AD 422710

UNCLASSIFIED

TR-1150

A TWO-WIRE SETTING SYSTEM FOR ELECTRONIC TIMERS

Ira R. Marcus

30 September 1963

HARRY DIAMOND LABORATORIES
FORMERLY: DIAMOND ORDNANCE FUZE LABORATORIES
ARMY MATERIEL COMMAND
WASHINGTON 25, D. C.

HARRY DIAMOND LABORATORIES

Robert W. McEvoy
LtCol, Ord Corps
Commanding

B. M. Horton
Technical Director

MISSION

The mission of the Harry Diamond Laboratories is:

(1) To perform research and engineering on systems for detecting, locating, and evaluating targets; for accomplishing safing, arming, and munition control functions; and for providing initiation signals: these systems include, but are not limited to, radio and non-radio proximity fuzes, predictor-computer fuzes, electronic timers, electrically-initiated fuzes, and related items.

(2) To perform research and engineering in fluid amplification and fluid-actuated control systems.

(3) To perform research and engineering in instrumentation and measurement in support of the above.

(4) To perform research and engineering in order to achieve maximum immunity of systems to adverse influences, including countermeasures, nuclear radiation, battlefield conditions, and high-altitude and space environments.

(5) To perform research and engineering on materials, components, and subsystems in support of above.

(6) To conduct basic research in the physical sciences in support of the above.

(7) To provide consultative services to other Government agencies when requested.

(8) To carry out special projects lying within installation competence upon approval by the Director of Research and Development, Army Materiel Command.

(9) To maintain a high degree of competence in the application of the physical sciences to the solution of military problems.

UNITED STATES ARMY MATERIEL COMMAND
HARRY DIAMOND LABORATORIES
WASHINGTON 25, D.C.

DA-1P523801A300
AMCMS Code 5523.11.624
HDL Proj 46345

30 September 1963

TR-1150

A TWO-WIRE SETTING SYSTEM FOR ELECTRONIC TIMERS

Ira R. Marcus

FOR THE COMMANDER:
Approved by

R. S. Hoff
Chief, Laboratory 400

CONTENTS

ABSTRACT

A method for setting an electronic timer through two wires is described. The electronic timer is powered, reset, set, monitored and its safety status line checked through two wires connecting the setter and the timer.

1. INTRODUCTION

Digital electronic timers and programmers contain memory devices. These devices must be set to the proper state initially to cause the outputs to occur at the proper time. Two methods of setting have been used. In the first, a wire from each stage is brought out to an external switch. This switch then sets all stages to the desired states simultaneously. In the second method, the timer is reset to the greatest time delay. Then pulses are inserted serially into the operating counter, partially filling the counter. The remaining count will give the desired time.

The first method requires many setting wires but a relatively simple setting device. The second method requires few setting wires but a complex preset counter The first method may have the setter remotely located with the setting switches connected to the timer by a multiwire cable. This allows remote setting by a simple setting device. It has the disadvantage of requiring multipin connectors. If remote setting is not required, the setting switches may be included with the timer in a single package. The setting switches must now survive the environment of the timer. The multiwire and switch method of setting does not include dynamic monitoring.

The second method is exclusively a remote setting method. The preset counter is connected to the timer through a few wires and allows dynamic monitoring to show that the timer was reset and set correctly and is in working order. However, additional wires are required for monitoring and for power.

It is the purpose of this report to show how a timer can be powered, reset, set, and monitored over only two wires by addition of circuitry to the preset counter and logic circuits normally required for serial setting.

2. GENERAL DESCRIPTION OF TWO-WIRE SETTING SYSTEM

Operation of the two-wire setting system is as follows (fig. 1). Power to the timer is provided by the two connecting wires. The preset counter sends a reset pulse to Network A, which applies a negative pulse of short duration to the power wires (fig. 2). This negative pulse causes Network B to reset the timer. The preset counter then sends positive pulses of the desired number to Network A, which applies positive pulses of short duration to the power wires. These pulses cause Network B to operate the timer circuits an equal number of times. The monitoring circuit in Network B monitors the

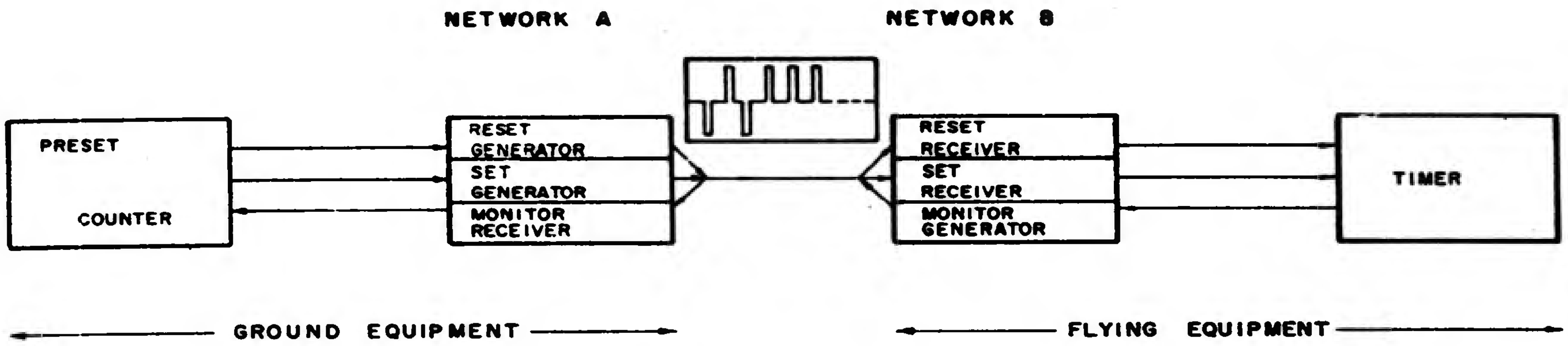


Figure 1. Logic diagram of two-wire setting system.

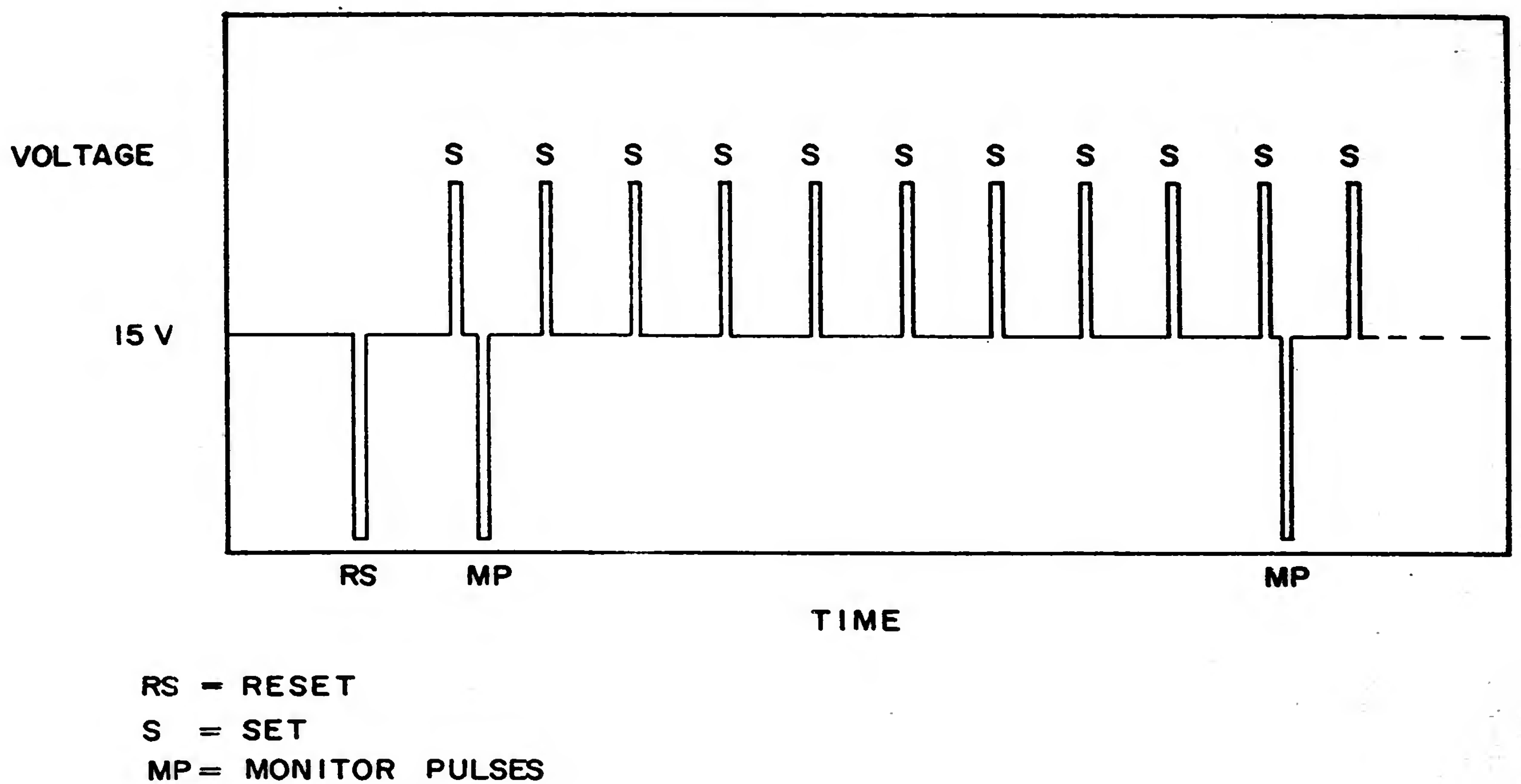


Figure 2. Sequence of pulses to electronic timer.

timer and gives out a pulse each time the timer monitor circuit gives an output. The monitor pulses fed into Network B, cause it to place a negative pulse on the power wires after the completion of the particular setting pulse. The negative pulse is received by Network A and then sent to the preset counter for comparison purposes. The preset counter can be designed to indicate whether the monitor pulses are occurring at the correct place in the sequence, thus indicating that the timer is working and is at the right count.

3. PERFORMANCE REQUIREMENTS OF NETWORK A AND NETWORK B

Networks A and B are required to:

(a) Supply 15 v dc to the timer.
(b) Limit the maximum current through the two wires to a nonfire level for squibs, detonators, etc.
(c) Reset the timer to the maximum time.
(d) Set the timer to the desired time.
(e) Check the safety device status switch.
(f) Receive monitor pulses from the timer and indicate that the timer is functioning properly.

4. TWO-WIRE SYSTEM LOGIC

Figure 3 is a block diagram of the system. All the specifications can be met by the sequence of series pulses (fig. 2) superimposed on a 15-v d-c level which is maintained between the two connecting wires.

(a) If the safety device status switch is open, indicating that the safety device is armed, B+ and pulses cannot be applied to the timer. Item (f), below, describes how the ground equipment can sense this condition.

(b) Network A supplies 15 v and charges C_1 through R_1 and R_2. The value of C_1 and the time constant R_1C_1 are such that a nominal 15-v d-c voltage is maintained on the capacitor and thus across the timer, if the voltage at point D is interrupted periodically for a short period of time.

(c) R_2 limits the maximum current through the two wires.

(d) Point K is at 15 v. If the reset generator pulses point A from +15 v to ground, point K goes to ground and E is positive with respect to D. When E is positive with respect to D, the reset receiver in Network B is activated and resets the timer to the maximum time. The circuitry is such that the set generator, the monitor receiver, the monitor generator, and the set receiver do not interfere with or respond to the negative-going pulse at point D.

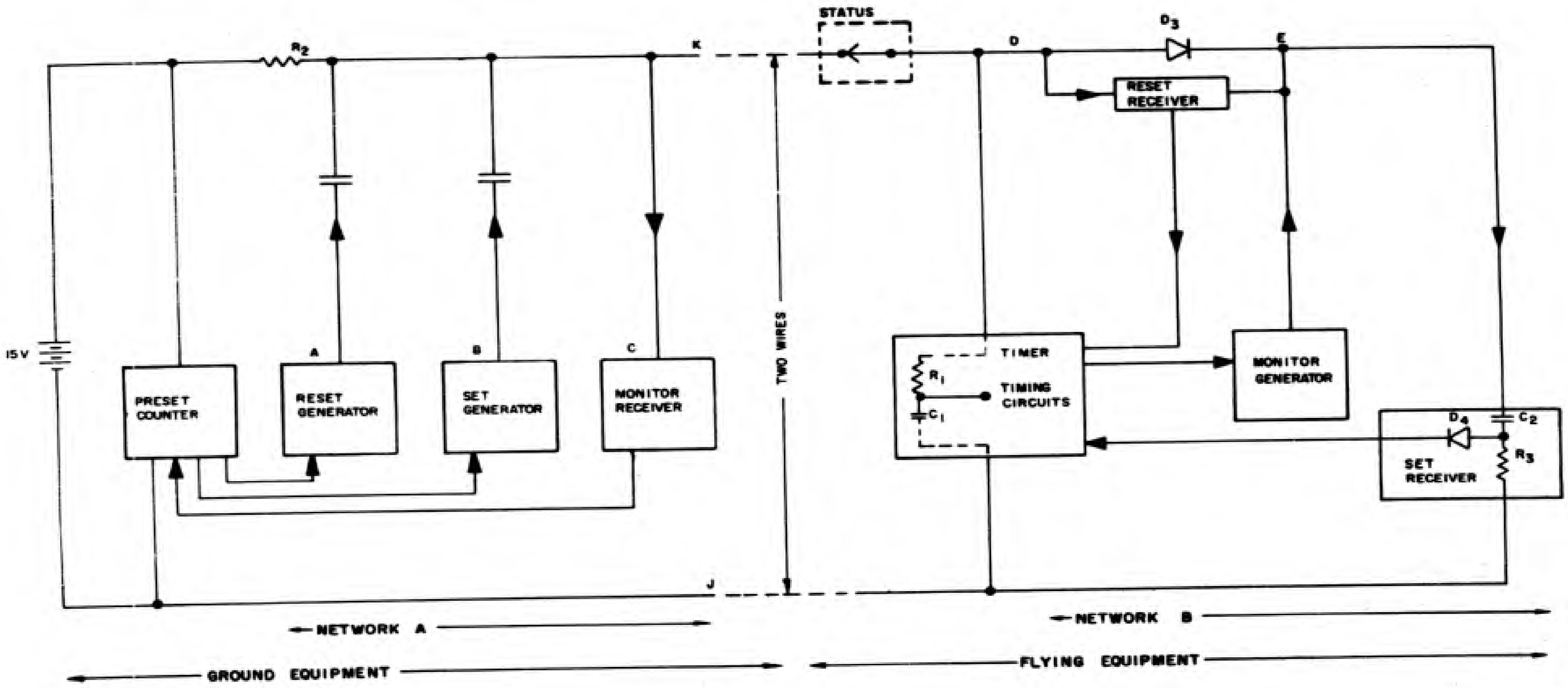


Figure 3. Block diagram of two-wire setting system.

(e) The set generator pulses point B from ground to +15 v. Point K is pulsed from +15 v to +30 v. The set receiver is pulsed +15 v for each set pulse. The circuitry is such that the reset generator, the monitor receiver, the monitor generator, and the reset receiver do not interfere with or respond to the positive-going pulse at point D.

(f) After the set receiver has received a specified number of set pulses, the timer pulses the monitor generator. The monitor generator pulses point E from +15 v to ground. The monitor receiver is gated open to receive these negative pulses during the time they are expected by the preset counter. When the timer is functioning properly and the monitor generator is sending back negative pulses, the reset generator, the reset receiver, the set generator and the set receiver do not interfere with or respond to these pulses.

Thus to set the timer to the desired function time, only two wires are connected to the timer. The waveform at point D is shown in figure 2. The reset and set pulses are programmed by the preset counter, while the monitor pulses originate from the timer. The preset counter gates the monitor receiver at the proper time to receive the monitor pulses. If the status switch is open or if the timer is not operating properly, the monitor receiver will not receive negative pulses when it is gated to receive them. The preset counter will indicate "error" and shut off.

5. CIRCUITRY

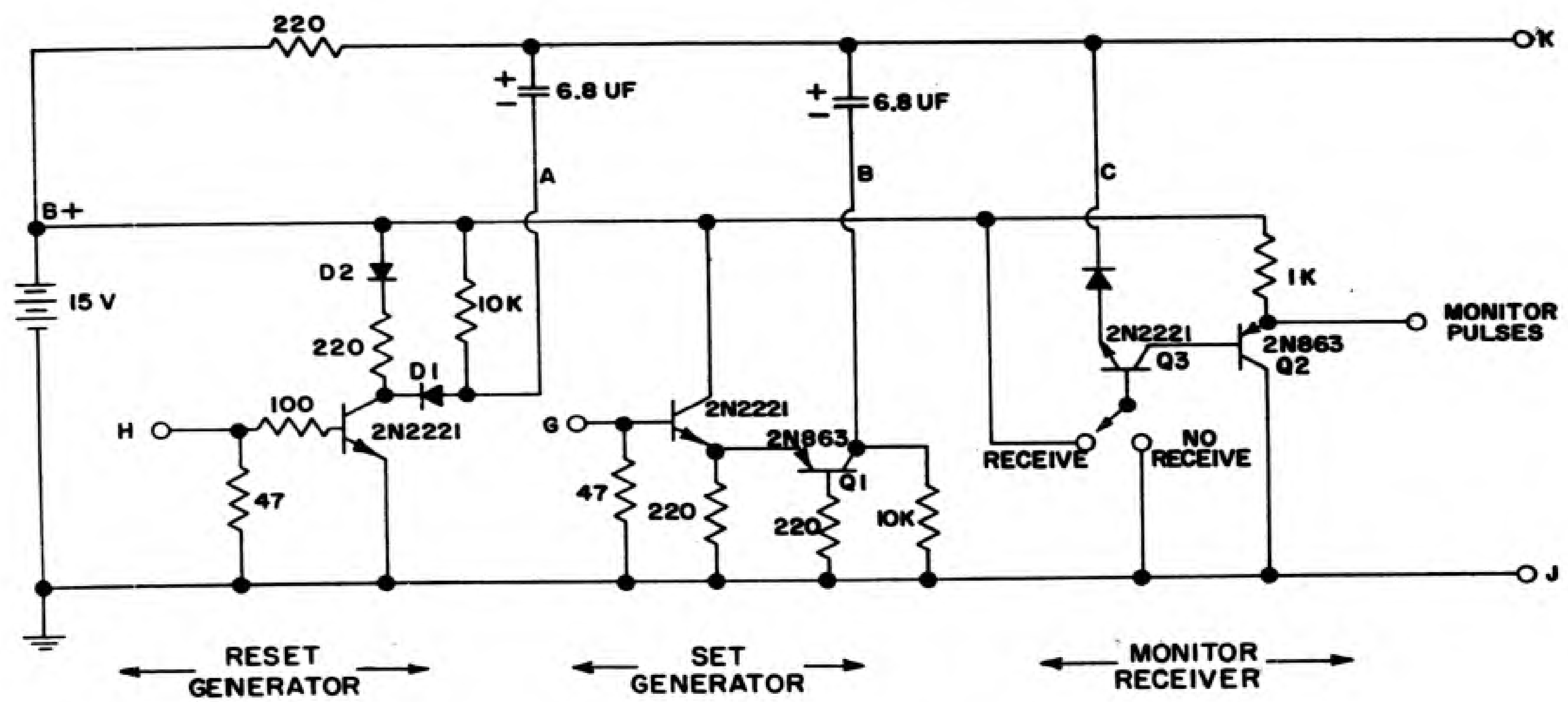
5.1 D-C Supply to the Timer

For the timer to respond to reset and setting pulses, 15 v dc must be applied to the B+ terminals of the timer (fig. 4,5). Since the resetting, setting, and monitor pulses interrupt the 15 v to the timer, a method is required to filter these pulses out so that the timer is constantly powered during the resetting, setting, and monitor pulses. This is accomplished by a simple RC network.

C_1 is large enough so that the 15-v supply, across it and the timer, does not fall appreciably when the voltage at point D varies. In the model built, the width of all pulses appearing at point D is about 20 μsec. The time constant R_1C_1 is greater than 20 times this value. When C_1 is called upon to power the timer, due to pulse voltage changes at point D, it maintains a nominal 15 v across the timer. It recharges back to 15 v before the next pulse is received at point D.

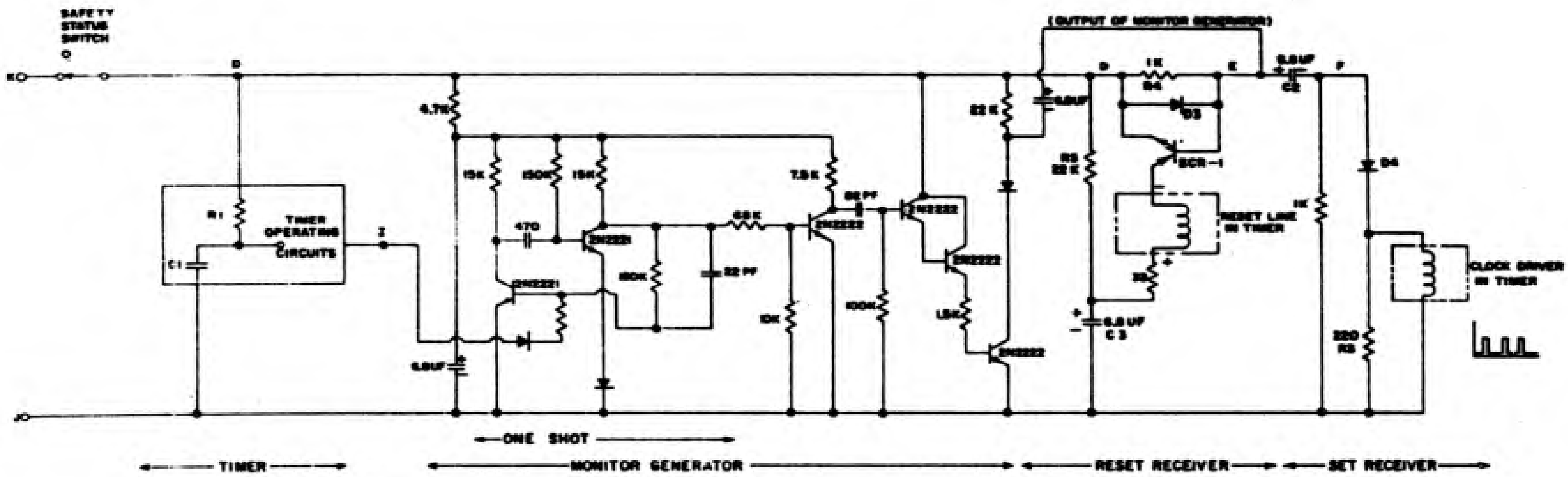
5.2 Maximum Current Through the Two Wires

R_2 limits the maximum possible current through the two connecting wires (fig. 3). In the model, 70 ma is the maximum value. A more elaborate current limiter can limit the maximum



G = INPUT TO SET GENERATOR FROM PRESET COUNTER
H = INPUT TO RESET GENERATOR FROM PRESET COUNTER
ALL DIODES IN3067

Figure 4. Network A in ground equipment.



R1 AND C1 REPRESENT VARIOUS R C COMBINATIONS LOCATED IN THE ELECTRONIC TIMER.

I = INPUT TO MONITOR GENERATOR.

ALL DIODES 1N3067.

Figure 5. Network B in flying equipment.

current to approximately the current required by the timer. However, the simple resistor limiter shown limits the current to about two to four times the current used by the timer.

5.3 Reset Generators

The preset counter portion of the ground equipment is simulated by a pulse generator (fig. 3,4). Positive pulses from the simulated preset counter feed point H of the reset generator. Each pulse pulls point K toward ground. The pulses are 20 μsec wide. When the reset pulses are generated from the preset counter, only one pulse is required for each time the timer is set. Diode D1 isolates the input point H of the reset generator from negative monitor pulses that appear at point K. Positive set pulses raise the collector voltage but do not feed through to the input of the reset generator. Diode D2 isolates the B+ line from positive set pulses from the set generator. Thus the reset generator can pull point K toward ground and is not affected by other pulses appearing at point K.

5.4 Reset Receiver

The reset receiver is pulsed when point E is positive with respect to point D (fig. 5). This situation occurs when point D goes to ground. The silicon-controlled rectifier (SCR-1) in the reset receiver normally has its anode and cathode at 15 v. When D is pulsed negative by the reset pulse from the reset generator, the cathode goes toward ground, and the anode stays at 15 v, due to the long R_5C_3 time constant and the short duration of the reset pulse. The gate, point E, is positive with respect to the cathode, point D, of the SCR, and the SCR fires. Pulse current flows through the reset line of the timer. In the model, about 400 ma flows for 20 μsec and is used to reset a three-decade magnetic-core timer. Neither set pulses nor monitor pulses allow E to be positive with respect to D. Diode D3 shunts out R_4 for the feedback and set pulses.

5.5 Set Generator

The preset counter supplies set pulses to the set generator at point G (fig. 3,4). In the model a pulse generator simulates the preset counter. Positive pulses applied to the input of the set generator, cause the set generator to pulse point B from ground to +15 v, thereby pulsing point K from +15 v to +30 v. The purpose of transistor Q1 is to isolate the set generator input from all negative pulses at point K. Set pulses in the model run at 1 kc and are 20 μsec wide. Thus the set generator can push point D to +30 v and is not affected by other pulses superimposed on the 15 v at point K.

5.6 Set Receiver

Due to the diode D4 in the set receiver, the set receiver will respond to positive pulses only (fig. 3,5). When the set generator pulses E above 15 v, point F goes positive from ground. (Both the monotor generator and the reset generator pulse point F negative.) In the model, the positive pulses operate a magnetic-core driver in the timer. The magnetic-core driver moves the bit, which is inserted by the reset receiver, from stage to stage. The number of pulses determines the timer setting.

5.7 Monitor Generator

When the timer is being set at certain counts, it pulses the monitor generator at point I (fig. 3,5). The first section of the monitor generator is a 50-μsec one-shot multivibrator. The pulse from the one shot is inverted, differentiated, and amplified. The result is used to generate a negative pulse at point E. This is the monitor pulse. It is delayed about 50 μsec after the set pulse is received by the set receiver. In the model every tenth set pulse generates one monitor pulse. The frequency of the monitor pulses is 100 cps and the pulses are about 25 μsec wide.

5.8 Monitor Receiver

When Network A expects to receive monitor pulses from the monitor generator, the switch is in the receive position (fig. 3,4). The emitter of Q_2 goes to ground when a pulse is received, because Q_3 is saturated and its collector is pulled toward ground. This forward biases Q_2 and its emitter is pulled toward ground. Thus each expected monitor pulse causes a negative pulse at the emitter of Q_2. In a fully developed ground box, which would include logic circuits, the mechanical switch would be replaced by a transistor switch. If monitor pulses are not received, the preset counter would shut off and would indicate "error."

5.9 Safety-Device Status Switch

The safety-device status switch conducts if the safety device is in the safe position. Thus 15 v and pulses can be applied to the timer. However, if the status switch is open, no B+ or pulses are applied to the timer and no feedback pulses are received. The setter would then indicate "error."

6. CONCLUSION

A two-wire setter for an electronic timer has been demonstrated to be feasible. It has the capability to power, reset, set, monitor the setting process, and check the safety status switch; and can be safely used with devices containing squibs and detonator since the maximum current the equipment can deliver is limited.

DISTRIBUTION

Office of the Director of Defense Research & Engineering
Washington, D.C. 20301
Attn: Mr. R. Thorkildsen

Commanding General
Hq, US Army Materiel Command
Washington, D. C. 20315
Attn: AMCRD-DE (Dev Div)
Attn: AMCRD-RS (Res Div)
Attn: AMCRD-DN-RE-2 (G. Rosenberg)
Attn: AMCAD-PP-D (Library)

Commanding General
U.S. Continental Army Command
Washington, D.C. 20315
Attn: AMCGS-LN-D

Commanding Officer
U.S. Army Combat Development Command
Washington, D. C. 20315
Attn: AMCGS-LN-G

President
U.S. Army Artillery Board
Fort Sill, Oklahoma

Commanding General
U.S. Army Munitions Command
Dover, New Jersey
Attn: AMSMU
Attn: AMSMU (Projectile Ammo. Group)
Attn: AMSMU (Rocket Ammo Group)
Attn: AMSMU (Demolition Ammo Group)

Commanding Officer
Office of the Project Manager, Selected Ammo.
Picatinny Arsenal
Dover, New Jersey
Attn: AMCPM, Col J. A. Ulrich

Commanding Officer
Picatinny Arsenal
Dover, New Jersey
Attn: SMUPA-T (J. Drake)
Attn: SMUPA-T (H. Painter)
Attn: D. Costa
Attn: P. Montelione
Attn: SMUPA-TW1, L. Marino

Commanding Officer
Picatinny Arsenal
Dover, New Jersey
Attn: W. Reiner
Attn: A. Hendrickson
Attn: W. Wronka
Attn: Ammo. Dev. Lab
Attn: B. Frey
Attn: D. Shaw
Attn: R. Katz
Attn: W. Schuster
Attn: A. Nunes-Vais
Attn: Tech Serv Lab
Attn: L. Adelson

Commanding Officer
Frankford Arsenal
Philadelphia 37, Pennsylvania
Attn: Library, 0270
Attn: Electromech Fuze Branch 1610

Commanding General
U.S. Army Missile Command
Redstone Arsenal, Alabama
Attn: AMSMI (Lance Project Office)

Redstone Scientific Information Center
U.S. Army Missile Command
Redstone Arsenal, Alabama
Chief, Document Section

Commander
Air Proving Ground Center
Eglin Air Force Base, Florida
Attn: Sgt J. Wetzel, Detachment 4, ASD, ASQW

Commander
Wright-Patterson Air Force Base, Ohio
Attn: Library

Commander
Naval Ordnance Laboratory
White Oak, Maryland
Attn: Mechanisms Div (N. Czajkowski)

Commander
Naval Ordnance Laboratory
Corona, California
Attn: Library

Defense Documentation Center
Cameron Station, Bldg 5
5010 Duke Street
Alexandria, Virginia
Attn: TISIA (20 copies)

Commander
Naval Ordnance Test Station
China Lake, California
Attn: Library

Sandia Corporation
Sandia Base
Albuquerque, New Mexico
Attn: Library

National Aeronautical & Space Admin.
Langley Station
Hampton, Virginia
Attn: Technical Library

Internal

Horton, B.M./McEvoy, R. W., Lt. Col.
Apstein, M./Gerwin, H. L./Guarino, P. A./Kalmus, H. P.
Spates, J.E./Schwenk, C. C.
Hardin, C. D., Lab 100
Sommer, H. Lab 200
Hatcher, R. D., Lab 300
Hoff, R. S., Lab 400
Nilson, H. M., Lab 500
Flyer, I. N., Lab 600
Campagna, J. H., Div 700
DeMasi, R., Div 800
Landis, P. E., Lab 900
Seaton, J. W., 260
Scudder, K., 310
Tuccinardi, T. E., 530
Mead, O., 610
Doctor, N., 920
Marcus, I., 450 (25 copies)
Technical Reports Unit
Rotkin I./Godfrey, T. B./Bryant, W. T.
Distad, M. F./McCoskey, R. E./Moorhead, J. G.
HDL Library (5 copies)
Technical Information Office, 010 (5 copies)

(Two pages of abstract cards follow.)

AD________ Accession No.________

Harry Diamond Laboratories, Washington 25, D. C.

A TWO-WIRE SETTING SYSTEM FOR ELECTRONIC TIMERS -- Ira R. Marcus

TR-1150, 30 September 1963, 6 pp text, 5 illus. Department of the Army Proj 1P523801A300, AMCMS Code 5523.11.624, HDL Proj 46345, UNCLASSIFIED Report

A method for setting an electronic timer through two wires is described. The electronic timer is powered, reset, set, monitored and its safety status line checked through two wires connecting the setter and the timer.

Electronic devices

Electronic programmers

Memory devices

AD________ Accession No.________

Harry Diamond Laboratories, Washington 25, D. C.

A TWO-WIRE SETTING SYSTEM FOR ELECTRONIC TIMERS -- Ira R. Marcus

TR-1150, 30 September 1963, 6 pp text, 5 illus. Department of the Army Proj 1P523801A300, AMCMS Code 5523.11.624, HDL Proj 46345, UNCLASSIFIED Report

A method for setting an electronic timer through two wires is described. The electronic timer is powered, reset, set, monitored and its safety status line checked through two wires connecting the setter and the timer.

Electronic devices

Electronic programmers

Memory devices

AD________ Accession No.________

Harry Diamond Laboratories, Washington 25, D. C.

A TWO-WIRE SETTING SYSTEM FOR ELECTRONIC TIMERS -- Ira R. Marcus

TR-1150, 30 September 1963, 6 pp text, 5 illus. Department of the Army Proj 1P523801A300, AMCMS Code 5523.11.624, HDL Proj 46345, UNCLASSIFIED Report

A method for setting an electronic timer through two wires is described. The electronic timer is powered, reset, set, monitored and its safety status line checked through two wires connecting the setter and the timer.

Electronic devices

Electronic programmers

Memory devices

AD________ Accession No.________

Harry Diamond Laboratories, Washington 25, D. C.

A TWO-WIRE SETTING SYSTEM FOR ELECTRONIC TIMERS -- Ira R. Marcus

TR-1150, 30 September 1963, 6 pp text, 5 illus. Department of the Army Proj 1P523801A300, AMCMS Code 5523.11.624, HDL Proj 46345, UNCLASSIFIED Report

A method for setting an electronic timer through two wires is described. The electronic timer is powered, reset, set, monitored and its safety status line checked through two wires connecting the setter and the timer.

Electronic devices

Electronic programmers

Memory devices

REMOVAL OF EACH CARD WILL BE NOTED ON INSIDE BACK COVER, AND REMOVED CARDS WILL BE TREATED AS REQUIRED BY THEIR SECURITY CLASSIFICATION.

AD________ Accession No.________

Harry Diamond Laboratories, Washington 25, D. C.

A TWO-WIRE SETTING SYSTEM FOR ELECTRONIC TIMERS -- Ira R. Marcus

TR-1150, 30 September 1963, 6 pp text, 5 illus. Department of the Army Proj 1P523801A300, AMCMS Code 5523.11.624, HDL Proj 46345, UNCLASSIFIED Report

A method for setting an electronic timer through two wires is described. The electronic timer is powered, reset, set, monitored and its safety status line checked through two wires connecting the setter and the timer.

Electronic devices

Electronic programmers

Memory devices

AD________ Accession No.________

Harry Diamond Laboratories, Washington 25, D. C.

A TWO-WIRE SETTING SYSTEM FOR ELECTRONIC TIMERS -- Ira R. Marcus

TR-1150, 30 September 1963, 6 pp text, 5 illus. Department of the Army Proj 1P523801A300, AMCMS Code 5523.11.624, HDL Proj 46345, UNCLASSIFIED Report

A method for setting an electronic timer through two wires is described. The electronic timer is powered, reset, set, monitored and its safety status line checked through two wires connecting the setter and the timer.

Electronic devices

Electronic programmers

Memory devices

AD________ Accession No.________

Harry Diamond Laboratories, Washington 25, D. C.

A TWO-WIRE SETTING SYSTEM FOR ELECTRONIC TIMERS -- Ira R. Marcus

TR-1150, 30 September 1963, 6 pp text, 5 illus. Department of the Army Proj 1P523801A300, AMCMS Code 5523.11.624, HDL Proj 46345, UNCLASSIFIED Report

A method for setting an electronic timer through two wires is described. The electronic timer is powered, reset, set, monitored and its safety status line checked through two wires connecting the setter and the timer.

Electronic devices

Electronic programmers

Memory devices

AD________ Accession No.________

Harry Diamond Laboratories, Washington 25, D. C.

A TWO-WIRE SETTING SYSTEM FOR ELECTRONIC TIMERS -- Ira R. Marcus

TR-1150, 30 September 1963, 6 pp text, 5 illus. Department of the Army Proj 1P523801A300, AMCMS Code 5523.11.624, HDL Proj 46345, UNCLASSIFIED Report

A method for setting an electronic timer through two wires is described. The electronic timer is powered, reset, set, monitored and its safety status line checked through two wires connecting the setter and the timer.

Electronic devices

Electronic programmers

Memory devices

REMOVAL OF EACH CARD WILL BE NOTED ON INSIDE BACK COVER, AND REMOVED CARDS WILL BE TREATED AS REQUIRED BY THEIR SECURITY CLASSIFICATION.

UNCLASSIFIED

UNCLASSIFIED