Aug. 9, 1966 J. R. BRANDELL 3,265,940

SOLENOID KICKER

Filed April 10, 1964

FIG. 1

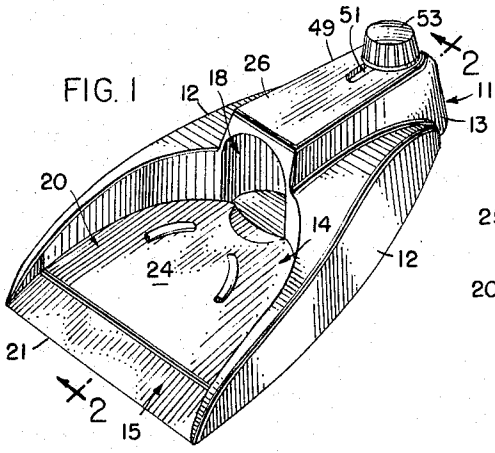


FIG. 3

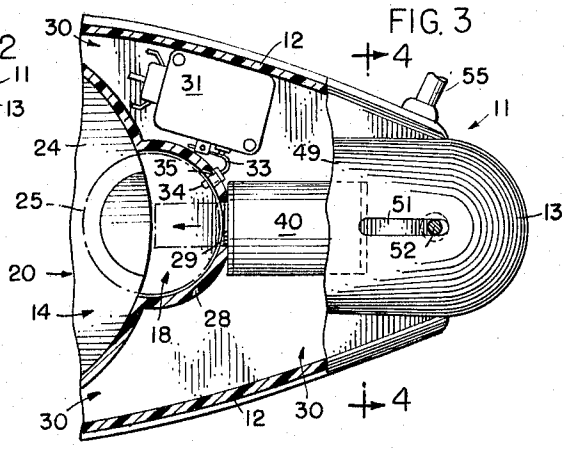


FIG. 4

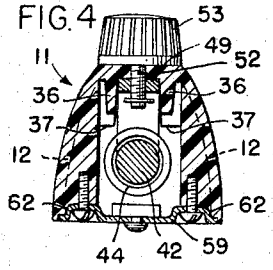


FIG. 2

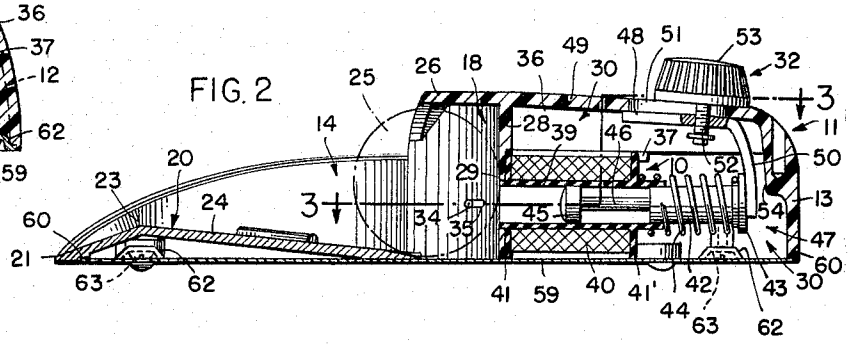
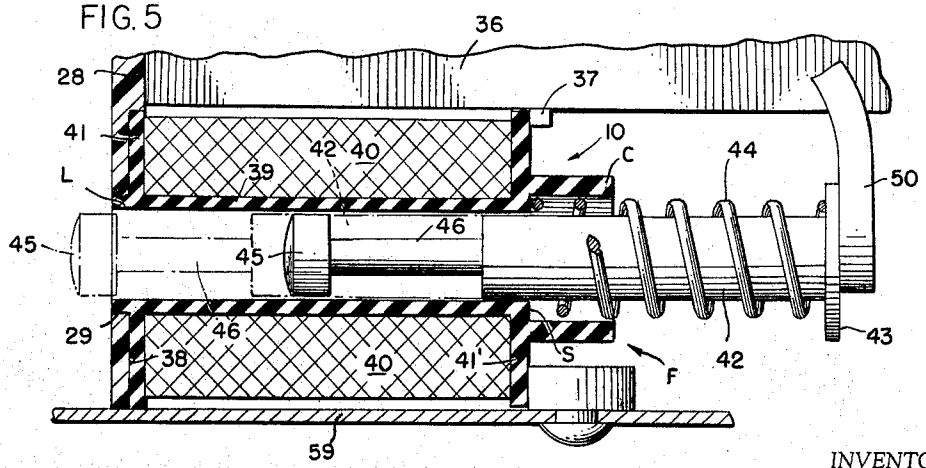


FIG. 5



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SOLENOID KICKER

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The present invention relates in general to game equipment, and has more particular reference to improved ball kicking or solenoid apparatus especially well adapted for use in golf putting practice devices for automatically ejecting, to a remote station outwardly of the device, a golf ball putted into the same from the direction of said remote station, the present application relating to improvements in the kicker apparatus disclosed in my copending applications Serial Nos. 48,503 and 750,814, filed respectively August 9, 1960, and July 24, 1958, and in my U.S. Letters Patent No. 2,709,594, No. 3,003,769, and No. 3,030,113, which issued May 31, 1955, October 10, 1961, and April 17, 1962, respectively.

In kickers comprising a solenoid and an axially shiftable armature rod or plunger movable axially into the solenoid from a retracted position, when the solenoid is energized, in order to produce a brisk, snappy kicking action, it is desirable that the armature should be traveling at maximum velocity in the solenoid at the moment of kicking impact. Axial motion is imparted to the armature rod because of its tendency to be drawn toward a centered position in the solenoid, that is to say, the solenoid, when energized, tends to hold the armature rod in a position centered in the solenoid coil; and it will not tend to project the armature rod in either direction from such centered position. This phenomenon occurs because the magnetic field established by the solenoid coil, when energized, is symmetrical with respect to the solenoid and has its strongest concentration in the space within the coil, the field being relatively weaker outwardly of the opposite ends of the solenoid and in the area around the solenoid. The driving force on the armature rod is a maximum, of course, when the armature rod is in a fully retracted position, outwardly of an end of the solenoid, and is understood to remain substantially at such maximum value until the forward end of the armature rod reaches a position substantially medially of the opposed ends of the solenoid coil. Thereafter, as the armature rod continues to move into the solenoid, the driving force will taper off somewhat and will approach zero, as and when the forward end of the rod reaches the front end of the solenoid.

An important object of the present invention is to provide a solenoid kicker in which the armature driving force is at maximum value at the instant of kicking impact.

Another important object of the invention is to provide a solenoid comprising a unitary coil winding form providing a central sleeve for receiving and guiding the armature rod longitudinally of the solenoid, the sleeve having a pair of integral spaced flanges formed thereon inwardly of the opposed ends of the sleeve to form end plates for containing the coil of the solenoid between the flanges, whereby the same define the opposite ends of the coil and hold it against movement longitudinally of the sleeve.

A further object of the invention is to form one of the integral end plates inwardly of one end of the sleeve sufficiently so that the end of the sleeve outwardly of said end plate may extend interlockingly in a wall opening to aid in anchoring the solenoid on the wall at said opening; a still further object of the invention being to form the other of the integral end plates on the central sleeve at an appreciable distance from the end thereof, to constitute the outwardly projecting end of the sleeve as a stop in position to engage an abutment flange formed on the armature rod or plunger, and to stop movement of the plunger when the flange reaches a limit position

spaced from the end plate a distance to accommodate the armature retracting spring when compressed between the abutment flange of the armature and the integral end plate of the solenoid.

Another important object is to provide a kicker or striking device embodying a solenoid and an associated rod or plunger forming an armature, wherein the plunger has a driving portion of length substantially less than the axial length of the solenoid, and a striking head spaced forwardly of the driving portion and interconnected therewith by means of a connecting stem, whereby the forward end of the driving portion will be disposed within and substantially behind the forward end of the solenoid when the striking head engages an object to be struck, kicked or impelled.

The foregoing and numerous other important objects, advantages and inherent functions of the invention will become apparent as the same is more fully understood from the following description, which, taken in connection with the accompanying drawings, discloses a preferred embodiment of the invention.

Referring to the drawings:

FIG. 1 is a perspective view of a game device embodying the present invention;

FIG. 2 is a sectional view taken substantially along the line 2—2 in FIG. 1;

FIGS. 3 and 4 are sectional views respectively taken substantially along the line 3—3 in FIG. 3, and the line 4—4 in FIG. 3; and

FIG. 5 is an enlarged view of a portion of the structure shown in FIG. 2.

To illustrate the invention the drawings show an improved solenoid kicker 10, which, while useful as a general purpose kicker wherever the services of a kicker may be needed, may be employed to advantage in the automatic ball return game device illustrated in the drawings, the same comprising a frame 11 of generally triangular shape forming a nose 13 at one end, and an open top target chamber 14 having a lateral entrance portal 15 opening at the nose remote end of the frame. The width of the entrance portal 15 at its narrowest portion may equal the diameter of a conventional golf hole.

The frame 11 may be formed with a ball receiving pocket 18 which opens upon the target chamber 14 opposite the entrance portal 15, said pocket being preferably sized to snugly yet freely receive a standard golf ball therein, in order to position the same in alinement with the kicker 10 mounted in the frame behind the ball receiving pocket and operable in response to the presence of a ball in the pocket to impel the ball forcibly from the pocket and outwardly of the device through the portal 15.

The frame 11 may also provide a bottom wall or floor 20 for the target chamber, said floor extending at the portal 15 where it forms a thin, forwardly facing edge 21, over which a golf ball may enter the target chamber. The bottom wall 20 may provide an inclined plane portion 24 extending downwardly toward the pocket 18 from a ridge 23 extending parallel to the edge 21 and inwardly thereof, whereby a ball which passes over the ridge 23 in entering the chamber will thereafter gravitate into the pocket 18, for ejection thence outwardly of the device, by operation of the kicker 10.

The pocket 18 is preferably deep enough to receive a substantial portion of a golf ball 25, as clearly shown in FIG. 2 of the drawings, whereby to properly aline the ball with the kicker 10. To this end, the pocket may be provided with a top or roof wall 26 in position overlying a ball in the pocket.

The frame may provide an upstanding semi-cylindrical wall 28 defining the pocket 18, said wall 28 being formed centrally with an opening 29 therethrough communicat-

ing the pocket with a housing cavity 30 formed in the frame 11 behind the target chamber. The housing cavity 30 provides for the reception and enclosure of the kicker 10 as well as a microswitch 31 for controlling the operation of the kicker. The frame portions defining the cavity 30 may also provide for the support of adjustable means 32 for varying the force of the impact applied by the kicker upon a ball 25 in the pocket 18. To these ends, the frame 11 behind the wall 28 may form a seat for supporting the microswitch 31 adjacent said wall, said microswitch having a switch actuating arm 33 forrmed with a finger 34 having an end extending into the pocket 18 through an opening 35 in the wall 28 adjacent the opening 29.

The frame may also be provided with a pair of spaced strengthening flanges or ribs 36 extending between the wall 28 and the nose portion 13 of the frame, said ribs having a pair of projecting fingers 37 forming abutment shoulders facing toward the medial portions of the wall 28 which may be flattened to form a seat 38 around the opening 29.

The kicker 10 may comprise a solenoid embodying an integral coil winding and supporting form F, preferably of molded nylon or other suitable moldable material, providing a central sleeve 39, and a pair of spaced flanges 41, 41' formed on the sleeve 39 to define the opposite ends of a wire coil or winding 40 of generally cylindrical configuration wound upon and concentrically encircling the sleeve between the end plates 41, 41', which serve to contain the winding and to hold the same against displacement axially of the sleeve. The end plate 41 may be of circular peripheral shape and is preferably formed on the sleeve 39, inwardly of one end thereof, to provide a sleeve end portion L which projects outwardly of the end plate 41. The end plate 41' is preferably square or rectangular and is formed on the end of the sleeve 39, remote from the end portion L. Concentric with respect to the sleeve 39, the end plate may be formed with an integral outwardly extending collar C of diameter somewhat greater than that of the sleeve to define a seat S on the end plate, surrounding the end of the sleeve which opens through the end plate 41', within the collar.

The solenoid may be mounted in the frame by applying the plate 41', at one end of the solenoid, in interfitting engagement with the abutments 37, and by then pressing the projecting end L of the sleeve 39, at the opposite end of the solenoid, interfittingly into the opening 29 in the wall 28, while simultaneously bringing the adjacent end plate 41 into engagement with the seat 38. The resilience of the solenoid structure, including that of the end plates, may thus be employed to secure the solenoid firmly in mounted position between the seat 38 and the abutments 37. The solenoid, accordingly, may be assembled in mounted position merely by snapping the locking end L of the sleeve 39 into the opening 29, after applying the corners of the end plate 41' into position against the abutments 37.

The kicker may also include an armature comprising a rod or stem 42 of magnetic material, such as steel, sized for free sliding movement longitudinally within the sleeve 39, said stem having an end extending outwardly of the pocket remote end of the sleeve, through the collar C, and formed with an armature stopping tail piece 43. This tail piece preferably comprises an integral circular flange formed on and at the pocket remote end of the armature rod. The rod may be normally urged toward retracted position with respect to the solenoid, as by means of a helical spring 44 concentrically encircling the stem 42, between the tail piece 43 and the seat S at the pocket remote end of the sleeve 39.

When the solenoid is electrically energized, the stem 42 will be drawn abruptly to ball striking position, within the solenoid, against the influence of the spring 44, such movement being stopped by engagement of the armature stopping tail piece 43 with the projecting, armature stopping end of the collar C. The armature stem is provided with a ball striking head 45 at the end thereof remote from the tail piece 43, said head being adapted to strike a ball in the pocket, when the armature is drawn to ball striking position within the solenoid. The projecting collar C is adapted to accommodate all of the coils of the spring 44, within the length thereof, without binding or crushing the same when the armature rod is in ball striking position within the solenoid, with the tail piece 43 in movement limiting engagement with the projecting end of the collar C.

The armature stem 42, of course, may be made long enough to constitute the forward end thereof, remote from the tail piece 43, as a ball striking head. The ball striking head 45, however, preferably comprises a button connected with the adjacent end of the armature stem 42, as by means of a mounting member 46, whereby the end of the stem 42, adjacent the kicker head 45, may be disposed substantially inwardly of the pocket adjacent end of the solenoid when the armature is in ball kicking position. In other words, the stem has length such that the portion thereof which extends within the solenoid, when the head 45 reaches ball striking position, is appreciably shorter than the solenoid itself. Indeed, as shown, the forward end of the stem is disposed substantially midway between the ends of the solenoid, when in ball striking position. Such arrangement appreciably improves the ball striking action of the kicker device.

In this connection, the stem 42 comprises magnetic material, such as steel. The ball striking head 45 and the connecting member 46 may also comprise steel or other magnetic material, if desired. Indeed, the striking head 45 and the connecting member 46 may be integrally interconnected together and with the stem 42. The head 45 and connecting member 46, however, may be formed of non-magnetic material, if desired, and secured to the stem 42 in any suitable, preferred or convenient fashion. When formed of non-magnetic material, the connecting member 46 and the stem 42 may have the same diametral size.

In order to adjust the striking force of the kicker, adjustable stop means 47 mounted on the frame 11 within the solenoid housing cavity 30 may be provided for determining the extent of retraction of the stem 42 with respect to the solenoid under the influence of the spring 44. The stop means 47 may conveniently comprise a strip of preferably non-magnetic metal, such as brass or other cuprous material, having an arm 48 adapted to slidingly underlie a wall portion 49 of the frame 11 which forms the closed top of the chamber 30, said arm being slidingly guided between the spaced flanges or ribs 36 which depend beneath the wall 49 and extend between it and the solenoid in a direction parallel with respect to the axis of the stem 42.

The metal strip comprising the stop means 48 may have a dependent arm 50 in position to engage the tail piece 43 and hence limit the spring induced retracting movement of the stem 42 outwardly of the solenoid. The arm 48 may underlie an elongated slot 51 formed in the wall 49 between the dependent flanges 36. A clamping stem 52, extending in the slot 51 and having threaded engagement in the strip arm 48, may be provided for securing the adjustable stop means 47 in any position of adjustment within the range afforded by the slot 51, said stem 52 being provided with a manually operable clamping knob 53 upwardly of the wall 49 and formed for clamping engagement therewith. If desired, the nose portion 13 of the frame may be formed with an embossment 54 for limiting the movement of the adjustable stop means in a direction away from the solenoid.

The microswitch 31 may be electrically connected in series with the actuating winding 40 of the kicker means and with any suitable source of electrical energy, such as the outlet socket of a domestic power supply system,

as through a preferably insulated electrical cable **55** of conventional character, which may extend into the solenoid and switch housing chamber **30**, as through a notched opening formed in a wall portion **12** of the frame adjacent the nose **13**, the device remote end of the cable **55** being preferably provided with a conventional electrical connection plug.

A cover plate **59** may be provided for enclosing the lower open side of the solenoid and switch housing chamber **30**. The cover plate may comprise any suitable relatively thin sheet material, such as steel, fiberboard, plastic, and the like. In this connection, the frame **11** may be formed with a peripheral groove **60** shaped to snugly receive the peripheral edge of the cover plate **59**, which may be held in place on the frame **11** by means of holding screws **63** extending through embossments **62** formed in the cover plate and taking into threaded embossments formed on the frame, the cover plate, when attached on the frame, serving to hold the kicker device in mounted positition between the seat **38** and the abutments **37**.

It will be appreciated that the formation of the coil winding form F of the solenoid as a unitary one-piece molded element embodying the end plates **41** and **41'**, as well as the coil supporting sleeve, effects considerable manufacturing economy and produces a strong and serviceable solenoid structure. Manufacturing costs are also very substantially reduced by forming the tail piece **43** as an integral part of the armature rod **42** at the rearward end thereof, such cost reducing arrangement being made possible by providing the collar C on the coil supporting form F, in position extending outwardly of the end plate **41'**, to thereby support the end of the spring **44** and to guard the coils thereof against the application of squashing pressure, when the armature is in ball striking position.

It is thought that the invention and its numerous attendant advantages will be fully understood from the foregoing description, and it is obvious that numerous changes may be made in the form, construction and arrangement of the several parts without departing from the spirit or scope of the invention, or sacrificing any of its attendant advantages, the form herein disclosed being a preferred embodiment for the purpose of illustrating the invention.

The invention is hereby claimed as follows:

1. An electromagnetic solenoid comprising a winding form embodying a central sleeve and a pair of flanges secured on the sleeve in spaced relation, a wire coil applied upon the central sleeve in position confined by and between said flanges, said form having a collar coaxial with said sleeve and forming an extension projecting outwardly of a said flange at an end of said winding form, an armature rod mounted for axial sliding movement in said sleeve, said rod having an end disposed outwardly of said extension, and an armature stop flange on and extending radially outwardly of said outwardly disposed end of the rod in position to engage with said extension, to stop sliding movement of the rod into the sleeve, when the flange remote end of the rod reaches the extenson remote end of the form.

2. An electromagnetic solenoid as set forth in claim **1**, including spring means mounted in position bearing oppositely upon the flange of the winding form at said extension and upon the stop flange outwardly of the rod.

3. An electromagnetic solenoid as set forth in claim **1**, including a helical compression spring encircling the armature rod and bearing at one end upon said stop flange, the opposite end of said spring bearing upon the flange of the winding form at said extension.

4. An electromagnetic solenoid having front and rear ends comprising a central sleeve and a pair of flanges secured thereon in spaced relation, a wire coil wound upon the sleeve between said flanges, a collar forming an extension projecting outwardly of a said flange at the rear end of the solenoid, said collar and sleeve being coaxial, an armature rod mounted for axial sliding movement in said sleeve, said rod having a head end and a tail end disposed outwardly of said extension, bias means normally urging the armature to retracted position at the rear end of the solenoid, an outstanding stop flange on the rod in position to engage with said extension, to stop the armature in projected position with its head end located between the opposite ends of the solenoid, and means supporting a kicking head on and in spaced relation in front of the forward end of the armature, to thereby dispose the head in kicking position outwardly of the forward end of the solenoid, when the armature is in projected position.

5. An electromagnetic solenoid as set forth in claim **4**, wherein the bias means comprises a helical spring encircling the rod and mounted, at one end, on a said flange at the rear end of the solenoid, in position concentric with said extension, the opposite end of the spring bearing upon said stop flange to normally urge the armature toward retracted position at the rear end of the solenoid.

6. An electromagnetic solenoid comprising a central sleeve, front and rear end flanges secured on said sleeve, a wire coil supported on the sleeve between said flanges, an integral sleeve portion forming front and rear end extensions projecting outwardly of said flanges at the opposite ends of said solenoid, an armature rod mounted for axial sliding movement in said sleeve, an armature stop flange on and extending radially outwardly of the rod in position to engage said extension at the rear end of the solenoid, to stop axial movement of the rod into the sleeve, and a mounting for said solenoid comprising a frame forming a seat for engaging said front end flange and a socket for demountably receiving the said front end extension, said frame providing abutment means remote from said seat for detachably engaging said rear end flange to secure the solenoid on said seat with said front end extension disposed in said socket.

7. An electromagnetic solenoid as set forth in claim **6**, including a cover plate detachably secured on said frame in position overlying said rear end flange to hold the same in engagement with said abutment means.

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