Jan. 30, 1945. C. P. CLARE 2,368,201

ELECTRIC RELAY SYSTEM

Original Filed Jan. 4, 1941

FIG. 1

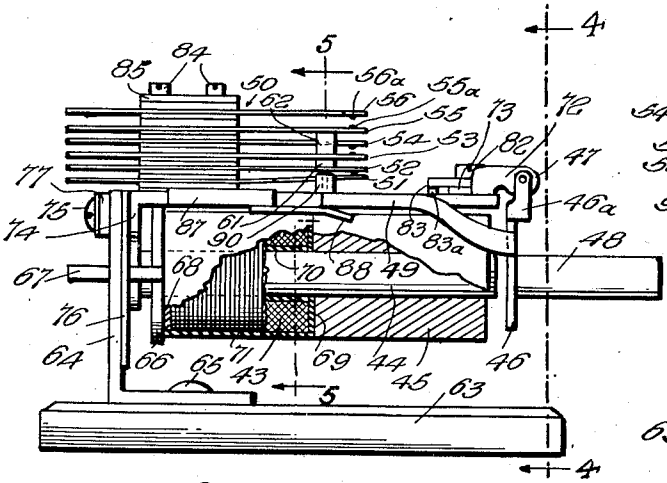


FIG. 4

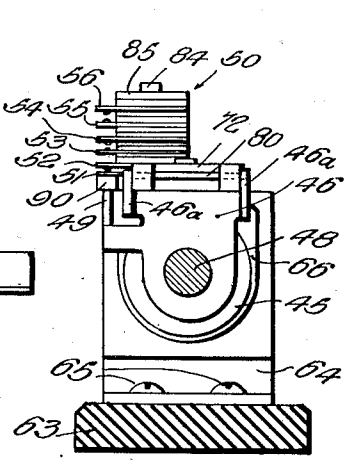


FIG. 2

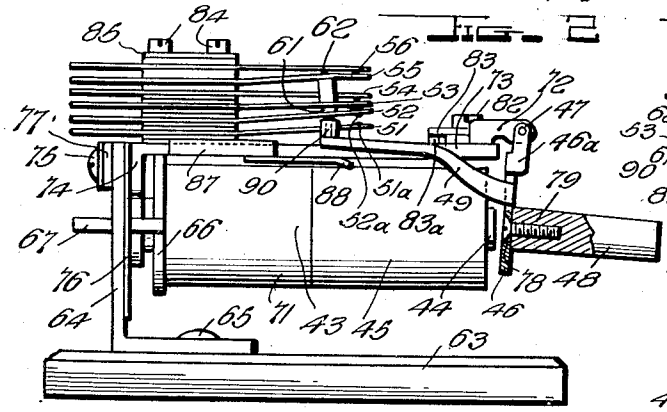


FIG. 5

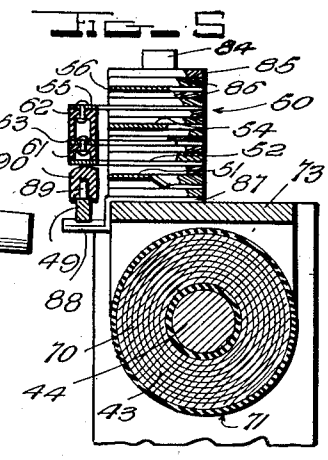


FIG. 3

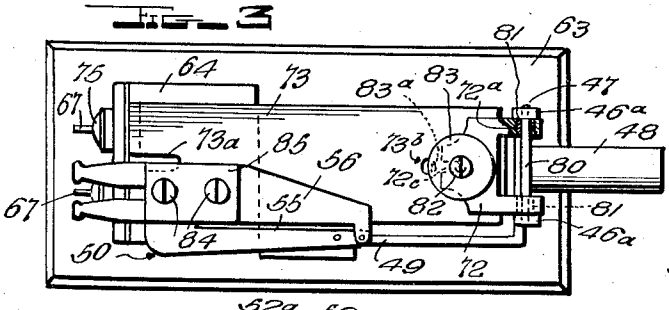


FIG. 6

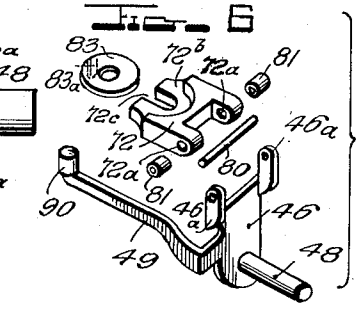
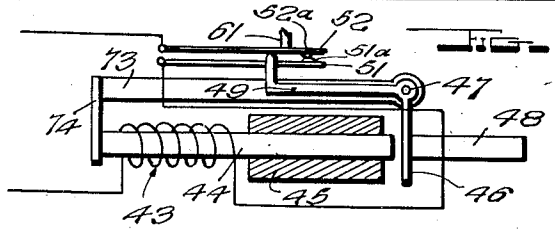


FIG. 7



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2,368,201

ELECTRIC RELAY SYSTEM

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Original application January 4, 1941, Serial No. 373,173. Divided and this application May 31, 1941, Serial No. 396,141

4 Claims. (Cl. 172—126)

My invention relates broadly to relays and more particularly to an electric relay system for use in remote control systems.

This application is a division of my application Serial No. 373,173, filed January 4, 1941, for Electric relay system.

One of the objects of my invention is to provide an electric relay for operation in a remote control system by which various circuit permutations and combinations may be effected and in addition a repeating warning signal may be controlled by the relay system.

Another object of my invention is to provide an electric relay comprising a solenoid and moving armature system adapted to control a multiplicity of sets of spring contacts, one set of which is arranged in the control circuit to the solenoid winding and in which the armature is characterized by such inertia that combined mechanical and electrical forces are employed to effect repeated make and break operations of the sets of spring contacts for effecting the transmission of a warning signal of predetermined characteristic.

Still another object of my invention is to provide a construction of electric relay employing a solenoid winding and a weighted armature having means for imparting make and break movement to a multiplicity of sets of spring contact members in a spring pile-up where one of the sets of contact members is arranged in series with the control circuit to the solenoid winding and the inertia of the weighted armature employed for limiting the movement of the armature with respect to the spring pile-up to repeated short strokes for impressing a warning signal of predetermined characteristics from a source to a control circuit through other sets of the spring contact members.

A further object of my invention is to provide a construction of electric relay including a core structure, an operating winding, a movable armature controlled thereby and a spring pile-up including a multiplicity of sets of contact members, one set of which is disposed in series with the solenoid winding wherein electrical and mechanical forces are introduced upon excitation of the solenoid winding to cause rapid repeat movements of the armature and corresponding rapid make and break operations of the sets of contact members, and certain of which control the application of a power source of predetermined characteristic to a control circuit.

Still another object of my invention is to provide an electric relay system including an operating winding, a movable armature and a spring pile-up assembly having means for normally exerting a restoring force on the movable armature, and including means for electrically controlling the operating time of the winding and mechanically controlling the inertia of the movable armature so that the flux cycle in the magnetic parts may be regulated to control at comparatively high speed the operation of the spring pile-up assembly upon application of a continuous current to the relay winding for controlling through the pile-up assembly the application of current of predetermined characteristic to a control circuit.

Other and further objects of my invention reside in an arrangement of electric relay system having means for controlling the operating and release time of the magnetic system of the relay as set forth more fully in the specification hereinafter following by reference to the accompanying drawing, in which:

Fig. 1 is a side elevational view showing the construction of the electric relay employed in the electric relay system of my invention, parts being broken away and illustrated in section for more clearly illustrating my invention, the view being shown with the armature in normal position with a normal restoring force exerted thereon by the spring pile-up; Fig. 2 is a side elevational view of the electric relay system illustrated in Fig. 1 showing the armature moved to operating position and illustrating the displacement of the contact members under control of the movement of the armature; Fig. 3 is a top plan view of the electric relay illustrated in Figs. 1 and 2; Fig. 4 is a vertical transverse sectional view taken on line 4—4 of Fig. 1; Fig. 5 is a vertical transverse sectional view taken substantially on line 5—5 of Fig. 1; Fig. 6 is a perspective view illustrating the weighted armature, the lever arm associated therewith and the bearing for pivotally mounting the armature; and Fig. 7 is a schematic view showing the electrical self-interrupting circuit arrangement of the electric relay system and illustrating the means for both electrically and mechanically controlling the operating time of the relay for correspondingly controlling the operation of the spring contacts of the spring pile-up.

My invention is directed to a construction of relay adapted for use with a radio broadcast transmitter or other signalling system for transmitting a warning signal in advance of a broadcast. The relay of my invention is particularly applicable in aircraft traffic control and naviga-

tion systems in which an operator in a remote position with respect to a transmitting ground station is required to notify aircraft that a broadcast is about to commence. The operator in the remote control station may dial a particular digit on the remote control mechanism at the control station and then hold down the signalling key and in accordance with the system of my invention effect the transmission of warning signals at a rate of approximately eight per second on any selected audio tone frequency such as 1,020 cycles. The warning signals at 1,020 cycles are transmitted so long as the control operator holds the control key closed, thereby advising the pilots of aircraft that a broadcast is about to commence. This method of transmission has proven highly effective in the transmission of weather, emergency, traffic and other information to aircraft in a particular area. However, the relay of my invention is not limited to this particular application and is applicable to signalling systems generally in which a calling signal of predetermined characteristic is to be transmitted in advance of the signalling operation. The relay of my invention also has application to the transmission of signals of particular tones for controlling of start-stop functions for the motor circuits of facsimile and printing telegraph systems and for the starting and stopping of the auxiliary control circuits of television equipment by remote control.

The drawing shows the mechanical construction of the relay system of my invention. The relay is shown mounted upon any suitable base 63 by means of a bracket 64 secured to the base by suitable means 65. The core structure 44 is provided with spool head 66 formed from insulation material and recessed at opposite sides thereof for the passage of terminals 67. Winding insulators 68 and 69, blanked from hard rubber sheet, free of acid and alkali, form end members between which the turns of the operating winding 43 are wound over the tubular base of insulation material such as heavy empire cloth 70. The turns of winding 43 are protected by a wrapping of insulation material indicated at 71. The slow operating control slug is indicated at 45 abutting against the disc-like winding insulation 69. The slug 45 is generally formed from copper which is toroidal in shape and forms a solid short circuiting ring immediately in the flux of the magnetic field of winding 43 and introduces predetermined eddy cufrrent losses controlling the electrical time period of operation of the solenoid. The copper slug 45 is off-set sufficiently from the end of the core 44 to allow the magnetic lines from core 44 to readily thread the magnetic path through the movable armature 46, the heavy duty bearing member 72 and the magnetic frame 73 which is integral with the magnetic heelpiece 74 which is secured to the end of the magnetic core 44; to facilitate formation of the heelpiece 74 integral with the frame 73, a portion of frame 73 is removed adjacent the end of the frame as indicated at 73a. The heelpiece 74 is secured by suitable screws 75 to the upper portion of the bracket 64. The magnetic path is limited to the core 44, armature 46, bearing member 72, frame 73 and heelpiece 74 by reason of the insulation member 76 disposed between the heelpiece 74 and the bracket 64 and by the bushings of insulation material indicated at 77 which center the securing means 75 away from bracket 64. The apertures in bracket 64 for the passage of terminals 67 are of such size as will permit the passage of terminals 67 without contact with bracket 64.

The armature 46 is centrally apertured at 78 for the passage of screw 79 which enters the end of weight 48, securing weight 48 to the movable armature and thereby introducing predetermined inertia in the movement of the armature. Weight 48 is in the shape of an extended rod forming a lever arm which controls the angular movement of armature 46 about the pivot 47. The pivot 47 comprises a rod member 80 which passes through the lugs 46a on armature 46 and is journaled in the heavy duty sleeve bearings 81 which fit within the cylindrical recesses 72a in bearing member 72. These heavy duty bearings constitute self-lubricating means for journaling the armature which because of the rapid and repeating operation of the armature in this particular class of relay requires a much more substantial bearing than is customary. The bearing member 72 is recessed at 72b and is slotted at 72c, permitting the passage of screw 82 therethrough and through yieldable washer 83. Washer 83 has a lug 83a thereon which extends into a centering aperture 73b retaining the washer 83 in a fixed position with respect to screw 82. This arrangement permits adjustment of the position of the pivot 47 of the armature and control of the special relation of the armature 46 with respect to the end of the magnetic core 44 by loosening screw 82 and allowing bearing 72 to be moved forward or backward with slots 72c embracing opposite sides of screw 82 while washer 83 is maintained in a fixed position by engagement of lug 83a in aperture 73b of frame 73.

The spring pile-up assembly 50 is constituted by the leaf spring members and associated contacts as heretofore explained where the leaf spring members are secured in stacked arrangement by means of screws 84 which pass through top plate 85 and the insulation and spacer plates indicated at 86 assembled on opposite sides of leaf springs 51, 52, 53, 54, 55 and 56 as shown. The screws 84 also pass through the plate member 87 which is provided with a stop arm 88 thereon which projects into the path of the lever arm 49 forming an abutment stop for lever arm 49 and thus limiting the normal unoperated position of armature 46 as shown in Fig. 1. The end of lever arm 49 has an upstanding pin 89 thereon forming a seat for an insulated button 90 which serves as the engagement means for the end of the lever arm with leaf spring 52. As indicated in Fig. 1 the insulated button 90 normally rests against leaf spring 52, the contacts 51a and 52a being closed while the contacts in the remaining portions of the spring pile-up assembly are open as represented in Fig. 1. However, in the energized conditions of the winding 43, armature 46 moves to the position shown in Fig. 2 opening contacts 51a and 52a and closing the circuits between the contacts carried by the set of leaf springs constituted by 53 and 54 and also the set of contacts constituted by the leaf springs 55 and 56 by reason of the coupled relation of the leaf springs through bushings 61 and 62 as shown in Figs. 1, 2 and 3. It will be seen in referring particularly to Fig. 5 that insulated bushing 61 is firmly riveted to leaf spring 53 while the somewhat longer bushing 62 is firmly riveted to leaf spring 55. Accordingly, movement imparted through insulated button 90 to leaf spring 52 is transferred through couplings 61 and 62 to leaf springs 53 and 55. Thus the

self-interrupting circuit to the winding 43 is operated at the same time that the control circuit contacts in the spring pile-up are opened and closed.

I have found the relay structure of my invention very practical and successful in operation. The mass added by weight 48 provides the movable armature system with that amount of mechanical inertia which will coact with the electrical influence introduced by slug 45 to enable operating winding 43 while energized from a continuously applied source to cause the controlled circuit connected through sets of contact springs 53, 54, 55 and 56 to alternately connect and disconnect a source of control potential to the circuit to be controlled. The rate at which this control is applied is readily controllable by changing the character of slug 45 and the effective mass 48, schematically illustrated in Fig. 7.

The flux density increases and decreases in the magnetic system according to time, the flux building up during the make period of contacts 51*a* and 52*a* and decreasing to a condition where it commences to increase again before the flux cycle through the magnetic parts has been completed. The influence of slug 45 in the example illustrated is such that the flux cycle increases through a time period represented by a unit of time while the decrease in flux takes place over a fourth of the increase time. The self-interruption effected by the breaking of the circuit through winding 43 by contacts 51*a* and 52*a* produces a repetition of alternate increases and decreases of the flux cycle. In order to increase the rate of make and break of the spring pile-up system the mass 48 is added to armature 46. The time period for initial build-up of the magnetic flux is now one unit of time compared to a tenth of the time for decrease of flux. The flux cycle is not completed but repeats in a series of substantially saw-tooth curves until the controlling current is removed. During this period the spring pile-up assembly is being operated through a series of rapid repeating strokes and may impress a characteristic tone frequency from a suitable source upon the load circuit or modulation circuit of a radio transmitter. By proportioning the mass of the movable armature system and the arrangement of slug 45 in the field of winding 43 a rate of make and break of, for example, eight times per second may be obtained.

I realize that various changes may be made in the relay arrangement and while I have described my invention in certain preferred embodiments, I desire that it be understood that modifications may be made and I intend no limitation upon my invention other than may be imposed by the scope of the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States is as follows:

1. An electric relay system comprising a magnetic frame, a magnetic core mounted on said frame, an actuating winding carried by said core and disposed in a self-interrupting exciting circuit, a member bifurcated on one end and having journalling means on the other end, adjustable means passing through the bifurcated end of said member and engaging said frame for selectively fixing said member in a predetermined position with respect to the end of said frame, an armature pivotally mounted in the journalling means in said member adjacent one end of said core, means for limiting the displacement of said armature with respect to the end of said core, spring means for maintaining said armature normally at one limit of said displacement, a rod member conforming in section to the section of said core and fastened to said movable armature and extending normally therefrom along an axis aligned with the axis of said core and constituting a weighted lever arm for determining the inertia of the armature in proportion to the magnetization of the relay for inducing a characteristic periodic movement of the armature, the weight of said rod member being counterbalanced by said spring means associated with the pivotal mounting of the armature.

2. An electric relay system comprising a magnetic frame, a magnetic core mounted on said frame, an electromagnetic actuating winding mounted on said core and disposed in a self-interrupting exciting circuit, a slidable member supported on the end of said magnetic frame, said member being bifurcated on one end and having journalling means on the other end, the bifurcated end of said member being countersunk, a clamping device retained in position with respect to said frame and adjustably engageable with the countersunk portion of said member for selectively adjusting said member throughout a limited range to a predetermined position on said frame, an armature pivotally mounted in the journalling means on said slidable member and operable under control of said magnetic core, spring means for limiting the displacement of said armature, a rod member fastened to said armature and extending normal therefrom along an axis aligned with the axis of said core and constituting a weighted mass for fixing the inertia of the armature in proportion to the magnetization of the relay for inducing a characteristic periodic movement of the armature under control of said magnetic core, and spring means for counterbalancing the mass of said armature and normally maintaining said armature in a remote displaced position with respect to said magnetic core.

3. An electric relay system comprising a magnetic frame, a magnetic core mounted on said frame, an electromagnetic actuating winding mounted on said core and disposed in a self-interrupting exciting circuit, a slidable member supported on the end of said magnetic frame and selectively adjustable throughout a limited range to a predetermined position on said frame, a clamping member secured to said frame and adjustable to clamp said slidable member in selected position with respect to the end of said core, an armature pivotally mounted on said slidable member and operable under control of said magnetic core, spring means for limiting the displacement of said armature, a rod member conforming in section to the section of said core and fastened to said armature and extending normal therefrom along an axis aligned with the axis of said core and constituting a weighted mass for fixing the inertia of the armature in proportion to the magnetization of the relay for inducing a characteristic periodic movement of the armature under control of said magnetic core, and spring means for counter-balancing the mass of said armature and normally maintaining said armature in a remote displaced position with respect to said magnetic core.

4. An electric relay system comprising a magnetic frame, a magnetic core mounted on said frame, an electromagnetic actuating winding

mounted on said core and disposed in a self-interrupting exciting circuit, a slidable member supported on the end of said magnetic frame and selectively adjustable throughout a limited range to a predetermined position on said frame and slidably removable in a longitudinal direction from one end of said frame, an armature pivotally mounted on said slidable member and operable under control of said magnetic core, spring means for limiting the displacement of said armature, a rod member conforming in section to the section of said core, means passing through said armature and extending into said rod member for securing said rod member to said armature in a position extending normal to the plane of the armature and along an axis aligned with the axis of said core, said rod member constituting a weighted distributed mass for fixing the inertia of the armature in proportion to the magnetization of the relay for inducing a characteristic periodic movement of the armature, and spring means for counterbalancing the mass of said armature when said armature is displaced to the maximum limit of movement of the armature with respect to said core.

CARL P. CLARE.