On the spindle is provided a hook, the purpose of which is to take the loop of an elastic band **E**, the opposite end of which goes over another and similar hook at the inner end of a spindle, passing through a projection from the weight **A**. At the other end of the spindle a crank **J** for winding purposes is made. A double cranked spindle turns the larger wheel of the bicycle, to which the rider's feet are pivoted. Likewise, the legs are pivoted together at the knee joints and at the hips to the body of the figure, so that on the turning of the pedal cranks the man will assume to be driving the machine. About fifty turns of the crank **J** and the elastic is twisted.

Self-rewinding Elastic Toy - A toy somewhat on the same principle as that described is shown in Fig. 139. Here the power of elastic is aptly demonstrated. At each end of a strong strip of elastic a fairly heavy ball is affixed, as at **A** and **B**. These balls are exactly equal in size and weight. By holding one of them firmly while turning the other the elastic strip between them becomes twisted; then on placing both down on a level surface and releasing the hold, the two balls will immediately commence to chase one another over a circular path. As they thus fly round they will each gather sufficient momentum to carry them far beyond the point at which the elastic is untwisted, and will over-run themselves, twisting the elastic in an opposite direction. Their momentum will, however, become less and less at each reverse action, until at last they come to rest.

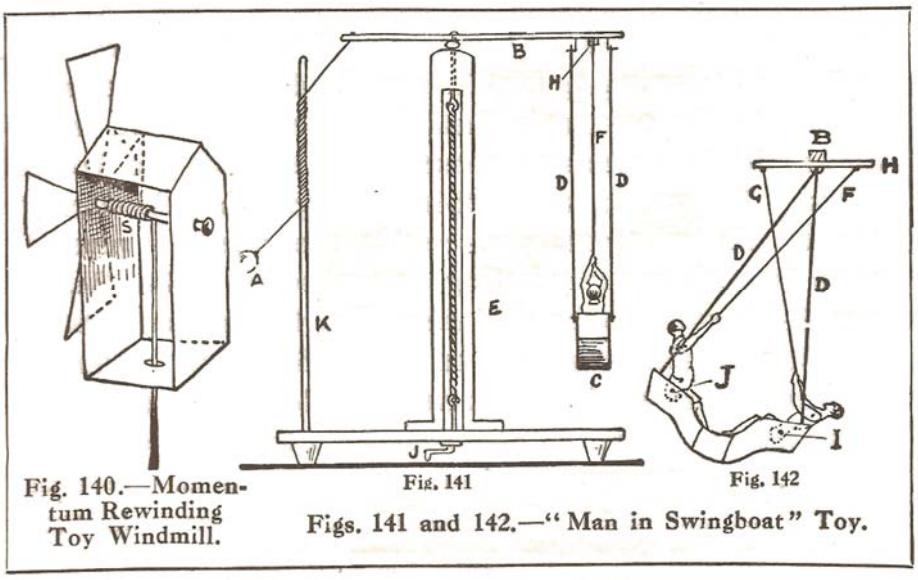


Fig. 140.—Momentum Rewinding Toy Windmill.

Fig. 141

Fig. 142

Figs. 141 and 142.—"Man in Swingboat" Toy.

Momentum Rewinding Windmill - This toy (Fig. 140) does not, as its name would seem to suggest, depend for its action on the wind; it is rather an imitation of the genuine article in appearance only. It is mentioned here as being somewhat on the lines of the last device described, insomuch that reverse rewinding comes into play through the medium of momentum. Thus the vanes of the mill are made to act the part of a fly-wheel. A string having been wound on the spindle on which the vanes are affixed, it is pulled sharply, and quickly allowed to run free. It over-runs itself, rewinding the string on the spindle in an opposite direction, which being again sharply pulled reverses the rotation, and the process may be repeated indefinitely, thus sustaining the action of the toy to any desired length of time.

Before leaving the subject of elastic as a motive power, some reference should be made to the very ingenious toy shown in Figs. 141 and 142, which embodies several devices that are supplementary to that dependent for its action on the elastic itself. Thus the revolutions of the main beam **B** are dependent on the twisted elastic **E**; but the peculiar movement of the ball weight **A**, and also the characteristic actions of the swinging boat with its occupants, depend on other things.

The wire rod **K** is the means whereby a check action is imparted to the working of the model. Thus through the agency of a ball **A** suspended by a thread fastened to the shorter side of the beam **B**, the rotation of the latter is for a few moments suspended; and at the moment of contact of the thread with the wire a sudden jerk is communicated to the swinging boat, thus giving it a start. It is by centrifugal force that the ball is made to wind up the thread around the standard and again to unwind itself. At that moment when the thread becomes completely untwisted, the tension exerted on the beam **B** by the twisted elastic **E** causes the beam to swivel round, making one complete revolution, when it is again arrested by the swinging ball. Hence so long as there is any power left in the elastic the model will continue to work. But the sudden jerk imparted to the swinging boat brings about other movements, relative to the occupants that ride therein, making them appear to be exercising muscular control of the boat's action. The way in which this is brought about is worthy of note, illustrating as it does relative movements of pivoted parts through communicating or connecting rods. Reference being made to the side view (Fig. 141) of the parts in question, a secondary beam **H** is affixed at right angles to the main beam **B**. The boat hangs by four rods (two only of which are shown at **DD**) pivoted centrally under **B** and with their

four opposite ends rigidly fixed to the four corners of the boat. The bodies of the men are connected to the boat by stationary pivots at **J** and **I** respectively, and their arms are pivoted to their respective bodies.

Rods **F** and **G**, representing ropes with which the occupants are supposed to keep themselves swinging by pulling thereon, are pivoted at points towards the ends of the second beam **H**. It will be noticed that the man on the right-hand side is lying low down in the boat, while his companion is rising out of the boat, with the apparent intention of giving the rope **F** a pull. The explanation of these movements is simple, and what applies to one figure is equally true of the other. Take the left-hand figure, for example; the arm and rod **F** being in one piece, the distance from the point at which the arm is pivoted and that at which the rod is pivoted to the beam **H** remains constant, in whatsoever position the boat may be; whereas the distance between the stationary pivot **J** and the point at which **F** is pivoted varies according to the position of the boat. Thus it is shorter when the boat is raised towards the left, and longer when it swings towards the right-hand side. The body of the man is pulled up when on the left-hand side, and pushed down when it is on the right-hand side, swivelling on the stationary pivot **J**. Hence these movements are secondary, and quite independent of any action of the elastic **E** (Fig. 141).

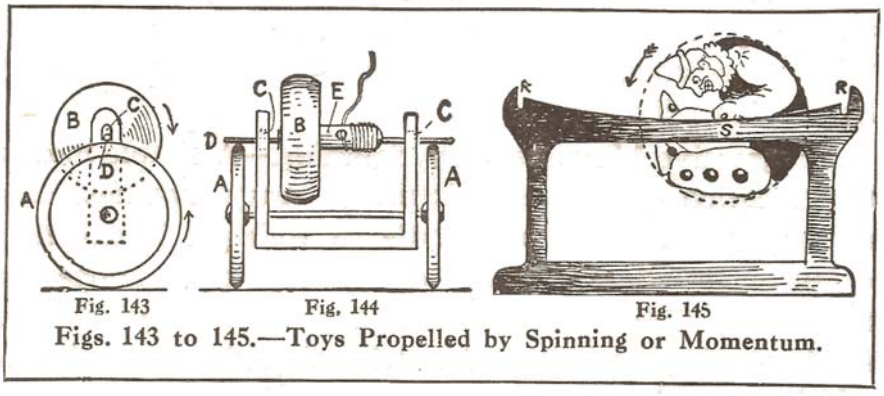


Fig. 143 Fig. 144 Fig. 145

Figs. 143 to 145.—Toys Propelled by Spinning or Momentum.

Progressive Movement by Spinning - A simple means of propulsion consists in spinning a heavy fly-wheel and allowing the ends of the spindle on which it is mounted to rest on the edges of the wheels it is intended to operate by friction. Thus in Figs. 143 and 144 the heavy wheel **B** is set spinning by means of a string threaded through the hole in the hub **H**, and wound thereon in such a manner that it can be pulled free when all the string has been untwisted; **B** is virtually a top spinning in a horizontal plane and taking its bearings on the edges of the wheels **AA**, the friction of **D** against **AA** being sufficient to cause the latter to revolve, thus making the vehicle travel. The slots at **CC** are provided so that freedom is afforded to the top at the moment when the string is pulled. Another good example of progressive movement by spinning is shown in Fig. 145, called the "gymnastic clown." In this case, however, the conditions are reversed. Instead of the spinner remaining in one position and the body on which it spins progressing, it is the spinning body that travels, while its support remains stationary. The spindle is fixed to the body, representing a tumbling clown. To operate, the spindle is taken between the thumb and forefinger and then given a quick twist, starting the toy at one end of the horizontal bars. The figure being designed to come approximately within a circle (dotted line), it acts very much like a fly-wheel and is well balanced. The smallness in the diameter of the spindle makes it necessary for the figure to revolve a good many times before it has rolled itself over the whole surface, from one end of the parallel bars to the other end. When first placed on the market this toy was made with a straight edge on the top, but it was afterwards found that by curving the bars, as shown in

the illustration, the action could thereby be prolonged. The impetus gathered at the start as the toy rolls down the curve causes it to roll some distance up the opposite side and oscillate to and fro for some time. The recesses at **RR** are to receive the ends of the spindle should the spinning at the start prove to be too severe. Without them the toy would run off its bearings and fall to the ground. The spindle should be exactly central in the figure, and the lower parts of the body should be slightly heavier than those above. This precaution ensures a good swinging motion, and makes the figure come to rest in an erect position.

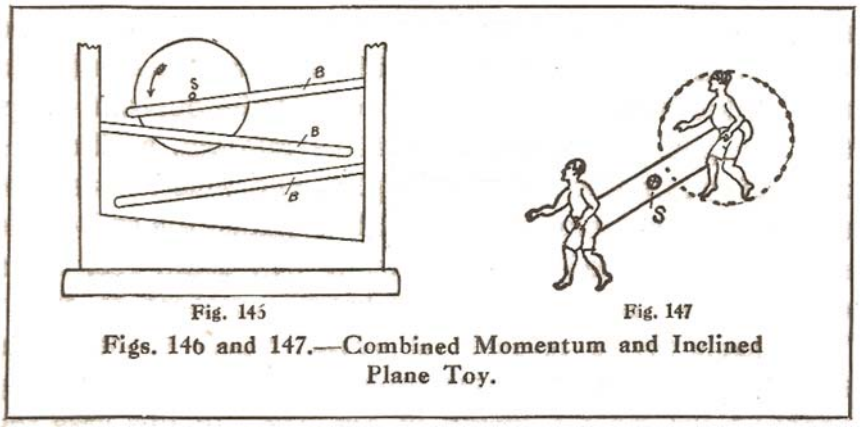


Fig. 145 Fig. 147

Figs. 146 and 147.—Combined Momentum and Inclined Plane Toy.

Despite the fact that curved surfaces serve to prolong the action in the manner described, the duration is not long, so that further improvements have been forthcoming. Thus the idea has been extended in the manner now to be described and which is roughly shown in Fig. 146, where **BBB** are inclined bars. Let the circle represent the clown with the rolling spindle at **S**. It is obvious that when it gets to the end of the first bar it will drop in a vertical direction, and then rest for a moment at the upper end of the second inclined bar. It will then proceed to roll down the incline, and repeat its action at the opposite end. A framework with any desired number of inclined bars can be made, and being fitted at each end with a supporting base, it may be inverted every time the toy reaches the last inclined surface.

A further elaboration of the same toy consists in substituting the clown figure with two distinct figures, such as are shown in Fig. 147. Let **S** represent the end of the rolling spindle affixed to the centre of a small beam. At equidistances from the spindle the two small figures are pivoted, so that when the contrivance is placed on inclined planes the whole will rotate; while the figures go through a series of somersault movements, each turning on its respective axis and thus tumbling one over the other.

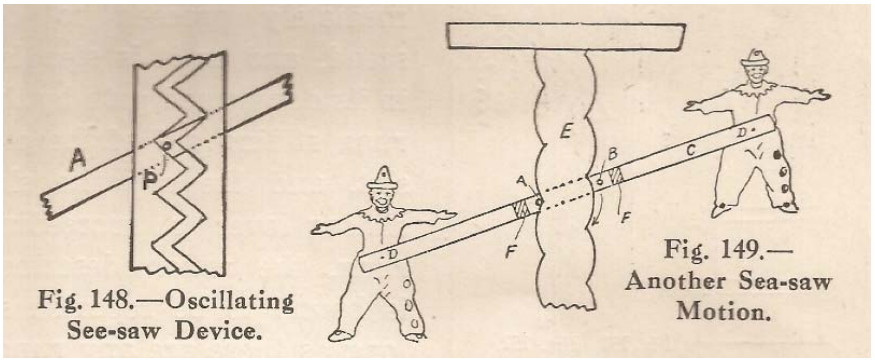


Fig. 148.—Oscillating See-saw Device.

Fig. 149.—Another Sea-saw Motion.

See-saw Toys - Somewhat akin to the toys just described are the oscillating see-saw devices, the simplest form of which is actuated by a combined sliding and rotating action of the

spindle on which the see-saw beam takes its support. Thus in Fig. 148 the beam **A**, forming the support for the dolls, is provided with a central spindle **P**. When the see-saw motion starts and the left-hand end is down, as at **A**, the spindle will rest for a moment, and then as the beam commences to rock in the opposite direction the pull on the spindle will be released, so that the force of gravitation comes into play, and thus causes it to slide down the incline plane and fall against the end of the succeeding inclined plane, when it will again rest for a moment, as before, while the beam continues to sway. The whole toy is reversed to obtain repeat action. The see-saw motion is sometimes obtained on similar lines by adopting the scheme shown in Fig. 149. In this case the apparatus for arresting the downward action of the beam takes the form of a solid standard piece **E**, having its sides cut away to form a series of convex surfaces, the arc of each curve being struck from centres coming exactly at the meeting-point of any two successive curves, as shown in the figure. The rocking beam **C** is furnished with a pair of dividing blocks **FF**, to which an overlay piece is fastened (not shown in the drawing), so that the standard works within the slot thus formed. Pins **AB** are inserted within the slot in such positions that when the left-hand end of the beam is down the pin **A** rests momentarily at the juncture or pit formed between the two curves. The companion pin **B** will sway over in the direction indicated by the arrow at the reverse movement of the beam, until this pin, in its turn, takes up a similar position, but at the opposite side of the standard. The toy figures, of equal size and weight, are pivoted at **DD** respectively, their lower parts being slightly weightier than their upper parts, so that they may swivel into an erect position at all positions of the rocking beam, and also as the device is turned over for purposes of repeating. The two see-saw toys just described depend for repeat action on being turned over or reversed.

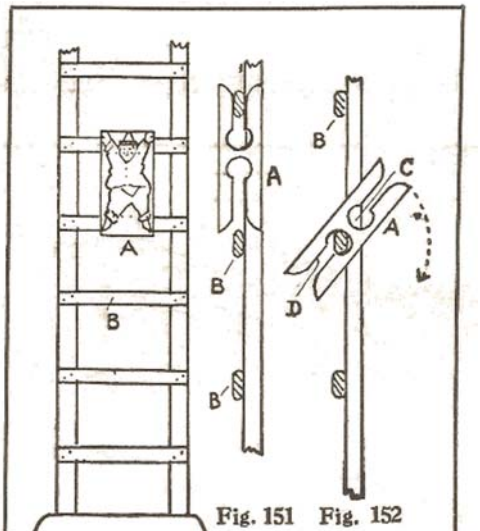


Fig. 150 Fig. 151 Fig. 152

Figs. 150 to 152.—Details of "Clown on Ladder" Toy.

"Clown on a Ladder" Toy - A front view of this movement is shown in Fig. 150, and slightly enlarged side views in Figs. 151 and 152. A rectangular piece **A**, slotted as shown at **DC**, carries on its reverse surfaces the representation of a clown in the act of tumbling. The rungs of the ladder **B** are just thin enough to comfortably slide into the slot **D** without undue friction, while their width is such as to permit them to turn in the circular cut out end **C** of the slots in the block. The action will be understood by reference to Figs. 151 and 152. Suppose the block **A** to

be in the position shown in Fig. 151, it must drop in a vertical direction, sliding its slot over the rung **B** till the latter reaches the circular cut out **C**. There will then be more than half of the entire block poised above this point, and as vertical edges of the rungs are rounded off there remains nothing to prevent the block from tilting over, which it will proceed to do, as shown in Fig. 152, its direction being indicated by the arrow. Arriving again in a vertical position, it will immediately proceed to descend, and as it is steadied in its downward path by the rung sliding out of the one slot, and the opposite slot sliding over a succeeding rung, the action described is bound to be repeated so long as there are any rungs left to traverse over.

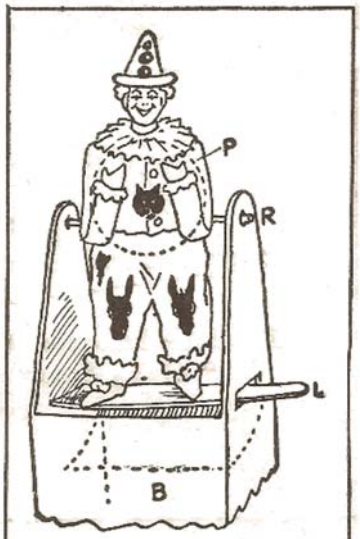


Fig. 153.—" Clown on Money-box " Toy.

"Clown on the Moneybox" - Another tilting over device takes the form of the toy here indicated (Fig. 153). The figure is made to receive a penny piece (**P**, dotted circle) and to deposit it in the box on which it stands.

It is fixed to a spindle **R** and is steadied by means of a lever **L** resting lightly against the feet of the clown. Before the coin is placed in position there is nothing to prevent the figure from maintaining an erect attitude, its heavier portion being situated below the point of suspension. When, however, a penny is put within its arms and the steadying lever **L** is pressed from contact, the added weight of the coin causes the whole figure to turn upside down, and just as the slot formed by the two arms is in a vertical but inverted position the penny slides out by its own weight and falls into the box below. Being thus relieved of its burden the figure swivels back to its original erect position.

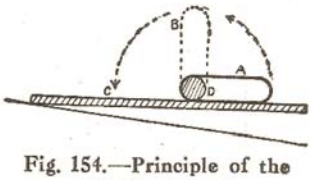


Fig. 154.—Principle of the " Living Bean."


Fig. 155.—" Topsy-Turvy Jack."

Captive Weight-operated Toys - Loose but captive weights are employed to make bodies move with intermittent jerks along an inclined plane. Two examples of this type of toy will suffice to show the principle. In Fig. 154 is a side sectional view of what is known as the "living bean." A light but rigid capsule **A** contains a bullet **D**. On placing this on the surface of an inclined plane the bullet rolls from the upper to the lower end of the capsule, when its action is momentarily retarded, but as the ends of the capsules are round, the bullet by its weight overcomes the resistance of the opposite end of the capsule and rolls onward, lifting the latter from **A** to **B** and then pressing it down from **B** to **C**, when the ball repeats its movements.

The principle of the "living bean" has been utilised to produce the movements of "Topsy-Turvy Jack" shown in Fig. 155. The weight container is in the form of a stiff but flexible bag, indicated by the dotted line **B**, and the weight instead of being a sphere is a roller **W**. The toy is made of cloth, so that under pressure of the heavy roller it becomes doubled and rolled up on itself, as it is made to progress with intermittent jerks down the inclined plane. In this instance it is necessary that the surface on which it tumbles should be covered with cloth, otherwise the whole thing slides from top to bottom without performing its evolutions.

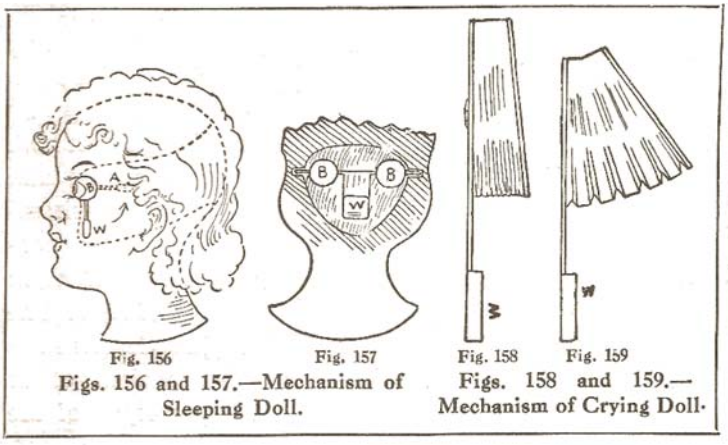


Fig. 156 Fig. 157 Fig. 158 Fig. 159

Figs. 156 and 157.—Mechanism of Sleeping Doll.

Figs. 158 and 159.—Mechanism of Crying Doll.

Sleeping and Crying Dolls - Dolls are made to close their eyes on being laid to rest by pivoting the eyes to the temples inside the head and providing a counterbalance weight. The subject is more particularly dealt with later. The method of fitting up will be clearly seen by reference to Figs. 156 and 157, wherein **BB** are the eyes and **W** the weight. When the doll is erect the eyeballs will be so adjusted that details of the pupils will be opposite the eye socket openings, and when the doll is turned, so that its body is horizontal, the weight swings round in the direction of the arrow till it reaches **A**, when the white section of the eyeballs will fill the eye-socket apertures.

To make a doll cry when it is laid down necessitates the use of the apparatus shown in Figs. 158 and 159. It is affixed within the body of the doll, sufficient room being provided for the opening and closing of the bellow device shown. When the doll is erect the bellows are fully expanded and the weight **W** hangs vertically. On lying the doll on its back the weight **W**, under the influence of gravitation, gradually presses the bellows together, thus forcing the air through a squeaker or reed device.

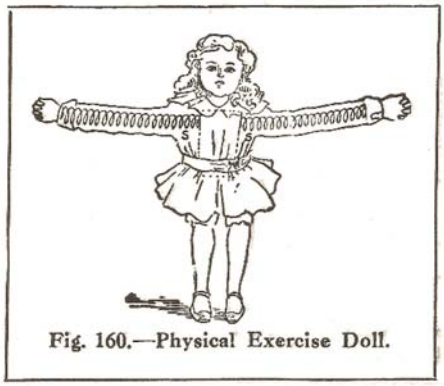
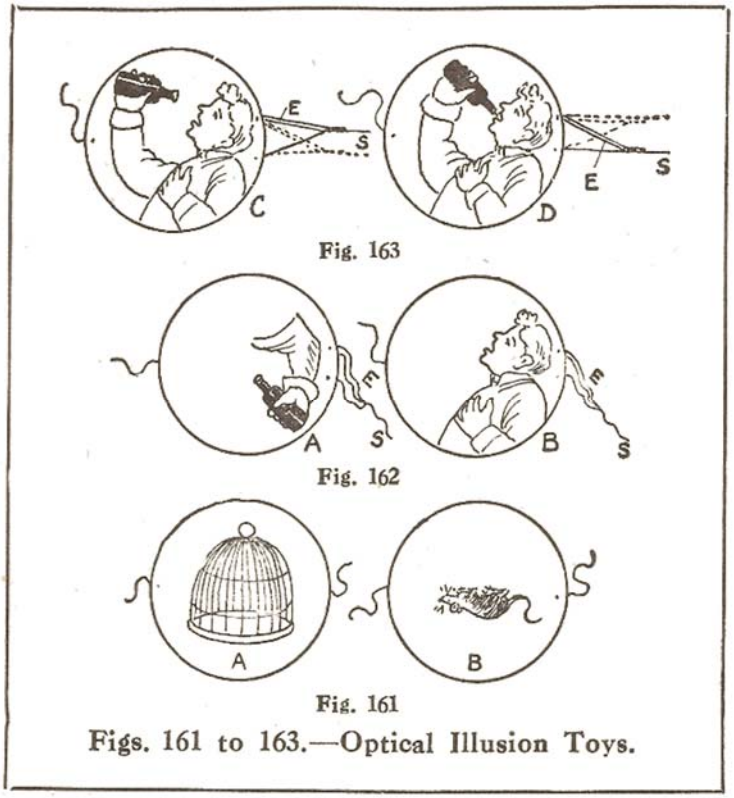


Fig. 160.—Physical Exercise Doll.

Physical Exercise Dolls - Fig. 160 is a rough sketch indicating the nature of this class of doll. It has been designed for the express purpose of imitating physical exercises. As the figure shows, two strong spiral springs **SS** are fitted within the sleeves of the arms, one end of each being fixed to hand pieces and the other end of each being fixed to a block situated within the doll's body. A child using the toy takes hold of the doll's hands, meanwhile standing at the back, and stretches the arms out so that the springs are expanded as shown. The tension of the springs, or their tendency to contract, call for muscular exertion on the part of the child.



Figs. 161 to 163.—Optical Illusion Toys.

Optical Illusion Toys -There exists quite a number of simple toys giving a semblance of life by means of the laws of persistence of vision and the rapid succession of dissimilar phases. As a simple means for illustrating persistence of vision the toy known as the thaumatrope, sometimes termed a metamorphosis, may be taken as an example. It is shown in Fig. 161, and consists of a card having images on each face, inverted with respect to each other, as in the figure. By means of threads fastened to the axis of the card, the latter is made to turn rapidly by twirling, so that both pictures persist and so appear simultaneously and continuously present in the field of view. The toy just described is often spoken of as the prototype of the cinematograph, although

it is only persistence of vision that is thereby demonstrated. Few writers, however, appear to be aware of the fact that the thaumatrope in its simple form was also made to exhibit the effects of animation by very slight additions in its design. Thus, in reference to Figs. 162 and 163, the improved toy is shown in which the only addition to that already described is an elastic band at **E**. On twirling this toy the man with the bottle of beer will appear to lift the bottle to his mouth and take a drink and to hold it away again. It is worthy of note also that the toy is capable of exhibiting all the phases possible between the two extreme attitudes seen at **C** and **D**. The improvement on the common thaumatrope consists in inserting in one side of the circular card a string **S** and a small length of elastic **E**, uniting the two at a point a short distance from the card. The points at which both the elastic **E** and string **S** are joined to the edge of the card are slightly removed from the true axis of the latter. If, therefore, while the card is in the act of spinning the string **S** be pulled with an increased force it will take the position shown in the last diagram, while the elastic will lean towards the string. On the other hand, if a lesser tension be exerted on the string **S** then the elastic **E** will tend to come more into effect, so that the axis on which the card turns will be raised or lowered as the case may be. This deviation of the spinning axis causes a displacement of the pictures or parts of the picture depicted on reverse sides of the card as regards their relative positions one with the other, resulting in a series of dissimilar phases which constitutes illusory animation.

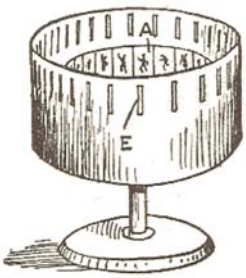


Fig. 164.—The Zoetrope.

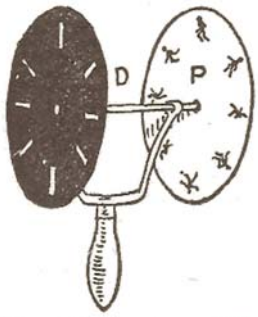


Fig. 165.—Adaptation of Zoetrope.

The Zoetrope - It is hardly necessary to say that this toy (Fig. 164) also depends for its results on persistence of vision. A cycle of phases **A** of a figure in motion are placed around the bottom inside edge of a shallow cylinder, and towards the top there are slots **E** corresponding in number to the pictures in the cycle, the slots being spaced equal distances apart. On rotating the cylinder on its vertical axis a momentary view is obtained (through the succeeding slots) of every picture within the cylinder, the whole series of phases blending into one and thus creating the illusion of a single object in motion. A toy based on the same principle, but for viewing in a horizontal position, is shown in Fig. 165, **D** being a slotted shutter disc through which a view is obtained, and **P** the picture disc, both revolving together on a fixed rod, turning in a handle bearing as shown.

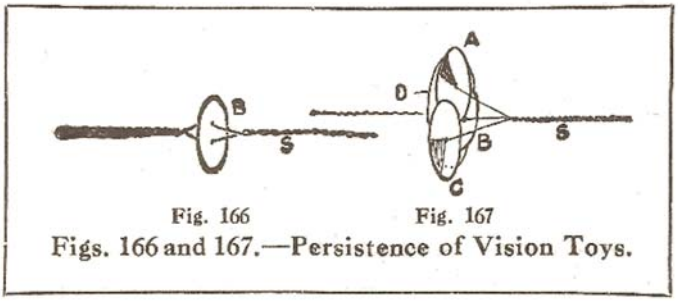


Fig. 166 Fig. 167

Figs. 166 and 167.—Persistence of Vision Toys.

The Buzzer as a Persistence of Vision Toy - The common buzzer consists of an ordinary button **B** (Fig. 166) threaded with a doubled string **S**. The two ends of the doubled string being held stationary, the button is twisted round, so that the string on opposite sides of the button is twisted in reverse directions. Tugging sharply on the string causes the button not only to unwind itself, but to overrun the twist of the string, thus rewinding the latter in a reverse order ready for the next pull thereon.

An elaboration of the common buzzer is shown in Fig. 167. Three cardboard discs of equal diameter **ABC** are separately pivoted to a fourth and larger disc **D**. Three strings may constitute the means of attachment for the discs **ABC**, which strings become twisted into one strand **S** in operation. Another string at the back is attached to the disc **D** by passing it first through one hole and then returning it through a second hole, placed a short distance from the centre of the disc.

Pulling on the opposite strings causes the toy to be operated in the same manner as the common buzzer, but with the difference that the discs **ABC** are free to rotate on their respective axes. Their edges overlap and different colours are painted on their front surfaces, resulting in an ever-varying admixture of tints as the whole thing swiftly rotates. At the moment when the strings are about to reverse the direction of their twist the discs **ABC** are jerked into new positions relative to each other, so that a fresh combination, by persistence of vision, comes into view at every pull on the strings.

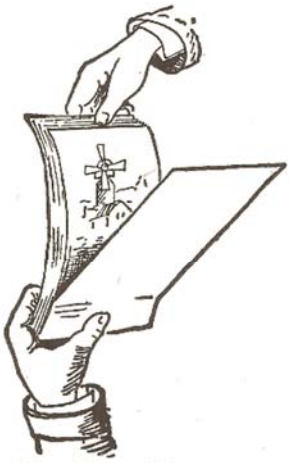


Fig. 168.—Cinematograph Book.

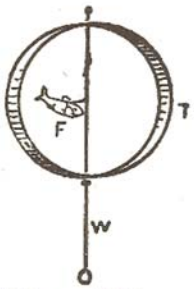


Fig. 170.—Goldfish in Bowl Toy.

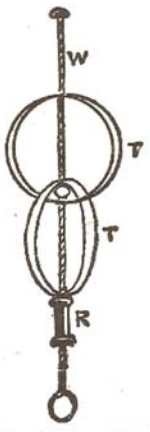


Fig. 169.—Wire Bubbles.

Cinematograph Book - The leaves of the book (Fig. 168) are allowed to escape under the thumb nail in rapid succession, so that a whole series of complementary phases of a scene are successively exhibited, thus creating the illusion of animation.

Wire Bubbles - If two hoops **TT** made out of tin are threaded over a twisted double wire rod **W**, as shown in Fig. 169, and reel **R** slides over the wire, the hoops can be forced to the top of the rod, and owing to the hole in the top of the higher hoop being shaped to fit the double strand of wire, both hoops will rotate rapidly. The semblance of floating bubbles will be the result.

Also dependent on the laws of persistence of vision is the toy shown in Fig. 170. A hoop of tin **T** is threaded on a plain piece of wire **W**, and a toy goldfish **F** is supported from the centre by an additional strip of wire. The hoop is made to spin while the rod **W** is slowly given a turn, with the result that the fish appears to swim round inside a globe of glass.

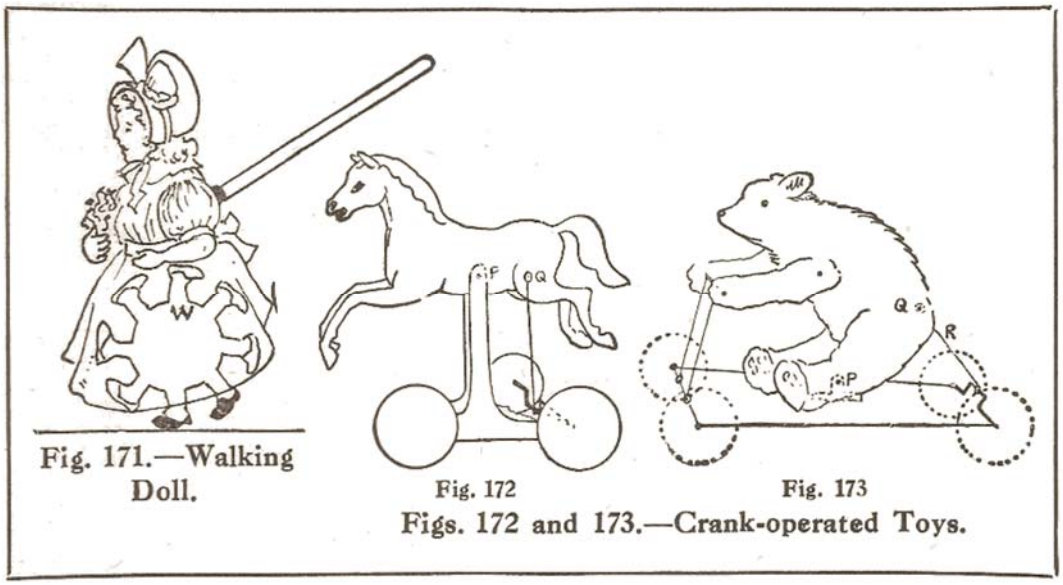


Fig. 171.—Walking Doll.

Fig. 172

Fig. 173

Figs. 172 and 173.—Crank-operated Toys.

Walking Doll - A cycle of eight feet, making what may be termed a foot wheel, is pivoted between two thicknesses of wood cut to the shape of a doll (Fig. 171) and a push rod attached at the back. Two feet only are visible at once, and the even succession of their appearance, as the wheel is made to turn by friction against the ground, creates the desired illusion of the doll trotting along in the most natural manner.

Toys on Wheels - The crank is a useful mechanical factor for imparting secondary movements to toy figures of any kind, such as are mounted on a vehic1e. As a rule, such a device is provided on the spindle for the axes of the wheels, examples of which are shown in Figs. 172 and 173. The horse's body turns on a stationary pivot **P** and is given a see-saw motion by means of a rod pivoted to the hind part at **Q** and turning with the crank on the spindle of the back wheels. Likewise a crank is provided between the back wheels of the teddy-bear device. The stationary pivot is at **P**, and the communicating rod **R** is pivoted to the hind parts of the animal at **Q**. As the bear's front legs are pivoted to the body and at the paws to the handle-bar, which in turn works freely on the spindle of the front wheels on drawing or pushing the toy forward, the animal appears to be propelling itself. To dispense with the crank idea other means have been employed to give motion to rolling toys, such, for instance, as the eccentric mounting of the front wheels **AA** (Fig. 174). In this case the back spindle is fixed to the true axes of the wheels **BB** and turns in holes made in the back legs of the animal. On drawing the toy along a vertical oscillation is imparted to the front of the animal, producing a semblance of a rabbit's lifelike movements.

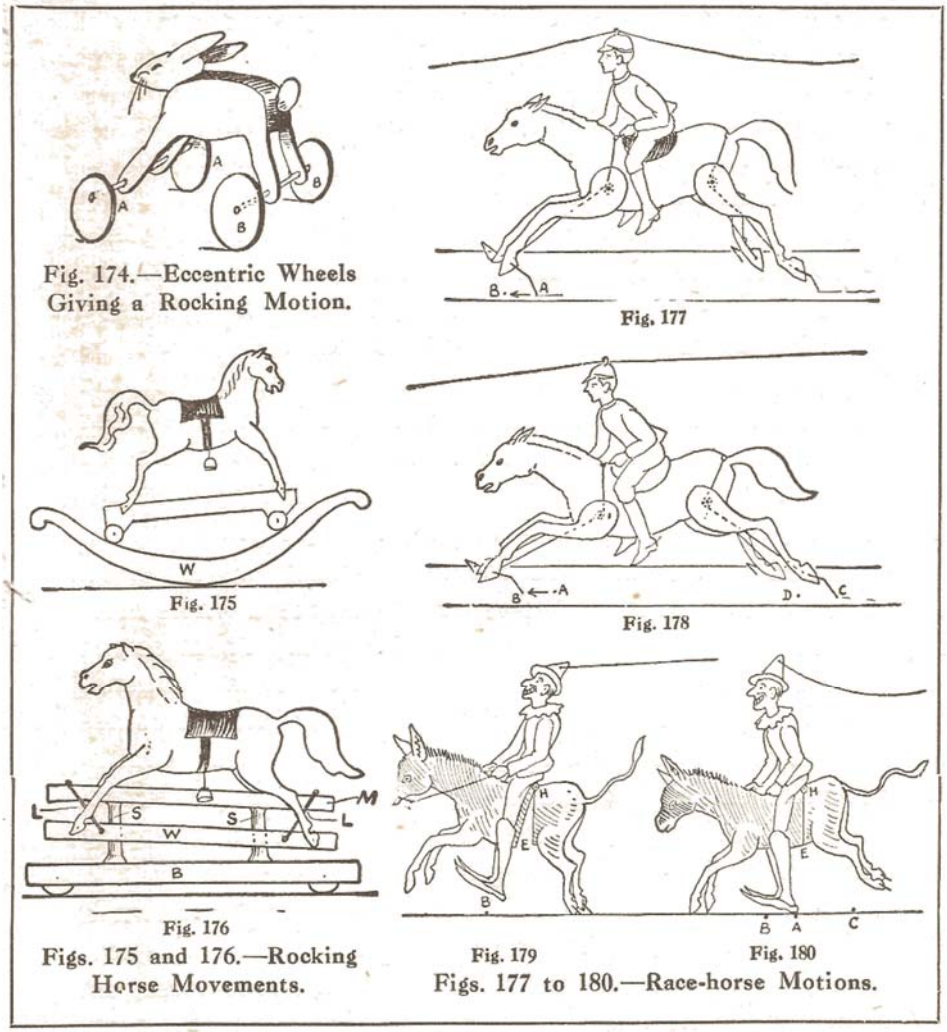


Fig. 174.—Eccentric Wheels Giving a Rocking Motion.

Fig. 177

Fig. 175

Fig. 178

Fig. 176

Figs. 175 and 176.—Rocking Horse Movements.

Fig. 179

Fig. 180

Figs. 177 to 180.—Race-horse Motions.

Rocking Horses - Toy horses were originally affixed to a pair of curved beams or rockers, and a simple rocking motion was all that could be obtained therefrom. Modern designs have been devised whereby secondary motion comes into play. Thus in Fig. 175 the horse, affixed to a carriage, is placed on the old rocking beams **W**, so that the animal is capable of not only rocking to and fro, but also of travelling a short distance backward and forward.

A still further improvement is shown in Fig. 176, wherein **B** is the base, supporting fixed standards **SS**, which in turn support the top beam **M**; this is likewise a fixture. The horse is affixed to a second beam **W**, hanging on strong iron struts **LL**, pivoted to **M** and **W** in the manner shown. If the horse in its present position is pushed from the back its front parts will sink lower while its hind parts will rise, the action being the reverse if the horse in its present position be pushed from the front.

Race-horses - A number of schemes have been suggested for the progressive action of horses used in race games and for other amusements. An example is shown by Figs. 177 and 178. The horse, with legs pivoted to the body, is provided with wires that serve the double purpose of being hooks for anchoring into the surface of the racecourse and of raising the body of the animal after it has been depressed. The diagrams indicate the disposition of the wires, and the line threaded through the cap of the jockey represents the cord by which the racer is controlled. The operation is as follows: having fixed one end of the control cord at the goalpost, the player takes the opposite end. When the cord is allowed to slack, as in Fig. 177, the position

of the horse will be as here shown. On tightening the cord, as in Fig. 178, the body of the animal will be depressed, the legs will have become more expanded, and one space forward will have been covered by the front legs (from point **A** to point **B**). It should be understood that, when the cord is tightened and the body thus depressed, the hind legs are held by the wire projections at **C**, which anchor into the course and thus prevent them slipping backwards; as, however, the legs as a whole must expand, the front pair are forced forward. Then, as the control cord is slackened, the body rises under the influence of the spring wires. The front legs anchor into the course and the back legs are drawn along from point **C** to point **D**. Alternate slackening and tightening of the control cord, therefore, brings about the desired effect of a galloping horse making progress along a racecourse.

Man on Donkey - In Figs. 179 and 180 is shown a toy that can be used for racing games or as a single toy. Its action is quite different from that of the race-horse just described, while it can be considered as an improvement, insomuch that the control cord need not be anchored. The donkey is divided into two parts, hinged together at **H**, and pin points are affixed to the back hoofs of the animal.

We hope you have been inspired by the wise words included this chapter on 'The Movement of Toys'. If you decide to make a toy based on the guidelines given here do share a photograph or video of the finished product with us on Facebook, Twitter or Pinterest. We would love to see what you have achieved.

More vintage woodwork and carpentry advice and guidance is provided in our two titles *Woodwork Tools and How to Use Them* by William Fairham and *Home Carpentry* by John Barnard. More details about these titles can be found on the Products page of our website www.wordstothewise.co.uk Both books are available to buy as ebooks on Amazon and at many other reputable ebook retailers.