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TITAN DESTRUCT SYSTEMS FOR LIQUID PROPELLENT MISSILES AND BOOSTERS

This paper describes the evolution of Command Destruct Systems for the Titan family of liquid propellent ballistic missiles and space boosters. Included are destruct tests using large quantities of liquid propellents, the RF subsystem, command receivers, automatic destruct system for inadvertent stage breakup, electrical subsystem, ordnance subsystem, sequencing, reliability, and environment. The electrical subsystems are presented in Figures 1 through 4. Emphasis will be on use of the ordnance subsystem to achieve the best liquid propellent destruct system and supporting test results.

With cryogenic rockets, such as Titan I, the safest flight termination system has simple, reliable circuitry, avoids propellent intermixing, and obtains maximum propellent dispersion with the ordnance subsystem. This is to avoid and/or minimize a high order detonation and possible explosion damage.

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With the advent of storable liquid hypergolic rockets, such as Titan II and Titan III, the problem is reversed. The safest flight termination system for hypergolic fueled rockets is to maximize the propellent intermixing with proper use of the ordnance components and obtain maximum reaction of the propellents. This is to avoid possible problems due to the toxic and corrosive properties of unreacted storable hypergolic propellents.

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System Description

The objectives in designing these propellant destruct systems were simplicity and reliability. Additional reliability has been designed into these missile destruct systems through redundancy, without sacrificing simplicity.

As new members have been added to the Titan family of vehicles the RF subsystem has made a transition from four Archimedian spirals (Figure 5) to two cruciform slot antennas (Figure 6). The range safety destruct signal is received through the two antennas on the last powered stage.

Due to anticipated environments during future flights, requirements for extreme sensitivity, high current switching, and low power consumption, solid-state command receivers will be required with high current output switches. The automatic destruct system on Titan I and Titan II for inadvertent stage separation uses lanyard type switches to initiate the destruct signal in case of structural breakup during flight. The automatic destruct system uses the same destruct components that are used for range safety command destruct.

Figure 7 shows ordnance component location on opposite sides of cryogenic rockets for maximum propellent dispersion minimum intermixing and minimum reaction. Figure 8 shows ordnance component location between tanks on hypergolic propellent vehicles to achieve maximum propellent intermixing, minimum dispersion and maximum reaction of the propellents.

The presentation includes 3 to 5 minutes of movie clips showing ½ scale destruct tests using hypergolic propellents. See Figures 9, 10, 11, and 12.

To obtain complete propellent destruct action of all missile stages, it is necessary to develop a system of sequential primer detonation to insure that the stages not containing the range safety power supplied would detonate first. This paper presents the results of this study and tests leading to the development of this sequence system used on Titan I and Titan II. See Figure 13.

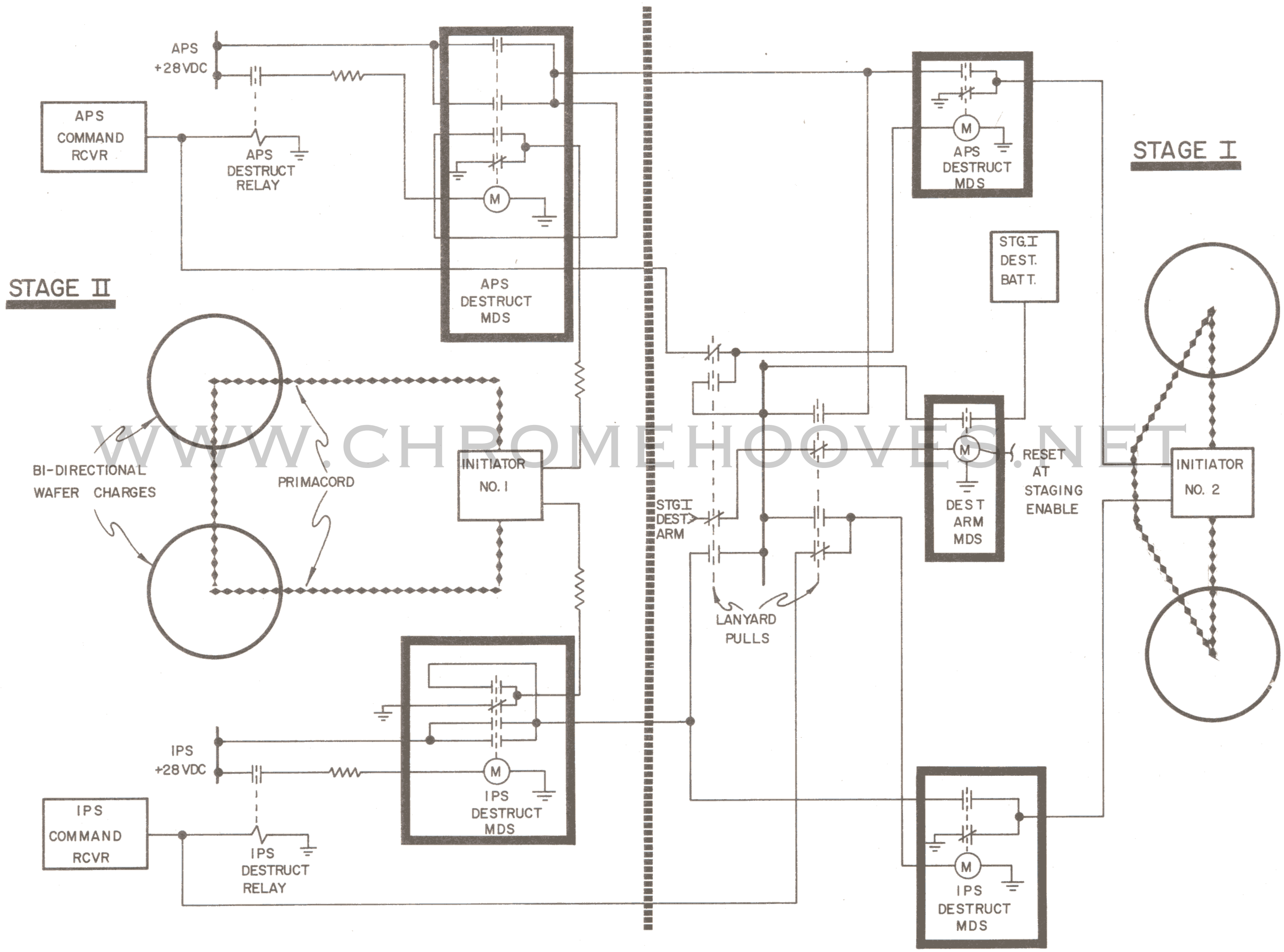
To achieve maximum hypergolic propellent reaction in all stages of Titan III, a hot wire system will be used. This will eliminate the sequencing problem, by use of solid state switches to actuate the destruct system in each stage. This hot wire system can be actuated by range safety command or by breaking the hot wire anywhere along the full length of the vehicle.

<u>Results and Conclusions</u>

1. Splitting opposite tank sides for cryogenic rockets, minimizes propellent mixing and minimizes destruction by detonation.

2. Maximum intermixing and reaction is obtained with hypergolic propellents by breaking tank domes and the resulting thermal column disperses vapors well above ground, even if detonation occurs at ground level.

3. Bi-directional destruct wafers obtain maximum destruction of tank domes with minimum side effects.



COMMAND DESTRUCT SYSTEM

FIGURE 1

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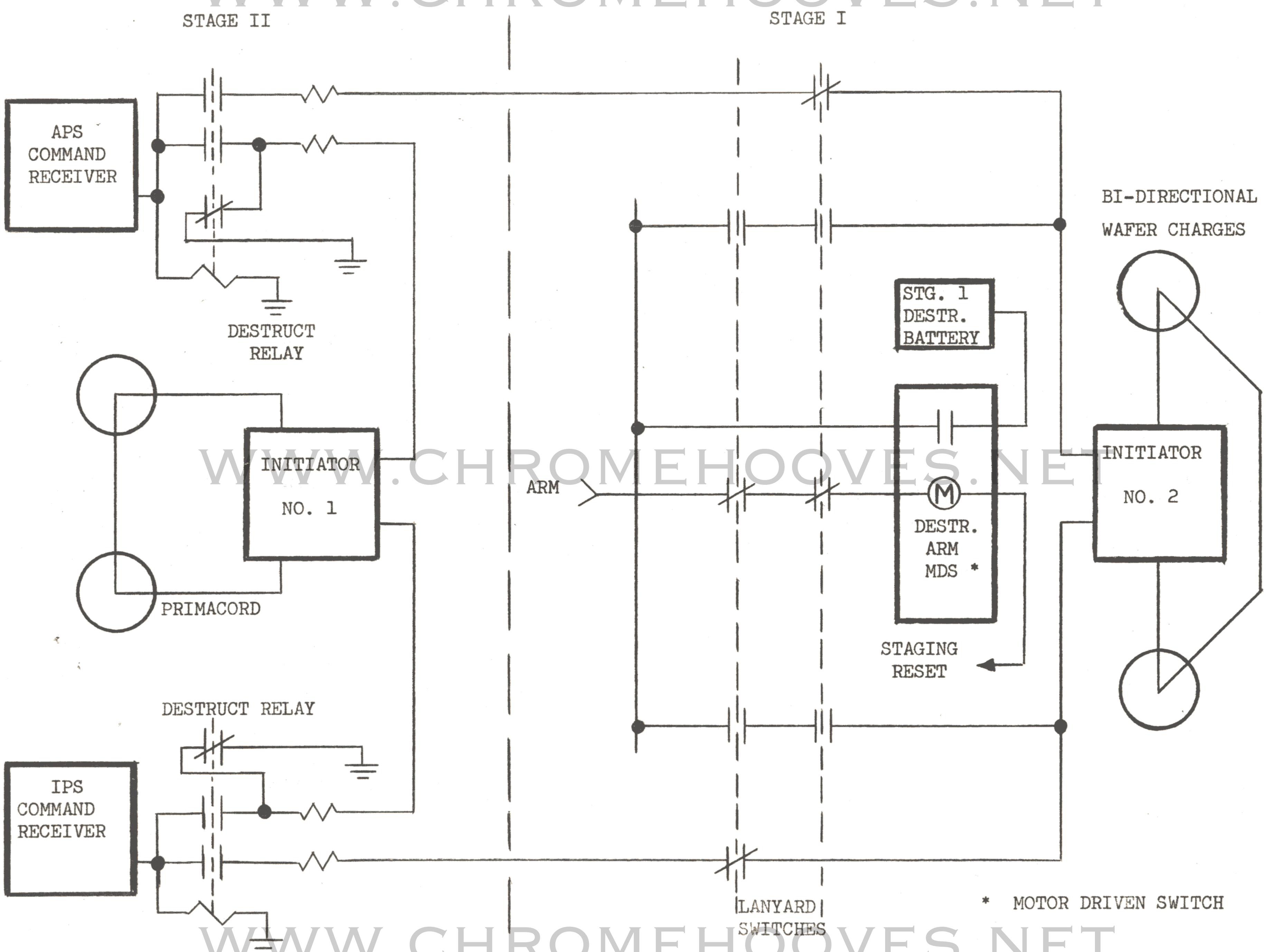

FIGURE 3 COMMAND DESTRUCT SYSTEM

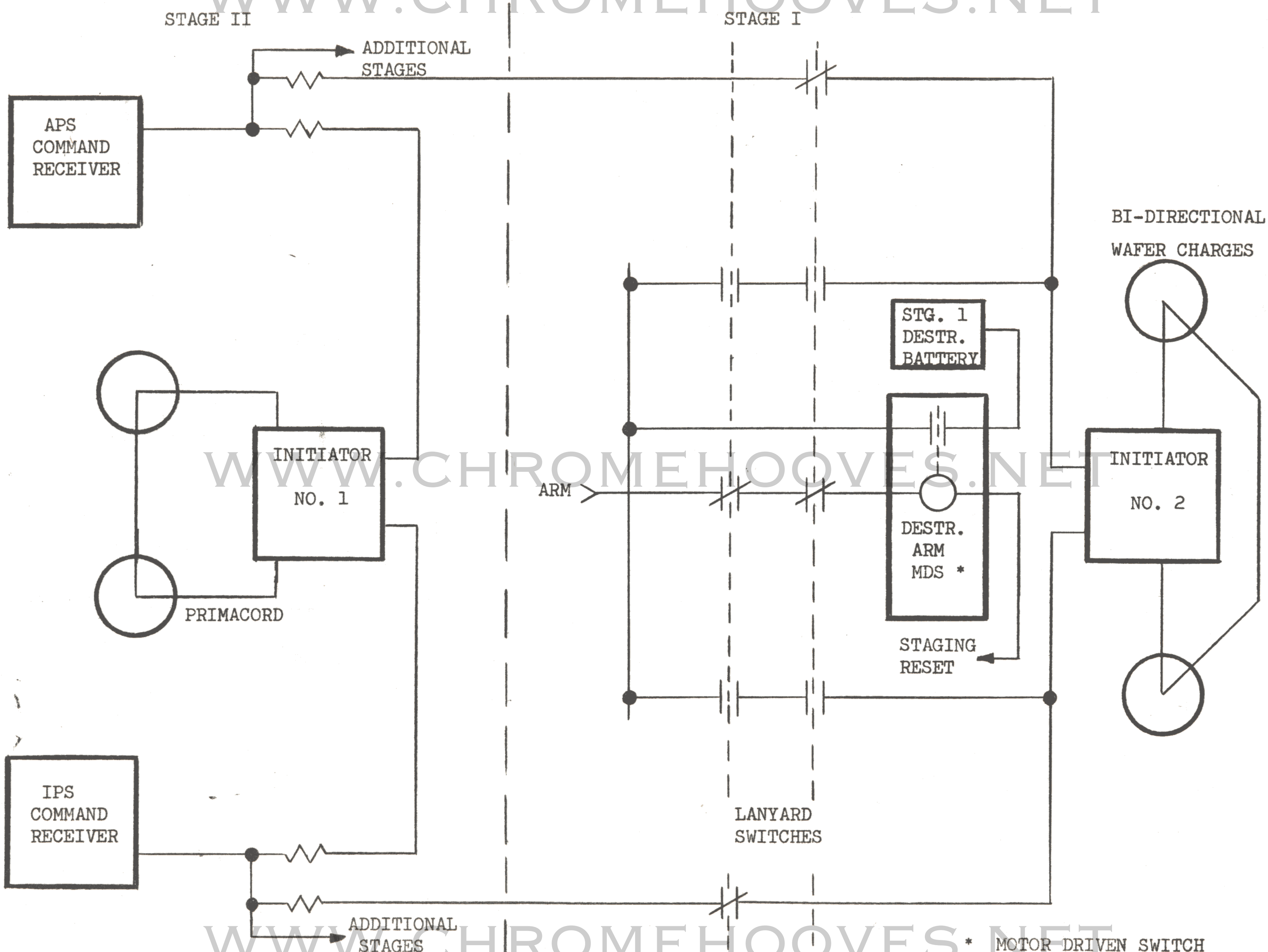

FIGURE 4 COMMAND DESTRUCT SYSTEM

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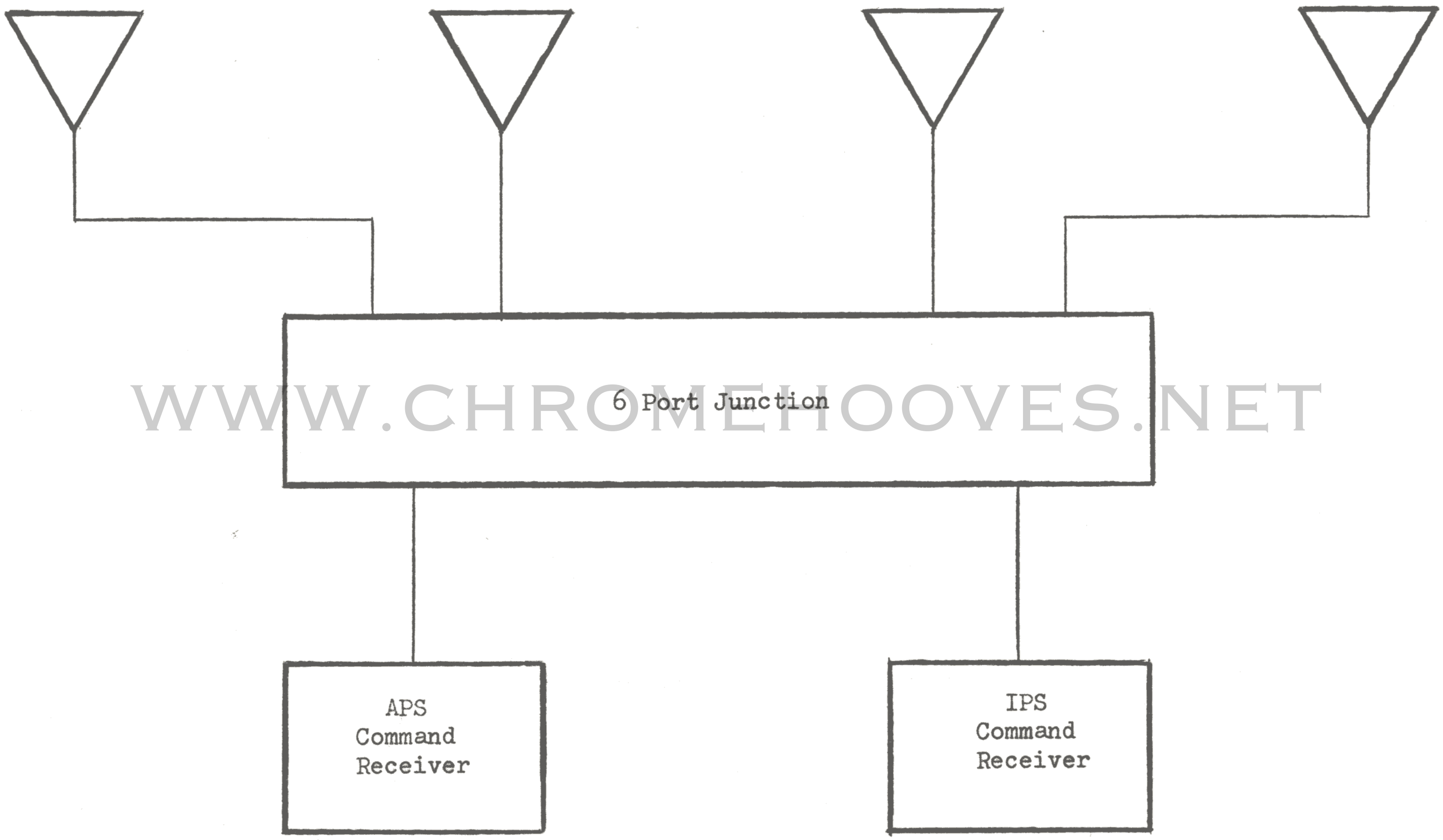


Figure 5 Archimedian Spiral Antennas

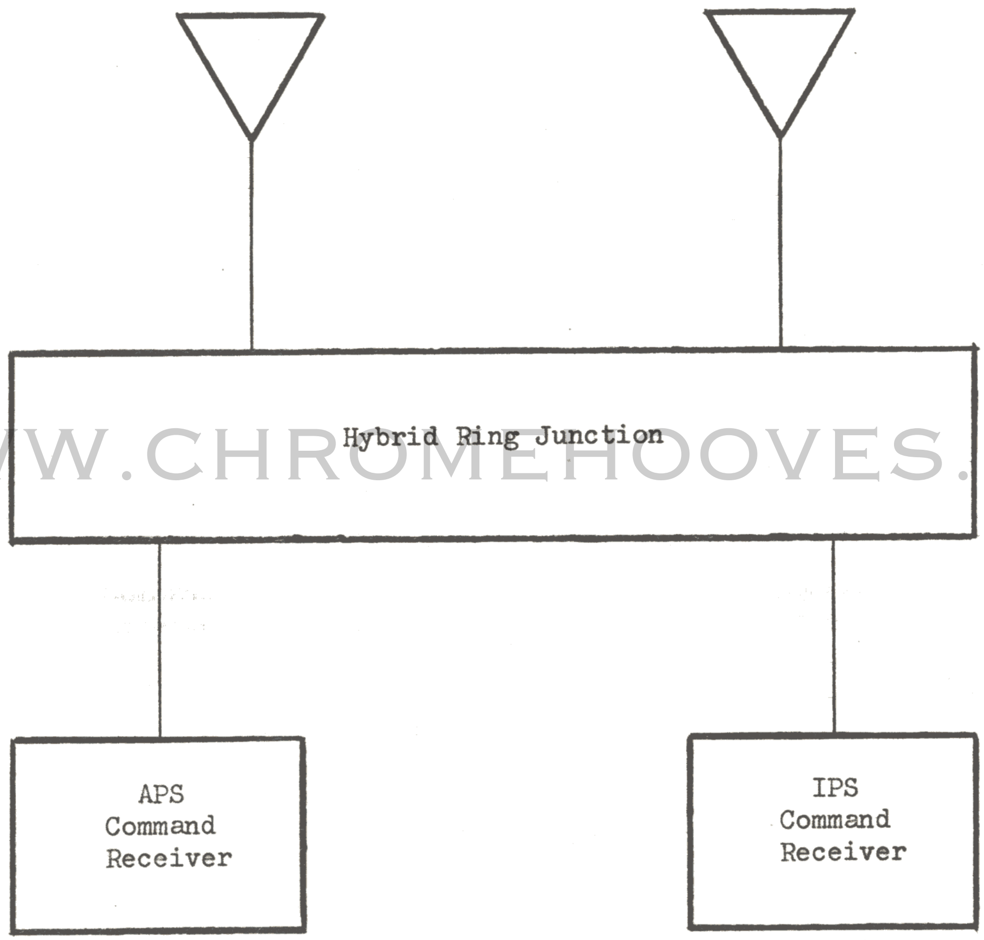


Figure 6   Cruciform Slot Antennas

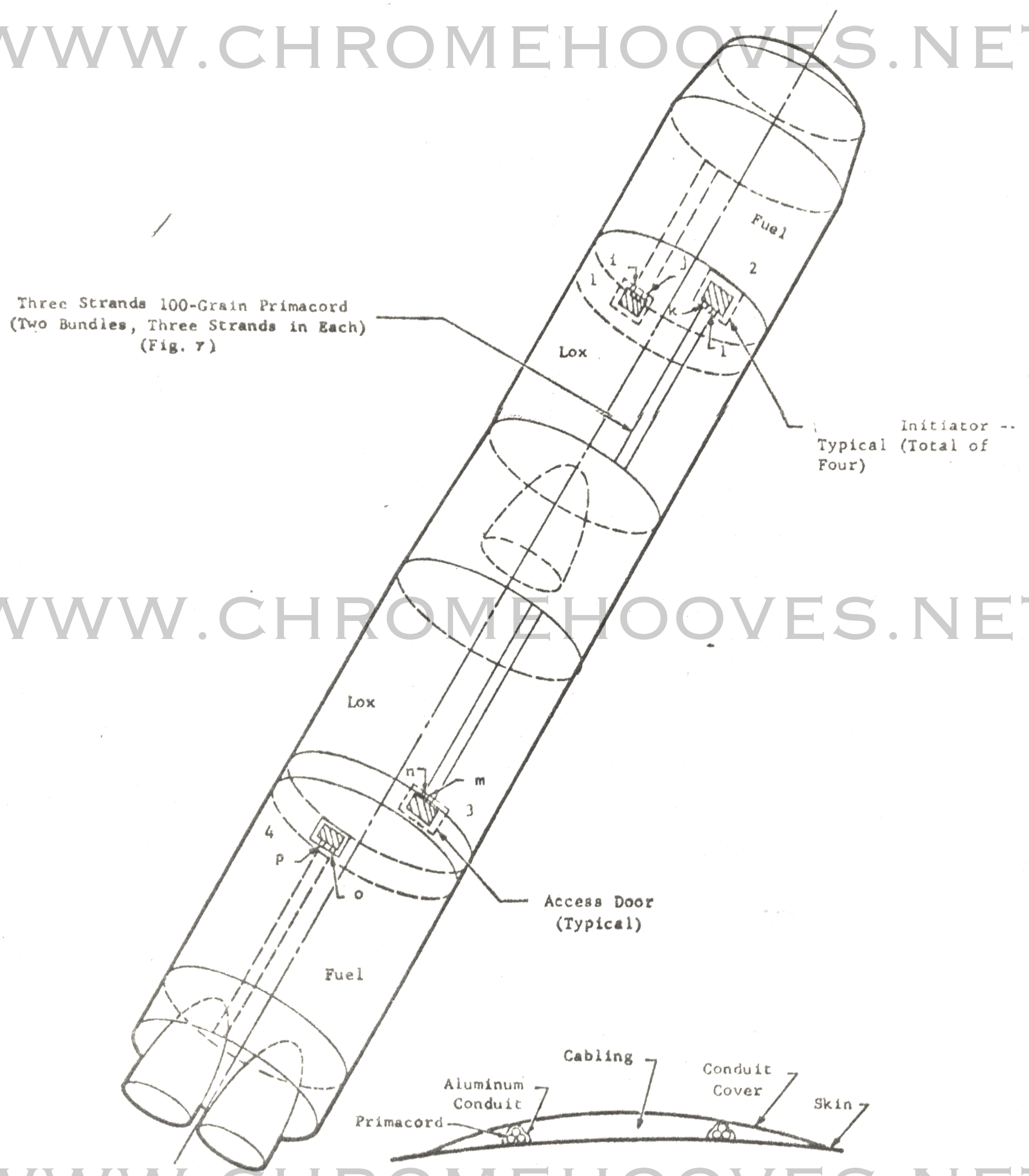
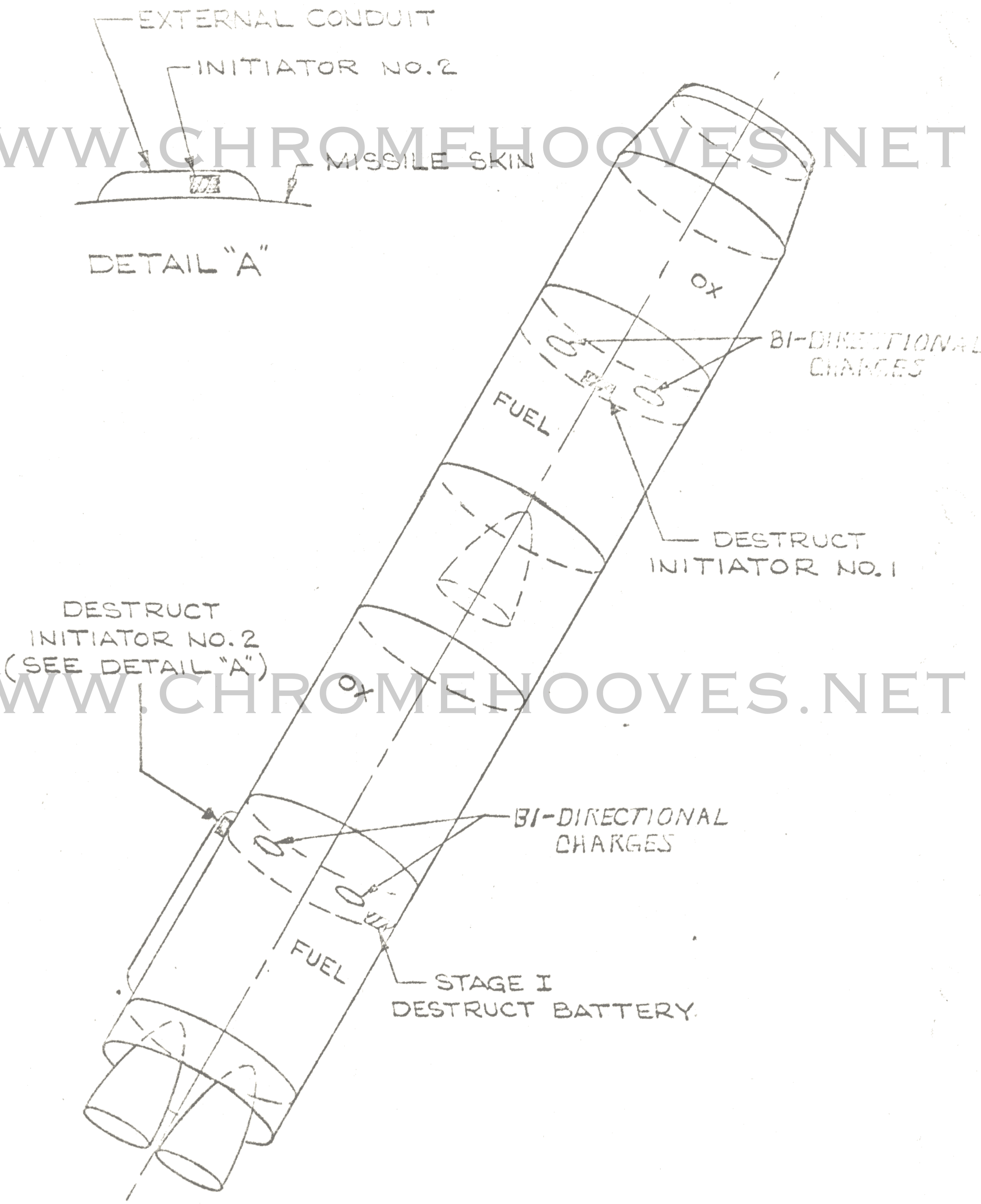


Fig. 7 Explosive Destruct System
(Cryogenic Propellants)



EXPLOSIVE DESTRUCT COMPONENT LOCATION (HYPERGOLIC PROPELLENTS)

FIG. 8