Aug. 20, 1935. R. R. GONSETT 2,012,064

ELECTROMAGNETIC SWITCH

Filed Jan. 25, 1932

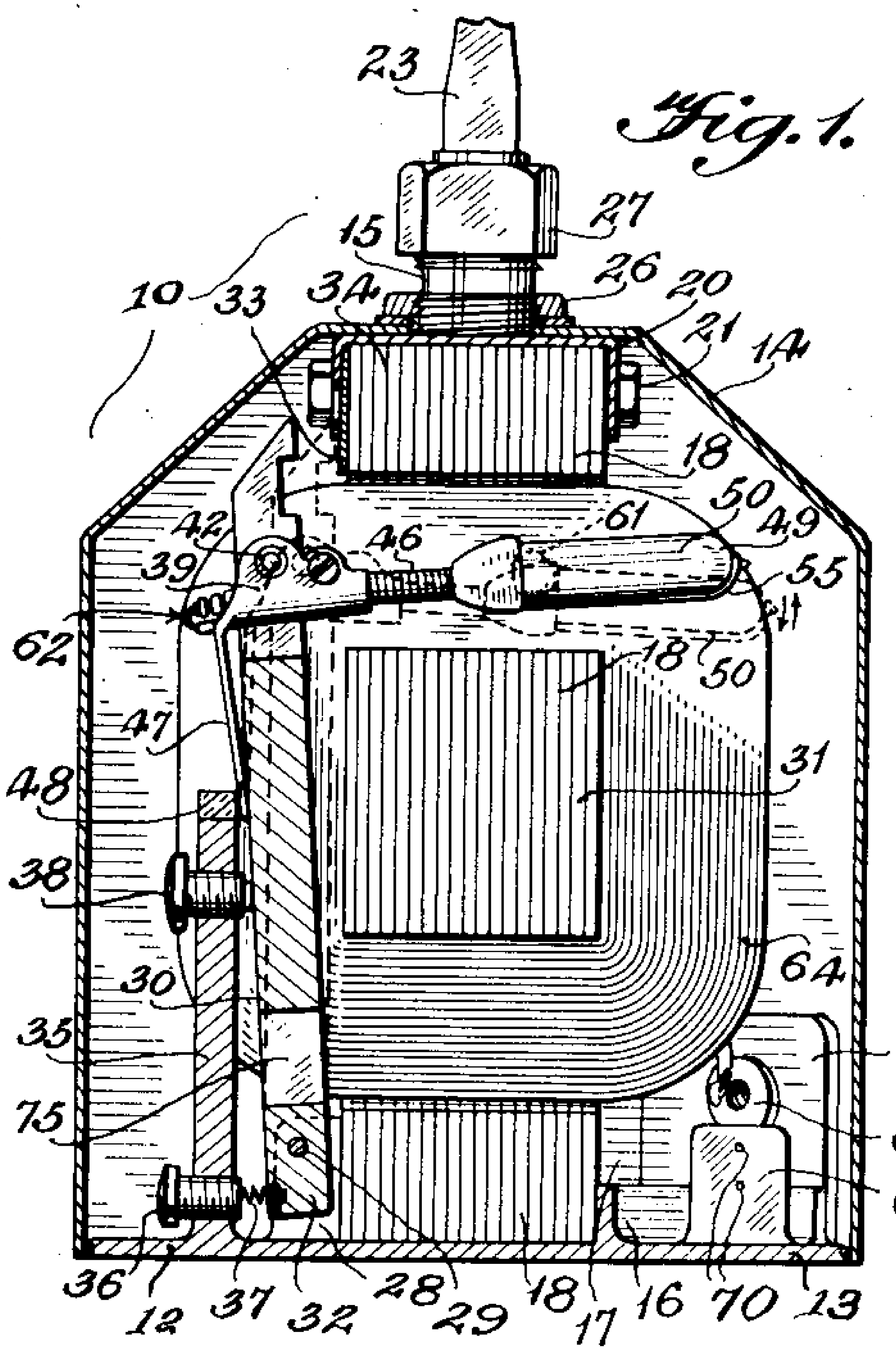


Fig. 1.

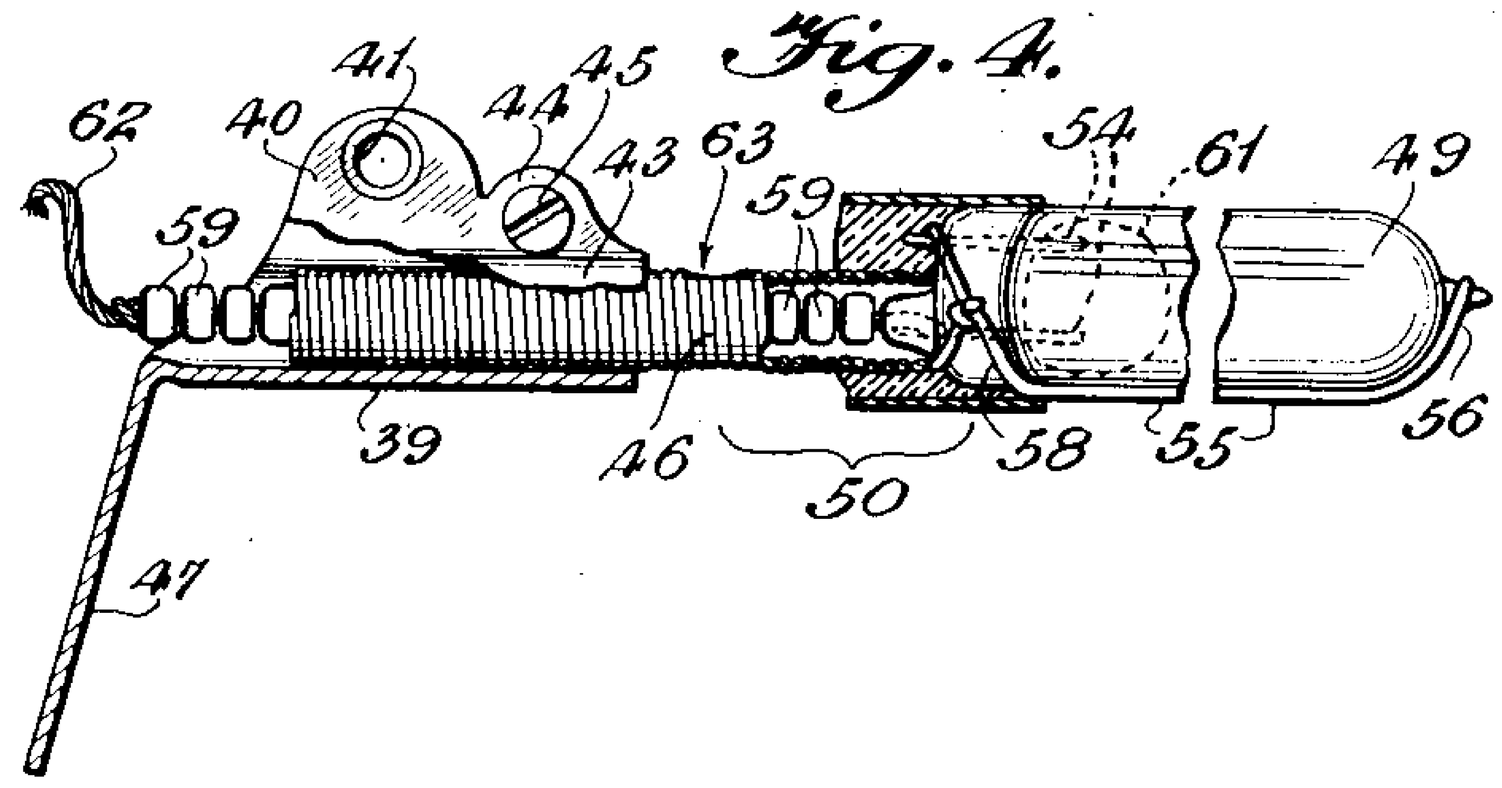


Fig. 4.

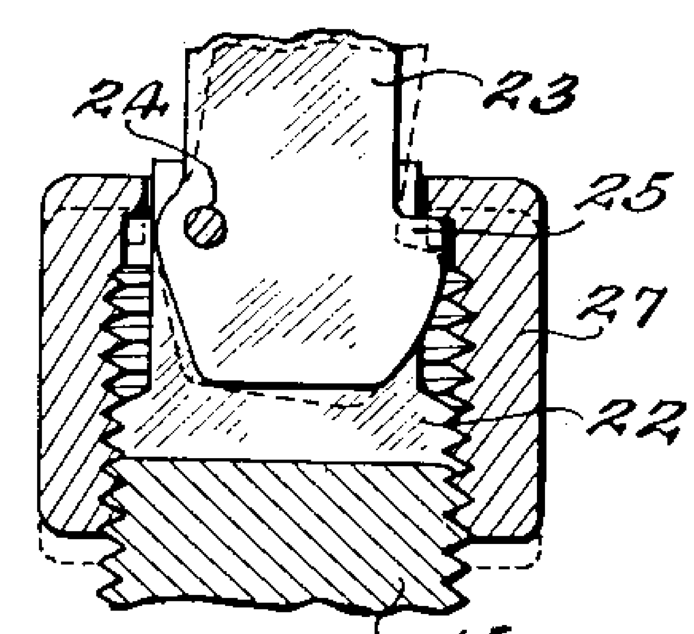


Fig. 3.

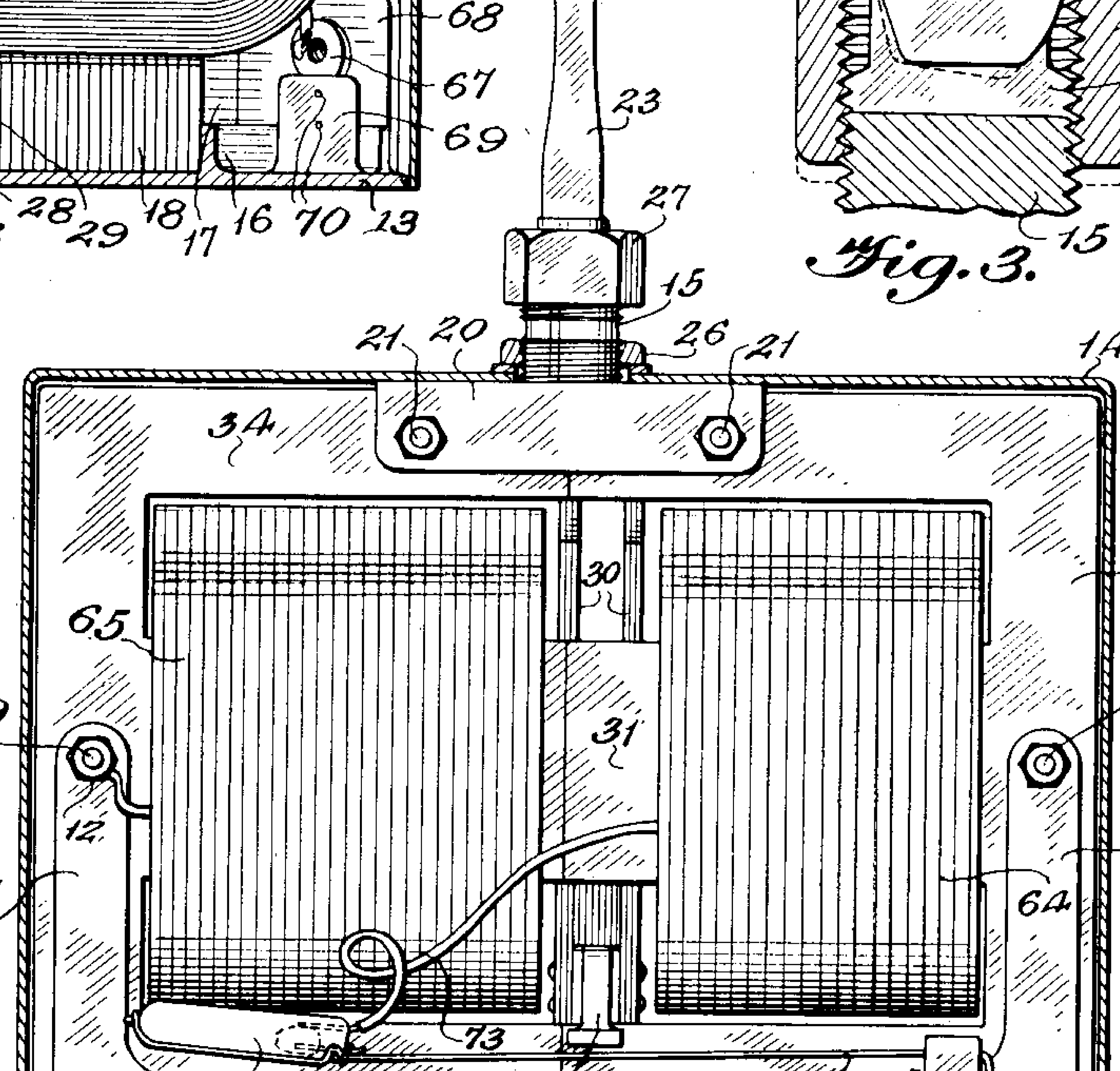


Fig. 2.

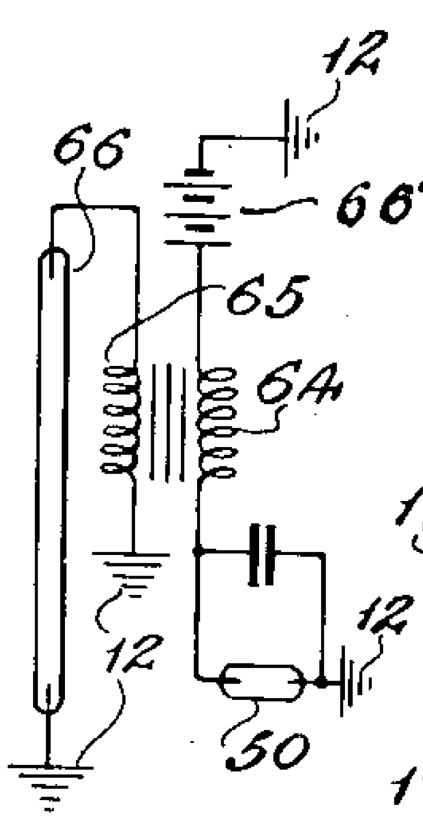


Fig. 7.

Fig. 6.

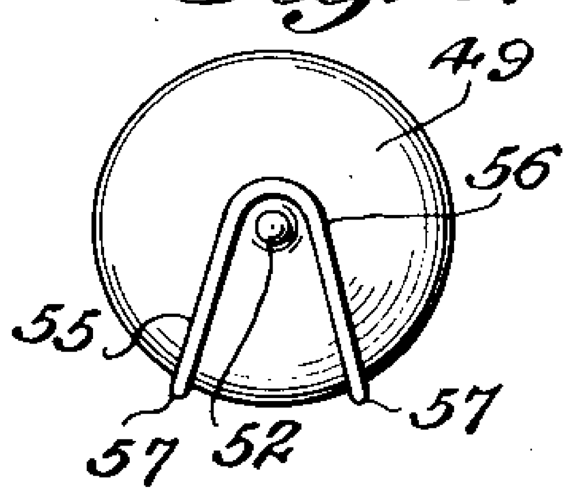
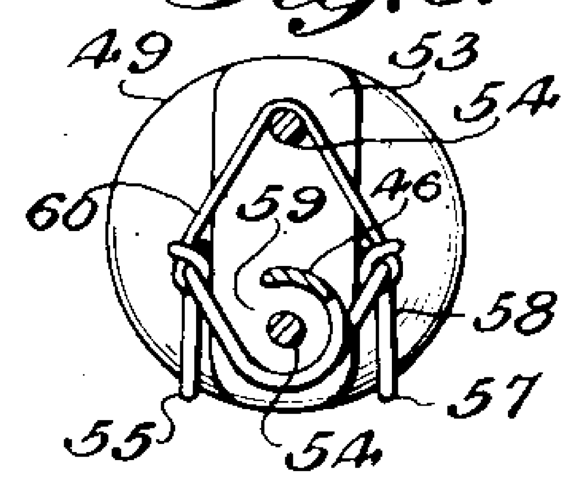


Fig. 5.



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UNITED STATES PATENT OFFICE

2,012,064

ELECTROMAGNETIC SWITCH

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Application January 25, 1932, Serial No. 588,796

10 Claims. (Cl. 200—112)

The invention relates to signal or other flashers of the character disclosed in my applications Serial No. 546,950 filed June 26, 1931 and Serial No. 560,728 filed September 2, 1931.

The object of the invention is to further perfect appliances of this kind to the end that their functions will be improved in important particulars, and that its utilization and maintenance may be facilitated.

A specific aim is to improve the construction of the combined transformer and electromagnet so that still greater efficiency may be attained in the function of the transformer at the same time that the operation of the interrupter armature is carried on with efficiency.

A further object is to enable the regulation of the timing of the signal flashes in a novel and extremely simple way, obviating necessity for exposing or disturbing the operative parts, but on the contrary, permitting adjustment by manipulation of a simple rotatable member exteriorly of the case in which the complete operative unit is enclosed.

A still further purpose is to make it possible to embody a unit of this nature using tilting switches dependent on gravity for the timing function in such manner that while being manually variable by persons without mechanical skill, they may also be mounted by unskilled persons without liability of failure to function correctly because of failure to accurately position the unit with respect to the horizontal.

Another object of importance is to present a novel mounting of a mercury tube switch specially valuable in my appliances. With this it is an important attainment that I have evolved a lead-in connection of novel kind minimizing liability of short circuit or failure by wear, and enabling the connecting of such a switch in its circuit in an extremely simple and economical manner, as to production of parts and their assembly.

Additional objects, advantages and features of invention are involved in the construction, arrangement and combination of parts involved in the embodiment of the invention, as may be understood from the following description and accompanying drawing, wherein,

Figure 1 is a cross section of a complete unit, case and mounting, full size, with a slow speed interrupter.

Figure 2 is a rear view of the unit with the case broken away, showing the use of a high frequency interrupter.

Figure 3 is an enlarged vertical section through the hanger and adjuster.

Figure 4 is an enlarged longitudinal section of the tube mounting and lead-in construction.

Figure 5 is an enlarged rear view of the tube and mounting with the spring support broken away.

Figure 6 is an enlarged front end view of the tube and mounting.

Figure 7 is a diagram of the electrical circuits.

There is illustrated an operating unit 10, for an electric sign flasher, particularly utilizing discharge tubes for its illumination, such as the neon units now commercially well known, although other lamps or devices operating on other principles may also be controlled or operated by my device.

This unit is adapted to be suspended from a hook or pin on any proper support, as the back of a sign which is to be operated, or a single hook or bracket forming a fixed part of the sign or other structure may be employed, if desired, as will be readily understood.

This unit includes a cast oblong base or frame 12 of aluminum or other non-magnetic metal including a bottom plate 13 slightly wider than the transformer coils involved in the device, and slightly longer than the laminated core of the transformer. Over this base and covering all parts of the unit there is a hood-like case 14 of sheet metal the lower edge of which is continuous and snugly fits around the plate 13. A sound-deadening strip 13—*a* may be interposed, secured to the edge of the plate preventing the cover from contacting therewith which might resonate vibrations or sounds in the mechanism. The case is closed throughout except for apertures adjacent certain threaded terminal sockets or junction fittings into which terminal lugs may be screwed without removing the case, to connect the device to the service and control leads, and one aperture at the top through which a suspension stud 15 projects by which the device is suspended, as will be more particularly described.

The plate 12 has two parallel longitudinal flanges 16 from which there are continued at each end respective pairs of upstanding arms 17 the flanges and arms forming together medially of the plate a channel and mounting for a core 18 which is set snugly between the flanges and arms and held by bolts 19 engaged through the arms 17 and core. The core comprises two sets of opposed and alined E-shaped laminated core sections, all of the blanks being of uniform size and shape, and closely fitted to each other throughout. The ends of the arms of the two cores are in abutment so as to form substantially continuous members, and I have found it important to insure a good pressure of the opposed members into contact. At the upper side of the top arm of the core the junction is bridged by a top plate 20 having flanges downturned on each side of the core and secured thereto by bolts 21. Centrally on this plate the stud 15 is fixed, its axis being as nearly as practicable coincident with the center of gravity of the whole unit. The stud is exteriorly threaded at its base and also intermediately of its length, with an intervening interruption, while the upper extremity is reduced and formed with a diametrical slot 22 opening on the upper end in a vertical plane at right angles to the major plane of the armature cores. A suspension link 23 or hanger 23 stamped from heavy sheet metal is fitted and connected pivotally in this slot, by means of a pin 24 engaged through the two side portions of the stud and across the slot spaced as far as practicable from the axis of the stud. The slot extends below the pin a distance and the lower end of the link is formed with a bill 25 projecting from the slot at the side opposite the pin. The aperture in the top of the case fits snugly around the stud and the case is retained in place by a nut 26 engaged on the lower part of the stud and pressing the case upon the plate 20. A ferrule nut 27 is engaged on the upper threads of the stud having a flange fitting close around the reduced part of the stud so as to engage the upper side of the bill 25 when screwed down thereon. It will be understood from the foregoing that with the ferrule 27 at its uppermost position, when the unit is suspended from the link, it will be inclined transversely downward toward the side opposite the pivot pin 24, while if the ferrule is screwed down on the bill 25 this inclination may be lessened or the unit inclined the opposite way.

The front flange 16 is interrupted medially of its length and two pivot lugs 28 formed thereadjacent through which a pintle 29 is engaged supporting an armature 30 movable transversely of the core immediately adjacent the plane of abutment of the core arms but nearer one end than the other so that the armature is actually a little out of the plane of abutment.

This armature is formed of soft iron laminations and includes a lower body portion beside the middle leg 31 of the core, its lower end receiving the pintle loosely therethrough a distance above the lower end of the armature, to provide an arm 32. The upper end is bifurcated and extended to a sufficient height to engage a cushion material 33 at the side of the top leg 34 of the core and held under the flange of the top plate 20, which is notched to permit engagement of the armature with this cushion.

The frame 12 is provided with a standard 35 through the base of which a screw 36 is engaged carrying a weak compression spring 37 bearing against the arm 32 to hold the armature body retracted. The upper part of the standard has a stop screw 38 engaged therethrough having a cushioned end engaging the armature to check its movement away from the cores.

Between the bifurcations of the armature there is pivoted a switch lever 39 which is formed of sheet metal having an upper part bent into U-shape in cross section to form two parallel ears 40 which are apertured to receive a bushing 41 through which there is engaged a pivot pin 42 fixed across the furcations of the armature so as to support the lever above the middle leg of the core. Beyond the ears toward the core the lever is shaped as a split tube 43 with clamp ears 44 receiving a clamp screw 45 therethrough by which the tube may be clamped on a close coiled helical spring 46 inserted in the extremity of the lever. This spring I have formed of steel wire. At the outer end of the lever 39 an arm 47 is extended downwardly adjacent the inner side of the standard 35 and arranged to engage a cushion material 48 on the standard, which material may be rubber.

The coil 46 carries at its outer end a mercury switch 50. This includes a glass tube 49 of cylindrical elongated form projecting longitudinally from the coil 46 and having the usual sealing tit 52 at the outer end, and at its base end having a flattened lug part projecting therefrom through which electrodes 54 are engaged, having contact points or electrodes projecting into and exposed within the space within the tube, as well as extending outward from the tube for connection with suitable current leads.

An important detail to note is that the lug is arranged in a vertical plane, and the electrodes are spaced one above the other, which has a peculiar advantage in my device over locating them horizontally because of greater certainty of breaking circuit, although they may be spaced transversely at the end or sides of the tube. The tube is mounted at the extremity of the spring by means of a wire cradle frame 55 which may be formed integrally with the spring 46. The cradle is formed with a loop 56 at the outer end engaged over the tit and from the loop side members 57 extend parallel in supporting relation to the tube, to the inner end thereof, where each side member is formed with an upwardly bowed part 58 engaged snugly against the respective side of the lugs 53. One side of the cradle is continued directly from the spring as a continuation of the wire of which it is formed, while the return end of the wire at the opposite side of the cradle is welded or soldered directly to the helical part of the spring thereadjacent. The helical extremity of the spring is concentric with the lower electrode and may be insulated in that relation by means of beads 59 of insulating material loosely arranged in helices and engaging the electrodes. The bows 58 are linked and electrically connected to the upper electrode as at 60, adding to the security of the tube in the cradle frame. In the tube there is a globule 61 of mercury. The tube as ordinarily used in this construction is less than twice the vertical dimension which the body of mercury tends to assume by its inherent surface tension when at rest on the lower side of the tube; and the upper electrode is at a position to engage the globule when in this form adjacent the inner end of the tube. Beads 59 are located at intervals throughout the length of and within the spring 46, and a very fine strand of braided or tinsel wire 62 is engaged through these beads and electrically connected to the lower electrode 54. The beads are continued on the wire outwardly of the lever 39 a suitable distance.

In one section of the core a primary coil 64 is mounted around the middle leg of the core, while in the opposite section a secondary coil 65 of greater dimension longitudinally is mounted. One end of the primary coil is connected to the wire 62 while the other end of this coil may be connected to the battery 66′ or other electrical source, the opposite terminal of the battery being grounded on the frame 12, completing the circuit to the switch through the spring 46. The secondary 65 has its ends connected to respective ends of a neon tube 66.

The spring 46 is proportioned in strength to the weight of the tube and mercury so that a considerable oscillation of the tube occurs when the armature 30 is attracted by the magnet. As indicating the action of the spring, if it were detached and held, with the tube very slightly inclined upward from the electrode end, with the mercury in contact, if pressed downward, the weight of the mercury shifting to the outer end of the tube is sufficient to cause the tube to remain in this open circuit position. The formation of the cradle parts and securing of the spring in the lever 39 make it desirable to use a wire which will not be liable to deformation easily, and for that reason I have ordinarily used a spring stock somewhat thicker and stronger than necessary, and have ground off a portion of the spring, midway between the lever sleeve 43 and the tube 49 as indicated at 63, producing a medial part of the spring of exceeding flexibility, adapted to produce the peculiar effects desired.

One terminal of the secondary is connected to a junction fitting 67 mounted on a plate of insulation mounted at one end of the frame 12, the other end of the secondary being grounded on the frame. The wire 63 is connected to one end of the primary 64 while the other end of the primary is connected to a second junction fitting mounted like the first at the opposite end of the frame.

With the construction presented a flashing signal utilizing a neon tube or other high tension electrical manifestation may be produced from the energy of a one and one-half volt source (a neon tube of 56 inches length and one-half inch diameter has been so operated) at intervals ranging from one-fifth of a second or less to more than one full second, and by lengthening the mercury tube much longer intervals may be secured. The device is specially adapted to be operated from a single commercial dry cell, and has operated continuously at something less than one second intervals for a period of over thirty days on a single cell without change.

At one end of the plate 13 an upstanding lug 69 is formed integrally thereon in which vertically spaced apertures 70 are formed. This provides a mounting for an alternative switch structure by which flashing at much shorter intervals is practicable than obtainable with the switch 50 and its mounting (see Fig. 2). This comprises a simple spring wire 71 having one end portion inserted through the upper aperture 70, then recurved and inserted in the lower aperture and secured. The wire extends parallel to the core 18 to near the far end of the unit from the lug 69, and has mounted at its extremity a mercury switch 72 comprising a tube similar to the one 49, but having its lower electrode connected to the spring electrically and having the insulated flexible lead 73 to the upper electrode from one terminal of the primary 64. The previously described switch mounting including the lever 39 may be removed, and an arm 74 is connected to the lower part of the armature 30, extending beneath the middle leg 31 of the core between the primary and secondary windings and over the wire 71, arranged to strike the wire when the armature is attracted to the core 18. The mercury tube in this switch is adjusted at more of an upward inclination from the electrodes and the globule of mercury engages and disengages one or both electrodes in such manner when the arm 74 strikes the central part of the wire spring 71, as to rapidly make and break the circuit by reactions of the spring for a considerable time without further actuation by the arm 74. The reaction of the spring causes it to strike the arm and rebound a number of times on each operation of the armature. The frequency of these oscillations is greater than the period of charging of the coil 64 to the degree necessary to operate the armature, and as the oscillations subside, the mercury finally comes into such relation to the contact at the upper electrode that a sustained contact is formed sufficient to produce an operation of the armature, when the action is repeated. Each of the frequent interruptions thus produced in the earlier stage of the oscillations of the spring after each operation of the arm 74, causes a high tension discharge from the secondary across the neon tube, but without the drain on the source of energy that would be required to operate the armature 30. A high frequency interruption of the primary circuit sufficient to produce the necessary high tension current for actuating the neon tube is thus secured with operation of the armature at comparatively long intervals, and with resultant economy of current from the source. For this form of interrupter, the link 23 and slot 22 should be arranged longitudinally of the core 18 instead of transversely, and by its use the inclination of the switch 72 may be adjusted to produce the desired frequency of interruption. The wire 71 is less flexible than the spring 46 and there is not produced the same degree of movment of the tube as at the switch 50 nor the same simple movement.

In the operation of the device of Figure 1, the device being assembled as described and connected as indicated by Figure 7, when the armature is attracted toward the core, it moves into engagement with the cushion 33 by which it is silently checked. The movement is abrupt enough and in a direction to produce a substantial element of motion horizontally in the mercury, projecting it toward the outer end of the tube after movement of the armature is checked. Initially, in overcoming the inertia of the mercury, the latter is caused to press into the electrode end of the tube, banking around the electrodes, and preserving a very positive closure of the circuit during the time the armature is moving toward the core, insuring the loading of the primary fully to secure the full magnetic effect possible before the circuit is broken by separation of the mercury from the electrodes. During the movement under energization of the coils, the arm 47 swings backwardly, permitting the tube 49 to swing downward rapidly: by gravity and also momentum imparted, the mercury being moved from the electrodes to the opposite extremity of the tube and causing the tube to move to an extreme lowered position by momentum, flexing the spring 46. The circuit having been broken in this movement, the armature swings back by action of the spring 37 and by engagement of the arm 47 against the cushioned upper end of the standard 35 the lever 39 is returned to initial position abruptly. This puts the spring 46 under additional stress and in its reaction it flicks the tube 49 upwardly to a maximum high position, the tube continuing to oscillate then by the action and reaction of the spring 46 in such a manner that centrifugal force acting toward the outer end of the tube retains the mercury there, delays its return until the oscillations diminish to only a slight movement, the mean incline of the tube causing the mercury to move then by gravitation toward initial position again. The weight of the mercury in the outer part of the tube also lessens the mean inclination of the tube so as to delay return movement of the mercury, and makes it easier for the oscillations to keep the mercury from returning.

In case it is desired to make the interval of interruption longer, the ferrule nut **27** is unscrewed to decline the unit toward the outer end of the tube, and to shorten the interval an opposite adjustment is made. Also the initial position of the armature may be adjusted by screw **38** with some effect on the inclination of the tube and action of the armature.

As each contact is made in the primary circuit the coil **64** becomes loaded, building up the magnetic flux, and in the resultant break of the circuit the fall of potential generates a high tension current in the secondary, which is sufficient to discharge across the electrodes of the tube **66**. In this way an extremely small voltage current is employed to actuate a neon tube with high efficiency.

It is to be noted that the formation of the two core sections into a unit with the ends of opposing legs merely in abutment instead of having laminations of the opposed members overlapped, and operating an armature thereat is a departure from usual practice, and results in enabling the utilization of the transformer also as a magnet notwithstanding that the core is substantially continuous, effecting a substantial economy over the practice in which a separate magnet is employed to operate the armature switch. It is also important to note that the armature is in a position at the time of circuit interruption to overlap the junction of the core sections and cause a confinement of the flux to the path through the windings, and this is at the instant when the inductive action of the device is manifest. Thus, no energy is used to operate the armature at that time, but all may be directed to the production of the illuminating current.

The assurance of a good tight contact of the opposed core sections avoids excessive vigor in the action of the armature, and causes a sufficiently positive operation which projects the mercury from closed circuit position without breaking the globule. Maintaining the globule unitary results in a very uniform intermission of contact. On fast operation the mercury does not move all the way to the outer end of the tube, while on an adjustment for slow timing the mercury reaches the far end of the tube, causing greater range of oscillation, as well as giving a greater distance for the mercury to travel on its return to contact position, both of which are material in the timing action attained. If the ends of the core sections are separated the armature will be more powerfully drawn and the mercury globule may be disrupted, causing irregularity in the timing or even double contacts on its return.

Timing may also be lengthened by increasing compression of the spring **37** against the arm **33**, opposing magnetic response of the armature **30**, and this also may be utilized to secure higher magnetic loading of the primary coil to some extent.

With respect to the device using the spring **71**, it may be pointed out that variations of effect of the device may be secured by varying the position of the end of the spring with respect to the horizontal. Thus if the spring be inclined upward at its outer part the operation will tend to cause flexure actions of the spring tending to hold the mercury outwardly from the contacts over several oscillations, after which the diminishing activity of the spring causes rapid make and break effects until subsidance of the mercury sufficiently to make the longer contact that will actuate the armature again. Thus there would be produced an intermittent series of closely following flashes with a time interval of substantial period between the last contact of one series and the first contact of the next series of flashes.

In a primary coil such as utilized in Figure 1 to induce a high tension current in the secondary to illuminate a neon tube with high efficiency, an appreciable period of time is involved in securing the building up of the lines of force around the primary (called here "loading") to the maximum, and a simple oscillation device such as a vibrator spring, or immediately responsive armature switch, is not adapted to form the closed primary circuit for a sufficient period to secure an effective result. My invention overcomes this deficiency by reason of the fact that closing of the primary circuit in which the tubes **31** and **32** are included as shown in Figure 11 causes projection of the tube longitudinally in the direction opposite the electrodes or contacts. The inertia of the mercury causes it to bank and press into the impacting end of the tube so as to secure not only high efficiency in contact, but retaining the contact throughout the movement of the armature toward the magnet, delaying the opening or breaking of the circuit for a sufficient period to build up a maximum loading effect in the primary coil. It results in the highest possible potential in the induced current being attained. On the other hand, the period during which it is necessary to hold the circuit closed for full loading is still very brief, and a simple tilting mercury tube contact will close the circuit for an unnecessarily long period, while my device opens the circuit so quickly after closure that wasted energy in maintaining the primary closed circuit after the necessary loading period is minimized. The period of closure may be made proportionate to the loading period without materially varying the period of intermission by adjusting the initial position of the armature. The period of intermission may be regulated by adjusting the whole device so that the initial inclination of the tubes is varied, and by using longer or shorter tubes, or increasing the flexibility of the arms **68**—**69** to secure a longer period of oscillation producing centrifugal force.

By forming the spring **49** of steel wire, and using this wire for the cradle **55**, when the armature **30** is actuated and the lever **33** swings downwardly, the cradle of the tube is brought into the field of the middle legs **31** of the core **18** adjacent the abutment of the two core parts, and as a result the cradle will be magnetically attracted, increasing the deflection of the spring of the tube **49**, increasing the effectiveness of the action of the switch in a peculiar way. In case the globule should have become disrupted and divided, and one part should adhere to the contacts, the increased declination thus obtained will insure separation from the contacts of the adhering part and its union with the other part of the globule, and continued operation of the device whereas, if an adhering part of the globule should form and not be dislodged, the circuit would remain closed and the switch cease to function for the time until started in some special way.

I claim:—

1. In a device of the character described, an

electromagnetic field device, a yieldingly retracted armature responsive thereto, a switch lever pivoted on the armature having a vertically oscillatable part, a spring projected from the swinging end of the lever, and a tube projecting longitudinally from the spring having contacts at its inner end and inclined upwardly therefrom, a globule in the tube, said tube and spring being adapted to oscillate vertically in a substantial degree whereby to hold the globule at the outer end of the tube in opposition to action by gravity, for the purposes described.

2. In a device of the character described, a mercury switch comprising an elongated receptacle, electrodes in the receptacle, a support for the receptacle attached thereto and projecting from one end of the receptacle consisting of a helical spring having an intermediate portion of reduced strength, and including flexible electrical connections for the electrodes.

3. In a device of the character described, a switch comprising a lever, a highly flexible spring on the lever and extended therefrom distant from the pivot, and a tube receptacle at the extremity of the spring containing a globule of mercury and adapted to oscillate on an axis and over an arc having its center adjacent the longitudinal axis of the tube, to produce centrifugal force in the mercury, and contact means in the tube to be connected by the mercury at one position of the mercury.

4. In a device of the character described a switch comprising a lever, a highly flexible helical spring extended therefrom, a tube of insulating material having a tit at the outer end and a flattened longitudinal lug at the opposite end, one end of the spring being extended and looped over the tit, its intermediate portion being formed as a cradle for the tube and secured to the lug, a globule of mercury in the tube and contacts therein at one end.

5. In a device of the character described, a switch comprising a lever having its outer part formed as a split sleeve, a highly flexible helical spring longitudinally slidable in the sleeve, a tube receptacle mounted at the extremity of the spring, a globule of mercury in the receptacle, contact means in the tube arranged to be connected by the mercury at one position of the mercury and means to clamp the sleeve on the spring.

6. The structure of claim 3 in which the spring is a helix, the said contact means consisting of electrodes exposed in the tube and extended exteriorly of the tube, the spring being secured to the tube in line with one electrode, an articulated tubular insulation means within the spring and a flexible conductor extended therethrough to the alined electrode.

7. The structure of claim 3 in which the spring is a helix, the said contact means consisting of electrodes exposed in the tube, electrical connection between one electrode and the spring in a tube-supporting relation, and a flexible electrical conductor extended from the other electrode in insulated relation within the spring.

8. The structure of claim 3 in which the spring is a helix, one of the contacts of the switch having a flexible electrical conductor extended therefrom axially through the spring, and a multiplicity of separate annular insulating members engaged loosely upon the conductor loosely disposed within and supported by the spring.

9. In a device of the character described, an electromagnetic device including a coil and a movable armature, a switch lever pivoted thereon, a stationary member adjacent the armature and spaced from the coil, said lever having an arm extended at an angle therefrom between the coil and stationary member to engage the stationary member on movement of the armature, and a tilting switch carried by the lever.

10. The structure of claim 9 in which said switch includes a spring extended from the lever, and a tube-receptacle containing a mercury globule at the outer part of the spring and having a predetermined normal inclination in initial position.

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