July 26, 1960 J. G. JOLLY 2,946,905

SINGLE COIL REPEATER SOLENOID

Filed Feb. 13, 1958

3 Sheets-Sheet 1

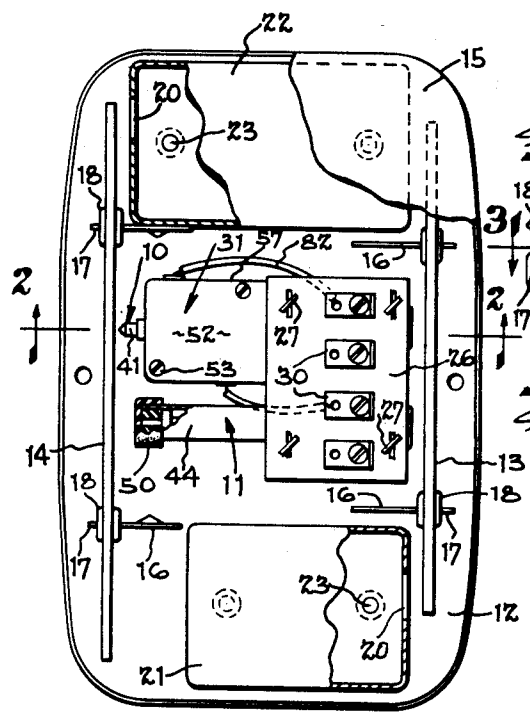


Fig. 1

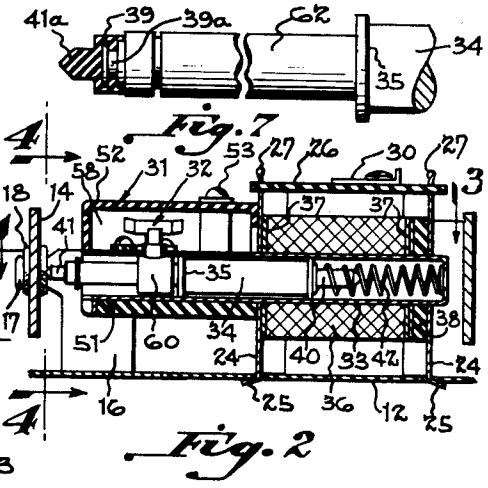


Fig. 2

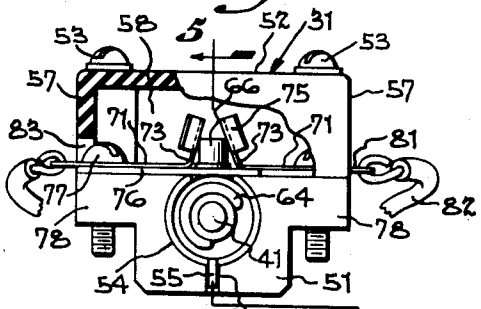


Fig. 4

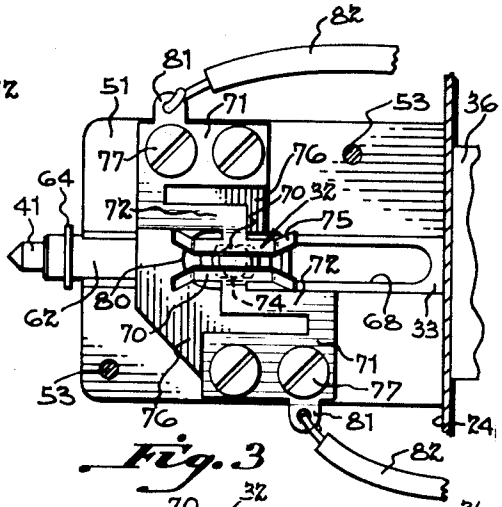


Fig. 3

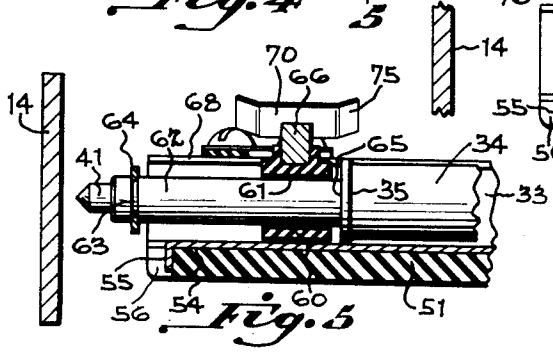


Fig. 5

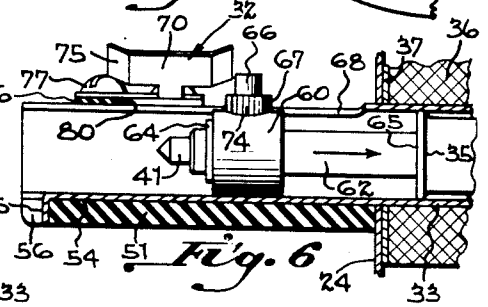


Fig. 6

Fig. 7

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SINGLE COIL REPEATER SOLENOID

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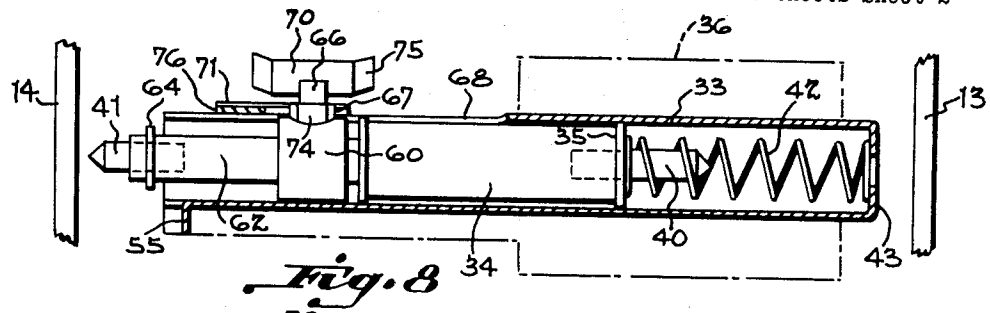


Fig. 8

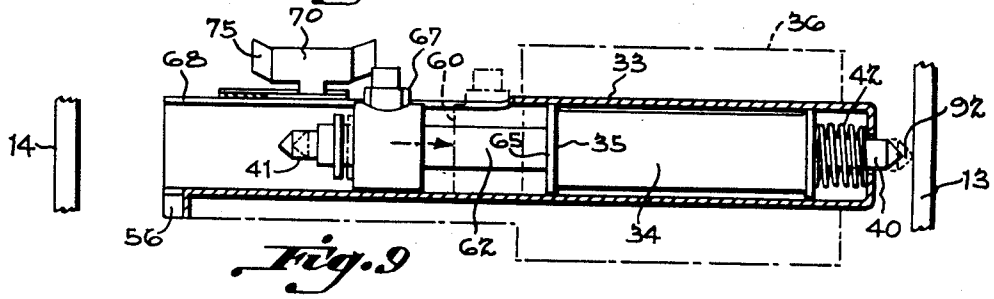


Fig. 9

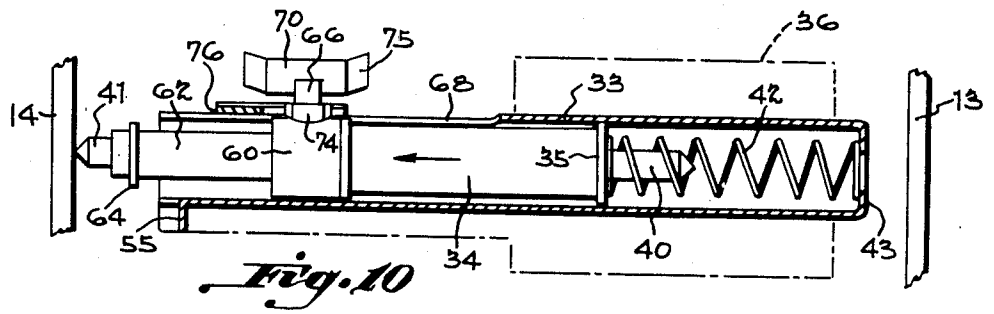


Fig. 10

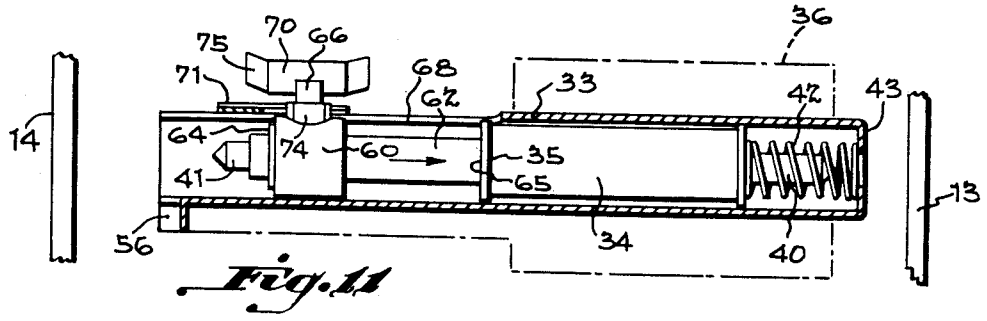


Fig. 11

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SINGLE COIL REPEATER SOLENOID

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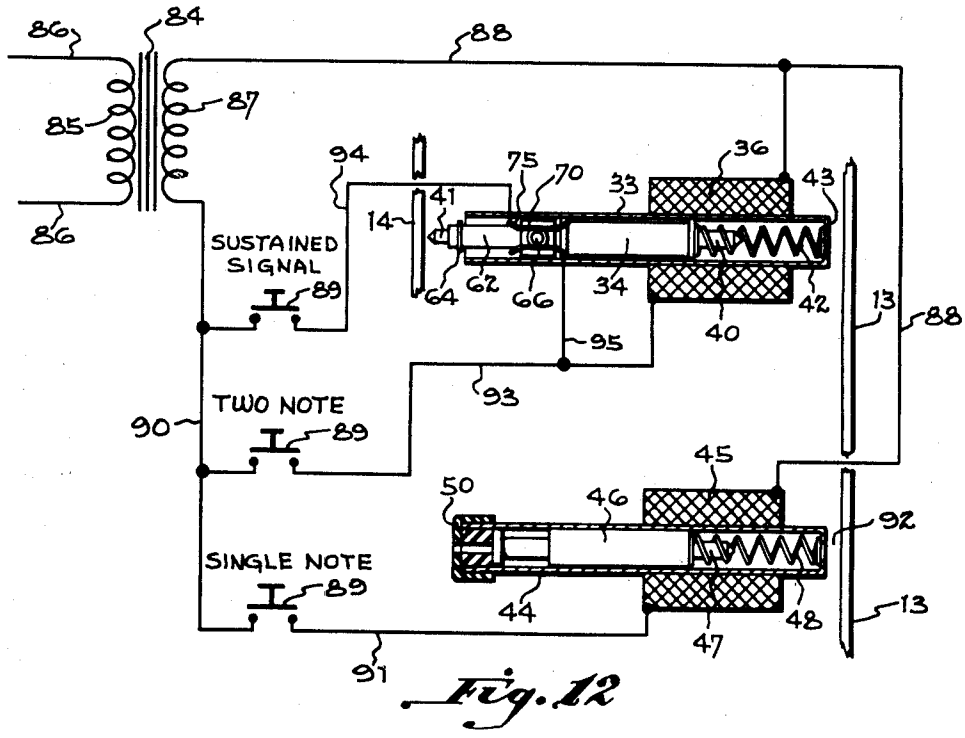


Fig. 12

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United States Patent Office 2,946,905 Patented July 26, 1960

2,946,905

SINGLE COIL REPEATER SOLENOID

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Filed Feb. 13, 1958, Ser. No. 715,027

6 Claims. (Cl. 310—34)

This invention relates to electrically operated signal chimes and is directed particularly to a repeater solenoid mechanism which creates either a two-note signal or a sustained signal in response to actuation of two separate push buttons.

A repeater mechanism of this general character is disclosed in the prior patent of James W. Christy, No. 2,820,913, issued to the present assignee. In general, the prior patent discloses a solenoid having a pair of coils spaced apart axially from one another and energizing a double-acting solenoid through a repeater switch mechanism. The repeater switch energizes the two coils alternately, causing a double-acting plunger alternately to strike a pair of tone bars to create the sustained signal. For the two-note signal, the two coils are energized in sequence through one cycle, causing the plunger to strike the two bars, whereupon both coils are deenergized. For a third single-note signal, one of the two coils is energized, causing the plunger to strike one of the bars.

One of the primary objectives of the present invention has been to provide a simplified repeater solenoid utilizing a single solenoid coil to provide both the two-note signal and the sustained note signal. The repeater solenoid is provided with a double-acting plunger arranged to strike two tone bars, the plunger being biased by a compression spring which stores energy during the power stroke of the plunger to propel it in the opposite direction for the second note.

When the sustained signal button is depressed, the coil is energized to propel the plunger magnetically toward one tone bar; a repeater switch mechanism then deenergizes the coil, such that the energy stored in the compression spring propels the plunger in the opposite direction toward the second tone bar, thus sounding the second note. As the plunger strikes the second tone bar, the repeater switch again energizes the coil to repeat the cycle, thus sustaining the signal by continued plunger reciprocation. Briefly therefore, the repeater solenoid strikes one tone bar under magnetic force and strikes the second tone bar under stored spring energy.

When the two-note button is depressed, the repeater mechanism is inactive; in this case, the plunger is propelled magnetically to strike the first tone bar and is propelled in the opposite direction by the compression spring when the push button is released.

In order to provide a third single-note signal, a single acting solenoid is mounted alongside the double-acting solenoid in a position to strike one of the tone bars. The single acting solenoid is energized by a third push button through a separate circuit.

Another objective of the invention has been to provide a simple repeater switch which assures reliable operation of the repeater solenoid for a prolonged period of service without requiring attention on the part of the householder. According to this aspect of the invention, the double-acting solenoid plunger actuates a slidable shuttle sleeve having a contact pole which establishes a bridging connection across a pair of stationary contact plates. A

lost motion coupling provides a driving connection between the plunger and shuttle, the arrangement being such that the pole completes a circuit to the solenoid coil when the plunger resides in a retracted position. When the circuit is energized by the sustained signal button, the circuit is completed through the switch pole to energize the coil; toward the limit of the power stroke of the plunger, the lost motion coupling shifts the shuttle and pole to an open circuit position to deenergize the solenoid. The spring then urges the plunger toward its retracted position, and as the plunger approaches the end of the retracting stroke, the lost motion coupling shifts the shuttle back to its circuit closing position. The lag in the reciprocating motion of the shuttle thus provides sustained reciprocation of the double acting plunger so long as the sustained signal button is depressed.

A further objective of the invention has been to reduce the frictional resistance of the repeater switch mechanism and to improve the circuit closing action of the switch contact elements. In order to reduce friction, the switch pole is free to float laterally in an arc with respect to the opposed contact plates which are yieldably mounted to permit the pole to slide between them as it opens and closes the circuit. By virtue of the lateral floating action of the pole, the yieldable plates react under equal pressure against opposite sides of the pole with minimum frictional resistance to the longitudinal motion of the pole as it slides between them. The opposed contact plates reside in planes which are inclined upwardly toward one another and are spaced apart slightly less than the diameter of the pole. By virtue of this relationship, the pole establishes a line contact with the opposed plates, creating a self-cleaning action to provide reliable circuit closing action, even after prolonged service.

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

In the drawings:

Figure 1 is a front view of a chime assembly which embodies the present invention.

Figure 2 is an enlarged sectional view taken along line 2—2 of Figure 1, detailing the construction of the repeater solenoid and its switching mechanism.

Figure 3 is an enlarged fragmentary top plan view of the switching mechanism with the cover rebound, as viewed along line 3—3 of Figure 2.

Figure 4 is an enlarged end view of the switching mechanism as indicated along line 4—4 of Figure 2.

Figure 5 is an enlarged fragmentary sectional view taken along line 5—5 of Figure 4, further detailing the plunger and switching mechanism of the repeater solenoid.

Figure 6 is similar to Figure 5, showing the motion of the parts during the power stroke of the repeater solenoid plunger.

Figure 7 is a fragmentary side view illustrating a solenoid plunger of modified construction.

Figures 8–11 inclusive are diagrammatic views showing the operation of the switching mechanism during the forward and retracting strokes of the repeater plunger.

Figure 12 is a diagram of the electrical circuit which energizes the repeater and single action solenoids.

Chime assembly

Described generally with reference to Figure 1, the chime assembly comprises a repeater solenoid **10** and a single action solenoid **11**, mounted in side-by-side relationship upon a base or mounting panel **12**, formed of sheet metal. Two tone bars, indicated at **13** and **14**, are mounted upon the panel adjacent the opposite ends of the solenoids in position to be struck by the solenoid

plungers. The several components, which are mounted upon panel 12, are enclosed by a cover 15 formed of sheet metal and attached by conventional means (not shown) to the periphery of the panel. The cover 15 is broken away in Figure 1 in order to illustrate the components which it encloses.

The two tone bars 13 and 14 are carried by respective pairs of brackets 16 projecting outwardly from panel 12 each bracket having a right angular neck 17 (Figure 2) at its free end. The necks 17 project through matching soft rubber grommets 18 seated within openings formed in the tone bars. The grommets and brackets thus cushion and support the tone bars with respect to the mounting panel.

As shown in Figure 1, a free end portion of tone bar 13 resides adjacent an opening 20 formed in the end wall of a tuned resonator chamber 21. The tone bar 14 likewise has a free end portion residing adjacent the opening 20 of a second resonator chamber 22. Both resonator chambers 21 and 22 are attached to panel 12 by means of screws indicated at 23. The tone bars and their related resonator chambers are pitched to provide two distinctive notes when the tone bars are struck individually and to provide a two-note chord signal when struck in sequence.

As explained later in detail, when the single-note push button is depressed, the plunger of the single action solenoid 11 strikes only the tone bar 13, thus sounding a single note signal. When the two-note push button is depressed, the plunger of the repeater solenoid 10 first strikes the tone bar 13, then strikes tone bar 14 to sound the two-note chord signal. When the sustained signal button is depressed, the plunger of the repeater solenoid 10 is reciprocated continuously to alternately strike both tone bars, thereby to sound the sustained chord signal.

As best shown in Figure 2, the two solenoids 10 and 11 are mounted upon panel 12 between a pair of sheet metal mounting plates 24—24, rising upwardly from the surface of panel 12. The lower edge of each mounting plate is provided with attachment tangs 25 passing through slots which are formed in panel 12, the tangs being clinched over upon the opposite side of the panel to lock the mounting plates in position. Upon the upper edges of the mounting plates there is secured a terminal panel 26 formed of insulating material. The upper edges of the mounting plates 24 are provided with tangs passing through slots formed in panel 26, the tangs being twisted to lock the panel 26 in position. The mounting plates 24 and panel 26 thus form a housing enclosing the coils of the two solenoids. The top surface of panel 26 is provided with a series of electrical terminals indicated at 30 (Figure 1) of conventional design. These terminals complete the electrical circuits from the push buttons and through the two solenoid coils, as described later with reference to Figure 12.

Solenoid structure

According to the present disclosure, the two solenoids 10 and 11 are similar in construction except that the repeater solenoid 10 is provided with a switch housing, indicated generally at 31, which encloses the repeater switch mechanism indicated generally at 32. As best shown in Figure 2, the repeater solenoid comprises a solenoid tube 33 formed of brass or similar non-magnetic material, having a solenoid plunger 34 slidably confined within the tube. The plunger 34 is fabricated from a magnetic material, such as iron or steel, and its opposite ends are delineated by relatively narrow flanges 35 slidably interfitting the tube to reduce friction. In the normal retracted position of the plunger (Figure 2), the forward end of the plunger extends partially within the solenoid coil 36 which is wound upon the forward portion of tube 33. The opposite ends of the coil 35 include insulating washers 37 and a spacer 38, also formed of insulating material. The coil is confined endwisely between the mounting plates 24—24, the insulating washer 37 and spacer 38 being seated against the opposed plates 24. The opposite ends of the solenoid tube 33 pass through openings formed in the mounting plates 24.

The opposite ends of the repeater or double-acting plunger 34 are provided with respective striker pins 40 and 41 which are formed of a fibrous or plastic material, the pins being pressed into bores drilled axially to the opposite ends of the plunger, as indicated in broken lines in Figure 8. A compression spring 42 has one end seated against the end wall 43 of tube 33, and has its opposite end seated against the end of the plunger. As described later, the magnetic flux generated by the coil 36 acts upon the plunger with sufficient force to compress spring 42, causing the pin 40 to strike the tone bar 13. When the coil is deenergized, the energy stored in the spring is sufficient to propel the plunger in the opposite direction, causing pin 41 to strike the second tone bar 14. This action provides the two-note signal and the sustained signal as described later.

The single acting solenoid 11 includes a solenoid tube 44 similar to the repeater solenoid, a solenoid coil 45 being wound upon the tube (Figure 12). The opposite ends of the tube project through the mounting plates 24—24 and the coil 45 is confined between the plates. This structure is similar to the repeater solenoid shown in Figure 2, therefore it is omitted from the drawings. The single acting solenoid acts only upon the tone bar 13, its plunger 46 being provided with a single striker pin 47, similar to the pins 40 and 41. The plunger 46 is normally maintained in the retracted position shown in Figure 12 by a compression spring 48 similar to the spring 42 of the primary solenoid. The opposite end of the solenoid tube 44 includes a rubber cap 50 against which the end of the plunger normally seats. When the single acting coil 45 is energized, plunger 46 is propelled under magnetic flux with sufficient force to compress spring 48, causing the pin 47 to strike tone bar 13.

The modified plunger structure shown in Figure 7 represents an end portion of the repeater plunger 34 on an enlarged scale, showing a striker pin molded upon the plunger instead of being press fitted. For this purpose, stud 39 is machined on the plunger, the stud having an annular groove 39*a*. In fabricating this structure, the machined plunger may be placed in a suitable split mold having a cavity surrounding stud 39 and delineating the profile of the molded striker pin 41*a*. Molding material, such as a commercial thermoplastic in a flowable state, is forced into the closed cavity to form the pin. This material penetrates into groove 39*a* and thereby keys the pin permanently to the stud. It will be understood that both striker pins may be molded to the opposite ends of the plunger of the same time and that the striker pin 47 of the single acting plunger may be molded in place in the same manner.

Repeater switch mechanism

Referring to Figure 2, the switch housing 31 of the repeater solenoid 10 comprises a fixed base 51 and a detachable cover 52 secured over the base by screws 53. The switch housing preferably is molded from a plastic composition and is arranged to enclose and protect the switch components from dust and dirt. The base 51 of the switch housing is bored longitudinally as at 54 (Figure 4) and is snugly fitted upon the portion of the solenoid tube 33 which projects to the left through the mounting plate 24. The base is locked in position upon the tube by a tang 55 struck from the end portion of the tube and bent downwardly into a slot 56 formed in the end of the base (Figure 5). The tang thus locks the base longitudinally against the mounting plate 24, and its engagement with the slot locks the base against rotary motion with respect to the tube. As best shown in Figure 4, the cover 52 of the switch housing includes a vertical wall 57 which delineates a chamber 58 above the base 51,

The switch mechanism includes a sliding shuttle sleeve 60 having a bore 61 loosely fitted upon a stem 62 which projects from the rearward end of the double-acting plunger 34, as viewed in Figure 5. The outside diameter of the sleeve 60 slidably interfits the tube 33 for longitudinal sliding motion. Stem 62 comprises a lost motion coupling between the plunger and shuttle, as described below. Sleeve 60 is fabricated from a suitable dielectric material, such as a plastic or fibrous composition. The outer portion of stem 62 has an annular groove 63, a retainer ring 64 being locked within the groove. The sleeve 60 is free to move along stem 62 between the retainer ring 64 and the shoulder 65 which is delineated by the major diameter of the plunger 34.

The length of the stem 62, as delineated by the retainer ring 64 and shoulder 65, is related to the total stroke of the plunger to shift the shuttle alternately to the two positions indicated at Figures 8 and 9. As seen in these views, the stroke of the shuttle is but a fraction of the total stroke of the plunger. Thus, as the plunger is propelled magnetically in its power stroke (Figure 9), it attains maximum velocity before the lost motion shifts the shuttle to the open circuit position. During the return stroke under spring action, the plunger again reaches maximum velocity before it shifts the shuttle to the circuit closing position (Figure 10) near the end of the stroke. Accordingly, the lost motion connection takes advantage of the momentum of the plunger in shifting the shuttle to its two positions. It will be understood that the shuttle is slidably guided by the sleeve while the stem 62 passes loosely through the shuttle sleeve. Accordingly, during the major portion of the plunger stroke there is no frictional resistance between the plunger and shuttle.

The shuttle sleeve 60 includes a reciprocating switch pole or finger 66, consisting of a cylindrical metal stud embedded in a boss 67 formed on the periphery of the sleeve. To provide for longitudinal motion of the sleeve and switch pole, a longitudinal clearance slot 68 is formed in the upper portion of the solenoid tube. Boss 67 fits loosely within the slot and projects upwardly beyond the periphery of the tube. The boss limits rotary motion of the sleeve and switch pole; it also insulates the metallic switch pole from the solenoid tube.

The switch pole 66 moves longitudinally relative to a pair of stationary contact plates 70—70 which are formed of thin flexible sheet metal; the pole completes the circuit across the plates intermittently during reciprocation of the plunger, as explained later.

As viewed from above (Figure 3), each contact plate 70 forms a part of a one-piece stamping comprising a base section 71 having a spring arm 72 yieldably supporting the contact plate 70. As viewed in Figure 4, the endwise portion 73 of each yieldable arm 72 is bent upwardly at an angle to the plane of the base section 71. The spacing of the opposed angular portions 73—73 is greater than the diameter of switch pole 66 to provide clearance for the lower portion of the pole. However, the opposed contact plates 70—70 reside in planes which are inclined upwardly toward one another, such that the opposed plates normally intercept the upper edge of pole 66 at diametrically opposite sides. The normal spacing of the plates 70 is slightly less than the diameter of the pole, such that the plates 70 are sprung apart by the pole to provide a wiping line contact with the upper edge of the pole as it passes longitudinally between the opposed plates. The pole thus completes an electrical circuit across the plates and the sliding action keeps the contact surfaces clean to provide a good electrical contact even after prolonged service.

As viewed in Figure 3, the sleeve boss 67 loosely interfits the longitudinal slot 68, being provided with flats 74—74 at opposite sides for clearance. Since the shuttle sleeve is rotatable about stem 62, the switch pole 66 is free to swing in an arc laterally within the limits provided by the slot clearance. Accordingly, when the pole slides between the plates 70—70 and springs them apart, the plates react under equal pressure against the opposite edges of the pole by reason of its floating action. This assures the most efficient circuit closing action across the plates and offers minimum resistance to the reciprocating motion of the switch pole.

To provide a camming action with respect to the switch pole, the opposite ends of each contact plate are provided with outwardly inclined skid sections 75—75 (Figure 5). These sections delineate converging passageways which guide the floating switch pole into alignment as the pole approaches the plates in its reciprocating motion.

The base section 71 of each contact stamping is seated upon a spacer plate 76 formed of dielectric material (Figure 3). The base sections are secured by screws 77 passing through the spacers 76 and threaded into the opposed flanges 78 of base 51. The spacer plate 76 extends transversely across the longitudinal slot 68 and provides a stop, as indicated at 80, which engages the boss 67 and thus limits the outward motion of the shuttle sleeve 60. The base sections 71 each include an outwardly projecting tab 81, providing a terminal for the wires 82—82 which complete the electrical circuit across the contact plates. As shown in Figure 4, the wall 57 of cover 52 is notched out as at 83 to provide clearance for the screws 77 and tabs 81 which project outwardly beyond the sides of the cover.

It will be understood at this point, that the switch pole normally resides between the contact plates as shown in Figures 4 and 5. When the primary winding 36 is energized and the plunger is propelled toward the right, the stem 62 shifts longitudinally relative to the shuttle sleeve 60 to provide lost motion which maintains the circuit through the coil during a major portion of the power stroke. However, as the plunger approaches its right hand limit (Figure 6), ring 64 contacts the sleeve and thus shifts the switch pole toward the right to open the circuit.

Electrical circuit and operation

The circuit illustrated in Figure 12, represents a typical household installation, utilizing three separate push buttons, indicated at 89, for the different entrances to the building. The circuit is powered by a standard bell transformer 84 having a primary winding 85 energized by the A.C. lines 86. One side of the secondary winding 87 is connected by way of line 88 to the coils 36 and 45 of the two solenoids. The opposite side of the circuit is completed to the coils individually by way of line 90, through the single-note push button, two-note push button or sustained signal button, as indicated in the diagram.

When the single-note push button is depressed, the circuit to the single acting solenoid 45 is completed by way of line 91, propelling the plunger magnetically toward the right, compressing its spring 48, and causing the pin 47 to strike tone bar 13. Upon striking the tone bar, the plunger rebounds to create an air gap between stem 47 and the tone bar, as indicated at 92 by the broken lines. The plunger is held in this position so long as the coil is energized, the magnetic flux acting in one direction and the energy stored in the spring 48 acting in the opposite direction, the two forces being in balance. When the single-note button is released to deenergize the coil, spring 48 shifts the plunger back to its retracted position into engagement with cap 50.

When the two-note button is depressed, the circuit to the repeater solenoid coil 36 is completed through the line 93, causing the double-acting plunger 34 to be propelled magnetically toward the right, compressing its spring 42 and causing striker pin 40 to impinge against tone bar 13 and immediately to rebound to create an air gap 92, as indicated in Figure 9. It will be seen that when the circuit is energized through the two-note button, the switch mechanism 32 is not brought into the circuit, although the shuttle sleeve is shifted to the right, as indicated in broken lines in Figure 9. It will be understood that the plunger 34 is held magnetically in the rebound position, shown in full lines, so long as the primary solenoid coil 36 remains

energized by the two-note button. When the button is released, the energy stored in the compressed spring 42 propels the plunger sharply toward the left, causing striker pin 41 to impinge against tone bar 14, as shown in Figure 10, thus striking the second note. After striking the tone bar, the plunger rebounds from the tone bar and resides in the inactive retracted position shown in Figure 8, with the circuit closed across the contact plates 70.

When the sustained signal button is depressed, a circuit is completed to one of the contact plates 70 by way of line 94 (Figure 12). The circuit is completed through switch pole 66 to the opposed contact plates 70, and by way of line 95 to repeater coil 36. As soon as repeater coil 36 is energized, the plunger is magnetically propelled toward the right (Figure 11) to strike tone bar 13. During the major portion of the power stroke, the stem 62 slides longitudinally with respect to shuttle sleeve 60, thus providing lost motion for maintaining the circuit to the solenoid coil. Toward the end of the power stroke, retainer ring 64 contacts the shuttle sleeve and shifts it toward the right (Figure 9) thus opening the circuit to coil 36. However, the plunger will have attained sufficient velocity to complete its right hand stroke under momentum to overtravel and impinge against tone bar 13 as it compresses spring 42.

Upon striking the tone bar 13 (coil 36 now being deenergized), spring 42 immediately propels the plunger toward the left with sufficient force to strike tone bar 14 (Figure 10) and also to shift the shuttle sleeve to switch closing position. This again energizes coil 36 to repeat the cycle. It will be seen in Figures 9 and 10 that the shuttle remains in switch open position during the major portion of the return stroke under spring action and that the shuttle is shifted to switch closing position as pin 41 strikes the second tone bar 14. Accordingly, as the plunger rebounds from tone bar 14, it is immediately propelled magnetically toward bar 13. The shuttle action thus provides continuous reciprocation so long as the sustained button is depressed.

Having described my invention, I claim:

1. A repeater solenoid comprising, a solenoid tube, a solenoid coil mounted on a forward portion of said tube, a solenoid plunger slidably sustained for longitudinal motion within said tube, a plunger spring connected to the plunger and normally urging said plunger toward a retracted position relative to said coil, a pair of stationary contact plates extending in parallelism with said tube, spring means yieldably mounting said plates in transversely spaced relationship relative to the tube, a switch pole mounted for longitudinal motion relative to the tube, said pole projecting generally at right angles to the longitudinal axis of the tube and in a radial direction transversely thereof, said contact plates having opposed relatively inclined contact surfaces which intercept the outer end of said pole, said pole residing in a first position between said contact surfaces when the solenoid plunger is in said retracted position, the outer end of said relatively inclined contact surfaces engaging the outer end of said pole when the pole is in said first position and providing line contacts with said contact surfaces which complete an electrical circuit across the plates to the coil, whereby the coil propels the plunger forwardly in a power stroke, and a lost motion coupling element in driving connection between said plunger and pole, said coupling element shifting the pole longitudinally to a second position spaced from said contact surfaces as the plunger approaches the end of said power stroke, said pole in said second position opening the circuit across said contact plates and deenergizing said coil, said plunger spring thereupon propelling the plunger toward said retracted position, said coupling means shifting said pole back to said first position as the plunger approaches said retracted position and thereby providing sustained reciprocation of the plunger.

2. A repeater solenoid comprising, a solenoid tube, a solenoid coil mounted on a forward portion of said tube, a solenoid plunger slidably sustained within said tube, spring means connected to the plunger and normally urging said plunger to a retracted position relative to the solenoid coil, a shuttle slidably mounted within a rearward portion of said solenoid tube, said shuttle being partially rotatable relative to said tube, a pair of contact plates mounted relative to the solenoid tube and spaced apart transversely from one another, a switch pole mounted on said shuttle and projecting at right angles to the longitudinal axis of the tube, said pole residing in a first position between said contact plates when the solenoid plunger is in said retracted position, said switch pole completing an electrical circuit across said plates to the solenoid coil, whereby the coil propels the plunger forwardly in a power stroke, and a coupling stem projecting longitudinally from said plunger and providing a lost motion connection with said shuttle, said stem shifting the shuttle and switch pole longitudinally to a second position as the plunger approaches the end of said power stroke, said contact pole in said second position opening the circuit across said contact plates and deenergizing the solenoid coil, said spring means thereupon propelling the plunger toward said retracted position, said stem shifting said shuttle and switch pole back to said first position whereby said pole provides sustained reciprocation of the plunger.

3. A repeater solenoid comprising, a solenoid tube, a solenoid coil mounted upon the forward portion of said tube, a solenoid plunger slidably sustained within said tube, spring means connected to said plunger and normally urging the plunger toward a retracted position relative to said coil, a shuttle slidably mounted for longitudinal motion within the rearward portion of the solenoid tube, the rearward portion of said tube being slotted longitudinally, a contact pole mounted on said shuttle and having an outer end projecting generally at right angles to the axis of the tube and in a radial direction transversely of the tube, said outer end extending outwardly through said slot and beyond the periphery of said tube, a pair of opposed contact plates mounted relative to said tube at opposite sides of said slot, said plates spaced apart transversely in angular planes intercepting the outer end of said pole at opposite sides, and a lost motion coupling element in driving connection between said plunger and shuttle, said shuttle residing in a first position with the outer end of the pole interposed between said contact plates when the plunger is in said retracted position, said pole completing an electrical circuit across said plates to said solenoid coil, whereby the coil propels the plunger forwardly in a power stroke, said coupling element shifting said shuttle and contact pole longitudinally to a second position as the plunger approaches the end of said power stroke, the outer end of the pole in said second position being spaced longitudinally from said plates and opening the circuit to the coil to deenergize the same, said spring means propelling the plunger toward said retracted position, said coupling means shifting said shuttle back to said first position as the plunger approaches said retracted position, whereby the contact pole provides sustained reciprocation of the plunger.

4. A repeater solenoid comprising, a cylindrical solenoid tube, a solenoid coil mounted upon the forward portion of said tube, a solenoid plunger slidably sustained within said tube, spring means connected to said plunger and normally urging the plunger toward a retracted position relative to said coil, a cylindrical shuttle slidably mounted for rotary and longitudinal motion within the rearward portion of the solenoid tube, the rearward portion of said tube being slotted longitudinally, a contact pole projecting radially from said shuttle, said pole passing outwardly through said slot and beyond the periphery of said tube, said pole having a diameter less than the width of said slot, the rotary motion of the shuttle providing arcuate motion of the pole laterally

relative to said slot, a pair of opposed contact plates yieldably mounted relative to said tube at opposite sides of said slot in planes intercepting opposite sides of said pole, and a lost motion coupling element in driving connection between said plunger and shuttle, said shuttle and contact pole residing in a first position with the pole interposed between said contact plates when the plunger is in said retracted position, said pole completing an electrical circuit across said plates to said solenoid coil, whereby the coil propels the plunger forwardly in a power stroke, said coupling element shifting said shuttle and pole longitudinally to a second position as the plunger approaches the end of said power stroke, said pole in said second position being spaced longitudinally from said plates and opening the circuit to the coil to deenergize the coil, said spring means thereupon propelling the plunger toward said retracted position, said coupling means shifting said shuttle back to said first position as the plunger approaches said retracted position, whereby the contact pole provides sustained reciprocation of the plunger.

5. A repeater solenoid comprising, a solenoid tube, a solenoid coil mounted upon the forward portion of said tube, a solenoid plunger slidably sustained within said tube, spring means connected to the plunger and normally urging the plunger to a retracted position relative to the solenoid coil, a cylindrical shuttle sleeve slidably mounted upon the rearward portion of the solenoid plunger for longitudinal and rotary motion relative to the plunger, a pair of opposed contact plates yieldably mounted relative to the solenoid tube and spaced apart transversely from one another, a switch pole projecting outwardly from said shuttle sleeve, said pole having a substantially flat outer end residing in a first position between said contact plates when the solenoid plunger is in said retracted position, said rotatable shuttle sleeve providing lateral rocking motion of said pole for guiding the outer end of the pole laterally relative to said yieldable contact plates, said substantially flat outer end providing a line contact with the surfaces of the opposed contact plates and completing an electrical circuit across said plates to the solenoid coil, whereby the coil propels the plunger forwardly in a power stroke, and a pair of longitudinally spaced abutments on said plunger, one of said abutments engaging the shuttle sleeve and shifting the same longitudinally to a second position as the plunger approaches the end of said power stroke, said switch pole in said second position being spaced longitudinally from said plates and opening the circuit to deenergize the coil, said spring means thereupon propelling the plunger toward said retracted position, the other of said abutments engaging said shuttle sleeve, and pole back to said first position as the plunger approaches the said retracted position and thereby providing sustained reciprocation of the plunger.

6. A repeater solenoid comprising, a solenoid tube, a cylindrical solenoid coil mounted on the forward portion of said tube, a solenoid plunger slidably sustained within said tube, compressible means connected to said plunger and normally urging the plunger to a retracted position relative to the coil, a cylindrical shuttle sleeve sleeve slidably mounted for longitudinal motion within the rearward portion of said tube, the rearward portion of said tube being slotted longitudinally, a contact pole mounted on said shuttle and projecting outwardly through said slot and beyond the periphery of said tube, said slot guiding said pole for motion along a longitudinal path, a pair of opposed contact plates mounted relative to said tube at opposite sides of said slot, said plates spaced apart transversely in planes along the path of motion of said pole, said plates being yieldably mounted relative to the tube and presenting opposed contact surfaces which reside in inclined planes intercepting the outer end of the pole at opposite sides, said shuttle sleeve and pole residing in a first position with the pole interposed between said opposed contact plates when the plunger is in said retracted position, said inclined contact surfaces engaging the outer end of the pole at opposite sides and providing a line contact therewith when the pole is in said first position, said pole completing an electrical circuit across said plates to said coil, whereby the coil propels the plunger forwardly in a power stroke, a coupling stem projecting rearwardly from said plunger and passing loosely through said shuttle sleeve, spaced abutments on said stem residing on opposite sides of said shuttle sleeve, said stem movable longitudinally relative to said sleeve during a major portion of said power stroke, one of said abutments engaging the shuttle sleeve as the plunger approaches the end of the power stroke and shifting the shuttle sleeve and pole longitudinally to a second position deenergizing said coil, said compressible means thereupon propelling the plunger toward said retracted position, the other of said abutments engaging the shuttle sleeve and shifting the shuttle sleeve and contact pole back to said first position as the plunger approaches the end of said retracting stroke to energize the coil and thereby provide sustained reciprocation of the plunger.

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