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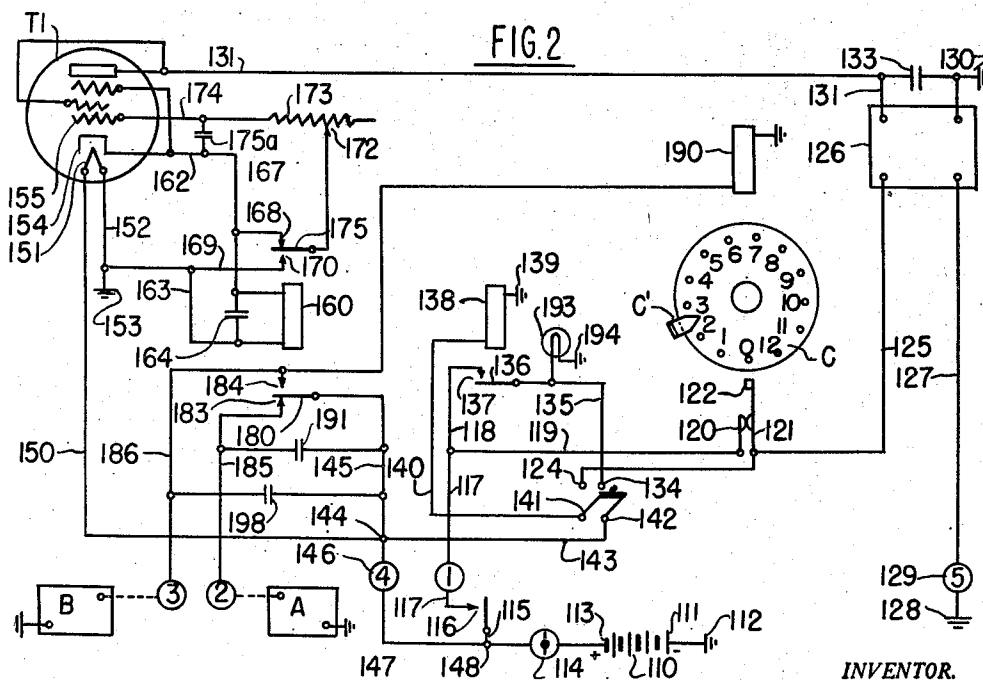
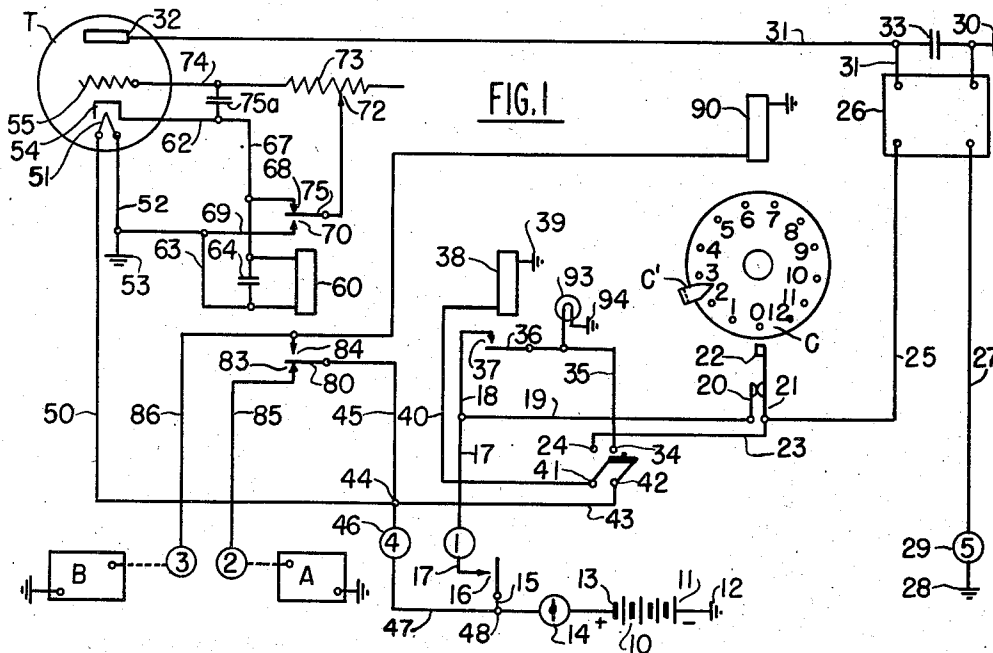
J. W. BROWN

2,359,967

TIMING ARRANGEMENT

Filed Dec. 29, 1941

2 Sheets-Sheet 1



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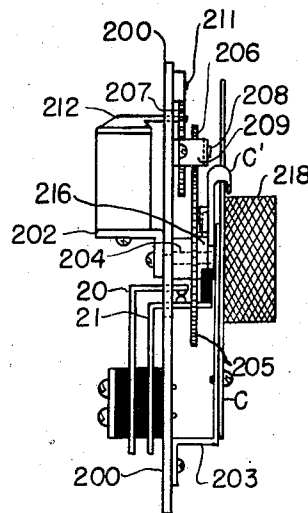
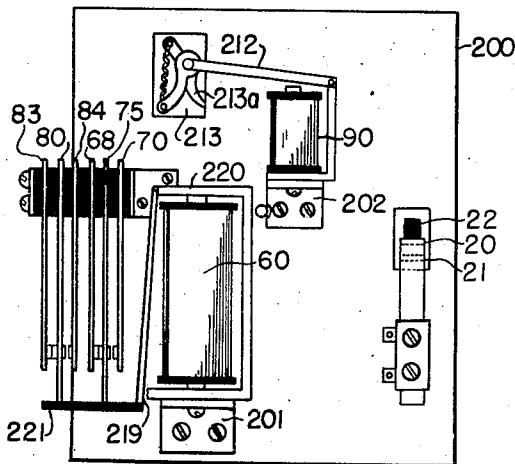
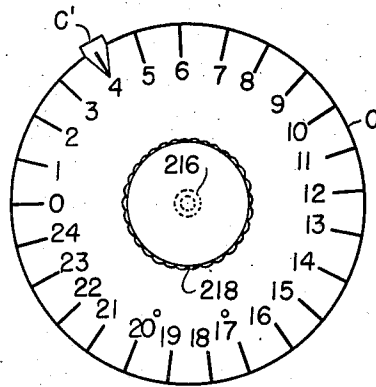
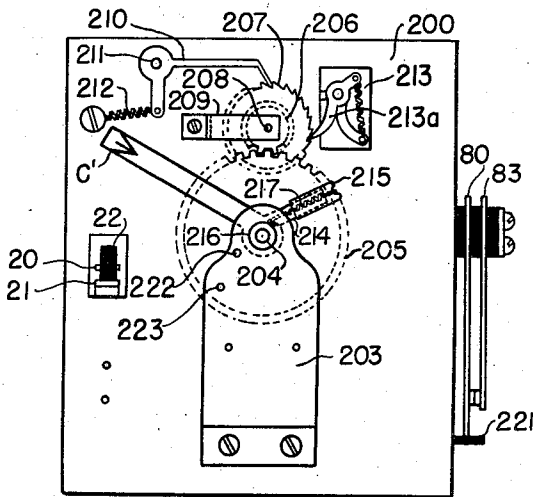
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TIMING ARRANGEMENT

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2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

2,359,967

TIMING ARRANGEMENT

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Application December 29, 1941, Serial No. 424,758

4 Claims. (Cl. 177—380)

My invention relates in general to a timing arrangement and more specifically to a device which operates intermittently, under control of a counter, to transmit a predetermined number of impulses at a predetermined rate.

The main object of the invention is to provide an intermittently operating control device, which operates independently of temperature variation to periodically control a work circuit as many times as desired at variable periods of time.

The control device as illustrated comprises a vacuum tube having a power source and a relay in circuit therewith which operates periodically as long as power is applied to the tube, to transmit impulses, of either make or break variety, over a work circuit. Adjustable means is provided to control the speed of operation of the relay, and a counter is provided which may be set to the number of impulses which it is desired to transmit and which is thereafter controlled by the relay to count off the impulses and stop transmission after the proper number of impulses have been transmitted. In addition a key or starting device is provided and a lock relay is shown as controlled by the key to maintain the device in operation independent of the key and under control of the counting device.

Further features and objects will be apparent from the accompanying drawings and the following specification and claims.

In the drawings Figure 1 is a circuit diagram of one embodiment of my invention.

Figure 2 is a circuit diagram of a modification of my invention.

Figure 3 is a front view of the counter, shown diagrammatically in Figures 1 and 2, with the front dial and pointer removed.

Figure 4 is a back view of the mechanism shown in Figure 1.

Figure 5 is a side view of the mechanism taken from the right side of Figure 4.

Figure 6 is a view of the indicator dial and pointer as taken from the right of Figure 5.

This application is a continuation in part of my prior application Serial #376,843 filed January 31, 1941 which has become abandoned.

In Figure 1 of the drawings, 10 indicates a battery or source of power of approximately 24-volts, one terminal 11 being suitably grounded as at 12. The other terminal 13 is connected to a switch 14 and the switch 14 is connected by line 15 to a switch 16, in turn connected to a line 17. The line 17 from the terminal marked 1 includes two branches 18 and 19. Branch 19 terminates in a switch member 20 adapted to contact a

switch member 21, which in turn includes a projecting portion 22 adapted to be cyclicly engaged.

When member 22 is engaged by pointer C' and moved to the right the circuit across the switch 20—21 is opened. A line 23 from contact 21 leads to one terminal 24 of a double pole single throw switch. Another line 25 from line 23 leads to a 24-volt synchronous vibrator 26 of standard manufacture and from the same leads line 27 which is grounded as at 28 or connected to a terminal 29 and designated by the number 5. This unit 26 not only includes a vibrator but includes a transformer arrangement as well, and the two output terminals therefrom are connected respectively to ground as at 30 and to the line 31 which is the main supply line to the plate 32 of the tube T which is of vacuum tube.

Across the terminals of the output end of this synchronous vibrator current supply arrangement, is a condenser 33 which also is grounded as at 30 and this condenser smooths out the current supply in the output circuit of the vibrator in the well known manner. No further description of the unit 26 is believed necessary since it is a standard structure. The voltage at the output end is approximately 150-volts but may be any desired voltage, depending upon the characteristics of the tube utilized and the characteristics of the control circuit for the same, the same hereinafter to be described more fully.

The other pole 34 of the double pole, single throw switch, previously described, is connected by a line 35 to a switch member 36. This switch member is adapted to engage a contact 37 connected to the line 18, previously described, in opposition to a constraint normally holding 36—37 open, whenever the magnet 38, grounded as at 39, and connected by line 40 to terminal 41 of the switch, is energized. The terminal 42 of this switch is connected by line 43 to the junction 44 in a line 45 including a terminal 46 carrying the number 4, in turn connected by line 47 to the line 15 as at 48. Whenever the double pole switch is closed and switches 14 and 16 are closed and the switch 20 and 21 is closed, which is its normal position, current is supplied to the coil 38 to hold down or close the switch 36—37 and current is also supplied through switch 14 to the line 50, which leads to one terminal of the tube heating filament 51.

This tube heating filament 51 is connected by line 52 to ground 53 and this circuit is always maintained in closed circuit position and it will be noted as hereinafter pointed out, that as long as the switch 14 is closed, the filament of the tube

will be heated. It takes about five seconds at normal temperature for this heating filament to become fully heated for proper tube operation. The remainder of the control, previously specified, is utilized for other control purposes in relation to tube operation. The filament 51 in turn heats the cathode 54 of said tube and maintains that cathode at the proper temperature at all times, so that the cathode seeks or tends to emit electrons at a predetermined rate, depending upon this particular proper temperature and other factors relative to which reference will be had hereinafter.

The tube includes the grid 55 which is the varying factor of the tube for it will be obvious that predetermined potential is imposed on plate 32 and that predetermined temperature is imposed on cathode 54 by the heating filament 51. A magnet 60 is included in the tube circuit and energizes in series therewith when the tube becomes active. The magnet 60 has a pair of springs 75 and 80 operated, when the magnet is energized, to control the tube to cause subsequent deenergization of the magnet, to transmit pulses over the exterior control circuit and also to transmit pulses to the operating magnet 90 of the counter. The current supplied to the plate 32 is interrupted by the opening of the switch 20—21 and hence, the duration of tube operation is determinable by the length of time that the switch 20—21 remains closed.

The counter which is operated to open the springs 20—21 after a predetermined number of impulses have been transmitted by magnet 60 to load A or B is shown in detail in Figures 3, 4, 5, and 6. In Figures 1 and 2 only the indicator dial C, the pointer C', the operating or stepping magnet 90 and the control springs 20—21 are shown.

Referring now to Figures 3, 4, and 5, it will be seen that the counting mechanism comprises a supporting plate 200 supporting an impulsing magnet 60 (Figure 4) by means of bracket 201 and a stepping magnet 90 by means of bracket 202 (Figures 4 and 5). On the opposite side of plate 200 is a bracket 204 (Figure 3) fastened to plate 200 as indicated and having its free end acting as a bearing for one end of a shaft 204, the other end of which has a bearing in plate 200. Loosely mounted on shaft 204 is a large gear wheel 205 which meshes with the small gear 206. The gear 206 and a ratchet wheel 207 are rigid with each other and rotatable as a unit on a small shaft 208 which has a bearing at one end in plate 200 and one at the other end in a bracket 209 fastened to plate 200 as shown. A holding pawl 210 (Figure 3) is pivoted at point 211 in plate 200 and has a spring 212 normally holding it in engagement with the teeth of ratchet 207. The armature 212 of magnet 90 is bent at its outer end and extends through an opening 213 in plate 200 and carries at its end a pawl 213a which, when the magnet 90 is energized engages a tooth of ratchet 207 to step the same with gear 206 and through gears 206 and 205 to move pointers C' one step counterclockwise as seen in Figures 3 and 6 toward its zero point. The pointer C' is rigid with an arm 214 and both are rigidly mounted on a hub 216 which rotates on shaft 204. On the end of arm 214 is a sliding detent 215 engaging the teeth of gear 205 and held in frictional engagement therewith by a small spring 217. Thus pointer C' and arm 214 are both normally carried by gear 205 as it is rotated counterclockwise. Referring now to Figure 6 the indicator plate C when in position is fastened to bracket

203 by means of the holes shown. The knurled knob 218 is rigid with the outer end of sleeve 216 and therefore with pointer C' and arm 214. Thus pointer C' may be moved to any position by knob 218 such as to position 4 (Figure 6), by merely overcoming the tension of spring 217 and causing the detent 215 to ride over the teeth of gear 205. After manual setting of pointer C' to any position the continued operation of magnet 90 will step gear 205 through ratchet 207 and gear 206, carrying pointer C' step by step toward the zero point on dial C. The pointer C' is so adjusted that the last step to move it to zero position causes it to engage a bushing 22 on the end of a spring 21 and move it, against its tension, out of engagement with the spring 20 to stop further operations of the device until pointer C' is moved away from its zero position. Thus if pointer C' is manually set to position 4 as shown in Figure 6 it will take four energizations of magnet 90 to move the pointer to zero position and open springs 20—21. A pair of pins 222 and 223 are provided and project through the back of bracket 203 into the path of arm C'. The pin 222 limits the counterclockwise movement of pointer C' and the pin 223 limits clockwise movement thereof when manually set in a clockwise direction. Pin 223 is not engaged by arm 214 which is slightly offset from arm C'.

The magnet 60 is the usual type of relay having an armature 219 which is pivoted at one end on heel piece 220 and carries a link 221 on its other end which flexes springs 75 and 80 out of engagement with back contacts 68 and 83 respectively when magnet 60 is energized and into engagement with their front contacts 70 and 84.

The purpose of the double pole, single throw switch and the magnet 38 it will be obvious, is to maintain circuit operation after the switch 16 has been momentarily closed manually to initiate circuit control functioning and to maintain circuit conditioning for subsequent and continued circuit control. In other words, the magnet 38 and the switch member 36 and 37 are so connected with the switch 16 and are controlled thereby so that current is supplied by 16 to the magnet 38 and to the input circuit of vibrator 26, and following release of the switch 16, this switch arrangement 36—37 continues to supply current to the vibrator input circuit.

The remainder of this description relates to the arrangement whereby the periodicity may be varied and whereby the frequency of operation for any given periodicity selected is obtained and these impulses at the given rate for which the system is adjusted may be utilized in a large number of commercial applications.

For example, for bomb control purposes where an aeroplane is provided with a large number of bombs arranged for sequential and periodic discharge, this invention is highly advantageous because it has been tested and over a twenty-four hour period of operation, there has been substantially no detectable variation or departure from the predetermined interval between successive impulses. Secondly this particular control arrangement at normal room temperature requires but five seconds to heat the vacuum tube filament and thus heat the cathode. Also, when the temperature is reduced to 60° below zero Fahrenheit, the time element for heating the cathode for proper tube operation was but 9½ seconds.

The circuit herein set forth and more fully hereinafter described, includes an arrangement

whereby if there be any variation incident to temperature variation, the summation of such variations appears to be substantially zero so that the correction factor due to temperature variation in use either over a long period of time or incident to different altitudes is still zero, which makes this device peculiarly desirable, applicable and satisfactory for multiple bomb discharge control.

In further explanation, the pilot of the plane can whenever near the target or military objective, close the switch 14 and this switch 14, as stated, energizes the filament and that same operation of closing switch 14 either directly, electrically or otherwise, may open the doors of the bomb compartment, or the switch 14 can be automatically closed when the control for opening the door of the bomb compartment is energized or when the doors are actually opened.

The aviator, after five to ten seconds have elapsed, depending upon the temperature as previously set forth so that the pilot is convinced that the tube is properly heated and the bomb sight registers on the target, can close the switch 16 which secures instantaneous operation of the control for bomb release and as previously described, this circuit remains closed through the switch 36—37 as long as switch 20—21 remains closed. As each bomb is discharged in succession at a predetermined rate, as herein-after pointed out, the counting device is automatically actuated and registers the number of bomb discharges still to be made. If the pilot has set this counting device to actuate switch 20—21 after ten bombs have been discharged by turning knob 218 to move pointer C' to position 10 then when the ten bombs have been discharged, the main circuit is opened and no further bombs are discharged, and the indicator C' stands at zero position.

If the pilot proceeds to a second target and is carrying additional bombs and the same rate of discharge is to be maintained and the same number of bombs is to be dropped on the second military objective, then the pilot again closes switch 14 after the counting device has been reset to position 10 and when the bomb sight registers on the new target, the switch 16 is closed and the same number of bombs is dropped in succession at the same rate.

The counting device is so arranged that it will register any number of operations or bomb discharges. Following each series of operations, it is required to be moved from zero position which permits switch 20—21 to close, and the actuating member of this counter is then adjusted for the desired number of bomb discharges, which may be the same as the first discharge series or a different number.

In explanation of the reason it is critical that a predetermined rate of operation be obtained, the following by way of example only is given. If the military objective is a supply or troop train and if depending upon the normal speed of the plane a certain time interval is required to register hits on the first, third, fifth, et cetera, or first, fourth, or seventh, et cetera, cars in the train, the periodicity of operation is adjusted in accordance with the normal speed of the plane to secure energization of bomb release automatically and repetitiously at the predetermined rate to insure hits on the selected targets, as defined above providing the aiming is right.

In bombing a column of troops or a military

convoy of trucks or tanks, the same general plan is followed. Dumping all bombs in one position is not military effectiveness. Demoralization of a column or destruction of a long stretch of roadway or railway is desirable military practice; hence, the necessity for accurate timing and sequential discharge and of predetermined variation interval discharge.

For different objectives, it is essential that the bombs be discharged at different intervals; consequently provision is made herein and to which reference now will be had, whereby the duration or interval may be adjusted and not only will that be described but the normal functioning of the circuit, whether it includes such adjustability or not will be set forth.

In the central portion of Figure 1 there is illustrated a magnet 60 and this magnet is connected by a line 67 to the line 62, in turn connected to one terminal of the cathode. The other terminal of this magnet 60 is connected by a line 63 to the line 52 connected to the ground 53. A condenser 64 is connected across the magnet 60. Magnet 60 imposes its effect upon the switch members 75 and 80 of a material that has substantially a zero coefficient as far as temperature is concerned and which has a relatively long life insofar as crystallization is concerned due to repetitious operation.

The line 62 has a branch connected to a contact spring 66. A line 69 is connected to the line 63 at one end and to a contact spring 70 at the other end, and these two contact springs 68 and 80 are spaced apart and are selectively engaged by the switch member 75. The switch member 75 is connected by a line 72 to an adjustable resistance 73 in turn connected by line 74 to the control grid 55 of the tube. Between the lines 62 and 74 there is connected a condenser 75a. The adjustable resistance 73 determines the rate of operation when the proper condenser 75a is utilized.

It will be remembered that the heating filament 51 has been energized; therefore, the cathode 54 has been properly heated. It also will be remembered the plate 32 has proper potential imposed thereon. The normal idle position of the parts is with the switch member 75 elevated so that it engages contact 68. When switch 16 is closed potential immediately is supplied to plate 32 which immediately supplies energy to the coil 60 over the plate circuit and when that is energized its armature switch member 75 is attracted and is pulled downwardly against its normal tension and engages contact 70 and opens the normal circuit to the control grid and connects the control grid circuit through resistance 73 to the lower end of the coil 60, thereby changing the characteristics of this circuit. Each energization of magnet 60 also causes spring 80 to disengage spring 83 and engage spring 84.

The effect of this transfer is that the characteristics of the vacuum tube change in the corresponding manner so that there is more negative potential on the control grid than heretofore as soon as condenser 75a becomes charged and consequently, less current flows in the plate circuit and, therefore, there is less current in the magnet 60. This smaller current is insufficient to oppose the tension of springs 75 and 80. Therefore, on this lower current condition becoming effective, magnet 60 deenergizes and opens the circuit across the contact 70 and 71, thus reestablishing the circuit in its original position. The condenser 75a is now discharged

through adjustable resistor 73 and grid 55 is restored to its original potential. It is the time element determinable by the resistor 73 and condenser 75a that determines the time element of operation of the magnet 60 and thus the periodicity of the circuit for control purposes can be accurately adjusted and maintained.

Each time magnet 60 operates to move spring 80 into engagement with spring 84 it closes a circuit for the stepping magnet 90 of the counter. This circuit extends from battery through switch 14, conductor 47, conductor 45, springs 80 and 84, and through magnet 90 to ground. Each operation of magnet 60 therefore causes one operation of magnet 90 and a consequent step of indicator pointer C' one step toward zero.

So far the circuit has been self-contained, as it were, and there has been no portion set forth which is effective for subsequent control. This is conventionally illustrated as follows: The switch member 80 which is simultaneously operated by magnet 60 may have upper and lower contacts 83 and 84 as shown each connected to lines 85 and 86. Line 85 terminates in the terminal bearing numeral 2—and line 86 terminates in the terminal bearing numeral 3.

If it is desired to operate a device such as the bomb release mechanism by closing a circuit, it will be obvious that the terminals of that control device, such as load B (shown dotted) must be connected between terminal 3 and ground. If the control is to be utilized for opening a circuit for control purposes, the terminals of that device such as load A (shown dotted) are connected between the terminal which is numbered 2 and ground. Thus assuming device B to be connected for operation, then each time magnet 60 is energized an impulse is sent over lead 68 from battery, leads 47 and 45 and through springs 80 and 84 to lead 86 and to the device B to release one bomb and at the same time indicator C' is moved one step to record the release.

In Figure 2 there is illustrated a slightly different form of the invention and herein the difference is in the tube T' and in the addition of a condenser 191 between the lines 145 and 185. The other elements of the construction are designated by numerals similar to the primary form of the invention numeral designation but increased by 100.

Both forms of the invention, if desired, may be provided with a pilot light and in Figure 1a line leading from the line 35 connects to one terminal of a 24-volt lamp 93, the other terminal of which is grounded as at 94.

Referring to the form of the invention illustrated in Figure 2, the filter 133 across the output of the vibrator is .5 microfarad condenser. The adjustable resistance 173 is between 250,000 and 200,000 ohms capacity. The condenser 175a is of two microfarad capacity. The condenser 184 across the coil 160 is $\frac{1}{2}$ microfarad in capacity. The coil 160 is approximately 1250 ohms resistance. The coil 138 has an approximate resistance of 1,000 ohms. The condenser 191 is approximately 100 microfarad capacity and this is variable, depending upon the external load connected across the terminals 187 and 129. A condenser of similar character may be interposed across line 145 and 186 as indicated at 198.

The tube T' is a 25A6 commercial vacuum tube and no further description thereof is believed necessary. The absolute or approximate values of the resistances and condensers hereinbefore given, are based upon an assumed applied volt-

age of 150-volts applied to the tube plate. Any variation or change in this voltage of necessity will necessitate a change in the values of the elements previously set forth. The departure in the tube T' over the tube T is that the plate and cathode herein each has in multiple therewith an internal grid, not numbered but illustrated. Any triode vacuum tube or any pentode or multiple grid tube capable of substantially functioning as a triode vacuum tube may be utilized in this circuit for the described control function.

While the invention has been illustrated and described in great detail in the drawings and foregoing description, the same is to be considered as illustrative and not restrictive in character.

The several modifications described herein as well as others which will readily suggest themselves to persons skilled in this art, all are considered to be within the broad scope of the invention, reference being had to the appended claims.

The invention claimed is:

1. A system for controlling the number of impulses and the timing of the impulses transmitted over the bomb release circuit of an aircraft, including an electron discharge tube, a source of potential connected thereto, a relay having its winding connected to the cathode of the tube, contacts on the relay connected to the grid of the tube, other contacts on the relay connected to the bomb release circuit, said relay energized over a circuit including said cathode and said source, to operate said first contacts to thereby control the grid potential of said tube to in turn cause intermittent operation of the relay and to operate said other contacts to send an impulse over said bomb release circuit, means for starting the operation of the relay, and means for continuing the intermittent operation thereof independent of the starting means until any predetermined number of impulses have been transmitted over the bomb release circuit.

2. In a system for controlling the release of trains of bombs from an aircraft, an impulse transmitter, comprising an electron discharge tube and a relay, for transmitting impulses to the bomb release mechanism of the aircraft, a start key, a step by step mechanical counter settable at different points to determine the number of bombs to be released in a train, means controlled by the start key for causing the relay and tube of the transmitter to interact to send impulses at regularly spaced intervals to the bomb release mechanism and to the counter, an adjustable means for setting the transmitter to deliver impulses at intervals spaced in accordance with the speed of the aircraft, a relay controlled by the start key for continuing the operation of the transmitter independent of the start key and under sole control of the counter, and means controlled by the counter after it has been moved a number of steps in accordance with its setting, by the impulses received from said transmitter, for preventing further transmission of impulses.

3. A system for controlling the release of trains of bombs from an aircraft, comprising a bomb release circuit, an electron discharge tube and a relay, said relay connected to the control electrode of said tube, a condenser connected between the cathode and the control electrode of said tube, contacts on said relay in the bomb release circuit and other contacts controlling the charging and discharging of said condenser to

in turn control the bias potential of said control electrode, means for starting the operation of said relay, the contacts of said relay when operated by said relay causing said condenser to be alternately charged and discharged to cause intermittent operation of said relay and the consequent transmission of a train of impulses over said bomb release circuit, means for adjusting the discharge time of said condenser to determine the frequency for bomb release, and means for predetermining the number of bombs released in any one train.

4. In a bomb release circuit having a suitable controller for determining the number of bombs to be released and a relay for sending timed impulses to release bombs, a vacuum tube and a

condenser interacting to time the operation of said relay, said relay connected to the cathode of said tube and energized in series therewith, said condenser connected to one cathode and grid of said tube, means for adjusting the discharge time of said condenser, the charging and discharging of said condenser determining the speed of operation of said relay, contacts on said relay operated by each energization thereof to transmit impulses to release bombs, other contacts on the relay operated to control the release of said controller from its preceding position, and other contacts thereon controlling the charging and discharging of said condenser.

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