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ELECTRONIC TRIGGER CIRCUIT WITH
PULSE OUTPUT ATTENUATING MEANS
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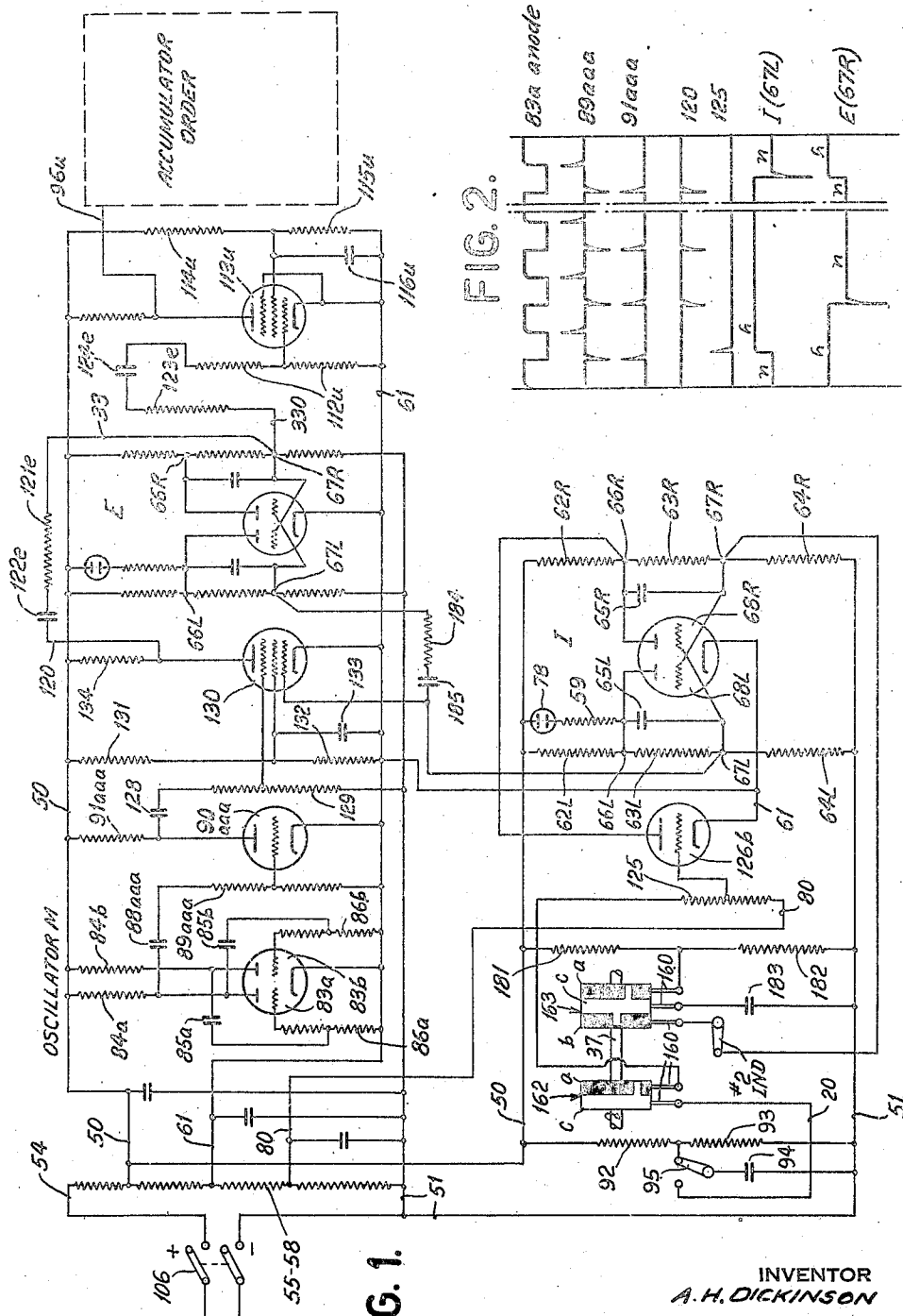
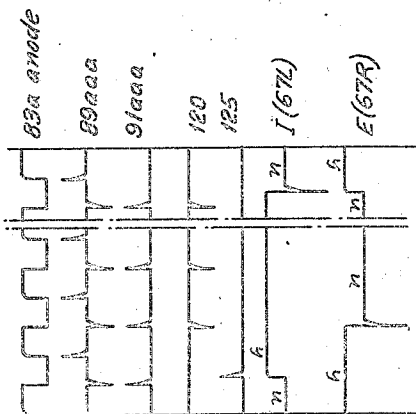


FIG. 1.

FIG. 2.



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ELECTRONIC TRIGGER CIRCUIT WITH
PULSE OUTPUT ATTENUATING MEANS

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Original application December 27, 1943, Serial No.
515,719. Divided and this application March 17,
1945, Serial No. 583,273

2 Claims. (Cl. 250—27)

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This application is a division of my applica-
tion Serial No. 515,719, filed December 27, 1943,
and is directed to improvements in electronic
switching arrangements.

The electronic switching means with which the
invention is concerned comprises electronic trig-
ger circuits. This trigger circuit may assume
either of two opposite electrical conditions. The
circuit is so biased that upon application of a
pulse of sufficient amplitude to a point of the cir-
cuit, it will be tripped to a reverse condition. If
the pulse impressed on this point of the circuit
be positive and of adequate value, it will be
capable of tripping the circuit from one of its con-
ditions to the reverse condition. If the pulse im-
pressed on the same point of the circuit be nega-
tive and of sufficient value, it will be capable of
tripping the circuit from said reverse condition
to the alternate condition. As a trigger circuit
is tripped from one condition to the other, posi-
tive and negative pulses may be derived there-
from. A particular point of this circuit will pro-
vide a positive pulse when the circuit is tripped
to one state and a negative pulse when the cir-
cuit is returned to its previous state. If this
point of the circuit be coupled directly to a point
of another such trigger circuit, a double reversal
or reciprocation in status of the first circuit may
effect a double reversal on reciprocation in status
of the second circuit. It is desirable, however,
in many cases, to trip the second circuit only in
one direction for each reciprocation in status of
the first circuit. For this purpose, the prior art
has provided electronic discharge means between
the first and second circuits.

An object of the present invention is to pro-
vide trigger circuits of such nature that a con-
trolling trigger circuit may be coupled to a con-
trolled trigger circuit without intervening elec-
tronic discharge means and yet, upon a recipro-
cation in status, effect only a single reversal of
the controlled trigger circuit.

An object of the invention is to provide an
electronic trigger circuit which upon a reciproca-
tion in its status will produce positive and nega-
tive pulses of unequal amplitude in combination
with means for applying these pulses with selec-
tive or discriminative effect upon a controlled
circuit.

An object of the invention is to provide elec-
tronic trigger circuits, one of which may be
coupled without intervening electronic discharge
means to a point of a controlled trigger circuit,
and which will act with discriminative effect upon
the point of the controlled trigger circuit.

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Other objects of the invention will be pointed
out in the following description and claims and
illustrated in the accompanying drawings, which
disclose, by way of examples, the principle of the
invention and the best mode, which has been con-
templated, of applying that principle.

In the drawings:

Fig. 1 is a circuit diagram of elements involved
in the invention.

Fig. 2 is a diagrammatic showing of the waves
of potential produced at pertinent points of the
circuit network shown in Fig. 1.

Referring to Fig. 1, a line switch 106 is closed
to connect a suitable source of potential to lines
54 and 51. Across these lines is a voltage divider
53—58 tapped by lines 50, 61, and 59 which are
positive with respect to each other and to line 51
in the order named.

Pulses are required for operating elements of
the apparatus. Preferably, an oscillator of the
multivibrator type is used as the main source of
pulses. The multivibrator produces two trains of
square-topped pulses, each train being 180 de-
grees out of phase with the other. Such pulses
are suitable for conversion into derived pulses of
extremely steep wave front and short duration.

In Fig. 1, the multivibrator oscillator, as a
whole, is designated M. It includes two triodes
83a and 83b which are shown, for convenience, as
units of a duplex tube. The common cathode of
the triodes is connected to line 61. The indi-
vidual anodes are connected by resistors 84a and
84b to line 50. The grid of 83a is coupled by a
condenser 85a to the anode of triode 83b, while
the grid of 83b is coupled by a condenser 85b to
the anode of 83a. Grid lead resistances 86a and
86b connect the condensers and associated grids
to line 61. The operation of the multivibrator is
well-known and it is sufficient to state that
square-topped pulses of potential are produced
on the anode of 83a which are 180 degrees shifted
in phase with respect to similar pulses on the
anode of 83b. For the present case, only those
pulses on the anode of 83a are used. The form
of these pulses is indicated in Fig. 2.

The rise and fall of potential on the anode of
83a are communicated by a condenser 88aaa to
a resistor 89aaa. The R. C. product of this con-
denser and resistor is relatively small so that the
square-topped pulses on the anode of 83a are
transformed into very sharp pulses on resistor
89aaa, as indicated in Fig. 2. Resistor 89aaa is
tapped by the grid of a triode 90aaa. The cathode
of this triode is connected to line 61 and its anode
is connected by a resistor 91aaa to line 50. The

triode 90aaa is of the type which is fully conductive when it is at zero grid bias. Since the cathode of the triode and the resistor 89aaa both connect to line 61, the triode is normally at zero grid bias and is fully conductive. Accordingly, the positive pulses fed to the grid of triode 90aaa from resistor 89aaa have no appreciable effect. On the other hand, the negative pulses received from 89aaa by the grid of 90aaa so reduce the grid potential as to drive 90aaa to cut-off. Each time the triode is driven to cut-off, an amplified positive pulse appears at the lower end of resistor 91aaa, as indicated in Fig. 2.

The resistor 91aaa is connected by a condenser 128 to a resistor 129 which is tapped by the suppressor of a pentode tube 130. Hence, the positive pulses on resistor 91aaa will produce corresponding positive potential pulses on the suppressor of the tube 130. The screen of this tube is maintained at suitable fixed potential by connection to the junction of resistors 131 and 132 and by a condenser 133 which shunts 132. The control grid of tube 130 is connected to a point 67L of a trigger circuit I which will be described later. Point 67L may be at either of relatively high and low potentials. When point 67L is at its high potential, the control grid bias of tube 130 is substantially zero, whereby the tube will become conductive each time a positive pulse is fed to its suppressor from the resistor 129. When point 67L is at lower potential, the tube 130 is maintained at cut-off even at the time a positive pulse appears on the suppressor. The resistor 129, to which the suppressor is connected, terminates at line 51 which is lower in potential than line 61 to which is connected the cathode of tube 130. The relation is such that in the absence of a positive pulse on the resistor 129, the suppressor potential will be sufficiently less than cathode potential to prevent appreciable current flow even when the control grid bias is zero. When the control grid bias is zero, the positive pulses fed to the suppressor will be converted by tube 130 into negative pulses on anode resistor 134 and connected wire 120. The form of these negative pulses on wire 120 is shown in Fig. 2. When the control grid bias is at cut-off, then the positive pulses on the suppressor will be ineffective, and negative pulses will not be produced by the tube 130, which accounts for the absence of some of these pulses in Fig. 2. The purpose of these negative pulses will be made clear later.

The trigger circuit will now be described. There are two similar trigger circuits shown in Fig. 1. One of these is designated I and the other is designated E. Since both trigger circuits are alike, it will be sufficient to explain circuit I in detail.

The trigger circuit comprises two impedance networks which may be referred to as left and right hand sides or impedance branches. The branches are symmetrical and corresponding elements have the same electrical value and are given the same reference number which may be accompanied by letter L or R to denote left or right hand side, respectively. Each impedance branch comprises resistors 62, 63, and 64, which constitute a voltage divider, a triode 68, and a condenser 65 shunting resistor 63. The triodes 68L and 68R are shown as units of a duplex tube, for convenience. The grid of the triode in each branch connects to the point 67 of the opposite branch. The two impedance branches are thus cross-coupled. The anode of each triode connects to line 50 via the related resistor 62. The common cathode of the triode connects to line

61. An efficient arrangement of the circuit is one in which resistors 62 and 64 are equal in value, resistors 63 are approximately three times this value, and condensers 65 have a capacity of the order of a few hundred micromicrofarads.

The two impedance branches of the trigger circuit are so interconnected that when one branch is at low impedance (its triode conducting), the other branch is at high impedance (its triode non-conducting). Assume that the left branch is at low impedance; i. e., its triode 68L is conductive. Accordingly, point 66L is only slightly above cathode potential and the potential drop across resistors 63L and 64L forces the potential at point 67L below that of cathode line 61. Since the grid of triode 68R is connected to point 67L, then 68R will be held at such negative grid bias as to be at cut-off. Hence, the point 66R will be at high potential, and the drop across resistors 63R and 64R does not force the potential at point 67R to cut-off value. Since point 67R is connected to the grid of triode 68L the triode will then be maintained in conductive status. The above conditions define one stable state of the circuit which may be termed, for convenience, the on state. The reverse or off state is one in which triode 68R is conductive and triode 68L is non-conductive. The interaction between the branches is such that, for reasons already made clear, the circuit is self-sustaining in either status. A glow discharge tube 78 is connected via a resistor 59 to point 66L of the trigger circuit. When the circuit is in on state, point 66L is at low potential, and there is sufficient potential drop across the tube 78 to light the tube. But, when the circuit is off, then point 66L is at high potential, and tube 78 remains unlit. Thus, tube 78, when lit, indicates that the trigger circuit is on. To reverse the status of the circuit, an electrical unbalance must be produced in the circuit. For instance, the circuit may be reversed from on to off status by applying a sufficient positive potential to point 67L which connects to the grid of triode 68R, or by applying a negative pulse to point 67R which connects to the grid of triode 68L.

Assume that the trigger circuit is in off state; i. e., its triode 68R is conductive while its triode 68L is at cut-off. If a positive driving pulse of sufficient amplitude is applied to point 67R, the grid bias of triode 68L will be reduced sufficiently to allow 68L to start conducting. Current will flow from line 50 via resistor 62L and the triode 68L to line 61. The potential at point 66L will drop suddenly, so that a negative pulse will be fed by condenser 65L to the grid of triode 68R. The grid bias of triode 68R will increase to cut-off bias, and current flow in 68R will cease substantially instantaneously. Point 66R will rise suddenly in potential, so that a positive pulse will feed via condenser 65R to the grid of 68L, promoting the increase in grid potential of 68L which was initiated by the positive driving pulse applied to the point 67R. Triode 68L is now conductive and triode 68R is non-conductive; i. e., the trigger circuit has been reversed to on state. To trip the circuit back to on state, a positive pulse of sufficient amplitude may be applied to point 67L. The grid of 68R will be increased in potential to start current flow through 68R. In a manner now clear, the shift to on status of the circuit will be completed and will be self-sustained. Thus, positive pulses successively applied to opposite branches of the circuit effect successive reversals of the circuit.

Similarly, a steep negative driving pulse may

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effect reversals of the trigger circuit. In order for the negative pulse to effect the same shift of the circuit as a positive pulse, the negative pulse must be applied to a point of the circuit opposite the point to which a positive pulse must be applied. Thus, if the circuit is off, it may be tripped to on state by a steep positive pulse impressed on point 67R or, alternatively, by a steep negative pulse impressed on point 67L. The steep negative pulse impressed on point 67L will reduce the grid potential of triode 68R to cut-off value. Point 66R thereupon will rise abruptly in potential, feeding a positive pulse via condenser 65R to the grid of triode 68L. The grid bias of 68L thereby will be reduced sufficiently to allow 68L to start conducting. Point 66L will drop suddenly in potential, feeding a negative pulse to the grid of 68R, promoting the blocking of 68R which was initiated by the negative driving pulse applied to point 67L. The circuit thus may be reversed from off to on state by a steep negative pulse applied to point 67L. Similarly, the circuit may be reversed from on to off state by a steep negative pulse applied to point 67R.

In Fig. 2, the potential changes at point 67L of the trigger circuit I (Fig. 1) are graphically indicated. At the start of the period of operation covered by Fig. 2, the circuit I is in on status. Hence, point 67L is then at its low potential, designated n , which is sufficiently lower than cathode potential to sustain triode 68R in non-conductive state. Shortly thereafter, under control of means described later, the circuit I is tripped to off status. Hence, point 67L rises in potential and, eventually, in the fully triggered off status of the circuit, reaches the steady potential designated h in Fig. 2. The potential h is such as to sustain triode 69R in conductive status. Thereafter, by means described later, the circuit I is shifted back to its on status. In the initial portion of the shift, triode 68L starts to conduct and condenser 65L discharges substantially instantaneously through a circuit including triode 68L and resistor 64L, thus producing a sharp and steep drop in potential at point 67L, which is in the form of a sharp negative pulse. The amplitude of this negative pulse, as indicated in Fig. 2, exceeds the n potential value. As the condenser 65L completes its discharge, point 67 exponentially rises in potential to the n value at which it stays until the circuit is again tripped to off status. Thus, whenever the trigger circuit is shifted from off to on status, a steep, sharp negative pulse is produced at point 67L. This negative pulse exceeds the amplitude of the positive pulses which appears at point 67L when I is turned off. Similarly, such a negative pulse will be produced at 67R of the trigger circuit as the circuit is being turned off. Fig. 2 shows the negative pulse thus produced at point 67R of trigger circuit E.

The production of this negative pulse at either point 67L or 67R of the trigger circuit and the utilization of such pulse are features of the present invention. By reason of this negative pulse being of an amplitude greater than the positive pulses, discriminative or selective utilization of the pulses may be effected. Thus, point 67L of circuit I is coupled by a condenser 185 and resistor 184 to point 67L of circuit E. The condenser and resistor have such values that the positive pulse appearing at 67L of I when it is turned off, is attenuated to such extent that it is ineffective upon point 67L of E. A negative pulse of similar amplitude would also be reduced by

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condenser 185 and resistor 184 to ineffective value. But by producing a negative pulse at point 67L of I which exceeds the amplitude of the positive pulse which may appear at this point, effective negative potential is transmitted by condenser 185 and resistor 184 to point 67L of E. As representative, circuit I was so arranged and powered that the n potential (see Fig. 2) at point 67L was approximately 30 volts and the h value was about 50 volts, so that the positive pulse had an amplitude of about 20 volts. The negative pulse was between two and three times the amplitude of the positive pulse or between 40 and 60 volts negative with respect to the h value. The condenser 185 was in the order of about 100 micro-microfarads and the resistor 184 was between .1 to .2 megohm. Other values could be used which will give the required result. It is only necessary that if E is on and then I is turned off, the positive pulse appearing at point 67L of I shall be so reduced as it is fed through condenser 185 and resistor 184 that it is ineffective to trip E to its off status. On the other hand, if E is off and I is turned on, the steep negative pulse at point 67L of I shall be effective, by way of condenser 185 and resistor 184, to trip E to on status. In this manner, negative and positive pulses at the same point of the controlling circuit I are selectively effective upon a controlled circuit.

The means for applying driving pulses to trigger circuit I will now be described. Circuit breakers 162 and 163 (Fig. 1) are mounted on a continuously rotating shaft 37. Circuit breaker 162 has two tracks a and c wiped by brushes 160. Circuit breaker 163 has three tracks a , b , and c wiped by similar brushes 160. Tracks c are common contact rings. Track a of 162 has one short contact spot. Track a of 163 has one short contact spot which reaches its brush 160 after the spot on track a of 162 has reached its brush position, and track b of 163 has a contact spot which reaches its brush position after the spot on track a of 163 has traversed its brush position. In short, the contact spots on tracks a (162), a (163) and b (163) successively reach brush positions.

The brush 160 which wipes track c (162) is connected by a wire 20 to the normally open side of a switch 95. The opposite, normally closed side of switch 95 is connected to the junction of resistors 92 and 93 which are in series across plus and minus lines 50 and 51. The common of the switch 95 is connected to one side of a condenser 94 which connects at the other side to line 51. Accordingly, in the shown position of switch 95, condenser 94 will be charged to the potential across resistor 93. Upon the reversal of switch 95, condenser 94 is connected to wire 20 and is ready to discharge a steep positive pulse. The pulse discharge, however, is timed by the engagement of the contact spot of track a of circuit breaker 162 with its brush 160. Upon such engagement, a positive pulse of current flows from one side of condenser 94 via the switch 95 in reversed position, the wire 20, the circuit breaker 162, a resistor 125, the line 30, thence via a portion of voltage divider 55—58 to line 51 and back to the opposite side of condenser 94. Resistor 125 is tapped by the grid of a triode 126b. The resistor 125 terminates at line 30 which is lower in potential than the line 61 to which the cathode of triode 126b connects. Hence, triode 126b is normally at negative bias and is non-conductive. When resistor 125 is positively

pulsed by the circuit just traced, the potential of the grid of triode 126b rises above cut-off value, and an amplified negative pulse appears on the anode of the triode. This negative pulse is transmitted to point 66R of trigger circuit I. It may be assumed that circuit I is on at the start of the period under discussion. Hence, the negative pulse now applied to point 66R of I and fed via resistor 63R to point 67R brings about reversal of circuit I from on to off state in the manner previously explained. Accordingly, point 67L of circuit I rises from its low potential *n* (Fig. 2) to its upper potential *h*. This rise in potential, or the positive pulse on point 67L of trigger circuit I is so attenuated by condenser 185 and resistor 184 that it has no effect on point 67L of trigger circuit E. Hence, circuit E which is on at this time, for reasons which will be made clear later, will not be reversed in status under control of the positive pulse at 67L of I.

When circuit I is off, its point 67L is at the higher potential *h* (Fig. 2). Point 67L of I also is connected to the control grid of pentode 130. As previously described, the suppressor grid of 130 continually receives the positive pulses derived from the lower end of resistor 91aaa. Now, with the control grid raised in potential, tube 130 will respond to the positive pulses in its suppressor and will convert them to amplified negative pulses at the lower end of resistor 134, and the connected wire 120, as indicated in Fig. 2. The negative pulses on wire 120 are communicated by a condenser 122e and resistor 121e to point 67R of trigger circuit E. The circuit E is on at the start of the period under discussion. Hence, the first negative pulse derived from wire 120 and applied to point 67R of E is effective to reverse E from its on to its off state. This reversal is attended by the appearance of the steep negative pulse at point 67R of E, as indicated in Fig. 2. This negative pulse is fed by a resistor 123e and condenser 124e to a resistor 112u. Resistor 112u is tapped by the grid of a pentode 113u. The screen of this pentode is maintained at suitable fixed potential by a pair of resistors 114u and 115u and a condenser 116u shunting 115u. The suppressor of 113u is connected to its cathode. Hence, operation of tube 113u is controlled solely by its control grid. The cathode of tube 113u and the resistor 112u both connect to line 61, so that the tube is normally at zero grid bias and is conductive. Upon the appearance of a negative pulse on resistor 112u, the grid bias of 113u is increased and current flow in 113u is reduced. As a result, a positive pulse is produced on the anode of 113u and is fed by a wire 96u to an electronic accumulator order which is described in my parent application, Serial No. 515,719, filed December 27, 1943. The positive pulse received from wire 96u by the accumulator order effects an entry of value 1 in this order.

Subsequently, the circuit I is triggered back to its on status and, in consequence, circuit I switches the circuit E back to its on status. The return of circuit I to on status is timed by circuit breaker 163. Track *a* of 163 is connected via its brush 160 to the junction of a pair of resistors 181 and 182 across lines 50 and 51. Track *c* of 163 is coupled via a condenser 183 to line 51. Track *b* of 163 is connected by a switch #2 IND., in the position shown, to point 67R of circuit I. When the contact spot on track *a* of 163 reaches brush position, a charging circuit for condenser 183 is closed from line 50 via resistor 181, the brush for track *a* of 163, the contact spot of this

track, the common track *c* of 163, the brush for this track *c*, and via the condenser 183 to line 51. Condenser 183 is thereby charged to the potential across resistor 182. Thereafter, the contact spot on track *a* of 163 leaves the related brush 160 and the contact spot on track *b* of 163 reaches the brush 160 for track *b*. A discharge circuit for condenser 183 is thereby established, and the condenser discharges a positive pulse via common track *c* of 163, the spot on track *b*, and the switch #2 IND., upon point 67R of circuit I. This positive pulse is of sufficient force to bring about the triggering of circuit I from its off to its on status. As circuit I reverses to its on status, a steep negative pulse appears at its point 67L, as previously described. This negative pulse is transmitted by condenser 185 and resistor 184 to point 67L of circuit E, turning on E in the manner previously explained.

To summarize, circuits I and E are initially in on state. Upon reversal of switch 95, I is turned off under control of circuit breaker 162. This renders tube 130 effective to produce negative pulses on wire 120. The first pulse on wire 120 turns off circuit E. As circuit E turns off, a steep negative pulse appears at its point 67R. This pulse is converted by tube 113u into an entry pulse on wire 96u for an accumulator order. Subsequently, I is turned on under control of circuit breaker 163. Accordingly, a steep negative pulse is produced at point 67L of I. This pulse is fed to point 67L of circuit E and turns E on again.

While there have been shown and described and pointed out the fundamental novel features of the invention as applied to a preferred embodiment, it will be understood that various omissions and substitutions and changes in the form and details of the device illustrated and in its operation may be made by those skilled in the art, without departing from the spirit of the invention. It is the intention, therefore, to be limited only as indicated by the scope of the following claims.

What is claimed is:

1. The combination with a controlled circuit capable of responding to positive and negative pulses of adequate amplitude; of an electronic trigger circuit having two alternative stable states and comprising a pair of parallel, resistive, voltage dividers adapted to be energized from a source of voltage, first and second electronic tubes corresponding to the first and second of said dividers respectively, each of said tubes having an anode and a cathode connected in parallel circuit relation with a portion of the corresponding divider and also having a grid, the anode of each tube being connected to a first intermediate point on the corresponding divider and the grid being connected to a second intermediate point on said portion of the other divider, and first and second condensers corresponding to said first and second dividers, respectively, each condenser being connected between the first and second points on the corresponding divider, the first tube being conductive and the second tube being non-conductive in one of said stable states of the trigger circuit with the conductive status of the tubes being reversed in the opposite stable state, whereby the grid of the first tube is at a higher voltage level in said one stable state than in said opposite stable state, said trigger circuit being switchable from either stable state to the other upon an application thereto of an unbalancing potential, whence upon the trigger circuit being switched to said one state a positive voltage pulse appears at the grid of the first tube and upon being switched

to said opposite state a negative voltage pulse appears at that grid, the condenser connected between the first and second points on the second divider being charged while the second tube is non-conductive and thereafter discharged through the second tube and a part of said portion of the second divider when the second tube becomes conductive upon the trigger circuit being switched to said opposite state, to cause the negative pulse at the grid of the first tube to exceed the positive pulse in amplitude; and pulse-attenuating reactance means coupling the grid of the first tube to the controlled circuit for transmitting pulses appearing at said grid of the first tube to the controlled circuit while attenuating such pulses to an extent that the positive pulse is inadequate to operate the controlled circuit while the negative pulse of greater amplitude is adequate.

2. The combination with a controlled trigger circuit having two alternative stable states, which controlled circuit is capable of being switched from one stable state to the other upon application of a positive voltage pulse of adequate amplitude to a portion of the circuit and of being switched back to said one state upon application to the same portion of a negative voltage pulse of adequate amplitude; of an electronic controlling trigger circuit having two alternative stable states and comprising a pair of parallel resistive voltage dividers adapted to be energized from a source of voltage, first and second electronic tubes corresponding to the first and second of said dividers respectively, each of said tubes having an anode and a cathode connected in parallel circuit relation with a portion of the corresponding divider and also having a grid, the anode of each tube being connected to an intermediate point on the corresponding divider, means including a part of said portion of the first divider and a first condenser shunting said part for coupling the anode of the first tube to the grid of the second tube, and means including a part of said portion of the second divider and a second condenser shunting said part for coupling the anode of the second tube to the grid of the first tube, the first tube being conductive and the second tube being non-conductive in one of said stable states of the trigger circuit with the conductive status of the tubes being reversed in the opposite stable

state, whereby the grid of the first tube is at a higher voltage level in said one stable state than in said opposite stable state, said trigger circuit being switchable from either stable state to the other upon an application thereto of an unbalancing potential, whence upon the trigger circuit being switched to said one state a positive voltage pulse appears at the grid of the first tube and upon being switched to said opposite state a negative voltage pulse appears at that grid, the second condenser being charged while the second tube is non-conductive and thereafter discharged through the second tube and another part of said portion of the second divider when the second tube becomes conductive upon the trigger circuit being switched to said opposite state to cause the negative pulse at the grid of the first tube to exceed the positive pulse in amplitude; and condenser-resistor means coupling the grid of the first tube to the controlled circuit for transmitting pulses appearing at the grid of the first tube to the controlled circuit while attenuating such pulses to an extent that the positive pulse is inadequate to operate the controlled circuit while the negative pulse of greater amplitude is adequate.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,266,401	Reeves	Dec. 16, 1941
2,266,526	White	Dec. 16, 1941
2,272,070	Reeves	Feb. 3, 1942
2,338,395	Bartelink	Jan. 4, 1944
2,373,145	Sensiper et al.	Apr. 10, 1945
2,402,916	Schroeder	June 25, 1946

OTHER REFERENCES

"Trigger Circuits," Electronics, Aug. 1939 (250-27 TR), pages 14-17.)

"A Four-Tube Counter Decade," Electronics (250-27 TR), pages 110-113, 358 and 360, June 1944.

A.I.E.E. Technical Paper 40-119, June 1940—"A Wide-Band Square-Wave Generator," by Bartelink. Copy in 250-36-13.2.