

Aug. 23, 1966

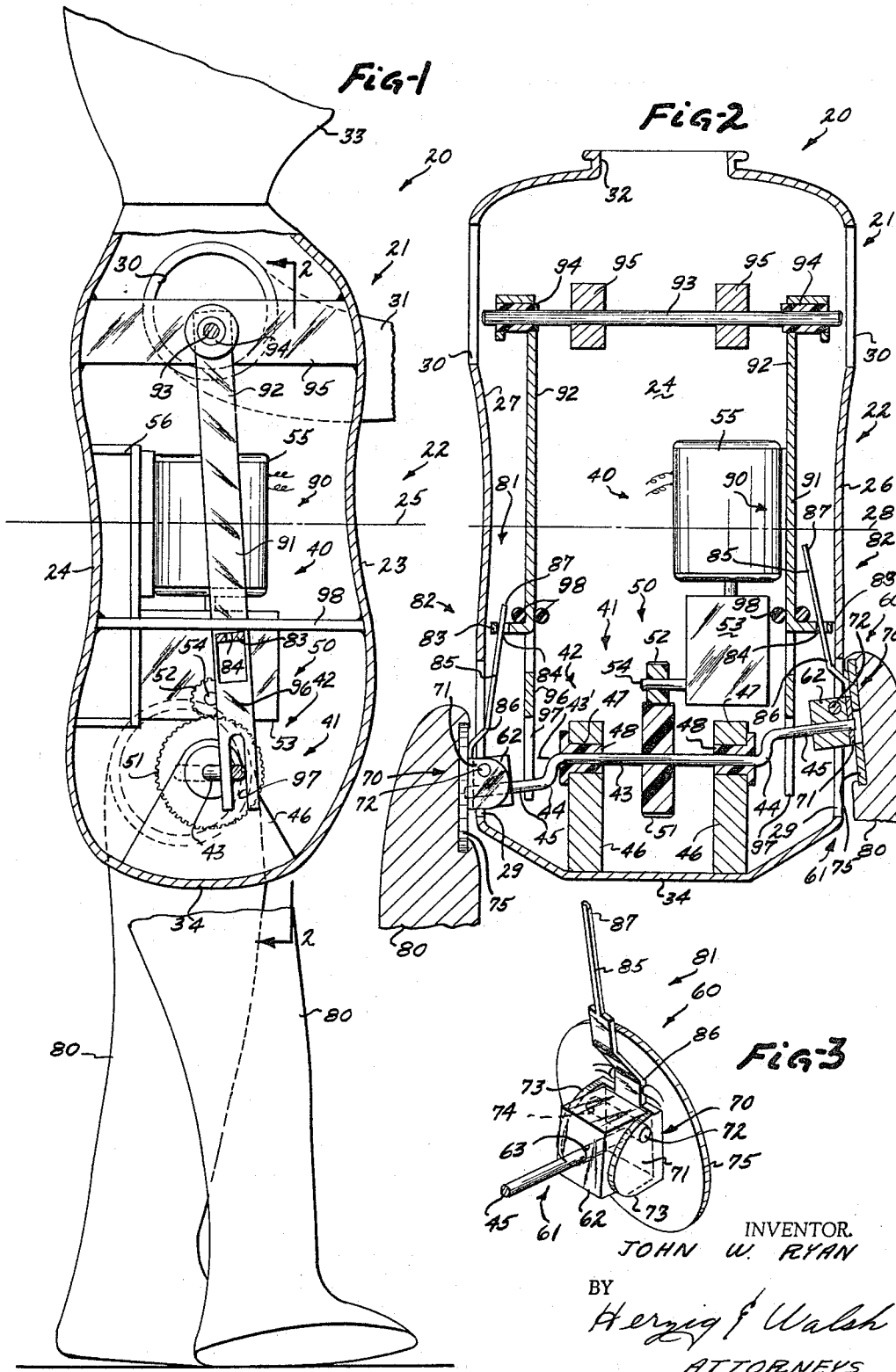
J. W. RYAN

3,267,607

WALKING TOY

Filed Nov. 27, 1963

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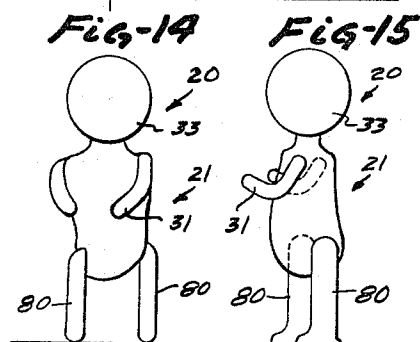
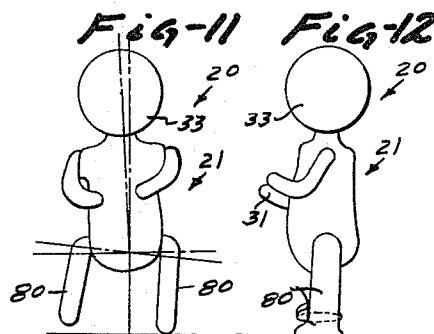
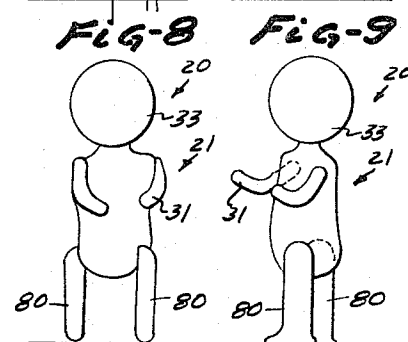
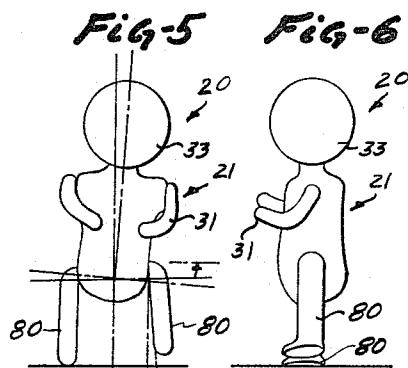
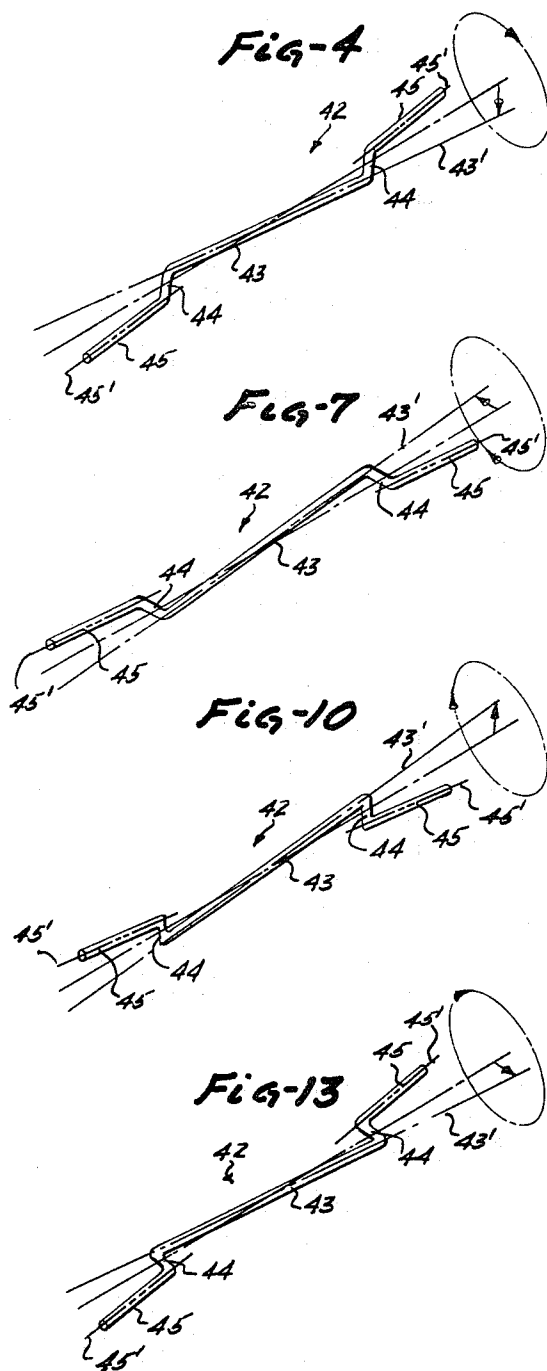
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WALKING TOY

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3 Sheets-Sheet 2



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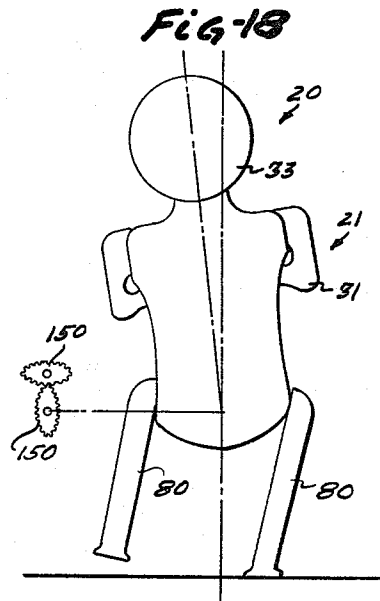
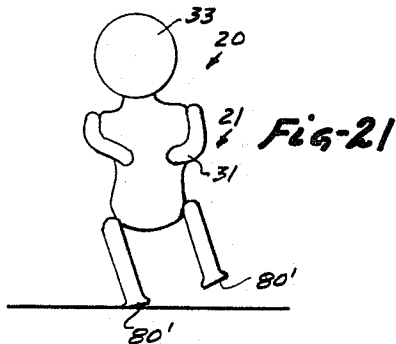
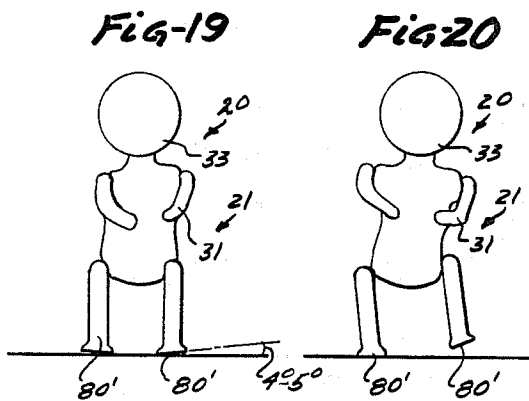
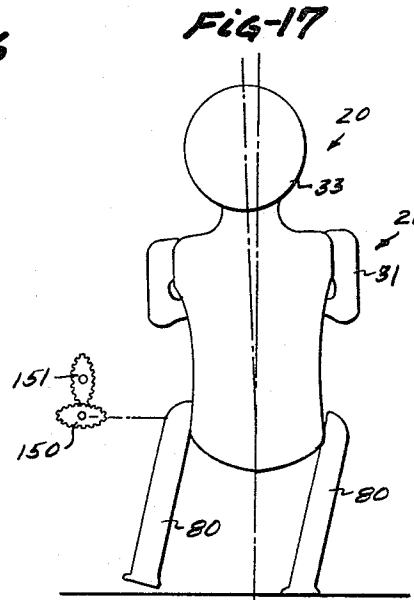
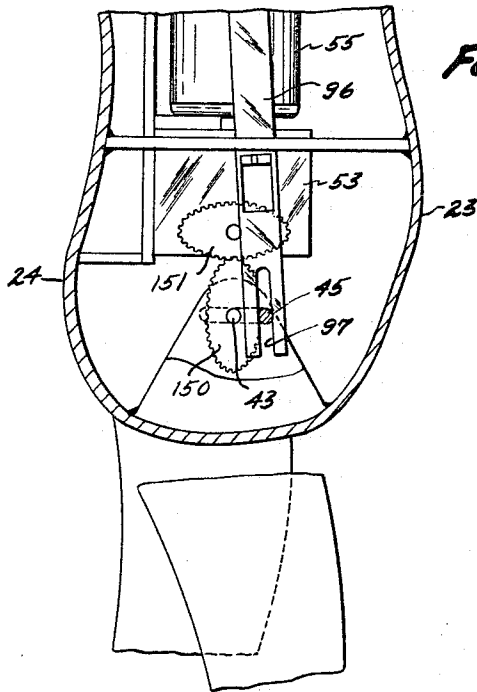
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WALKING TOY

Filed Nov. 27, 1963

3 Sheets-Sheet 3



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3,267,607

WALKING TOY

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Filed Nov. 27, 1963, Ser. No. 326,544
12 Claims. (Cl. 46-247)

In general, the present invention relates to a walking toy. More specifically, the present invention involves a doll adapted to walk independently with natural body and leg motions.

Various problems discussed below in connection with prior art walking toys have been solved to a substantial extent by the applicant, as set forth in his copending application entitled, Walking Toy, Serial No. 326,489, filed November 27, 1963, which is being filed concurrently herewith and which disclosure is hereby incorporated in this application.

In the past, there have been many attempts to create walking toys, such as walking dolls, to simulate the actual behavior of people or animals. However, the usual resulting walking toy merely goes through some motion which only remotely resembles the usual walking motion. A common expedient is to put the toy on wheels and have the legs of the toy move up and down as the wheels roll along a surface. It is apparent, however, that the use of wheels to achieve such results immediately precludes the creation of a walking toy, since it is obvious that the toy is riding on wheels rather than walking on its legs. Furthermore, such wheel toys, while they might move the legs in conjunction with the movement of the wheels, normally do not include motion in the remaining portion of the body, contrary to the normal walking body motions. Other prior art walking toys have had the toy actually walk on its legs, but the walking motion usually involved rigid, mechanical movements so that a stiff, awkward appearance is given. Also, such walking toys normally were relatively unstable and frequently toppled over in the course of the walking movement.

However, the walking toy described in applicant's aforementioned patent application has a number of shortcomings. Initially, it might be noted that, as described therein, the walking motion was achieved by pivoting the upper and lower torso portions with respect to each other, with the legs simply pivoted to the torso. Such construction of the torso is relatively expensive and complicated. More important, such walking toy had a relatively specific walking motion which was determined by the particular construction of the doll body. Thus, it was not possible to adjust the forward-rear angular displacement of the leg without affecting the remaining portions of the doll construction or the walking motion itself. In addition, the legs are adapted to achieve only forward-rear angular displacement without any side angular displacement and much less did it have control over any side angular displacement of the leg. More important, the lifting of the leg is dependent solely on the basic body motion without any direct connection between the drive means and the leg. Also, the bending and twisting of the body portions with respect to each other were fixed by the pivot connection so that it is not possible to independently vary the bending or twisting of the doll body.

Consequently, an object of the present invention is a doll adapted to walk independently with natural body and leg motions, including the motion of bending of the torso and lifting of the legs in sequence.

Another object of the present invention is a walking doll wherein the leg motions are movable independently of the body motions.

Still another object of the present invention is a walking toy wherein the body controls the drive means for such

toy to synchronize the movement of the body and legs and the drive means.

Still another object of the present invention is a walking doll wherein the body motions include both bending of the torso and twisting of the torso and such bending and twisting motions may be varied independently.

Still another object of the present invention is a walking doll wherein the pivotal attachment between the torso and each of the legs includes a first pivot means for rotating said leg approximately about a side lateral axis of the torso and a second pivot means for rotating said leg approximately about a forward-rear lateral axis of the torso.

Still another object of the present invention is a walking doll which includes control means for each of said legs wherein a first regulator means governs the side angular displacement of the leg and a second regulator means governs the forward-rear angular displacement of the leg.

Still another object of the present invention is feet adapted to increase the rate at which the body center of gravity is raised to counter over-rocking during walking.

Other objects and advantages of the present invention will be readily apparent from the following description and drawings which illustrate a preferred exemplary embodiment of the present invention.

In general, the present invention involves a toy adapted to walk independently with natural body and leg motions and comprises a body including a torso and legs pivotally attached thereto. The torso has drive means mounted therein for bending the torso and lifting the legs in sequence. Such drive means is controlled by the motions of the body to synchronize the movement of the body and the drive means. Also, the drive means is directly connected to the legs to cause the above-described movements of the torso and the legs. The leg motions of the toy may be movable independently of the body motions and the toy includes control means for directing the movement of said legs.

In order to facilitate understanding of the present invention, reference will now be made to the appended drawings of a preferred specific embodiment of the present invention. Such drawings should not be construed as limiting the invention which is properly set forth in the appended claims.

In the drawings:

FIG. 1 is a side cross-sectional view of a specific embodiment of the walking doll of the present invention.

FIG. 2 is a cross-sectional view of FIG. 1 taken along the lines 2-2 of FIG. 1.

FIG. 3 is a perspective view of a portion of FIG. 2 showing the means pivotally attaching each leg to the torso.

FIGS. 4-6 are schematic views showing a portion of the operation of the doll wherein FIG. 4 shows the position of the shaft portion of the crank means, FIG. 5 shows the corresponding front view of the doll, and FIG. 6 shows the corresponding side view of the doll at the height of a step.

FIGS. 7-9 are similar to FIGS. 4-6, except that the corresponding positions are shown at the end of a step forward by the left doll foot.

FIGS. 10-12 are similar to FIGS. 4-6, except that the positions are shown for the height of a step for the right foot.

FIGS. 13-15 are similar to FIGS. 4-6, except that the corresponding positions are shown at the end of a step forward by the right foot.

FIG. 16 is a cross-sectional view similar to the gear portion of FIG. 1 and shows an alternate embodiment of the gear means of the present invention.

FIG. 17 is a schematic view of the doll at the beginning of a step and shows the position of the gears illustrated in FIG. 16.

FIG. 18 is a schematic view of the doll at the height of a step and shows the position of the gears illustrated in FIG. 16.

FIG. 19 is a schematic front view of the doll and illustrates the position of the feet in a standing position.

FIG. 20 is similar to FIG. 19, except the doll is shown at the intermediate portion of a step.

FIG. 21 is similar to FIG. 19, except the doll is shown at the height of the step.

In general, as illustrated in FIGS. 1-3, the present invention involves a doll 20 which is adapted to walk independently with natural body and leg motions and to have the leg motions movable independently of the body motions and the leg motions movable independently of each other. The doll 20 comprises a body 21, including a torso 22 with legs 80 attached thereto by a pivotal attachment 60. The torso 22 has drive means 40 mounted therein for sideways bending and twisting of the torso and lifting the legs 80 in sequence. The drive means 40 is controlled by the motions of the body 21 to synchronize the movement of the body 21 and the drive means 40. Also, the drive means 40 is directly connected to the legs 80 to cause said movements of the torso 22 and the legs 80. In addition, the doll 20 includes control means 81 for directing the movement of the legs 80.

The torso 22 comprises a front wall 23 and a rear wall 24 which are oriented substantially perpendicular to a forward-rear lateral axis 25 of the torso 22. Similarly, the torso 22 has side walls 26 and 27 which are oriented substantially perpendicular to a side lateral axis 28 of the torso 22. The torso 22 has holes 29 in its lower portion through which the drive means may be directly connected to the legs 80 and preferably holes 30 for connecting arms 31 and a hole 32 for connecting a head 33 to the torso 22. The arms 31 and the head 33 may be connected to the torso 22 by any conventional means.

The drive means 40 for the doll body 21 comprises a rotatable crank means 41 connecting the torso 22 to the legs 80 and adapted to periodically bend the torso 22 and the legs 80 towards each other, twist the torso 22 with respect to the legs 80 and lift the legs 80 with respect to each other alternately to each side. The crank means 41 are rotated by a gear means 50 and the gear means 50 in turn are driven by a motor means 55. The crank means 41 comprises a substantially offset shaft 42 having a central body 43 with angle arms 44 at each end extending in substantially opposite directions from the axis of the central body 43. Preferably, the angle arms 44 have an angle of 180° therebetween so that the movement of each leg 80 is 180° from the other leg 80, i.e., the leg movements are equally spaced. Also, preferably, the angle arms 44 extend at substantially right angles to the central body 43. However, other angles may be utilized, as discussed below in connection with the description of the operation of the present invention. Extending outwardly at the outer end of each angle arm 44 is a finger 45 at an acute angle to the axis 43' of the central body 43 of the shaft 42. The axes 45' of the fingers 45 are displaced from each other. The shaft 42 is mounted on the bottom wall 34 of the torso 22 by means of a pair of posts 46 having coaxially aligned holes 47. Seated in the holes 47 of the posts 46 are bearings 48 through which the central body 43 of the shaft 42 extends.

The gear means 50 of the drive means 40 includes a first gear 51 fixedly mounted on the central body 43 of the shaft 42 and a second gear 52 engaged with the first gear 51. The second gear 52 is in turn operatively connected to a gear box 53 by means of a shaft 54 on which it is fixedly mounted. The gear box 53 is in turn connected to a motor means 55 which is adapted to drive the gear means 50. The gear box 53 contains a conventional gearing arrangement for suitably adjusting the speed of the motor means to the desired rate of rotation of the crank means 41. Both the gear box 53 and the motor

means 55 are mounted on a stand 56 which is in turn connected to the rear wall 24 of the torso 22.

The pivotal attachment 60 between the torso 22 and each of the legs 80 comprises a first pivot means 61 for rotating the leg 80 approximately about a side lateral axis of the torso, i.e., an axis parallel to the side lateral axis 28. The first pivot means 61 comprises a block 62 joined to the leg 80 having a bore 63 extending approximately parallel to a side lateral axis of the torso. The finger 45 of the drive means 40 is rotatably received in the bore 63 of the block 62. The pivotal attachment 60 also includes a second pivot means 70 for rotating the leg 80 approximately about a forward-rear axis of the torso 22, i.e., an axis parallel to the forward-rear axis 25 to effect a side angular displacement of the leg 80 either to or from the body 21. The second pivot means 70 comprises a yoke 71 which is joined to the leg 80 by mounting the yoke 71 on a plate 75 embedded in leg 80. The yoke 71 has a rod 72 extending between its ears 73 which extends approximately parallel to the forward-rear axis of the torso 22. The second pivot means 70 also includes a second bore 74 in the block 62 of the first pivot means 61 in which the rod 72 of the yoke 71 is rotatably mounted.

The movement of the legs 80 is directed by the control means 81. The control means 81 comprise for each of the legs 80 a first regulator means 82 for governing the side angular displacement of the legs 80 and a second regulator means 90 for governing the forward-rear angular displacement of the leg 80. The first regulator means 82 comprises a hanger 83 mounted within the torso 22 having a holding means in the form of an aperture 84 therethrough. The first regulator means 82 also includes a strut 85 with its first end 86 fixed to the yoke 71 which is in turn joined to the leg 80 and its second end 87 slidably received in the aperture 84 of the hanger 83. The holding means is adapted to restrain the side angular displacement of the second end 87 of the strut 85. The operation of the first regulator means 82 involves the tilting outward of the leg 80 as the finger 45 of the shaft 42 moves upwardly, since the strut 85 is caused to rotate towards a horizontal position as the rod 72 approaches the aperture 84 and the converse movement takes place during the downward movement of the finger 45 during the rotation of the shaft 42. The second pivot means 70 makes only the bending of the body independent of the movement of an associated leg 80 without affecting the relationship of the twisting of the body and the leg and also makes the side angular displacement of the leg independent of the rotation of the shaft, but the first regulator means 82 forms a new relationship between the rotation of the shaft and the side angular displacement of the leg and makes such relationship adjustable, depending on the position of the first regulator means 82.

The second regulator means 90, similar to the first regulator means 82, comprises the hanger 83 having a holding means in the form of an aperture 84 therethrough and the strut 85 with its first end 86 fixed to the yoke 71 and its second end 87 slidably received in the aperture 84 of the hanger 83. However, in the case of the second regulator means 90, the holding means is adapted to restrain the forward-rear angular displacement of the second end 87 of the strut 85. In addition, the second regulator means 90 includes a bracket 91 rotatably mounted at its first end 92 about a side lateral axis in the upper portion of the torso 22. More specifically, the first end 92 of the bracket 91 is rotatably mounted on a rod 93 and separated therefrom by bearings 94. The rod 93 extends parallel to a side lateral axis of the doll torso 22 and is mounted on the ribs 95 extending between and attached to the front wall 23 and rear wall 24 of the torso 22. The second end 96 of the bracket 91 is operatively connected to the drive means 40 to follow the forward-rear movement of the drive means 40. More specifically, the second end 96 of the bracket 91 has a slot 97 therein in which

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is slidably received the finger 45 of the drive means 40. The configuration and location of the slot 97 are such that the movement of the finger 45 caused by the rotation of the crank means 41 swings the bracket 91 back-and-forth on rod 93. The hanger 83 is mounted on the bracket 91 adjacent to the leg 80 and preferably, as shown, the hanger 83 is simply punched out of the bracket 91. Also, preferably, the forward-rear movement of the bracket 91 is insured by a pair of spaced parallel guide bars 98 which extend between and are attached to the front wall 23 and rear wall 24 of the torso 22. The bracket 91 is slidably received between the guide bars 98 whereby they form a track upon which the bracket 91 travels. It is to be noted that the forward-rear angular displacement can be regulated by the bracket 91 independent of the holding means or aperture 84.

When the doll 20 is actuated to start walking, the motor means 55 rotates the crank means 41 of the drive means 40 which causes the offset shaft 42 to rotate. The effect of the rotation of the shaft 42 is relatively complex with respect to the torso 22 and the legs 80 and may best be explained by discussing each portion of the configuration of the shaft 42 with respect to the relative movement which such configuration causes between the legs and the torso.

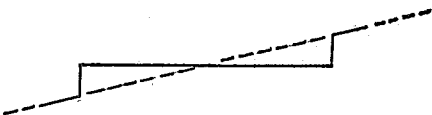
If the shaft 42 were formed as illustrated in Sketch A below, the rotation of the shaft would merely lift one leg with respect to the other leg without causing any bending or twisting of the torso with respect to the legs. Of course, there would be some bending of the body with respect to the surface upon which the doll is walking. However, such bending would be similar to the mechanical type of motion associated with prior art walking dolls.

Sketch A



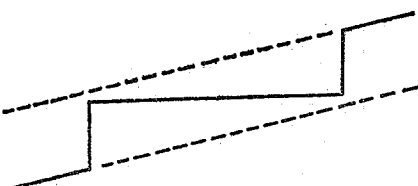
On the other hand, if the shaft 42 were shaped as illustrated in Sketch B below, wherein the fingers of the shaft are coaxially aligned, the resulting motion would involve merely the bending and twisting of the torso with respect to the legs without any lifting of the legs with respect to each other.

Sketch B



However, as set forth above, the configuration of the shaft is as illustrated in Sketch C below, wherein the fingers are at an acute angle to the central body of the shaft but are axially displaced from each other. With such configuration, the rotation of the shaft causes not only the legs to lift with respect to each other, but also the torso to bend and twist with respect to the legs. Thus, the center of rotation of the shaft is displaced from the axis 43' of the central body 43 of the shaft and from the axes 45' of the fingers 45, as illustrated in FIGS. 4, 7, 10 and 13.

Sketch C



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It should be noted at this point that a possible alternate embodiment of the shaft may have the configuration as illustrated in Sketch D below, wherein the fingers are set at an acute angle to the axis of the central body of the shaft and are displaced with respect to each other, but are joined directly to the shaft.

Sketch D



However, it is preferred to utilize angle arms 44 as set forth above in Sketch C and in the drawings (FIG. 2, for example), since they produce a substantial lifting motion between the legs while requiring only relatively short fingers, i.e., a greater displacement between the fingers can be achieved thereby. More important, the angle arms 44 facilitate independent movement of the lifting motion as compared to the bending and twisting motion between the torso and the legs.

It should be noted at this point that the foregoing analysis of the effect of the rotation of the shaft on the torso and legs has ignored any possible rotation of the leg with respect to the shaft for purposes of simplicity. However, in order to understand the actual walking motion of the doll of the present invention, it is necessary that any rotation of the legs with respect to the shaft be included in the total analysis of the operation. Consequently, the rotation of the leg with respect to the shaft will be discussed at this point before the over-all operation of the doll is discussed.

When the separate operation of the various parts of the doll are brought together, as they are in the doll 20, the over-all walking motion of the doll 20 may be explained. As partially illustrated in FIGS. 4-6, the initial movement of the body involves substantially side-to-side bending and twisting of the torso 22 with respect to the legs 80 and forward-and-side angular displacement of the legs 80 without substantial lifting of the legs 80 during such movement. Such initial movement may be explained by the following theory of the operation of the invention. However, this theory should be regarded as merely a probable explanation for the unusual and unexpected results achieved by the present invention and not as a limitation upon the invention. The initial movement apparently involves the interaction between the natural period of oscillation or rocking of the doll body 21 and the movement of the drive means 40. Because of the relatively large mass involved in the torso 22 and the small power output of the motor means 55, the initial movement imparted to the body 21 by the motor means 55 is not sufficient to raise the legs 80. However, once an oscillatory or rocking motion has been imparted to the doll body 21, the additional impulses imparted by the successive rotations of the drive means 40 reinforce the oscillatory movement of the doll body 21 so that the lifting of the legs is commenced.

After the initial period of movement without substantial lifting of the legs 80, the doll, when moving its body 21 to the left, for example, will simultaneously bend the left shoulder to the side and twist it forward and raise the leg 80 with both a side angular displacement and a forward angular displacement. Such movement represents a realistic reproduction of the natural body motions during walking. When the drive means 40 initiates the bending and twisting of the doll body 22, the angle between the fingers 45 and the central body 43 of the shaft 42, coupled with the angle arms 44, are adapted to both twist and bend the torso 22 with respect to the legs 80 and to lift the legs 80 with respect to each other. However, as set forth above, the first pivot means 61 eliminates any direct mechanical connection between the bending of the torso 22 and the legs 80, although such connection is retained between the twisting of the torso 22 with respect to the legs 80. In addition, the first

regulator means 82, when coupled with the second pivot means 70, may be adapted, for example, to generate an angle of 165° between the torso 22 and the leg 80 by the side angular displacement of the leg 80. Since the torso 22 is relatively heavier than the leg 80, i.e., the torso 22 has a greater moment of inertia than the leg 80, the movement of the drive means 40, rather than the direct mechanical connection thereof between the torso and the leg, achieves the predominant result of bending the leg 80 upward, rather than bending the torso 22 downward, bringing these two doll parts together. Counterbalancing such effect is the force of gravity on the torso 22 and leg 80 which, absent the other forces involved, tends to cause the torso 22 to move downward while the leg 80 remains stationary. The resultant affect of the mechanical action between the leg and the torso and drive means, as well as the remainder of the forces created by the doll movement, is designed to bend the torso 22 through an angle of about $7-8^\circ$, while the leg 80 raises to a height of about 0.1 to 0.2 inch. Of course, by suitably varying the design of the doll, e.g., varying the weight or configuration of the torso or legs, the legs may move through a greater or lesser angle than the torso. Even more important, merely by varying the speed of the drive means, control of the relative movement between the legs and torso may be achieved. Thus, at very high speeds, the torso may not substantially bend at all. However, it has been found that for a total angle of bend of about $7-8^\circ$, a speed which produces an angle of about 3° for the torso and about $4-5^\circ$ for the legs with respect to the surface on which the doll is standing is preferable. It would appear that the direct mechanical connection of the leg to the drive means and body, coupled with the greater moment of inertia of the torso 22, has a greater effect on the resulting bending of the leg 80 than the force of gravity on the torso 22 because the doll is displaced to a relatively small angle from a vertical position. In other word, the effect of the force of gravity is substantially nullified, since it is exerting only a relatively small bending moment.

Additionally, when the angle is formed between the torso and legs alternately to each side, both the torso and the legs are moved from a position at rest so that they are both accelerated. Since the legs are accelerated faster than the torso, they move up relative to the torso. More specifically, although the acceleration due to gravity aids the torso and hinders the legs, the acceleration due to the drive means is much greater on the legs than on the torso.

Another factor which must be considered is the effect of the moving part of the body on the relatively stationary part, e.g., the effect of the moving foot on the foot remaining on the floor. For example, when the left foot takes a step (FIGS. 4-9), if we assume there is no body twist and the right foot is securely fastened to the floor, then the resulting body movement would be as illustrated in FIGS. 4-9. However, if the right foot is free to move as it actually is and there is no body twist, then, when the left foot and the body move forward, they exert a turning force on the right foot. Thus, when viewed from above, the body would rotate in a counterclockwise direction during a step by the left foot and in a clockwise direction during a step by the right foot. Such result is prevented by twisting the body a sufficient amount in the opposite direction so that the two movements are effectively cancelled and the body remains facing forwardly during each step. Experimentally, for the dolls tested to date, about a 5° body twist is sufficient.

From the foregoing theories, the initial lifting of the leg can be understood. Thus, as illustrated in FIGS. 10-15, after the completion of one step the identical sequence takes place with respect to the other end as the doll then bends to the right. The result is that the doll moves one foot in front of the other in sequence, utilizing both a side and a forward angular displacement

and, in addition, has a corresponding bending and twisting of the body. Thus, the doll walks in a natural fashion, bending not only to the side, but also twisting the body to correspond to the movement of the particular leg.

The movement of the body controls the drive means so that the movement is synchronized, i.e., the body movement achieves a governor action with respect to the drive means.

Such governor action or synchronization occurs in the present invention since, when the doll 20 reaches a maximum height of a step, the motor means 55 of the drive means 40 slows down so that the drive means maintains the synchronization between the natural oscillation of the doll body and the movement of the drive means. For example, when the motor is running at high speed the doll takes correspondingly short, quick steps with relatively a smaller amount of lifting of the leg from the surface upon which the doll is walking. On the other hand, when the motor is slowed down, the doll takes slow, large steps with a relatively high raising of the leg during each step. In any case, the motor means 55 of the drive means 40 slows down during the step so that the drive means movement is maintained in synchronization with the natural oscillation of the doll body. Such operation may be explained by the following theory or explanation. However, such theory should be regarded as merely a probable explanation for the unusual and unexpected results achieved by the present invention and not as a limitation of the invention.

As the doll 20 approaches the height of a step, the drive means 40 reverses its motion so as to start the body bending and twisting, as well as the leg lifting in the opposite direction. However, the momentum of the doll body tends to continue to move the leg upward and to bend and twist the body in the initial direction. In addition, in moving the body when it is bent to one side to a bent position on the other side, the center of gravity of the body must be lifted while the body is moving toward a vertical position. Consequently, although the drive means attempts to start bending and twisting the body in the opposite direction, as well as lifting the legs in the opposite direction, the movement and position of the doll body, at least initially, results in a resultant force which is more powerful than the force exerted by the motor on the drive means so that the drive means is slowed down by the doll body. Once the doll body movement has been overcome and it has been brought to an upright position, the restraining force of the body on the drive means is released so that the natural step movement described above can take place.

Another factor which must be considered in connection with the above discussed body motions is the orientation of the body at the changeover point. The changeover point is considered the point during the rocking motion of the doll when both feet are on the floor and the weight of the doll body is substantially equally supported by each leg. It has been found that for proper rocking, the center line of the body should be substantially vertical at the changeover, otherwise an unstable condition is promoted during oscillation. Also, although rocking can be obtained by moving a large body mass through a small displacement, it has been found preferable to utilize a small body mass moving through a relatively large displacement. Such arrangement simplifies rocking, since the doll becomes self-starting, i.e., the doll will begin rocking from an at-rest position when power is applied.

The synchronization of the doll body and drive means also involves considering the acceleration and deceleration of the doll body. Assuming the center line of the body is substantially vertical at the changeover point, the body displacement will be at a maximum angular velocity and zero acceleration at the changeover point. On the other hand, as the body displacement increases, it is decelerated until at maximum displacement the velocity is zero and

the deceleration is at a maximum. When the resulting forces are transferred to the drive means, it is slowed down.

From the foregoing explanation it can be seen that the body movement does, indeed, control the drive means to synchronize the movement of the body and the drive means. Also, it should be noted that the foregoing relationship permits a relatively small motor to be utilized in the drive means, since the synchronization of the body movement and the drive means makes use of both the natural oscillation of the body and the power output of the motor. Consequently, only a small energy input is required for each step to maintain the walking motion and only a very small motor need be utilized in the doll body.

In FIGS. 16-18, an alternate embodiment of the gear means of the present invention is illustrated which is adapted to vary the force applied to the body by the drive means in synchronization with the force required by the doll for its walking motion. FIG. 16 is a cross-sectional view similar to the gear portion of FIG. 1, except that the circular gears 51 and 52 are replaced by a first elliptical gear 150 and a second elliptical gear 151. The first elliptical gear 150 is operatively connected to the crank means, while the second elliptical gear 151 is operatively connected to the motor and engaged with the first elliptical gear. As shown in FIG. 17, when the body 21 is beginning a step, i.e., the leg 80 starts to rise, the orientation of the elliptical gears 150 and 151 is such that the gear portion adjoining the minor axis of the motor elliptical gear 151 engages the gear portion adjoining the major axis of the crank elliptical gear 150. With such gear positions, the motor gear 151 has an effective diameter equal to its minor diameter and the crank 150 has an effective diameter equal to its major diameter. In other words, at such gear positions the power from the motor means 55 is transmitted to the crank means 41 from a small diameter gear 151 to a much larger diameter gear 150. Consequently, the effective force of the motor is multiplied by the gear ratio. Also, the maximum force is exerted on the body 21 at the beginning of a step by the motor means 55 when the maximum force is needed by the body 21 to lift the leg 80.

As shown in FIG. 18, the situation is just reversed from FIG. 17. By reversing the foregoing analysis, it can be seen that the effective force of the motor is divided by the gear ratio. Consequently, the minimum force is exerted on the body 21 at the height of a step by the motor means 55 when the minimum force is needed by the body 21.

Still another embodiment of the present invention is illustrated schematically in FIGS. 19-21. As shown, the feet 80' are inclined up-and-out at an angle of about 4° to 5° when the doll is in a standing position. Such arrangement insures that during the initial portion of the rocking or oscillation involved in walking, the raising of the body center of gravity is minimized, since the foot moves towards the floor. Thus, the doll rocks on the inside of the feet, as shown in FIG. 20. However, when the rocking tends to increase excessively, i.e., after the doll rocks over about 4° to 5°, the situation is reversed. Thus, the foot moves away from the floor because the doll rocks on the outside of the foot and the rate at which the body center of gravity is raised is increased (see FIG. 21). Consequently, over-rocking is restricted and the feet effectively act as a governor.

Many other specific embodiments of the present invention will be obvious to one skilled in the art in view of this disclosure. For example, note the alternate shaft illustrated in Sketch D above. Also, since the bending and twisting of the torso are independent of each other, the twisting of the torso may be simply eliminated by having the axes of the shaft fingers parallel to the axis of the central body of the shaft. Any suitable pivot means may be utilized to form the pivotal attachment between the leg and the drive means to form the control

means for directing the movement of the legs. For example, if the aperture 84 of the hanger 83 instead of being circular is elongated substantially in the direction of a forward-rear lateral axis, the bracket portion of the second hanger of the second regulator means may be eliminated. In addition, the drive means of the present invention may include any suitable motor means having any convenient source of power. Thus, the motor may be an electric motor operated by batteries, a wired connection to a power outlet, or it may be simply a spring motor, but in such case, a governor should be used to insure that it produces constant speed. Still another variation which may be utilized is designing the leg dimensions so that the legs take positions as though they were the rim of a wheel with a larger radius than the distance between the body center of gravity and the floor.

It will be understood that the foregoing description and examples are only illustrative of the present invention and it is not intended that the invention be limited thereto. All substitutions, alterations and modifications of the present invention which come within the scope of the following claims or to which the present invention is readily susceptible without departing from the spirit and scope of this disclosure are considered part of the present invention.

I claim:

1. A doll adapted to walk independently with natural body and leg motions, comprising:

a body including a torso and legs pivotally attached thereto;

drive means mounted in said torso, said drive means comprising:

(a) rotatable crank means connecting said torso to said legs and adapted to periodically bend said torso and said legs toward each other, twist said torso with respect to said legs and lift said legs with respect to each other alternately on each side of said doll;

(b) gear means for rotating said crank means; and

(c) motor means for driving said gear means, said crank means comprising a substantially off set shaft having a finger extending outwardly at each end at an acute angle to the axis of the central body of said shaft, the axes of said fingers being displaced from each other, said gear means comprising a first elliptical gear operatively connected to said crank means and a second elliptical gear operatively connected to said motor means, said elliptical gears being engaged and adapted to exert the maximum force on said legs at the beginning of a step and the minimum force at the height of a step.

2. A walking figure adapted to walk upon a substantially flat surface, comprising:

a torso;

leg means including at least a pair of legs and associated feet means centrally disposed in a plane of symmetry of said figure;

pivotal attachment means pivotally connecting the leg means and torso together for predetermined side-to-side relative swinging movement between said torso and said leg means, said pivotal attachment means comprising a first pivot means extending in a lateral direction and providing for forward-rear angular displacement of said leg means approximately about a lateral axis of said torso and a second pivot means extending in a forward-rear direction and providing for side angular displacement of said leg means approximately about a forward-rear axis of said torso;

drive means carried by said figure and connected to said attachment means for causing said side-to-side movement to cause said feet means to leave the ground on successive alternate sides responsive to successive movements of the torso, said drive means twisting said torso in synchronism with said side-to-side movement; and

means urging the foot means which has left the ground in a forward walking direction relative to said torso and for urging the other foot means rearwardly relative to said torso to give a resultant forward motion to said figure.

3. A walking figure as stated in claim 2 wherein said first pivot means comprises a block joined to said leg having a first bore therein extending approximately parallel to the side lateral axis of said torso with a finger of said drive means rotatably received in the block bore.

4. A walking figure as stated in claim 2 wherein said second pivot means comprises a yoke joined to said leg having a rod extending between its ears, said rod extending approximately parallel to a forward-rear axis of said torso and a block joined to said drive means and rotatably mounted on said yoke rod.

5. A toy figure adapted to walk independently with natural body and leg motions and to have said leg motions displaceable independently of said body motions, comprising:

a body including a torso and legs, each of said legs including a pivotal attachment for connecting said leg to said torso, said pivotal attachment for each of said legs comprising:

(a) a first pivot means for facilitating a forward-rear angular displacement of an associated leg approximately about a side lateral axis of said torso; and

(b) a second pivot means for facilitating a side angular displacement of an associated leg approximately about a forward-rear axis of said torso;

drive means mounted in said torso, said drive means being controlled by the motion of said body to synchronize said motion and drive means, said drive means comprising:

(a) rotatable crank means connecting said torso to said pivotal attachment and adapted to periodically bend said torso and legs toward each other, twist said torso with respect to said legs, and lift said legs with respect to each other alternately on each side of said doll, said crank means comprising a substantially offset shaft having a finger extending outwardly of each end at an acute angle to the axis of the central body of said shaft, the axes of said fingers being displaced from each other;

(b) gear means for rotating said crank means; and

(c) motor means for driving said gear means; and control means connected to said legs for directing the movement thereof, said control means including for each of said legs a first regulator means for governing the side angular displacement of said leg and a second regulator means for governing the forward-rear angular displacement of said leg.

6. A toy figure as stated in claim 5 wherein said first regulator means comprises a hanger mounted within said torso having a holding means and a strut with its first end fixed to said leg and its second end slidably received in said holding means, said holding means being adapted to restrain the side angular displacement of the second end of said strut and wherein said second regulator means comprises means operatively associated with said holding means for restraining the forward-rear angular displacement of said second end of said strut.

7. A toy figure as stated in claim 6 wherein said operatively associated means includes a bracket rotatably mounted at its first end about a side lateral axis in the upper portion of said torso and operatively connected at its second end to said drive means to follow the forward-rear movement of said drive means and wherein said hanger is mounted on said bracket adjacent to said leg.

8. A doll adapted to walk independently with natural body and leg motions, comprising:

a body including a torso and rigid legs pivotally attached thereto;

drive means mounted in said torso, said drive means being controlled by the motion of said body to synchronize said motion and drive means, said drive means comprising:

(a) rotatable crank means connecting said torso to said legs and adapted to periodically bend said torso and legs toward each other, twist said torso with respect to said legs and lift said legs with respect to each other alternately on each side of said doll;

(b) gear means for rotating said crank means; and

(c) motor means for driving said gear means, said crank means comprising a substantially offset shaft having a finger extending outwardly at each end at an acute angle to the axis of the central body of said shaft, the axes of said fingers being displaced from each other.

9. A walking figure adapted to walk upon a substantially flat surface, comprising:

a torso having a forward-rear axis and a side-to-side axis;

leg means including at least a pair of rigid legs separately pivotally mounted relative to each other on said torso for fore-and-aft pivotal movement and having associated feet means thereon;

pivotal attachment means pivotally connecting the leg means and torso together, said pivotal attachment means including a first pivot means extending, and defining an axis, approximately parallel to said forward-rear axis for effecting a side-to-side movement of said leg means and a second pivot means defining an axis extending approximately parallel to said side-to-side axis providing for forward-rear angular displacement of said leg means approximately about said side-to-side axis; and

drive means carried by said figure and connected to said attachment means for inducing said side-to-side movement to cause said feet means to leave the ground on successive alternate sides responsive to successive movements of the torso,

said drive means urging the foot means which has left the ground to pivotally swing in a forward walking direction relative to said torso and for urging the other foot means rearwardly relative to said torso to give a resultant forward motion to said figure.

10. A walking figure as stated in claim 9 wherein said drive means rocks said torso and said leg means toward each other in such a manner that the top of said torso moves in a direction toward the ground-engaging portion which has left the ground.

11. A walking figure as stated in claim 9 wherein the bottoms of said ground engaging portions have means so configured that side to side rocking of their associated leg means first causes lowering of the center of gravity of the figure then tends to raise that center of gravity.

12. A walking figure as stated in claim 9 wherein the bottom surfaces of said ground-engaging portions extend laterally outwardly and upwardly from the inner edges thereof at an angle of about 4° to 5°.

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