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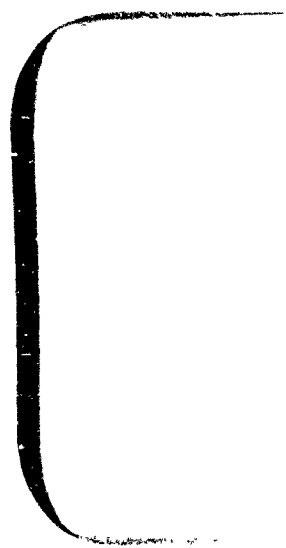
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Human Research Unit Nr 3, CONARC Fort Benning, Georgia

Under the Technical Supervision of

**The George Washington University
HUMAN RESOURCES RESEARCH OFFICE
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STAFF MEMORANDUM
ON
TASK TRAINFIRE

EXPERIMENTAL DEVELOPMENT OF TRAINING METHODS
AND PROFICIENCY TESTS FOR IMPROVING THE EFFECTIVENESS
OF COMBAT RIFLEMEN

REALISTIC TARGETS FOR THE TRAINING AND TESTING OF COMBAT RIFLEMEN


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Summary

The development of realistic targets was included as an essential phase of Task TRAINFIRE: Experimental Development of Training Methods and Proficiency Tests for Improving the Effectiveness of Combat Rifleman. As a result of this target development program, two devices were designed and produced. One is a remotely controlled, stationary target device which is electrically raised and lowered and falls when struck by a bullet; the other is a hand-powered, moving target device which is mechanically raised and lowered but does not fall when hit.



Acknowledgments

With the cooperation and willing assistance provided by personnel of the Armament Shop, Post Ordnance, Fort Benning, Georgia, the development of the target devices was successfully implemented.

Especially worthy of note were the efforts of Mr. Otto Wolfe, Superintendent, and Mr. Ray Miller, Design Engineer. These two individuals figured prominently in the success of the target development program.

Acknowledgment is also extended to Major Edgar Fenstemacher and to Post Ordnance, Fort Jackson, South Carolina from whom some of the basic ideas were borrowed.

I. BACKGROUND

Early in the planning phase of TRAINFIRE I, it became apparent that the development of methods of (1) training riflemen to use their weapons efficiently in combat situations, and (2) measuring rifle marksmanship in situations closely simulating combat conditions, made the utilization of realistic targets mandatory. Inasmuch as this requirement was not met at the time by any existing device, the development of realistic targets became essential for TRAINFIRE I.

Analysis of combat situations, and interviews with combat veterans indicated that the majority of visible targets encountered by riflemen are briefly exposed, camouflaged, stationary human targets. Encountered to a lesser extent are briefly exposed, indistinct, fleeting human targets. Accordingly, a program was launched to develop devices that would simulate these combat targets.

As a result of this target development program, two devices were designed, and produced in sufficient quantity to construct both a training range and a proficiency testing range as required for TRAINFIRE I. One of the target devices consisted of an electrically powered, stationary mechanism which presented a camouflaged silhouette to the rifleman. The other device consisted of a hand-powered, track-mounted carriage which briefly presented a camouflaged, moving silhouette to the rifleman. One hundred of the stationary and 21 of the moving devices were installed.

II. STATIONARY TARGET DEVICE

A. General

"Punchy Pete," the stationary target device, is an electrically powered, remotely controlled mechanism which presents a silhouette target that falls when struck by a bullet. It is designed to simulate a human figure that suddenly appears, remains exposed in the same position and then disappears. The working mechanism is placed in a shallow hole or trench so that only the silhouette target is visible to the observer, and the structural parts are protected against destruction by direct hits or ricochets. When the device is ready for operation, the silhouette is lying on its side below ground level, hidden from view. As the control operator closes a remote switch, the silhouette is suddenly rotated into a vertical position. It remains locked in this position until a sear mechanism is released, at which time the target falls back to the horizontal position, disappearing from view. Release of the sear mechanism may be accomplished by (1) activation of a remote switch by the control operator or (2) the impact of a bullet striking the target.

The most notable characteristic of this device is that it presents the trainee with a "killable" target; that is, the target falls when it is hit. This characteristic of responding to the impact of a bullet makes it possible for the firer to have immediate knowledge of his accuracy, thus providing greater realism in field problems. The principle of the "killable" target lends itself equally well to either known- or unknown-distance firing, and operates effectively with all types of small arms presently in use.

Though simple, inexpensive, and constructed in major part of standard commercial items, more important are the realism and flexibility in target range location afforded by the device. It is readily portable, measuring only 18 inches on a side and one foot in height and weighing 75 pounds, including the battery. Further, inasmuch as the device is remotely controlled, pit details are eliminated.

B. Construction

Diagrams of the device appear in Figures 1 and 2 of Appendix A.

The structural and mechanical components of the device are fabricated of iron and steel. The commercially obtainable electrical components consist of one pull and one push solenoid, three relays, four switches, a six-volt storage battery, and approximately ten feet of wire.

1. Structural and Mechanical Components

a. Frame

The square, welded, angle-iron frame is designed to permit easy portability and efficient mounting of the operational elements of the device. Its 18-inch square base is sufficiently large to provide stability for the device without additional support.

b. Axle

A counterweighted lever system, which raises and lowers the silhouette, is mounted on the axle. At the forward end of the axle, a lever is attached and linked to the pull solenoid which furnishes the power to rotate the target to the vertical position. A metal sleeve, which accommodates the target stake, is welded at the middle of the axle. Opposing this sleeve on the axle is the counterweight. This counterweight is adjustable so that optimum balance with various silhou-

ette targets can be attained.

c. Locking Mechanism

The silhouette is maintained in the vertical position by a simple locking system consisting of a latching lever welded to the forward end of the axle, and a spring-loaded sear which is mounted on the plate in position to engage the latching lever. Another spring assists the gravity fall of the target when the sear releases.

d. Plate

The locking mechanism and all electrical components are mounted on a steel plate bolted to the front of the frame; a galvanized iron cover protects the plate and all parts mounted upon it from weather and dust.

e. Target

The device is designed to accommodate standard E (kneeling) or F (prone) cardboard silhouette targets mounted on wooden staves.

2. Electrical Components

Circuit diagrams appear in Appendix B. Operation of the target is achieved through three circuits: a raising circuit and a lowering circuit, both remotely controlled, and a kill circuit which is actuated by the strike of a bullet. Power to operate the remote control system and the three target circuits is derived from the local six-volt storage battery. The use of a DC power supply at each target allows the remote control to be accomplished with very low current. Thus standard Signal Corps field wire (WD1) is adequate for the remote wiring.

a. Raising Circuit

The raising circuit includes a switch located at the control

point, a heavy-contact relay, and a pull solenoid which raises the silhouette.

b. Lowering Circuit

The lowering circuit also includes a switch at the control point, a relay, and a push solenoid which disengages the gear locking mechanism.

c. Kill Circuit

The kill circuit utilizes the same solenoid as the lowering circuit, a relay which delivers current to the solenoid, and a normally closed wafer switch which momentarily opens when the target is hit.

C. Installation

To install "Punchy Pete," certain preparations of the terrain are necessary. Two feet of defilade achieved by digging a hole or building a mound, are needed to protect the vital parts of the target and to conceal the silhouette while it is down. Although the control wires running to the target can frequently be placed where they have natural protection, it may be necessary to bury them. It is necessary to lay all wires near the target area in trenches at least six inches deep.

Circuit preparation requires only the laying of the three remote control wires, hooking into the control panel and the terminals at the target, and connecting the battery power source.

Care should be taken in making all wiring connections, especially in taping adequately to insure against moisture.

1. Single Unit Hookup

Only three components are necessary to install a single unit. In addition to the target device itself (complete with battery), a control

panel having two switches and a supply of field wire are needed.

After setting up the target device and the control panel, three lengths of wire are run between them. The remainder of the installation consists of attaching the appropriate wires to the corresponding terminals at the target and the control panel, and hooking up the battery.

2. Multiple Unit Hookup

A multiple unit hookup is merely an expansion of the single unit hookup to include a group of targets wired in series. In this instance several targets are operated by a single set of switches at the control panel.

Having the option of either single or multiple hookups, all desired combinations of targets can be set up depending upon the requirements of the specific problem.

3. Readying the Target for Use

Once the target device is installed, five steps are involved in putting it into operation:

- a. A cardboard silhouette is securely fastened in the sleeve holder.
- b. The axle is checked for free movement.
- c. The counterweight is adjusted so that the target is slightly top-heavy.
- d. The kill switch is clamped to the outer edge of the cardboard silhouette and adjusted so that the kill circuit operates when any spot on the target is lightly tapped.
- e. The raising and lowering of the target are checked by operating the remote control switches.

When these steps have been completed, the device is ready for use.

D. Operation

The range set-up is completed by wiring in the centrally located control panel with a separate set of switches for each group of simultaneously operated targets. Each group or bank of silhouettes can be raised and lowered as a unit, from this point. When the targets are standing, however, the kill circuit in each target operates independently.

1. Raising the Target

The remote raising switch is closed to raise the target. This switch sends current to the heavy-contact relay. This completes the circuit to the pull solenoid and at the same time breaks the kill circuit, rendering it inoperative.

As the solenoid draws in, it rotates the axle, and the target is raised to the vertical where it is caught and locked in place by the sear. When the target is up, the remote switch is opened, releasing the pull solenoid circuit and allowing current to flow to the kill switch. The target is now ready to be fired upon.

2. Kill Switch

The "kill" principle is based upon the fact that the impact of a projectile striking the cardboard silhouette produces a vibration. This vibration is transmitted to an electrical switch clamped to the silhouette. The kill switch has two flexible arms adjusted so that they touch together lightly at one end. When the target surface is disturbed, the point of contact between the two arms is momentarily broken, activating the kill circuit.

3. Kill Circuit

The kill circuit is comprised of two component circuits: (1) a circuit including the kill switch and a relay; and (2) the push solenoid circuit controlled by this relay. The relay is so utilized that when the kill-switch circuit is closed, no current is delivered to the push solenoid. With the target standing ready to be fired upon, current is flowing through the circuit containing the kill switch and the relay; thus the circuit to the solenoid is open.

When the target is struck, the kill switch is jarred, breaking the circuit to the relay. The clapper of the now inactive relay moves to its alternate position, closing the push solenoid circuit and activating the solenoid.

The plunger of the solenoid strikes the sear, causing it to disengage the latching lever. Since the lever is welded to the axle, the release of the lever frees the axle to turn and thus permits the target to fall by gravity.

Since the kill switch closes again after the vibration stops, the system automatically readies itself to operate again when the target is raised.

When the target is down, no current is flowing in any of the target circuits. This is accomplished by a micro switch wired into the circuits, so placed that it is closed only when the target is up.

4. Lowering the Target

The remote lowering switch is closed to lower the target, in the event the target has been exposed the specified time without being hit. Current applied to the lowering relay closes it. This relay

completes a circuit to the push solenoid, activating it, and the target falls. When the remote switch is open, the target is ready for the next cycle.

E. Maintenance

The kill switch is vulnerable on two counts: (1) contact pressure is critical, and (2) it is not waterproof or dustproof. Making an occasional check of the switch will disclose any contact adjustment needed and should keep it free from trouble. To protect against moisture, steps should be taken to cover the target unit when not using it and to provide a drainage system for the pit, if necessary.

If the device is kept clean, all bearing and friction surfaces oiled, the battery charge maintained and a check made periodically for loose thumb-screws, it can be maintained in operation with little effort.

F. Modification

Time limitations prevented the perfection of this device. The development program is being continued to correct the existing limitations. (See Appendix D for suggested changes.)

III. MOVING TARGET DEVICE

A. General

This device is designed to simulate a human figure that suddenly appears, briefly exposes itself while moving, and then disappears. The working mechanism is set in a trench so that only the cardboard silhouette is visible when the target is in motion, and the rest of the parts are protected against destruction by direct hits or ricochets. The target does not fall when hit.

With the carriage at the starting end of the track, the silhouette is lying in a horizontal position, hidden from view. As the carriage begins to move along the track, the silhouette is suddenly raised to the vertical position and locked in place. The silhouette remains in this position, exposed to view, until the carriage reaches the far end of the track. At this point, the locking mechanism is tripped and the silhouette falls back to the horizontal position, disappearing from view. This completes the run of the target. To ready the carriage for the next run, it is returned to the starting end of the track with the silhouette in the horizontal position, unseen from the firing line.

B. Construction

Diagrams of the moving target appear in Figures 3 and 4 of Appendix A.

The device is fabricated of iron and steel. The carriage is constructed of angle-iron, rod and sheet steel, and cast-iron pulleys. The track and track supports are made exclusively of angle-iron. Cast-iron pulleys and steel cable comprise the motive system.

1. Carriage

The carriage consists of a square, angle-iron frame suspended between the rails of the track assembly by four U-groove pulley wheels. A counterweighted lever system, which raises and lowers the silhouette target, is fixed to a rotating axle with bearing surfaces in the two sides of the carriage frame. The silhouette is maintained in the upright position by a simple locking system. This locking mechanism consists of a latching lever, welded to the left end of the rotating axle, and a spring-loaded sear mounted on a steel plate directly beneath the latching lever.

2. Target

The target is a stake-mounted E silhouette narrowed down to approximate a side view of the upper body of a human. A metal sleeve, opposite the counterweight on the raising lever, accommodates the target stake. The counterweight is adjustable so that optimum balance with the silhouette target can be obtained with a variety of target styles.

3. Track Assembly

The track assembly consists of two parallel lengths of angle-iron bolted to angle-iron spanners. The spanners are constructed so that the attached rails are approximately a foot above the bottom of the trench. Thus, when the carriage wheels are placed upon the rails, the suspended carriage frame and counterweighted raising lever clear the bottom of the trench. At the starting end of the track a hinged ramp is clamped to the right hand rail. This ramp is so positioned that the raising lever rides up the ramp, and the silhouette is raised to the

vertical position, as the carriage begins to move along the track. Bumpers are installed at both ends of the track to stop the carriage. The bumper at the far end of the track includes a trip-peg to disengage the locking mechanism.

4. Motive System

The carriage is moved along the track by a cable-pulley system. A pulley is mounted at each end of the track with the drive pulley equipped with a hand-crank. The cable is fed through both pulleys and fastened to the front and rear of the carriage. This, in effect, attaches the carriage to an endless cable which can be run either forward or backward.

C. Installation

A diagram of the installation employed for TRAINFIRE I is presented in Figure 3.

1. Track Assembly

The dimensions of the track assembly require a trench no less than two feet deep by two feet wide, with length depending upon the requirements of the particular firing problem. A depth of two feet puts all parts of the mechanism several inches below ground level, giving sufficient clearance to prevent their destruction during firing. A width of two feet provides a tight fit for the track over the full length of the trench. The trench must extend a few feet beyond each end of the track to permit the carriage to run to the end of the track when the silhouette is in the horizontal position.

The bumpers at both ends of the track may be improvised of sand bags, logs or target staves. For the purposes of Task TRAINFIRE, wooden

staves driven into the ground were sufficient.

The hinged ramp employed to raise the target is clamped to the right hand rail at the starting end of the track. The ramp must be positioned at least two feet from the end of the track so that in the starting position the carriage is between the end of the track and the ramp.

2. Operator's Pit

The operator's pit may be of any design suited to the terrain, within the specifications provided by D/A TM 9-855. The target device is operable from either end of the trench; the pit should therefore be placed at the higher end to prevent its filling with surface water. Field wire, laid from the pit to the control point, provides phone control of target operation.

3. Motive System

The two pulleys for the motive system are mounted at each end of the trench. The hand-cranked drive pulley is bolted to a wooden frame which fits across the pit opening facing the trench. The frame is constructed so that it rests upon a sill on the bottom of the trench and extends across the opening into the two side walls of the pit. Thus the pulley is operable from inside the pit.

The anchor pulley is mounted on a four-foot log, or other suitable support, at the far end of the trench. At the end of the trench, slots are dug into each of the two sidewalls to accommodate the log as it is laid across the trench. The log crosses the trench approximately at the level of the rails and is held in place by the slots dug in the sidewalls. The return pulley is mounted in the middle of this log.

After both pulleys are installed, the cable is fed through the pulleys and fastened to the two ends of the carriage. One end is fastened directly; the other through a turnbuckle which provides slack adjustment.

D. Operation

In the ready position the carriage is at the starting end of the track with the silhouette horizontal. Upon command from the control point, the operator begins to drive the carriage along the track by turning his hand-crank. As the carriage moves along the track, the raising lever rides up the hinged ramp. As the raising lever rides up the ramp, the silhouette and opposite counterweight are rapidly rotated about their common axle. This causes the silhouette to appear suddenly. When the lever reaches the top of the ramp, the spring-loaded sear engages the latching lever, and locks the silhouette in the vertical position. The silhouette remains in this position, exposed to view, while the carriage traverses the track. As the carriage reaches the bumper at the far end of the track, the sear is rotated out of position by the trip-peg. Thus the locking mechanism is disengaged, and the silhouette falls back to the horizontal position, disappearing from view. To ready the carriage for the next run, the direction of the carriage is reversed, and it is returned to the starting end of the track, with the silhouette horizontal. As the carriage nears the starting end of the track, the raising lever passes under the hinged ramp, displacing it upward. After the lever passes beyond the ramp, the ramp drops back into the inclined position. At this point the device is ready for the next run.

E. Maintenance

The track assembly requires periodic inspection for bolts loosened by carriage-produced vibrations. An application of heavy oil on the hinge of the ramp will reduce friction.

The various bearing surfaces on the carriage require heavy oil or graphite lubrication.

Axle grease on the bearing surfaces of the drive and return pulleys is the only lubricant necessary for the motive system. To prevent cable stretching, the turnbuckle should be loosened when the device is not in operation.

F. Modifications

As with the stationary device, time limitations prevented perfection of the moving device. Accordingly, development work is continuing.

Major effort is being directed toward incorporating the "killable" characteristic of the stationary device, so that the moving target will not only pop up and disappear, but will also fall when hit during its run.

Further work should also make remote control of the device possible.

Appendix A

DRAWINGS OF THE STATIONARY AND MOVING TARGET DEVICES

FIGURE 1

STATIONARY TARGET DEVICE

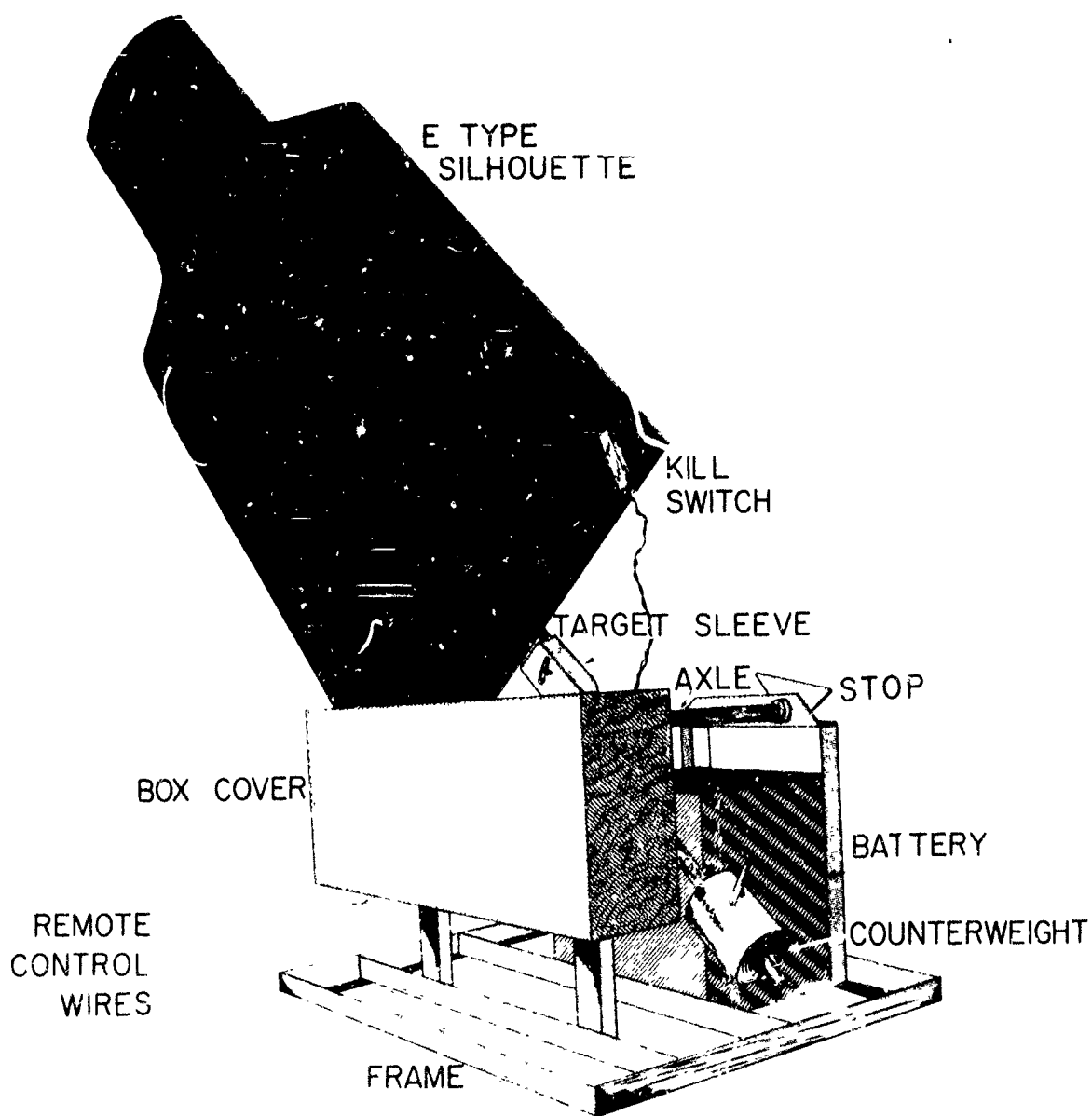


FIGURE 2

STATIONARY TARGET DEVICE
MECHANICAL DETAIL

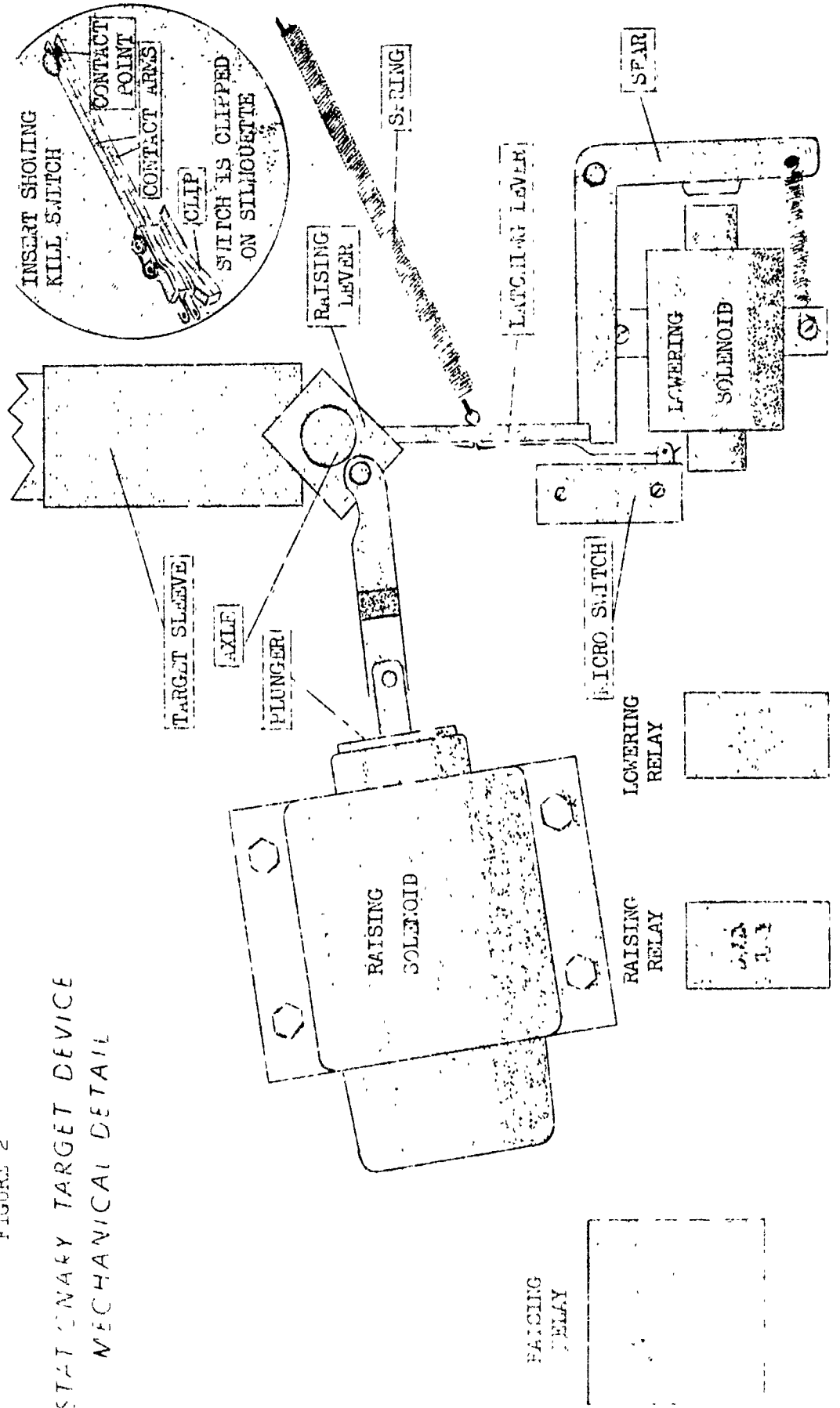


FIGURE 3

MOVING TARGET DEVICE

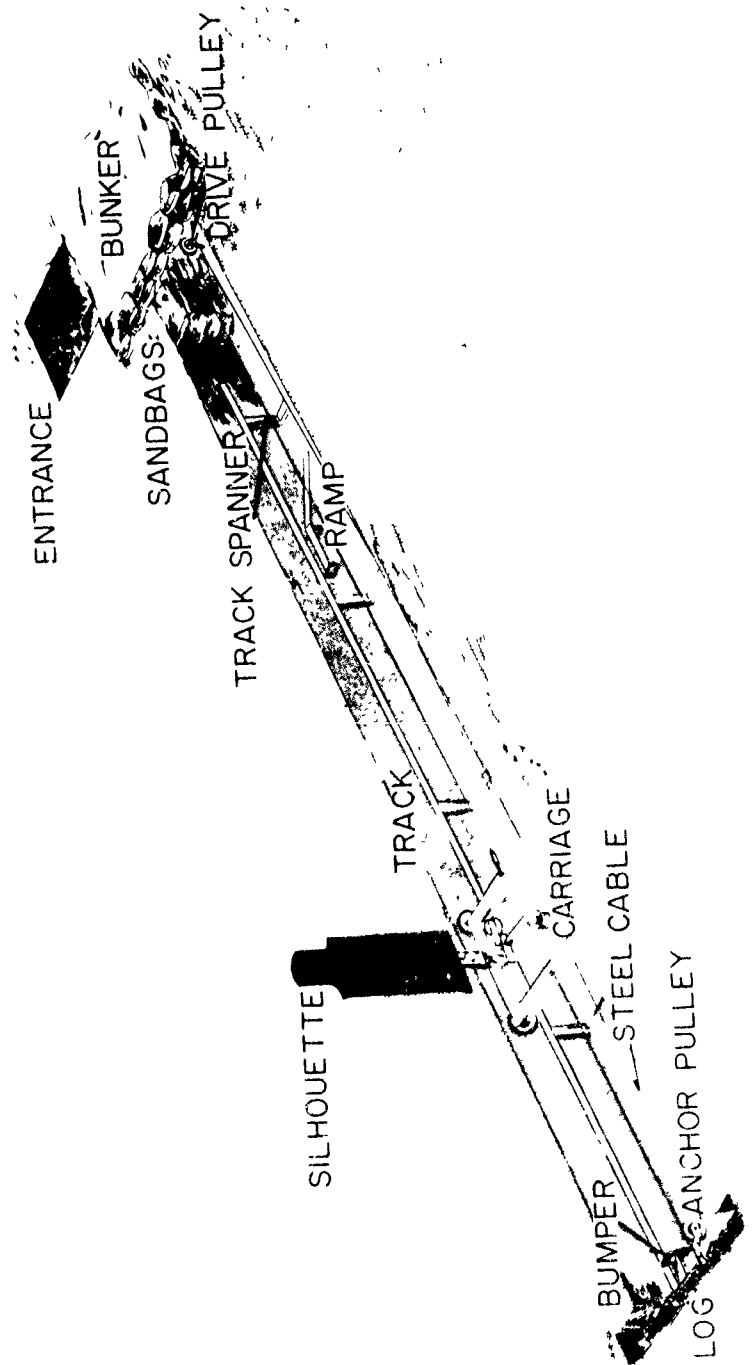
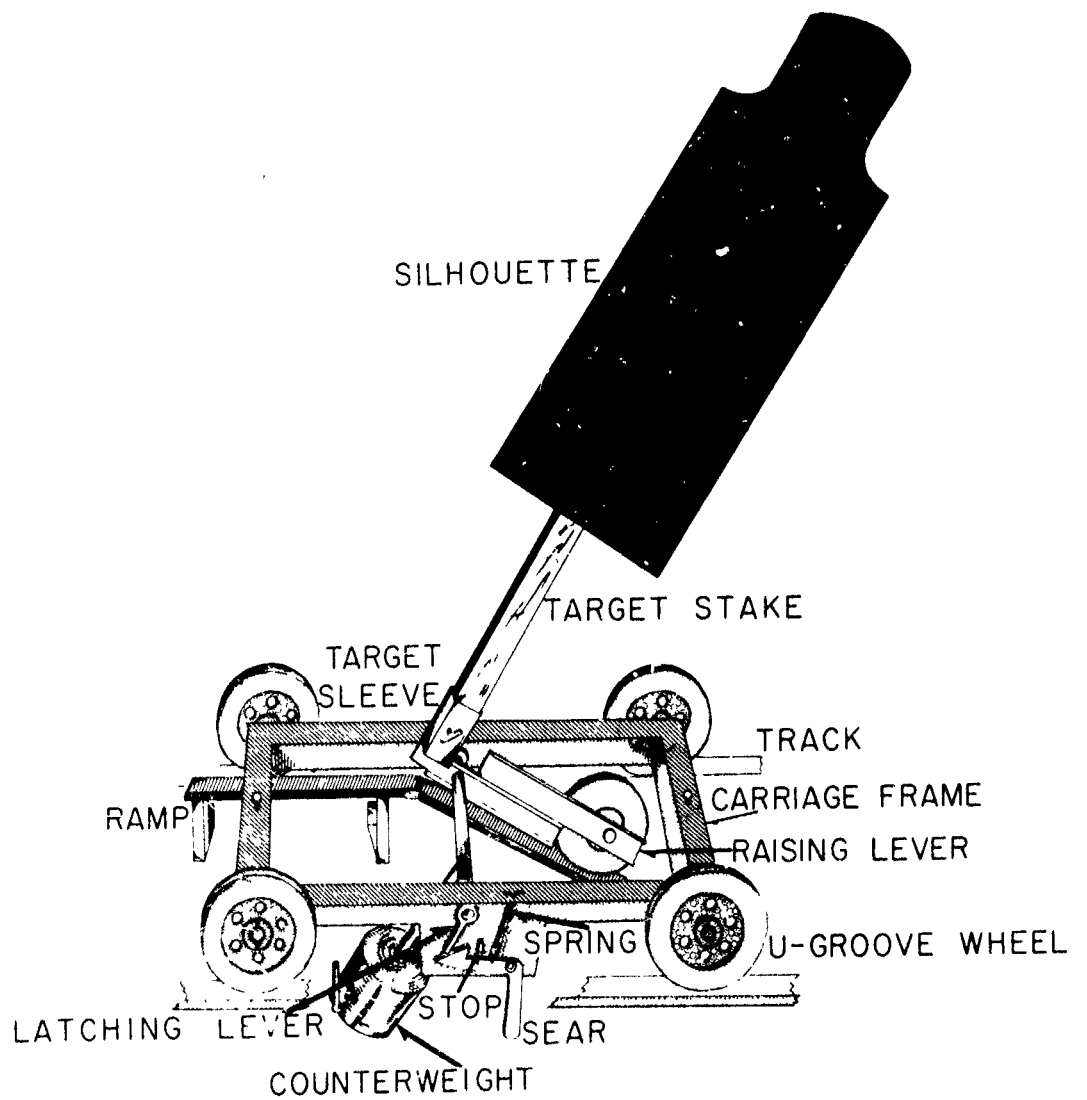


FIGURE 4

MOVING TARGET DEVICE

MECHANICAL DETAIL



Appendix B

DRAWINGS OF CIRCUITRY FOR THE STATIONARY TARGET DEVICE

FIGURE 5

WIRING DIAGRAM

- KEY
1. N/O raising switch.
 2. N/O raising relay.
 3. Pull raising solenoid.
 4. N/O microswitch which is closed when target is up.
 5. N/C kill relay.
 6. N/O lowering switch.
 7. N/O lowering relay.
 8. Push lowering solenoid.
 9. N/C kill switch.

THIS DIAGRAM SHOWS THE COMPLETE WIRING OF PUNCHY PETE. IT INCLUDES THE REMOTE CONTROLS NECESSARY FOR INDIVIDUAL OPERATION OF THE TARGET.

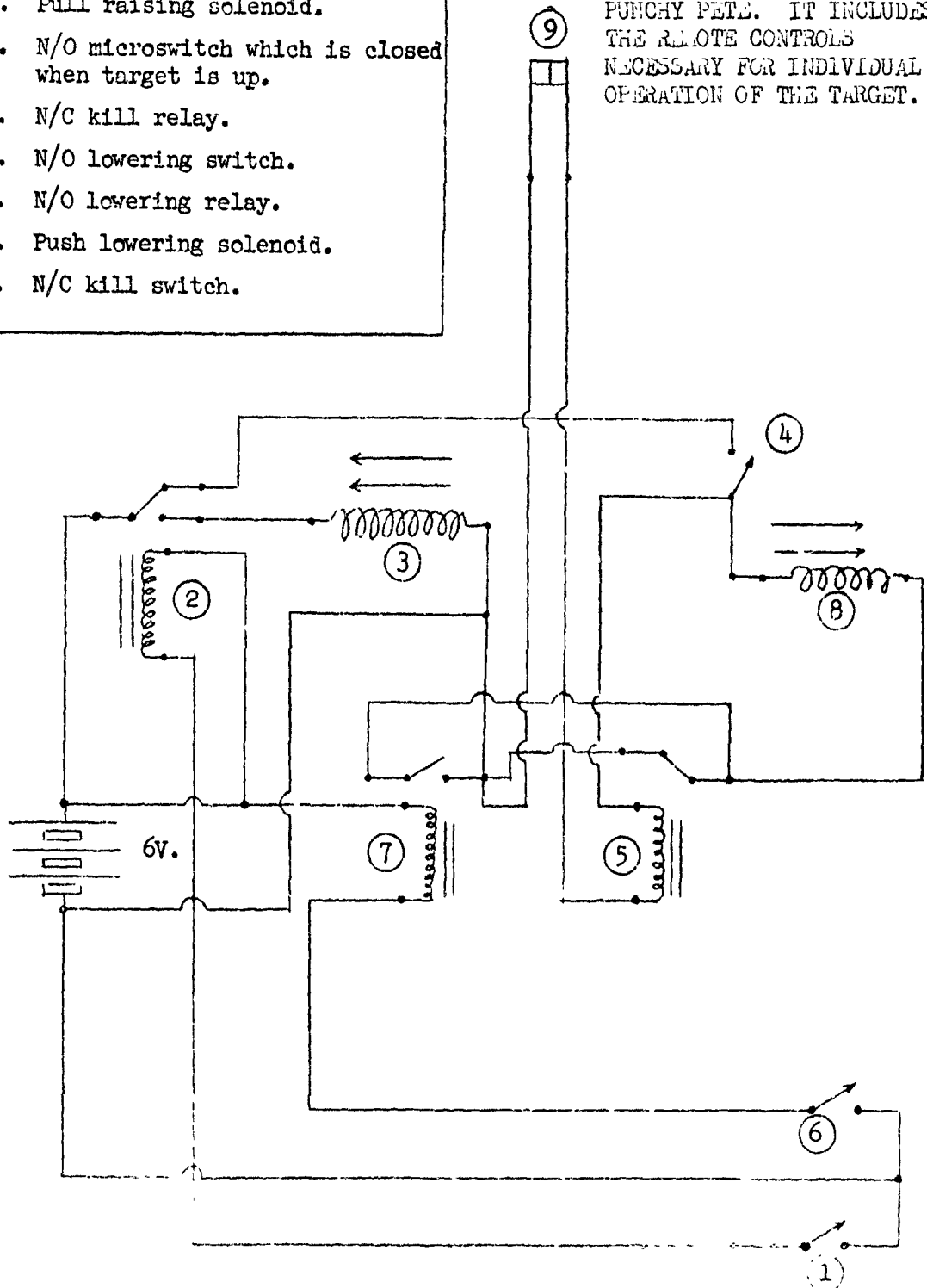


FIGURE 6

SCHEMATIC
WIRING DIAGRAM

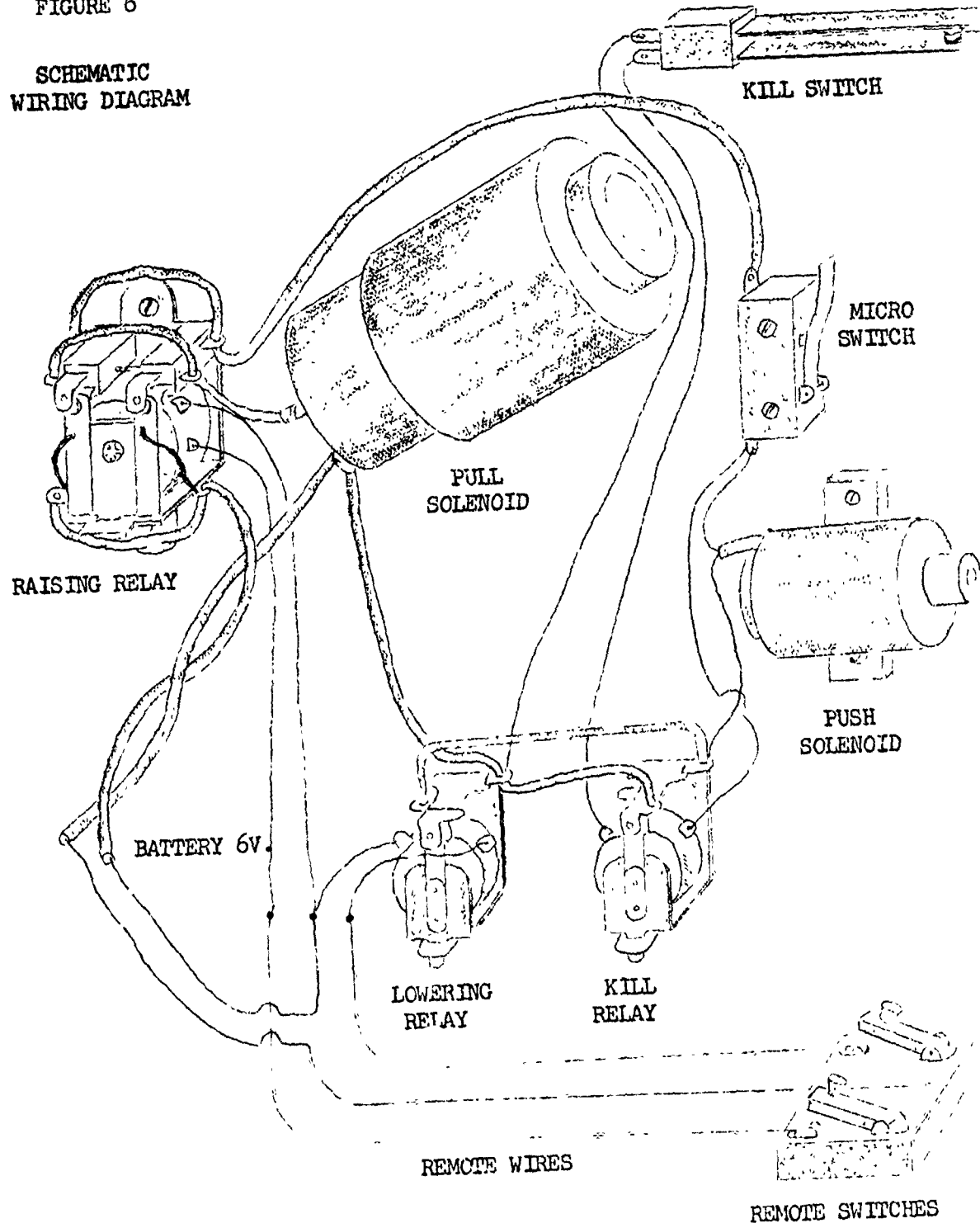
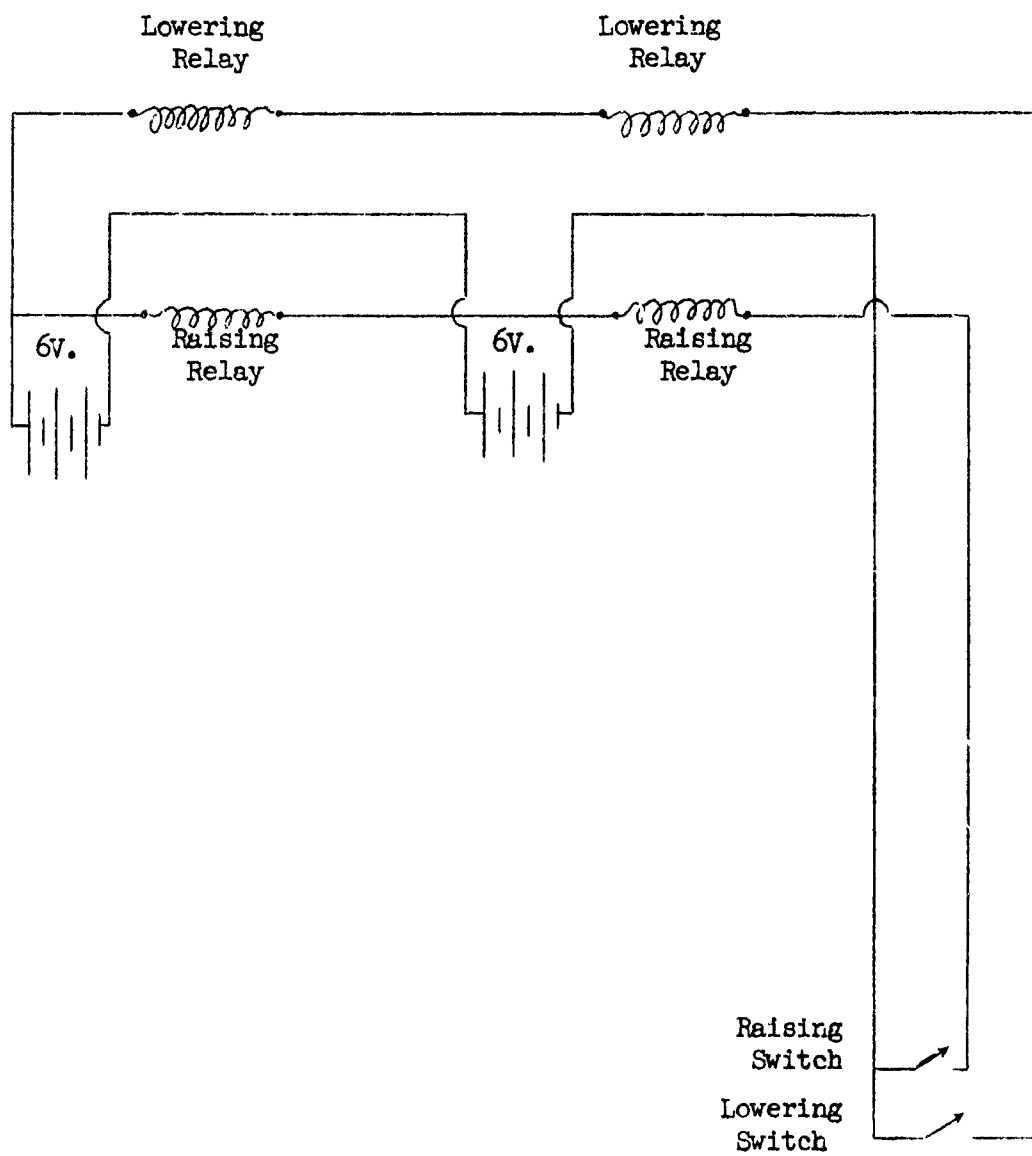


FIGURE 7

DIAGRAM OF TWO TARGETS WIRED IN SERIES



Appendix C

COST ANALYSIS OF STATIONARY TARGET DEVICE

The one hundred target devices employed during TRAINFIRE I were made by hand at the Armament Shop, Post Ordnance, Fort Benning, Georgia. It is anticipated that production engineering will reduce the cost per unit.

PRODUCTION NOTES

(A Breakdown of the Cost of Production per Unit)

A. ELECTRICAL

	<u>ITEM</u>	<u>COST</u>	<u>AMOUNT USED</u>	<u>TOTAL</u>
1.	1118135 Switch, Delco Remy	\$4.78 ea.	1 ea.	\$4.78
2.	1912939 Plunger, Delco Remy	.68 ea.	1 ea.	.68
3.	Solenoid, Pusher, 6V, 3A(hand.made)	4.50 ea.	1 ea.	4.50
4.	MRL1D, D.C. Relay, 6V, 40 ohm	3.47 ea.	1 ea.	3.47
5.	KR5D, D.C. Relay, 6V, 40 ohm	2.00 ea.	2 ea.	4.00
6.	MLB-335, Mu-Switch	.99 ea.	1 ea.	.99
7.	Switch, inertia (hand made)	.25 ea.*	1 ea.	.25
8.	Battery, Allstate Twelve, 6V 300 amp hour	8.95 ea.	1 ea.	8.95
9.	Wire, Belden, 18 gauge	1.45 per 100'	8'	.12
10.	Wire, Belden, 14 gauge	3.60 per 100'	8'	.29
11.	Clip, battery, Mueller #24	.11 ea.	2 ea.	.22
12.	Clip, Mueller, Pee Vee #45	.08 ea.	4 ea.	.32
13.	Lug, 3/8"	.01 ea.	1 ea.	.01
14.	Lug, 3/16"	.01 ea.	1 ea.	.01

*Cost estimated.

TOTAL \$28.59

B. STEEL AND IRON

	<u>ITEM</u>	<u>COST</u>	<u>AMOUNT USED</u>	<u>TOTAL</u>
1.	1" x 1" x 1/8" angle iron	\$.0745 per '	152"	.95
2.	1 1/2" x 1 1/2" x 1/8" angle iron	.1683 per '	10"	.14
3.	1/8" x 8 1/2" x 18" mild steel plate with 5/8" right angle bend	1.30 ea.	1 ea.	1.30
4.	7 1/2 lb cylindrical casting with center core finished to 21/32"	2.25 ea.	1 ea.	2.25
5.	Cover, galvanized iron	3.48 ea.	1 ea.	3.48

<u>ITEM</u>	<u>COST</u>	<u>AMOUNT USED</u>	<u>TOTAL</u>
6. 1" diameter cold rolled round	.27 per'	2½"	.06
7. 5/8" diameter cold rolled round	.111. per'	25½"	.24
8. 3/8" diameter cold rolled round	.045 per'	2"	.01
9. ¼" diameter cold rolled round	.024 per'	2½"	.01
10. 5/8" diameter cold rolled hex-rod	.05 per'	2"	.01
11. ½" x 1" cold rolled flat	.03 per'	1½"	.01
12. ¼" x 3" cold rolled flat	.04 per'	½ of piece 3" x 3"	.01
13. ¼" x 1½" cold rolled flat	.02 per'	5½"	.01
14. ¼" x 5/8" cold rolled flat	.02 per'	2½"	.01
15. ¼" x ½" cold rolled flat	.02 per'	5 3/4"	.01
16. 3/16" x ½" hot rolled flat	.034 per'	1"	.01
17. 1/8" x ½" hot rolled flat	.058 per'	5"	.03
18. 16 gauge steel	.041 per sq.'	3½" x 3¼"	.01
		<u>TOTAL</u>	<u>\$8.54</u>

C. HARDWARE

<u>ITEM</u>	<u>COST</u>	<u>AMOUNT USED</u>	<u>TOTAL</u>
1. 3/8" N.C. hex head cap screw, 1 3/4" long	\$.02 ea.	1 ea.	\$.02
2. 5/16" N.C. hex head cap screw, 3/4" long	.02 ea.	1 ea.	.02
3. ¼" N.C. hex head cap screw, 5/8" long	.02 ea.	2 ea.	.04
4. ¼" N.F. hex head cap screw, 5/8" long	.02 ea.	8 ea.	.16
5. ¼" N.C. allen screw, ¼" long	.005 ea.	5 ea.	.03
6. 6-32 N.C. round head machine screw 1" long	.02 ea.	2 ea.	.04
7. 6-32 N.C. round head machine screw ¾" long	.02 ea.	2 ea.	.04
8. ¼" N.C. wing nut	.015 ea.	2 ea.	.03

	<u>ITEM</u>	<u>COST</u>	<u>AMOUNT USED</u>	<u>TOTAL</u>
9.	1/4" N.F. castle nut	.015 ea.	1 ea.	\$.02
10.	6-32 nut, N.C. plus shakeproof washer to fit	.03 ea.	6 ea.	.18
11.	1/4" lock washer	.005 ea.	11 ea.	.06
12.	3/16" x 1" cotter pin	.003 ea.	1 ea.	.01
13.	1/8" x 3/4" cotter pin	.005 ea.	3 ea.	.02
14.	1/16" x 1" cotter pin	.0009 ea.	2 ea.	.01
15.	#3 tapered pin, 1 1/4" long	.005 ea.	3 ea.	.02
16.	Spring, screen door	.10 ea.	1/10 ea.	.01
17.	Spring, latch return	.01 ea.	1 ea.	.01
18.	Grommet, rubber, to fit 3/8" hole	.01 ea.	2 ea.	.02
			<u>TOTAL</u>	\$.74

D. MISCELLANEOUS

	<u>ITEM</u>	<u>COST</u>	<u>AMOUNT USED</u>	<u>TOTAL</u>
1.	Solder	\$1.38 per lb.	1/30 lb.*	\$.05
2.	Welding rod, 3/16" diameter	.14 per lb.	1 1/4 lbs.	.19
3.	Silhouette target, E type Cardboard	.02 ea.	1 ea.	.02
4.	Stake, wood, 23/16" x 11/16" x 24"	.11 ea.	1 ea.	.11
5.	Staples, Bostich, 5/8" long	.50 per M	10 ea.	.01
6.	Paint, O.D.	6.00 per gal.	1/40 gal.*	.15
7.	Shellac, clear	4.25 per gal.	1/50 gal.*	.08
			<u>TOTAL</u>	\$.61

*Estimate of amount used.

E. LABOR

<u>HOURS LABOR PER TARGET</u>	<u>AVERAGE HOURLY WAGE</u>	<u>TOTAL</u>
18.49	\$ 2.18	\$ <u>40.32</u>

F. TOTALS (Cost per target, all items included)

Electrical	\$ 28.59
Steel and iron	8.54
Hardware	.74
Miscellaneous	.61
Labor	40.32
<u>TOTAL</u>	<u>\$ 78.80</u>

Appendix D

PROPOSED MODIFICATIONS OF THE STATIONARY TARGET DEVICE

A. Structural and Mechanical Components

1. General

Consolidation of parts would allow reduction in the size of the device and make it sturdier and easier to carry. A handle placed at the center of balance would also be desirable.

2. Frame

In order to overcome an axle bind which occurs in the present model when the frame sits on uneven ground, the frame should be more rigid.

3. Axle

To reduce binding the axle should be shorter. In order to achieve balance with the smallest possible counterweight, it is desirable to reduce weight where possible and to make the counterweight shaft as long as frame construction will allow.

4. Plate

Consolidation of parts within the requirement of accessibility for easy repair would reduce the size of the plate.

5. Cover

The box cover should be a watertight, dustproof container, for protection of the enclosed parts.

6. Stop Mechanism

The box cover should enclose this part, to prevent fouling by

twigs, dirt, and mud.

7. Counterweight

The present weight is too heavy to counterbalance an F silhouette. An optimal weight for both E and F silhouettes should be determined.

The design of the thumb-screw adjustment, not always reliable, should be improved.

B. Electrical Components

1. General

All parts should be selected to fit the characteristics of the circuit. At present the margin of effective operation appears to be too narrow. Parts should be water resistant and durable.

2. Plate Micro Switch

The micro switch should be made waterproof and dustproof.

3. Battery

Battery power has been proven to be most satisfactory. The relative merits of 6-volt and 12-volt systems should be investigated.

4. Kill Switch

Since the kill switch is so sensitive and susceptible to damage, it should be a sealed unit requiring no field adjustment.

5. Raising Circuit

In the present model the remote raising switch must be held closed until the raised target has stopped vibrating because this vibration activates the kill switch. A delayed-release relay would function more efficiently than this manual control.

6. Kill Circuit

If this circuit were made a holding circuit, a momentary break of the kill switch would deliver a steady current to the lowering solenoid instead of a short pulse.