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TECHNICAL REPORT 2699

T51 AERIAL EMPLACED MINE-CLEARING DEVICE (CRESSET) (U)

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DECEMBER 1960

NOX

AMMUNITION DEVELOPMENT DIVISION
PICATINNY ARSENAL
DOVER, N. J.

ORDNANCE PROJECT TS1-400NN
DEPT. OF THE ARMY PROJECT 5A07-02-001

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by

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TABLE OF CONTENTS

(C) OBJECT

1. To develop a means for the aerial delivery of linear charges into minefields.

2. To develop a linear charge which, when delivered aerially, will (a) clear lanes in minefields for assault passage of troops and tactical vehicles, (b) clear beach obstacles for amphibious assault troops, and (c) provide a linear blast for the destruction of light structural targets, such as hangar walls.

(C) SUMMARY

A satisfactory system (Cresset) for the aerial delivery of a linear charge into minefields, against beach obstacles, and against light structures was developed. A parachute dispensing system was used, capable of deploying 300 feet of linear charge in a relatively straight line.

In 24 drops made to develop and test various parachute systems and components, an average effective length of 65% was achieved. In 13 later drops made to compile statistical data on the system selected as best, this average was improved to 75%.

Four drops of the system selected as best onto the beach gave an average effective length exceeding 92%. Against inland targets, three drops gave inadequate performance because of defects which have since been eliminated and three were unsatisfactory because of unusually rough terrain and breaking of the arming wires upon release from the aircraft. The arming wire defects have been corrected.

It is believed that an average effective length of 85 to 90% can be expected from the Cresset system. Linear charge effectiveness against antitank mines was well over the minimum requirement of 90% clearance of a 20-foot lane. The average of all clearance results showed 65-foot lanes cleared 90%, 36-foot lanes cleared 100%.

(C) CONCLUSIONS

The clearance capability of the Cresset system meets the requirement specified for the program. The system is ready for service trials and tactical development exercises.

The Cresset system, as developed, can be installed in and carried by all current Marine Corps attack aircraft. Suitably trained pilots will be able to place the linear charge on the target with satisfactory accuracy by using a "seaman's eye" (i.e., on the basis of good judgement and experience).

The Cresset system has the following advantages over other devices for delivering and laying linear charges:

a. Tactical surprise and saturation possibilities are increased.

b. Delivery is performed at high speed, and time of exposure of the attack vehicle to opposing forces is shortened.

c. Control of the area attacked is not required for delivery of the weapon.

d. The weapon stockpile can be quite remote from the area attacked.

e. The delivery vehicle needs no special configuration.

f. The complete weapon can be stockpiled and ready for issue in the same manner as airborne bombs.

The chief disadvantages of the new system are:

a. Aerial deployment of the linear charge will probably never be as accurate as surface launching of a similar charge (for example, by using the XM–125 projected charge demolition kit).

b. Tactical use will require coordination of surface forces with an air arm of the service, introducing an additional function in control not required for a purely surface force operation.

Future military operations may justify increasing Cresset aircraft speeds from 400 knots to 600 knots. Analytical studies, shown in Appendix C (p 99) indicate that the present Cresset container can be adapted for use at such speeds by a relatively simple modification involving only the parachute arrangement.

(C) RECOMMENDATIONS

1. It is recommended that the Cresset munition as presently developed be subjected to final Engineering-User Tests.

2. It is further recommended that, if speeds up to 600 knots are to be required, consideration be given to the parachute system described in Appendix C.

(C) INTRODUCTION

1. (U) This report summarizes the development work performed on the T51 aerial emplaced mine clearing device, also known as Cresset.

2. (C) In 1951, the Marine Corps initiated a project (Ref 1) calling for the development of a linear explosive charge which could be deployed from an aircraft to clear beach obstacles for amphibious assault troops, to clear minefields, and to destroy light structures. The original intent was to lay this charge in the surf, on the beach, or inland by aircraft flying at speeds varying from 50 to 400 knots. Later in the development, the primary concern and interest was in performance at the higher speeds.

Basic Requirements for the Cresset System

3. (C) The military requirements for this device were as follows:

a. The device was to be capable of being coiled, flaked, or otherwise stowed for carrying and drop by tactical aircraft.

b. It was to be capable of being dropped with maximum accuracy by tactical aircraft during low-level attack at air speeds of 400 miles per hour.

c. By means of devices to control the altitude of the charge during the fall, it was to come to rest on the ground in extended position.

d. It was to include suitable means of safely detonating the charge by electronic, time, or other fuzing immediately following impact. Fuze detonator system to function equally well whether the linear charge is dropped on land or in water.

e. It was to have safety features in shipment, on aircraft in flight, and during drop which in all respects meet established requirements for aerial munitions.

f. It was to provide a vehicle path (at least 15 feet wide) in which 90–100% of standard-type antitank mines will be detonated, displaced, or uncovered. The width requirement was later increased from 15 feet to 20 feet (Ref 2).

g. It was to carry an explosive load of approximately 5 pounds of Comp C–4 per linear foot, or equivalent.

h. It was to be at least 300 feet long. Additional attachable 100-foot segments to provide increased length are considered desirable.

Fuze Requirements

4. (U) In order that a reliable, safe fuze might be developed, certain requirements were established. These were that the fuze:

a. Meet the requirements of the following environmental tests:

(1) MIL–STD–300 jolt test

(2) MIL–STD–301 jumble test

(3) MIL–STD–302 40-foot drop test

(4) MIL–STD–303 transportation vibration test

(5) MIL–STD–304 temperature humidity test

(6) MIL–STD–306 salt spray test

(7) High and low temperature test

(8) Underwater functioning test

(9) 100-foot drop test

b. Not arm until the linear charge is far enough from the aircraft to insure the safety of the aircraft.

c. Function after the linear charge has come to rest on the target. An adjustable time delay of 5 to 92 seconds was established.

d. Be safe when unarmed. That is, if a detonator is fired from any cause whatsoever, it will not cause functioning of a booster or any successive part of the explosive train.

e. Pass an out-of-line firing test.

Working Responsibilities and Relationships

5. (U) The Ordnance Corps was assigned technical control and supervision of this project (Ref 2). Picatinny Arsenal was to be responsible for the complete development of an aerial line demolition charge for the Marine Corps in accordance with Marine Corps military requirements. Specifically, Picatinny would develop the linear charge, fuze, and explosive propagation technique. Initially Picatinny would provide Naval Air Development Center (NADEVCEN) with 5 inert linear charges for use in development of the linear charge dispensing technique.

6. (U) The Naval Bureau of Aeronautics (BuAer) was given responsibility for developing essential aircraft carrying and drop material for use with the aerial linear demolition charges, and for advising the Ordnance Corps on aeronautical features of the design. BuAer assigned this work to NADEVCEN under project ADC–AR–8003.

7. (U) The project originally included requirements (Ref 4) for development of a similar dispensing system for a smaller linear charge to clear antipersonnel mines. Helicopters were to be considered as delivery aircraft for both systems, even though different types of dispensers might be required for fixed and rotary wing aircraft. As the project developed, however, emphasis was placed increasingly on the linear charge to clear antitank mines. Development of the smaller charge and also of systems for dispensing the linear charges from helicopters was postponed.

8. (U) Responsibility for the preparation of a handbook on the final Cresset design (Ref 4) was assigned to Picatinny Arsenal during a conference on 10 and 11 April 1956 (Ref 5).

(C) GENERAL DESCRIPTION OF CRESSET

9. (C) The system eventually selected, after a series of design studies and 37 aerial drop tests, calls for a bomb-shaped container (the T4 dispenser) in which a 300-ft linear charge (designated T96) is stored. A T1304 mechanical time fuze is housed in the nose of the dispenser. In operation (Fig 1, p 6), the aircraft releases the dispenser while flying at an altitude of 300–400 feet and at a speed of 300–400 knots. A parachute system is used to draw the linear charge from the dispenser, slow both dispenser and linear charge down during their descent, pull the linear charge straight, and maintain the charge in a position relative to the dispenser and the ground which will ensure a straight layout after impact. Total time of fall is from 5 to 6 seconds. A delay mechanism, presettable for 7 to 92 seconds, is incorporated in the fuze to allow time after impact for the linear charge to settle to the bottom of a body of water, for greater effectiveness against submerged mines. To provide safety in use, the linear charge fuze is designed with two safety pins, which must be drawn in proper sequence before the fuze is armed. In case

of accidental release or deliberate jettison, the first pin is not pulled and the fuze remains unarmed.

Linear Charge

11. (C) The linear charge (Figs 2 and 3, pp 7 and 8) consists of 400 individual wax-coated pellets of Comp C–4 explosive (minimum density, 1.5 g/cc) attached with fiberglas tape in opposed pairs along a ¾-inch-diameter nylon rope. Each pellet weighs 1.25 pounds and is enclosed in a plastic bag. The rope is made up in three 100-foot sections, bolted together to make the required total length of 300 feet. Three strands of 100-grain PETN detonating cord, each 156 feet long, are attached along the ¾-inch nylon rope to propagate the initiation and detonation of the linear charge. Primacord splices adjacent to the bolted linkages provide explosive continuity between the 100-foot sections. Two 24-gage knitted nylon sleeves cover the entire assembly. The sleeves are tied together with nylon cord between pellets, giving the linear charge the appearance of linked sausage. The linear charge has an explosive weight of 5 pounds per foot and a gross weight including cover and accessories of 1730 pounds.

Fuzing

12. (U) The fuze is a mechanical-time type with a selection of delays ranging from 7 to 92 seconds (Fig 4, p 9). It is provided with two arming pins which must be pulled in the proper sequence before the fuze will operate. The first pin is pulled by one of the dispenser arming wires as the dispenser leaves the aircraft. The second arming step occurs, if the first has been completed, as the last of the linear charge leaves the dispenser. When arming is accomplished, the detonator slide is free to move in line with the booster and detonator. After the clockwork time delay has run the preset period, the striker is released and initiates the firing train.

Dispenser

13. (C) The dispenser is a 17-foot-long cylindrical body (Fig 5, p 10) designed to house the linear charge, fuze, and line-deploying parachutes. It is aerodynamically shaped to permit external mounting on high speed aircraft and safe dropping at speeds of up to 450 knots. The usual altitude range is between 300 and 500 feet.

14. (U) The linear charge is packed in the dispenser (Fig 6, p 11) in a double coil and so arranged that it can be easily pulled out of the aft end just as a length of twine is pulled out of the center of a ball. The arming wire for the explosive tail decouplers on the rear of the dispenser is attached to the bomb rack or aircraft structure in such a manner that it is always pulled whenever the munition is separated from the aircraft. This provision assures that the line will always be deployed, armed or safe, whether released intentionally or not. The explosive tail decouplers, activated by 2 M–3 initiators (Fig 7, p 12), blow the fairing assembly from the dispenser.

15. (C) After the tail fairing is released, it discharges a 72-inch parachute,

Fig 1 Typical Delivery of Cresset Linear Charge

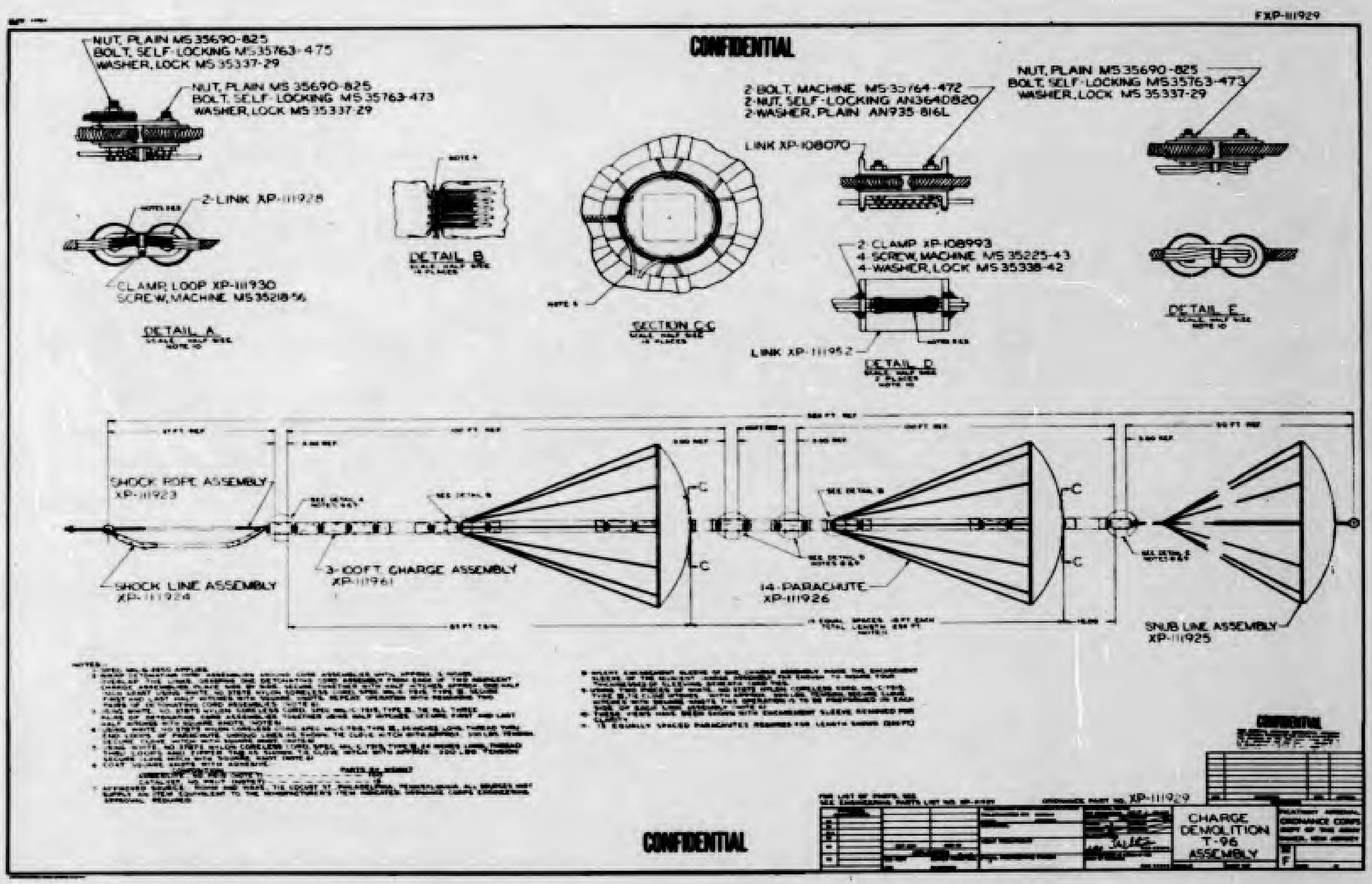


Fig 2 T96 Linear Demolition Charge, Assembled

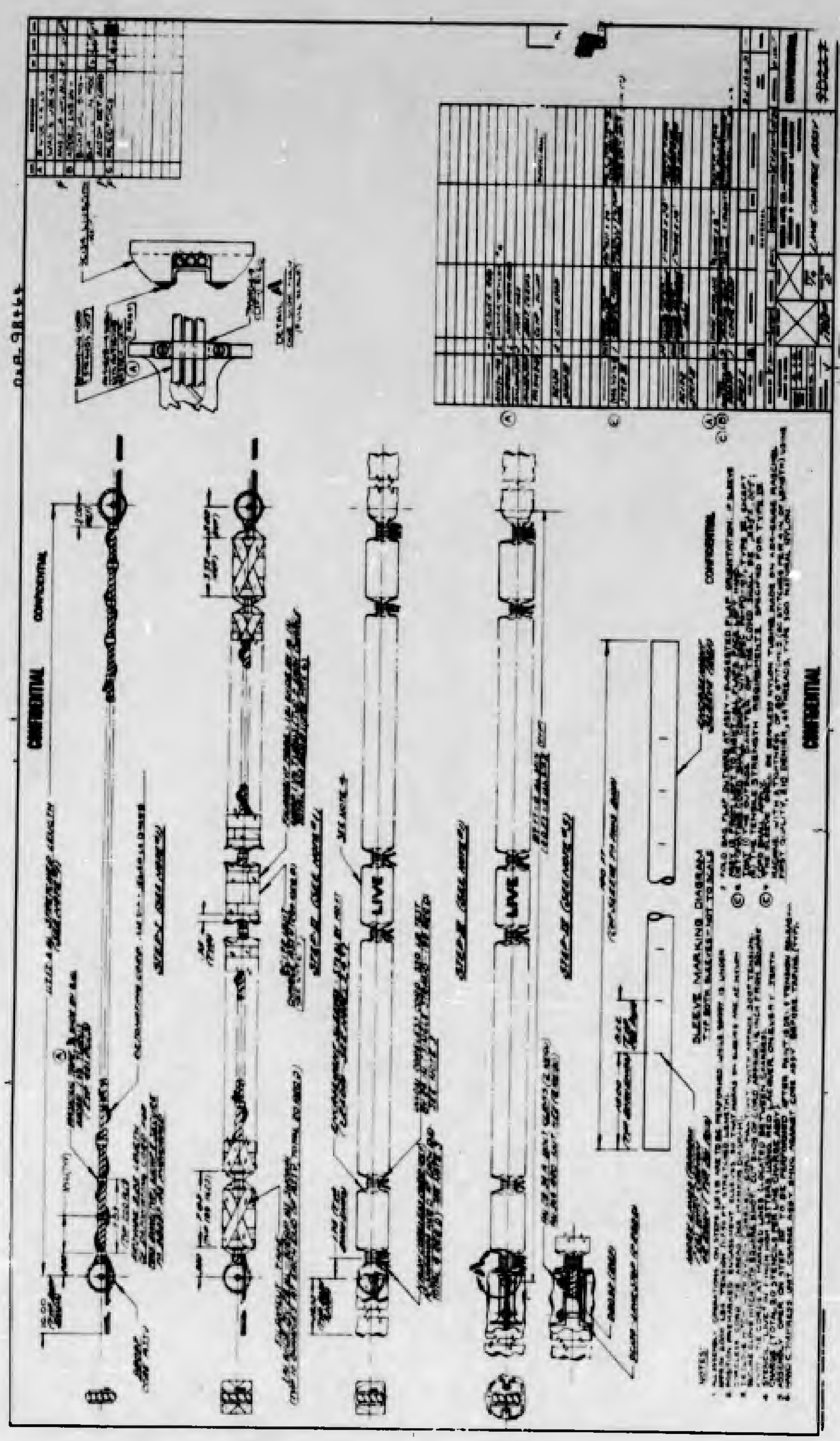


Fig 3 One-Hundred-Foot Segment of T96 Linear Charge

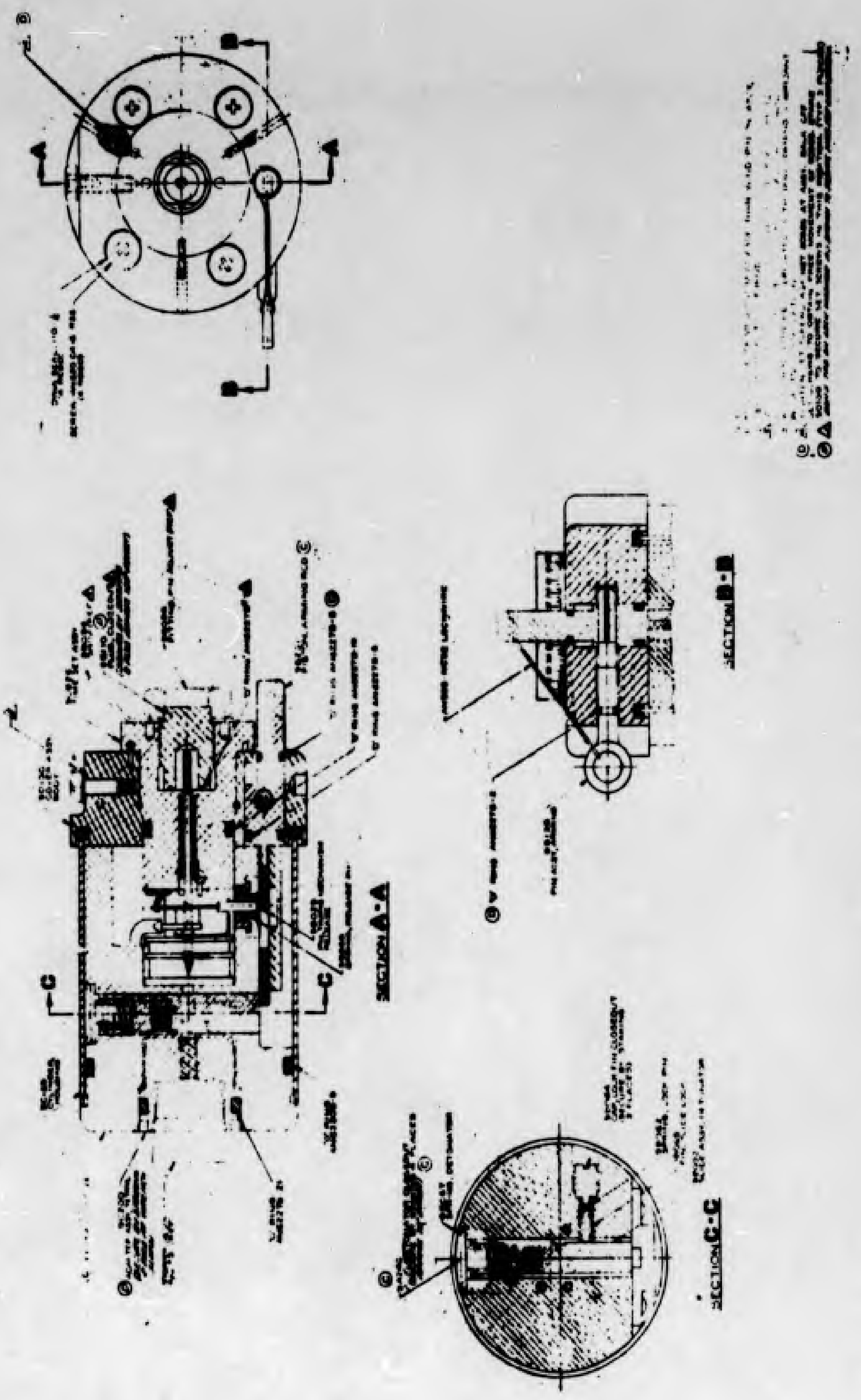


Fig 4 T1304 Mechanical Time Fuze

Fig 5 External View of Dispenser

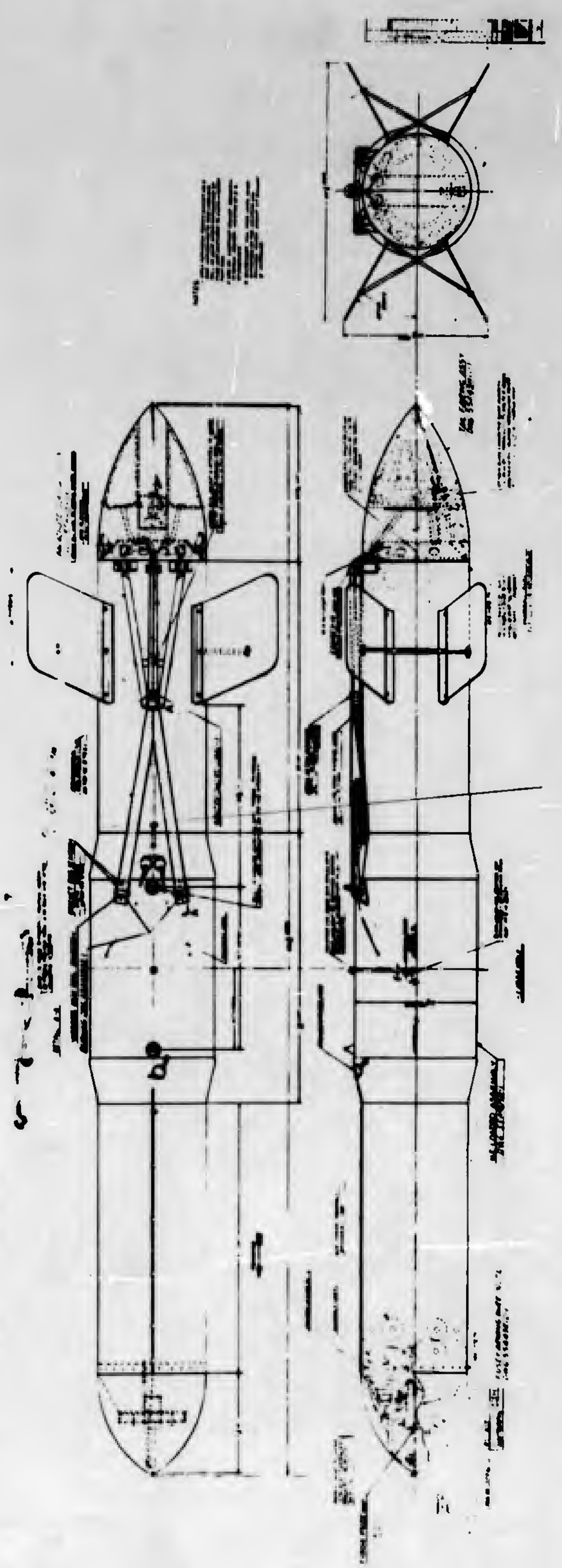


Fig 6 Loaded T4 Dispenser

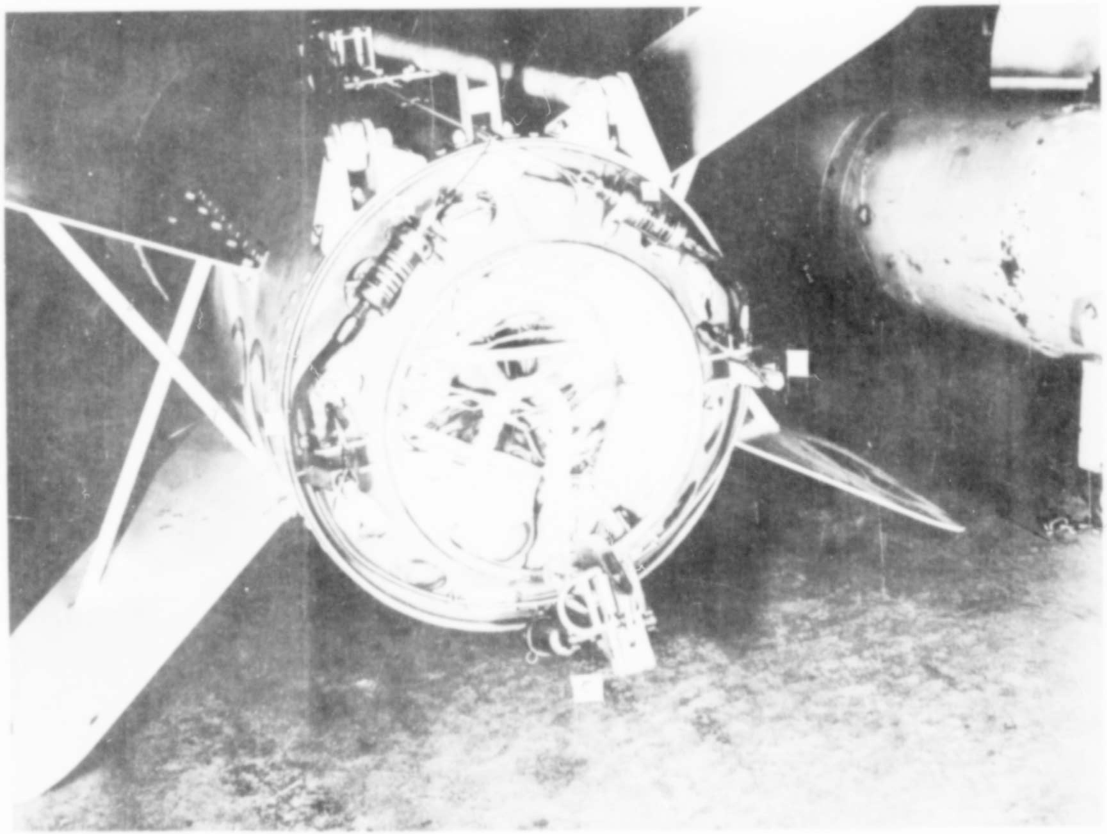


Fig 7   End View of Dispenser Body (with Tail Fairing Removed), Showing (A) M3 Initiator, (B) Explosive Tail Decouplers, and (C) M27 Initiator and Parachute Release Mechanism

a 54-inch parachute, and a parachute-release mechanism which is attached to the 72-inch chute. The 72-inch parachute starts payout of the linear charge. The 54-inch parachute attached to the dispenser serves to reduce the forward velocity of the dispenser and to keep its rate of descent lower than that of the linear charge. Two seconds after release from the aircraft, the parachute release mechanism, utilizing T27 initiators and M38 delay cartridges, automatically and explosively decouples the 72-inch parachute from the linear charge. Removal of this chute allows the tail end of the linear charge to fall and impact first, ahead of the forward end. The drag produced helps to straighten the charge out. One 36-inch-diameter parachute 1½ feet from the tail end and fourteen 42-inch-diameter parachutes mounted coaxially on the linear charges at 18-foot intervals along its length continue deployment of the charge from the dispenser and decrease its forward velocity. The overall parachute system slows the linear charge and dispenser so that the assembly contacts the beach at about 100 feet per second and lies in a relatively straight line.

Shock Line Assembly

16. (U) The shock line assembly (Fig 8, p 14) consists of 50 feet of ¾-inch-diameter nylon rope (10,000 pounds minimum breaking strength) with a 37-foot length of ⅜-inch-diameter nylon rope (2700 pounds minimum breaking strength) spliced to it at each end. Metal thimbles are attached at both ends with conventional 5-tuck tapered eye-splices. Three strands of 100-grain primacord, each 87 feet long, are routed along the entire length of the ¾-inch-diameter rope with the same routing used on the 100-foot linear charge sections. On the forward end of this primacord, an adapter is provided to permit connection, upon assembly, to the fuze adapter at the forward end of the dispenser. The ¾-inch-diameter nylon rope and primacord are encased for protection in a 1½-inch-diameter seamless nylon knitted sleeve.

17. (C) The shock line assembly has three purposes. First, it serves as a connecting link between the linear charge and the dispenser. Second, it absorbs much of the initial shock that occurs between the dispenser and the linear charge just after complete linear charge payout. This force is partially absorbed by the elongation and then separation of the ⅜-inch nylon rope. Third, it provides explosive train continuity between the fuze assembly and linear charge assembly. The shock line was designed to conform to the requirements specified by the Naval Air Development Center.

Extraction Line Assembly

18. (C) The extraction line assembly (Fig 9, p 15) consists of one 3-foot section and one 50-foot section of ¾-inch-diameter nylon rope. At the end of the 3-foot length is a parachute release mechanism to which is attached the 50-foot section. At the end of the 50-foot section one 72-inch guide surface parachute is attached by splicing the parachute shroud lines into the lay of the ¾-inch nylon rope. Two connecting links and attaching bolts are provided at the forward end of the

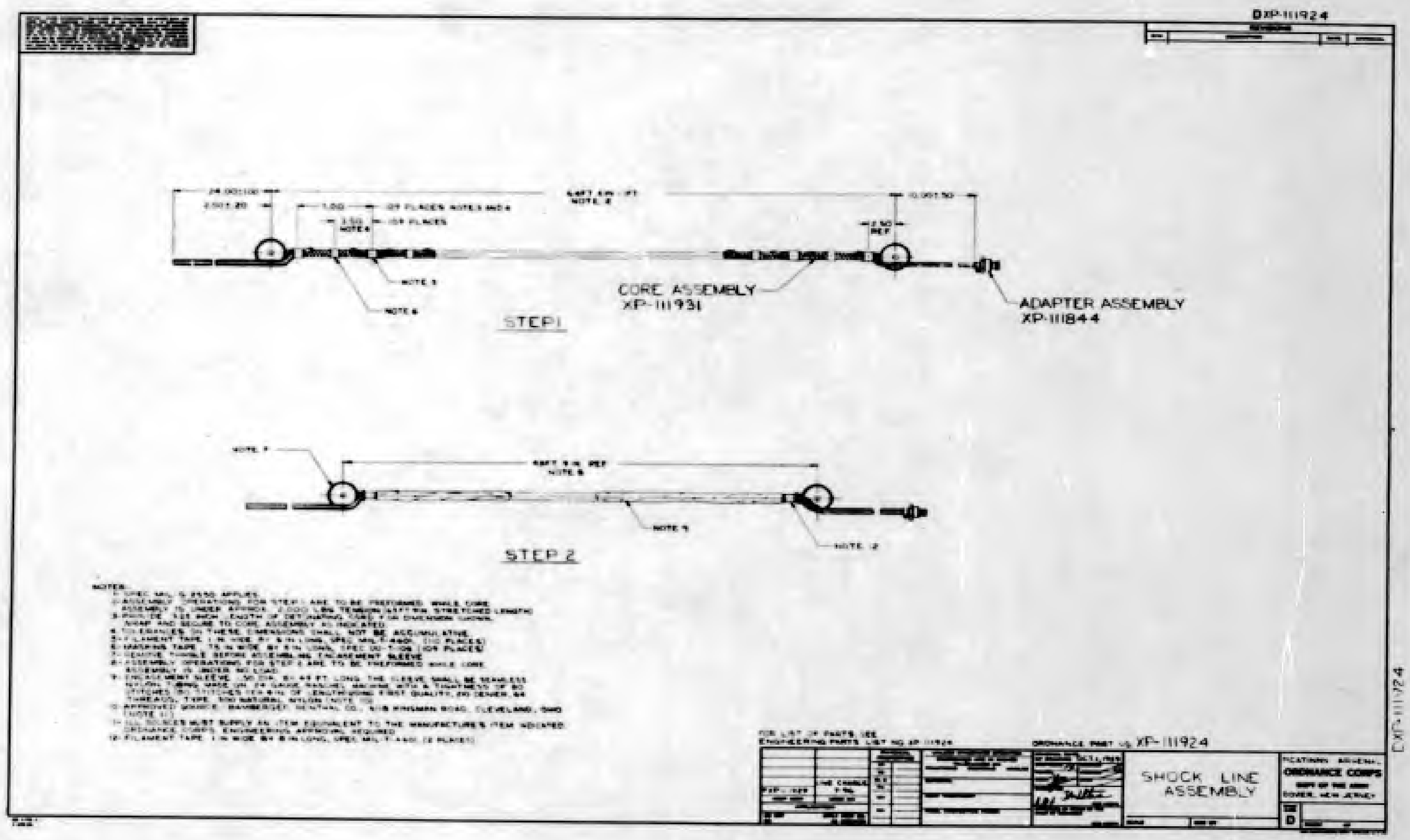


Fig 8 Shock Line Assembly

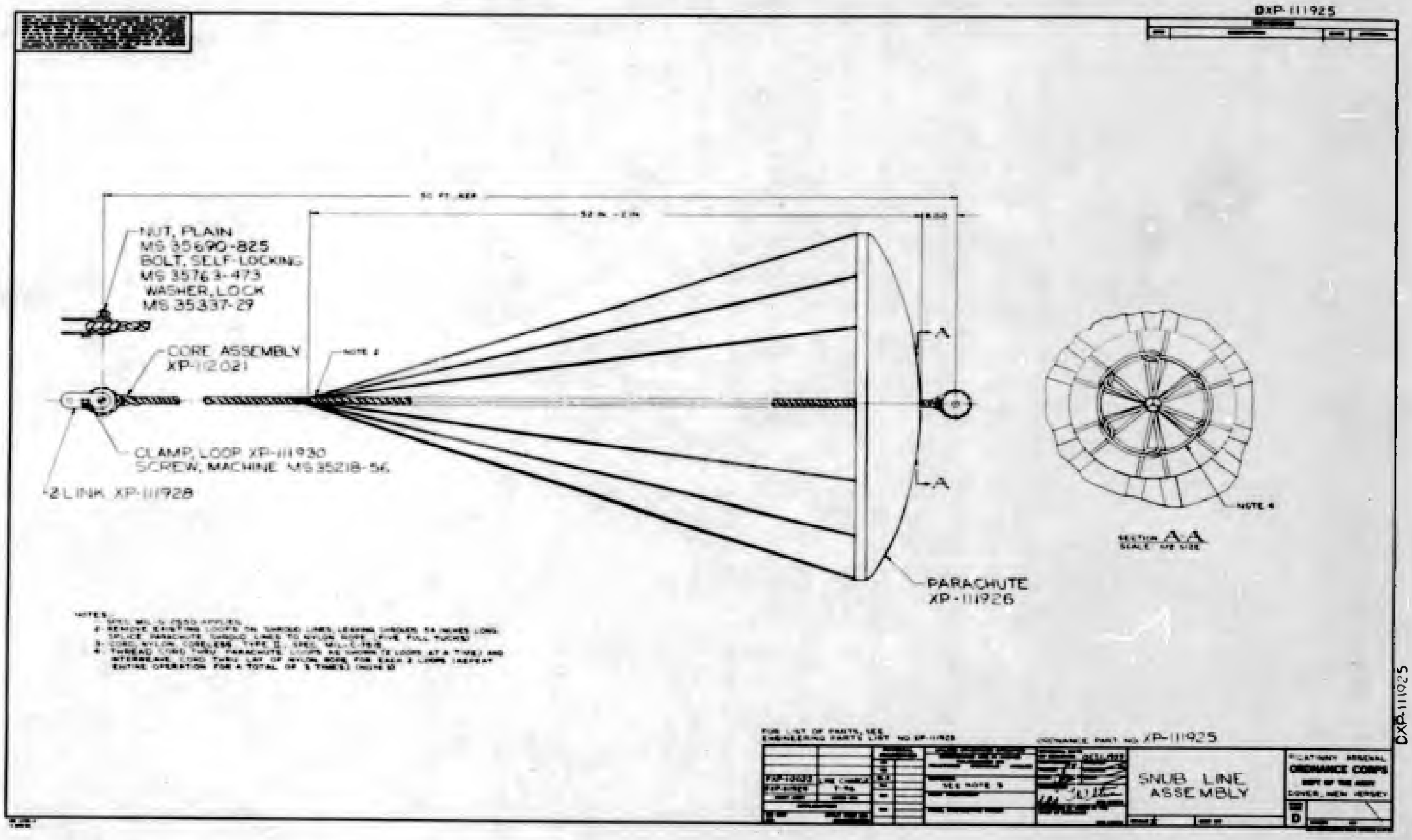


Fig 9 Extraction Line Assembly

3-foot section to provide attachment to the linear charge assembly. Figure 9 (p 15) depicts the complete system assembly when deployed.

(C) DEVELOPMENT AND TESTING OF CRESSET

19. (U) The 37 aerial drop tests involved in development of the Cresset system are described in some detail below, together with tests of the minefield clearing capabilities of the linear charge under various temperature and soil conditions, environmental tests of the linear charge, and fuze development tests. Other tests – structural adequacy of the Cresset container, vibrational characteristics of Cresset, strength of lugs and arming wires, and structural adequacy of the "A" frame and associated webbing – are reported in Appendixes B through E of Reference 39.

Development of Aerial Dispensing Mechanisms and Techniques

20. (U) Before any drop tests were conducted, the Naval Air Development Center (NADEVCEN) conducted theoretical studies of various methods of aerial delivery of line charges. Details of their findings – which covered the use of drogues (or sea anchors), harpoon-type land anchors, retro-rockets, and parachutes – are given in Appendix A (p 82). Parachute delivery was found best in terms of simplicity, low cost, reliability, availability, and reasonable accuracy in laying the linear charge on the beach.

Drops 1 through 11

21. (C) In aerial drop tests 1 through 11, various combinations and arrangements of parachutes were tested (See Appendix B, p 88, for details), and a delivery system was developed which performed satisfactorily under low-speed (225-knot) release conditions. However, when tested at higher speeds (300–400 knots), this system proved unsatisfactory and considerable changes were required in chute arrangement, initiator design, and dispenser fin and tail cone configurations. Figure 10 (p 17) portrays the final delivery system.

Drops 12 through 24

22. (C) In this series of aerial drop tests (Figs 11 and 11a, pp 18 and 19; and Table 1, p 21), a parachute delivery system suitable for use under conditions of high-speed release was developed. In addition to evaluating various arrangements of parachutes, this series included tests (Drops 22–24) to determine the usefulness of drogues and scoop anchors in retarding or anchoring the tail end of the linear charge during drop and on impact. These devices were unsuccessful. The final design, shown in Figure 10 and described in the GENERAL DESCRIPTION section, combined the best features of all of the designs used in Drops 12 through 24. Several failures which occurred in drops 12 through 21 were attributed primarily to improper operation of two component parts of the system. These were the dispenser supporting chutes and the parachute release mechanism containing the M4 initiators. Failure of drop 16 was charged to human error rather than design error. Drops 14, 15, 17, 18, and 19 showed failure of both of the above-mentioned

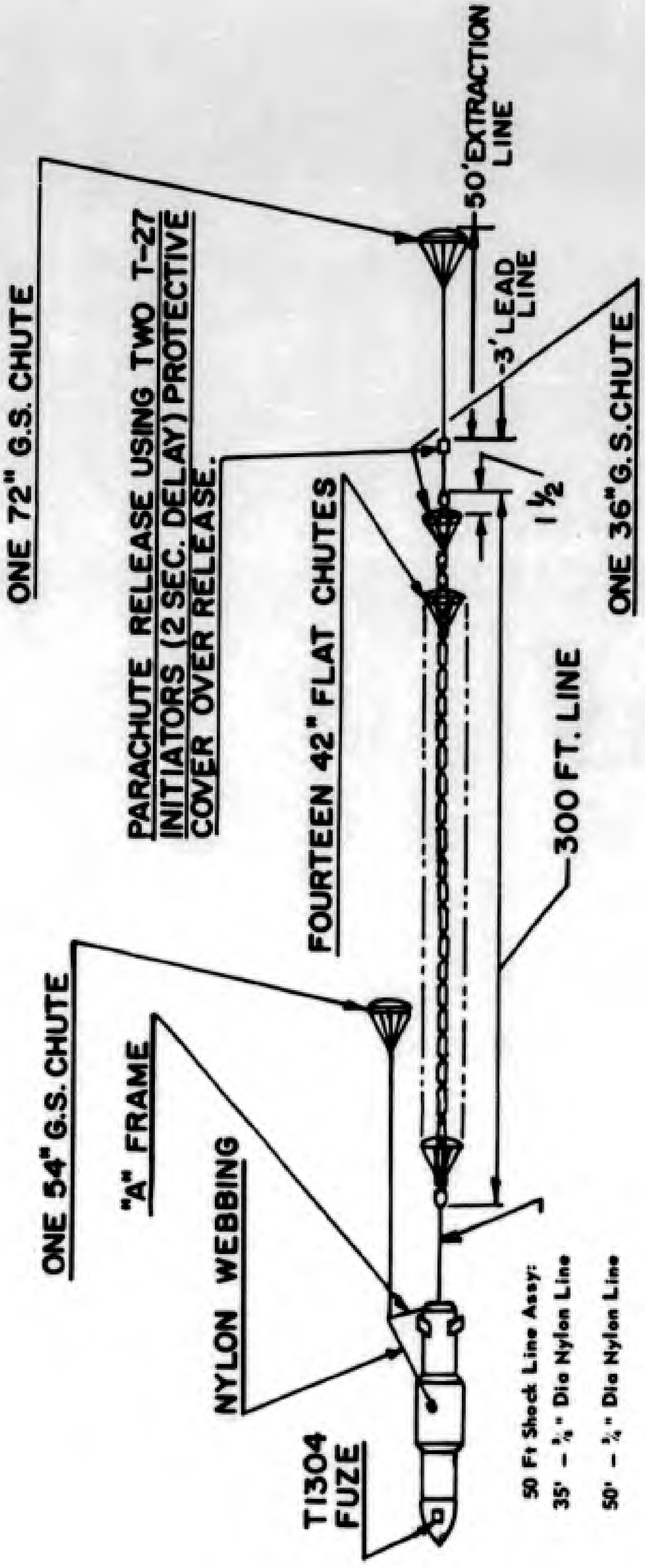


Fig 10 Final Cresset Design

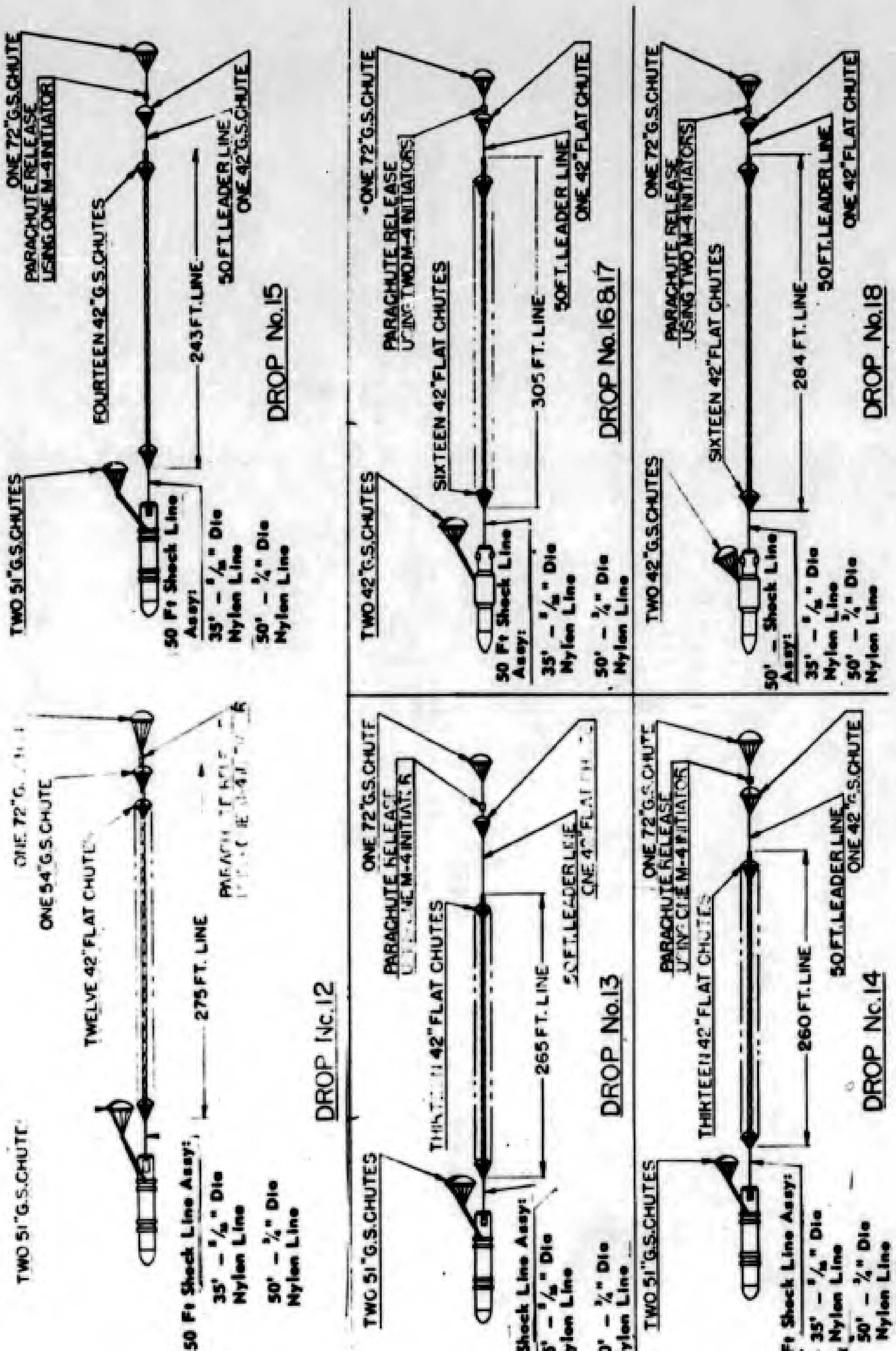


Fig 11 Aerial Deployment Configurations, Drops 12 through 18

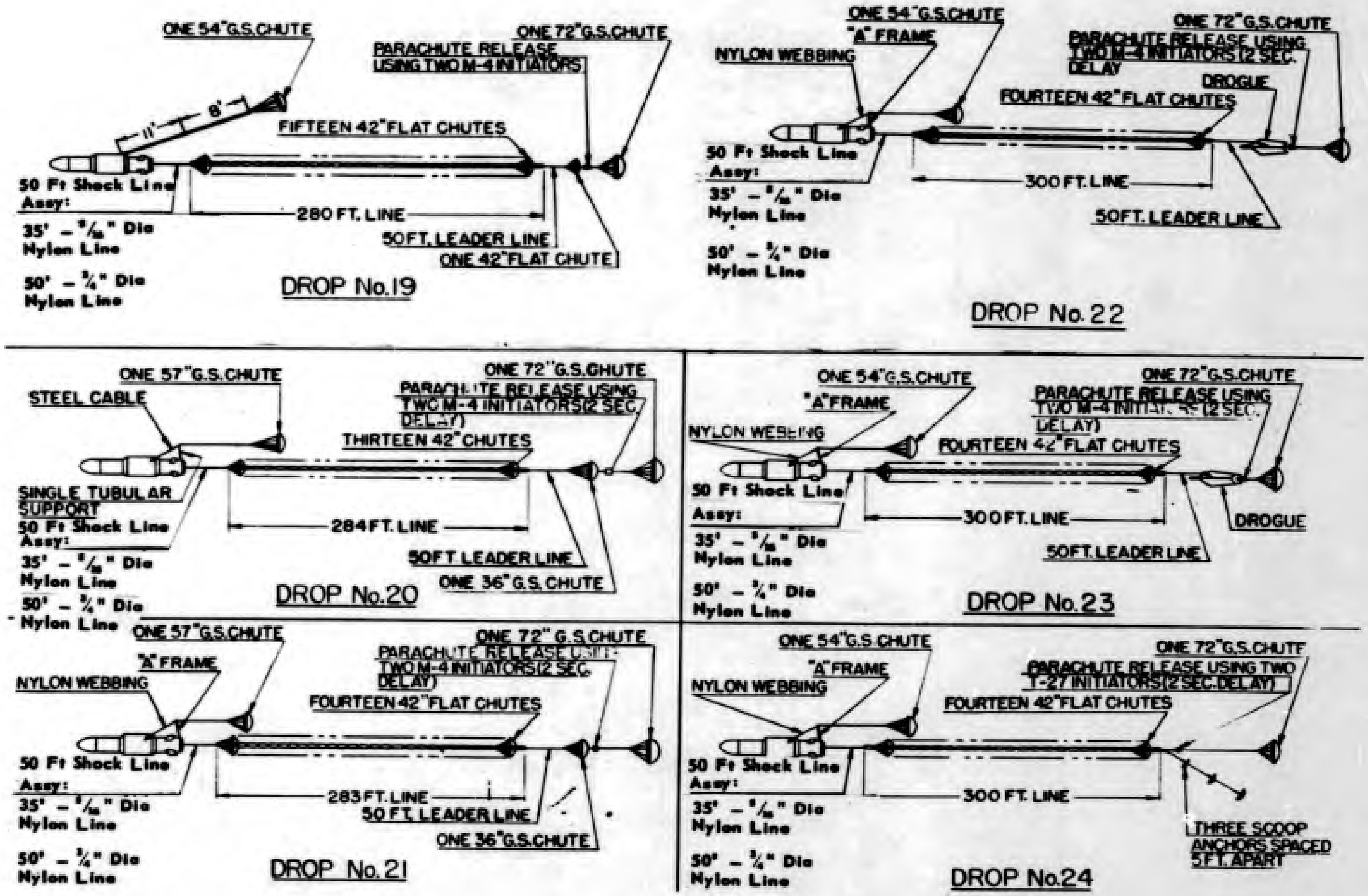


Fig 11a Aerial Deployment Configurations, Drops 19 through 24

component parts. Drop 20 had an ineffective dispenser chute and drop 21 a fouled release mechanism. All other component parts and assemblies operated satisfactorily during the tests. Drops 22–24 proved that an "A" frame design would solve the dispenser chute problem.

Drops 25 through 37
(Tests of Final Design)

23. (C) Three check tests (drops 25 through 27) were conducted before the statistical test program was begun, to resolve deficiencies in the final design. These Cressets, which were dropped onto beach terrain, gave effective lengths of 64%, 97%, and 91%. In drop 25, the dispenser was seen to roll and many zipper failures in the linear charge chutes were noted. One fuze failure (Drop 26) occurred.

24. (C) The last ten aerial tests (drops 28 through 37) were conducted to provide statistical data on the performance of the final design under various conditions of loading (inert, partially explosive loaded, fully explosive loaded) and of terrain (beach vs inland). The four partially loaded Cressets contained explosive sections at the front and rear ends and explosive detonating cord throughout the linear charge and the shock line. Results are given in detail below and in Table 1 (p 21).

25. (C) Two inert-loaded Cressets dropped onto the beach from an A4D aircraft at Chincoteague, Virginia gave effective lengths of 77% and 93% (drops 28 and 29). The 54-inch dispenser chute was severely damaged in drop 28 but not significantly damaged in drop 29. On both drops, the fuzes functioned satisfactorily.

26. (C) Two partially explosive-loaded Cressets were dropped onto the beach from an A4D aircraft (Drops 30 and 31). On drop 30, the linear charge broke in the air at a point 100 feet from the rear end. Drop 31 gave an effective length of 101% (Fig 12, p 22). In both cases, the fuze functioned properly and the shock line was initiated. The propagation of the detonation in each shock line was incomplete; it travelled only 4 feet on drop 30, and 26 feet on drop 31. After drop 31, the linear charge was initiated by a blasting cap and detonated completely.

27. (C) One inert-loaded Cresset, when dropped inland from an A4D aircraft at Quantico, Va., gave an effective length of 32% (drop 33). The 54-inch dispenser chute was severely damaged, the 72-inch line chute failed to cut off, and the linear charge separated in flight at its junction with the shock cord.

28. (C) Two partially explosive-loaded Cressets dropped inland from an A4D aircraft at Quantico, Va., (Drops 32 and 34) gave effective lengths of 82% and 59%. The 54-inch dispenser chutes were damaged in both cases, severely in drop 34. Both fuzes functioned and initiated the shock lines. One shock line initiated 5 to 10 feet of the detonating cord in the linear charge and the other failed to detonate completely. Numerous

TABLE 1

Results of Aerial Drops 12 Through 37

Drop No. and Date	Type of Loading: Shock Line	Type of Loading: Line Charge	Release Altitude, ft	Release Velocity, knots	Effective Length, ft % Straightness	Functioning: Fu	Functioning: Shock Line	Functioning: Linear Charge	Target Miss Distance, ft	Comment
12–10/28/54	5/16 nylon, 37'	4.5" OD Inert	480	310	200/73	AN–M–146 type, OK	OK	OK	Not applicable	Release functioned properly.
13–1/4/55	Lost at sea because of defective bomb rack on F3D–2									
14–5/10/55	5/16 nylon, 37'	5.575 lb per ft	224	327	205/79	AN–M–146 Failed	OK	OK	300	M4 initiator did not release aft chute. Dispenser chute damaged.
15–8/23/55	"	"	228	400	181/78	Rheem. OK	OK	OK	No target used	Release did not function. One 54" dispenser chute torn by linear charge.
16–12/20/55	"	"	263	393	–	–	–	–	"	Defective arming wire. Tail fairing not ejected by M3's.
17–2/29/56	"	One nylon cover	228	374	254/83	OK	OK Primacord failed	Severely damaged No continuity	"	Line chg and disp. chutes badly damaged. Did not release.
18–3/22/56	"	Two nylon covers	271	393	245/87	"	OK	Some damage 18" gap	"	Premature release made. Disp chutes not completely effective.
19–7/18/56	Flexible copper covering	"	286	397	135/50	"	"	Slight damage,	"	Premature release caused severe damage to disp. chute w/extended visers.
20–9/19/56	"	"	259	415	80/30	–	Failed	Severe damage	"	Disp. chute and support failed. Dispenser sep. from line chg.
21–4/12/57	"	"	158	423	186/66	OK	"	Minor damage	26'	High impact velocity. 72" chute shroud lines fouled release mech.
22–7/26/57	"	"	350	180	162/58	"	–	OK	No target used	Drogue used at aft end. F3D–2 rack would not release. Payout not complete.*
23–8/24/57	"	"	138	410	100/33	"	Failed	Minor damage	"	Drogue used. Payout not complete.
24–10/16/57	No cover	"	245	393	200/66	–	OK	Minor damage	"	72" chute cut off too soon by anchors. Impact too high.
25–3/28/58	Inert	Inert	335	397	192/64	OK	"	OK	"	Fin strut failed. Not heat treated. Chg slightly damaged.
26–3/24/58	"	"	317	428	290/97	Failed	"	Negative	"	Charge slightly damaged.
27–3/29/58	"	"	343	430	274/91	OK	"	OK	"	Linear charge OK.
28–6/4/58	"	"	295	417	231/77	"	"	"	150 left 750 long	54" chute damaged. Dispenser rolled in air.
29–6/4/58	"	"	300	410	279/93	"	"	"	200 left 350 long	54" chute and inert det. cord intact.
30–6/6/58	H.E.	Part H.E.	359	428	Unknown/Lost	"	Detonated to 4'. Det cord broken	Negative	Not applicable	Line charge splice failed. 54" chute undamaged.**
31–6/6/58	"	"	364	436	303/101	"	Detonated to 26'. Det cord broken	–	90 right 850 long	Impact velocity low. Line charge det. w/bl. cap.**
32–6/10/58	"	"	300	420	245/82	"	OK	Detonation stopped after 5–10'	150 right 50 long	Det cord damaged in line charge.**
33–6/11/58	Inert	Inert	300	420	96/32	"	–	–	Not applicable	54" chute badly damaged. 72" chute not cut off. Line separated from dispenser.
34–6/11/58	H.E.	Part H.E.	300	420	176/59	"	Detonated to 5'. Det cord broken	Negative. Det cord broken	200 left 550 long	54" chute badly damaged.**
35–6/25/58	H.E. (mod)	Inert	400	415	205/68	Negative	–	–	No target used	Fuze arming wire broke on release. Impact in wooded ravine caused poor lay.
36–6/30/58	"	H.E.	400	400	230/77	OK	OK	169' of line detonated	"	Impact in wooded ravine caused poor lay.
37–7/1/58	H.E. (std)	"	400	400	205/68	Negative	–	–	"	Ejector foot cut arming wires. Impact in wooded ravine caused poor lay.

*Bomb rack failed to release at high speed.
**Nonspecification detonating cord used in error.

Fig 12   Project Cresset Line Charges on Beach After Aerial Drops 29 and 31

breaks in the remaining detonating cord were noted.

29. (C) One inert-loaded Cresset reassembled with a modified explosive shock line and with a protective sleeve over the parachute release was dropped inland at Camp Pendleton from an FJ–4B aircraft (drop 35). The effective length obtained was 68%. Linear charge deployment was excellent and fuze and shock line were satisfactory after impact. The fuze failed to function, however, because of a broken arming wire. Upon initiation by a blasting cap, the shock line functioned satisfactorily.

30. (C) Two explosive-loaded Cressets dropped inland from an FJ–4B aircraft at Camp Pendleton (drops 36 and 37) gave effective lengths of 77% and 68%, respectively. Drop 36 functioned properly except that the last 61 feet did not detonate. Drop 37 deployed excellently but the fuze did not function because the arming wire broke on release from the aircraft.

Final Design Changes

31. (C) The primary causes of failure in drops 28–37 were (a) detonating cord breaks, (b) dispenser chute damage, and (c) arming wire breaks.

32. (C) The detonating cord breaks in drops 30, 31, and 34 occurred because a significantly lower-strength nonspecification detonating cord had been used in error in line charge manufacture. Subsequent tests showed that no further failures of this type would occur when the proper grade of detonating cord was used.

33. (C) The 54-inch chute damage was found to be caused by interference between the chute and the parachute release mechanism. In later drops, a nylon protective sleeve was used over the release mechanism; this modification eliminated damage to the 54-inch chute.

34. (C) Fuze functioning was prevented in two drops (35 and 37) by arming wire breaks, caused by a change in the method of rigging the arming wires. In drop 35, a sharp bend in the wire caused it to break, and in drop 37 the ejector foot on the bomb release rack is believed to have pinched the arming wire against the dispenser, breaking it before it could pull the arming pin from the fuze. A revised method of fuze arming was devised and demonstrated to be satisfactory in numerous static tests. Since this failure occurred only in the final drops, operation of the new system could not be checked by an actual drop test.

Development of Linear Charge

35. (C) A linear charge development contract was placed with the Rheem Manufacturing Company in June 1954. Results of previous investigations of linear charges and other information of value in the design of the Cresset linear charge were analyzed and the following basic design parameters were established:

a. The linear charges would be fabricated in three 100-foot sections, with the individual sections joined by load-carrying links. This decision was based upon an investigation of the problems associated with the fabrication of both longer and shorter sections. The use of shorter sections proved to be economically unfeasible because of the cost of the additional links and the splices which would be required. The idea of using longer sections was discarded because of fabrication, handling, and storage problems.

b. The center core of the linear charge would be made of ¾-inch-diameter nylon filament rope. Data procured from the Naval Air Development Center indicated that the linear charge should be capable of withstanding loads up to 10,000 pounds. A study of the physical properties of nylon ropes made by the Plymouth Cordage Company, Plymouth, Massachusetts, and the Columbia Rope Company, Auburn, New York, indicated that the ¾-inch-diameter rope could withstand the anticipated loads.

c. The high explosive charges would be made of Comp C–4 formed into 1¼-pound pellets encased in plastic bags. Hand-packed charges were investigated initially. However, it was found that this method produced low-density charges. By pelletizing the charges, the required explosive density was achieved.

d. Initiation of the explosive charges would be accomplished by means of continuous lengths of primacord located near the center core.

e. The outer cover of the linear charges would be made of 24-gage seamless knitted nylon sleeving. Selection of this cover was based upon the results of an investigation of the following materials:

(1). Dacron-cotton combination, 0.125-inch wall, woven, seamless

(2). Vinyl-impregnated fiberglas, 0.050-inch-wall, bias weave, seamless

(3). Whipcord nylon, 0.040-inch wall, woven, ¾-inch bonded seam

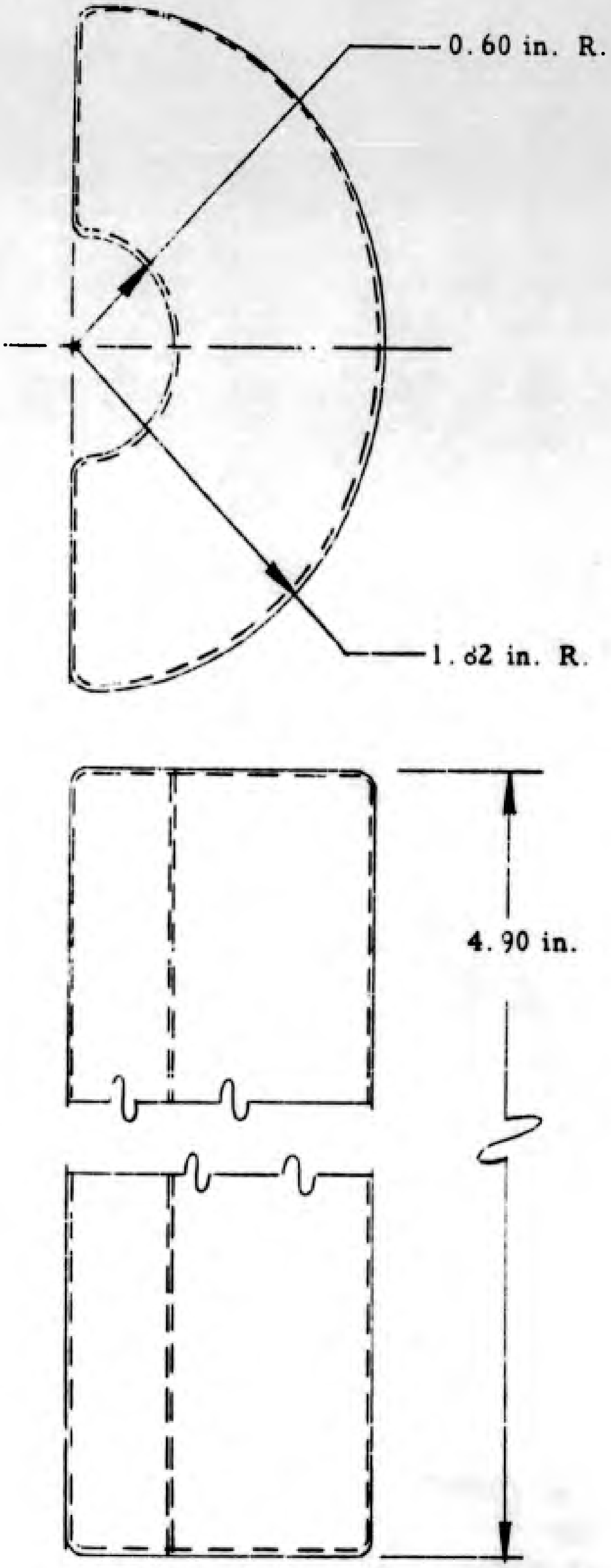
(4). Knitted nylon sleeving, currently used at USNOTS, Inyokern

(5). Knitted nylon sleeving, used at Picatinny Arsenal.

36. (U) After the basic principles of construction of the linear charge were established, work was started on the detail problems associated with each of the components. Although work was done concurrently on several problems, the designs of individual components are treated separately for clarity.

Pellet Design

37. (U) Figure 13 (p 25) illustrates the design of the first pellets. During initial fabrication, contamination of the polyethylene bag around the pellet prevented accomplishment of a proper heat seal. This problem was eliminated by wax coating the individual pellets before they were sealed into bags. Later, because of difficulties in coiling the charge into the dispenser it was found necessary to modify the cross-sectional shape of the pellet (Fig 14, p 26). Further investigation in connection with a weight reduction study of the linear charge revealed that its weight could be reduced considerably by substituting silicone



NOTE -
Pellet totally encased
in wax.

Fig 13 Semicircular Pellet Design

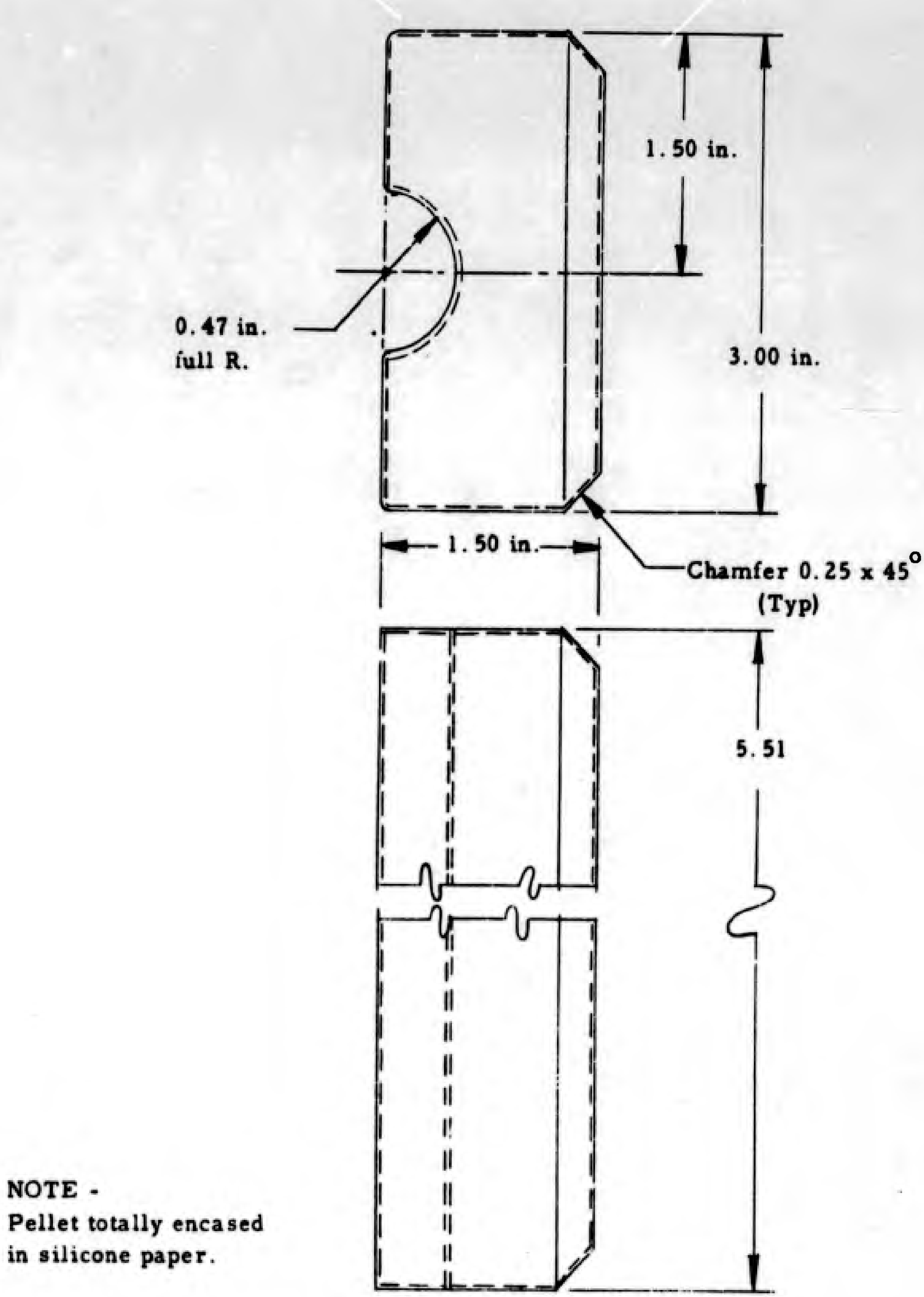


Fig 14 Rectangular Pellet Design

paper for the wax coating. Hence, this change was also incorporated into the pellet design.

Splice and Link Design

38. (U) Two methods of joining the linear charge sections were considered. Method 1, shown in Figure 15 (p 28), consisted of overlapping the thimbles of two sections and connecting them with a 1-inch-diameter pin. Method 2, shown in Figure 16 (p 29), utilized circular thimbles and aluminum links. This second method was chosen as the more practical, and destructive tests were conducted. Failure of the links occurred when the applied tension load reached 23,000 pounds. This gave approximately a 55% safety margin over the desired ultimate design load of 15,000 pounds. Later, the connecting link was modified to provide a backing plate to prevent the unit charge assemblies from slipping off the ends of the center core because of deployment acceleration. This modified design, Method 3, is shown in Figure 17 (p 30).

Initiation of HE Charges

39. (U) Initial tests using detonating cord to initiate HE charges were only partly successful. Therefore an extensive program was initiated to establish a reliable means of insuring detonation of the HE charges. Detailed information on these tests is contained in References 22 to 28.

40. (U) On the basis of the results of such tests, it was decided that three strands of 100-grain detonating cord, routed along the core of the linear charge as shown in Figure 18 (p 31), would be used. All detonation tests in which this method was used were completely successful.

Structural Tests

41. (U) Numerous tests were conducted to establish the structural adequacy of the various linear charge components. While these tests are important, individually they are minor in nature and do not warrant detailed review in a report of this type. The tests conducted were:

a. Elongation and tensile tests on the nylon core.

b. Elongation and tensile tests on the linear charge cover

c. Abrasion tests on sample linear charge specimens

d. Tensile tests on core splices

e. Acceleration, tensile, and snatch tests on sample linear charge specimens

f. Linear charge coiling tests

g. Shock line tensile tests.

Clearance Tests

42. (C) Minefield clearance tests were conducted under various temperature and soil conditions. The overall results showed that clearance ability is not appreciably affected by temperature or type of soil. However, a definite reduction in efficiency was noted in frozen ground. Tests 1, 2, and 3 in Table 2 (p 32) show this effect.

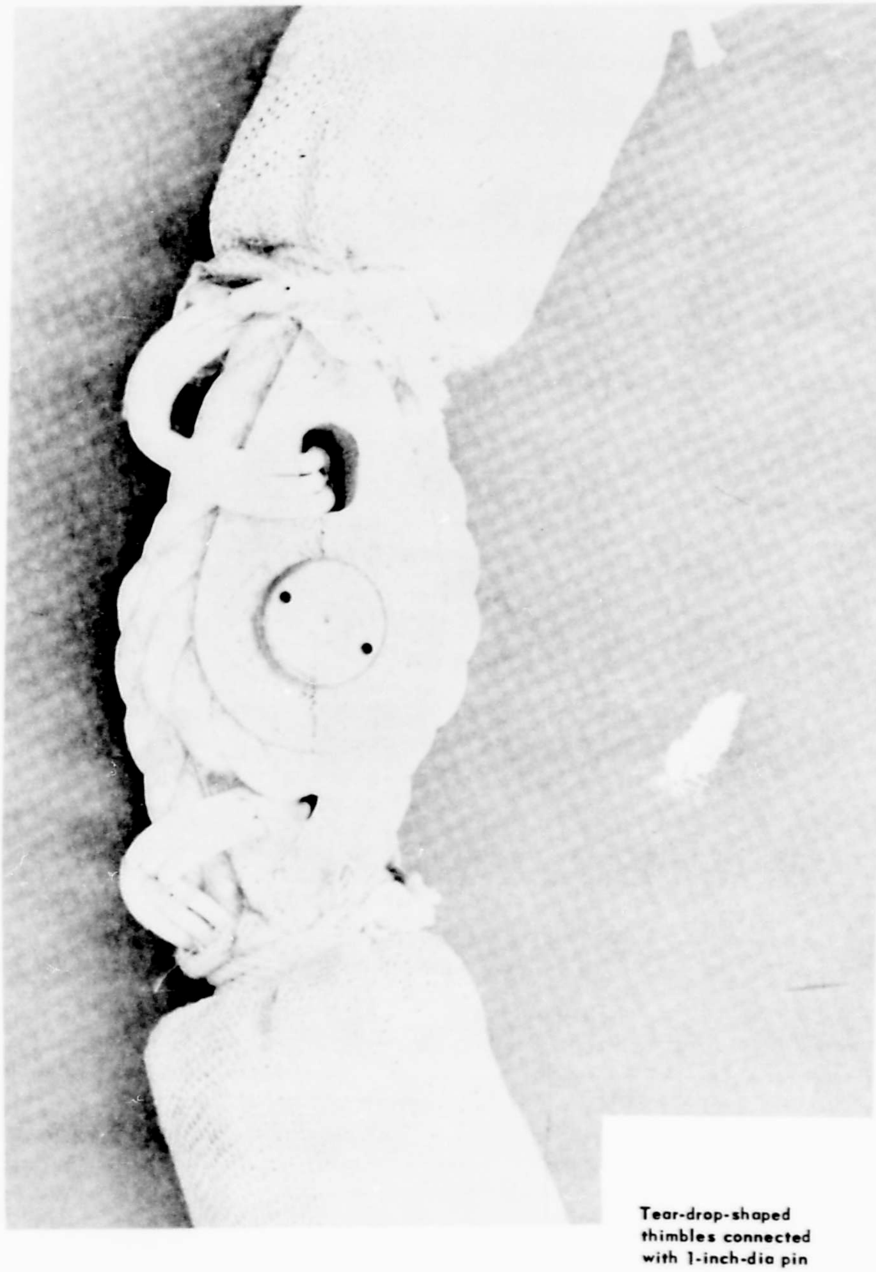


Fig 15 Splice and Link Design (Method 1)

Fig 16   Splice and Link Design (Method 2)

Fig 17 Splice and Link Design (Method 3)

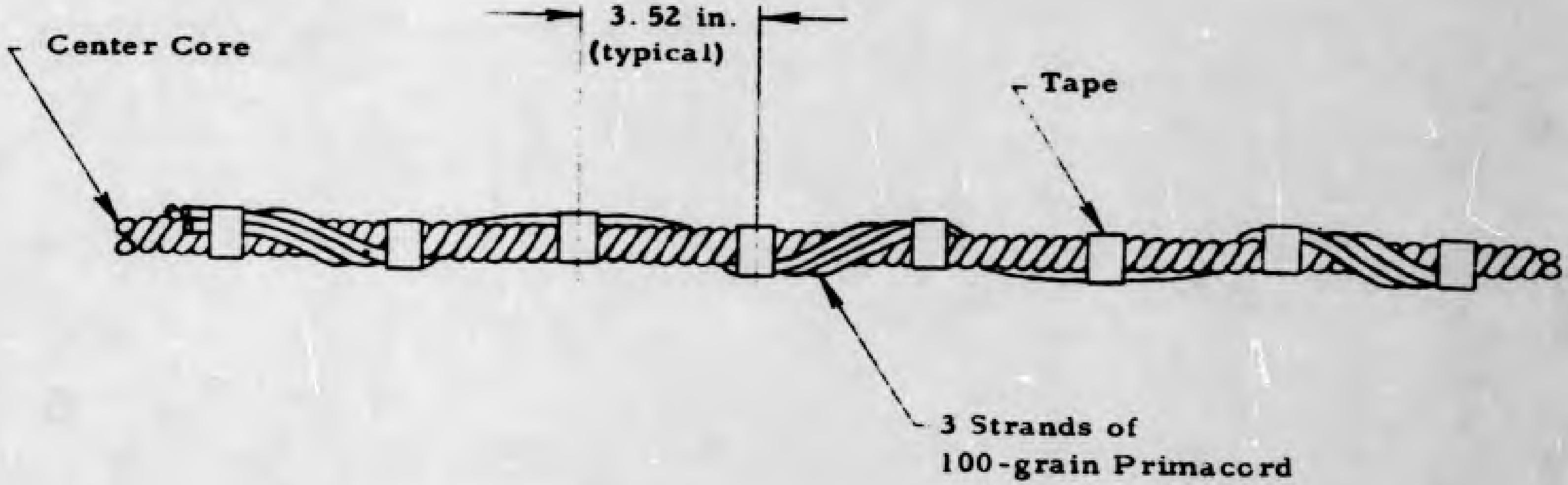


Fig 18 Routing of Primacord Along Linear Charge

TABLE 2

Mine Clearance Test Results

Test Location and Date	Test No.	Max Lane Available for Clearance, ft	No. of Mines Buried*	Width of Lane Cleared, ft 100% Cleared	96% Cleared	90% Cleared	Ground Condition
Quantico, Va. (Jan '56)	1	64	32	40	48	60	Frozen. Mines laid just before test.
	2	64	32	32	44	52	Mines laid prev. day. Ground frozen 2½" deep.
	3	64	32	8	28	44	Mines laid prev. day. Ground frozen 5" deep.
29 Palms, Calif. (Aug '56)	4	64	32	64	64	64	Not frozen. Muddy.
	5	64	80	8	40	64	Dry sand.
	6	80	100	64	80	80	Dry sand.
Jefferson Prvg. Ground (Jan '56)**	7	300	300	40	50	96	Muddy.

*M15AT mines were used in all tests except test 4, in which M19 mines were used.

**Only mines of normal burial – 5 inches deep to pressure plate – were considered. Effect of linear charge on mines buried by the modified technique was not determined.

43. (C) The requirement for clearance states that a lane 240 feet long and 20 feet wide must be at least 90% cleared of mines and other obstacles to the passage of troops and vehicles. Results of the clearance tests conducted (Table 2, p 32) indicate a clearance ability well above the minimum requirements. For example, using average values, lanes 65 feet wide rather than 20 feet were cleared at the 90% level.

Linear Charge Development Tests

44. (U) Handling, compatibility, resistance to corrosion and fungus growth, functioning at temperature and humidity extremes, and storage capability were found satisfactory during contractor development tests.

45. (C) Sensitivity tests conducted at Jefferson Proving Ground (Ref 11) showed no effects from .30 cal and .50 cal machine gun fire. The impact of tracer rounds (.30 and .50 cal) and of fragments from 75 mm HE ammunition caused rapid burning in five minutes, but no detonation.

46. (C) In explosive propagation tests conducted at normal and extreme temperatures, it was found that 3 strands of 100-grain detonating cord would satisfactorily detonate the linear charge. A special technique for assembling the detonating cord to the linear charge was found necessary to allow for approximately 50% stretch of the nylon rope core of the linear charge under maximum load conditions.

47. (U) A knitted nylon sleeve was found to be the lightest and most compact protective covering for the snub line assembly. The sleeve was required to protect the snub line from abrasion against the rear dispenser cone on payout, to confine the detonating cord if separated from the snub line nylon core, to prevent snagging of the detonating cord on impact, and to withstand abrasion on impact.

48. (U) Abrasion-resistant coatings applied to the nylon sleeves to permit the use of a single sleeve instead of two sleeves did not improve performance enough to justify the weight increase from the coating. Two sleeves were required to withstand abrasion and to hold the explosive pellets on the linear charge during payout and on impact.

49. (U) A square cross-sectional shape for the linear charge was found most compact for loading the charge into the T4 dispenser. Compared to the original round cross-sectional shape, loaded volume was reduced 16%.

Development of Fuzing

50. (U) Initial tower drop tests were made with M146E3 fuzes containing T-3 timers to determine whether the timer would operate after it had been subjected to impact. At that stage, no information on loads encountered during actual drops was available. Therefore, no positive conclusions could be drawn. However, the tests did establish that the T-3 timing mechanism can be subjected to acceleration loads of considerable

magnitude without impairment of its operating characteristics.

51. (U) Early fuze models were subjected to military standard and miscellaneous tests. Generally the results were good, though minor failures did occur. Reference 9 gives further information on these tests.

52. (C) The functioning of the fuze explosive train and the initiation of the three strands of 100-grain primacord were tested. Results were completely satisfactory (Ref 9).

53. (U) Environmental and detonation tests showed that minor deficiencies were present but that they could be corrected by modification of the fuze design.

54. (U) Actual drop tests showed acceleration loads to be about 1400 g's. Fuzes were armed to start the timing mechanism and then dropped 100 feet onto a sand target. The average acceleration loads imposed upon the fuze exceeded 2000 g's. Of 45 fuzes tested, 4 were failures. Two fired on impact (due to sheared firing pins) and two failed to fire because of cocked firing pins. On reassembly and retest, both of these latter fuzes functioned. These drop tests indicated that the timing mechanism continues to function after drop impact.

55. (U) Appropriate changes were made to correct all failures encountered in previous fuze tests. Eighty fuzes were then manufactured according to the new design and were subjected to the following tests:

a. Nondestructive functional inspection tests, including internal pressure tests to check seals, tests to check arming delay and functioning times, and pull tests to determine arming pin force and rate of application.

b. MIL-STD-300 jolt test

c. MIL-STD-301 jumble test

d. MIL-STD-306 salt spray test

e. MIL-STD-303 transportation vibration test

f. MIL-STD-304 temperature and humidity test

g. High and low temperature tests

h. Underwater firing tests

i. Out-of-line tests

j. 100-Foot drop test

56. (U) Only 5 out of 80 fuzes tested failed. One fuze failed in the low temperature test because of faulty fuze assembly. The four other fuzes that failed showed breakdown of the protective coating on internal parts in the temperature-humidity test. Analysis of the test results revealed other minor faults which were corrected. Primarily, the modifications consisted of improving dimensional control over detailed parts and using a thicker protective coating on the firing pin release levers.

57. (U) One hundred fuzes were manufactured incorporating all approved modifications. Nondestructive functional inspection showed the delay time to be

controlled within the required limits. Functional firing time on all but seven fuzes was within the ±1 second tolerance. Faulty T–3 timers running fast caused these seven fuzes to fire as early as 2.2 seconds after arming.

58. (U) Thirteen of the 100 fuzes were used in aerial drop tests 25 through 37. All but one fuze operated satisfactorily. Further fuze testing was suspended by curtailment of the Cresset program.

(C) DISCUSSION

Final Design

59. (C) The final design (Fig 10, p 17) was based on the design tested in drop 18 (Fig 11, p 18). This design exhibited the best overall performance of all designs tested in the high-speed drops (up to and including drop 23). The deficiencies in the drop 18 design were corrected by redesign based on the results of prior and subsequent tests. Primarily, three faults were noted:

a. The dispenser chutes were inefficient because of interference with the parachute release mechanism.

b. The parachute release mechanism operated prematurely.

c. The elevation of the aft end of the linear charge was too great with respect to the forward end because of excessive vertical lift by the aft chutes.

60. (C) The twin dispenser chutes used in drop 18 were partly ineffective as they rotated about each other. No lead line was used in this design to bring the chute forward of the tail dispenser cone to protect it from the linear charge during payout. This condition caused poor chute action. With a leader line as in earlier tests (drops 14, 15, and 17), the linear charge damaged the chutes on payout. Drops 20 through 23 showed that an A frame device would lessen the possibility of damage to the dispenser chute by the linear charge. This modification to the drop 18 design partially resolved the dispenser chute problem. Parachute fouling with the parachute release occurred later but was corrected by installing a fabric cover over this mechanism.

61. (U) The parachute release failures were caused by high acceleration forces which prevented the firing pin spring from forcing the pin with sufficient force to penetrate the primer in the M4 cartridge. New initiators designed to meet the acceleration loads were developed. Designated T–27, they performed satisfactorily in subsequent tests.

62. (C) Vertical drag on the tail end of the linear charge was reduced by the following changes:

a. Elimination of the 50-foot leader line between the linear charge and the aft 72-inch guide surface chute.

b. Replacement of the 42-inch guide surface chute installed concentrically on the aft end of the linear charge with a 36-inch guide surface chute installed concentrically 1½ feet from the end of the linear charge.

Dispenser and Delivery Development

63. (C) The first 11 aerial drop tests, which were conducted to determine the best packaging and dispensing techniques, showed that:

a. The dispenser must be released from the aircraft.

b. The dispenser body and the linear charge must remain connected to each other so that the dispenser body will provide sufficient momentum to keep the linear charge straight during descent.

c. A release elevation of 300–400 feet appears best. Further testing is needed to confirm this conclusion.

d. The linear charge chutes should be assembled coaxially with the linear charge to control drag, prevent catenaries from forming in the linear charge between chutes, and prevent the chutes from rotating about the linear charge.

e. Effective linear charge layout can be maintained above approximately 75%.

f. The system is satisfactory for delivery at velocities of about 225 knots.

Further details on development and testing during the period of drops 1 through 11 are given in Appendixes A and C (pp 82 and 99). The second series of aerial tests, Drops 12 through 24, demonstrated that the low-speed design was not satisfactory at higher speeds (400 knots).

64. (U) In drops 10 and 11, the reliability of the parachute release mechanism was low, apparently because the cartridges used were not hermetically sealed. It was also evident that additional effort would have to be concentrated on straightening the aft end of the linear charge lay.

65. (U) NADEVCEN contacted Frankford Arsenal which furnished M3 and M4 two-second delay initiators. These items, which have hermetically sealed cartridges, were used with a redesigned release mechanism.

66. (C) Drops 12 and 14, which were made at the next higher speed increment (i.e., 300 to 325 knots), resulted in the line charges being laid on the beach 73% and 79% straight (Refs 11, 12). Drop 13, also made at 300–325 knots, was aborted by a bomb rack malfunction (Ref 13). The parachute release mechanism operated satisfactorily in drop 12 with the M4 initiator loaded with an M46 two-second delay cartridge. However, in drop 14, this same release mechanism failed to function because of a too-light strike on the primer of the M46 cartridge. Post-drop examination revealed that this initiator was not properly assembled.

67. (C) In drops 12 and 14, the single 72-inch-diameter parachute previously used to reduce the velocity and rate of fall of the dispenser was replaced by two 51-inch guide surface chutes. It was thought that these two smaller parachutes, although equivalent in drag to the 72-inch chute, would interfere less with the linear charges during payout. This hope was not realized; the dispenser chutes were damaged.

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68. (C) Drop 15, made at 400 knots, gave a line straightness of 78%. Again, the parachute release mechanism did not function properly although the M4 initiator was used with the M46 two-second delay cartridge. One 51-inch guide surface parachute canopy was torn away from the dispenser by the linear charge. A strong cross wind, together with the failure of the aft parachute to release, caused the aft end to be rotated or deflected in a large sweeping arc from the front end of the linear charge. This effect also reduced the overall straightness. Reference 14 contains a detailed report on this test drop.

69. (C) In drop 16, an F3D–2 aircraft was used and the first of the final prototype dispensers (Fig 5, p 10) was tested. The dispenser was released at 393 knots, but the parachutes did not deploy properly because the arming wire was not strong enough to extract the initiating pins of the explosive device used to decouple the tail cone. As a result, the dispenser traveled much like a standard streamline bomb and was destroyed upon impact (Ref 15). This drop led to the designing of a more reliable arming arrangement.

70. (C) Drop 17, which was made with the same dispenser configuration, gave a straightness of 83%. However, the linear charge struck the beach at a very high velocity since the parachutes on the dispenser were damaged severely. In addition, the cutoff mechanism failed to release the aft parachute, and this resulted in very high line tension. In this drop, a dummy linear charge, with only one nylon sleeve covering the pellets, was used. On the basis of the results of this test, it was decided that the single cover would be insufficient to hold the pellets intact.

71. (C) To prevent or eliminate the difficulties experienced with the parachute release mechanism and the parachutes attached to the dispenser, NADEVCEN took the following definite steps. First, because it was suspected that high acceleration forces acting on the firing pin at the time of actuation were preventing the firing pin from contacting the primer with sufficient force to detonate the primer and cartridge, NADEVCEN installed two M4 initiators at right angles to each other, as shown in Figure 19 (p 38). With this arrangement, at least one of the initiators would be relatively unaffected by the acceleration forces imposed by the deployment of the 72-inch parachute. Secondly, the suspension lines of the two parachutes attached to the dispenser were shortened to bring the parachutes forward of the opening from which linear charge payout occurs. These chutes were enclosed in suitable external cylinders mounted by the top fin roots (Fig 20, p 39).

72. (C) In drop 18, made at 393 knots, the line was laid 87% straight (Ref 16). All of the components seemed to function satisfactorily. However, post-flight examination of the flight films and of the unit itself revealed that the parachutes on the dispenser had not been fully effective in slowing down the dispenser, since they had been located in disturbed air at the wake of the dispenser. The

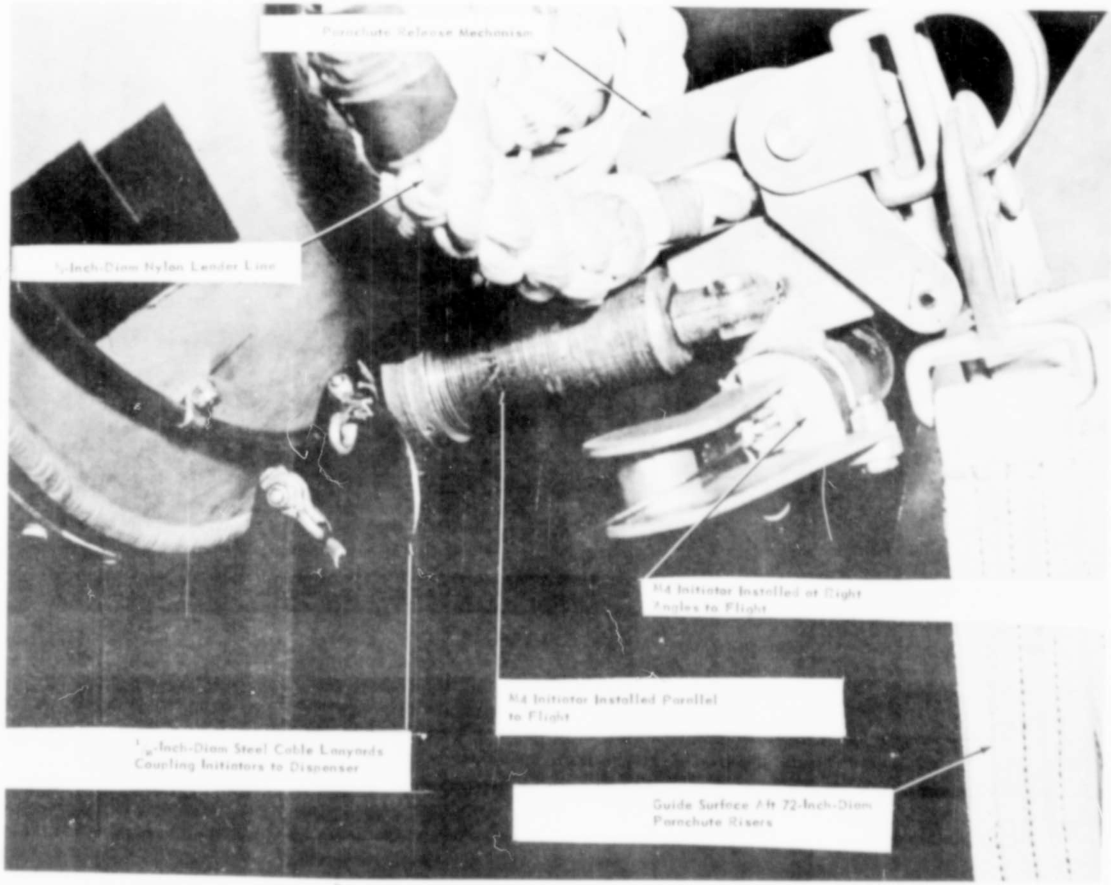

Fig 19 Improved Arrangement of M4 Initiators

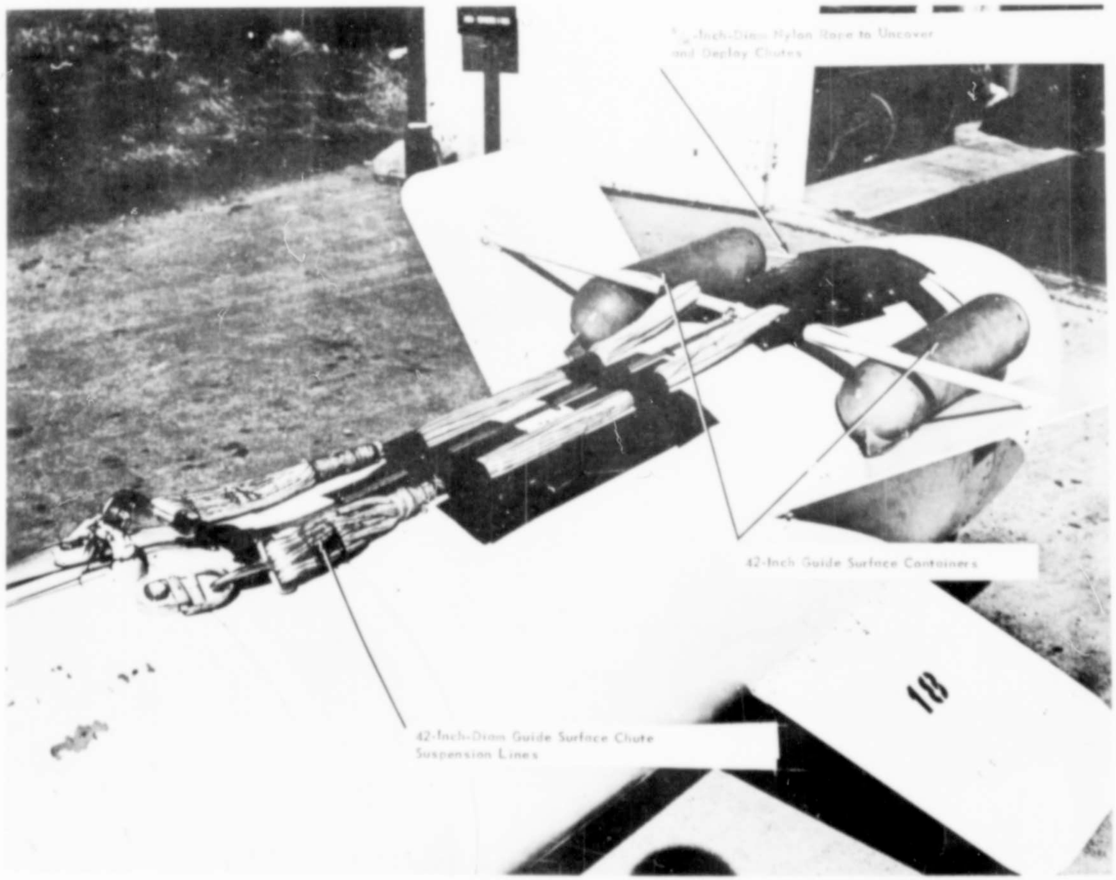

Fig 20 Method of Mounting Dispenser Chutes

shock line and the snubbing line operated satisfactorily, but the detonating cord between the fuze and the linear charge was severely broken. It was decided that the detonating cord used in the next drop should be protected by enclosing it in a flexible copper-braided sleeve. This change is shown in Figure 21 (p 41). It was also decided that the parachutes on the dispenser should have longer suspension cords to place these parachutes far enough behind the dispenser to be in undisturbed air. An 11-foot suspension cord was installed between the standard guide surface parachutes and the dispenser. It was learned later from motion pictures of the drop that, when two parachutes are used side by side, one will move or rotate above the other. Because of this phenomenon, one parachute tended to move directly into the path of the deploying line. It was decided that one 54-inch parachute should be used instead of the two 42-inch-diameter guide surface parachutes.

73. (C) In drop 19, the parachute release operated too soon and the parachute attached to the dispenser was severely damaged by the linear charge. Because of this damage, the linear charge and dispenser had a very high velocity at impact (240 fps). This test indicated that when two nylon covers are used the linear charge can absorb and withstand severe impact. The copper-braided cover over the shock cord system and detonating cord did not keep the detonating cord intact; rather, it sustained severe damage. It was concluded, however, that this drop was not realistic in relation to the shock line since the velocity at impact was so high. It was further concluded, as a result of drop 19, that measures would have to be taken to protect the dispenser parachute.

74. (C) The dispenser used in drop 20 was equipped with a single tubular support with two guy wires running forward from the top of the tube to anchor points on the center of the dispenser. The lower end of the tubular support was hinged and bolted to the steel tail cone. This support, after release and separation of the dispenser from the aircraft, would unfold and hold the lines of the 57-inch parachute away from the dispenser to prevent possible interference and damage to the parachute by the linear charge. This design also had the advantage of placing the parachute in undisturbed air flow and thus giving it maximum effectiveness in reducing the velocity of the dispenser.

75. (C) In aerial drop 20, the dispenser separated satisfactorily from the F3D–2 aircraft at 400 knots, but immediately upon deployment of the parachutes the new type support was torn completely away from the dispenser. As a result, the dispenser remained at high speed and subsequently separated from the dummy linear charge. The line straightness, reported in Reference 17, was very poor.

76. (U) After the above tests, it was determined that the steel guy wires were probably subjected to a yaw condition which caused the full parachute load to impact on one guy wire and its attachment bracket. This bracket could not rotate or swivel to permit proper alignment

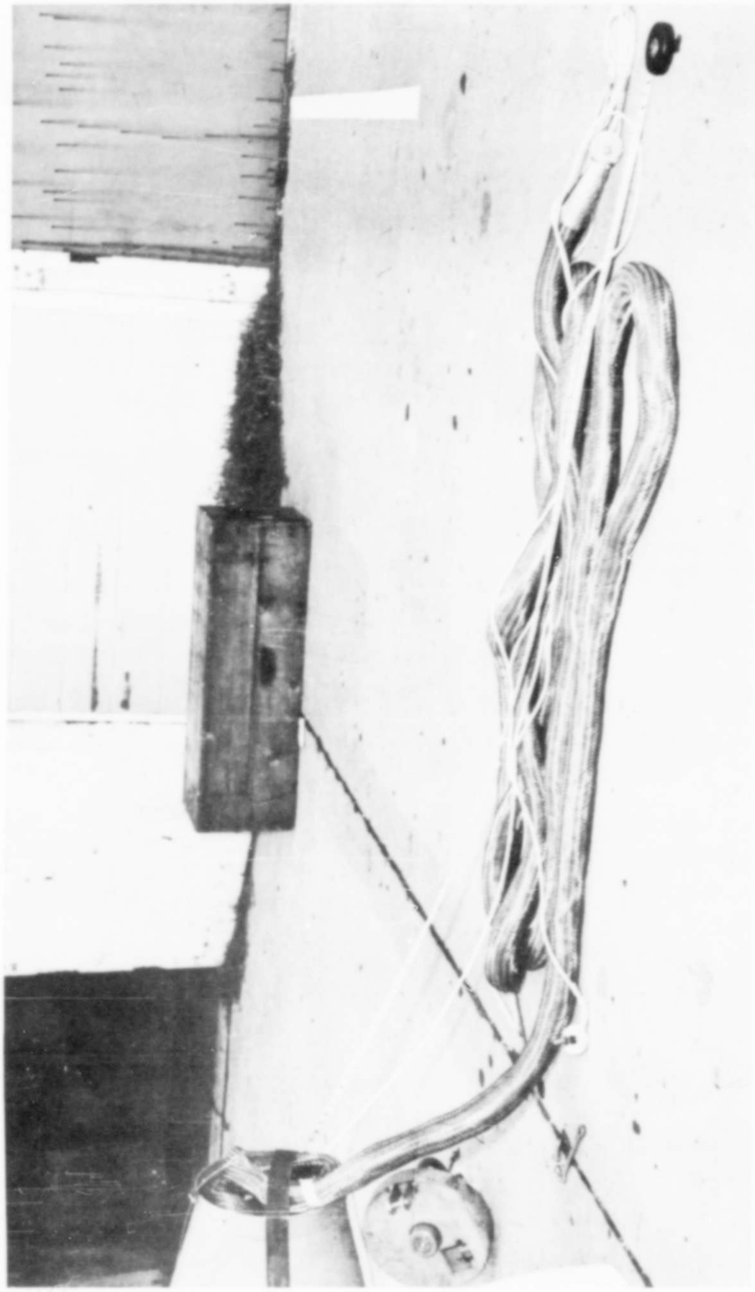

Fig 21 Linear Charge in Copper Sleeve

with the load and so failed. The second bracket and complete parachute rig are presumed to have failed thereafter.

77. (U) To prevent recurrence of this type of failure, NADEVCEN designed a tubular A frame, using heavy nylon webbing in place of the steel cable. Such A frames were installed on all remaining dispensers and no further failures of these or associated members were experienced. The continuous nylon webbing had the advantages of flexibility and adjustability under load.

78. (C) The dispenser used in drop 21, the first to have the A frame, was dropped at 423 knots airspeed and very low altitude (158 feet). The linear charge was only 66% straight since there was not enough time during free fall to permit the parachutes to slow the overall system sufficiently. The shroud lines of the aft 72-inch parachute became entangled with one of the M4 initiators of the aft parachute release mechanism, rendering the release inoperative. It was believed that this entanglement of the shroud lines occurred because of unanticipated forward accelerations occasioned by collapse of the nose wheel of the F3D–2 aircraft during take-off. The aircraft was repaired and the drop made without disassembly and inspection of the dispenser. To preclude parachute or shroud line movement in future drops, NADEVCEN incorporated a compartmentalized parachute section (Fig 22, p 43) for all drops subsequent to drop 24.

79. (C) Witnesses of aerial drop 21 proposed that some device or design change be incorporated to overcome the high kinetic energy of the dispenser and linear charge before impact and thereby to prevent the linear charge from traveling excessively on the beach. It was proposed that some type of anchor be incorporated to accomplish this by digging or penetrating into the beach.

80. (C) NADEVCEN decided that a specially shaped aerodynamic drogue could be installed inside the tail fairing between the aft 72-inch parachute and the linear charge. This drogue (shown in Figs 23 and 24, pp 44 and 45) would provide a negative lift on the aft end of the linear charge to help to pull this aft end lower than the center and the front end. The drogue would also penetrate the ground to form an anchor or tether for the linear charge. Because of limitations on the size and aerodynamic shape of the drogue, its stability constituted a major problem. Three preliminary models were fabricated and tested by aerial towing and by free fall behind a 250-pound streamlined bomb. Later, four drogues were installed on four 250-pound streamlined bombs. Two of these operated satisfactorily by stopping the bombs within 10 feet of the impact point. The other two did not penetrate the beach sufficiently to retard the high momentum of the bombs. These bombs were all dropped at about 250 knots and from altitudes of about 300 feet. After these tests, drogues were installed in the dispensers for drops 22 and 23.

81. (C) In drop 22, the F3D–2 aircraft could not release the dispenser from the starboard wing Mk 51 bomb rack at the

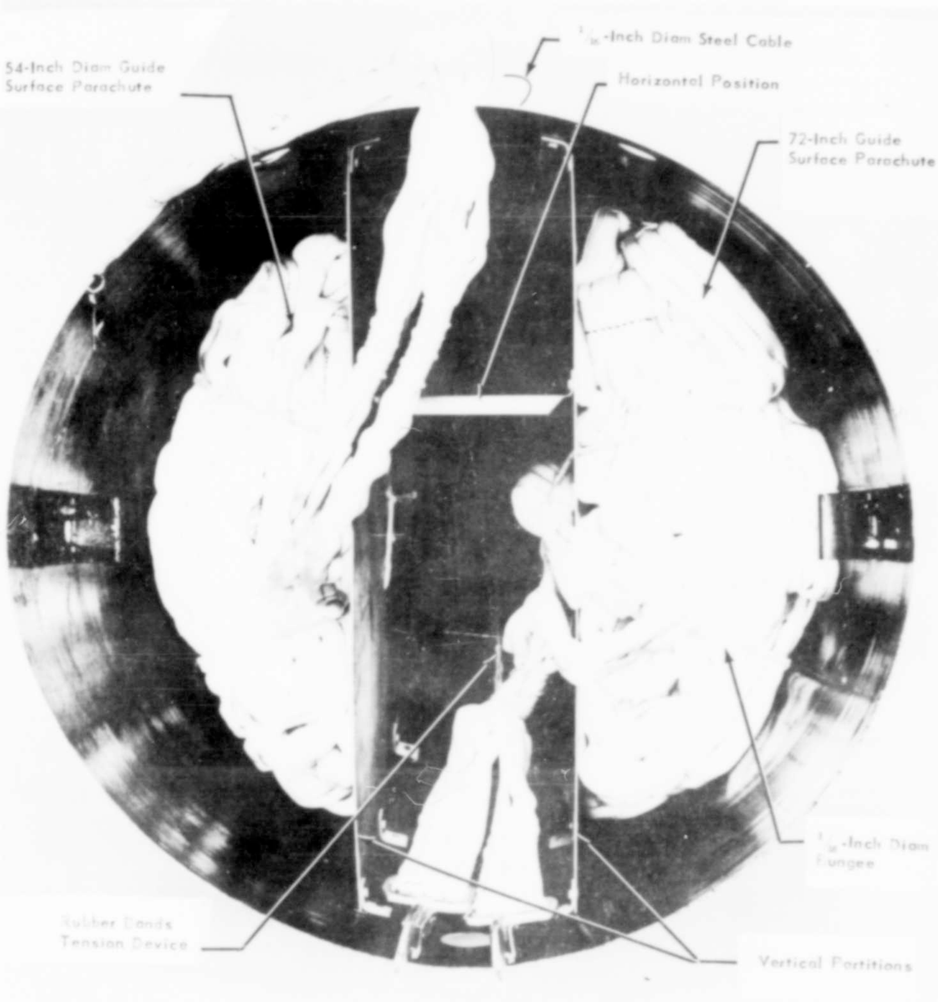

Fig 22   Compartmentalized Parachute Section

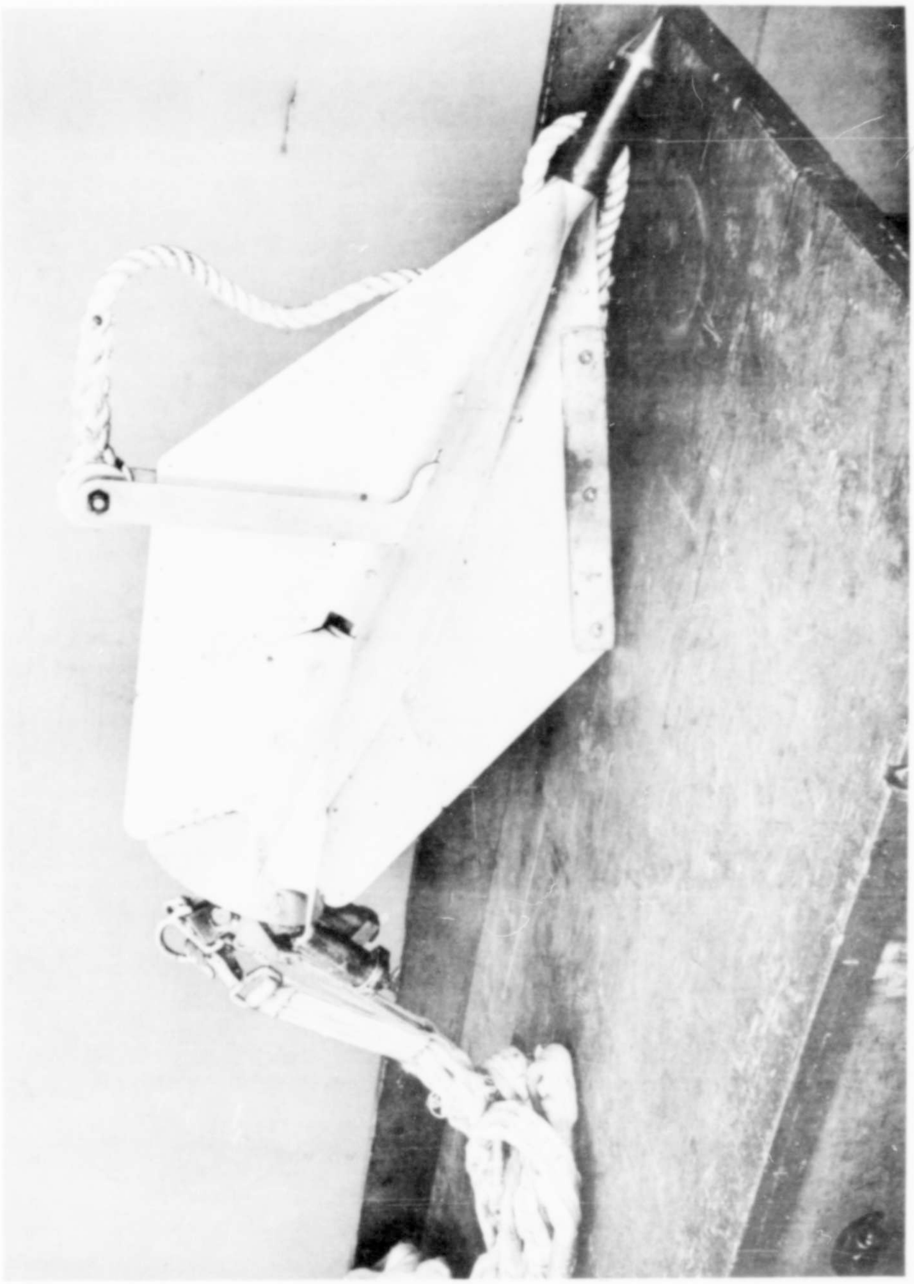

Fig 23   Drogue Unopened, as When Stowed in Dispenser

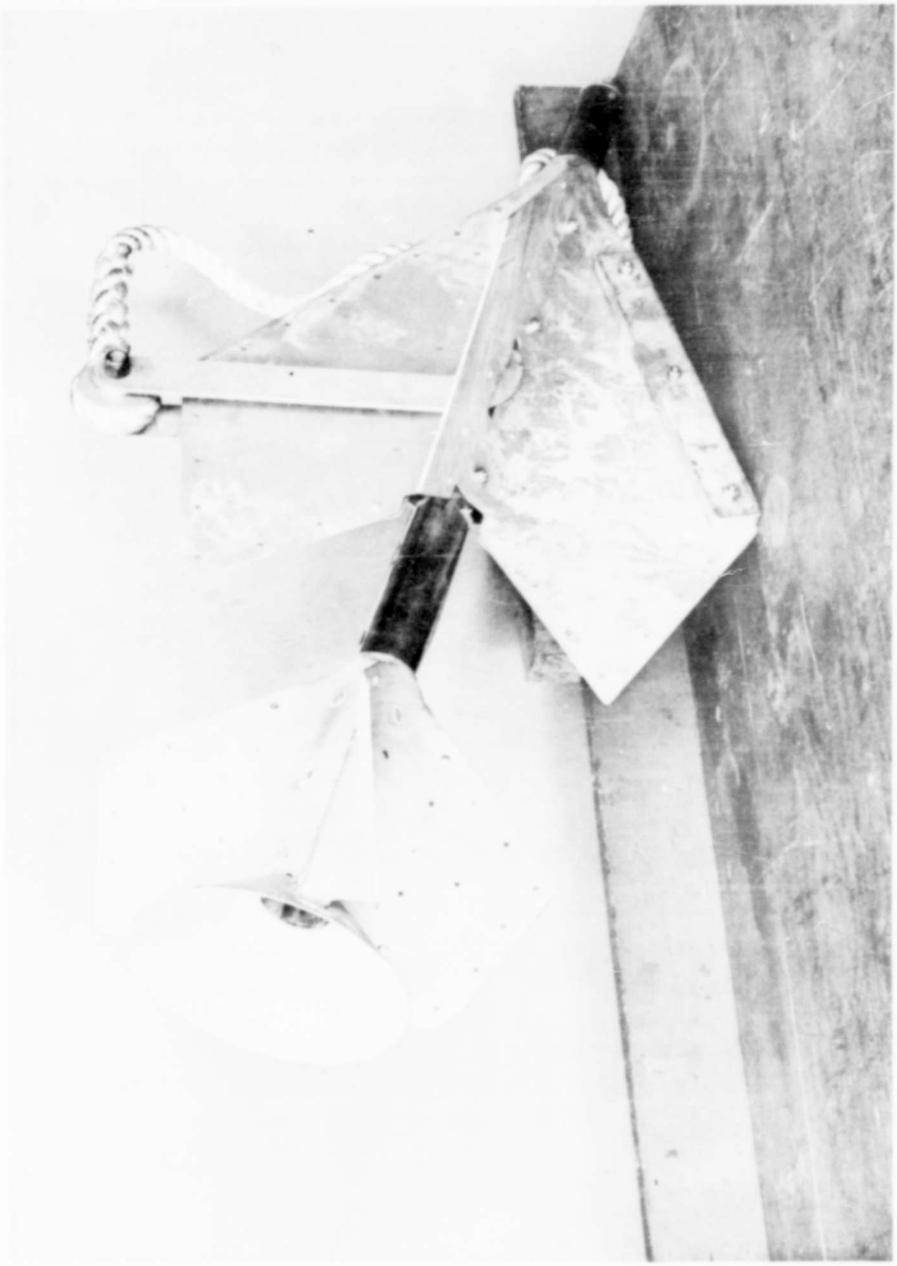

Fig 24 Drogue Opened, as in Use

400-knot airspeed. Release by both electrical and mechanical release systems in the aircraft was attempted without success. The Marine pilot returned to the landing field, where a ground check of the release systems indicated that operation was satisfactory.

82. (C) The pilot tried again but still could not release the Cresset dispenser at high speed. He then reduced his airspeed to 180 knots, at which speed the dispenser separated satisfactorily. However, his altitude was only 350 feet, which at slow speed did not leave enough free-fall time for complete payout of the linear charge before impact. It appeared from the motion picture films that the drogue was stable, and all other items appeared to operate satisfactorily.

83. (C) The dispenser used in drop 23 was similar to the one used in drop 22 with the drogue installed as before. However, it was decided that an F7U aircraft would be used to make the drop since it was available and had ejector-type bomb racks to insure positive separation. In this drop, the dispenser was released at 410 knots and at the extremely low altitude of 138 feet. Again, the parachutes did not have time to slow the linear charge and dispenser to a low enough velocity. As a result the linear charge impacted on the beach at about 375 feet per second (the highest speed recorded) and bounced forward doubling up on itself so that its final lay was only 33% straight. It is to be noted that the linear charge sustained only slight damage from this high-velocity impact. The drogue appeared to hit the beach upside down in a flat or pancake manner instead of right side up and with the nose down; thus, it did not penetrate or anchor itself into the beach. Post-flight examination indicated that the tail section of the drogue had come off because of shearing of some of its rivets by high-impact loading. The margin of stability was therefore much lower than had been planned.

84. (C) It was decided that, for drop 24, several four-pointed steel anchors should be used instead of the drogue. Three of these steel anchors were fabricated and installed in the tail section of the dispenser (Fig 25, p 47). They were to swing downward during payout, like pendulums, and dig into the beach or water before impact of the aft end of the linear charge. Unfortunately, the anchors appeared to become tangled in the aft chute before any appreciable line payout could occur. Without the benefit of the aft chute, the line and dispenser hit the beach with too high a velocity. For this drop, the release altitude was 245 feet and the release velocity 393 knots. The line was delivered only 66% straight on the beach.

85. (U) After drop 24, the Marine Corps requested that the results obtained be surveyed and an optimum Cresset system be decided on (Ref 6).[1] Three drops of this optimum system would then be made as check tests. Assuming success in the three trials, ten dispensers would be prepared to corroborate the test system and

[1] The Bureau of Aeronautics project number covering NADEVCEN work on Cresset was also changed at this time, from TED Project ADC-AR-8003 to ADC-AV-34012 (Refs 18 and 19).

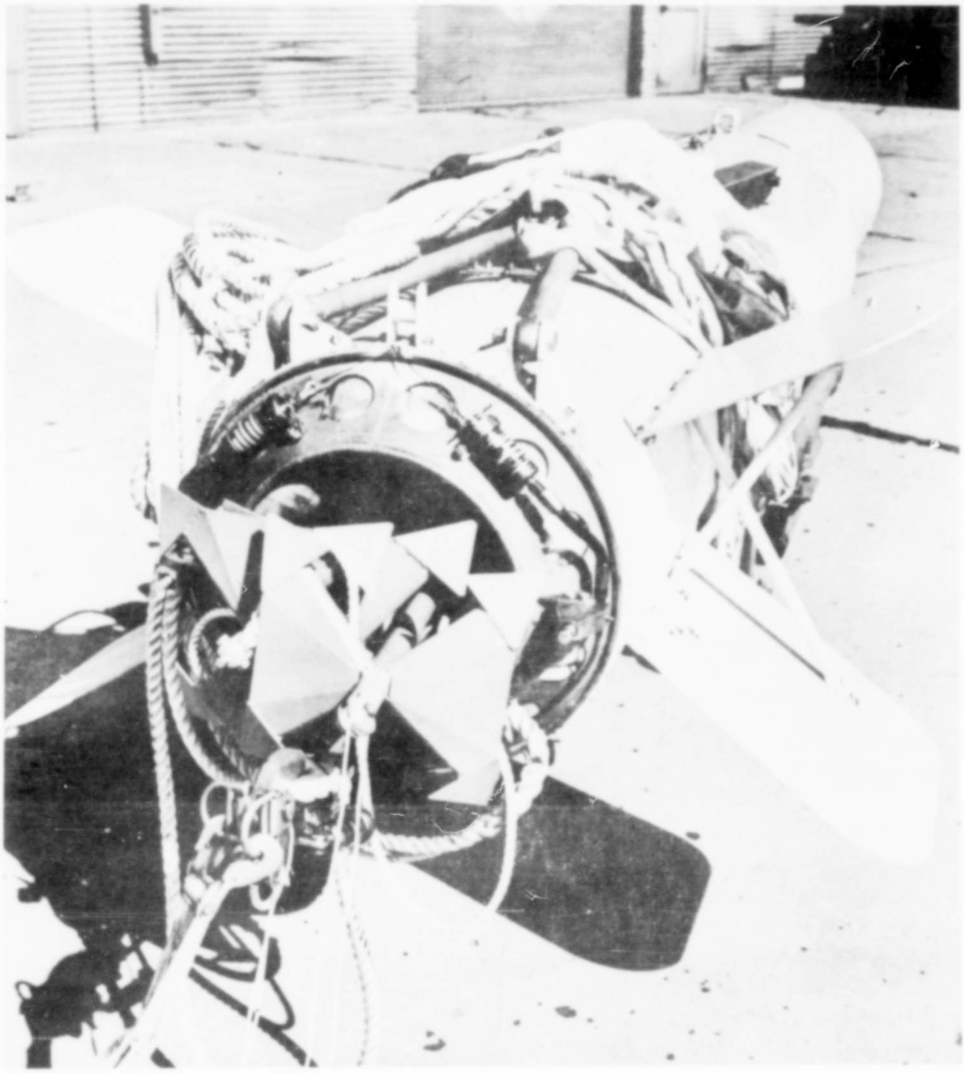

Fig 25 Method of Stowing Steel Anchors in Cresset

drops would be made against both inland and beach targets. Two of the last ten dispensers would be loaded with explosive linear charges and all 10 would have live fuzes.

86. (C) Drop 25, first of the three check tests, was made from an F4D–2 aircraft. The line was only 64% straight on the beach and had a distinct curvature suggesting that the dispenser had yawed to the port side as it fell. Later examination of films taken from the plane showed that separation was satisfactory, but that the tubular struts supporting the tail fins on the dispenser had failed, causing the out-of-trim condition. The films showed clearly that the dispenser had rolled and yawed. It was later determined that the struts were inadequate because they had not been heat-treated.

87. (C) Drops 26 and 27, made the following day from the A4D aircraft, produced outstanding results. Linear charge straightness was 97% for drop 26 and 91% for drop 27 (Fig 26, p 49). All components functioned satisfactorily. It was found, however, that approximately half of the slide fasteners had failed on the 42-inch flat parachutes during drop 27. Also, the dispenser parachutes had been damaged somewhat by the linear charge. It was concluded that for the remaining drops the slide fasteners should be reinforced with a fabric tape sewn over them. The fin struts were checked and found satisfactory. The last ten drops were made without failure of these items.

88. (U) The shock cord, snubbing line, and inert detonating cord, which were enclosed in a nylon sleeve for these drops, held up satisfactorily.

89. (C) In drop 26, a few pellets became separated from the linear charge during payout. This resulted in a 6-foot gap in the aft 100-foot section of the charge. Stronger ties between the pellets were adopted to prevent recurrence of this type of failure.

90. (C) Drops 28, 29, 30, and 31 were made at Wallops Island Naval Aviation Ordnance Test Station, Chincoteague, Virginia, from an A4D–2 aircraft. The target was composed of brightly painted ammunition boxes (Fig 27, p 50). In drop 28, the dispenser performed similarly to the dispenser used in drop 25 in that it rolled slightly and hit the beach before the linear charge. Examination showed that the 54-inch-diameter dispenser chute had been damaged by the linear charge. The charge was only 77% straight.

91. (C) The next three drops – 29, 30, and 31 – all appeared to be similar to drops 26 and 27 in that the dispenser held the forward end of the linear charge at a higher position than the center and the aft end. This resulted in a slight dragging of the linear charge before lay-down on the beach. Straightnesses of 93% and 101% were obtained in drops 29 and 31. This latter drop was the best achieved; the charge was dropped at the highest release velocity and had the lowest impact velocity of any charge tested.

92. (C) Drop 30 had a splice failure during payout between the center and aft sections of the charge. As a result of this

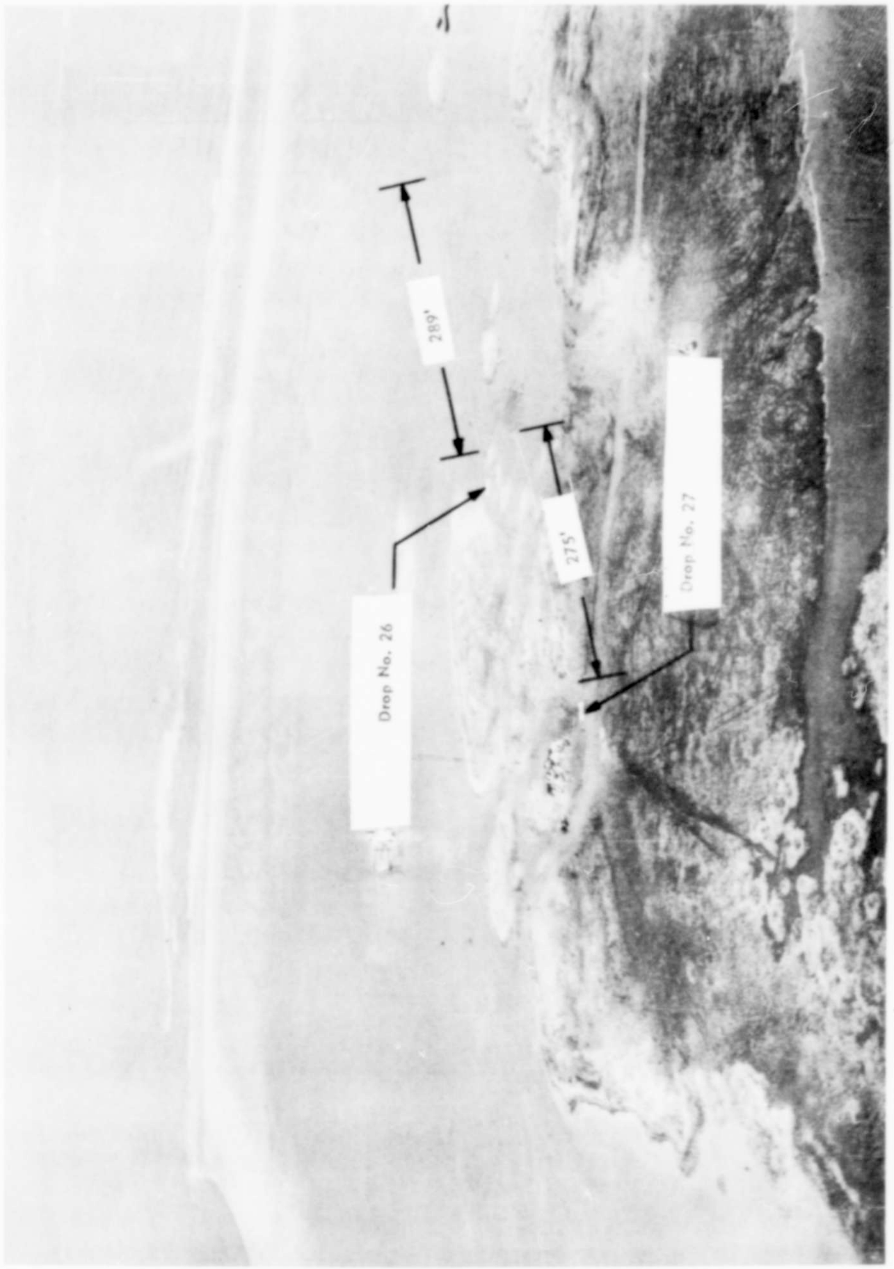

Fig 26 Results of Drops 26 and 27

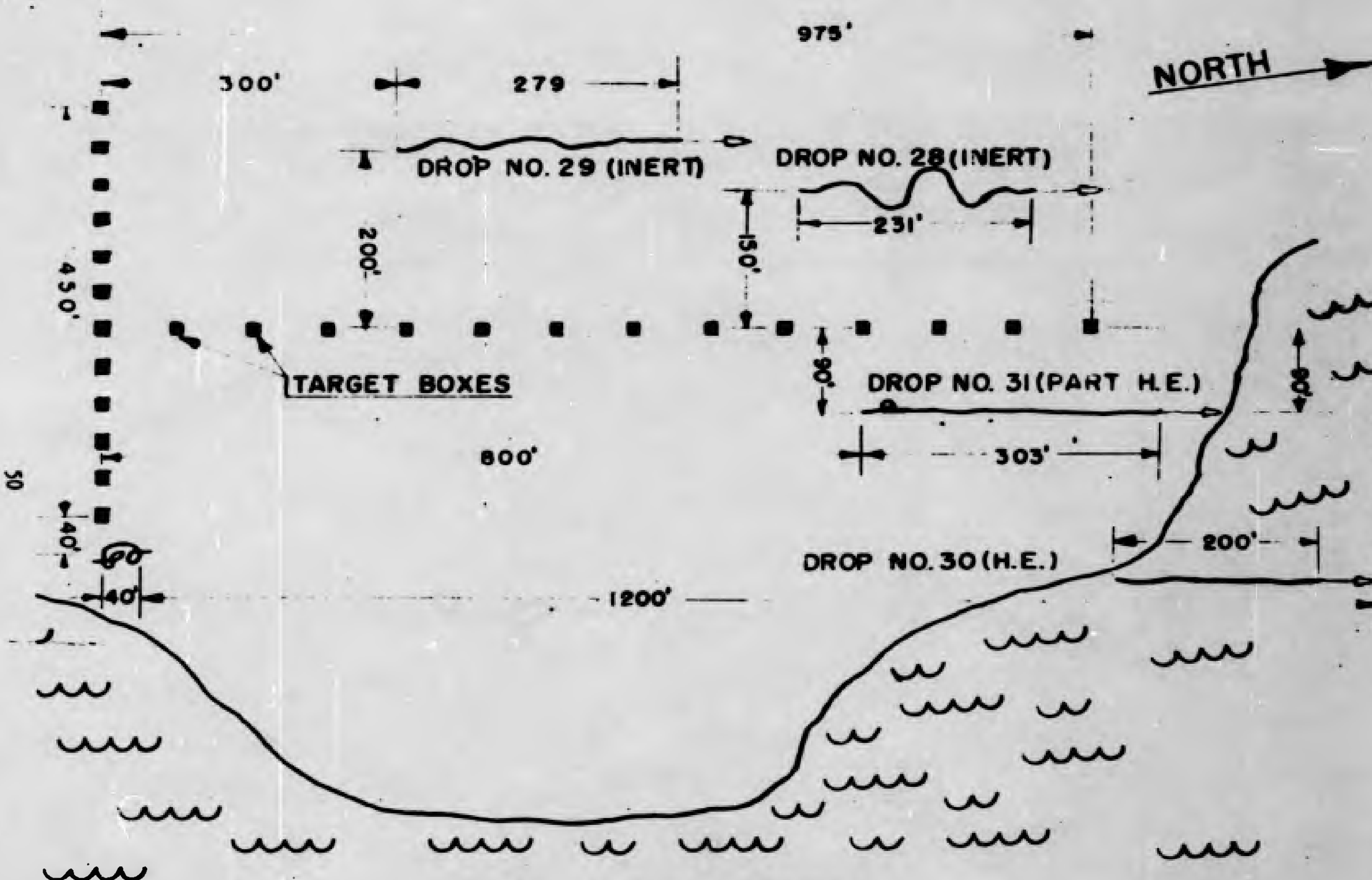

Fig 27 Results of Drops 28 through 31

failure, the dispenser overshot the target and landed in the bay inlet. Upon recovery of this dispenser and linear charge the dispenser parachute was shown to be undamaged. It appeared from the films that this drop would have been an excellent one also, if the splice had not failed. The splice failure was the only one experienced during any of the drops. It is believed that the splice was faulty and would have held if properly made.

93. (C) As is noted in Table 1 (p 21), drops 30, 31, and 32 had explosive detonating cords and dummy linear charges. About 4 feet of detonating cord was fired by the fuze on drop 30, and about 21 feet on drop 31. One of these two charges was fired submerged, and the other on the beach. Later, the rest of the charge used in drop 31 was detonated by separate fuzing from the aft end. Records revealed that the detonating cords assembled with the dummy charge had not met specifications.

94. (C) Drops 32, 33, and 34 were made over a grassy, shrubby, hilly region at the Marine Corps Schools, Quantico, Virginia, from an A4D–2 aircraft. In the first of these drops, the dispenser end was high and the linear charge tail end low, a familiar characteristic of previous good drops. The line straightness was 82%. The results of the next two drops were not good; in both instances, the 54-inch dispenser chutes were either badly damaged or completely torn off. Figure 28 (p 52) shows the positions of these lines in relation to the target area. In drop 33, the parachute release failed to function because of entanglement of the T27 initiators with the 54-inch parachute. This was the only time during the last 13 drops when the T27 initiators failed to operate the release. There was no phototheodolite camera coverage for drops 32, 33, and 34. The altitude and airspeed values shown are those reported by the pilot as his instrument readings. For drop 34 it is possible that the altitude was lower than the 300 feet requested and the resulting impact velocity may have been rather high.

95. (C) Since the parachutes attached to the dispenser had in a number of instances been damaged by the linear charge and/or the parachute release mechanism, NADEVCEN proposed that several changes be made to remedy this weakness before authorizing the dropping of the last three units in California. It was apparent that the success of the drops was directly proportional to the amount of damage inflicted upon the parachute attached to the dispenser. It was observed that in one of the drops at Chincoteague, Virginia, a piece of dispenser parachute cloth had been caught in the aft parachute release mechanism. In addition, the damaged parachute canopies had been marked by a black graphited oil which was traceable to the dummy linear charge since this oil had been used to facilitate the loading of the line into the dispensers. It was agreed by Picatinny Arsenal and NADEVCEN that a fabric sleeve should be installed over the parachute release mechanism for drops 35, 36, and 37, which were conducted later at Camp Pendleton, California.

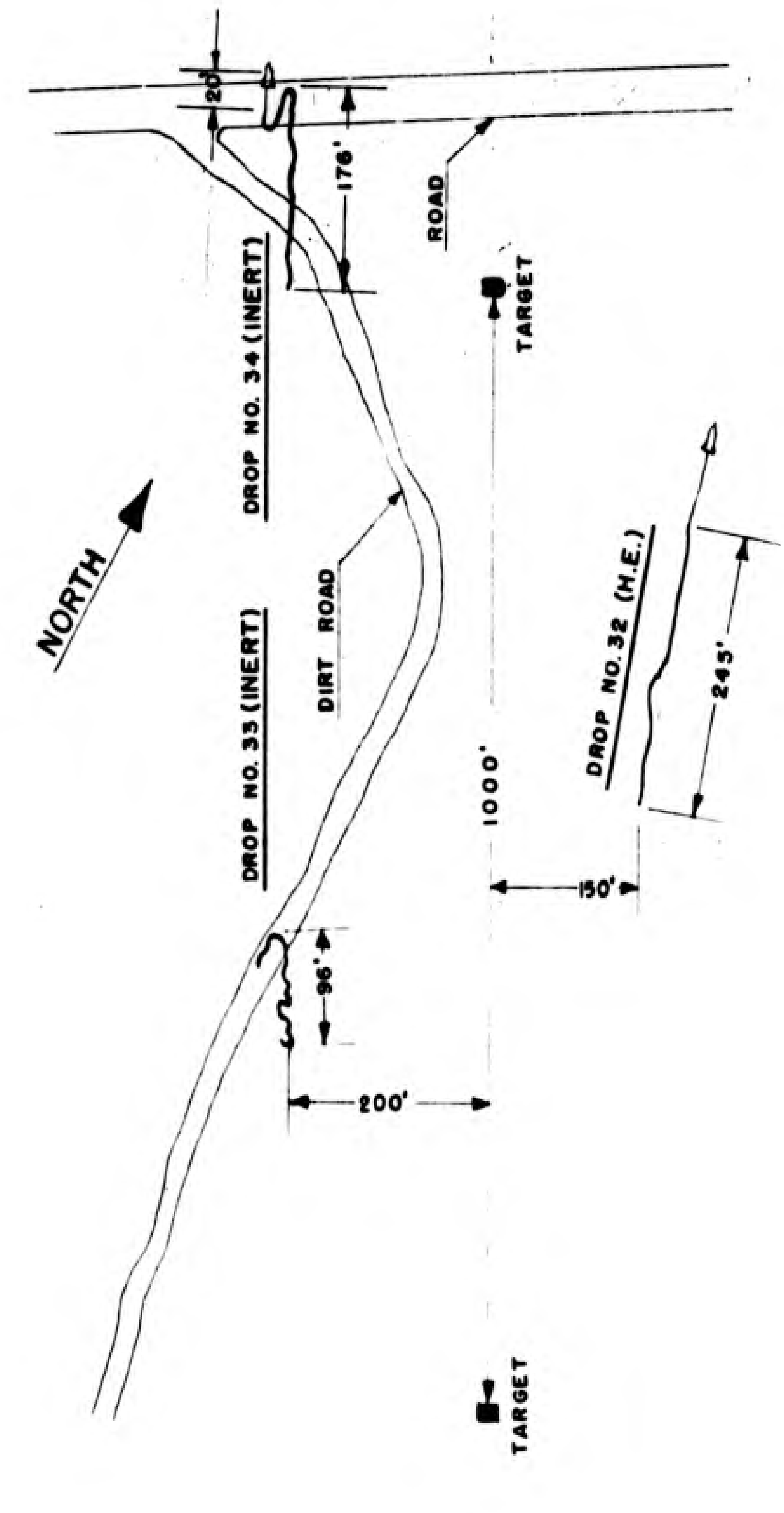

Fig 28 Results of Drops 32 through 34

96. (U) In addition, new shock line assemblies were installed in two of the three charges (for drops 35 and 36). These charges had the proper specification-type detonating cord rather than the weaker cord used in error for shock lines in drops 30, 31, and 32.

97. (U) It had been planned that all the last ten drops would be made from the same type aircraft and by the same pilot, to minimize variables. However, an FJ–4B aircraft was assigned for the last three aerial drops since no A4D–2 aircraft were available to the Marine squadrons on the west coast. It was agreed that one inert Cresset dispenser should be diverted from the drops scheduled for Quantico, Virginia, and transferred to the west coast for a preliminary drop from the FJ–4B before making the drops of the explosive linear charges.

98. (C) No NADEVCEN personnel witnessed the drops (35, 36, and 37) at Camp Pendleton, but reports by Marine Corps personnel indicated the parachutes attached to the dispensers were not damaged and the linear charges were deployed very satisfactorily. After impact, however, the lines were poorly aligned because of topographical features. Broken ground, hills, ravines, and trees combined to give poor lays and damaged lines. It was concluded that the fabric sleeves installed over the parachute release mechanism effectively prevent damage to the dispenser parachutes. It was also concluded that use of the specified detonating cord will prevent breaks like those which occurred in the shocklines during drops 30, 31, and 32.

99. (C) The straightness values for the charges laid in these three drops were 68%, 77%, and 68%, respectively. In drop 36, the fuze armed satisfactorily and 169 feet of linear charge was exploded. The cause for the failure of the balance of the linear charge to detonate is unknown.

100. (U) An FJ–4B aircraft was used for all three drops and no separation problems were encountered. However, the arming wire was broken in the first drop because of poor routing and was severed in the third drop by the pinching action of the Aero 7A rack ejector foot. In connection with this last drop, it was noted that during the loading of the dispenser onto the aircraft, the ejector foot had not been adjusted to touch the top of the dispenser. The squadron ordnance personnel had adjusted the ejector foot to a locally prescribed mark. This adjustment produced a gap of approximately ¼ inch between the ejector foot and the dispenser. The arming wires were taped away from the foot contact area as a precautionary measure, but the air stream around the pylon and dispenser is believed to have loosened the wires enough to permit their getting under the foot before the charge was released. Consequently, the fuze was not armed in the aerial drop and the linear charge was not detonated. The arming wire arrangement on the dispenser has now been revised so that on future aerial drops the arming of the fuze will be completely reliable, and the arming wire will not be susceptible to severing by the ejector foot. The proposed system is shown in Figs 29 and 30 (pp 54 and 55). This arrangement, which eliminates

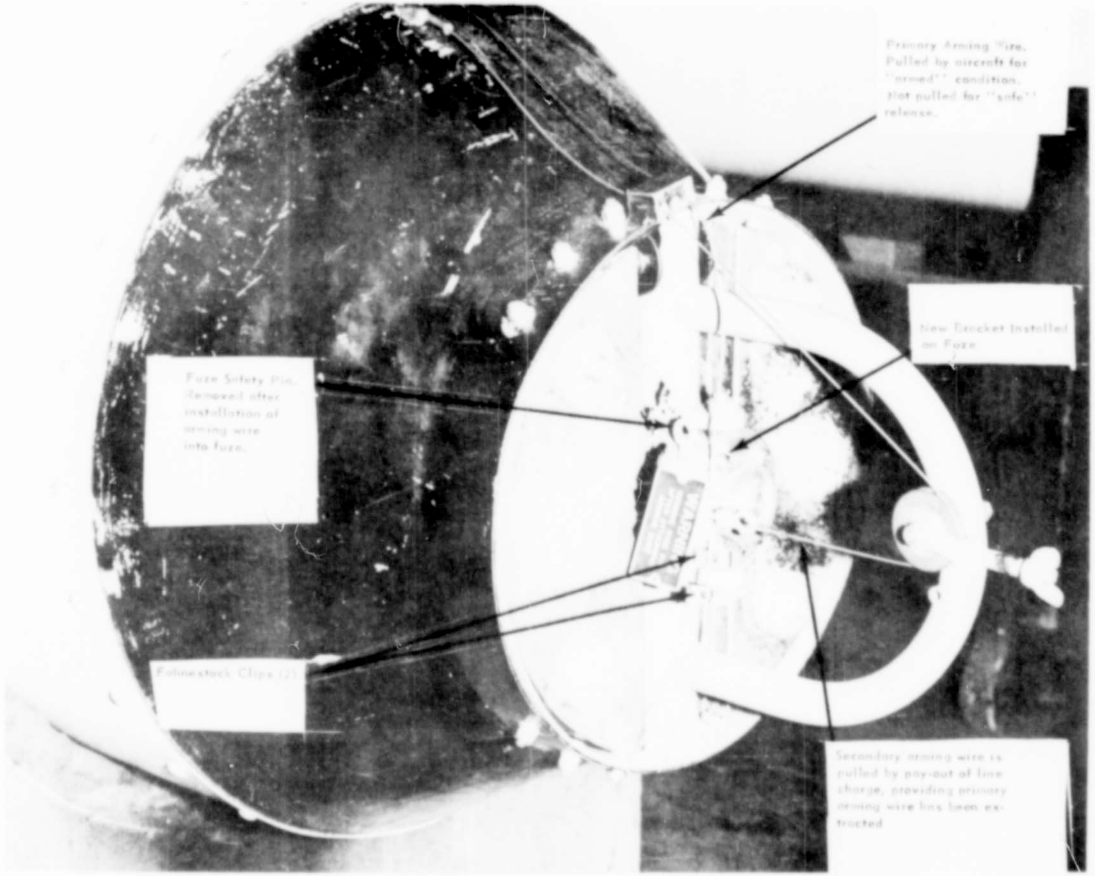

Fig 29 Fuze Linkages of Revised Arming Wire System

the routing of wires into the vicinity of the ejector foot, is readily adaptable for use on any of the aircraft presently assigned to the Marine Corps.

101. (U) The revised arming wire system consists of a single 1/16-inch flexible stranded aircraft cable, one end of which is anchored to the dispenser at the fairing for the center section while the other end passes through the arming wire loop, forward through a steel tube, and then through a hole in the arming pin and bracket. For "safe" release, the arming wire loop is pulled free from the aircraft and therefore does not pull the arming wire. For "armed" release, the wire loop pulls the arming wire out of the arming pin and metal tubes. The arming wire remains anchored to the dispenser and the wire loop remains in the arming solenoid. This keeps the aircraft clean and free from dangling wires or heavy metal rings. The arming wire length can be adjusted to match the location of the arming solenoid on any applicable aircraft.

102. (U) The revised arming wire system requires either that a small bracket be installed on the front of the standard Cresset fuze or that an equivalent modification be made (Fig 29, p 54). This can be readily accomplished by using existing screws, without disturbing the operation or performance of the present fuzes. After insertion of the fuze in the Cresset dispenser and after insertion of the arming wire through the bracket and secondary arming pin, the primary arming pin can be removed from the fuze since it is no longer needed as a safety pin. One or two safety (Fahnestock) clips would be installed on the arming wire after insertion through the arming pin. This modification does not alter the fuzing policy or sequence previously established.

Accuracy and Sighting Problem and Solution

103. (C) In the first tests in which actual targets were used (drops 14 and 21), miss distances were 300 feet and 26 feet, respectively. Figures 25 and 26 (pp 47 and 49) show the positions of the linear charges in relation to their targets for aerial drops 28 through 34. In early discussions, military personnel expressed great concern as to whether the Cresset dispenser could be placed on the beach with accuracies of ±25 feet. Later, they indicated that possibly accuracies of ±50 feet would be acceptable.

104. (C) NADEVCEN conducted a study of the Cresset sighting problem to determine the effects of airspeed on accuracy (Ref 21). This study indicated that:

a. A fixed-sight system in combination with the eyes of a trained pilot will give greater accuracy in hitting a target with the line charge than will a simplified lightweight computer, since existing airspeed and altitude measuring devices are not accurate enough to provide sound basic data for the computer.

b. An error analysis showing the effects of airspeed and altitude variations on horizontal range when the target can be seen by a fixed sight method is as follows:

Sight Angle Optimized for

Airspeed, knots	Altitude, ft	Error in Altitude, ft	Error in Airspeed, knots
200	300	2	4.5
250	300	2.5	4
300	300	3	3.5

c. No suitable bomb sight is available for use in dropping the Cresset dispenser from altitudes of 300 to 400 feet at airspeeds of 200 to 600 knots.

105. (C) A comparison of range data for the Cresset dispenser is given in Figure 31 (p 58). As can be seen, close agreement of range data is shown for drops 26 and 27. For these two drops, the dispensers' characteristics were about identical, release was made under almost identical conditions from the same A4D–1 aircraft, and practically identical performance resulted. This aircraft was equipped with an ARW–3 transmitter, with which the exact release point was recorded. Unfortunately, other releases made under about the same conditions were made with an A4D–2 aircraft that was not so equipped and thus the range data could not be determined from the phototheodolite data. The difference in performance between drop 30 and drop 26 is due in part to the separation of the line charge in drop 30 because of a splice failure. Thus the drop 30 dispenser traveled slightly farther than the drop 26 dispenser.

106. (C) It must be kept in mind that the Cresset dispenser and linear charge will travel about 400 feet less than a standard 2000-pound general purpose bomb since the parachutes used with the Cresset reduce the forward velocity and kinetic energy. In addition, it is to be noted that the error in placing the linear charge on the target is somewhat less critical than that for a bomb since the linear charge covers a greater area because of its 300-foot length.

107. (C) From the phototheodolite data, which is in rather close agreement with calculated range data, the Cresset dispenser will travel about 1400 feet for a 225-knot release, about 1900 feet for a 325-knot release, and about 2100 feet for a 400-knot release, as shown in Figure 32 (p59).

108. (C) Figures 33, 34, and 35 (pp 60, 61, and 62) show the Cresset dispenser installed on A4D–2, FJ–4B, and F4D–1 aircraft, respectively. On an attack mission, the A4D aircraft is capable of carrying and releasing one dispenser. The FJ–4B and F4D can deliver two dispensers each, and the AD type aircraft, although slower, can deliver three dispensers.

109. (C) To improve the lay of the line charge and obtain optimum results during an attack mission, the Project Cresset dispenser should be released with the aircraft in a horizontal or nose-up attitude. This does not preclude a diving pass on the target, but it is recommended that the pilot level off and even pull up slightly, as he does when using the toss-bombing technique, just before he releases the Cresset dispenser. The relationship of

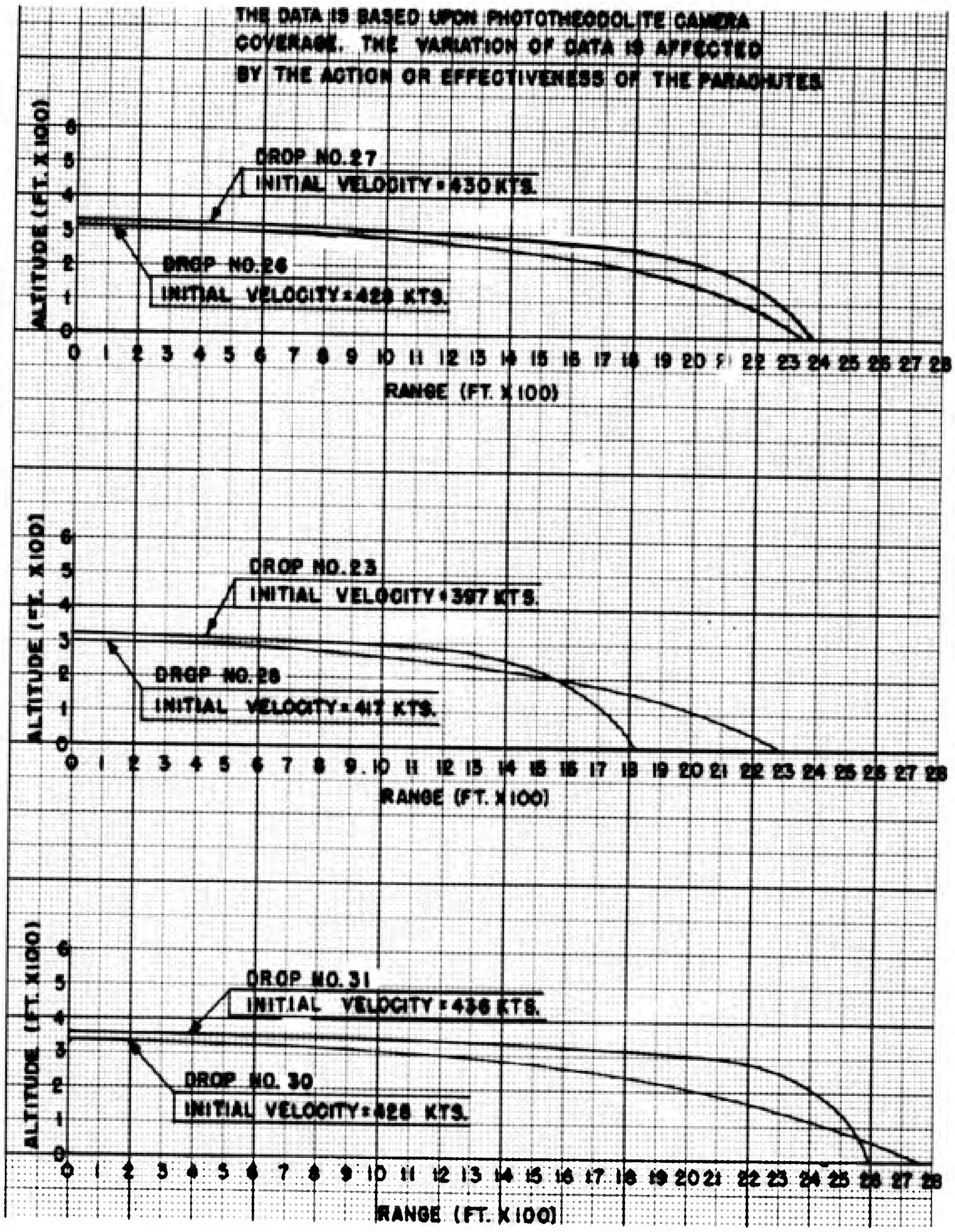

Fig 31 Comparison of Cresset Range Data

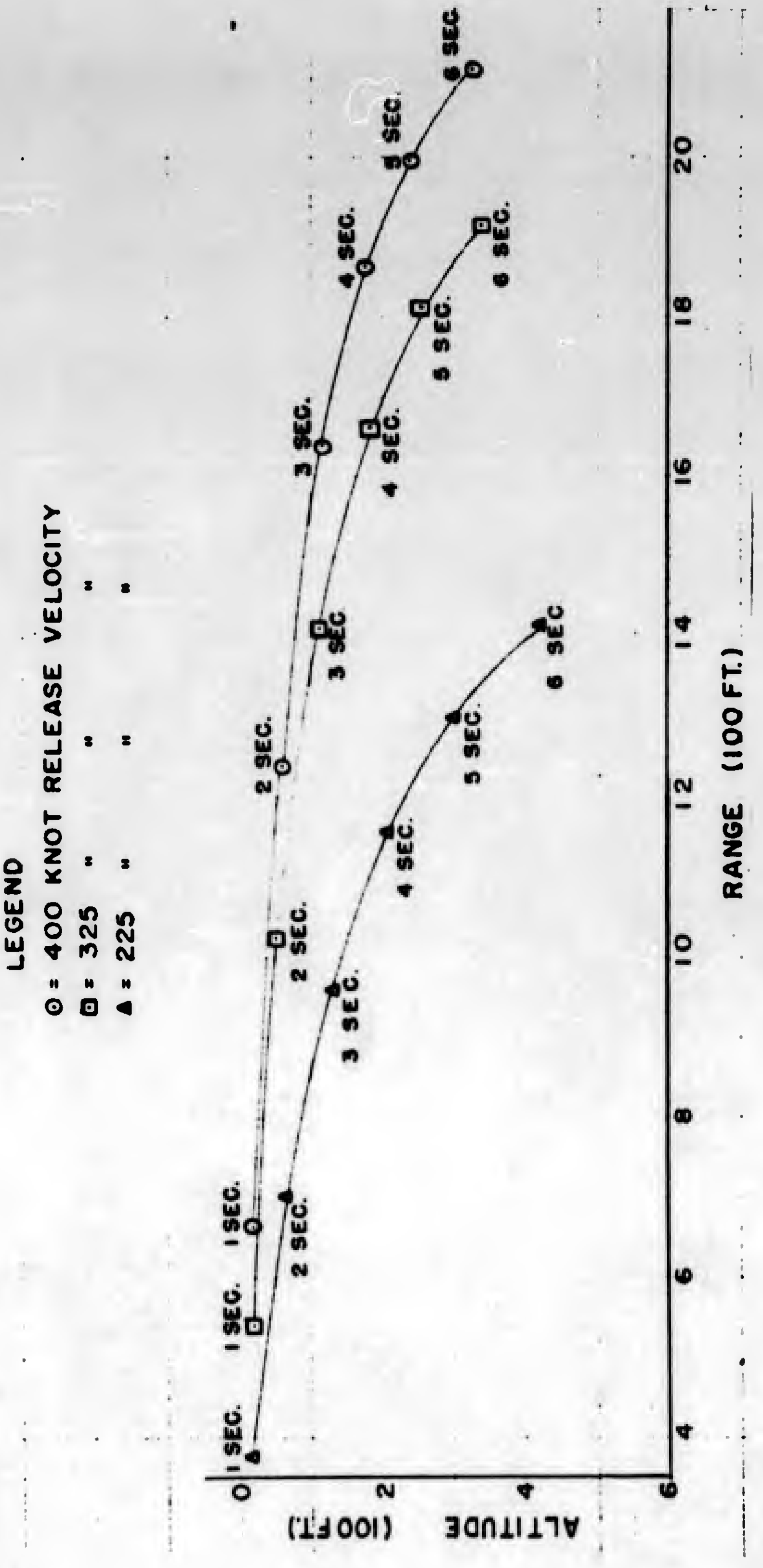

Fig 32 Calculated Range and Payout Time Data

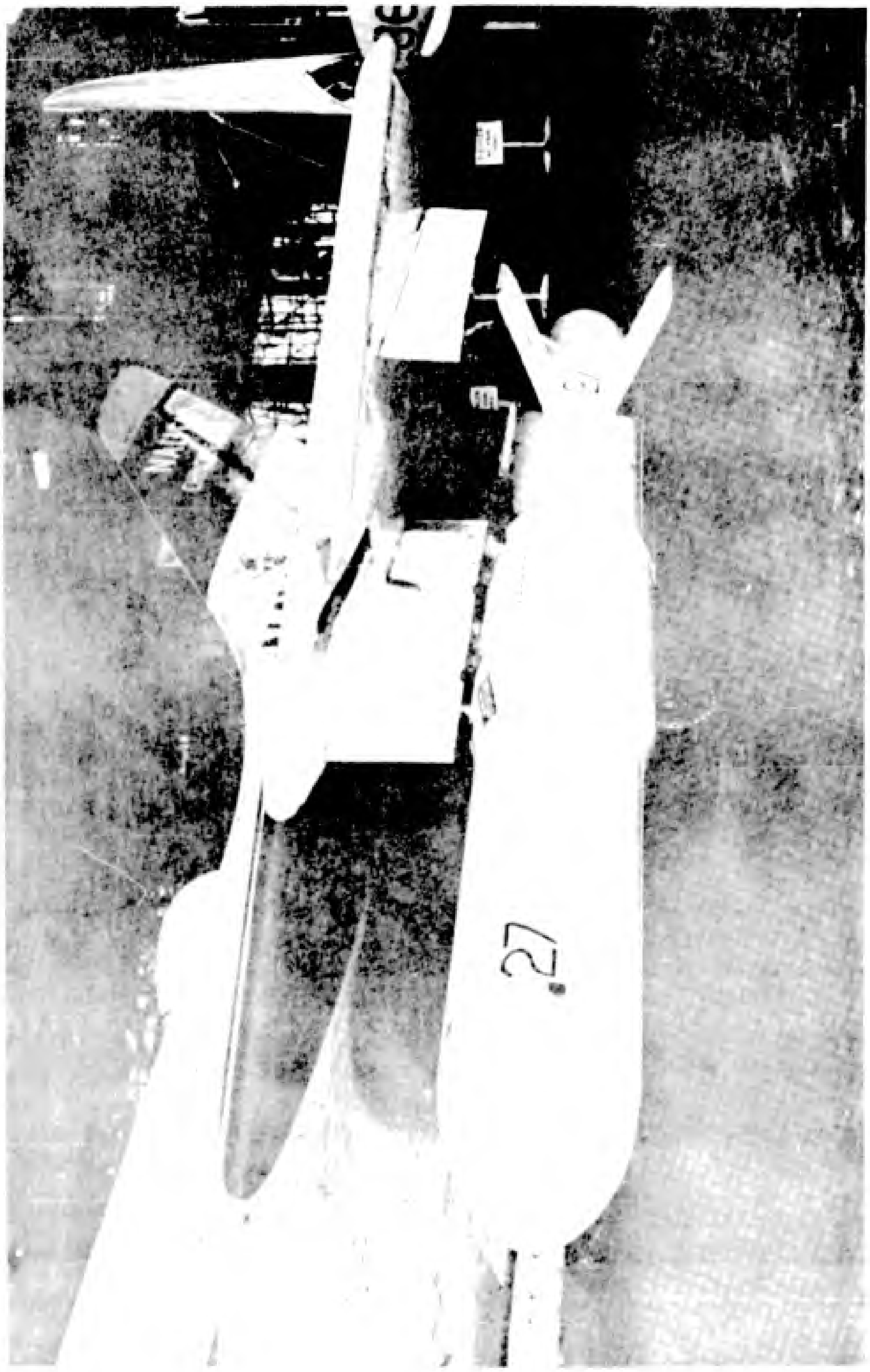

Fig 33 Project Cresset Dispenser Installed on A4D-2 Aircraft

Fig 34 Project Cresset Dispenser Installed on FJ–4B Aircraft

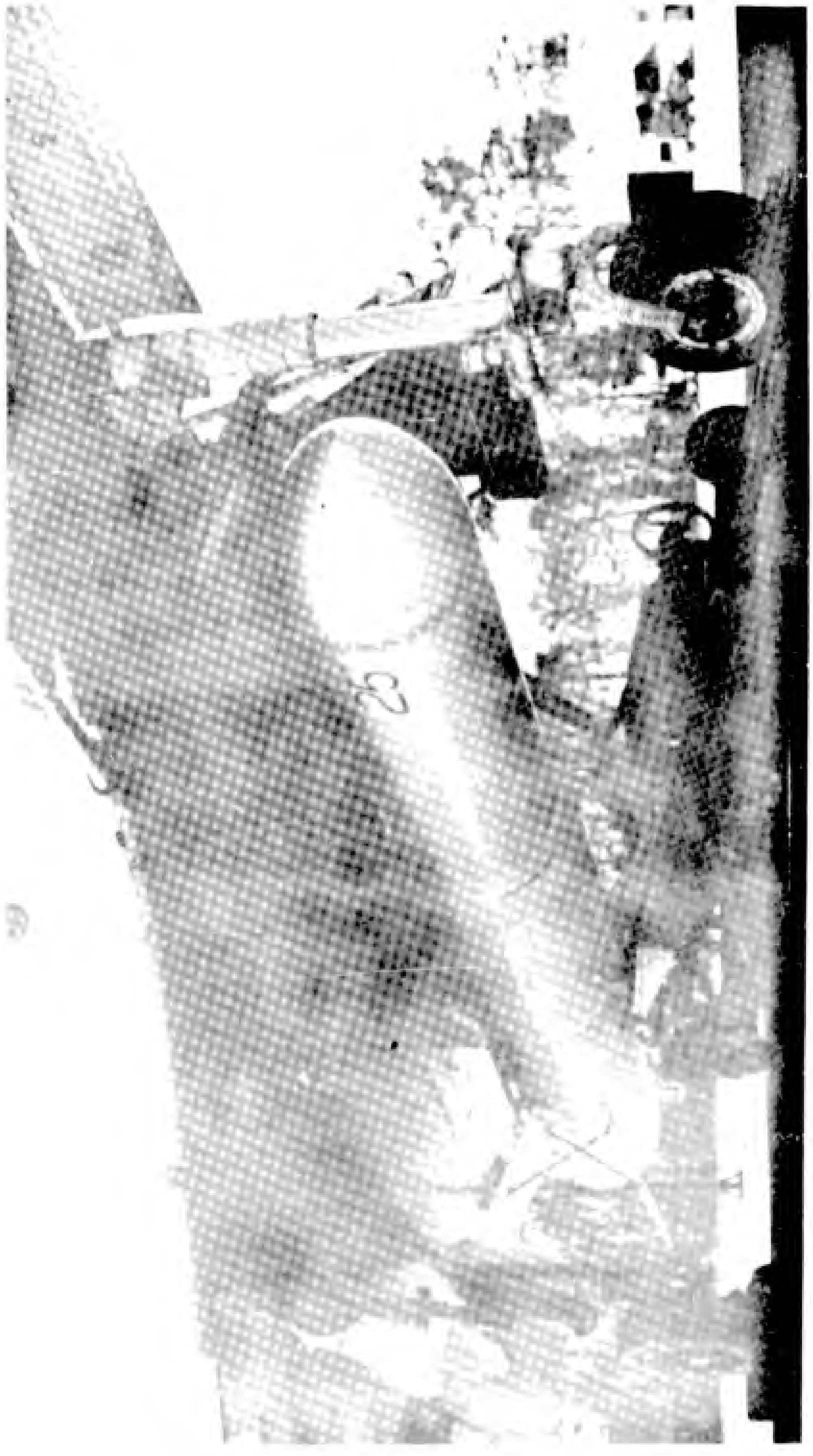

Fig 35 Project Cresset Dispenser Installed on F4D-1 Aircraft

impact velocity to line charge straightness was studied, and found to be inverse (Fig 36, p 64).

Linear Charge Development

110. (U) Development of the linear charge is covered in the section Development and Testing of Cresset, paragraphs 35 through 49. Further details are contained in Reference 10.

Fuze Development

Preliminary Design (Model A)

111. (U) A study of the overall problem and of existing fuzes indicated that a fuze similar in principle to the M146 mechanical time bomb fuze could be designed to meet the requirements of the Cresset system. Design layouts were made and analyzed, and a design which embodied many of the operating principles of the M146E3 fuze was selected. This design was presented to representatives of the United States Marine Corps, Bureau of Aeronautics (Navy), Bureau of Ordnance (Navy), Naval Air Development Center, Picatinny Arsenal, Chief of Ordnance, Naval Ordnance Test Station, and Los Angeles Ordnance District at the First Cresset Conference, held at the Rheem Research and Development Laboratories on 30 September and 1 October 1954. Upon the request of various participants in the conference, minor design changes were made. A description of this fuze, which has been designated Model A, is contained in Reference 29.

Fuze Location

112. (U) An important factor affecting the design of the fuze was its location with respect to both the linear charge and the dispenser. This problem was complicated by three considerations:

a. Availability of space within the dispenser for storage of the fuze

b. Availability of independent sequential forces to actuate the fuze

c. Proximity of the fuze to the main explosive charge at the time of firing.

113. (C) At first the fuze was located on the aft end of the linear charge. This arrangement proved undesirable for two reasons: (a) it was found that the forces used to actuate the fuze would not be reliable, and (b) safety would become a problem. With the fuze extracted from the container first, the whole linear charge could detonate while still in the dispenser and close to the launching aircraft. By locating the fuze at the forward end and completing arming after the linear charge was extracted, the pilot and aircraft were made safe from any blast effects of the linear charge.

114. (U) Subsequently, by agreement between representatives of the Naval Air Development Center and Rheem, the fuze installation was further changed to simplify the installation procedure. Figure 37 (p 65) shows this installation.

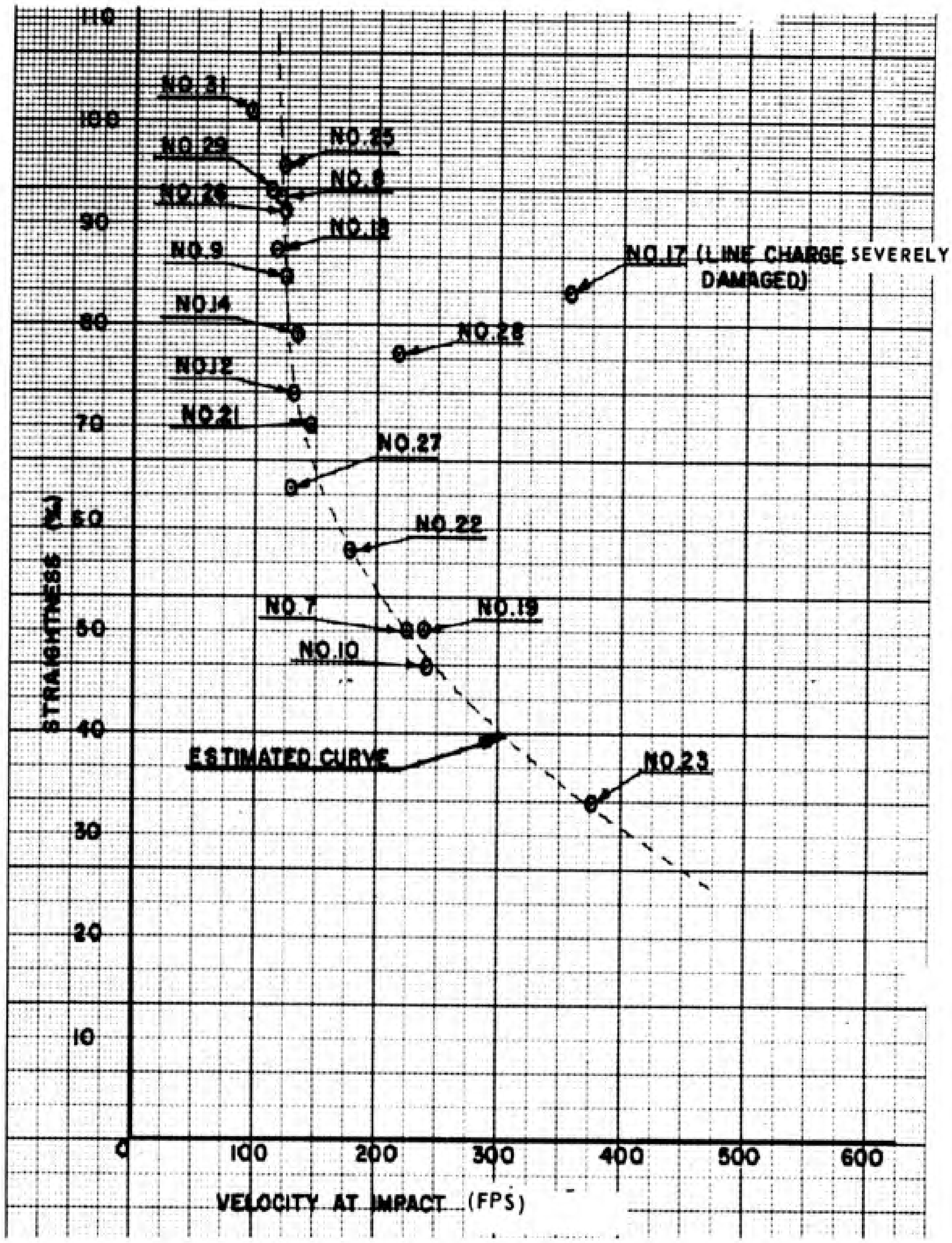

Fig 36 Line Charge Straightness vs Impact Velocity

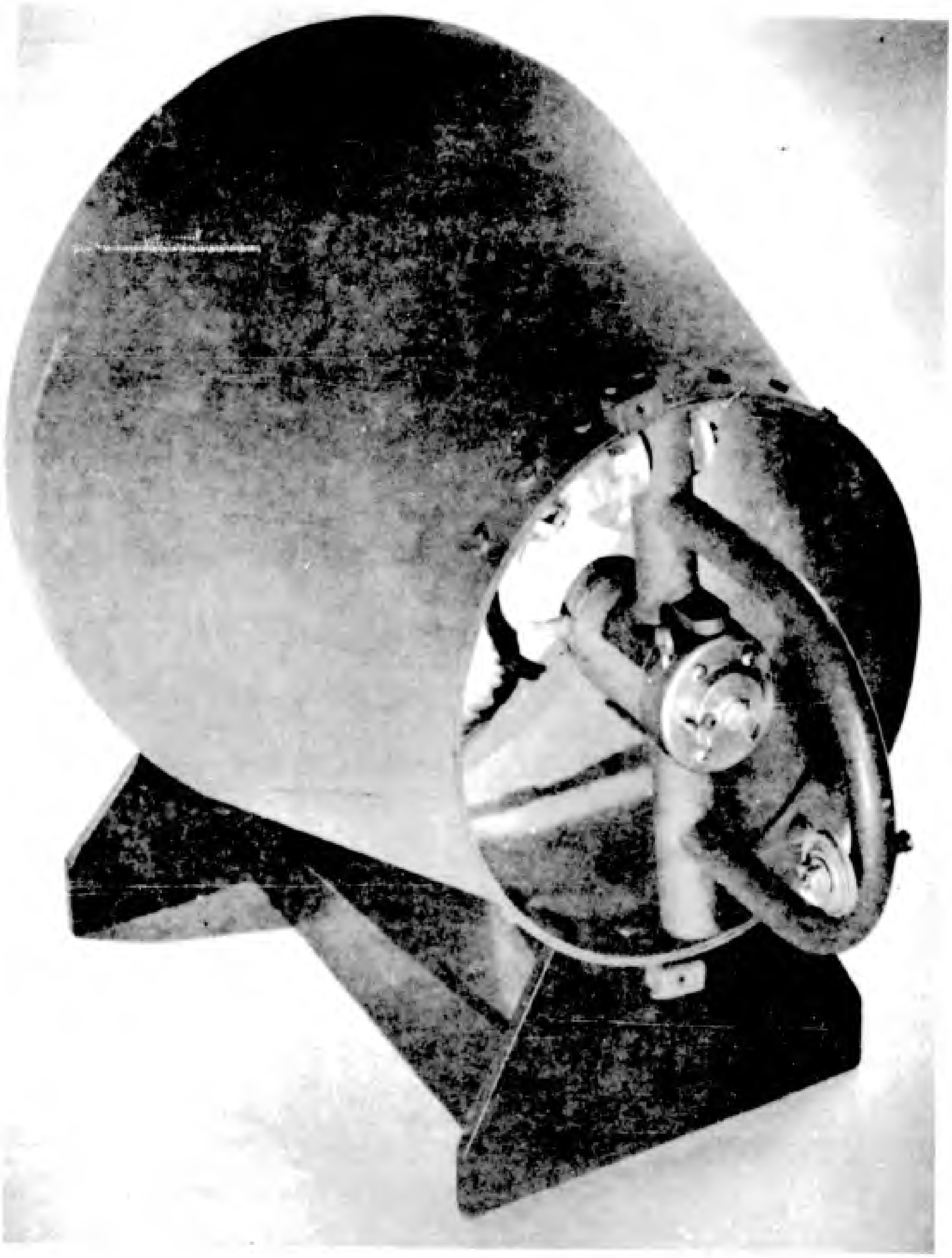

Fig 37 Fuze Installation Mockup

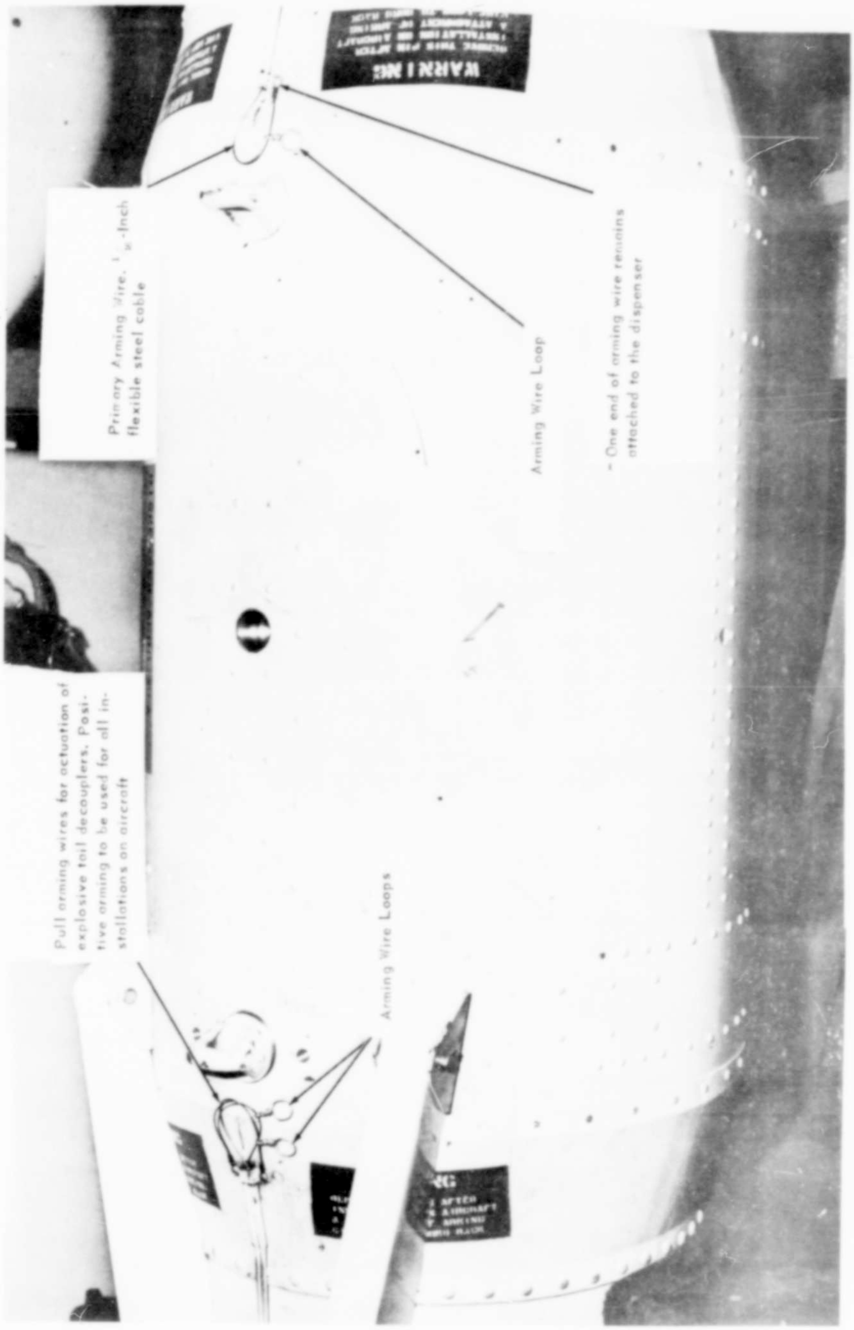

Fig 30 Loops of Revised Arming Wire System

Preliminary Tests

115. (U) Concurrent with the initial design of the fuze, preliminary tests were conducted to validate engineering judgments on some phases of the design. Of main concern was whether the T3 timer would continue to operate after being subjected to impact. Test results showed that the timer could be subjected to acceleration loads of considerable magnitude without impairment of its operating characteristics. On the basis of these findings and because the fuze could be shock mounted in the dispenser if necessary, the T3 timing mechanism was accepted for use in the Cresset fuze.

116. (U) Preliminary in-line and out-of-line tests established that the fuze was adequate in these respects. Results of other miscellaneous tests were in general quite good but minor failures did occur. Consequently, a development program involving tests and model changes (Models A through D) was conducted. Primarily, modifications were needed to the detonator slide, the secondary arming pin and lock mechanism, the arming pin seals, the cocking pin, and the detonator slide spring.

117. (U) A final design, T1304, Model D (Fig 38, p 67), was established upon completion of the fuze test program. It embodied modifications to eliminate all the flaws in the fuze which had become apparent as a result of the development test program.

Operation of the Model D Fuze Design

118. (C) The T1304 fuze (Fig 38) is a mechanical time fuze covering a time span of 5 to 92 seconds. To set the fuze to fire at any predetermined time between 5 and 92 seconds, the time set lockscrew (Fig 39, p 68) must first be loosened. The time set assembly (9C026, Fig 38), can then be rotated until the desired time graduation is in line with an indexing marker on the face of the body cover assembly. Under actual flight conditions, the time set assembly is then locked with the lock screw (9A248, Fig 39) and this screw is secured by bending up the tab on the lock washer (9B249, Fig 39).

119. (U) To start operation of the fuze, it is necessary first to cut the safety lock wire which restrains movement of the arming pins. (Section BB, Figure 38, shows these pins in cross-section.) Both pins must be pulled, and pulled in the proper sequence. When the primary pin is removed, it can no longer interfere with the lateral movement of the other pin or arming rod piston. When the arming rod piston is pulled, the arming rod (9B031, Fig 40, p 69) moves out of interference with the timing mechanism release pin. The lock washer is forced outward by the action of its release pin spring (9B088, Fig 38), permitting the timing mechanism assembly (9C227, Fig 40) to start. At the same time, the arming rod moves out of interference with the detonator slide assembly (9B092, Fig 38) so that it is no longer in a position to impede motion of the slide.

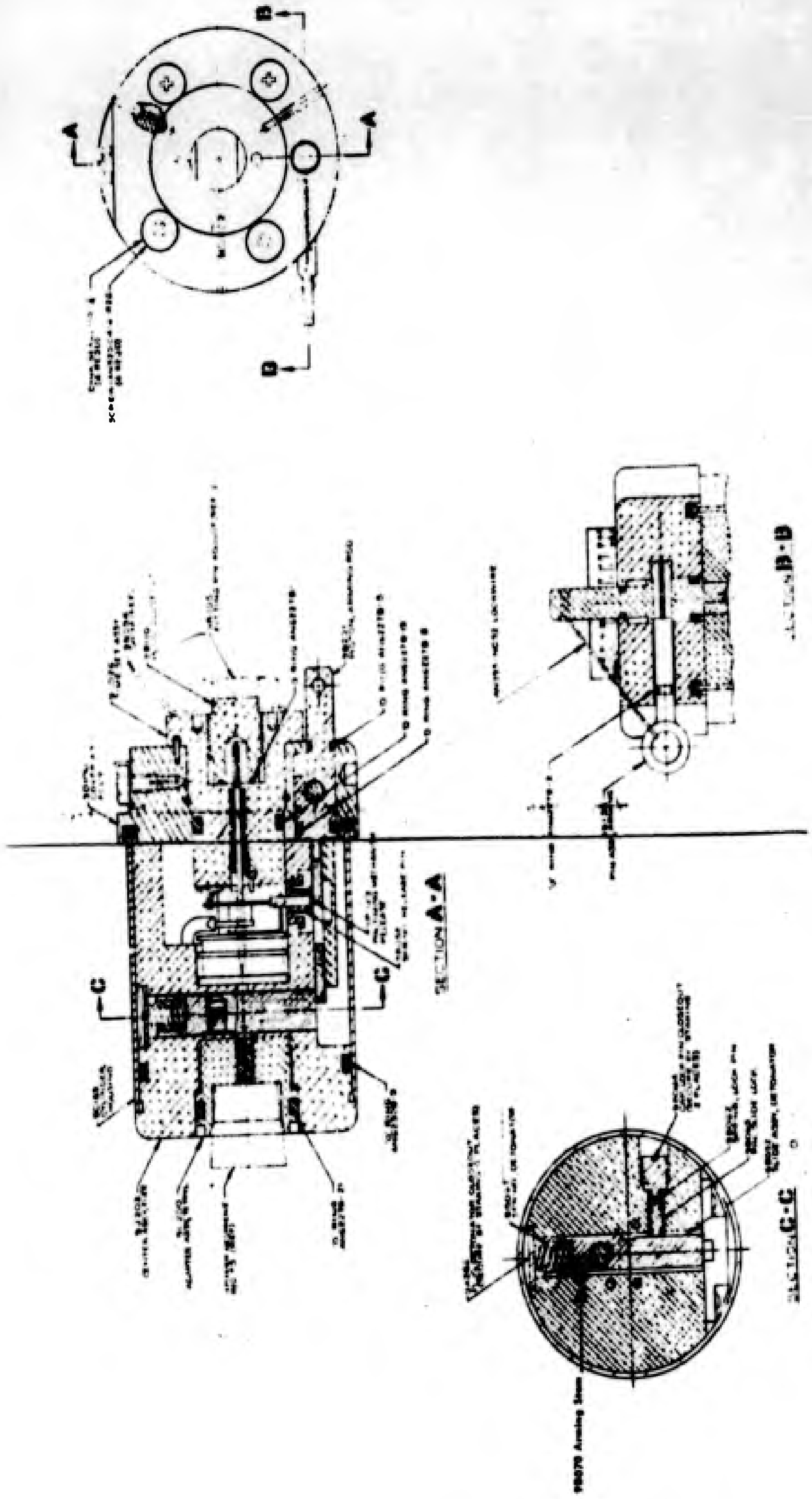

Fig 38 Model D of the T1304 Fuze

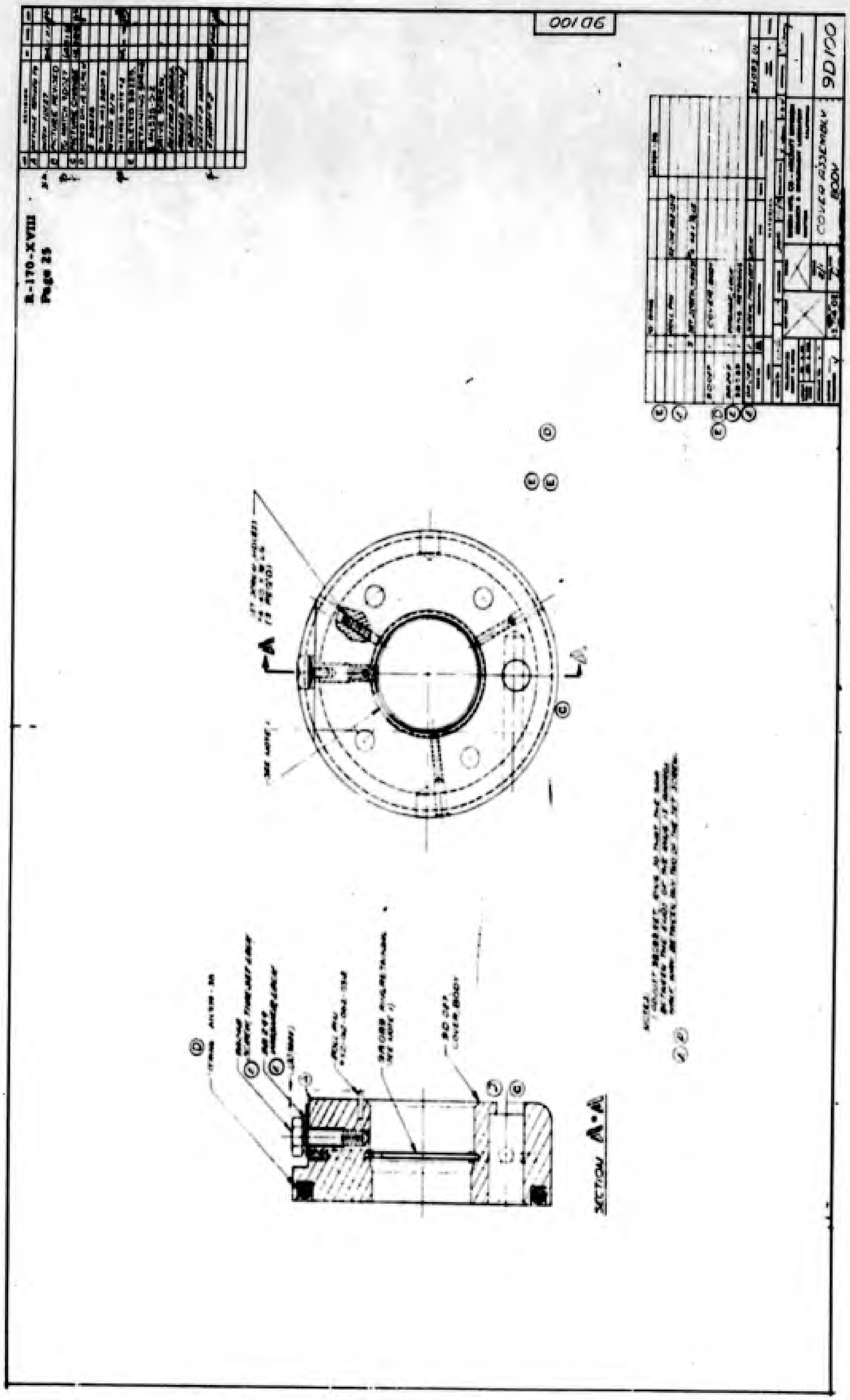

Fig 39 Cover Assembly Body

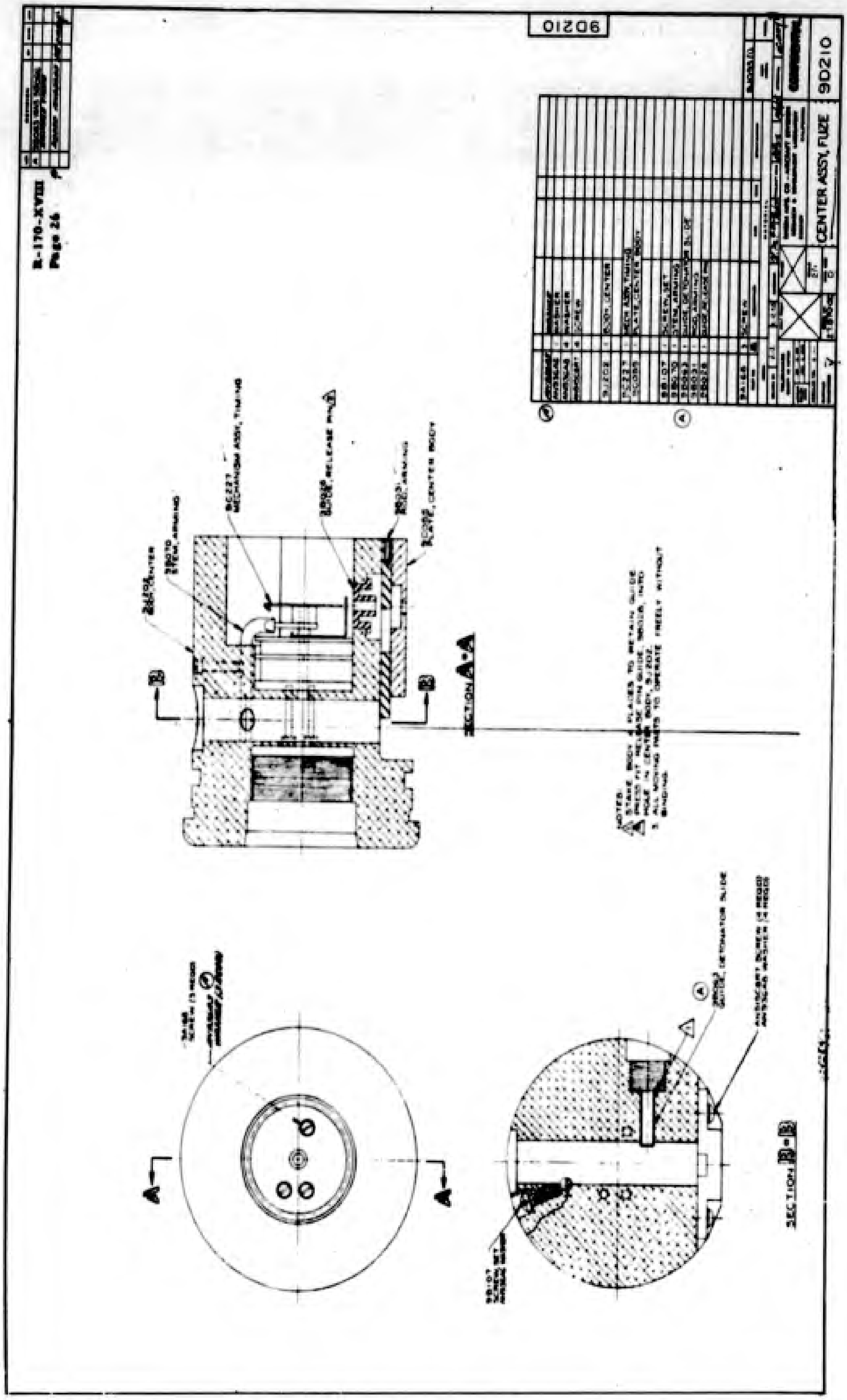

Fig 40 Center Assembly of T1304 Fuze

120. (U) At this point in the cycle, the fuze is still unarmed since the arming stem (9B070, Fig 38, p 67) is still in engagement with the detonator slide assembly. To release the slide assembly, the arming stem must rotate through 90 degrees; however, it is prevented from doing so by the disc assembly cam which is attached to the central shaft of the timing mechanism. After the timer is started, this cam rotates out of interference with the end of the arming stem, permitting the arming stem to rotate; this, in turn, permits the detonator slide assembly to move into the in-line position. This occurs after approximately 4 seconds.

121. (U) At this point in the fuze operating cycle, the only step left is to release the firing pin assembly. When locked, this assembly is under spring pressure by action of its compression spring (9B068, Fig 41, p 71), and is restrained by two levers (9B083 and 9B084, Fig 41) and the cocking pin assembly (9B087, Fig 41). The 9B084 lever bears against the periphery of the disc assembly, which is attached to and rotates with the time mechanism assembly. This disc assembly has a small recess in its periphery, in which lever 9B084 will engage at the end of the prescribed time setting. This engagement permits movement of the two levers which, in turn, permits the cocking pin assembly to rotate 90 degrees about its axis. This rotation releases the firing pin assembly. The firing pin strikes the detonator, and the detonation continues on through the remainder of the fuze explosive train.

Test Results for Proposed Final Fuze Design (Model D)

122. (U) Eighty T1304 fuzes of the Model D design were manufactured and tested by the contractor. The results of these tests are given below:

Nondestructive Functional Inspection Tests

123. (U) Pull Test. The force needed to remove the primary arming pin was found to vary between 34½ pounds and 51 pounds. The average force was 41¼ pounds. The force needed to pull the secondary arming pin varied between 11½ pounds and 19½ pounds, averaging 16 pounds. In all cases, the rate of application of this force was approximately ½ pound per second. These results were found satisfactory.

124. (U) Arming Delay Cycle Time Test. The arming delay time for the 75 fuzes varied between 2.9 and 4.2 seconds, but only five fuzes had times of 4.0 seconds or more. Therefore, most of the arming delay times were below the requested minimum of 4 seconds. As previously stated, the delay time could not be controlled on this model, but was to be corrected on the final fuze design.

125. (U) Nondestructive Functioning Test. The firing time was preset at 81 seconds on all fuzes. The tolerance of the firing time had been established as ±1 second of the preset time. The functioning times for the 75 fuzes varied between 78.9 and 81.0 seconds, with 33 units below the minimum of 80 seconds.

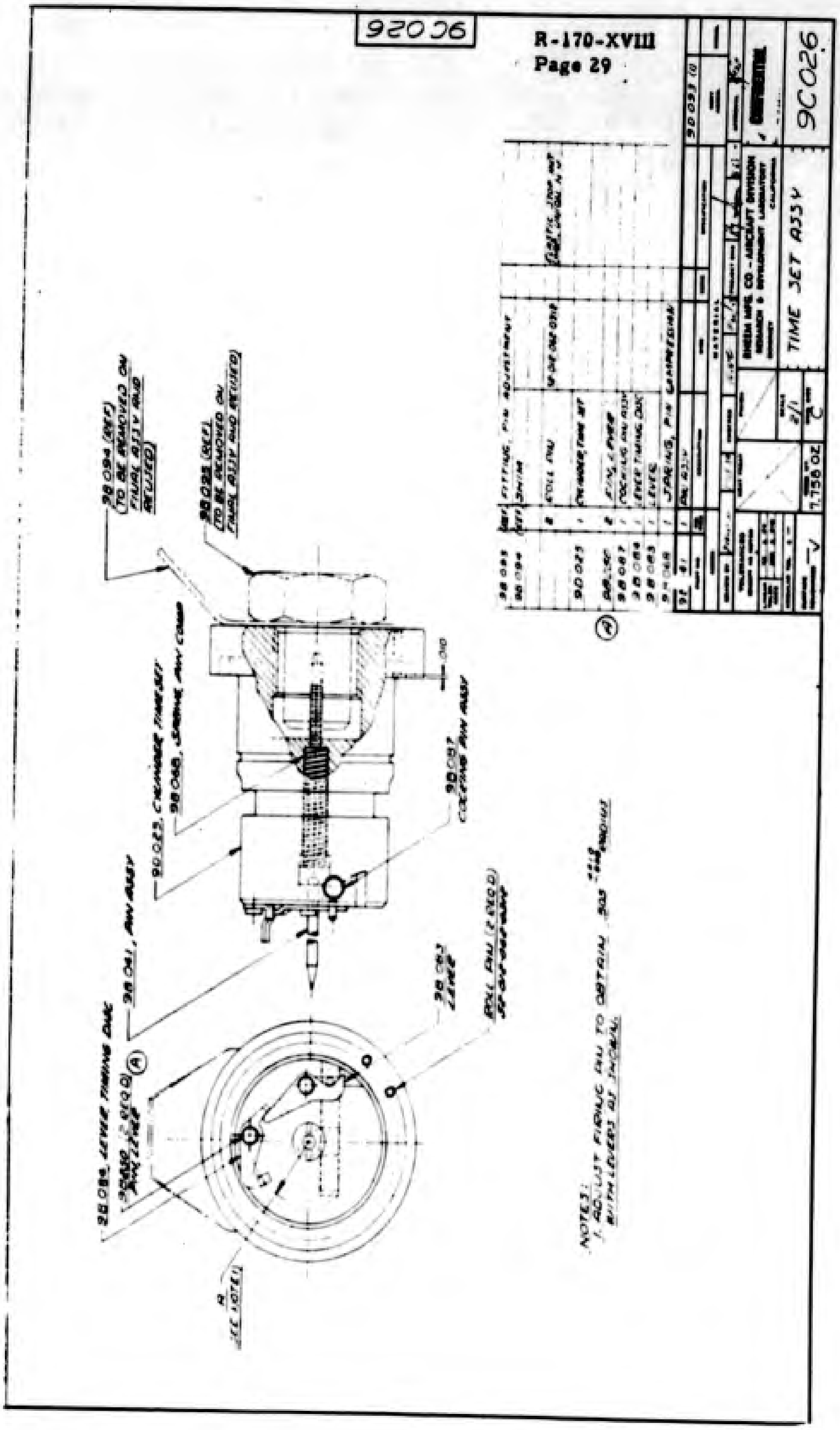

Fig 41 Time Set Assembly

The exact cause of the fast functioning times was not determined.

126. (U) Test on Seals of Fuzes. Twenty-five fuzes were subjected to an internal gas pressure of 13 psig after immersion in water for at least 5 minutes. No leaks at the seals were noted. Subsequently, 10 of these 25 fuzes were used in the temperature and humidity test, 10 in the underwater functional firing test, and 5 in the salt spray test.

Functioning Tests

127 (U) MIL-STD-300 Jolt Test. Five fuzes were subjected to the MIL-STD-300 jolt test (Ref 30). Upon completion of the test, all fuzes were examined for safety. Since all were found safe to handle, they passed the test. The fuzes were then subjected to functioning tests. Four of them functioned properly, but the timer on one fuze did not start. The cause of the failure could not be determined.

128. (U) MIL-STD-301 Jumble Test. Five fuzes were subjected to the MIL-STD-301 jumble test (Ref 31), and were then examined for safety. All were found safe to handle. The fuzes were then subjected to functioning tests. One fuze functioned properly. The four which did not function were disassembled. In one case, the timer had not started. The reason for this failure could not be determined, but the fuze may not have been fully wound at the time of assembly. On three fuzes, the threaded portion of the arming rod piston had fractured. When these fuzes were operated manually, all functioned properly.

129. (U) MIL-STD-306 Salt Spray Test. Five fuzes were subjected to the MIL-STD-306 salt spray test – four for 48 hours, and one for 96 hours (Ref 32) – and were then inspected, checked for safety, and subjected to functional tests. All fuzes were found safe and all functioned properly.

130. (U) MIL-STD-303 Transportation Vibration Test. Fifteen fuzes were subjected to the MIL-STD-303 transportation vibration test (Ref 33). Upon completion of the test, all fuzes were subjected to functional tests, and all functioned properly.

131. (U)MIL-STD-304 Temperature and Humidity Test. Ten fuzes were subjected to the MIL-STD-304 temperature and humidity test (Ref 34). Upon completion of the temperature and humidity cycling, eight fuzes were subjected to functional tests and two fuzes were disassembled and examined for internal corrosion. Six of the eight fuzes subjected to the functional tests operated properly. One of the two failures which occurred was caused by a spot of rust approximately 1/16 inch in diameter on the bottom surface of the firing pin release lever. This rust prevented the firing pin from being released when the preset firing time had expired. The exact cause of the second failure was not determined. On this fuze, the timer ran for approximately 2 seconds and then stopped. During disassembly of the fuze, the timer started again and ran for approximately 5 minutes. Examination of the timer revealed a spot of corrosion 1/16 inch in diameter beneath one of the weights on

the pallet of the timer. Clearance between the weight and the corroded spot was approximately 0.010 inch. This corroded spot was the only evidence of any abnormality in the timer. Both of these fuzes showed rust on the bottom surfaces of the firing pin release levers. A check of the cadmium plating on the levers revealed it to be thinner than specified on the drawings.

132. (U) Examination of all the fuzes which were subjected to the temperature and humidity test failed to reveal any evidence of leakage of the fuze seals.

133. (U) High- and Low-Temperature Tests. Ten fuzes were subjected to high- and low-temperature tests (Ref 35) and the following results were obtained:

a. Five fuzes were temperature conditioned for a minimum of 12 hours at +160°F and then subjected to functional tests. All functioned properly.

b. Five fuzes were temperature conditioned for a minimum of 12 hours at −65°F and then subjected to functional tests. Four functioned properly. On one fuze the timer started, ran for approximately 10 seconds, and then stopped. When this fuze was disassembled, it was found that the timer had not been fully wound during assembly.

134. (U) Underwater Firing Test. For the underwater firing tests (Ref 36), 10 fuzes were submerged in water under a pressure of 15 psig to simulate submersion to a depth of 30 feet. After approximately 3 minutes, and while still submerged, each fuze was subjected to a functioning test. All fuzes functioned properly.

135. (U) Out-of-Line Tests. Five fuzes were subjected to out-of-line firing tests (Ref 37). All passed the test.

136. (U) 100-Foot Drop Test. Fifteen fuzes were expended in the 100-foot drop test (Ref 38). Fourteen functioned properly. On the fifteenth drop, the drop test fixture was damaged, and the time set cylinder became disengaged from the fuze body. The test fixture was repaired, the fuze was reassembled, and the test was repeated. After the second drop, the fuze functioned properly.

137. (U) The overall results showed that of the 80 fuzes tested, only five failed to satisfy the requirements of the individual tests. In the temperature and humidity tests, four fuzes showed evidences of breakdown of the protective coatings on internal parts. Two of the four were tested but did not function. This would indicate that the breakdown of the coatings and the subsequent rusting of the parts was responsible for the malfunctions. The other two fuzes were disassembled but not tested. Had they been tested, they too would probably not have operated properly.

Design Modifications to Final Fuze Design (Model E)

138. (U) A complete analysis of the fuze design and the results of the tests

showed that the Model D fuze had no serious design defects. However, some minor faults were found. The engineering drawings were modified to correct these. Other desired changes were also incorporated into the drawings. The modified design was designated the Model E fuze.

139. (U) Most of the modifications consisted of improved dimensional control of the detail parts. The most significant changes are described below:

140. (C) Arming Delay Cycle Time. The requirement for the arming delay cycle time was relaxed by the contracting agency from between 4 and 5 seconds to between 4 and 5¼ seconds. The Model D fuze had a possible variation of 5 seconds between minimum and maximum arming times. This indicated the need for more rigid dimensional control on all parts affecting the time interval, to decrease this variation to an acceptable 1¼ seconds. Therefore, an engineering study of the problem was conducted.

141. (C) A method was developed for controlling the time variation without resorting to restrictive and costly dimensional tolerance requirements. All affected parts were dimensionally controlled so that when the timer was assembled, the delay time would never be less than 4 seconds. If the maximum time ran over 5¼ seconds, the arming stem was shortened as required to decrease its dwell time on the cam of the timer. This was done during the final assembly before the cover assembly was attached to the center body. Each fuze was checked for actual delay time. If this time was within the required limits, the assembly of the fuze would proceed. If the time span was over the maximum limit, 0.022 inch of material was removed from the tip of the arming stem for each second of time over the limit. The fuze was then reassembled and rechecked (Fig 42, p 75).

142. (U) This method of control permitted the use of a delay mechanism having the same parts and dimensions as were used in the Model D fuze, with one exception. The positioning flat on the cam and its corresponding flat on the nut of the disc assembly were removed. This permitted assembly control of the angular position of the cam relative to the disc without the need for tight angular tolerances on the parts (Fig 43, p 76).

143. (U) Threaded Shank. The threaded shank of the aluminum arming rod piston (secondary arming pin) was replaced by a steel stud. This was done to prevent any recurrence of the structural failure of the shank. Although the fuzes passed the MIL–STD–301 jumble test satisfactorily, three units could not be functioned after the test because of this type of piston failure.

144. (U) Timer and Arming Stem Cavity. The timer and arming stem cavity of the center body was modified to decrease possible clockwise rotation of the stem and prevent arming failure of the detonator

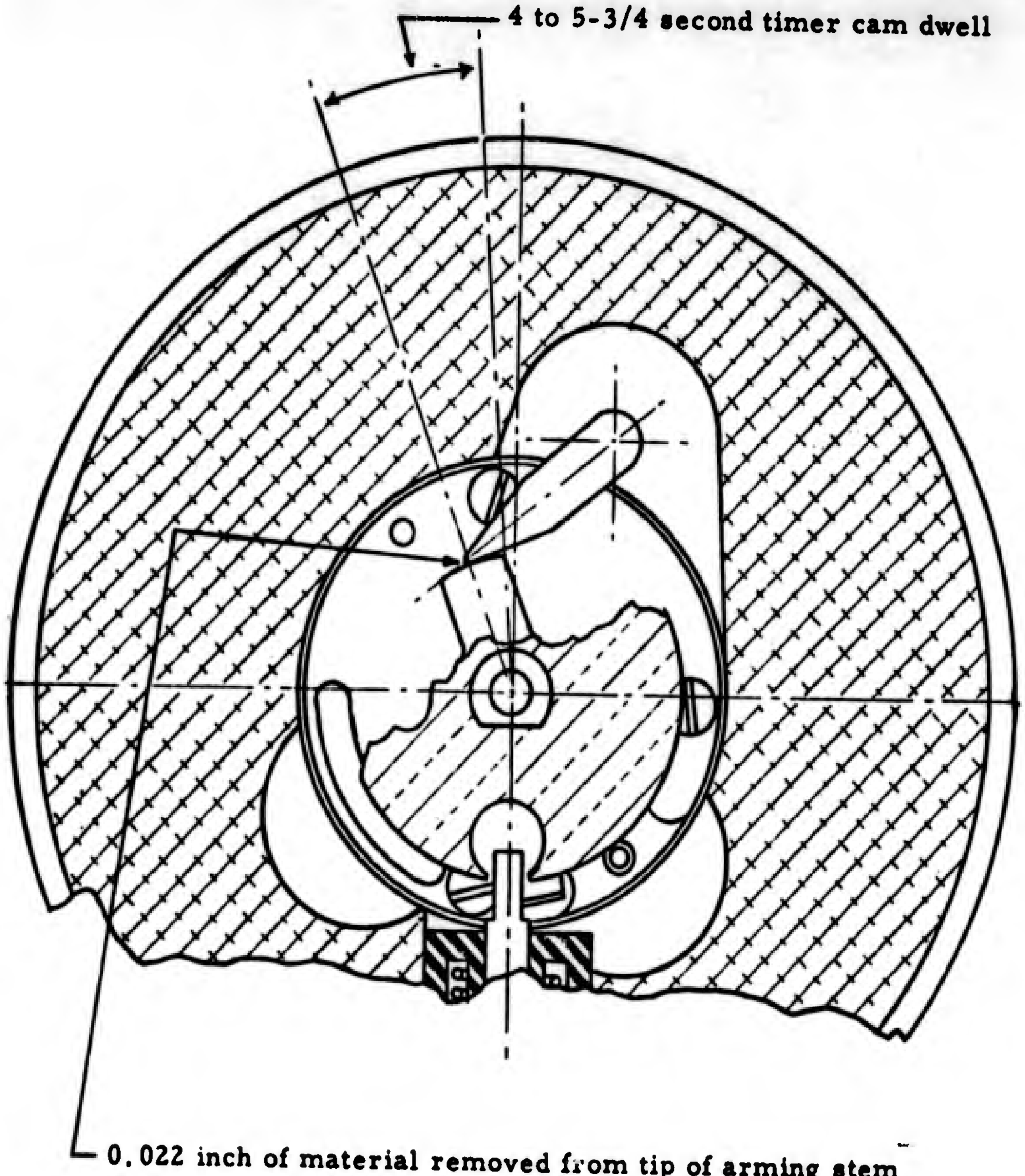

Fig 42 Adjustment of Maximum Arming Delay Cycle Time

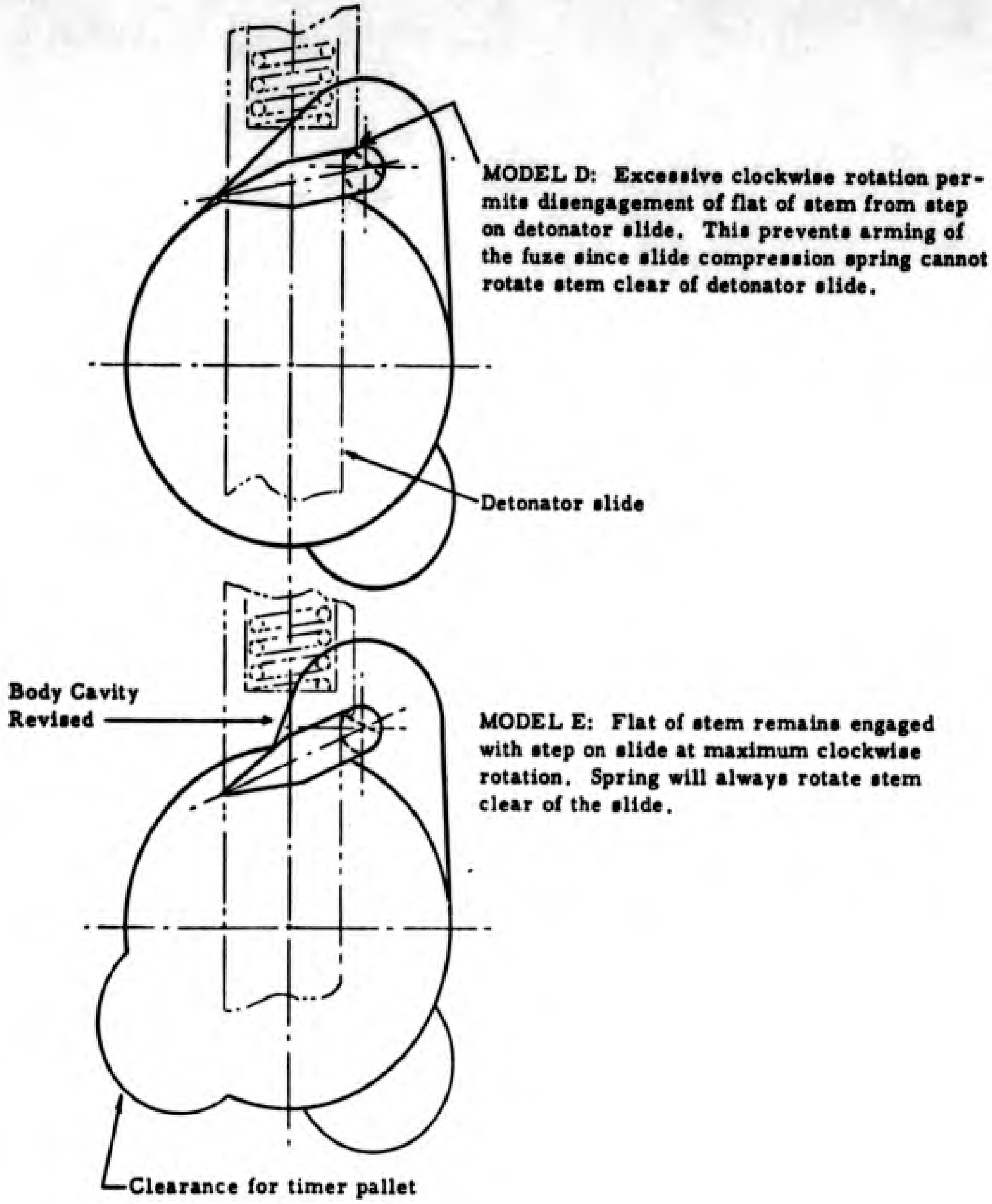

Fig 43 Comparison of Models D and E Fuze Body Cavities for Arming Stem and Timer

slide. In the Model D fuze, it had been possible to rotate the stem far enough to disengage the flat section of the stem from the step on the slide, which would cause a lockup of the two parts and prevent arming of the fuze (Fig 44, p 78).

145. (U) Additional Clearance in Center Body. Additional clearance was provided in the center body for the movement of the T3 primer pallet, as Figure 43 (p 76) shows.

146. (U) Relocation of O-Ring. The O-ring on the closeout plug was relocated to provide a seal around the circumference of the part rather than at the bottom of the plug.

147. (U) Body Cover Assembly. The staking operation and the set screws in the body cover assembly were replaced by self-locking set screws. The type of locking screw used contains a nylon pellet which is mounted permanently in the body of the screw, so that it projects slightly beyond the crest of the thread. When the screw is tightened down, the nylon is compressed and grips the threads with a wedging action.

148. (U) Thickness of Protective Coating. The thickness of the protective coating on the firing pin release levers was increased from 0.00015 inch to 0.0005 inch.

Fabrication and Final Inspection

149. (U) One-hundred Model E Cresset fuzes were fabricated. These units incorporated all approved modifications.

150. (C) Arming delay times and functional firing times were recorded during assembly of the fuzes. The delay time was controlled within the required limits by the method described in Paragraph 141 (p 74). The functional firing times of all but seven fuzes were within the prescribed ±1 second tolerance. The other seven fuzes fired before the preset time had elapsed, in some cases as soon as 2.2 seconds. T3 timers which ran too fast caused these discrepancies. Since replacement timers were not available, these fuzes were included in the lot of 100 which were fabricated.

Proposed Engineering Service Tests

151. (C) It is recommended that the following tests be included in the service test program:

Test	No. of Items
Air drop onto beach	6*
Air drop inland	6*
Catapult and arresting landing	2**
Transportation vibration	1**
Aircraft vibration	1**
Rough handling	2**
Functioning at 125°F (beach)	1
Functioning at −65°F (beach)	3
Jettison drop safety	1
Total	23

*Three items should be tested against an explosive minefield 200 yards deep, one item being dropped from an aircraft flying at an altitude of 30 feet and at a speed of 400 knots, and the other two from an aircraft at other speeds and elevations.

**These items should be dropped, after the environmental test if possible, from an aircraft flying at an altitude of 300 feet and at a speed of 400 knots.

Cost and time data for these tests is given in Table 3 (p 79).

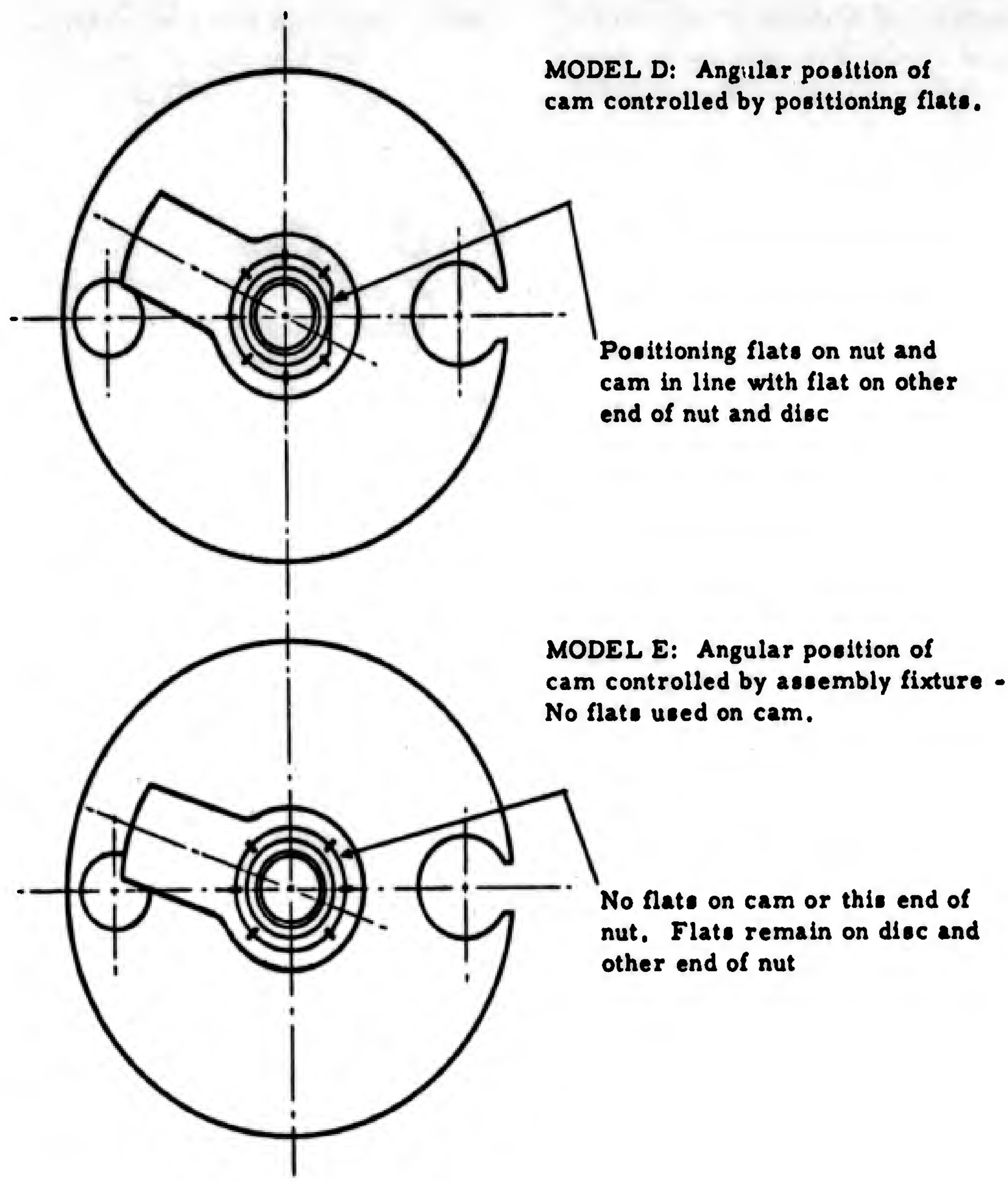

Fig 44 Comparison of Model D and E Timer Disc Assemblies

TABLE 3

Cost and Time Data for Engineering Test Program

		Cost	Time
Preparation of Explosive Cressets:			
Manufacture of T4 dispensers (19* at $7000 each)		$133,000	9 mo
Manufacture of T96 linear charges (23 at $8000 each)		184,000	9 mo
Loading of Cresset dispensers (23 at $1000 each)		23,000	2 mo
Packing and shipping costs		20,000	1 mo
	Subtotal	360,000	1 yr
Proving Ground Tests:			
Transportation- and aircraft-vibration		10,000	3 mo
Rough handling		10,000	2 mo
	Subtotal	20,000	5 mo
Drop Tests**			6 mo
Engineering Support		70,000	2 yr***
Total Cost and Time		$450,000	2 yr***

*Four dispensers already available at Picatinny Arsenal.

**Marine/Navy will conduct flight drop tests.

***Includes 6 months beyond final drop tests to cover reporting of test results.

(U) ACKNOWLEDGEMENTS

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APPENDIX A

THEORETICAL ANALYSES OF LINE CHARGE DELIVERY

In an attempt to determine the best method for laying the linear charge from a dispenser, the Naval Air Development Center (NADEVCEN) conducted theoretical studies of the following methods:

(a) Dispensing by Drogue

This method involved the use of a specially shaped drogue (or sea anchor) which would be released initially from the dispenser carrying the linear charge. The air drag of the drogue would pay out a leader line which would allow it to contact the water or land, thus increasing the drag force sufficiently to pay out the linear charge from the dispenser. This system would necessitate the release of the drogue before release of the dispenser from the carrying aircraft at the appropriate time so that the drogue would contact the water first. Since estimates indicated that excessive and variable forces would be applied to the linear charge at 400 knots, a major revision of the design strength of the linear charge was required. Using the then established limiting load of 4,000 pounds in the linear charge, this system would limit the release airspeed to 134 knots without the benefit of skid distance. Allowing a skid distance of about 3,000 feet would make it possible to drop the existing line with a payout tension of not more than 4000 pounds at a speed of 400 knots. However, this method places severe restrictions on the dispensing aircraft flight path, on the line's physical properties, and on the drogue design. It is dependent upon underwater and beach terrain. Its primary advantage is simplicity. This method is shown in Figure A1 (p 84).

(b) Parachute Method

This method involves deployment of a parachute or parachutes to provide the necessary drag force to pay out the linear charge from the dispenser and to reduce the forward velocity of the linear charge to protect it from excessive impact damage. This method appears to have the advantage of low cost, high reliability, and safety. It appears to be less accurate than other methods (see Fig A2, p 85).

(c) Harpoon Method

This method would use a rocket-fired or explosive-fired harpoon connected to the linear charge by a suitable leader line. The harpoon would be fired in a downward and slightly forward direction so that it would be embedded in the terrain and act as an anchor and tether line. The linear charge would be payed out as the inertia carried the dispenser forward either in free flight or while it was still attached to the aircraft. The leader line would have to be long enough to insure penetration before the slack was lost because of the start of the dispensing procedure. This method (Fig A3, p 86) appears to be too complicated and hazardous to the delivery aircraft. It could fail to function suitably over rocky terrain or possibly over water. Accuracy would probably be good, if specific aircraft altitudes could be assured.

(d) **Retro-rocket Method**

The retro-rocket method uses a rocket attached to the aft end of the linear charge and fired in an aft direction. The thrust of the rocket is used to pay out the linear charge from the dispenser and to dissipate the kinetic energy of the charge. The timing of the firing of the rocket and the release of the dispenser would be critical and the direction and stability of the rocket would be too unpredictable. Further, this method presents the problem of the development of a suitable rocket and rocket motor which would have the desired thrust and operating performance (see Fig A4, p 87).

Upon completion of preliminary studies of the above described methods, NADEVCEN decided that the parachute method would be best because of its advantages over the other methods – simplicity, low cost, reliability, availability, and reasonable accuracy in laying the linear charge on the beach. As a consequence, NADEVCEN followed this approach for the Cresset program.

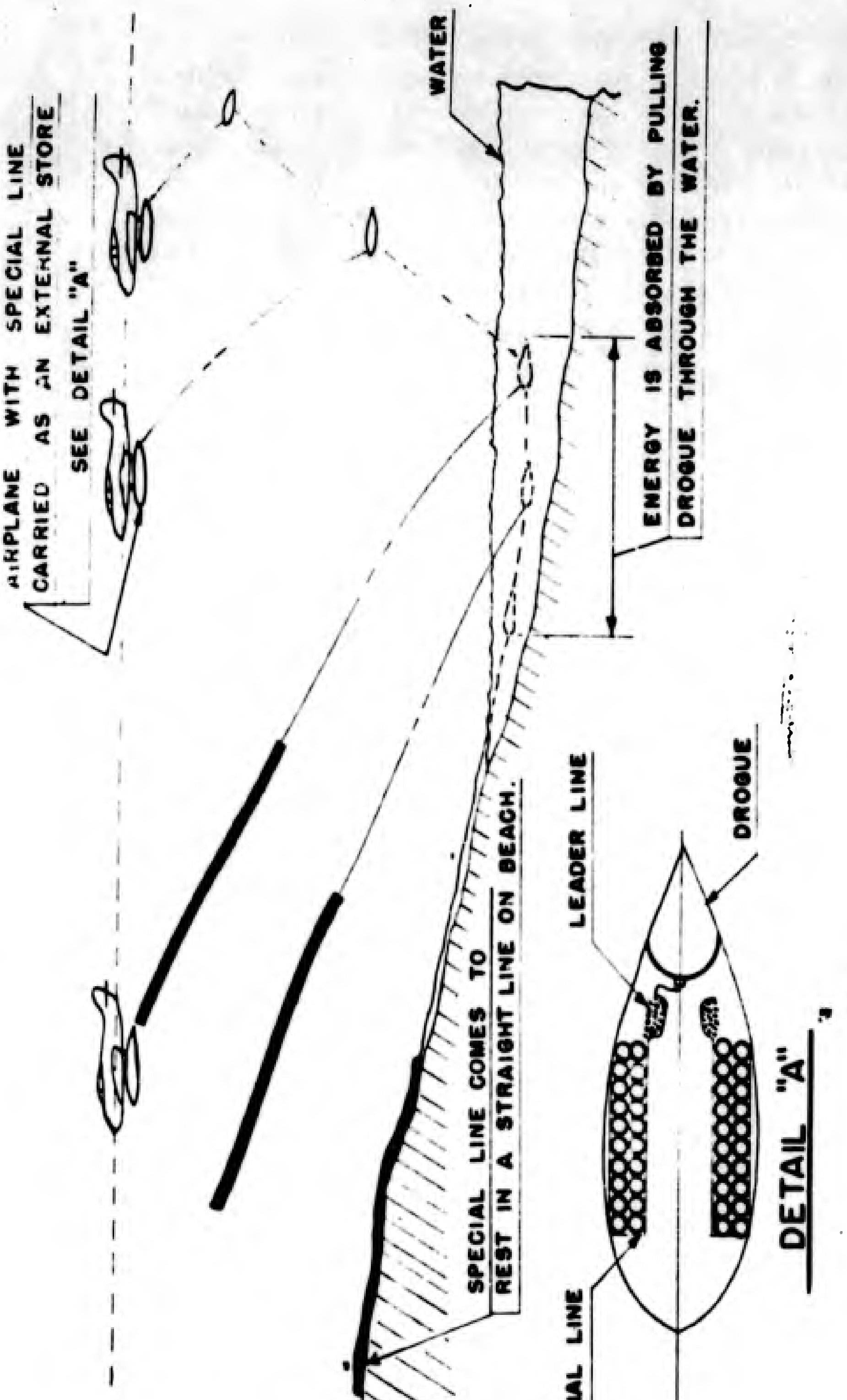


Fig A1 Sketch of Proposed Drogue Method of Dispensing the Linear Charge

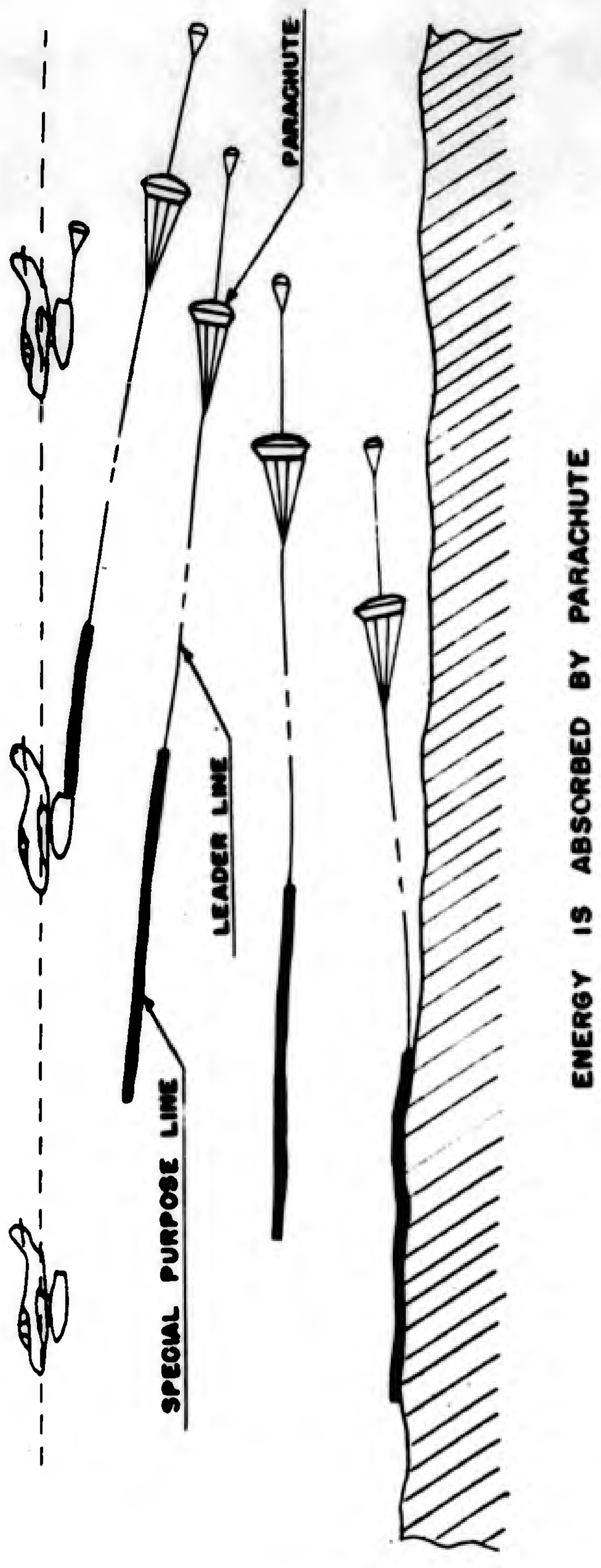


Fig A2 Sketch of Proposed Parachute Method of Dispensing the Linear Charge

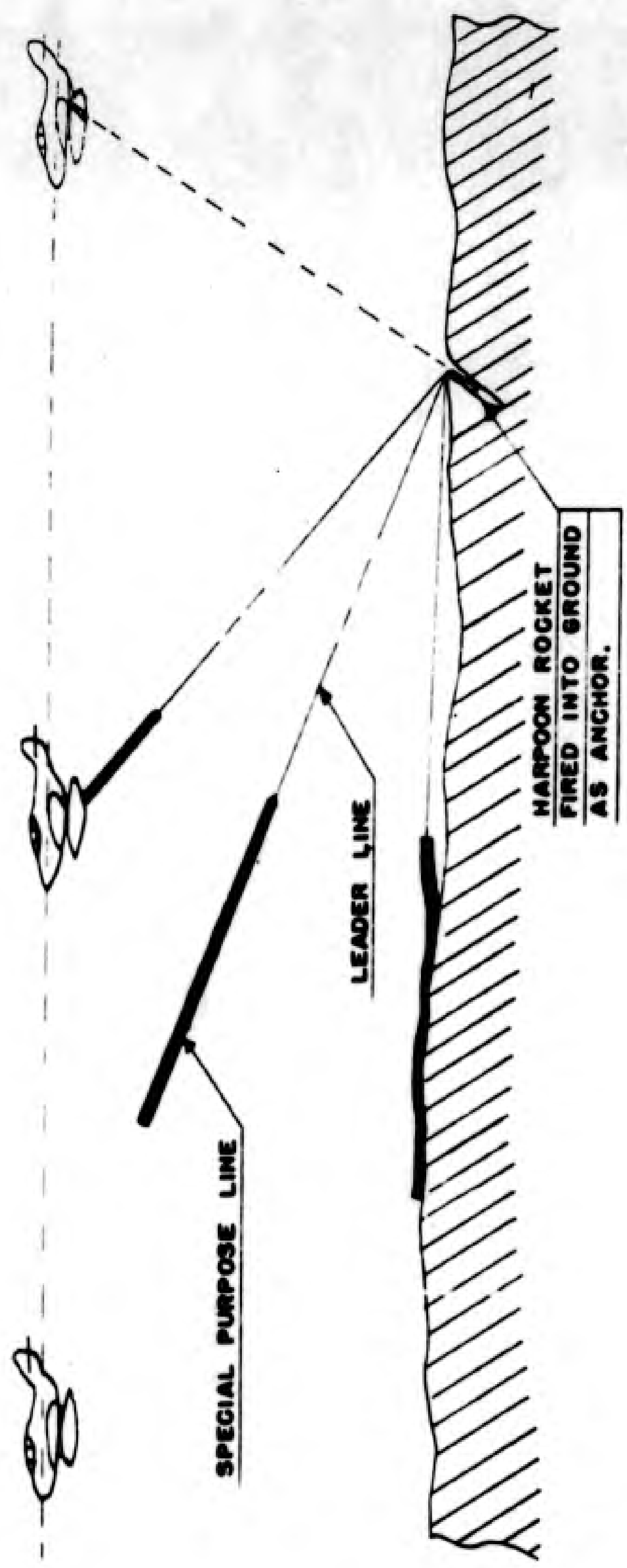


Fig A3 Sketch of Proposed Harpoon Method of Dispensing the Linear Charge

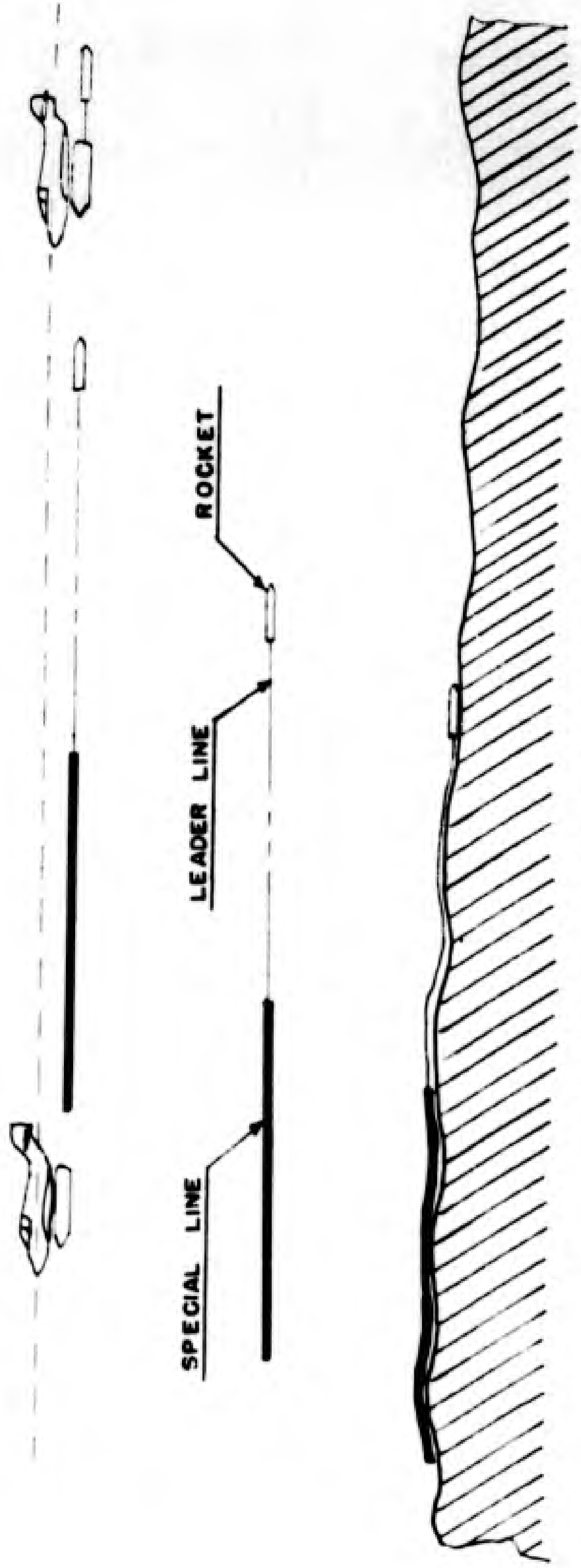


Fig A4 Sketch of Proposed Retro-Rocket Method of Dispensing the Linear Charge

APPENDIX B

INITIAL DISPENSER DEVELOPMENT INCLUDING AERIAL DROPS 1 THROUGH 11

Dispenser Development

Two principal methods of packaging the linear charge into a cylindrical dispenser were tested. The first system consisted of coiling the charge in a helix within a second helix. In this arrangement, the linear charge was payed out first from the inside helix, beginning at the aft end and moving toward the forward end, after which the outer helix was uncoiled from the forward to the aft end. This method developed excessive friction, and the linear charge interfered with itself while the outer helix was uncoiling. The required payout force and time for payout were affected adversely.

In the second method, the linear charge was coiled in a modified bank wind as follows: one inner coil, two outer coils, two inner coils, two outer coils, etc. This system permitted the linear charge to be payed out from the aft end to the forward end without excessive friction, without tangling, and with uniform tensile stress during extension. Payout time was cut to half that of the other method.

The Naval Air Development Center (NADEVCEN) performed a series of ground tests using both of the above coiling methods with a 75-foot section of linear charge coiled inside a metal drum to determine the payout characteristics. Although these tests were limited by the maximum velocity of the motor vehicle, about 45 mph, the snaking or unfurling action demonstrated in these tests was also exhibited by aerial drops at higher speed. On the basis of these ground tests, the NADEVCEN concluded that the dispenser should be released from the aircraft before payout of the linear charge to preclude the possibility of the charge contacting the aircraft. Figure B1 (p 93) shows the ground test of the linear charge payout in which the motor truck was used.

Aerial Drops 1 through 11

NADEVCEN designed and fabricated an experimental dispenser capable of holding 300 feet of linear charge and suitable for carriage on an AD type aircraft as shown in Figures B2 and B3 (pp 94 and 95). Laboratory tests were conducted locally to verify the structural and vibrational integrity of these units. This experimental dispenser was used for the first 15 drop trials.

It was decided that a series of drops would be made at low speed (about 200 knots) and then, depending on the success of these drops, additional drops would be conducted at increased speeds until 400 knots was attained. (Figures B4 and B5, pp 96 and 97, show the configurations used for the dispensers tested in drops 1–11. Tables B1 and B2, pp 91 and 92, summarize the results of these drops.)

The first drop, as reported in NADEVCEN confidential letter AR–64, Serial 0042, 24 June 1953, was made on 18 June 1953 at the Naval Aircraft Torpedo Unit, Quonset Point, Rhode Island at an airspeed of 225 knots and an altitude of 1000 feet. A single 54-inch-diameter guide surface parachute was attached to the aft end of the linear charge. After satisfactory separation of the dispenser from the aircraft, this 54-inch chute was deployed and pulled the linear charge out of the dispenser. For this test the linear charge was attached to the dispenser so that the momentum of the dispenser would be used to pilot or lead the front of the charge and thus keep it straight and prevent the air drag from folding or pushing the front end back.

This first test demonstrated that the parachute would pay out the line charge from the dispenser. The dispenser piloted the linear charge and the line was reasonably straight after payout. The overall system appeared to be safe for the pilot and aircraft.

For aerial drops 2 through 6, the linear charge was not attached to the dispenser, and several different parachute arrangements were tested to determine their performance and effects upon the linear charge. It was apparent from these tests that, with the arrangements tried, the front end of the linear charge would always hit the beach before the aft end and that a poor or ineffective lay of the charge would result. Aerial drops 3, 4, and 6 are discussed in detail in NADEVCEN confidential letters Serial 0072, 22 Oct 1953, and AR–64, Serial 03, 4 Jan 1954.

To keep the forward end of the linear charge high, NADEVCEN incorporated the following changes in the parachute systems used in drops 7 and 8:

a. A separate parachute was attached to the dispenser to retard its velocity and rate of fall.

b. The linear charge was connected to the dispenser with a nylon shock cord and snubber line.

c. Small parachutes were installed along the linear charge coaxially with it (see drop 7, Fig B5, p 97). Previously installed chutes connected to the linear charge only by the shroud lines (see drop 5, Fig B4, p 96) were observed to rotate around the line in a random manner, so that the resulting drag direction was unpredictable and uncontrollable.

d. An explosive mechanical release was incorporated between the aft parachute and the aft end of the linear charge. This device was to release the aft chute about two seconds after deployment by burning the nylon strength member between the chute and the linear charge. This revision provided payout drag and then eliminated the unwanted aft end support.

Drop 7, as reported in NADEVCEN confidential letter AR–64, Serial 0465, 23 March 1954, partially verified the above named changes, except that all of the linear charge was not payed out of the dispenser before impact. This was due to aerodynamic "spoiling" of the aft chute by the chute attached to the dispenser. However, drop 8 (reported in NADEVCEN confidential letters AR–64, Serial 0668, 21 April 1954, and AR–64, Serial 0737, 3 May 1954, clearly demonstrated the feasibility of the parachute system and the above changes in that the linear charge was 92.5% straight on the beach and had only two small loops at the aft end, as shown in Figure B6 (p 98). The parachute attached to the dispenser was damaged slightly by the linear charge. This problem plagued most of the remaining drops. However, all components functioned satisfactorily and the dispenser landed in a nose-high attitude, pulling the front of the linear charge straight.

In an attempt to evaluate the effect of eliminating the parachute release and thus keep the aft chute attached to the linear charge, aerial drop 9 was made using the same configuration and same air speed as in drop 8. Again all components functioned satisfactorily. However, the linear charge was only 83.7% straight (9% less than that of drop 8). It was concluded that the releasing of the aft chute would give the best results. NADEVCEN confidential letter AR–64, Serial 0935, 3 June 1954, reported the results of aerial drop 9.

It was decided to make another drop with the same parachute system and the same release conditions as had been used for drop 8, to demonstrate repeatability. The dispensers used for drops 10 and 11 were similar to that used for drop 8. However, the aft parachute release did not function properly on either of these items. The aft parachute was not cut off, and the resulting effective straightnesses were 46.5% and 72%, respectively.

TABLE B1

Results of Aerial Developmental Drops 1–11

Drop No. and Date	Release Altitude ft	Release Velocity knots	Effective Length	% Straightness	Line Charge Arrangement	Target Miss Distance	Comments
1 6/18/53	1000	225	Not determined	Not determined	270' of 3" diam Totally inert	No target used	Demonstrated safety and feasibility to pay out line charge.
2 7/24/53	500	225	Not determined	Not determined	275' of 3" diam Totally inert	"	Payout velocity increased by using two aft 54" chutes.
3 9/29/53	365	221	137'	54%	254' of 4" diam Totally-inert	"	Forward end of line charge impacted beach first.
4 9/29/53	300	225	146'	59%	250' of 4" diam Totally inert	"	Parachute held aft end of line charge high.
5 10/13/53	290	225	125'	50%	"	"	Additional chutes on forward end of line charge failed to keep front up and straight.
6 12/15/53	150	225	140'	56%	250' of 4.5" diam Totally inert	114'	Air drag folded line charge back.
7 3/2/54	290	225	128'	85%	254' of 4.5" diam Totally inert	No target used	Dispenser attached to line chg. 85% of line payed out. Release operates OK.
8 4/14/54	404	225	244'	92.5%	270' of 4.5" diam Totally inert	"	Dispenser pulled line charge straight – aft chute released. All items operated satisfactorily.
9 5/5/54	305	238	216.3'	83.7%	"	Bullseye	No release used. Resulted in 9% loss in straightness.
10 6/11/54	426	226	128'	46.5%	"	No target used	Release did not function.
11 7/27/54	499	228	194'	72%	267' of 4.5" diam Totally inert	"	Aft chute did not release. Front of line straight. Aft end had loops.

TABLE B2

Item Identification – Functioning Data for Drop Nos. 1–11

Drop No.	Type of Loading: Shock Line	Type of Loading: Line Charge	Deployment % Effective Length	Line Charge Quality	Functioning: Fuze	Functioning: Shock Line	Functioning: Line Charge	Functioning: Comments
1	$^5/_{16}$ steel cable	3" OD inert	Not determined	–	Not available	OK	OK	All items functioned satisfactorily. Line charge followed dispenser into bay.*
2	None used	3" OD inert	Not determined	–	"	None used	"	All items functioned satisfactorily.*
3	"	4" OD inert	54%	Fair	"	"	"	All items functioned satisfactorily. Chute arrgt caused poor lay of line chg.*
4	"	4" OD inert	59%	Fair	"	"	"	All items functioned satisfactorily. Chute arrgt caused poor lay of line chg.*
5	"	4" OD inert	50%	Poor	"	"	"	All items functioned satisfactorily. Chute arrgt caused poor lay of line chg.*
6	$^1/_8$ nylon cord	4.5" OD inert	56%	Fair	"	Inadequate	"	All payed out. Shock line inadequate.*
7	$^5/_8$ nylon 37 ft	"	85%	Excellent	"	Not tested	"	Only 85% payed out. Release operated to cut off 72" chute.
8	"	"	92.5%	Excellent	AN–M–146 type used OK	OK	"	All items functioned satisfactorily.
9	"	"	83.7%	Excellent	"	OK	"	No release used. 9% loss in straightness.*
10	"	"	46.5%	Poor	"	OK	"	Release cartridge failed to fire. Dispenser chute damaged slightly. Aft end of line chg impacted last.
11	"	"	72%	Poor	"	OK	"	Release cartridge failed to fire. Dispenser pulled front of line chg straight. Aft end had loops.

*Tail parachute release was not installed.

Fig B1 Ground Test of Line Charge Payout

Fig B2 Right Side View of Cresset Installation on AD Type Aircraft

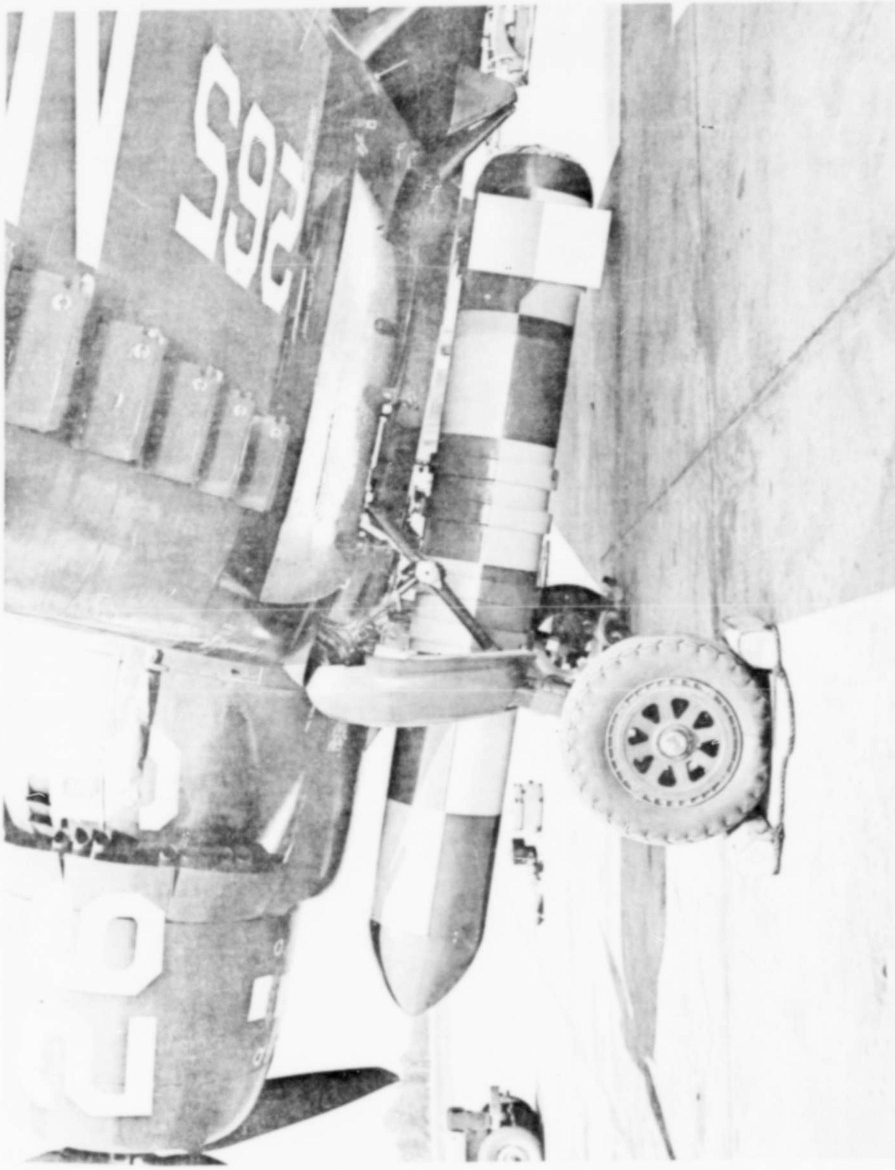


Fig B3 Left Side View of Cresset Installation of AD Type Aircraft

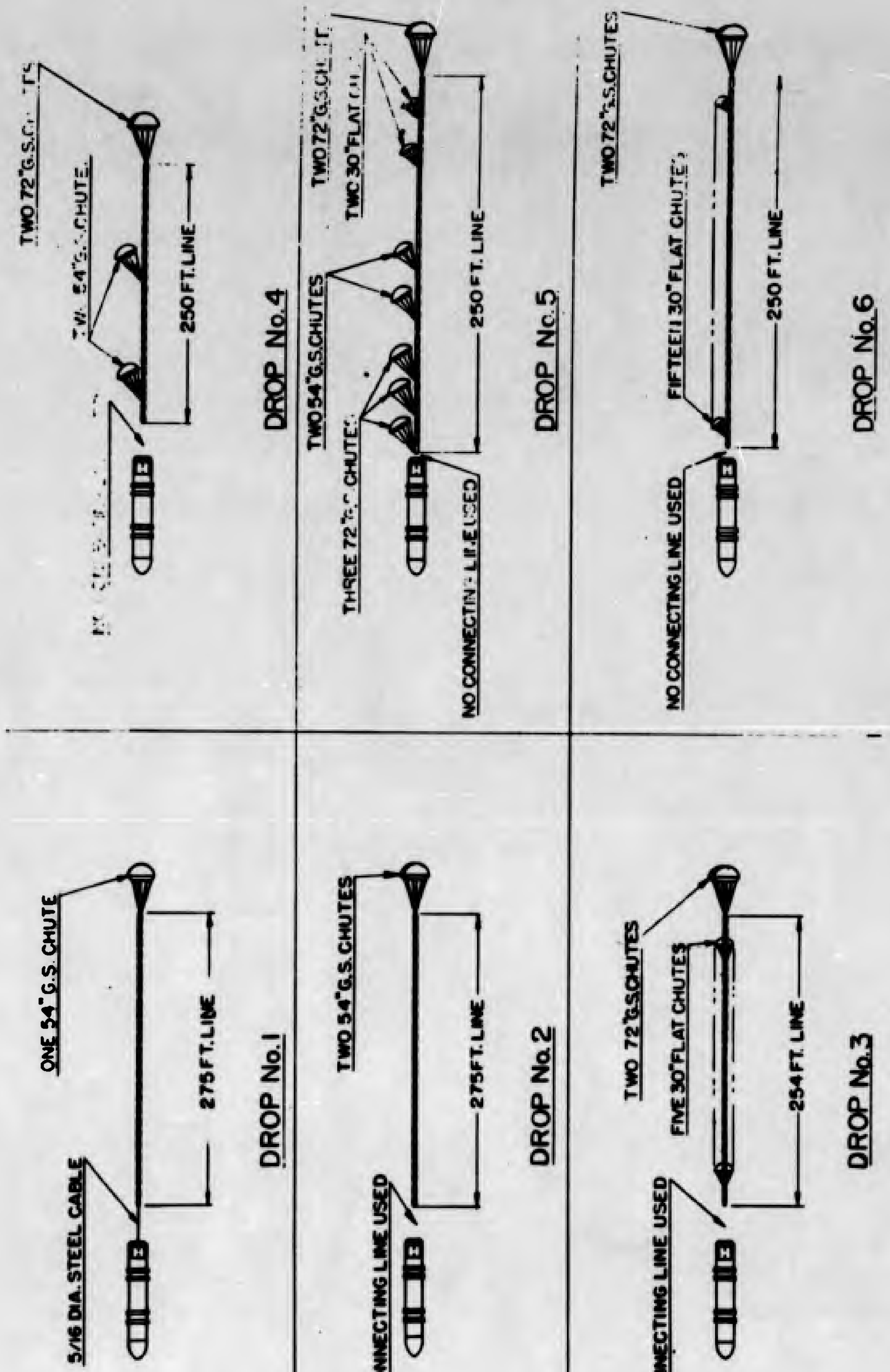


Fig B4 Aerial Deployment Configurations – Drops 1–6

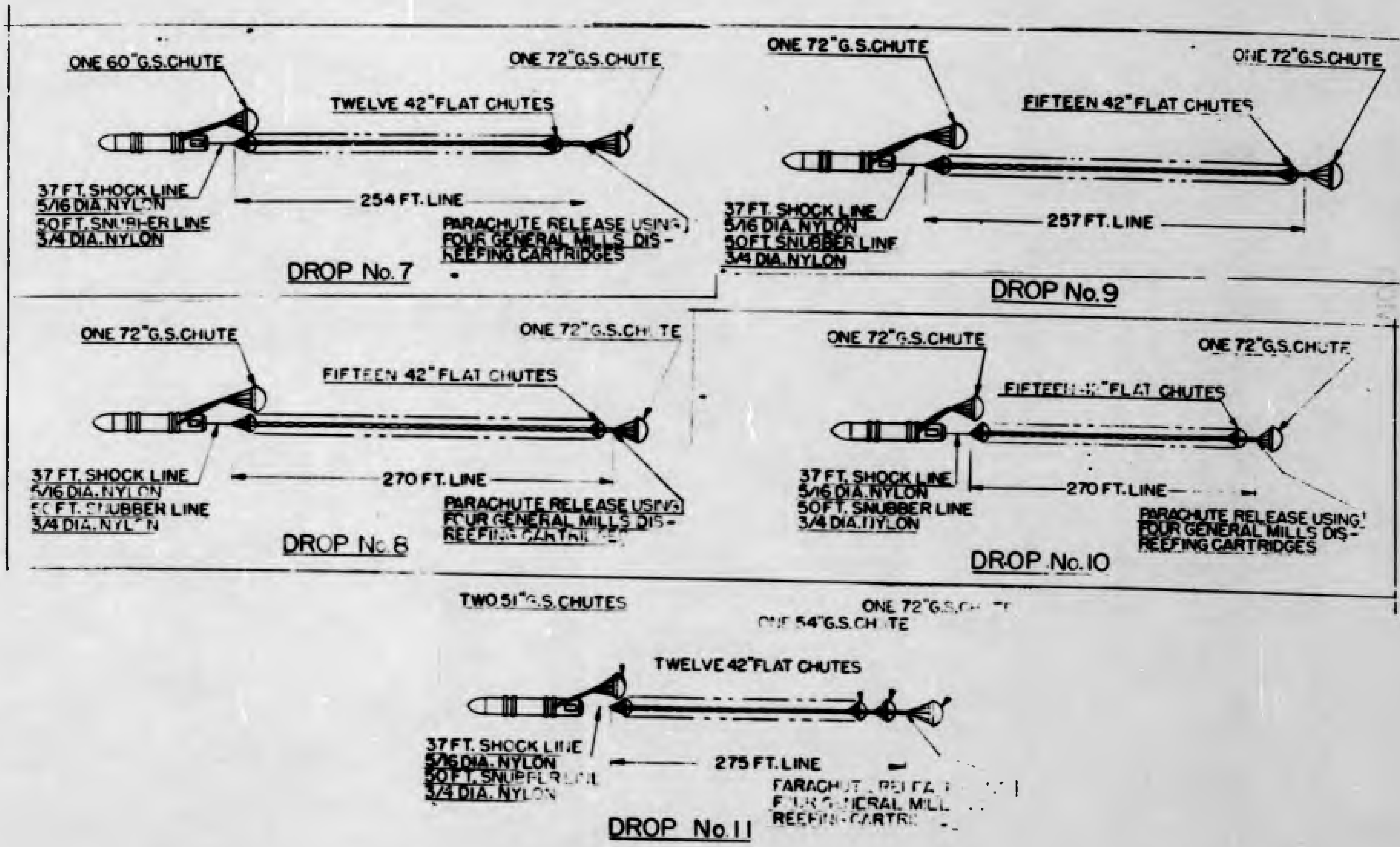


Fig B5 Aerial Deployment Configurations – Drops 7–11

Fig B6 Layout, Drop No. 8

APPENDIX C

OPTIMUM CRESSET DESIGN

Early analytical work on the parachute system for the Project Cresset Dispenser was accomplished by the process of iteration, with the aid of the commom desk calculator. Numerous parachute arrangements were checked analytically before the selection of the tested arrangements. These analytical processes consumed about one man-week per variation (that is, the change in size or removal of one parachute). For each variation, a set of new numbers was derived. Because of the labor and time involved in these calculations, NADEVCEN attempted to set up, without success, one differential equation which would satisfy the Cresset dynamics and which would permit a faster evaluation of parachute systems.

In reference C1 the Marine Corps requested that an optimum parachute system be selected and tested in 13 aerial drops. It was decided that an optimum design could be selected by analytical means. The principal dynamics of the Cresset system are as follows:

a. Cresset container is released from the aircraft and has the same velocity as the aircraft.

b. Parachutes attached to linear charge are deployed and withdraw the charge from the rear of the container. Thus the linear charge's forward velocity is reduced.

c. The difference between the velocity of the linear charge and that of the dispenser is the payout velocity.

d. A separate parachute is attached to the dispenser to retard its forward and downward velocities. The size of this parachute must be controlled so the dispenser will remain at a higher forward velocity but have a slower rate of descent than the linear charge until payout is complete and the forward velocities of the linear charge and dispenser are equalized.

Five equations were set up to describe the payout of the linear charge and the changes in the acceleration of the dispenser and the linear charge due to the drag forces from the parachutes. These equations were programmed into the computer to simulate the action of the parachutes during payout. The machine calculated the payout in one-foot increments and recorded data for every 10-foot increment of the linear charge. This greatly increased the accuracy of the computations over the results of the manual calculations where 30-foot increments were used. From the tabulated results supplied by the computer, shock force and remaining velocity data were calculated for the linear charge and dispenser in a free fall from a 350-foot altitude. On the basis of experience gained from the developmental aerial drops, certain arrangements could be readily eliminated. Thirty-one other arrangements were computed and examined in terms of aerial release airspeeds of from 350 to 600 knots.

The following equations, which describe the payout of the linear charge from the container, can be used to determine the separate and combined dynamic forces, velocities, and accelerations of the linear charge and the container after they are released from the aircraft.

The time, T, to pay out a certain number of feet is given as $T = N/V$

where N = number of feet of linear charge payed out

and V = velocity of payout (relative velocity of line charge with respect to dispenser),

or $V = V_c - V_l$

where V_c = velocity of the container

and V_l = velocity of the linear charge.

The change in time to pay out N feet then becomes

$$\Delta T = \frac{N}{V_c - V_l} \qquad (1)$$

The velocity of the container (V_{ct}) is determined at the end of ΔT seconds by

$$V_{ct} = V_{co} + A_c (\Delta T)$$

where V_{co} = initial velocity of the container at the beginning of ΔT seconds and A_c = acceleration of the container. Since the change in acceleration or velocity in this case is negative, then

$$V_{ct} = V_{co} - A_c (\Delta T) \qquad (2)$$

The drag force acting on the linear charge due to change of velocity from container velocity to linear charge velocity is given by

$$F_a = \frac{(NW)A'_1}{g} = MA'_1$$

where W = weight per unit foot of linear charge

A'_1 = acceleration of N feet of the linear charge being payed out

and

g = acceleration due to gravity.

Again, using $T = N/V$ as given above for the payout time of N feet at V payout velocity,

$$A_1 = \frac{V}{T} = \frac{V}{N/V} = \frac{V^2}{N}$$

Then, substituting and combining, we have

$$F_a = \frac{(NW)(V^2/N)}{g} = \frac{WV^2}{g} = \frac{W(V_c - V_1)^2}{g}$$

or

$$F_a = \frac{W(V_c - V_1)^2}{g} \qquad (3)$$

The drag force acting on the linear charge due to deceleration of line already payed out is given by

$$F_b = \frac{NW}{g} A_1 = MA_1$$

where A_1 = acceleration of linear charge already payed out.

The total force acting on the linear charge is given by

$$F_a + F_b = \frac{W(V_c - V_1)^2}{g} + \frac{NW}{g} A_1$$

or

$$F_a + F_b = \frac{W}{g} [(V_c - V_1^2) + NA'_1]$$

or

$$F_a + F_b = \frac{W}{g}[(V_c^2 - 2V_c\ V_l + V_l^2) + NA_l'].$$

The acceleration of the linear charge is given by

$$A_l = \frac{V}{T}.$$

For one increment of time, this can be written

$$A_l = \frac{V_c - V_l}{\Delta T}.$$

Substituting into the equation shown above, the total drag of the line chutes is

$$F_a + F_b = \frac{W}{g}\left[N\frac{(V_c - V_l)}{\Delta T} + V_c^2 - 2V_c\,V_l + V_l^2\right].$$

The total drag acting on the container is given by

$$D_{ct} = Y(V_c)^2$$

where Y = a constant obtained from the drag formula for the container parachute and the air drag of the container body. As an example, for the 54-inch diameter guide surface parachute, the drag, as given in the parachute handbook, is

$$D_{cp} = C_d\rho/2SV_c^2$$

where

C_d = drag coefficient for guide surface parachute = .85

$\rho/2$ = standard air density at sea level = $\frac{.002378}{2}$ = .001189 slugs per ft^3

$S = \frac{\pi d^2}{4}$ = parachute projected area =

$$3.14\frac{(d^2)}{4} = \frac{3.14}{4} \times \left(\frac{54}{12}\right)^2 = 15.9\ ft^2$$

V_c^2 = velocity of parachute (fps)^2

$D_{cp} = C_d\ \rho/2\ SV_c^2 = 0.85 \times .001189 \times 15.9 \times V_c^2 = 0.016065\ V_c^2.$

The approximate air drag of the container is given as

$D_c = C_d\ \rho/2S\ V_c^2$

where

C_d = drag coefficient; for streamline body is assumed to be 0.131

and

$S = \frac{\pi d^2}{4}$ = profile area $= \frac{3.14(2.0)^2}{4} = 3.14$ ft^2.

$D_c = 0.131 \times 3.14 \times .001189 \times V_c^2 = 0.00048\ V_c^2.$

Hence, the total drag on the container is

$D_{ct} = D_{cp} + D_c$

$= .016065\ V_c^2 + .00048\ V_c^2$

or

$= .016545\ V_c^2$

Therefore

$Y = .016545.$ (4)

The acceleration of the container is determined as follows:

$A_c = \frac{D_c}{M_c}$

where

D_c = total drag force acting on the container

M_c = mass of the container.

Since the mass of the container is decreasing as the linear charge pays out, we obtain

$$A_c = \frac{D_c}{M_c - \frac{WN}{g}}$$

$$= \frac{g D_c}{W_c - WN} \qquad (5)$$

where

W_c = total weight of container

W = unit weight of linear charge per foot

N = number of feet of linear charge payed out.

By using the above numbered equations in the proper sequence and with the proper change in coefficients for pertinent system changes, the data was obtained for various systems.

Figures C–1 to C–5 (pp 106 to 110) present the data for the final configuration selected and tested in the last 13 Project Cresset aerial drops. Each figure presents a different release airspeed: 350, 400, 450, 500, and 600 knots. For this data, the parachute opening time has been found to be an average of 0.25 second. In actual testing, the opening time was 0.15 second at 425 knots and 0.45 second at 325 knots. This variation is considered not critical and only moves the curves very slightly to the left for the faster opening and to the right for slower opening times.

Figures C–6 through C–10 (pp 111 through 115) contain the data for a system which is similar to the above system except for two changes. First, the 72-inch-diameter guide surface parachute attached to the end of the line was replaced by one 36 inches in diameter. Secondly, the 54-inch guide surface parachute attached to the container was rigged to remain reefed to a skirt diameter of 36 inches for one second, after which it was allowed to expand to the 54-inch skirt diameter.

Figures C–11 to C–15 (116 to 120) present the data for a parachute system which is identical to the preceding one except that the explosive release is deleted and the aft 36-inch-diameter parachute remains attached to the linear charge.

A comparison of the above curves indicates only slight variations in payout, container, and end velocities for each of the airspeed variations. There is a difference in the amount of shock force absorbed in the shock line. However, all of these values are well within the capabilities of the present shock system.

The real significance and advantage of the above systems is in the use of the 36-inch-diameter aft chute and the reefing of the 54-inch chute, since this arrangement decreases the forces applied to the linear charge and to the container. It is to be noted that the drag force of the 72-inch chute will exceed the tensile strength of the linear charge for releases at velocities above 500 knots. Also the drag force exerted by the 54-inch chute would exceed the structural limitations for the container "A" frame for airspeeds of over 500 knots. However, when the smaller 36-inch-diameter chute is used and the 54-inch-diameter chute is reefed to 36 inches, the drag forces of these two chutes do not exceed the structural limitations of either the linear charge or container "A" frame at airspeeds up to 625 knots. It is also evident that with a lower force on the "A" frame, the container will not pitch excessively during the initial opening of the dispenser parachute. This will help to prevent damage to the linear charge at the beginning of payout. Similarly, the lower force on the linear charge from the smaller aft chute will produce a lower payout velocity of the linear charge initially which will also protect the charge. The reefing of the 54-inch chute to 36 inches diameter has the advantage that more clearance is provided between the linear charge and the chute. This clearance is very important in preventing damage to the chute, increasing its effectiveness, and producing a higher percentage of line straightness.

It must be realized that on a military mission such as the delivery of the Cresset package or any other weapon to a combat zone, the pilot will want to make his aerial release at or near the maximum velocity of his aircraft. To be less vulnerable to ground fire, he will not want to slow down by using his speed brakes. Moreover, if release airspeed is not limited, the pilot has one more bit of information that he does not have to concentrate on, and he can concentrate more on controlling his aircraft and selecting the proper altitude and target area.

The Cresset munition as presently developed can be dropped within the airspeed range of 350 to 450 knots and the altitude range of 300 to 500 feet. The Cresset airspeed can be expanded to 600 knots or higher by using the parachute system proposed in Figures C–6 through C–10 (pp 111 through 115), inclusive. This entails only the replacement of parachutes and does not require any modification of the dispenser or its component parts.

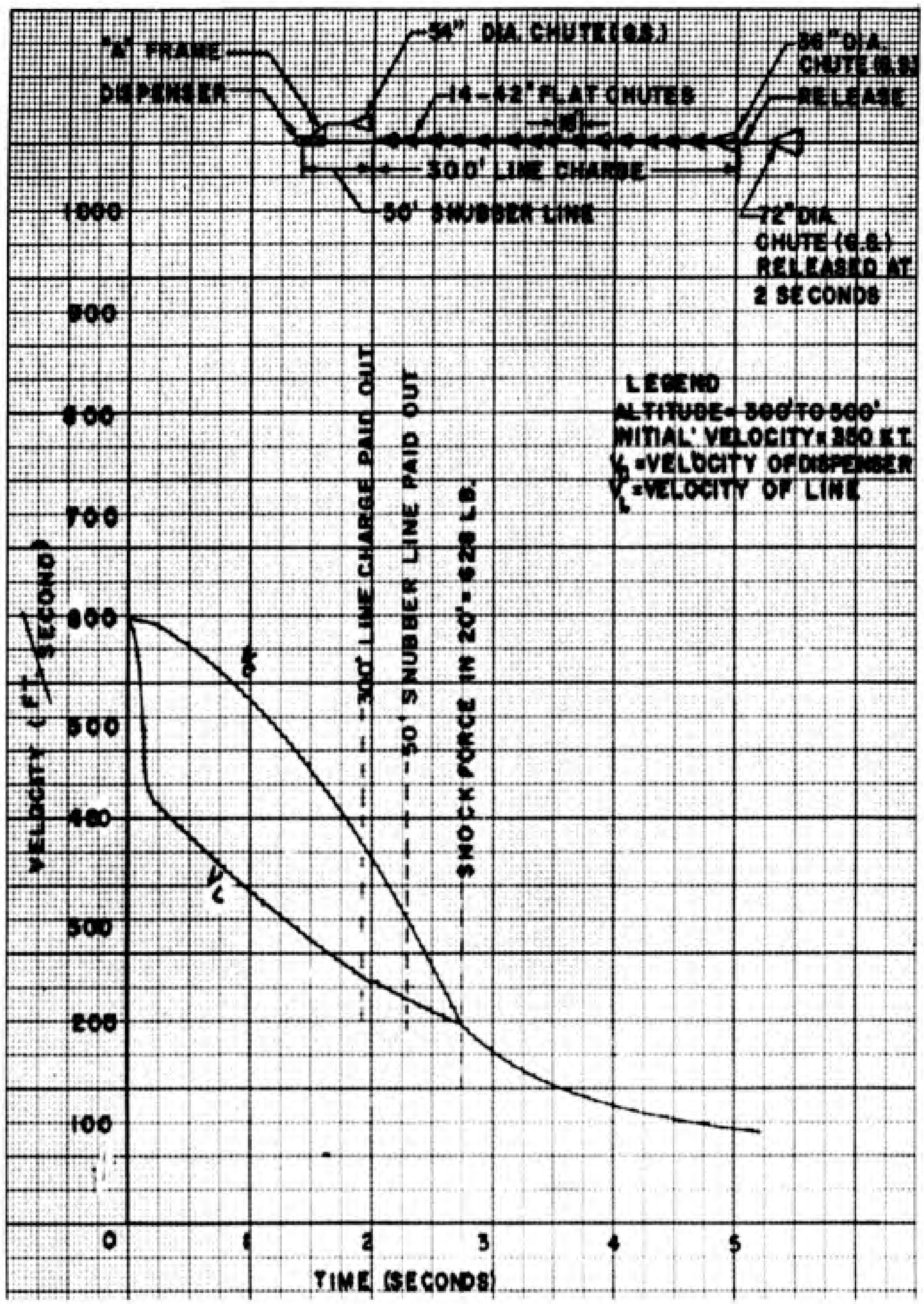
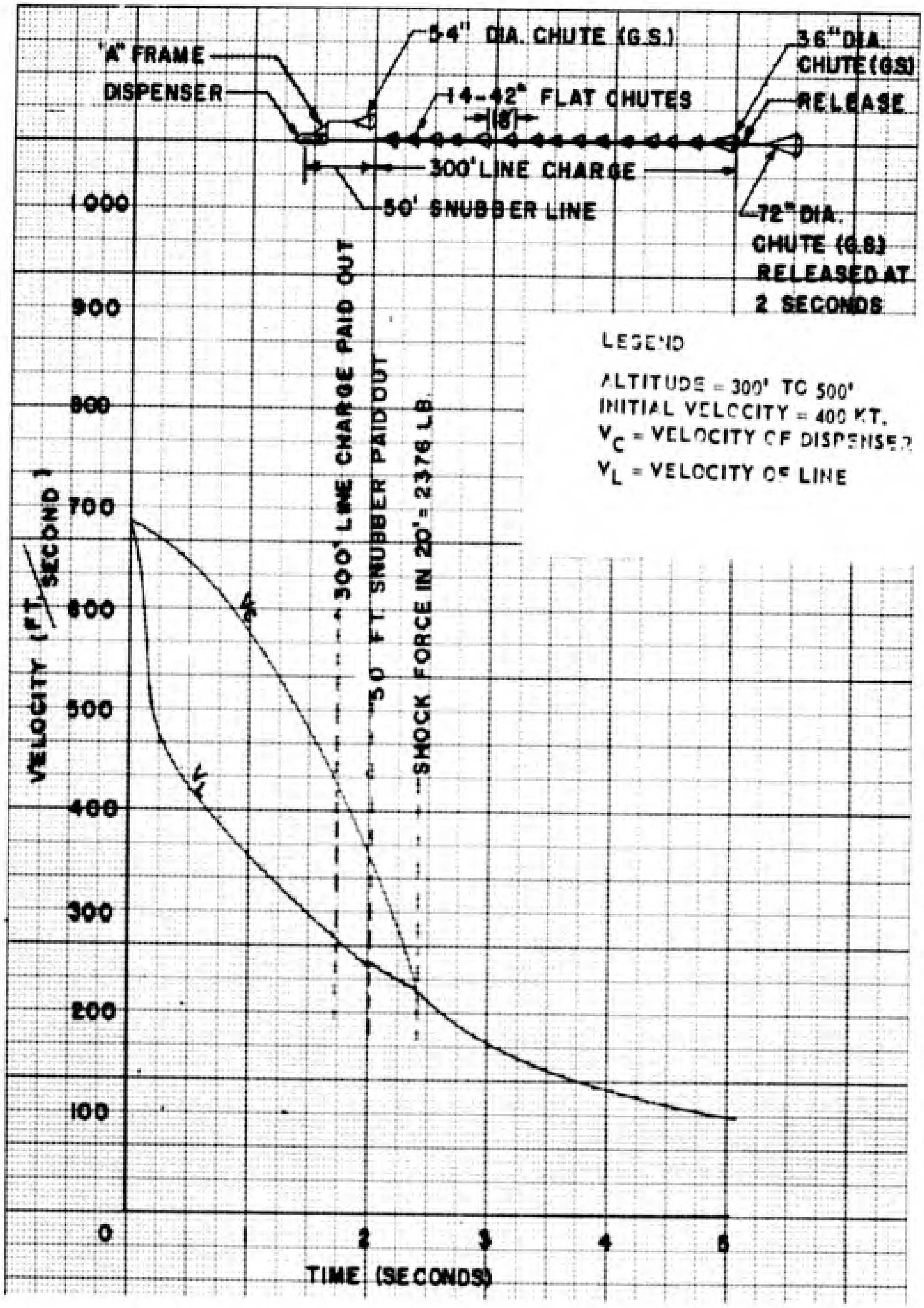

"A" FRAME
DISPENSER
54" DIA. CHUTE (G.S.)
14-42" FLAT CHUTES
300' LINE CHARGE
50' SNUBBER LINE
72" DIA. CHUTE (G.S.) RELEASED AT 2 SECONDS
LEGEND
300' LINE CHARGE PAID OUT
50' SNUBBER LINE PAID OUT
VELOCITY (FT./SECOND)
TIME (SECONDS)
1000
900
800
700
600
500
400
300
200
100
0
1
2
3
4
5

Fig C-1



'A' FRAME
DISPENSER
54" DIA. CHUTE (G.S.)
14-42" FLAT CHUTES
36" DIA. CHUTE (G.S.)
RELEASE
300' LINE CHARGE
50' SNUBBER LINE
72" DIA. CHUTE (G.S.) RELEASED AT 2 SECONDS
LEGEND
ALTITUDE = 300' TO 500'
INITIAL VELOCITY = 400 KT.
V_C = VELOCITY OF DISPENSER
V_L = VELOCITY OF LINE
300' LINE CHARGE PAID OUT
50 FT. SNUBBER PAID OUT
SHOCK FORCE IN 20'= 2376 LB
VELOCITY (FT/SECOND)
1000
900
800
700
600
500
400
300
200
100
0
1
2
3
4
5
TIME (SECONDS)

Fig C-2

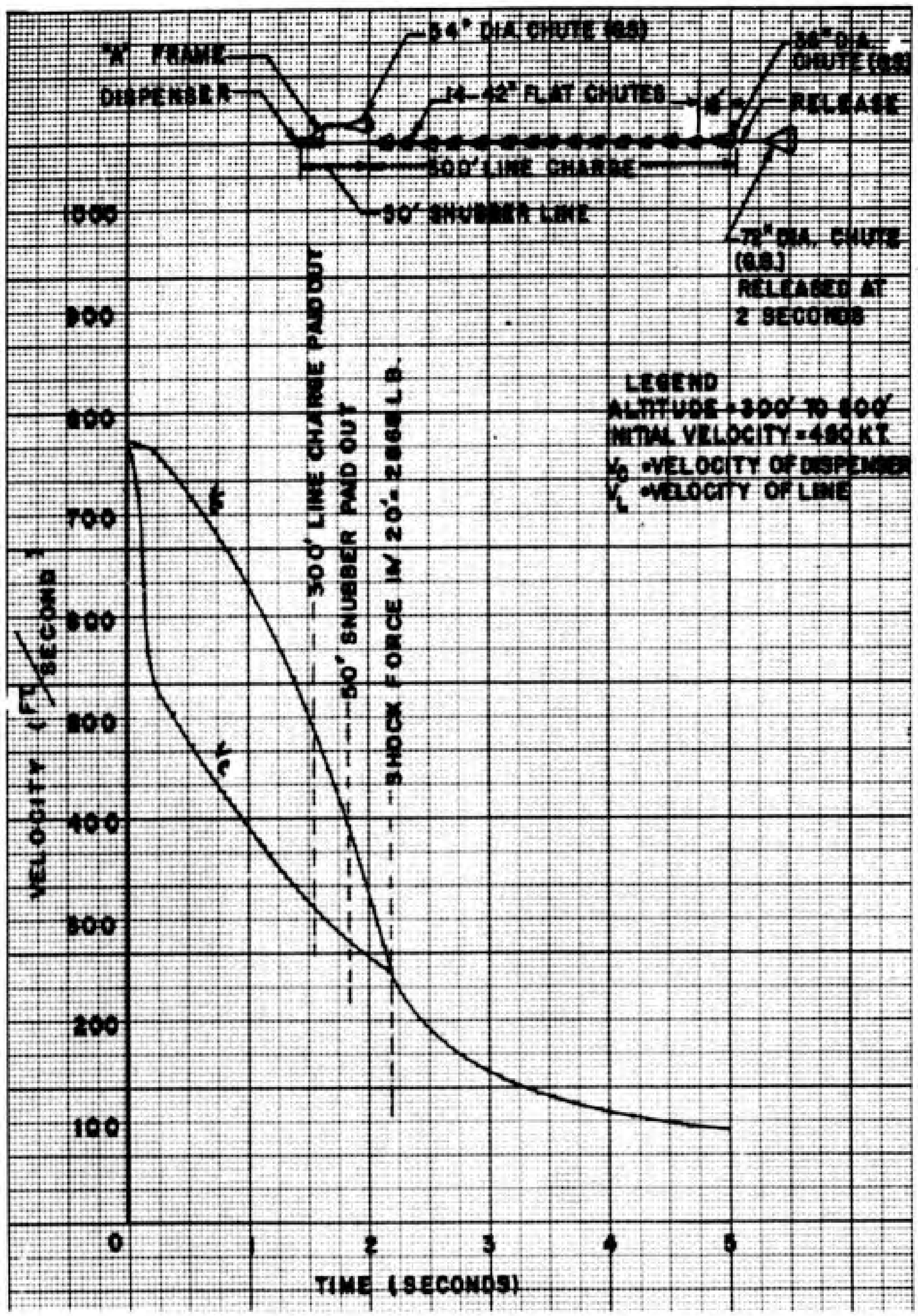

"X" FRAME
DISPENSER
14-42" FLAT CHUTES
RELEASE
300' LINE CHARGE
50' SNUBBER LINE
RELEASED AT
2 SECONDS
300' LINE CHARGE PAID OUT
50' SNUBBER PAID OUT
LEGEND
ALTITUDE = 300' TO 600'
INITIAL VELOCITY = 460 KT
VELOCITY OF DISPENSER
VELOCITY OF LINE
1000
900
800
700
600
500
400
300
200
100
0
1
2
3
4
5
TIME (SECONDS)

Fig C–3

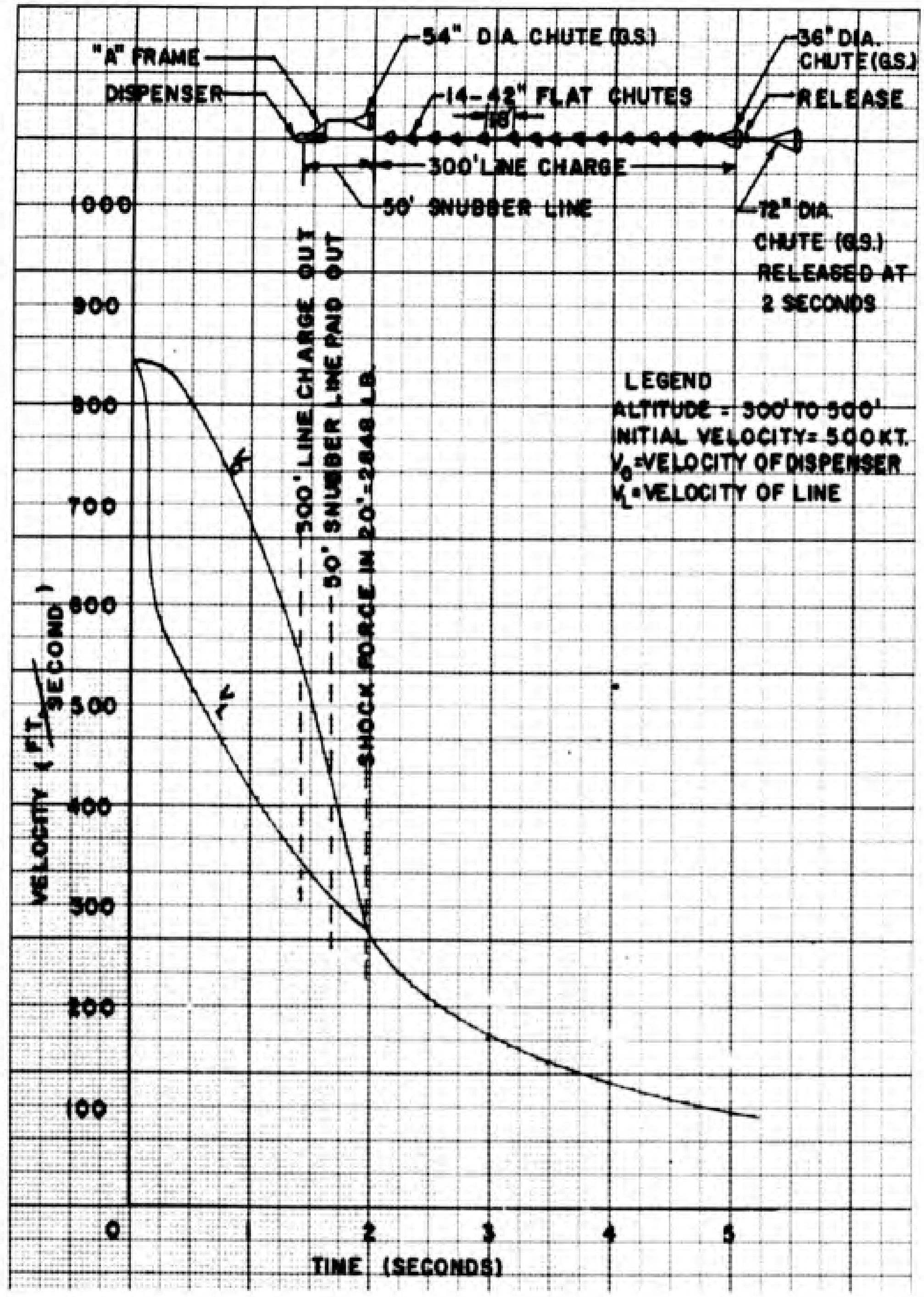

"A" FRAME
DISPENSER
54" DIA CHUTE (G.S.)
14-42" FLAT CHUTES
36" DIA. CHUTE (G.S.)
RELEASE
300' LINE CHARGE
50' SNUBBER LINE
72" DIA. CHUTE (G.S.) RELEASED AT 2 SECONDS
300' LINE CHARGE OUT
50' SNUBBER LINE PAID OUT
SHOCK FORCE IN 20'=2848 LB.
LEGEND
ALTITUDE = 300' TO 500'
INITIAL VELOCITY = 500 KT.
V_0 = VELOCITY OF DISPENSER
V_L = VELOCITY OF LINE
VELOCITY (FT./SECOND)
TIME (SECONDS)
0
100
200
300
400
500
600
700
800
900
1000
1
2
3
4
5

Fig C-4

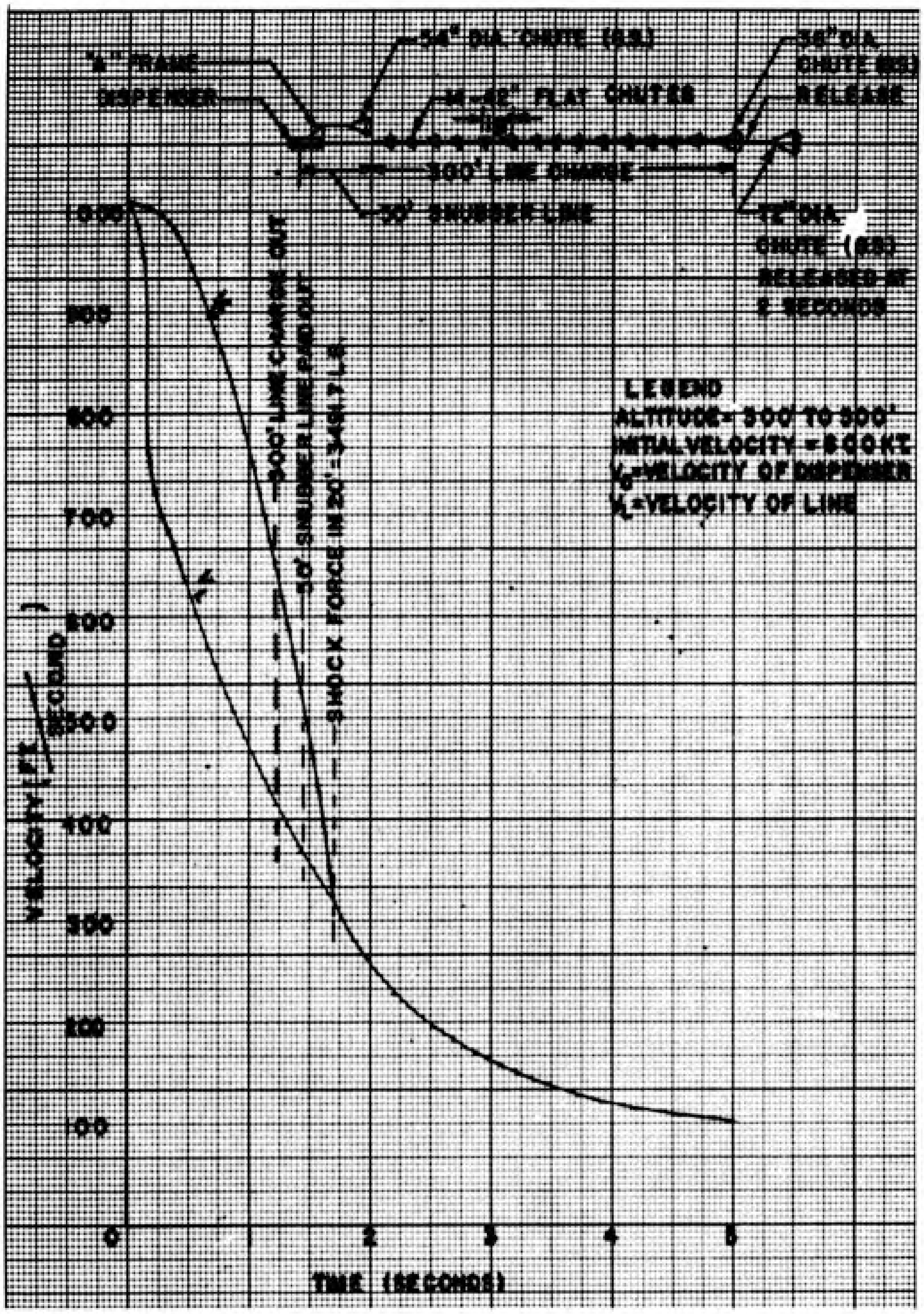

300' LINE CHARGE
FLAT CHUTES
RELEASE
LEGEND
VELOCITY OF LINE
1000
700
400
300
200
100
0
1
2
3
4
5
TIME (SECONDS)

Fig C–5

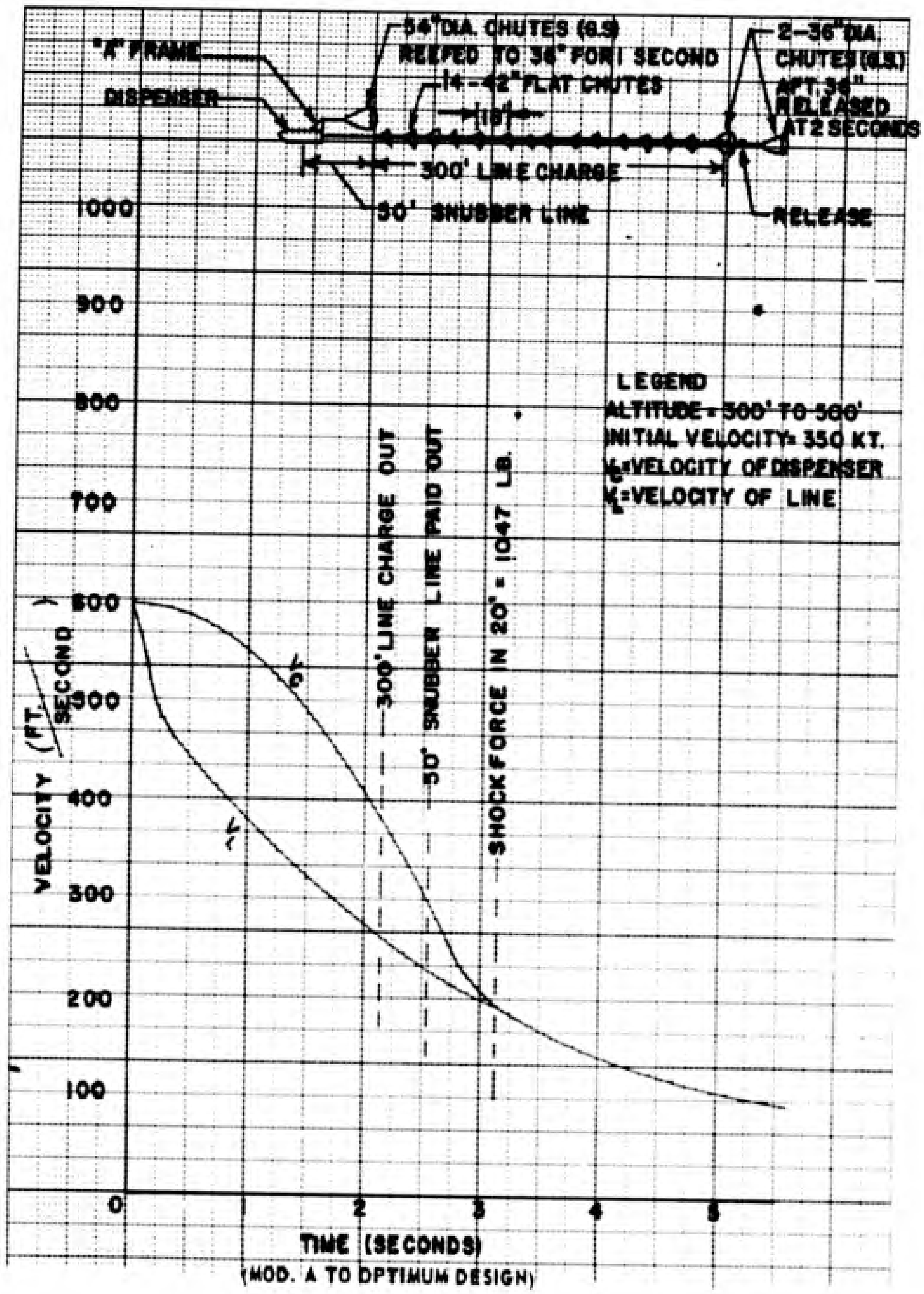

"A" FRAME
DISPENSER
54"DIA. CHUTES (G.S.)
REEFED TO 36" FOR 1 SECOND
14-42" FLAT CHUTES
(18')
300' LINE CHARGE
50' SNUBBER LINE
2-36" DIA. CHUTES (G.S.)
AFT 36"
RELEASED
AT 2 SECONDS
RELEASE
LEGEND
ALTITUDE = 300' TO 500'
INITIAL VELOCITY = 350 KT.
V_D = VELOCITY OF DISPENSER
V_L = VELOCITY OF LINE
300' LINE CHARGE OUT
50' SNUBBER LINE PAID OUT
SHOCK FORCE IN 20' = 1047 LB.
VELOCITY (FT./SECOND)
1000
900
800
700
600
500
400
300
200
100
0
1
2
3
4
5
TIME (SECONDS)
(MOD. A TO OPTIMUM DESIGN)

Fig C–6

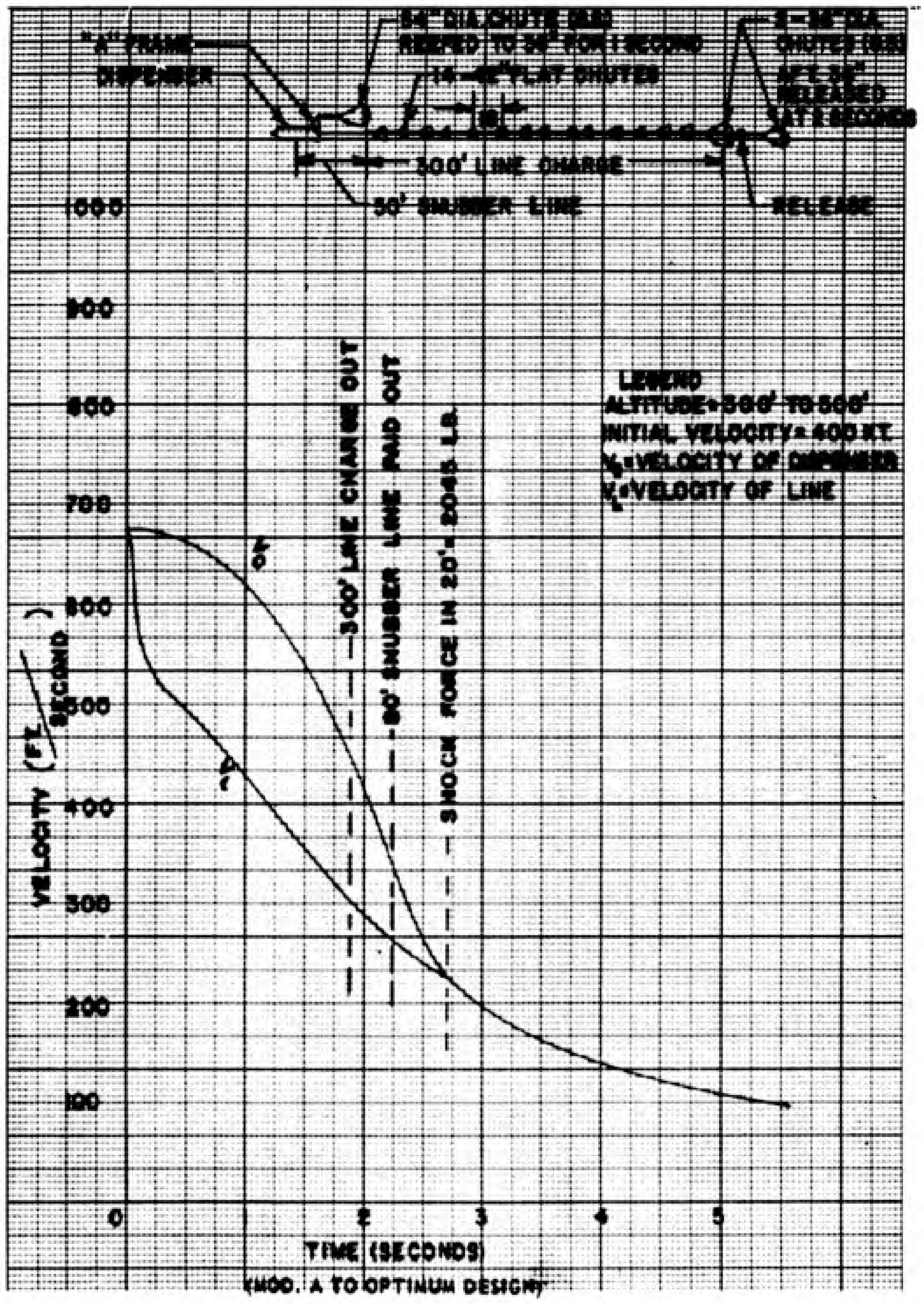


Fig C–7

CONFIDENTIAL

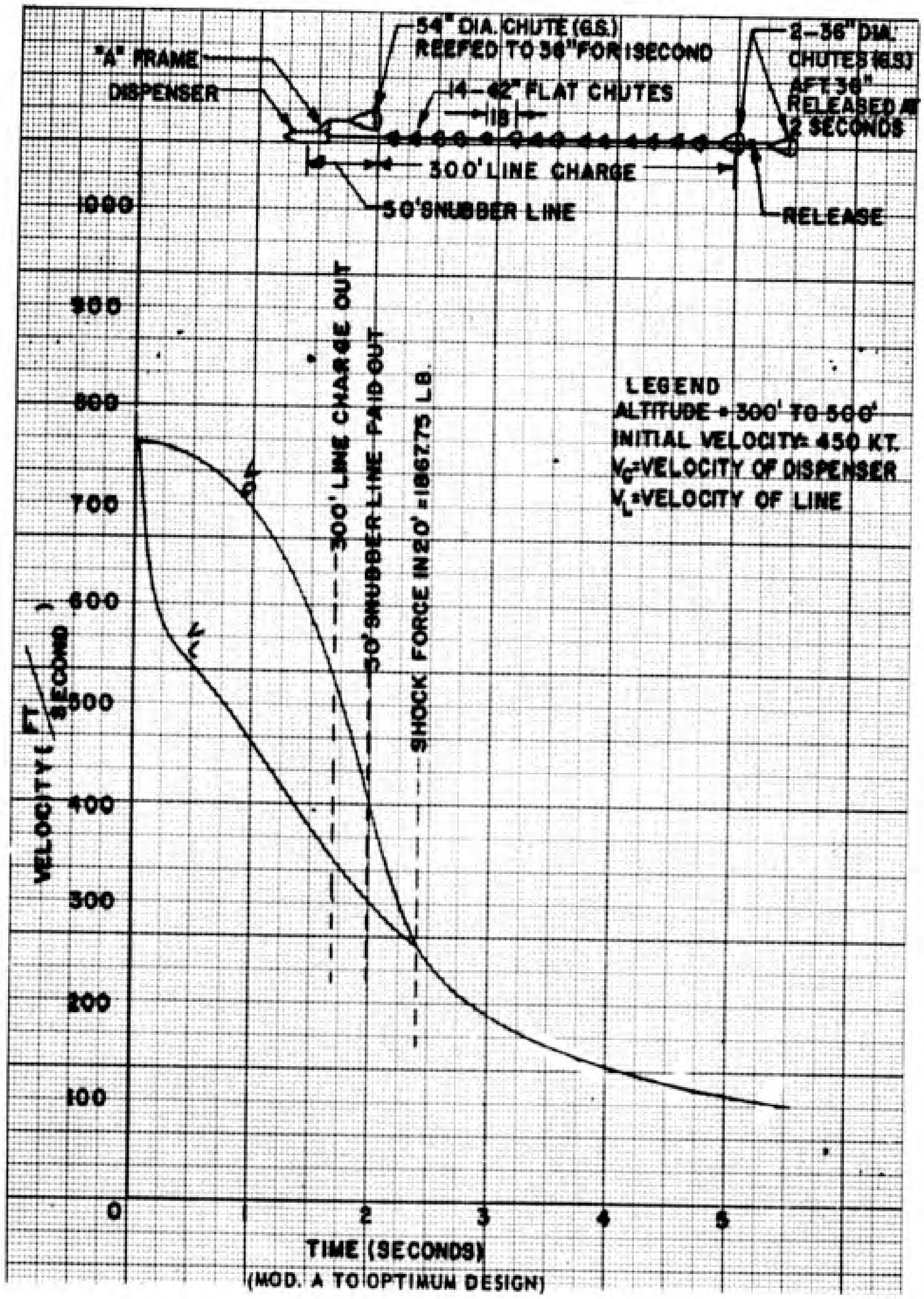

"A" FRAME
DISPENSER
54" DIA. CHUTE (G.S.)
REEFED TO 36" FOR 1 SECOND
14-42" FLAT CHUTES
18
2-36" DIA. CHUTES (G.S.)
AFT 36" RELEASED AT 2 SECONDS
300' LINE CHARGE
50' SNUBBER LINE
RELEASE
1000
900
800
700
600
500
400
300
200
100
0
1
2
3
4
5
VELOCITY (FT / SECOND)
300' LINE CHARGE OUT
50' SNUBBER LINE PAID OUT
SHOCK FORCE IN 20' =18677.5 LB.
LEGEND
ALTITUDE = 300' TO 500'
INITIAL VELOCITY = 450 KT.
V_C=VELOCITY OF DISPENSER
V_L=VELOCITY OF LINE
V_C
V_L
TIME (SECONDS)
(MOD. A TO OPTIMUM DESIGN)

Fig C-8

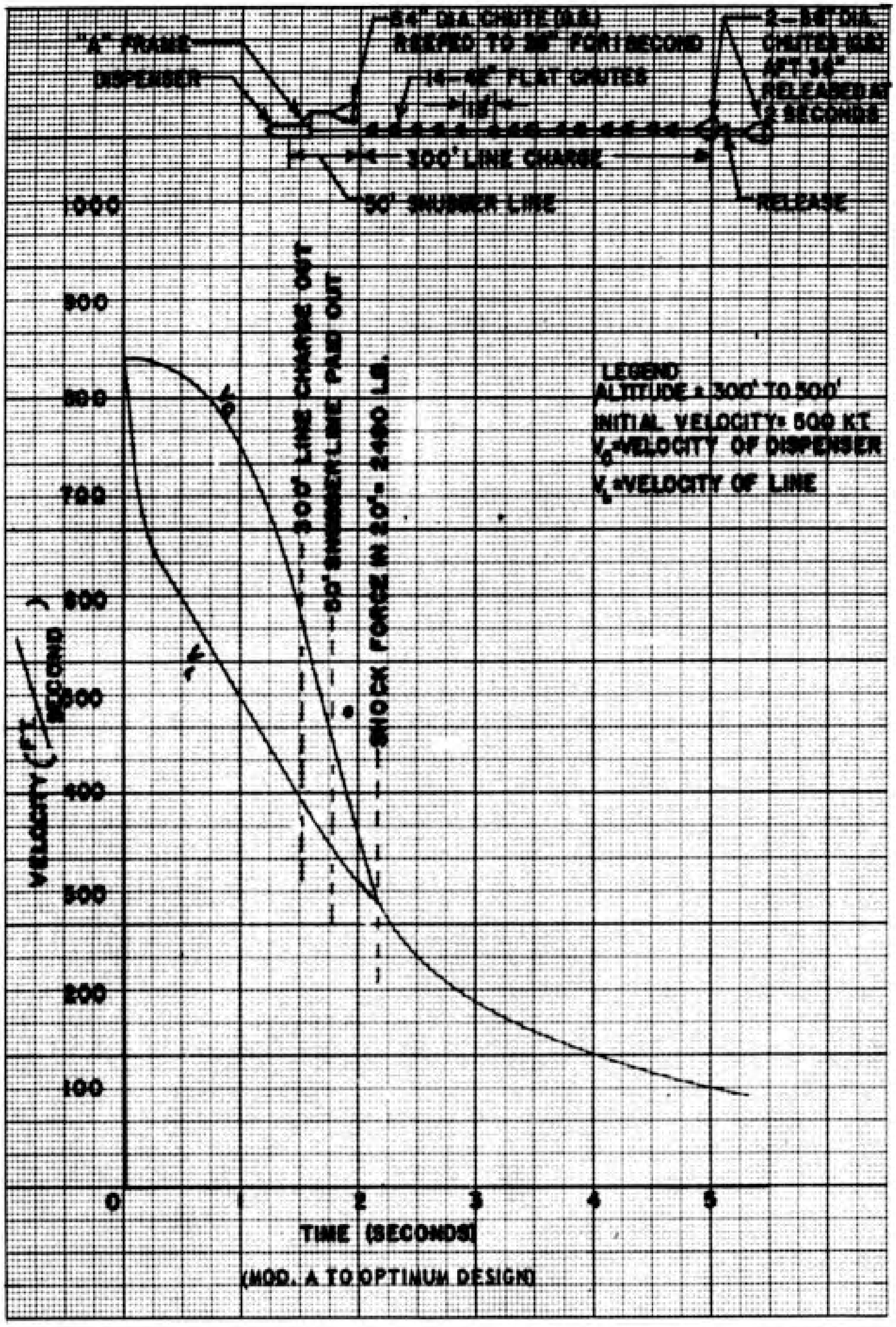
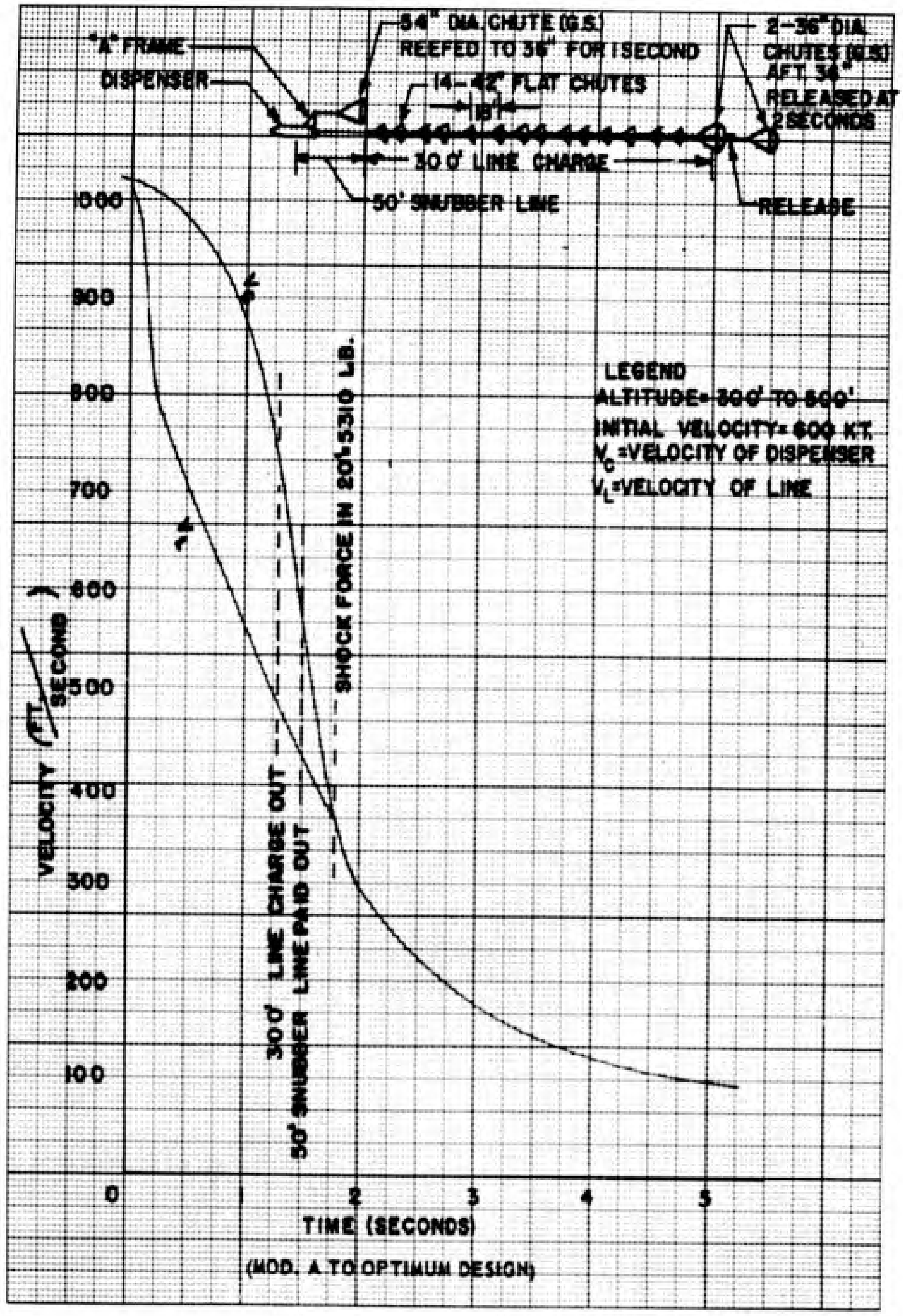
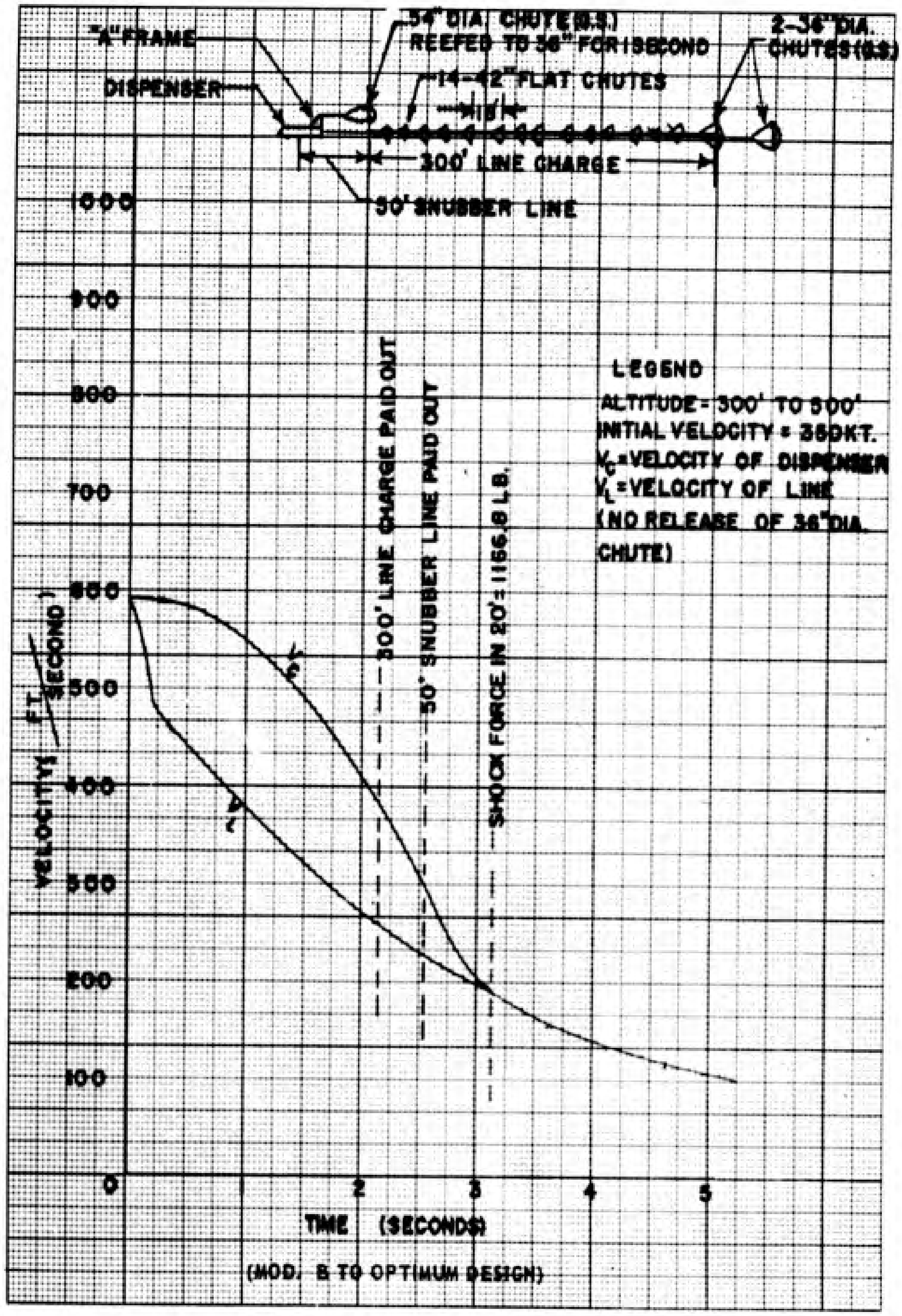

"A" FRAME
DISPENSER
14—48" FLAT CHUTES
300' LINE CHARGE
50' SNUBBER LINE
RELEASE
1000
900
800
700
600
500
400
300
200
100
300' LINE CHARGE OUT
50' SNUBBER LINE PAID OUT
SHOCK FORCE IN 20'= 2480 LB.
LEGEND:
ALTITUDE = 300' TO 500'
INITIAL VELOCITY= 500 KT
V_D=VELOCITY OF DISPENSER
V_L=VELOCITY OF LINE
VELOCITY (FT/SECOND)
0
1
2
3
4
5
TIME (SECONDS)
(MOD. A TO OPTIMUM DESIGN)

Fig C-9



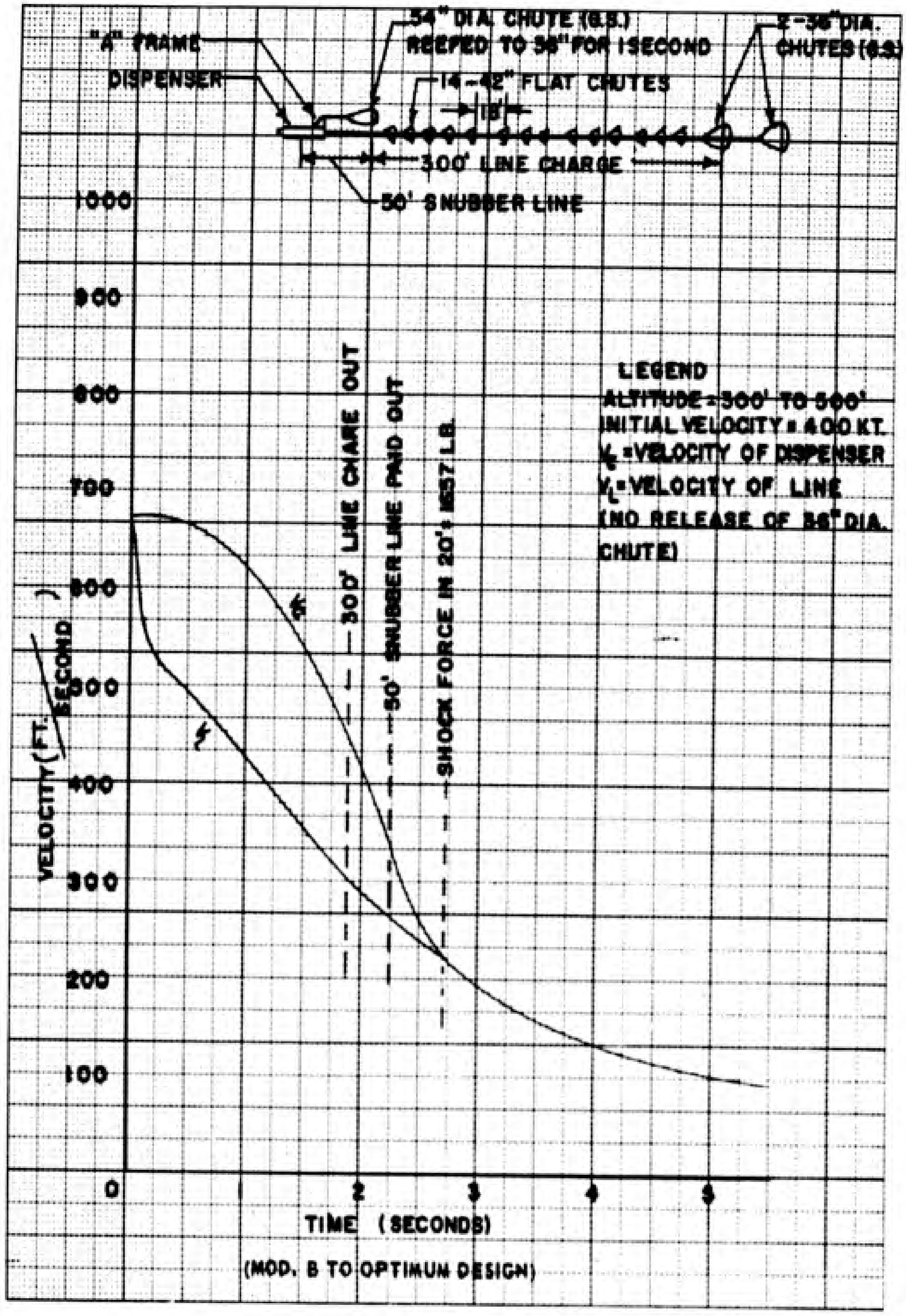
"A" FRAME
DISPENSER
34" DIA CHUTE (G.S.) REEFED TO 36" FOR 1 SECOND
14-42" FLAT CHUTES
18'
300' LINE CHARGE
50' SNUBBER LINE
2-36" DIA CHUTES (G.S.) AFT 34" RELEASED AT 2 SECONDS
RELEASE
LEGEND
ALTITUDE= 300' TO 500'
INITIAL VELOCITY= 600 KT.
V_C =VELOCITY OF DISPENSER
V_L =VELOCITY OF LINE
SHOCK FORCE IN 20'=5310 LB.
300' LINE CHARGE OUT
50' SNUBBER LINE PAID OUT
VELOCITY (FT/SECOND)
TIME (SECONDS)
(MOD. A TO OPTIMUM DESIGN)

Fig C-10



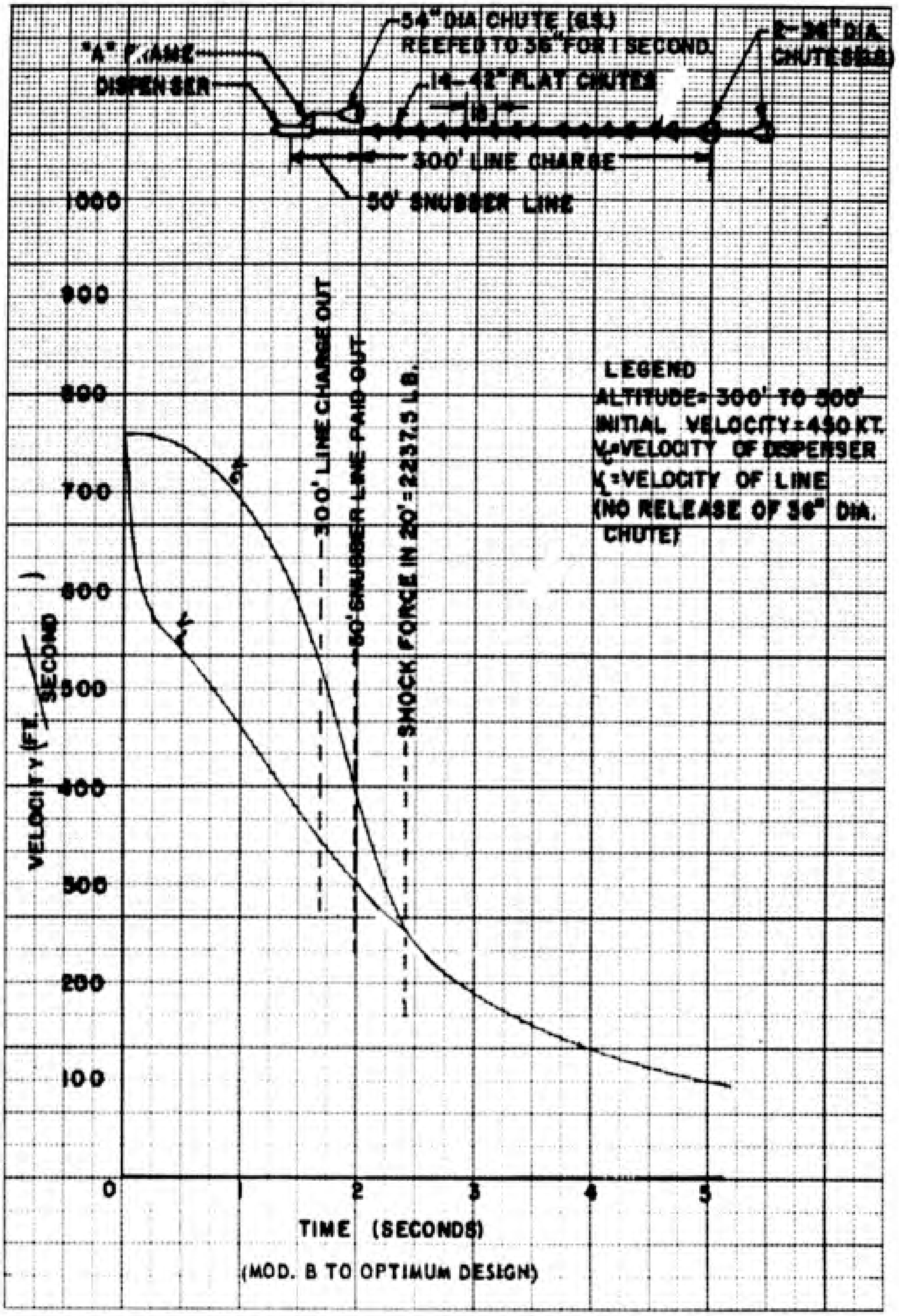
"A" FRAME
DISPENSER
54" DIA. CHUTE (S.S.) REEFED TO 36" FOR 1 SECOND
14-42" FLAT CHUTES
2-36" DIA. CHUTES (S.S.)
300' LINE CHARGE
50' SNUBBER LINE
LEGEND
ALTITUDE = 300' TO 500'
INITIAL VELOCITY = 360 KT.
V_C = VELOCITY OF DISPENSER
V_L = VELOCITY OF LINE
(NO RELEASE OF 36" DIA. CHUTE)
300' LINE CHARGE PAID OUT
50' SNUBBER LINE PAID OUT
SHOCK FORCE IN 20' = 1156.8 LB.
V_C
V_L
VELOCITY (FT./SECOND)
1000
900
800
700
600
500
400
300
200
100
0
1
2
3
4
5
TIME (SECONDS)
(MOD. B TO OPTIMUM DESIGN)

Fig C–11



"A" FRAME
DISPENSER
54" DIA. CHUTE (G.S.)
REEFED TO 36" FOR 1 SECOND
14-42" FLAT CHUTES
15'
300' LINE CHARGE
50' SNUBBER LINE
2-36" DIA. CHUTES (G.S.)
LEGEND
ALTITUDE = 300' TO 500'
INITIAL VELOCITY = 400 KT.
V_D = VELOCITY OF DISPENSER
V_L = VELOCITY OF LINE
(NO RELEASE OF 36" DIA. CHUTE)
300' LINE CHARGE OUT
50' SNUBBER LINE PAID OUT
SHOCK FORCE IN 20'± 1637 LB.
VELOCITY (FT./SECOND)
1000
900
800
700
600
500
400
300
200
100
0
1
2
3
4
5
TIME (SECONDS)
(MOD. B TO OPTIMUM DESIGN)

Fig C–12



"A" PLANE
DISPENSER
54" DIA CHUTE (G.S.) REEFED TO 36" FOR 1 SECOND
14-42" FLAT CHUTES
2-36" DIA. CHUTES
300' LINE CHARGE
50' SNUBBER LINE
300' LINE CHARGE OUT
50' SNUBBER LINE PAID OUT
SHOCK FORCE IN 20'=2237.5 LB.
LEGEND
ALTITUDE= 300' TO 500'
INITIAL VELOCITY=450 KT.
V_C=VELOCITY OF DISPENSER
V_L=VELOCITY OF LINE
(NO RELEASE OF 36" DIA. CHUTE)
VELOCITY (FT./SECOND)
1000
900
800
700
600
500
400
300
200
100
0
1
2
3
4
5
TIME (SECONDS)
(MOD. B TO OPTIMUM DESIGN)

Fig C-13

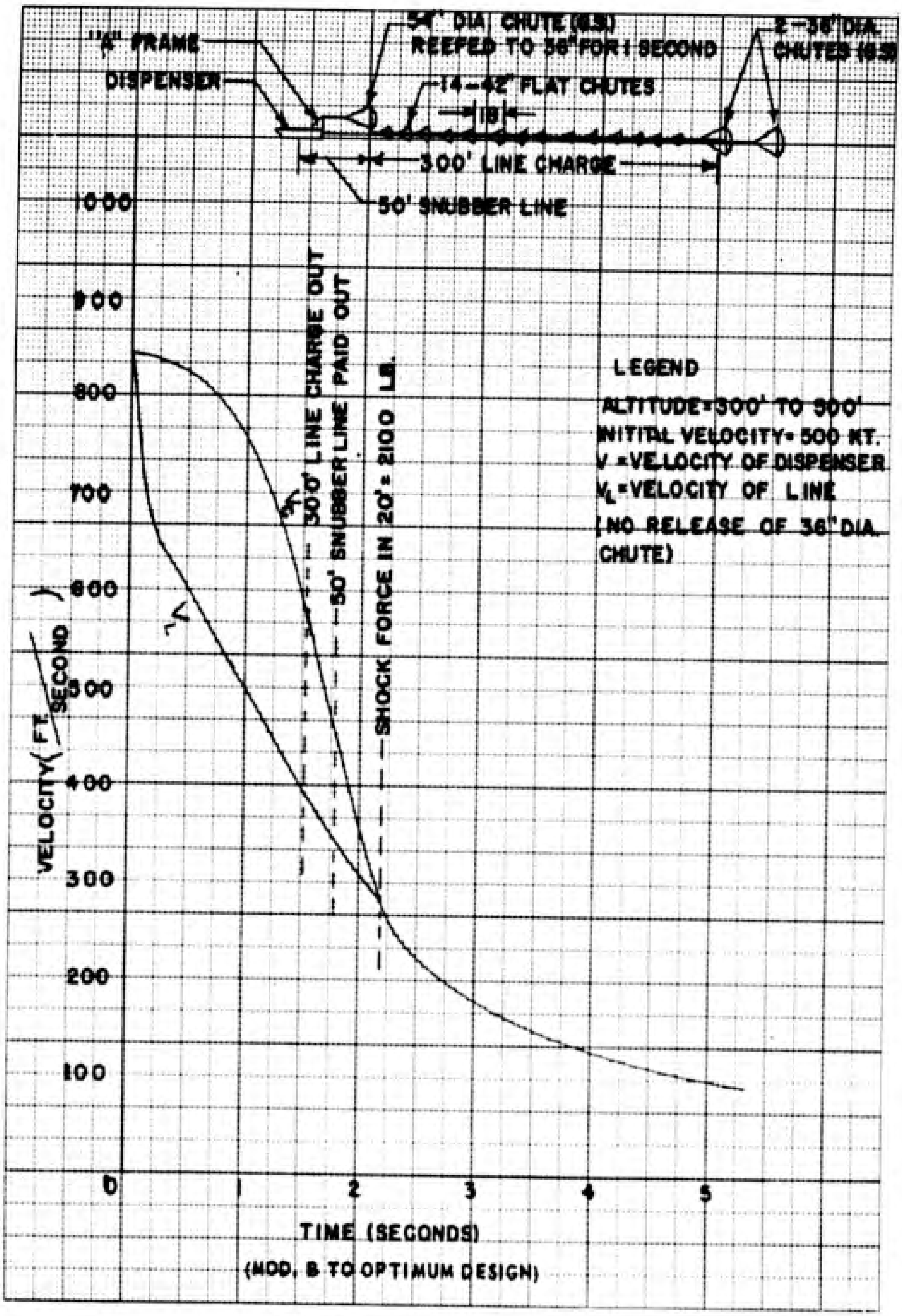
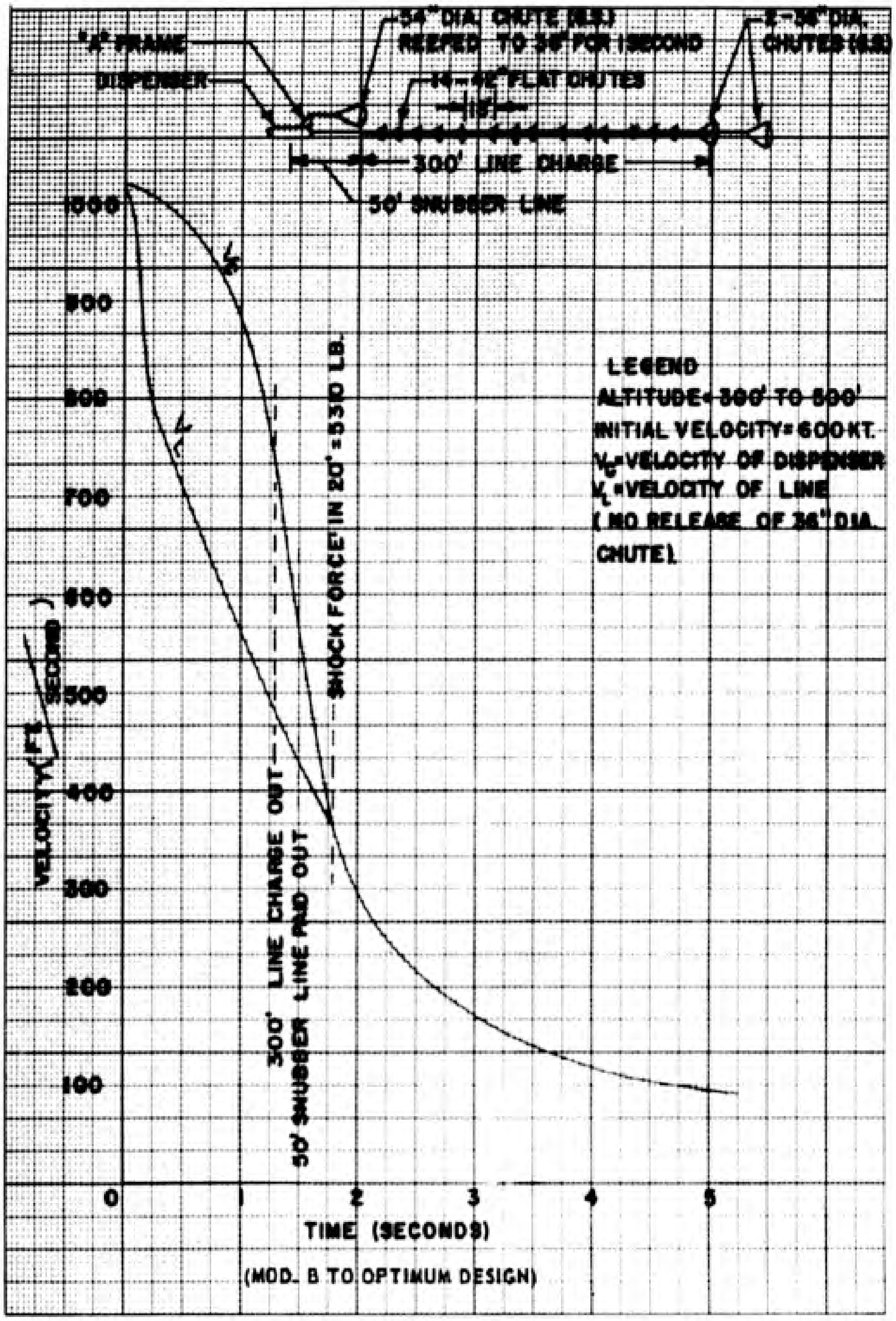

"A" FRAME
DISPENSER
REEFED TO 36" FOR 1 SECOND
14-42" FLAT CHUTES
300' LINE CHARGE
50' SNUBBER LINE
1000
900
800
700
600
500
400
300
200
100
0
1
2
3
4
5
VELOCITY (FT./SECOND)
300' LINE CHARGE OUT
50' SNUBBER LINE PAID OUT
SHOCK FORCE IN 20' = 2100 LB.
LEGEND
ALTITUDE=300' TO 500'
INITIAL VELOCITY= 500 KT.
V = VELOCITY OF DISPENSER
V_L = VELOCITY OF LINE
(NO RELEASE OF 36" DIA. CHUTE)
TIME (SECONDS)
(MOD. B TO OPTIMUM DESIGN)

Fig C-14



"A" FRAME
DISPENSER
REEFED TO 36" FOR 1 SECOND
FLAT CHUTES
300' LINE CHARGE
50' SNUBBER LINE
LEGEND
INITIAL VELOCITY=600 KT.
VELOCITY OF DISPENSER
VELOCITY OF LINE
CHUTE)
300' LINE CHARGE OUT
50' SNUBBER LINE PAID OUT
SHOCK FORCE IN 20' = 5330 LB.
VELOCITY (FT / SECOND)
1000
900
800
700
600
500
400
300
200
100
0
1
2
3
4
5
TIME (SECONDS)
(MOD. B TO OPTIMUM DESIGN)

Fig C–15

APPENDIX D

DEVELOPMENT OF SIGHTING EQUIPMENT FOR CRESSET

COPY

02145 AR-65

29 December 1955

From: Commanding Officer, U. S. Naval Air Development Center

To: Chief, Bureau of Aeronautics (AR)

Subj: TED Project ADC-AR-8003, Project Cresset Sighting Equipment Phase: Completion of

Ref: (a) NADC Conf ltr AR-64 ser 01391 of 17 August 1954
(b) BuAer Conf ltr Aer-AR-4400 ser 021738 of 9 November 1954
(c) Marine Corps Conf ltr AO-4F-kj ser 04A23054 of 13 September 1954 to BuAer

Encl: (1) One (1) copy of NADC Conf Memo AR-4 of 26 October 1955
(2) One (1) copy of NADC Conf Photograph No. NP(58)-5409 of 1 November 1955, "Showing Project Cresset Dispenser on AD-5 Aircraft and Low Level Bomb Sighting Arrangement"
(3) NADC Photograph No. NP(58)-5413 of 1 November 1955, "Low Level Sighting Dots on Canopy of AD-5 Aircraft"
(4) One (1) copy of NADC Conf Photograph No. NP(58)-5411 of 1 November 1955, "Project Cresset Dispenser Installed on AD-5 Aircraft - showing Flap Clearance"
(5) One (1) copy of NADC Conf Photograph No. NP(58)-5410 of 1 November 1955, "Project Cresset Dispenser Installed on AD-5 Aircraft - Ground View"
(6) One (1) copy of Conf NADC Photograph No. NP(58)-5412 of 1 November 1955, "Project Cresset Dispenser Installed on AD-5 Aircraft - Ground View"
(7) One (1) copy of NADC Conf Photograph No. NP(58)-5408, "Installation of Aero X1A Dispenser on AD-5 Using Mk 2 Mod 2 Bomb and Torpedo Truck"
(8) One (1) copy of NADC Conf Photograph No. NP(58)-5407 of 11 November 1955, "Aerial View of AD-5 Carrying Project Cresset Aero X1A Dispensers"

1. Reference (a) stated that the Naval Air Development Center (NADC) had initiated a preliminary study of the sighting requirements for Project Cresset and proposed the following program:

a. Investigate the use of existing sight units to accomplish solution of the Project Cresset problem.

b. Investigate and accomplish modification of an existing sight unit for Project Cresset if required.

c. Make recommendations for the development of a suitable sight unit for Project Cresset if existing sights or modifications thereto are shown to be not usable.

The objective of the proposed sighting system was to obtain an accuracy of plus or minus twenty-five (25) feet from the target in range. It was believed that a considerably larger lateral error could be tolerated under most tactical situations.

2. Reference (b) approved the sighting program proposed by reference (a) with the understanding that the Cresset sighting equipment will in no way affect or interfere with the inherent sighting equipment of the aircraft when it is being employed in its primary mission.

3. Enclosure (1) is forwarded herewith and presents a summary of the sighting study conducted by the NADC for aerial release of Project Cresset Dispenser from the AD-4, 5 and 6 and the A4D aircraft. For the AD series aircraft, the presently installed illuminating sights are not adaptable for dropping the Project Cresset Dispenser since sufficient depression of the sight line from the horizontal reference line is not available over the nose of these aircraft. However, the A4D with its present sight equipment could be used since the nose is short enough to give the required depression angles. It is to be noted here that, even though the A4D is listed to carry the Project Cresset Dispenser by reference (c), the parachute system limits the release velocity to a maximum of 450 knots. The Project Cresset Dispenser, however, has been designed to meet the structural requirements of MIL-A-8591 revision (b) and can be carried at higher speeds probably up to Mach No. 1.0.

4. Enclosure (1) also presents the results of an error analysis conducted by the NADC to determine the effects of airspeed and altitude variations on the horizontal range if the target could be seen at the time of release

by means of a periscope in the AD series aircraft. It is concluded from these results that a fixed sight used in conjunction with a trained pilot's eye would give suitable accuracy for dropping the Project Cresset Dispenser.

5. The Marine Corps furnished an AD-5 aircraft to the NADC for fit and flight tests of the Project Cresset Dispenser. This aircraft was equipped with a fixed sighting bar on the port side of the fuselage just forward and below the cockpit canopy as shown in enclosure (2). Black dots were installed on the port side of the plexiglas windshield as shown in enclosure (3). The pilot determines prior to take-off his release velocity, altitude, angle of dive and aircraft weight. During the bombing run, he moves his head slightly to the port side and then releases the special weapon when he has the proper sighting dot lined up with the sighting bar and the target. In the discussion with Marine Corps personnel, it was learned that this method gave accuracies within plus or minus 50 feet for firebombs. It appeared that this same range of accuracy would satisfy the Project Cresset requirements in lieu of plus or minus 25 feet originally proposed by the NADC. This fixed sight method is readily adaptable for low level bombing runs since the pilot has maximum visibility and is not restricted to look into a scope or sight. In addition, as shown in enclosure (1), this method offers a higher degree of accuracy (due to errors in altitude and airspeed) than the other methods investigated, including a simplified computing sight system.

6. As a result of the NADC study for the sighting problem for the Project Cresset Dispenser, the NADC makes the following recommendations:

a. The Marine Corps utilize the fixed sight system for dropping the Cresset dispenser until such time as a low level bombing sight system is developed.

b. That a low level bomb sighting system be developed for use by the Armed Forces, as presented in paragraph 10 of enclosure (1).

7. The NADC has modified a few Mk XV, 100-pound water or sand filled practice bombs by adding a small parachute on the aft fins. These modified bombs, when dropped at airspeeds and altitudes similar to the Cresset Dispenser requirements, are to have about the same trajectory characteristics as the actual full size Cresset store. The NADC is presently obtaining these trajectory characteristics. Upon completion of this phase, it is

recommended that the Marine Corps have some of these bombs so modified for use in pilot training purposes prior to releasing the much more expensive Cresset Dispensers. It is estimated that these practice bombs can be modified and equipped with the parachute for less than $50.00 each. The NADC will furnish drawings to the Bureau of Aeronautics which will specify the detail modifications to these practice bombs, at a later date.

8. Enclosures (2), (4), (5) and (6) show the installation of the Project Cresset Dispensers on an AD–5 aircraft. No difficulties were encountered in installing the Cresset Dispenser on the AD–5 aircraft and ample clearances were obtained as shown on enclosures (2) and (4). Enclosure (7) shows the use of the standard Mk 2 Mod 2 bomb and torpedo truck to install the Cresset Dispenser on the AD–5. Enclosure (8) is an aerial shot of the AD–5 carrying three (3) Cresset Dispensers. The pilot reported no adverse or noticeable effects of these stores on the performance of the aircraft.

9. With the submittal of the above information, the sighting phase of this program is considered complete. The NADC does not plan to perform any additional work in this regard on Project Cresset unless otherwise directed by the Bureau of Aeronautics.

/s/ H. P. Wirth
H. P. WIRTH
By direction

Copy to:
Commandant, USMN
The Pentagon, Wash., D.C.
Attn: Lt. Col. H. G. Lawrence (AO4F)
Commanding General
Picatinny Arsenal
Attn: Pvt. J. G. Lenhart
BuAer (AR–4400)

COPY

AR–4

26 October 1955

MEMORANDUM

From: L. Bradley, Air-to-Air Armament Division

To: Special Equipment Program Engineer,
Weapons Equipment Division

Via: Superintendent, Air-to-Air Armament Division

Subj: Project Cresset; sighting phase, report on

Ref: (a) E. O. No. 8003–10

1. In accordance with reference (a), an investigation was conducted to determine if existing sight units, with or without modification, could be used for the solution of the Project Cresset sighting problem. Requirements were that the aft end of the Cresset weapon, launched from an AD–4, –5, –6 or A4D–1 aircraft at an altitude of 300 feet, land within ±25 feet of a prescribed point on the ground.

2. The speed range of the AD–4, –5, –6 aircraft is between 200 and 300 knots true airspeed. Calculations based on theoretical trajectories for the Cresset weapon showed that for a launch from an AD type aircraft in straight and level flight, with the aircraft angle of attack considered, the maximum angle of depression of the sight line from a horizontal reference was 19.8 degrees. The maximum angle the pilot could see over the nose of the AD series aircraft, based on Douglas Aircraft Company sight installation drawings was 15.5 degrees. Therefore, it was impossible to see the target over the nose of the AD–4, –5, –6 aircraft at the proper instant of release.

3. Computations showed that no difficulty would be experienced in seeing the target at the proper release time in the A4D aircraft. The airspeed range of the A4D was unknown but it was assumed in the 600 knot class. The Cresset trajectory curves had to be extrapolated to obtain the horizontal range at 600 knots. The calculated maximum sight line depression was 7.7 degrees. According to Douglas Aircraft Company drawings, the maximum angle that the pilot could see over the nose was 20 degrees, so it was easily possible for him to see the target at the time of release.

4. An error analysis was conducted to determine the effects of airspeed and altitude variation on the horizontal range if the target could be seen

at the release point by means of a periscope in the AD series aircraft. The results were found to be as follows:

TABLE I

Fixed Sight Method

Sight Angle Optimized For			Error in Feet	
Airspeed, knots		Altitude, ft	Per Ft Error In Altitude	Per Knot Error In Airspeed
200	300	300	2	4.5
250		300	2.5	4
300		300	3	3.5

It was found from theodolite data recorded on actual drops of the Cresset weapon that a pilot could be off as much as 50 feet in altitude and 25 knots in airspeed, especially if the plane were dived to pick up airspeed before levelling off for the drop. It can be seen from the previous error figures that an error of 10 feet in altitude or 10 knots in airspeed would cause a range error larger than that noted as allowable in paragraph 1 of this memorandum.

5. A method investigated for use in AD type aircraft was one in which a preset delay was incorporated between the bomb release switch and the bomb rack. The line of sight was depressed a fixed amount so that the pilot looking through the sight could just see over the aircraft nose. The bomb release switch was triggered when the sight pipper passed over the target but the built in delay element would not trigger the bomb rack until the proper time had passed for the aircraft to be over the release point. For the AD–4, –5, –6 aircraft in straight and level flight at 300 feet altitude and with a fixed sight line depression of 8 degrees, the delay times were found to range from 1.5 to 3.5 seconds, depending on the airspeed. An error analysis conducted for this method showed the following:

TABLE II

Delay Method Errors

Sight Angle Optimized For		Horizontal Range Error, In Feet	
Airspeed, knots	Altitude, ft	Per Ft Error In Altitude	Per Knot Error In Airspeed
200	300	6	11
250	300	6	8
300	300	6	6

From Tables I and II it can be seen that the method incorporating the delay between the bomb release switch and the bomb rack is even more sensitive to airspeed and altitude errors than is the method where the target is in view of the release point.

6. The Mk 3 Mod 3 Bomb Director System was investigated for use with Cresset weapon. This system is listed in the AD–4, –5, –6 flight handbooks as standard equipment in these aircraft. The system was deemed unsatisfactory for this application when it was noted in Franklin Institute Report No. F2231 that the system was subject to large range errors due to the method of altitude measurement used.

7. A search was made in the NADC Library to check the sighting system proposed for Project "Hail" or "Lazy Dog". However the only information available was dispersion data where the missile container was triggered by a ground signal. A report of the project investigations was ordered from ASTIA but has not arrived to date.

8. The sighting system proposed for the Emerson Electric Manufacturing Company 20 mm strafing system as noted in Emerson Report No. 429 was also investigated. For the sighting of this package, the line of sight was depressed as much as possible and still clear the nose. Then the package was oriented in elevation so that the actual projectile launcher line intersected the line of sight at the ground when the aircraft was at a preset altitude. The actual projectile launcher line was determined from the vector sum of the aircraft velocity and projectile muzzle velocity. Since the Cresset missile has no forward velocity relative to the parent aircraft at release, this method cannot be utilized.

9. Thought was given to periscopic sighting systems but the idea was abandoned for two reasons. First, periscopic systems are essentially the same as the fixed sighting systems mentioned previously and are therefore subject to the same errors. Secondly, there would be a serious problem of how to present the information to the pilot, because the low altitudes and relatively high velocities involved require the pilot to be able to see the horizon or his instruments at all times.

10. The results of this investigation indicate that there is no existing system that can be modified to satisfactorily solve the Cresset sighting problem. Development of a sighting system would entail the design of a computer and method of presentation, and coupling of a system with an

air-to-surface radar. A penalty would have to be paid for the weight of the additional equipment installed in the aircraft. It is extremely doubtful if any simplified computer of greatly reduced weight could give any greater accuracy than that of a trained pilot's eye due to the inaccuracies of existing airspeed and altitude measuring devices.

11. This memorandum completes the work requested by reference (a).

/s/ L. A. Bradley
L. A. BRADLEY

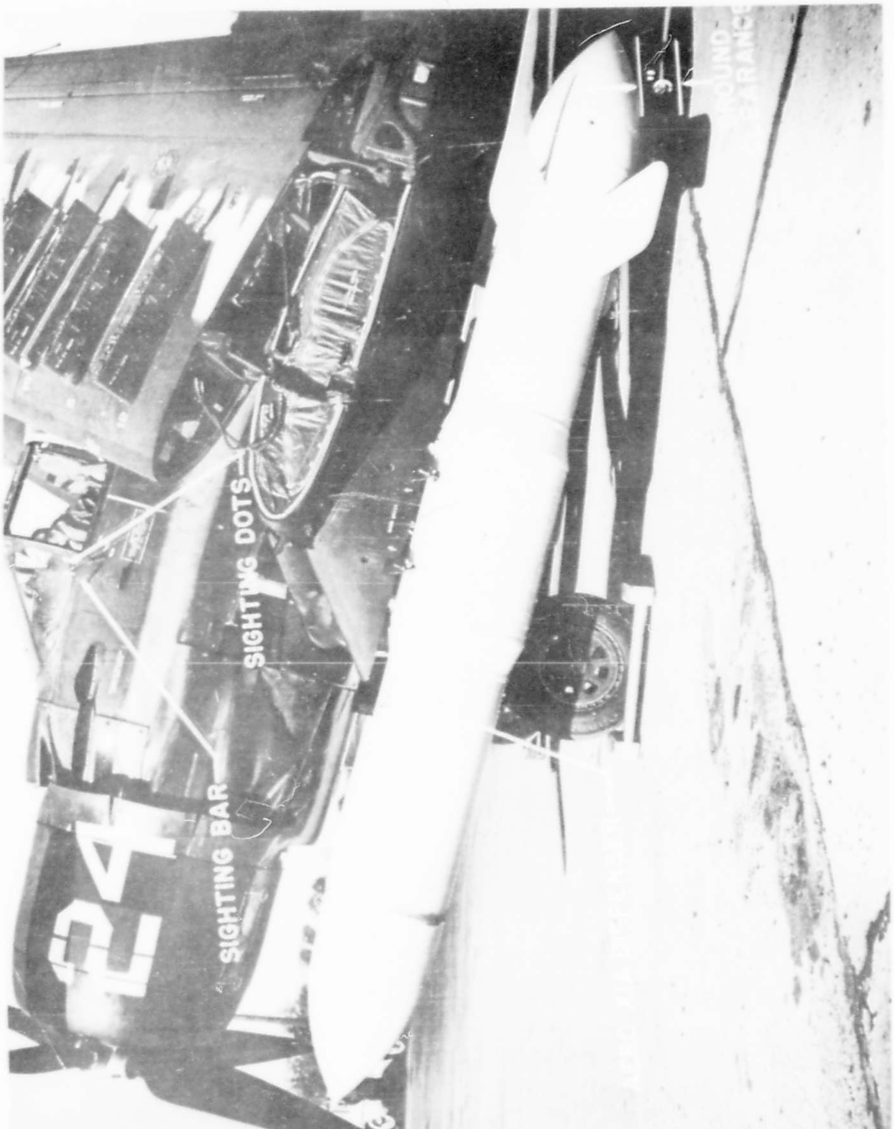


Fig D–1

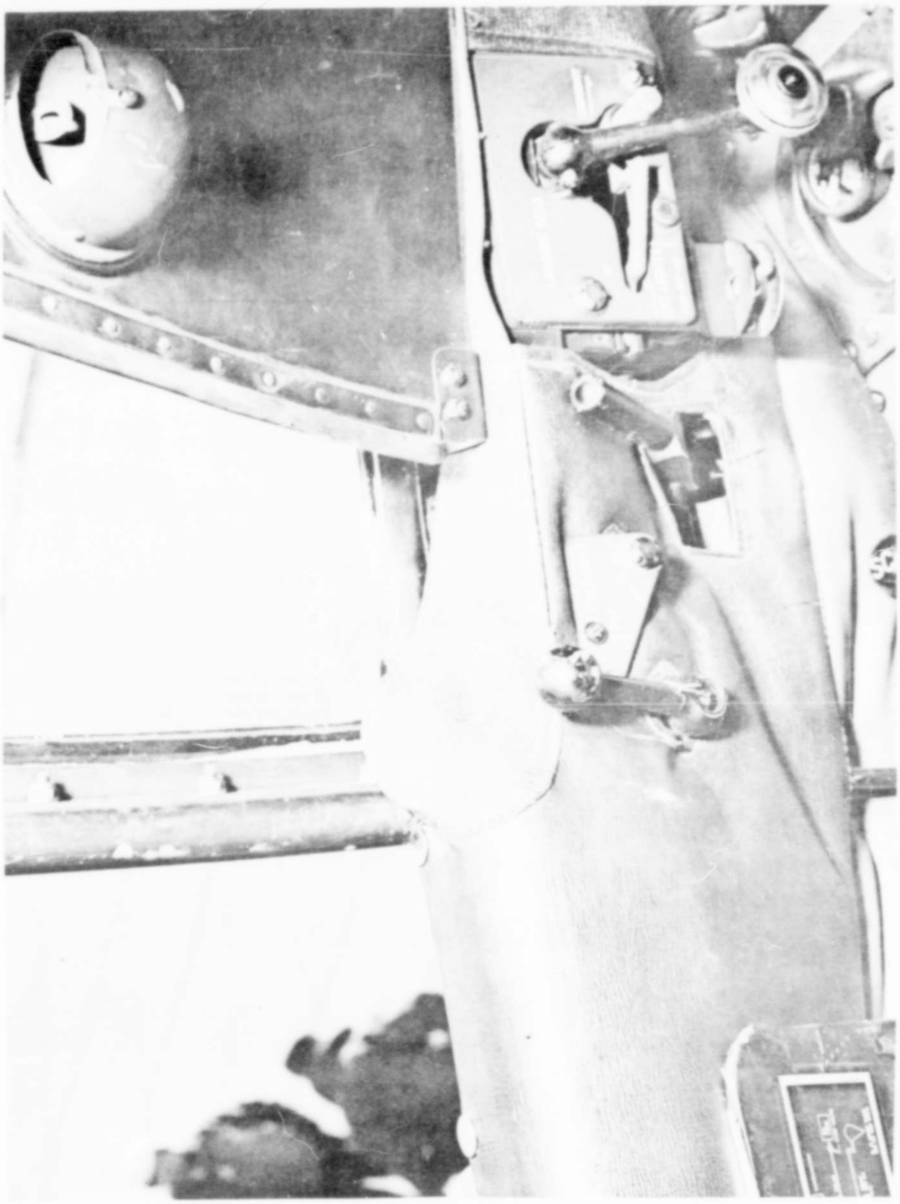


Fig D–2

Fig D–3

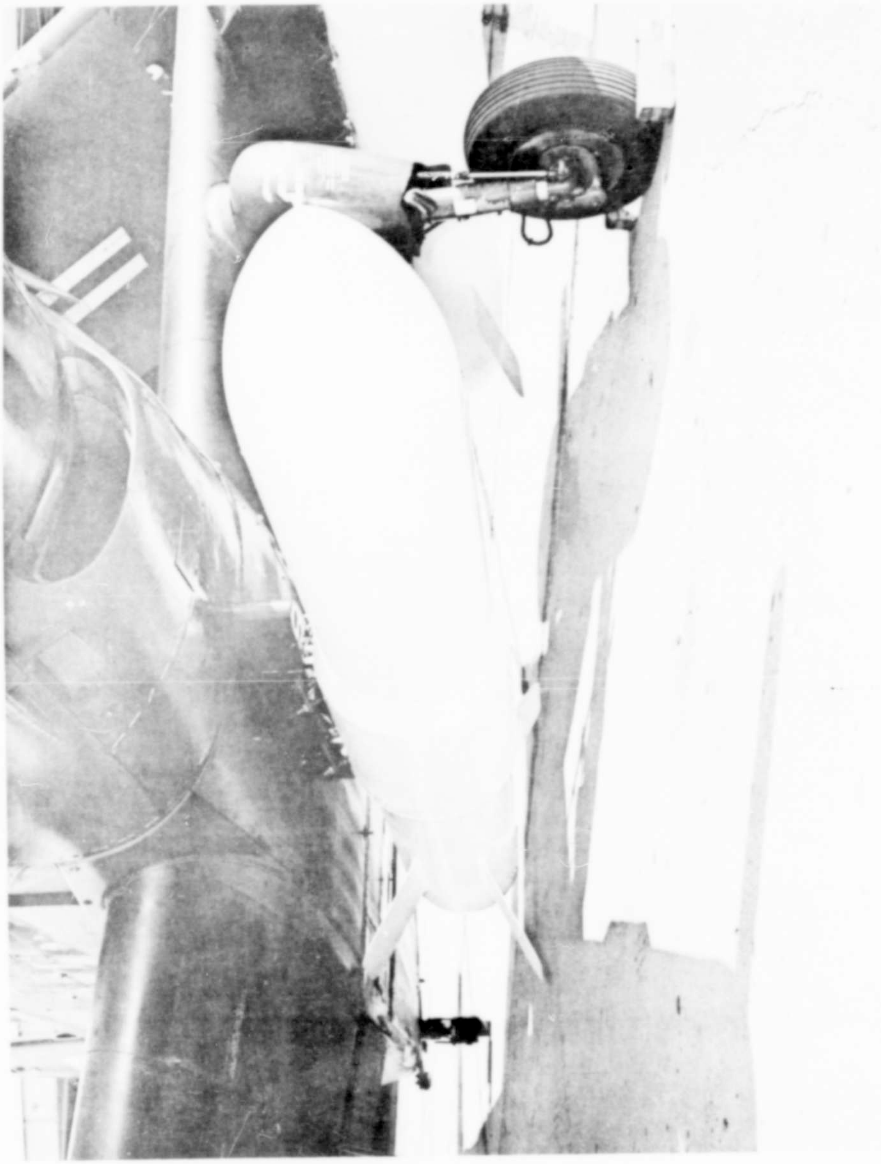


Fig D–4

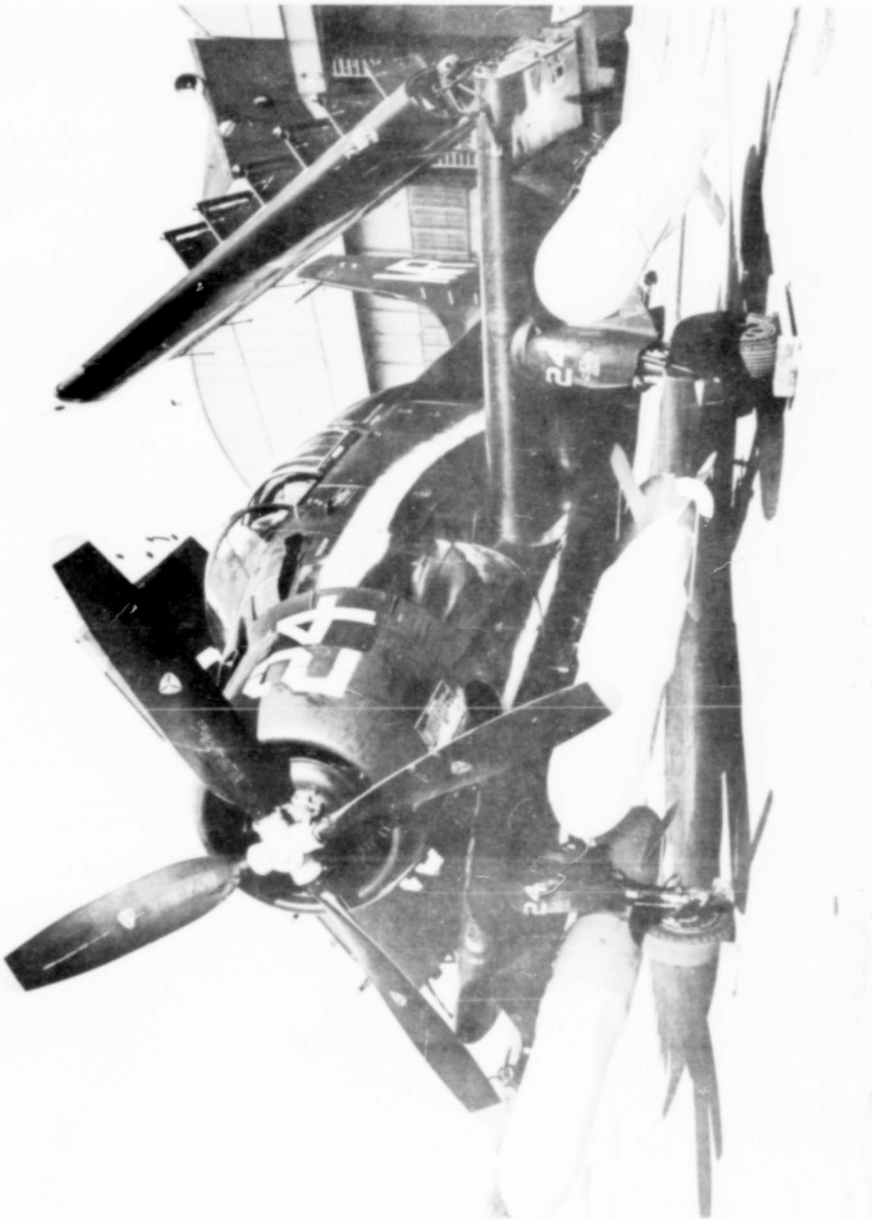


Fig D–5

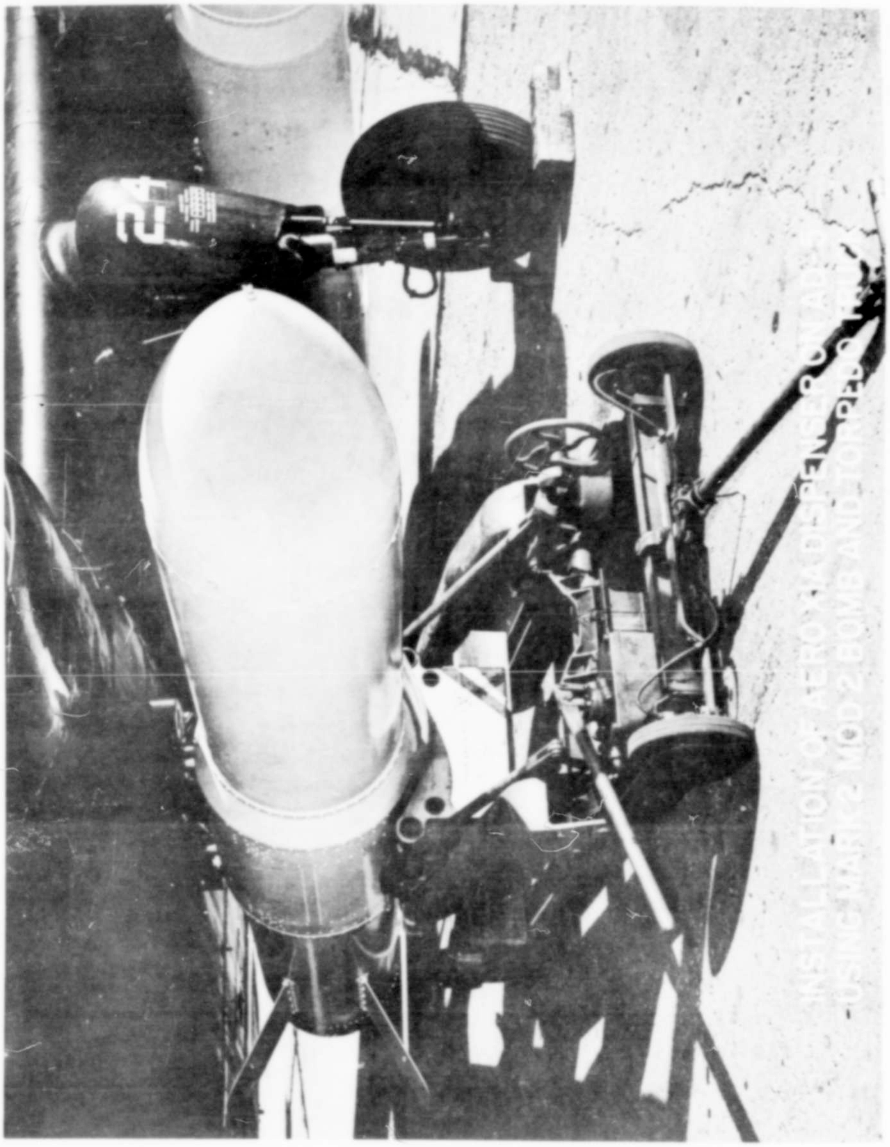


Fig D–6

CONFIDENTIAL

Fig D–7

APPENDIX E

LIST OF DRAWINGS – CRESSET DISPENSER

Drawing No.	Title
55A43R1, Rev B	General Arrangement
55A43R2, Rev C	Center Section Assembly
55A43C3, Rev A	Lug Suspension Assy & Details
55A43D4, Rev C	Cone Assembly – Forward
55A43R5, Rev B	Beam Detail – Main
55A43R6, Rev C	Mechanisms Tail & Parachute Release Installations
55A43E7, Rev B	Release Parachute Assy & Details
55A43D8, Rev C	Release & Ejection Mechanism Tail Cone Assy & Details
55A43D9, Rev B	Fairing Tail Detail
55A43D10, Rev B	Fairing Tail Structural Assy
55A43H11, Rev A	Fairing Tail Assembly
55A43R12, Rev A	Fuze & Arming Wire Inst. & Details
55A43D13, Rev A	Support Fuze Assy & Details
55A43R14, Rev A	Line Charge Assy & Details
55A43B15, Rev B	Bushing – Cable
55A43A16	Arm
55A43A17, Rev C	Loop Assembly
55A43B18	Delay Initiator (Cancelled)
55A43B19, Rev A	Bracket Tail Cone
55A43D20, Rev A	Body Painting & Marking
55A43R21, Rev A	Loading Arrangement
55A43A22	Elastic Cord Assembly (Cancelled) Dispenser Airborne – Special Line Aero X1A
55A43R23, Rev C	Cone Tail – Assembly
55A43B24, Rev A	Guide – Pulley

Drawing No.	Title
55A43D25, Rev A	Shock Line Assy
55A43A26	Tag – Safety
55A43B27, Rev C	Arming Wire Assembly
55A43A28	Arm Assembly
55A43B29, Rev A	Stencil Legend
55A43B30	Bushing – Shock Line Assembly
55A43B31, Rev B	Coupling Arming Wire
55A43B32, Rev B	Coupling
55A43D33, Rev A	Nose Fairing
55A43D34	Major Component Assy.
55A43C35	Universal Fitting "A" Frame
55A43R36	"A" Frame Assembly
55A43D37	Bracket "A" Frame Support
55A43D38	Strut, Assembly
55A43C39	Webbing
55A43C40	Bracket
55A43C41	Bracket Parachute Support
55A43B42	Bushing Bracket Suspension Line
55A43B43	Bushing "A" Frame Suspension Line
55A43B44	Spacer – Parachute Shroud Line
55A43R45, Rev A	Fairing – Webbing Tie Down
55A43C46	Bracket "A" Frame Tie Down
55A43B47	Spring – Dispenser Airborne – Special Line Aero X1A
55A43C48	Intercostal – Side
55A43C49	Intercostal – Lower
55A43D50	Ring – Center Section
55A43C51	Ballast
55A43B52	Spring Initiator

Drawing No.	Title
55A43B53	Spring – Tail Cone
55A43B54	Spacers – Tail Arming System
55A43B55	Bracket – Fuze Arming Wire
55A43B56	Arming Wire Assembly
55A43A57	Guide – Pulley Tail Arming
55A43R58	Installation – A4D
55A43R59	Installation – FJ–4B
55A43R60	Installation F4D–1
55A43R61	Installation – AD–4, 5 & 6

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