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(54) **TOY ROBOT APPARATUS AND METHOD**

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(52) **U.S. Cl.** **446/330**

(57) **ABSTRACT**

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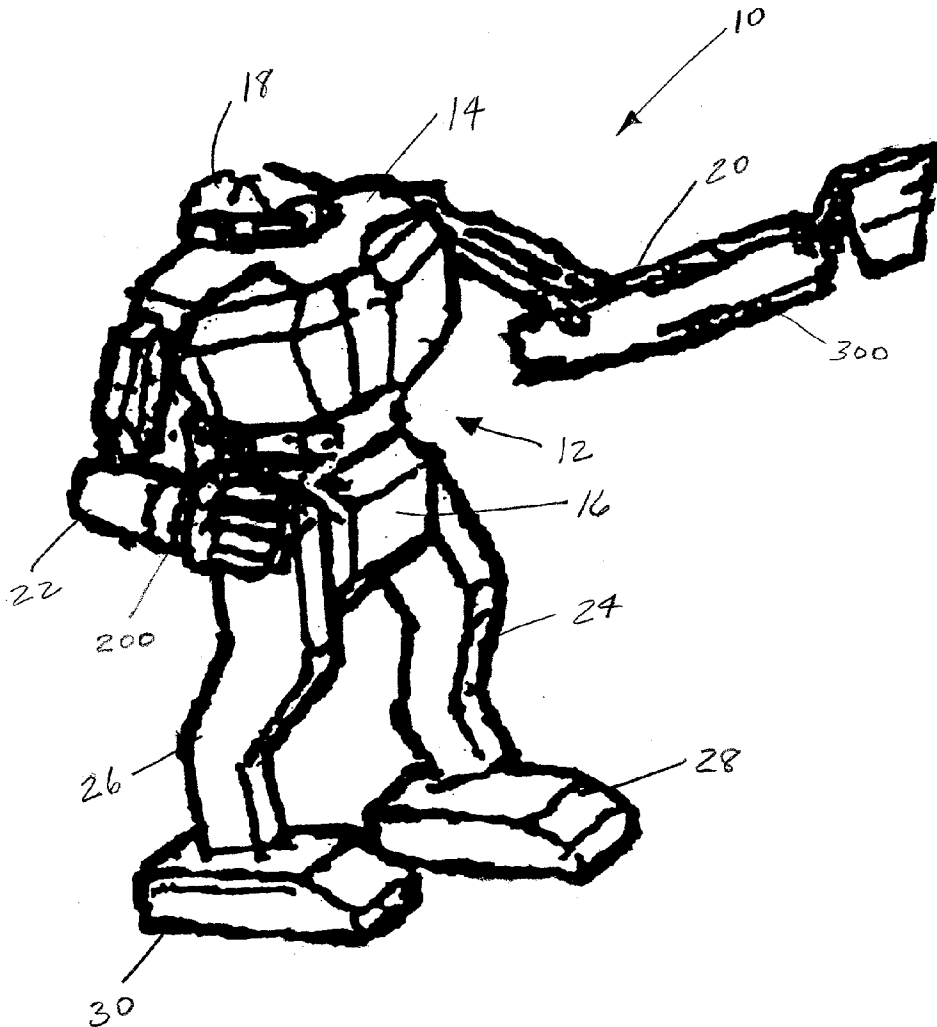
A toy robot capable of simulating walking motion with robotic legs and/or feet that rise and fall with respect to the ground. Some preferred embodiments of the toy robot are capable of changing directions effectively by using independent motors in each of two robotic feet. In another aspect of the present invention, a toy robot can include several different interchangeable arm mechanisms capable of complex motions and/or functions. The toy robot is preferably controlled by a remote control unit capable of communicating with the toy robot in order to control the walking motion of the toy robot and the motions and functions of the arm mechanisms.

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Related U.S. Application Data

(60) Provisional application No. 60/289,376, filed on May 8, 2001.



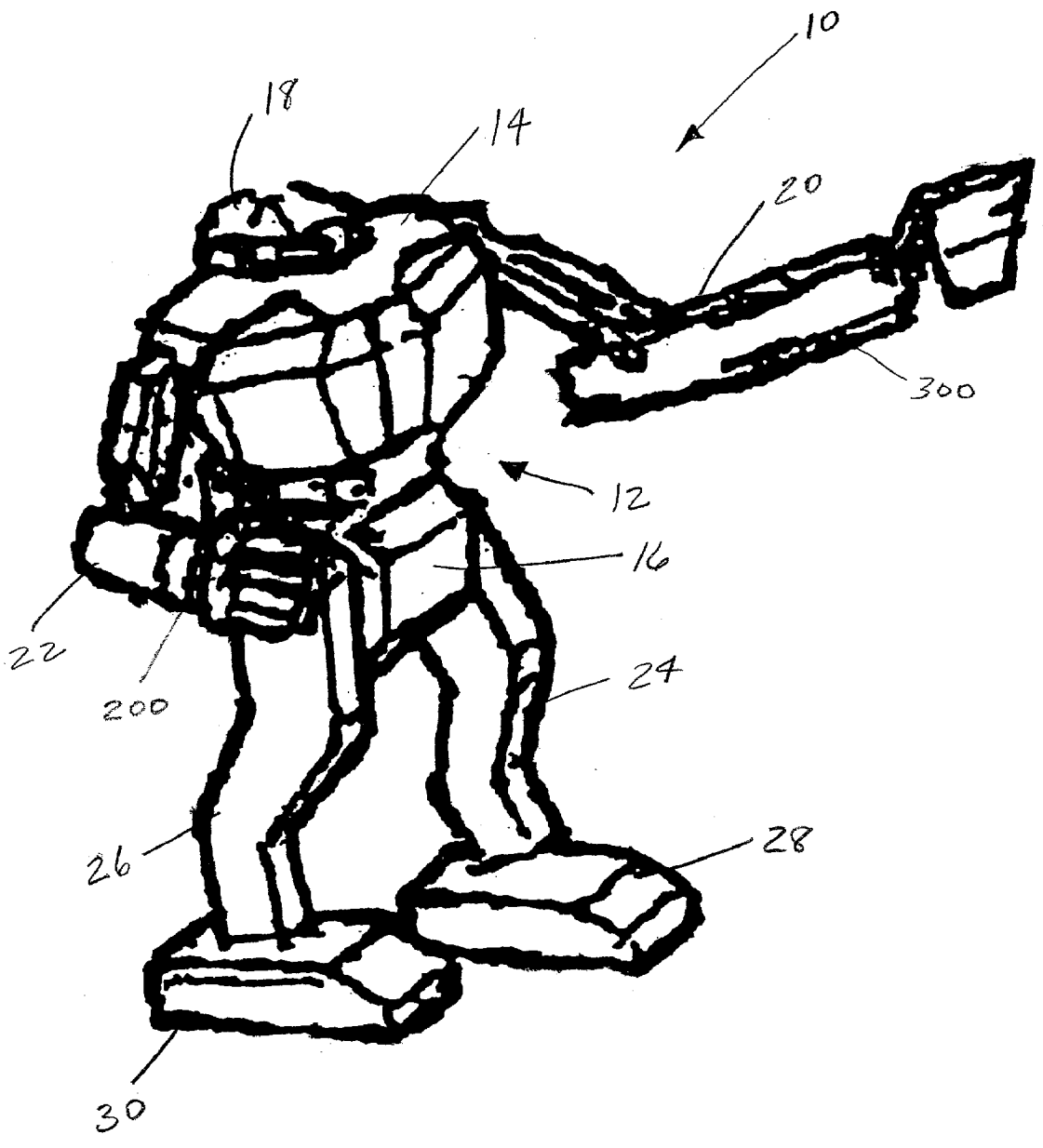
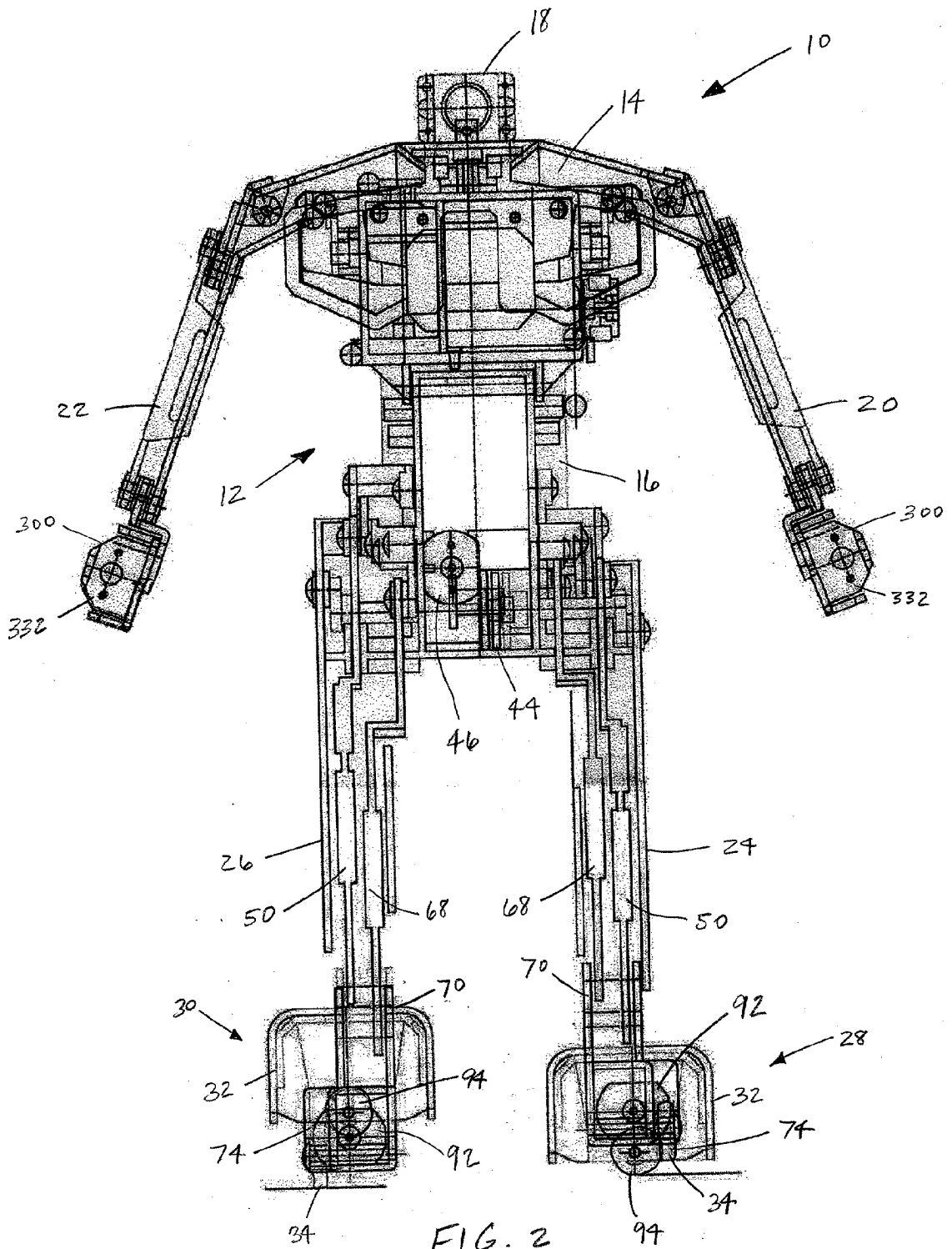


FIG. 1



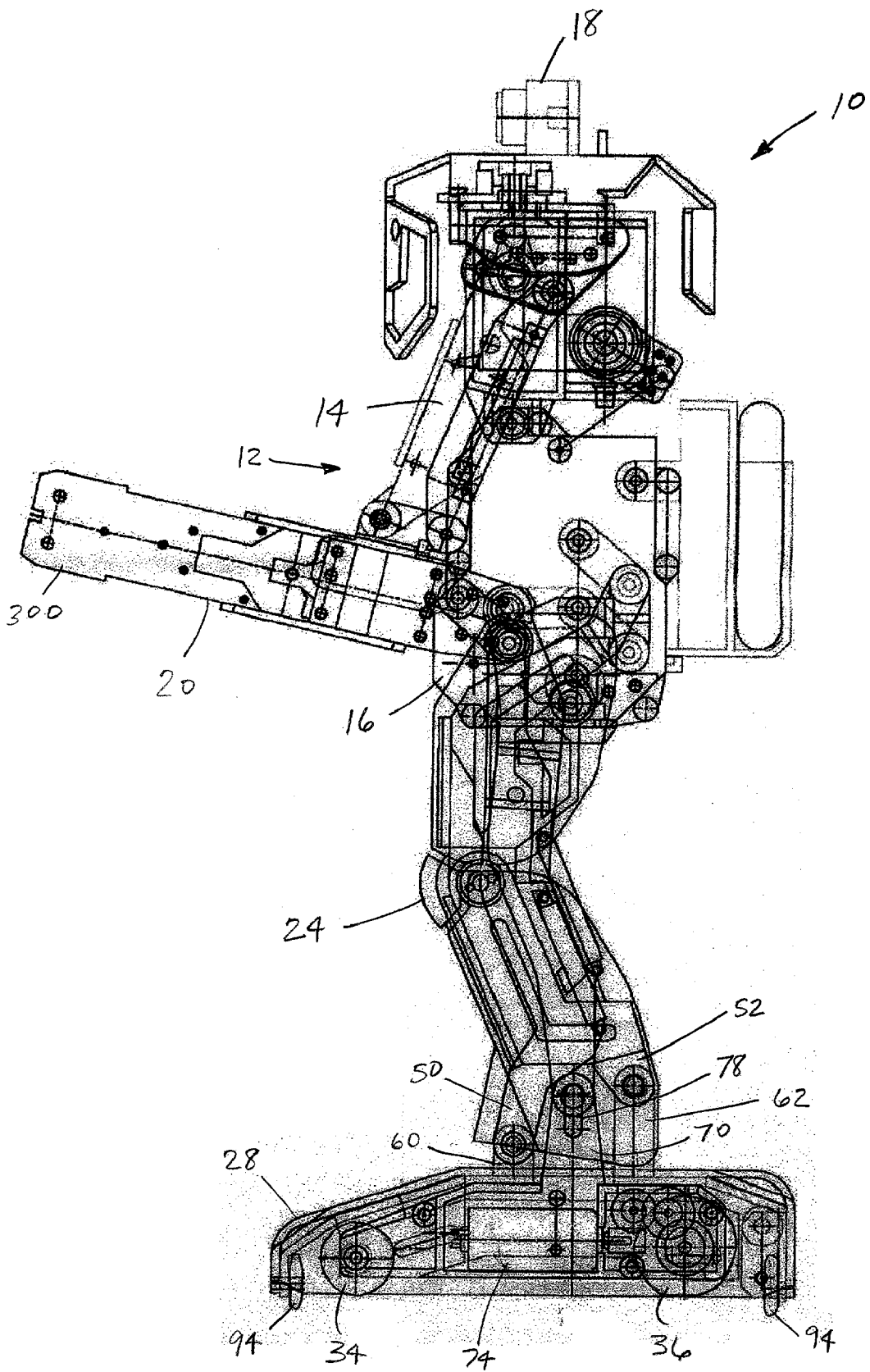


FIG. 3

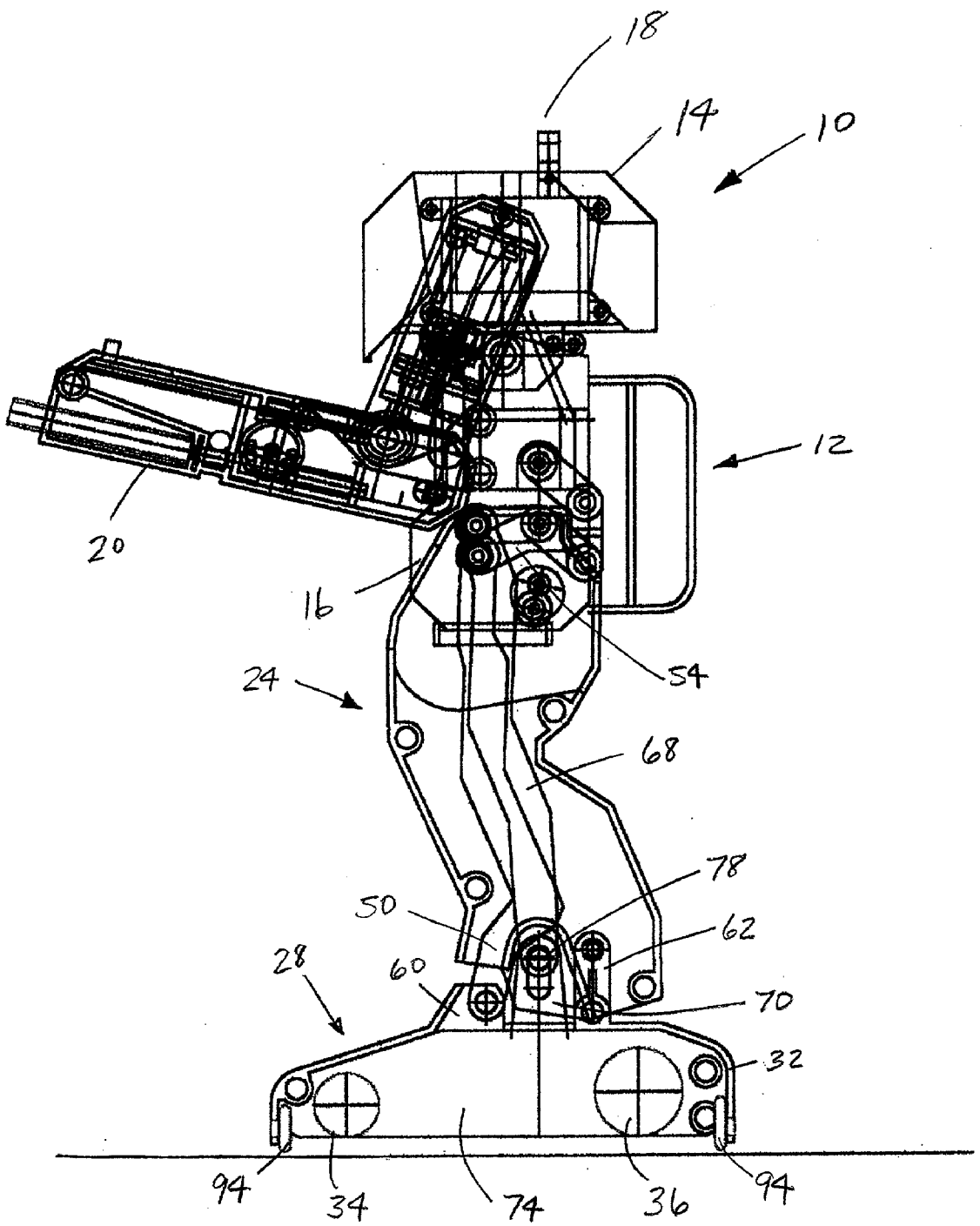


FIG. 4

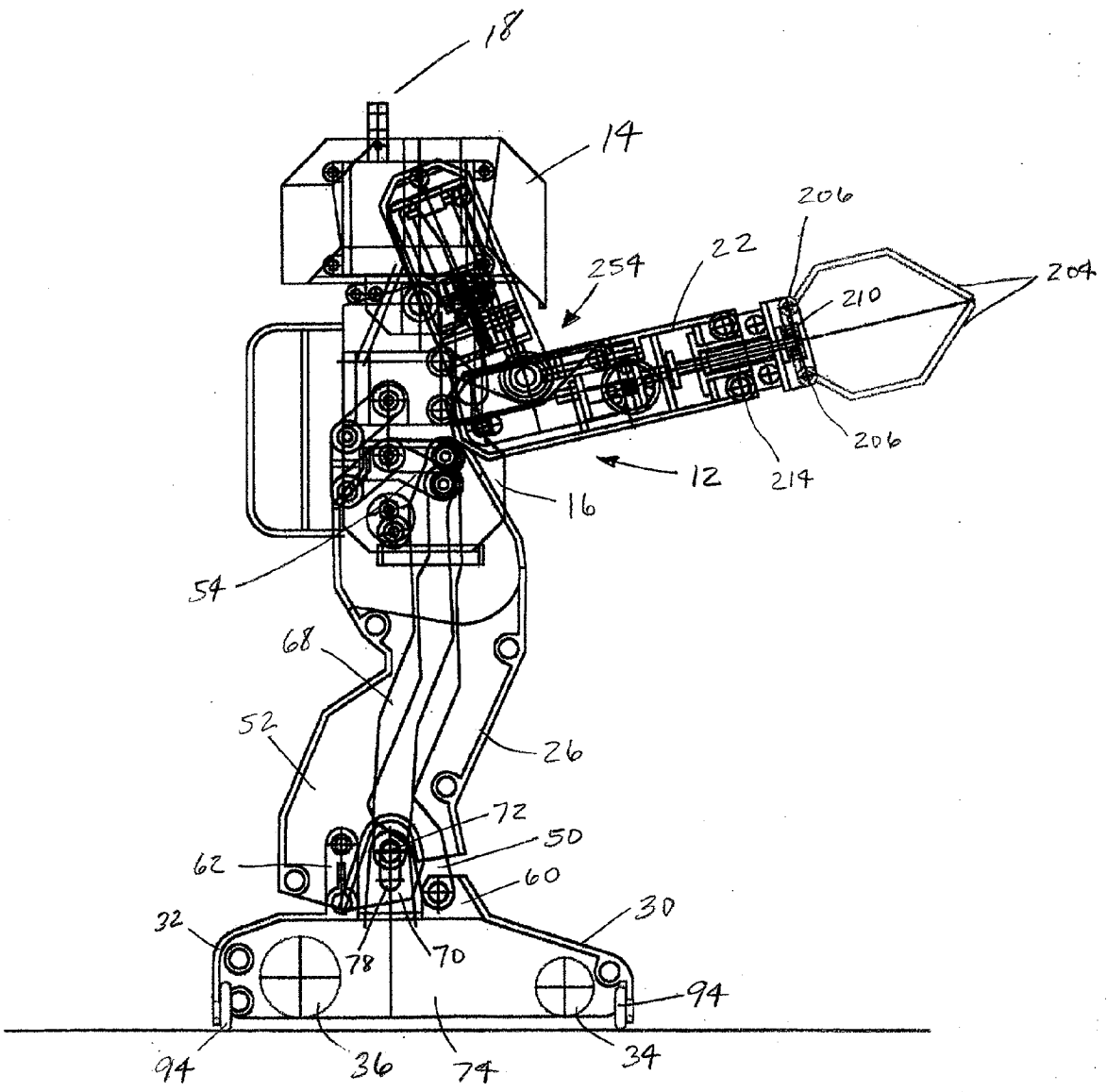
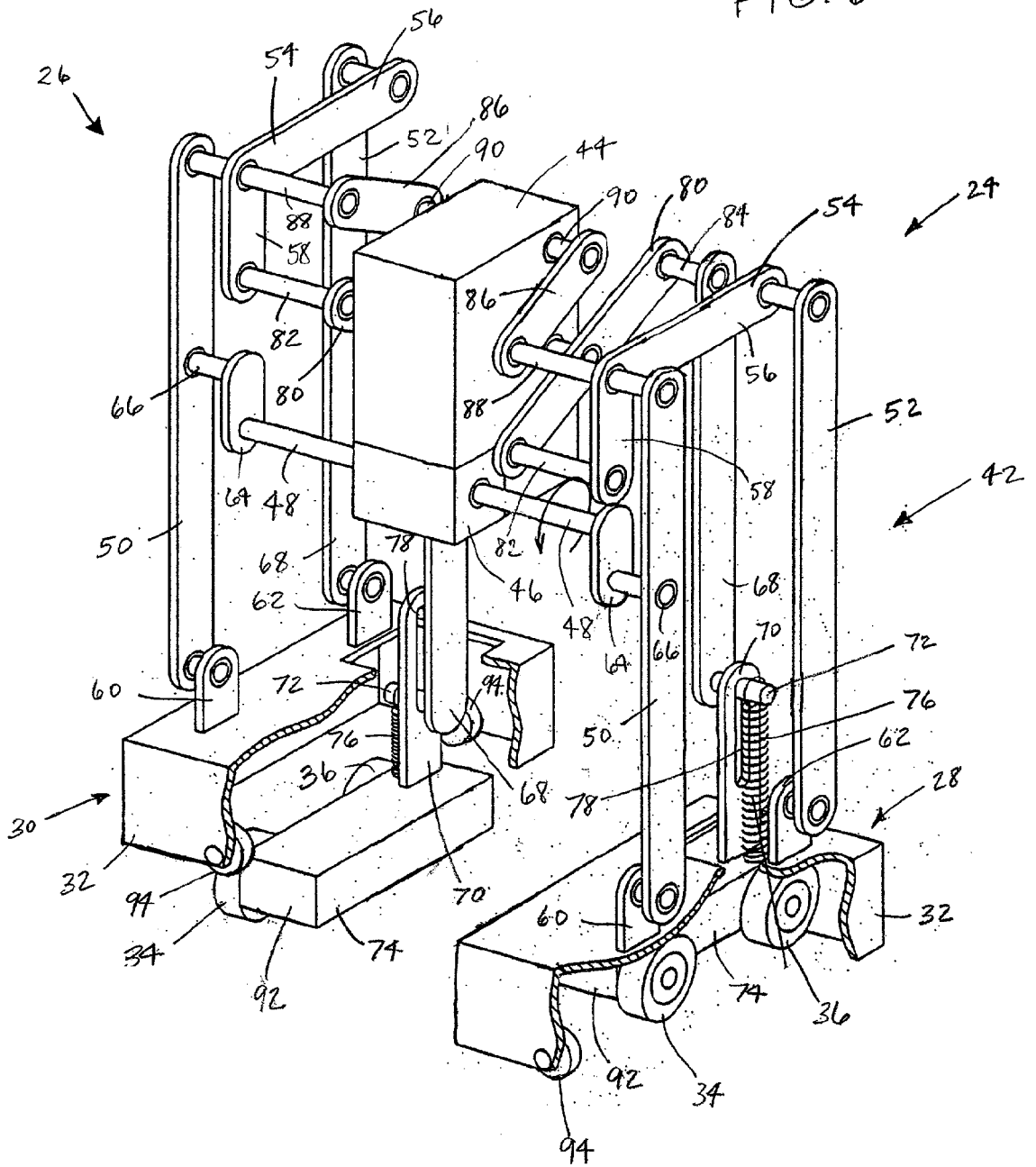


FIG. 5

FIG. 6



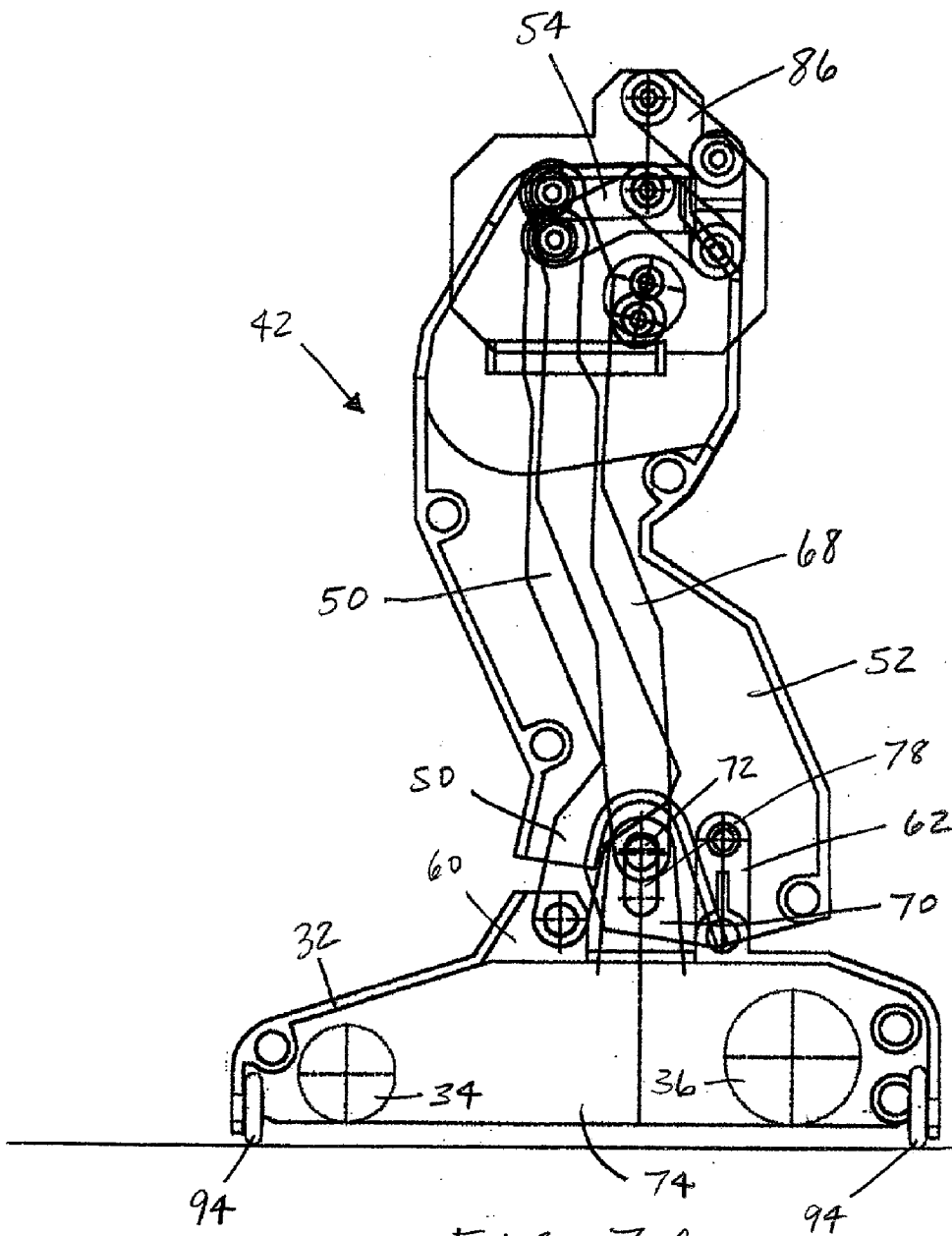


FIG. 7A

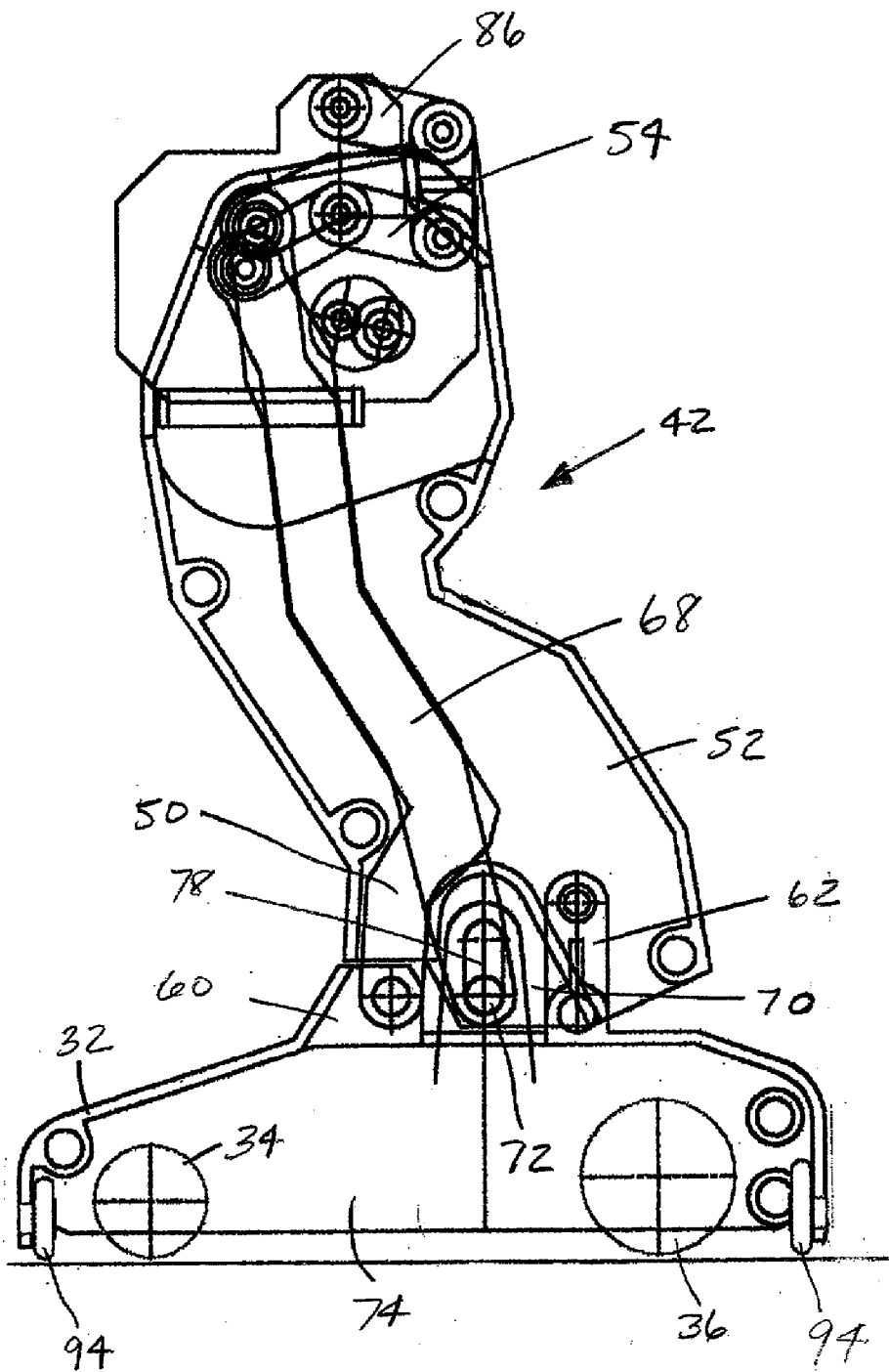


FIG. 7B

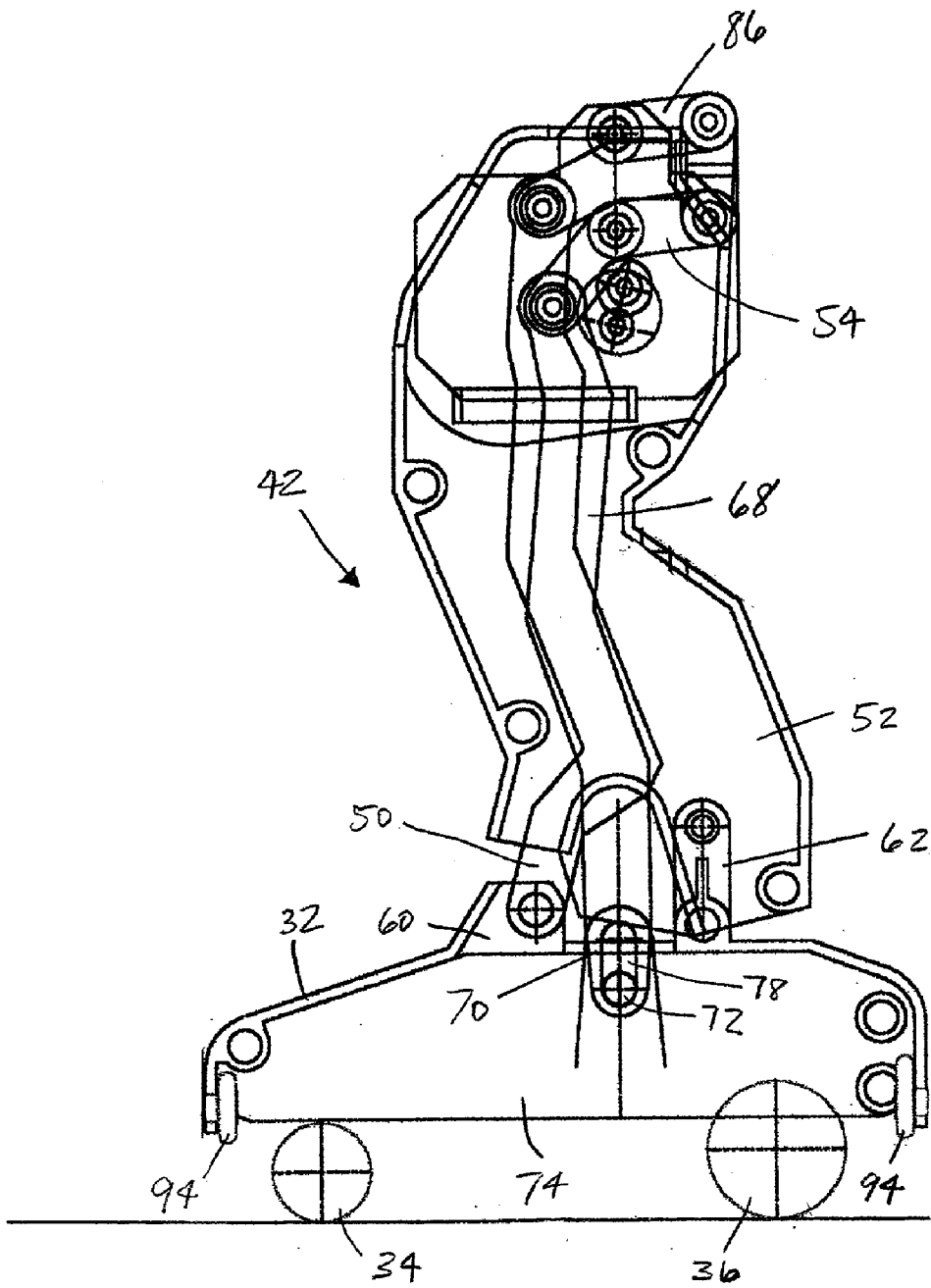


FIG. 7C

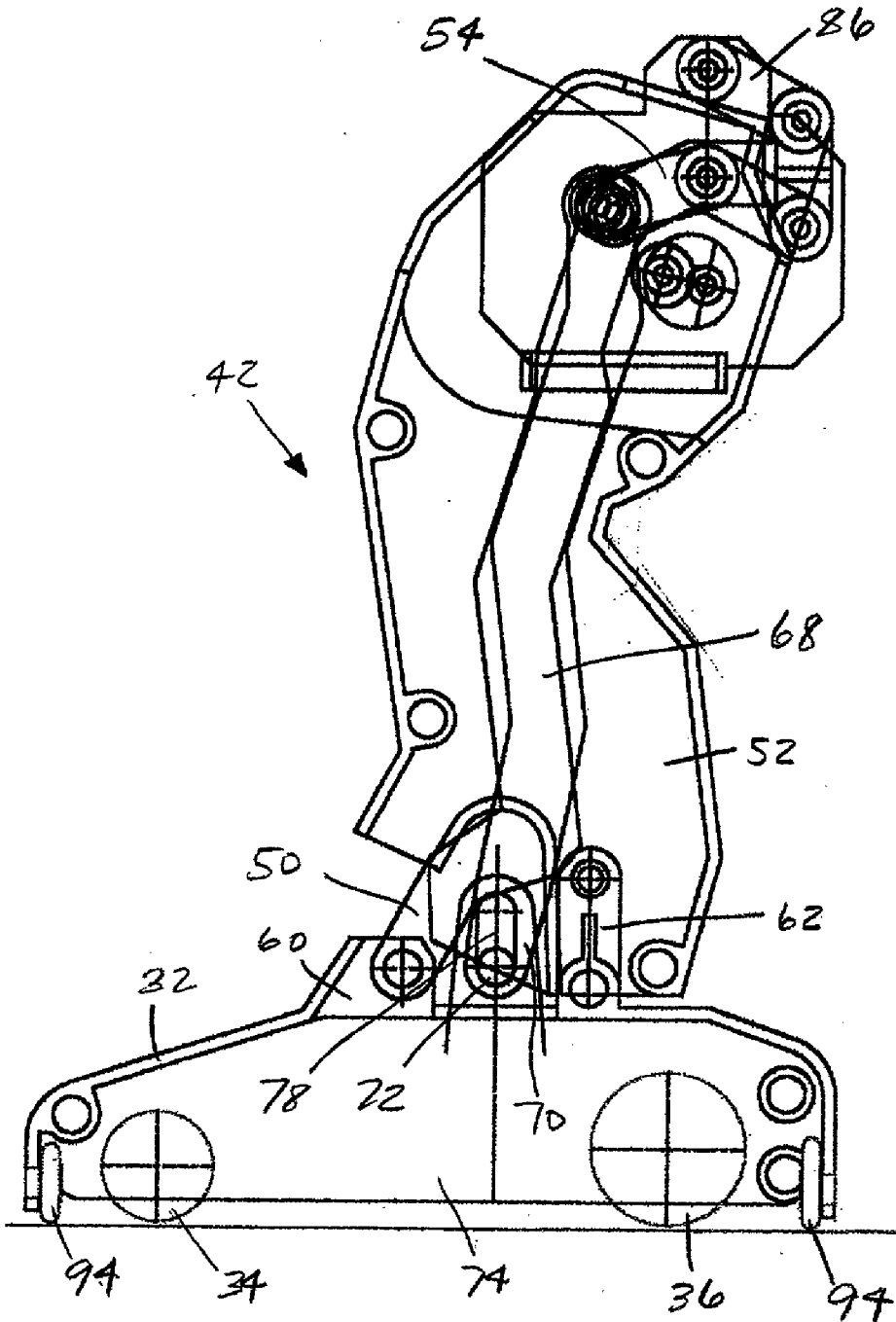


FIG. 7D

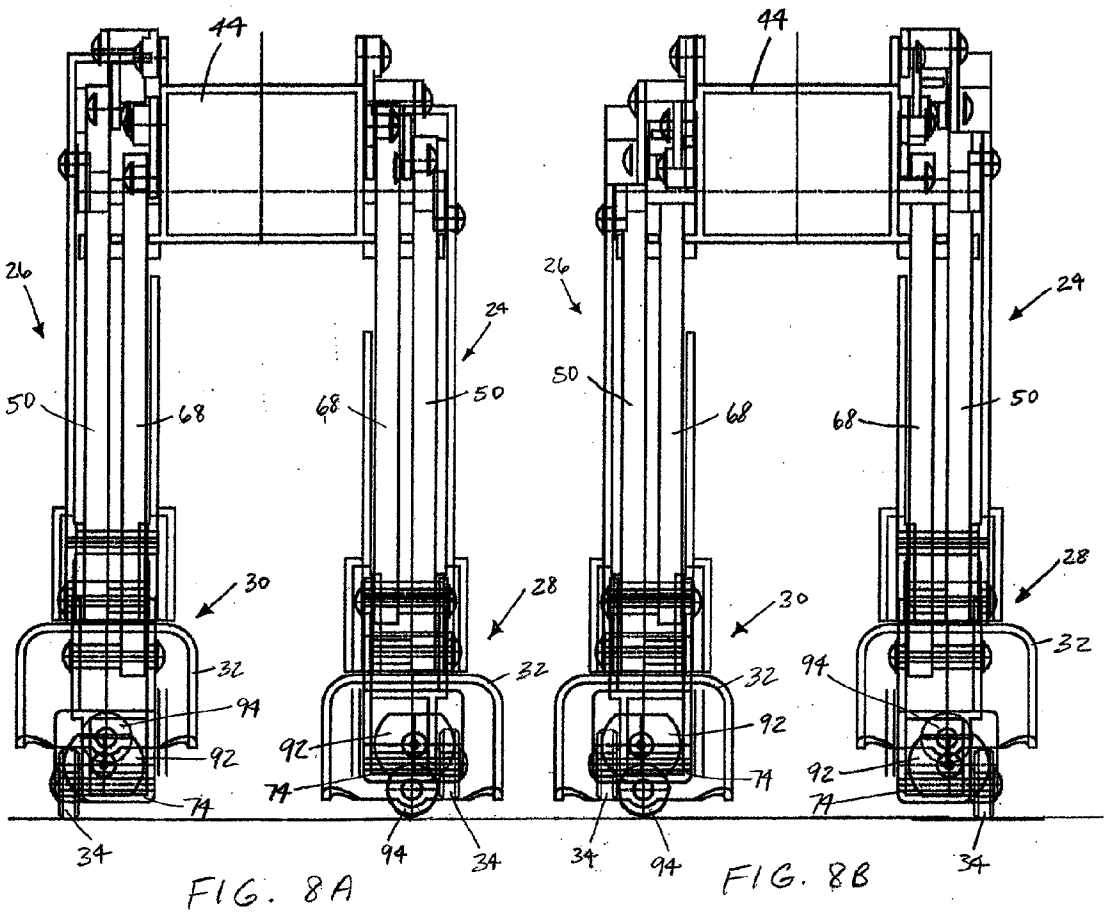


FIG. 8A

FIG. 8B

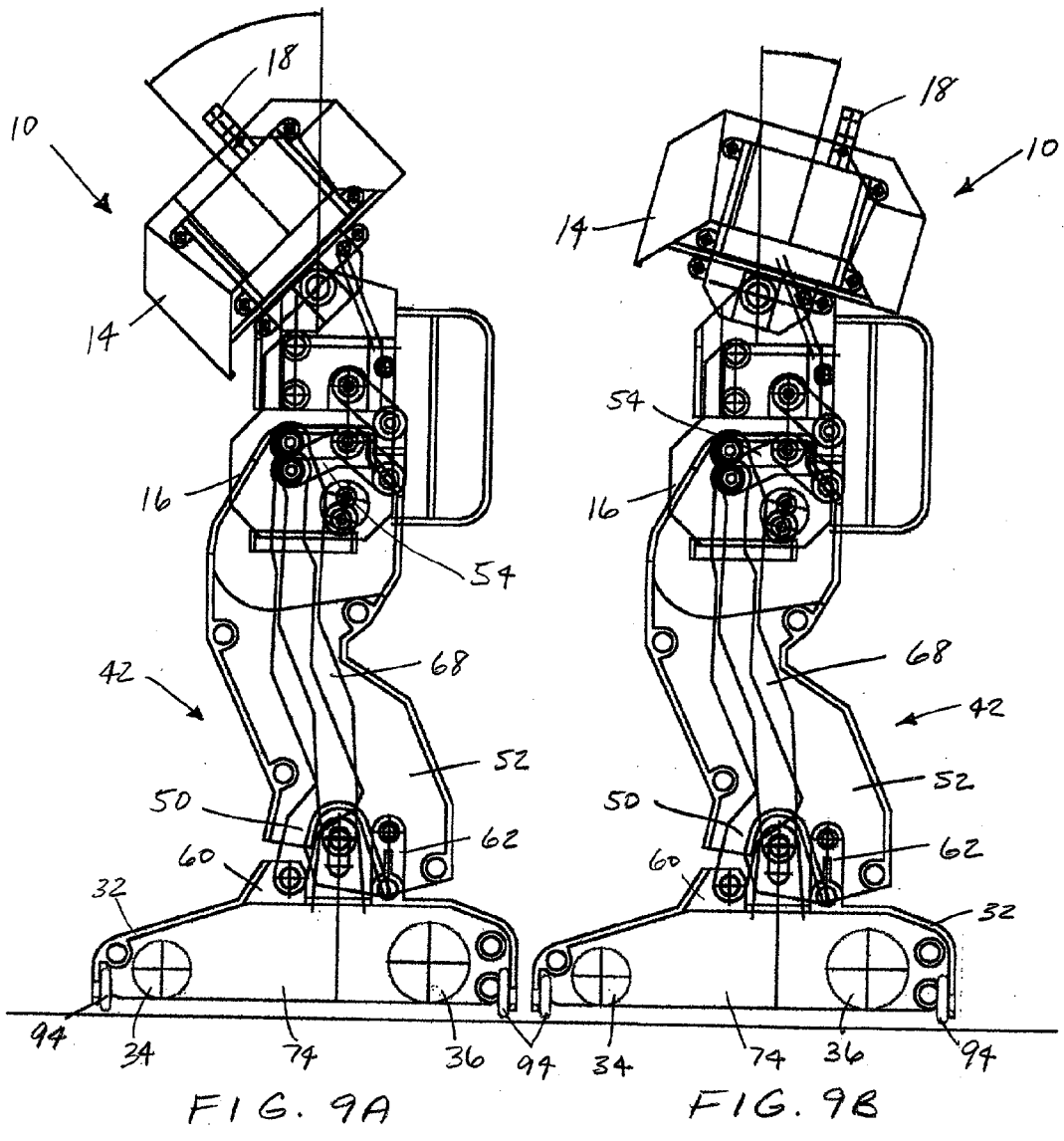


FIG. 9A

FIG. 9B

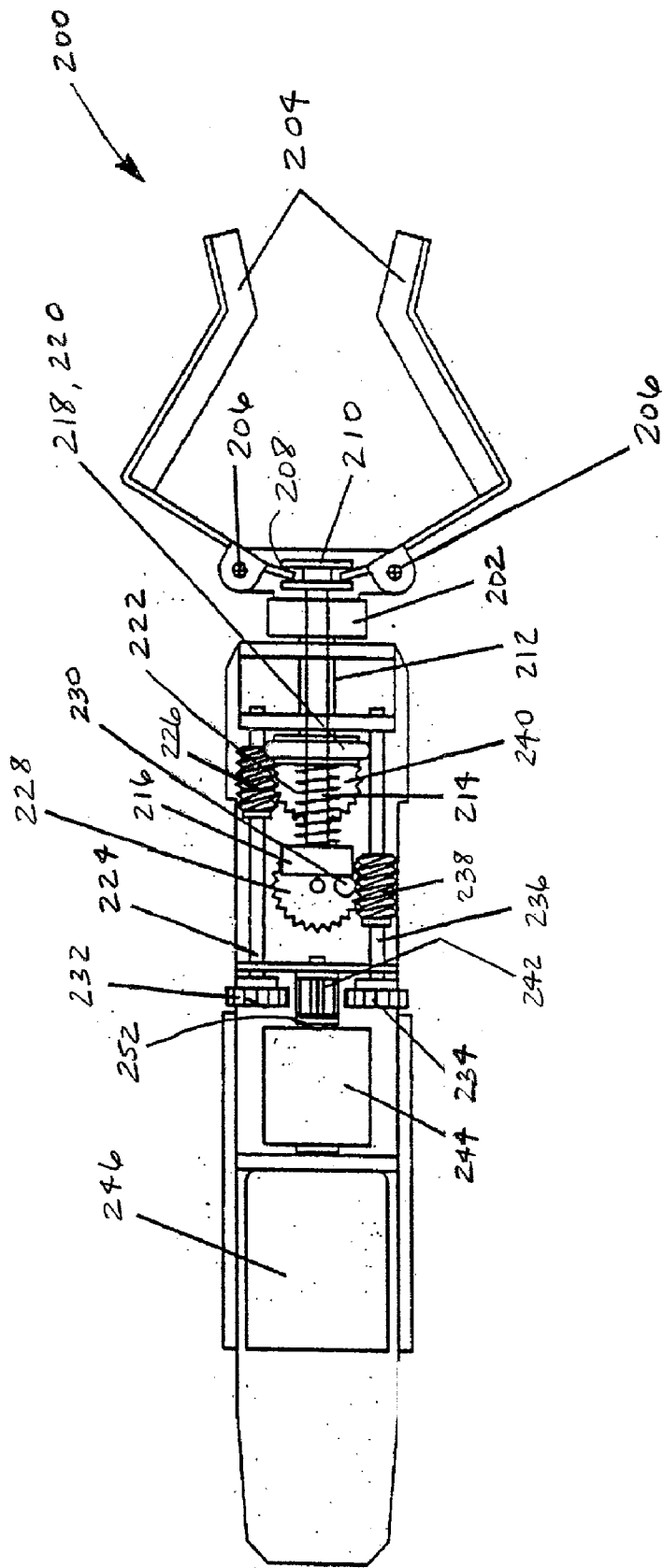
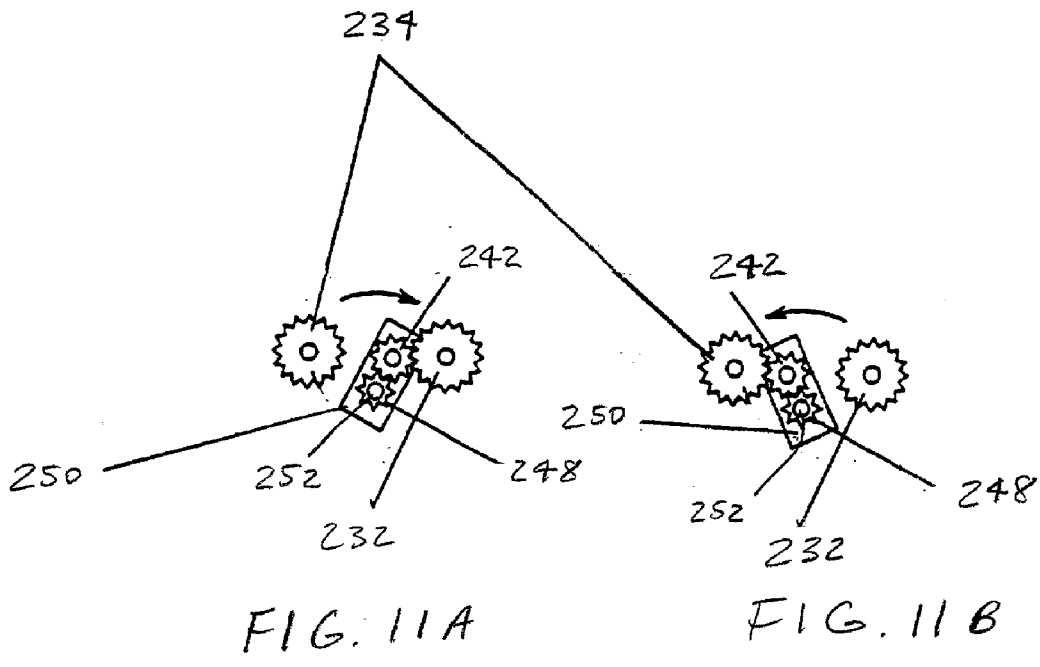


FIG. 10



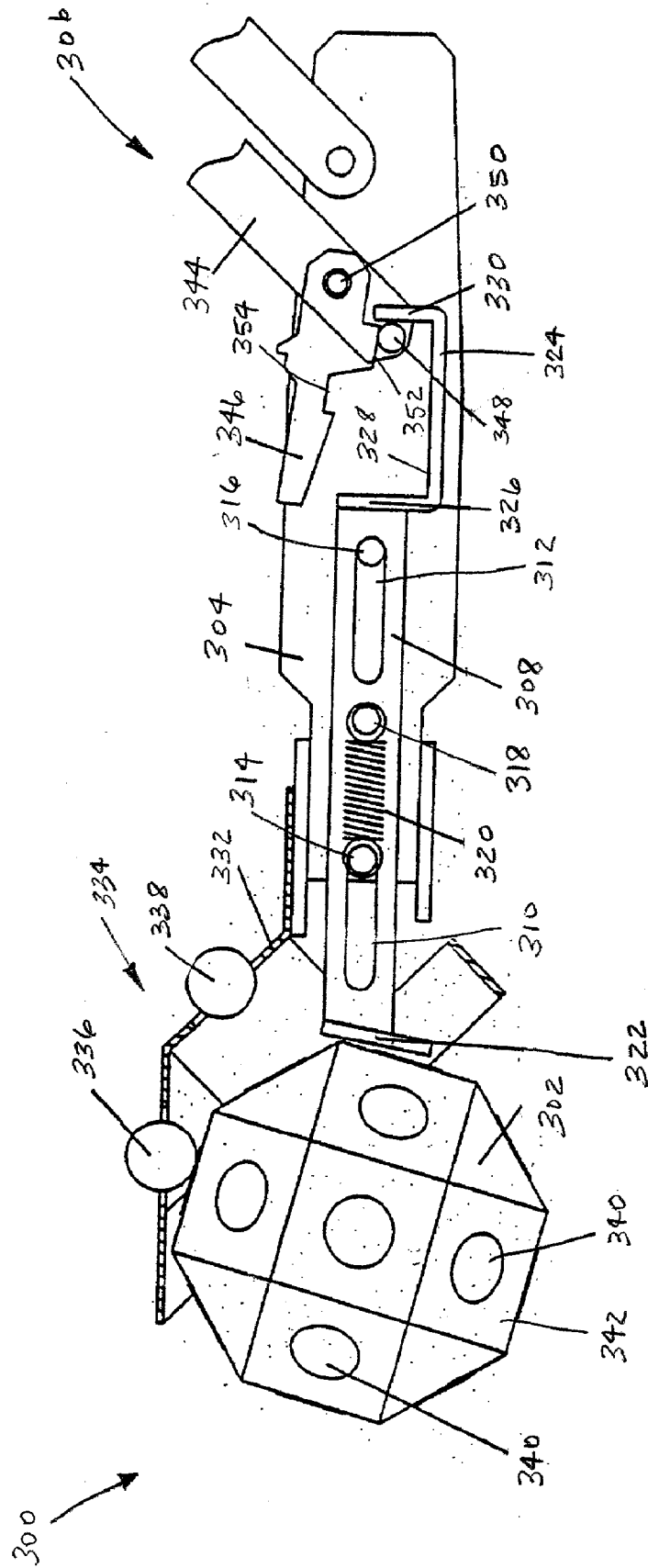
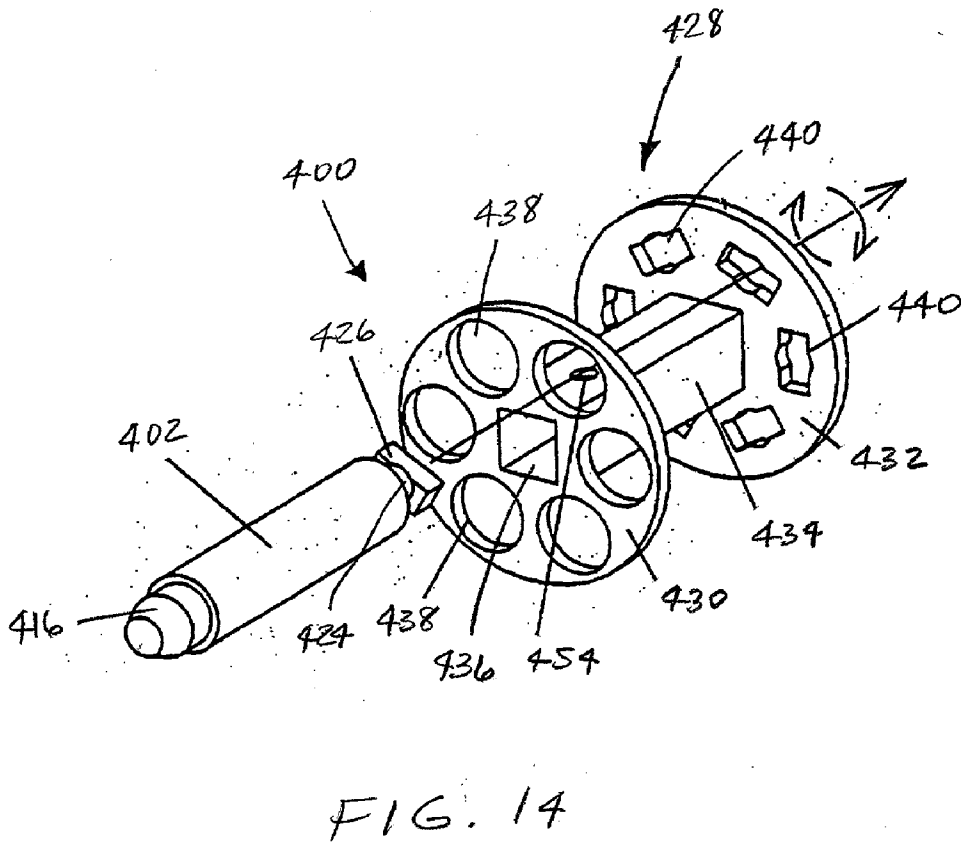
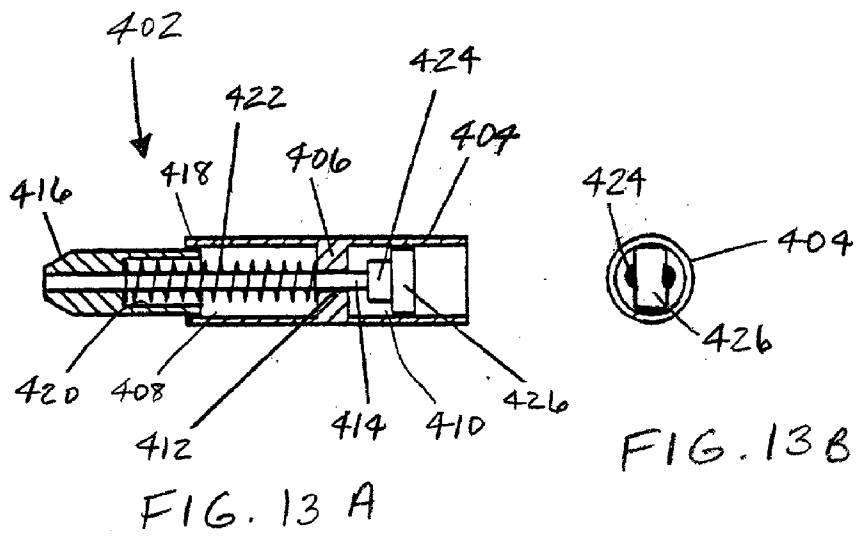
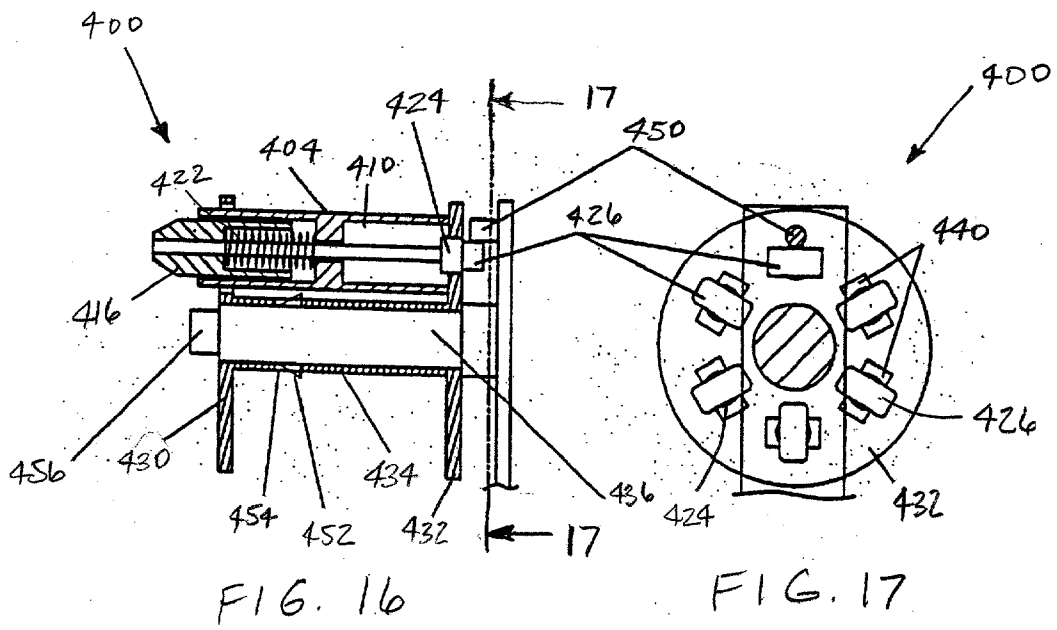
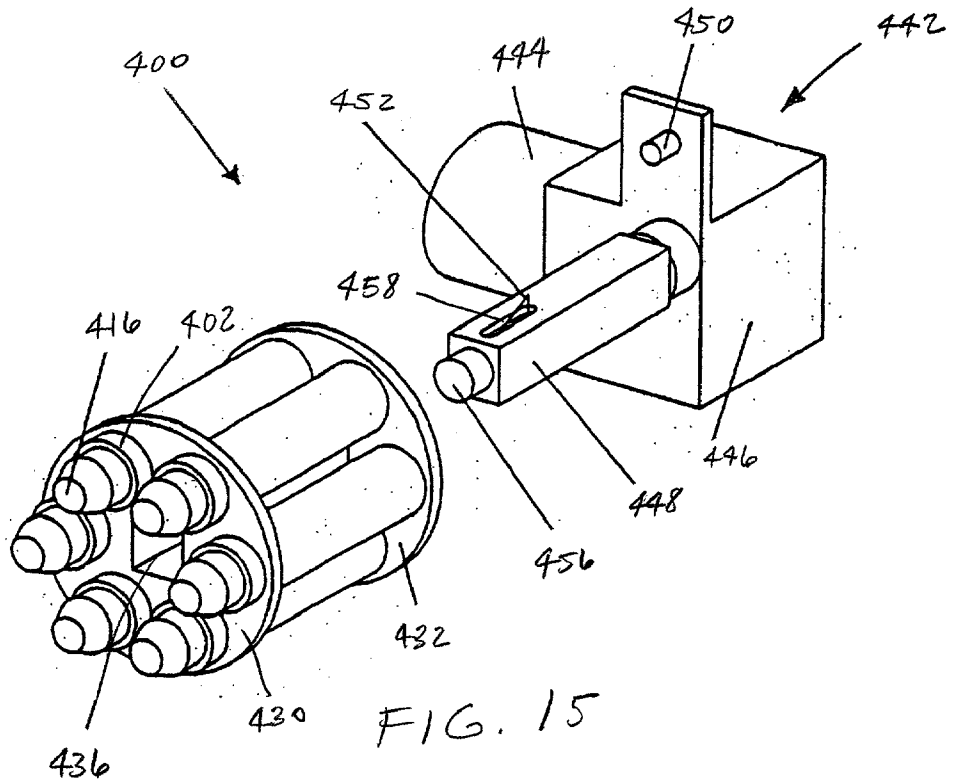


FIG. 12B





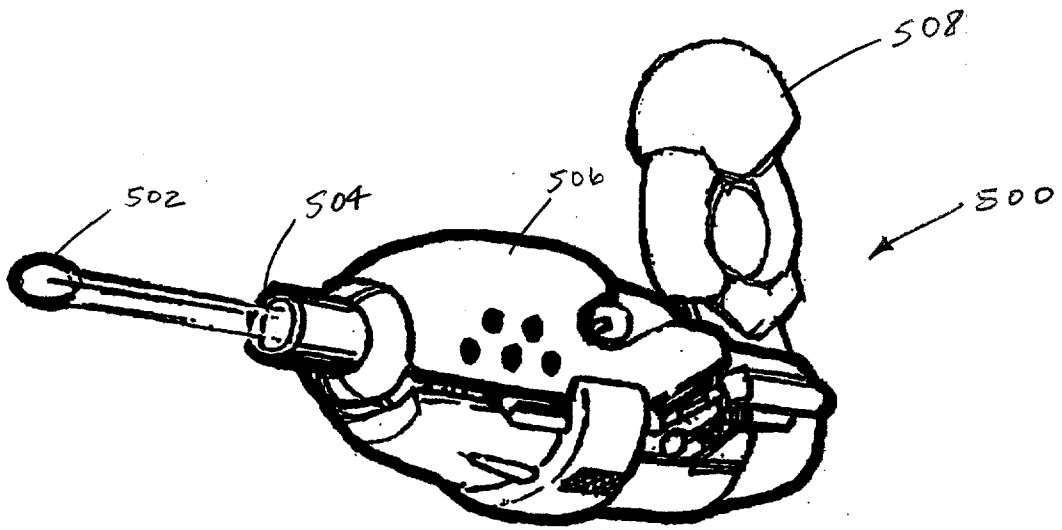


FIG. 18

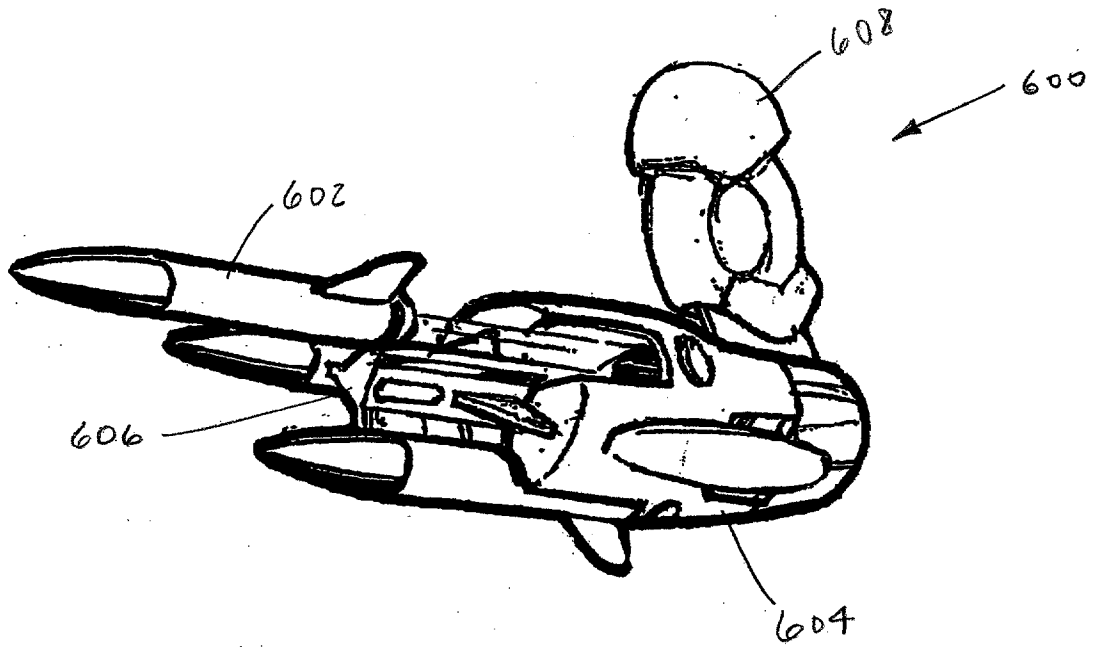


FIG. 19

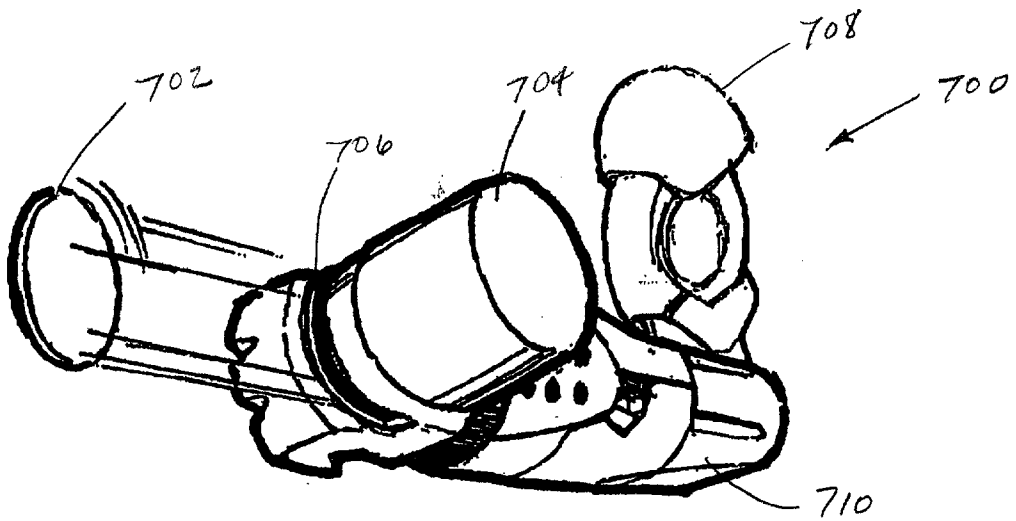


FIG. 20

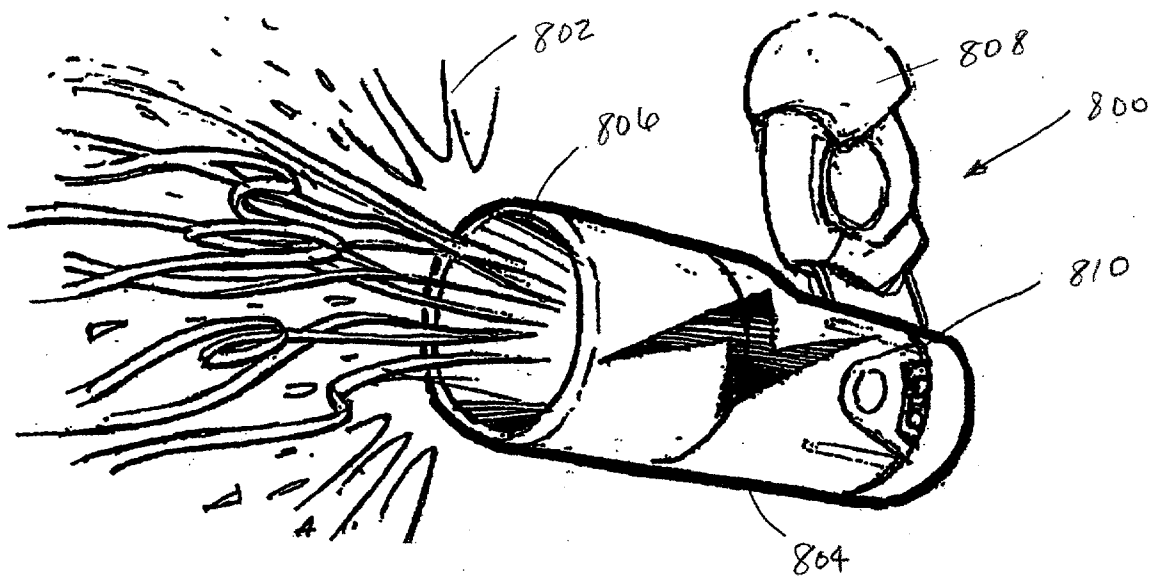


FIG. 21

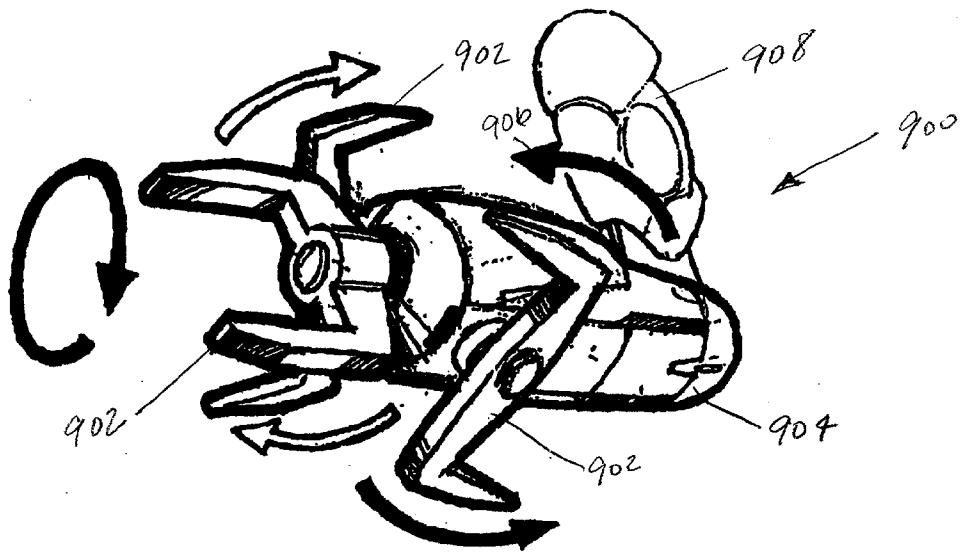


FIG. 22

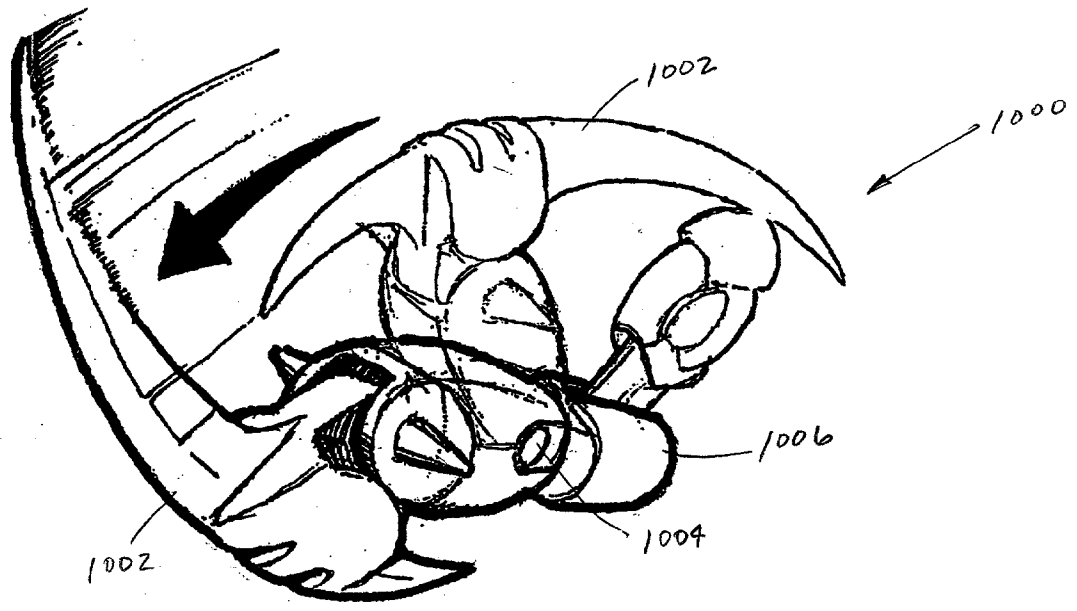
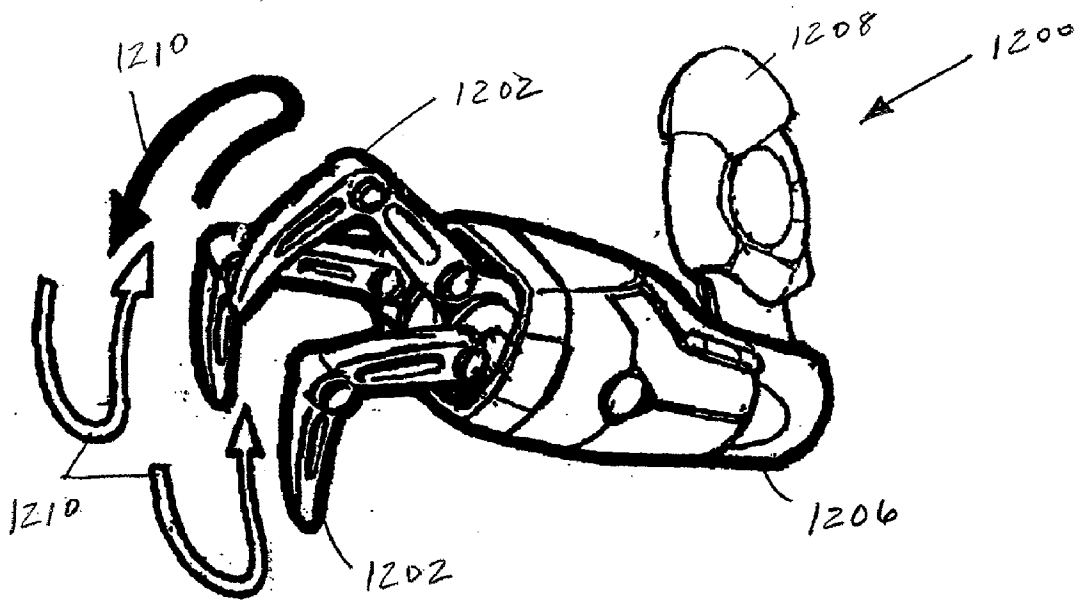
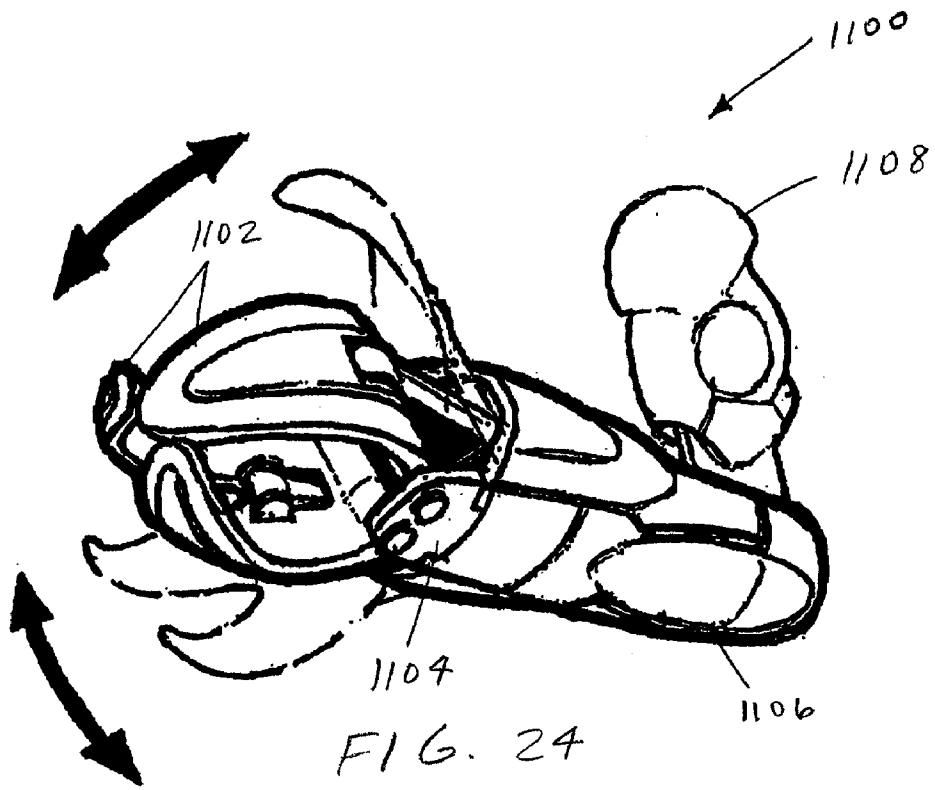


FIG. 23



TOY ROBOT APPARATUS AND METHOD

RELATED APPLICATIONS

[0001] Priority is claimed under 35 U.S.C. §119 to U.S. Patent Application Serial No. 60/289,376 filed May 8, 2001, the entire disclosure of which is incorporated herein by reference.

FIELD OF THE INVENTION

[0002] This invention relates generally to robotic devices, and more particularly to apparatuses and methods for toy robots.

BACKGROUND OF THE INVENTION

[0003] Many toy robots are capable of walking motion. Several of such toy robots having two legs simulate walking motion with wheels on the bottoms of two robotic legs. In these and other toy robots, the robotic legs usually appear to be in continuous contact with the ground, rather than rising and falling with respect to the ground. Also, toy robots having legs are typically unable to change directions effectively without having complex drive mechanisms in the robotic legs. For example, some two-legged toy robots capable of changing directions use a quadruple crank mechanism mounted to a drive gear via several other gears. These two-legged toy robots are often wide, cumbersome, and poorly maneuverable.

[0004] Many toy robots include some type of arm mechanism. If employed, such arm mechanisms are typically devices operable to open and close a hand or other gripping structure of the arm. Conventional toy robots generally do not include arm mechanisms capable of complex motions and/or functions. Conventional toy robots also do not include interchangeable arm mechanisms enabling several separate arm mechanisms to be attached to and detached from the toy robot in order to selectively perform various complex motions and/or functions.

[0005] In light of the problems and limitations described above, a need exists for a toy robot capable of improved simulated walking motion, such as walking motion using robotic legs and/or feet that rise and fall with respect to the ground. A need also exists for a toy robot capable of simulating walking motion and changing directions effectively by using a relatively-simple, miniaturized, and easily-controllable drive mechanism that preferably can be remotely controlled. A need further exists for a toy robot having one or more improved drive assemblies for driving the toy robot in various directions. A need also exists for a toy robot having arm mechanisms that are capable of complex motions and/or functions. In addition, a need exists for a toy robot having interchangeable arm mechanisms that can be attached to and detached from the toy robot in order to selectively perform various complex motions and/or functions.

SUMMARY OF THE INVENTION

[0006] Several embodiments of the present invention provide a toy robot capable of simulating walking motion with robotic legs and/or feet that rise and fall with respect to the ground. In some embodiments, the toy robot is also capable of changing directions effectively by using a relatively-simple, miniaturized, and easily-controllable drive mecha-

nism that can preferably be remotely controlled. Preferably, the toy robot is a two-legged toy robot with motors in each of the robotic feet for driving the toy robot in various directions. Also preferably, the independent motors can be controlled independently in order to provide an effective turning mechanism for the toy robot.

[0007] In some embodiments, the toy robot includes one or more arm mechanisms capable of complex motions and/or functions. The toy robot can also have interchangeable arm mechanisms that can be attached to and detached from the toy robot. Such mechanisms preferably perform different complex motions and/or functions. For example, the toy robot can include one or more of the following arm mechanisms: a grasping arm, a throwing arm, a firing arm, a toy missile launcher arm, a disc launcher arm, a toy explosive device arm, a drill arm, a blade arm, a claw arm, a spider claw arm, etc. Some embodiments of the grasping arm can preferably grasp objects and can also rotate (such as about a wrist). Some embodiments of the throwing arm can be used to pick up objects, hold the objects, and then throw the objects. Preferably, the firing arm, the toy missile launcher arm, the disc launcher arm, and the toy explosive device arm are capable of projecting various objects from the toy robot. The drill arm, the blade arm, the claw arm, and the spider claw arm each preferably include various rotating and/or translating members. Some embodiments of the toy robot also include a toy missile launcher device that can be mounted on the shoulder of the toy robot in order to launch toy missile-type objects from the toy robot.

[0008] The toy robot is preferably controlled by a remote control unit capable of communicating with the toy robot. For example, the remote control unit preferably includes a transmitter that communicates with a receiver on board the toy robot which in turn communicates with a processor on board the toy robot. The processor on board the toy robot is preferably electrically connected to the various motors and control mechanisms of the toy robot. Thus, control signals from the remote control unit are sent to the processor on board the toy robot in order to remotely control the various motions and functions of the toy robot.

[0009] The various embodiments of the present invention are described for use in toy robot devices. Although such applications are most preferred, it should be noted that the present invention finds utility in other robot applications, including robots used for exploration, manufacturing, assembly, military operations, and any other application in which robot assistance is beneficial or desirable. For purposes of discussion, the following description of the present application will with reference to toy robots, it being understood, however, that the present invention is not limited in this manner.

[0010] Further objects and advantages of the present invention, together with the organization and manner of operation thereof, will become apparent from the following detailed description of the invention when taken in conjunction with the accompanying drawings, wherein like elements have like numerals throughout the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The present invention is further described with reference to the accompanying drawings which show preferred embodiments of the present invention. However, it

should be noted that the invention as disclosed in the accompanying drawings is illustrated by way of example only. The various elements and combinations of elements described below and illustrated in the drawings can be arranged and organized differently to result in embodiments which are still within the spirit and scope of the present invention.

[0012] In the drawings, wherein like reference numerals indicate like parts:

[0013] FIG. 1 is a perspective view of a toy robot according to a preferred embodiment of the present invention;

[0014] FIG. 2 is a front elevational view of the toy robot;

[0015] FIG. 3 is a right side elevational view of the toy robot;

[0016] FIG. 4 is a right side elevational view of the toy robot, showing a number of the elements illustrated in FIG. 3 removed for clarity;

[0017] FIG. 5 is left side elevational view of the toy robot;

[0018] FIG. 6 is a partial perspective view of leg and foot mechanisms of the toy robot according to a preferred embodiment of the present invention;

[0019] FIGS. 7A-7D are side elevational views of the toy robot leg and foot mechanisms of the toy robot illustrated in FIGS. 4 and 5, shown in various stages of movement;

[0020] FIGS. 8A and 8B are front elevational views of the toy robot leg and foot mechanisms illustrated in FIGS. 7A-7D, shown in different stages of movement;

[0021] FIGS. 9A and 9B are side elevational views of the toy robot illustrated in FIGS. 4 and 5, shown with the arms of the toy robot removed and showing the toy robot's torso in different positions;

[0022] FIG. 10 is a side cross-sectional view of a toy robot grasping arm according to a preferred embodiment of the present invention;

[0023] FIGS. 11A and 11B are schematic views of the driving mechanism in the grasping arm illustrated in FIG. 10;

[0024] FIGS. 12A and 12B are side elevational views of a toy robot throwing arm according to a preferred embodiment of the present invention, shown in different stages of operation;

[0025] FIG. 13A is a side cross-sectional view of a toy missile for a shooting arm according to a preferred embodiment of the present invention;

[0026] FIG. 13B is a cross-sectional view of the toy missile shown in FIG. 13A;

[0027] FIG. 14 is a perspective view of a toy missile shooting arm according to a preferred embodiment of the present invention;

[0028] FIG. 15 is a partially exploded perspective view of the toy missile shooting arm illustrated in FIG. 14, shown loaded with toy missiles such as that shown in FIGS. 13A and 13B;

[0029] FIG. 16 is an assembled partial cross-sectional side view of the toy missile shooting arm illustrated in FIG. 15;

[0030] FIG. 17 is a cross-sectional view of the toy missile shooting arm illustrated in FIGS. 15 and 16, taken along line 17-17 of FIG. 16;

[0031] FIG. 18 is a perspective view of a projectile firing arm according to a preferred embodiment of the present invention;

[0032] FIG. 19 is a perspective view of a toy missile launcher arm according to a preferred embodiment of the present invention;

[0033] FIG. 20 is a perspective view of a disc launcher arm according to a preferred embodiment of the present invention;

[0034] FIG. 21 is a perspective view of a toy exploding device arm according to a preferred embodiment of the present invention;

[0035] FIG. 22 is a perspective view of a drill arm according to a preferred embodiment of the present invention;

[0036] FIG. 23 is a perspective view of a blade arm according to a preferred embodiment of the present invention;

[0037] FIG. 24 is a perspective view of a claw arm according to a preferred embodiment of the present invention;

[0038] FIG. 25 is a perspective view of a spider claw arm according to a preferred embodiment of the present invention; and

[0039] FIG. 26 is a schematic illustration of a control system for a toy robot according to a preferred embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0040] FIG. 1 illustrates a toy robot 10 according to a preferred embodiment of the present invention. Preferably, the toy robot 10 includes a torso 12 including an upper torso 14 and a lower torso 16 movable with respect to one another. The upper and lower torsos 14, 16 can preferably move with respect to one another in one or more different manners. For example, the upper torso 14 and the lower torso 16 can preferably twist with respect to one another about a substantially vertical axis. Also or alternatively, the upper torso 14 can preferably bend forward about a substantially horizontal axis so that the toy robot 10 bends at the waist (as shown in FIGS. 9A and 9B). In embodiments having upper and lower torsos 14, 16 movable with respect to one another, the upper torso 14 and the lower torso 16 can preferably move with respect to one another using any conventional mechanism, such as various drive motors, solenoids, hydraulic or pneumatic cylinders, or other actuators actuable to pivot the upper torso 14 about one or more pivots or rotational shafts, ball joints, hinges, or any other conventional pivot elements. In other embodiments, the torso 12 can be a single unit, without having separate portions for the upper torso 14 and the lower torso 16.

[0041] In some embodiments of the present invention, the toy robot 10 includes a head 18, a left arm 20, and a right arm 22 connected to the upper torso 14, and preferably movable with respect to the upper torso 14. If desired, the

head 18 can rotate about a substantially vertical axis with respect to the upper torso 14. In some embodiments, the head 18 includes eyes that preferably light up when the toy robot 10 is operated. In these and other embodiments, the head 18 can be incorporated into the upper torso 14 or the head 18 can be entirely omitted. As will be described in more detail below, the left arm 20 and/or the right arm 22 in some embodiments can preferably be comprised of a number of different arm mechanisms. The left arm 20 and the right arm 22 are each preferably rotatable with respect to the upper torso 14, such as by a ball joint, hinge, pivot pin, or other connection to the upper torso 14. In some preferred embodiments, either or both arms can be driven to move (e.g., pivot) using any suitable mechanism, such as those described above with regard to pivotable upper torso 14.

[0042] Preferably, the toy robot 10 includes a left leg 24 and a right leg 26 connected to the lower torso 16. In some embodiments, the left leg 24 is connected to a left foot 28, and the right leg 26 is connected to a right foot 30. The left foot 28 and the right foot 30 each preferably have a foot housing 32 which substantially covers one or more wheels. In the illustrated preferred embodiments for example, each foot 28, 30 has two primary wheels: a front primary wheel 34 and a rear primary wheel 36. Some preferred embodiments of the present invention employ foot housings 32 each connected to a respective link assembly 42 that operates to alternatively raise and lower the foot housings 32 so that the toy robot 10 appears to be walk when the link assemblies 42 are driven.

[0043] The link assembly 42 is preferably directly or indirectly connected to a body housing 44 positioned in the lower torso 16 of the toy robot 10. A body drive motor 46 located at least partially within the torso 14, 16 (and preferably in the lower torso 16) is preferably drivably connected to the link assemblies 42. The body drive motor 46 can be located within the body housing 44, can be coupled to the bottom of the body housing 44, or can be located elsewhere within the toy robot 10, if desired. As best shown in FIG. 6, the body drive motor 46 preferably includes a rotating crank shaft 48 connected to the link assembly 42.

[0044] With continued reference to FIG. 6, a preferred embodiment of the link assemblies 42 includes substantially identical left and right portions corresponding to the left leg 24 and the right leg 26, respectively. The link assembly 42 for the left leg 24 will be described in detail below. The link assembly 42 for the right leg 26 is preferably a substantially identical, mirror image of the link assembly 42 for the left leg 24. Elements and features of the link assembly 42 for the right leg 26 having a form, structure, or function similar to the link assembly 42 for the left leg 24 are given the same reference numbers herein and in the accompanying figures.

[0045] Prior to describing a preferred embodiment of the link assembly 42 in greater detail, it should be noted that the various elements of the link assembly 42 can take a number of different shapes and forms, and are only shown in FIG. 6 as straight, flat, and elongated members, links, or rods for purposes of description and easier understanding. In this regard, some of the elements of the link assembly 42 can define body and housing portions of the toy robot or can be separate interior or exterior elements of the robot leg 24, 26 associated with the link assembly 42. Accordingly, each of

the elements of the link assembly 42 can take any shape and size capable of performing the same functions described below.

[0046] The link assembly 42 preferably includes a front foot support rod 50, a back foot support rod 52, and a top connecting link 54. Preferably, the top connecting link 54 includes a first portion 56 and a second portion 58. In some embodiments, the first portion 56 is horizontal or relatively horizontal, while the second portion 58 is vertical or relatively vertical. The top ends of the front foot support rod 50 and the back foot support rod 52 are preferably rotatably coupled to the first portion 56 of the top connecting link 54 at different locations (e.g., front and back ends of the top connecting link 54). The bottom ends of the front foot support rod 50 and the back foot support rod 52 are preferably rotatably coupled to the foot housing 32. In the illustrated preferred embodiment for example, the bottom ends of the front and back foot support rods 50, 52 are rotatably connected to a front attachment plate 60 and a back attachment plate 62, respectively, which are each connected to the foot housing 32.

[0047] In the illustrated preferred embodiment of FIG. 6, the crank shaft 48 is preferably connected to the front foot support rod 50 by a crank shaft throw 64 and a pin 66. The crank shaft throw 64 is preferably connected to the front foot support rod 50 by the pin 66 in order to impart motion from the crank shaft 48 to the front foot support rod 50. As best shown in FIG. 6, although structurally identical, the crank shaft throw 64 for the left link assembly 42 is preferably positioned in a direction opposite to the direction of the crank shaft throw 64 for the right link assembly 42.

[0048] Returning to the description of the link assembly for the left leg 24 shown in FIG. 6, the link assembly 42 preferably also includes a foot control rod 68, the bottom end of which is preferably movably coupled to a lost motion linkage 70 (such as by a pin 72 and aperture 78 connection as illustrated). Preferably, the lost motion linkage 70 is rigidly connected to a wheel base 74 to which the primary wheels 34, 36 are rotatably connected. A spring 76 preferably connects the wheel base 74 to the foot control rod 68 and provides a biasing force between the wheel base 74 and the housing 32 in some positions of the lost motion linkage 70 (e.g., in the raised position of the pin 72 in the aperture 78 of the lost motion linkage illustrated in FIG. 6). In some embodiments, the maximum height of the raised position for the wheel base 74 is defined by the elongated aperture 78 in the lost motion linkage 70. The primary wheels 34 and 36 preferably slightly protrude from the bottom of the foot housing 32 (or are at least partially recessed within the foot housing 32) at one extreme of the lost motion linkage 70. In the illustrated preferred embodiment of FIG. 6 for example, the primary wheels 34, 36 are substantially retracted within the foot housing 32 when the pin 72 is positioned at the top of the elongated aperture 78. Conversely, the wheels 34 and 36 preferably protrude (or protrude further) from the bottom of the foot housing 32 at an opposite extreme of the lost motion linkage 70. In the illustrated preferred embodiment of FIG. 6 for example, the primary wheels 34, 36 are substantially extended from the foot housing 32 when the pin 72 is positioned at the bottom of the elongated aperture 78.

[0049] Preferably, the second portion 58 of the top connecting link 54 is also rotatably coupled to a toggle link 80,

such as by a pin **82** or other rotatable connection. For example, the top connecting link **54** can be rotatably connected to an end of the toggle link **80** by a pivot pin **82** as shown in **FIG. 6**. The toggle link **80** is preferably rotatable about a pivot in order to move the pin **82** (and therefore, the top connecting link **54**) to different positions. Preferably, the toggle link **80** is also rotatably connected to the foot control rod **68**, such as by a pin **84** or other rotatable connection. The pin **84** and toggle link **80** therefore transfers the motion of the top connecting link **54** to the lost motion linkage **70**.

[0050] Preferably, the front foot support rod **50** (e.g., the top end of the foot control rod **50** in the embodiment of **FIG. 6**) and the top connecting link **54** (e.g., the front end of the top connecting link **54** in the embodiment of **FIG. 6**) are each rotatably coupled to a stabilizing rod **86**, such as by a pin **88** or other rotatable connection. The stabilizing rod **86** is preferably rotatably coupled to the body housing **44**, such as by a pin **90** or other rotatable connection. In some preferred embodiments, the stabilizing rod **86** is rotatably connected to the front foot support rod **50** and the top connecting link **54** at one end, and is rotatably connected to the body housing **44** at an opposite end. The stabilizing rod **86** preferably provides additional stability to the link assembly **42**.

[0051] As mentioned above, although each of the rods, links, and members of the link assembly **42** described above are shown in **FIG. 6** as being substantially straight (or comprised of substantially straight portions), each of the rods, links, and members of the link assembly **42** can have any suitable shape, as long as the pivot points are positioned to produce the motions enabled by the elements described above. For example, as shown in **FIGS. 3-5** and **FIGS. 7-9**, the rods, links, and members of the link assembly **42** can have various complex shapes. Moreover, in some embodiments, the link assembly **42** can be simplified and/or miniaturized without requiring all of the described rods, links, and members. Also, the link assembly **42** (and any other portion of the toy robot **10**) is preferably covered by one or more suitable outer shells in order to give the toy robot **10** any desired appearance.

[0052] Each wheel base **74** preferably houses a drive motor **92** (as shown schematically in **FIGS. 2 and 3**) so that the wheels **34, 36** of the left and right feet **28, 30** can be driven to propel the toy robot **10**. Each motor **92** is connected to either or both wheels **34, 36** of the corresponding foot **28, 30**, and in some embodiments, is controlled independently of the other motor **92** in order to turn the toy robot **10**. If desired, caster wheels **94** can be provided for each of the feet **28, 30** in order to assist in guiding the turning motion of the toy robot **10**. By way of example only, caster wheels **94** can be rotatably mounted to the front and back of each foot housing **32** as best shown in **FIG. 6**. The caster wheels **94** preferably turn freely to reduce friction between the ground and the foot housing **32** as the toy robot **10** turns.

[0053] In operation, the body drive motor **46** preferably drives the crank shaft **48** in the direction indicated by the arrow in **FIG. 6**. The crank shaft throw **64** preferably imparts motion to the pin **66** which pivots with respect to the front foot support rod **50** and serves to raise and lower the front foot support rod **50**. Preferably, the crank shaft **48** and the pin **66** are misaligned with respect to one another so that as the crank shaft **48** turns, the support rod **50** (and therefore,

the leg **24**) moves rearwardly or forwardly from the position shown in **FIG. 6** as the foot support rod **50** and leg **24** move in upward and downward. This combined motion therefore better simulates walking motion of the toy robot **10**, whereby the feet **28, 30** move upward and downward as the feet are driven forward and rearward with respect to the body drive motor **46** (and therefore, the torso **14, 16**).

[0054] In order to better simulate the walking motion of the toy robot **10**, the front foot support rod **50** preferably pivots with respect to the front attachment plate **60** in order to raise and lower the front of the foot housing **32** while permitting relative rotation of the feet **28, 30** with respect to the link assemblies **42**. Due to the left and right crank shaft throws **64** being positioned in opposite directions in the illustrated preferred embodiment, when the front foot support rod **50** is raised on one side of the toy robot **10**, the front foot support rod **50** is lowered on the other side of the toy robot **10**, and vice versa. As a result, the left and right foot housings **32** preferably move up and down relative to the front and back wheels **34, 36** in order to give the left and right feet **28** and **30** the appearance of being alternately lifted off of the ground. In addition, the left and right foot housings **32** preferably appear to alternately support the weight of the toy robot **10** as it walks.

[0055] To further improve the simulated walking motion of the toy robot **10**, the front and back support rods **50, 52** are alternately lifted and lowered to selectively impart lifting forces to the front and rear of the foot housing **32**. To alternately lift and lower the front and back support rods **50, 52** in this manner, some embodiments of the present invention employ front and back support rods **50, 52** connected to the top connecting link **54** at different locations. With reference again to **FIG. 6** for example, the first portion **56** of the top connecting link **54** imparts reciprocal motion from the front foot support rod **50** and to the back foot support rod **52** (i.e., when the front foot support rod **50** is raised, the back foot support rod **52** is lowered, and vice versa). The back foot support rod **52** preferably pivots with respect to the back attachment plate **62** in order to raise and lower the back of the foot housing **32**. Similarly, the second portion **58** of the top connecting link **54** preferably imparts motion from the front foot support rod **50** through the toggle link **80** to the foot control rod **68** and the lost motion linkage **70**.

[0056] Preferably, the lost motion linkage **70** operates to retain the wheel base **74** substantially on the ground while the foot housing **32** moves up and down during at least part of the motion of the link assembly **42**. In some preferred embodiments, the foot housing **32** can only move up and down in a vertical direction relative to the wheel base **74**. In the illustrated preferred embodiment for example, the pin **72** connected to the foot control rod **68** moves vertically within the elongated aperture **78** of the lost motion linkage **70**, allowing the wheel base **74** and the wheels **34** and **36** to remain on the ground. Thus, movement of the foot control rod **68** is not always transferred to the wheel base **74**. Rather, movement of the foot control rod **68** is only transferred to the wheel base **74** when the pin **72** is at its extreme upper position or its extreme lower position within the slot **78**.

[0057] For embodiments of the present invention in which the wheels **34, 36** of each foot **28, 30** are driven by one or more motors **92** as described above, the wheels **34, 36** on the wheel base **74** preferably rotate at a speed and in a direction

according to each individual drive motor 92. In some preferred embodiments, the drive motor 92 of each foot 28, 30 can drive either or both wheels 34, 36 in a forward direction and a reverse direction. When the wheel base 74 protrudes below the bottom of the foot housing 32, the rotary motion of the front wheel 34 and/or the back wheel 36 preferably causes the foot housing 32 to move forward and backward relative to the body housing 44 in a simulated walking motion.

[0058] In some embodiments, the wheel base 74 also moves horizontally forward and backward relative to the body housing 44. The foot housing 32 preferably makes contact with the ground and stops moving while the foot housing 32 moves horizontally on the opposite side of the toy robot 10. This series of movements is repeated so that each foot housing 32 is alternately vertically lifted and horizontally moved in relation to one another.

[0059] While the crankshaft 48 turns, the drive motor 92 in the wheel base 74 preferably rotates either or both wheels 34, 36 in a forward or a backward direction. Depending on the direction and speed of each of the drive motors 92, the toy robot 10 can move forward, backward, or turn in either direction while carrying out the above-described walking movements. In order to turn the toy robot 10, one of the drive motors 92 preferably rotates either or both wheels 34, 36 in a corresponding foot 28, 30 on one side of the toy robot 10 faster than the other drive motor 92 rotates either or both wheels 34 and 36 in the other foot 30, 28 on the other side of the toy robot 10. If desired, caster wheels 94 can support the foot housing 32 when the toy robot 10 is turning in order to reduce friction between the bottom of the foot housing 32 and the ground. When the toy robot 10 is moving backward, the direction of the crank shaft 48 is preferably reversed so that the foot housing 32 moves according to a backward walking motion.

[0060] FIGS. 7A-7D illustrate various positions of the foot housing 32 and wheel base 74 of the left leg 24 in one preferred embodiment of the present invention. For example, FIG. 7A illustrates the caster wheels 94 in contact with the ground and the foot housing 32 in a lowered position, while the front and back wheels 34, 36 of the wheel base 74 are not in contact with the ground. However, in some embodiments, the front and back wheels 34, 36 are always in contact with the ground. FIGS. 7B and 7D illustrate the foot housing 32 in a lowered position so that the caster wheels 94 are in contact with the ground, in addition to the front and back wheels 34, 36 being in contact with the ground. FIG. 7C illustrates the foot housing 32 in a raised position so that the caster wheels 94 are raised off of the ground, while the front and back wheels 34, 36 of the wheel base 74 are in contact with the ground. FIGS. 8A and 8B also illustrate (from the front of the toy robot 10) various positions of both foot housings 32 and wheel bases 74 in one preferred embodiment of the present invention. For example, FIG. 8A illustrates the foot housing 32 of the right foot 30 in a raised position with respect to the ground while the front wheel 34 of the right foot 30 is in contact with the ground and while (at the same time) the caster wheels 94 of the left foot 28 are in contact with the ground and the wheel base 74 of the left foot 28 is off the ground. FIG. 8B illustrates an arrangement opposite to that of FIG. 8A. Moreover, in some embodiments, a rotating track propulsion

system or any other suitable propulsion system can replace the wheels 34, 36 as described above.

[0061] Also in some embodiments, guide plates (not shown) including grooves are provided for establishing the range of movement for the front foot support rod 50, the back foot support rod 52 and/or the foot control rod 68. Guide grooves can receive either or both ends of any of the pins or other pivots 66, 72, 82, 84, 88 in the link assembly 42, or can receive and guide any part of the link assembly 42 (such as for guiding, directing, and stabilizing the rods 50, 52 and/or 68). Such guide elements are especially preferable in order to stabilize the horizontal movements of the rods 50, 52 and/or 68.

[0062] Additional features of the present invention relate to the use of toy robot arm mechanisms. Specifically, some embodiments of the toy robot 10 according to the present invention include one or more types of arm mechanisms capable of performing one or more tasks or operations. The arm mechanisms can be permanently attached to the upper torso 14 of the toy robot 10. However, the arm mechanisms are more preferably detachable from the upper torso, and in some cases are detachable in order to enable the attachment of other (different) arm mechanisms. In such cases, each arm mechanism is preferably attachable to and detachable from the upper torso 14 of the toy robot 10 in order to allow the toy robot 10 to perform various different functions and motions interchangeably. The arm mechanisms can be attached to and detached from the upper torso 14 in any suitable manner. For example, each arm mechanism can include a male portion that is received by a female portion in the upper torso 14, or each arm mechanism can include a female portion that receives a male portion on the upper torso 14. The arm mechanism can be secured to the upper torso 14 in any suitable manner, such as by a press-fit connection, a snap-fit connection, a threaded connection, bolts, screws, mating pins and apertures, inter-engaging elements, or any other suitable releasable fasteners or fastening systems.

[0063] As shown in FIGS. 10, 11A, and 11B, some embodiments of the toy robot 10 include a grasping arm 200 preferably capable of grasping various objects and/or rotating. The grasping arm 200 illustrated in FIGS. 10, 11A and 11B includes a rotatable wrist 202 and two or more grasping levers 204. The grasping levers 204 pivot with respect to one another about a pivotable connection (e.g., pins 206 or any other pivotable connection desired) in order to converge upon and engage one or more objects positioned between the grasping levers 204. The proximal ends (i.e., toward the upper torso 14) of the grasping levers 204 are positioned in a circumferential groove 208 on a first circular plate 210 so that the grasping levers 204 are opened or closed by sliding the first circular plate 210 in a distal or outward direction (i.e., away from the upper torso 14) or in a proximal or inward direction (i.e., toward the upper torso 14), respectively. The proximal ends of the grasping levers 204 can instead be received within one or more grooves, recesses, or other apertures in any other element movable in distal and proximal directions as just described. Such alternative elements need not necessarily be circular, and can instead take any other shape desired.

[0064] Preferably, the rotatable wrist 202 is coupled to a wrist cylinder 212. A slide shaft 214 received through a

cylindrical aperture in the wrist cylinder 212 is preferably connected to the plate 210 in order to actuate the plate 210 and move the grasping levers 204 as described above. The slide shaft 214 can be actuated in a number of different manners, such as by a hydraulic or pneumatic cylinder, a solenoid, a motor, and the like. Preferably however, a pressing plate 216 is connected to the proximal end of the slide shaft 214 and is driven by rotation of a gear 228 driven by a motor as will be described in greater detail below.

[0065] In order to bias the pressing plate 216 into position to be driven by the gear 228, a second plate 218 is preferably secured to the slide shaft 214 and is located between the pressing plate 216 and the wrist cylinder 212, and provides a stop for a compression spring 222 seated against the pressing plate 216. The second plate 218 can take any shape or form desired capable of functioning as just described, and in the illustrated preferred embodiment is a second circular plate 218. Preferably, the second plate 218 has a circumferential ring 220 (e.g., an O-ring preferably made of rubber or other elastomeric material). In other embodiments, the second circular plate 218 and the rubber ring 220 are replaced by one or more gears. The compression spring 222 preferably biases the first circular plate 210 in the distal or outward direction in order to bias the grasping levers 204 in the closed position.

[0066] In some preferred embodiments such as that shown in FIG. 10, the grasping arm 200 includes a turning gear shaft 224 having a first worm gear 226 engaged with a turning gear 240 mounted for rotation within the grasping arm 200. When driven, the turning gear shaft 224 and first worm gear 226 preferably operate to rotate the grasping levers 204 by driving the turning gear 240. Specifically, the turning gear 240 preferably meshes with and drives the ring 220 to rotate the grasping arm 200. Although preferred, this mechanism represents only one of several driving mechanisms that can be used to turn the grasping levers 204. In other embodiments, more than one opening/closing gear can be used. For example, several opening/closing gears can be positioned to form a circle on the periphery of the first circular plate 210.

[0067] In addition or alternatively, the grasping arm 200 in some preferred embodiments includes an opening/closing gear 228 having a second worm gear 238 engaged with an opening/closing gear 228. A pressing pin 230, extension, cam, or other element on the opening/closing gear 228 is preferably positioned to contact and drive the pressing plate 216.

[0068] Mechanical power can be transmitted to the turning gear shaft 224 and to the opening/closing gear shaft 236 in a number of different manners. In the illustrated preferred embodiment for example, the grasping arm 200 includes a first rotation transfer gear 232 and a second rotation transfer gear 234. The first rotation transfer gear 232 is coupled to the turning gear shaft 224, while the second rotation transfer gear 234 is coupled to the opening/closing gear shaft 236. The first and second rotation transfer gears 232 and 234 are preferably each positioned a distance from the rotatable wrist 202. In some preferred embodiments, the turning gear shaft 224 and the opening/closing gear shaft 236 are disposed on opposite sides of and parallel to the wrist cylinder 212.

[0069] Preferably, the grasping arm 200 further includes a drive gear 242 which is selectively engagable with the first

and second rotation transfer gears 232 and 234 in order to selectively drive the gear shafts 224, 246. The drive gear 242 is preferably connected to a gearbox 244 and a drive motor 246 (preferably a bi-directional drive motor 246). Although not required to practice the present invention, the purpose of the gearbox 244 is to decelerate the speed of the drive motor 246 to an appropriate rate for controlling the functions of the grasping arm 200. Preferably, a single drive motor 246 is used to control both the opening/closing and the turning functions of the grasping arm 200.

[0070] As shown schematically in FIGS. 11A and 11B, the drive gear 242 is preferably positioned in engagement with a pinion gear 248. The drive gear 242 and the pinion gear 248 are preferably mounted on a gear plate 250 or other common element. The pinion gear 248 is preferably connected to an output shaft 252 of the gearbox 244. The direction that the pinion gear 248 rotates determines which one of the first and second rotation transfer gears 232 and 234 the drive gear 242 engages (i.e., if the output shaft 252 rotates in one direction, the planetary gear engages the first rotation transfer gear 232, and if the output shaft 252 rotates in the other direction, the planetary gear engages the second rotation transfer gear 234). The direction that the pinion gear 248 rotates also preferably determines the direction that the drive gear 242 rotates. Also, the direction that the drive gear 242 rotates preferably determines whether the grasping levers 204 are opened or closed. The direction that the planetary gear 242 rotates preferably also determines the direction that the rotatable wrist 202 rotates.

[0071] With reference to the preferred embodiment of the grasping arm 200 illustrated in FIGS. 10, 11A, and 11B, the operation of the grasping arm 200 is performed by first selecting whether to turn the rotatable wrist 202 or to open or close the grasping levers 204. The selection between the two functions is made by selecting the direction in which the drive motor 246 turns. Depending upon which direction the pinion gear 248 is rotated by the output shaft 252 of the gearbox 244, the planetary gear 242 engages and rotates one of the first and second rotation transfer gears 232 and 234. When the planetary gear 242 engages and rotates the first rotation transfer gear 232, the first worm gear 226 turns. The first worm gear 226 engages the turning gear 240. The teeth of the turning gear 240 are pressed into contact with the rubber ring 220 on the second circular plate 218 in order to cause the rubber ring 220 and the rotatable wrist 202 to rotate.

[0072] When the planetary gear 242 engages and rotates the second rotation transfer gear 234 in a first direction, the second worm gear 238 turns in the first direction. The second worm gear 238 engages the opening/closing gear 228. The pressing pin 230 on the opening/closing gear 228 engages and moves the pressing plate 216 in the distal or outward direction toward the grasping levers 204. The pressing plate 216 correspondingly moves the slide shaft 214 (within the wrist cylinder 212) and the first circular plate 210 in the distal or outward direction to cause the grasping levers 204 to open. When the planetary gear 242 engages and rotates the second rotation transfer gear 234 in a second direction, the second worm gear 238 turns in the second direction. The second worm gear 238 engages the opening/closing gear 228. The pressing pin 230 on the opening/closing gear 228 does not engage the pressing plate 216. When the pressing pin 230 is not in contact with the pressing plate 216, the first

circular plate **210** moves proximally or inward (i.e., toward the upper torso **14**) due to the biasing force of the compression spring **222**. In this manner, the grasping levers **204** are normally in the closed position and are able to clutch objects in their grasp.

[0073] In some embodiments, the grasping arm **200** also includes an elbow mechanism **254** which preferably allows the grasping arm **200** to bend about an elbow shaft **256**.

[0074] As shown in FIGS. 1, 2, 3, 12A, and 12B, some embodiments of the toy robot **10** include a throwing arm **300** preferably capable of picking up and throwing a ball **302**. Any type of ball **302** can be employed depending at least partially upon the particular manner in which the ball **302** is retained by the throwing arm **300**. In some preferred embodiments for example, the ball **302** has a polyhedral shape with flat surfaces as shown in FIGS. 12A and 12B. In other embodiments, the ball **302** can have any other suitable shape, such as a spherical shape with or without flat surfaces.

[0075] Preferably, the throwing arm **300** includes a forearm assembly **304** and an upper arm assembly **306**, although a throwing arm without identifiable forearm and upper arm sections can also be employed as desired. With reference to the embodiment illustrated in FIGS. 12A and 12B, the forearm assembly **304** preferably includes a slide bar **308** preferably including a first slot **310** and a second slot **312**. The slide bar **308** can preferably slide forward (or distally) and backward (or proximally) a predetermined distance defined by the lengths of the first slot **310** and the second slot **312**. Preferably, a first pin **314** is connected to the forearm assembly **304** and is received within the first slot **310**, and a second pin **316** is connected to the forearm assembly **304** and is received within the second slot **312**. A third pin **318** positioned between the first pin **314** and the second pin **316** and connected to the slide bar **308** can be employed in order to connect an extension spring **320** to the slide bar **308**. Preferably, the compression spring **320** is positioned between the first pin **314** and the third pin **318** in order to bias the slide bar **308** outwardly or distally away from the upper arm assembly **306**.

[0076] By virtue of the slide bar and pin structure just described, the slide bar **308** is preferably spring biased in a distal or outward direction in order to eject a ball **302** from the forearm assembly **304** as will be described in greater detail below. The pins **314**, **316** in the slots **310**, **312** of the slide bar **308** guide and stabilize the slide bar **308** as it retracts under force from the spring **320** and as it extends in its ejection movement. Although the slide bar and pin structure described above and illustrated in FIGS. 12A and 12B is preferred, it should be noted that this structure is one of several that can be employed to spring bias a pin, rod, bar, or other element into a retracted position and to provide an element that can move under action of the spring toward and against the ball **302** in the throwing arm **300**. Each of these alternative elements and mechanisms fall within the spirit and scope of the present invention.

[0077] An angled plate **322** is preferably connected to or integral with the distal end of the slide bar **308** in order to contact the ball **302**. Other distal end shapes of the slide bar **308** can be employed as desired. A cup-shaped structure **332**, frame, or receptacle is preferably connected to the distal end of the forearm assembly **304** in order to hold the ball **302** therein. The cup-shaped structure **332** can have any shape

that corresponds to the particular shape of the ball **302**. The cup-shaped structure **332** can also have a shape corresponding to the particular shapes of several different types of balls or other objects.

[0078] In some embodiments, the cup-shaped structure **332** includes one or more magnets **334**. For example, a front magnet **336** and a back magnet **338** can be connected to the cup-shaped structure **332**. In such embodiments, the ball **302** is preferably constructed of a lightweight material with one or more metallic pieces that are attracted to the magnet(s) on the cup-shaped structure **332**. By way of example only, the ball **302** in the illustrated preferred embodiment has thin metallic pieces **340** coupled to the exterior thereof. The ball **302** (which can be constructed of paper, plastic, closed-cell foam, or other preferably lightweight material) preferably has one or more pieces of thin, lightweight iron **340** coupled to flat surfaces **342** on the exterior or interior of the ball **302**. The thin metallic pieces **340** are attracted to the magnets **334** on the cup-shaped structure **332**.

[0079] The slide bar **308** can preferably be retained in a retracted and spring-biased position using any conventional latch structure. One such structure is illustrated in FIGS. 12A and 12B by way of example. Specifically, a hook engagement member **324** is preferably connected to the proximal end of the slide bar **308** in order to couple the slide bar **308** to the upper arm assembly **306**. The hook engagement member **324** includes a base **326** connected to or integral with the proximal end of the slide bar **308**. The hook engagement member **324** preferably extends to an end **330** which is shaped to be engaged with a hook **346** on the throwing arm **300**. The hook engagement portion **324** of the slide bar **308** can take any shape desired capable of being engaged with and retained by the hook **346** as will be described below, all such shapes falling within the spirit and scope of the present invention.

[0080] The upper arm assembly **306** preferably includes an upper arm link **344** and the hook **346**, although the hook **346** can be movably connected to the forearm assembly **304** to move toward and engage the hook engagement member **324**. In some preferred embodiments, the upper arm link **344** is pivotally coupled to the end **330** of the hook engagement member **324** by a first pivot pin **348**. If desired, the hook **346** can be pivotally coupled to the upper arm link **344** by a second pivot pin **350**. With continued reference to the illustrated preferred embodiment of FIGS. 12A and 12B, the hook **346** preferably includes a boss **352** and a recess **354**. As shown in FIG. 12B, the boss **352** is preferably adapted to extend downward into contact with the first pivot pin **348**. As shown in FIG. 12A, the recess **354** is preferably adapted to releasably receive the end of the hook engagement member **324**.

[0081] As shown in FIG. 12A, the throwing arm **300** is grasping a ball **302**. The upper arm link **344** rotates and extends outward (i.e., at an angle away from the upper torso **14**) so that the elbow of the throwing arm **300** preferably bends. The upper arm link **344** can be rotated by a drive motor (not shown) or by any other suitable driving device or mechanism. When the upper arm link **344** extends outward, the end **330** of the hook engagement portion **324** is preferably pushed inward (i.e., toward the upper torso **14**) in order to retract the slide bar **308** inwardly. Also, when the upper arm link **344** extends outward, the hook **346** rotates down-

ward into engagement with the base 326 of the hook engagement portion 324 in order to hold the slide bar 308 in the retracted position. Preferably, the weight of the hook 346 causes the hook 346 to rotate downward into engagement with the base 326 of the hook engagement portion 324. However, the hook 346 can also be biased in any suitable manner to rotate downward. When the slide bar 308 and the angled plate 322 are retracted inwardly, the thin metallic pieces 340 are able to come into close enough contact with the magnets 334 in order to become attracted by the magnets 334 so that the ball 302 is held within the cup-shaped structure 332.

[0082] As shown in FIG. 12B, the throwing arm 300 can be activated to throw the ball 302. Specifically, as the upper arm link 344 rotates inward (i.e., toward the upper torso 14), the elbow of the throwing arm 300 preferably straightens. When the upper arm link 344 extends inward, the first pivot pin 348 contacts the boss 352 of the hook 346 in order to release the hook 346 from engagement with the base 326 of the hook engagement portion 324. When the hook 346 is released, the slide bar 308 thrusts outward due to the biasing force of the compression spring 320. As the slide bar 308 thrusts outward, the angled member 322 contacts and ejects the ball 302 from the attraction of the magnets 334 in order to throw the ball 302.

[0083] As shown in FIGS. 13-17, the toy robot 10 can include a toy missile launcher 400 preferably capable of launching one or more toy missiles 402. The toy missile launcher 400 can be permanently or releasably mounted on any part of the toy robot 10, such as on a shoulder of the toy robot 10, incorporated into an arm that can be permanently connected to the toy robot 10, incorporated into an arm that is attachable to and detachable from the toy robot 10.

[0084] The toy missiles 402 of the toy missile launcher 400 can take a number of different form, and in some preferred embodiments are spring biased to enable the toy missiles 402 to be self-propelled from an ejector (i.e., the toy missile launcher). One such self-propelled toy missile is illustrated in FIGS. 13A and 13B. In this embodiment, the toy missiles 402 preferably each include a cylindrical body 404 with a partition wall 406 or other body portion that can stop the stopper collar 424 when the stopper collar 424 impacts the partition wall 406 under force of a spring 422 during launch of the toy missile 402 as will be described below. The partition wall 406 or body portion can have any shape and can take any form capable of stopping movement of the stopper collar 424 as just described, and in some embodiments divides the cylindrical body 404 into a first portion 408 and a second portion 410. In some embodiments, a slide shaft hole 412 extends through the partition wall 406 and receives a slide shaft 414.

[0085] A spring-loaded tip 416 is preferably received within a first end 418 of the cylindrical body 404. The tip 416 can have any desired shape, such as a faceted shape (as shown in FIG. 13A), a rounded shape, an arrow shape, a square shape, etc. The tip 416 preferably includes a recessed portion 420 within which the slide shaft 414 is positioned. Alternatively, the tip 416 and the slide shaft 414 can be integral with one another or can be attached together in any manner. The spring 422 is preferably a coil spring received over the slide shaft 414 within the first portion 408 of the cylindrical body 404, but can take any other form capable of

exerting spring force against the tip 416. In the preferred embodiment illustrated in FIGS. 13A and 13B, a portion of the spring 422 extends into the recessed portion 420 of the tip 416 in order to bias the tip 416 away from the partition wall 406. The stopper collar 424 is preferably received in the second portion 410 of the cylindrical body 404, and functions to stop the slide shaft 414 after release of the toy missile 402. The stopper collar 424 can have any shape capable of performing this function.

[0086] The slide shaft 414 preferably has a portion or has an element attached thereto that can be retained in order to hold the slide shaft 414 in place within the toy missile 402 in a spring-loaded position. One example of such an element is stopper 426 on the slide shaft 414 of the illustrated preferred toy missile in FIGS. 13A and 13B. The stopper 426 can have any shape capable of being retained by the toy missile launcher 400, and in the illustrated preferred embodiment is bar-shaped. The size of the stopper 426 is preferably less than the diameter of the interior of the cylindrical body 404 so that the stopper 426 can be positioned inside the cylindrical body 404. Similarly, the size (e.g., diameter) of the stopper collar 424 is preferably greater than the width of the stopper 426 as shown in FIG. 14B.

[0087] As shown in FIG. 14, the toy missile launcher 400 preferably includes a magazine 428 for receiving several toy missiles 402 (e.g., six missiles 402 as shown and described herein, although the toy missile launcher 400 can be adapted to hold any other number of toy missiles 402 as desired). In some preferred embodiments, the magazine 428 includes a front loading plate 430 and a check plate 432 coupled to either end of a pipe 434 tube, or magazine frame. Preferably, the pipe 434 is shorter in length than the missiles 402. The pipe 434 is preferably hollow with an elongated aperture 436. Although shown as having a square-shaped cross section, the pipe 434 can have any other cross-sectional shape desired. The front loading plate 430 includes one or more holes 438 for receiving the cylindrical bodies 404 of the toy missiles 402. The holes 438 thus preferably have a diameter slightly greater than the diameter of the toy missiles 402. For each hole 438 on the front loading plate 430, the check plate 432 preferably includes a corresponding, elongated hole 440. The elongated holes 440 are preferably shaped to receive the stopper collar 424 and the bar-shaped stopper 426 of the toy missiles 402. The space between each one of the holes 438 and each one of the corresponding elongated holes 440 is preferably adapted to receive one missile 402. The toy missiles 402 are loaded into the magazine 428 by inserting the cylindrical body 404 through one of the holes 438 in the front loading plate 430 and inserting the stopper 426 into a corresponding one of the elongated holes 440 in the check plate 432. In order to hold each of the toy missiles 402 in the magazine 428, the stopper 426 of each missile 402 is preferably pulled backward and twisted with respect to the length of each of the elongated holes 440 (as shown in FIGS. 16 and 17). In addition to holding the toy missiles 402 in the magazine 428, pulling the stopper 426 backward through the check plate 432 preferably causes the spring 422 to become energized.

[0088] As shown in FIG. 15, a loaded magazine 428 can be attached to a firing drive 442. The firing drive 442 preferably includes a motor 444, a gearbox 446, and an output shaft 448. The motor 444 preferably drives the gearbox 446 which in turn preferably drives the output shaft

448. However, in some embodiments, the output shaft **448** can be manually rotated. Although not required to practice the present invention, the purpose of the gearbox **446** is to decelerate the speed of the motor **444** to an appropriate rate for controlling the magazine **428**. The pipe **434** of the magazine **428** is preferably inserted over the output shaft **448** of the firing drive **442**. The pipe **434** and the output shaft **448** preferably have corresponding cross-sectional shapes. In some preferred embodiments such as that shown in FIGS. **14-16**, the pipe **434** and the output shaft **448** each have a square cross-sectional shape so that when the output shaft **448** turns, the pipe **434** also turns. Other suitable cross-sectional shapes are also possible (e.g., a triangular, octagonal, or other polygonal shape, an irregular shape, and the like) as long as when the output shaft **448** turns, the pipe **434** also turns.

[0089] The firing drive **442** preferably includes one or more release pins (e.g., a single release pin **450** as shown in FIGS. **15-17** or two or more release pins so that two or more toy missiles can be fired at once). The release pin **450** is preferably positioned on the firing drive **442** a distance from the output shaft **448** that corresponds to the distance between each of the toy missiles **402** and the output shaft **448**. Preferably, the release pin **450** is positioned to engage the stopper **426** of each toy missile **402** in order to release the stopper **426** from the check plate **432** through the elongated hole **440**. Any alternative element or feature of the firing drive can be used as an alternative to the release pin **450**, including without limitation a cam, bump, or other protrusion extending from the firing drive or otherwise into a position where the stopper **426** will be contacted during rotation of the magazine **428**.

[0090] In some preferred embodiments of the present invention, the firing drive **442** includes one or more safety catches **452** which can be positioned (for example) on the output shaft **448**. The safety catch **452** can be a tab, finger, pin, or other element protruding from the output shaft **448**, and in the illustrated preferred embodiment is a wire protruding from the output shaft **448** in order to prevent the magazine **428** from unintentionally releasing from the output shaft **448** of the firing drive **442**. When the magazine **428** is attached to the output shaft **448**, the safety catch **452** preferably extends into a hole **454** or other aperture or recess in the pipe **434** (as shown in FIG. **14**). When the pipe **434** is positioned upon the output shaft **448**, the safety catch **452** is preferably compressed into an aperture **458** in the output shaft **448** until the safety catch **452** reaches the hole **454** in the pipe **434**. The safety catch **452** can then decompress and move out of the aperture **458** and into the hole **454** in the pipe **434**. In some preferred embodiments, the firing drive **442** also preferably includes a release button **456** that cooperates with the safety catch **452** to release the safety catch **452**. For example, when the release button **456** in the illustrated preferred embodiment of FIGS. **15-17** is pressed, the safety catch **452** is compressed into the aperture **458** in the output shaft **448** in order to allow the magazine **428** to be released from the output shaft **448**.

[0091] For a better understanding of the toy missile launcher, operation of the exemplary embodiment illustrated in FIGS. **13A-17** will now be discussed. In order to operate this toy missile launcher embodiment, several missiles **402** are inserted into the holes **438** in the front loading plate **430**. The stopper **426** of each missile **402** is inserted through the

elongated hole **440** on the check plate **432** that corresponds to each hole **438** in the front loading plate **430**. The stopper **426** is then rotated (e.g., rotated about 90 degrees) in order to secure the missile **402** into the magazine **428**. Once the magazine **428** is loaded, the output shaft **448** of the firing drive **442** is inserted into the elongated aperture **436** of the pipe **434**. The safety catch **452** decompresses into engagement with the hole **454** in the pipe **434** to prevent the magazine **428** from releasing from the firing drive **442**.

[0092] When the output shaft **448** is rotated by the motor **444** and the gearbox **446**, the release pin **450** on the firing drive **442** contacts the stoppers **426** of each of the missiles **402**. The release pin **450** causes each stopper **426** to turn so that the stopper **426** fits through the elongated hole **440** on the check plate **432**. Once the stopper **426** is released from the check plate **432**, the energized spring **422** projects the toy missile **402** forward out of the front loading plate **430**. Preferably, all of the toy missiles **402** that are loaded in the magazine **428** are fired in sequence as the output shaft **448** turns and the release pin **450** engages each stopper **426**. Once all of the toy missiles **402** are fired, the magazine **428** can be released from the firing drive **442** by pressing the release button **456** and manually removing the magazine **428** from the output shaft **448**.

[0093] Several additional arm mechanisms for use with a toy robot (such as the toy robot **10** illustrated in FIGS. **1-9B**) will be described below. Any of the arm mechanisms described herein can be permanently or releasably attached to a toy robot **10** in any combination, including two arm mechanisms of the same type on the same toy robot **10**. However, each of the arm mechanisms described herein is preferably attachable to and detachable from the upper torso **14** of the toy robot **10**. For example, the toy robot **10** can be sold with several interchangeable arm mechanisms, only two of which can be used at any given time. In the description of the arm mechanisms below, elements and features of each of the arm mechanisms having substantially the same form, structure, or function are given corresponding reference numbers in a different series (i.e., the **500, 600, 700, 800, 900, 1000, 1100, and 1200** series).

[0094] As shown in FIG. **18**, another type of arm mechanism according to the present invention is a firing arm **500** preferably capable of rapidly firing toy bullets **502**. The firing arm **500** is preferably activated by a spring mechanism to rapidly project toy bullets **502** (e.g., soft resin plastic beads or other elements preferably made of safe and non-toxic material) out of an opening **504** in the firing arm **500**. Preferably, several toy bullets **502** can be loaded into a body portion **506** of the firing arm **500**. The firing arm **500** can include several levels of firing action, such as single-bullet firing or rapid firing of the toy bullets **502**. The firing arm **500** also preferably includes an attachment mechanism **508** that can be used to attach the firing arm **500** to and detach the firing arm **500** from the upper torso **14** of the toy robot **10**. The attachment mechanism **508** can be any suitable attachment device that corresponds to an attachment portion of the upper torso **14**. Although the firing arm **500** can be non-movable with respect to the toy robot **10** to which it is attached, the attachment mechanism **508** is more preferably movable with respect to the upper torso **14** for a shoulder-type structure and/or with respect to the firing arm **500** for an elbow-type structure.

[0095] As shown in FIG. 19, another type of arm mechanism according to the present invention is a toy missile launcher arm 600 capable of firing toy missiles 602 (e.g., toy missiles made of soft foam, plastic, or other preferably safe and lightweight material). The toy missile launcher arm 600 can include some components similar to the components of the missile launcher 400 shown and described above with respect to FIGS. 13A-17. For example, the toy missile launcher arm 600 can include a firing drive 604 and an output shaft 606 (whether the output shaft 606 rotates or not). The toy missile launcher arm 600 preferably uses a spring mechanism to launch the toy missiles 602. The toy missile launcher arm 600 also preferably includes an attachment mechanism 608 that can be used to attach the toy missile launcher arm 600 to and detach the toy missile launcher arm 600 from the upper torso 14 of the toy robot 10. The attachment mechanism 608 can be any suitable attachment device that corresponds to an attachment portion of the upper torso 14. Although the toy missile launcher arm 600 can be non-movable with respect to the toy robot 10 to which it is attached, the attachment mechanism 608 is preferably movable with respect to the upper torso 14 for a shoulder-type structure and/or with respect to the missile launcher arm 600 for an elbow-type structure.

[0096] As shown in FIG. 20, another type of arm mechanism according to the present invention is a disc launcher arm 700 capable of firing discs 702 (e.g., discs made of a soft foam, plastic, or other preferably safe and lightweight material). The disc launcher arm 700 preferably includes a storage portion 704 for storing several discs 702. Also, the disc launcher arm 700 preferably uses a spring mechanism to project the discs 702 through an elongated opening 706 in a body portion 710 of the disc launcher arm 700. The disc launcher arm 700 can include several levels of firing action, such as single-disc firing or rapid firing of the discs 702. The disc launcher arm 700 also preferably includes an attachment mechanism 708 that can be used to attach the disc launcher arm 700 to and detach the disc launcher arm 700 from the upper torso 14 of the toy robot 10. The attachment mechanism 708 can be any suitable attachment device that corresponds to an attachment portion of the upper torso 14. Although the disc launcher arm 700 can be non-movable with respect to the toy robot 10 to which it is attached, the attachment mechanism 708 is preferably movable with respect to the upper torso 14 for a shoulder-type structure and/or with respect to the disc launcher arm 700 for an elbow-type structure.

[0097] As shown in FIG. 21, another type of arm mechanism according to the present invention is an exploding device arm 800 capable of triggering a burst of safe material 802 (e.g., a commercially available party cracker) and/or to simulate an exploding sound. The exploding device arm 800 preferably includes a cylindrical portion 804 with an opening 806 in one end and an actuating mechanism 810 in the other end. Preferably, the exploding device arm 800 also includes an attachment mechanism 808 that can be used to attach the exploding device arm 800 to and detach the exploding device arm 800 from the upper torso 14 of the toy robot 10. The attachment mechanism 808 can be any suitable attachment device that corresponds to an attachment portion of the upper torso 14. Although the exploding device arm 800 can be non-movable with respect to the toy robot 10 to which it is attached, the attachment mechanism 808 is preferably movable with respect to the upper torso 14 for a

shoulder-type structure and/or with respect to the exploding device arm 800 for an elbow-type structure.

[0098] As shown in FIG. 22, another type of arm mechanism according to the present invention is a drill arm 900 with one or more rotatable drill devices 902 attached to a body portion 904 of the drill arm 900. The body portion 904 of the drill arm 900 preferably includes one or more drive motors and rotational shafts in order to rotate the drill devices 902. Preferably, each of the drill devices 902 can be rotated at the same time and at the same speed or individually at different speeds. The drill devices 902 of the drill arm 900 are preferably designed to effectively attack the armor of another toy robot 10. The drill arm 900 also preferably includes an attachment mechanism 908 that can be used to attach the drill arm 900 to and detach the drill arm 900 from the upper torso 14 of the toy robot 10. The attachment mechanism 908 can be any suitable attachment device that corresponds to an attachment portion of the upper torso 14. Although the drill arm 900 can be non-movable with respect to the toy robot 10 to which it is attached, the attachment mechanism 908 is preferably movable with respect to the upper torso 14 for a shoulder-type structure and/or with respect to the drill arm 900 for an elbow-type structure (as indicated by the arrow 906 in FIG. 22).

[0099] As shown in FIG. 23, another type of arm mechanism according to the present invention is a blade arm 1000 capable of moving a blade 1002 or other weapon to produce a chopping motion. The blade 1002 or other weapon can be in any suitable shape or configuration (e.g., the pick axe shape shown in FIG. 24, a sledge hammer shape, etc.). The blade 1002 is preferably attached to the blade arm 1000 through a rotatable shaft 1004 powered by a drive motor in a body portion 1006 of the blade arm 1000 or powered by a manually-actuatable lever (not shown). The blade arm 1000 also preferably includes an attachment mechanism 1008 that can be used to attach the blade arm 1000 to and detach the blade arm 1000 from the upper torso 14 of the toy robot 10. The attachment mechanism 1008 can be any suitable attachment device that corresponds to an attachment portion of the upper torso 14. Although the blade arm 1000 can be non-movable with respect to the toy robot 10 to which it is attached, the attachment mechanism 1008 is preferably movable with respect to the upper torso 14 for a shoulder-type structure and/or with respect to the blade arm 1000 for an elbow-type structure.

[0100] As shown in FIG. 24, another type of arm mechanism according to the present invention is a claw arm 1100 including one or more claw levers 1102 and preferably a rotatable wrist 1104. The claw arm 1100 can include some components similar to the components of the grasping arm 200 shown and described above with respect to FIGS. 10-11B. Preferably, the claw arm 1100 uses a rotational or spring mechanism in a body portion 1106 of the claw arm 1100 to open and close the claw levers 1102 and to rotate the wrist 1104. The claw arm 1100 also preferably includes an attachment mechanism 1108 that can be used to attach the claw arm 1100 to and detach the claw arm 1100 from the upper torso 14 of the toy robot 10. The attachment mechanism 1108 can be any suitable attachment device that corresponds to an attachment portion of the upper torso 14. Although the claw arm 1100 can be non-movable with respect to the toy robot 10 to which it is attached, the attachment mechanism 1108 is preferably movable with

respect to the upper torso **14** for a shoulder-type structure and/or with respect to the claw arm **1100** for an elbow-type structure.

[0101] As shown in FIG. 25, yet another type of arm mechanism according to the present invention is a spider claw arm **1200** with claw members **1202** capable of producing a clawing-type motion (i.e., moving up and down and/or in and out to produce a rotational-type motion as indicated by arrows **1210**) with respect to a body portion **1206**. Preferably, the claw members **1202** move up and down in succession (i.e., one claw member **1202** is up while the other claw members **1202** are down). The claw members **1202** are also preferably adapted to tear body parts and/or armor off of another toy robot **10**. The spider claw arm **1200** also preferably includes an attachment mechanism **1208** that can be used to attach the spider claw arm **1200** to and detach the spider claw arm **1200** from the upper torso **14** of the toy robot **10**. The attachment mechanism **1208** can be any suitable attachment device that corresponds to an attachment portion of the upper torso **14**. Although the spider claw arm **1200** can be non-movable with respect to the toy robot **10** to which it is attached, the attachment mechanism **1208** is preferably movable with respect to the upper torso **14** for a shoulder-type structure and/or with respect to the spider claw arm **1200** for an elbow-type structure.

[0102] As shown schematically in FIG. 26, some preferred embodiments of the toy robot **10** according to the present invention include a control system **1300**. The control system **1300** can include a remote control unit **1302** for communication (preferably wireless communication) with the toy robot **10**. The remote control unit **1302** preferably includes a processor **1304** and a transmitter **1306**. The transmitter **1306** may also be a transceiver capable of transmitting signals to and receiving signals from the toy robot **10**. The toy robot **10** can be equipped with various sensors in order to communicate operational information back to the remote control unit **1302**. For example, the toy robot **10** could include position sensors for determining the position of the head **18**, the feet **28** and **30**, the arms **20** and **22**, and/or the upper and lower torsos **14** and **16**. Also, the toy robot **10** could include sensors within the arm mechanisms in order to sense when the various members (i.e., the toy bullets **502**, the toy missiles **602**, the discs **702**, and/or the exploding device **802**) fired by each of the arm mechanisms need to be refilled. In addition, sensors could be used to assist in aiming the various arm mechanisms in order fire the various members (i.e., the toy bullets **502**, the toy missiles **602**, the discs **702**, and/or the exploding device **802**) at the appropriate targets.

[0103] For those embodiments of the present invention employing a remote control unit **1302**, the remote control unit **1302** preferably communicates with a receiver **1308** and a processor **1310** on board the toy robot **10**. The receiver **1308** can also be a transceiver capable of receiving signals from and transmitting signals to the remote control unit **1302**. The processor **1310** is preferably electrically connected to one or more of the following: the body drive motor **46** in the body housing **44**, the drive motors **92** in each of the wheel bases **74**, the drive motor **246** in the grasping arm **200** (if the grasping arm **200** is attached to the toy robot **10**), and the motor **444** in the firing drive **442** (if the toy missile launcher **400** is attached to the toy robot **10**). Alternatively,

the processor **1310** could be omitted, and a receiver could be connected to each individual motor on board the toy robot **10**.

[0104] One or both of the processors **1304** and **1310** are preferably programmed to control the toy robot **10** in response to the output of user-manipulatable devices (not shown) (e.g., a steering wheel, buttons, levers, switches, etc.) on the remote control unit **1302**. For example, the remote control unit **1302** can be used to move the toy robot **10** forward and backward or to turn the toy robot **10** from side to side. In order to perform each of these functions, the processors **1304** and **1310** preferably send signals to the drive motors **92** so that the drive motors **92** operate in the proper direction and at the proper speed to perform such functions. The remote control unit **1302** can preferably control the motions and functions of each of the arm mechanisms described herein. In general, the remote control unit **1302** can be designed to control every function of the toy robot **10**. The various motors and components shown schematically in FIG. 26 are shown by way of example only, and the control system **1300** is not to be limited in scope to the motors and components shown in FIG. 26.

[0105] Although each of the various robotic devices and mechanisms described herein have been described with respect to the toy robot **10**, it should be noted that the various devices and mechanisms can also be used in gaming devices, movie or television props, exploration and scientific equipment, stage or display devices, theme parks, military applications, and the like.

[0106] The embodiments described above and illustrated in the figures are presented by way of example only and are not intended as a limitation upon the concepts and principles of the present invention. As such, it will be appreciated by one having ordinary skill in the art that various changes in the elements and their configuration and arrangement are possible without departing from the spirit and scope of the present invention as set forth in the appended claims.

We claim:

1. A toy robot capable of walking across a surface, the toy robot comprising:

- a motor;
- a crank shaft coupled to the motor;
- a left foot housing and a right foot housing;
- a link assembly connected to the motor, the link assembly including
 - a left support member rotatably coupled between the motor and the left foot housing;
 - a right support member rotatably coupled between the motor and the right foot housing;
- the crank shaft alternately moving the link assembly between
 - a first position in which the left foot housing is in a lowered position with respect to the surface and the right foot housing is in a raised position with respect to the surface; and

- a second position in which the left foot housing is in a raised position with respect to the surface and the right foot housing is in a lowered position with respect to the surface.
2. The toy robot of claim 1, further comprising:
- at least one left wheel;
 - at least one right wheel; and
 - the link assembly further comprising
 - a left control member rotatably coupled between the crank shaft and the at least one left wheel;
 - a right control member rotatably coupled between the crank shaft and the at least one right wheel.
3. The toy robot of claim 2, wherein the left foot housing substantially covers the at least one left wheel and the right foot housing substantially covers the at least one right wheel.
4. The toy robot of claim 2, wherein:
- when the link assembly is in the first position, the at least one left wheel is in contact with the surface and the at least one right wheel is not in contact with the surface; and
 - when the link assembly is in the second position, the at least one left wheel is not in contact with the surface and the at least one right wheel is in contact with the surface.
5. The toy robot of claim 2, further comprising a left lost motion linkage connected between the left control member and the at least one left wheel and a right lost motion linkage connected between the right control member and the at least one right wheel.
6. The toy robot of claim 2, further comprising:
- a left drive motor connected between the left control member and the at least one left wheel; and
 - a right drive motor operating independently of the left drive motor and connected between the right control member and the at least one left wheel.
7. A toy robot comprising:
- a torso having a shoulder attachment plate; and
 - a plurality of arm mechanisms attachable to and detachable from the torso, each one of the plurality of arm mechanisms including
 - a first end having an arm attachment plate attachable to and detachable from the shoulder attachment plate by at least one releasable fastener; and
 - a second end having at least one of grasping levers, a cup structure adapted to receive a ball, a toy bullet shooter, a toy missile launcher, a disc launcher, an exploding device, at least one rotatable drill, a movable blade, and at least one claw lever.
8. The toy robot of claim 7, wherein the second end has grasping levers movable between an open position and a closed position in which the grasping levers can hold an object.
9. The toy robot of claim 7, wherein the second end has a cup structure, the cup structure includes at least one magnet, and at least a portion of the ball is metallic and attracted to the at least one magnet.
10. The toy robot of claim 7, wherein the second end has a toy bullet shooter, the toy bullet shooter includes a body portion for storing a plurality of toy bullets, and the toy bullet shooter can fire the plurality of toy bullets from the body portion in succession.
11. The toy robot of claim 7, wherein the second end has a toy missile launcher including a spring mechanism to launch at least one toy missile.
12. The toy robot of claim 7, wherein the second end has a disc launcher, the disc launcher includes a storage portion for storing a plurality of discs, and the disc launcher can fire the plurality of discs from the storage portion in succession.
13. The toy robot of claim 7, wherein the second end has an exploding device retainer and the exploding device retainer includes an opening to receive an exploding device and an actuating mechanism.
14. The toy robot of claim 7, wherein the second end has at least one rotatable drill and the at least one rotatable drill includes a first rotatable drill that rotates about a first axis and a second rotatable drill that rotates about a second axis at an angle with respect to the first axis.
15. The toy robot of claim 7, wherein the second end has a movable blade, the movable blade is shaped like an axe, and the movable blade rotates about an axis.
16. The toy robot of claim 7, wherein the second end has at least one claw lever, each one of the at least one claw lever being movable up and down in succession, and the at least one claw lever being movable in and out of a body portion of the arm mechanism.
17. A toy robot capable of grasping an object, the toy robot comprising:
- a torso having a shoulder attachment plate; and
 - an arm mechanism including
 - a first end having an arm attachment plate connected to the shoulder attachment plate;
 - a body portion having
 - a drive motor with a rotatable shaft;
 - a first gear connected to the rotatable shaft; and
 - a second gear connected to the rotatable shaft; and
 - a second end having at least two grasping levers connected to the first gear and movable to open and closed positions by rotation of the first gear, and a rotatable plate connected to the second gear to rotate the at least two grasping levers.
18. The toy robot of claim 17, further comprising a spring connected between the first gear and the at least two grasping levers in order to bias the at least two grasping levers toward one another in a closed position.
19. The toy robot of claim 17, further comprising a first worm gear connected to a second gear shaft and positioned to engage the second gear and a second worm gear connected to a first gear shaft and positioned to engage the first gear.
20. The toy robot of claim 19, further comprising a drive gear connected to the rotatable shaft, a first rotation transfer gear connected to the second gear shaft, a second rotation transfer gear connected to the first gear shaft, and a motor gear in engagement with the drive gear, the motor gear movable between a first position in which the drive gear engages the first rotation transfer gear and a second position in which the drive gear engages the second rotation transfer gear.

21. A toy robot capable of receiving and throwing a ball, the toy robot comprising:

- a torso having a shoulder attachment plate; and
- an arm mechanism including
 - a first end having an arm attachment plate connected to the shoulder attachment plate;
 - a second end having a cup adapted to receive the ball; and
- a body portion having
 - a slide bar; and
 - a link connected to the slide bar, the link movable between a retracted position with respect to the cup and a second position in which the slide bar is extended into the cup.

22. The toy robot of claim 21, wherein the ball includes at least one metallic portion and the cup includes at least one magnet.

23. The toy robot of claim 21, wherein the ball is polyhedral shaped and the cup is polyhedral shaped to receive the polyhedral shaped ball.

24. The toy robot of claim 21, further comprising a spring connected to the slide bar to bias the slide bar toward the cup.

25. A toy robot capable of launching a plurality of toy missiles, the toy robot comprising:

- a torso including a toy missile launcher attachment plate; and

a toy missile launcher connected to the toy missile launcher attachment plate, the toy missile launcher including

- a magazine having
 - a pipe; and
 - at least one support plate connected to the pipe to releasably support a plurality of toy missiles; and
- a firing drive having
 - an output shaft positionable substantially over the pipe; and
 - a release pin positioned to contact each one of the plurality of toy missiles in the magazine as the output shaft rotates.

26. The toy robot of claim 25, wherein the output shaft has a cross-sectional shape corresponding to the cross-sectional shape of the pipe so that the pipe rotates when the output shaft rotates.

27. The toy robot of claim 25, wherein each one of the plurality of toy missiles includes a tip biased by a spring.

28. The toy robot of claim 25, wherein each one of the plurality of toy missiles includes a stopper releasably securable to one of the at least one support plates.

29. The toy robot of claim 25, wherein the firing drive includes a motor that rotates the output shaft.

30. The toy robot of claim 25, further comprising a safety catch connected to the output shaft to prevent the magazine from unintentionally releasing from the firing drive.

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