Morphological Chart Explanations

Throwing the Balls with a Desired Spin

Pressurized Air

This approach leverages air pressure to propel the ball forward with a controlled amount of spin. By adjusting the airflow direction and pressure, the system can vary the spin and speed of the ball.

2 Wheels and Spinning Head

In this design, the table tennis ball is positioned between two wheels that spin in opposite directions. The wheels impart both forward motion and spin to the ball, depending on their relative speeds and rotation directions. The rotating head allows for adjustable angles, enabling control over the type of spin on the ball.

3 Wheels

Each wheel rotates in a specific direction and at a controlled speed, allowing precise manipulation of the ball's spin and trajectory. By adjusting the speeds of the individual wheels, the mechanism can create various spins—topspin, backspin, or sidespin—depending on the configuration without rotating the head.

4 Wheels

Compared to the three-wheel configuration, the four-wheel mechanism provides even greater control over the ball's spin and speed. While the three-wheel setup can create a variety of spins by adjusting each wheel's speed, the four-wheel configuration allows for finer adjustments and increased stability in spin control. However, the three-wheel setup is typically simpler and may be sufficient for most standard spins, making four-wheel less efficient in terms of design complexity and energy consumption.

Small Adjustable Ledges

The ledges make contact with the ball at different points, and by adjusting their positions and angles, they impart various spins on the ball. This setup allows for subtle control over the ball's rotation, enabling a range of spin types by simply repositioning the ledges.

Belt

The belt moves at a controlled speed, driven by two motors, which allows it to transfer rotational energy to the ball as it makes contact. By adjusting the belt speed and direction, the system can create various spins. This method is relatively straightforward and efficient, making it suitable for delivering consistent spin due to longer contact with balls.

Friction Surface

The ball makes contact with a rotating friction pad, which transfers rotational energy to the ball. By adjusting the speed and direction of the friction pad, the mechanism can create various types of spin, such as topspin or backspin. This method is simple and effective, allowing for controlled spin with minimal mechanical complexity. However, it is less versatile.

Arm

The arm can move up and down, allowing it to hit the ball at different angles and positions, which determines the ball's spin and velocity. By controlling the force and angle, this setup can impart various spins, such as topspin or sidespin.

Speed

Throwing with Disk

The disks rotate in opposite directions, allowing them to grip and propel the ball forward with a desired speed. By adjusting the rotation speed of each disk, the mechanism can control the ball’s velocity and, to some extent, its spin.

Throwing with Propeller/Paddle

The motor drives the rotation of this component, which pushes the ball forward as each arm makes contact. By adjusting the rotational speed, the mechanism can control the ball's exit velocity.

Throwing with Spring

The spring is compressed and then released to apply force to the ball, propelling it forward. By adjusting the compression level, the mechanism can control the ball’s exit speed.

Slider-Crank

A motor drives a rotating wheel connected to a crank and slider mechanism, which generates linear motion. As the slider moves forward, it pushes the ball, imparting speed. By adjusting the motor's speed, the mechanism can control the velocity of the ball.

Pneumatic

The system consists of an air reservoir connected to a release valve positioned behind the ball. When the valve opens, a burst of compressed air pushes the ball out of the chamber at high speed. By adjusting the air pressure and valve timing, this setup can control the ball's exit velocity. Pneumatic mechanisms are highly effective for producing rapid, consistent shots.

Hydraulic

In a hydraulic ball-throwing mechanism, fluid pressure is used to drive a piston or actuator that propels the ball. This setup involves a hydraulic pump that generates pressure within a cylinder containing a piston. When activated, the piston moves forward, applying force to the ball and launching it at a desired speed.

Electromagnetic

An electromagnetic thrust mechanism for throwing a ball uses magnetic force to propel the ball forward. This setup involves an electromagnetic coil or a series of coils placed in a line behind the ball. When an electric current flows through the coils, it generates a magnetic field that pushes a magnetic or metal component attached to the ball or a pusher behind it, accelerating the ball forward. However, this approach requires that the ball or pusher have magnetic properties.

Yaw and Pitch Angle

Gear

Gear 1

A gear system controls the yaw angle of the ball’s trajectory. A partial or segment gear is attached to the thrower. The partial gear allows for controlled, limited rotation, which is used to adjust the yaw angle of the ball’s launch direction.

Gear 2

The mechanism rotates the entire throwing mechanism tower from its base, allowing the whole setup to pivot and adjust its orientation. This design typically uses a large, horizontal gear mounted at the base of the tower, connected to a motor that drives the gear's rotation. As the motor turns the base gear, it rotates the entire tower structure, enabling the throwing mechanism to change its yaw angle.

Single Worm Gear

A single worm gear to control the yaw angle of the ball's trajectory. The worm gear, driven by a motor, allows precise rotational control, enabling the mechanism to adjust the yaw angle by rotating the ball launcher left or right. This setup ensures stable positioning and accurate angle adjustments.

Bevel Gear

Two bevel gears are positioned at a right angle to each other. One gear is connected to a motor, which drives the rotation, and the other is attached to the ball launcher. By rotating the motor-driven bevel gear, the launcher's yaw angle is adjusted, allowing the ball to be directed left or right as needed.

Dual Slider-Crank

The mechanism uses a dual slider-crank system to control the yaw angle. In this design, two cranks are driven by motors to move sliders connected to the launcher. By adjusting the motion of each crank independently, the system can tilt the launcher left or right, allowing precise control over the yaw angle.

Four bar

The mechanism uses a four-bar linkage to control the yaw angle. In this setup, a motor drives a rotating crank, which is connected to a linkage system that adjusts the position of the launcher. The four-bar linkage enables the launcher to pivot left or right.

Double Worm Gear

A double worm gear system controls the pitch and yaw angles. The setup includes two worm gears positioned on either side of the launcher, each driven by its own motor. The worm gears provide precise rotational adjustments, allowing the mechanism to tilt up or down (pitch angle) and move horizontally.

Rope Controlled Head

A rope-controlled head adjusts the pitch angle. The mechanism uses a rope or cable attached to the throwing head, which can be pulled or released to tilt the launcher up or down, thereby changing the pitch angle.

Hydraulic Lever

The setup involves a hydraulic cylinder connected to a lever that tilts the launcher up or down, controlling the pitch. By adjusting the hydraulic fluid level, the cylinder extends or retracts, changing the launch angle of the balls.

Accepting Information from the User

Potentiometer

Using potentiometers, the mechanism allows the user to control frequency, speed, and launch angles (yaw and pitch) for each ball throw. Each potentiometer is dedicated to one parameter: one for frequency, adjusting the interval between throws; another for speed, setting the launch velocity; and additional potentiometers for yaw and pitch angles, defining the trajectory direction. This setup enables intuitive, real-time adjustments, providing smooth and precise control over the ball's release rate and path.

Encoder

The encoder serves as a digital input device to control the throw frequency. As the user rotates the encoder, it generates digital pulses that are counted by a microcontroller or processor, translating these pulses into a frequency setting. By turning the encoder clockwise or counterclockwise, the user can increase or decrease the frequency and trajectory information of the ball.

Touchscreen

Using a touchscreen interface, the mechanism allows the user to input frequency and trajectory parameters (such as speed, yaw, and pitch angles) for controlling ball throws. The touchscreen displays adjustable sliders or input fields for each parameter: one for frequency to set the interval between throws, one for speed to control the launch velocity, and others for yaw and pitch angles to determine the ball’s direction.

Buttons

Using buttons to control frequency and trajectory (speed, yaw, and pitch angles), the mechanism provides a straightforward interface for the user to make adjustments. Separate

buttons are designated for each parameter: frequency, speed, yaw, and pitch. The user can press "+" or "−" buttons to incrementally increase or decrease each setting. For example, pressing "+" on the frequency button increases the throw rate, while pressing "−" on the yaw button adjusts the horizontal angle left.

Remote (IR)

Using an infrared (IR) remote with buttons, the mechanism allows the user to control frequency and trajectory settings (speed, yaw, and pitch angles) wirelessly. The remote has dedicated buttons for each parameter, with "+" and "−" options to adjust frequency, speed, and angles incrementally. The user points the remote at the receiver on the mechanism and presses the appropriate buttons to increase or decrease values.

Mobile Application

Using a mobile application, the mechanism allows the user to control frequency and trajectory parameters (such as speed, yaw, and pitch angles) directly from their smartphone or tablet.

Wired Remote

Using a wired remote with buttons and potentiometers, the mechanism enables the user to adjust frequency and trajectory parameters (such as speed, yaw, and pitch angles) through a direct, reliable connection.

Allowing User to Position the Device

Manual Positioning

Clamps

Clamps allow the user to place the device securely on a table or other surface. The mechanism features adjustable clips and a lever that can be tightened to hold the device firmly in place.

Magnets

The mechanism includes magnetic poles (north and south) on the base, which provide a strong magnetic grip when placed on a compatible surface. The user can manually position the device and use the lever to lock it in place, ensuring stability during operation.

Suction Cups

The base of the device has suction cups, which adhere firmly when pressed down, providing stability during operation. The user can easily position the device anywhere on the surface and then activate the suction cups to lock it in place.

Rail System

The device is mounted on a rail, enabling it to slide smoothly in the designated direction. By adjusting its position along the rail, the user can control where the device is placed on the table. This setup offers guided movement, making it easy to reposition the device along a fixed line.

Wheel System

The wheels enable 360-degree rotation, making it easy to reposition the device in any direction. Each wheel is equipped with a lock mechanism that can be engaged to hold the device securely in place once positioned.

Catching the Balls

Net

Using a net system around the table helps catching the balls and enables a continuous training session for the trainer. The ball feeding mechanism does not run out of balls.

Air Flow

The balls could be manipulated to some desired region by the influence of air flow. Balls are to be pushed to the converging section.

Electromagnetic Field

An electromagnetic field could be used in order to magnetize the balls and prevent them from exiting the system, so that the system becomes continuous.

Wipers

2 wipers similar to the windshield wipers are positioned on the shooter side of the table and wipes the balls that are on the table towards the machine.

Keeper Glove

Using a ball-keeper glove attached to the tip of a mechanical arm that can reach the required positions. The mechanism acts like a ball collecting hand.

Spherical Wall

Using a spherical wall upon the table enables the balls to converge to a desired region and provides a continuous experience.

Storing the Balls

Box

The box serves as a container, keeping the balls organized and accessible for feeding into the throwing mechanism.

Tunnel-Spiral Tube

The balls are loaded into the top of the spiral and travel down the tube in a controlled manner, allowing a steady, organized flow toward the throwing mechanism. The spiral shape maximizes storage space while ensuring the balls move gradually through the tube, preventing jams.

Groove

The groove keeps the balls aligned in a single file, directing them toward the throwing mechanism in an orderly manner. Gravity or slight inclination assists in feeding the balls smoothly along the groove.

Magazine Mechanism

The balls are stored in a vertical column, feeding down toward the throwing mechanism as each ball is used. The magazine can be designed to be removable, allowing for quick and easy reloading or replacement when empty.

Gravity Funnel

The balls are loaded into a wide funnel that narrows toward the bottom, guiding them into a feeding tube that leads to the throwing mechanism. Gravity ensures a continuous flow of balls as they move downward through the funnel, preventing jams.

Feeding the balls with a desired frequency

Maltese Wheel 1

A maltese wheel rotating with a motor is placed near the storage or inside the storage regulates ball supply to the system.

Maltese Wheel 2

A maltese wheel rotating with a motor placed near the launching mechanism regulates ball throwing rate.

Slider-Crank

A slider crank mechanism placed at the same level with launching or near the storage mechanism pushes the balls to the throwing system at a desired frequency.

Wiper Sweep

Wipers that are placed on the table supply the balls to the feeding system. They work at adjustable frequencies similar to car wipers hence regulates the ball supply.

Hydraulic Piston

A hydraulic piston is present to be able to adjust the frequency be using the hydraulic entry. The purpose is to change the fluid level, mainly.

Spiral Lift

A spiral elevator rotating at a desired speed regulates the frequency of ball supply to the throwing mechanism.

Rotating Hole

A rotating hole, consisting of a rotating base and holes on it, make the ball feeding frequency adjustable. The ball could go freely by entering one of the holes, or bump to the base and be recycled to the system.

Belt Mechanism

A belt mechanism with indents that can hold balls carry the balls to the launching mechanism at a required frequency in an ordered way.

Lid Mechanism

A lid mechanism could be used to adjust the entrance of the balls to be fed. The mechanism could open and close (fully or partially), which determines if the balls are able to go freely or not, or how many balls can be fed at that instant.