Sept. 13, 1966 J. P. EGBERT 3,272,194

BALL PROJECTING DEVICE

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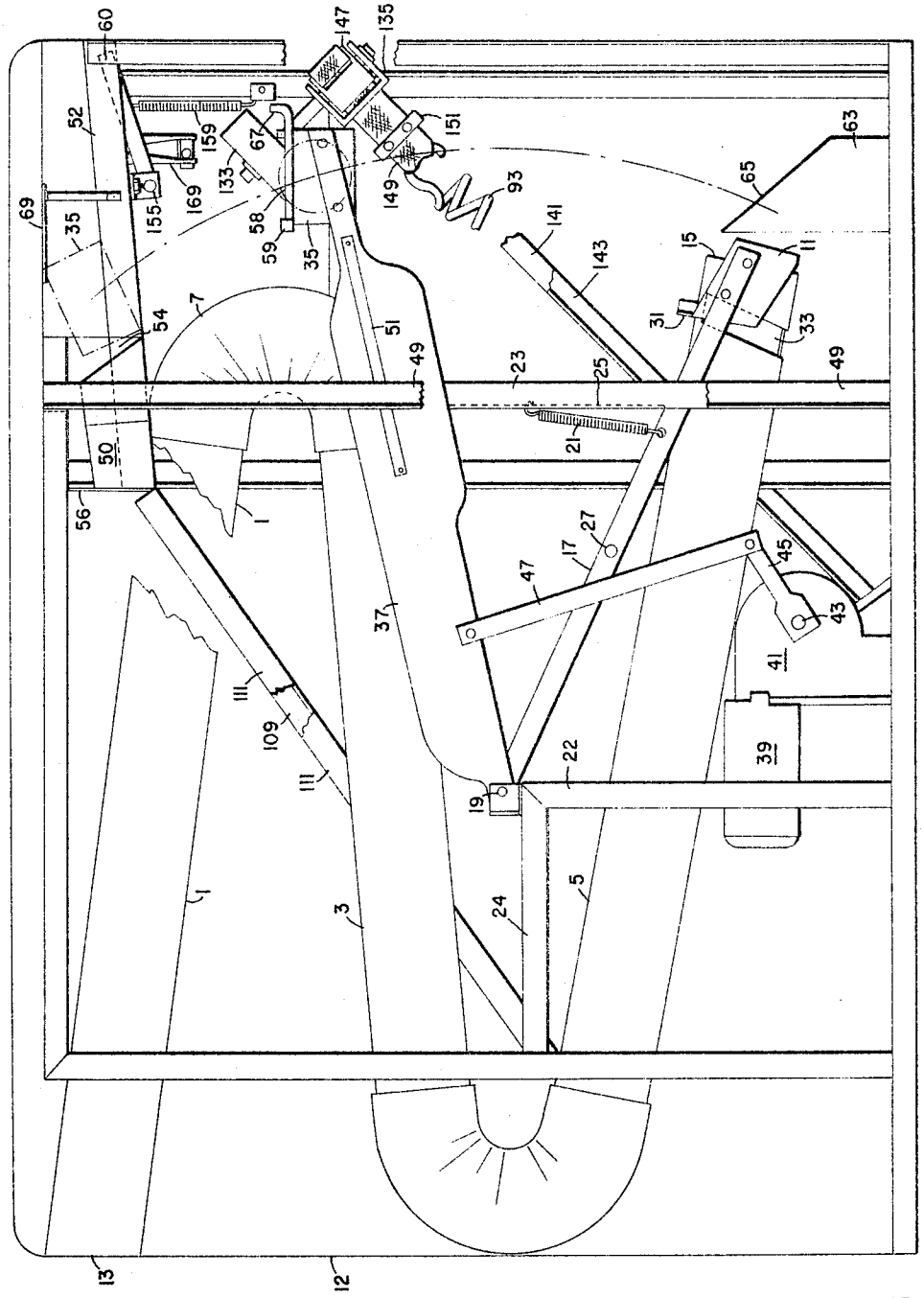



FIG. 1

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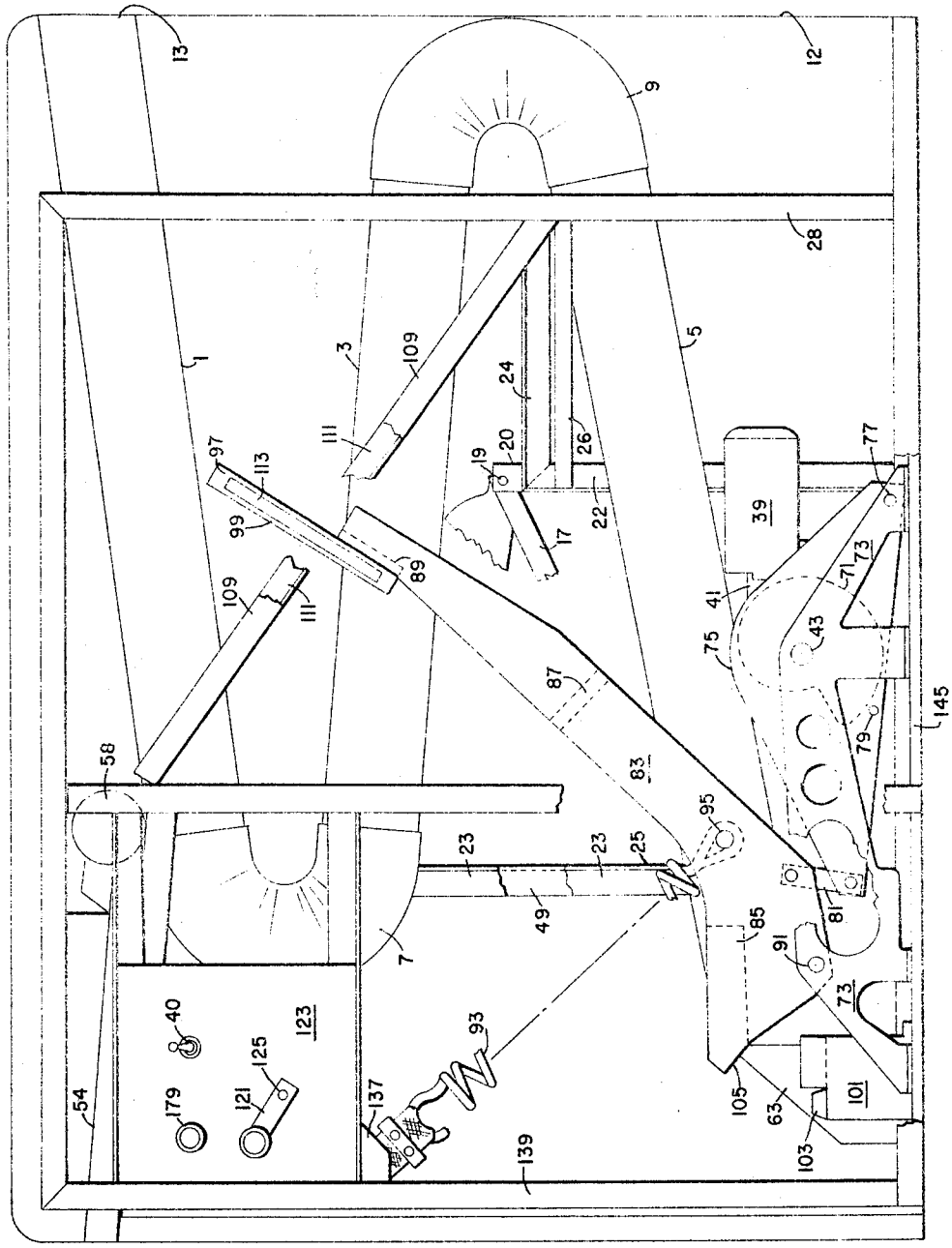



FIG. 2

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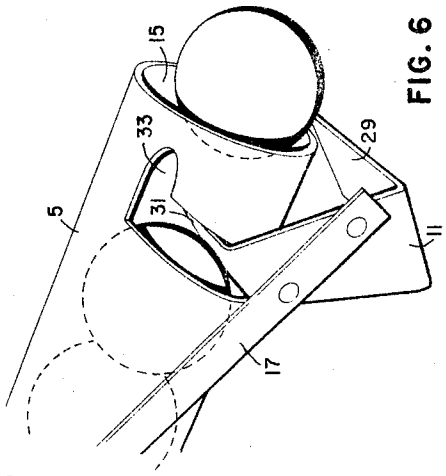



FIG. 6

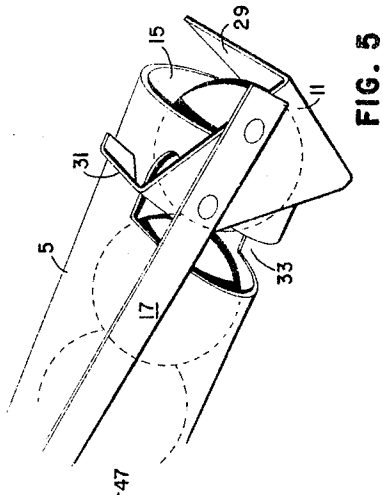



FIG. 5

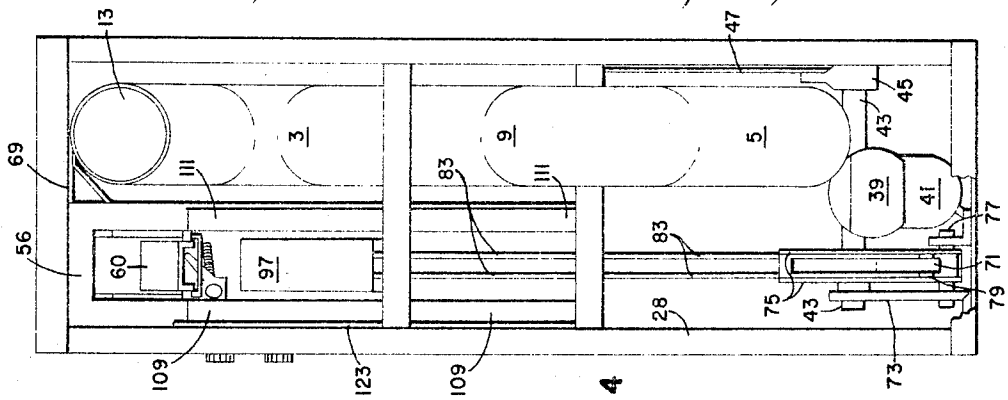



FIG. 4

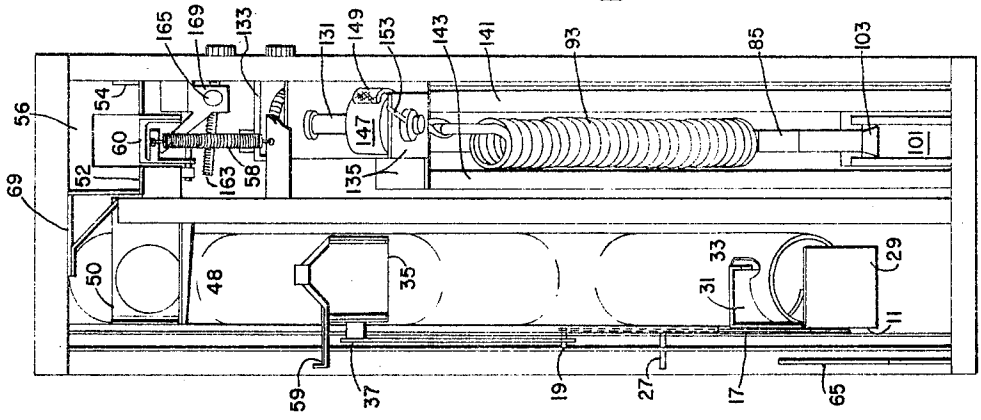



FIG. 3

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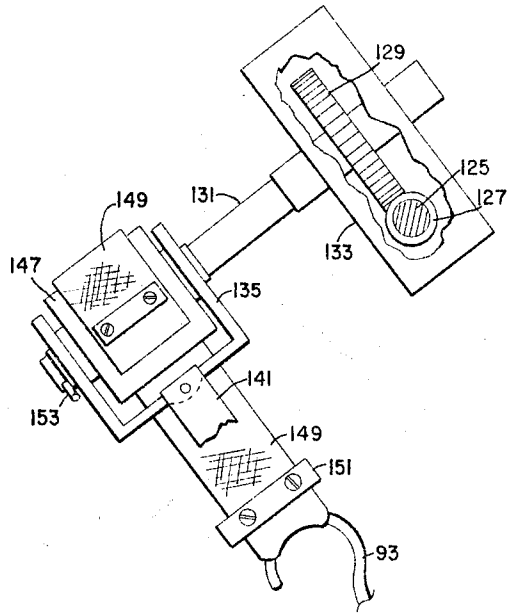



FIG. 10

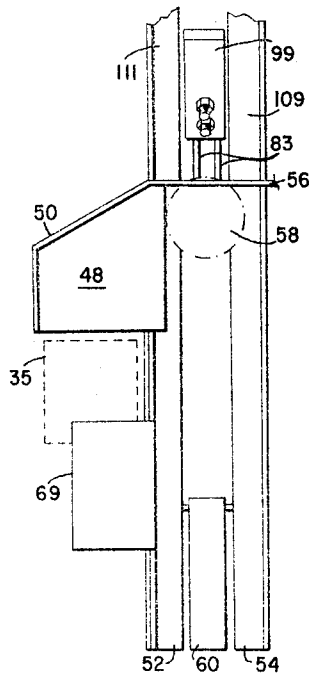



FIG. 7

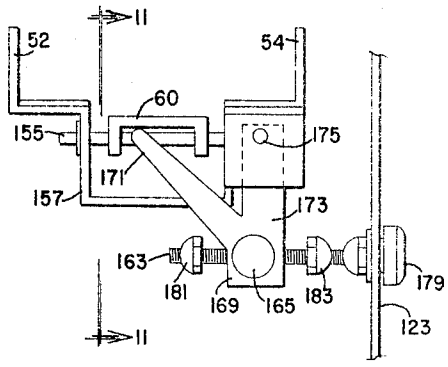



FIG. 9

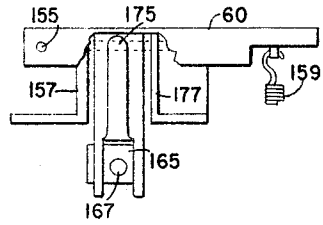



FIG. 11

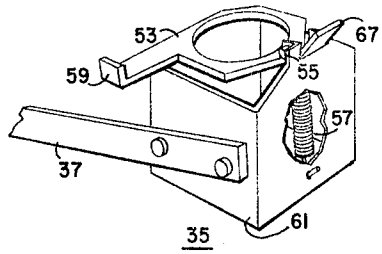



FIG. 8

United States Patent Office

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Patented Sept. 13, 1966

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3,272,194

# BALL PROJECTING DEVICE

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Filed July 13, 1962, Ser. No. 209,554
11 Claims. (Cl. 124—26)

The present invention relates to practice devices and more particularly to portable machines for automatically projecting tennis balls in simulation of the manner in which such balls are driven by a person using a tennis racket. This invention provides a portable compact practice device of relatively small size and lightweight and which requires no external attachments other than an electrical cord. Because of its compactness and light weight the instant practice device may be carried by both men and women and may be placed in operation by merely attaching the electrical cord to a source of power.

The practice machines heretofore known have been, by contrast, rather heavy and bulky. Many of these devices, although considered portable, have in fact been movable only by those of great strength. Many practice machines of the prior art have been provided with external attachments such as ball storage compartments and ball feeding trays. These attachments increase the bulk of the practice device thus making them difficult if not impossible to carry. Such attachments have been made removable and thus must be attached and adjusted each time the device is set up and removed each time the device is moved.

Accordingly, a primary object of the invention is to provide a simple, economical, and compact portable practice device for intermittently ejecting tennis balls.

An object of this invention is to provide a portable device for projecting tennis balls, said device requiring no external attachments and having internal means for storing balls.

The above stated objects are accomplished by providing a ball striking mechanism of simple but sturdy design and a simplified ball feeding mechanism which intermittently removes a ball from a ball storage device and transports it into a position where it may be struck by the ball striking mechanism.

An object of the invention is to provide a ball striking mechanism comprising a linkage, a spring for biasing the linkage toward a position to strike a ball, and cam operated means for moving the linkage against the force of the spring. The spring may be connected at one end to a crank mechanism so that the tension of the spring may be adjusted to thus vary speed at which balls are projected from the practice device.

An object of this invention is to provide a ball striking mechanism having a motor driven cam, a linkage, a spring connected to one link of said linkage, and a cam follower roller connected to another link of said linkage and driven by said cam to create a tensional force in said spring, said cam having a sharp change of slope whereby said linkage is suddenly released and returned by said spring.

A further object of the invention is to provide a ball feeding mechanism for selecting and transporting one ball at a time from a ball storage device to a ball firing track. The ball storage device is a tubular member having an opening into which balls may be inserted through a hole in the cover of the practice machine. The other end of the ball storage tube is open and an opening is provided in the tube at a distance slightly more than the diameter

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of a ball from this end. A ball transport cup is cylically driven between a position opposite the end of the tube and a position opposite the firing track. A retaining means is provided for holding the ball in place as it is being transported. The retaining means is pivoted at a point intermediate its ends and is spring biased to apply a retaining force to a ball in the transport cup. A first means is provided to apply an upward force to the retaining means when the cup is opposite the tube opening and a second means is provided to apply a downward force to the retaining means when the cup is opposite the firing track. This opens the retaining means to receive and then eject the ball transported in the cup.

A further feature of the invention is the provision of novel means for selectively blocking the ball storage tube at its end or at a point removed from its end whereby only one ball is permitted to exit from the tube on each cycle of the machine. The blocking means comprises an arm having first and second blocking members mounted thereon in fixed relationship. A spring normally holds the arm in a position whereby the first member blocks the end of the tube thus preventing the balls in the tube from rolling out while the second member is completely out of the tube. A ball transport cup is moved into position to receive the first ball in the tube. The linkage which moves the cup into position drives the arm holding the blocking members so that the second member is inserted in the tube between the first and second balls and the first member is removed from in front of the tube so that the first ball may enter the cup. As the ball transport linkage moves the transport cup toward the firing track a bias spring attached to the blocking member arm returns the blocking members to their initial position. This permits the next ball to move from the second to the first blocking position so that it may enter the cup on the next cycle.

Further features of the invention include the provision of manual controls whereby the speed at which a ball is fired and the angle at which it is directed are easily adjustable from a control panel mounted on the side of the machine.

The angle at which a ball is directed is normally determined by the angle of inclination of a pair of spaced guide rails along which a ball moves after being struck by the firing arm. A deflector plate is pivotally mounted below the guide rails and means are provided responsive to rotation of a knob on the control panel for pivoting the deflector upward between the guide rails at an angle with respect to the inclination of the rails.

The present invention employs a mechanical linkage which is normally spring biased such that a ball striking arm is held between a pair of spaced guide rails. Drive means including a cam with an abrupt change of slope applies force to the linkage to slowly move the striking arm in an arcuate path in one direction and increase the tension in the spring. Upon reaching the abrupt change in slope the cam no longer applies a force to the linkage and the ball striking arm moves rapidly through the arcuate path in the opposite direction to strike a ball resting on the guide rails. The velocity of the ball striking arm determines the velocity with which the ball is ejected with the velocity of the ball striking arm being determined by the tension in the bias spring. A feature of the invention is the provision of means operable in response to rotation of a control panel crank for rotating a drum element about a fixed axis. A flexible member is attached to the

drum and one end of the bias spring whereby the tension of the spring may be varied by winding more or less of the flexible member about the drum. Further means are provided for limiting the rotation of the drum whereby the tension in the bias spring is variable only between a predetermined maximum and a predetermined minimum.

Other objects of the invention and its mode of operation will become apparent upon consideration of the following description and the accompanying drawings in which:

FIGURE 1 is a partial view of the left side of the invention showing the ball storage and ball feeding mechanisms;

FIGURE 2 is a partial view of the right side of the invention showing the ball striking mechanism;

FIGURE 3 is a partial front view of the invention;

FIGURE 4 is a partial rear view of the invention;

FIGURES 5 and 6 illustrate the mechanism for selecting one ball at a time;

FIGURE 7 is a top view of the ball feed tray and firing track;

FIGURE 8 shows the details of the ball transport cup;

FIGURE 9 is a front view of the deflection plate controls;

FIGURE 10 shows the details of the spring tension controls; and

FIGURE 11 is a sectional view taken along the line 11—11 of FIGURE 9.

Generally speaking, the major operating components of the present invention are the ball storage and feed mechanisms and the striking or ball firing mechanism. On each cycle of operation the ball feed mechanism withdraws one ball from a storage device and transports it to a firing position on a ball firing track. The firing mechanism is synchronized with the feeding mechanism so that after each ball is positioned on the firing track an arm strikes the ball to propel it along the track and out of the machine at high velocity.

FIGURE 1 is a side view of the machine showing primarily the ball storage and feeding mechanism. The back of the machine is to the left of the figure with the front being to the right.

The ball storage device includes three rigid hollow tubular members **1**, **3** and **5** and a pair of flexible tubular members **7** and **9**. Rigid tubes **1**, **3** and **5** are inclined and mounted on suitable supports (not shown) so that a ball entering one end of a tube rolls toward the other end under the force of gravity. Flexible tube **7** connects the lower end of tube **1** to the upper end of tube **3** and flexible tube **9** connects the lower end of tube **3** to the upper end of tube **5**. The lower end of tube **5** is open but is normally blocked by a movable blocking member **11** which has an arm **29** (FIGURE 2) extending across the open end of the tube to prevent egress of balls from the storage device. The upper end of tube **1** terminates at an opening **13** and the cover of the machine is provided with a hole so that balls may be inserted through the hole in the cover **12** and enter tube **1**. Before the machine is placed in use a plurality of balls are inserted into the machine through hole **13** and these balls come to rest one behind the other with the first ball inserted being held at the lower end of tube **5** by the arm on element **11**. When the machine is not in use the balls may be stored in the tubes to prevent them from being lost.

One ball is released from the lower end of tube **5** on each cycle of operation of the machine. This is accomplished through the action of blocking means **11** which is mounted on an elongated arm **17** which is pivoted on fixed pivot **19**. Pivot **19** is carried by bracket **20** which is supported by L-members **22** and **24**. A horizontal brace **26** extends diagonally to the rear of the rear of the machine and is connected to a vertical L-member **28** (FIGURE 2) to give lateral rigidity to the pivot mounting bracket.

A tension spring **21** is connected between arm **17** and an L-member **23**. L-member **23** has one arm **25** which extends toward the inside of the machine. The lower portion of this inwardly extending arm is removed and the tension in spring **21** exerts a bias force on arm **17** to normally hold the arm against the lower extremity of the arm **25**. Arm **17** carries a stud **27** which extends outwardly therefrom. In a manner subsequently described force is applied downwardly against stud **27** by an arm **37** once during each machine cycle to overcome the bias force of spring **21** and force the arm **17** and blocking means **11** in a clockwise direction about pivot **19**.

Reference is now made to FIGURES 1, 5 and 6 to show the manner in which blocking means **11** permits one ball to exit from the lower end of tube **5** during each machine cycle. FIGURE 5 shows the position of arm **17** and blocking means **11** relative to the opening **15** of tube **5** when the tension in spring **21** is holding the arm **17** against the lower extremity of arm **25**. FIGURE 6 shows the position of arm **17** and blocking means **11** when the tension in spring **21** is overcome and the arm **17** pivoted in a clockwise direction.

Blocking means **11** comprises a bracket having a first arm **29** and a second arm **31**. Arms **29** and **31** are substantially parallel to one another and are spaced apart by a distance slightly greater than the diameter of one ball. As shown in FIGURE 5, the arm **29** normally blocks the end of tube **5** while the arm **17** is resting against the back stop **25**. At this time the arm **31** is positioned above the tube **5** and does not extend into the path of balls rolling through the tube.

Tube **5** is provided with a semi-circular slot **33** for receiving the arm **31** when arm **17** is pivoted in a clockwise direction in response to a force exerted on stud **27**. As shown in FIGURE 6, the arm **17** pivots downwardly and the arm **29** is removed from the end of tube **5** thus allowing the first ball in the tube to roll out. As subsequently described, this ball enters the transport cup which carries it to the firing position. As arm **29** moves away from the end of tube **5** the arm **31** enters the slot **33** to prevent the second and subsequent balls from rolling out of the tube **5**. As soon as the force is removed from stud **27** arm **17** moves in a counterclockwise direction under the tension in spring **21**. As arm **17** pivots in a counterclockwise direction arm **29** blocks the end of tube **5** and then the arm **31** moves away from the path of the balls in the tube so that all of the balls move forward and the next ball comes to rest against the arm **29**.

As stated before, each ball leaving tube **5** through opening **15** enters a ball transport cup which carries it to the ball firing position. Referring now to FIGURES 1 and 2, the ball transport mechanism includes a ball transport cup **35** mounted on an elongated arm **37**. An electric motor **39** controlled by an electric switch **40** operates through a conventional speed-reduction gearing mechanism **41** to rotate shaft **43** in a clockwise direction. A crank **45** is connected by means of a linkage **47** to the arm **37**. Arm **37** is mounted on pivot **19** so that arm **37** moves in an arcuate path in a vertical plane as the shaft **43** rotates. As the arm **37** moves it carries ball transport cup **35** from a lowermost extent of travel where it is opposite the opening **15** to an uppermost extent of travel where it dumps a ball into a feed tray **48** from which it rolls onto a firing track. This latter position of the transport cup is indicated in outline in FIGURE 1.

The arm **37** is made of sheet material preferably a lightweight metal such as aluminum. Two upright L-members **23** and **49** serve as guides for the arm **37**. As viewed in FIGURE 1, L-member **23** has one arm parallel to arm **37** with the other arm extending inwardly toward the center of the machine. L-member **49** has one arm parallel to the arm **37** with the other arm extending outwardly from the machine. One or more pieces of strip material **51** which may be Teflon are attached to each side of the arm **37** to reduce friction and noise caused by arm **37** coming in contact with upright L-members **23** and **49**.

Feed tray **48** is inclined to the left and inwardly toward a ball firing track so that when the ball is dumped

onto the tray from the ball transport cup it rolls onto the ball firing track and into firing position.

FIGURE 7 is a top view of the feed tray and firing track. As shown therein, the feed tray is open on the side nearest the front of the machine so that balls may roll from the transport cup **35** onto the tray. The tray is provided with a vertical side wall **50** which holds the ball on the tray and guides it toward the right side of the tray. The right side of the tray is open so that balls rolling onto the tray from the ball cup roll out of the tray and onto the ball firing track.

The ball firing track comprises two parallel spaced L-members **52** and **54**. Reference is made to FIGURE 9 which is a front view showing the L-members which comprise the firing track. L-members **52** and **54** are inclined toward the rear of the machine so that a ball rolling onto the firing track rolls back to an apertured stop plate **56**. Ball **58** (FIGURE 7) is shown in position ready for firing. By a mechanism subsequently described a ball striking surface **99** is caused to move forward suddenly. The striking surface moves forward through the aperture in stop plate **56** and between the firing track members **52** and **54**. This propels the ball out of the front of the machine at high velocity. A deflection plate **60** described in detail with reference to FIGURE 9 controls the vertical angle at which the ball is propelled from the machine.

The ball transport cup **35** is shown in FIGURE 8 and comprises a box-like structure having a bottom and three sides. One side of the cup is open to receive each ball as it emerges from the lower end of tube **5**. The ball transport cup has a substantially flat ring-like retaining arm **53** mounted on a pivot **55**. A tension spring **57** normally holds the retaining arm down so that the retaining arm extension **59** rests against the side **61** of the cup. When the retaining ring is in this position the distance between the retaining arm and the bottom of the cup is less than the diameter of a ball so that balls cannot enter or leave the ball cup.

The extension **59** is used to lift the retaining arm **53** as the ball transport cup moves into position opposite the lower end of tube **5**. A plate-like vertical member **63** (FIGURE 1) has a camming surface **65**. As the ball transport cup approaches its lower limit of travel the extension **59** strikes surface **65** thus lifting the retaining arm and permitting the ball emerging from tube **5** to enter the cup. As the ball transport cup begins its upward movement extension **59** moves away from surface **65** thus permitting tension spring **57** to pull the retaining arm downward against side **61**. The hole in the retaining arm is made somewhat less than the diameter of a ball to prevent balls from escaping from the cup through the hole as they are being transported to the ball firing track.

When the ball transport cup reaches its upward extent of travel it is necessary to again lift the retaining arm so that the ball may roll out of the cup and into firing position. Tab **67** on the retaining arm is provided for this purpose. As the ball transport cup reaches its upward extent of travel tab **67** strikes stop plate **69** (FIGURES 1 and 7) and the downward force exerted on tab **67** pivots the retaining arm against the force of its tension spring. The bottom of the cup is tilted toward tray **48** at this time so the ball rolls out of the cup and onto the tray **48**.

FIGURES 2 and 4 are right side and rear views, respectively, showing primarily those elements which comprise the ball firing mechanism. The speed reduction gearing **41** shown in FIGURE 1 has a single output shaft **43** which extends from both sides of the gear housing. As explained with reference to FIGURE 1, the ball feed mechanism is operated by the crank **45** mounted on one end of the shaft. The ball firing mechanism is driven by a radial cam **71** which is mounted on the opposite end of the shaft **43**. This end of shaft **43** is supported in bearing support **73**. A primary connecting linkage **75** comprises two identical plate-like members. These members have spacers between them and they are bolted together so that they lie in parallel vertical planes. The primary connecting linkage is mounted on a fixed pivot **77**. A cam follower **79** is mounted between the two plate members of the primary connecting linkage and when the machine is assembled cam **71** is mounted on shaft **43** between the parallel plates so that it may pivot primary connecting linkage **75** about point **77** by applying a force to cam follower **79**.

A connecting linkage **81** connects primary connecting linkage **75** to a ball firing arm **83**. Arm **83** is constructed in the same manner as connecting linkage **75**. That is, arm **83** comprises two flat plates having a plurality of spacers **85**, **87** and **89** between them. Arm **83** is mounted on fixed pivot **91** and a tension spring **93** connected to spacer **95** between the two plates of arm **83** tends to pull the arm in a counterclockwise direction about the pivot **91**. At the upper end of arm **83** a plate **97** having a ball striking surface **99** is attached to spacer **89**.

A forward stop block **101** having a rubber cushion **103** mounted thereon is provided for limiting the counterclockwise movement of arm **83**. When cam follower **79** is riding on the lower dwell of cam **71** the tension in spring **93** rotates arm **83** so that the surface **105** of arm spacer **85** presses against the rubber bumper **103**. At this time the ball striking surface **99** is in a substantially vertical position and is forward of the point at which it normally strikes a ball. Ball **58** shown in phantom outline illustrates the position of a ball ready for firing. It is, accordingly, obvious that arm **83** and striking surface **99** move between two limits or positions which are determined by cushion **103** and the outermost surface of cam **71**. As will become obvious from the following description a ball is never in the position shown when the firing surface **99** is forward of this position.

As shaft **43** rotates in a counterclockwise direction, cam follower **79** begins to ride up toward the high portion of the surface of cam **71**. The force exerted on the cam follower pivots primary linkage **75** in a counterclockwise direction about pivot **77**. This exerts a downward force on connecting link **81** to in turn apply a force to arm **83**. This force tends to rotate arm **83** in a clockwise direction about pivot **91** and in doing so stretches the spring **93**. The spring is quite strong so that a considerable amount of energy is stored therein as the arm **83** moves about pivot **91**.

As cam **71** continues to rotate in a counterclockwise direction the roller **79** suddenly drops from the high to the low dwell on the cam. When the cam follower drops to the low dwell there is nothing resisting the force exerted by spring **93** so the arm **83** rotates in a counterclockwise direction at a rapid rate under the force of the spring. As the arm **83** was being moved in a clockwise direction the ball feeding mechanism described above placed a ball **58** in firing position. When the arm **83** moves in the counterclockwise direction the ball striking surface **99** strikes the ball **58** with terrific force and propels it along the firing track and out the front of the machine.

As the arm **83** is rotated in response to the force exerted by spring **93** a force is exerted through linkage **81** to move primary linkage **75** in a clockwise direction and thus hold the cam follower **79** against the surface of cam **71**.

A pair of L-members **109** and **111** are provided for guiding the ball striking plate and firing arm. As shown in FIGURES 4 and 7, each of these members has one arm which lies in a plane parallel to the plane of movement of arm **83** with the two remaining arms of members **109** and **111** lying in the same plane and pointing toward each other. To reduce friction and wear between these latter arms in the sides of ball striking plate **97**, a piece of Teflon **113** or other similar material is attached to each side of the ball striking plate. In actual practice L-members **109** and **111** may be continuations

of the L-members **52** and **54** which form the firing track. This reduces the possibility of the ball striking surface striking the rear end of members **52** and **54** where they join guide members **109** and **111**.

The speed at which a ball is ejected from the machine is dependent upon the velocity of the ball striking surface **99** as it strikes the ball. The velocity of this surface is determined by the tension force exerted on arm **83** by the spring **93**. In the present invention this tension is readily adjusted by means of a crank **121** mounted on the control panel plate **123** shown in FIGURE 2.

The details of the spring tensioning device are shown in FIGURE 10 which is a sectional view looking into the machine from the rear of control panel plate **123**.

Crank **121** is mounted on a shaft **125** which carries a worm gear **127**. A gear **129** is mounted on a second shaft **131** which extends through bracket **133** in a direction perpendicular to shaft **125**. Bracket **133** is mounted on the rear of the control panel plate **133**.

Shaft **131** extends through a second bracket **135** which is fastened to a further bracket **137**. Bracket **137** is not shown in FIGURE 10 but is connected to vertical L-member **139** shown in FIGURE 2. Also fastened to bracket **137** are a pair of elongated L-shaped braces **141** and **143** which are mounted to the base plate **145** of the machine. These braces are positioned as shown in FIGURE 1 so that the force in the spring **93** is exerted substantially parallel to their longitudinal axis.

A drum **147** is mounted on shaft **131** and rotates therewith. An elongated piece of web-like material **149** has one end attached to the drum. The bottom of bracket **135** has a slot therein and the other end of the web is fed through this hole, looped over the hook on spring **93**, and then clamped with bail member **151**.

The tensioning device operates as follows. As the crank rotates shaft **125** drum **147** is rotated. This either winds the web onto the drum to increase the tension in spring **93** or unwinds the web from the drum to decrease the tension. A limit pin **153** extends through shaft **131** and rotates therewith. The limit pin is long enough to strike the rear of the control panel plate **123** as shaft **131** rotates. This insures that the tension in the spring is never increased beyond a predetermined maximum nor decreased below a predetermined minimum.

As stated before, the present invention also includes a mechanism for adjusting the vertical angle at which a ball is fired from the machine. Front and sectional side views of this mechanism are shown in FIGURES 9 and 11.

The ball deflection plate **60** is mounted on a pivot **155**. The pivot is mounted in a bracket **157** which is suspended from beneath guide rails **52** and **54**. A tension spring **159** is connected to the deflection plate forward of its pivot to thereby tend to pull the deflection plate down and out of the path of a ball moving along the guide rails.

A knob **61** is mounted on a threaded shaft **163** which extends through control panel plate **123**. A pivot **165** having a threaded hole **167** is screwed onto the shaft **163**. A deflecting member **169** is free to pivot on pivot member **165** and has first and second arms **171** and **173**. Deflection plate **60** is normally held against arm **171** by tension spring **159**. Arm **173** is mounted on a fixed pivot member **175** which is suspended at one end in bracket **157** and at the other end in a bracket **177**.

The angle of deflection is adjusted as follows. Rotation of knob **179** in a counterclockwise direction forces interally threaded pivot member **165** to move to the left as viewed in FIGURE 9. This moves the lower part of element **169** to the left. Since the upper end of arm **173** is mounted on pivot **175** this movement causes element **169** to rotate in a clockwise direction with respect to pivot **165**. This forces arm **171** upward against the bottom of deflection plate **60** to pivot the front end of the plate upward into the path of balls moving along the firing track.

To reduce the firing angle the control knob is rotated in the opposite direction to move pivot member **165** to the right. This lowers arm **171** and the tension in spring **159** causes the front of deflector plate **60** to pivot down and follow arm **171**. A pair of lock nuts **181** and **183** are mounted on shaft **163** with one nut being on each side of pivot **165** to thereby limit the adjustment within a reasonable operating range.

The novel ball feeding and ball striking mechanisms herein described require very few parts thus enabling the size and weight of the device to be considerably less than that of prior practice devices. The double plate construction of the primary connecting linkage and ball firing arm permits light weight materials such as aluminum to be used even though relatively large forces are exerted on these members. By using aluminum L-members for the frame and various brackets the weight is even further reduced. In accordance with these techniques an operative device was made which measured approximately 10 by 30 by 38 inches and weighed approximately 30 pounds. It should be understood that the particular materials and dimensions recited herein are by way of example only and are not intended as limiting the invention.

While the various elements of the invention have been described with a certain degree of particularity various modifications therein falling within the spirit and scope of the invention will be obvious. It is intended therefore to be limited only by the scope of the appended claims.

I claim:

**1.** In a cyclically operable ball projecting device wherein a plurality of balls are transported from storage to a firing location one at a time, the improvement comprising: an inclined open ended tube for storing a plurality of balls simultaneously; a slot in said tube; said slot being spaced from the lower end of said tube by a distance approximating the diameter of one ball; blocking means having first and second blocking members for blocking said tube at said lower end and said slot, respectively; means for moving said blocking means; and means for holding said blocking members in fixed position with respect to each other whereby said second blocking members blocks said tube at said slot when said lower end is unblocked and said first blocking member blocks said tube at said lower end when said tube is unblocked at said slot, wherein said means for moving said blocking means comprises a pivotally mounted lever, said first and second blocking means being attached to said lever, a spring connected to said lever to urge said first blocking member into blocking position, and cyclically operable means for urging said second blocking means into blocking position and transporting balls released from said tube to said firing location.

**2.** In a ball firing device of the type having a pair of spaced members for guiding a ball, a striking arm having a ball striking surface movable in an arcuate path between said spaced members, means for intermittently moving said ball striking surface through said arcuate path in one direction, and a tension spring connected to said striking arm for moving said ball striking surface through said arcuate path in the other direction, the improvement comprising: means for varying the rate of movement of said ball striking surface through said arcuate path in said other direction, said means comprising a manually rotatable shaft having a worm gear thereon, a second rotatable shaft having a gear mounted thereon and in mesh with said worm gear, a winding drum mounted on said second shaft, and flexible means connected at one end to said drum and at the other end to said tension spring whereby rotation of said first shaft winds said flexible means on said drum and varies the force applied to said striking arm through said tension spring.

**3.** A ball firing mechanism comprising: base means including first and second fixed pivots; an elongated member pivoted at one end on said first pivot and having a ball striking surface at the opposing end thereof, said ball striking surface being disposed in a plane normal to the

plane of movement of said elongated member; linkage means pivoted at one end thereof on said second pivot; means connecting the opposing end of said linkage means to said elongated member at a point near said first pivot whereby arcuate movement of said opposing end of said linkage means are amplified and cause larger arcuate movements of said ball striking surface; a spring for applying a bias force to said elongated member and acting through said connecting means to move said linkage means in a first direction; and means for intermittently moving said linkage means in a second direction and then releasing it so that it may be moved in said first direction in response to said bias force.

4. A ball firing mechanism as claimed in claim 3 wherein said means for intermittently moving said linkage means in said second direction comprises a cam acting against said linkage means, and means for rotating said cam, said cam having a gradually increasing radius with an abrupt decrease in radius.

5. In a ball projecting device, the combination comprising: a ball striking arm pivoted at one end about a pivot; a ball striking surface on said striking arm, said ball striking surface moving through an arc between first and second limits as said arm is rotated about said pivot; a ball feed and firing track comprising first and second members spaced apart by a distance less than the diameter of a ball and disposed on opposite sides of said arc for at least a portion of the distance between said limits whereby said striking surface may move between said first and second members; a ball firing station including means for holding a ball on said track at a position which lies on said arc; cyclically operable drive means for rotating said ball striking arm about said pivot to move said ball striking surface to said first limit; said drive means including means releasing said striking arm when said surface reaches said first limit; spring means associated with said striking arm for storing energy as said ball striking surface is moved to said first limit, said spring means acting against said striking arm to release said energy stored by said spring and move said ball striking surface toward said second limit when said striking arm is released; and feed means operatively responsive to said drive means for feeding a ball into said firing station during the interval said ball striking surface is moving between said ball firing station and said first limit; and means for stopping said striking arm when said ball striking surface reaches said second limit.

6. In a ball projecting device, the combination comprising: a ball striking arm pivoted at one end about a pivot; a ball striking surface on said striking arm, said ball striking surface moving through an arc between first and second limits as said arm is rotated about said pivot; a ball feed and firing track comprising first and second members spaced apart by a distance less than the diameter of a ball and disposed on the opposite sides of said arc for at least a portion of the distance between said limits whereby said ball striking surface may move between said first and second members; a ball firing station including means for holding a ball on said track at a position which lies on said arc; cyclically operable drive means for rotating said ball striking arm about said pivot to move said ball striking surface to said first limit, said drive means including means releasing said striking arm when said ball striking surface reaches said first limit; spring means associated with said striking arm for storing energy as said ball striking surface is moved to said first limit, said spring means acting against said striking arm to release said energy stored by said spring and move said ball striking surface toward said second limit when said striking arm is released; and feed means operatively responsive to said drive means for feeding a ball onto said track during the interval said striking surface is moving between said ball firing station and said first limit, said track being inclined toward said ball firing station so that a ball feeds onto said track and rolls toward said firing station.

7. The combination as claimed in claim 6, said feed means comprising a ball feed arm having a cup attached thereto; a tray mounted adjacent said ball track; an inclined open ended ball storage tube; and means connected to said drive means for moving said ball feed arm, said feed arm being pivoted at one end whereby said cup moves in an arcuate path from a position opposite the lower end of said storage tube to a position opposite said tray.

8. The combination as claimed in claim 7 and further comprising a lever pivoted at one end, first and second blocking members mounted on said lever in a fixed relationship with each other, said tube having a slot therein whereby one of said blocking members normally blocks the lower end of said tube and the other of said blocking members blocks said tube at said slot when the first blocking member unblocks the end of said tube, and means for moving said lever to unblock the lower end of said tube when said cup is moved into position opposite it.

9. A ball projecting device comprising: a ball track having first and second track members disposed in parallel relationship and spaced apart by a distance less than the diameter of a ball, said track members being elevated at one end so that a ball deposited thereon rolls under the force of gravity to the other end thereof; a ball striking arm having a ball striking surface thereon; means supporting said arm for pivotal movement of said striking surface over an arcuate path at least a portion of which lies between said track members at said other end; means for depositing a ball on said tracks intermediate said ends; and means for rotating said striking surface between said track members toward said opposite end, whereby a ball deposited on said track travels in both directions over a portion thereof before it is projected from said opposite end.

10. A ball feed device for feeding balls one at a time to a loading tray, said device comprising an inclined hollow, open ended member for storing a plurality of balls wherein there is a slot in said hollow member; pivotally mounted blocking means including means for blocking the travel of a ball through said hollow member past said slot when the end of said hollow member is not blocked; means for normally applying a force to said blocking means to hold it in blocking position opposite the lower end of said hollow member; a ball transport mechanism including a cup mounted on an elongated pivotally mounted member and cyclically operable drive means connected to said elongated member for cyclically moving said cup from a position opposite the lower end of said hollow member to a position opposite said loading tray; means responsive to said ball transport mechanism for overcoming the force normally applied to said blocking means to thereby remove said blocking means from the end of said hollow member when said cup is opposite the lower end of said hollow member; and wherein said transport cup has retaining walls on three sides thereof, the fourth side being open to receive balls from said hollow member and discharge balls to said loading tray; retaining means for preventing a ball from leaving said cup as it is being transported, said retaining means comprising a member pivoted at a point intermediate its ends and resilient means for urging said member downwardly against a ball in said cup; first means for pivoting said member against the force of said resilient means while said cup is opposite the lower end of said hollow member; and second means for pivoting said member against the force of said resilient member while said cup is in position to discharge balls into said loading tray.

11. The combination as claimed in claim 10 and further comprising a pair of spaced guide rails forming a ball firing track, said tray being inclined and having an opening adjacent said track so that balls deposited therein from said cup roll onto said track; and cyclically operable firing means including a striking arm movable between said rails for projecting a ball along said track.

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