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SOLENOID ASSEMBLY MEANS FOR ACTUATING PIANO PLAYING MEANS

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2 Sheets-Sheet 1

Fig. 2.

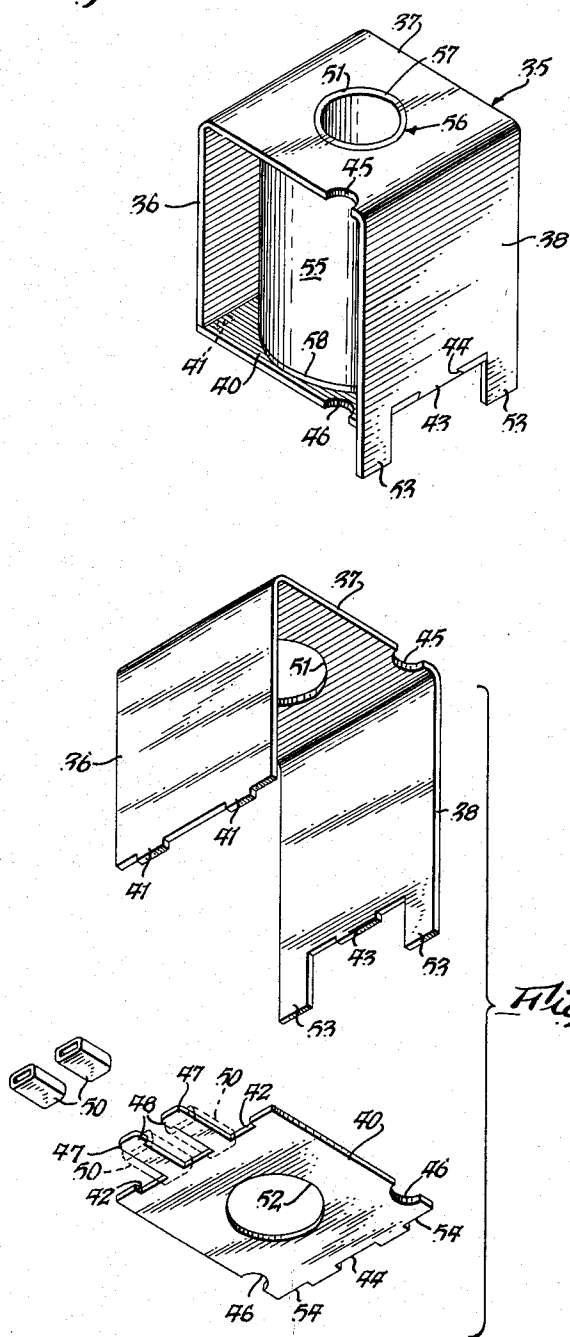


Fig. 1.

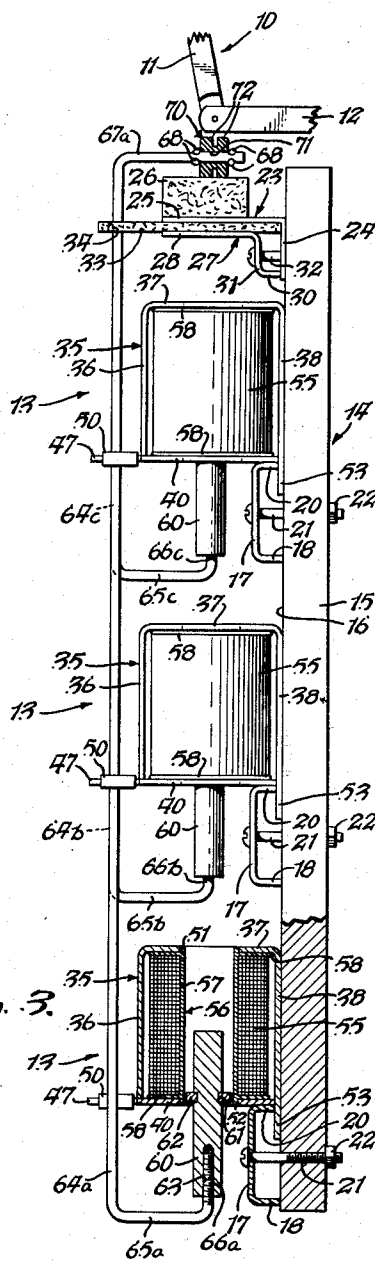
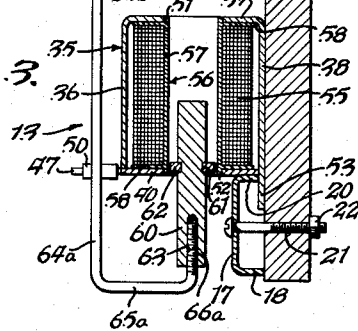


Fig. 3.



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SOLENOID ASSEMBLY MEANS FOR ACTUATING PIANO PLAYING MEANS

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This invention relates to pianos having solenoid-actuated playing means, and more particularly to new and improved solenoid assembly means for actuating such playing means.

As described in a related and copending application of Lee L. Von Gunten, Serial No. 86,916, filed February 3, 1961 and entitled Solenoid Means and Solenoid Mounting Means for Pianos, it is both necessary and desirable to provide solenoid means and mounting means therefor which are so constructed and designed as to facilitate adjustment of the solenoid means relative to the piano playing means regardless of the number and spacing of the action brackets, groups of keys, actions and strings. As a result such solenoid and mounting means are readily adapted for use with pianos of various makes.

It is likewise both necessary and desirable that the solenoid assembly means be so constructed and designed as to facilitate assembly thereof in a most economical manner, in order to reduce the cost of manufacture, and this is a primary object of the present invention.

Another object is to provide such solenoid assembly means wherein the casing means and coil means are so constructed and designed as to facilitate the assembly thereof.

Still another object is to provide such solenoid assembly means wherein the casing means are provided with readily assemblable guide means not only for effectively controlling the movement of the armature rod means for proper operation thereof but also for ensuring quiet operation of said armature rod means.

A further object is to provide such solenoid assembly means which are simple, yet rugged in construction and readily assembled or disassembled to facilitate repair or replacement.

Other objects and advantages of the invention will become apparent upon consideration of the following detailed description and accompanying drawings wherein:

FIG. 1 is a fragmentary side elevational view of part of a piano action, solenoid mounting means arranged below the action, and a plurality of solenoid assembly means, one being shown in section, supported on the mounting means, and each assembly means constituting a preferred embodiment of the invention;

FIG. 2 is a rear perspective view of part of the solenoid assembly means shown in FIG. 1 and including the casing means and coil means therein;

FIG. 3 is an exploded bottom perspective view of the casing means shown in FIG. 2 and including the armature rod guide means thereon;

FIG. 4 is a view identical to FIG. 1 except that the solenoid assembly means illustrated herein constitutes another embodiment of the invention;

FIG. 5 is a rear perspective view of the solenoid assembly means shown in FIG. 4 and including the casing means and coil means therein, and

FIG. 6 is an exploded front perspective view of the casing means shown in FIG. 5 and including the armature rod guide means thereon.

Referring to the drawings, and particularly FIGS. 1-3, a portion of a typical piano action is generally indicated at 10, and this action includes a sticker or abstract 11 which is raised by a playing key (not shown) and is piv-

otally connected to the forward end of a whip 12. Upon operation of the playing key, the sticker 11 causes the whip 12 to pivot in a clockwise direction as viewed in FIG. 1 and actuate the hammer (not shown) of the action and sound the desired note. This type of action is generally used with an upright type of piano (not shown), all as is well known and understood by those skilled in the art. However, the application of the present invention is not necessarily restricted to such an action or upright type of piano.

Located below the whip 12 of action 10 are the inventive solenoid assemblies, each generally indicated at 13, and the solenoid mounting means generally indicated at 14. The solenoid assemblies 13 are electrically connected to a chord and note playing mechanism such as described in the aforesaid copending application and even more fully in a second related and copending application of Lee L. Von Gunten Serial No. 794,902, filed February 24, 1959 and entitled Piano Having Electric Playing Means Therefor. Upon energization, the solenoid assemblies 13 strike the corresponding whip or whips 12 to actuate the hammers of the actions, as noted above.

The solenoid mounting means 14 includes an upright panel 15 which is made of any suitable material such as fiberboard, is spaced below and extends transversely of the whip 12. This panel is provided with a flat, front working surface 16 and is secured to the piano frame (not shown) in any suitable manner. Secured to support panel 15 are the various solenoid assemblies 13, three such assemblies being shown in vertically spaced arrangement. Actually the solenoid assemblies 13 are arranged in vertically spaced horizontal rows with the solenoid assemblies in one row being staggered or offset with respect to those in another row. Only one solenoid assembly 13 is shown in each of the three rows represented so that the movable portions thereof which strike the corresponding whip 12 may be arranged directly beneath such whips.

Continuing with FIG. 1, the solenoid mounting means 14 includes a plurality of vertically spaced, horizontal and elongated clamping bars 17 which also extend transversely of the actions 10. These bars 17 are arranged along the front flat surface 16 of support panel 15, and one bar is preferably provided for each row of solenoid assemblies 13. Each bar 17 is preferably channel-shaped in cross-section and is arranged so that the edge of its lower flange 18 opposes and abuts the flat surface 16 of panel 15, while its upper flange 20, which is narrower than the lower flange 18, has its edge opposing but spaced from surface 16. Each bar 17 is also mounted for generally normal movement relative to surface 16, and the clamping action of each bar with respect to the surface may be varied by any suitable fastening means such as bolts 21 which pass through a hole provided in the bar 17 between its flanges, as well as an aligned hole provided in the panel 15, and are secured in place by nuts 22.

The motion of certain movable elements of the solenoid assemblies 13 is preferably controlled by the following elements of the mounting means 14. A single horizontal shelf 23 is provided for the three rows of solenoid assemblies, and this shelf is preferably formed from an elongated sheet of metal, such as aluminum, which is bent into a substantially L-shape in cross section. The shelf 23 is arranged horizontally along support panel 15 to extend transversely of the actions 10, and the depending vertical leg 24 of the shelf abuts against working surface 16 of panel 15, and is rigidly secured in place by any suitable fastening means, such as screws (not shown). The upper horizontal leg 25 of the shelf extends laterally outwardly or frontwardly away from panel 15, and is provided on its upper surface with an elongated cushioning member 26 which is preferably made of a suitable, non-

metallic resilient material such as felt, and may be adhesively secured to the top surface of the horizontal leg 25 of the shelf.

Spaced below each shelf 23 is an elongated and horizontal upper clamping bar 27 which is generally Z-shaped in cross section. The upper horizontal leg 28 of bar 27 is spaced below and arranged substantially parallel to the horizontal leg 25 of shelf 23, while the edge of the lower horizontal leg 30 of bar 27 opposes the flat surface 16 of panel 15 and engages the vertical leg 24 of the shelf. These upper and lower horizontal legs 28, 30 are connected by a vertical leg 31, and the bar 27 is arranged for generally normal movement relative to shelf 23, the bar being adjustably secured to the panel by any suitable fastening means such as screws 32 which pass through aligned holes provided in the vertical legs 31 and 24 into the body of the panel.

A plurality of elongated upper guides 33 (only one being shown) are arranged in juxtaposition between the horizontal leg 25 of shelf 23 and the upper horizontal leg 28 of upper clamping bar 27. For quietness of operation, each guide 33 is preferably made of suitable non-metallic material such as felt, the inner end of each guide being clamped between shelf 23 and bar 27, and the outer end protruding frontwardly from the shelf and bar and being arranged longitudinally of and directly beneath the corresponding whip 12 of each action 10. In addition, the outer end of each guide 33 is provided with a through opening 34, for a purpose to be described below.

Referring also to FIGS. 2 and 3, the detailed structure of each solenoid assembly 13 which constitutes a preferred embodiment of the invention, will now be described. Such an assembly includes a generally rectangular casing generally indicated at 35 and which is composed of two metal plates. One plate is elongated and is bent into a substantially U-shape to form a front wall 36, a top wall 37, and a rear wall 38. The bottom wall 40 of casing 35 is preferably formed from a separate plate of metal, and is secured to the front and rear walls in the following manner.

As best seen in FIGS. 2 and 3, front wall 36 is provided with a pair of laterally spaced, depending lugs 41 which extend into laterally spaced, mating recesses or notches 42 provided in the front edge of bottom wall 40. Likewise, rear wall 38 is provided with a central depending lug 43 which extends into a central mating recess or notch 44 provided in the rear edge of bottom wall 40. In assembling the casing 35, it is but a simple matter to stake the lugs 41 and 43 in the notches 42 and 44, respectively, at the same time, by any suitable device (not shown), thereby providing the dovetail-shaped engagement shown in FIG. 2.

In addition, the top wall 37 of casing 35 is preferably provided with a generally semi-circular notch 45 adjacent its rear end and the bottom wall 40 is likewise provided with a pair of similarly shaped notches 46 adjacent its rear end. These notches are designed to receive various lead-in and lead-out wires (not shown), and thereby facilitate the close juxtaposition of the solenoid casings, such as shown and described in the aforesaid copending applications.

The casing 35 is also provided with lower guide means which are preferably in the form of a pair of laterally spaced and parallel, horizontal and elongated guides or arms 47 which project frontwardly from the front end of bottom wall 40, and are arranged longitudinally of and beneath the corresponding whip 12 of action 10. As illustrated in FIG. 3, each guide 47 is provided at its outer end with an inwardly turned flange 48 opposing the flange on the adjacent guide, and slidably mounted over each guide is an elongated, resilient sleeve 50. These sleeves are preferably made of suitable non-metallic and resilient material such as rubber, to facilitate quiet operation of the solenoid assembly, and as shown in dotted

lines in FIG. 3 are located behind flanges 48, the latter serving to hold the sleeves in place.

In addition, the top wall 37 and bottom wall 40 of casing 35 are provided with vertically aligned, through openings 51, 52 respectively for receiving portions of the solenoid coil means described below.

At its lower end, the rear wall 38 of casing 35 is provided with a pair of laterally spaced and vertically depending tongues 53. These tongues are adapted to fit adjacent their upper ends in mating notches 54 provided in the rear edge of bottom wall 40, and as illustrated in FIG. 1, the exposed portions of the tongues 53 are adapted to fit between the upper flange 20 of a lower clamping bar 17 and the flat surface 16 of support panel 15. As will be apparent, by adjusting the bolts 21, the clamping action of each bar 17 may be readily varied to permit the desired movement of each casing 35 along the bar and thus transversely of the corresponding action 10, and the desired positioning of each casing directly beneath the corresponding whip 12.

Each solenoid assembly 13 also includes vertically arranged coil means preferably composed of a cylindrical coil 55 of wire which may be grounded to the casing 35 in any suitable manner (not shown) and which is wound around a cylindrical spool or bobbin 56, which spool may be made of any suitable non-metallic material such as nylon. As illustrated in the lower sectional portion of FIG. 1, the spool is composed of an elongated and hollow cylindrical core 57 and a pair of laterally outstanding, annular flanges 58 spaced inwardly from each end of core 57. The flanges 58 of spool 56 respectively engage the opposing sides of the casing top and bottom walls 37, 40 and the protruding ends of the core 57 are received in the aligned openings 51, 52 provided in such top and bottom walls, all for securely retaining the coil means in proper position within casing 35.

In manufacturing the casing, it will be apparent that the elongated plate forming the front, top and rear walls is first stamped or punched out to provide the various lugs 41, 43, tongues 53, notch 45 and through opening 51 in one operation, after which the plate is then bent into the desired U-shape. Likewise, the plate forming casing bottom wall 40 may be punched or stamped in one operation to form the various guides 47, notches 42, 44, 46 and 54, as well as through opening 52.

Following these stamping or punching operations, the coil means may be readily inserted in place with the corresponding protruding end of core 57 received in the corresponding opening of the top or bottom wall 37 or 40. Next, the bottom wall 40 is assembled with the front wall 36 and rear wall 38, and the lugs 41 and 43 are stacked in place in recesses 42 and 44, respectively, in a single staking operation. As will be evident, the above described procedure for manufacturing the casing and assembling the same with the coil means is quite simple, yet produces a desired end product in a rapid, efficient and economical manner.

Referring particularly to FIG. 1, the solenoid assembly also includes an elongated, cylindrical armature 60 which is preferably made of suitable magnetically permeable metallic material. This armature is adapted to reciprocate vertically within core 57 of spool 56, and intermediate its ends is provided with an annular notch or groove 61 into which is inserted an annular, outstanding guide 62. This guide is preferably made of suitable non-metallic material such as felt, and actually slides along the inner periphery of core 57 as armature 60 reciprocates. Thus, the felt guide 62 not only controls the movement of the armature so that it will always be properly centered along the central longitudinal axis of core 57, but also insures quiet movement of the armature. At its lower end, armature 60 is provided with an internally threaded recess 63 for receiving a portion of the armature rod to be described below.

Each solenoid assembly 13 also includes a vertically

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movable and elongated armature rod which passes through the lower guides 47, actually between rubber sleeves 50 thereon, as well as through the hole 34 provided in the outer end of the upper guide 33. In FIG. 1, there are actually portions of three armature rods illustrated. The longest one being designated as 64a, the one of intermediate length as 64b and the shortest as 64c. Each of these armature rods is provided with a lower, laterally offset end portion 65a, b or c having a vertically arranged and externally threaded tip 66a, b or c which is threaded into the recess 63 provided in each armature 60, and a horizontal upper end portion 67a, b or c (the latter two not being shown) which extends over the cushioning member 26 on shelf 23. Each upper end portion, such as the typical one 67a shown, is provided with a plurality of longitudinally spaced projections such as 68, and mounted on such upper end portion is a striking head 70 which is located between adjacent projections 68. This striking head is preferably in the form of an annular grommet which is preferably made of suitable non-metallic and resilient material such as rubber, and is provided with a central through bore 71 to facilitate mounting of the grommet on the upper armature rod portion such as 67a, and is also provided with a pair of laterally outstanding end flanges 72 which actually make contact with the corresponding whip 12.

At its position of rest, as shown in FIG. 1, each striker head 70 is supported upon the cushioning member 26 and is spaced directly below the forward end of the corresponding whip 12. However, upon energization of the corresponding solenoid assembly 13, the armature 60 and armature rod such as 64a move vertically upwardly to lift the head which strikes the whip to actuate the piano action for sounding the desired note.

From the foregoing description, it will be noted that the casings 35 and the upper guides 33 may be readily adjusted transversely of the corresponding whips 12 for properly positioning the striking heads 70 directly therebeneath. Likewise, it will be noted that the movement of the movable elements of the solenoid assemblies 13 is effectively controlled by the annular felt guide 62, the lower guides 47, and the upper guides 33. The felt material of the guides 62 and 33 and the cushioning member 26 and the rubber material of the sleeves 50 on guides 47 and of striking heads 70 insure quiet operation of the solenoid assemblies 13.

Referring now to FIGS. 4-6, the solenoid assemblies each constituting another embodiment of the invention will now be described in detail. As will be apparent, FIG. 4 is quite similar to FIG. 1, the illustrated portion of the piano action and the solenoid mounting means being identical and indicated by the same numerals. However, the detailed structure of each solenoid assembly generally indicated at 13a is substantially different.

Each such assembly includes a generally rectangular casing generally indicated at 80, and which casing is also composed of two metal plates, each plate being bent into a substantially L-shape. One plate forms the front wall 81 and top wall 82, while the other plate forms the rear wall 83 and bottom wall 84.

As best seen in FIG. 6, the front wall 81 is provided with a pair of laterally spaced depending lugs 85 which project into a corresponding pair of laterally spaced through slots 86 provided in the bottom wall 84 adjacent its front end. Likewise, the top wall 82 is provided with a pair of laterally spaced lugs 87 projecting rearwardly from its rear edge into a corresponding pair of laterally spaced through slots 88 provided in rear wall 83 adjacent its upper end. Once again, in assembling the casing 80, it is but a simple matter to stake the lugs 85 and 87 in slots 86 and 88 respectively, by any suitable device (not shown).

The casing 80 is also provided with lower guide means which preferably take the form of a pair of laterally spaced, horizontal guides or arms 90 which protrude

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frontwardly from the front end of bottom wall 84, and are arranged longitudinally of and beneath the corresponding whip 12 of action 10. Adverting to FIG. 6, the opposing edges of guides 90 are cut away to form a generally key-hole-shaped slot 91, and an annular grommet 92 is inserted into the arcuate portion of slot 91. This grommet is preferably made of suitable non-metallic and resilient material such as rubber, and is provided with a central through bore 93 for receiving the armature rod, as well as a pair of radially outstanding end flanges 94 which overlap the opposite faces of guides 90. Actually, the grommet 92 may be identical to grommet 70 used as the striking head in FIG. 1.

As with the embodiment of FIGS. 2 and 3, the top and bottom walls of casing 80 are provided with vertically aligned, through openings 95, 96, respectively, for receiving the protruding ends of the core 57 of the solenoid coil means.

At its lower end, the rear wall 83 of casing 80 is provided with a pair of laterally spaced, vertically depending tongues 97, and as illustrated in FIG. 4, these tongues are adapted to fit between the upper flange 20 of the lower clamping bar 17 and the flat surface 16 of support panel 15. Just as with the previously described embodiment, adjustment of bolts 21 and nuts 22 varies the clamping action of the corresponding bar 17 to permit the desired movement of the casing transversely of the whip, and the desired positioning of the casing directly beneath such whip.

The coil means illustrated in FIGS. 4-6 is identical to the coil means of FIGS. 1-3, as is the engagement between the radial flanges 58 on core 57 with the opposing surfaces of top and bottom walls 82, 84 respectively, as well as the reception of the protruding ends of the core in aligned openings 95 and 96, respectively.

In manufacturing the casing 80, the plate forming front wall 81 and top wall 82 may first be punched or stamped in the flat condition to provide the lugs 85, 87 and the through opening 95, after which the plate may be bent into the desired L-shape. The same is true for the fabrication of the plate forming rear wall 83 and bottom wall 84 of the casing, it being most convenient to stamp or punch out the various slots 86, 88, guides 90, tongues 97 and through openings 96 while the plate is flat, after which it may be bent to the desired L-shape. Actually, in forming the tongues 97, they are struck from the rear end of the portion forming the bottom wall 84 at an acute angle thereto, and upon bending the plate to shape, take the upright or vertical position illustrated in the drawing.

In assembling the casing 80 with the coil means, the corresponding protruding end of core 57 may be inserted in either one of openings 95 or 96, after which the two plates are secured together by inserting the lugs 85 and 87 into slots 86 and 88, respectively. Normally, the assembling operation is completed by separately staking the lugs 85 in recesses 86 and the lugs 87 in recesses 88. However, this could be done in one operation by the use of an especially designed staking machine having two sets of staking plungers.

Each solenoid assembly 13a also includes a cylindrical armature 98 which is preferably made of suitable magnetically permeable metallic material. This armature, which is of substantially greater diameter than armature 60 illustrated in FIG. 1, is likewise adapted to reciprocate vertically within core 57 of spool 56. However, the armature 98 is closely spaced to the core and such close fit is maintained by the guide grommet 92 receiving the armature rod as hereinafter explained. At its lower end, the armature 98 is provided with an internally threaded recess 100 for a purpose to be described below.

In addition, each solenoid assembly 13a includes a vertically movable and elongated armature rod which is adapted to pass through the hole 93 provided in the grommet 92 secured between lower guides 90, as well as through the hole 34 provided in the corresponding upper

guide 33. Once again, there are portions of three armature rods illustrated in FIG. 4, the longest being designated at 101a, the one of intermediate length as 101b and the shortest as 101c. Each armature rod is provided with a lower, laterally offset end portion 99a, b or c having a vertically arranged and externally threaded tip 102a, b or c which is screwed into the recess 100 in armature 98, and a horizontal upper end portion 103a, b or c (the latter two not being shown) which extends over the cushioning member 26 on shelf 23 and is provided with an eye 104 at its outer end. Mounted in the eye is a striking head 105 which is preferably made of suitable resilient material such as rubber. This head 105 may actually take the form of an annular rubber grommet, such as 92 of FIG. 6 or 70 of FIG. 1, and is provided with radially outstanding end flanges 106 which overlap the opposite faces of the eye 104.

This embodiment of the solenoid assembly operates the same as the previously described embodiment, with the exception that the flat or radial face of the striking head 105 is employed to strike the forward end of the whip, whereas the peripheries of the radial flanges in the embodiment of FIG. 1 are adapted to strike the forward end of the whip.

In comparing the two embodiments of the inventive solenoid assembly, the one illustrated in FIGS. 1-3 is preferred for the following reasons. First of all, the fabrication and assembling of the casing 35 is quicker and more economical than for the casing 80 because only one bending operation is required as opposed to two such operations, and only one staking operation of the lugs in the recesses is required in the first embodiment as opposed to the two staking operations normally required in the second embodiment. In addition, the operation of the preferred solenoid assembly is quieter than that of the embodiment illustrated in FIGS. 4-6 because the annular felt guide 62 on the armature 60 of the first embodiment prevents any engagement between the armature and the core 57 of spool 56. In contrast, such contact is more likely with the embodiment of FIGS. 4-6 wherein the armature 98 is not provided with any such guiding means and reliance is solely upon the circumscribing rubber guide 92 to prevent this undesirable contact.

In addition, the solenoid assembly of FIGS. 1-3 can be more readily assembled and disassembled for repair or replacement than that of FIGS. 4-6. For example, when the grommet 92 of FIG. 6 is employed, the armature rod such as 101a must be threaded therethrough before the lower end of the armature rod can be assembled with the armature 98. In contrast, the armature rod 64a of the one can be readily slid into place between the sleeves 50 on guides 47 after assembly with the armature 60.

Finally, the use of the peripheries of the radial flanges on the grommet striking head 70, FIG. 1, provides a more resilient striker for engaging the whip than the flat sides of the striking head 105, FIG. 4. Also, the striking head 70 is easier to mount on the upper end of the armature rod than the striking head 105.

However, it will also be noted, despite the preference for the embodiment of FIGS. 1-3, that each embodiment constitutes a solenoid assembly which is economical to manufacture and assemble, and which is also both effective and quiet in operation. It will further be evident how the invention accomplishes its various objects, and the numerous advantages will now be apparent.

While the invention has been described and illustrated with respect to two embodiments thereof, it will be apparent that various changes and modifications may be made in the invention by those skilled in the art without departing from the spirit of the invention. For example, the guides 47 (FIG. 3) or guides 90 (FIG. 6) might be formed either as planar extensions of the top wall 37 or 82 such as by being struck out from the front wall 36 or 81, respectively, or alternately be formed on such

front wall intermediate the top and bottom walls by being struck out entirely from the front wall, instead of being formed on the bottom wall as shown. Accordingly, the embodiments shown and described are intended as illustrative and not limitative of the invention the scope of which is to be determined by the appended claims.

What is claimed is:

1. A solenoid assembly for actuating piano playing means, comprising movable armature rod means, and generally rectangular casing means including front and rear walls connected by end walls, said casing means having guide means receiving said armature rod means, one of said walls having a recess, and another of said walls adjacent to said one of said walls having lug means receiving in said recess.

2. A solenoid assembly for actuating piano playing means, comprising a movable armature rod, and a generally rectangular casing including front and rear walls connected by end walls, one of said front and end walls having guide means receiving said armature rod, one of said front and end walls having a recess, and another of said front and end walls having a lug received in said recess.

3. A solenoid assembly for actuating piano playing means, comprising a movable armature rod, and a generally rectangular casing including front and rear walls connected by end walls, one of said front and end walls having guide means receiving said armature rod and also having a recess, and another of said front and end walls having a lug received in said recess.

4. A solenoid assembly for actuating piano playing means, comprising a movable armature rod, and a generally rectangular casing including front and rear walls connected by end walls, one of said end walls having guide means receiving said armature rod and also having a recess, and said front wall having a lug received in said recess.

5. A solenoid assembly for actuating piano playing means, comprising a movable armature rod, coil means including a spool having a hollow cylindrical core, and a generally rectangular casing including front and rear walls connected by end walls, said end walls having aligned through openings receiving the ends of said core, one of said front and end walls having guide means receiving said armature rod, one of said front and end walls having a recess, and another of said front and end walls having a lug received in said recess.

6. A solenoid assembly for actuating piano playing means, comprising a movable armature rod, and a generally rectangular multi-plate casing including front and rear walls connected by end walls, one of said plates forming said front wall, another of said plates forming one of said end walls, one of said front and end walls having a pair of laterally spaced and frontwardly projecting guides receiving said armature rod, one of said front and end walls having a pair of laterally spaced recesses, and another of said front and end walls having a pair of laterally spaced lugs received in said recesses.

7. A solenoid assembly for actuating piano playing means, comprising a movable armature rod, and a generally rectangular multi-plate casing including front and rear walls connected by end walls, one of said plates forming said front wall, another of said plates forming one of said end walls, one of said front and end walls having a pair of laterally spaced and frontwardly projecting guides receiving said armature rod and also having a pair of laterally spaced recesses adjacent said guides, and another of said front and end walls having a pair of laterally spaced lugs received in said recesses.

8. A solenoid assembly for actuating piano playing means, comprising a movable armature rod, and a generally rectangular two-plate casing including front and rear walls connected by end walls, one of said plates being bent to form said front wall and one of said end walls, the other of said plates forming the other of said

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end walls, one of said end walls having a pair of laterally spaced and frontwardly projecting guides receiving said armature rod and also having a pair of laterally spaced recesses adjacent said guides, and said front wall having a pair of laterally spaced lugs received in said recesses.

9. A solenoid assembly for actuating piano playing means, comprising a movable armature rod, coil means including a spool having a hollow cylindrical core and an outstanding radial flange spaced inwardly from each end of said core, and a generally rectangular two-plate casing including front and rear walls connected by end walls, one of said plates being bent to form said front wall and one of said end walls, the other of said plates forming the other of said end walls, said end walls engaging said flanges and having alined through openings receiving the ends of said core, one of said end walls having a pair of laterally spaced and frontwardly projecting guides receiving said armature rod and also having a pair of laterally spaced recesses adjacent said guides, and said front wall having a pair of laterally spaced lugs received in said recesses.

10. A solenoid assembly for actuating piano playing means, comprising a movable armature rod, and a generally rectangular two-plate casing including front and rear walls connected by end walls, one of said plates being bent into a substantially U-shape to form said front and rear walls and one of said end walls, the other of said plates forming the other of said end walls, said casing having a pair of laterally spaced and frontwardly projecting guides receiving said armature rod, said other end wall having recesses, and said front and rear walls having lugs secured in said recesses.

11. A solenoid assembly for actuating piano playing means, comprising a movable armature rod, and a generally rectangular two-plate casing including front and rear walls connected by end walls, one of said plates being bent into a substantially U-shape to form said front and rear walls and one of said end walls, the other of said plates forming the other of said end walls, said other end wall including a pair of laterally spaced guides projecting frontwardly from its front end and receiving said armature rod, said other end wall having a recess adjacent said guides and another recess adjacent its rear end, and said front and rear walls having lugs secured in said recesses.

12. A solenoid assembly for actuating piano playing means, comprising a movable armature rod, and a generally rectangular two-plate casing including front and rear walls connected by end walls, one of said plates being bent into a substantially U-shape to form said front and rear walls and one of said end walls, the other of said plates forming the other of said end walls, said other end wall including a pair of laterally spaced and elongated parallel guides projecting frontwardly from its front edge and provided with opposing flanges at their outer ends, elongated resilient sleeves surrounding said guides behind said flanges and receiving said armature rod therebetween, said other end wall having a pair of through recesses formed in its front edge adjacent to and spaced laterally on opposite sides of said guides and also having a central through recess formed in its rear edge, said front wall having a pair of laterally spaced lugs projecting through and staked in said pair of recesses, and said rear wall having a lug projecting through and staked in said central recess.

13. A solenoid assembly for actuating piano playing means, comprising a movable armature rod, coil means including a spool having a hollow cylindrical core and an outstanding radial flange spaced inwardly from each end of said core, and a generally rectangular two-plate casing including front and rear walls connected by end walls, one of said plates being bent into a substantially U-shape to form said front and rear walls and one of said end walls, the other of said plates forming the other

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of said end walls, said end walls engaging said flanges and having alined through openings receiving the ends of said core, said other end wall including a pair of laterally spaced and elongated parallel guides projecting frontwardly from its front edge and provided with opposing flanges at their outer ends, elongated resilient sleeves surrounding said guides behind said flanges and receiving said armature rod therebetween, said other end wall having a pair of through recesses formed in its front edge adjacent to and spaced laterally on opposite sides of said guides and also having a central through recess formed in its rear edge, said front wall having a pair of laterally spaced lugs projecting through and staked in said pair of recesses, and said rear wall having a lug projecting through and staked in said central recess.

14. A solenoid assembly for actuating piano playing means, comprising a movable armature rod, and a generally rectangular two-plate casing including front and rear walls connected by end walls, each of said plates being bent into a substantially L-shape, one to form said front wall and one of said end walls and the other to form said rear wall and the other of said end walls, said casing having a pair of laterally spaced guides receiving said armature rod, one of said front and other end walls having a recess, the other of said front and other end walls having a lug secured in said recess, one of said rear and one end walls having a recess, and the other of said rear and one end walls having a lug secured in said last mentioned recess.

15. A solenoid assembly for actuating piano playing means, comprising a movable armature rod, and a generally rectangular two-plate casing including front and rear walls connected by end walls, each of said plates being bent into a substantially L-shape, one to form said front wall and one of said end walls and the other to form said rear wall and the other of said end walls, said other end wall having a pair of laterally spaced guides projecting frontwardly from its front end and receiving said armature rod and also having a recess adjacent said guides, said front wall having a lug secured in said recess, said rear wall having a recess adjacent its end remote from said other end wall, and said one end wall having a lug secured in said recess in said rear wall.

16. A solenoid assembly for actuating piano playing means, comprising a movable armature rod, and a generally rectangular two-plate casing including front and rear walls connected by end walls, each of said plates being bent into a substantially L-shape, one to form said front wall and one of said end walls, the other to form said rear wall and the other of said end walls, said other end wall including a pair of laterally spaced guides projecting frontwardly from its front edge with their opposing edges cut away to form a frontwardly open substantially keyhole-shaped slot, a resilient hollow cylindrical bushing inserted into the arcuate portion of said slot and provided with outstanding radial end flanges overlapping the opposite faces of said guides forming said slot and also provided with a central through hole receiving said armature rod, said other end wall having a pair of through slots formed adjacent to its front edge and spaced laterally on opposite sides of said guides, said front wall having a pair of laterally spaced lugs projecting through and staked in said slots, said rear wall having a pair of laterally spaced through slots formed adjacent its end remote from said other end wall, and said one end wall having a pair of laterally spaced lugs projecting through and staked in said slots in said rear wall.

17. A solenoid assembly for actuating piano playing means, comprising a movable armature rod, coil means including a spool having a hollow cylindrical core and an outstanding radial flange spaced inwardly from each end of said core, and a generally rectangular two-plate casing including front and rear walls connected by end walls, each of said plates being bent into a substantially

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L-shape, one to form said front wall and one of said end walls and the other to form said rear wall and the other of said end walls, said end walls engaging said flanges and having alined through openings receiving the ends of said core, said other end wall including a pair of laterally spaced guides projecting frontwardly from its front edge with their opposing edges cut away to form a frontwardly open substantially keyhole-shaped slot, a resilient hollow cylindrical bushing inserted into the arcuate portion of said slot and provided with outstanding radial end flanges overlapping the opposite faces of said guides forming said slot and a central through hole receiving said armature rod, said other end wall having a pair of through slots formed adjacent to its front edge and spaced laterally on opposite sides of said guides, said front wall having a pair of laterally spaced lugs projecting through

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and staked in said slots, said rear wall having a pair of laterally spaced through slots formed adjacent its end remote from said other end wall, and said one end wall having a pair of laterally spaced lugs projecting through and staked in said slots in said rear wall.

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