DEVICE HAVING COACTING WHEELS FOR PROJECTING TENNIS BALLS

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Field of Search........... 124/1, 51 A, 30 R, 124/49, 29 A, 50, 32; 254/DIG. 2; 273/26 D

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ABSTRACT

A ball throwing machine ejects tennis balls in regular sequence and at a controlled velocity to simulate tennis service from an opponent during practice sessions. The machine is adapted to intermittently vary the vertical and horizontal angles of ball ejection thereby providing game-like situations. An anti ball jamming device is located in the base of a ball hopper. The machine has structure for permitting rotation of the subframe about a vertical axis to vary the horizontal angle of discharge of a projectile. As an alternate method for varying the horizontal angle of discharge of a projectile the subframe may be oscillated about a vertical axis.

4 Claims, 27 Drawing Figures
DEVICE HAVING COACTING WHEELS FOR PROJECTING TENNIS BALLS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates to pitching machines used for projecting balls of various types during practice sessions. Specifically, the invention relates to machines adapted to project tennis balls in simulated ball service.

2. Description of the Prior Art

The sport of tennis has gained in popularity throughout the past decade as an individual as well as a team sport. Where tennis is being taught, whether in schools, athletic clubs or other institutions, there is frequently a need for a type of ball throwing machine which can be used during practice sessions to simulate game-like situations for the benefit of the individual novice or professional. Machines which have been devised to date for throwing tennis balls have largely been adaptations of baseball pitching machines. Though these machines have been effective in propelling tennis balls, they have imparted considerable objectionable spin to the ball, caused a significant amount of wear on the covers of the balls and have led to frequent jamming. In addition, they have required an attendant to manually operate the controls and refill the ball magazine. In this respect none of the pitching machines of the prior art have been adapted to fully automatic operation. A prior patent teaches the concept of utilizing high speed rotating cones or discs, obliquely situated, to propel tennis balls. This invention, however, falls short of fully automatic operation in that there is no remote means by which to start or stop the machine. The user is faced with the same practice shot repeated time after time unless he makes frequent trips to the machine to alter the adjustments and even then he cannot substantially alter the type of throw he will receive.

Based on the above, there is an obvious need for a type of tennis ball serving machine which will more closely simulate game situations and which will be capable of truly automatic operation for use in the absence of an attendant or additional player. These and other objects of the present invention will be perceived in the following description and appended claims.

SUMMARY OF THE INVENTION

The apparatus of the present invention as disclosed herein comprises a frame and housing which mounts a ball discharge mechanism, a ball feed mechanism, remote and machine located control means, and appropriate handles and wheels for portability. A plurality of balls are placed into a feed hopper and are individually selected by a rotating gate and fed into a flexible tube. Upon reaching the end of the tube, each ball enters a propelling mechanism which consists of two narrowly spaced cylindrical drums which are synchronously rotated about parallel axes by electric motors. The moving tennis ball, having entered the propelling mechanism, is engaged between the two drums by friction, momentarily compressed, and discharged outwardly at a velocity approximating the circumferential speed of the rotating drums. A pivotal portion of a frame member which supports the discharge mechanism enables the vertical angle of ball discharge to be varied. The horizontal angle of discharge is controlled either by a movable deflecting baffle situated outward of the rotating drums or by oscillating a sub-frame which supports the discharge mechanism.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a front view of a machine built in accordance with the invention, showing an aperture in the housing to permit the discharge of tennis balls.
FIG. 2 is a rear view of the complete machine.
FIG. 3 is a side view of the machine showing the handle and wheel structure.
FIG. 4 is a top view of the machine revealing the ball hopper and feed mechanism and an anti-jamming spring guide.
FIG. 5 is a front view of the machine without the housing, revealing the ball discharge mechanism.
FIG. 6 is a rear view of the machine without the housing, showing the location of the electronic controls.
FIG. 7 is a left side view showing details of the ball feed and ball discharge mechanisms.
FIG. 8 is a right side view showing details of the ball feed and ball discharge mechanisms.
FIG. 9 is a top view showing the location of the flexible tube connecting between the ball feed and ball discharge mechanisms.
FIG. 10 is a view of the underside of the machine showing details of the height adjustment assembly.
FIG. 11 shows in a somewhat schematic view a tennis ball being engaged between the rotating drums.
FIG. 12 is a partial view of the rotating gate drive mechanism.
FIG. 13 is a partial view of the flexible tube in cooperative arrangement with the gate mechanism.
FIG. 14 is a partial perspective view of the deflector plate camming assembly.
FIG. 15 is a partial perspective view of the deflector plate showing the position of the solenoid.
FIG. 16 is a partial side view of the deflector assembly.
FIG. 17 is a partial side view of the height adjustment assembly.
FIG. 18 shows an alternate height adjustment assembly utilizing a reversible motor.
FIG. 19 shows the control panel.
FIG. 20 is a circuit diagram of the preferred embodiment.
FIG. 21 is a circuit diagram of an alternate embodiment.
FIG. 22 is a diagram of the pitching drum dimensions used in one embodiment.
FIG. 23 is a perspective view of a ball guide.
FIG. 24 is a top perspective view of an alternate embodiment of the invention showing a sub-frame adapted to laterally oscillate the ball discharge mechanism.
FIG. 25 is a bottom partial perspective view of the oscillator mechanism of the alternate embodiment.
FIG. 26 is a partial elevation view of a height adjustment mechanism of the alternate embodiment and showing in dashed lines an elevated position.
FIG. 27 is a somewhat schematic and enlarged view of the anti-jamming mechanism.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIGS. 1 through 4, in a preferred embodiment the pitching machine of the invention, generally identified by 10, comprises a frame 15 composed
of tubular aluminum segments joined by welding or the like into a rectangular base supporting vertical and horizontal structural members. Two U-shaped leg members 16, 17 are adapted to provide upright support and are secured to said frame member and fitted with respective hand grip portions 19, 20, axle 25, and wheels 26, 27. A removable housing member 30 formed of sheet aluminum includes four sides walls, and in the front wall a ball discharge aperture 31 which permits the exit of discharged tennis balls. A control access aperture 32 and an associated door 36 are located on the rear wall which permits access to the manual controls. The complete housing assembly is open at the bottom and attaches to frame 15 at appropriate screw attachment points 18. Housing 30, immediately below its open upper end, is fitted with a metal ball hopper 33 formed with a depressed area at the top of said housing adapted to hold a plurality of tennis balls. A bottom aperture 34 permits the entry of balls into the machine from the hopper. Ball hopper 33 is provided with an anti-jamming assembly 35 later described. It is contemplated that the entire housing assembly may be of unitary construction and fabricated of formed aluminum sheeting.

A ball feed mechanism 40 is suitably secured to the frame 15 and is situated immediately beneath the hopper aperture 34 to receive the balls one by one. A rotatable feed gate 42 is adapted to rotate about shaft 43 which is fitted with a pulley 44 and a belt 45 for being driven by a variable speed, drive motor 46 through reduction means 47, as best shown in FIGS. 5, 12 and 14. Control of gate 42 is of course obtained by control of motor 46 with respect to being on or off and speed. Rotatable gate 42 is composed of sleeve 49 which mounts on shaft 43, vertical dividers 50, 51, 52 and a surrounding cylindrical wall member 53. Thus, gate 42 effectively forms six open-ended columns each of which is adapted to temporarily contain no more than one tennis ball. A tension arm 60, FIG. 12, is pivotally secured to frame cross member 14 and is tensioned by spring 61 which connects between tension arm 60 and a supportive vertical member 13. An idle roller 62 is situated intermediate the ends of tension arm 60 and is rotatably secured by appropriate means thereto. Tension arm 60 is adapted to apply sufficient tension to belt 45 to cause normal rotation of feed gate 42 while allowing slippage between belt 45 and pulley 44 in the event of malfunction of jamming of feed gate 42.

An aperture plate 41 has a wedge-shaped aperture 73 through which the balls pass from gate 42 to flexible tube 70. Plate 41, except for aperture 73, provides a temporary ball support surface for any balls in any of the gate columns. A flexible feed tube 70 is secured by suitable clamping means 71 below aperture plate 41 and in a position immediately below and in alignment with aperture 73. Thus, as gate 42 rotates at a selected speed and as the column in feed gate 42 each containing a tennis ball pass over aperture 73, each respective ball will be permitted to exit said column and fall freely through aperture 73 into the flexible feed tube 70. The opposite end of feed tube 70 is connected by similar clamping means to a pivotal frame member 74 which is movably supported on a vertical frame member 12 so as to introduce a ball arriving at said opposite tube ending, into an adjacent ball discharge mechanism 100. Final guidance is provided by a V-shaped metal guide 69 having a discharge end positioned to guide the balls to the pitching drums 80, 81 as shown in FIGS. 16 and 23. As will be more fully appreciated from later disclosure, flexible and extensible tube 70 provides a unique advantage to the overall invention. In particular, the flexibility allows the discharge end of the tube which mounts the V-shaped metal guide 69, FIGS. 16 and 23, to be moved to different angles for variation in loft of the ball as later described. However, irrespective of any such angular position the ball is given a positive, low friction path of guidance through the tube. Various helically reinforced, flexible tubes such as used in vacuum systems are of course readily available for such purpose.

The ball discharge mechanism 100 includes two variable speed DC electric pitching motors 72, 72' having drive shafts 75, 76. Motors 72, 72' are mounted on pivotal framing member 74 and are oriented such that the shafts of the motors rotate about parallel axes. While not shown, it should be noted that the motors are mounted on slots allowing lateral adjustment to vary the spacing between the shafts 75, 76. Two cylindrical drums 80, 81 are rotatably secured to the mentioned drive shafts and reside in the same plane in opposed positions. These drums, best shown in FIG. 11, may be of hollow aluminum or magnesium casting or solid construction and have concave circumferential edges fitted with a soft compressible material, i.e., rubber, vinyl or the like so as to be adapted to conform said edges to the outside diameter, texture, and hardness of a given ball. As shown diagrammatically in FIG. 11, drums 80, 81 are adapted to be synchronously rotated in opposite directions outwardly, represented by the solid arrows, such that a ball upon reaching the end of flexible tube 70, indicated by the dashed lines, will be introduced into, temporarily engaged between and instantaneously discharged from drums 80, 81 at a velocity approximating their circumferential speed. Motor adjustment slots previously mentioned enable the distance between the motors, and correspondingly between the drums, to be altered so as to adapt the discharge mechanism for use with relatively lightweight balls of varying sizes, i.e., tennis balls, handballs, whiffle balls, softballs, as well as various types of rubber practice balls.

Various motors may be employed for performing the pitching function of motors 72, 72'. In one embodiment a pair of DC type pitching motors are employed for motors 72, 72' and are supplied from an AC source through AC to DC converter circuitry. The pitching motor speed is controlled by keeping the field voltage constant and varying the armature voltage by sensing the back emf (electromotive force). The speed in this embodiment ranges between 1,200 and 3,600 r.p.m. For a standard 5 5/8 inch diameter tennis ball the radius R is this embodiment, shown in FIG. 22, is two inches and the spacing X is held between 1 3/4 inch and 1 7/8 inch. During projecting the center line of the ball lines up with the central axis Y—Y. In the same embodiment the base diameter Z of each drum is 6 inches. Other diameters may be used.

A height adjustment mechanism 87, best shown in FIGS. 7, 8, 17 and 18, is mounted on frame 15 and enables the vertical angle of ball discharge to be varied. Mechanism 87 comprises an arm 75 which is movably secured at one end to pivotal frame member 74, and at an opposite end to yoke 76, which rides screw or worm gear means 77 and to which is secured a handle 78.
The electronic control circuitry of the preferred embodiment is shown in a generalized and somewhat schematic block circuit diagram in FIG. 20. The control means include a remote control receiver 120, having appropriate electronic switching capabilities electrically connected to control feed motor control 121. Receiver 120 receives signals through antenna 126. A remote circuit transmitter 122 is adapted to send signals to activate receiver 120. The control circuit of FIG. 20 also includes a deflector control 125 as shown in FIG. 20 and which is adapted to energize the deflector mechanism 90. The control further includes a motor speed control circuitry 123, interconnecting circuitry and leads 127, 128 which connect the control circuit to a suitable source of power. Manual control switches 55, 56, 57, 58 and 65, shown in FIG. 20, control the functions indicated. Since remote controls and circuitry of this type are well-known and are clamped only in conjunction with the specific application it is not deemed necessary to further detail this circuitry, per se. Switches 66, 67 control the ball interval and speed respectively. A control panel 130, best seen in FIGS. 6 and 19, is secured to frame member 15. Fig. 19 shows the detailed location of appropriate manually operable switches and dials of the control panel which, in the assembled machine, are concealed behind door 31.

In an alternate circuitry embodiment shown generalized and schematically in FIG. 21, the circuitry enables the principle functions of the machine to be remotely controlled. In the circuit of FIG. 21 there is provided a remote control receiver 120' which is electrically connected to a servomechanism 129. Servomechanism 129 is deemed to have appropriate electronic switching and rheostat capabilities to remotely govern (a) the speed of the pitching motor speed control 123', (b) activation of the deflector mechanism control 125', (c) the feed motor speed control 121', and (d) the height adjustment 130 through the alternate reversing motor 79 of FIG. 18. Manual override controls, not numbered and shown schematically, enable all functions to be manually operable from the alternate machine control panel, not shown.

According to the invention's first embodiment, operation of the machine 10 proceeds in the following manner. A plurality of tennis balls are placed into hopper 33 and machine 10 is wheeled to a playing surface and positioned to discharge tennis ball across a net in the direction of the player. Prior to assuming the playing position, a player connects the machine to a suitable source of power, energizes the controls, and manually pre-sets the desired speed of ball discharge, height of ball trajectory, the desired rate of ball feed, and whether or not the deflector is to be utilized. At this time, pitching motors 72, 72' are rotating, however, ball feed motor 46 has not yet been energized. Next the player switches the manual controls over to the "remote" mode of operation, at which time he takes the transmitter with him to the opposite side of the net. Having assumed the playing position, on the opposite side of the playing surface from the machine, a player may now energize the ball feed motor 46 through the controls on his remote transmitter and initiate simulated play. Correspondingly, individual balls are now being selected from the ball hopper 33 by rotating gate 42 and are being permitted to fall through aperture 73 down into tube 70, whereupon a ball travels to the opposite end of tube 70 over guide 69, FIGS.
16 and 23, and becomes introduced into ball discharge mechanism 100. The ball is then drawn into and momentarily engaged between the two outwardly rotating drums 80, 81 and is procured outwardly at a fast rate of speed. If the deflector mechanism 90 has been energized, the deflector baffle 95 will intermittently interfere with the path of the discharged ball according to the rotation of cam 112, thus providing a series of simulated tennis "returns" falling at different locations on the playing surface. Alternately, if the deflector mechanism 90 has not been energized, the machine will provide a series of precisely controlled simulated tennis "serves". Play may be terminated or resumed at will through the use of the remote transmitter 122.

In the alternate embodiment of FIG. 21, the transmitter 122' is deemed to have sufficient controls such that when the manual controls shown in FIG. 21 are closed and transmitter 122' is on command all principle functions become remotely controllable. Thus, drive motor 46 is controlled remotely as to on-off and speed as are pitching motors 72, 72'. Also, the deflector control mechanism 125' and height adjustment 130 are controlled remotely either by the player or his instructor. At best shown in FIGS. 4 and 27, hopper 33 is provided with the previously mentioned anti-jamming assembly 35. This assembly includes a somewhat semi-circular shaped plate 35 which is secured to hopper 33 and is horizontally positioned above the open, receiving end of tube 70. The area of plate 35 is sufficiently large to prevent the dropping of balls into the gate 40. That is, any ball which is to be dropped into tube 70 must have found its way into gate 40 prior to arriving at the position at which plate 35 is located. Furthermore, in order to minimize the tendency of balls tending to jam the gate 40 at the point of exit into tube 70 a coil spring 36 is secured at point A on plate 35 at one end and at point B on hopper 33 at its opposite end. Spring 36 thus provides a means for resiliently urging such incoming balls, as indicated by the solid arrow in FIG. 27, away from the edge of aperture 34 and away from the ball entry position above tube 70 as to assume the dashed line arrow direction shown in FIG. 27. The lack of any kind of baffle above tube 70 has been found to produce both jamming and entry of more than one ball at a time into tube 70. It has also been found that a baffle having a fixed guiding edge in the same position as spring 36 fails to avoid jamming whereas the resilient guiding edge provided by spring 36 does substantially eliminate both jamming and multiple ball dropping when combined with the smooth edge of plate 35.

To further describe the drums it will be noticed that the inwardly curved, ball engaging surfaces are centrally positioned around axis Y-Y' and that the central plane which includes Y-Y' is the central plane of the surfaces and that such plane is perpendicular to the drum axis. The drum axis has no lateral tilt but may be tilted rearwardly as previously stated up to about 45° or more off vertical though substantially less adjustment is normally sufficient. While both on machine direct wired and off machine radio "remote" controls are shown, it is also contemplated that the "remote" control could be through a long electrical extension corded from the machine to a control box.

An alternate means for varying the lateral angle of ball trajectory is shown in FIGS. 24, 25 and 26. In this embodiment a sub-frame member 74 mounts the previously mentioned synchronous motors 72, 72' and associated rotating drums 80, 81. Sub-frame 74 is adapted to rest upon a rotatable bearing assembly 131. Assembly 131 includes top and bottom circular plates 135, 133 which are arranged horizontally with an integral race means adapted to receive a plurality of ball bearings 134. The bearing assembly bottom plate 133 is suitably secured to the previously mentioned framing 15 and the bearing assembly top plate 135 is secured to a U-shaped sub-frame member 132 such that sub-frame member 132 is adapted for rotation on the bearing assembly through an arc of at least 10°.

A motor 138 having a drive shaft 139 turns a cam 140. Motor 138 is secured to framing 15 proximate sub-frame member 132. An arm 142 connects between cam 140 and a suitable pivot point 144 on sub-frame member 132 and thus sub-frame member 132 to oscillate upon the energization of motor 138 and the corresponding rotation of cam 140.

A flange 150 is secured to pivotal framing member 74. Flange 150 supports the discharge end of the flexible feed tube 70 as the sub-frame member oscillates so as to maintain accurate feeding of the tennis balls between the rotating drums 80, 81.

A height adjustment mechanism 152 includes a threaded shaft 153 which extends through a correspondingly threaded pivotal yoke member 151. Yoke member 151 is movably secured to pivotal frame member 74 and an anchor member 154 is movably secured to sub-frame member 132 and is adapted to rotatably secure an end 156 of thread shaft 153. A flexibly shaft 155 extends between an opposite end 157 of thread shaft 153 and a handle 158. Handle 158 is rotatably secured through a journal opening 159 in framing 15 which enables threaded shaft 153 to be rotated in response to rotation of handle 158 thereby enabling the vertical angle of ball trajectory to be varied accordingly. As threaded shaft 153 is rotated in a clockwise direction, movable yoke 154 is correspondingly urged rearwardly along thread shaft 153, and said pivotal frame member 74 assumes a substantially horizontal or lower position. Conversely, as threaded shaft 153 is rotated in a counterclockwise direction, pivotal frame member 74 is raised as indicated by the dashed lines in FIG. 26.

In keeping with the objective of fully automatic operation, appropriate electrical linkages may be substituted for selected remote controls of the preferred or alternate circuitry embodiment as indicated by dashed lines 160 in FIG. 21. The circuitry which controlled the deflector mechanism may, in this last embodiment, now control the oscillator function as indicated.

It is contemplated that this alternate form of the invention provides an opportunity for variation in a tennis ball pitching machine heretofore not possible with conventional pitching machines. In addition, rather than the intermittently deflected shots of the preferred embodiment utilizing the previously described deflector mechanism, oscillation of the sub-frame, which is achieved in the alternate embodiment, provides a sequence of balls having continuously changing lateral trajectories, simulating actual playing conditions.

We claim:

1. A tennis ball throwing machine for throwing balls of a selected substantially uniform compressible type comprising, in combination:

a a main machine supporting frame;
3,777,732

a pair of cylindrical-shaped ball throwing drums rotatably mounted on said frame with their axes being parallel, laterally spaced and positioned without lateral tilt and with a predetermined rearward tilt, each said drum having an inwardly curved ball engaging peripheral surface, said surfaces being opposed and said arms lying in a common plane which is perpendicularly positioned with respect to said axes, said surfaces being laterally spaced and of sufficient rigidity such that the outer surface of a ball is at least slightly compressed when passing between said surfaces;
c electrical drive motors mounted on said frame and operatively connected to rotate said drums in opposite directions at a predetermined speed and having in association therewith control means for controlling the energization and speed thereof;
d a ball supply structure including a hopper supported on said frame above said drums and having a ball discharge aperture in the bottom thereof, an electrically driven ball gating wheel mounted on said frame below said aperture and having structural gates to sequentially receive and pass successive balls one at a time and at a predetermined rate, and having in association therewith control means for controlling the energization and speed of said ball gating wheel, a flexible elongated hollow tube mounted with a ball receiving end fixedly positioned below said gating wheel to receive each said ball passed by said gating wheel in succession and with the opposite discharge end of said tube being directed between said drums whereby to guide balls through said tube to the drums in the peripheral direction of said surfaces whereby each ball when received, is at least slightly compressed between and is propelled from and free of said surfaces at some predetermined speed, said tube being flexible so as to permit changes in the angle of rearward tilt of said drum axes;
e a pivotal subframe mounted on said main frame, said drums, drum electrical drive and discharge end of said tube being mounted on and movable with said subframe; and
f electrical operator means for controlling the tilting of said subframe, said electrical operator means being mounted and connected to said main and subframes so as to vary the position of the subframe about the horizontal axis to cause rearward tilting of said drum axis and thereby adjust the vertical angle of throwing said ball while causing said tube member to be appropriately flexed and its discharge end to be repositioned according to the amount of such adjustment, said electrical operator means having an associated control enabling control of its energization and the degree of said tilt.

2. In a tennis ball machine as claimed in claim 1 wherein said pivotal subframe is pivotally mounted for pivoting on horizontal and vertical axes and including an electrical subframe operator therefor arranged to pivot said subframe about said vertical axis to vary the horizontal trajectory of successive balls and having an associated electrical control for said subframe operator.

3. In a tennis ball machine as claimed in claim 1 including a baffle plate having smooth curved edges and secured to said hopper within said aperture and above said receiving end of said tube and an elongated resilient member secured at one end to said baffle plate and at an opposite end to the edge of said aperture to resiliently urge and direct arriving balls away from and around said baffle plate whereby to prevent jamming of balls in said gating means space proximate said tube's ball receiving end.

4. In a tennis ball machine as claimed in claim 3 wherein said resilient member comprises a coil spring.

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UNIVERS STATES PATENT OFFICE
CERTIFICATE OF CORRECTION


Inventor(s) Donald P. Holloway; William H. Payne; Donald H. Peeler

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 52, a period should be inserted after "portability". first occurrence
Column 3, line 48, "of" should be -or-. 
Column 3, line 57, "column" should be -columns-. 
Column 4, line 15, "includees" should be -includes-. 
Column 5, line 59, "ro" should be -or-. 
Column 6, line 33, "switching" should be -switching-. 
Column 6, line 47, "ball" should be -balls-. 
Column 6, line 64, "ar" should be -are-. 
Column 7, line 3, "ht" should be -the-. 
Column 7, line 4, "prooelled" should be -propelled-. 
Column 7, line 41, -so- should be inserted after "70".
Column 7, line 57, "45'" should be -45°-. 
Column 7, line 63, "cored" should be -cord-. 
Column 8, line 16, -causes- should be inserted after "thus".
Column 8, line 30, "flexibly" should be -flexible-. 
Column 9, line 7, "arms" should be -drums-. 
Column 9, line 32, "whereby" should be -so as-. 
Column 10, line 31, "aoerture" should be -aperture-.

Signed and sealed this 1st day of October 1974.

(S.S.L.)
Attest:

McCOY M. GIBSON JR. C. MARSHALL DANN
Attesting Officer Commissioner of Patents