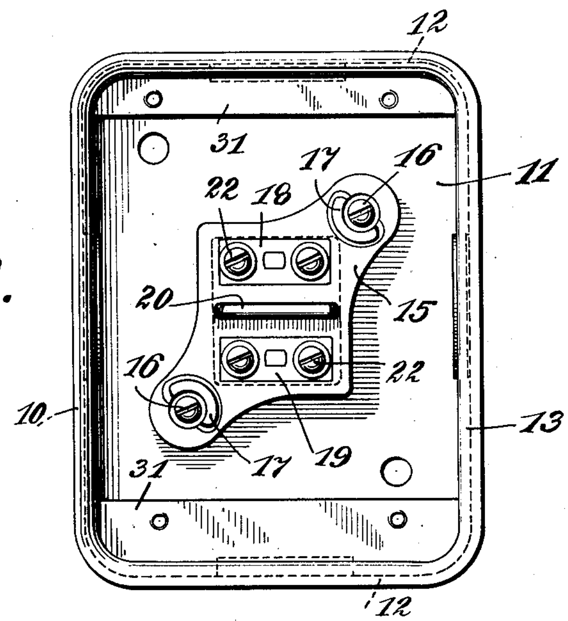
June 17, 1930. J. F. MORAN **1,764,277**

ELECTROMAGNETIC BELL

Filed May 12, 1923 2 Sheets-Sheet 1

Fig. 2.



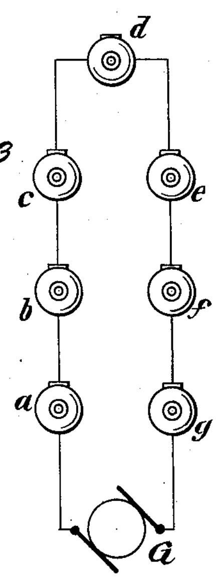
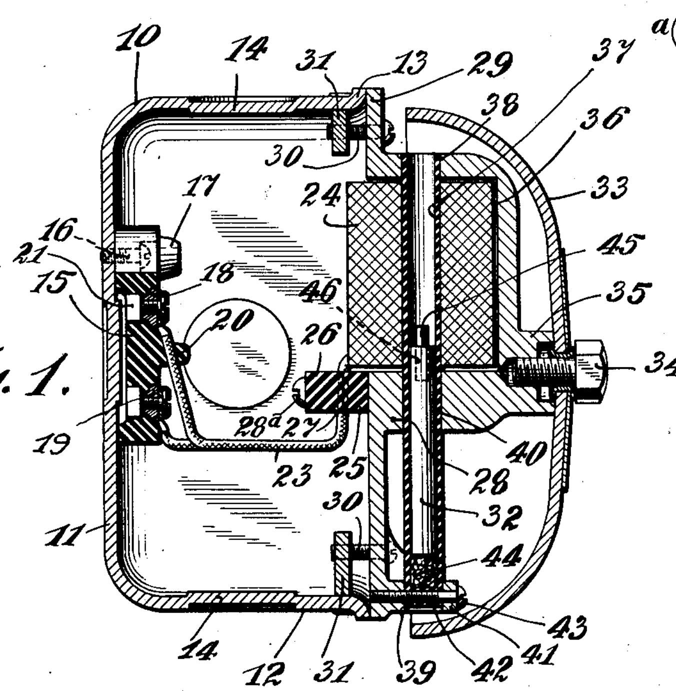


Fig. 5.

Fig. 1.



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Filed May 12, 1923 2 Sheets-Sheet 2

Fig. 3.

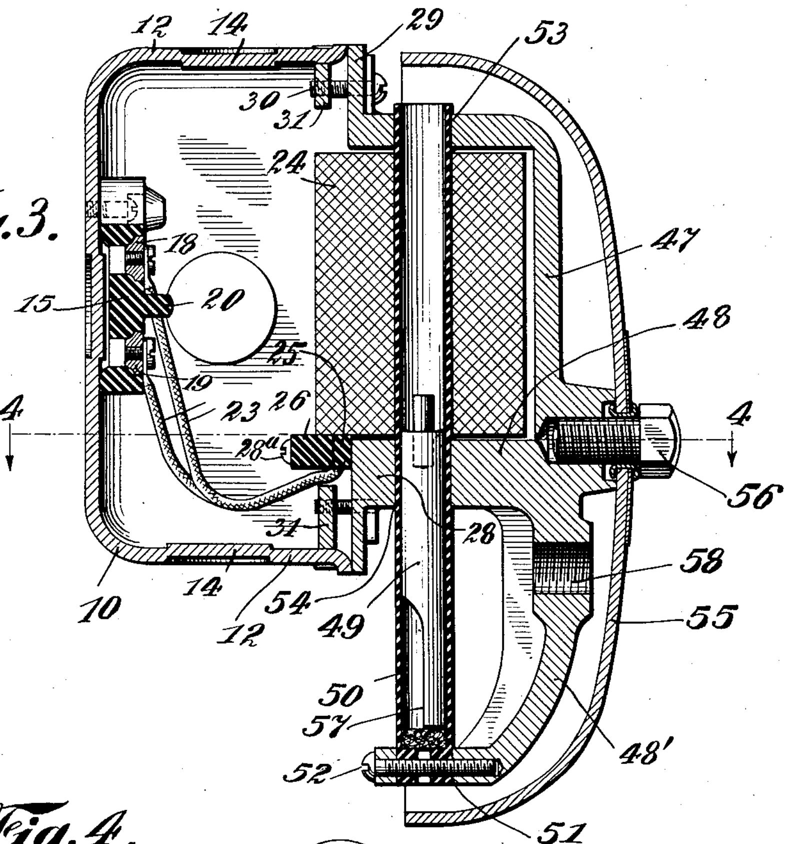
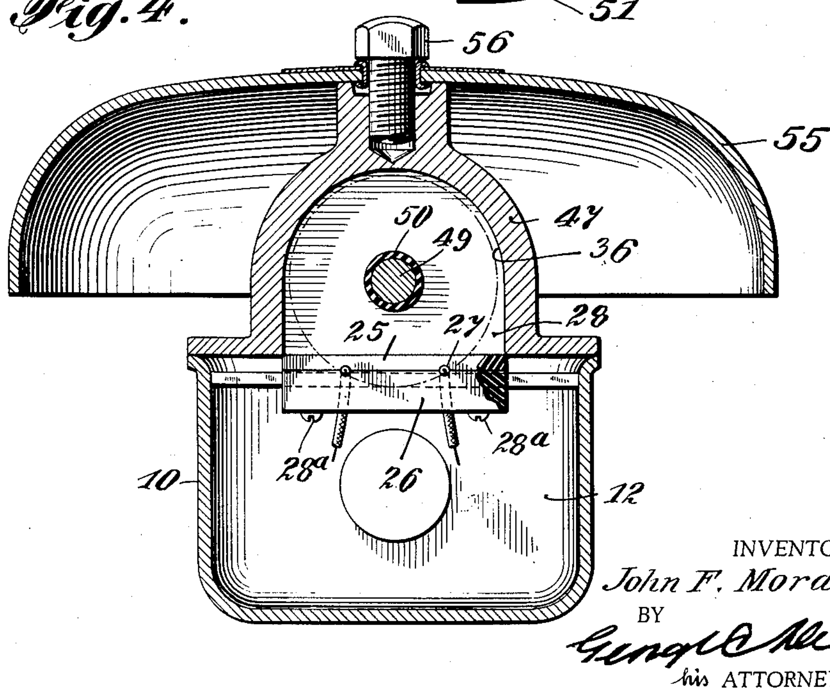


Fig. 4.



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Patented June 17, 1930

1,764,277

UNITED STATES PATENT OFFICE

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ELECTROMAGNETIC BELL

Application filed May 12, 1923. Serial No. 638,475.

My present invention relates primarily to electric signaling apparatus, and more particularly to bells of the single stroke type.

The preferred structure includes an outlet box, closed by a removable cover casting of unitary construction, which casting constitutes a yoke for the operating solenoid, a guide and support for the solenoid plunger and also a mount for the gong. More specifically, the cover casting has a concavity in the under or concealed side thereof, within which the solenoid is disposed with its axis vertical in the mounted bell. The plunger is supported upon an integral arm protruding from the lower end of the cover-yoke member. The gong is removably secured upon the cover-yoke casting, and substantially covers the same, a portion near the rim of the gong being in the path of movement of the upper end of the plunger.

The form elected for the more specific claims hereof is a single stroke alternating current bell, but its novel features are closely inter-related with several other novel features and combinations, structural and functional, which, taken together, constitute a new standardized system for commercial installation of all kinds of electric bells.

This bell embodies novel features whereby the rear casing which serves as the outlet box or fixture is of a relatively small size such that its front is completely closed by the smallest bell which it is proposed to use as standard equipment. In order that such small size outlet box may serve also as a rear casing for a large size alternating current bell the latter is made with its solenoid coil and yoke of a size practically co-extensive with the area of the open face of the outlet box, while the plunger guide and support is pendant any desired distance below the outlet box, and the whole is covered by the larger size bell or gong which is then employed. This support element for the plunger guide and bell may be formed with two independent bell-securing clamp elements, at different levels with respect to the top of the plunger guide, so that bells of substantially different size may be employed, yet both present striking surfaces in exactly the same position with respect to the up-stroke of the plunger.

Functionally, this bell embodies novel electrical relations and reactions.

First: Alternating current bells, in the absence of special precautions, may give a second or third signal on one closure of the circuit, particularly, if the cycle of magnetism should be substantially synchronous with the return or drop of the plunger after impact with the gong. I avoid such recurrent signal, by unbalancing the magnetic circuit structure, substantially when the plunger is in gong-striking position, so as to effect a preponderance of magnetic flux toward one side of the plunger, the latter tending thereby to move laterally for effective braking thereof, until after the control circuit has been interrupted and the plunger has returned to its normal position. In the present specific application of this principle, the trailing end of the plunger, which is normally beyond the magnetic circuit, is preferably asymmetrical, being cut away at one side thereof, so that when it passes into the magnetic circuit upon impact with the gong, the magnetic attraction will be asymmetrical and will brake the plunger movement.

Second: A considerable number, as for instance, eight or ten alternating current single-stroke bells of the solenoid and plunger core type, may be used in series on the same circuit. In such series use on an alternating current circuit, the difficulty has been that the time constant of response of the plungers of the different bells is practically never the same for different bells of the same model. The quickest plungers move into the magnetic field of their solenoids ahead of the others and choke the flow of current in the circuit including the solenoid coils of the slower bells, before the plungers of the latter can reach the powerful part of the fields of their respective solenoids. The result is that the slower plungers do not operate at all.

It has been proposed to obviate this difficulty by providing condensers to balance the inductance of the coils, but this is expensive. It has also been proposed to decrease the choking effect of the plunger within the coil by making the plunger very light but this result is ineffective.

I accomplish the desired result by slowing down the time period of response of all the plungers, preferably utilizing two factors. First, the initial position of the plunger core is pretty well outside of the field of the solenoid so that the initial pull of said field is relatively weak; and second, the plunger itself is preferably heavy. By utilization of these two expedients, I create a situation where a powerful current must be built up in the solenoid coil of all of the bells before any plunger moves. Then when the quickest plunger does move it moves slowly and has a relatively long distance to travel before it gets in position to operate as a choke. The result is that, though some of the plungers are slower than others, they are all well under way on their operative stroke before any of them get to effective choking position. Moreover, they are then rapidly moving to positions where the solenoid pull is amply sufficient to cause them to complete the stroke, notwithstanding the progressive choking inductance that each of them contributes as its said stroke progresses.

In the accompanying drawings in which is shown one or more of the various possible embodiments of the several features of this invention,

Fig. 1 is a transverse sectional view of one embodiment of bell,

Fig. 2 is a plan view of the outlet box apart from the bell structure,

Fig. 3 is a view similar to Fig. 1 of a modified form of bell structure, and;

Fig. 4 is a sectional view taken along the line 4—4 of Fig. 3.

Fig. 5 is a circuit diagram.

Referring now to Figs. 1 and 2 of the drawings, I have shown a bell structure including a stamped metal outlet box 10, having a bottom 11, side and end walls 12 and a rim 13. The box is provided with the usual knock outs 14 which may be punched out, as desired, for insertion of the conduits from the source of current. In the bottom or base of the outlet box is mounted an insulating contact support 15, which may be of molded insulating composition and which is preferably secured to the base as by screws 16, upstanding shields 17 integral with the support, preventing arcing over between said screws and the contiguous contact or terminal strips 18 and 19, and an integral upstanding rib 20 between the two terminal strips, preventing short-circuiting, creeping or arcing over therebetween. The terminal strips comprise rectangular pieces of metal embedded as at 21 within the molded composition, each bearing a pair of screws 22, one pair being connected to the source of current (not shown) and the other pair through conduits as at 23 to the solenoid 24 of the bell. Conductors 23 are clamped between a pair of insulating fibre strips 25 and 26, best shown in Fig. 4, provided with corresponding registering notches 27 in their contiguous edges and secured together and against the lower face of casting 28 as by screws 28^a.

The casting 28 has an integral rectangular frame 29, which serves as a closure for the outlet box removably clamped against the rim 13 thereof by screws 30 and threaded into transverse ledges 31 secured in the outlet box. The casting in the preferred embodiment constitutes a combined magnet yoke and support for the solenoid 24, a carrier support or guide for the solenoid plunger 32 and a mount for the gong 33. The gong, as shown, is preferably removably secured as by a screw 34 upon an integral stud 35 in the casting. The casting as shown in the drawings, includes a semi-cylindrical cavity 36 similar to that shown best in Fig. 4 and in the under, concealed or enclosed side of the casting or cover, within which the solenoid 24 fits with relatively small clearance.

In the embodiment shown, a vertical insulating tube 37 extends through the axis of the solenoid 24 and is supported in corresponding apertures 38, 39, and 40 respectively at the upper end of the yoke and at the lower end thereof, in an integral lug 41 depending from the lower edge of frame 28, and below the yoke portion of the casting. The lower end of the tube 37 is preferably closed as by a plug 42 and is, moreover, secured in position by screw 43 extending transversely therethrough and threaded into the frame 28 of the casting. The plunger 32 is an ordinary soft iron cylindrical rod and is normally cushioningly supported upon a yielding felt wad 44 resting upon plug 42 in the guide tube. A resonant metal striking tip 45 has a driving fit in a corresponding socket 46 in the upper end of the plunger, the rim of the gong 33 extending over the upper or open end of the tube 38 to be struck by said tip.

In operation, upon energizing the solenoid, say by direct current, the plunger 32 is drawn upward into the solenoid 24. As it rises it comes into more effective range of the solenoid "suction" and accelerates until it passes what may be termed the center of solenoidal attraction, after which it "overthrows," this is, travels by acquired momentum the short remaining distance until the tip 45 strikes the bell. The elastic reaction, down suction of the solenoid and gravity combine to cause rebound of the plunger, thus making the blow on the bell a sharp, clean tap. While the circuit remains closed, the plunger may oscillate up and down, but with decreasing amplitude, and the bell will not be struck again until after the circuit has been opened and the plunger has fallen by gravity to the initial position. The dropping of the plunger is effected without substantial vibration or jarring upon the parts, as it is cushioned by the yielding wad 44.

In Figs. 3 and 4 is shown a modified form of construction. In this embodiment, the casting 47 performs substantially the same functions as in Figs. 1 and 2, but is particularly designed for use with larger gongs. The casting member here also has a closure frame 29 for the outlet box 10, and a yoke for the solenoid 24, and has, furthermore, an integral bracket arm 48′ protruding in this case downward from the lower outer edge of the yoke portion 48 and serving to sustain the plunger 49 and the guide tube 50 therefor. More specifically, the tube 50 extends through a corresponding aperture 51 in the lower end of the bracket arm 48, where it is secured in position as by screw 52 and is supported at its opposite end as at 53 by the upper end of yoke 49 and held intermediate its ends in an aperture 54 through the lower portion of the yoke 48. The gong 55 is supported upon the yoke casting as by screw 56 at its center, and substantially covers the casting, together with the bracket arm thereof, as shown. For direct-current operation, a plunger generally similar to that shown in Fig. 1, but larger, may be used. Other details need not be described, as they are substantially identical with the embodiment of Figs. 1 and 2 heretofore described, corresponding parts bearing identical reference numerals.

The specific bell shown in Figs. 3 and 4, although suitable for direct current operation, is more particularly designed for operation by alternating current.

The core is a relatively heavy plunger and, in its rest position, only its upper end is within effective range of the lower end of the solenoid field. Hence it moves not at all until a powerful magnetic field has been built up in the solenoid by closure of the circuit, but when it once starts, it accelerates very rapidly until it reaches the center of attraction of the coil. Thereafter it overthrows by momentum, delivers a sharp tap upon the gong, and leaves it immediately, free to vibrate without interference. The mechanical rebound from the bell, plus the back pull of the solenoid and the weight of the plunger, causes the plunger to rebound deeply into the solenoid. Where direct current is used this results in relatively weak oscillations of the core which do not result in striking the gong a second time. In the case of alternating current, however, the rebound of the plunger is very likely to synchronize with a succeeding reversal and rise of magnetism, due to reversal of the alternating current in the coil. In such case there may be two or even three taps and rebounds before the oscillation of the plunger dies down to a point where the gong is no longer tapped.

According to my invention, the structure of the magnetic circuit is broadly such that the initial magnetic pull on the plunger is directly upward, but this automatically changes to a laterally unbalanced magnetic pull upon the plunger during the upper part of its stroke, thereby bringing it into frictional engagement with the sides of the guide. The resulting braking effect begins just before the plunger strikes the gong, but due to the inertia stored in the plunger in its long upward travel, it is not sufficient to materially affect the force of the blow on the gong. When the plunger drops after striking the gong, to its magnetically held position, the braking effect is sufficient to keep it from moving in synchronism with the variations in the magnetic field due to the fluctuations of the alternating current. In the preferred embodiment, this result is accomplished by the simple expedient of asymmetrically reducing the cross-section of the plunger 49 at its lower end, that is, at the portion thereof initially outside or beyond the circuit of the magnetic flux. To this end, the plunger may be cut away as at 57 at one side and near the lower end thereof, so that the first or leading portion will be symmetrical while the last or follow portion will be asymmetrical.

In the operation of the plunger-magnet mechanism of Fig. 3, whereby the damping effects may be realized, the axisymmetry of the upper or first portion of the armature 49 renders this member passively responsive to longitudinal draw of a symmetrical magnetic field developed about the axis of the tubular coil or solenoid 24. Unhindered, therefore, the plunger core accelerates rapidly and may be shot approximately to the gong 55, before its lower portion comes under appreciable energization. Due solely to the axial asymmetry provided by the cut 57 over the latter section of the core, bias of the magnetic field is established for setting up derived or transverse stress on the plunger. According to the length and character of the cut 57, the time and abruptness of build-up of the biasing stress may be controlled. Preferably, the asymmetrical portion of the plunger should be short and the cut sloped, so that bias may begin late in the stroke and then gradually increase in strength. When so applied, the effect of the bias will be negligible until rebound of the core from the gong, when the transverse drag will be adequate to stay the plunger against excessive recoil and quickly bring it to rest at its point of balanced suspension in the magentic field. Under this arrangement for damping the plunger against oscillation, the speed of the stroke is not affected, and the efficiency of the device is therefore not reduced, while the degree of bias automatically proportions to the longitudinal draw, under different current strengths or changes of reluctance in the magnetic circuit. Therefore, the striker is dependably restrained against oscillation or recurrent longitudinal effects, thus insuring bonafide single stroke operation of the gong irrespective of whether alternating current or direct current may be used for energizing the solenoid.

I have already described how, by making the plunger core heavy and its upper end normally far down in the solenoid field, these bells may be used in series on an alternating circuit because the plunger cores start slowly during times of maximum magnetization, with the result that none of them can operate quickly enough to get into current choking position within the solenoid until the slowest member of the group is also well started. The result is that the slowest bell strikes as surely as the quickest one. This important arrangement of my bells requires no illustration but for purpose of reference it is diagrammatically indicated in Fig. 5 where the bells *a*, *b*, *c*, *d*, *e*, *f*, *g*, and *h* are indicated as being serially connected in the same circuit, the latter being energized from a suitable alternating current source, as G.

As before explained, one and the same size and type of outlet box is preferably employed for mounting bells of all the various sizes and types. To this end the large size bells are made so that the outlet box fits only the upper solenoid-enclosing portion of said large size bell. The outlet box thus being suitable for the larger size bell, any smaller bell may be applied, down to and even below the size indicated in Fig. 1.

The bracket arm 48′ is preferably provided with an additional tapped hole 58 for mounting thereat, in lieu of the gong 55, a larger gong (not shown), the structure being unaltered otherwise.

I claim:—

1. In a signal mechanism, a tubular coil to develop a longitudinal magnetic field, a core coordinated with said coil to form a plunger-magnet, said core having axial asymmetry over the follow portion of its length for biasing said magnetic field.

2. In a signal mechanism, a tubular coil to develop a symmetrical magnetic field about its axis, a plunger-core having its stroke through said coil, said plunger-core having axial asymmetry over the follow portion of its length for effecting bias of said magnetic field to damp said plunger-core against oscillation following its stroke.

3. In an alternating current signal mechanism, a gong, a core to form a plunger-striker for said gong, a tubular coil to develop a longitudinal magnetic field for acceleratedly drawing said core, said core having axial asymmetry over a limited portion of its following length to derive transverse stress from said magnetic field for restraining said core against oscillation subsequent to its striking said gong.

4. In a signal mechanism, a gong, a tubular coil to provide a longitudinal magnetic field, a plunger-core for said coil to strike said gong, said core being axisymmetric over more than two-thirds of the leading portion of its length for passive response to the longitudinal draw of said magnetic field, while the remainder of said core is axially asymmetric to effect bias of said magnetic field for stressing said core against oscillation following a single blow to said gong.

5. In a plunger magnet for alternating current, a tubular coil, a plunger acceleratedly drawn by said coil to effect a single stroke, said plunger being axisymmetric over the leading and greater portion of its length to render it passively responsive to longitudinal magnetic draw of said coil, the remainder of said plunger being so designed that wholly due to its configuration bias of said longitudinal magnetic draw will be accomplished for quickly bringing said plunger to rest following a stroke thereof.

6. In an alternating current signal mechanism, gong means, a striker for said gong means, a tubular coil to develop a longitudinal magnetic field, a carrier for said striker comprising a core for said coil in the form of a plunger acceleratedly attracted by said magnetism, said core being proportioned over the first and greater section of its length to render it passively responsive to the longitudinal draw of said magnetic field, the remaining section of said core being proportioned to accomplish biasing of said magnetic field for restraining said core against excessive recoil after striking said gong.

7. In a plunger magnet for alternating current, a gong, a plunger striker for said gong, a tubular coil developing a longitudinal magnetic field acceleratedly to impel said plunger-striker for delivering a blow to said gong, the first and greater portion of the length of said plunger being formed

axisymmetric to render it free and passively responsive longitudinally to said magnetic field, the last and least portion of the length of said plunger being formed axially asymmetric in a manner to effect a slow-to-build-up bias of said magnetic field for stressing said plunger against recurrent striking of said gong following delivery of a single blow thereto.

Signed at New York city in the county of New York and State of New York this 10th day of May A. D. 1923.

JOHN F. MORAN.