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D. A. McCONNELL

ELECTRIC HORN

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Fig. 1.

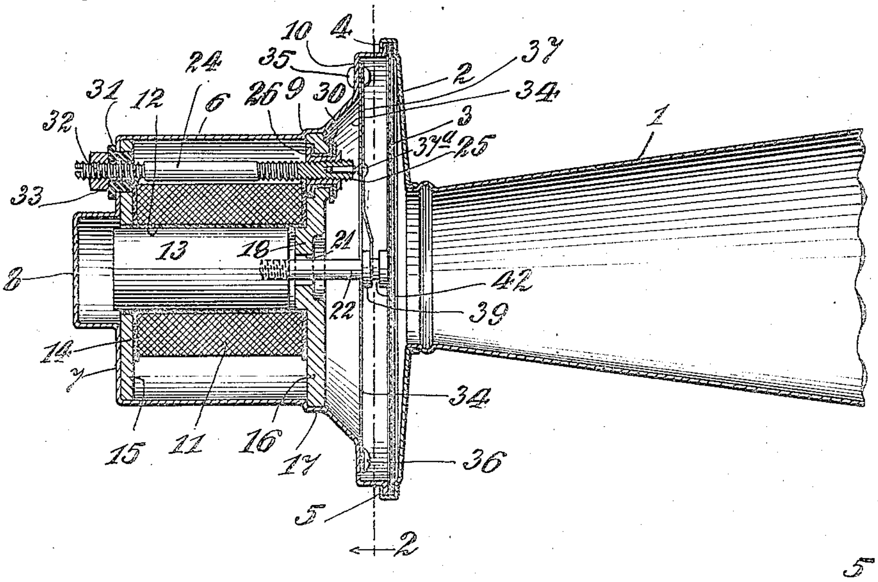


Fig. 2.

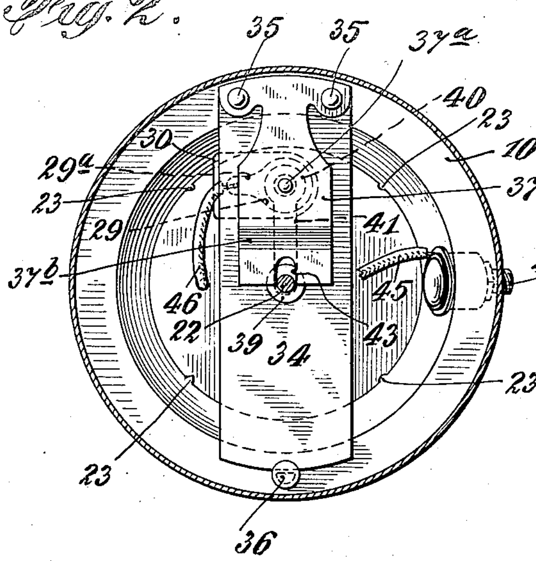
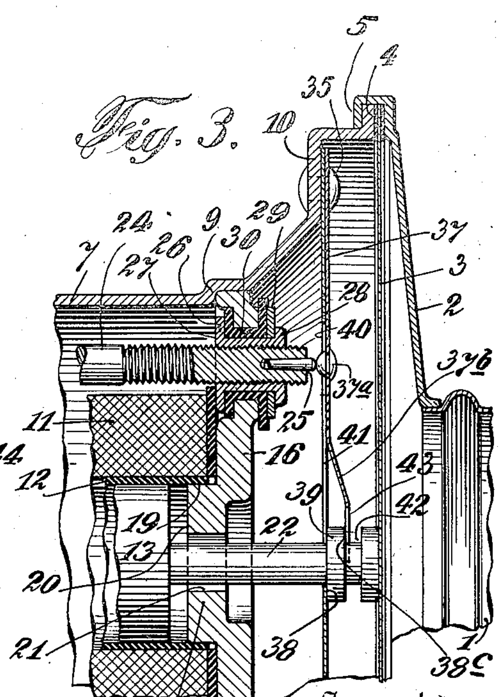


Fig. 3.



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UNITED STATES PATENT OFFICE.

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ELECTRIC HORN.

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This invention relates more particularly to electric horns of the type in which the sound producer is an elastic diaphragm actuated through a plunger by the armature or core of a solenoid coil, the circuit of which is automatically opened and closed by the movement of the plunger, the movements of the plunger in one direction being forced by the solenoidal pull when the circuit is closed and in the other direction by an elastic element which may be the diaphragm either alone or in combination with auxiliary springs.

The general purpose has been to embody the above essentials in a compact, simple structure having few parts, cheap to make and assemble, yet durable, easily adjustable and efficiently functioning, both electrically and acoustically. The special features include the following.

The rear casing of the horn is a drawn metal shell shaped to afford the structural frame and support for the solenoid. Preferably also there is a seat for a supplemental recoil spring and a seat for the diaphragm, embodied in the same single piece shell, insuring proper spacing and relative arrangement for all the above-mentioned parts.

The drawn metal shell which affords the support for the solenoid coil elements is of mild steel arranged to afford the external magnetic circuit for the solenoid. There are special end discs of magnetic material, one encircling the exteriorly displaced end of the solenoid core and the other closely confronting the other end of the core—the end toward which the core is to be sucked by the solenoid. Thus the gaps in the magnetic circuit at the respective ends of the core are a minimum and the motor efficiency of the coil is correspondingly increased.

The power stroke of the solenoid core is in a direction to push the diaphragm outward and the supplemental spring for checking the rearward movement of the plunger, and the contact spring for making and breaking the circuit, are both located between the solenoid and the diaphragm.

The contact spring is between the recoil spring and the diaphragm and preferably has its fixed end secured by the same clamping means employed to secure the recoil spring. The co-operating stationary contact is on a screw rod extending through the rear of the casing and the contacts function through an opening formed in the recoil spring.

The recoil spring is preferably rigidly clamped at one end only, the other end extending loosely into a slot beneath a head which closely limits its spring movement but does not interfere with endwise and angular movements of the spring when it is bowing in normal operation of the device. The recoil spring is not secured to the plunger, but loosely surrounds the plunger stem so as not to interfere with the automatic self-centering and self-aligning tendency of the core as it reciprocates in the solenoid and it engages the plunger head only against a rearwardly directed surface thereof. The latter feature has the advantage that the plunger head and recoil spring are free to function independently from the time the recoil spring reaches its midway or untensed position on the forward stroke until the same position is passed on the rear stroke of the plunger.

As the recoil spring is not positively actuated on the forward stroke by the plunger, a separate contact spring is provided which is so actuated. Its free end extends in the path of a forwardly presented surface of the plunger head so as to be positively actuated thereby on the outward or power stroke but not attached. Hence the head and contact spring are free to function independently from the time said spring reaches the contact closing position on the rearward stroke until the plunger reengages it on the forward stroke.

Thus the head is unattached either to the diaphragm or to the buffer spring or to the contact spring, although the size and spacing of these elements are preferably such that they are in contact when in normal rest position.

The above and other features of my invention will be more fully evident from the following description in connection with the accompanying drawings, in which—

Fig. 1 is a vertical longitudinal section of the device.

Fig. 2 is a transverse section on the line 2—2, Fig. 1.

Fig. 3 is a view like Fig. 1 but showing a part of the device on a larger scale.

The projector 1 may be of sheet metal of any known or desired construction, brazed or otherwise secured to a stamped metal member 2 forming the front closure and clamp for the diaphragm 3.

The rear casing is formed with the co-operating diaphragm seat 4 against which the diaphragm is clamped, preferably by spinning inward the metal of front casing as at 5.

The rear casing also comprises a cylindrical or body portion 6, the rear wall 7, the rearward cylindrical boss 8, the annular seat 9 of slightly greater diameter than 6, and a second annular seat 10 of greater diameter than 9.

The solenoid contained within the casing comprises a winding 11 which may consist of wire having a flexible enamel insulating coating, wound on a tubular member or sleeve 12 of insulating material which is preferably thin and hard and having a smooth inner surface adapted to withstand the wear and afford minimum friction for the reciprocating core 13. The end washers 14 are of similar insulating material.

The structural support for the rear end of the coil is afforded by a flat annular member 15 of iron having the insulating sleeve fitted therein and supported thereby. This member 15 directly engages the shell to afford low resistance magnetic circuit therethrough. Preferably it is large enough to fit the interior of the cylinder 6, so as to be accurately centered thereby.

The forward support for the solenoid coil is an iron disc 16 which fits laterally against the shoulder 9 and peripherally against the cylindrical annulus 17 of the casing.

The disc 16 has a central boss 18 having an outer shoulder 19 fitting within the insulating sleeve 12, a rear surface 20 closely confronting the forward surface of core 13 and formed with a central opening 21 large enough to permit free passage of the plunger shank 22 which is rigidly secured to and projects from the center of core 13.

It will be evident that in manufacture the above-described elements 11, 12, 14, 15 may be secured together before assembling them, but the disc 15 may be merely slipped on 12, then inserted in cylinder 6 and thereafter disc 16 inserted with its periphery engaging 17 and its boss projecting within 12. Being already accurately centered, disc 16 may be secured from withdrawal in any desired way, as for instance, by slightly deforming and punching outward the metal of the disc or punching inward the metal of the shell, as at 23, Fig. 2.

In the particular arrangement shown, the screw rod 24 may be utilized as means for clamping disc 16 against the parts intervening between it and the rear face of the shell.

The primary function of the rod 24, however, is that of adjustable support for the stationary contact member 25. Pursuant to this function the forward end of the rod extends through aligned openings in the rear wall 7 of the casing, in rear annulus 15 and in forward disc 16. It is insulated from all three of these elements. At the forward end it is screw threaded to a sleeve 26 which may be the barrel of a brass rivet having a head 27 held in position by riveting over the other end of the barrel as at 28 upon a washer 29. Between the disc 16 and the rivet is the insulating sleeve 30. At the rear end there is a single insulating sleeve 31 through which the threaded portion 32 of rod 24 extends freely without screw threaded engagement therewith. The rod may be screw adjusted to project any desired distance from the disc 16 and when so adjusted a clamping nut 33 may be screwed down to lock said rod 24 in the adjusted position.

The recoil spring 34 spans the recess in front of disc 16, being supported on an annular face 10 of the casing. One end of 34 is clamped as by rivets 35, 35, in intimate engagement with the flat surface of 10. The other end extends under an overhanging lug 36 but is not clamped thereby, and hence this end is free for angular and endwise play when spring 34 bows in normal operation of the device.

As described above, the recoil spring 34 preferably loosely surrounds the plunger stem 22 and engages the plunger only against rearwardly directed surface 38 on the plunger. This surface is on a collar 39, which is preferably a part of or secured to said stem 22. For convenience in applying the spring 34 to the stem, said spring is provided with a circular opening 40 which is slightly larger than the maximum diameter of 39, from which circular opening extends a slot 41 of slightly greater diameter than the stem 22 and of a length slightly greater than the distance to the far side of the stem.

The circular opening 40 is preferably located opposite the fixed contact 25 in operative relation to the movable contact 37^a on contact spring 37. This contact spring 37 is secured against the forward face of recoil spring 34 and preferably by means of the same rivets 35 which hold said recoil spring in place. The said spring 37 may be initially formed with a forward curvature or set which is flattened out when rivets 35 are headed down. Spring 37 is bent outwardly to form an offset portion 37^b, the end of which engages groove 42 adjacent the forward surface 38^c of collar 39. Preferably the free end of the spring is formed with a slot 43 which straddles the plunger stem 22 and preferably extends only to the diametric point of the latter. It normally projects closely adjacent to or in light contact with surface 38^c and by reason of the groove 42, is free to remain at rest when the plunger makes its reciprocation rearwardly of the normal or midway position.

The device is actuated by electric current supplied from any suitable source, as for instance, direct current from the storage battery of the lighting and starting system of an automobile. As shown, the circuit is serially through a suitable exterior binding post 44, wire 45, coil 11, wire 46, projection 29^a on washer 29 and through the fixed contact 25 to the movable contact 37^a. Thence the return may be by another wire or by a ground as through the horn casing and the frame of an automobile.

In operation, the closing of the circuit energizes the solenoid which sucks forward the core 13, bowing the diaphragm 3 outwardly and also flexing spring 37 and breaking the circuit at 37^a. The solenoid being de-energized the resiliency of the outwardly bowed diaphragm forces the rearward return stroke of the core 13. During the rearward stroke, the spring 37 is stopped by fixed contact 25, and the rear surface 38, of the plunger engages the recoil spring 34, which absorbs the rearward momentum of the plunger, being itself flexed rearwardly and put under tension thereby. The closure of the circuit at 37^a re-energizes the solenoid to cause the next forward stroke of the plunger 13. On this forward stroke the energy stored in spring 34 is available to accelerate the forward movement of the plunger up to the midway position.

The above cycle of operation is repeated, building up a substantial amplitude of reciprocation of plunger 13. Such increase in amplitude does not affect contact spring 37 which has no movement rearwardly of the midway position. When the stiffness of the spring elements is properly designed with reference to weight of core 13 and the time period of the coil 11, the synchronized, harmonious action of the coil 11, diaphragm 3, recoil spring 34 and contact spring 37 may be perfected merely by trial adjustment of the fixed contact rod 25, preferably during operation of the device, the proper adjustment and harmony of operation being determined by the loudness and quality of the note produced by the horn.

As an illustration of suitable proportions, we may instance a horn having a 3½ inch diaphragm, of spring steel about .018 inch in thickness, made as flat as possible. The buffer spring and contact spring were made of the same spring steel and of the same thickness and of the proportions shown, but it will be obvious that the above dimensions, as well as the proportions, may be widely varied.

The core of the plunger is, of course, of first quality magnetic iron or steel, but the plunger stem 22 is preferably of non-magnetic material such as brass so that it has no tendency to become part of the magnetic circuit when the core is magnetized. Hence it does not attract or stick to any of the adjacent members. Bronze or brass also seem to have an acoustic advantage over steel or iron, because it is softer and seems to have less elastic recoil. Hence it is less likely to cause chattering contact with the springs and with the diaphragm. While the stem 22 may be screw threaded into the core 13, a drive fit will be cheaper and equally satisfactory, especially where the stem is of brass.

It is to be noted that the thin spring steel strip 34, being clamped at one end only, opposes rearward movement only by its transverse stiffness. No matter how far it bows rearwardly, the free end yields and the longitudinal elasticity (stretchability) of the strip is never brought into play. Hence the strip functions as an auxiliary recoil device assisting the suction of the solenoid coil in stopping the rearward movement. With this relatively uniform resilience applied throughout the rearward half of the plunger reciprocation, the distance and speed of said rearward half of the movement, and thereby the frequency of the plunger strokes, may be adjusted within reasonable limits by varying the time of closure of the circuit and thus the time of establishing forward suction in the solenoid coil. This may be accomplished by slight adjustment of the stationary contact 25 as above described. This functioning is noticeably different from that which results where the plunger is secured to a transverse bar or strip which is clamped at both ends. In such case the bar is very stiff relative to the weight of the plunger and the two vibrate at a rate which is practically predetermined by the stiffness of the bar.

I claim:

1. A signalling device comprising, in combination, a casing supporting a horn; a diaphragm; magnetic discs provided in said casing forming partitions therein; a rod screw-threaded at both ends, one of which is in threaded connection with an insulated collar on the one disc while the other end of the rod is slidably carried in an insulating collar supported in the other disc; a lock nut on the end of the rod that is slidably carried; a contact element on the other end of the rod; a movable contact arm adapted to engage said contact element; and electro-magnetic means carried by the discs and including an armature having means for disengaging said contacts and striking the diaphragm.

2. A signalling device comprising, in combination, a casing supporting a horn; a diaphragm; discs provided in said casing forming partitions therein; a contact carrying member insulatingly supported by said

discs; means for adjusting said contact carrying member relative to said discs; a movable contact member supported by the casing so as to engage the stationary contact; and a solenoid coil supported between said discs and containing a plunger-core adapted to be actuated by said coil said plunger core including means adapted to strike the movable contact member and diaphragm.

3. A signalling device comprising, in combination, a cup-shaped casing formed of thin magnetic material; a horn supported on the edge of said casing; a diaphragm interposed between the horn and casing; discs of comparatively thicker magnetic material than the casing held in spaced relation within said casing and forming partitions therein; a stationary contact; means insulatingly supporting said contact on said discs; a movable contact member supported by the casing so as to permit said member to engage with the stationary contact; a solenoid coil supported between said discs, and insulated therefrom, said coil containing a plunger-core; and a member on said plunger core adapted to strike the movable contact and diaphragm.

4. A horn of the type comprising an elastic diaphragm, a plunger for vibrating the diaphragm, a solenoid coil actuating a plunger core and a circuit breaker operated by movements of said plunger, and, in combination with said parts, a rear casing element comprising a drawn metal cup of mild steel formed with a cylindrical body portion, a forward seat for the diaphragm, an intermediate seat of less diameter for a supplemental recoil spring, and a seat of still less diameter for a transverse partition member, all parallel, spaced-apart and embodied in the same single-piece shell.

5. A signalling device, comprising in combination, a casing; a diaphragm carried by said casing; an electromagnet in said casing, having a movable armature provided with a head portion; a circuit controlling device for said electromagnet, comprising a resilient member supporting a contact, said member being secured at one end, to the casing, the free end thereof engaging the head portion of the armature; a stationary contact adapted to be engaged by the contact on the resilient member; and an apertured recoil spring attached at its ends to the casing and located in a plane between the said resilient member and the stationary contact, and engaging the armature head portion, the contact on the resilient member extending through the aperture in the recoil spring.

6. A signalling device, comprising in combination, a casing; a diaphragm carried by said casing; an electromagnet in said casing, having a movable armature provided with a head portion located between the magnet and the diaphragm; a circuit controlling device for said electromagnet, comprising a resilient member supporting a contact, said member being secured at one end, to the casing, the free end thereof engaging the head portion of the armature on the side thereof adjacent the diaphragm; a stationary contact adapted to be engaged by the contact on the resilient member; and an apertured recoil blade spring attached at its ends to the casing and located in a plane between the stationary contact and the resilient member, said blade spring engaging the head portion of the armature on the side opposite that engaged by the resilient member, the contact on said member extending through the aperture in the said recoil blade spring.

7. A signalling device, comprising in combination, a cup-shaped casing having parallel flange and shoulder portions transverse to the axis thereof; a diaphragm secured to the flange portion; a flat recoil spring having one end secured to the shoulder portion, the other end being slidably supported thereon; a solenoid magnet having a plunger core provided with a head portion, one side of which is engaged by the recoil spring; a circuit interrupter for the said magnet, comprising a flexible contact member one end of which engages the other side of the armature head portion, the other end of said flexible contact member being secured to the casing shoulder; and common means for securing the recoil spring and flexible contact member to the shoulder of the casing.

8. A signalling device, comprising in combination, a drawn metal, cup-shaped casing having a flange and a shoulder portion; a diaphragm secured to said flange portion; an apertured partition member in said casing; a solenoid coil supported by said partition member; a plunger core in said coil; an apertured blade spring spanned between opposite portions of the casing shoulder, one end being secured to the shoulder, the other being slidably supported thereon; a stem secured to the plunger core and extending loosely through the partition member and blade spring, said stem having a head portion at its end adapted to strike the diaphragm, one side of said head engaging the blade spring; and a circuit controlling device for the solenoid coil, comprising a flexible contact member secured to the shoulder portion of the casing and engaging the side of the head portion of the stem opposite the blade spring.

Signed at Newark in the county of Essex and State of New Jersey this 10th day of April, A. D. 1922.

DUNCAN A. McCONNELL.