

BALL SERVING DEVICE

This invention relates to a ball serving device.

Various devices for serving balls to players, for practice or for sport, in games such as table tennis, tennis, and baseball are well known in the prior art. For example, the U.S. Patent to Littell et al, No. 2 087 575 , issued July 20, 1937, describes devices that can be employed in table tennis, for example, for ejecting lightweight balls. The device disclosed in Littell includes an overhead supply means, typically in the form of an overhead hopper. The overhead hopper is fed by a conveyor system having a series of ball carrying members mechanically mounted for movement in a continuous loop.

U.S. Patent to Lemon, No. 2 508 461, issued May 23, 1950, describes an apparatus for ejecting table tennis balls employing pressurized air, as from a home vacuum cleaner, to propel and eject the balls from a conduit. A gravity fed collector box is provided for introducing a ball into a lower portion of the conduit. The Lemon device provides no control on the entrance of the balls, and failure of the balls to feed properly can result in a loss of air pressure particularly as a plurality of balls are introduced into the system.

U.S. Patent to Schrier et al, No. 3 917 265, issued November 4, 1975, is another pneumatic ball ejecting machine including pneumatic means for transporting the balls from a collection source, for loading the balls to an ejection means and for ejecting the balls.

Again, maintenance of air pressure in the device is critical. The ejection means includes a plurality of barrels mounted at fixed angles with respect to each other so as to provide a predetermined number of variations in the trajectories of the ejected balls. The spin on an ejected ball is imparted through random contact between the ball and the wall of a particular barrel as the ball is propelled through that barrel. This results in an uncontrollable assortment of spins.

The U.S. Patent to Berliner, No. 4 116 438, issued September 26, 1978, describes a device for throwing table tennis balls, having a mechanical throwing means including two flexible, thin throwing discs extending generally parallel with respect to each other, for grasping a table tennis ball between them and ejecting it along a guide. The material properties of the discs thus are important considerations, due to the repeated flexure of the discs. Balls also are returned to the serving discs by a pneumatic means. The U.S. Patent to Cook, No. 2 793 636, issued May 28, 1957, describes a fan operated device, as does the U.S. Patent to Horvath, No. 3 911 888, and the U.S. Patent to Augustine, No. 3 989 245.

The U.S. Patent to Newgarden, No. 3 794 011 issued February 26, 1974, describes a relatively simple device for imparting variations in the amount of spin applied to a ball being served by a server. The disclosure of the Newgarden patent is intended to be incorporated herein by reference.

While all of these prior art devices, and others in the art, work for their intended purposes, it is evident from the large number of these devices, that no one device has solved the problems of providing a low cost, reliable, and relatively uncomplicated automatic serving device for table tennis. Pneumatic devices are inherently unreliable. Mechanically operated devices have been relatively complex if full functions were to be provided. Even when mechanical devices were simplified,

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they lacked the ability to provide a full range of shots for practice or sport.

The invention disclosed hereinafter provides a relatively low cost, simple to construct robot that provides a full range of play both for practice and for sport. The robot, in combination with a return net, provides for automatic replay of balls returned by player. The device construction provides mechanical simplicity, low cost, and a wide range of shot capabilities.

One of the objects of this invention is to provide a ball serving device which closely emulates the variety of serves expected from a human competitor.

Preferred further objects are to provide an elevated serving device which is automatically supplied with balls from the level of a playing surface, without the need of overhead hoppers;

to provide a table tennis ball serving device which will not cause excessive wear or deformation of the balls during the course of operation of the device;

to provide a ball serving device which is relatively easy to set-up and remove from a set-up condition;

to provide a table tennis ball serving device which will precisely duplicate various combinations of ball velocity, spin and trajectory, as well as adjustable rates of serve, in order to permit repeated practice of a particular shot or return ;

to provide a ball throwing device of flexible operation and performance, but of relatively simple and inexpensive

construction ;

to
provide a ball throwing device having component parts
which are not subject to excessive wear during extended
use ;

to pro-
vide a ball serving device which will recycle returned
balls to permit continuous practice or play with a
minimum number of balls ;

to
provide a ball serving device which will vary the
trajectory of a served ball through a predicatable
pattern;

to provide a robot serving device which
has a controllable panning pattern for the serving head.

According to the present invention, there is
provided an automatic ball serving device having a
head and an enclosure and including means associated
with said head for feeding balls to and for expelling
balls from said head, the improvement comprising means
operatively connected between said head and said
enclosure for permitting panning of said head, said
panning permitting means comprising a flange pivotally
mounted at a pivot point to said enclosure and connected
to said head, a pair of cam arms mounted to the pivot
point and each selectively movable with respect to said
flange, means for securing said cam arms with respect to
said flange, a motor operatively mounted to said
enclosure, and cam means driven by said motor for
engaging said cam arms alternately to move same and
control the panning movement of said head.

In the drawings, Figure 1 is a view in perspective of one illustrative embodiment of ball serving device of this invention;

Figure 2 is a side sectional view thereof;

Figure 3 is a sectional view, taken along the line 3-3 of Figure 2;

Figure 4 is a sectional view, taken along the line 4-4 of Figure 3;

Figure 5 is a sectional view, taken along the line 5-5 of Figure 3;

Figure 6 is a sectional view , taken along the line 6-6 of Figure 3;

Figure 7 is a sectional view, partly broken away, taken along the line 7-7 of Figure 2;

Figure 8 is a sectional view, taken along the line 8-8 of Figure 2;

Figure 9 is a diagrammatic view of the operational control system for the device of Figure 1;

Figure 10 is a view in front elevation illustrating the net and robot 1 operation of this invention;

5 Figure 11 is a view in side elevation of the net and robot as shown in Figure 10;

Figure 12 is a view in perspective of a second illustrative embodiment of the ball serving device of this invention;

10 Figure 13 is a side sectional view thereof;

Figure 14 is a view in perspective of a third illustrative embodiment of ball serving device of this invention;

Figure 15 is a side sectional view thereof;

15 Figure 16 is a sectional view , partly broken away , taken along the line 16-16 of Figure 13;

Figure 17 is a sectional view, taken along the line 17-17 of Figure 15;

20 Figure 18 is a sectional view, taken along the line 18-18 of Figure 15;

Figure 19 is a sectional view, partly broken away , taken along the line 19-19 of Figure 18;

Figure 20 is a top plan view of a robot and net combination employing the robot of Figure 12;

25 Figure 21 is taken along the line 21-21 of Figure 20 illustrating the folded position of the net; and

Figure 22 is a sectional view, partly broken away, taken along the line 22-22 of Figure 20.

Referring now to the Figure 1, reference numeral 1 indicates one illustrative embodiment of robot ball serving device of this invention. The robot 1 includes an enclosure 2 generally delimiting a serving head 3,
10 a panning system 4 and a body 5, the robot 1 being utilized in conjunction with a net assembly 6, best seen in Figures 10 and 11, and later described in greater detail.

The body 5 includes a base 10 having an
15 entrance 11 defined by a bottom 12 and sides 13 and 14 respectively.

An upper portion of the body 5 is generally rectangular in plan, having a front 15, sides 16 and 17 and a back 18. A lower portion of the body 5 is enlarged
20 along a part 19. The part 19 is designed to mate with the base 10 by any convenient method. The front 15 of the body 5 has a mouth 20 formed in it along the junction of the bottom 12 of the entrance 11 and the enlarged part 19 of the body 5. As thus described, the entrance 11 is
25 designed to feed table tennis balls, for example, rearwardly toward the mouth 20.

As is best seen in Figures 1 and 3, the enlarged part 19 is arranged to house a feed mechanism 25. The feed mechanism 25 functions to engage balls, for
30 example, as they arrive at the entrance 11 and mouth 20 and bring them inwardly of the body 5 of the robot 1. The mechanism 25 includes a feed motor 26 which drives a gear train 27. The gear train 27 includes a first
35 relatively smaller gear 28 driven by the motor 26 and an enlarged gear 29. The gear 29 has a plurality of fingers 30 mounted to it. The fingers 30 rotate with the gear 29 and are adapted to engage balls of the table tennis variety, for example, and force them inwardly

of the body 5 of the enclosure of the robot 1. As will be appreciated, the fingers 30 can assume a variety of design shapes, and the number of fingers 30 may vary in other embodiments of this invention.

The feed motor 26 and the gear train 27 are mounted within the body 5 in any convenient way. In the embodiment illustrated, the motor 26 is attached to a bracket 31 which in turn is attached to a wall of the body 5. Threaded fasteners work well as the attachment means. The motor 26 is a conventional alternating current drive motor which has an output shaft mounted to the gear 28 of the gear train 27. The gear 28 in turn intermeshes with the gear 29 to drive that gear and rotate the fingers 30.

The body 5 of the enclosure 2 delimites an internal feed passage 33, which is best observed in Figures 3, 5 and 6. The feed passage 33, in the embodiment illustrated, is defined by a plurality of internally formed walls 34, 35, 36 and 37. The walls 34-37 extend vertically downwardly along the passage 33, and provide point contact for a plurality of balls 38 as they are fed upwardly in the passage 33 by the feed mechanism 25. Also mounted to the body 5 is an attachment device 50, which is shown in Figure 5, and later described in greater detail. It is here noted that the attachment device 50 is utilized to mount the robot 1 of this invention to the net assembly 6.

As is observable in Figure 2, the feed passage 33 extends from the mouth 20 to the serving head 3. The feed passage is generally vertical, except along the panning section 4 of the robot 1. At that point, it defines an elbow 22 so as to interconnect the body 5 with the serving head 3.

As thus described, the feed mechanism for the robot 1 is substantially simpler than those known in the prior art in that the robot 1 is designed to return

balls along entrance 11 and to feed the balls from the mouth 20 to the head 3. The feed passage is sized so that the balls 38 are relatively close fitting with the passage 33 upon their insertion into the passage 33. That is to say, the balls are free to move in the passage 33 without undue friction, but the passage 33 is sized so that jamming is nonexistent. In addition, the balls are fed magazine style to the serving head 3 in that the ball approaches the serving head from the feed passage 30 only upon the entrance of a new ball under the influence of the fingers 30 into the feed passage 33. Consequently, a player needs only one ball in addition to those aligned in the passage 33 to provide continuous operation of the robot 1.

The speed with which balls 38 are engaged by the fingers 30 for insertion within the passage 33 is controlled by the feed motor 26, that speed being variable by the operator of the robot 1.

The panning system 4 and the serving head 3 operate in conjunction with one another to permit variation in the placement of a ball expelled from the serving head 3. As is best seen in Figure 8, the serving head 3 is mounted to the panning system 4 at a pivot axis 45. Also mounted about the pivot 45 is a flange 46 having a rear edge 47. The edge 47 has a plurality of notches 48 formed in it, for purposes later described. Also attached to the pivot axis 45 are a pair of cam arms 40 and 41 respectively. The cam arms include a stop 42 which is selectively engageable in the notches 48 to position and hold the respective cam arms 41 and 42 in preselected positions. As shown in Figure 8, the head 3 and the flange 46 are connected to one another, and both may be rotatably driven about the pivot axis 45.

Mounted above the cam arms 41 and 42 is a panning motor 43. The panning motor 43 is operatively connected to a cam follower driver 44 which has a cam follower 39 mounted to it. The cam follower 39 is adapted to engage the cam arms 40 and 41 and to track along an

(3)

- 9 -

edge of the arms, during rotation of the cam driver 44.

The simplified structure for providing panning of the serving head 3

is best explained with respect to Figure 8. As a shaft of the panning motor 43 rotates, it rotates the cam driver 44 which in turn causes the cam follower 39 engagement with an edge of the arm 40. In the position shown in Figure 8, follower 39/arm 40 engagement causes the follower 39 to trace a linear path during rotation of the motor, and no motion will be imparted to the head 3. As the motor 43 continues to rotate, however, the cam follower 39 engages an edge of the arm 41. Engagement of the follower 39 with the arm 41 imparts a force which will tend to rotate the head 3 toward the right in the direction of the arrow shown in Figure 8. This rotation toward the right continues until the follower 39 disengages the cam arm 41 at a point 52, also shown in Figure 8. Since the head is now moved rightwardly in the direction of the arrow shown in Figure 8, as the cam follower 39 re-engages the arm 40 at a point 53, it will exert a force on the flange 46 and consequently the head 3 to drive the head 3 oppositely to the arrow shown in Figure 8, so that the head would come to a centerline position at point 54 indicated by the cam follower 39 notation in Figure 8. As will be appreciated, movement of the cam arm 41 to a position parallel with the cam arm 40 means that the head 3 will remain in its centerline position. That is to say, when the cam arms 40 and 41 are parallel to one another, maximum force is exerted by the follower 39, causing full panning of the head 3 between full left and full right positions. Movement of the cam arms 40 and 41 to their maximum open position, i.e. their maximum angular relationship, means that the head 3 has minimum motion, if any motion is imparted at all, about the centreline axis.

Also attached to the flange 46 is a C-shaped bracket 60. The bracket 60 is sized to receive a complimentary C-shaped flange 61. The flange 61 in turn is attached to an enclosure for the head 3. Each of the brackets 60 and 61 preferably have at least one opening formed in them, which is sized to receive a threaded fastener 62. In addition, the bracket 60, as may best be observed in Figure 1, has a slot 63 formed in it, which receives the threaded fastener 62 and permits rotation of the head 3 about an arc defined by the arc of the slot 63. The head 3 thus may have its "pitch" changed merely by untightening a nut 91 mounted to the fastener 62, adjusting the head 3 to a desired pitch position, and re-tightening the nut 91.

The bracket 61, in the embodiment illustrated, is mounted to a collar 70. The collar 70 receives a flange 71 of the head assembly 3 in a slip friction fit, which permits rotation of the head about the collar 70. Preferably, a detent structure 72, which comprises a bearing race 73, a ball stop 74, and a biasing means 75 is mounted within the collar 70 to permit selective positioning of the serving head 3 with respect to the rotational position of the head.

Mounted within the head 3 is a serving wheel drive motor 80, having a shaft 81 operatively connected to a serving wheel 82. A stationary block 85 is mounted along a lower portion of the head 3. As may be seen in Figure 7, as a table tennis ball 38 approaches the head 3, the ball is engaged by the stationary block 85 and the serving wheel 82. The wheel 82 has an outer surface 86 which preferably is of some form of relatively frictional material for engaging the ball and expelling it from an exit port 90 in the head 3. In the alternative, a dual wheel arrangement can be employed as disclosed in the above-referenced Newgarden Patent No. 3 794 011. We find the use of a stationary

block and single wheel, however, an improvement over the Newgarden device in that only one drive wheel is required for device operation. The single wheel eliminates
5 problems with synchronization of the wheels or the motor or motors driving them. Spin or english is imparted to the balls 38 entering the head 3 by rotation of the head 3 about the collar 70. Since the feed passage 33 is stationary, while the head 3 may be rotated with respect
10 to it, balls entering the head 3 may be expelled from the exit port 90 with spin imparted to them, depending upon which way the head 3 is rotated. As indicated above, loft or ball trajectory can be changed by movement of the head 3 along the slot 63 by adjustment of the tightening nut 91. As also previously discussed, the panning
15 motion of the head can be controlled by movement of the cam arms 40 and 41.

Control of the feed pan and throw motors 26, 43 and 80, respectively, is accomplished through the
20 use of a control means 88. Each of the motors 26, 43 and 80 are intended to be conventional alternating current motors, which may have their speeds controlled by the control means 88. Preferably, individual controls for each of the motors are provided, so that the rate of
25 feed for the feed motor 26, the speed of panning and the rate of expulsion of balls from the exit port 90 may be controlled individually. Because of the novel feed system employed with this invention, however, the feed motor 26 necessarily must operate at approximately the same speed as the wheel drive or throw motor
30 80 so that balls continually are fed through the feed passage 33. It will be appreciated that the control means 88 may be located remotely from the robot 1 so that a player may vary robot 1 operation as the player practices or plays.

35 Referring now to Figure 10, the net assembly 6 includes a base 100 having a central pole 101 extending upwardly from it. The pole 101 is attached to a spider 102 having a plurality of arms 103, 104, 105,

106, and 107 extending outwardly from it. The number of arms and their angular position with respect to the spider 102 may vary in embodiments of this invention.

5 The arms 103-107 are intended to be foldable upon one another into an upright position, as indicated by directional arrows in Figure 10. An extension of the arms 103 and 104, indicated by the numerals 110 and 111, respectively, also may be provided, if desired, so that the
10 net assembly extends substantially beyond an end position 120 of a table tennis table 121. The table tennis table 121 is conventional, and it is not described in detail. It is here sufficient to note that the net assembly is
15 intended to extend about the end 20 of the table 121 so that balls returned in response to the robot 1 operation are caught by the net and returned to the robot. The arms 103 and 107 have a plurality of attachment devices 126 associated with them, which permit the arms and net assembly to be attached to the table 121. We find that
20 conventional wing nuts and threaded fasteners work well for the attachment method, for example.

As indicated above, the robot 1 has an attachment means 50 associated with it. In the embodiment illustrated in Figure 5, the attachment means 50 includes
25 a flange 56 which defines a central opening 55 sized to receive the arm 105. The robot 1 and the arm 105 are attached to one another by conventional methods.

Again, threaded fasteners 89 work well. The robot 1 is slidable on the arm 101 for purposes later described
30 merely by adjusting the fastener 89.

A conventional net 130 is stretched over the arm of the net assembly 6. The lower portion of the net assembly 6 has a bottom 131 which is attached to the arm 103 and 104 and to the remaining net portions.
35 In the operation of this invention, the robot 1 is positioned so that the entrance 11 of the robot 1 is positioned below the height of the table 121. This is

accomplished by attaching the robot 1 to the arm 105 and sliding the robot downwardly until the bottom 131 of the net assembly is drawn tautly downwardly. As shown in
5 Figure 11, this has the effect of forming sloping sides and a sloping front for the bottom 131, so that balls returned to the net assembly 6 are fed directly toward the entrance 11 of the robot.

The particular embodiment shown is well
10 adapted for convertible use. That is to say, once the robot 1 is attached to the net assembly 6, and set up for practice, it may be removed merely by removing the attachment means 126 between the arms 103 and 107 and the table 121. The arms in turn may be folded upwardly, and
15 the device removed from the table 121 in a relatively compact, stored position. Replacement is quickly accomplished in a reverse order in that unfolding of the arms 103-107 and reconnecting the attachment means 126 to the table 121 re-positions the robot 1 for operation.

20 Operation of the robot 1 of this invention is relatively simple. Once a sufficient number of balls are inserted or fed to the robot 1 so that the feed passage 33 is full, the robot will automatically expel a ball from the exit port 90. As described, above, the method of
25 expelling a ball from the exit port 90 will vary depending upon the speed of the feed, pan and throw motors, the location of the panning arms 40 and 41, the rotational position of the head 3 on the collar 70, and the position of the head with respect to the slot 63. All of these
30 may be varied individually or in combination to give a much higher degree of playability and variation to the robot performance than have been available with prior art devices. The simplicity and high performance characteristics of this invention make it unusual from the standpoint of
35 the robot 1's ability to provide that variation at a relatively low cost.

We envision that the robot 1 of our invention may take a variety of forms. For example, in Figure 12,

- 14 -

the body 5 has an enlarged lower part 19, to provide an enlarged mouth 20 which may aid in feeding the balls to the robot 1.

5 In addition, the entrance 11 of the robot 1 may be rotated 180° so that the robot may be mounted directly to the table 121. Such an embodiment is shown in Figures 14 through 21. In general, the robot shown in Figure 14, and denominated herein as robot 150 is shown
10 as similar to the robot 1 except as described hereinafter. Like numerals are employed for like parts where appropriate. The primary change of the robot 150, as indicated above is the rotation of the mouth 11 for the robot to be rotated 180° with respect to the head 3. A
15 support 140 includes a side edge 141 which is intended to abut an end of the table 121, and a top edge support edge 142, which abuts the top surface of the table 121. The support 141 also includes a block 143 having a plurality of mounting openings 144 formed in it.
20 The openings 144 are intended to receive a plurality of support members 145, best seen in Figure 22. The supports 145 may be three in number, one to engage an upper surface of the table 121, and two to engage an underside of the table 121, as best seen in Figure 22.
25 Other arrangements may be utilized, if desired.

As shown in Figure 16, a single spring 135 is used to bias the block 85. Dual springs are used in conjunction with the embodiment of the robot shown in Figure 7. In either case, the springs are used so that
30 the block 85 is self adjusting.

Because of the re-arrangement of the mouth 11, a substantially simplified net structure 152 may be employed with the robot 150. Thus, a spider assembly 153 is attached to the robot 150 along a support 154. A
35 plastic or similar material trowell 154 is attached to the spider 153 and is separable along a center connection 155. The spider 153 has a pair of arms 156 and 157 associated with it, which serve to support a net 158. As

with the embodiment of the robot 1, the arms and trowell may be folded to the dash line position shown in Figure 1, for storage of the robot. We have found that the robot 5 150 is substantially lower in cost than previous embodiments of our invention, primarily because the net structure is simplified. The trough 154 in particular can be manufactured at a lower cost, and the elimination of a stand is in large measure responsible for the decrease 10 in cost.

The robots per se, however, function in substantially similar manners.

It will be appreciated that it is not intended to limit the invention to the above example only, many variations, such as might readily occur to one skilled in the art, being possible, without departing from the scope thereof, as defined by the appended claims .



CLAIMS

1. In an automatic ball serving device having a head and an enclosure and including means associated with said head for feeding balls to and for expelling balls from said head, the improvement comprising means operatively connected between said head and said enclosure for permitting panning of said head, said panning permitting means comprising a flange pivotally mounted at a pivot point to said enclosure and connected to said head, a pair of cam arms mounted to the pivot point and each selectively movable with respect to said flange, means for securing said cam arms with respect to said flange, a motor operatively mounted to said enclosure, and cam means driven by said motor for engaging said cam arms alternately to move same and control the panning movement of said head.

2. The ball serving device as defined in claim 1, wherein said flange has a plurality of notches with which stops on the cam arms can engage to secure the arms in selected positions with respect to the flange.

3. The ball serving device as defined in claim 2, including means for manually changing the elevation of a ball expelled from the head structure about a transverse, horizontal axis, and means for manually rotating the head structure about its longitudinal axis

to impart a varying angle of spin on a ball expelled from the head structure.

4. The automatic ball serving device of claim 3, wherein said expelling means comprises a wheel rotatably mounted within said head structure, means for driving said wheel, and a friction block positioned to support a ball prior to expulsion from said serving head.

5. The automatic ball serving device as defined in claim 4, including a net, said net including a central portion having a plurality of arms extending outwardly from it, and netting extending between said arms, said net being operatively connected to said serving device to permit feeding balls to said serving device.

6. The automatic ball serving device as defined in claim 5, wherein said serving device is positioned with respect to a bottom wall of said net so as to cause said net to provide sloping sides along said bottom wall of said net to permit feeding of balls to said serving device.

7. The automatic ball serving device as defined in claim 1, and including means for feeding balls upwardly against gravity by said ball feeding means, said ball feeding means being arranged so that insertion of a ball in said feed passage forces a ball into said head structure.
