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DOUBLE-ACTING SOLENOID FOR CHIME SIGNALS

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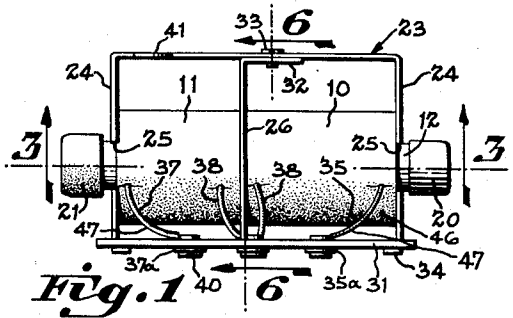


Fig. 1

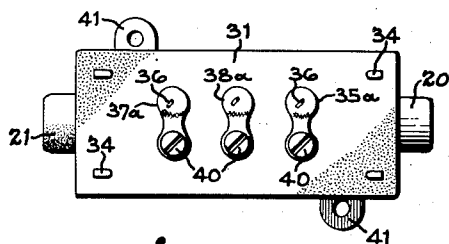


Fig. 2

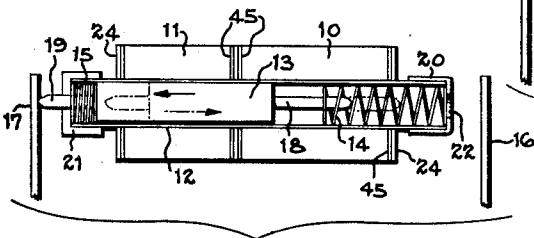


Fig. 4

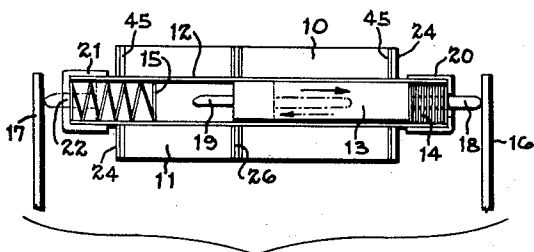


Fig. 5

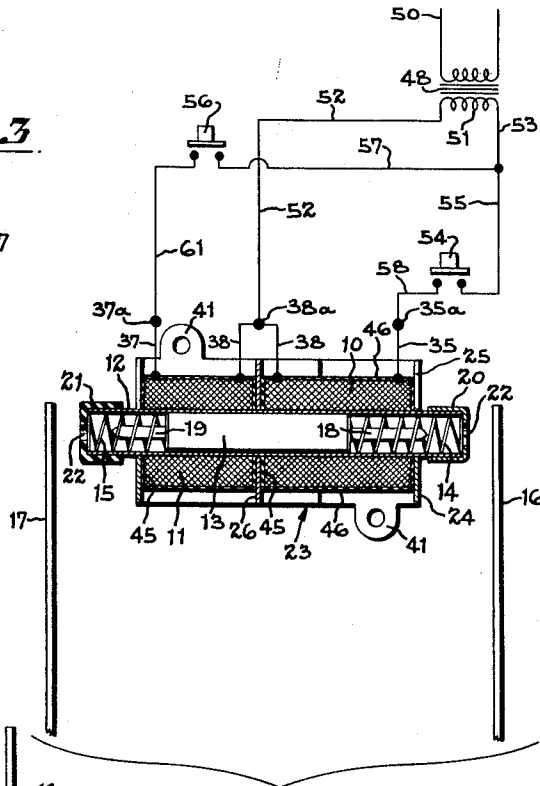


Fig. 3

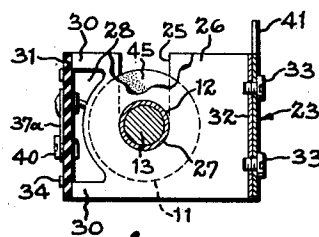


Fig. 6

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DOUBLE-ACTING SOLENOID FOR CHIME SIGNALS

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3 Claims. (Cl. 340—392)

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This invention relates to electric two-tone signal chimes of the type used extensively as door signals and is directed particularly to a solenoid unit for striking the tone bars or tubes of such chimes.

Two-toned chimes of this class in general consist either of a pair of tone bars and related resonator tubes, or a pair of tubes which are struck directly and the present solenoid unit is applicable to either class although it is disclosed in conjunction with a tone bar chime. The tone bars are struck in rapid sequence to provide a harmonious two-tone chord effect for one signal and one of the bars is struck to sound a single note, thereby providing two distinct signals. When used as a door chime, the circuit usually is arranged to sound the two-tone signal when the main door button is depressed and to sound the single note when a secondary or service door button is depressed.

A chime unit of the tone bar construction is disclosed in the prior patent of Lowell M. Alexander, Re. 21,370, issued February 20, 1940. This patent discloses a two-tone chime unit having two tone bars and resonator tubes with two separate solenoids arranged in parallelism and located between the spaced tone bars for striking them. In this structure, one of the solenoid plungers moves in both directions to strike both bars for the two-tone chord effect while the second solenoid plunger strikes only one of the bars so as to produce the single note signal. The two solenoids are operated by individual push buttons such that the double or single tone signal is produced by the respective push buttons.

A primary object of the invention has been to provide a simple inexpensive solenoid unit having a pair of coaxial solenoid coils cooperating with a single plunger, arranged selectively to strike a two note chime signal or a single note in response to the individual energization of the coils. The double acting single plunger substantially duplicates the joint operation of the parallel plungers disclosed in the prior patent but is more desirable since the double acting plunger is the only moving part and therefore provides more reliable operation. Moreover, the single plunger strikes both sound producing members at the same point along their length. In this respect, it is of particular advantage in chimes having long tubes which are struck directly since such paired tubes produce best results only when struck at or near corresponding points near their upper ends.

Briefly, the present structure consists of a pair

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of coaxial coils of different magnetic strength wound upon a common tube with a double acting plunger residing partially in both coils so as to respond to either of them. Paired biasing springs which provide differential deflection, normally balance the plunger in an intermediate position with respect to the coils. When the magnetically weaker coil is energized momentarily, the plunger is pulled toward the coil counter to the weaker spring, overtravels slightly to strike a tone bar adjacent the coil and is returned by the weaker spring to its balanced intermediate position. When the magnetically stronger coil is energized, the plunger is pulled in the opposite direction against the bias of the stronger spring, and strikes the tone bar adjacent the stronger coil; however, when this coil is deenergized, the plunger is propelled by the stronger spring with sufficient velocity to travel toward the opposite tone bar, compress the weaker spring and strike the opposite tone bar before returning to centralized position. In other words, when the signal button corresponding to the single note is depressed, the plunger strikes the tone bar adjacent the weaker coil and when the second button is depressed, the plunger strikes the bar adjacent the stronger coil and then strikes the first tone bar under spring action when the button is released.

In its preferred embodiment, the two coils are wound in tandem upon a common solenoid tube, the stronger coil having a greater number of turns and being somewhat longer than the weaker coil. The plunger is approximately the same length as the longer coil and its opposite ends are provided with stems arranged to project beyond the tube at either end to strike the respective tone bars when the respective coils are energized. The plunger is sufficiently long to reside partially within both of the coils so as to respond to the magnetic flux of either and is maintained in this position by the opposed compression springs engaging the opposite ends of the plunger.

These springs reside within the coils and are related in length to the length of the coils; the longer spring being arranged to bias the plunger against the stronger coil and the shorter spring to bias the plunger against the weaker coil. In operation the longer spring stores sufficient energy to compress the shorter spring by the momentum of the plunger when the stronger coil is deenergized and thereby to strike the second bar. Thus, the springs are related to one another to provide the single and double plunger movements and the coils are related to the springs

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to provide sufficient magnetic force to bias the springs.

The tube with the coils wound upon it is mounted within a housing formed of sheet metal slotted to permit the assembly to be slipped laterally within the housing with the opposite ends of the tube extending outwardly of the housing. One end of the tube includes a fixed closure cap having a central opening to provide clearance for the plunger stem and the opposite end of the tube includes a detachable cap formed preferably of flexible material such as rubber also having a central opening to accommodate the stem. The removable cap facilitates the assembly of the plunger and its springs within the tube, the ends of the springs being seated against the respective caps under a slight amount of compression to centralize the plunger.

The compression springs are relatively light in proportion to the weight of the plunger in order that the plunger may respond reliably to the magnetic flux of the coils. By virtue of the weight of the plunger with respect to the strength of the springs, the solenoid unit is mounted upon a horizontal axis such that the weight of the plunger is not applied against the springs. The related strength of the springs and coils is such that the plunger strikes both tone bars with approximately the same percussive force and thereby sounds the notes with equal volume.

The improved solenoid is mounted as a unit between the tone bars approximately in the same position formerly occupied by the two units. Since only one solenoid unit is needed, the weight and bulk of the chime assembly is substantially reduced and by reason of its simplified construction, the unit is more reliable in operation.

Other features and advantages of the invention will be more fully apparent to those skilled in the art from the following detailed description taken in conjunction with the drawings.

In the drawings:

Figure 1 is a top plan view of the assembled solenoid unit.

Figure 2 is a side view projected from Figure 1, further illustrating the unit, particularly the terminal panel and its attachment to the solenoid housing.

Figure 3 is a sectional view taken on line 3—3, Figure 1, showing the structure with the plunger in its normal centralized position and its relationship with the tone bars and illustrating diagrammatically the circuit for energizing the coils.

Figure 4 is a diagrammatic view showing the movements of the plunger in striking a single note.

Figure 5 is a view similar to Figure 4 showing the movements of the plunger in striking both tone bars to sound the two-tone or chord signal.

Figure 6 is a sectional view taken on line 6—6, further detailing the construction of the unit.

Referring to Figure 3, illustrating a preferred arrangement, the double acting solenoid assembly is shown in relationship with the tone bars of a door chime, together with a transformer and push button circuit for energizing the solenoid coils. The tone bars are associated with tuned resonator tubes (not shown) forming a part of the chime unit, substantially as disclosed in the above noted prior patent and the solenoid unit is mounted between the bars in a horizontal plane. The tone bars and their resonator tubes preferably are pitched musically to produce two

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distinctive notes when sounded individually and to produce a harmonious two tone or chord effect when sounded in rapid sequence.

The solenoid unit consists essentially of a pair of solenoid coils 10 and 11 wound in tandem upon a tube 12 formed of brass or similar non-magnetic material, with a plunger 13 slidably sustained within the tube. The plunger extends partially into both of the coils so as to respond to the magnetic flux of either of them and is normally maintained in the balanced intermediate position by the light springs 14 and 15 seated against the opposite ends of the plunger. Coil 10 is relatively stronger magnetically than coil 11; therefore spring 14, biasing the action of coil 10, is correspondingly stronger than spring 15 which biases coil 11. The compressive strength of the springs is such that the plunger is held by them balanced in the intermediate position shown when coils 10 and 11 are deenergized and are compressed by the plunger when the respective coils are energized.

When the stronger solenoid coil 10 is energized, the plunger is drawn sharply to the right, counter to the bias of spring 14, causing the plunger to compress the spring and to overtravel sufficiently to strike the right tone bar 16; when the coil is deenergized, spring 14 propels the plunger sharply to the left and by momentum compresses the weaker spring 15 causing the plunger to overtravel and to strike the left tone bar 17. When the weaker coil 11 is energized, the plunger is drawn to the left counter to the weaker spring 15, causing it to overtravel and strike the left tone bar 17. When the weaker coil is deenergized, the spring 15 thrusts the plunger to the left, but the force of the spring is insufficient to overcome the resistance of spring 14; therefore, a single note is sounded and the plunger is returned to its centralized position. In Figure 5 the plunger is shown diagrammatically in the two movements it executes when the stronger coil 10 is energized; the plunger being shown in full lines in its right hand position and in broken lines in the left hand position it assumes the coil is deenergized. In Figure 4 the plunger is shown in full lines in the position it assumes when the weaker coil 11 is energized for the single tone.

As shown in Figure 3, the opposite ends of plunger 13 are provided with stems 18 and 19 formed of a non-magnetic material such as plastic or fibrous material. The stems are pressed into holes drilled axially into the opposite ends of the plunger. The stem 18 at the right end of the plunger is slightly longer than the left hand stem corresponding to the increased range of movement of the plunger to the right and the ends of the spurs are arranged to project beyond the ends of the tube to strike the tone bars as shown in Figures 4 and 5. In the present structure the right hand end of tube 12 is provided with a metal cap 20 which provides a seat for the spring 14 and the left end of the tube is provided with a rubber cap 21 which seats the opposite spring 15. Both caps are provided with clearance holes 22—22 slightly larger in diameter than the stems and the stems are sufficiently long to contact the respective tone bars before the springs are compressed to their solid length. The rubber cap provides a friction fit upon the end of the tube for convenient assembly of the solenoid unit; the plunger and its springs being slipped into the tube from the open end before the cap is applied. When the cap is slipped in

position, the springs are compressed slightly to hold the plunger centralized in its intermediate position.

The assembled solenoid unit is mounted within a stamped sheet metal housing 23 which is generally U-shaped as viewed in Figure 1 having a terminal panel mounted upon its open side. The end limbs 24—24 of the housing are provided with lateral slots 25—25 slightly wider than the diameter than tube 12 to permit the coil assembly to be slipped in position with the coils 10 and 11 confined between the limbs and with the opposite ends of the tube extending outwardly beyond the limbs.

The coil assembly is wound with an intermediate angle bracket 26 interposed between the coils 10 and 11, the angle bracket having a central hole 27 (Figure 6) to accommodate the tube and having a relieved portion 28 at its outer end to provide a clearance opening for the terminal wires of the coils. The edges of the bracket bounding the relieved area provides a pair of limbs 30—30 engaged against the terminal panel 31 which mounts the terminal clips as hereinafter described. The opposite end of bracket 26 is bent to provide an angular foot 32 which is seated against the base of the U-shaped housing as shown in Figure 1, the foot being secured in position by means of the screws 33—33.

The terminal panel 31 is secured in position upon the limbs 24—24 of the housing by means of tangs 34 formed along the outer edges of the limbs 24—24. The tangs pass through holes formed in the panel and are clinched over upon the outer face of the panel.

As shown in Figure 2, the terminal panel is provided with terminal clips of conventional design which are riveted in position upon the outer surface of the panel for connecting the solenoid unit in its operating circuit. The terminal wire 35 of coil 10 is connected to the terminal clip 35a, the wire being passed through the panel and soldered upon the outer surface of the clip as at 36. The terminal wire 37 of coil 11 in a similar manner is soldered to the clip 37a. The opposite terminal wires 38—38 of both coils are connected in common to the middle terminal clip 38a. The opposite ends of the clips are provided with screws 40 for anchoring doorbell circuit wires to the clips.

After the terminal wires of the coils are soldered to the clips, the coil assembly is slipped laterally into the slots of the U-shaped housing, and the screws 33 are applied to the intermediate bracket to lock the coil assembly in position within the housing. The terminal panel 31 is then placed upon the tangs 34 and pressed into engagement against the ends of the housing and intermediate bracket after which the tangs are clinched down upon the panel to complete the assembly. The assembled unit is mounted in the chime housing (not shown) by applying screws through the respective lugs 41—41 formed along edges of the housing at diagonally opposite ends as shown in Figure 2.

In order to protect the insulation of the respective coils, insulating washers 45 formed of fiber or equivalent material are placed upon the tube 12 at the respective opposite ends of the coils. These washers prevent injury to the insulation as the coil unit is inserted in its housing. In addition, a layer of insulating tape 46 is applied upon the outside diameters of the coils for protection and insulating tubes 47 are slipped upon

the respective terminal wires of the coils before they are connected to their terminal clips.

The circuit disclosed diagrammatically in Figure 3 is intended to represent a typical home installation arranged to provide a two-tone or chime signal when the main door button is depressed and to sound a single note when the rear or service door button is depressed. The circuit is powered by a standard ten or fifteen volt bell transformer 48 which is energized by the A. C. service lines 50. One end of the secondary winding 51 is connected by way of line 52 to the intermediate terminal clip 38a indicated diagrammatically in the diagram, the inner ends of coils 10 and 11 being connected to line 52 in common by way of the terminal wires 38—38 as previously described. The opposite end of the secondary transformer coil is connected by way of line 53 and branch line 55 to the main door button 54 and to the rear or service door button 56 by way of branch line 57. The opposite contact of the main door button 54 is connected by way of line 58 to the terminal clip 35a which is connected to the terminal wire 35 of the stronger coil 10. The contact of the service door button 56 is connected by way of branch line 61 to the terminal clip 37a of the weaker coil 11.

When the service door button 56 is depressed, a circuit is established by way of line 61 through the weaker coil 11 to line 52, to the opposite side of the transformer winding. This energizes the coil causing the plunger to overtravel and strike the left tone bar 17. When the main door button 54 is depressed, the circuit is completed by way of line 58 through the stronger coil 10, through line 52 to the opposite transformer terminal. This pulls the plunger to the right with sufficient force to overtravel and strike the right hand tone bar 16. The plunger is held in its right hand position with the stronger spring compressed so long as the button is held in depressed position. As soon as the button is released, the energy stored in the stronger spring will propel the plunger to the left under sufficient momentum to compress the weaker spring overtravel and strike the left hand tone bar. After striking the bar, the weaker spring will force the plunger back to the right causing it to assume its intermediate position between the deenergized coils.

It will be observed that the compression springs are balanced with respect to one another so as to poise the plunger normally in its intermediate position when the coils are deenergized. In the intermediate position, both springs are under a slight amount of initial compression to hold the plunger in centralized position with respect to the coils. In the embodiment disclosed, the stronger spring is proportionately longer than its opposed mate to provide a greater number of turns, both springs being approximately of the same lead and wire gage. By reason of its greater length, the stronger spring, under full compression stores sufficient energy, to fully compress the weaker spring. In other words, upon release, the stronger spring develops a plunger velocity and momentum sufficient to compress the weaker spring and sound the second note. It will be apparent, however, that a similar spring action can be obtained by springs of equal length by making them of different wire gage sizes or of different materials if the design of the unit so requires.

It is to be observed that the stems 18 and 19 are sufficiently long to impinge against the tone bars before the springs are compressed to their solid

length. In order to produce a sharp impact, the plunger is arranged to overtravel and strike the bar and immediately bounce back to a slightly retracted position even though the coil is energized so as to avoid damping the vibrations by contact with the bar after percussion.

The difference in magnetic flux between the two solenoid coils is obtained preferably by a proportionate differential in the number of turns making up the respective coils. However, the flux values also can be varied, if desired by other means; for example, by adjusting the electrical resistance of the individual coil circuits or by making them of different materials. In the present disclosure, the stronger coil 10 is made somewhat longer than its companion coaxial coil and the plunger is approximately the same length as the long coil. This produces a degree of plunger movement sufficient to deflect the longer spring almost to its solid length as shown in Figure 5 and thereby to store sufficient energy to strike the second tone bar when released. The shorter coil produces a sufficient degree of plunger movement similarly to compress the shorter spring, but insufficient to compress the long spring upon release.

By virtue of the relatively light opposed compression springs, there is very little vibratory plunger movement when it is returned to its balanced position after operation of either of the coils. Thus, when the two-tone button is pressed and released, the plunger returns immediately, by operation of the springs to its balanced stationary position after striking both tone bars. This produces reliable operation even though the two-tone button is depressed and released repeatedly.

The solenoid unit by virtue of its coaxial arrangement, is inexpensive and simple to fabricate and assemble and is found in practice to duplicate the operation of the parallel structure formerly employed for sounding single and double chime signals. The unit is intended primarily for door signals but it is contemplated also to apply it to electric chiming clocks, dinner chimes and to other devices which require selective plunger movements.

The improved solenoid, by virtue of its single plunger, is also of advantage in sounding chimes of the type known in the trade as cathedral chimes, consisting of relatively long chime tubes which are struck directly by the plunger to sound the signals. These tubes usually are suspended by their upper ends and the solenoids are located between them in a position to strike the tubes near their upper ends. It has been discovered that in order to obtain the best sound effect, the tubes should be struck at corresponding points near their upper ends. The parallel plunger arrangement formerly used with these chimes falls in this respect since the plungers are disposed one above the other and naturally strike the tubes at different elevations relative to their upper ends. For example, one of the plungers may be arranged to strike both tubes at the critical elevation, but it necessarily follows that the other plunger will strike either above or below the critical point and therefore cannot produce the same sound effect as the other plunger. An important advantage, therefore, of the double acting arrangement when applied to such chimes, is that the single plunger strikes both tubes at the same elevation either when sounding both tubes or in sounding one of them and thus improves the tonal quality of the chime.

We claim:

1. A double and single stroke solenoid unit having a single plunger comprising, a solenoid tube, a pair of coaxial solenoid coils disposed in tandem upon said tube, one of said coils having a greater number of windings and thereby being adapted to provide a stronger magnetic flux than the other, a solenoid plunger slidably sustained within said tube and normally having its opposite ends extended within both of said coils and arranged to move in respectively opposite directions when the said coils are energized selectively, and a pair of opposed coil springs disposed within said tube and normally engaged respectively against the opposite ends of the plunger to maintain the plunger normally in an intermediate position with respect to the solenoid coils and being adapted to be compressed respectively upon movement of the plunger in either direction in response to energization of the respective solenoid coils, one of said springs having a greater number of coils and a greater compression range and thereby being adapted to store a greater amount of energy than the other of said springs upon being compressed, the spring having the greater number of coils being in bias with respect to the solenoid coil providing the stronger magnetic flux, whereby the plunger is returned to its intermediate position when the weaker of said solenoid coils is deenergized and is propelled beyond the intermediate position to the opposite end of the tube when the stronger of said solenoid coils is deenergized.

2. A double acting solenoid unit adapted to energize a chime signal having a pair of tone bars, the solenoid adapted to be interposed between the tone bars and arranged to strike one or both of said members selectively, said solenoid unit comprising, a solenoid tube, a pair of coaxial solenoid coils wound in a tandem upon the tube and arranged to be energized independently of one another, a solenoid plunger slidably disposed in said tube and arranged to be moved in respective opposite directions in response to the magnetic flux generated by either of said coils, a respective stem extending outwardly from opposite ends of the plunger for striking the tone bars, respective compression springs surrounding the stems and having their inner ends engaged against the plunger to position the same normally in an intermediate position with respect to the solenoid coils, respective closure caps mounted upon the opposite ends of the solenoid tube for seating the outer ends of said springs, the closure caps each having an opening for passage of the stems therethrough when the solenoid coils are energized, one of said springs providing a greater range of compression than the other and the corresponding solenoid coil providing a greater magnetic flux than the other, the spring having the greater range of compression being capable of storing a sufficient amount of energy upon being fully compressed to drive the plunger at a velocity to fully compress the weaker spring, whereby one plunger stem strikes one of the tone bars when the stronger coil is energized and strikes the other tone bar when the same is deenergized, and the other stem strikes one of the tone bars when the other coil is energized.

3. A double and single stroke solenoid having a single plunger comprising, a solenoid tube, a pair of coaxial solenoid coils disposed in tandem upon said tube, one of said coils having a given magnetic strength, the other coil having a greater magnetic strength, a solenoid plunger

slidably sustained within said tube and normally residing in an intermediate position with its opposite ends extended within both of said coils, means for selectively energizing said solenoid coils, said plunger being movable respectively in opposite directions when said coils are energized selectively, and a pair of opposed coil springs disposed within said tube and normally engaged respectively against the opposite ends of the plunger and maintaining the plunger normally in said intermediate position, said coil springs being compressed respectively upon movement of the plunger in either direction in response to the energization of the solenoid coils, one of said springs having a given compressive strength and the other coil having a greater compressive strength, the spring having the greater compressive strength being in bias with respect to the solenoid coil having the greater magnetic strength, whereby the plunger is returned to its

intermediate position when the solenoid coil of given magnetic strength is dennergized and is propelled beyond the intermediate position to the opposite end of the tube when the solenoid coil of greater magnetic strength is deenergized.

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